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REPORT NO. 399

AN INVESTIGATION OF KINNE CREEK WITH RECOMMENDATIONS FOR IMPROVING THE FISHING[1]

In making recommendations for the improvement of fishing, it is first necessary to know what type of fishing is wanted, just as an architect must know his clients' preferences before designing a residence for him. In the case of Kinne Creek, management proposals will depend to some extent upon the preferences of the members. Do they want fishing for brook, brown or rainbow trout or combinations of all three? Do they want a relatively few large trout which are difficult to catch (as at present), or a greater number of 8 to 12 inch fish? What methods of fishing are favored: bait fishing, fly fishing during the day or fly fishing after dark?

When these questions were asked of Mr. Henry Idema, President of Kinne Creek Club, and Mr. William Loutit, they felt that the Club unanimously favored fly fishing, but that the membership would be divided in their preferences for species.

The present system of large ponds favors the production of a few large fish at the expense of a larger number of smaller trout. Also, much of the present pond system is more or less spoiled for trout due to dense masses of weeds, partial filling with sand or to the presence of large cannibal trout, pike and (in the case of ponds above the railroad) perch and horned dace.

Examination of the data collected in our survey of Kinne Creek indicates factors in Kinne Creek which we believe are responsible for its poor production.

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[1] The detailed data and observations upon which these recommendations are based will be found in the Appendix.

Discussion of Possible Factors Limiting Fish Production

1. Unbalanced fish population. Our observations during the spawning season convince us that Kinne Creek contains an unusually large percentage of big trout (at least 100 from 14 to 18+ inches). The Institute's studies of fish populations have shown that any given stream or lake will support a limited number of larger fish or a greater number of a smaller average size. Furthermore, food studies of brown trout have shown that these large trout feed almost exclusively on fish and crayfish and that a large percentage of the fish taken are often young trout. A few large pike are reported in the ponds each year and are removed as quickly as possible by the caretaker. Studies of pike in trout waters have shown them to be capable of eating large numbers of trout up to an 8 or 10 inch size.

Yellow perch are reported to be abundant at times in the ponds above the railroad, and horned dace up to 6 inches in length were taken in the Creek at the head of Austin Pond. Both of these fish compete with trout for food and will eat young trout. These competitors may well account for the relatively poor results obtained from plantings of brook trout fingerlings made in the stream at the head of Austin Pond.

The system of ponds and large sheltered pools on Kinne Creek, the latter difficult or impossible to fish with a fly at present, favors the presence of large brown trout and pike below the railroad, and perch, pike and (to some extent) large horned dace above the railroad. Drainage of these ponds and restoration of normal stream conditions in Kinne Creek would discourage or eliminate these undesirable fish and result in a more nearly normal population. Neither pike nor perch can thrive in the typical, small, rapid trout streams such as Kinne Creek. Eliminating the large ponds below the railroad and opening up too sheltered pools would likewise discourage large brown trout and pike.

The re-establishment of brook trout (and rainbow) fishing below the railroad would also be favored by the proposed restoration of normal stream conditions. In fact this may be the only way in which brook trout can be successfully restored regardless of the size of fish planted.

2. Sterile pond conditions. From our studies of beaver ponds and from investigations of impounded waters in various parts of the country, we have found that new dams create exceptionally good fishing for a period of from 3 to 5 years following flooding of formerly dry land. After from 3 to 5 years the production falls very low and apparently never recovers, so that the ponds either produce no fish at all or fewer than the original stream did. Apparently this cycle has occurred in Kinne Creek--in fact, must have passed its peak of production before 1927.

3. Deficiency in pools and shelter. As described in the Appendix, certain stretches of Kinne Creek need more pools and shelter if the stream is to afford the maximum amount of fishing. Some good work has been done by the Club in this direction, but this work needs to be extended to make all parts of the stream productive.

4. Limited food supply. As shown by food studies of Kinne Creek reported in the Appendix, food organisms for trout are below average in this stream. Eliminating the system of ponds, installing additional deflectors to expose more productive bottom and hauling in rocks and gravel should improve the food supply.

5. Inadequate stocking. Considering the number of large trout in the lower part of the stream and the presence of perch and the abundance of perch and large creek chubs in and above the ponds upstream from the railroad, it seems doubtful to us if the planting of 3,700 1¼-2" brook trout per year (average for past 5 years) would do much if anything to build up fishing even though these fish were carefully planted in the best places on the stream. The catch records clearly show that this stocking has been ineffective. Reducing the number of large, cannibal trout and competitive fishes and changing environmental conditions to favor the smaller trout coupled with planting of larger sized fish should correct this.

If the original stream is restored and improved, allowing grasses and shrubs to establish themselves on the exposed portions of the former pond bottoms, it is possible that refilling the ponds, say after a 5 or 10 year period, would bring on another cycle of exceptional fishing if it should be desirable to go back to such a system.

It is our opinion that good fishing for brook trout can be made above the railroad and that excellent fishing for brooks, browns and rainbows can be had below the railroad by the following plan:

1. Drain all ponds (except the pond above the railroad which presumably cannot be eliminated because of the power plant) to the lowest level possible, restoring Kinne Creek to its original stream condition. Dams should be left as nearly intact as possible so that they may be refilled if this should prove desirable.

2. Beginning at the highway bridge above Austin Pond install a series of deflectors and covers to create a goodly number of medium sized pools and riffles throughout the entire stream. It should be the aim in improvement in this stream (in contrast to public waters) to make every pool fishable with a fly; not entirely devoid of hazards, of course, but open enough so that a man of average skill can take trout from every one of them when they are rising. This not only adds to the pleasure of fishing, but also helps to prevent large trout from developing and taking over choice pools. Detailed suggestions as to type and frequency of structures recommended for Kinne Creek will be found in the Appendix (page X). Following establishment of the new stream channel in the old pond beds, bank plantings of shrubs which attract insects should be made. Dogwood (red osier), willow and tag alder are recommended. All these shrubs may be transplanted from adjacent areas on the Club property.

3. Reduce the number of brown trout over 14 inches in the stream below the railroad by any practicable method. From our observations this fall, we believe that a considerable number could be seined out while the fish are on the spawning beds. Set lines baited with large minnows should take a number from the deeper pools. A record should be kept of the number and lengths of the fish so removed. Removal of large trout each year has long been an accepted practice on English streams. The object is to maintain as large a population of 8-14 inch trout as possible since this size takes a fly most readily. Trout larger than this live almost exclusively on fish and crayfish and are usually taken by fly after dark

only during the brief times heavy mayfly and caddisfly "hatches" occur. Brown trout so removed should not be planted in Mill Lake as there is grave danger that if they should spawn successfully the fry would pass through the revolving screen below Mill Lake and that brown trout would thus find their way into Kinne Creek in the section above the railroad (where they are absent at present) and would interfere with plans for brook trout restoration.

4. In 1937 plant 500 brook trout from 6-8 inches in length above the railroad and 500 each of brooks and rainbows from 8-10 inches below the railroad. Planting in 1937 should be done after draining the ponds and installing the stream improvement recommended. Thereafter plantings of 2,000 3-5 inch fingerlings each year should keep the entire stream stocked to capacity, provided that the large cannibal trout are controlled. Trout for stocking purposes should be carefully inspected by a disinterested, competent fish culturist before being accepted to be certain that they are healthy and vigorous and of the size specified.

5. Remove part of the streamside cover in sections of the stream where it now interferes with fly fishing. (See also under 8 in Appendix.)

6. Open up the larger pools so that they can be fished with a fly. Many of these pools have logs extending over the stream above or partly beneath the water. These should be submerged or a section should be removed to permit floating a fly through them.

7. Kinne Creek should be watched during the winter and fish ducks should not be allowed to concentrate there. A permit should be secured for the caretaker to enable him to take proper steps against these predators.

8. Keep the screens in Kinne Creek, both below Mill Lake and near the mouth of the Creek, in good operating condition to prevent, so far as possible, the descent of lake fish and entrance of fish from the river as well as the escape of desirable fish from the Creek. Remove as many horned dace (creek chubs), shiners and perch as possible from the stream above the railroad. Seining and the use of wire minnow traps are recommended.

9. If practicable, haul in stones from 4 inches in diameter upward and distribute these in the riffles where sand is the dominant type at present. There is no method by which food conditions can be improved as readily as increasing the amount of gravel and rubble bottom.

10. Maintain as constant a flow as possible below the power plant since this favors the establishment of weed beds in the stream and of weeds and silt beds behind the deflectors. Flushing a stream such as Kinne Creek is definitely harmful by disturbing or smothering fish food organisms. As shown by our studies of different bottom types, shifting sand is barren of food, but even a thin growth of weeds over sand is quite productive.

The plan outlined will be expensive during 1937 but should require little outlay thereafter. The stocking as recommended will cost about $1,000. The improvement by installing deflectors and covers should not cost over $1,000 additional. Subsequent stocking and improvement maintenance should not exceed $300 per year.

APPENDIX

The investigation reported upon was requested of the Institute by the Kinne Creek Club through Mr. William Loutit. All expenses connected with it are to be borne by the Club.

A preliminary examination of Kinne Creek was made July 27 and 28 by the writer and J. W. Leonard of the Institute. A second examination was made by Mr. Leonard and Mr. R. W. Eschmeyer on August 18 and 19. The final study was conducted by Mr. Leonard and the writer on November 7 and 8 during the brown trout spawning season.

Following is a discussion of the data collected during these visits. The data appear in complete form in the tables at the end of this report.

1. General description of the stream. Kinne Creek, as considered in this report, heads in Mill Lake about in the center of Section 31, T. 18 N., R. 14 W. (Lake Co.) It flows in a general westerly direction to the Pere Marquette River which it joins in the southeast corner of Section 34. The total length of the stream is about 3 miles. Starting as a warm, sluggish creek with sand bottom and an average width of about 10 feet, it soon becomes rapid in flow with medium gravel (and some sand) bottom until it reaches the head of the Austin Pond. In its course to this point it flows through a mixed second growth forest of oak, pine and hemlock. Spring water begins to enter about 200 yards above the highway bridge and by the time this bridge is reached the temperature is suitable for trout. Spring seepage and drainage increase rapidly from this point to the mouth of the stream where the flow is probably three times that of the stream when it leaves Mill Lake.

Kinne Creek has eroded a narrow valley which increases in width as the mouth is approached. Below the railroad plantings of White and Norway pines have reached good size although the stream side cover is of mixed cedar, alder, willow, birch and hemlock.

A revolving screen about 200 yards from the mouth prevents the passage of fish up or down and a similar, smaller screen functioning in the same way has been placed just below Mill Lake.

Seven dams below the railroad form ponds of varying size and depth. Above the railroad are two large ponds controlled by dams. The upper (Austin Pond) at least could be drained presumably without affecting the operation of the Club's power plant which is located just below the railroad fill.

2. <u>Temperatures</u> (Table 1). From the highway bridge (about 1/2 mile upstream from the railroad) to the mouth, the temperature range is suitable for brook, brown or rainbow trout. The creek above the highway is too warm for any species of trout to inhabit during the summer months and should not be planted. Starting about 200 yards above this bridge a series of small spring seeps and feeders ranging in temperature from 48° to 53° enter the stream and make it suitable for trout by the time the bridge is reached.

The Austin Pond and the pond above the railroad may warm the water to some extent, but if so, this warming is more than neutralized by the spring water which enters from the head of Austin Pond to the power plant. This is shown by the water temperature at the head of Austin Pond, which was 73° at 12 noon but only 69° below the power plant at 6 p.m., which at this time of year is about the peak for water temperatures.

The ponds (Austin, Morley's, stone dams, etc.) probably help to raise the water temperatures in this section as the surface water at the lowest dam (with the fish screen) was also 69° at 6:15 p.m. of the same day in spite of the many spring feeders which enter at about 48° along this stretch of stream. What the temperatures of this part of Kinne Creek would be without the dams, it is impossible to say, but it does <u>not</u> seem probable they would be too low for good trout growth providing the stream is well exposed to sunlight.

That the dense beds of water weed (<u>Elodea</u>) in these ponds help to keep the temperature down is shown by the two readings--62° at the surface near the head of the lower pond and 55° at the same place twenty inches below the surface in a thick growth of <u>Elodea</u>.

Water temperatures clearly limit the trout water in Kinne Creek, but within these limits (highway bridge to mouth) the range should be suitable for any of the three species of trout with or without the present system of ponds.

3. Chemical conditions (Table 2). Chemical conditions are likewise favorable to trout in the entire section described as having suitable temperatures.

The Hydrogen Ion Concentration or pH ranges from 7.8-8.0 showing that the water is decidedly alkaline. This is well within the range of good trout water.

Dissolved oxygen is lowest in Austin Pond (6.7 parts per million) and highest in the lowest pond, but should be sufficient throughout the section suitable for trout.

Free carbon dioxide tested at from 4.5 to 9.0 parts per million which is likewise favorable for trout.

Methyl Orange Alkalinity (bicarbonates) was from 112-144 p.p.m. This places Kinne Creek in the class of "hard" water streams which are considered conducive to good growth of both fish food and trout.

In general, chemical conditions are normal and favorable to good trout production in Kinne Creek.

4. Bottom composition. In the faster stretches of stream, considerable gravel and some larger stones up to 4 inches in diameter are present. Hardpan (clay) is exposed in some places along the margins and in the pool bottoms; and in the ponds, sand is present covered by a varying thickness of silt. While there is sufficient gravel for spawning in all parts of the stream, food production is limited by the amount of shifting sand present. Since there is practically no bank erosion in this watershed, the sand must be brought in constantly by the springs. This is evident in examining the small feeders which are numerous. However, even without these springs the dominant stream bottom would probably be sand as Kinne Creek flows through soil in which sand is the principal element. Numerous samples of the soil were taken in the stream bed and in every case sand was found to be present in large quantities even under bottom which was entirely gravel or rock at the surface. This indicates that gravel and stones have been exposed only as the water has washed the bottom and has carried the sand downstream.

Shifting sand is virtually barren of fish food, but where it is bound together with even a thin covering of water plants, fair production is evident (Table 3).

Food production would evidently be improved by increasing the amount of gravel and rock bottom and plant beds as advised under improvements recommended. This is especially needed between the lower stone dam and the Cartier Pond.

5. Pools. Exclusive of the ponds, pool conditions are fairly good in Kinne Creek. Above the Austin Pond there is only a short stretch of stream (about 200 yards) having summer temperatures suitable for trout. Several additional pools are needed here. Pools are fairly frequent from the power plant to the head of Cartier Pond, partly as a result of improvement work, but from here down some additional pools and shelter are needed. The pools in Kinne Creek range from the small, shallow type to large deep holes (4± feet). Most of these pools in the lower section are well supplied with shelter for fish--in fact a number have too much shelter and are difficult or impossible to fish with a fly. This is an undesirable condition on a private stream where the maximum of fishing is desired. This type of pool is usually taken over by large brown trout which are immune to fly fishermen and which, through cannibalistic tendencies, tend to reduce the production of the stream.

The present system of large ponds reduces the number of pools which it is possible to have on the stream. These ponds likewise encourage predacious species as well as large cannibal trout.

6. Streamside cover. In many places the trees and brush along the stream are too dense to permit enjoyable and productive fly fishing. As in the case of too much shelter in the pools, this condition favors large trout at the expense of the sizes which provide the best fly fishing. This is especially true from Cartier Pond to the mouth of Kinne Creek.

Streamside cover which is too dense likewise reduces the food supply in three ways:

1) Production of terrestrial insects has been found to be greater where the stream banks are partly open.

2) Exposure to sunlight is desirable in Kinne Creek in order to counter-balance the effect of the cold spring water in lowering temperatures below the range for the best food production and fish growth.

3) Exposure to sunlight promotes the growth of water plants (especially algae) which are the food of the forms upon which trout live.

7. Erosion and silting. Little bank erosion occurs due to the very low flood crest and good vegetative bank cover. It seems likely that part of the white, shifting sand in Kinne Creek comes from the numerous spring tributaries, but part is washed out of the mixture of sand and gravel which makes up the present stream bottom.

8. Food supply (Table 3). A count of food organisms was made in Kinne Creek on July 28 and November 7, 1936. In this sampling the standard food census method was employed, which consists in removing 1 square foot of stream bottom to a depth of 2-4 inches and enumerating and measuring the volume, in cubic centimeters, of all organisms found therein. Samples of this sort were taken at 6 different points in the stream on July 28, and at 5 points on November 7. It is believed that each of the dominant stream bottom types has been sampled.

With the exception of one sample, rather small volumes of food organisms were found. It is believed, however, that this is explained at least in part by the dates on which the samples were collected: in late summer and fall, most food organisms are just hatching from the egg and starting growth. In late winter and early spring, the total volume of food organisms should be greater than during late summer and fall, although the actual numbers of organisms may be smaller.

However, compared with certain other Michigan streams which have been similarly studied by the Institute, Kinne Creek does not have a rich food supply, but one slightly below average.

Past experience leads us to believe that the most important single step in endeavoring to increase the food supply would be the creation of more gravel areas, whether brought about by sand removal or by actual introduction of gravel and stone. After this, occasional thinning of the bank shade, as recommended in section 6 antea, should aid production, as should stream bottom alterations produced by stream improvement devices. These changes would especially favor mayflies and caddisflies, whose present number is not so great as could be desired.

On July 28, drift net sets were made to determine whether or not many terrestrial insects were falling into the stream. These sets captured too few insects to be worth recording. It is almost certain that judicious thinning of bank vegetation would result in an increase of such insects, to the benefit of the trout.

It is interesting to note in Table 3 that sandy areas bound by sparse growths of *Chara* and white water buttercup produced considerable numbers of Diptera (midge larvae). These are greatly relished by trout, and their increase is greatly to be desired.

9. The fish population. Judging by observations during the fishing season and during the brown trout spawning season, there is a fairly large population of brown trout in Kinne Creek below the power plant. No brook trout or rainbow trout were observed in this part of the stream by us. On November 7 we counted 50 brown trout nests which were being actively worked, and estimated we saw about 150 trout from 8 to 18 inches in length. No nests were seen in any of the ponds; all were in rapid water at the tail of the pools, as is characteristic of brown trout. It is hard to say what proportion of the total population this number represents since all spawners do not appear on the beds at one time. We estimated that at least two-thirds of the spawners were from 14 to 18+ inches. If each nest produced only 1,000 fry and if we saw all the nests, the total seeding for this 1 1/2 miles of stream would be 50,000 fry. Allowing a 5% survival to legal size, there should be 2,500 brown trout produced naturally in this part of the stream for each season's fishing. We suspect the percentage of survival is much lower than 5%, however, because of the number of large adults and unfavorable conditions for small trout.

Above the power plant only brook trout were observed and relatively few of these. Only one nest was seen (beneath the highway bridge). A few good-sized brook trout were observed near the head of the pond above the railroad.

Sculpins (Cottus) seemed fairly common in Kinne Creek. These little fish are choice food of larger trout. A number of suckers are present in the larger ponds below the power plant, especially in the lowest pond. They are probably beneficial as young suckers are used as food by trout and the adults do not compete seriously with trout for food. The large numbers of horned dace (Semotilus) in the stream above the railroad are a menace to brook trout. Seining revealed an abundance of these fish, many of them from 4-6 inches or larger. Trout fry and fingerlings are readily eaten by horned dace of this size. A few pike are reported to be present in the ponds, particularly in the lower pond near the Pere Marquette River. The revolving fish screen below Mill Lake probably keeps most of the undesirable lake fish from reaching the waters below. Large numbers of perch fingerlings were observed above this screen on July 27th.

10. Predators. A few kingfishers and herons were seen along Kinne Creek and occasional snapping turtles are reported. The caretaker states that fish ducks (mergansers) visit the stream each winter. Any concentration of these ducks should be prevented, as our studies have shown them to be highly destructive to brown trout during the winter.

11. Past stocking and catch records. The only available records of planting in Kinne Creek were given to us by the caretaker. These covered the period from 1931 to 1936. Brook trout were planted exclusively during this period, the majority being distributed above Austin Pond near the entrance of springs although some were planted below the railroad. Except in 1931 when 1,000 trout from 5-8 inches were stocked, the fish were fingerlings from 1 1/4 to 2 inches in length.

There is no record of planting brown or rainbow trout in Kinne Creek and it is presumed that these ascended the stream from the Pere Marquette River before a screen was installed at the lower end of the creek. This seems a very probable explanation.

Brown trout have maintained themselves below the railroad to the virtual exclusion of brooks and rainbows.

Records of the fish catch are entered in the Club's Register by members and their guests. Although probably not complete, they doubtless present a fair picture of fishing over the years. Unfortunately, it is impossible to tell from these records the amount of time and effort required to catch a given number of trout in any year since the number of hours fished is not given. However, these records graphically demonstrate the fluctuation of the catch and the steadily increasing ratio of browns to brooks. This record, however, will be invaluable in determining the actual results of the improvement plan proposed in this report.

A study of the records of catch from the Register of the Club (Table 5) shows that small catches were made in 1927 and 1928 as well as in the past three years. In fact, the second lowest catch in the ten year period covered by our table is in 1927. Apparently the phenomenal catches which the older club members recall were made longer than 10 years ago. It would be desirable to know more of the history of fishing, stocking and time of construction of dams. From our knowledge of other streams, it appears likely to us that the years of extremely high catches may have followed immediately after the construction of the large dams on the stream.

The total number taken has decreased rapidly since 1930 in spite of planting 41,000 brook trout in 1931. It is difficult to understand why a larger number of brook trout were not taken in the years following this planting.

The number of brown trout in the catch increased from 1927 to 1933 and though the total number of all trout taken decreased from then to the present year, the browns outnumbered the brooks every year from 1934 to 1936. The percentage of the total catch made up by the brown trout from 1931 to 1936 is as follows: 12%, 39%, 47%, 53%, 69%, 54%.

Rainbow trout have been decreasing steadily since 1930 but never made up an appreciable percentage of the catch in this ten year period.

In comparing the records of planting with the brook trout catch two years later (when they should be legal size) no correlation whatever is evident. The 1,000 brook trout fingerlings planted in 1932 yielded 103 fish in 1934; 7,500 fingerlings stocked in 1934 resulted in a catch of only 38 trout of this species in 1936. Nor is there any correlation if we allow three years between planting and the catch record. It seems fair to conclude that planting from 1931 to 1934 inclusive gave very poor results. Of 54,500 brook trout stocked during these years, only 509 (less than 1%) had been caught by the end of the season of 1936.

STREAM IMPROVEMENT STRUCTURES RECOMMENDED FOR KINNE CREEK

Study of the natural and man-made pools on Kinne Creek reveals the following:

1. Dams are of little use in forming permanent pools because they soon partially or completely fill with sand due to the soft bottom present and the amount of sand constantly in motion.

2. Deflectors in the form of logs partly or completely across the stream (natural or placed there for the purpose) whether partially or entirely submerged and stumps have formed effective pools and shelter due to the digging action of the current on the soft bottom. Such pools are permanent and if made fishable are of the type recommended.

The following types (as illustrated in Bulletin No. 1, Methods for the Improvement of Michigan Trout Streams) are recommended:

Deflectors

Figure No. 3 (p. 30) Boulder wing. If rocks from 50 pounds upward can be secured, boulder wings make excellent deflectors, are natural in appearance, harbor food and are favored by trout. They should be carefully built, chinked with smaller stone and well banked with gravel on the upstream side. As the water can be kept at a fairly constant level in Kinne Creek because of the dam at the power plant, these deflectors should be permanent and may be made of smaller boulders than in streams subjected to high water. The level of these and all other deflectors should be a few inches above the high water mark to prevent destruction of weed and silt beds which form on the downstream side of the deflectors. Some rich soil should be placed on top of each deflector and sod established to hold the surface of the structure and give it a natural appearance.

Deflectors may be made in pairs, i.e. from opposite banks (see Fig. 8, p. 32) leaving an opening about 3 feet wide (for Kinne Creek). This concentrates the current and results in a long, deep hole at the downstream end of the funnel.

Figure No. 4, Log wing (p. 30). Due to scarcity of stone and abundance of logs, this type will probably be used most extensively. These deflectors should also be well banked with gravel on the upstream side. Stakes should be cut off at the level of the top log and sod or moss such as found on natural logs along or partly submerged in the stream should be placed on top of the deflector to give the structure a natural appearance. Many partly waterlogged trees or logs are present in Kinne Creek and by judicious re-arrangement can be made to do effective work.

Underpass deflectors (as described on p. 34) are very effective in Kinne Creek. Several of the finest natural pools on the stream have been formed by trees which have fallen across the stream and are partly submerged. However, these deflectors should either be submerged at least six inches or should extend only part way across the stream in order to be properly fishable.

Covers

Small stumps can be staked down (as has been done very effectively in several places in Kinne Creek) to form shelter and to scour small holes for trout. These can be used most efficiently at the downstream end of deflectors or at the edge of the stream channel near the head of a shallow pool lacking in cover. (See Plate II, Fig. 2, opp. p. 19).

In several places bend covers (Fig. 13, p. 37) can be added to improve existing pools which are open and lack cover or in connection with deflectors to be installed. However, it is better to embed the ends of the logs in the bank rather than to wire them together as a raft.

In many places one or more logs can be arranged to form a bank cover (such as Figure 14, p. 37) which, if placed toward the head of a pool, will tend to deepen it by the action of the current beneath. This type has been used effectively in several places in Kinne Creek.

Table 1. Kinne Creek Temperatures, 1936.

Location	Date	Air	Water	Time
Lower dam near mouth	7/27	76.0°	57.5°	10 a.m.
" " " "	7/27	76.0°	69.0°	6:15 p.m.
Lower dam	11/7	33.0°	43.0°	12 noon
Head of lower pond	7/28		62.0°	2 p.m.
" " " " in *Elodea* bed 20" deep	7/28		55.0°	2 p.m.
Lower stone dam	7/27	76.5°	58.0°	10:30 a.m.
Morley Spring opposite clubhouse		...	48.5°	3 p.m.
" " " "		76.0°	69.0°	6 p.m.
Surface of pond above railroad	7/27	79.0°	67.0°	12 noon
Surface of Mill Lake	7/27	...	78.0°	1:30 p.m.
Bridge below Mill Lake	7/27	81.0°	79.5°	1:15 p.m.
100 yards below spring	7/27	...	73.0°	1:45 p.m.
At fish screen 1/4 mile below Mill Lake	7/27	81.0°	78.0°	2 p.m.
1/2 mile below Mill Lake	7/27	...	77.0°	2:30 p.m.
At sand trap	7/27	...	77.0°	3 p.m.
At site of old screen	7/27	...	77.5°	3:15 p.m.
1st spring seep 200 yards below old screen site	7/27	....	53.0°	3:30 p.m.
Center of Kinne Creek, 50 yards below entrance of seep	7/27	...	75.0°	3:30 p.m.
At road bridge	7/27	...	74.0°	3:45 p.m.
Spring below road bridge near head of Austin Pond	7/27	...	48.0°	4 p.m.
Kinne Creek opposite spring	7/27	...	73.0°	12 noon

Table 2. Chemical Analyses of Kinne Creek
(Wingleton Club)
August 18, 1936, 6 p.m., Clear, Air Temp. 80°F.

By R. W. Eschmeyer

Pond, 75 feet above revolving screen:

H_2O temp.	60.75° F.
CO_2	9.0
M.O. alk.	144.0
ph. alk.	0.0
O_2	8.0
pH	8.0

Morley's Spring (near) August 19, 6:15 a.m., cloudy.

Air temperature	64.5°F.
H_2O "	57.5
CO_2	7.0
M.O. alk.	112.0
ph alk.	0.0
O_2	7.5
pH	7.3

Austin Pond (above R.R.) August 19, 10:30 a.m., cloudy.

Air temperature	75.5°F.
H_2O "	63.0
CO_2	4.5
M.O. alk.	115.0
ph. alk.	0.0
O_2	6.75
pH	7.3

General Conduct of the Work

The stream improvement work done for the Club by Mr. Pullman appears to be solidly constructed and effective. However, a great deal more of this work is needed to bring the carrying capacity of the stream to its highest level.

When the existing dams have been removed and the stream has cut down to its normal level through deposits of sand and silt in the ponds, it is suggested that the writers cruise the stream with Mr. Pullman (or whoever will be in charge of the improvement work) and stake out the work needed, making a plan for the improvement of the entire section. Work should then begin at the upper end and proceed downstream.

INSTITUTE FOR FISHERIES RESEARCH

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Table 3. Food Production of Various Bottom Types in Kinne Creek (Each Sample One Square Foot of Bottom) Showing Numbers, and Volume of Organisms in Cubic Centimeters

By J. W. Leonard

Date	Locality of Sample	Annelida (worms)		Mollusca (snails & clams)		Crustacea (crayfish & shrimp)		Megaloptera (alderflies)		Ephemeroptera (mayflies)		Odonata (dragonflies)		Plecoptera (stoneflies)		Coleoptera (beetles)		Trichoptera (caddisflies)		Diptera (true flies)		Total volume in cubic centimeters
		No.	Vol.	No.	Vol.	No.	Vol.	No.	Vol.	No.	Vol.	No.	Vol.	No.	Vol.	No.	Vol.	No.	Vol.	No.	Vol.	
July 28, 1936	Just below lower dam. Fine gravel + clay. Rapid current, 8-10" deep.	1	0.05			1	tr.			14	0.05					41	0.10	25	0.25	191	0.25	0.70
July 28, 1936	Just below above. Sand bar with sparse white water buttercup. Moderate current, 2" deep.	132	0.30			28	0.20			37	0.05					2	tr.	11	0.05	136	0.25	0.85
July 28, 1936	Head of lower pond. Dense Elodea over 8-10" of silt. Current slow, 30" deep.	100	0.75			12	15.20*	2	0.05	2	tr.					2	tr.			228	0.35	16.35[1]
July 28, 1936	Near above. Sparse Elodea & white water buttercup over organic debris & silt. Current slow, 24" deep. Silt layer 6-8" deep	15	0.10	4	0.05	6	0.05	1	tr.	1	tr.					1	tr.	4	0.05	443	0.55	0.80[2]
July 28, 1936	Sparse growth of Chara over sand. Water 6" deep	1	tr.	2	0.10															41	0.10	0.20
November 7, 1936	Austin Pond. Edge of Elodea bed over silt 3" deep. Water 15" deep. No current.	4	0.70	9	0.45	5	tr.	1	tr.					1	tr.					118	0.60	1.75
November 7, 1936	Just below bridge above railroad. Fine gravel & sand. Swift current 6" deep.	6	0.13							53	0.10			18	0.13	47	0.05	171	1.00	15	0.01	1.42
November 7, 1936	As above. Sparse white water buttercup over fine gravel + sand. Swift current, 6" deep.	1	0.10			1	tr.			43	0.10	1	0.10	16	tr.	36	0.03	68	0.20	69	0.52	1.05[3]
	North of clubhouse. Moderate gravel over sand. Current swift, 4" deep. Sample taken 18" from north edge of stream.	5	tr.			1	tr.			34	0.40	2	1.50	63	0.10	71	0.10	147	0.70	116	0.65	3.45
	Just below above. Fine gravel + sand. Swift current, 4" deep.	7	0.05			8	0.03			7	0.07			35	0.03	61	0.10	79	0.13	80	0.43	0.84[4]

* Composed of 1 crayfish ... 15.00 cc.
11 freshwater shrimp ... 0.20 cc.

1 Contained 4 Corixids (water boatmen), too small to measure

2 " 1 " " " " " " "

3 " 1 Turbellarian (Flat worm) " " " "

4 " 1 " " " " " " "

NOTE: A 6th sample taken on July 28 in pure sand contained no food organisms whatever.

Table 4. Records of fish planting in Minne Creek

from Vint Pullman, Caretaker

1931	1,000	Brook	Trout	5 to 8" long	(Greenway)	
	40,000	"	"	Size ?	"	
1932	1,000	Brook	Trout	fingerlings	1 1/4"-2"	(Northville)
1933	5,000	"	"	"	"	"
1934	7,500	"	"	"	"	"
1935	No trout planted					
1936	5,000	Brook	Trout	fingerlings	1 1/4-2"	(Northville)

Table 5. The Catch. From: Register of Minne Creek Club

	Brooks	Browns		Rainbow	Total
1927	104	20		37	161
1928	190	33		36	259
1929	378	34		32	444
1930	497	69		55	621
1931	391	71	(combined) 69	44	575
1932	328	241		45	614
1933	298	284		22	604
1934	103	138		18	259
1935	72	188		14	274
1936	36	45		3	84