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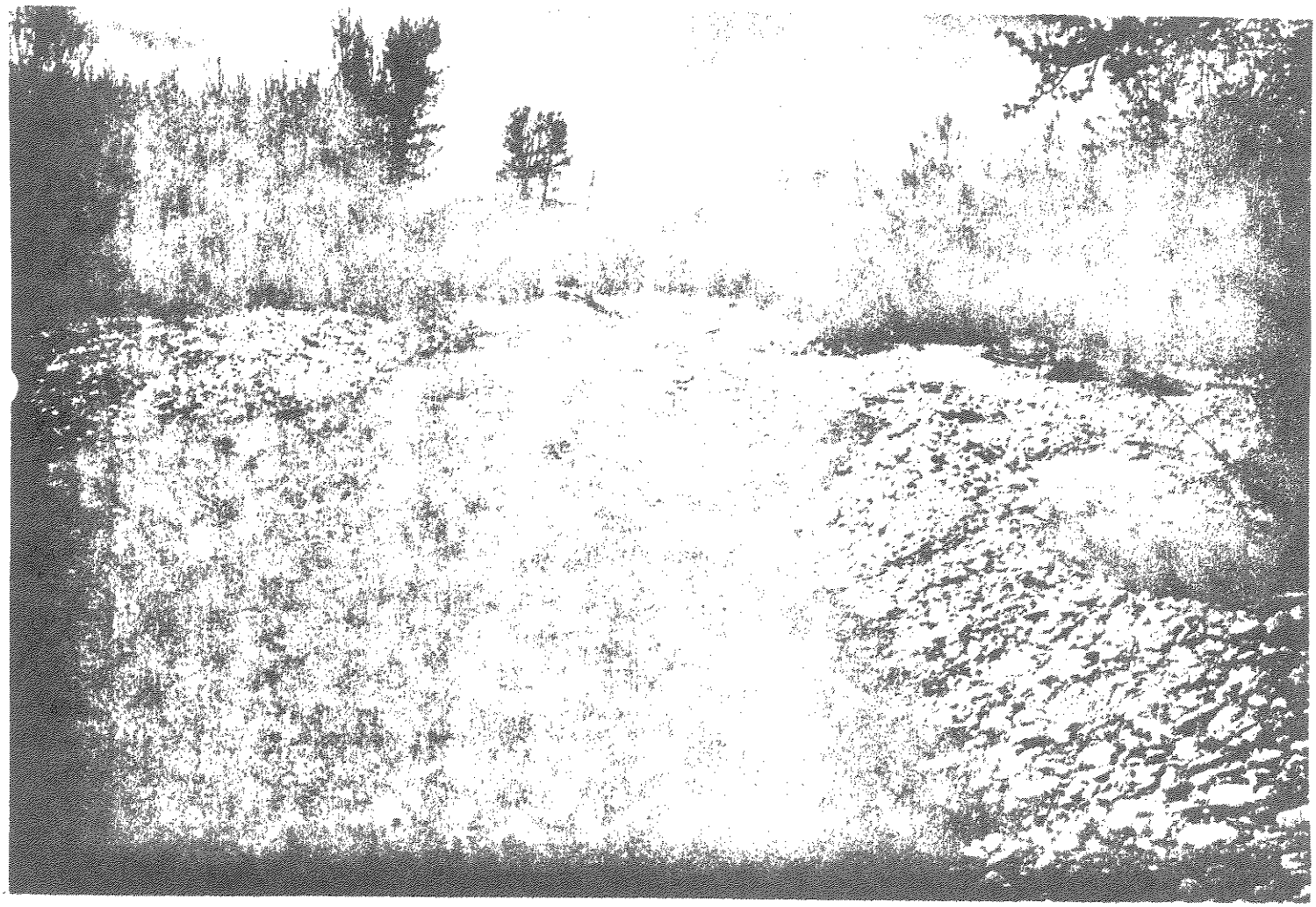

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The carrying capacity for trout in streams is greatly reduced when channels or stream banks are altered by man's activities. In a study describing the relationships between trout populations and cover, Boussu (1954) reduced the number and the weight of trout in sections of Trout Creek by removing stream bank vegetation and undercut banks. In developing flood plain land, man often removes stream bank vegetation, reconstructs stream banks with riprap or a dike, or re-routes the stream into a new, shortened channel. Most of these developments reduce the amount of cover available for trout.

Whitney and Bailey (1959) recorded that the number of catchable-sized trout (6... inches or larger) in a section of Flint Creek dropped from 69 the year before rechanneling by highway construction to six the following year. Boulders have been added to the altered section to try to replace the shelter areas that were destroyed. In 1962, five years after rechanneling, Whitney[1] reported there were only one-third as many trout in the study section.

Nelson and Hill[2] found a 75 per cent decrease in the trout population in a section of Rock Creek after it was rechanneled for flood control. They measured 17 miles of stream channel altered as a result of the flood control project. Snags and fallen logs were removed from the channel and stream bed gravel bulldozed into dikes that replaced the natural stream bank.

In 1961, Nelson and Bianchi[3] surveyed the Little Big Horn River to measure the amount of man-made channel alterations. They found that over half of this river had its channels altered by man's activities. Twelve trout streams or rivers located throughout the state were surveyed for man-made channel alterations in 1962. The results of the 1961 survey and the 1962 survey on 12 streams are included in this report.

The purpose of the stream channel alteration inventory was to measure the amount of stream channel changed by man, the type of channel alteration, and the party responsible for the alteration. For comparative purposes, standing crop estimates of the fish populations were censused in both natural and altered channels in the streams surveyed.

METHODS

Aerial photographs (1 inch = 660 feet) were used to measure the original length of the stream channel. Channel alterations visible on the photographs were inspected

[1]Personal communication from Arthur N. Whitney, Highway 93 South, Missoula, Mont.

[2]Nelson, Perry H., and Cliff W. Hill. (1960) Fishery history of Rock Creek. Montana Fish and Game Report, Helena, Montana, 14 pp. (Multilith)

[3]Nelson, Perry H., and Donald R. Bianchi. (1962) Stream channel alteration inventory. Job Completion Report, Montana, D-J Project F-20-R-7, Job IV, 4 PP. (Multilith)

in the field, measured from the photographs with a map measure, and recorded on the photos. Channel alterations not visible on the aerial photos, or made after the photograph flight date, were measured in the field with a steel tape and recorded on the photos. In addition, all channel alterations were recorded on a field note form.

Blueprints of construction projects adjacent to rivers and streams were obtained from the Montana Highway Department and from railroad companies. The prints were examined carefully and compared with the aerial photos to verify man-made stream channel alterations. The blueprints were useful in determining if a cutoff meander was natural or man-made and the party responsible for the alteration. Personal contacts with residents further verified man-made alterations.

Old issue U. S. Geological Survey quadrangle maps and U. S. Forest Service maps were used also to verify man-made alterations. Only stream channel alterations that were positively assessed as man-made were enumerated in this survey.

The four types of man-made alterations measured were defined as follows:

(1) Channel relocation is replacement of the natural meandering with a length of man-made channel. The relocated channel has a flume-like appearance, without pools, deep holes, or undercut banks. It is shorter and lacks the well-defined areas of erosion and deposition associated with a meandering stream.
(2) Riprapping is placing materials other than stream bed rubble adjacent to the natural stream bank to prevent lateral erosion. Some of the more common materials observed were car bodies, stumps or logs, large angular rocks, and brush. These materials may or may not be anchored.
(3) Channel clearance is removal of materials occurring naturally within the stream channel such as fallen logs, stumps, or gravel and rubble.
(4) Diking is using natural material from the stream bed to construct an artificial stream bank.

Stream channel alterations were grouped on the basis of activities: railroad construction, road construction, urban and industrial development, and agricultural activities. No attempt was made in this survey to evaluate whether or not the alterations were preventing lateral channel erosion.

Standing crop estimates of the fish populations in the streams surveyed were made by electrofishing 4,000 square feet areas of stream. Blocknets were placed at the upstream and downstream boundaries delineating the areas of stream censused. Two sections of equal area were censused for fish in each stream surveyed: (1) a natural meandering stream channel and (2) a stream channel altered by man's activities.

RESULTS

The amount of channel altered. The greatest loss of fishing water in the 13 streams inventoried resulted from man's apparent unwillingness to allow the streams to meander throughout their natural courses. Their total length was shortened by 68 miles when 137 miles of natural stream was re-routed into 69 miles of inferior, man-made channel (Table 1). The man-made relocated channels were typically flume-like in appearance, without undercut banks or a well-defined pool-riffle complex found in a natural meandering stream.

One-third of the total length of the streams inventoried (250 of 768 miles) had been altered from their natural condition (Table 2). Four of the streams had more than one-

Table 1. The Length of Natural Meandering Stream Channel Lost, the Length of Relocated Stream Channel Replacing the Natural Meandering Stream Channel, and the Resulting Reduction in Length of Stream Channel Measured in 13 Montana Streams and Rivers

	Miles of		
	Natural meandering stream channel lost	Relocated stream channel replacing natural meandering stream channel	Reduction in stream length (miles)
Little Big Horn River	52.9	16.5	36.4
St. Regis River	6.3	5.4	0.9
Ninemile Creek	0.9	0.7	0.2
Sheep Creek	3.6	2.0	1.6
Otter Creek	6.7	2.9	3.8
Belt Creek	8.6	7.2	1.4
Beaver Creek	3.5	2.0	1.5
West Gallatin River	4.4	4.1	0.3
Rocky Creek	9.3	5.3	4.0
Big Hole River	17.3	4.4	12.9
Boulder River	2.1	1.5	0.6
Prickley Pear Creek	19.2	16.0	3.2
Ashley Creek	2.8	1.4	1.4
Total	137.6	69.4	68.2

Table 2. The Length of Stream Channel Altered and the Number of Alterations by Type in 13 Montana Streams or Rivers

River or Stream	Channel Relocation		Riprapping		Channel Clearance		Diking		Total			
	Miles altered	No. of alterations	Miles altered	No. of alterations	Miles altered	No. of alterations	Miles altered	No. of alterations	Miles altered	No. of alterations	No. of stream miles	Per cent altered
Little Big Horn R.	16.5(36.4)[1]	68	6.2	95	1.4	13	3.4	15	63.9	191	120.0	53
St. Regis R.	5.4(0.9)	23	17.9	88	0.0	0	1.2	10	25.4	121	37.1	68
Ninemile Cr.	0.7(0.2)	6	1.7	53	0.0	0	2.4	22	5.0	81	23.9	21
Sheep Cr.	2.0(1.6)	15	0.1	9	0.1	1	0.0	0	3.8	25	12.4	31
Otter Cr.	2.9(3.8)	23	0.7	18	0.5	9	0.1	3	8.0	53	34.5	23
Belt Cr.	7.2(1.4)	36	3.4	55	0.3	2	8.8	66	21.1	159	81.0	26
Beaver Cr.	2.0(1.5)	6	1.2	30	0.2	7	0.5	23	5.4	66	49.5	11
West Gallatin R.	4.1(0.3)	20	9.5	143	0.7	13	5.6	88	20.2	264	85.9	23
Rocky Cr.	5.3(4.0)	31	1.3	62	0.2	3	0.8	12	11.6	108	18.4	63
Big Hole R.	4.4(12.9)	56	11.0	107	0.8	13	17.0	219	46.1	395	147.6	31
Boulder R.	1.5(0.6)	14	7.9	246	1.0	21	1.4	27	12.4	308	86.3	14
Prickley Pear Cr.	16.0(3.2)	21	1.0	72	0.9	31	0.1	7	21.2	131	41.0	51
Ashley Cr.	1.4(1.4)	8	1.9	73	2.1	3	0.1	1	6.9	85	30.2	23
Total	69.4(68.2)	327	63.8	1051	8.2	116	41.4	493	251.0	1987	767.8	33

[1]Number in parenthesis refers to miles of stream channel lost as a result of the channel relocations.

half of their length altered. All but one of the streams had more that 20 per cent of their length altered by man's activities.

Channel relocations accounted for 55 per cent of the alterations in the streams surveyed. The remaining alterations consisted of riprapping (26 per cent); diking (16 per cent); and channel clearance (3 per cent). There were 1,987 individual alterations recorded in 768 miles of stream channel inventoried, nearly three alterations per stream mile. The average length of a channel alteration was 664 feet.

The parties responsible. The party responsible for the channel alteration was also determined and enumerated (Table 3). More than one-half of the alterations were attributed to road and railroad construction. The majority of railroad work was done prior to 1920 while state, county, and federal road construction projects were mostly of a more recent occurrence.

Agricultural activities accounted for over one-third of the channel alterations. The largest number of individual alterations were enumerated in this catagory. Urban and industrial development accounted for the remaining channel changes.

Fish statistics. Table 4 lists the comparisons between the fish population standing crop statistics in the censused areas of natural and altered channels. In the natural meandering channels, the total number of trout and whitefish made up nearly two-thirds (62 per cent) of the standing crop. In the altered channels, trout and whitefish made up only one-third (32 per cent) of the standing crop. There were over 5½ times as many trout and nearly 10 times as many whitefish censused in the natural channels as in the altered channels. Six of the 13 streams that had trout 6 inches or larger in their natural channels had no trout 6 inches or larger in their altered channels.

Comparing the total weight of all fish in the natural channels to that of the altered channels disclosed: (1) the total weight of all fish species was over 5½ times greater in the natural channels; (2) the total weight of the trout and whitefish combined was over 9 times greater in the natural channels; and (3) in each stream, there was a greater total weight of fish in the natural channels.

DISCUSSION

Economically, a trout stream can be considered as a self-sustaining, long term capital investment. McConnen[4] reported that fishermen in Montana in 1960 spent $36,300,000 pursuing their sport. This money can be thought of as the interest from the capital investment, the fishing waters in the state. Bishop[5] reported that two-thirds of Montana fishermen prefer to fish in streams or rivers. We can only speculate on the dollar value of the stream trout fishery in the year 2000 (U. S. Department of Interior, 1962). The loss of the fishing dollar to the economy, now or in the future, would affect everyone in the state, including people who do not fish.

The statewide stream channel alteration inventory pointed out that channel alterations in trout streams and rivers are abundant throughout the state, and altered

[4]McConnen, Richard J. (1961) Economic importance of hunting and fishing in Montana, Montana Fish and Game Report, Helena, Montana, 13 pp. (Multilith).

[5]Bishop, Clinton G. (1959) Statewide creel census. Job Completion Report, Montana, D-J Project F-4-R-8, Job III, 9 pp. (Multilith).

Table 3. The Length of Stream Channel Altered, the Number of Alterations, and the Party Responsible for the Alterations in 13 Montana Streams or Rivers

River or Stream	Railroad Construction		Road Construction		Urban and Industrial Development		Agricultural Activities		Total			
	Miles[1] altered	No. of alter-ations	Miles[1] altered	No. of alter-ations	Miles[1] altered	No. of alter-ations	Miles[1] altered	No. of alter-ations	Miles[1] altered	No. of alter-ations	No. of stream miles	Per cent altered
Little Big Horn R.	39.8	48	2.9	22	2.0	7	19.2	114	63.9	191	120.0	53
St. Regis R.	13.0	54	10.7	60	1.6	6	0.1	1	25.4	121	37.1	68
Ninemile Cr.	0.1	5	0.6	24	1.9	4	2.4	48	5.0	81	23.9	21
Sheep Cr.	0.0	0	3.8	25	0.0	0	0.0	0	3.8	25	12.4	31
Otter Cr.	0.0	0	4.6	41	0.1	1	3.3	11	8.0	53	34.5	23
Belt Cr.	1.2	10	9.3	74	4.4	28	6.2	47	21.1	159	81.0	26
Beaver Cr.	1.5	3	2.7	25	0.2	10	1.0	28	5.4	66	49.5	11
West Gallatin R.	0.8	6	11.8	98	0.7	26	6.9	134	20.2	264	85.9	23
Rocky Cr.	3.6	7	1.6	22	1.0	26	5.4	53	11.6	108	18.4	63
Big Hole R.	3.8	21	6.1	50	1.3	12	34.9	312	46.1	395	147.6	31
Boulder R.	2.5	26	3.1	49	1.9	18	4.9	215	12.4	308	86.3	14
Prickley Pear Cr.	3.6	26	0.4	7	14.6	24	2.6	74	21.2	131	41.0	51
Ashley Cr.	0.8	9	0.7	35	1.3	3	4.1	38	6.9	85	30.2	23
Total	70.7	215	58.3	532	31.0	165	91.0	1075	251.0	1987	767.8	33

[1] Includes miles of stream channel lost as a result of the channel relocations.

Table 4. The Number of Fish, the Number of Fish 6 Inches or Larger, and the Weight of Fish Censused in Equal Areas of Altered and Natura tream Channels in 13 Montana Streams and River

River or Stream	Channel Type	Number of				Number of fish 6 inches or greater				Weight of			
		Trout	White-fish	Others	Total	Trout	White-fish	Others	Total	Trout	White-fish	Others	Total
Little Big Horn R.	Natural	76	5	0	81	26	5	0	31	13.7	3.0	0.0	16.7
	Altered	37	1	9	47	1	1	1	3	1.6	0.0	0.4	2.0
St. Regis River	Natural	22	35	19	76	9	35	0	44	4.1	19.8	0.6	24.5
	Altered	6	5	39	50	5	5	1	11	0.8	1.5	1.7	4.0
Ninemile Creek	Natural	65	0	11	76	17	0	0	17	4.3	0.0	0.0	4.3
	Altered	13	0	14	27	0	0	0	0	0.6	0.0	0.0	0.6
Sheep Creek	Natural	35	40	0	75	9	33	0	42	2.4	4.7	0.0	7.1
	Altered	1	0	4	5	0	0	0	0	0.1	0.0	0.1	0.2
Otter Creek	Natural	16	0	75	91	14	0	60	74	8.5	0.0	22.0	30.5
	Altered	1	0	16	17	1	0	11	12	0.4	0.0	4.2	4.6
Belt Creek	Natural	2	3	6	11	1	3	5	9	0.2	2.4	1.8	4.4
	Altered	0	0	16	16	0	0	2	2	0.0	0.0	0.9	0.9
Beaver Creek	Natural	88	0	12	100	17	0	12	29	5.6	0.0	1.7	7.3
	Altered	3	0	5	8	0	0	0	0	0.1	0.0	0.6	0.7
West Gallatin R.	Natural	6	16	10	32	6	15	10	31	4.4	14.6	20.9	39.9
	Altered	1	11	0	12	1	11	0	12	0.1	7.2	0.0	7.3
Rocky Creek	Natural	63	13	59	135	62	13	54	129	29.3	12.9	50.7	92.9
	Altered	55	0	28	83	24	0	24	48	5.0	0.0	4.9	9.9
Big Hole River	Natural	17	68	46	131	14	63	45	122	9.0	26.3	13.8	49.1
	Altered	1	0	2	3	0	0	1	1	0.1	0.0	0.1	0.2
Boulder River	Natural	41	1	0	42	22	1	0	23	4.2	1.3	0.0	5.5
	Altered	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0
Prickley Pear Cr.	Natural	19	0	45	64	11	0	38	49	5.5	0.0	23.5	29.0
	Altered	13	0	52	65	5	0	48	53	1.7	0.0	23.7	25.4
Ashley Creek	Natural	0	0	86	86	0	0	26	26	0.0	0.0	5.8	5.8
	Altered	0	0	54	54	0	0	0	0	0.0	0.0	0.4	0.4
Total	Natural	450	181	369	1000	208	168	250	626	91.2	85.0	140.8	317.0
	Altered	121	17	239	387	37	17	88	142	10.5	8.7	37.0	56.2

channels do not support nearly as many game fish as do natural meandering channels. Our capital investment principal decreases every time another section of stream channel is altered.

Recently, channel alterations by road construction projects have received criticism by resource managers. However, this inventory points out that railroad construction; urban and industrial development; and agricultural activities, in addition to road construction projects, have altered many miles of streams. The implications of the effects of channel alterations for resource use have been summarized in Berryman et. al. (1962).

Part of the money spent by man on flood plain development is from tax money. For example, all the money spent on road construction comes from the federal, state, or county tax dollar. The Agricultural Conservation Program of the Department of Agriculture partly subsidizes channel alteration programs for flood control. These programs are legal instruments, an integral part of the law of the land.

Legislation is needed to protect our trout streams from further channel disturbances. The growing demand for outdoor recreation is a nation-wide cause for immediate concern. The economic benefits of sport fishing to a community or state are large and justify the need for protective legislation. Unfortunately, a dollar value can not be placed on the enjoyment derived from fishing.

SUMMARY

There were 1,987 individual alterations in the 768 miles of stream channel inventoried. As a result of the man-made alterations, the length of the channels were shortened by 68 miles. Agricultural activities accounted for the greatest length of channel altered followed in order by railroad construction, road construction, and urban and industrial development. Relocated channels accounted for the greatest length of channel altered followed in order by riprapping, diking, and channel clearance. Standing crops of game fish were several times more abundant in natural, meandering channels than in altered channels.

ACKNOWLEDGMENTS

In each fisheries management district, at least one stream was surveyed for stream channel alterations by fisheries biologists and their summer crews. The interest and enthusiasm generated by these biologists stimulated this written summary of the statewide inventory. Perry H. Nelson and Lloyd Casagranda, Montana Fish and Game Department Information and Education Officers, contributed in many ways toward implementing and coordinating this project.

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