



Relationship between trout populations and cover on a small stream
by Marvin F Boussu

A THESIS Submitted to the Graduate Faculty in partial fulfillment of the requirements for the degree
of Master of Science in Fish and Wildlife Management

Montana State University

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Abstract:

A two year study was made of the relationship between trout populations and cover on a small, spring-fed creek in Gallatin County, Montana. Fourteen study sections were established with regard to the types of cover present or absent. These sections were inventoried four times at intervals of two to four months. Cover on eight of the sections was altered in one of three ways; by (1) the application of artificial brush cover, (2) removal of natural brush cover, or (3) removal of under-cut bank. Following alteration, all sections were inventoried three more times. In four sections altered by the application of brush cover, there was a marked increase in the number and weight of fish. Two sections which were altered by the removal of brush cover showed a reduction in the weight of fish present, but numbers remained relatively constant. Undercut bank was removed from two sections. These sections had a decrease in the weight of fish but the number of fish increased. Five sections were unaltered and acted as controls. One section was used for general observations. Aquatic vegetation appeared to have cover value for smaller fish while rooted. After breaking loose from the stream bottom, the plants would form rafts of cover which were utilized by fish of all sizes.

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AND COVER ON A SMALL STREAM

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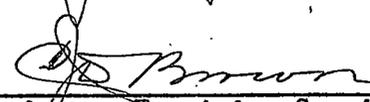
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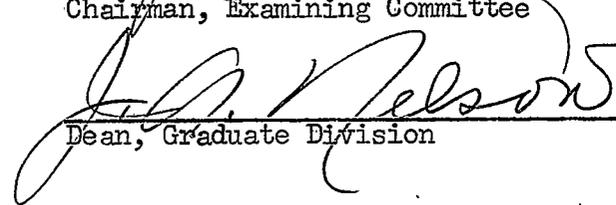
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Chairman, Examining Committee



Dean, Graduate Division

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ABSTRACT

A two year study was made of the relationship between trout populations and cover on a small, spring-fed creek in Gallatin County, Montana. Fourteen study sections were established with regard to the types of cover present or absent. These sections were inventoried four times at intervals of two to four months. Cover on eight of the sections was altered in one of three ways; by (1) the application of artificial brush cover, (2) removal of natural brush cover, or (3) removal of under-cut bank. Following alteration, all sections were inventoried three more times. In four sections altered by the application of brush cover, there was a marked increase in the number and weight of fish. Two sections which were altered by the removal of brush cover showed a reduction in the weight of fish present, but numbers remained relatively constant. Under-cut bank was removed from two sections. These sections had a decrease in the weight of fish but the number of fish increased. Five sections were unaltered and acted as controls. One section was used for general observations. Aquatic vegetation appeared to have cover value for smaller fish while rooted. After breaking loose from the stream bottom, the plants would form rafts of cover which were utilized by fish of all sizes.

INTRODUCTION

The preference of trout for stream areas with protective cover has been recognized for a long time. In England, for example, the establishment of artificial "lies", which act as shelter for trout, has been practiced for many years. Greeley (1936), Tarzwell (1937, 1938), and Shetter, Clark, and Hazzard (1946) are among those who have investigated the influence of cover on trout in this country. Their studies have shown that stream improvement, including the use of artificial cover, can increase the number and size of trout in a given section of stream. Physical improvements used on streams often incorporate the use of shelters along with deflectors, low dams, and other structures. While there is considerable information on the over-all effect of stream improvement, little quantitative data have been presented on the extent to which various types of cover affect trout populations. The present study is concerned with the relation between trout populations and (1) the various kinds of natural cover in a small stream, (2) the effect of partial or complete removal of natural cover, and (3) the application of artificial cover to areas naturally devoid of such protection.

The stream selected (Trout Creek) is located about $3\frac{1}{2}$ miles northeast of Belgrade, Gallatin County, Montana. It originates primarily in springs and meanders through flat, cultivated and pasture lands for a distance of about four miles before emptying into the East Gallatin River. It is 3 to 5 feet in width near its source and widens to approximately 25 feet in the region adjacent to its mouth.

Trout Creek remains free of ice throughout the year. The highest water temperature recorded during the study period (June, 1951 - March, 1953) was 63 degrees F. and the lowest 39 degrees F.

Bank vegetation in the upper third of the stream is composed principally of heavy, alternating growths of sedge (Carex nebraskensis and C. rostrata) and willow (Salix sp.). These two types are about equally abundant in the area. In the middle third there is short-grass pasture with only occasional clumps of willow bordering the stream. The lower one-third, which did not include any study sections, supports a dense growth of willows.

Aquatic vegetation was abundant during certain times of the year. Watercress (Nasturium officinale), water speedwell (Veronica comnata), pondweed (Potamogeton sp.), brook grass (Catabrosa aquatica), and several species of algae were found. The most important aquatic plants from the standpoint of cover were watercress and a grass-green algae, Enteromorpha intestinalis.

Fish present included rainbow trout (Salmo gairdnerii), eastern brook trout (Salvelinus fontinalis), and brown trout (Salmo trutta); with the first two comprising about 98 per cent of the total trout population. On one occasion ten whitefish (Prosopium williamsoni) were found. Fresh-water sculpins (Cottus sp.), while common, were not included in population figures.

The presence or absence of natural cover, such as overhanging willow, under-cut banks, etc., served as a basis in the selection of 14 study

sections. These varied in length from 39 to 98 feet, with an average of 58 feet. Widths ranged from 4 to 21 feet, with an average of 10 feet. The water area, depth, cover, and other physical data were determined for each section. Variations in cover were recorded at the time of each population inventory.

The water areas in each section were classified as either riffle, flat water, or pool. These categories are defined as follows:

Riffle: (1) surface waters choppy, (2) average depth shallow - under 8 inches, (3) increased water velocity, (4) bottom of coarse sand or gravel.

Flat water: (1) surface waters smooth, (2) depth variable, (3) moderate velocity maintained through area and flow usually in a straight course, (4) bottom of silt or fine sand.

Pool: (1) surface waters quiet, although some swirls may be evident, (2) comparatively deep - over 12 inches, (3) appreciable reduction in water velocity, often associated with a change in stream course or some obstruction, (4) bottom of silt or clay pan.

Inventories were taken four times in each section; cover on eight of the sections was then altered and all sections inventoried three more times. The first four inventories will be referred to as "pre-alteration", and the last three as "post-alteration". The elapsed time from one complete series of inventories to the next varied from 2 to 5 months. Each series was completed as quickly as possible (usually less than a week) to minimize any variations which might arise from population fluctuations.

To East Gallatin
River

TROUT CREEK STUDY SECTIONS

1. BRUSH COVER APPLIED
2. GENERAL OBSERVATION
3. CONTROL ON 4
4. BRUSH COVER APPLIED
5. CONTROL ON 6 AND 8
6. UNDER-CUT REMOVED
7. BRUSH COVER REMOVED
8. UNDER-CUT REMOVED
9. BRUSH COVER APPLIED
10. CONTROL ON 9
11. CONTROL ON 7 AND 12
12. BRUSH COVER REMOVED
13. CONTROL ON 14
14. BRUSH COVER APPLIED

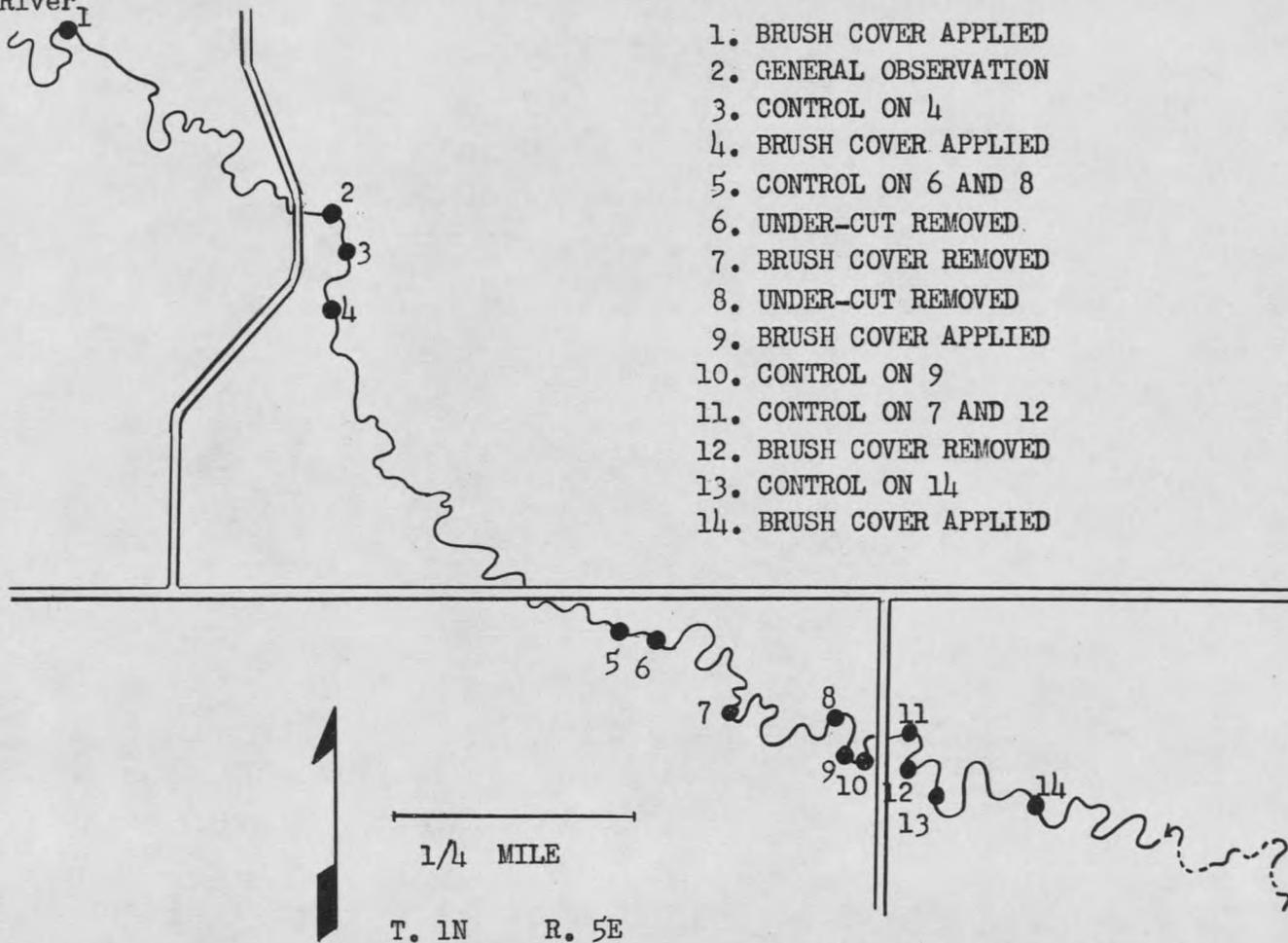


Fig. 1. Trout Creek

Control sections (those not altered) were usually inventoried the same day as the corresponding experimental sections.

Individual sections were isolated by use of blocking nets during population inventories. Fish were collected (shocked with a 250 watt D. C. generator), weighed, measured, and returned to the water. All fish collected from a section (sculpins excepted) were measured to the nearest 0.1 inch (total length) and weighed to the nearest 0.01 pound. Difficulties in weighing fish during winter operations necessitated the application of length-weight data to obtain certain of the weights used. The fish were arbitrarily divided into three length groups: Legal, 7 inches or over; sub-legal, 4.0 to 6.9 inches; and fingerling, less than 4.0 inches.

APPLICATION OF BRUSH COVER

Cover devices were applied to four sections. These consisted of plank frames with interwoven willow branches (Fig. 2). Their sizes ranged from 15 to 50 square feet. An attempt was made to simulate natural willow cover in density and position. All devices were installed at least one month before any post-alteration inventories were made in the sections where they occurred. The total area of cover applied to the four sections was 155 square feet.

While the rate of increase for individual sections varied, there was a marked increase in numbers and pounds of fish in each of the experimental sections. A description of the experimental and control sections, and the results obtained are as follows:

Section 1: This section was primarily flat water, but two pools (maximum depth 24 inches) were present. Overhanging cover was non-existent, however, a total of 4.6 square feet of under-cut occurred near one end of the section. This under-cut was believed to be largely ineffective as cover due to the shallow water associated with it. Aquatic vegetation was sparse; only a small patch being present at the head of each pool. The length of this section was 88 feet; average width 163 inches; average depth 12.9 inches. Fifty square feet of brush cover was placed over the pool areas.

The numerical increase in legal size fish following the application of cover was less than either that of sub-legals or fingerlings, but the weight increase was several times that of the latter two combined. The increase in weight of legals was much greater than in other sections where brush cover was applied; the increase of sub-legals smaller. This may have resulted from the presence of three large brown trout which utilized the cover device. Most of the fish were concentrated in the pool areas both before and after the application of brush cover.

The pre-alteration and post-alteration averages per inventory were as follows: Legals 1.50 (0.29 pounds) to 4.00 (2.97 pounds); sub-legals 7.50 (0.47 pounds) to 12.60 (0.54 pounds), and fingerlings 5.20 (0.05 pounds) to 29.33 (0.25 pounds). The average total pounds per inventory previous to cover application was 0.81; following application this increased to 3.76.

Section 4: Previous to alteration this section was composed entirely of flat water without pools, cover, or under-cut banks. Aquatic vegeta-

tion was sparse. It had a length of 51 feet, and an average width of 219 inches. The average depth was 11.7 inches, but a channel near one edge of the stream averaged about 15 inches in depth. This channel extended through the entire section. Two brush covers having a total area of 45 square feet (14 and 31) were installed at mid-section over the channel.

Following cover application there was an increase in the number and weight of fish. No legals, and only one sub-legal fish, were found during the pre-alteration inventories. Post-alteration inventories averaged one legal and 4.3 sub-legals. Fingerlings increased from an average of 4.25 per inventory to 19.30. The pre-alteration and post-alteration weights were as follows: legals, 0 - 0.44; sub-legals, 0.02 - 0.23; fingerlings, 0.02 - 0.18. The average total pounds per inventory was 0.04 previous to alteration and 0.86 post-alteration.

Section 3: Located about 300 yards downstream from section 4, this section had much the same physical characteristics as the experimental section with the exceptions of a shallower depth (average 9.4 inches), and more abundant aquatic vegetation. No alterations were made in this section.

During the first four shockings, the population corresponded to that in section 4. Both supported a few small fish during periods of aquatic growth. Whereas the experimental section had an average increase in total pounds of 0.82 per inventory, section 3 changed relatively little with an increase of 0.01 (0.02 - 0.03) pounds.

Section 9: Flat water was predominate in this section (approximately

60 per cent), although about 10 per cent of the upper end was riffle area. One pool (maximum depth, 15.0 inches) and 3.0 square feet of under-cut bank were present. There was no overhanging cover. Aquatic vegetation was abundant, especially from late summer to mid-winter. The length of this section was 52 feet; the average width 119 inches; the average depth 6.0 inches. A brush cover of the same size (45.0 square feet) and type as used in section 4 was placed over the pool area.

The increase in total pounds in this section was twice that of section 4. The increase in pounds of legals was nearly the same in both sections; the larger increase in this section being made up of sub-legals and fingerlings. Extensive beds of watercress were present in section 9, and were practically lacking in section 4, during the inventories of September and December, 1952. This may account for the larger increase in section 9. Average numbers and weights of fish per inventory in section 9 before and after alteration are as follows: Legals, 2.25 (0.31 pounds) to 4.66 (0.79 pounds); sub-legals, 12.00 (0.58 pounds) to 30.00 (1.39 pounds); fingerlings, 19.25 (0.13 pounds) to 40.00 (0.51 pounds). The total pounds per pre-alteration inventory averaged 1.02 and post-alteration, 2.69.

Section 10: This section was used as a control for section 9, and was located about 40 feet upstream from the experimental section. Physical characteristics of the two sections corresponded except that there were two pools in the control section (maximum depths of 16 and 18 inches), and the average depth was greater (9.0 inches).

The increase in average total pounds per inventory was 41.5 per cent (1.30 - 1.84) for the control section compared to 163.7 per cent (1.02 - 2.69) for the experimental section. This increase may have resulted from uprooted aquatic vegetation forming rafts of temporary cover during the September and December, 1952 inventories. These natural covers were 11 and 18 square feet in extent respectively. Several legals were known to utilize this shelter.

Section 11: This section, located in the uppermost part of the stream, was composed entirely of flat water. No pools were present, but under-cut banks were extensive (22.5 square feet). Heavy growths of sedge overhung the banks from mid-summer to early winter. From the data obtained, it was not possible to correlate this grass cover with population fluctuations. This section was 51 feet in length; 45.3 inches in average width, and 5.1 inches in average depth.

In proportion to the area of cover applied, the actual numerical and weight increases were greater in this section than in other sections which received like treatment. The average number of legals present per inventory before application of cover was 0.75 (0.13 pounds); after application, 2.00 (0.35 pounds). The number of sub-legals increased from 8.13 (0.41 pounds) to 18.74 (1.05 pounds); fingerlings from 9.00 (0.09 pounds) to 13.33 (0.20 pounds). The total pounds per inventory averaged 0.62 previous to cover application, and 1.60 following application.

Section 13: This section was the control for section 11. Physical characteristics of the two were similar with the following exceptions:

The control section contained 4 square feet less under-cut; the average depth (6.8 inches) was greater, as was the average width (75 inches). Bank vegetation, water type, and section length were approximately the same as in section 15.

The increase in average total pounds per inventory was 9.2 per cent (1.74 - 1.90) in the control section and 158.1 per cent (0.62 - 1.60) in the experimental section. Although there was an increase in total pounds, the control section showed a smaller post-alteration number of fish in all size classes. A brown trout, weighing 2.7 pounds, captured during the December, 1952 inventory accounted for this weight increase. There is no obvious explanation why this section held a consistently higher pre-alteration pounds of fish than section 15, which had 4 square feet more under-cut, although average width and depth were greater.

The increase in total pounds of fish following the application of brush cover to four experimental sections amounted to 258.1 per cent. The three sections which were unaltered increased an average of 22.5 per cent. There was an average increase in legals of 0.62 pounds per inventory per 100 square feet of cover applied (Table I).

REMOVAL OF BRUSH COVER

Overhanging brush cover was removed from two sections, 7 and 12. This was accomplished by chopping the overhang back to bank level at least five weeks before the first post-alteration inventory. Approximately 128 square feet of cover was removed from the two sections. Section 11 was used as a control.

BRUSH COVER APPLICATION

Table I. Average number and pounds (in parentheses) of fish per inventory, pre-alteration - post-alteration.

	Experimental Sections 1, 4, 9, 15		Control Sections 3, 10, 13	
	pre-alt.	post-alt.	pre-alt.	post-alt.
Legals	1.12 (0.18)	3.00 (1.14)	2.66 (0.47)	2.66 (0.61)
Sub-legals	6.87 (0.37)	18.16 (0.80)	9.25 (0.47)	6.66 (0.30)
Fingerlings	9.43 (0.07)	25.50 (0.28)	9.66 (0.08)	10.44 (0.13)
All Fish	17.44 (0.62)	45.25 (2.22)	21.58 (1.02)	19.77 (1.25)

BRUSH COVER REMOVAL

Table II. Average number and pounds (in parentheses) of fish per inventory, pre-alteration - post-alteration

	Experimental Sections 7 and 12		Control Section 11	
	pre-alt.	post-alt.	pre-alt.	post-alt.
Legals	11.40 (2.09)	5.18 (0.87)	6.75 (1.00)	7.33 (1.36)
Sub-legals	34.25 (1.96)	26.66 (1.24)	28.75 (1.62)	25.33 (1.45)
Fingerlings	21.77 (0.18)	35.16 (0.41)	14.75 (0.15)	12.00 (0.14)
All Fish	66.12 (4.22)	67.00 (2.51)	50.25 (2.77)	44.66 (2.95)

Section 7: This section was principally flat water and was located immediately downstream from a short riffle area. Two pools were present; one without cover and the other having about 98 square feet of willow cover. Maximum depth in the open pool was 19.5 inches, and in the covered pool, 18.0 inches. Another willow (19 square feet) overhung shallow water at one end of the section. About 9 square feet of under-cut bank was present under the willow overhanging the pool. Aquatic vegetation was abundant with beds of watercress totaling about 70 square feet in extent being present during both seasons. The length of this section was 59 feet; average width 156 inches, and average depth 9.8 inches. This section was altered by removing the 98 square feet of willow covering the one pool (Figs. 3 and 4).

Previous to the removal of this cover, the average number of legals per inventory was 12 (2.37 pounds). Following removal, the average was 4 (0.80 pounds). The number of sub-legals decreased from an average of 38.75 (2.08 pounds) to 33.00 (1.26 pounds) per inventory. Fingerlings increased from 48.74 (0.23 pounds) to 88.90 (0.67 pounds). There was a decrease in total pounds from a pre-alteration average of 4.69 to a post-alteration average of 2.73 per inventory.

Section 12: Flat water predominated in this section but a short stretch of riffle and one pool with a maximum depth of 21 inches were present. Thirty square feet of brush cover overhung this pool. Approximately 6 square feet of under-cut bank occurred in the upper part of the section. During the September and December inventories there was approximately 26 square feet of aquatic vegetation present. This section

