SEA LAMPREY SPAWNING: MICHIGAN STREAMS OF LAKE SUPERIOR

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SPECIAL SCIENTIFIC REPORT: FISHERIES No. 70

UNITED STATES DEPARTMENT OF THE INTERIOR

FISH AND WILDLIFE- SERVICE

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Washington, D. C. February, 1952 United States Department of the Interior, Oscar L. Chapman, Secretary Fish and Wildlife Service, Albert M. Day, Director

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SEA LAMPREY SPAWNING: MICHIGAN

STREAMS OF LAKE SUPERIOR

by

Howard A. Loeb and Albert E. Hall, Jr. Fishery Research Biologists

Special Scientific Report: Fisheries No. 70

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Introduction

During the three decades since the capture of the first specimen in Lake Erie in 1921, the sea lamprey (Petromyzon marinus) has established itself in great numbers in the upper Great Lakes. Partial destruction of the commercial and sport fisheries of Lakes Huron and Michigan has resulted. Details of the problem in those lakes have been presented in recent papers (Applegate 1950; Hile 1949; Hile et al. 1951).

The present situation in Lake Superior differs from that in Lakes Huron and Michigan in that the sea lamprey is still in its initial states of dispersal and establishment (first specimen taken at Isle Royale, 1946). The lamprey appears already to have caused some damage to the fish populations (especially lake trout) in the Superior basin. Commercial catches have declined (owing partially, perhaps, to increased fishing pressure) throughout the lake, but the greatest decrease has taken place in the eastern areas. If the relation between the fish populations and the sea lamprey follows the pattern established in Lakes Huron and Michigan, commercial fishing for lake trout and certain other species of present importance in Lake Superior will be unprofitable within three or four years.

Control of the sea lamprey in all of the lakes will probably be effected by attacking the parasite during one of the stream phases of its life cycle; for example, the upstream migrations of sexually mature individuals can be blocked by dams, mechanical weirs, and electrical barriers in streams suitable for spawning (Applegate and Smith 1951).

The relative importance of most of the watersheds of the Lake Huron and Lake Michigan basins as sea-lamprey spawning areas has been determined. Suitable spawning habitat is present in only a small percentage of streams in these basins. Unfortunately, those streams that do possess this facility have a tremendous potential for reproducing the species.

Before the stream surveys reported herein, little was known of the characteristics of the majority of the streams flowing into Lake Superior or of their relative importance as present or future producers of sea lampreys.

The surveys of Lake Superior streams were instituted to determine the following:

1. The extent of sea lamprey penetration westerly in Lake Superior, as judged by actual observations of lampreys, spawning activities, and nests in the tributary streams (sea lampreys are now distributed throughout the lake). 2. The location and extent of potential spawning and larval habitats in the streams of the basin. Criteria used to determine the relative suitability of streams were established by Applegate (1950) and other workers; specific water temperatures, velocities, and bottom types necessary for successful completion of the stream phases of the life cycle were determined.

3. The best sites for control structures in streams which are apparently suitable or are actually used by sea lampreys for spawning.

During the summer of 1950, all of the streams from the Tahquamenon River (Chippewa County, Mich.) west to the tip of the Keweenaw Peninsula were examined (figs. 1-17). The personnel included, in addition to authors, Clifford Brynildson, Daniel Garn, William Gaylord, Carl Jacoby, Alberton McLain, and Phillip Parker. The 1951 survey was conducted by Howard Loeb, William Gaylord, Carl Jacoby, and George Simmons; this party examined streams in the area between the tip of the Keweenaw Peninsula and the Michigan-Wisconsin border (figs. 1, 18-23).

Appreciation is extended to the Institute for Fisheries Research, Michigan Department of Conservation, for data on the Two Hearted River, and to Leo F. Erkkila of the Fish and Wildlife Service for data on utilization by the lamprey of several streams (table 23. Alan C. Bennett prepared the maps, and William Gaylord identified lamprey larvae.

Digest of principal findings

Results of the 1950 and 1951 stream surveys in the Lake Superior watershed are summarized as follows (figs. 2-17 and 18-23):

Number of streams and tributaries examined:

- 1950: 869 (Tahquamenon River west to the tip of Keweenaw Peninsula)
- 1951: 178 (tip of Keweenaw Peninsula west to Michigan-Wisconsin border)

Of the streams examined in 1950, detailed data were obtained for 330. (Tables 1-16 present information on the 112 streams which possessed some potential for reproducing the sea lamprey.) The remaining 539 streams which appear on large-scale maps of the area were found to fall in one of the following categories:

- 1. Nonexistend.
- 2. Considered from preliminary examination as not suitable for the reproduction of sea lampreys.
- 3. Tributaries not in need of examination because extensive potential spawning habitat had already been found in the watershed.

Detailed data were collected for all of the 178 streams examined in 1951 (tables 17-22). The 1951 survey was less extensive than that of 1950 in that most of the minor tributaries of each watershed were not examined.

However, all of the 315 watersheds flowing directly into Lake Superior from the Tahquamenon west of the Michigan-Wisconsin border (1950 and 1951 survey areas) have now been examined in sufficient detail for the purposes of this survey.

Streams with a large productive potential (Space for more than 75 nests): 53 Streams with a medium productive potential (Space for 6 to 75 nests): 117 Streams with a small productive potential (Space for 1 to 5 nests): 75

The standards on which the above groupings are based are, of course, arbitrary and are intended only to provide a convenient system of classification. Productive potential is defined as the capacity of a stream to produce sea lampreys, expressed as the number of nests which may be constructed on the spawning sites available when:

- Certain less variable factors such as quality of gravel (Spawning material), gradients, velocities, and stream sizes are believed to be satisfactory for reproduction.
- .2. Highly variable factors such as temperature and effects of freshets, which cannot be accurately evaluated (in most situations) on the basis of available information, are considered as favorable.
- 3. Survival of larvae from the nests may be anticipated to be normal.

Streams in which adult sea lamoreys were observed or reported (see also table 23):

- 1950 survey area: 7 (Additional records available from 1951 rechecks will be presented in a later report.)
- 1951 survey area: none (Most of the streams were examined after the spawning season.)

Streams in which sea lamprey nests were observed or reported (see also table 23):

1950 survey area: 14 (Additional records available from rechecks made in 1951 will be presented in a later report).

1951 survey area: 1

It is probable that nests were present in other streams but were not observed because:

- The general rarity of nests in the Lake Superior region would make it entirely possible to miss an occasional single nest.
- 2. The brown color of many streams may have obscured some nests.
- 3. Nests may have been destroyed in streams examined long after the spawning season.

Streams in which sea-lamprey larvae were obtained (see also table 23):

- 1950 survey area: 1 (Almost all streams were examined for larvae; lamprey larvae of several species were obtained from 23 streams).
- 1951 survey area: none (No streams in this area were checked for larvae).

Streams upon which some type of control may eventually be necessary:

1950 survey area: 112

1951 survey area: 136

Tributary streams in this group can be controlled by devices placed on main streams. The need for control on many of these streams can be determined only by future examination.

Stream mileages: Over 1,300 miles of stream were surveyed in 1950; the combined lengths of all streams in the area amount to considerably more than that. The lengths of all streams in the 1951 area aggregate over 1,500 miles, of which several hundred miles were surveyed.

Scandards and methods

Criteria used in estimating the productive potentials of Lake Superior basin streams were established during a study of the life history of the sea lamprey by Applegate (1950).

The life history of the sea lamprey in the Great Lakes can be summarized as follows. In the spring the adults ascent streams and spawn on gravel. After a short period of incubation the eggs hatch and the larvae emerge. These larvae, carried downstream by the current, dive for and burrow into the bottom when quiet water is reached. Metamorphosis takes place after a larval life of about 4 years. The resulting sexually immature adults are carried by high water to the lakes where the parasitic life of 12 to 20 months begins.

For successful completion of the stream phases of the life cycle, certain known basic conditions among others must prevail in the streams. Suitable larval habitat consisting of soft (sand or silt) bottom material must be present in the streams proper or in their estuaries. In order to spawn, adult lampreys require (1) water temperatures of about 53° F. or above, (2) water velocities of 1 to 5 feet a second, and (3) the presence of suitable gravel formations (or other hard elements such as clam shells) for nest building (Applegate 1950). These factors were found to be of optimum quality in certain streams when (1) water temperatures were between 60° F. and 70° F.; (2) water velocities ranged from 1 to 3 feet a second; (3) stream-bed formations consisted of concentrated gravel of ideal size $(3/l_1)$ inch to 3 inches in diameter) in bars or ridges which formed riffle areas. These criteria are based on studies of lampreys in streams flowing into Lakes Huron and Michigan. It is suspected that spawning may be inhibited in many Lake Superior streams by certain conditions which are common in that area, such as colder water temperatures, steep gradients, sudden freshets, and heavy turbidity due to lake clay.

The streams were examined by walking or canoeing along their courses for the distance required to determine their productive potentials; if abundant spawning habitat or an obvious barrier was found in a stream section just above the mouth, examination of that stream was discontinued; streams in which gravel was lacking were surveyed from mouths to headwaters to make certain of the lack.

Standardized methods and techniques were employed so far as it was practical to do so. The necessity for covering a large amount of territory demanded deviation from preferred methods (usually the employment of visual estimates instead of measurements) often enough to warrant an explanation of those actually used in this particular survey.

5

Stream lengths: Computed from county maps (Michigan Department of Conservation); a correction factor (variable) based on the estimated increase due to meandering, was applied to each computed length.

Stream widths: Average widths were computed from a series of measurements and visual estimates taken at varying distances apart; accurate measurements (steel tape) were made at potential control sites, and at most points where lampreys, nests, and suitable spawning habitat were located. At the beginning of the 1950 survey, the majority of widths were determined by direct measurement. As the season progressed and biologists became more experienced, most widths were determined by visual estimates checked frequently by tape measurements.

Stream depths: Depths were determined at the time widths were recorded. Accurate depth measurements in shallow streams were made with a yardstick. The average depth of a stream at any one point was calculated from measurements at the stream center and at points midway between the center and the edges. Individual depths in deep streams (often turbid) were obtained with a sounding line.

<u>Water velocities:</u> Velocities were determined at the time widths and depths were recorded. At the beginning of the survey, velocities at individual points were taken by the "chip" method (velocity in feet per second was calculated from the time required for a small glass vial half filled with water to float over a measured distance; an average was obtained from three measurements). As the survey progressed, velocities were determined by visual estimates, checked frequently by the chip method. The chip method was impracticable in many small streams because of obstructions.

Water temperatures: Taken with Taylor pocket thermometers to the nearest degree Fahrenheit.

Gradients: Determined by visual estimation, and classified as follows:

Slight: Stream bed appearing to be flat or with slight evidence of gradient.

Steep? Appearing to be approximately 1° or more.

Moderate: Between slight and steep.

Visual estimates were accurate enough for the purposes of this survey. Gradients were noted frequently.

Bottoom types: The total amounts of each type were arrived at by visual estimates. Soft bottom was classified as sand, silt, mud, and clay. The presence of hardpan was also noted. Hard bottom was classified as bedrock, boulders (12 inches in diameter and up), rubble (3 inches to 12 inches in diameter), large gravel (3/4 inch to 3 inches in diameter), and small gravel (1/4 inch to 3/4 inch in diameter).

Spawning sites: Gravel deposits were classified as follows (in order of suitability):

- 1. Concentrated
 - a. Gravel bars and ridges on riffles.
 - b. Continuously flat, pavement-like formations in riffle areas.
- 2. Scattered
 - a. Patches of large gravel.
 - b. Discontinuous, variable amounts of gravel in or upon other substrata.
 - c. Gravel mixed with rubble and boulders.

Possible number of nests: A visual estimate was made of the possible number of nests which could be constructed on the gravel formations present.

Barriers: Classified as natural or man-made. Great Lakes sea lampreys cannot ascent smooth perpendicular barriers which are 3 feet or more in height. Their ability to ascend broken and irregular rock formations is greater; they have been observed negotiating a falls 7 feet high, which had a face of irregularly eroded limestone.

Adult lampreys and nests: Locations and numbers of nests were recorded with accompanying notes on type of spawning material, quality of gravel formations, and other factors. The numbers of adult lampreys were recorded in relation to activity (swimming, resting, spawning), condition (unspawned, partially spawned, spent, dying, or dead), and location. Samples of lampreys were collected and preserved.

Larval lampreys: During the 1950 survey, almost all streams were examined at various distances below spawning habitat for larvae, which were collected from all types of habitat by digging. All larvae were preserved for identification. No attempt was made to collect larvae in 1951. Color of streams: Classified as brown or colorless, by visual examination.

Turbidity of streams: Classified as clear, or slightly, moderately, or heavily turbid.

Water levels: Annual fluctuations were determined by noting high-water marks and condition of stream at time of examination. When possible, the characteristics of individual streams in relation to extent of precipitation were recorded. Special attention was paid to water-level conditions at proposed control sites.

Pollution: Sources of industrial and domestic pollution were noted (visually) and recorded.

General topography and geographical features: Stream banks, flood plains, and the surrounding country were described. General measurements such as heights, widths and contour were recorded. Soil and plant types were noted, although not in great detail. Road conditions, location of power lines, and relative accessibility of streams and proposed control sites were noted.

Location of control sites: Potential control sites were located in most streams which were found to have productive possibilities. Criteria for selecting control sites (for mechanical weirs; barrier dams, and electrical devices) were established during experimentation with various types of control devices (Applegate and Smith 1951). Flora and fauna: Only limited observations were made. Exceptional conditions (for example, extreme abundance of aquatic plants) were noted. A limited amount of seining for fish was done.

Evaluation of streams

For the sake of convenience and simplicity, the entire Michigan watershed of Lake Superior has been divided into 22 areas (figs. 2-23; tables 1-22), each of which is discussed separately.

With each figure and table are brief comments on the area and its streams, factors which may inhibit or prevent spawning in the future, and control possibilities.





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| Name of stream \mathcal{I} | County, township line, renge, and section no. at mouth | Lengta of stream in milea 2/ | width of atream 3/ in ft. 3/ | depth depth of straam 3/ in ft. 3/ | Fange in gredient <u>3</u> / | Ranga in valucity in ft./aac. 3/ | Tampara- tures in dagreas F. | Deta | Product1ve potential | Possible limiting factors | Typa of contral passible <u>4</u> / |
|------------------------------|--|--|---------------------------------------|--|---------------------------------|--|------------------------------------|-----------|-------------------------|------------------------------|---|
| Tabquemenon River | Chippewa, 48-6-14 | 20.0 | 300.0 | 0*8 | Slight-moderate | Sluggish-5.0 | 59-68 | 6/6-6/29 | Madlum | Spewning eites, welosity | Electricsl |
| Obriens Creek | Chippewa, 49-6-27 | 2.0 | 4°0 | 1.5 | Slight-moderate | Sluggiah-2.5 | 52-68 | 6/9-7/10 | Small | Tempersture | Mechenical mair & tren |
| Betsy Myvar | Chippewa, 49-6-2 | 42.0 | 25°0 | 2.0 | Slight | Sluggiab-3.0 | 55-71 | 6/13-7/10 | Larga | None | Electricel |
| Craek # 1 | Chippewa, 50-7-1 | 0.25 | 6.0 | 0.5 | Slight | 1.25 | 63 | 6/28 | Small | Shifting bottom | lechanical weir & fran |
| Vermilion Creek | Chippewa, 50-7-2 | 0.25 | 10.0 | 1.0 | Slight | 2°0 | 65 | 6/26 | hadium | Shifting bottom | Mechanical weir & tran |
| Craek # 2 | Chippewa, 50-7-4 | 0.05 | 5.0 | 0.33 | Slight | 1.25 | 56-68 | 6/27-7/2 | Small | Shifting bottom | Wechenicel weir & trap |
| | | | | | | | | | | | |

Lat includes only those streams which sppear to have a productive potential or for which control devices have been recommended.

"Langth" is the meseurament of that portion of the stream surveyed, and is composed of a celculation of map distance plus application of a correction fector (veriable) compiled from field meseuramenta. The atream length figures differ from totel langth in ell cases where barriar dams or field conditions terminated the area useble by see lamprays short of the hoadwatera. ने ले

Appliceble only to the surveyed portion of the stream. ল ৰা

From an engineering standpoint, elactrical control devices can probably be installed in all streams for which mechanical devices here recommended.

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Figure 2.--Area 1.

Description of Area 1 (Fig. 2)

numerous small coastal streams. Adult sea lampreys and nests were observed only in the Tahquamenon a greater extent in portions of the North Branch of the Betsy River. The Tahquamenon River is much it is much smaller, the Betsy River presents a similar problem. Creeks Nos. 1 and 2 are relatively and sandy-bottomed. Most of them drain extensive bogs and swamps, and flow through thick tag alder River just below the Lower Falls . Limited potential spawning habitat is present at that point and near the mouths of four small coastal streams (table 1). Potential spawning habitat is present to too large for mechanical control devices; an electrical control device is recommended. Although Embraces most of the western portion of Chippewa County, Mich., and contains a few large and inaccessible. All but a very few of the streams are brown in color, of relatively low velocity, flood plains. The soil, which is generally sandy and poor, supports a jackpine - white pine popple climax type. Topography is gentle.

Table 2.--Productive potentiel, recommended control devices, and miscellanous fectors concentring streams in Aree 2 (Survey made in 1950)

| Type of control 4/ possible 4/ | Mechenicel weir & trep | Electricel |
|--|--|--|
| Possible limiting factors | Spewning aitee, tempereture, velocity | Spawning sites, shifting bottom, tempereture |
| Productive potential | Medium | Međium |
| Date | 7/2-7/3 | 7/4-7/8 |
| Tempere- tures in degrees F. | 50-54 | 53-76 |
| Range in velocity in ft./sec. 3/ | 0.75-1.25 | 1.0-2.0 |
| Fange in gredient 3/ | Slight | Slight |
| Average depth of stream in ft. 3/ | 0.66 | 2.0 |
| Averege width of etreen <u>3</u> / in ft. <u>3</u> / | 8.0 | 20.0 |
| Length of stream in miles 2/ | 5.0 | 32.0 |
| County, township line, renge, end section no. et mouth | Luce, 50-8-16 | Luce, 50-9-24 |
| Neme of stream <u>1</u> / | Three Mile Creek | Little Two Reerted R. |

List includes only those streams which sppear to have a productive potential or for which control devices have been recommended.

"Langth" is the meeurement of thet portion of the atream surreyed, and is composed of a celculation of map distance plus application of a correction fector (variable) compiled the restrict meeting the stream length figures differ from total langth in all ceeds where field conditions termineted the area useble by see lampraye about of the head each area. নিল

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Applicable only to the surveyed portion of the streem. From an angineering standpoint, electrical control devicee can probebly be installed in ell atreems for which machanical devices have haan recommanded.



Description of Area 2 (Fig. 3)

climax type is predominantly coniferous. The topography is low and accordingly much of the area erally brown in color, of relatively low velocity, and sandy-bottomed; they flow through flood plains covered with a dense growth of tag alder. The soil is sandy and poor, and the forest mechanical control, and an electrical device is recommended. The streams in the area are gen-Embraces a portion of eastern Luce County, Mich., and contains only two streams and their tributaries. No adult sea lampreys or nests were observed, but both main streams contained potential spawning habitat. The Little Two Hearted River is probably too large for practical consists of bogs and swamps.

Table 3. -- Productive potentiel, recommended control devices, and miscellaneous fectors concerding streams in Ares 3 (Survey made in 1950)

| Name of atreem <u>1</u> | Coupt libe, secti | y, township renge, sud ou no. st.mouth | length of etreem in miles 2/ | Averege width of stream 3/ in ft. 3/ | Average deptb of etreem 3/ in ft. 3/ | Pange in 3/ gredient 3/ | Range in velocity in ft./sec. 3/ | Tempere- tures in degrees F. | Date | Productive potentiel | Possible limiting fectors | Type of control possible <u>4</u> / |
|-------------------------|-------------------------|--|--|--|--|----------------------------|--|------------------------------------|-----------|-------------------------|------------------------------|---|
| Two Heerted River | Luce, | 50-9-27 | 10.0 | 50.0 | 4.0 | Slight | 1.0-3.0 | 53-68 | 7/11-7/13 | Large | Tempersture | Electricel |
| E. Br. Two Heerted R. | Iuce, | 50-10-1 | 25.0 | 25.0 | 1.5 | Slight | Sluggieh-3.0 | 51-72 | 7/11-7/22 | Lerge | Tempereture | 5/ |
| W. Br. Two Reerted R. | Iuce, | 49-9-6 | 50.0 | 30.0 | 3.0 S | light-moderete | 1.3 | 53-65 | 7/13-7/31 | Large | Tempereture | 2/ |
| Dewson Creek | Luce, | 49-10-29 | 20.0 | 15.0 | 1.0 S | light-moderate | Sluggieh-2.25 | 56-61 | 7/25-7/26 | Parge | Temperature | 5/ |
| N. Br. Two Rearted R. | Iuce, | 48-11-1 | 30.0 | 10.0 | 0.66 | Slight | Sluggieh-1.0 | 57-65 | 7/28-8/3 | Medium | Tempere ture | 5/ |
| Deed Sucker River | Luce, | 50-11-34 | 8.0 | 20.0 | 1.0 | Slight | Sluggish=2.5 | 56-65 | 8/5 | Medium | Velocity | Electricel |
| | | | | | | | | | 4 . q | | | |

List includes only those streams which appear to have a productive potential or for maich control davices have been recor

"legth" is the messurement of thet portion of the stream surveyed, and is composed of a celculation of map distance plue application of a correction factor (variable) compiled from field messurements. The atream length figures differ from total length in all cases where field conditions terminated the area usuble by sea lambraye ahort of the headwetere. ने ले

Appliceble only to the surveyed portion of the etreem.

From an engineering stendpoint, electrical control devices can probebly be installed in ell streams for which mechanical devices beve been recommended.

Streem tributery to enother upon which it would be more precticel to place a control device. ल के जे



Figure 4.--Area 3.

Description of Area 3 (Fig. 4)

swamps. The streams of the Two Hearted River system are brown in color and of moderate water velocity; River. Unlimited facilities for spawning are present throughout much of the Two Hearted River system; Embraces the northern portion of western Luce County, Mich., and contains only two streams, both of which are large. Limited amounts of potential spawning habitat are present in the Dead Sucker swamps. The topography is low. The soil is sandy and poor and accordingly the forest climax type is several adults, larvae, and over 60 nests were observed in 1950 in this watershed. Both streams are too large for practical mechanical control devices; electrical devices are recommended. The Dead they flow through flood plains covered with dense stands of tag alder and drain extensive bogs and Sucker River is clear and of relatively low velocity; it drains an extensive low area of bogs and predominantly coniferous.

Table 4.--Froductive potentiel, recommended control devices, and miscellacourd fectors concerning etremme in Area 4 (Survey made in 1950)

| Name of stream 1/ | County, township line, recge, and section po, at mouth | Length of stream in miles 2/ | Averega width of stream <u>3</u> / in ft. <u>3</u> / | Averaga depth of etream in ft. 3/ | Range in gradient 3/ | Ranga in valocity io ft./eec. <u>3</u> / | Tempera- turae 10 degrace F. | Date | Productive potential | Possibla limi ting factors | Type of costrol poesibla 4/ |
|-------------------|--|--|--|---|-------------------------|--|------------------------------------|----------|-------------------------|--|-----------------------------------|
| Sucker Myer | Alger, 49-13-4 | 30.0 | 25.0 | 1.0 | Slight-moderate | 1.0-5.0 | 52-65 | 8/7-8/18 | Large | Velocity, * emmere *:!*e | Electrical |
| Beker Creek | Algar, 49-13-4 | 7.0 | 10.0 | 0.66 | Slight | 0.75-1.0 | 1 | 1 | Small | Spawning sites, | Machaoicel |
| Creek#1 | Alger, 49-13-5 | 0.3 | 1.5 | 0.12 \$ | Slight-moderate | 1.0-2.0 | 59-67 | 6/8 | Small | Temperetura, Temperetura, | Mechanical |
| Craek # 3 | Alger, 49-13-6 | 0.75 | 5.0 | 0.16 | 311ght-moderate | 1.0 | 57-60 | 6/8 | Small | graurenus Tempareture, arediente | Mechanical Weir & tran |
| Creek # 4 | Alger, 49-13-6 | 0.3 | 1.0 | 0*08 | 311ght-moderate | 0.5 | 55 | 6/8 | Small | Width, depth. | Mechanical weir & tran |
| Sable Greek | Alger, 49-14-2 | 0,5 | 15.0 | 1.0 | Slight-moderata | 1.25-2.0 | 64 | 6/8 | Medium | Spawnlog sitee, velocity. | Electrical |
| | | | | | | | | | | temperature | |

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Liet iccludes only those atreems which appeer to have a productive potential or for which control devices have heen recommended.

"Length" is the messurement of thet portion of the stream eurospeed, and is composed of a calculation of map distance plus application of a correction factor (variable) compiled from full messurements. The stream length figures differ from total length in all cases where field conditions terminated the area usable by sea lampreys short of the headed reads. नेले

Appliceble only to the surveyed portion of the stream. ল ৰা

From an apgineering standpoint, electricel control devices can probably be installed in all streame for which machanical devices have been recommended.



Figure 5.--Area 4.

Description of Area 4 (Fig. 5)

of West Bay and the mouth of Sable Creek. The soil is sandy and poor, and accordingly the forest Creeks Nos. 1, 3, and 4, and Sable Creek. The Sucker River is too large for a practical mechania rule, gentle; an exception is the steep snoreline of former glacial Lake Nipissing, just south flood plains covered with heavy stands of tag alder, hardwoods and cedar. The topography is, as cal control device; an electrical device is recommended. Mechanical control devices can be con-Embraces the northeast portion of Alger County, Mich., and contains six streams which are structed in the remaining streams, but fluctuations in water volumes may be a problem. The streams in the area are generally brown in color and of moderate velocity; they flow through accessible to the sea lamprey. Sea lamprey nests were observed in the Sucker River in 1950. Extensive spawning habitat is present in that river and to a limited extent in Baker Creek, climax type is predominantly coniferous. Much of the area is cut and burned over.

Table 5.--Productive potential, recommanded control devices, and miscallaneous fectors concerning streams in Area 5 (Survey made in 1950)

| ype of ontrol sseible 4/ | echenicel | echenical | echenicel | 5/ | 5/ | 5/ | 5/ | |
|--|--|-----------------|------------------|-----------------|---------------|---------------------|-----------------|--|
| T Posaible limiting c fectore p | Valocity, gradiant, M and tamparature | Temperature | Tampareture W | Tempersture | Tamperatura | Gradiant, valocity, | Temperstura | |
| Productive potantiel | Larga | Medium. | Large | Madium | Medium | Medium | Small | |
| Date | 1 | ł | 1 | 8/10 | 9/10 | 9/4 | 9/10 | |
| Tampara- turas in defraes F. | 4 1 1 | | | 50 | 56 | 54 | 49-55 | |
| Range in valocity in ft./sec. 3/ | 1.0-5.0 | 1.0-4.0 | Sluggi ah-3.0 | Sluggiab-1.0 | 1.25 | 1.0-2.0 | 0.75-1.0 | |
| Range in 3/ gredient 3/ | Slight-steep | Slight-moderate | Slight-modarete | Slight-moderete | Slight | Slight-ateep | Slight-modarete | |
| Avarege depth of atream 3/ in ft. 3/ | 1.0 | 0.58 | 1.0 | 1.0 | 0.5 | 0.25 | 0.5 | |
| Averege width of etraem <u>3</u> / in ft. <u>3</u> / | 20.0 | 5.0 | 20.0 | 15.0 | 6.0 | 6.0 | 4 ° Ü | |
| Length of atreem in miles 2/ | 12.0 | 6.0 | 10.0 | 3.0 | 4 。 0 | 3.5 | 3.5 | |
| , township range, end 1 Do. et mouth | 49-15-3 | 49-15-9 | 49-16-25 | 49-16-17 | 48-16-17 | 48-16-13 | 48-17-13 | |
| County, lire, J sectior | Algar, | Algar. | Alger. | Alger. | Alger. | Alger. | Alger, | |
| Name of atream <u>1</u> / | Hurricana Creek | Sulliven Greak | Seven Mile Crsek | Lownay Craak | Tributary # 7 | Tributery # 6 | Tributary # 5 | |

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List includae only those atreams which eppear to beve e productive potentiel or for which control devices heve been recommended.

"Legth" is the meesurement of thet portion of the streem surveyed, and is composed of a celculation of map distance plus application of a correction fector (variable) compiled from field meesurements. The stream length figures differ from total length in all ceses where field conditions tarmineted the eres usoble by see lambrays short of the heedweters. निले

Applicable only to the aurveyed portion of the streem. 0 4 0

From en sugineering standpoint, electrical control devices cen probebly be installad in all streams for which mechanical devices bere been recommended.

Stream tributery to another upon which it would be more practical to place a control device.



Figure 6.-Area 5.

Description of Area 5 (Fig. 6)

is relatively inaccessible. Migrations to the streams of the Beaver Lake watershed can be constreams in which spawning facilities are accessible to upstream migrants (table 5). Mechanical Beaver Lake Creek is interesting in that it forms an exact line of demarcation between the low, (often overlying bedrock) which is predominant to the west. Gradients are steep and velocities The latter trolled by a device in Beaver Lake Creek; most of the streams in this system are relatively sandy country extending east to the Tahquamenon River and the more rugged sandy-loam country Embraces the north-central portion of Alger County, Mich., and contains at least seven inaccessible. Stream gradients are slight to steep and water velocities vary accordingly. are higher in many of the western streams. Hardwoods are predominant on the better soils control devices can be constructed in Nurricane, Sullivan, and Seven Mile Creeks.

Table 6.--Productive potential, recommended control devices, end miscelleneoue factors concerning streems in Aree 6 (Survey made in 1950)

| | ontrol | achenicel eir & trap | 2/ | 5/ | fechanicel eir & tran | 5/ | fechanical eir & tran | echanical eir & tran | echulcal | echanical | terna & trap | eir & trup schanical | teir & trap fechanical | reir & trap Nectricel | 2/ | llectrical | <u>5</u> / | 2/ | 5/ | dechanicel reir & tran | dechanicel veir & trap | |
|---------------------|---|--|------------------------------------|------------------------------------|--------------------------|-----------------|--------------------------|-------------------------|-----------------------|-----------------------|------------------------------------|--------------------------------------|------------------------------------|------------------------------|---------------------|------------------------------|--------------------------|---------------------------------|-----------------|---------------------------|---------------------------|--|
| E | Poseible limiting c fectors p | Scouring et mouth, W pertiel berrier, W | temperature Gredient, valocity, | temperetura Gredient, velocity, | Velocity, Velocity, v | Velocity, | Tempereture | Gredient, velocity, N | Gradient, velocity, k | Grediect, velocity, N | tempereture "Gradient, velocity, M | temperature Gradient, velocity, N | tempereture Gradient, velocity, | temperature Temperature E | Gradient, velocity, | temperature, Tempereture, | velocity Temperature, | Velocity Gradient, velocity, | Temperature | Temperature 1 | Temperature, dry A | |
| | Product1ve potent1e1 | Medium | Small | Medium | Large | Small | Large | Small | Small | Small | Small | Small | Spell | Nedi un | hedium | Large | Wedium | Medium | Small | Small | Small | |
| | Date | 9/11 | ł | 9/14 | 9/14 | 9/14 | 8/6-2/6 | 9/16-9/18 | 9/16 | 9/16 | 9/16-9/18 | 9/16-9/18 | 8/16-9/18 | 9/16-9/28 | 9/16 | 61/6 | 9/28-9/30 | 9/20 | 9/20 | 9/19 | 9/18 | |
| Tomore | tures in degrees F. | 58 | | 48-50 | 53 | 51 | 50-60 | 46+50 | 46 | 48 | 51 | 46-50 | 46-48 | 46-50 | 50 | 54 | 51-52 | 50-53 | 48-49 | 51 | 53 | |
| Danza in | velocity in ft./sec. 3/ | Slugg1sh-1.0 | 1.0-3.0 | Sluggi sh-3.0 | 1.0-3.0 | 1.0-3.0 | 0.75-1.25 | 0.75-1.25 | 0.75-1.25 | 0.75-1.25 | Sluggieh-0.75 | 0.75-1.25 | 0.75-1.25 | 0.75-2.0 | 1.0-3.0 | Sluggish-3.0 | 0.75-2.0 | Sluggi sh-2.0 | 0.75-1.0 | Sluggieb | luggieh-0.75 | |
| | Range 12 gredient 3/ | light-moderete | light-steep | light-steep | light-steep | light-moderate | light-moderete | ligh t- steep | light-steep | light-steep | light-moderete | light-steep | light-steep | Slight | light-steep | light-moderate | light-eteep | light-steep | 1 | Slight | Slight S | |
| average depth | stream $\frac{3}{10}$ | 2°0 S | 0.33 S | 0.33 \$ | 0.5 | 0.12 \$ | 0.5 | 0.08 S | 0.08 | 0.08 S | 0.33 5 | 0.16 S | 0.25 5 | 1.0 | 0.25 5 | 1.0 \$ | 0.5 S | 0.5 | 0.04 | 0.25 | 0.33 | |
| Average | stream 3/ in ft. 3/ | 18.0 | 20.0 | 4.0 | 15.0 | 5.0 | 15.0 | 2°0 | 2.0 | 2.0 | 4.0 | 2.0 | 3.0 | 10.0 | 10.0 | 12.0 | 6.0 | 10.0 | 2.0 | 2.0 | 4 • O | |
| of | in miles 2/ | 1.0 | 0.25 | 2.0 | 3.0 | 0.25 | 4.0 | 0.75 | 0.25 | 0.25 | 0.5 | 0.5 | 0.25 | 10.0 | 0.3 | 0.75 | 4.0 | 6.0 | 0.3 | 2.0 | 0.75 | |
| Provinskie komochia | county, commany line, renge, end section no. et mouth | Alger, 48-17-21 | Algar, 48-17-28 | <u>Alger</u> , 48-17-29 | <u>Alger</u> , 48-18-25 | Alger, 48-18-31 | Alger, 47-18-3 | Alger, 47-18+30 | Alger, 47-19-36 | Alger, 47-19-36 | Alger, 47-19-36 | Alger, 46-19-1 | Alger, 46-19-1 | Alger, 46-19-2 | Alger, 46-19-11 | Alger, 47-19-29 | Alger, 47-19-29 | Alger, 47-19-29 | Alger, 47-20-25 | Alger, 47-19-19 | Alger, 47-19-18 | |
| | Name of stream <u>1</u> / | Chapel lake Creek | Tributery # 13 | Tributary # 16 | Mosquito River | Tributary # 17 | Miners Ruyer | Creek # 22 | Creek # 23 | Creek # 24 | Creek # 25 | Creek # 26 | Creek # 27 | Anna Ruver | Wegner Creek | Furnace Creek | Gongeeu Creek | Hanson Crcek | Tributery # 5 | Creek # 6 | Creek # 7 | |

List includes only those streams which appear to heve a productive potential or for which control devices have been recommended.

"Langth" is the messurement of that portion of the streem eureyed, and is composed of a calculation of map distance plue application of a correction factor (variable) compiled from field measurements. The stream langth figures differ from total langth in all ceses where field conditions terminated the area useble by sea lampreys compiled from field measurements. short of the headwaters. ने ले

Applicable only to the surveyed portion of the atream. From an engineering standpoint, electrical control devices can probably be installed in all streams for which mechanical devices have deen recommended. Stream tributary to another upon which it would be more practical to place a control device. লাৰ্শাল

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Figure 7.-Area 6.

Description of Area 6 (Fig. 7)

streams are irregular due to the presence of rubble, boulders, and bedrock. The topography of the area is relatively rugged. The sandy-loam soil overlies a bedrock substratum. Hardwoods Embraces a portion of northwestern Alger County, Mich., and contains at least one stream which was utilized by sea lampreys in 1950. Nests were observed in Miner's River; dead adults a mechanical weir is recommended for Miner's River and an electrical device for Furnace Creek. gradients range from slight to steep and velocities vary accordingly. The bottoms of several Both streams have a large productive potential; Fifteen other streams contain spawning facilities. Chapel Lake Greek and the Mosquito River predominant. Grant Island which lies off the shore of Area 6 has not been examined. The streams of the area are both clear and brown in color; were observed at the mouth of Furnace Creek. are relatively inaccessible. are

Table 7.--Productive potential, recommended control devices, and miscallaneous factors concerning streems in Aree 7 (Survey made in 1950)

| Type of control 4/ | Electricel | 2/ | 5/ | 5/ | <u>ହ</u> / | 5 | 2 | <u>5</u> / | Electricel | 5 | 2 | 2/ | <u>5</u> / | 2/ | 2 | Electricel |
|---|--------------------|--------------------------|----------------|---------------|-----------------|----------------|----------------|-----------------------|-----------------|----------------|--------------------------|-------------------|-----------------|---------------------|---------------------|--------------------------|
| Poesible limiting fectors | Grediect, velocity | None | Gradient, | Temperature | Tempere ture | Tempera tu re | Temperature | Wetar level | Temperature, | Temperatura | Tempereture, size | Temperature, size | Temperature | Gradient, velocity, | Gradient, velocity, | Gradient, tempereture |
| Product1ve potential | Small | Medium | Medium | Medium | Small | Small | Medium | 2 | large | Medium | Small | Smell | Med1um | llems | Stue 11 | Large |
| Date | 1 | 9/30 | 9/27-9/28 | 9/22 | 9/22 | 1 | 1 8 | 10/4 | 9/21 | 10/8 | 1 | 1 | 10/7 | 1 | 1 | 9/21-10/6 |
| Tempere- tures in degrees F. | 1 | 59 | 51-52 | 48-51 | 48 | 48 | 48 | 47 | 53 | 47 | - | - | 47 | | | 47-55 |
| Range in velocity in ft./sec. 3/ | Sluggieh=l.0 | Sluggieh | 1.0-2.25 | 0.75 | 0.75 | 1.0 | 1.0-1.25 | Veriea | 1.0-1.25 | 0.75-1.0 | 1.0 | 1.0 | 0.75-1.0 | Sluggish | Sluggish | Sluggish-4.0 |
| Ranga in 3/ gradient 3/ | Slight-steep | Slight | Slight-ateep | Slight | Slight-moderate | 1 | Slight | 1 | Slight-moderate | Slight | Sligh t-m oderate | Slight-modereta | Slight-moderete | Slight-eteep | Moderete-steep | Slight-moderate |
| Averege depth of etream 3/ in ft. 3/ | 0.25 | 3,0 | 0*2 | 0.5 | 0.5 | 0.33 | 0.33 | Variee | 0.66 | 0.25 | 0.5 | 0.25 | 0.5 | 0.5 | 0.5 | 1.0 |
| Avarage width of etream <u>3</u> / | 5.0 | 100.0 | 6.0 | 7.0 | 12.0 | 5.0 | 10.0 | 25.0 | 20.0 | 4 . 0 | 3.0 | 4.0 | 8.0 | 15.0 | 15.0 | 20.0 |
| Length of etream in milee 2/ | 0.1 | 10.0 | 6.0 | 0°6 | 4.0 | 6 | 3.0 | 6.0 | 22.0 | 6.0 | 3.0 | 6.0 | 10.0 | 1.0 | 1.5 | 30.0 |
| cunty, township ine, range, and ection no, et mouth | lger, 47-20-28 | lger, 47=20+29 | lger, 47-20-32 | lger, 46-20-8 | lger, 46-20-8 | lger, 46-20-16 | lger, 46-20-18 | lgar, 46-20-18 | lger, 47-21-15 | lger, 47-21-22 | lger, 47-21-27 | lger, 47-21-27 | lger, 46-21-15 | lger, 47+21-18 | dger, 47-21-18 | lger, 48-22-26 |
| Name of stream <u>1</u> | Creek # 10 A | Au Traic River (lower) A | Joel's Creek | Gols Creek | Buck Bay Creek | Tributery # 4 | Addis Creek | Au Trein R. (upper) A | Rock River | Nelson Creek | Tributery # 1 A | Tributary # 2 💧 | Silver Creek | Tributery # 7 A | Tributery # 8 | Laughing Whitefish R. |

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List includes only those streams which appear to have a productive potential or for which control devices have been recommended. "Incgat" is the measurement of thet portion of the stream surveyed, and is composed of a calculation of map distance plus sphintation of a correction factor (variable) compiled from field measurements. The stream length figures differ from total length in all cases where field conditions to minated the area useble by see lampreys abort of the headwaters. Applicents only to the surveyed portion of the stream. Applicents only to the surveyed portion of the stream. From an engineering standpoint, alectrical control devices cen probably be installed in all streams for which mechanical devices have been recommended. Stream thuburer to another upoo which it would be more practical to place a control device. नेले

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Figure 8.-Area 7.

Description of Area 7 (Fig. 8)

Rock River. These three rivers are too large for practical mechanical control; electrical devices devices (mechanical) need be placed only in Creek No. 10 and Deer Lake Creek. The streams of the Embraces part of the northwestern portion of Alger County, Mich., and contains at least two Laughing Whitefish Rivers. Adult sea lampreys were seen in the Au Train and at the mouth of the area are both clear and brown in color and gradients range from slight to steep. The bottoms of are recommended. Spawning facilities are present in 13 other streams, but, at present, control several streams are irregular due to the presence of rubble, boulders, and bedrock. The typo-graphy of the area is relatively rugged. The sandy-loam soil overlies a bedrock substratum. streams which were utilized by sea lampreys in 1950. Nests were observed in the Au Train and Hardwoods predominate.

| devices, | Area 8 | |
|--------------------|--------------------|--------------------|
| anded control | ; atreama in | 11 |
| potential, reconne | factors concerning | urvev made in 1950 |
| Table 8 Productive | and mi acellaneoua | (5) |
| | | |

| | | Length of | Average width | Average depth | | | | | | | |
|---------------------------|--|--------------------------|-----------------------------------|-----------------------------------|-------------------------|--|------------------------------------|-------------|-------------------------|------------------------------|-----------------------------------|
| Name of atream <u>1</u> / | County, township line, range, and section no. at mouth | stream in miles 2/ | of stream in ft. <u>3</u> / | of atream in ft. <u>3</u> / | Pange in gradient 3/ | Pange in velocity in ft./sec. 3/ | Tempera- tures in degrees F. | Date | Productive potential | Possible liniting factors | Type of control possible 4/ |
| | | | | | | | | | | | |
| Sand River | Algar, 47-22-6 | 20.0 | 33.0 | 1.0 | Slight | 0.25-1.75 | 52 | 10/7/50 | Nedium | Tempersture, | Electrical |
| | | | | | | | | | | velocity | |
| E. Br. Sand River | Marquette, 47-23-35 | 9°25 | 6.0 | 0.33 | Slight | 1.75 | 52 | 10/7/50 | Stall | Tamperatura, | 5/ |
| | | | | | | | | | | obstacles | L |
| Chocolay River | b.arquette, 47-24-6 | 23.0 | 46.0 | 1.0 | Slight | 1.0-2.5 | 44-67 | 6/6-9/25/50 | Large | Level fluc., | Electrical |
| | | | | | | | | | | temperaturs ? | |
| E. Br. Chocolay River | Marquette, 46-24-14 | 3.3 | 22 . 5 | 0.9 | Moderate | 1.5 | 51-52 | 9/14,15/50 | Medium | Temperature, | 5/ |
| | | | | | | | | | | level fluc. | 1 |
| W. Br. Chocolay River | Warquette, 46-24-14 | 4.0 | 20.0 | 0*9 | light-steep | 1.5-2.25 | 54-56 | 8/24/50 | Small | Obstacles, | 5/ |
| | | | | | | | | | | temperature | I |
| | | | | | | | | | | | |

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list includes only those streams which appear to bave a productive potential or for which control devices have been recommended. Thegeth is the mesurement of that print of the atterm survey, and is composed of a calculation of map distance puts application of a corrective factor (variable) compiled from the mesurements. The stream langth figures differ from total length in all cases where field conditions terminated the area usable by see lamprove short of the beedwaters. नोन्गे

Applicable only to the surreyed portion of the strear. From an engineering studyoint, electrcal control devices can probably be instelled in all streams for which machanical devices have been recommended. From an engineering studyoint, electrcal control devices can probably be instelled in all streams for which machanical devices have been recommended. लेकोज



Figure 9.--Area 8

Description of Area 8 (Fig. 9)

recommended. The streams of the area are brown in color and gradients range from slight to steep. Embraces the northeast portion of Marquette County, Michigan, and the watersheds of the Sand and Chocolay Rivers. Nests and adults were observed in considerable numbers in the Chocolay; both The area is characterized by rolling to rugged topography, sandy to gravely moraines, fairly rich streams contain appreciable amounts of spawning facilities. Control by electrical devices is soils, and mixed northern hardwood forest.

| otentisl, recommended control devices, | ectors concerning streems in Aree 9 | rvey made in 1950) |
|--|-------------------------------------|--------------------|
| Teble 9 Productive] | end miscelleneous | (5) |

| Type of control possible <u>4</u> / | Electrical | Mechanicel weir & trep | 21/ | Mechenicel weir & trep | Mechenical weir & trap |
|---|--|---|------------------------------|---------------------------|---|
| Possible limiting fectors | Level fluc., tempereture, collutte | potructor Spawning sites, velocity, | Spawaing sites, obstacles | Spawning eites | Spewning ma- teriels, barrier falls |
| Product1¥6 potent1a1 | Medium | Small | Medium | Medium | None |
| Date | 10/5 | 6/30 | 10/1 | 9/30 | 10/2 |
| Tempere- tures in degreee F. | 44-45 | 57 | 58 | 55-57 | 59 |
| Radge in velocity in ft./sec. 3/ | 0.5-2.5 | e Up to 1.0 | 2°5 | 1.0-1.75 | 0.9-1.5 |
| Range in $3/$ | Slight-staap | Slight-moderate | Slight-steep | Slight-steep | Slight |
| Averege depth of stream in ft. 3/ | 0*0 | 0.5 | 0.5 | 0.5 | 0.75 |
| Averege width of etreem in ft. 3/ | 37.5 | 15.0 | 15.0 | 17.5 | 20.0 |
| Length of stream in miles 2/ | 10.0 | 13.0 | B.5 | 8.0 | 13.0 |
| nship , end at mouth | 48-25-36 | 49-25-20 | 49-26-24 | 49-26-2 | 50-26-21 |
| County, tom line, reage section no. | Merquette, | Marquette, | Marquette, | Marquette, | Marquette, |
| Name of stream <u>J</u> | Carp River | Herlow Creek | Bismark Creek | Little Carlic River | Big Garlic River |

List includes only those streams which eppear to have a productive potential or for which control devices have bean recommended. "Length" is the meseurement of the portion of the stream surveyed, and is composed of a calculation of map distance plus upplication of a currective factor (variable) compiled from field mesuremente. The stream length figures differ from total length in all cases where field mesuremented the area usable by see lampreys short of the heedweters. नेले

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Appliceble only to the surveyed portion of the stream. From an engineering standport, electrcel control devices can probebly be installed in ell atreame for which machanicel devices beve been recommended. Stream tributery to another upon which it would be more practical to place a control device.



Figure 10.-Area 9.

Description of Area 9 (Fig. 10)

bottom constituents in many forms are abundant. Rugged, rocky hill and moraine topography pre-dominates except in the narrow coastal sand plain; soils are light to heavy sandy loams over bedrock. control devices are recommended for the Carp and Big Garlic, and mechanical structures for the other Embraces the north central portion of Marquette County, Mich., and includes the Carp, Dead, Big tends to be turbid and polluted in the lower reaches). Gradients range from slight to steep. Hard potentially productive streams. The streams in the area are generally clear and brown (the Carp tributary to Lake Superior. All of these streams except the Dead River, with a barrier near its mouth, are potential lamprey producers but no evidence of utilization was observed. Electrical Garlic, and Little Garlic Rivers, Harlow and Compeau Creeks, and several small coastal streams Northern hardwoods are predominant.

| lcee, | 10 | |
|-------------------------|---------------|---------|
| l dev | Aree | |
| otro | 1 n | |
| dad cou | treems | |
| recommen | arning e | a 1950) |
| iel, | COLCI | ade 1: |
| potent | factore | M Vevin |
| <pre>LOProduct1ve</pre> | miecellanaous | (3) |
| Table 1 | and | |

| Name of stream 1/ | County, township line, renge, and eection no. at mouth | Length of etreau in miles <u>2</u> / | Averaga width of stream <u>3</u> / in ft. <u>3</u> / | Average depth of atream <u>3</u> / in ft. <u>3</u> / | Ranga in <u>3</u> / gradiant <u>3</u> / | Range in valocity in ft./sac. <u>3</u> / | Tampare- tures in degreae F. | Date | Product1 ve potent1 el | Possihls limiting factors | Typa of control poseible 4/ |
|--------------------|--|--|--|--|--|--|------------------------------------|------------|---------------------------|--|-----------------------------------|
| ron Ruver | Mørquette, 51-26-18 | 3.0 | 60.0 | 1.5 | Slight | 1.5 | 60 | 9/28/50 | Small | Spawning sites | Electrical |
| elmon Trout River | harquatta, 52-27-32 | 12.0 | 31.0 | 1.0 | Slight-steep | 1.0-2.5 | 51-54 | 9/27,28/50 | Wedium | Temperature | Lechabical mair & tran |
| ine River | Marquette, 52-28-21 | 3.0 | 30.0 | 1.5 | Slight | 1.0-2.0 | 56 | 9/27/50 | Medium | Spawning sites, temperetura, and | Electrical |
| ueh Creek | Marquette, 52-28-20 | 1.0 | 7.0 | 0.25 | Slight | Up to 1.0 | 58 | 9/26/50 | Small | velocity Ohstacles, velocity | 5/ |
| fountair Stream | Marquette, 52-28-29 | 1.6 | 10.5 | 0.5 b | loderete-steap | ຎ | 57 | 9/26/50 | Medium | Obetaclae, | 5/ |
| Little Buron River | Marquatte, 52-29-17 | 0*4 | 0*6 | 0.5 | 311ght-moderate | 1.5-1.75 | 43-44 | 9/24/50 | Medium | sparning eitze, temparature, obstecle | s Mechenicel weir & trap |

List includes only those streams which appear to have a productive potential or for which control devices have been recommended. "Length" is the mesurement of that portion of the stream surveyed, and is composed of a calculation of map distacce plus application of a corrective factor (variabla) compiled from field mesuremente. The stream langth figures differ from total langth in all cases where field conditions terminated the area usable by see lamprays headwatare. the short of 1

Applicable only to the surveyed portion of the stream. From an engineering standpoint, electrical control devicee can probably be imatalled in all streams for which mechanical davices have been recommended. Stream tributary to another upon which it would be more practical to place a control davice. 2


Figure 11. -- Area 10.

Description of Area 10 (Fig. 11)

and Little Huron. Clear, organically brown streams typify the area. Gradients range from slight to for the Yellow Dog-Iron system and the Pine; mechanical structures are suitable for the Salmon Trout mountainous wilderness characterizes the area. Morainic slopes and ridges occur commonly; soils are Embraces the northwestern portion of Marquette County, Mich., and contains the Yellow Dog-Iron, Salmon Trout, Pine, and Little Huron River watersheds. All have recognizable productive potentials Electrical control devices are recommended steep. Hard-bottom materials are common but soft constituents occur frequently. Rugged, rocky relatively rich, and overlay bedrock. Northern hardwoods and mixed growth predominate. but no evidence of past or present utilization exists.

Table 11. -- Productive potentiel, recommended control devices. end miscelleneous fectors concerning atreems in Aree 11 (Survey made 10 1950)

| de of stream 1/ | County, township line, renge, and section no. at mouth | Length of atreem in miles 2/ | Averege width of stream in ft. 3/ | Averege depth of etream 3/ in ft. 3/ | Range in gradient <u>3</u> / | Range in velocity in ft./sec. 3/ | Tempera- turea in degrees F. | Dste | Froductive potential | Fossible limiting fectors | Type of control possible <u>4</u> / |
|--------------------------|--|--|---|--|---------------------------------|--|------------------------------------|----------------|-------------------------|--|---|
| Ri ver | harquette, 52-29-18 | 12.0 | 31.5 | 1.0 | Slight-steep | 1.5-1.75 | 48-51 | 9/23 | Nedlum | Tempereture, level fluctuetions, obstacles | Electricel |
| Huron River | Barege, 52-30-35 | 4.75 | 25°0 | 0,33 | l'oderetc-steep | 0.0 | 48 | 12/6 | Nedium | Temperature, level fluctuetiose, obsteclee | ات ا |
| # 1 to E. Br. n River | Barege, 51-30-1 | ۍ ۲۵ | 10.0 | 0.33 | Slight-moderete | 1.75 | 48 | 9/21 | Small | Temperature, spewning sites | 2 |
| Huron River | Вагаде, 52-30-35 | 5.0 | 12.0 | 0.66 | b,oderete | 0*0 | 1 | 1 | Nedium | Level fluctuations, temperature, obstacles | آتر |
| River | Baregs, 51-31-4 | 10.0 | £1.5 | 0.5 | Moderete-steep | 0+75-2+0 | 62 | 8/31 | Large | Level fluctuotioos | Mechenical Weir & trep |
| Ravioe River | Barege, 51-31-2 | 6.75 | 6.0 | 0.75 | Modere te-steep | 2.0- 7 | * | 1 | ्राक11 | Spawning si tes, level fluctuations, temperature, obstacles | 5 |
| Ruver | Bsrege, 51-31-8 | 1.0 | 15.0 | 0.5 | Slight-steep | 0.5-1.75 | 59-63 | 8/31 & 9/12 | Medium | Spawning sites, level fluctuetions, herriers | Electricel |
| River | Barege, 51-31-18 | 13.0 | 45 , C | 0.5 | Moders te -ste ep | 1.0-1.75 | 54 | 8/31 | Meðtum | Spawning aites, fluctuetions, tempereture, obstacles | Electricel |

list includes only those streams which eppear to have a productive potential or for which control devices have hose recommended. "Langth" is the measurement of that portion of the stream surveyed, and a composed of a calculation of map distance plus application of a corrective factor (veriable) compiled from tigh" is a new measurement of the stream stream stream is only as where field conditions form maked the eres usable by see lamprus short of the headwaters. निवि

Applicable only to the surveyed portion of the stream. From an engineering standpoint, electrical control devices can probably be installed in all atreams for which machanical devices have been recommended. Stream tributery to acother upon which it would be more prestical to place a control device. लेकोल



Figure 12.--Area 11.

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and their tributaries are potential sea lamprey producers, and in several of them rather questionable clated rocky terrain typifies much of the area, particularly in the east, but old lake sands and wet Ravine, Slate, and Silver River watersheds, and several small coastal streams. All of these streams Slate, and Silver Rivers, and a mechanical structure for the Ravine. The streams of the area are brown in color. Gradients range from slight to steep, and surface velocities vary accordingly. Hard-bottom components of frequently inferior character (as spawning material) are common. Glaevidence of utilization was observed. Electrical control devices are recommended for the Huron, Embraces a section of the northern portion of Baraga County, Mich., and contains the Huron, lowlands are more common to the west and along the Superior shore. Mixed growth composed of dominant hardwoods and some scrub popple forms the forest cover.

| -Productive potential, recommended control devices, | celleneous factore concerning streems in Aree 12 | (Survey made in 1950) |
|---|--|-----------------------|
| Table 12F | and misce | |
| | | |

| Type of control possible 4/ | Mechanical weir & trup |
|--|---|
| Possible limiting factors | Spewning sites, obstacles, valocity |
| Productive potential | Small |
| Date | 9/6/50 |
| Tempera- tures in degraes F. | 56 |
| Range in velocity in ft./ssc. 3/ | 1.0 |
| Range in gradient <u>3</u> / | Slight |
| Average depth of stream in ft. 3/ | 0.25 |
| width of etream 3/ | 0°8 |
| Length of streem in miles 2/ | 10.25 |
| County, township line, range, and section no. at mouth | Barage, 52-33-27 |
| Name of stream <u>1</u> / | Kelsey Greek |

List includes only those streams which appear to beve a productive potential or for which control devices have been recommanded. Twength is the mean mean of that portion of the stream entworked, and is composed of a calculation of map distance plus application of a corrective factor (variable) compiled from file if measurements. The stream lactor figures differ from total length in all cases where field conditions time acted the area usable by see lampraye abort of the beddatere. applicable only to the surveyed portion of the atream. Applicable only to the surveyed portion of the atream. Arom su ecgineering standpoint, electrical control devices can probebly be installed in all atreams for which mechanical devices have been rocommended. নিন্ন

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Figure 13.-Area 12.

Description of Area 12 (Fig. 13)

Embraces a portion of north and northwestern Baraga County, Mich., and contains the watersheds of the Falls and Little Carp Rivers, Little Silver, Backwater, Six Mile, and Kelsey Creeks, and a number of small coastal streams. Only Kelsey Creek has a productive potential; a mechanical conslightly rolling, wet sand plain on the old glacial lake shores. Drainages are poorly defined, and bogs and swamps are common. Soils are light; alder-popple scrub and bog confiers characterize trol device is recommended. This stream is brown in color, has a slight gradient and low water velocity, and contains only a trace of spawning materials. The area is made up of level or the area.

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Table 13.--Productive potential, recommended control devices, and miscallancous factors concerting stresms in Ares 13 (Survey made in 1950)

| | pe of putrol 4/ | - 0T01860 | lectricel | lectrical | 5/ | 5/ | 2/ | 2/ | 2/ | 2/ | 5/ | echaoical eir & trep | |
|------------------|--------------------------------------|----------------------|--------------------------------------|--|---|---|---|-------------------------------|--|--|--------------------------------|---|---|
| É | Possible limiting co | Isctors | Spawning materiels, El level fluc | obstacles Level fluc., El obstacles. | temperature Obstacles, level fluc., | tempereture Level fluc., obstacles, | temperature Ubstacles, velocity, anawning materials | Spawoing sites, obstacles, | temperature Spawoing sites, velocity, obstacles, | temperature Cbstaclee, temperature | Spawning sites, temperature | Level fluc., b. velocity, w temperature | |
| | Froductive | potential | None | Large | Large | Iarge | Small | hedium | ানিয | Small | Small | hedium | |
| | | Date | 8/29 | 9/10 | 9/14 | 6/6 | ł | 1 | 1 | ł | 1 8 1 | 5/3 | |
| | ampere- urea in | egrees F. | 60-62 | 58 | 52 | 50-54 | | 2 | 4 9 1 | 1 | 8 | 52-54 | |
| | ange in T elocity t | n ft./sec. 2/ d | Sluggish=l.5 | l.75- ? | 1.0 -2.25 | l.5-l.75 | Sluggish-1.25 | 0.75-1.5 | Sluggish-1.0 | 1.5-1.75 | 1.75 | 1.0-1.5 | - |
| | Range in ", v | gradient 2/ i | 311ght-moderate | Slight-moderate | Slight-steep | Slight-moderate | Slight | Jight | Slight | Koderete-steep | Woderete-steep | Slight-moderste | |
| Average depth | of atream _ , | in ft. 2/ | 5*9 | 0.66 | 0.75 | 1.0 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 1 | 1.0 | |
| Averege width | of atream | in ft. 3/ | 76.0 | 27.5 | 35.0 | 22.0 | 12.0 | 14.5 | 10.0 | 15.0 | 6.0 | 18•0 | |
| Length of | streem io | miles 2/ | 80.0 | 26.0 | 32.0 | 26.0 | 1.75 | 8.0 | 1.0 | 2.25 | 0*5 | 8° 0 | |
| | County, township lice, renge, and | section no. at mouth | Houghton, 54-33-33 | Berage, 51-34-16 | Houghton, 52-34-14 | Houghton, 51-35-1 | Houghton, 52-35-25 | Houghton, 53-34-32 | Houghton, 53-35-35 | Houghton, 51-35-16 | Houghton, 51-35-19 | Houghton, 53-33-5 | |
| | | Name of stream 1/ | Sturgeon River | W. Br. Sturgeon River | Otter River | N. Br. Otter River | Beer Creek | Sante River | Thirteeo Creek | Bruno Creek | Lake Fifteen Cr. | Pike River | |

List includes only those streams which appear to here a productive potential or for which control devices have been recommended. "Leagth" is the measurement of that portion of the stream surveyed, and is composed of a calculation of map distance plus application of a corrective fector (vuriable) compiled from field measurements. The stream length figures differ from that length in all cases where field conditions terminated the area usable by see lempreys short of the headwaters. নালা

Applicable only to the surveyed portion of the stream. From an engineering standpoint, electrical control devices can prohably be installed to all atreams for which mechanical devices have heen recommended. Stream tributery to another upon which it would be more prectical to place a control device. लेकोल



Figure 14.--Area 13.

Description of Area 13 (Fig. 14)

to steep. Hard-bottom materials are common, but soft components also occur frequently. Much of the Embraces central Houghton County and portions of western Baraga and eastern Ontonagon Counties, facilities. An electrical device is recommended for the Sturgeon; a mechanical structure is suitable for the Pike. The streams of the area are generally brown in color and gradients are slight area lies in the old lake clays region; the topography varies from wet bottoms to rolling hills. Michigan, and contains the Sturgeon, Snake, and Pike River watersheds, and several small coastal The tremendous Sturgeon system and the Pike watershed both contain abundant spawning Forest and agricultural lands occur equally. streams.

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| Table 1 | end 1 | |

| Type of control possible 4/ | Machanical wair & trap | Electricel | 2 | Wechanical Wair & trap | Mechanical weir & trap | kechanical weir & trap |
|---|----------------------------|-----------------------------------|---|--|--|---------------------------|
| Possible limiting factore | Tamperature, obsteclas, | Level fluctuations, pollution, | distance Spawning sites, velocity, pollution | Obstacles, level fluc., temperature | Obstacles, level fluc., temperature | Spewning sites, velocity |
| Product1ws potential | large | Medium | STe 11 | 1. ខេ៨1 ឃោ | Madium | Sma 11 |
| Date | 8/27-9/4 | 6/16 & 17 | 8/17 | 0/27 | 8/27 | 8/16 |
| Tempera- turea in degreae F. | 45-55 | 56~65 | 63~64 | 24 <u>4</u> -25 | 54 | 57 |
| Range in valocity in ft./sec. 3/ | 1.25-1.5 | 1.0-1.5 | 0.75-2.0 | 1.25-2.0 | 1.5-2.25 | Slugg1sh-0.5 |
| Renge in gredient 3/ | Slight-moderata | Moderate | Slight-steep | 3li "t-stcep | Slight-moderate | Slight |
| Averege depth of etream in ft. 3/ | 0.66 | 1.25 | 0*2 | 0.5 | 0•£ | 1.0 |
| Average width of stream in ft. 3/ | 21.5 | 27.5 | 6,0 | 6.0 | 6 . 5 | 12.0 |
| Length of stream in miles 2/ | 15.25 | 12.0 | 3,25 | 6.0 | 6.0 | 2,25 |
| County, township libe, range, and setion no. et mouth | Houghton, 54-33-5 | Houghton, 55-32-5 | Houghton, 56-32-32 | Houghton, 55-32-5 | Houghton, 55-32-18 | Roughton, 54-32-22 |
| Name of stream <u>J</u> | Pilgrim River | Trap Rock Rivar | Harmell Creek | Sewmill Creek | AcCallum Greek | lahti Creak |

List includes only those streems which oppear to have a productive potentiel or for which control davices have been recommended. "Loogh" is the measurement of that portion of the etream surveyed, and is composed of a calculation of mep distance plus application of a corrective factor (variable) compiled from field measurements. The stream langth figures differ from total length is all cesses where field conditions terminated the area usable by see lampraye ebort of the headweters. नोलो

Applicable only to the surveyed portion of the stream. From an aginearing standpoir, instruction for the stream standard in all streams for which mechanical devices have been recommended. Stream thinkery to another upon which it would be more practical to place e control device. 21410



Figure 15.---Area 14.

Description of Area 14 (Fig. 15)

and contains the watersheds of the Pilgrim and Trap Rock Rivers, Hanmell, Lahti, Gooseneck, Sawmill, Rock; an electrical device will be necessary in that stream. The streams of the area are generally and McCallum Greeks, and a large number of small coastal streams tributary to either Lake Superior or the Portage Waterway. Appreciable productive potentials occur in all but Lahti and Gooseneck brown in color and clear (except for some transient turbidity in the Trap Rock due to pollution). Embraces most of the northern half of Houghton and a small portion of Keweenaw County, Mich., Creeks. Mechanical control devices are recommended for all the potential producers but the Trap broken, and drainages are well defined. Agricultural lands predominate in the valleys, but much Gradients range from slight to steep. Mard-bottom materials are plentiful. The topography is forested upland and timbered bog are present.

Table 15 .- - Productive potential, recommended control davices, and miscellaneous factors concerning straams in Aras 15 (Survey made to 1950)

| Type of control possible 4/ | Electrical | Electrical | Mechanicel weir & tran | Mechenical weir & trap |
|--|----------------------------------|----------------------------------|---------------------------|---|
| Possible limiting fsctora | Spewning eites, fluctuetions, | Sparning sites, fluctuations, | Velocity, obstaclea | Spawning sites, fluctuations, obstaclas, tempersture |
| Product1ve potantial | Medium | Medium | Small | Small |
| Date | 8/14,16/50 | 8/10 | 8/8 | 1 |
| Tempera- tures in degrees F. | 55-57 | 66-68 | 62-64 | 1 |
| Range in velocity in ft./sec. 3/ | 1.0-2.25 | 0,5-3,5 | Sluggish-0.75 | 0.5-2.5 |
| Range in gredient <u>3</u> / | Slight | Slight-moderete | Slight | 311ght-moderate |
| Average depth of etream <u>3</u> | 1.0 | 1.0 | 1.0 | 0.75 |
| Average width of atream 3/ in ft. 3/ | 13.5 | 13.5 | 7.5 | 6 • D |
| Length of etresm in milee 2/ | 11.5 | 22°0 | 3.5 | 1.75 |
| County, townehip line, renge, end arctinn no, at mouth | Houghton, 55-31-4 | Кетепаи, 56-30-20 | Кажаеваж, 57-30-36 | Кемеецая, 57-29-29 |
| Name of stream 1/ | Traveres River | Tobacco River | Big Betsy River | Little Botsy River |

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list iocludes only those streams which appear to have a productive potential or for which control devices have been recommended. "Jeaguant is the meanurement of that portion of the arream entryed, and is compased of a calculation of map distance plue application of a corrective factor (variable) compiled from fight meanurements. The stream entry from the from the area where field conditions feare plue application of a corrective factor (variable) compiled beadwaters.

Appliceble only to the surveyed portion of the stresm.

From ac engineering standpoint, electrical control devices can probebly ha installed in all atreams for which mechanical devices have been recommended. Stream tributary to snother upon which it would be more practical to place control device. 2





Description of Area 15 (Fig. 16)

devices will also be more suitable in the Betsy Rivers if power lines are made available. The streams Embraces the southeastern portion of Keweenaw County, Mich., and contains the watersheds of the materials are abundant. The topography ranges from low, sandy plains and bogs in the lower water-sheds to rugged, rocky, upland wilderness; glaciated soils and land features characterize the area. Traverse, Tobacco, Big Betsy, and Little Betsy Rivers, and several small coastal streams. All of the named streams are potential sea lamprey producers, but only the Traverse and Tobacco are significantly dangerous. A questionable record of five "probable" nests exists for the Traverse. in the area are generally brown in color and gradients range from slight to steep. Hard-bottom Electrical control devices are recommended for both the Traverse and Tobacco Rivers; electrical Ecological situations are equally varied and complex.

| Name of streem <u>1</u> | County, t líne, ran eection n | cownehip ge, and o. et mouth | Length of stream in miles 2/ | Average width of stream ic ft. 3/ | Avarege depth of etream in ft. 3/ | Renge in gradient <u>3</u> / | Range in velocity in ft./sec. 3/ | Tempere- turae in dagreea F. | Date | Product1 ∀ e potantie1 | Poesible limiting fectore | Type of control possible <u>4</u> / |
|-------------------------|-------------------------------------|------------------------------------|--|---|---|---------------------------------|--|------------------------------------|-------------|----------------------------------|--|---|
| Little Gretiot River | Катерат | 58-29-31 | 8.5 | 14.0 | 1.75 | Woderate | 1.5-2.0 | 66-70 | 7/30 | Large | Fluctuations, | |
| Elster Creek | Хетеелат, | 57-30-4 | 5.0 | 3.0 | 0.5 | Slight-steep | Sluggish-1.5 | 53 | 8/2 | Small | obstecles, 1solation Spawning sites, | Electrical |
| Nine Thirty Two Creak | Кежеелаж, | 57-30-8 | 1.5 | 3.0 | 0.5 | Slight-steep | 7-1.0 | 1 | | Smell | velocity, obstaclea | ر اور |
| Bear Creek | Кемеелем, | 58-28-30 | 2.0 | 5.5 | 0.66 | Moderate-ataep | Sluggiah-1.0 | 51-53 | 7/24 & | Small | temparature Spewning sites, fluc. | নি |
| Hoar Creek | Кетеелат, | 58-28-25 | 2.0 | 4.0 | 0.25 | Slight | 0.5 | 60 | 8/3 7/27 | 11 ams | velocity, obstacles, tamperature Spawning eitea, | Mechanical Weir & trap |
| Union Greek | Кетеслат | 58-27-21 | 4.5 | 5.0 | 0.5 | Slight-moderate | 0.5-1.5 | 62 | 7/27 | Sme 11 | velocity, obstecles Obstacles | Mechanicel wair & trap Mechanicel |
| | | | | | | | | | | | | weir & trap |

Table 16. -- Productive potential, recommended control devices, and miscellaneous factore concerning streams in Ares 16 (Survey made in 1950)

-43-

List includes only those streams which eppear to heve a productive potantial or for which control devices have been recommended. "Length" is the mesurement of that portion of the stream eurveyed, and is composed of a calculation of map distance plue application of a corrective factor (veriable) compiled from field messurements. The stream length figures differ from total length in all cases where field conditions terminated the area usable by see lamprays short of the नेले

beedwatere.

Appliceble only to the surveyed portion of the stream. From an emgineering standpoint, electrical control devices can probehly be instelled in all streams for which mechanical davices heve been recommended. Stream tributary to another upon which it would be more practical to place a control device. ले*के*ले



Figure 17.--Area 16.

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sheds of the Little Gratiot River-Mendota system, the Montreal River, Bear, Hoar, and Union Creeks, and a number of small coastal streams; all but the Montreal have a productive potential; only the a narrow band of low, swampy, sand plain borders the lakeshore; soils are generally light and thin. only in the Little Gratiot. Characteristically the area is rugged, rocky, mountainous upland, but uniformly brown in color and gradients range from slight to steep. Hard-hottom types are abundant Little Gratiot is considered dangerous. An electrical installation is recommended for the Little Embraces most of the southeastern portion of Keweenaw County, Mich., and contains the water-Gratiot; mechanical devices will be suitable in the other streams. The streams in the area are Coniferous stands in the lowlands and mixed hardwoods on the slopes form the forest cover.

| ed cootrol devicee, | ee 17 | | |
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| able 17Potentiel nest sites, productive potential, recommende | end miscelleneoue fectore concerning streams in Are | (Survey made in 1951) | |

| | | Langth | Averege | Averege depth | | Range in | | | Number of | | | |
|------------------------------|--|--------------------------|---------------------------|------------------------------|-------------------------|------------------------------|----------------------------------|---------|-------------------------|-------------------------|--|----------------------------|
| Name of etream $\frac{1}{2}$ | Cousty, township line, range, and section no. et mouth | etreem in milee 2/ | of stream in ft. 3/ | of stream 3/ in ft. 3/ | Range in gradient 3/ | velocity in ft./sec.3/ | 1'empersture in degress F. | Date | potentiel pest sites | Product1ve potent1e1 | Possible limiting fectore | Type of control poesible 4 |
| Lake Fenny Hooe Creek | Кетеелет, 59-28-33 | 0.5 | 25 . 0 | 1.0 | Moderete | 1.5 | 62 | 7/24 | Моде | 0 | | Berrier dam |
| Wud Lake Creek | Кетевлам, 59-28-34 | 0.5 | 15.0 | 0.75 | Slight | Sluggish | 4 9 1 | ł | 12 | Medium | Temperature | 5/ |
| Vulcen Creek | Кетевет, 59-28-34 | 0°6 | 8.0 | 0.25 | Moderate | 1.0 | 61 | 7/23 | 25 | Medium | Irreguler hottom | 5/ |
| Gerdeo Brook | Кетерет, 59-28-32 | 5.5 | 8.0 | 0.2 | Slight-moderete | 0-1.0 | - | 1 | 40 | Wedium | Tempereture, | 5/ |
| Glezon Creek | Кемеелаж, 59-29-31 | 0.75 | 3°0 | 0.2 | Slight | 0-1.0 | 1 | 1 | ю | Small | Temperature | Wechenicel |
| Silver River | Keweenew, 52-30-35 | 2.0 | 20.0 | 1.0 | Slight-steep | Sluggish-l.C | 57 | 7/24 | 100 | Large | Tempereture | weir & trep Berrier dam |
| Little Silver River | Кежеележ, 59-30-35 | 1.0 | 3°0 | 0.2 | Slight-steep | 0.5-1.0 | 58 | 7/24 | 1 | Wedlum | Tempcreture, irreguler | 2/ |
| Ceder Creek | Кетеелет, 58-30-5 | 5.0 | 6,0 | 0.5 | Slight-steep | 0.5 | 56 | 7/24 | 40 | Medium | bottom Temperature, velocity, irreg- | Electricel |
| Elizo Lake Creek | Кетеелет, 58-30-6 | 1.0 | 15.0 | 0.5 | Slight-steep | 0.5 | 64 | 7/24 | 80 | Large | ular hottom Velocity | Mechanical weir & trep |
| 1/ Idst includes on! | y those streams which ar | pper to be | ve a produc | tive potent | tel or for which | i cootrol dev | icee beve hee | recomme | anded. | | | |

Applicable only to the surveyed portion of the stream. From an engineering standpoint, electrical control devices can probably be installed in all streams for which machanical weirs and traps or barrier dams have been recommanded. Stream tributery to another upon which it would be more prectical to place a control device. <u>ত্</u>যিকাজ





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systems. Some type of control may be required in five of them. The Silver River, Elizo Creek, stream bottoms are largely hard and irregular. Low water temperatures and sudden freshets may Fanny Hooe Creek systems may be controlled by concrete barrier dams which can be constructed lampreys; Glazon and Cedar Creeks have facilities for fewer nests. The Silver River and Lake Lake and Glazon Creeks, but an electrical control device will probably be necessary in Cedar and the Lake Fanny Hooe Creek systems appear to be capable of producing large numbers of sea Embraces the northeast portion of Keweenaw County, Mich., and contains six small river on bedrock substrata. Sites for mechanical weirs are present close to the mouths of Elizo gradients are generally steep, and water velocities are high in some stream sections. The Creek because of the low banks. All of the control sites are readily accessible. Stream limit the amount of spawning and the freshets may interfere with control operations.

| control devices, | 18 | |
|-------------------------------------|------------------------------------|-----------------------|
| , productive potentiel, racommended | factors concerning atreams in Area | [Survey made in 1951] |
| Tahle 18Potential nest sites, | and miecellaneous | |

| Name of stream 1/ | County, township line, range, and section no. at mouth | Langth of stream in milee 2/ | Average width of etream in ft. 3/ | Averege dapth of atream in ft. 3/ | Pange in gradiant 3/ | Pange in ▼elocity in ft./aac. 3 | Tempereture 10 degrees 7. | Date | Number nf potential nest sites observad 3/ | Productive potential | Possible limiting factore | Typa of control possible <u>4</u> / |
|-------------------|--|--|---|---|-------------------------|---------------------------------------|---------------------------------|------|---|-------------------------|------------------------------|---|
| arden City Brook | Kaweenaw, 58-31-19 | 4.0 | 10.0 | 0.3 | Moderate-steap | 1.0 | 63 | 7/25 | 40 | Medium | Nona | Mechanical |
| orrison Creak | Кежаелаж, 58~32-26 | 7.0 | 20.0 | 0.2 | Slight-steep | Sluggish | 61 | 7/27 | 50 | Wedium | None | Electricel |
| ratiot River | Кетеелат, 57-33-11 | 25.0 | 40°0 | 0.5 | Slight-steep | 0.5 | 60 | 7/28 | 200 4 | Large | None | Electrical |
| 111 Creek | Кетеелат, 57-33-14 | 18.0 | 15.0 | 0.5 | Slight-moders te | 1.0 | 56 | 1/31 | 100 + | Large | Temperatura | Electrical |
| lack Creek | Keweensw, 57-33-14 | 14.0 | 10.0 | 0.75 | Slight-steep | deigguld-0.0 | 62 | 7/31 | 25 | hedium | Drying | <u>5</u> |

List includes only those streams which appear to have a productive potential or for which control devices heve been recommanded. "Length" is recorded as there the calculated map distance it usuelly at leest doubled by the setuel meanders of the stream). Applieble only to the surveyed portion of the stream. Applieble on the surveyed portion of the stream. Stream streams for which mechanical devices can probebly be installed in all streams for which mechanical devices have been recommended. Stream tributary to another upon which it would be more predicel to place a control device. নানালাকাকা





Description of Area 18 (Fig. 19)

cal in the other streams; good sites for mechanical weirs are lacking. Morrison Creek is relatively can be constructed close to the mouth of Garden City Brook. Electrical devices will be more practi-Embraces the northwest portion of Keweenaw County, Mich., and contains nine small river systems. for fewer nests (40-50) are present in both Garden City Brook and Morrison Creek. A mechanical weir Abundant spawning facilities are available in the Gratiot River and in the Hill Greek system; sites inaccessible. The stream gradients are generally steep, and velocities are high during the spring. The surrounding country is sandy and rugged. Hardwoods are predominant. Table 19.--Potential nest sites, productive potential, recommended control devices, and miscallaneous factors concerbing atreams in Area 19 (Survey made in 1951)

| | | Length | Averaga width | Average depth | | Range 15 | | | Number of | | | |
|---------------------|--|----------------|---------------------|---------------------|----------------------------|-------------------------------|------------------|------|--|-------------------------|--|--|
| Name of stream $1/$ | ucunty, commantp line, renge, and section no. at mouth | in miles 2/ | stream in ft. 3/ | stream in ft. 3/ | Range in grodient 3/ | velocity in ft./sec. 3/ | in degress F. | Deta | potential best sites observad 2/ | Productive potantial | Possible limiting fectors | Type of control possible $\frac{4}{2}$ |
| drewery Creek | Houghton, 56-33-5 | 7.0 | 3.0 | 1.5 | Moderata | 0.5 | 62 | 7/31 | 4 | Small | Small size, irreg- | Nechebicel |
| Gardenar's Craek | Houghton. 56-33-6 | 3.5 | 4.0 | 0.25 | Slight-steep | 1.0-3.0 | 63 | 7/31 | 4 | Small | uler bottom Irregular bottom | weir & trap Nechenical |
| Creek # 1 | Heughton, 56-33-7 | 1.0 | 6.0 | 0.25 | Moderata-steep | 1.5 | 56 | 9/31 | 30 | Vedium | Temperatura, | weir & trap Nechanical |
| Creak # 2 | Houghton, 56-33-7 | 3.0 | 4 . 0 | 0.25 | Modara ta-s taep | 1.5 | 67 | 7/31 | 30 | Nedium | velocity Valocity | weir & trap Nechanical |
| Creek # 3 | Houghton, 56-33-7 | 2°0 | 2.0 | 0.25 | Woderste-steep | 1.5 | 60 | 7/31 | 6 | Medium | Velocity | weir & trap Lechabical |
| McGunn'a Creek | Houghton, 56-34-12 | 6.5 | 20.0 | 0.3 | Mo dera ta-steap | 2.0 | 66 | 7/31 | 12 | Madium | Irregular bottom | weir & trap Lechanical |
| Smith Cresk | Houghton, 56-34-13 | 5.0 | 3.0 | 0.3 | Steap | 1.0-2.0 | 66 | 8/1 | 3 | Small | Irragular bottom | weir & trap Mechanical |
| Creek # 5 | Houghton, 56-34-13 | 2.5 | 3.0 | 0.1 | Moderata-steep | 0.0-sluggish | 61 | 7/31 | 4 | 3ma11 | Irregular hottom, | weir o trep iechenical |
| Bear Creek | Houghton, 56-34-14 | 6 • O | 17.0 | 2°0 | Slight-moderata | 1.0 | 56 | 8/1 | 25 | h.edium | small size Temperature | wair o trup Léchanical |
| Boston Creek | Houghton, 56-34-33 | 8.0 | 25.0 | 0.5 | Slight-steap | 1.5 | 57 | 8/1 | 100 4 | Larga | Temperature | weir & urap Electrical |
| Iily Creak | Houghton, 56-34-34 | 10.0 | 30.0 | 0.5 | Slight-steep | 1.0 | 61 | 8/1 | £ 002 | Larga | None | 5 |
| Creek # 1 | Houghton, 55-34-4 | 2.5 | 3.0 | 0.3 | Steap | 1.0 ≠ | 64 | 8/1 | 4 | Small | Smell size, | Mechanicel |
| | | | | | | | | | | | verocity, irregular bottom | weir œ trap |
| Creak # 2 | Houghton, 55-34-9 | 3.0 | 5.0 | 0.2 | Steep | 1.0 | 56 | 8/1 | 8 | Wedium | Temperature, irregular hottom | Mechanical weir & tren |
| Creek#4 | Houghton, 55-34-16 | 1.0 | 8,0 | 0.1 | Steep | 0.75 | 55 | 8/1 | 50 | Small | Temperature, velocity, irrez- | Lechanical weir & tran |
| Swede Town Creek | Hour 55-34-28 | ¢. | 0 81 | 0.25 | นักที่ครอร์เค-อร์เคอบ ม | 1.0.1 | 61 | R/1 | 65 | Medium | ular bottom Temperature. | Wachanical |
| | | | | | | | 1 | 1 | | | velocity, irreg- | weir & trap |
| Creek # 1 | Houghton, 55-34-35 | 5.0 | 20.0 | 0.1 | Slight-steep | 0.75 | 70 | 8/2 | 4 | LT BUL | Irregular bottom, | bechanical weir & twen |
| Colea Craak | Houghton, 55-34-28 | 8.0 | 25.0 | 0.5 | Steep | 3.0 | 54 | 8/2 | 4 | Smell | Temparatura, | Electrical |
| Sablots Prook | 10.144.000 55.44.0 | a | C L | u C | clicht_modenate | 701 | ζ L | L/8 | 7 001 | Ιαταο | velccity, irreg- ular hottom Temmaratura | Vechanical |
| Selmon Trout River | Houghton, 55-35-20 | 22.0 | 40.0 | 0.25 | Moderete | sluggiah-1.0 | ୦ ୟ ହ | 8/3 | 12 | Medium | None | weir & trap Electrical |
| Gravaraet Rivar | Houghton, 55-36-35 | 17.0 | 25°0 | 1.0 | Slight-steep | 1.5 | 54 | 8/6 | 100 / | Large | None | Barrier dam |
| Elm River | Houghton, 54-36-30 | 26.0 | 30.0 | 0.4 | Mo darate-steap | 1.5-2.0 | 59 | 8/7 | 50 | Medium | Temperature, valocitv. irrag- | Elactrical |
| South Branch Elm R. | Hou <i>e</i> hton. 54-36-30 | 8.0 | 20.0 | 0.8 | Slight-steap | 1.0 4 | 59 | 8/7 | 100 4 | Large | ular hottom Temperatura, | 5/ |
| | | | | | | | | | | | velocity | |
| Little Elm River | Houghton, 54-36-31 | 14.0 | 35.0 | 1.0 | Slight-staep | 0.0-1.5 | 60 | 8/8 | 20 | Nedium | None | Electrical |
| | | | | | | | | | | | | |

List includes only those atreams which appear to have a productive potential or for which control devices have been recommended. "Longth" is recorded as twice the calculated map distance (the map distance is usually at least doubled by the actual meanders of the atream). Applicable only to the surveyed portion of the stream. From a pergineering standpoint, cleatrical control devices can probably be installed in all streams for which nechanical weirs and traps or barrier dons have been recommanded. Stream tributery to another upon which it would be more practical to place a control device.

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Figure 20.--Area 19.

Description of Area 19 (Fig. 20)

high. Low water temperatures and freshets may inhibit spawning. The large water volumes present in the spring and during periods of heavy rain may interfere with control operations. The country east of the Portage Waterway is generally sandy while morainic formations and lake clays are prethan 5 nests are present in each of the remaining streams listed (table 19). Sites for mechan-Embraces the entire northern coastline of Houghton County, Mich., and the northern portion of the Portage Waterway. Spawning facilities are available in 21 river systems, 8 of which flow of the area. Ten other watersheds each offer facilities for from 6 to 65 nests. Sites for less dominant to the west. The entire area is rugged. The forest climax type is largely hardwood. Schlotz Creeks, tributary to the canal, and the Graveraet and Elm Rivers in the western portion lacking. A concrete barrier dam is recommended for the Graveraet River. The Graveraet and Elm mechanical structures, and for Boston and Coles Creeks in which sites for mechanical weirs are Rivers are relatively inaccessible. Stream gradients are generally steep, and velocities are ical weirs are present near the mouths of 15 streams. Electrical control devices are recominto the Portage Waterway. Abundant facilities are present in four watersheds: Boston and mended for the Salmon Trout, Elm, and Little Elm Rivers, which are too large for practical

Table 20.--Potential meet eites, productive potential, recommended control davicas, and miscellaneous fectors concerning streams in Aree 20 (Survey made in 1951)

| Name of etream <u>J</u> | County, towns line, renge, section no. a | thip and t mouth | Langth of etream in milee 2/ | Average midth of etream 3/ in ft. 3/ | Averege depth of stream <u>3</u> / | Range in gradient <u>3</u> / | Fange in valocity in ft./sec. 3/ | temperature to degrees F. | Date o D | umber of $oten tigles$ est sites $bserved \overline{3}$ | Froductive potentiel | Fossible limiting fectora | Type of control possible 4 |
|-------------------------|--|------------------------|--|--|---|---------------------------------|---|---------------------------------|----------|---|-------------------------|------------------------------------|----------------------------|
| Liaery Rivar | Ontonagon, 53 | -37-10 | 30.0 | 45.0 | 2.0 | Slight-moderete | 0.0-2.0 | 54 | 8/11 | 80 | Large | Tempera ture | Electrical |
| East Sleeping River | Cntonegon, 53 | -38-13 | 30.0 | 60.0 | 0.5 | Slight-steep | Sluggish-1.0 | 60 | 8/25 | 200 🖌 | Large | None | Electricel |
| West Sleeping River | Cutonagon, 53 | -38-13 | 11.0 | 10.0 | 0.3 | Slight-moderete | Slugg1sh-1.5 | 59 | 8/24 | 100 4 | Iarge | Tempe re ture | Electricel |
| firesteele Rivar | Cntopegon, 52 | -39-1 | 75.0 | 40.0 | 1.0 | Slight-steep | Sluggish-2.0 | 72 | 8/27 | 1000 4 | large | None | Electrical |
| Fliptsteele River | Cntonegon, 52 | -39-2 | 33°U | 100.0 | 6.0 | Slight | Sluggish-0.75 | 52 | 8/27 | 100 🖌 | Large | Nobe | Electrical |
| Baer Creek | Optonagon, 52 | -39-15 | 16.0 | 20.0 | 0.5 | Slight-moderate | Sluggish-l.O | ! | - | 4 | llers | Tempera ture | Mechanical Weir & tran |
| Uptonagon River | Ontonagon, 52 | -40-25 | 100 4 | 100.0 | 2.0 | Slight-steep | Sluggish-5.0 | 59 | 8/23 | 200 4 | Large | Nope | Electrical |
| First Creek | Ontonegon, 52 | -40-34 | 14.0 | 10.0 | 0.5 | Slight-moderate | Sluggish | 60 | 8/22 | 4 | Small | Spewning materiele | Mechanical mair & tran |
| Second Creek | Ontonegop, 52 | -40-34 | 14.0 | 12.0 | 0.5 | Slight | Sluggish-1.0 | 58 | 8/25 | 4 | Small | Temperature, enemning materiale | metr & tran |
| Poteto River | Untonagon, 52 | -40-33 | 30.0 | 35.0 | 2.0 | Slight-moderete | Sluggish-1.0 | 58 | 8/22 | 100 🖌 | large | Temperature | Electrical |
| Floodwood River | Untonagon, 51 | -40-4 | 17.0 | 20.0 | 0+5 | Slight-moderete | Sluggieh | 58 | 8/25 | 75 | Large | Tempereture, valocity | Electrical |
| Crenberry River | Ontonegon, 51 | -40-6 | 25.0 | 40°0 | 0.6 | Slight-moderste | Sluggish | 64 | 8/27 | 100 4 | Large | None | Electrical |
| L1 ttle Crenberry R. | Ontonegon, 51 | -40-6 | 16.0 | 30.0 | 1.0 | Moderete | Sluggi ab | 63 | 8/23 | 100 🖌 | Larga | None | Electricel |
| | | 1 | | | | da se foit- | 4 ah aoat mol | 4 and have b | 0001 000 | anne ndad. | | | |

List includes only those streams which appear to heve a productive potential or for which control devices have been recommended. "Largth" is recorded as three the calculated map distance (the map distance is usually at least doublad by the octual meanders of the stream). "From on only to the surveyed portion of the stream." From on engineering standpoint, electrical control devices probably can be lostalled in all streams for which mechanical weirs and trops heve been recommended. Stream tributary to enother upon which it would be more prectical to place a control device.

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Description of Area 20 (Fig. 21)

is rugged, and lake clay soils are predominant. The forest climax type is largely hemlock-hardwood. inaccessibility of the three or four suitable streams east of Fourteen Mile Point. The entire area high velocities may limit spawning in some streams. Control operations will be hampered by the electrical control devices are recommended for them. Control may be especially difficult in the during periods of heavy rain, and changes in water levels are rapid. Low water temperatures and Embraces the northeast portion of Ontonagon County, Mich., and contains at least 13 streams Abundant spawning facilities are present in all but three of the streams. Sites for mechanical weirs are present Ontonagon, Flintsteel, and Firesteel Rivers because of their large size. One lamprey nest was observed in the Firesteel River in 1951. Stream gradients are generally steep, and velocities devices. The 10 streams capable of producing great numbers of sea lampreys are all large, and in these three, and the streams themselves are small enough for practical operation of such above the area of "lake level effect" are high. Most of the streams are exceedingly turbid Much of the area has been logged recently and is covered with impenetrable slash and second in which sea lampreys may spawn. The status of Paddys Creek and Creek No. 1 just east of Ontonagon, and of Black Creek just east of Wolf Point is unknown at present. growth.

| devices, | | |
|-----------------------------------|-----------------------------------|----------------------|
| contro | 21 | |
| productive potential, recommended | actors concerning streams in Area | wertow mode in 10511 |
| Tabla 21 Fotential neat sites, | and miscellaneous f | |

| Name of stream <u>J</u> / | County, township line, range, and section no. at mouth | length of atream in miles 2/ | Average width of strend ip ft. 3/ | Average daptb of stream in ft. 3/ | Renga in gradient 3/ | Ranga in velocity in ft./sec. 3/ | Temperatura in degraea F. | Date | Number of potential neat sites observed 3/ | Productive potential | Possible limiting factors | Type of control possible 4 |
|---------------------------|--|--|---|---|-------------------------|---|---------------------------------|------|---|-------------------------|----------------------------------|-------------------------------|
| Town Line Creek | Ortonegon, 51-41-1 | 19.0 | 85.0 | 0.ô | Slight-moderate | 0.75 | 54 | 8/8 | 100 🖌 | Large | Temperature | Electrical |
| lislfway River | Ontonagon, 51-41-1 | 34.0 | 30.0 | 2.0 | l'oderate-steap | 1.5 | 59 | 9/6 | 100 ¥ | Larga | Temperature | Electrical |
| Juck Greek | Ontonagon, 51-41-11 | 31.0 | 30.0 | 0.5 | Slight-moderata | 1,5 | 54 | 8/8 | 80 | Larga | Тегратаtura | Electrical |
| Pine River | Ontonegoo, 51-41-3 | 22.0 | 20.0 | 1.0 | Slight-moderate | Sluggish-1.0 | 55 | 5/8 | 100 / | Larga | Temperature | Electrical |
| Stony Greek | Ontonagon, 51-41-3 | 14.0 | 14.0 | 0.5 | Slight-moderate | Sluggish-1.0 | 54 | 9/4 | 40 | hedium | Terperature, irrevular bottom | Wechunical weir & trap |
| Minaral River | Cntonagon, 51-41-7 | 24.0 | 50°0 | 1.0 | Slight-noderate | 1.0-2.0 | 61 | 9/4 | 250 4 | Large | Temperatura | Electrical |
| Iron River | Cntonagon, 51-42-12 | 60.0 | 200.0 | 5 1 8 | Moderete-steep | 1.0-5.0 | | | <i>t</i> 001 | Unknown | | Electrical |
| Little Iron River | Ontonagon, 51-42-11 | 25.0 | 35°0 | 0.75 | Steap | 1.5 | 52 | 9/4 | 100 🖌 | Larga | Temperatura | Electrical |
| Jnion River | Untomagon, 51-42-15 | 14.0 | 40°0 | 1.0 | Slight-steep | Sluggish-2.0 | 51 | 8/3 | 200 4 | Larga | Tampera tura | Elactrical |
| Carp River | Ontonagon, 51-44-33 | 30.0 | 35.0 | . 8 0 | Nodera ta-staap | 0.5-2.0 | 53 | 6/6 | 35 | Medium | Temperatura, irregular bottom | Barrier dam |
| | | | | | | | | | | | | |

List includes only those streems which eppear to have a productive potential or for which control darices have bear recommended. Trength is recorded as three the calculated map distance (the map distance is usually at least doubled by the actual mesoders of the atream). Applicable only to the surveyed portion of the stream. From en engineering standpoint, electrical cortor devices on probebly be installed in all atreams for which machanical weirs and traps or barriar dams have bean recommended. Stream tributery to another upon which it would be more practical to place a control device. নানালালালা



Figure 22.-Area 21.

Description of Area 21 (Fig. 22)

mechanical means, and electrical devices are recommended. The Carp River is relatively inaccessible. Stream gradients are generally steep above the areas of "lake level effect," and velocities are high. The large water volumes and resulting heavy turbidity may interfere seriously with control opera-Mud Creeks is unknown. The shoreline from the Carp River east to Union Bay has not been surveyed; with spawning facilities for sea lampreys. At present, the status of the Iron River and Ash and streams (excepting the Carp River in which a barrier can be placed) are too large for control by tions in the spring and during periods of heavy rain. The surrounding country is rugged. Lake Embraces the northwest portion of Ontonagon County, Mich., and contains at least 9 streams potential while two, Stony Creek and the Carp River, have facilities for fewer nests (30 each). A site for a mechanical weir is present just above the mouth of Stony Creek. The remaining several small streams may be present in this area. Seven streams have a large productive clay soils and a forest climax type of hemlock-hardwood are predominant. Table 22.--Potential nest sites, productive potential, recommended control devices, and miscelleneous fectors concerning streems in Aree 22 (Survey made in 1951)

| | | Length | Averege widtb | Average depth | | Range in | | | Number of | | | |
|------------------------------|--|--------------------------|-----------------------------------|---------------------------|-------------------------|-------------------------------|---------------------------------|------|--|-------------------------|---|----------------------------|
| Nems of stream $\frac{1}{2}$ | coupty, township line, rengo, and section no. at mouth | atream 1n miles 2/ | or etream in ft. <u>3</u> / | of stream in ft. 3/ | Range in gredient 3/ | velocity in ft./sec. 3/ | Temperature 11 degreea F. | Dete | potentiel seat sites sbeerved 3/ | Productive potentiel | Possible limiting fectore | Type of control possible 4 |
| Creek # 2 | Gogebic, 50+45-2 | 1.0 | 10+0 | 0°5 | Slight-moderate | 1.0 | 56 | 6/6 | 50 | Medium | Tempe re ture | Berrier dam |
| Creek # 3 | Gogebic, 50-45-2 | 1.0 | 6.0 | 0.2 | Slight-moderete | 1.0 | 56 | 6/6 | 50 | Medium | Tempereture | Barrier dam |
| Little Cerp River | Gogebic, 50-45-2 | 35+0 | 35.0 | 0.8 | Moderete-steep | 0.5-2.0 | 56 | 6/6 | 100 ¥ | Large | Tempere ture | Barrier dam |
| Crcek # 4 | Gogebic, 50+45-2 | 1.0 | 2°0 | 0.1 | Steep | 0.75 | 56 | 6/6 | 4 | Small. | Tempereture, aize | Barrier dam |
| Greek # 5 | Gogebic, 50-45-2 | 1.0 | 10.0 | 0.1 | Steep | 0.75 | 55 | 6/6 | 25 | Medium | Tempereture, | Barrier dam |
| Finkerton Creek | Gogebic, 50-45-10 | 8.0 | 30.0 | 0.5 | Steep | 1.5 | 56 | 6/6 | 80 | Large | Terperature | Berrier dam |
| Kenebeek Creek | Gogebic, 50-45-16 | 5.0 | 15.0 | 0.25 | Noderete-steep | 0.5-1.0 | 56 | 9/10 | 15 | Medium | Temperature, velocity inner- | Barrier dam |
| Creek # 7 | Gogebic, 50-45-16 | 3°0 | 5+0 | 0.25 | Slight | Slugglah-0.5 | 56 | 01/3 | 25 | 1.edium | Temperature | Electrical |
| Creck # 8 | Gogebic, 50-45-16 | 2.0 | 12.0 | 0,25 | Moderete | 1.0 | 58 | 9/10 | 40 | Nedium | Tempe r atu re | Electrical |
| Tiebel Creek | Gogebic, 50-45-16 | 12.0 | 25.0 | 0.5 | Moderetc | 1.0 4 | 55 | 9/10 | 100 4 | Large | Tempe rature | Electrical |
| Speaker Crock | Gogobic, 50-45-16 | 8.0 | 25.0 | 0.5 | Moderete | 1.0 4 | 55 | 9/10 | 100 4 | Large | Temperature | Electrical |
| Cardinal Creak | Gogabic, 50-45-20 | 3.0 | 20.0 | 0.25 | Steep | 0.5-1.0 | 53 | 8/6 | 12 | 1.edium | Temperature, freshets, irreg- | Barrier dam |
| Creek # 1 | Gogebic, 50-45-20 | 1.0 | 6. O | 0.25 | Steep | 0.5-1.0 | 53 | 9/8 | 12 | Medium | ular bottom Tempereture, fresheta, irreg- | Barrier dam |
| Big Presque Isle R. | Gogebic, 50-45-19 | 50 🖌 | 75.0 | 0 | Noderste-stoep | 2.0-1.0 | 59 | 9/13 | 10 | Medium | uler bottom Temperature, | Electrical |
| Camp 8 Creak | GogAbic, 50-46-25 | 5.0 | 20.0 | 0.6 | Stoep | 2°0 | 60 | 9/13 | 50 | l.edium | Velocity | Electricel |
| Creek # 1 | Gogebic, 50-46-36 | 1.0 | 6.0 | 0.5 | Moderate-ateep | 2.0 4 | 58 | 9/13 | 30 | Wedium | Tempereture, | Barrior dam |
| Creek # 2 | Gogebic, 50-46-36 | 1.0 | 3+0 | 0.25 | Woderste-steep | 1.0 | 58 | 9/13 | 30 | Medium | Veruer uy Tempereture | Barri er dam |
| Namehinag Creek | Cogebic, 50-46-35 | 5.0 | 8.0 | 0.5 | Woderate-steep | 2.0 | 58 | 9/13 | 80 | Large | Tempere ture | Barrier dam |
| Gijik Creck | Gogebic, 49-46-2 | 4 • 0 | 10.0 | 0.3 | Steep | 1.0-2.0 | 56 | 9/14 | 20 | l edium | Temporature | Electrical |
| Creek # 3 | Gvgebic, 49-46-2 | 2.0 | 3.0 | 0.25 | Woderste-sterp | 0*1 | 56 | 9/14 | 25 | hedlum | Temperature | Perrier dam |
| Creek # 4 | Gogebic, 49-46-2 | 2.0 | 5.0 | 0.2 | Modere te-staap | 1.0 | 56 | 9/14 | 40 | lved i um | Temperature | Barrier dam |
| laneger Creek | Gogebic, 49-46-2 | 4 • 0 | 6.0 | 0.3 | Steep | 0.5-1.0 | 55 | 9/16 | 35 | Ncdium | Temperature | Barrier dam |
| Bobolink Creek | Gogebic, 45-46-2 | 4 • O | 6.0 | 0.3 | Moderet#-stecp | 0.5-1.0 | 53 | 9/15 | 50 | l, edium | Terperature | Berrier dam |
| Chickedeo Creek | Gogebic, 49-48-3 | 4 . 0 | 3.0 | 0.25 | hoderste | 1.0 | 53 | 9/15 | 15 | hedium | Тепрега ture | Børrjer dam |
| Bleck River | Gogebic, 49-46-3 | 20 ¢ | 125.0 | 6.0 | Noderate | 2.0-3.0 | 24 | 9/17 | . 15 | l'edium | Tempereture | Electrical |
| Pelofoce Creek | Gogebic, 49-46-9 | 2.0 | 6+0 | 0.3 | Steep | 1.0 | 51 | ô/17 | 25 | ly.ed1um | Tempere ture | Barrier dam |

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| Table 22, |

| Name of atream 1/ | County, tow line, renga aectien no. | nship , and at mouth | of etream in miles 2/ | width of stream in ft. 3/ | depth of stream in ft. 3/ | Range in Gradient 3/ | Range in velocity 1 in ft./sec. 3/ | cuperatura n degrees F. | Data | Number of potential nest sites observed 3/ | Productive Potential | Possible limiting fectors | Type of control pessible 4 |
|-----------------------|---|----------------------------|--------------------------------|------------------------------------|------------------------------------|-------------------------|---|-------------------------------|------|---|-------------------------|---|-------------------------------|
| Creek # 18 | Gogebic, 49 | -47-20 | 1.0-2.0 | 6.0 | 0.25 | Steep | 1.0 | 54 | 9/20 | 25 | 1.edium | Temperature, fuschat | Barrier dam |
| Craek # 17 | Gogebic, 49 | -47-30 | 1.0-2.0 | 4 。0 | 0.2 | Medarate | 1.0 | 46 | 9/25 | 10 | Wedium. | Temperature, freshete | Barrior dam |
| Creak # 16 | Gogabic, 49 | -47-20 | 1.0-2.0 | 0°2 | 0.25 1 | oderate-steap | 1.0 | 46 | 9/25 | 25 | Medium | Temperat ure , frasheta | Barrier dam |
| Creek # 15 | Gogebic, 49 | -47-20 | 1.0 | 6.0 | 0.25 | Staep | 1.0 | 48 | 9/25 | 50 | hedium. | Tamperature, fresbets | Barrier dam |
| Craek # 14 | Gogebic, 49 | -47-20 | 1.0-2.0 | 2.0 | 0.1 | Moderate | 1.0 | 48 | 9/25 | 1 | Smell | Tempereture, small size, | Berrier dam |
| Creek # 13 | Gogebic, 49 | -47-19 | 1.5 | 3.0 | 0,1 | Moderata | 1.0 | 46 | 9/25 | 4 | Sme 11 | rrestate Temperature, freshate | Barriar dam |
| Creak # 12 | Gogebic, 49 | -47-19 | 1.0-2.0 | 6.0 | 0.25 | Moderate | 1.0 | 48 | 9/25 | 80 | Larga | Temperature, | Berter dam |
| Creek # 11 | Gogebic, 49 | -47-19 | 1.0-2.0 | 2.0 | 0.1 | Steep | 1.0 | 48 | 9/25 | 4 | Small | Iresdets Tempereture, smell sizc, | Berrier dam |
| Greck # 10 | Gogebic, 49 | -47-19 | 1.0 | 6.0 | 0.25 | Medera te | 1.0 | 48 | 9/25 | 12 | Medium | freabets Tamperatura, | Barrier dam |
| Creek# 9 | Gogehic, 49 | -47-19 | 1.0-2.0 | 4.0 | 0.25 | Moderate | 1.0 | 48 | 9/25 | 12 | Medi um | frasbets Temperature, | Barrier dam |
| Craek # 8 | Gogebic, 49. | -48-25 | 1.0-2.0 | 10.0 | 0.25 | ∥oderata-steep | 1.0 | 49 | 9/26 | 12 | Medium | fresbets Tamperature, | Berrier dam |
| Montana Creek | Gogebic, 49 | -48-25 | 3.0 | 12.0 | 0.3 | Moderate | 1.0 | 48 | 9/26 | 80 | Larga | freshats Temperatura, | Berrier dam |
| Killdeer Creek | Gogebic, 49 | -48-26 | 2.5 | 6.0 | 0.3 1 | koderate-steap | 1.5 | 48 | 9/26 | 5 | Small | Trearets Temperature, | Barriar dam |
| Scalp Creek | Gogebic, 49. | -48-27 | 3.0 | 12.0 | 0.5 | oderste~steep | 1.0 | 45 | 9/27 | 2 | Medium | Teaue va Temparature, | Barrier dam |
| Creek # 4 | Gogebic, 49. | -48-27 | 1.0-2.0 | 4.0 | 0.3 | ioderate-steap | 1.0 | 45 | 9/27 | 7 | Smell | fresheta Tamparatura, freshets | Barriar dam |
| Little Speckled Creek | Gogebic, 49 | -48-34 | 4.0 | 10.0 | 0.3 1 | inders te-steap | 1.0 | 45 | ç/27 | 12 | l edium | Ten parature, freshete | Berrier dam |
| Creek # 3 | Gogebic, 49. | -46-33 | 1.0-2.0 | 2°0 | 0.25 | L'odersto | 0.75-1.0 | 45 | 92/3 | 12 | ledium | Temperature, small size, | Barrier dam |
| Creek # 2 | Govebic, 45 | -46-33 | 0-2-0-1 | 6.0 | 0.25 |) oderate | 0.75-1.0 | 45 | 93/3 | 50 | h editur | tresnete Tei perature, Pasabate | Barrier dem |
| Creek # 1 | Gogebic, 49. | -46-33 | 1.0-2.0 | 6.0 | 0.2 | Acdarate | 0.75-1.0 | 51 | 9/19 | 2 | l, edium | Temperatura, Tresheta | Electricel |
| Ikresana Creek | Gogebic, 49 | -48+32 | 3.0 | 6°0 | 0.25 | Moderata | 0.75-1.0 | 52 | 9/19 | 10 | Madium | Temperature | Electrical |
| Creek # 2 | Gogebic, 49. | -48-32 | l.0-2.0 | 19.0 | 0.3 | Moderate | 0.75-1.0 | 53 | 9/19 | 9 | Medium | Tempe ra ture | Electricel |
| Chman Creck | Gogebic, 49 | -48-31 | 6.0 | 8.0 | 0.3 1 | oderate-sterp | 1.0 | 54 | 6/25 | 25 | adium . | Temperstura | Burrier dam |
| Flink Creek | Gogebic, 48 | -49-11 | 3.0 | 8.0 | 0.3 1 | oderate-staap | 1.0 | 56 | 9/25 | 25 | hedium | Tempara tu re | Barrier dam |
| Tressura Crask | Gogebic, 48 | -49-11 | 4.5 | 10.0 | 0.3 | /oderata∝ateap | 1.0 | 54 | 9/25 | 12 | Madium | Temperature | Barrier dam |
| Wontreel River | Gogabic, 48 | -49-10 | 50 / 1 | 0.00 | 3.0 | light-ateep | Sluggish=3.0 | 52 | 9/22 | ى ۱ | Sme 11 | Tempersture, spawnieg meteriele | Electrical |

List includes only these streams which appear to bave a productive potential or for which control davices have been recommended. "Leugh" is recorded as twice the calculated mep distance (the map distance is usually at least doubled by the actual meanders of the stream). "Found and only to the surveyed portion of the atreem. From an engineering standpoint, electricel fourted devices can probably be instaled in all streams for which mechanicel wairs and trape or barriar dama have been recommended. Stream tributary to enother upon which it would be more practicel to place a control davice. नोलोलोकोला

Table 22, continued

| | County, township | Length of atream | Average width of | Averaga depth of | | Range in vclocity | Tempe re tu re | | Number of potential | | | |
|-------------------|--|-----------------------------------|------------------------|------------------------|-------------------------|----------------------|------------------|---------------|-----------------------------------|-------------------------|---|--------------------------------|
| Name of stream 1/ | line, range, and section no. et mouth | $\frac{1}{1}$ miles $\frac{2}{2}$ | atream in ft. 3/ | stream 3/ | Range in gradient 3/ | 1n ft./sec. 3/ | in degreea F. | Dete | nest sites observed <u>3</u> / | Product1ve potert1a1 | Possible limiting factors | Type of control possible 4/ |
| Creck # 10 | Gogebic, 49-46-9 | 1.0 | 6.0 | 0.3 | Steep | 1.0 | 52 | 8/17 | 25 | Medium | Temperatura, fresheta | Barrier dem |
| Creek # 9 | Gogebic, 49-46-8 | 1.0 | 4 ° 0 | 0,25 | Steep | 1.0 | 52 | 6/17 | 25 | Medium | Tenperature, freshets | Berrier dam |
| Creek # 8 | Gogebic, 49-46-8 | 1.0 | 4.0 | 0.2 | Steep | 1.0 | 54 | 9/17 | 25 | Nedium | Temperature, freshets | Barrier dam |
| Creek # 7 | Gogebic, 49-46-7 | 1.0 | 2+0 | 0.2 | Steep | 1.0 | 52 | 9/17 | 10 | Medium | Temperature, fresbeta, small size | Barrier dam |
| Creek # 6 | Gogebic, 49-46-7 | 1.0 | 1.0 | 0.2 | Steep | 1.0 | 1 | | ю | Small | Tempcrature, freshets, small size | Berrier dem |
| Creek # 5 | Gogebic, 49-46-7 | 1.0 | 3.0 | 0.2 | Steep | 1.0 | 51 | 6/12 | 4 | Smell | Tempersture, fresbets, emall size | Barrier dem |
| Maple Creek | Gogebic, 49-46-7 | 9°0 | 25.0 | 0.5 | Steep | 2.0 | 51 | 6/12 | 30 | lvedium. | Temperature, freshets | Barrier dam |
| Creek # 9 | Gogebic, 49-47-12 | 1.0-2.0 | 4.0 | 0.25 1 | oderate-steep | 1.0 | 52 | 9/18 | çų | Grall | Temperstura, freshets | Barrier dam |
| Creek # 8 | Gogebic, 49-47-12 | 1.0-2.0 | 6.0 | 0.25 1 | iderete-steep | 1.0 | 52 | 9/18 | 12 | Wedium | Temperature, freshets | Barrier dam |
| Creek # 7 | Gogebic, 49-47-13 | 1.0-2.0 | 3.0 | 0.2 | Moderate-ateep | 1.0 | 53 | 9/18 | es | Small | Temp <i>e</i> rature, fresbeta | Barrier dam |
| Creek # 6 | Gogebic, 49-47-14 | 1.0-2.0 | 3.0 | 0.2 | Moderste-steep | 1.0 | 52 | 9/18 | ณ | Small | Tempere ture, fresheta | Barrier dam |
| Creek # 5 | Gogebic, 49-47-14 | 1.0-2.0 | 6.0 | 0,25 1 | doderate-steep | 1.0 | 53 | 8 /1 8 | 62 | Small | Temperature, fresbets | Berrier dem |
| Creek#4 | Gogebic, 49-47-14 | 1.0-2.0 | 6.0 | 0.25 | Moderate-steep | 1.0 | 54 | 9/18 | 20 | Nedium | Terperatura, freshets | Barrier dem |
| Creek # 3 | Gogebic, 49-47-14 | 1.0-2.0 | 6.0 | 0.25 1 | soderate-steep | 1.0 | 52 - | 9/18 | 4 | Small | Temperature, freahets | Barrier dam |
| Creek # 2 | Gogebic, 49-47-14 | 1.0-2.0 | 6.0 | 0.25 | Acderate-steep | 1.0 | 51 | 8/18 | 15 | Ledium | Temperature, freshets | Barrier dam |
| Creek # 1 | Gogebic, 49-47-14 | 1.0-2.0 | 3.0 | 2*0 | lodera te-ateep | 1.0 | 52 | 9/18 | 12 | Wedlum | Temperature, small size, freshets | Barrier dam |
| Mighthawk Creek | Gogebic, 49-47-15 | 3.0 | 2°0 | 0°5 | ioderate-steap | 1.0 | 51 | 9/18 | 10 | Wedium | Tempereture, freshets | Barrier dam |
| Chost Creek | Gogebic, 49-47-15 | 3,0 | 10.0 | 0.25 | derete-steep | 1.0 | 52 | ө1/ŝ | 12 | Ledium | lerperature, freshets | Berrier dam |
| Creek # 25 ' | Gogebic, 49-47-15 | 1.0-2.0 | 4.0 | 0.25 | Modera ta | 1.0 | 56 | 9/20 | 63 | Small | Temperature, freshete | Barrier dam |
| Creek # 24 | Gogebic, 49-47-16 | 1.0-2.0 | 10.0 | 0.25 | Moderate | I.0 | 57 | 9/20 | 15 | Nedium | Tenperature, fresheta | Barrier dam |
| Creek # 23 | Gogebic, 42-47-16 | 1.0-2.0 | 0*0 | 0.25 | Noderste | 1.0 | 57 | \$/20 | Ю | Small | Temperature, freshets | Barrier dam |
| Creek # 22 | Gogebic, 49-47-16 | 1.0-2.0 | 8,0 | 0.25 | Moderate | 1.0 | 57 | 9/20 | 25 | Ledium | Temperature, fresheta | Barrier dam |
| Creek # 21 | Gogebic, 49-47-16 | 1.0-2.0 | 4.0 | 0.2 | Slight | 1.0 | 57 | 9/20 | 12 | Medium | Temperature, freshets | Barrier dam |
| Creek # 20 | Goffebic, 49-47-20 | 1.0-2.0 | 4.0 | 0.2 | Steep | 1.0 | 2 0 0 | ł | 25 | ledium | Tempereture, frushete | Barrier dam |
| Creek # 19 | Gogebic, 49-47-20 | 1.0-2.0 | 6.0 | 0.25 | Steep | 1.0 | 57 | 9/20 | 25 | Medium | llemperature, freaheta | Barrier dam |

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Figure 23.-Area 22.

Description of Area 22 (Fig. 23)

many streams. Freshets, turbidity, and inaccessibility will offer problems in most of the streams Big Presque Isle, Black, and Montreal Rivers are very large, and electrical devices will probably provide the only practical means of control. Barriers can be constructed close to the mouths which spawning facilities are present. Seven streams, the Little Carp River, Pinkerton, Tiebel, when control devices are constructed. The surrounding country is rugged. Lake clays and a hem-The Creek in the western portion each contain facilities for 75 or more nests. Facilities for 6 to periods, turbidity is high. Low water temperatures and sudden freshets may inhibit spawning in 75 nests are present in 53 streams. Sixteen streams contain sites for only 1 to 5 nests. The Speaker, and Namebinag Creeks in the eastern portion of the area, and Creek No. 13 and Montana stream gradients are generally steep, and velocities are high. Heavy rains tend to raise the water levels of a number of streams to the point where they overflow their banks. During such Embraces the entire coastal area of Gogebic County, Mich., and contains 76 watersheds in electrical devices are also recommended. Many of the streams are relatively inaccessible. (and below all spawning grounds) of all but 11 of the remaining streams; for the latter, lock-hardwood climax type are predominant.

| | | | | B | te obtei | ned by surv | ey | | | Data from other cources |
|--------------------------|---------------|---------------------|---------------------------|---------|--------------------------|-------------|---------------|--------------|--|--|
| Name of stream | Cou: T-R-S | nty end et mouth | Number edults found | Date | Number nests found | Date | Larvee dug | Date | Identification of larves $\overline{3}/$ | |
| Tahquameron River | Chippew | e, 48-6-14 | 50 <i>4</i> | 6/29/50 | 10 | 6/29/50 | o | : | : | Upetream migrents (edulte) reported seen (resort owners) in epringe of 1948 and 1949. (1949 run largest-resched peek in 2nd week of June.) |
| Little Two Heerted River | Luce, 51 | 0-9-24 | 0 | : | 0 | : | 16 1/ | 7/5-7/11/50 | Netive lampreys | |
| Two Heerted River | Luce, 50 | 0-9-27 | 0 | • | 0 | • | 6 | 7/11-7/25/50 | Netive lampreye | 4/ |
| k. Br. Two Heerted River | Luce, 4 | 9-10-1 | 0 | • | 0 | : | 16 | 7/27-7/28/50 | Netivs lampreys | / 8 |
| W. Br. Two Hearted River | Luce, 4) | 9-9-6 | 63 | 7/29/50 | 64 | 7/25-7/28 | 25 2/ | 7/30-7/31/50 | 4 see end 21 | 4 |
| N. Br. Two Hearted River | Luce, 4 | 8-11-1 | 0 | • | 4 | 7/30/50 | 9 | 7/28/50 | native lampreya Netive lampreya | |
| Sucker River | Alger, | 49-13-4 | 0 | • | 23 | 8/7-8/22 | 43 | 8/7-8/17/50 | Netive lempreye | : |
| Baker Creek | Alger, | 49-13-4 | 0 | * | 0 | * * | 63 | 8/29/50 | Native lempreye | : |
| Tributery # 4 | Alger, | 48~13~1 | 0 | • | 0 | • | ল | 8/18/50 | Netive lampreya | : |
| Creek # 3 | Alger, | 49-1 3- 6 | 0 | • | 3(7) | 8/8/50 | 0 | • | :: | |
| Hurricene Creek | Alger, | 49-15-3 | 0 | • | 0 | • | ω | 8/22/50 | Native lampreys | ••• |
| Lowney Creek | Alger, | 48-16-17 | 0 | • | ı | 8/10/50 | 5 | 9/10/50 | Native lampreys | ••• |
| Tributery # 16 | Alger, | 48-17-29 | 0 | ••• | 0 | : | 63 | 9/14/50 | Native lampreys | |
| Mosquito River | Alger, | 48-18-25 | 0 | • | 0 | • | ю | 9/14/50 | Nativs lampreye | |
| Miner's River | Algar, | 47-18-3 | 0 | • | п | 9/8/50 | 0 | : | : | : |
| Anna River | Alger, | 46-19-2 | 0 | • | 0 | • | 2 | 9/16/50 | Native lampreys | *** |
| Furnace Creek | Alger, | 47-19-29 | 0 | : | 0 | : | • | : | : | Dead adults observed (resort ownere) on beach at mouth of streem, serly summer, 1950. |
| Creek # 7 | Alger, | 47-19-18 | 0 | • | 0 | : | 1 | 9/18/50 | Unidentifieble | ••• |
| Au Train River (lower) | Alger, | 47-20-19 | 0 | • | 0 | : | 1 | 9/30/50 | Native lamprey | Five adulte and 2 meets observed, July 9, 1950. 5/ |

Table 23,---Summary of information showing utilization of streeme from the Tabquamenon Hiver west to the tip of the Keweenew Feningule, 1950, and from the latter point to the Nichigan-Wisconsin border, 1951

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| | j | | ă | ta obtai | ned by surv | вy | | | Data from other sources |
|--------------------------|------------------------------|------------------|-------------|----------|-------------|---------------|-------------|--|---|
| | i e | Number | | Number | | | | | |
| Name of stream | County and T-R-S at mouth | adul ta found | Date | found | Date | Larvea dug | Date | Identification of larvee $\frac{3}{2}$ | |
| Rock River | Alger, 47-21-15 | 0 | : | 0 | : | 0 | • | : | Severel adults observed (resort owner) below dem at mouth, spring, 1950. |
| Laughing Whitefiab River | Alger, 48-22-26 | 0 | : | 0 | 0 • • | 0 | | Native lempreys | Tan nests observed, and 4 lervae dug, July 10, 1950, $5/$ |
| Chocoley River | Marquette, 47-24-6 | 0 | * * * | 0 | : | 0 | ÷ | Native lamprays | Approximataly 15 adults, 113 larvae, and approximataly 265 masts observed and/or recovered from 8/9 through 8/23/50. 5/ |
| Cedar Craak | Marquatte, 47-24-9 | 0 | • | 0 | • | 0 | ÷ | Native lamprey | One lamprey larva recovered, 9/20-28/50, $5/$ |
| E. Br. Chocolay River | Marquatte, 46-24-14 | 0 | • | 0 | 4 * * | 0 | •••• | : | Five nests observed $9/14$ and $9/15/50$. $\overline{5}/$ |
| Huron River | Baraga, 52-29-18 | 0 | : | 0 | * * * | 0 | : | Unidentifiable | Six larvae dug, Septembar 1, 1950. $5/$ |
| Ravine River | Baraga, 51-31-4 | 0 | : | 0 | • • | 0 | • • | 2 native lamproys | ; Thirteen larvaa dug, August 31, 1950. 5/ |
| Slata River | Berage, 51-31-8 | 0 | 0 6 8 | 0 | : | 0 | • | 11 unidentifieble Unidentifieble | Six probabla nasta observad, and 5 larvae dug. August 31, 1950. <u>5</u> / |
| Silver River | Baraga, 51-31-18 | 0 | • | 0 | 0 • • | 0 | : | l native, 21 un- | Ten nests observed, and 22 larvae dug, auguat 31, 1950, $\overline{2}/$ |
| Sturgeon River | Houghton, 54-33-33 | 0 | : | 0 | : | 5 | 8/29/50 | identificala Native lampreys | : |
| Traverse River | Houghton, 55-31-4 | 0 | : | 0 | : | 0 | 0 8 9 | | Five probable mests observed, July 6, 1950. $\overline{5}/$ |
| Tobacco River | Кемеелаж, 56-30-20 | 0 | ÷ | 0 | : | 3 | 8/28/50 | Native lampraya | • • |
| Firesteele River | Ontonagon, 52-39-1 | 0 | * * * | Ч | 8/27/51 | 0 | 6 0 0 | : | : |
| | | | | | | | | | |

One of the 5 taken from the stomach of an 8.5 inch brook frout. A number of larves ware size discent on August 8, 1950 from 10 see lampray mests with a square foot bottom sampler. These had been hatched only a short time previous to darve of collaction, and are assumed to be see lampray mests with a square foot bottom sampler. These had been hatched only a short time without of identification may be in need of further refinements to assume complets accuracy. Nethod of identification may be in need of further refinements to assume complets accuracy. Nethod Definement of conserveint. The figures 80 and 15 represent the total number of specimena these from the 3 river listed above. Used Performent of Conserveint, figures 80 and 15 represent the total number of specimena wildlife 3-river. নাথা চাৰা তা

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LEGEND FOR MAP AREAS 1-22 (SEE FIGURES 2-23)

SPOT LOCATIONS: ADULT SEA LAMPREYS LARVAL SEA LAMPREYS SEA LAMPREY NESTS SPAWNING HABITAT

NESTS OR SPAWNING HABITAT IN EXTENSIVE AREAS

NATURAL BARRIER MAN-MADE BARRIER

GOOD ROAD POOR ROAD

BASE MAPS: MICH. DEPARTMENT OF CONSERVATION, COUNTY MAPS

Control procedures

Control devices may have to be installed on 194 or more streams between the Tahquamenon River and the Michigan-Wisconsin border. Tentative sites have been located on the majority of the streams, subject to change as warranted by conditions on individual streams and future developments of control devices.

The majority of streams in possible need of control are small (5 to 15 feet in width). A considerable number are in the 15- to 35- foot class. However, at least 57 are large or very large (tables 1-22).

Electrical devices have been recommended for 65 streams which are too large for mechanical weirs or barrier dams or in which good sites for such devices are lacking. Many of these sites are some distance (several miles) from the nearest power lines. Mechanical weirs are recommended for 61 streams, although it is possible that this type of device will be discarded in favor of more practical structures on individual streams (Applegate and Smith, 1951).

Barrier dams are recommended for 68 streams, many of which are difficult of access. Most of these streams are located in Ontonagan and Gogebic Counties. Banks are ravine-like and the substratum at the potential barrier sites is bedrock. Gradients are generally steep; it is believed that mechanical weirs would be difficult or impossible to hold due to the sudden rises in water levels following heavy rains. A number of these barrier dams can be constructed on bedrock outcroppings which are already partial barriers.

Beyond the usual engineering problems accompanying the installation of control devices, the main problem to be faced in the Lake Superior basin is that of relative inaccessibility. Many potential control sites are miles from the nearest roads, and can be reached only by compass course through rugged areas often covered with almost impenetrable slash and second growth.

The control program in Lake Superior logically should be initiated by constructing control devices in those watersheds in which adult sea lampreys, nests, or sea lamprey larvae have already been observed. At the close of the 1951 season these watersheds numbered 15. At the recommended control sites, the main streams of eleven of these watersheds are large, three are of moderate size, and one is small. Details concerning utilization in these particular streams are presented in table 23.
Recommendations for future work

It will be necessary, in the future, to recheck all streams with a productive potential, to determine whether or not they are being used by adult sea lampreys. It is probable that a large number of these streams will never be in need of control measures; spawning may be inhibited by low temperatures, steep gradients, high velocities, relatively small size of a number of streams, and excessive turbidities (lake clay areas of Ontonagon and Gogebic Counties). The more questionable or marginal streams should be rechecked during the regular spawning season to determine accurately their temperatures, velocities, and water levels. The true extent of spawning activity in many streams (notably in Ontonagon and Gogebic Counties) can be determined only by rechecking during the spawning season before most of the nests are destroyed by freshets.

It will be necessary also to carry out further initial surveys of all of the remaining unsurveyed streams flowing into Lake Superior, if the sea lamprey is to be successfully controlled (Wisconsin, Minnesota, Ontario streams, and those on Isle Royale and other islands which have not yet been examined). Many of the unsurveyed areas are relatively inaccessible, and will call for much more highly organized surveys than those carried out to date.

Despite the fact that various types of control structures have been recommended for streams which have a productive potential, it will be necessary to experiment further in order to develop the most practical types. Many Lake Superior streams have characteristics (steep gradients, high velocities, rapid fluctuations in water levels, and extremely heavy turbidity) which, when combined with relative inaccessibility, may present control problems not encountered in previous experimental control operations (Applegate and Smith, 1951). Applegate, Vernon C.

1950. Natural history of the sea lamprey (<u>Petromyzon marinus</u>) in Michigan. U.S. Fish and Wildl. Serv., Spec. Sci. Rpt.: Fisheries No. 55, 237 pp.

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