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Measurement of Some Factors Affecting the Catch in a Minnow Seine[1]

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Introduction

In a study of the effects of drought and flood on fishes of a small stream (Paloumpis, 1958), it was necessary to compare the fish population at different seasons on as quantitative a basis as possible. Wire traps, an electric shocker, and rotenone were used to collect some of the data, but most of the quantitative data for comparative purposes were secured by regularly seining with a 20-foot common sense minnow seine.

It was recognized that many factors other than the abundance of fish in the area have an effect upon the catch per seine haul. The four following questions were examined to evaluate the effect on the catch per effort: (1) does the direction in which the seine haul was made affect the catch per seine haul? (2) does any difference exist between the first seine haul made in a section of stream and subsequent seine hauls due to the activity in the stream necessitated by the previous seine hauls? (3) does the water level in the stream affect the average catch? and (4) does the time the seine hauls were made (hour of the day and month of the year) affect the average catch? In addition, the sample size necessary to detect fluctuations of a given magnitude in the population and the degree to which the method sampled all species and size groups within species in proportion to their abundance in the population were considered.

Description of Area and Methods

Squaw Creek in Boone and Story Counties, Iowa, is a tributary of the Skunk River. It is approximately 40 miles long, with a drainage area of 210 square miles. The stream bed is largely composed of shifting sands. There are a few rubble or riffle areas but these comprise a very small portion of the stream bed. During drought periods the creek consists of a few isolated pools and many people seeing the expanse of sand think of the stream as com-

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pletely dry. At bank full stage the stream, where it goes past the Iowa State College campus, is about seven feet deep and 30 feet wide.

Three stations were established for regular seining. These three stations were approximately one mile apart and each contained a few riffle areas and deep pools with muddy bottoms. Each station was seined at monthly intervals, and at each station, seine hauls were made at one-hour intervals throughout a 24-hour period.

Upstream vs. Downstream Hauls

All seine hauls for the regular comparison of seasonal changes in the population were made in a downstream direction. However, comparative data between upstream and downstream seine hauls were collected from June 9, 1955, to July 14, 1955 to determine the differences in average catch and species composition due to the direction seined. Each test was conducted over a two day period at Stations 3, 6 and 8. On the first day five downstream seine hauls were made at Stations 3 and 8 and five upstream seine hauls were made at Station 6. On the following day an equal number of seine hauls were made in the opposite direction at each station.

Table 1

Catch of Fish in Upstream and Downstream Hauls. Squaw Creek, Summer, 1955

	Downstream		Upstream	
Species	Percentage of 135 hauls in which species appeared	Percentage of the 6,446 fish	Percentage of 135 hauls in which species appeared	Percentage of the 2,673 fish
Bigmouth shiner	92.6	80.87	81.5	70.37
Red shiner	74.8	6.97	48.9	8.53
Bluntnose minnow	45.2	4.27	34.8	10.66
Fathead minnow	34.1	4.16	11.9	5.20
Common shiner	25.9	1.07	14.1	1.01
Brassy minnow	23.0	0.90	11.1	2.36
Creek chub	20.0	0.82	5.9	0.45
Stoneroller	5.9	0.19	4.4	0.67
Quillback	4.4	0.13	3.0	0.22
Johnny darter	6.7	0.13	1.5	0.07
Emerald shiner	5.2	0.11	5.2	0.34
Hornyhead chub	4.4	0.09	0.7	0.04
White sucker	3.0	0.08	0.7	0.04
Orangespotted sunfish	3.0	0.08	–	–
Green sunfish	2.2	0.05	0.7	0.04
Silver chub	1.5	0.03	–	–
Stonecat	0.7	0.03	–	–
Carp	0.7	0.02	–	–
No fish	0.7		12.6	

Downstream seine hauls resulted in a higher average catch and in the capture of more species (Table 1). The bluntnose minnow comprised a higher percentage of the catch in the upstream seine hauls than in the downstream seine hauls. An analysis of variance testing the total catch by seining in the two directions showed a significant difference at the 99 percent level (Table 2). The variation caused by the differences in the three stations sampled and by the differences in the time of day the seine hauls were made was not significant at the 95 percent level in this series of data.

When seining upstream the force of the current caused the seine to bag and the lead line was pulled a few inches off the bottom allowing fish to swim under the net. In strong currents it was not possible to seine upstream but it was possible to seine downstream. There was also a certain speed of current when it was not possible to seine downstream, but these points were not determined.

Table 2

Analysis of Variance Testing the Numbers of Fish (All Species Combined) Caught Per Seine Haul, Upstream and Downstream, Squaw Creek, 1955

Source of variation	Degrees of freedom	Sum of squares	Mean squares	F
Between stations	2	46,817.81	23,408.91	1.68
Between periods	8	135,612.44	16,951.55	1.22
Stations x periods (Error A)	16	222,666.36	13,916.65	
Between directions	1	52,500.83	52,500.83	4.86**
Directions x stations	2	14,465.69	7,232.85	0.67
Error B	24	259,216.36	10,800.68	
Among samples	216	407,856.62	1,888.23	
Totals	269	1,139,136.11		

**Significant at the 99% level.

Effect of Consecutive Hauls

In making consecutive seine hauls in a section of stream each seine haul was 20 feet in length and a space of 20 feet was left before the next seine haul was made. The first seine haul in a section of stream did not appear to give larger catches than subsequent seine hauls (Table 3). The activity in the stream necessitated by the previous haul did not appear to affect the catch of subsequent seine hauls. Analyses of variance testing upstream and downstream data indicated no significant differences at the 95 percent level between the consecutive hauls. There was a suggestion of greater catches on the third haul and there is a possibility that the central seine haul tended to be in the best environment at the various stations.

Effect of Water Levels

Water levels were recorded on a water gauge, on which 19 inches indicated no continuous flow. The depth of water in the flat areas of the stream bed was thus the gauge reading minus 19 inches.

Seine hauls were made at 13 water levels from June, 1955, to August, 1955. Above 45.0 inches on the gauge it was no longer possible to seine effectively due to the depth of the water and the increased flow of current. Water levels have an effect on the numbers of fish collected per seine haul. Regression analysis (Table 4) indicated that on the average, the catch was reduced by 3.92 fish per seine haul with each 1-inch rise in the water level. There was

Table 3

Numbers of Fish Per Seine Haul of the 1st, 2nd, 3rd, 4th and 5th Seine Hauls in 15 Series of Samples, Squaw Creek, Summer, 1955

	Mean Number of Fish Per Seine Haul				
	1st	2nd	3rd	4th	5th
Downstream	30.33	33.87	49.47	35.80	38.00
Upstream	21.53	15.87	32.27	23.40	13.27

Analysis of Variance Testing the Number of Fish Caught Per Downstream Seine Haul, Squaw Creek, Summer, 1955

Source of variation	Degrees of freedom	Sum of squares	Mean squares	F
Between hauls	4	1,219.50	304.88	0.242
Within hauls	70	88,313.20	1,261.62	
Totals	74	89,532.70		

Analysis of Variance Testing the Number of Fish Caught Per Upstream Seine Haul, Squaw Creek, Summer, 1955

Source of variation	Degrees of freedom	Sum of squares	Mean squares	F
Between hauls	4	3,623.74	905.94	1.007
Within hauls	70	62,988.93	899.84	
Totals	74	66,612.67		

Table 4

Regression Analysis of Catch Per Seine Haul for 13 Water Levels, Squaw Creek Summer, 1955

Gauge reading in inches	Number of hauls	Mean c/e
23.0	201	72.81
24.0	52	67.71
25.0	21	49.29
26.0	69	58.45
27.0	20	28.00
28.0	120	41.44
29.0	27	36.63
30.0	20	33.90
31.0	23	27.83
32.0	59	34.58
36.0	4	10.25
37.0	55	22.16
40.0	10	11.60

Summary of data

$x^2 = 13{,}498.10$

$y^2 = 3{,}586{,}628$

$xy = 52{,}857.50$

$Y = 158 - 3.92\,X$

where Y = numbers of fish per seine haul (c/e)

where X = gauge reading in inches

considerable variation among seine hauls within water levels, however, and the low correlation coefficient (0.24, which is, however, significant at the 99 percent level) indicates that but 6 percent of the variation in numbers of fish collected per seine haul was linearly associated with fluctuations in the water levels. Using the regression formula it would be possible to adjust the mean catch per unit effort for each water level to a "standard" water level. For each inch on the gauge less than the "standard" water level subtract 3.9 fish from the mean catch, and for each inch on the gauge more than the "standard" water level add 3.9 fish to the mean catch. This would give an adjusted catch per unit effort index.

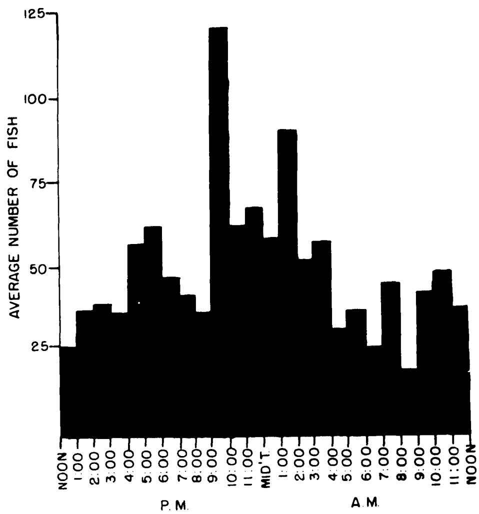

FIG. 1. AVERAGE NUMBER OF FISH COLLECTED PER SEINE HAUL PER HOURLY PERIOD, SQUAW CREEK, SUMMER, 1955

During high water levels the width and depth of the stream were increased allowing greater opportunity for the fish to swim around the seine. At lower water levels the catch per seine haul (c/e) was higher due to the concentration of the fish in the reduced area. In many places the width of the stream was reduced enough to allow seining the entire width of the stream.

Diurnal Fluctuation in Catch

Seine hauls were made at one hour intervals (midnight to 12:59 a.m., 1:00 to 1:59 a.m., etc.). There were greater catches per effort between the hours of 9:00 p.m. and 3:00 a.m. than in the daytime (Figure 1). This was true for the total catch and for the most abundant species, the bigmouth shiner. It might not be true for other species for they were taken in so small numbers that such an analysis was impractical.

The same number of seine hauls were not taken during each hourly period within a water level. The rapid rise and drop of the water levels in Squaw Creek allowed only a limited number of samples to be taken at higher water levels. Since lower water levels are maintained much longer, more samples were taken during these periods.

Sample Size

The number of seine hauls necessary to detect fluctuations in population abundance with samples collected at various times, at various water levels and at various stations was determined using the formula

$$n = 2 \left[\frac{T^2 \ V^2}{d^2} \right]$$

where:

n = sample size

T = normal deviate corresponding to the desired confidence probability, 95 percent with infinite degrees of freedom (1.96)

V^2 = square of the coefficient of variation $\frac{s^2}{\bar{X}^2}$

$\bar{X}$ = mean number of fish caught per seine haul

d = magnitude of the change in the population desired to be detected expressed as a fraction of the sample mean

For this analysis 111 seine hauls were made at Stations 3, 6 and 8 over an eight-day period (June 7-14, 1955) and the water level in the creek during this period varied between 28.0 and 31.5. A total of 3,873 fish were collected. The mean number of fish per seine haul was 34.89. The sum of the deviations from the mean squared (Sd^2) was 210,727.83. The variance ($s^2 = \frac{Sd^2}{n-1}$) was 1,915.71.

The number of samples necessary to detect a 10 per cent change in the population was 1,118 samples per sampling period. It is possible to make approximately 60 seine hauls per day. This figure will vary depending on the number of fish collected per seine haul and the length of the station being sampled. Squaw Creek is an unstable stream and drastic fluctuations may occur very rapidly. On the basis of the limitations placed on seining it was not practical to attempt to collect 1,118 samples per sampling period.

To detect a 20 percent change in the population 279 samples per sampling period were required. The number of samples necessary to detect a 30 percent change in the population was 124 samples, to detect a 40 percent change 70 samples and to detect a 50 percent change in the population 45 samples per sampling period.

Selectivity of Seining

The seining method was found to be selective for intermediate sized fish (1.0 to 5.0 inches total length). The larger fish were not readily caught due mainly to the inability to effectively seine the areas that the larger fish inhabit.

The wire traps, electric shocker, and rotenone sampling indicated that fish over 6 inches long were more abundant than the seine catches would indicate. These larger fish were only a relatively insignificant part of the fish population in Squaw Creek, however, and the seining apparently was relatively nonselective among the more abundant species in the stream.

Summary

Regular seining with a 20-foot minnow seine appeared to give a fairly satisfactory estimate of changes in the fish populations of Squaw Creek, a small intermittent stream. On the basis of statistical tests of the results, some of the factors affecting catch per seine haul were evaluated. Downstream seine hauls resulted in a higher average catch and in the capture of more species of fish than did upstream seine hauls. The first seine haul made in a section of stream did not appear to give larger average catches than did the subsequent seine hauls. At lower water levels the average catch per seine haul was higher due to the concentration of fish in the reduced area. The time of day the seine hauls were made affected the average catch per seine haul. There were greater catches per effort between the hours of 9:00 p.m. and 3:00 a.m. than in the daytime. The number of samples necessary to detect a 10 percent change in the population was 1,118 samples per sampling period, a 20 percent change 279 samples, a 30 percent change 124 samples, a 40 percent change 70 samples and a 50 percent change 45 samples. The seining method appeared to be selective for intermediate sized fish (1.0 to 5.0 inches total length).

Literature Cited

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