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REPORT

OF THE

COMMISSIONER OF FISH AND FISHERIES

RESPECTING THE

ESTABLISHMENT OF FISH-CULTURAL STATIONS

IN THE

ROCKY MOUNTAIN REGION AND GULF STATES.

FEBRUARY 8, 1892.—Referred to the Committee on Fisheries and ordered to be printed.

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LETTER OF THE COMMISSIONER OF FISH AND FISHERIES.

U. S. COMMISSION OF FISH AND FISHERIES,
Washington, D. C., February 4, 1892.

SIR: I respectfully transmit herewith reports made in conformity with a provision contained in the sundry civil bill making appropriations for the fiscal year ending June 30, 1892, which directed the Commissioner of Fish and Fisheries to make an investigation respecting the advisability of establishing a fish-hatching station in the State of Montana or Wyoming and also a station in the Gulf States. The same paragraph appropriated \$1,000 for the explorations in Montana and Wyoming and a like amount for explorations in the Gulf States.

While the direct object of the investigation was to arrive at a precise estimate of the availability for fish-cultural operations of the various sites suggested, it was made much more comprehensive in its scope than was necessary to settle questions of location, and the reasons for this are obvious.

The character of the fish-cultural operations which may be profitably undertaken in any region varies with climatic conditions and with the physical, chemical, and biotic features of its waters. These factors must be more or less accurately known in order to determine the extent and nature of the fish-cultural installation needed and to direct advantageously the stocking of the waters in the interest of which the station is established.

The investigations were conducted by Prof. B. W. Evermann, assistant in the Division of Scientific Inquiry. The field explorations in Montana and Wyoming began at Helena, Montana, on July 18, and were prosecuted continuously until August 27.

The explorations in Texas began November 2 at Galveston, and were continued actively until December 7, when Prof. Evermann returned to Washington, and has been since engaged in preparing his reports.

The field of investigation, both in the Rocky Mountain region and in Texas, was limited; it was not practicable, nor was it necessary for the particular purpose to be accomplished, to explore the entire area of the States named. I was able, from a knowledge of the conditions to be fulfilled, to limit the area to be examined and thus permit a more detailed and careful inquiry than would have been otherwise possible with the limited means available.

The advisability of establishing fish-cultural stations in the Rocky Mountain and Gulf regions does not admit of question, so long as it is the policy of the Government to undertake economic work of this kind in the general interest. Three years ago the fish-cultural stations of the Commission were all to be found in the States on the Atlantic and Pacific seaboard, and on the Great Lakes. Since then, recognizing the justice of a more equitable distribution of the appropriations made for this economic interest, Congress has made liberal provision for a splendidly equipped trout-breeding

station at Leadville, Colorado, and an equally well appointed station for the cultivation of pond fishes, as well as trout, at Neosho, in southwestern Missouri.

There yet remains a wide extent of country centering around the Yellowstone Park in which the Government has no fish-cultural establishment, and the waters of which can be stocked only by uncertain and costly transfers from remote stations, the resources of which are fully taxed to supply the demands of adjacent waters. In the South Atlantic and Gulf States the Government has no fish-cultural establishments in the interior, and no stations on the coast for the conduct of those investigations of the life history of the inhabitants of the waters which are necessary to give profitable direction to our fishery interests and fish-cultural methods.

In pursuance of the policy indicated in the establishment of the stations at Leadville, Colorado, and Neosho, Missouri, it is respectfully recommended that provision be made for the establishment of a trout-breeding station in southern Montana, in the vicinity of the Yellowstone National Park, at a point to be selected by the Commissioner of Fish and Fisheries.

It is further recommended that like provision be made for the establishment of a fish-cultural station in Texas for the hatching and pond culture of the fishes which are suitable for the fresh-water ponds and rivers of Texas and contiguous States.

It is further recommended that provision be made for a station for marine investigation and for the conduct of fish-cultural and oyster-cultural operations upon the Gulf coast, at such point as may be found, after due examination, to be best suited for the purpose.

It is not considered advisable to indicate definitely the locations for the hatcheries, either in Montana or Texas, since more detailed examinations may make it necessary to modify conclusions based upon information now available. The desirable locations that may be provisionally indicated for Montana are Horsethief Springs, Botteler Springs, and Davies Springs. For Texas, suitable locations supplying all necessary conditions are to be found at San Antonio, New Braunfels, San Marcos, and Austin. The more or less favorable conditions offered for control of ground and water franchises will probably determine selection.

To carry out the above recommendations, the following estimates of appropriations are submitted:

For the establishment of a fish hatchery in the State of Montana, at a point to be selected by the Commissioner of Fish and Fisheries, for the acquisition of title and purchase of lands, and for the construction of the necessary buildings, ponds, roads, and inclosures.....	\$15,000
For the establishment of a fish hatchery in the State of Texas, at a point to be selected by the Commissioner of Fish and Fisheries, for the purchase of land and acquisition of title, and for the construction of the necessary buildings, ponds, roads, and inclosures	15,000
For the establishment of a marine fish-cultural and oyster-cultural station on the Gulf coast, at a point to be selected by the Commissioner of Fish and Fisheries.....	10,000

Reports are also submitted herewith of the field explorations in Montana, Wyoming, and Texas, made by Prof. B. W. Evermann, an assistant in the U. S. Fish Commission, under my instructions and in compliance with the provision of law above referred to.

Very respectfully,

MARSHALL McDONALD,
Commissioner.

HON. LEVI P. MORTON,
President of the Senate.

TWO-OCEAN PASS.

1.—A RECONNAISSANCE OF THE STREAMS AND LAKES OF WESTERN MONTANA AND NORTHWESTERN WYOMING.

BY BARTON W. EVERMANN, PH. D.,
Assistant, U. S. Fish Commission.

[Plates I-XXVII.]

SUMMARY OF REPORT.

In this paper are presented the results of investigations in Montana and Wyoming made during the summer of 1891 under the direction of the U. S. Commissioner of Fish and Fisheries.

In carrying out the instructions furnished by the Commissioner, it was highly important that a careful study be made of the physical and natural-history features of the streams and lakes of the region. Attention was given to the general characters of the streams and lakes, their size, depth, current; the nature of obstructions, if any, in the streams; the source of water supply, whether from lakes, springs, or melting snow; the temperature of the water at different times and different places; its clearness, and to what extent contaminated by mining operations or heavy rains; the geology of the region through which the stream flows, and the composition and nature of the bottom and banks of each river or lake.

In studying the natural-history features of the streams special attention was given to the kinds of fishes they contain, their abundance, size, condition, and distribution; also to the invertebrate life, such as crustaceans, insects, and mollusks, serving as food for the fishes.

The important question of the geographical distribution of fishes was kept constantly in mind, and attempts were made to trace the limits in the range of certain species, and to determine, if possible, the definite solution of certain difficult problems presented in the distribution of the trout and blob in Yellowstone National Park.

In making my investigations looking toward the selection of a suitable site for a fish-cultural station, visits were made to as many places as our time would permit, or as was necessary for the purposes of the investigation. The station for this region would be devoted almost exclusively to the hatching and rearing of various species of trout and other *Salmonidæ*. The requirements for the successful operation of such a station may be stated briefly as follows:

1. *Pure water*: (a) A constant supply of not less than 1,000 gallons per minute. (b) The temperature should not at any time exceed 50° or 55°, and would better be under 50°. (c) There should be no danger of contamination from any source.

2. *Suitable ground*: (a) The amount should be 20 to 30 acres. (b) It should lie conveniently near to the source of water supply. (c) There should be sufficient fall

between the source of water supply and the hatchery building to permit a gravity supply. (d) The ground should lie so as to permit easy drainage of any or all of the ponds.

3. *The location* should be: (a) Central with reference to the region to be stocked. (b) Such as to afford good railroad facilities.

In the detailed portion of this report I have discussed at length the advantages offered by fourteen of the most promising localities. The one most nearly filling all the natural requirements is Horsethief Springs. These springs, located in Montana, near the northwest corner of the Yellowstone National Park, are among the largest and most remarkable that are to be found anywhere in the United States. Their remoteness from a railroad is apparently the only objection to them.

The springs at Botteler's ranch, just north of the Park, are excellent in every way, as are also the Davies Springs, near Bozeman. Child's bedrock drain near Helena, Cottonwood Creek at Deer Lodge, and Rattlesnake Creek near Missoula are places that should be considered, as each offers advantages of one kind or another.

After considering the advantages offered by each of these various places, I would recommend that the selection be made from the three which are near the Yellowstone National Park, viz, Horsethief Springs, Botteler Springs, and Davies Springs.

BRIEF STATEMENT OF ITINERARY.

I left Washington July 7, 1891, for the West, and, being joined at Terre Haute, Indiana, by Prof. O. P. Jenkins, of Leland Stanford Junior University, and Mr. Burnside Clapham, of Monroeville, Indiana, we proceeded to Leadville, Colorado, where we remained until July 15, when we left for Helena, Montana, where we arrived on the morning of the 18th. Here we began our work by examining the streams of that vicinity. From there we proceeded westward to Elliston, then south to Deer Lodge, Dillon, and Red Rock, carefully examining the waters of that region. Returning, we spent a little time at Silver Bow, then proceeded northwest to Missoula, where we spent three days exploring the streams accessible from that place. From Missoula we went still farther northwest to Ravalli, then by stage across the Flathead Indian Reservation to Flathead Lake, where we took the boat for Demersville, on Flathead River, about 30 miles above the head of the lake. After spending a day at Demersville, we took the steam yacht *Lillian*, which had been placed at our disposal by the owners, Hon. William Muth and Mr. Edward Harwood, and went down the river to the east side of the lake at the mouth of Swan River, where we stopped at the quarters of the Helena Rod and Gun Club for two days, during which time we examined that part of Flathead Lake, the Swan River, and made a trip across the country 7 miles to Swan Lake. Leaving the Flathead Lake region August 4, we returned to Helena, where we spent a day inspecting Hon. W. C. Child's bedrock drain, and then proceeded to Mammoth Hot Springs in the Yellowstone National Park. Here we secured a proper camping outfit, and started out August 7 for a tour of three weeks through the Yellowstone National Park and the little-known region in Wyoming lying south of the Park.

During this expedition we had as our guide Mr. Elwood Hofer, whose energy, intimate acquaintance with the region, and personal knowledge of the work already done by the Commission in the Park, made his services invaluable to us.

The objects of this trip were:

(1) In compliance with our instructions, we desired to visit all the waters of the Park in which plantings of various species of *Salmonide* had been made by the Commission in 1889 and 1890, to determine, if possible, the measure of success that has attended that work;

(2) A more thorough study of the streams of the Park than had hitherto been made was necessary to an understanding of the very interesting questions of geographic distribution which are there presented;

(3) It was desirable, as a part of the question of distribution, to visit the region at the headwaters of Atlantic and Pacific creeks, and to determine, if possible, the exact nature of the famous Two-Ocean Pass as a barrier to the distribution of fishes;

(4) We desired to make investigations with a view to discovering if there are not yet other waters in or near the Park that are without fish and the stocking of which might very properly be undertaken by the Commission; and

(5) We wished to examine various streams and springs in and about the Park with reference to the selection of a site for the location of a fish-cultural station, if any suitable could be found in that region.

It may be added here, that these explorations were very satisfactory from both the economic and scientific points of view, the results being among the most important obtained during the summer's work.

We returned to Mammoth Hot Springs at noon, August 25. The afternoon of that day and the day following were spent in examining the streams in that vicinity and at Cinnabar and Horr, just north of the Park line. On the evening of the 26th I went by rail to Bozeman, leaving Prof. Jenkins and Mr. Clapham to examine Botteler Springs, between Cinnabar and Livingston. After spending one day inspecting the streams and springs about Bozeman, I returned to Livingston, where I was again joined by Prof. Jenkins and Mr. Clapham. We decided here to close our investigations for the season.

ACKNOWLEDGMENTS.

In this connection I desire to express the thanks of myself and the other members of my party to the various gentlemen in Montana and Wyoming who assisted us in various ways in our work. Mention should first be made of Senator T. C. Power, who is greatly interested in the efforts of the Fish Commission looking toward increasing the value of the food-fishes of Montana. Senator Power took pains to acquaint the people of the State with the purposes of our visit, and through him we were enabled to meet many of the most prominent citizens, who rendered us assistance in many ways. At Helena numerous courtesies were extended to us by Maj. Robert C. Walker, secretary of the board of trade; also by Hon. William Muth and Hon. W. C. Child. At Deer Lodge we were able to make more thorough and extensive explorations than would have otherwise been practicable through the kindness of Mr. N. J. Bielenberg, Mr. Frank Conley, superintendent of the State prison, and Prof. Frank Traphagen, of the College of Montana. At Missoula we were assisted in visiting the various streams of that region by Hon. W. M. Bickford and Mr. E. A. Winstanley, and were shown favors by other gentlemen of that city.

We were enabled to visit the Swan Lake region through the kindness of Mr. Edward Harwood, of Demersville, and Hon. William Muth, who placed their small

steamer at our disposal. Mr. Harwood accompanied us on all of our trips about this region and assisted us in many ways. I was able to make much more thorough investigations in the vicinity of Bozeman than would otherwise have been possible in the time at my disposal, through the kind and courteous assistance of Hon. O. P. Chisholm, Walter Cooper, esq., and Mr. W. A. Imes. To Capt. George S. Anderson, U. S. Army, acting superintendent of the Yellowstone National Park, we are under special obligations for the loan of blankets and other articles, which added greatly to the comfort of our trip through the Park. Capt. Anderson takes an active and intelligent interest in the efforts of the Commission to stock the Park with valuable food-fishes, and is ever ready to assist it in all proper ways. The opportunity to make the trip from Cañon Hotel to Horsethief Springs was due to the kindness of Mr. R. R. Cummins, who furnished free conveyance to the springs and back again to Mammoth Hot Springs.

REPORT OF THE INVESTIGATIONS.

ITINERARY.

- July 7. Left Washington, District of Columbia, for Leadville, Colorado; was joined at Terre Haute, Indiana, by Prof. O. P. Jenkins and Mr. Burnside Clapham, and arrived at Leadville July 12.
- July 13-14. Spent at the Government hatchery at Evergreen Lakes, near Leadville.
- July 15. Left Leadville for Helena, Montana, where we arrived July 18.
- July 20. Drove to McClellan and Prickly Pear creeks, east of Helena.
- July 21. Went to Elliston, where we seined Little Blackfoot River.
- July 22. Went to Deer Lodge; seined Cottonwood Creek and Deer Lodge River.
- July 23. Started with teams and saddle horses for the headwaters of Dempsey Creek, returning July 25; examined Tineup Joe, Punch. Dempsey, and Race-Track creeks, and the lakes near Mount Powell, at the head of Dempsey Creek.
- July 25. Went to Dillon.
- July 26. Mr. Clapham went to Red Rock, where he seined the Red Rock River the next day.
- July 27. Prof. Jenkins and I seined the Beaverhead River near Dillon. Went to Silver Bow in the evening and examined Browns Gulch Creek.
- July 28. Went to Missoula; drove up Rattlesnake Creek several miles and examined it down to its mouth.
- July 29. Drove to Big Blackfoot River.
- July 30. Drove to Bitter Root River and Lolo Creek, about 12 miles south of Missoula.
- July 31. Went to Ravalli, and drove from there to St. Ignatius Mission, where we examined Mission Creek; returned to Ravalli in the afternoon and seined Joeko River.
- August 1. Took the stage for Flathead Lake, where we took the steamer for Demersville, on Flathead River, which we examined in the evening.
- August 2. Went on the steam launch down the river to the mouth of Swan River.
- August 3. Drove through the woods 7 miles to Swan Lake; examined the lake, river, and Depew Creek.
- August 4. Returned to Ravalli and took train for Helena.
- August 5. Drove to Mr. Child's ranch.
- August 6. Went to Mammoth Hot Springs, Yellowstone National Park.
- August 7. Started out from Mammoth Hot Springs equipped for a three-weeks' camping expedition. Traveled about 12 miles and camped at head of Beaver Lake.
- August 8. Traveled 18 miles to Cañon Creek, where we camped. Prof. Jenkins and Mr. Hofer made a detour to examine Gibbon River above Virginia Cascade.
- August 9. Traveled 9 miles to Nez Percé Creek, Prof. Jenkins and Mr. Clapham making a side trip to the junction of Firehole and Gibbon rivers.
- August 10. Rode about 10 miles to Firehole River, just above Old Faithful, where we camped.

August 11. Traveled 16 miles up the Firehole River, across the Divide and to the outlet of Shoshone Lake, where we made our fifth camp.

August 12. Shoshone Lake to Lewis River, below the upper falls, 10 miles.

August 13. Lewis River across Crawfish Creek near Moose Falls to President Camp, on Snake River, 20 miles.

August 14. Crossed Snake River and proceeded southward to Jackson Lake, 12 miles.

August 15. Turned eastward and camped on Pacific Creek, 12 miles from Jackson Lake.

August 16. Followed up Pacific Creek 18 miles, where we again camped.

August 17. Followed on up Pacific Creek 7 miles to Two-Ocean Pass, where we spent the day.

August 18. Followed down Atlantic Creek to its mouth, crossed the Upper Yellowstone River, and camped on Thoroughfare Creek, 12 miles.

August 19. Traveled 18 miles to the mouth of the Upper Yellowstone River, camping near the mouth of Beaverdam Creek.

August 20. Traveled along east side of Yellowstone Lake 10 miles to the mouth of Meadow Creek.

August 21. Followed on down east shore of the lake to the Yellowstone River, crossed over, and went up to Lake Hotel for mail, the rest of the party camping at mouth of Pelican Creek.

August 22. Proceeded down Yellowstone River to the Grand Cañon.

August 23. I left the party here and went across the country to the Norris Basin, from which place I accompanied Mr. R. R. Cummins to Horsethief Springs, about 42 miles west. The rest of the party proceeded down Yellowstone River to the foot of Mount Washburn, where they camped.

August 24. Examined Horsethief Springs and returned to Norris Hotel. The main party traveled on to Blacktail Deer Creek.

August 25. All members of the party reached Mammoth Hot Springs at noon.

August 26. Rode to Reese Creek above Cinnabar. Took the train in the evening, Prof. Jenkins and Mr. Clapham stopping off at Fridley's to examine Botteler Springs, while I went on to Bozeman.

August 27. Examined streams about Bozeman. Returning to Livingston that night, I was joined there by Prof. Jenkins and Mr. Clapham, and we took the train for the east.

PHYSICAL FEATURES OF THE REGION EXAMINED.

The desirability of reaching as many places as possible in the investigations pertaining to the selection of a site for the hatchery required us to cover a much wider area in the season's work than would otherwise have been advisable. Nothing like a thorough survey of the entire region traversed was possible in the time which we had to devote to it.

In the measurement of the streams, the widths and depths given are the average for the distance through which we measured the current. The rate of the current was obtained by timing a floater, and the rate given is usually the average of the results of several tests. Usually the floater was timed for a distance of 50 to 100 feet. The measurements taken were under rather than over; hence the volume determined for each stream is believed to be slightly under the exact amount. The volume given is the number of gallons the stream discharges per minute.

The temperatures were taken with one of Wilder's standard Fahrenheit thermometers, and, unless otherwise stated, the temperature given is that of the water near the surface. The seining was done with two Baird collecting seines, one 15 feet, the other 30 feet long.

According to Dr. Hayden,* Montana is separated into two very unequal areas by the dividing range of the Rocky Mountains, which forms the southwestern boundary from the west line of Wyoming to the intersection of 45° 40' north latitude and the 114th meridian. Here it suddenly bends eastward for some distance, and then runs north about 20° west to the northern boundary of the State. Extending from

* U. S. Geological Survey of Montana and adjacent Territory, 1871.

the mouth of the Yellowstone to the summit of the Bitter Root Mountains, about two-fifths belong to the mountain region, the remaining three-fifths consisting of broad, open plains lying east of the Rocky Mountain range. The mountain belt, which forms a broad margin along the western end, has probably an average width of 175 miles, running northwest parallel to the western boundary. Besides these two leading ranges and their interlocking spurs on the west slope, there are some minor ranges on the eastern side, which, though comparatively small in extent, are important in respect to the influence they have upon the course of the water drainage and the form and direction of the principal valleys.

In and about the Yellowstone National Park appears to be the great mountain nucleus of this region. Here the Bighorn, Yellowstone, Gallatin, Madison, Jefferson, Snake, and Green rivers have their origin. From this mountain center a number of short ranges run northward, giving direction to a number of streams. Along the southern border the Snow Mountains penetrate Montana for a short distance, compelling the Yellowstone River to make a grand detour in order to sweep around the northern flank. In the central portion are the Belt, Judith, and Highwood mountains, forming an irregular group of short and broken ranges, around which the Missouri sweeps to the northward before entering upon its long eastward stretch. These also have a nucleus where the Musselshell, Judith, Deep, and Shields rivers take their rise.

The mountains of this region, as a rule, are less rugged than those of Colorado. There are some very rough, rocky groups, such as the Grand Tétons, portions of the Main Divide southeast of Flathead Lake, and a number of peaks east of Yellowstone Lake. Instead of the rocky, jagged sides and serrated crests, we usually see here smooth slopes and rounded outlines.

According to Dr. Hayden, the elevation of both mountains and valleys of Montana is less than that of the great mountain belt of Colorado, Wyoming, Utah, Nevada, and New Mexico. The average altitude of the entire State is given as being 2,260 feet lower than that of the other States named, a difference regarded as the equivalent of seven degrees in latitude.

Climate.—Western Montana and northwestern Wyoming are among the most fortunate regions of America as regards rain and snow. According to Prof. Arnold Hague, "snow falls early in October [in the National Park region] and rarely disappears before June, and throughout the winter it is said to lie 6 feet in depth over the plateaus and higher regions of the Park."

A discussion of the forests and other vegetation will be given in detail in connection with the description of each stream or particular locality examined. It may be said here, however, that western Montana and Wyoming constitute a vast region which is for the most part covered with immense coniferous forests on the mountains, while here and there are a few large tracts with little or no timber, such as the plain at the south end of Flathead Lake, constituting the greater part of the Flathead Indian Reservation, and such valleys as those of the Prickly Pear and Deer Lodge. On the mountains the timber line is not far from 9,000 feet above sea level. At this height the dwarfed, scraggy spruce trees are mere bushes, not over a yard in length, and lie pressed flat upon the ground by the heavy snows. The forests are extremely heavy on the Big Blackfoot River, about Swan Lake, below Dempsey Lakes, and the region south and east of the Yellowstone National Park, which has recently been added to the Park as a timber preserve by proclamation of President Harrison.

Drainage.—The whole State of Montana and that portion of Wyoming visited by us are drained entirely by the Columbia and the Missouri, the headwaters of those two great rivers having their rise on the Great Continental Divide, near which our investigations were chiefly confined. By far the greater part of Montana, nearly all that portion lying east of the meridian of $112^{\circ} 30'$, lies within the Missouri drainage area. In the northwest part of the State the divide lies more than a degree farther west, and in the southwest the Missouri drainage extends westward to the Idaho State line. The Missouri also drains all of northwest Wyoming excepting the southwest portion of the National Park and part of the region south of the Park. This part of Wyoming belongs to the Columbia River Basin, being drained directly by the Snake River and its tributaries. In general it may be said that the streams of the Missouri system flow in a northeast or northerly direction. Those tributary to Clarke Fork of the Columbia flow to the northwest, while the drainage into the Snake River or Lewis Fork of the Columbia is to the southwest.

Nearly all of these rivers and creeks are, of course, swift mountain streams; most of them have their rise in small lakes of clear, cold water, high up in the mountains—lakes which as yet are difficult of access and but little known. Many of these lakes are known, however, to be well supplied with trout, while others are wholly without any fish life whatever. From these mountain lakes the swiftly flowing, turbulent streams make their descent through rocky gorges and cañons to the valleys below. Ordinarily the beds of the streams are very rocky, but now and then are found more quiet reaches where the streams have sand or gravel beds as they flow through small mountain meadows. Then, at other places, there are rapids and cascades, and in many of the streams are found considerable waterfalls. The best illustrations of this are in the numerous magnificent falls found in the streams flowing from the great volcanic plateau constituting the larger part of the Yellowstone National Park. As the streams leave this immense sheet of rhyolite, they do so in great falls, such as those of the Yellowstone, Gibbon, and Lewis rivers. Others of the same nature are to be found in the country lying to the east of the National Park in the Clarke Fork of the Yellowstone, and other streams of that region. These falls, of course, serve as more or less effective barriers to the distribution of fish, and as a result many of the mountain lakes, though of the most suitable character so far as temperature, purity, and abundance of food-supply are concerned, are wholly barren of fish life of any kind. The larger streams are, as a rule, less swift, and have more sandy and gravelly beds. There are few, if any, sluggish streams in this region, and all are clear unless contaminated by mining operations.

The following is a classified list of the waters examined:

A.—COLUMBIA RIVER BASIN.

I. *Clarke Fork*:

1. Flathead River.
2. Flathead Lake.
3. Swan River.
4. Depew Creek.
5. Swan Lake.
6. Post Creek.
7. Mission Creek.
8. Jocko River.

I. *Clarke Fork*—continued:

9. Missoula River.
10. Bitter Root River.
11. Lolo Creek.
12. Rattlesnake Creek.
13. Hell Gate River.
14. Big Blackfoot River.
15. Little Blackfoot River.
16. Deer Lodge River.

A.—COLUMBIA RIVER BASIN—Continued.

I. *Clarke Fork*—continued:

17. Rock Creek.
18. Tincup Joe Creek.
19. Cottonwood Creek.
20. Dempsey Creek; (a) Dempsey Lakes.
21. Race-Track Creek.
22. Peterson Creek.
23. Silver Bow River.
24. Browns Gulch Creek.

II. *Lewis Fork, or Snake River*:

1. Shoshone Lake; (a) Heron Creek.
2. Lewis River.
3. Lewis Lake.
4. Aster Creek.
5. Crawfish Creek.
6. Polecat Creek.
7. Jackson Lake.
8. Pacific Creek.
9. Inness Lake.

B.—MISSOURI RIVER BASIN.

I. *Upper Yellowstone River*:

1. Atlantic Creek; (a) Jay Creek; (b) Senecio Creek.
2. Bridger Lake.
3. Thoroughfare Creek.
4. Escarpment Creek.
5. Cliff Creek.
6. Mountain Creek.
7. Trapper Creek.

II. *Yellowstone Lake*:

1. Beaverdam Creek.
2. Columbine Creek.
3. Meadow Creek.
4. Pelican Creek.

III. *Lower Yellowstone River*:

1. Blacktail Deer Creek.
2. East Fork of Gardiner River; (a) Lava Creek.
3. West Fork of Gardiner River; (a) Glen Creek; (b) Indian Creek; (c) Beaver Lake; (d) Twin Lakes.

III. *Lower Yellowstone River*—continued:

4. Reese Creek.
5. Botteler Springs.

IV. *Madison River*:

1. Horsethief Springs.
2. Gibbon River; (a) Cañon Creek.
3. Firehole River; (a) Nez Percé Creek.

V. *Gallatin River*:

1. Bozeman Creek.
2. Bridger Creek; (a) Davies Springs.

VI. *Jefferson River*:

1. Red Rock River.
2. Beaverhead River.
3. Bighole River.

VII. *Prickly Pear Creek*:

1. McClellan Creek.
2. Child's bedrock drain.

COLUMBIA RIVER BASIN.

STREAMS TRIBUTARY TO CLARKE FORK OF THE COLUMBIA.

Clarke Fork of the Columbia.—This name is of somewhat varied application. It originally meant all of that river having its sources in the numerous small streams coming down from the mountains east and west and uniting into one stream of considerable size in Deer Lodge Valley, and which runs from there north, west, and then northwest, until just beyond the boundary of the United States in longitude 117°30' west, where it joins the Columbia at Fort Sheperd. Starting as a small stream on the divide near Silver Bow, flowing northward through the beautiful and fertile valley of Deer Lodge, and receiving on its way numerous smaller streams from the mountains between which it flows, it receives the Little Blackfoot River at Garrison, where it turns westward and continues in that general direction to the city of Missoula, 7 miles above which it receives the Big Blackfoot, a large tributary from the north.

All of that portion above the mouth of the Little Blackfoot River is now generally known as the Deer Lodge River. At the mouth of the Little Blackfoot it takes the

name Hell Gate River, which it bears to the mouth of the cañon just above Missoula, where it again changes its name and comes to be known as the Missoula River. The Hell Gate River is sometimes, however, made to include all that portion lying between the mouths of the Little Blackfoot and the Bitter Root, the latter uniting with the main stream just below Missoula; this seems to be the more logical division. For the next 30 miles, or until joined by the Flathead River, it is known as the Missoula River. From the junction of these two streams, it continues northwest for about 80 miles through a well-wooded and magnificent cañon, and it is to this portion that the name "Clarke Fork" is now usually restricted. At the lower end of this cañon the river widens out greatly, forming the beautiful Lake Pend d'Oreille. At the outlet of this lake it begins to flow more slowly and quietly as the Pend d'Oreille River, which name it continues to bear until it joins the Columbia. Some 25 or 30 miles below Lake Pend d'Oreille there is a vertical fall of 8 or 10 feet, known as the Seniakwoteen Falls. Here the river is said to enter a narrow cañon, through which it rushes with such violence as to be wholly unnavigable, and then falls into the Columbia in a final plunge of 15 feet. The streams tributary to this great river are among the most important and most interesting of any of the Rocky Mountain region.

Flathead River.—This is quite a large river and is the outlet of Flathead Lake. It receives numerous small streams from the east, chief among which are Jocko River, Mission, Post, Crow, and Muddy creeks.

Jocko River.—We examined this stream near the railroad station at Ravalli, where it has an average width of about 40 feet and a depth of over 3 feet. The current is very swift—so swift, in fact, that it was with great difficulty that we were able to use the seine. The bottom is of coarse gravel with occasional clusters of large boulders. There is little or no vegetation in the stream. The banks are lined in most places by quite a heavy growth of willows, alders, cottonwoods, and other bushes. In some places along the stream are small ponds, well filled with various species of *Algae* and swarming with larval insect life. Frogs and tadpoles were also common, and in one place a number of larval salamanders (*Amblystoma tigrinum*) were taken. The water of the river is clear and cold, the temperature at 5 p. m., July 31, being 58°. The Jocko is a very pretty river, and is regarded by sportsmen as a very good trout stream. We found trout quite abundant, as shown by the fact that we caught as many as a dozen at one haul with the 15-foot seine. Blobs and whitefish were also common—the blobs being large and fine, while only young whitefish were taken. A few small specimens of the long-nosed sucker (*Catostomus catostomus*) were also taken. We were told that salmon trout are also found in the Jocko, but we saw no specimens.

Mission Creek.—This is a clear, cold stream, about 25 feet wide and 2 feet deep, having its rise in the Mission Mountains northeast of Ravalli, and flowing through the reservation to join the Flathead River. We examined it in the vicinity of the Mission of St. Ignatius, where we found trout of small size in considerable numbers. Post, Crow, and Muddy creeks are other small streams crossed by the stage road from Ravalli to Flathead Lake. Each of them is well supplied with trout. From Post Creek, which is somewhat larger than the others, we obtained specimens of the Columbia River sucker. It appears to be common in this stream and is no doubt found in the others of this region. At the Mission we saw several good-sized specimens that had been brought in by the squaws.

Flathead Lake.—This lake, the largest in the State, lies 35 miles northward from Ravalli. It is about 30 miles in length from north to south and averages perhaps 12 miles in width. It is a very beautiful sheet of water, whose shores at the south end are without timber, but toward the north dense forests of pine and other evergreen trees come down to the water's edge. In the northern portion are several small islands tolerably well timbered. This lake lies in what appears to be an immense glacial valley, the lake itself being due to the enormous moraine lying at its lower end and through which the outlet has been cut. It is said to be very deep in many places, but we have no exact data upon that point. The waters are clear and cool.

Flathead Lake is perhaps as well supplied with fish as any body of water in the State. Mountain trout are abundant, grow to a good size, and are readily caught; salmon trout or bull trout are also common and are caught at certain seasons in considerable numbers by trolling. The Columbia River sucker also occurs in the lake, while the two large minnows, the Columbia chub and the "squawfish," are very abundant. At the different landings where our steamer stopped we amused ourselves by fishing for these species with hook baited with pieces of beef. Each species bites very readily and each shows some game qualities. It seems to make but little difference with what the hook is baited. In one instance, a very large "squawfish" was taken with the fly by Mr. Clapham in Swan River, who felt sure he had a very fine trout until it was landed. So abundant are these two species, and so readily do they take the hook, that they often prove quite an annoyance to him who is fishing for nobler game. Whitefish are also found in the lake and, judging from the number of young that we saw, would seem to be common. However, those persons best acquainted with the lake, with whom we talked, did not know of its occurrence there; and, still more curiously, the Oregon chub is known as "whitefish" by those familiar with the lake.

Flathead River.—At its north end, Flathead Lake receives its principal affluent, Flathead River. This is a large stream coming into the United States from British America west of Chief Mountain Lake, flowing through the lake, and then continuing southwest to join the Missoula as already described. We ascended the Flathead River 28 miles to the new town of Demersville, where it is still a very large and very deep stream with a rather swift current. Some 30 miles above Demersville the current becomes more rapid, the head of navigation being at Columbia Falls, near where the three forks of the river unite. The fishes of this part of Flathead River are, so far as we know, the same as found in the lake. At Demersville we found mountain trout, squawfish, and Columbia River chubs quite common. Salmon trout are also caught there, but we saw none.

Swan River.—Nearly east from the mouth of the upper Flathead River is the Swan River. Big Fork, Swan River, Sweating-house River, and Sweating River are different names by which this stream is known on different maps, but it is more generally known to citizens of that part of Montana as Swan River. It rises on the Divide southeast of Flathead Lake, near the head of the Clearwater, a tributary of Big Blackfoot River. It flows about 80 miles northwest and then widens out to form Swan Lake. Narrowing again, it continues northward and then westward for about 20 miles further and then flows into Flathead Lake, only about 3 miles east of Flathead River. Swan River, at the outlet of Swan Lake, is about 75 yards wide and averages about 5 feet in depth. Surface temperature at 3 p. m., August 3, 65°.

The water is very clear and the current quite rapid throughout the greater part of its course between the two lakes. Not far below Swan Lake, and again not far above the mouth of the river, there are very picturesque rapids. The bed of the stream is, of course, very rocky for most of its length. In the more quiet places there is a little water vegetation. The region through which it flows is covered with a very heavy growth of timber, coming down to the water's edge.

Swan Lake is distant from Flathead Lake about 7 miles, though the distance by the river is three times as great. This is a very beautiful lake, 16 miles long and varying from less than a mile to 3 miles in width. This lake, with its clear and sparkling waters, surrounded on all sides by dense evergreen forests, and studded here and there with small, well-wooded islands, rivals in beauty and picturesqueness any that the writer has ever seen; and the beauty of the river from the lake to the outlet is unexcelled. This lake is said to be a favorite resort for swans, ducks, and geese, several pairs of the latter breeding each year upon the small islands.

Depew Creek.—Just below the foot of Swan Lake the river receives from the right a small stream known locally as Depew Creek. This little creek rises in springs and runs through very dense pine forests for its entire course, a distance of about 8 miles. It has a flow of less than 2,000 gallons per minute. The water is very clear and pure, with a temperature of 48° at 11 a. m., August 3. The fishes of Swan Lake and Swan River are, so far as known, the common trout, salmon trout, whitefish, Columbia chub, squawfish, blob, and the Columbia River sucker. We obtained specimens of all of these except the salmon trout.

Swan River, between the two lakes, is noted as one of the best trout streams in Montana, the greater part of the entire distance being exceedingly well suited for trout fishing.

Rattlesnake Creek is a stream about 20 miles long, rising in the mountains north of Missoula and flowing through a rocky but well-wooded cañon to the Missoula River at the town of that name. It is said to have its source in two small lakes, near a third lake which is drained by Clearwater Creek into Big Blackfoot River. The "divide" between this third lake and the two others is said to be of such a character that, with very little work, a ditch could be cut across which would result in bringing the surplus water of the third lake into those drained by the Rattlesnake, thus greatly increasing the volume of that stream. This is a very clear, cold stream flowing with a rapid current over a very rough bed of gravel and larger rocks, and containing very little water vegetation. The banks are lined with a heavy growth of trees, bushes, and vines, but this promises not to remain very much longer. The larger timber is being cut off rapidly for wood, which is floated down the stream. At the time of our visit, at least 3 miles of the stream was literally filled with an immense jam of cordwood which had been started down, and still above this we saw a constant line of sticks floating by to augment the large amount already in the jam. From the best information we could gain, all of this timber is being cut from Government land, and, whether by Government permission or not, it is certainly to be very greatly deplored.

We examined this stream throughout the last 10 miles of its course, and took measurements just above Missoula. Temperature, 54° at 5 p. m., July 28. Width, 30 feet; depth, 1½ feet; current, 2½ feet per second. This would give over 56,000 gallons per minute. This creek flows its entire course through Government land, except the

last 2 miles. The city of Missoula gets its water supply from this stream, taking it out less than 2 miles above the mouth.

There seems to be an abundance of suitable fish food, many species of insect larvæ, etc., being seen at all places examined. The species of fishes found were the common trout, salmon trout, and blob. All of these were quite common, the salmon trout being, perhaps, the most abundant.

Big Blackfoot River.—This is one of the largest tributaries of the Hell Gate River, into which it flows at a point about 7 miles above Missoula. We examined it for the last 6 miles of its course. It is at least 100 yards wide and is very deep, so deep that the water, which is clear, appears very blue. Temperature at noon, July 29, 63°.

At Bommer, a mile or so above the mouth, is a very large sawmill, and the river for 3 or 4 miles above the mill is literally filled with logs which have been cut from the heavily timbered country through which the river flows and which were being floated down to the mill. Above this jam of logs the stream is open, but so deep and swift as to render seining wholly impossible except in occasional nooks and shallow places. This stream flows through a rocky gorge most of the way, there being but little bottom land. The mountains on either side are of highly metamorphic sandstone, and in most places densely timbered, but at the present rate of destruction it will not be many years until these magnificent forests are wholly destroyed, the mountains made barren, and the volume and beauty of the streams greatly diminished. An abundance of insect larvæ was found in several places, and the river is said to be a most excellent trout stream. We obtained specimens of the common trout, whitefish, blob, and one specimen of minnow (*Rhinichthys dulcis*). Frogs were not rare along the shore in suitable places.

Little Blackfoot River.—Examined on July 21, just above the town of Elliston. Temperature at 4 p. m., 55°; air, 71°. Width, 25 feet; depth, 2½ feet; current, 3 feet; volume, 84,375 gallons per minute. This is a good-sized stream, rising on the "divide" west of Helena and flowing westward to Garrison, where it joins the Deer Lodge to form Hell Gate River. The current is very swift, the bottom strewn with rocks of various sizes, and the banks are lined with willows, cottonwoods, and other small bushes. Below Elliston the water is muddied by mining operations, but above that place it is pure and clear.

Near the railroad bridge above town a small creek, averaging, near its mouth, 10 feet wide and 1 foot deep, flows into the Little Blackfoot. Its water is not so clear and is warmer (59°). In this we found an abundance of a small mollusk (*Limnæa palustris*) as well as various larval insects. In the river we found blobs and young whitefish abundant, and also took a few trout; while in the small creek we found trout of good size quite plentiful, a few whitefish, and an abundance of blobs, suckers (*Catostomus catostomus*), and minnows (*Rhinichthys dulcis*). Though we obtained no specimens, there is no doubt that the salmon trout also occurs in this river. Persons who have fished it frequently described to us two species of trout which they had taken here, one of which was quite certainly the salmon trout (*Salvelinus malma*). Frogs were not uncommon about the creek.

Cottonwood Creek.—Examined July 22 for the last 3½ miles of its course. Width, 20 feet; depth, 1½ feet; current, 3 feet; volume, 40,394 gallons per minute. Temperature at 3 p. m., 54°; air, 77°. This is a clear stream of considerable size rising in the

mountains some 15 miles east of Deer Lodge. Flowing through rocky gorges in the upper part of its course, and through rather rough meadow land in the lower portion, it unites with the Deer Lodge River at the city of that name. The bed of the stream is throughout very rough and rocky, but the banks are lined with a heavy growth of cottonwoods, alders, and other small trees and bushes. It seems to be well supplied with insect larvæ and other suitable food for fish, and is a most excellent trout stream. The seining that we did here was very unsatisfactory, owing to the roughness of the bottom and the extreme swiftness of the current; however, we took over 30 trout and a great many blobs. Quite a number of trout were also taken with the fly. None of the trout taken weighed over half a pound.

In some very small ponds along the creek we found a great many frogs, and insect larvæ literally swarmed in these pools. A few snakes (*Eutania* sp.?) were seen here. Quite a good deal of the water from Cottonwood Creek is used for irrigation, and the city of Deer Lodge receives its water supply from this stream. Up to the present time a little mining has been carried on along the upper course, but it has practically ceased now, and there is no great probability that the water of this creek will ever be in danger of contamination from that source.

Deer Lodge River.—This river has its origin in numerous small streams in the hills, chiefly to the westward of Butte City and on the divide, upon which also rise many of the affluents of Jefferson Fork of the Missouri. Flowing northward through a very beautiful and rich agricultural valley, it joins the Little Blackfoot River at Garrison, about 45 miles north of Silver Bow. We examined the Deer Lodge River throughout the greater part of its course. At Deer Lodge we found it to be 57 feet wide, 3 feet deep, and to have a current of 4 feet per second; this gives a flow of 307,800 gallons per minute. The temperature of the water at 10 a. m., July 23, was 59°; that of the air, 78°.

Throughout most of its course it has a very swift current. The bed of the stream is chiefly of coarse gravel and larger rocks. In some portions where the current is less swift the bed is made up of a constantly shifting mass of fine silt-like material, probably from the concentrators and reduction works at Anaconda and Butte. Throughout the entire length of this river the water is full of this solid matter in suspension. The amount of solid matter carried down by the Deer Lodge River from this source must be very considerable, and of course proves fatal to all kinds of fish life. We seined the river very thoroughly in the vicinity of Deer Lodge and did not find any fish whatever.

This stream is said to have been well supplied with trout and other fish, but none have been seen since the concentrators began operations. Other life was also scarce; no living mollusks or crustaceans and but few insect larvæ were seen. Upon a sandbar, below the town of Deer Lodge, we found a few dead shells of *Margaritana margaritifera* Linn., but careful search failed to discover any living specimens. The banks, usually low, are covered with a pretty heavy growth of alders, willows, and other small bushes. Except this fringe of trees along the streams, most of the Deer Lodge Valley is more or less rolling prairie or meadow land. In suitable places along the stream frogs were quite plentiful.

In its course from Silver Bow to Garrison the Deer Lodge River receives a great number of small streams from the mountains on each side of the valley. From the east come Browns Gulch, Silver Bow, Peterson, Cottonwood, and Freeze-out creeks;

while from the west the number is much greater, including Willow, Warm Spring, Lost, Modesty, Race-Track, Dempsey, Punch, Tincup Joe, and Rock creeks. Although these all comparatively small streams, they are, with few exceptions, well filled with trout. Warm Spring and Silver Bow creeks are ruined by mining operations, and perhaps others are somewhat contaminated.

Rock Creek, which flows into Deer Lodge River near Garrison, is a good stream, rising in a large lake. A large reservoir has been made upon this creek about 12 to 15 miles above Garrison, and this is said to be full of trout.

Tincup Joe is a good-sized creek, coming in not far from Deer Lodge.

Dempsey Creek is perhaps the most interesting one of this region. This stream rises in several small lakes lying near Mount Powell, flows about 20 miles or more, and joins the Deer Lodge River about 8 miles above the city of that name. Through the kindness of Messrs. N. J. Bielenberg and Frank Conley, of Deer Lodge, we were able to make a trip to the lakes at the head of this creek. In company with these gentlemen and Prof. Frank W. Traphagen, of the College of Montana, and Mr. Thomas Morgan, of Deer Lodge, we made a three days' trip to these lakes. The first day we drove about 18 miles southwest from Deer Lodge and camped on Dempsey Creek, perhaps 15 miles above its mouth. That portion of the creek lying between our camp and the valley is very rocky and very swift. There are a few short, quiet reaches, but most of the course is made up of rapids and small cascades which make it a very picturesque stream. In the vicinity of our camp there are some small mountain meadows, and the creek is more quiet as it flows through them. Its average width here was about 12 feet, the depth 2 feet, and the current not over 1 foot per second. The water was, of course, very clear and cold, and well suited to trout. A little time devoted to fishing with the fly in the evening near our camp resulted in a string of about twenty very nice fish.

The next day we took saddle horses and followed on up the creek to the lakes at its head, a distance of 5 or 6 miles. This ride was a very difficult one, through dense, almost impenetrable pine forests, over rough, rocky ridges almost too steep for a horse to climb, and across marshy meadows in whose soft mud our animals were in danger of miring. The first lake we reached was about 5 miles from our camp; a few hundred yards to the right was a second one, and about the same distance to the left a third lake. Each of these contains perhaps three sections or less. About them the country is quite rocky, great boulders and angular fragments of stone from the cliffs above being scattered here and there through the pine forests in which the lakes are set. These lakes are fed in great part from melting snows. Lying as they do around the base of the rocky peak of Mount Powell, they receive a multitude of little rivulets from a number of snow banks which linger in the gorges and cañons above until very late in summer, or even remain throughout the year. Indeed, right upon the shore of the third one of these lakes, we found a considerable bank of snow at the time of our visit, July 24. The lakes are in most places very deep, and the water clear and extremely cold. We neglected to take a thermometer with us on this trip, and consequently had no means of determining the temperature exactly, but it could not have been much above 40°.

In the first of these lakes we saw several trout, but though we fished quite a while they bit very poorly and we caught only a few. In the second lake we employed different methods with better success. At the lower end of the lake is the small stream which serves as an outlet to the lake. The beginning of this outlet is widened

into a miniature bay, which has a fine pebbly bottom, and in which the water is not over a foot deep. A line of rocks has been made by some one so as to separate this corner from the lake proper. One or two places had been left open, thus permitting the fish to pass through. We found a great number of good-sized trout in this little bay, but nearly all ran out into deep water upon our approach. Withdrawing only a short distance we had to wait but a few minutes until they began to return. Very soon the spot was literally alive with trout, when we hurriedly closed the few openings in the dam. When thus shut in it was an easy matter to capture all we wished with a small seine which we had. In this way we soon caught about thirty very fine specimens, which constituted but a small portion of the number in the cove.

This little cove is evidently used as a spawning ground, and our visit was at the height of the spawning season. Nearly all the females were ripe with spawn. In several instances the eggs came freely from the fish as we handled them, and a great number of eggs were seen lying around among the fine granite gravel. The testes of the males were in many cases greatly distended with milt, and both the males and females were very brilliantly colored.

In the third lake, already mentioned, we found trout most abundant. As a result of less than two hours' fly fishing, we took about one hundred and twenty-five, each weighing a half pound or less. Quite contrary to our experience with the trout in the other lakes, we found them to bite freely, even voraciously, in this lake. It seemed to matter very little what was used for bait, whether artificial fly, a real fly, trout eye, or parts of bright-colored flowers. Several good catches were made with bright-colored leaves of a species of painted cup (*Castilleja*). All these fish were caught in shallow water along the shore, but the best fishing was always at the mouths of the little streams flowing into the lake. The fish were all in excellent condition, their stomachs were well filled with insect larvæ and insects; in a few cases I found a number of small bivalve shells. In several instances the stomachs contained quite a lot of fine gravel or sand, probably the broken-down cases of caddis worms. Wherever examinations were made, suitable food for trout was found in abundance.

Besides the three lakes which we visited, there are said to be eight others lying about the base of the peak of Mount Powell. So far as we are able to learn, these lakes have not received separate names, but are known collectively as Dempsey Lakes. They all lie at an elevation of about 9,000 feet above the sea, and most of them are drained by Dempsey Creek. The elevation of Mount Powell is about 11,000 feet.

Dempsey Creek, though a rapid stream, does not contain any falls that trout can not ascend, and the difficulty of reaching the lakes is, fortunately, so great that they are not likely to become fished out very soon.

Race-Track Creek is also an excellent trout stream. About two miles from its mouth we found it about 30 feet wide, 2 feet deep, and with a 3-foot current.

Browns Gulch Creek.—This is a small stream in Browns Gulch, near Silver Bow. We spent some time examining it about a mile north from the railroad station. We found it here to be not over 6 feet wide, 2 feet deep, and with a rather swift current. The water was not very cold, about 63°, and was somewhat muddy, owing to recent rains. The stream is lined by a good growth of willows, and runs through a narrow strip of meadow land bordered by low hills. A few trout and a great many suckers (*Catostomus catostomus*) and *Rhinichthys dulcis* were obtained here, and it was from

this stream that we obtained the types of *Leuciscus gilli*. Small mollusks (*Limnæa palustris*), insect larvæ, and frogs were abundant.

This little creek flows into Silver Bow Creek near the railroad junction of that name. Silver Bow Creek is simply the name applied to the upper portion of Deer Lodge River. This comes down from the vicinity of Butte City, and its water has the consistency of thick soup, made so by the tailings which it receives from the mills at that city. No fish could live in such a mixture, and the fish in Browns Gulch are for the time being practically confined to that short stream.

The other tributaries of the Deer Lodge River are all small, but, with the exceptions already noted, are excellent trout streams.

Bitter Root River.—This is a fine large stream, reminding me very much of the beautiful Tippecanoe River, but it is about twice as large. It rises in the Bitter Root Mountains near the line between Idaho and Montana, flows north through the beautiful Bitter Root Valley, and empties into the Missoula River about 3 miles below the town. It is at least 75 miles long, its waters are clear and moderately cold, and the lower part of its course at least is over a bottom of sand and gravel covered toward the shores with a heavy growth of *Algae* and other water vegetation. This stream is apparently quite deep and flows with a steady, moderate current. The banks are usually low and well wooded. Several bayous or small ponds were noticed along the west bank, and these are invariably filled with *Algae*, a species of *Ranunculus*, and other aquatic plants.

Owing to the too great depth of the water we were not able to do any seining in the Bitter Root. Quite a number of specimens of *Mylocheilus caurinus* and *Ptychocheilus oregonensis* were obtained, however, by use of hook and line. These two species are evidently abundant in this river. Trout and "salmon trout" are also reported common, "salmon trout" weighing 12 to 14 pounds having been taken at the mouth of the river, according to Mr. E. A. Winstanley, of Missoula.

Lolo Creek.—This stream, also spelled "Lou-Lou," has its origin in the Bitter Root Mountains, on the Idaho State line, and flowing eastward for about 40 miles joins the Bitter Root River about 10 miles above its mouth, or about 12 miles southwest of Missoula. Like all other streams of this region the Lolo's waters are pure, clear, and cold. A mile or so above its mouth it was found to be about 35 feet wide, averaging perhaps $2\frac{1}{2}$ feet deep, and flowing with a very rapid current. Temperature at noon, July 30, 56°. We examined it throughout the last mile but one of its course. Here it flows over gravelly bottom and between gravelly banks which are covered with a dense growth of alders, willows, and cottonwoods, with here and there a mossy patch or a stretch of meadow land. The stream, in some places along here, is broken up into several streams flowing in different channels, but they soon come together again. There are also a number of bayous, or more properly small ponds, occupying detached portions of former old channels of the stream. These were invariably filled with a species of *Ranunculus* (most probably *R. aquatilis trichophyllus*). They were often very deep, and the extremely muddy bottom rendered seining them a matter of no little difficulty.

The Lolo is one of the very best trout streams in western Montana. During the time we seined we obtained numerous fine trout, also a good many blobs and young whitefish. In the ponds we found *Catostomus catostomus* and *Ptychocheilus oregonensis* very common.

As already stated, the stream formed by the junction of the Deer Lodge and the Little Blackfoot is called Hell Gate River. It bears this name to the mouth of the cañon just above Missoula River, or sometimes to the mouth of the Bitter Root, where it becomes known as the Missoula River, by which latter name it is known for 30 miles or more, or until it is joined by the Flathead River.

Hell Gate River (and its continuation, the Missoula) being composed largely of the muddy waters of the Deer Lodge and the lower Little Blackfoot, is, of course, a rather muddy stream. By the time Missoula is reached the amount of solid matter in suspension is probably not enough to prove wholly destructive to fish, though there is no doubt that the number of fish in the river even here is very greatly reduced on account of this contamination. It is greatly to be regretted that something can not be done to prevent such destruction of these fishing streams. The Hell Gate River flows through a very rough, rocky cañon (whence the name) and is quite a large stream. The mouth of the cañon is just above Missoula; below there the stream flows through a broad valley.

So far as we were able to determine, there are no natural obstructions anywhere above Lake Pend d'Oreille in this river system—the Clarke Fork of the Columbia and its tributaries—which interfere seriously with the free movement of fishes. There are certainly no falls in the larger streams, and we know of none of any importance in any of the smaller ones; and the only artificial obstructions are those already mentioned, the great drifts of cordwood in the Rattlesnake and sawlogs in the Big Blackfoot. The contamination of the Silver Bow, Deer Lodge, the lower Little Blackfoot, the Hell Gate, and the Missoula by the mills at Butte and Anaconda tends to drive fish from these streams. It is quite certain, however, that Seniakwoteen Falls, below Lake Pend d'Oreille, and the falls at the mouth of Clarke Fork interfere with the further ascent of salmon, and it is possible that they prevent it altogether.

STREAMS TRIBUTARY TO LEWIS FORK OF THE COLUMBIA.

Snake River.—This is the name now usually applied to what was once known as Lewis Fork of the Columbia; it is, however, on many maps, called the Shoshone River. This river is more than 900 miles long, and is one of the most important of the Pacific coast streams. The only waters of this basin that we examined are in the southwest corner of the Yellowstone National Park and the region immediately south of the Park—the extreme upper courses—the very beginnings of the Snake River. About one-fourth of the area of the Park is drained by streams which unite to form the Snake River. Most all of these have their origin in several picturesque lakes which rest on, or are surrounded by, the great bed of rhyolite which forms the floor of this plateau region. Among the most important of these lakes are Shoshone, Lewis, and Heart, the first two of which were visited by us.

Shoshone Lake.—We reached this lake from the Upper Geyser Basin, from which it is distant about a dozen miles to the southeast, across the "Great Continental Divide." The trail crosses the Divide much nearer the lake than the Geyser Basin, and from the crest the lake can be plainly seen to the south. The elevation of this lake is 7,740 feet. Its shape is somewhat like that of the letter T, the upright and the cross-pieces being each pretty heavy, and the letter being inclined very greatly to the right. The portion corresponding to the upright part of the T is very much

constricted at the upper end. According to Mr. Gannett, topographer of the U. S. Geological Survey, the greatest length of Shoshone Lake is $6\frac{1}{2}$ miles, the greatest width $4\frac{1}{2}$ miles, while the constricted portion is but half a mile across, and its area is about 12 square miles. There are but few streams flowing into this lake, and they are all small. At the western end is Shoshone Creek, a small stream running through the Shoshone Geyser Basin, a cluster of hot springs and geysers discovered in 1872 by Dr. C. Hart Merriam and others of the U. S. Geological Survey. At the north end there is a small stream called Heron Creek, which drains a considerable area on the south slope of the "Divide," lying immediately north from this part of the lake. At the time of our visit, August 11, this stream was very small, not over 3 feet wide and 1 foot deep at the outlet, but back a little distance it widens out a good deal, and there is scarcely any current. This creek runs for the last few miles of its course through low, somewhat marshy meadow land. The water is clear, but not very cold, the temperature at 3 p. m., August 11, being 63.5° .

From the mouth of Heron Creek we traveled down the east shore of the lake (*i. e.*, across the top of the T) to the outlet. The distance is about 5 miles through the heavy evergreen forest which covers the bold, in places precipitous, shores to the water's edge. The view of the lake from this trail is a most charming one, for Shoshone Lake is certainly one of the gems of the Rocky Mountains, and the setting could scarcely be improved. (See Pl. VI.) Its shores, nearly everywhere bold and commanding, are densely wooded; the beach is of very clean gravel, and the water is clear and pure. The temperature at the surface near shore was 66° , at 3 p. m.

The outlet of Shoshone Lake is called Lake Fork or Lewis River. This is a very pretty stream of clear, pure water flowing with a rather rapid current for 3 miles in a direction a little east of south, and then expanding into Lewis Lake.

Lewis Lake.—This is another beautiful sheet of water, 20 feet lower than Shoshone Lake. It is, however, much smaller, its length being but 3 miles and its width not greater than 2 miles. It is essentially the same kind of lake as Shoshone, and, like it, was totally without fish life of any kind until stocked by the U. S. Fish Commission in 1890 with Loch Leven and lake trout. We camped the night of August 11 at the outlet of Shoshone Lake, where we seined the lake and the river repeatedly, but found no fish, though plenty were found at the upper end of the lake, as stated elsewhere in this report. The river at its beginning is about 50 feet wide, $1\frac{2}{3}$ feet in average depth, and has a 2-foot current. Temperature at 8 a. m. was 59.5° ; air, 56° .

From our camp at the foot of Shoshone Lake we rode through the heavy woods around the east shore of Lewis Lake, to a point on Lewis River just below the mouth of Aster Creek, where we camped again. Just above our camp are the Lewis Falls. These falls are very beautiful. There is first a vertical descent of about 20 feet, then a very steep rapid or cascade of 50 or 60 feet. It does not seem possible that fish could ever get up these falls. Lewis River here is about 75 feet wide, averages $1\frac{1}{4}$ feet deep, and flows with a 2-foot current. Its temperature at 8 a. m., August 13, was 65.5° , the air being 66° .

Aster Creek is but a small stream, 12 feet wide, $\frac{3}{4}$ foot deep, and having a current of nearly 2 feet per second. It rises in the Red Mountains west of Heart Lake and flows nearly due west. Its temperature was 58° .

We seined Lewis River from the falls downstream for some distance, but found no fish of any kind. Mr. Hofer whipped the stream very thoroughly for a mile or

more, but not a trout rose to the fly. We also seined Aster Creek from its mouth upstream several rods, but saw no evidence of the presence of any fish. It is quite certain there are none here, and it is equally certain that it is not these falls that keep fish from entering Lewis and Shoshone lakes. These facts led us to make an attempt to reach a fall lower down the river, the existence of which had been reported by hunters, but about which little or nothing seemed to be certainly known. Next day we traveled on southward. Prof. Jenkins and Mr. Hofer making a detour to the left of the trail and following more closely down the right bank of the river. They found the cañon of Lewis River in this part of its course very wild and picturesque. (See Pl. XVII.) The walls are in many places quite high and vertical. About halfway between the Upper Falls and the mouth of Crawfish Creek, they came upon a very beautiful fall of considerable size. The stream is divided by a small island into two parts, the larger portion of the water flowing around to the right of the island. This part was estimated to be at least 50 feet wide and to fall almost perpendicularly at least 30 feet, then descend about 20 feet more in a very steep rapid, in which the stream widens out very much. That part of the stream passing around to the left of the small rocky island is about 8 feet wide, and it comes down in a series of very steep cascades and two principal falls, each apparently vertical. Both Prof. Jenkins and Mr. Hofer regard it as highly improbable that fish can ever ascend these falls. Mr. Hofer fished with the fly a short time just below these falls and found trout abundant. In a few minutes he landed six very fine fish, the largest measuring 14 inches in total length. A great many smaller ones were seen. So it may be considered as settled that these lower falls of Lewis River are the first impassable barrier that the fish meet in their efforts to ascend to Lewis and Shoshone lakes.

Crawfish Creek.—A few miles below the Lower Falls, Lewis River receives from the right a good-sized tributary known as Crawfish Creek. This stream rises on the Pitchstone Plateau, flows perhaps a distance of 10 to 15 miles southeast, and joins Lewis River just before that stream unites with Snake River. This is just inside the southern boundary of the Park. Where the trail crosses, Crawfish Creek is 27 feet wide, 1 foot in average depth, and has a slow current—100 feet in 1 minute. The water is very warm—81° at noon, August 13. There must be warm springs somewhere along its upper course. The water is clear and seems to be pure. The banks here and for some distance above the ford are low and marshy in some places. The bed of the stream is gravelly, the rocks generally being coated with *Algæ*. Water vegetation was abundant in places. Just below the ford, Crawfish Creek becomes very rapid and continues so to its mouth, about 1½ miles away. The banks are steep and rocky and covered with a heavy pine forest. A short distance below the ford are Moose Falls, where the creek falls in one vertical plunge a distance of at least 30 feet. We examined the creek very carefully both above and below the falls. No fish were found above the falls but trout were taken below. The bed of the stream below the falls is extremely rocky, rendering the use of the seine almost impossible.

Crawfish (*Astacus gambelli*) were found to be very common both above and below the falls. Crawfish were not found in any other stream of the entire region explored by us, except in Snake River and Jackson Lake south of this place.

Polecat Creek.—This is a stream much the same size as Crawfish Creek, and not unlike it in other particulars. It rises just within the Park limits, flows south across the line, and empties into Snake River at President Camp.

Snake River.—The old Sheridan trail, the trail we followed from the Upper Geyser Basin, crosses Snake River at what has come to be known as the "President's Camp." This is about 2 miles south of the south line of the Park. The river here flows through a wide meadow, grassy and open on the right side, on the other covered with a heavy growth of chapparal. It is a beautiful river with clear water and gravelly bottom. At the camp, the bank is 3 or 4 feet high, but a little lower down the shores are low and composed of gravel and sand. In the main stream the current was pretty strong, but there were some quiet nooks and coves where the water was filled with various species of *Alga*. The water was 62.5° at 9 a. m., August 14.

Fish were found to be abundant in the river here. Many fine trout were taken, mostly with the hook. Blobs, young whitefish, suckers (*Catostomus ardens* J. & G.), and minnows (*Leuciscus atrarius*, *Leuciscus hydrophlox*, and *Rhinichthys dulcis*) were found, the whitefish, Utah chub, and suckers being especially abundant. Most of these were gotten from a deep, quiet nook filled with *Alga* right at the camp, and nearly all were found covered with small dark specks, probably a parasitic protozoan. Crawfish were found to be common here.

Jackson Lake.—From President Camp we crossed Snake River and traveled south about 12 miles to Jackson Lake. This is a fine body of water about 15 miles long by 3 or 4 miles wide. Below our camp a short distance is Marymere, the mountain home of Mr. John D. Sargent. Across the lake to the southwest are the Téton Mountains, rising from the margin of the lake and their rugged peaks piercing the clouds. These peaks are very rough and wild. The pinnacles are very steep and storm-splintered; beds of snow that never disappear, and which may be glaciers, fill the gorges. There is no grander mountain group in America than the Grand Téton with the peaks which environ it.

Snake River flows into Jackson Lake at its upper end and out again below. About the upper end of the lake there is a good deal of low-lying meadow land. On the left it is bordered by low hills, while on the right the shore is precipitous and rocky. Near the upper end a small creek flows into it, in which we found suckers, minnows, blobs, trout, and crawfish. This creek, where we crossed it, is 6 or 8 feet wide and 2 or 3 inches deep. It has but little current. There are some very deep holes in which fish were common. The water was not cold, 67.5° at noon, August 14. The lake is rather shallow on the eastern side, but is said to be very deep on the west. The temperature at the surface was 62° at 9 a. m., August 15.

In the Tenth Annual Report of the Director of the U. S. Geological Survey, Capt. C. E. Dutton says, in writing of Jackson Lake and Snake River, which drains it:

The present area is not far from 40 square miles, while its watershed is between 750 and 800 square miles.

Snake River at low stages carries more than 3,000 second-feet of water. Its sources in Yellowstone Park and in the Téton and Wind River ranges are regions of large precipitation, which yield many perpetual streams. Emerging from the mountains the Snake flows out into an immense plain, 250 miles in length and from 50 to 100 miles in width. A large portion of this plain has been overflowed, in comparatively recent geological times, by extravasations of basaltic lava, much of which is still an expanse of barren rock, while some of it is imperfectly buried in drifted sand and soil. (Part II, p. 106.)

According to Mr. Sargent, Jackson Lake literally swarms with suckers in the spring, and trout are also abundant. We were not able to take any suckers or trout; nor did we think it worth while to use the seine in the lake. We fished some time

with hooks, however, and caught nine large Utah chubs (*Leuciscus atrarius*). Crawfish were also found here.

Pacific Creek.—From Jackson Lake we traveled across the mountains eastward about 12 miles to Pacific Creek. Our first camp on this creek was about 8 miles above its mouth. It is here a good-sized creek, 37 feet wide, 14 inches deep, and with a very swift current (5 feet per second). The bed of the stream is very rocky, being made up of water-rounded glacial boulders of small size. The banks are low and level, covered with a fair growth of bushes, and further back a good growth of pines. Trout were found to be quite abundant, no less than thirty very fine ones being taken with the fly in a short time. Most of these ranged in length from 10 inches to 17 inches; one very fine specimen, 19 inches in total length, was taken by Prof. Jenkins. Several very young trout and a few very small blobs were taken with the seine. Fish food seemed abundant. Numerous caddis-worm cases formed of bright-colored granite pebbles were found. No crawfish or mollusks were seen. The water is clear and cold, the temperature at 4 p. m., August 15, being 62°; at 8 the next morning, when the air was 50°, the water was 49°.

The next day we followed up the narrow valley of Pacific Creek for about 18 miles and camped about a mile above Inness Lake. We found Pacific Creek here very much reduced in size, it being not over 10 feet wide, 6 inches deep, and having a 2-foot current. Temperature at 5 p. m.: water, 59°; air, 66°; at 6:30 a. m. the air was 38°; at 9:15 the air had warmed to 62°, while the water was 50°. A small branch at our camp was somewhat colder, the thermometer indicating 48° when the air was 62°. About 2 miles below this camp Pacific Creek is joined by Mink Creek, which, being the larger of the two, should be regarded as the main stream. Trout were found to be abundant in Pacific Creek here, but all individuals seen were small. Insect larvæ and other suitable food for fish were common.

Inness Lake is the somewhat uncertain name of a peculiar lake lying near Pacific Creek, about 1 mile below this camp. So far as I can learn, no name has been given to this lake by the U. S. Geological Survey, but "Inness Lake" is the name by which it is known to Mr. Hofer. It is about 3 miles long and $\frac{1}{2}$ mile wide. It seems very deep in two crater-like depressions, but is rather shallow elsewhere. One shallow area was noticed near the center. A part of the bed of the lake and a portion of the shore at least are of limestone rock. The lake is surrounded on most sides by low marshy meadow. Its outlet is into Pacific Creek. Trout are very abundant in this lake. There was scarcely a moment when we were passing from one end to the other that one or more trout were not seen rising to insects upon the surface of the water.

The mountains about here are, in most part, covered with heavy coniferous forests. There are, however, among the ridges and upon the sides of some of the mountains, small but very beautiful grassy mountain meadows. The journey from Jackson Lake up Pacific Creek, while rather rough and difficult, is not attended with any hardships or danger. The chief difficulty is in getting through the fallen timber.

TWO-OCEAN PASS.

The next day, August 17, we traveled 6 miles farther up Pacific Creek and came to the famous Two-Ocean Pass. The importance of this pass justifies more than a brief notice. I have therefore collected all the published data regarding it that I could find. The first printed reference to this pass seems to be that made by Capt. W. F. Reynolds in his report of the exploration of the Yellowstone in 1868, page 11. Capt. Reynolds says:

Bridger also insisted that immediately west of where we made our final attempt to penetrate this singular valley [Yellowstone] there is a stream of considerable size which divides and flows down either side of the watershed, thus discharging its waters into both the Atlantic and Pacific oceans. Having seen this phenomenon on a small scale in the highlands of Maine, where a rivulet discharges a portion of its waters into the Atlantic and the remainder into the St. Lawrence, I am prepared to concede that Bridger's "Two-Ocean River" may be a verity.

Capt. Jones, of the U. S. Engineers, in his report of a Reconnaissance of north-western Wyoming, published in 1875, gives a description of the pass. He seems to have been the first to describe this interesting place from actual observation. He says:

At this divide occurs a phenomenon, probably the one referred to by the early trappers as the "Two-Ocean Pass." Marching at the head of the column where the trail approached the summit I noticed that the ribbon of meadow, in which the stream lay we had been following, suddenly dropped away in front of us with a contrary slope. I could still see the stream threading it and for a moment could scarcely believe my eyes. It seemed as if the stream was running up over this divide and down into the Yellowstone, behind us. A hasty examination in the face of the driving storm revealed a phenomenon less startling perhaps, but still of remarkable interest. A small stream coming down from the mountains to our left I found separating its waters in the meadow where we stood, sending one portion into the stream ahead of us and the other into the one behind us, the one following its destiny through the Snake and Columbia Rivers back to its home in the Pacific: the other through the Yellowstone and Missouri, seeking the foreign waters of the Atlantic by one of the longest voyages known to running water. On the Snake River side of the divide the stream becomes comparatively large at once, being fed by many springs and a great deal of marsh.

Capt. Jones gave a map of the pass, a copy of which I give in Fig. 1, Pl. II.

In October, 1878, Dr. Hayden visited the pass, an account of which he gave in Article xv, Bulletin 2, U. S. Geological and Geographical Survey of the Territories, as follows:

This pass is located about longitude 110° 00', and latitude 44° 05'. Atlantic Creek is a branch of the Upper Yellowstone River. The party with which the writer was connected passed up the east side of the Yellowstone Lake to the mouth of the Upper Yellowstone River, and thence up the valley of that stream about 30 miles to what may be called the Three Forks, near Bridger's Lake. The east [west] fork bears the name of Atlantic Creek.

From the Three Forks the party passed up the valley of Atlantic Creek to the southwest, for the most part over a grassy valley, which was inclosed between vertical walls of volcanic breccia 1,000 to 1,200 feet in height. This valley is purely one of erosion. The breccia itself is of very modern age, probably quaternary date, and the wearing out of this great groove must have been an exceedingly modern event. So far as can be seen from the summit of the mountains on either side no divide can be observed. The erosion seems to have produced a gentle slope on either side of the watershed. At the summit, not over 10 miles from the junction of Atlantic Creek with the Upper Yellowstone, the elevation, 8,081 feet, is not more than 150 feet above the valley of the main stream. The valley is at first quite narrow, but it gradually expands into an open, grassy meadow, which, near the pass, becomes one-third of a mile in width, and gradually closes up again into a cañon on the Pacific slope. So obscure is the drainage that we camped the night of October 3, 1878, within a fourth of a mile of the water divide, but did not perceive it until we commenced our march the following morning.

FIG. 1. CAPT. JONES'S MAP OF TWO-OCEAN PASS.

FIG. 2. DR. HAYDEN'S MAP OF TWO-OCEAN PASS.

FIG. 3. TWO-OCEAN PASS, FROM SKETCH MADE BY PROF. EVERMANN.

The conditions are as follows: The summit of the pass for a distance of about half a mile is so nearly level that a marsh is formed, which in times of high water becomes a small lake. A portion of the waters from the surrounding mountains accumulates in the marshy meadows and gradually gravitates from either side into two small streams, one of which flows to the northeast, the other to the southwest. On the east side of the divide there is a depression or gorge in the mountain, which is occupied by a small stream that at the time of our visit flowed in a well-marked channel toward the northeast into Atlantic Creek.

This is the well-known Two-Ocean Creek. At the base of the mountain side (*c*), a small stream rises from a sink hole or spring, which at the time the writer saw it (October 4) was nearly dry, and but little water was running in Two-Ocean Creek (*a*). This spring hole was not separated from the latter creek more than 6 feet, and a small dry channel connecting it with *a* showed that in times of high water a portion of the water that started down the mountain channel (*a*) broke over the side into the spring hole (*c*), and flowed thence through channel *c* to the Pacific. Lower down in the Two-Ocean channel are two places (shown by dotted lines), where there are two old channels connecting in time of high water with channel *c*, showing that a portion of the waters that started down the mountain side for the Atlantic was diverted toward the Pacific. On the opposite side of the pass there is a similar depression in the breccia wall, down which, at the time of the melting of the winter's snows, much water flows.

The points *b* and *d* are close together, and the waters of the grassy meadows, which lie between them, probably separate, a part taking one direction and a part the other. The little lake or marsh in the center, of course, furnishes a supply or reservoir for both. (See Dr. Hayden's map, Fig. 2, Pl. II.)

In September, 1884, Two-Ocean Pass was visited by Mr. Arnold Hague, of the U. S. Geological Survey, but he was prevented by a severe snowstorm from making any detailed observations. In Powell's Sixth Annual Report, p. 56, Mr. Hague says:

I determined, however, to follow up Pacific Creek and take as direct a course as possible to its sources in the meadows described by Dr. Hayden. From the information I had gathered and the erroneous character of the maps I was prepared for a difficult bit of travel. I found, to my surprise, with the exception of 1 or 2 miles of rough country, that the stream could be followed without any serious hinderance to its source in the broad meadows high up in the mountains. From this same meadow a small stream, known as Atlantic Creek, flows eastward and empties its waters into the Upper Yellowstone.

Unfortunately, we were caught on the summit in a severe snowstorm, although early in the month of September. Snow to the depth of 15 inches covered the ground. This not only caused a delay, but prevented us from determining accurately the conditions governing the supply and discharge of the waters. It is probable that the divide between Atlantic and Pacific creeks is but a few inches in height.

The conditions observed here are not unlike those seen in many places in flat, plateau-like country, the difference being that here they are on a grander scale and more than usually striking and impressive. The place is one of great beauty. If the Park limits should be extended to the 44th parallel, Two-Ocean Pass will be within the reservation.

From the above it appears that this interesting pass was evidently known to the famous guide, Jim Bridger; that the first account written by one who had seen it is that given by Capt. Jones, who visited it during a driving storm September 3, 1873; that the next to visit it was Dr. Hayden, in October, 1878, who, like Capt. Jones, approached it from the Yellowstone side; and that it was again visited by Mr. Hague, in September, 1884. Mr. Hague reached the pass from Jackson Lake by way of Pacific Creek at a time when the pass was covered with snow. Besides those who have published accounts of their visits, Two-Ocean Pass has been visited several times by our guide, Mr. Elwood Hofer, within the last few years. The route traveled by our party was essentially the same as that followed by Mr. Hague. We arrived at the pass on Monday morning, August 17, and remained until 10 o'clock the next morning. This gave us ample time to make a careful examination of the remarkable conditions which

obtain here. Reference to the accompanying diagram and the frontispiece (Fig. 3, Pl. II), from sketches made on the ground, will assist very much in understanding the description which follows.

Two-Ocean Pass is a nearly level piece of meadow land, surrounded by rather high hills except where the narrow valleys of Atlantic and Pacific creeks open out from it. Running back among the hills to the northward are two small cañons; on the opposite side is another cañon of the same character. Down these cañons come the three main streams which flow through the pass. The extreme length of the pass from east to west can not be much less than a mile, while the width from north to south is perhaps three-fourths of a mile. From our camp at *4*, just on the border of the meadow, an excellent view of the pass and its surroundings could be had. Just in front was Pacific Creek. Following it upstream for more than a mile above our camp, we found it to head west of the pass, then follow down a rocky cañon in a general northerly direction before finally turning somewhat abruptly to the southward just before entering the pass. The course is then southward across the western border of the meadow until a short distance to the right of our camp, when it turns suddenly west and leaves the pass through a narrow, grassy valley.

Atlantic Creek was found to have two forks entering the pass. At the north end of the meadow is a small wooded cañon down which flows the North Fork of Atlantic Creek. This fork hugs the border of the flat very closely, and at *3* turns rather abruptly to the east. At *c* we found a small tributary stream coming into Pacific Creek from across the meadow. Following up this stream we found it to start in a spring at *5*; but above this spring and connected with it we found a well-marked, dry channel, with gravelly bottom and distinct banks. This we followed to its source and found it to branch off from the North Fork at *3*. Very recently a green pine tree had fallen across this channel right at its origin in such a way as to completely dam it, thus throwing all the water back into Atlantic Creek. Only a little effort was needed to clear away the tree and the rubbish that had accumulated against it, and very soon a good portion of Atlantic Creek was flowing down the old channel to Pacific Creek. The distance from *3* to the spring, *5*, is about 1,000 feet, and the slope is very gentle. This, together with the fact that the ground throughout most of the distance was quite dry and took up water rapidly, caused the water diverted into the old channel to travel very slowly, and not until the next morning had it reached and connected with the running water at the spring. Mr. Elwood Hofer, our guide, traveled through this pass in September, 1890, at which time he says there was a continuous stream of water from point *3* to Pacific Creek by way of this old channel.

The South Fork of Atlantic Creek comes down a cañon to the right, skirting the brow of the hill a little less closely than does the North Fork. The phenomenon discovered on the north side was found to be repeated on this. At *1* an old channel was found branching from the South Fork and running toward Pacific Creek. It had also been dammed by a dead tree falling across right at its place of branching from the main stream, turning all its water back into Atlantic Creek. Putting a few rocks in the main stream and clearing away some of the rubbish resulted in sending at least 30 miner's inches down the old channel to *2*. This old channel runs along pretty close to the main stream for some distance, at one place, *d*, coming within a few feet of it. Across this narrow strip is another old bed through which water would be made to flow by a rise of a very few inches in Atlantic Creek. The old channel, beginning

at 1, was found to connect with the one from the other fork at 2, and by the next morning a good-sized stream was flowing from the South Fork of Atlantic Creek into Pacific Creek. The lower portion of this channel contained a little seepage water, and it is certain a live stream had been flowing through it earlier this season.

Besides the old channels already mentioned there are evidences of several others which, during even ordinary water, would connect the two creeks. As already stated, the pass is a nearly level meadow, covered with a heavy growth of grass and many small willows 1 to 3 feet high. While it is somewhat marshy in places, it has nothing of the nature of a lake about it. Of course, during wet weather the small springs in the meadow would be stronger, but the important fact is that neither Atlantic nor Pacific Creek rises in the meadow. Atlantic Creek, in fact, comes into the pass as two good-sized streams from two different directions and leaves it by at least four channels, thus making an island of a considerable portion of the meadow.

Pacific Creek is a strong stream long before reaching the pass, and its course through the meadow is well fixed, but not so with Atlantic Creek. The west bank of each fork is liable to break through almost anywhere and thus send a part of its water across to Pacific Creek. It is probably true that one or more branches connect the two creeks under ordinary conditions, and that in times of high water a very much greater portion of Atlantic Creek flows across to the other. At any rate, it is certain that there has been, and usually is, a free waterway through Two-Ocean Pass of such a character as to permit fishes to pass easily and readily from the Snake River over to the Yellowstone—or in the opposite direction. Indeed, it is possible, barring certain falls, for a fish so inclined to start at the mouth of the Columbia, travel up that great river to its principal tributary, the Snake, continue on up through the long, tortuous course of that stream, and, under the shadows of the Grand Tétons, enter the cold waters of Pacific Creek, by which it could journey on up to the very crest of the Great Continental Divide, to Two-Ocean Pass; through this pass it may have a choice of two routes to Atlantic Creek, where it begins the journey downstream: soon it reaches the Yellowstone River, down which it continues through Yellowstone Lake, then through the lower Yellowstone out into the turbid waters of the Missouri; for many hundred miles it may continue down this mighty river before reaching the Mississippi, the Father of Waters, through which it may finally reach the Gulf of Mexico—a wonderful journey of over 5,800 miles, by far the longest possible fresh-water journey in the world.

Standing upon the bank of either fork of Atlantic Creek, just above the place of the “parting of the waters,” we tossed chips, two at a time, into the stream. Though the two chips would strike the water within an inch or so of each other, not infrequently one would be carried by the current to the left, keeping in Atlantic Creek, while the other might be carried a little to the right and enter the branch running across the meadow to Pacific Creek; the one beginning a journey which will finally bring it to the Gulf of Mexico, the other entering upon a long voyage, in the opposite direction, to the Pacific. Where Pacific Creek leaves the pass it is about 6 feet wide and will average 2 or 3 inches deep, though it is much deeper in many places—in some places forming pools 1 to 2 feet deep. Just inside the pass, from *a* to *b*, the current flowed 268 feet at the rate of $1\frac{1}{2}$ feet per second. The two forks of Atlantic Creek come together near the east margin of the pass and form a stream much like Pacific

Creek in size and general features. There are relatively deep pools in each of these forks, particularly in the lower parts.

We seined all of these creeks quite carefully and found plenty of small trout everywhere on each side. We took specimens in each arm of each of the Y's of Atlantic Creek and in such places as would have easily permitted them to pass from one side to the other, and there is no doubt whatever that trout can and do pass over this divide at will.

As is well known, Yellowstone Lake is abundantly supplied with trout, while Shoshone and Lewis lakes, two very similar bodies of water, were wholly without any fish life. The absence of fish from Shoshone and Lewis lakes is readily explained by the presence of vertical falls in Lewis River. But the much greater falls in the Lower Yellowstone River would certainly prove as effective a barrier in preventing fish from ascending to Yellowstone Lake from the Missouri. Evidently, Yellowstone Lake and the Upper Yellowstone River were stocked from the west, and almost certainly via Two-Ocean Pass. The probability that the outlet of Yellowstone Lake at one time was toward the Pacific, as claimed by geologists, only strengthens this solution of the problem. But while this explains the origin of the trout of Yellowstone Lake, it leaves another equally interesting problem without any explanation, viz, the presence of the blob (*Cottus bairdi punctulatus*) in Pacific Creek and its absence from Atlantic Creek and the entire basin of Yellowstone Lake.

We caught four blobs in Pacific Creek in the pass, but though we seined carefully in Atlantic Creek, only a few yards away, we did not find a single blob; nor were we able to find any further down Atlantic Creek or in any of the streams tributary to Yellowstone Lake. This fish could surely get across just as easily as the trout, and the four we caught would have had to travel upstream but a few rods through a channel filled with an abundance of water in order to be on the Atlantic side.

The water of Atlantic Creek and the Upper Yellowstone River does not seem to differ in any way from that of Pacific Creek, and the conditions there seem just as favorable to blobs. At present I am wholly unable to account for their absence; the matter needs further investigation.

During the night that we camped in Two-Ocean Pass (August 17-18), ice froze half an inch thick in a basin at our camp, and nearly as thick on the creek near by. The temperature of the air at 6:30 a. m. was 33°; of the water at 8 a. m., 42°; at 11 a. m., 55°. According to the U. S. Geological Survey, the elevation of Two-Ocean Pass above sea level is about 8,200 feet.

The "Lake sheet" of the map of the Yellowstone National Park by the U. S. Geological Survey includes Two-Ocean Pass, but it needs changing in some particulars. All of the line representing Pacific Creek *above* the pass should represent the South Fork of Atlantic Creek, and should be connected with the North Fork at the east edge of the pass; and Pacific Creek should be made to come into the pass from the northwest. (See diagram, Fig. 3, Pl. II.)

MISSOURI RIVER BASIN.

Atlantic Creek.—On August 18 we followed Atlantic Creek down to where it flows into the Upper Yellowstone River. We seined it about a mile above its mouth and found a few young trout. At this point the creek is about 36 feet wide, $\frac{3}{4}$ foot deep, and has a 3-foot current. The temperature of the water at noon was 57° . Less than 2 miles below the pass the trail crosses Jay Creek, a few rods above where it joins Atlantic Creek. At the ford, Jay Creek was 20 feet wide, 8 inches deep, and had a current of $2\frac{1}{2}$ feet per second. The water at 10:30 a. m. was 47° . About 2 miles further down, we crossed Senecio Creek about one fourth of a mile above its mouth. This is a stream much like Jay Creek, but considerably smaller.

The Upper Yellowstone River.—We came upon the Upper Yellowstone at a point about 20 miles in a direct line above the lake, or 2 miles above Bridger Lake. Crossing it at this point, we traveled down the right bank to its mouth. This river is of good size and flows through a broad valley of meadow land which, in many places, has marshes bordering the river.

According to Mr. Arnold Hague, the Upper Yellowstone River "rises in an immense snow field on the north side of an isolated peak, about 25 miles south of the southern boundary of the Park. The peak attains an elevation of over 12,250 feet above sea level, and has been long recognized as a prominent point by all topographical survey parties. Although never visited, it has been designated as Yount Peak, after a trapper who lived for a long time along the banks of the Yellowstone. Three rivers—the Yellowstone, Gray Bull, and Buffalo Fork of Snake River—find their sources upon the abrupt slopes of this peak. To the southward and not far distant rises the Wind River. The region is an uncommonly rough one, with profound gorges penetrating far into the mountains and separated from each other by mere knife-edges of rock. The entire country is made up of volcanic material, for the most part andesitic breccia."*

We saw a great many young trout where we forded the river, and again near the mouth, where large fish were also abundant. A little time devoted to fly fishing here resulted in the capture of six very fine trout, 14 to 18 inches long, every one of which, however, was infested with the parasitic worm *Dibothrium cordiceps*. The temperature of the river near its mouth at 3:30 p. m. was 57° ; air, 68° . Throughout most of its course the Upper Yellowstone River has a clean, gravelly bottom and flows with a good, strong current.

Bridger Lake lies just outside the original Park boundary and between the Yellowstone River and Thoroughfare Creek. This is a pretty little lake, about a mile long by half a mile wide, and is well filled with trout.

Thoroughfare Creek.—This is the largest tributary of the Upper Yellowstone River. At our camp, just at the Park line, it is fully 100 feet wide, 2 feet deep, and flows 3 feet per second. Temperature of water at 5 p. m., August 18, 60° ; at 7:30 a. m., the next day, 45° ; temperature of air at 6:30 a. m., 31° . We seined this stream very thoroughly, but found nothing except numerous very young trout. A good deal of fly fishing did not result in a single catch. The water is clear and pure and full of fish food of various kinds.

* Hague, in Powell's Ninth Annual Report, page 93.

On the way down to the lake we crossed numerous small creeks, Escarpment, Cliff Mountain, and Trapper. The largest of these is Mountain Creek, it being 18 feet wide and a foot deep. These are all clear, cold streams, coming down from the heavily timbered mountains to the east, and all were found full of young trout.

Beaverdam Creek.—This stream flows into the lake just to the right of the mouth of the Upper Yellowstone River. Near its mouth, where we crossed, it is 20 feet wide, about 18 inches deep, and with a pretty swift current. Temperature of water at 10:30 a. m., August 20, 50°. The bed of the stream is very rocky, and there is little or no vegetation in the water. Fish food seemed scarce and no fish were observed, though we made several hauls with the seine. Near the mouth of this creek are several old beaver dams, from which doubtless the stream received its name.

From here our path led us down the east shore of Yellowstone Lake to the outlet. This is one of the most heavily timbered districts in the United States. The trees are of good size and so close together that it is no easy matter to find one's way along the game trails—the only trails found here. The lake is in sight most all the way and the views are very beautiful. (See Pl. VII.) We crossed Columbine Creek, a small stream of mineral water containing no fish, and camped at the mouth of Meadow Creek, another very small, sluggish stream, but full of young trout. In places this creek was 12 feet wide, a foot or more deep, and had a somewhat muddy bottom. These were really pools, with scarcely any current. In other places the stream was not so wide nor deep, but swift and rocky. Temperature of water at 3 p. m., August 20, 57°; at 8:30 next morning, air, 57°; water, 51°. Young trout were very abundant in this little creek.

Pelican Creek.—This is a fair-sized stream, flowing into Yellowstone Lake near the outlet. Near its mouth it is about 35 feet wide, 1½ feet deep, and flows with a moderately swift current. The temperature at the mouth at 6 p. m. August 21 was 52°. Along this stream are numerous springs, many of them of mineral water. The stream is full of young trout. From here we traveled down the Yellowstone River to the ford, where we crossed to the left bank, and then followed the Government road to the Mammoth Hot Springs Hotel.

Yellowstone Lake and the streams below it have already been well described by Dr. Jordan in his report on the Yellowstone National Park. (Bulletin ix, U. S. Fish Commission, pp. 41–63, 1891.) The following from Mr. Hague, Powell's Ninth Report, pp. 92 and 93, concerning Yellowstone Lake, should be added:

In comparison with its size the drainage area is small. This is readily accounted for by its great altitude above sea level and the very favorable conditions of the surrounding country for receiving a heavy snowfall throughout eight months of the year. Over a great part of this area these snows are protected by the forests from the dry westerly winds, and the water is allowed to percolate the soil gradually, supplying the springs and streams which feed the lake. The altitude of Yellowstone Lake is 7,740 feet above sea level, with a surface area of 139 square miles and an indented shore line of nearly 100 miles. As yet we possess but little accurate knowledge of its depth, although there is no question that it presents the grandest natural storehouse for water within what is known as the arid region of the West. If the broad valley of the Yellowstone for 200 miles is ever to be settled with a prosperous people, this body of water will be of inestimable value for the purposes of irrigation. From careful measurements made of the flow of the Yellowstone River just below the outlet of the lake, the discharge of water was found to be 1,525 cubic feet per second, or about 34,000,000 imperial gallons per hour. The ganging of the stream took place in September, when the lake stood at a lower level than at any other period of the year.

In 1889 the Irrigation Survey measured the Yellowstone River at Horr and Springdale, just north of the Park, and obtained results remarkably close to those obtained by Mr. Hague. Capt. Dutton says:

The Yellowstone in August carried at Horr 1,553 second-feet on the 26th of August, and at Springdale 2,111 second-feet, which is about as low as it may be expected to fall in any season.*

We examined the Yellowstone River pretty carefully between the lake and the falls, for the purpose of determining if any of the whitefish planted there in 1889 by Mr. Lucas could be found. Not one was seen, and it is not believed any have survived. Careful inquiry among members of Mr. Wyatt's road camp failed to elicit any evidence of the presence of whitefish. This party had been encamped upon the bank of the river for some time and had had excellent opportunities for observing the whitefish, if any were there. Trout, both large and small, were very abundant in the river here. They are eaten quite freely and are not regarded as being seriously affected by the parasitic worm. Many of the trout taken here are said not to be affected at all.

Blacktail Deer Creek was examined at the crossing of the Cooke City road, and Lava Creek or East Fork of Gardiner River was examined between the two falls, where one small trout was taken with the hook. Whether this was one of the plant made here by Mr. Lucas in 1889 can not be certainly known, as it is reasonably certain that trout were found naturally in this creek, as explained by Dr. Jordan in his report.

Red Rock River.—This river was examined by Mr. Clapham 3 miles north of Red Rock Station on the Union Pacific Railroad. It rises in Red Rock Lake, about 40 miles distant, in the mountains on the Idaho line. Near Red Rock it is a good-sized stream, about 30 feet wide and 20 inches deep. It is full of deep holes and eddies. The bottom is usually quite rocky, but there are stretches of sand and mud. The water is clear, but not very cold, the temperature being 58°. This is a very good fish stream, blobs, dace, suckers, grayling, and whitefish being abundant, and one specimen of the ling (*Lota lota maculosa*) was taken. No trout were found here, though higher up the stream and in Red Rock Lake trout are said to be abundant. The ling is also said to be common in Red Rock Lake.

Beaverhead River.—This is simply a continuation of Red Rock River, the name changing at Grayling Station. We examined this river at a point 2 miles above Dillon, Montana, and from there downstream to below the town. It is there a rather large stream, 50 feet wide and at least 2 feet in average depth. It flows through Dillon Valley, which is several miles broad. It has mud or adobe banks, usually covered with a rank growth of willows and other bushes. The bottom is usually one of gravel, but there are muddy places here and there where the current is less swift and where the stream is filled with *Ranunculus* and many species of *Algae*. Along its banks are many ponds filled with water vegetation. The temperature of the water at noon, July 27, was 63°. This is apparently too warm for trout, as none were seen, and we were told that none are found this far down the stream. It is, however, an excellent stream for whitefish and grayling, with which species it is well supplied. Suckers, dace, and blobs were also abundant, the blobs being exceptionally large. Black bass would certainly do well in such a stream as this.

* Powell's Tenth Annual Report, Part II, p. 89.

Beaverhead River flows in a general northeasterly direction, and joins the Bighole River east of Melrose to form the Jefferson River. The Bighole River is much the same kind of a stream as the Beaverhead. It is said to be well filled with whitefish and suckers.

Our route from the Mammoth Hot Springs to Shoshone Lake was essentially the same as that followed by Dr. Jordan's party in October, 1889. The waters of this region were fully described by him, and but little need be added in this report concerning them. A few observations were made, however, that should be recorded. The temperature of Glen Creek at 11 a. m., August 25, was 54°. The temperature of Indian Creek at 11:30 a. m., August 25, was 52°, while on August 7, when the air was 70°, the water was 55°.

The brook trout that were placed in these streams in 1889 are evidently thriving well, as we found not only individuals of that plant, but young that could not be over a year old. In Cañon Creek we found an abundance of blobs, but did not succeed in taking any trout, although specimens were collected there by Dr. Jordan.

A plant of 9,800 Von Behr trout was made in Nez Percé Creek in 1890. Though we were, at the time of our visit, unable to find any fish, we were informed by Lient, Pitcher that fish have been seen there this season; and Mr. Elwood Hofer writes me that, on October 9 of this year, he saw trout in Nez Percé Creek near the "Soldiers' Camp." These are most probably of the plant of 1890, as this creek was believed to be wholly barren of fish until the time of this plant. Mr. Hofer, however, believes that the native black-spotted trout is found in Nez Percé Creek, but can not see how they got there.

The *Firehole* was examined at various places. This stream contained no fish above Keppler Cascade until 1889, when a plant of Loch Leven trout was made here by the U. S. Fish Commission. Specimens of this trout were seen above the cascade, and one was obtained in the river above Old Faithful Geyser. At the mouth of Firehole River grayling, whitefish, dace, blobs, and suckers were found in abundance.

Gibbon River was examined at various points from above Virginia Cascade to its mouth, where it joins the Firehole to form the Madison. This stream was stocked with rainbow trout in 1889, and we found specimens both above and below Virginia Cascade. At the mouth of Gibbon River we found all the species that were found in the Firehole near by. These two streams unite about 6 miles below Gibbon Falls, and about the same distance below the Lower Geyser Basin.

Madison River.—On August 23, 24, and 25, I made a trip from Norris Basin down the Madison River to Horsethief Springs, beyond the western boundary of the Park. The road to this place passes down the Gibbon River, which it crosses near its mouth, and then follows the Madison River very closely for several miles, crossing it no less than five times before reaching Horsethief Springs. The upper course of the Madison River is through a narrow and very picturesque cañon which widens out below into a broad, grassy valley. The banks and bed of the stream are rocky or of coarse gravel. The water is clear and sparkling, but not cold—this latter fact being due, of course, to the great amount of hot water which is poured into it from the Upper and Lower Geyser Basins. The current is in most places quite swift, and the stream is well filled with *Chara*, *Algae*, and various other kinds of water vegetation. This is evidently an excellent fish stream, at least as far up as the forks—grayling and whitefish being really abundant; dace, blobs, and suckers were all common.

Horsethief Springs are described in detail in another part of this report, and the description need not be repeated here. Suffice to say that there is probably no other place in Montana where grayling, whitefish, and mountain trout are more abundant.

Mr. E. R. Lucas, in a note to Dr. Jordan, says:

On October 2 [1889], I collected from *Horsethief Springs* 2,000 whitefish, which I planted the next day in *Twin Lakes*. * * * On October 15 I collected 1,000 more whitefish and planted them in *Yellowstone River* above the falls. There are unlimited numbers of these whitefish in *Horsethief Springs*, running in size from 2 to 5 inches. There are also quite a large number of grayling in the stream.

Mr. R. R. Cummins, the owner of the springs, in a letter to me dated December 20, 1891, says:

The grayling and trout are just swarming in the stream. I caught eighty-two grayling weighing from one-half pound to 2 pounds 2 ounces in about five hours' fishing, using grubs for bait.

My own observations, made August 24, convinced me of the abundance of these species here. Every nook and corner and especially every deep pool was found to be full of fish, most of them young, but some of good size. The whitefish and grayling seem to exceed the trout in numbers. These three species not only find an abundance of suitable food here, but also use this as a spawning ground. The blob is also very common here.

Bozeman Creek.—This is one of a great number of interesting streams flowing through the rich agricultural *Gallatin Valley*. It flows northward from *Sour Dough Cañon*, through the town of *Bozeman*, and, with *Middle Creek*, forms the *East Gallatin River* about 10 miles northwest of *Bozeman*. This latter stream flows into the main *Gallatin River* at *Barton's Bridge*, about a dozen miles farther northwest, or about 10 miles east of where the *Gallatin*, *Madison*, and *Jefferson Rivers* unite to form the great *Missouri*. *Bozeman Creek* at the bridge in the edge of the town is perhaps 30 feet wide and will average 18 inches deep. The banks are covered with bushes and the bed of the stream is of coarse gravel. The water is pure and clear. The temperature at 9:30 a. m., August 27, was 61°.

Bridger Creek is a somewhat smaller stream, but is otherwise very much like *Bozeman Creek*, into which it flows. At *Davies Springs* this creek was 10 feet wide, 10 inches deep, and had a current of 2 feet per second. The temperature of the water at noon was 60° opposite the springs, while a little higher up it was but 56°. This difference is no doubt due to the fact that a warm spring pours its water into the creek just opposite *Davies Springs*. Just above these springs is a very interesting cañon, through which the creek flows.

Both of these creeks are very good fish streams, and are said to be well filled with trout and grayling.

Dr. F. V. Hayden says:

The drainage of the *Gallatin* is composed of a large number of little streams that rise in the *Great Divide* for a distance of 80 to 100 miles, and each of these little streams gashes out a deep gorge or cañon in the mountain sides. * * * The valley of the *Gallatin*, like the valleys of all the streams in *Montana*, is undoubtedly one of erosion originally, and was also the bed of a lake. This lake basin extended down to the junction of the *Three Forks* northward, and the modern deposits are found all along the base of the mountains on either side of the valley up to the very sources of the river, sometimes rising quite high on their sides. So great has been the removal of sediment, during and since the recession of the waters of the lake, that it is not always easy to determine the entire thick-

ness of the original deposit. Remnants are left, however, at different points, sometimes in the higher ranges of foothills, or in patches among the metamorphic rocks at considerable elevation on the divides between the Gallatin, Madison, and Jefferson forks. Areas of greater or less extent occur 600 to 800 feet above the channels of the rivers, showing that the waters must have been so high that only the more elevated summits were above the surface.

McClellan Creek rises among the hills on the "Crow Divide," flows northward about 15 miles, and empties into Prickly Pear Creek about 5 miles southeast of Helena. We examined this stream for some distance along its course, 12 miles east of Helena, near an old Spanish quartz mill or *arastra*. This creek is said to be usually a clear stream, but at the time of our visit the water was somewhat muddied by recent rains and by some placer mining going on in this vicinity. The banks and bed of the stream are very rocky and the current very swift. The stream is 8 to 15 feet wide and averaged perhaps 2 feet deep. The temperature of the water at 10 a. m., July 20, was 47.5°; air, 70°. Owing to the extreme swiftness of the current the use of the seine was made very difficult. Numerous hauls resulted in the taking of five trout, each 8 to 10 inches long. Some of these were full of eggs, showing this to be near the spawning season. No other life was noticed in the stream. A few frogs and snakes were seen along the banks.

Prickly Pear Creek, into which *McClellan Creek* flows, is a much larger stream, but nearly all of its water is used for irrigation purposes. It flows through the beautiful Prickly Pear Valley and empties into the Missouri north of Helena Junction. This was at one time an excellent trout stream, and a few trout are still found in its upper portion.

PLACES EXAMINED WITH REFERENCE TO THE LOCATION OF A STATION.

In general, it may be said that every stream and place visited by us was examined with reference to its furnishing the necessary natural conditions of such a fish-cultural station as is desired for that region. In another part of this report will be found a discussion of the general physical features of western Montana and northwestern Wyoming, including a somewhat full description of each particular lake, stream, or spring examined; this will show that there are several places, any one of which can furnish perhaps all the required natural conditions. It is proper to state here that it was not possible, within the time at our disposal, to visit all parts of Montana and Wyoming and examine all the localities that might supply suitable sites for a fish-cultural station. Nor was it necessary that every place should be visited, for among those that we were able to examine is found an ample number from which to make the selection.

The following is a list of the places where we made special examination with reference to the hatchery question: *McClellan Creek* and Child's ranch, near Helena; Little Blackfoot River, at Elliston; Cottonwood Creek, at Deer Lodge; Rattlesnake and Lolo creeks, near Missoula; Swan River, at Swan Lake; Glen Creek and Gardiner River, near Mammoth Hot Springs; Reese Creek, near Horr; Horsethief Springs, Montana; Botteler Springs, south of Livingston; and Davies and Wolverton springs, near Bozeman.

McClellan Creek rises in the hills on the Crow Divide, flows northward about 15 miles, and empties into the Prickly Pear Creek about 1½ miles south of East Helena. We examined the stream up and down for more than a mile, 12 miles east of Helena,

this being in the vicinity of the old Spanish arastra or quartz mill. Here it is a stream 8 to 15 feet wide and averaging 20 to 24 inches deep. It has a very swift current, the flow being not less than 3,300 gallons per minute. It is usually a clear stream, but at the time of our visit it was rather muddy, due to a heavy rain on the preceding day. Several mining ditches are taken out at various places both above and below where we saw the stream, and there is, of course, some danger of contamination from this source. The bed of the stream is very rocky, as are also the banks and much of the country through which the stream flows. The banks are in many places covered by a dense growth of alders and other small trees and bushes. The temperature of the water at 10 a. m., July 20, was 47.5°; air, 70°.

Owing to the rough character of the bed and the swiftness of the current, it was very difficult to use the seine to any advantage. Quite a number of attempts to haul the seine were made, however, resulting in the taking of but five small trout, from 8 to 10 inches long. Two of these were females, in one of which the eggs were quite ripe, showing that this was near the spawning season of the species in this locality. No other kind of life was noticed in this creek.

Child's bedrock drain is on the land of Hon. C. W. Child, about 2 miles from East Helena, or 6 miles east of Helena. Mr. Child has put in this drain for irrigation purposes. The water is collected by means of transverse ditches in the glacial drift resting upon the bed rock near Prickly Pear Creek. The water thus collected is carried in a box flume for some little distance and is then turned into an irrigating ditch where it goes to augment the supply in a ditch from McClellan Creek. The stream flowing from this drain was 20 inches wide, 10 inches deep, and had a current of 17 inches per second, which means a flow of 883 gallons per minute. The water is of course very clear and pure and exceedingly cold. The temperature at 11 a. m., August 5, was 42°; air, 75°. This is the coldest water that we found anywhere in Montana or Wyoming, and its temperature is no doubt constant or nearly so the year round. According to Mr. Child, the quantity of the flow is approximately constant. The nature of the source of supply, of course, makes these facts evident. The water is perfectly clear and free from solid matter, and would seem to be well suited for trout-cultural purposes, unless, indeed, it be somewhat too cold. A rather level tract of several acres lies below the drain about three-fourths of a mile, where suitable grounds for the building and ponds can be had. The ground is somewhat rocky, being covered with coarse morainic material, and the cost of clearing it off and constructing the ponds would be considerable. Sufficient fall from the drain to this place can be had to give a good gravity supply.

Both the Northern Pacific and the Montana Central railroads run within less than a mile of the place where the station would be located. By additional work the amount of water could be doubled, which would make an abundant supply for the purposes required. Mr. Child would make all the guarantees as to water control that the Commission would desire. No definite proposition has been made by Mr. Child as to what the necessary land would cost the Commission. The cost of getting the water in sufficient quantity under control and the expense that would be necessary in the construction of the ponds are serious objections.

Little Blackfoot River was examined July 21, near Elliston. It was at that time about 25 feet wide, 2½ feet deep, and had a current of 3 feet per second, this giving a flow of 84,375 gallons per minute. Above Elliston the water is clear and pure, but

below that place the stream is muddied by mining operations carried on along its banks. The current is very swift, the bed of the stream is strewn with rocks of various sizes, and the banks are well lined with willows, cottonwoods, and various other small bushes. The temperature of the water at 4 p. m. was 55°; air, 71°. In this river we found an abundance of blobs and young whitefish, and a few small trout. In a small creek flowing into the river, suckers and minnows (*Catostomus catostomus* and *Rhinichthys dulcis*) were abundant. The high temperature of the water and the danger of contamination from heavy rains are serious objections.

Cottonwood Creek.—We examined this stream from its mouth at Deer Lodge upstream for about 3½ miles. At a point about 2 miles above the town of Deer Lodge and on the land of Mr. Albee, we found the most suitable location. The stream here measured as follows: Average width, 20 feet. Average depth, 1½ feet. Current, 3 feet per second. Volume, 40,394 gallons per minute. Temperature, 54° at 3 p. m., July 22; air, 77°.

This is a clear stream flowing through gorges farther up, while here it flows through rather rough meadow land. The bed of the stream is very rocky; the banks are lined with cottonwoods, alders, and other bushes. The stream seems to be well filled with insect larvæ and other fish food, and is regarded as being an excellent trout stream. During less than two hours' fishing with seine and fly, we took a great many blobs and about thirty trout, the largest weighing about 7 ounces. The fall is sufficient for getting the water properly and easily into the hatchery, and very desirable ground can be had either near the residence of Mr. Albee or on the ranch of Mr. N. J. Bielenberg, a few rods farther up the stream. The cost of getting the water under control and of constructing the ponds would be very moderate. At the time of our visit a little mining was going on above Mr. Albee's; this contaminated the water somewhat, but Mr. N. J. Bielenberg assures us that this can be easily controlled. The town of Deer Lodge gets its water from this stream, and of course would interest itself in seeing that the stream is never seriously contaminated.

Mr. Bielenberg offers to donate as much land as would be needed and to make all necessary guarantees as to the water supply. The location with reference to the region to be stocked is a central one and the railroad facilities are good. The city of Deer Lodge is one of the prettiest, most thriving cities in the State, and would afford excellent school, church, and social advantages to all connected with the station, matters of no little importance.

Rattlesnake Creek.—This is a good-sized stream flowing into the Missoula River, at Missoula. We examined it throughout the last 8 miles of its course; average width, 30 feet; average depth, 1½ feet; current, 2½ feet per second; volume, 56,250 gallons per minute; temperature, 54° at 3 p. m., July 28. This stream rises in two small lakes in the mountains north of Missoula, is about 20 miles long, and flows through Government land, except for the last 2 miles of its course. The rock of the region seems to be chiefly a metamorphic sandstone; the bed of the stream is full of boulders of various sizes, and there is but little water vegetation. The water is pure, clear, and cold. The city of Missoula gets its water from this stream, the ditch being taken out less than 2 miles above the city.

There are many places within a distance of 2 to 6 miles of the city where very suitable land can be found. The fall is sufficient and the land lies so as to make it a comparatively easy matter to get the necessary amount of water under control.

Missoula is situated upon the Northern Pacific Railroad, in the western part of the State, a location hardly sufficiently central as regards the region to be supplied. I have no information as to what would be the cost of sufficient land in this locality. Hon. W. M. Bickford, of Missoula, would furnish any information of this kind that might be desired.

Lolo Creek is a very pretty mountain stream having its rise on the Divide, near the Idaho line. It flows eastward for about 40 miles and empties into the Bitter Root River about 12 miles southwest of Missoula. We examined this stream through the last mile of its course but one. It is here about 35 feet wide, with an average depth of $2\frac{1}{2}$ feet, and with a rather swift current. It flows over a gravelly bottom and between gravelly banks, which are covered by a heavy growth of alders, willows, and cottonwoods. The stream here is often divided up and runs in several channels with low-lying islands in between, which are covered with a heavy growth of bushes and small timber. There are also many small bayous or marshy places along this lower portion of the stream which are filled with a species of *Ranunculus* (*R. aquatilis trichophyllus*). Trout, blobs, suckers, and minnows were common. The temperature of this stream at noon July 30, was 56° .

Depew Creek is a small stream, about 8 miles long, which flows into Swan River from the right, just below the foot of Swan Lake. Its entire course is on Government land and through dense pine forests. It runs between 1,000 and 2,000 gallons per minute. The water is clear and pure and has a temperature of less than 50° . At 11 a. m., August 3, its temperature at its outlet was 48° . The amount of water is said not to vary much. It never becomes contaminated on account of rains, and there is no probability of its ever being injured in any way through mining operations. The fall is great enough to enable the water to be gotten under control very easily. All the natural advantages requisite for the establishment of a hatchery can be found at the mouth of this creek. Its nearness to Swan River and the large and interesting lakes which that river connects would prove a great advantage in many ways. The remoteness of the location from a railroad is a serious objection.

Horsethief Springs.—These springs are on the ranch of Mr. R. R. Cummins, in Gallatin County, Montana, about 4 miles from the west line of the Yellowstone National Park, and near its northwest corner. There are two of them coming out on the south slope of a small grassy mountain near its base, and soon uniting to form one stream, which flows into the North Fork of the Madison River. The accompanying diagram (Pl. III) will help to an understanding of these springs:

Distance between springs (<i>a</i> to <i>b</i>).....	feet..	135
Width of west spring at 1	inches..	40
Depth of west spring at 1	inches..	4
Current between 1 and 2 (35 feet)	feet per second..	$3\frac{1}{2}$
Volume of west spring	gallons per minute..	1,745
Width of main stream at 3	feet..	35
Depth of main stream at 3	inches..	5
Current from 3 to 4 (51 feet)	feet per second..	4
Volume of main stream at 4	gallons per minute..	26,181
Width of stream at 5	feet..	70
Depth of stream at 5	inches..	10
Current between 6 and 7 (50 feet), a trifle over 1 foot per second.		
Volume at 7, about 26,181 gallons per minute.		

Temperatures were taken in the morning of August 24, between 8 and 10 o'clock, when the air was about 70°:

	Degree.		Degree.
Temperature of water at <i>a</i> , at 8 a. m.	48	Temperature three-fourths mile below <i>e</i> , at 9:40 a.m.	49
Temperature at <i>b</i> , at 8 a. m.	45.5	Temperature of small stream <i>f</i>	46.5
Temperature at <i>c</i> , at 8:15 a. m.	46	Temperature of small stream <i>g</i>	44
Temperature at <i>d</i> , at 8:35 a. m.	48	Temperature of small stream <i>h</i>	46
Temperature at <i>e</i> , at 9 a. m.	48		

The stream, formed by the uniting of the waters from the two springs, flows south about 300 feet, then turns west and flows in that general direction for at least one-fourth mile, where it receives the small branch *h* from the left, and continues about 1 mile further before joining the Madison. The current within the first 180 feet from the springs is very swift, the fall being at least 20 feet. Below that the fall is very slight, the current in no part of this portion being much greater than 1 foot per second. Just north of the springs and west of them the ground rises rapidly; to the east there is also a slight rise, but to the south and southwest is very attractive meadow land with just sufficient slope to render the construction of ponds upon it a very easy matter. Indeed, the stream itself could be easily converted into ponds simply by damming, thus cutting it up into suitable sections, any one of which could be drained into the one below. The water is pure, clear, and cold, and certainly well suited in every way for trout. The bed of the stream is gravelly. There is an abundance of *Alga*, *Chara*, and other water vegetation in the stream. Small mollusks and insect larvæ abound, and trout, grayling, and whitefish are exceedingly abundant. In fact, the grayling and trout use this stream and the small branches coming into it as a spawning ground, vast numbers of these two species and many whitefish being found here during the breeding season. This is, of course, conclusive evidence as to the excellent character of these waters as breeding grounds for members of the *Salmonidae*.

The water in these springs never freezes, and Mr. Cummins informs me that it does not freeze in the creek at any point within a mile of the springs.

Mr. Cummins, who owns the springs and the lands through which the creek flows, will donate to the Commission all the ground that may be needed.

At present, the nearest railroad station to these springs is at Cinnabar, Montana, about 70 miles northeast. They are 125 miles south of Bozeman. The Northern Pacific Railroad has recently surveyed a line from Gallatin, Montana, to the north line of the Yellowstone Park, running within 1½ miles of the springs. The Union Pacific Railroad has two lines surveyed through this region, each of them running very close to these springs: one of the lines proposed by the Union Pacific is from Gallatin, the other from Beaver Cañon. Each runs to the Park line near Mammoth Hot Springs.

The natural advantages offered by Horsethief Springs are, in my judgment, superior to those found at any other place visited by us. The water is excellent in character and enormous in quantity. The topography could scarcely be improved. The location is central with reference to the region to be stocked—in short, *all* the *natural* conditions are most favorable. Should the Northern Pacific or the Union Pacific build a branch road to the Park over the line surveyed, I do not think a better location for the station could be found than at Horsethief Springs.

Glen Creek was examined just above the Golden Gate in the Yellowstone National Park. It is there a small stream about 5 feet wide, 6 inches deep, and with a current of about 18 inches per second. This gives it a flow of about 1,683 gallons per minute.

BOTTELER SPRINGS.

The temperature of the water at 10 a. m., August 25, was 50°. The water is clear and of good quality, but probably becomes muddy during heavy rains. This stream was examined again near where it flows into the Gardiner River, and this latter stream was also examined. The banks of both are quite high and the adjacent land entirely too rough and rocky for the purposes contemplated.

Reese Creek is a small stream flowing into the Gardiner River near Horr, Montana, a few miles north of Cinnabar. We examined it through a mile or more of its course just above the railroad. Most of its water is taken out for irrigation purposes, but above all these ditches we found it to be about 5½ feet wide, 7 inches deep, and to flow with a current of 2½ feet per second, which gives it a volume of 3,600 gallons per minute. The temperature of the water at noon, August 26, was 48°. About 1½ miles above the railroad is a very suitable tract of land which could probably be had if desired. This is above where the irrigation ditches are taken out, therefore the water needed for the station could be turned back into the stream and thus not interfere with any previous water rights. It is quite probable, however, that this stream becomes more or less muddy during heavy rains.

Botteler Springs.—These springs are on the west side of the Yellowstone Valley about 3 miles south of Fridley, Montana, just opposite Emigrant Peak, and on the National Park branch of the Northern Pacific Railroad. The distance to Cinnabar is about 25 miles, which is also about the distance to Livingston. There is a large number of these springs, some very small, just oozing from the ground, others issuing in strong streams. They all come out near the upper margin of a bench composed of morainic material, and are grouped in such a way as to unite into eight streams which cross the road in front of the bench within a short distance of each other. The springs of all the eight groups lie within a limit of 50 rods of each other, and the water from all could be easily gathered into one stream which would give a flow of at least 4,275 gallons per minute. This amount could be increased to probably 6,000 gallons per minute by gathering up the water from a number of small springs not taken into account in the above estimate. The bench is covered with trees, such as quaking asp, willows, rose bushes, and other small bushes. The immediate vicinity of the springs, though gravelly, is marshy. They are so situated that only the most northern group (No. 8) can receive any wash from the adjacent land during even heavy rains. Most of the springs are surrounded by a thick growth of bushes. Watercress and other plants are abundant in the streams made by the springs. Insect larvæ, young trout, frogs, etc., abound in the streams, and the Yellowstone River in the immediate vicinity has an abundance of trout, many individuals of very large size being noticed.

The ground in front of the bench is a plain with a gradual descent to Yellowstone River, three-fourths of a mile distant. The foot of the bench is 300 yards west of the railroad and 35 feet above it. The cultivated portion of the ranch which lies between the bench and the river is irrigated mainly by the water from a neighboring creek, the water from the springs being used only occasionally. The accompanying rough diagram (Pl. IV) will be helpful in understanding the position and nature of the springs.

These springs were inspected on August 26 and 27 by Prof. Jenkins and Mr. Clapham. The groups I have numbered from 1 to 8, beginning at the south. In determining the amount of water flowing from each group it was found that, owing to the marshy character of the ground and the ramifications and interlacings of the various little streams, only approximate results could be reached. It is believed, however, that the aggregate flow of these springs can not be less than 5,900 gallons.

The following table gives the approximate width, depth, current, and volume, together with the temperature of the water of each main spring:

Group.	Width in inches.	Depth in inches.	Current in inches per second.	Gallons per minute.	Temperature.
					°
1	8	2	48	200	50.75
2	8	2	36	149	-----
3	12	3	36	336	50.50
4	Could not well measure.				
5	24	6	12	449	48.50
6	36	3	16	449	49.00
7	72	6	16	1,795	48.00
8	36	8	12	897	50.00
Total flow over				4,275	

We were informed that the water in these springs never freezes, and that the volume and temperature remain approximately constant throughout the year.

This location seems to be an admirable one in every way, so far as natural conditions are concerned. Its nearness to the Yellowstone National Park, which is destined to become the great national game preserve, is a matter of no little importance. I have no doubt that satisfactory arrangements regarding the necessary land for the site can be made with Mr. Botteler, the owner.

Davies Springs.—These springs, two in number, are on the land of Mr. W. J. Davies, 4 miles from Bozeman. They come out at the roadside at the base of a limestone bluff. Two small streams are formed which flow across the wagon road and within a few yards enter Bridger Creek. The east spring, at 10 a. m. August 27, had a temperature of 46°. The stream flowing from it was about 10 feet wide and 4 inches deep, and flowed at least 1,496 gallons per minute. The west spring is a little warmer, its temperature being 47°. It flows a stream 3½ feet wide, 4 inches deep, and with a current which gives not less than 525 gallons per minute. The water from these two springs can be easily united into one stream which would give over 2,000 gallons per minute. Just across Bridger Creek is a good-sized spring of comparatively warm water, its temperature being 79°. Bridger Creek near the springs is about 10 feet wide, 10 inches deep, and has a current of 2 feet per second. Its temperature was 60°. The springs are surrounded by alders, rose bushes, willows, cottonwoods, and bushes of other kinds. There is an abundance of cress, moss, and other water vegetation in the springs and the streams running from them. Sufficient snitable ground could probably be had just below the springs, and it would no doubt be furnished to the Commission on satisfactory terms.

The accompanying plat (Pl. v) shows clearly the nature of the proposed site. The location is a central one with reference to the region to be stocked. Bozeman is on the Northern Pacific Railroad where the main line branches, one running to Helena, the other to Butte, both branches again uniting at Garrison. The Gallatin Valley, in which Bozeman is situated, is one of the most fertile and most attractive that we have ever seen. Bozeman is but 29 miles west of Livingston, where the branch road leaves the main line of the Northern Pacific for the National Park.

Wolverton Spring, 4 miles south of Bozeman, was also examined. This consists of one main spring and a great number of small ones coming out at various places in

DAVIES SPRINGS NEAR BOZEMAN.

a marshy tract of ground just below the main spring. The stream from the main spring was 2 feet wide and 10 inches deep, and flowed about 748 gallons per minute. Its temperature at 3:30 p. m., August 27, was 52°, or 48° in the spring itself, which was shaded. Measured at a point one-fourth mile below the springs, the stream was found to be 5 feet wide, 8 inches deep, and to have a current of 1 foot per second. This would indicate a flow of about 1,500 gallons per minute. The temperature here was 52° at 4 p. m. These springs all come out in a low marshy piece of ground and form a kind of pond filled with watercress and other water plants. The pond is surrounded by willows, cottonwoods, chokecherries, and other bushes. The stream flows across the road to the north from the marsh, and continues northward through a meadow for a mile or more. Its banks are covered with a dense growth of bushes. The ground over which it flows is perhaps too level to afford sufficient fall for a gravity supply.

ANNOTATED LIST OF FISHES OBTAINED IN MONTANA AND WYOMING.

As shown in the preceding pages of this report, the region over which our explorations extended is, in general, a mountainous one, most of whose streams are clear and cold, and flow with a rapid, often turbulent, current. The number of species of fishes in such waters is never great. Though our collection contains but 16 indigenous species, it no doubt represents fairly well the fish fauna of that region. The species represented, grouped by families, are the following:

Catostomidæ.

1. *Catostomus discobolus* Cope.
2. *Catostomus catostomus* (Forster).
3. *Catostomus macrochilus* Girard.
4. *Catostomus ardens* Jordan & Gilbert.

Cyprinidæ.

5. *Rhinichthys dulcis* (Girard).
6. *Mylocheilus caurinus* (Rich.).
7. *Ptychocheilus oregonensis* (Rich.).
8. *Leuciscus hydrophlox* (Cope).
9. *Leuciscus gilli*, sp. nov.
10. *Leuciscus atrarius* (Girard).

Salmonidæ.

11. *Coregonus williamsoni* Girard.

Salmonidæ—Continued.

12. *Thymallus signifer* (Rich.).
13. *Salmo mykiss* Walbaum.
14. *Salvelinus malma* (Walbaum).

Cottidæ.

15. *Cottus bairdi punctulatus* (Gill).

Gadidæ.

16. *Lota lota maculosa* (Le Sueur).

Salmonidæ (introduced into the Yellowstone National Park).

17. *Salmo iridens* Ayres.
18. *Salmo fario* Will.
19. *Salmo trutta levenensis* Walker.
20. *Salvelinus fontinalis* (Mitchill).

The most abundant, important, and generally distributed of these is, of course, the black-spotted or mountain trout, with its almost constant and destructive attendant, the blob. Just how destructive the blob is to the eggs of the trout I am unable to say, but it is probably a very serious pest during the spawning season.

1. *Catostomus discobolus* Cope. (Pl. XVIII.)

Catostomus discobolus Cope, Hayden's survey, 435, 1870.

Thirteen examples of this species were taken in Red Rock River near Red Rock, Montana, and an equal number from Beaverhead River at Dillon. These specimens are from very small size to 7 inches in length. Head, 5; depth, 5; eye, 5; snout, 2 to 2½; interorbital width 2; mouth and lips large, cartilaginous sheath of each lip well developed; fontanelle a very narrow slit; origin of dorsal fin much nearer snout than

caudal; scales very small and crowded anteriorly, about 93 in lateral line. D. 10, its height $1\frac{1}{4}$ in head, a little greater than length of its base; anal long, nearly equal to head; pectoral shorter, $1\frac{1}{5}$ in head.

2. *Catostomus catostomus* (Forster).

Cyprinus catostomus Forster, Phil. Trans., 1773, 155.

The collection contains the following specimens, which I refer to this species:

a. Little Blackfoot River, Elliston, Montana	16
b. Browns Gulch Creek, Silver Bow, Montana.....	47
c. Lolo Creek, near Missoula, Montana.....	22
d. Jocko River, Ravalli, Montana.....	5

All are young specimens, none being over 8 inches in length. Head, $4\frac{1}{4}$ to $4\frac{1}{2}$; depth, 5 to $5\frac{1}{2}$; eye, 5 to 6; snout, $2\frac{1}{5}$ to $2\frac{3}{4}$.

There is a little variation in the papillæ, but there are never over four rows on the upper lip; in fact two to three rows is the almost constant number. Compared with specimens of *C. griseus* from the South Platte, at Denver, Colorado, the Montana specimens have the lips much smaller, the rows of papillæ fewer, and the jaws with much less distinct cartilaginous cutting edge.

I have also compared them with specimens of *Catostomus catostomus* from various places, and others labeled *C. longirostris*, and am not able to see any important differences. The type of *C. retropinnis* Jordan has very much larger lips than in any other specimens I have examined, and the scales are smaller. It is perhaps best to retain it as a distinct species for the present at least.

3. *Catostomus macrochilus* Girard. (Pl. XVIII.)

Catostomus macrochilus Girard, Proc. Acad. Nat. Sci. Phila. 1856, 175.

This large sucker is very common in Post Creek, on Flathead Indian Reservation, and in Swan Lake. It is no doubt common in Flathead Lake and the streams of that region, but we obtained specimens only from Post Creek and Swan Lake, three from the former and seven small ones from the latter. Examples 16 inches long have the head 4, depth 5, and eye 6. Scales, 11 or 12-72 to 75-10 or 11, about 40 before dorsal. Dorsal long, of 14 or 15 rays; pectorals and anal long, the latter nearly equal to head; papillæ not very large.

4. *Catostomus ardens* Jordan & Gilbert. (Pl. XVIII.)

Catostomus ardens Jordan & Gilbert, Proc. U. S. Nat. Mus., 1880, 464. (Utah Lake.)

We found this sucker very abundant in the Snake River at President Camp, where numerous specimens were taken, from very small ones up to a foot in length. Very much larger individuals, presumably of this species, were seen in water too deep to seine. Specimens 7 to 12 inches long have the head 4 to $4\frac{1}{4}$, depth $4\frac{1}{2}$ to 5, eye $5\frac{1}{4}$ to 6, and the snout $2\frac{1}{4}$ to $2\frac{1}{2}$. Scales, 10-63-9, much crowded in front; origin of dorsal fin very slightly nearer snout than base of caudal. Papillæ on upper lip in about five rows, not evidently so many in younger specimens.

5. *Rhinichthys dulcis* (Girard). (Pl. XIX.)

Argyreus dulcis Girard, Proc. Acad. Nat. Sci. Phila. 1856, 185; P. R. R. Survey, x, 243, pl. LIV, figs. 5-8, 1858.

Rhinichthys dulcis, Jordan, Bull. U. S. Fish Com., ix, for 1889, 1891, 48.

This little minnow is pretty generally distributed throughout the region visited by us, numerous specimens being obtained at each of the following places:

	No. of specimens.
a. Beaverhead River, Dillon, Montana	115
b. Red Rock River, near Red Rock, Montana.....	5
c. Junction of Firehole and Gibbon Rivers.....	23
d. Snake River at President Camp, Wyoming	6
e. Browns Gulch Creek, at Silver Bow, Montana.....	3
f. Big Blackfoot River, near Bonner, Montana.....	4
g. Little Blackfoot River, Elliston, Montana.....	6

Those from Beaverhead River are the largest specimens seen, many being $3\frac{1}{2}$ to 4 inches in length. It was also more abundant here apparently than elsewhere. The specimens from the junction of the Firehole and Gibbon are all very small. In many examples measured, the origin of the dorsal is a little nearer the nostril than base of caudal fin, but midway between base of caudal fin and tip of snout.

6. *Mylocheilus caurinus* (Rich.) Girard. (Pl. XIX.)

Cyprinus (*Leuciscus*) *caurinus*, Richardson, Fauna Bor. Am., III, 304, 1836.

Mylocheilus caurinus, Girard, Proc. Acad. Nat. Sci. Phila. 1856, 169.

Common in Flathead Lake and in Bitter Root River. Curiously enough, at Flathead Lake it is called "whitefish" and is served at the hotels as such, while the true whitefish, which is not uncommon in the lake, does not appear to have attracted the attention of the local fishermen. About a dozen specimens were examined, ranging from 8 to 11 inches in length.

Head, 4 to $4\frac{1}{3}$; depth, $4\frac{1}{4}$ to $4\frac{2}{3}$; eye, $4\frac{3}{4}$ to 5; snout, $3\frac{1}{4}$ to $3\frac{3}{4}$; pectorals, $1\frac{1}{2}$ to $1\frac{3}{4}$ in head; ventrals, $1\frac{1}{2}$; dorsal, 8, a little longer than pectorals, about $1\frac{1}{2}$ in head; anal, 8, equal to ventrals.

Scales, 12-77-7; teeth, 1, 5-5, 1 in numerous examples studied; in fact, I do not find a single case in which there are two teeth in the lesser row.

Color in life, dark greenish above, extending down nearly to the lateral line, where there is a dark irregular band two scales wide. Below this is a reddish band two or three scales wide, extending the full length of the fish, while the dark band stops at the posterior edge of dorsal fin; below, white; top of head, greenish; cheeks and opercles paler, with fine punctulations of dark; corners of mouth with a reddish wash extending backward on cheeks; a little orange on opercles and at base of pectorals.

7. *Ptychocheilus oregonensis* (Rich.). (Pl. XIX.)

This voracious fish is very common in Flathead Lake, where it is currently known as "squawfish." We also found it common in Lolo Creek and in Bitter Root River, near Missoula.

Numerous individuals from 7 to 12 inches long were examined. Head, $3\frac{3}{4}$; depth, $4\frac{1}{2}$; eye, 6; snout, 3; scales, 19-80-7; teeth, 2, 5-4, 1. Tip of snout to angle of mouth, $2\frac{2}{3}$ in head. Dorsal, 10; anal, 8; the pectorals equal the anal but exceed the ventrals; the height of the dorsal fin is contained $1\frac{3}{4}$ times in the head, and is $\frac{1}{4}$ greater than its length.

Color in life, above nearly uniform muddy greenish, a few scattered scales showing silvery; growing gradually silvery on the sides, with a slight tinge of orange, and slightly dusted with dark, this extending about four scales below the lateral line; under parts white, pale greenish on caudal peduncle; cheeks silvery, with a few dark

spots, opercles silvery with orange washing and a few dark spots; ventral fins yellow, pectorals a little less so, anal same as ventrals; dorsal and caudal darkish or muddy yellow; maxillaries and tip of lower jaw with fine dark punctulations.

Younger individuals are essentially the same in color, only that the fins and posterior parts of the body are not so yellow and in the youngest there is a dark blotch at base of caudal fin.

8. *Leuciscus hydrophlox* (Cope). (Pl. xx.)

This species was very abundant in Snake River at President Camp, Wyoming, where eighty-three specimens were obtained; also in the small creek at the head of Jackson Lake. The specimens are 3 inches or less in length. Dorsal rays 9 in numerous specimens counted; anal usually 12, 11 in some examples; base of fin $6\frac{1}{2}$ in length of body; maxillary barely reaching orbit, lower jaw somewhat projecting; dark band on side continued forward over the opercle; lateral line less decurved than in Heart Lake specimens.

9. *Leuciscus gilli*, sp. nov. (Types No. 43953, U. S. Nat. Mus.) (Pl. xx.)

This species is based upon fourteen specimens, 3 to $4\frac{1}{4}$ inches long, taken in Browns Gulch Creek, at Silver Bow, Montana, July 27, 1891. Head, 4 to $4\frac{1}{4}$ in length to base of caudal; depth, $3\frac{1}{2}$ to $3\frac{3}{4}$; eye, $3\frac{1}{2}$ to 4 in head, $1\frac{1}{2}$ in interorbital width; snout, $3\frac{1}{2}$ to $3\frac{3}{4}$; D. 10 (occasionally 9 or 11); A. 14 (13, 15, or 16 in a few specimens); scales, 11-66-7; teeth, 2, 5-4, 2. Body compressed, deep, back little arched, ventral line considerably curved, bending gently upward at beginning of anal fin; head heavy, snout short and blunt, lower jaw not projecting, mouth oblique, maxillary not quite reaching front of orbit; caudal peduncle long and slender; scales moderate, deeper than long on anterior part of body, but longer than deep on caudal peduncle, about 32 before the dorsal. Dorsal fin small, much nearer caudal fin than snout, about midway between beginning of scaled surface at back of head and beginning of rudimentary caudal rays, its origin behind vertical line from ventrals a distance equal to the length of its base; base of dorsal fin $1\frac{2}{3}$ in its height, which in turn is $1\frac{1}{4}$ in head; its free margin falcate. Anal fin large, its base about $5\frac{3}{4}$ in length of body to base of caudal fin, or about equal to length of pectoral; longest rays a little shorter than length of fin; free margin very nearly straight; origin of fin under last fifth of dorsal; ventrals short, $1\frac{1}{2}$ in head, reaching vent in some specimens; pectorals long, $1\frac{1}{3}$ in head, nearly reaching ventrals in some examples; caudal fin very long and deeply forked, lower lobe the longer, $4\frac{1}{4}$ in total length.

Color in alcohol, upper parts dark down to level of eye; beginning at upper level of eye is a band about one scale in width that is chrome yellow on head, then widening slightly and becoming rosy until the middle of the side is reached, where it becomes gradually less distinct until hardly discernible on the caudal peduncle; below this is a dark band about twice as wide, the middle portion of which lies just above the lateral line, but at each end it extends a little below; side of body below lateral line rich rosy with tinge of yellow, whitening on the caudal peduncle; orange at base of ventrals and pectorals, the latter with some reddish; belly white; cheek with a large crescent of chrome yellow, very bright in some specimens, extending from angle of mouth across the cheek and up back of the eye, nearly connecting with the line first described; opercles silvery, with some little orange washing, covered over with many fine black punctulations, most numerous above, where they form a large dark blotch; whole body

sprinkled over with similar black specks, most numerous above the lateral line; lower jaw and branchiostegal membranes with numerous very fine dark specks; lower border of orbit dark; dorsal, anal, caudal, and ventral fins with a few fine black points; pectorals slightly yellowish green, with few black specks, the outer ray edged with black; a yellow blotch at base of pectoral extending forward to gill-opening.

This species is closely related to *Leuciscus montanus* (Cope), but differs from it in the shorter maxillary, smaller eye, greater width of the interorbital space, the shorter head, and the much greater depth. Compared with specimens of *L. montanus* from Utah Lake and Bear River, at Evanston, Wyoming, and with specimens of *Squalius tenia* (Cope) from Utah Lake, the snout is much more blunt and the anal fin larger. It is also related to *Leuciscus hydrophlox* (Cope), but the body is much deeper, the snout is very much blunter, the lower jaw does not project, and the lateral line is considerably more decurved; the dorsal fin in *L. hydrophlox* is midway between snout and base of caudal fin, while in this species it is placed midway between posterior line of head and base of caudal; there is also a difference of one in the number of dorsal rays; the anal fin is very much larger and the number of rays greater than in *L. hydrophlox*, from which it also differs notably in the brilliancy of its coloration.

In the following table I give measurements of the fourteen specimens:

Length in inches.	Head in length.	Depth in length.	Eye in head.	Snout in head.	Base of anal in length.	Dorsal rays.	Anal rays.
4 $\frac{1}{2}$	4+	3 $\frac{1}{2}$	4	4	5 $\frac{3}{4}$	9	14
4 $\frac{1}{2}$	4+	3 $\frac{1}{2}$	4—	4	6	10	15
4 $\frac{1}{2}$	4 $\frac{1}{2}$	3 $\frac{1}{2}$	3 $\frac{1}{2}$	3 $\frac{3}{4}$	6	10	14
4	4	3 $\frac{1}{2}$	3 $\frac{1}{2}$	4	5 $\frac{1}{2}$	10	14
4	4	3 $\frac{1}{2}$	3 $\frac{1}{2}$	4	5 $\frac{1}{2}$	10	14
4	4	3 $\frac{1}{2}$	3 $\frac{1}{2}$	3 $\frac{3}{4}$	5 $\frac{1}{2}$	10	14
4	4+	3 $\frac{1}{2}$	4	4	5 $\frac{1}{2}$	9	14
4	4 $\frac{1}{2}$	3 $\frac{1}{2}$	4	4	5 $\frac{1}{2}$	10	14
4	4 $\frac{1}{2}$	3 $\frac{1}{2}$	3 $\frac{3}{4}$	3 $\frac{3}{4}$	5 $\frac{1}{2}$	10	14
4	4	3 $\frac{1}{2}$	3 $\frac{3}{4}$	3 $\frac{3}{4}$	5	9	13
3 $\frac{1}{2}$	4 $\frac{1}{2}$	3 $\frac{1}{2}$	3 $\frac{1}{2}$	3 $\frac{3}{4}$	5 $\frac{3}{4}$	10	14
3 $\frac{1}{2}$	4 $\frac{1}{2}$	3 $\frac{1}{2}$	3 $\frac{1}{2}$	3 $\frac{3}{4}$	5 $\frac{1}{2}$	10	14
3 $\frac{1}{2}$	4 $\frac{1}{4}$	3 $\frac{1}{2}$	3 $\frac{1}{2}$	3 $\frac{3}{4}$	5	9	13
3	4	3 $\frac{1}{2}$	3 $\frac{1}{2}$	3 $\frac{1}{2}$	5 $\frac{1}{2}$	11	16

One small specimen, 1 $\frac{5}{8}$ inches in length, from the outlet of Swan Lake, near Flathead Lake, seems to belong to this species. Head, 4; depth, 4; eye, 2 $\frac{3}{4}$, greater than snout; the mouth more oblique than in the Browns Gulch specimens; the maxillary barely reaching the eye; body much compressed.

I may add that I have made a careful comparison of the specimens of *Clinostomus montanus* (Cope) from Utah Lake and Bear River, at Evanston, Wyoming, and those called *Squalius tenia* (Cope), from Utah Lake, which are in the National Museum, and I can not see any differences between them.

I take pleasure in naming this handsome minnow for Dr. Theodore Gill, whose studies have added so much to our knowledge of fishes.

10. *Leuciscus atrarius* (Girard). (Pl. xx.)

Siboma atraria Girard, Proc. Acad. Nat. Sci. Phila. 1856, 208; P. R. R. Survey, x, 297, 1858 (spring in Utah); Cope, Zööl. Wheeler Survey, v, 667, 1875.

Squalius atrarius, Jordan and Gilbert, Proc. U. S. Nat. Mus. 1880, 461 (Utah Lake); Synopsis, 241, 1882.

Leuciscus atrarius, Jordan, Bull. U. S. Fish Com., ix, 48, 1891 (Heart Lake and Witch Creek, Yellowstone Park).

Tigoma obesa Girard, Proc. Acad. Nat. Sci. Phila. 1856, 206; P. R. R. Survey, x, 290, 1858 (Salt Lake Valley, Utah).

Squalius obesus, Jordan and Gilbert, Synopsis, 237, 1882.

Tigoma squamata Gill, Proc. Bost. Soc. Nat. Hist. 1861; Ichthyol. Capt. Simpson's Expl., 405, 1876.

Squalius squamatus, Jordan & Gilbert, Synopsis, 241, 1882.

Squalius cruoreus Jordan and Gilbert, Proc. U. S. Nat. Mus. 1880, 460 (Utah Lake; young specimens).

Squalius rhomaleus Jordan and Gilbert, Proc. U. S. Nat. Mus. 1880, 461 (large specimens from Utah Lake); Synopsis, 240, 1882.

Siboma atraria longiceps Cope, Zööl. Wheeler Survey, v., 667, 1875.

This species is represented in the collection by nine large specimens taken with the hook in Jackson Lake, and by numerous smaller specimens from the small creek at the head of Jackson Lake, and from Snake River at President Camp. It is very abundant in Jackson Lake and takes the hook readily.

Measurements of nine specimens.

No.	Length in inches.	Head in length.	Depth in length.	Eye in head.	Snout in head.
27	11	3½	4	6	4½
28	12	3½	4	6—	3½
29	11	4	3½	6	4
30	10½	4	4+	6—	4
31	9	4	4+	5½	4
32	11	4	4	6	3½
33	13	4	4+	6	3½
34	12	4	4+	6—	3½
35	11	4	3½	6	3½

Scales, 11 to 13—56 to 63—6 or 7; 12—63—7 being the most usual number.

Teeth, oftener 2, 5—4, 1 than 2, 5—4, 2.

I have compared these specimens with those collected by Dr. Jordan in Heart Lake and find them identical. Girard's type of *Siboma atraria*, a specimen 6½ inches long, from "near 38° latitude, in Utah," agrees well with these, as do also others collected at Willow Springs, Utah, by Dr. G. K. Gilbert, and those called *S. rhomaleus* by Jordan and Gilbert. Specimens in the National Museum, labeled *Squalius squamatus* Gill, from Utah, are evidently *atrarius*. An examination of the type of *Squalius cruoreus* J. and G. shows it to be a little more slender than other examples of *atrarius*, but it differs in no other particular. Specimens in the Museum collected in Beaver River, Utah, by Henshaw and Yarrow, and called *Squalius egregius* Cope, can not be distinguished from *atrarius*, and that species should probably go in the above synonymy.

The type of Girard's *Cheonda carulea*, from Lost River, Oregon, is a very different-looking fish. The head is longer, the snout much longer and more pointed, the mouth is larger, the maxillary is longer and less oblique, the eye is somewhat larger, and the top of the head more flat.

11. *Coregonus williamsoni* Girard. (Pl. XXI.)

The collection contains specimens of whitefish from the following localities:

<i>a.</i> Swan River below Swan Lake, Montana	21
<i>b.</i> Jocko River, Ravalli, Montana.....	6
<i>c.</i> Big Blackfoot River, Bonner, Montana.....	3
<i>d.</i> Little Blackfoot River, Elliston, Montana.....	12
<i>e.</i> Cottonwood Creek, Deer Lodge, Montana	1
<i>f.</i> Snake River, President Camp, Wyoming.....	19
<i>g.</i> Red Rock River, Red Rock, Montana	7
<i>h.</i> Beaverhead River, Dillon, Montana.....	5
<i>i.</i> Junction of Firehole and Gibbon rivers	2

In addition to the material collected by us, I have examined numerous other specimens from the Upper Missouri Basin, comparing them with a large number from the upper tributaries of the Columbia, but I am unable to find any difference of value. The Columbia specimens are perhaps somewhat deeper. Examples from Red Rock and Beaverhead rivers have the head $4\frac{1}{2}$ (4 to $4\frac{2}{3}$); depth, $4\frac{1}{5}$ to $4\frac{1}{3}$; scales, 80 to 84. Those from Little Blackfoot and Swan rivers have the head $4\frac{1}{5}$ to $4\frac{1}{2}$; depth, 4 to $4\frac{1}{3}$; scales, 80 to 84.

Small specimens, 3 to 5 inches long, show the following color markings: Silvery over entire surface below the lateral line, with a few scattered dark punctulations and a little black on lower caudal rays, plainest toward the base; bluish above lateral line, with numerous larger and darker punctulations; under these are seen the vanishing bluish blotches so evident in younger examples. Dorsal and adipose fins, as well as snout and top of head, covered with very fine dark spots. Younger specimens, a little under 3 inches in length, have the steel-blue blotches very distinct, there being about 10 of them, most of which just touch the lateral line from above; above these are about 20 similar blotches of various sizes—mostly smaller, however, than those along the lateral line.

A still smaller specimen ($2\frac{1}{2}$ inches) in life was silvery below, 8 or 9 dark-bluish spots along side, mostly above lateral line; back darker, with numerous spots; top of head with very fine spots.

The fact that the young whitefish has the *parr* markings is a very interesting one, and is of value in showing its relations to the trout. (See Pl. XXI.)

12. *Thymallus signifer* (Richardson). (Pl. XXII.)

We found the grayling in Red Rock River, Beaverhead River, and in the Gibbon at its junction with the Firehole River; and also in the stream formed by Horsethief Springs—all tributary to the Upper Missouri.

Two examples, 10 and 11 inches long respectively, from the junction of the Firehole and the Gibbon, show some differences in measurements; the larger has the head $4\frac{3}{4}$; depth, 4 ; eye, $4\frac{1}{3}$; scales, 8-97-10, and dorsal 19; the other, head, $4\frac{3}{5}$; depth, $3\frac{1}{5}$; eye, $4\frac{1}{2}$; scales, 8-91-10, and dorsal 19. Length of dorsal fin a little greater than head, height about $1\frac{1}{2}$ in head, but much less than depth of body; origin of dorsal one-third length of body from snout. About 18 inky black spots and about 6 fainter ones on side of body. The number of these spots is of little value, however, as the smaller of these two specimens has 25 distinct spots on one side and but 18 on the other; nearly all the spots are anterior to the dorsal fin.

A small specimen (3 inches long) from Beaverhead River has the depth and head about equal, each 4 in length of body. Upper half of its body covered with fine dark specks, most numerous on edges of scales where they form a dark border; along the region of the lateral line is a series of about fifteen steel-blue blotches, the vertical diameter greatest, much resembling the *parr* markings of young trout and whitefish. Above these are many smaller spots or blotches of same color. (See Pl. XXII.)

Two specimens, $3\frac{1}{2}$ and $3\frac{1}{2}$ inches long respectively, from Red Rock River, have the steel-blue blotches very distinct, while the dark borders or lines between the rows of scales on the upper half of body have begun to break up into short, inky, zigzag lines each with one to eight or more angles.

13: *Salmo mykiss* Walbaum. (Pl. XXIV.)

The black-spotted or mountain trout is represented in the collection by specimens from the following localities:

a. Swan River below Swan Lake, Montana..	8	m. Crawfish Creek just below Moose Falls..	2
b. Flathead Lake.....	2	n. Snake River, President Camp, Wyoming..	9
c. Mission Creek near Ravalli, Montana...	1	o. Pacific Creek 25 miles below Two-Ocean	
d. Jocko River, Ravalli, Montana.....	20	Pass	6
e. Rattlesnake Creek, Missoula, Montana..	7	p. Pacific Creek about 8 miles below Two-	
f. Lolo Creek, Missoula, Montana.....	9	Ocean Pass.....	3
g. Big Blackfoot River, Bonner, Montana..	1	q. Pacific Creek at Two-Ocean Pass.....	13
h. Little Blackfoot River, Elliston, Montana	12	r. Atlantic Creek at Two-Ocean Pass.....	20
i. Cottonwood Creek, Deer Lodge, Montana	19	s. Atlantic Creek 1 mile above its mouth..	1
j. Dempsey Lakes, Deer Lodge, Montana..	12	t. Mouth of Upper Yellowstone River.....	2
k. Browns Gulch Creek, Silver Bow, Mon-		u. Meadow Creek near its mouth.....	6
tana.....	3	v. East Fork Gardiner River above falls..	1
l. Lewis River just below Lower Falls....	2	w. McClellan Creek near Helena, Montana .	2

This species is found abundantly in all suitable streams and lakes explored by us.

Besides the 135 specimens from the Columbia basin and the 32 from the Missouri side, a great many individuals were examined in the field which were not preserved. In addition to the above, numerous specimens in the collections in the U. S. National Museum were compared with those of my own collection. The whole amount of material examined goes to show the correctness of the conclusion reached by Dr. Jordan,* that all the native trout of the Park belong to a single species, and that *Salmo clarkei*, *Salmo lewisi*, etc., can not be recognized even as varieties.

The fact that there is a free waterway over Two-Ocean Pass, by means of which trout can pass readily from either side of the "Divide" to the other, as explained elsewhere in this report, is of great importance in showing that the trout of the two sides can not be regarded even as geographical forms. The differences that are observable among different specimens do not exist as differences between Missouri and Columbia drainage specimens, but rather as slight peculiarities due to the nature of each particular stream. This will appear evident from a comparison of the following color notes, based upon specimens of different sizes and from different places:

A specimen $4\frac{3}{4}$ inches long, from McClellan Creek, Helena, Montana: Side with about ten dark blotches lying on the lateral line, the vertical diameter being the greater; a series of about a dozen larger, rounder ones along middle of space between lateral line and middle line of back; among and about these are numerous small spots; spots

* Bull. U. S. Fish Commission, vol. IX, 50, 1891.

below lateral line not numerous, about ten large and perhaps twice as many small ones; cheek with two or three small dark spots and numerous fine punctulations; a few small spots on top of head; dorsal fin with about a dozen small spots or blotches; adipose fin dark-edged; caudal fin well spotted, the spots more or less evidently arranged in five vertical rows; other fins plain; tip of lower jaw dark.

A specimen, 7 inches long, from the same place, differs from the smaller one in having the large vertical blotches less distinct, and the other spots more numerous, especially on dorsal, adipose, and anal fins, and on top of head; the spots on the cheeks are also less distinct.

Twenty specimens, each about $4\frac{1}{2}$ inches long, from Atlantic Creek in Two-Ocean Pass, show no marked differences from those from McClellan Creek. The spots are a little larger in some specimens; the large blotches seem a little less distinct than in the larger, but much the same as in the smaller specimen from McClellan Creek. Those from Atlantic Creek are a little more slender than the others.

A specimen $2\frac{3}{4}$ inches long, from Atlantic Creek, about one mile from its mouth, does not differ in color from those taken in the same creek at Two-Ocean Pass.

Sixteen specimens, 4 to $6\frac{1}{2}$ inches long, from Pacific Creek, in Two-Ocean Pass, can not be distinguished from those of the same size taken in Atlantic Creek, a few yards away.

Three examples taken in Pacific Creek, about 7 miles below the pass, and measuring $5\frac{1}{2}$ and $6\frac{1}{2}$ inches in length, have the spots less numerous and larger, agreeing in this with the Atlantic Creek specimens.

A specimen 14 inches long from Pacific Creek, about 25 miles below the pass, presented the following life colors: Above, dark greenish, very dark on head, lighter posteriorly; paler on sides, nearly white on belly, but with some dark washings. No spots on top of head, very few on body in front of dorsal, more numerous behind; ten or eleven small round spots on cheek. Sides of head with red or pinkish wash, old gold at upper edge of opercle and a blotch of the same behind the eye. Shoulder above pectoral reddish; throat white, with red gash; rim of lower jaw washed with dark. Pectorals dark wine color; ventrals and anal red. Spots on body nearly round.

Another specimen, $11\frac{1}{2}$ inches long, from same place, was, in life, dark-greenish above, silvery on the sides, but with an underwash of yellowish; belly white; few, if any, spots on head or on back in front of dorsal, and but few on anterior half of body, while they are rather thick under the dorsal and quite thick along the back between the dorsal and caudal fins; not over fifty spots altogether below the lateral line; dorsal and caudal fins well spotted; two dark blotches on cheek; opercles pinkish, yellowish at top; red gash on throat not heavy; pectorals dark, ventrals and anal yellow.

Another specimen, 12 inches long, was yellowish like the one just described, but had the spots more numerous and not so nearly round, each spot being made up of two or more short black lines joined in such a way as to make the spots appear somewhat star-shaped at first glance.

An examination of about thirty large individuals from this place seemed to show that they may be separated into two groups: one more slender, and yellowish in color; the other less slender and with little or no yellow. The star-shaped spots seemed to be more common among the yellow examples, but all were not so marked, nor was this style of marking absent from the other form.

Two specimens, 4 and 7 inches long, respectively, from Crawfish Creek, just below Moose Falls, can not be distinguished from specimens of the same size from Cottonwood Creek or from McClellan Creek.

Ten specimens from Little Blackfoot River, $3\frac{1}{2}$ to $7\frac{1}{2}$ inches in length, show considerable variation among themselves as to number, size, and shape of the spots, but these variations are independent of size, sex, or age of the fish.

An 11-inch specimen from Lolo Creek, in life, was washed with red along the lateral line, more on upper parts of belly; back dark, with numerous black spots which are larger and more irregular in outline toward the caudal peduncle; seven rather regular vertical rows of spots on the tail, about same number on dorsal fin; but few spots below the lateral line anteriorly, more numerous behind; two black spots on opercle; bright red dash on lower jaw; pectoral fins pale yellow, ventrals and anal darkish; very few spots on head. Little or no red on jaw of younger specimens.

A great many examples from Dempsey Lakes were examined. These present no peculiarities of coloration, but some of them are a trifle deeper than any others that I have examined. The specimens from Rattlesnake Creek are also inclined to be deeper than the usual form.

Two specimens, each 7 inches in length, from Swan River, at outlet of Swan Lake, present some peculiarities. One of them has the spots of the usual form and number, but the other has scarcely any spots on the anterior two-thirds of the body, while those on the caudal peduncle and caudal fin are much less numerous than usual.

A specimen, 14 inches long, from Lewis River, just below the lower falls, showed the following color markings in life: Ground color of the body dirty white, yellowish toward under side; spots very thick, largest posteriorly; dark greenish on back; no spots on top of head; sides of head yellowish silvery, with a few small, round, black spots; a red blotch below and behind eye, wash of same on preopercles; opercles washed with red on lower two-thirds, extending over the branchiostegals to the red on the throat; a reddish wash along sides, mostly below lateral line; pectorals, anal, and ventrals all dark-reddish with some little traces of yellow; caudal and dorsals well covered with spots.

A small specimen, 6 inches long, from Big Blackfoot River, in life showed four pale red splotches on side, the last one under the dorsal fin; few black spots on top of head, along back, and on dorsal and caudal fins; other fins, plain pale yellow; under parts silvery; opercles purplish; small red lines on lower part of throat, the beginning of the red gash characteristic of the species.

I have given thus fully color notes on so many individuals and from streams tributary both to the Columbia and the Missouri, to make plain the little importance of color distinctions and the futility of attempting to find even varietal differences among the trout of the Columbia and Upper Missouri river basins.

14. *Salvelinus malma* (Walbaum). (Pl. xxv.).

Salmo malma Walbaum, *Artedi Pisc.*, 66, 1792.

This is the salmon trout or bull trout of western Montana. We obtained six specimens, $6\frac{1}{2}$ to 10 inches long, from Rattlesnake Creek, at Missoula, and from information gained from local fishermen we have no doubt that it is common in most of the larger affluents of the Columbia in Montana, particularly in the Hell Gate, Missoula, Pend d'Oreille, Flathead, Bitter Root, and Big Blackfoot rivers and in Flathead and

Swan lakes. This extends its known range considerably eastward. The following table gives measurements of six specimens from Rattlesnake Creek:

No.	Length in inches.	Head in length.	Depth in length.	Eye in head.	Maxillary in head.	Interorbital space in head.	Snout in head.	Pectoral fin in head.	Ventral fin in head.	Anal fin in head.	Longest dorsal ray in head.
53	10	3 $\frac{1}{2}$	4 $\frac{1}{2}$	5 $\frac{1}{2}$	2	3 $\frac{1}{2}$	3 $\frac{1}{2}$	1 $\frac{1}{2}$	2	1 $\frac{1}{2}$	1 $\frac{1}{2}$
54	7 $\frac{1}{2}$	3 $\frac{1}{2}$	4 $\frac{1}{2}$	5+	2	3 $\frac{1}{2}$	4	1 $\frac{1}{2}$	2 $\frac{1}{2}$	1 $\frac{1}{2}$	1 $\frac{1}{2}$
55	7 $\frac{1}{2}$	3 $\frac{1}{2}$	4 $\frac{1}{2}$	5+	2	3 $\frac{1}{2}$	4+	1 $\frac{1}{2}$	2 $\frac{1}{2}$	2	1 $\frac{1}{2}$
56	6 $\frac{1}{2}$	3 $\frac{1}{2}$	4 $\frac{1}{2}$	5	2	4	4 $\frac{1}{2}$	1 $\frac{1}{2}$	2 $\frac{1}{2}$	2	1 $\frac{1}{2}$
57	7 $\frac{1}{2}$	3 $\frac{1}{2}$	4 $\frac{1}{2}$	5	2	3 $\frac{1}{2}$	4	1 $\frac{1}{2}$	2 $\frac{1}{2}$	2	1 $\frac{1}{2}$
58	7 $\frac{1}{2}$	3 $\frac{1}{2}$	4 $\frac{1}{2}$	5	2	3 $\frac{1}{2}$	4	1 $\frac{1}{2}$	2 $\frac{1}{2}$	1 $\frac{1}{2}$	1 $\frac{1}{2}$

Color, in alcohol, of No. 53, which is not unlike the others: Dark gray, darkest on head and body in front of dorsal fin, becoming lighter below; yellowish white on belly; sides with about three longitudinal rows of orange or reddish spots, each about $\frac{1}{2}$ of an inch in diameter; these rows are irregular, but in general it may be said that the upper row lies along the middle of the space between the dorsal fin and the lateral line, the second one along the lateral line, and the third about midway between the lateral line and the level of the origin of the pectoral fin: there are a few other spots that do not lie evidently in any of these lines; those on upper part of body smaller than those below. Besides the orange spots, the body is well covered with numerous dark punctulations, especially abundant on sides of head, fins, and lower parts of body; median line of belly, plain yellowish white; branchiostegals and lower jaw with some punctulations; upper parts of pectorals and ventrals darker than lower. Comparing these with specimens of same size from McCloud River shows the Rattlesnake Creek specimens to be much more slender (those from McCloud River having the depth $3\frac{1}{2}$ to $4\frac{1}{2}$ in length), the eye a little larger and the color darker.

Specimens of "salmon trout" weighing 12 and 14 pounds have been taken from the Bitter Root River, near Missoula.

15. *Cottus bairdi punctulatus* (Gill). (Pl. xxii.)

Potamocottus punctulatus Gill, Proc. Bost. Soc. Nat. Hist. 1861, 40 (Bridger Pass).

Cottus bairdi punctulatus, Jordan, Bull. U. S. Fish Com., ix, for 1889, 29, 1891.

Numerous specimens of the blob, or "bullhead," as it is known in Montana where known at all, were obtained from the following localities:

a. Beaverhead River, Dillon, Montana.....	76	j. Cottonwood Creek, Deer Lodge, Montana.....	32
b. Red Rock River near Red Rock, Montana.....	20	k. Little Blackfoot River, Elliston, Montana.....	57
c. Cañon Creek, Yellowstone National Park.....	9	l. Rattlesnake Creek, Missoula, Montana.....	11
d. Junction of Firehole and Gibbon Rivers.....	19	m. Lolo Creek near Missoula, Montana.....	13
e. Pacific Creek in Two-Ocean Pass.....	4	n. Jocko River, Ravalli, Montana.....	7
f. Pacific Creek 25 miles below the Pass ..	5	o. Swan River at outlet of Swan Lake, Montana.....	15
g. Small Creek at head of Jackson Lake..	21		
h. Snake River, President Camp, Wyoming	2		
i. Browns Gulch Creek, Silver Bow, Montana.....	2		

It was also seen in Horsethief Springs and in Gardiner River below the falls.

The specimens from Red Rock and Dillon are very large, measuring from 3 to $4\frac{1}{2}$ inches in length, while those from the head of Jackson Lake are all very small, as are most of those from Pacific Creek.

In numerous specimens examined the head is a little shorter than indicated by Dr. Gill's description, it being $3\frac{1}{2}$ instead of 3 in body to base of caudal. There are also other slight differences; the dorsal is VI or VII-17 or 18, and the anal 12 or 13. The length of the head is just about equal to its width measured at the preopercular spines; the pectoral fins $1\frac{1}{2}$ in head, the rays extending markedly beyond the inter-radial membrane. In most specimens the black spots are evident, but some seem to be almost or entirely without them; a dark blotch at base of caudal, and three or four on the side are very plain in some individuals. One of the specimens, $2\frac{1}{4}$ inches long, from Rattlesnake Creek, is greatly distended with nearly ripe eggs, which gives us some idea as to their time of spawning in that region. Some of the specimens from this place, and others from the outlet of Swan Lake, have the visceral cavity completely filled by a parasitic worm more than an inch in length, in blobs that are not over 2 inches long. Some of these parasites were sent for identification to Prof. Linton, who says:

The parasite in the abdominal cavity of the fish is *Schistocephalus dimorphus* Crellin. It is immature. Like *Dibothrium cordiceps* Leidy, of the trout, it attains the adult stage in the intestine of fish-eating birds. This, so far as I know, is the first find of this worm in America. In Europe it has been found most commonly in *Gasterosteus*.

16. *Lota lota maculosa* (Le Sueur). (Pl. XXIV.)

Gadus maculosus Le Sueur, Jour. Acad. Nat. Sci. Phila., 1, 83, 1817.

A single specimen of the ling was taken in the Red Rock River, and it is said by Mr. Scott, of Red Rock, to be common in Red Rock Lake, in which the river has its origin. While this is a very widely distributed fish, it has not been previously reported from any point near the headwaters of the Missouri. Head, $4\frac{1}{2}$; depth, $6\frac{1}{2}$; eye, $6\frac{1}{2}$; snout, 4. The maxillary reaches the posterior edge of the pupil; the barbel is a little longer than the eye; pectorals $1\frac{3}{4}$ in head, and about equal to the ventrals.

Specimens of the following species, introduced into the waters of the Yellowstone National Park by the U. S. Fish Commission in 1889 and 1890, were taken and are now in the collection:

17. *Salmo irideus* Ayres. Rainbow trout. (Pl. XXIII.)

Two specimens from Gibbon River above Gibbon Falls.

18. *Salmo trutta levenensis* Walker. Loch Leven trout. (Pl. XXIV.)

One specimen from mouth of Heron Creek, Shoshone Lake.

19. *Salmo fario* Will. Von Behr trout; Brown trout. (Pl. XXIII.)

One yearling specimen from Firehole River, above Old Faithful Geyser.

20. *Salvelinus fontinalis* Mitchill. Eastern brook trout. (Pl. XXV.)

One specimen 12 inches long from Indian Creek, near its mouth.

RESULTS OF STOCKING THE WATERS OF YELLOWSTONE NATIONAL PARK WITH FISH.

In 1889 and 1890 yearling fish were placed by the U. S. Fish Commission in the waters of the Yellowstone National Park, as follows:

Date.	Place.	Kind of fish.	Number.
Sept. 22, 1889	Gardiner River.....	Brook trout.....	4,975
Sept. 15, 1890	West Fork of Gardiner River.....	do.....	7,875
Sept. 22, 1889	Gibbon River.....	Rainbow trout.....	990
Do.....	Firehole River.....	Loch Leven trout.....	995
Sept. 2, 1890	Lewis Lake.....	do.....	3,350
Do.....	Shoshone Lake.....	do.....	3,350
Sept. 22, 1889	East Fork Gardiner River.....	Mountain trout.....	968
Aug. 9, 1890	Shoshone Lake.....	Lake trout.....	18,000
Aug. 23, 1890	do.....	do.....	7,262
Do.....	Lewis Lake.....	do.....	7,263
Sept. 2, 1890	do.....	do.....	4,750
Do.....	Shoshone Lake.....	do.....	4,750
Sept. 15, 1890	Nez Percé Creek.....	Von Behr trout.....	9,300
Oct. 3, 1889	Twin Lakes.....	Native whitefish.....	2,000
Oct. 15, 1889	Yellowstone River.....	do.....	980
Aug. 15, 1890	do.....	do.....	5,000
Sept. 11, 1890	do.....	do.....	5,000

Excepting the Yellowstone and Gibbon rivers, and possibly the East Fork of the Gardiner, there were no fish whatever in any of these streams or lakes, the falls that are found in each having apparently proved effective barriers in preventing fishes from ever reaching the waters above. The only species known from the Upper Gibbon River is the little blob or miller's thumb, while the native mountain trout was well known to be abundant in the Yellowstone River, above the falls as well as below. Each of these bodies of water is practically so isolated from the others that fish can not pass from one to another. The Commissioner, therefore, planted a different species in each basin, except in Lewis and Shoshone lakes, where two species were placed. This will greatly simplify any observations that it may be desired to make upon them at any time.

One of the principal purposes of our visit to the Park was, as directed by the Commissioner, "to make such examinations as are possible with a view to determining what success has attended the plantings of fish already made in that reservation." I visited the different places where the plants were made, and am able to report that, as a whole, the work of the Commission in that region has proved very successful. At least five of the seven species planted are doing well, and we have no reason to think that a sixth species (lake trout) is not also doing equally well. We obtained specimens of brook, Loch Leven, rainbow, and black-spotted native trout, and learned that the Von Behr trout, which was put in Nez Percé Creek, have been seen at different times this year by several persons.

At least the brook and Loch Leven trout, which were planted in 1889, spawned in 1890, as we found young of these species that could not be over a year old. All of the specimens we took were in excellent condition, thus showing that the waters are suitable and the food supply abundant.

It is doubtful if any of the whitefish that were transplanted from Horsethief Springs to Twin Lakes and Yellowstone River have survived. Each of these places was examined, and we made careful inquiry of persons who had opportunities for

knowing, whether they had seen any whitefish in Yellowstone River, but none had been seen and no one believes any are there. Every one inquired of is of the opinion that the whitefish fell a ready prey to the voracious native trout which abound in that stream. Their failure to thrive in Twin Lakes is probably due to the mineral character and high temperature of the water.

Upon the whole, the Commission is certainly to be congratulated upon the high degree of success which has attended its efforts toward supplying valuable food-fish to these hitherto barren waters.

Following is the detailed account of our investigations:

Gardiner River.—This stream was stocked September 22, 1889, with 4,975 young brook trout. Our examinations were made on Indian Creek, at and above the mouth of Obsidian Creek, and along Obsidian Creek in Willow Park. We saw at least five trout near the mouth of Indian Creek, one of which was caught. This one was a foot in length, and the others seen were estimated to be at least 9 inches long. These streams were so rocky and the current so swift that it was not possible to use the seine to any advantage. In Winter Creek we saw two small trout, each perhaps 6 inches long or less. From these facts it is evident that the brook trout is thriving in these streams (all branches of the Gardiner River) and that the fish planted in 1889 spawned in 1890, the small specimens seen being yearlings. I should add that the large specimen caught was full of spawn.

Gibbon River.—This stream was stocked with 990 rainbow trout September 22, 1889, the plant being made just above Virginia Cascade. We examined the stream for some distance both above and below the cascade. One trout (a male, $10\frac{1}{4}$ inches long) was taken about one-eighth of a mile above where the plant was made, and another male of the same size was taken about the same distance below the cascade. Four others of apparently the same size were seen above the cascade, and at least five others, equally large, below it. Owing to the nature of the stream, all of our fishing here had to be done with the fly. Other persons familiar with Gibbon River report seeing fish in it this year.

Firehole River.—A plant of 995 Loch Leven trout was made September 22, 1889, in this stream above Keppler Cascade. We seined the river below the cascade, near Old Faithful Geyser, and caught one example, $3\frac{1}{2}$ inches long. We also fished with the fly for some distance along the stream above the cascade, and, though no specimens were secured, the two small trout (not over 4 inches long) which rose to the fly are sufficient evidence that this plant has also proved successful. The fish of the plant certainly spawned last year, as the one specimen secured, as well as the others seen, are yearlings.

Nez Percé Creek.—On September 15, 1890, 9,300 Von Behr trout were placed in this creek. We examined the stream just above the "Soldiers' Camp" near the Fountain Hotel, but were unable to find any fish. Lieut. Pitcher, who was stationed here, assures us, however, that fish have been seen in the stream this year. On October 9, of this year, Mr. Elwood Hofer saw trout in this creek.

Shoshone and Lewis Lakes.—In August and September, 1890, there were placed in these lakes 6,700 Loch Leven and 42,025 lake trout. In the mouth of Heron Creek, at the north end of Shoshone Lake, I saw a great many young trout, apparently 5 to 6 inches long. In one bunch there were at least 50. One specimen was caught which proved to be a Loch Leven trout, $5\frac{1}{2}$ inches long. We were not certain that we saw

any fish in the lake, but on October 7 Mr. Hofer was passing along the east shore of Shoshone Lake and reports seeing several trout rise to the surface out about 75 yards from the shore. He also reports seeing trout at a beaver dam in Heron Creek about $1\frac{1}{2}$ miles from the lake. Whether any of these were lake trout could not be certainly determined, but the probabilities are that those seen in the lake were lake trout, while those in the creek were Loch Leven trout. Finding them so numerous in the creek would seem to be very satisfactory and positive evidence of the success of this important planting.

East Fork of Gardiner River.—This stream was stocked September 22, 1889, with 968 native trout gotten by Mr. Lucas from Howard Creek. We made a somewhat hurried examination just above Undine Falls and caught one trout, $6\frac{1}{2}$ inches long. There seems to be a question as to whether this stream did not already contain trout before this plant was made. The nature of the divide between this stream and Blacktail Deer Creek, in which there are no falls, makes it quite possible for trout to get over from Blacktail Deer Creek, which is well supplied with trout. This, of course, makes it impossible to say whether the trout taken by us is of the plant or not.

NOTES ON MAMMALS NOTICED IN MONTANA AND WYOMING.

Though no special attention was given to the mammals found in the region traversed by us, no specimens collected, and no special attempt made to list the species of the region, yet numerous notes were made upon some of the species observed. Such of these notes as seem to be of value are given here.

1. *Arctomys* sp.?

Ground hogs were seen in several places south of the Yellowstone National Park. On Pacific Creek, not far below Two-Ocean Pass, we saw a pair of old ones and four or five half-grown young, one of which our dog killed. Dr. Merriam informs me that the marmot found there is probably *Arctomys dakota*.

2. *Tamias* sp.?

Chipmunks were frequently seen about Flathead Lake, on Dempsey Creek, at Missoula, and perhaps other places. Two different species were probably seen.

3. *Sciurus richardsoni* Bachman?

A squirrel, likely this species, was abundant at Swan and Flathead lakes, Missoula, and the National Park.

4. *Castor canadensis* Kuhl.

Fresh signs of beaver were seen at Beaver Lake, Willow Park, and on Lewis River just below the Upper Falls; also near the mouth of Beaverdam Creek.

5. *Lagomys princeps* Rich. Rocky Mountain pika.

Several were seen near Obsidian Cliff in National Park; and four or five others were noticed in a rocky slide on the divide between Shoshone Lake and the Firehole River.

6. *Cervus canadensis* Erxleben.

A drove of sixteen elk was seen on Pacific Creek below Two-Ocean Pass. Several young elk were seen at Horsethief Springs. They had been captured in the mountains near by and were being raised by hand by Mr. Marshall. This man does quite a thriving business rearing elk and deer in this way and selling them to owners of private parks in the East.

7. *Cariacus macrotis* (Say). Blacktail deer.

Seen on Swan River (one doe, one fawn, and one old buck). The old buck when first seen was standing in the road just ahead of us. As we drove toward him he made a few bounds and stopped behind the top of a fallen pine tree not over 40 feet from the road, and there he remained while we drove by and on down the road. Two others were seen within a few rods of the hotel at the Mammoth Hot Springs. Others were seen at various places about the Park.

8. *Antilocapra americana* Ord. Antelope.

Several were seen on Pacific Creek, between Jackson Lake and Two-Ocean Pass.

9. *Ovis canadensis* Shaw. Mountain sheep.

A skull was found near our camp on Dempsey Creek near Mount Powell.

10. *Bison bison* (L.). Buffalo.

None were seen in the Park, but it was reported, August 23, that a herd had been seen about that time on the east side of Yellowstone Lake. Charles Allard, a half-breed, who runs the stage line from Ravalli to Flathead Lake, has a herd of about 70 on his ranch on the Flathead Reservation. We were told that he was very successful in crossing them with domestic cattle.

11. *Canas latrans* Say. Coyote.

Heard at Silver Bow and Deer Lodge.

12. *Gulo luscus* (L.). Wolverine.

August 21, I saw one on the east shore of Yellowstone Lake near Steamboat Point.

13. *Mephitis* sp.?

President Camp, on Snake River; also near Polecat Creek.

14. *Taxidea americana* (Bodd.). Badger.

One seen near Steamboat Point, August 21.

15. *Ursus americanus* Pallas. Black bear.

One seen one evening at the Lake Hotel. He had come up to feed at the swill barrel. Another seen on Lewis River below Upper Falls. Fresh bear tracks were also seen on Big Blackfoot River, above Bonner.

16. *Erethizon epixanthus* Brandt. Porcupine.

One dead one seen on east side of Yellowstone Lake. At various places in the Park, and especially in the heavy pine forests south of the Park, about Shoshone, Lewis, and Yellowstone lakes, a great many pine trees were seen from which great patches of bark had been eaten away. These barkless areas frequently, perhaps usually, encircled the tree and were at various heights above the ground, from only a few inches to 25 to 35 feet; generally, however, the height was 8 to 15 feet. Mr. Hofer and the other men of our party say that this is the work of porcupines and that the place indicates the depth of the snow.

ANNOTATED LIST OF REPTILES AND BATRACHIANS COLLECTED.

[By Frederick C. Test, Aid, Department of Reptiles, U. S. National Museum.]

The collecting of Reptiles and Batrachians was merely an incidental feature of the work of the party. No time was devoted to searching for specimens of these groups, and those found in the collection are such as the members of the party chanced to see while carrying on the main work of the expedition. Only a short time was spent at each locality and only the most common forms were found. The Batrachians greatly predominate, and the series of *Rana pretiosa* is an especially good one.

I wish here to express my thanks to Dr. Leonhard Stejneger for aid and suggestions in preparing these notes.

1. *Eutænia sirtalis parietalis* Cope.

Two typical adult specimens of this species were collected.

Museum No.	Collector's No.	Locality.	Date.
17566	8	Swan River, near Swan Lake, Montana.....	Aug. 3
17567	9	do	Do.

2. *Eutænia vagrans* B. and G.

Of this species there are five specimens of varying ages and sizes.

Museum No.	Collector's No.	Locality.	Date.
17565	7	Swan River, near Swan Lake, Montana.....	Aug. 3
17568	10	do	Do.
17569	74	McClellan Creek, near Helena, Montana.....	July 20
17570	75	do	Do.
17571	76	do	Do.

3. *Ambystoma tigrinum* Green.

Of this widely spread and usually abundant species, only four specimens were found, all larvæ.

Museum No.	Collector's No.	Locality.	Date.
17583	6	Jocko River, Ravalli, Montana	July 31

4. *Bufo halophilus* Baird.

Three typical specimens.

Museum No.	Collector's No.	Locality.	Date.
17634	15	Lewis Falls, Wyoming	Aug. 12
17635	16	do	Do.
17636	66	President Camp, Wyoming.....	Aug. 13

5. *Rana pipiens brachycephala* Cope.

The two specimens collected have some of the proportions of *R. pipiens pipiens*, the head being considerably less than 3 in the length instead of $3\frac{1}{2}$, as it is said to be

in *brachycephala*, but they have been referred to the latter on account of the absence of a well-defined dark bar on the front of the femur, a color feature more or less characteristic of Western specimens.

Museum No.	Collector's No.	Locality.	Date.
17572	80	Beaverhead River, Dillon, Montana	July 27
17573	.....	Swan River, near Swan Lake, Montana.....	Aug. 3

6. *Rana pretiosa* B. & G.

Of the fifty-six specimens all but five are from streams that empty into the Pacific. These five, Nos. 17574 to 17578, are from the junction of Firehole and Gibbon rivers, the headwaters of the Madison Fork of the Missouri. This fact is particularly interesting, inasmuch as I have been able to find but three other records of this species occurring in streams flowing to the east. One of these is noted by Prof. E. D. Cope, who found it in Prickly Pear Cañon, just north of Helena, Montana. (Am. Nat., 1879, p. 435.) Another is a single specimen, U. S. National Museum, No. 11503, collected at Fort Ellis, Montana, by W. B. Pratt; and the third record consists of two specimens, U. S. National Museum, Nos. 11937 and 11939, collected by C. Hart Merriam at "Upper Firehole Basin, Yellowstone Park." In the list of specimens of *Rana pretiosa* belonging to the U. S. National Museum (see Cope's *Batrachia* of North America, p. 434) there are apparently two more records of this species occurring east of the Rocky Mountains, but both are due to misidentification, No. 3437, from the Red River of the North, R. Kennicott, being *R. septentrionalis*, and No. 4824, St. Catharine, Canada, D. W. Beadle, *R. sylvatica*. It may possibly be owing in part to insufficient exploration that there are so few instances of this frog being found east of the Great Divide.

In looking over this series, a very noticeable point is the lightening in color as the frog increases in age and size. The young is very dusky, the moss-agate-like dark dorsal spots being barely apparent, but as it grows the ground color pales, and while some of the black markings thus become more prominent, others fade entirely away. The largest specimen collected, No. 17603, a female from Deer Lodge River, Montana, is also the lightest colored. The ground color is very pale, rendering more conspicuous the few black dorsal blotches. The inferior dark markings are absent, and the usual bars on the legs are broken up into several small spots. There is indication of a light median line on the back posteriorly. No. 17604, a smaller female from the same locality, is much darker, with all the usual markings, and the dorsal blotches more numerous.

Four or five small specimens from Cottonwood Creek, Deer Lodge, Montana, show the darkest phase of the young very well, particularly No. 17593, a female, which has the black marbling of the throat finely marked, and all the spots on the sides and lower surface unusually distinct, while the upper ground color is so dark that the blotches on the back are hard to distinguish. No. 17591, a very slightly larger male, is almost as well marked. These differences in color are plainly not due to local causes, since dark and light come from the same locality; nor to sex, for dissection shows that the sexes are irregularly distributed among the varying shades of color.

There are a few exceptions to the general rule, notably No. 17572, a small male, which should be dark, but is quite light, and No. 17606, a rather large female, which is considerably darker than it ought to be.

Museum No.	Collector's No.	Locality.	Date.
17574	71	Junction of Firehole and Gibbon rivers, Montana.....	Aug. 9
17575	72	do.....	Do.
17576	73	do.....	Do.
17577-8	.....	.....do.....	Do.
17579	68	Lolo Creek, Missoula, Montana.....	July 30
17580	69	Big Blackfoot River, above Bonner, Montana.....	July 29
17581	70	do.....	Do.
17582	67	Ravalli, Montana.....	July 31
17587-8	.....	Little Blackfoot River, near Elliston, Montana.....	July 21
17589-602	.....	Cottonwood Creek, Deer Lodge, Montana.....	July 22
17603-4	.....	Deer Lodge River, Montana.....	Do.
17605-16	.....	Browns Gulch, Silver Bow, Montana.....	July 27
17617-24	.....	Cañon Creek, National Park, Wyoming.....	Aug. 8
17625	14	Foot of Shoshone Lake, Wyoming.....	Aug. 12
17626-7	.....	Crawfish Creek, at Moose Falls, National Park, Wyoming..	Aug. 13
17628	26	Jackson Lake, Wyoming.....	Aug. 14
17629	44	Two-Ocean Pass, Wyoming.....	Aug. 17
17630	45	do.....	Do.
17631	46	do.....	Do.
17632	48	do.....	Do.
17633	49	do.....	Do.

PRESERVATION OF FORESTS IN AND ABOUT YELLOWSTONE PARK.

According to Dr. Hayden, the Yellowstone Park region has a climate differing in many respects from that of other parts of the Rocky Mountain region. It has a very moist atmosphere, the rainfall is greater, its mean annual temperature is lower, and it is better clothed with vegetation. This region and the adjacent portions of Idaho and Wyoming constitute the most heavily timbered area in the West, excepting parts of Oregon and Washington west of the Cascade Range. The climate is, as regards temperature, subarctic. The winter begins with September and ends only in June, and frosts occur every month in the year.

On the morning of August 8, at our camp on Beaver Lake, the thermometer stood at 29° at 8 o'clock. At Two-Ocean Pass the temperature was 33° at 6:30 a. m., August 18, and nearly every night, during the time of our stay in and about the Park, the temperature was down to freezing.

According to Mr. Hague, "few regions in the Rocky Mountains are so highly favored as regards snow and rain fall. Snow falls early in October and rarely disappears before June, and throughout the winter is said to lie 6 feet in depth over the plateau and higher regions of the Park. On the evening of October 9 a storm began and continued without abatement for thirty-six hours, the snowfall measuring 36 inches. The Park is peculiarly well adapted for holding broad sheets of water. In consequence, we find here such bodies of water as the Yellowstone, Shoshone, Heart, and Lewis lakes, besides innumerable smaller ones. These lakes are the natural reservoirs for storing up the water supply. The Yellowstone Lake alone has an area of 150 [139] square miles," and the others no doubt double this area. From these numerous lakes the water is gradually fed out to the upper tributaries of the Missouri and the Columbia during the season of little rain.

Mr. Hague further says:

Forests cover the hills to the water's edge. The timber retains the snow late in the season, while it slowly melts away and fills the springs and lakes. If the forests are removed the snow will rapidly disappear under the direct rays of the sun by evaporation, and it will be largely carried off by the dry west winds which prevail. There would be enormous freshets in the spring, followed by a long parched season, the lakes and springs diminishing rapidly.

In another place Mr. Hague, who has given much attention to this important question, says:

I know of no tract in the Rocky Mountains where the necessity for the conservation of the forests appears so urgent, or the direct advantage to be gained so immediate, as right here on the Park Plateau at the headwaters of the Yellowstone and the Snake rivers. If the broad valley of the Yellowstone is ever to support any considerable population the forests and streams from these elevated regions must be protected. The Yellowstone Valley can stand no diminution in the water supply which it now receives.

The importance of this matter cannot be overestimated, and it is very gratifying to know that, under authority of an act of Congress of March 3, 1891, the President has already, by proclamation, set apart and reserved from settlement a wide strip of land lying south and east of the Yellowstone Park. This important addition to the Park comprises the greater part of the densely timbered region already mentioned.

RECOMMENDATIONS.

Among the many falls in and about the Yellowstone National Park, there are several in which the placing of fishways should receive consideration. Virginia Cascade and Gibbon Falls in Gibbon River, Keppler Cascade in Firehole River, and the upper and lower falls of Lewis River are of this number. All of these rivers, both above and below the falls which they contain, are ideal trout streams. Below each of the lower falls there is an abundance of excellent food-fishes—trout in the Lewis, and trout, grayling, and whitefish in the Gibbon—while above these falls there are no fish whatever, except those planted by the Commission in 1889 and 1890.

It would be comparatively an easy matter to construct a fishway at each of these falls which would enable the valuable native species to ascend to the upper courses of these streams and to the cold lakes in which most of them rise.

When sufficient time has elapsed to enable the various species of trout planted by the Commission in these waters to become thoroughly established, the desirability of placing fishways in these streams should receive careful consideration.

In the country about Cooke City, east of the National Park, are several lakes similar to those in the Park, but smaller. Clarke Fork of the Yellowstone, about the headwaters of which these lakes lie, has in it considerable falls which fish can not pass. As a result, these lakes and upper tributaries are barren of fish, and their stocking with species of *Salmonidae* might be very properly undertaken by the Commission.

SHOSHONE LAKE, NORTH SHORE.

MOSS ENG. CO. N. Y.

YELLOWSTONE LAKE, MOUNT SHERIDAN.

HAYDEN VALLEY.

MUSSEY & CO. N.Y.

YELLOWSTONE RIVER: RAPIDS ABOVE THE UPPER FALLS.

UPPER FALLS OF THE YELLOWSTONE RIVER.

LOWER OR GREAT FALLS OF THE YELLOWSTONE RIVER.

GRAND CANYON, FROM THE BRINK.

Obsidian Cliff and Beaver Lake.

VIRGINIA CASCADE OF GIBBON RIVER.

GIBBON FALLS OF GIBBON RIVER.

LOWER FALLS OF FIREHOLE RIVER.

KEPPLER CASCADE OF FIREHOLE RIVER.

RAPIDS ON LEWIS FORK OF SNAKE RIVER.

1. *CATOSTOMUS DISCOBOLUS* Cope. Sucker. About four-fifths natural size.

2. *CATOSTOMUS MACROCHILUS* Grd. About one-half natural size.

3. *CATOSTOMUS ARDENS* J. and G. Red-horse Sucker. About one-half natural size.

1. RHINICHTHYS DULCIS Grd. Dace. About one and one-third times natural size.

2. MYLOCHEILUS CAURINUS (Rich.). Columbia Chub. About five-eighths natural size.

3. PTYCHOCHEILUS OREGONENSIS (Rich.). Sacramento Pike. About one-half natural size.

1. *LEUCISCUS HYDROPHLOX* (Cope). Chub. Natural size.

2. *LEUCISCUS GILLI*, sp. nov. Gill's Chub. Natural size.

3. *LEUCISCUS ATRARIUS* (Grd.). Utah Chub. Three-fourths natural size.

1. COREGONUS WILLIAMSONI Grd. Williamson's Whitefish. Adult. One-half natural size.

2. COREGONUS WILLIAMSONI. Young.

3. COREGONUS WILLIAMSONI. Head of breeding male. Natural size.

1. THYMALLUS SIGNIFER (Rich.). Grayling. Adult. One-half natural size.

2. THYMALLUS SIGNIFER. Young.

3. COTTUS BAIRDI PUNCTULATUS (Gill). Blob. Two-thirds natural size.

1. *SALMO IRIDEUS* Ayres. Rainbow Trout. Adult male. Three-tenths natural size.

2. *SALMO IRIDEUS*. Rainbow Trout. Young. Five eighths natural size.

3. *SALMO FARIO* Will. Von Behr Trout. One-half natural size.

1. *SALMO MYKISS* Walbaum. Red-throated Trout. Adult. One-half natural size.

2. *SALMO MYKISS*. Red-throated Trout. Young. Natural size.

3. *SALMO TRUTTA LEVENENSIS* Walker. Loch Leven Trout. One-half natural size.

1. *SALVELINUS MALMA* (Walbaum). Dolly Varden Trout. Two-fifths natural size.

2. *SALVELINUS FONTINALIS* (Mitchill). Brook Trout. Two-thirds natural size.

3. *LOTA LOTA MACULOSA* (Le Sueur). Burbot. Three-tenths natural size.

— NOTE —
Area without Trout enclosed by heavy line
Route of exploration by David S. Jordan in 1894
Places where Trout were taken

Route of exploration by Nathan W. Evermann in 1891
Camping places

NOTE
Topography North of lat 44° from
U.S. Geological Survey map, 1896

MAP OF
YELLOWSTONE NATIONAL PARK
TO ACCOMPANY A RECONNAISSANCE
OF THE
STREAMS AND LAKES OF WESTERN MONTANA
AND
NORTHWESTERN WYOMING
BY HARTIN WEVERMANN
1891

2.—A REPORT UPON INVESTIGATIONS MADE IN TEXAS IN 1891.

BY BARTON W. EVERMANN, PH. D.,
Assistant, U. S. Fish Commission.

[Plates XXVIII to XXXVI.]

This paper is a report upon the investigations made by the U. S. Fish Commission in the State of Texas in November and December, 1891, as contemplated in an act of Congress, approved March 3, 1891, providing "For investigating respecting the advisability of establishing a fish-hatchery station in the Rocky Mountain region in the State of Montana or Wyoming, and also in the Gulf States."

The character of the station which it is desired to establish in this region is indicated in the memorandum of instructions furnished me by Col. Marshall McDonald, the Commissioner of Fish and Fisheries, viz:

It is desirable, if practicable, to unite in one station the facilities for fish-cultural work with the salt-water species, for the pond culture of fresh-water species, for the investigation and development of methods for the propagation and rearing of the oyster, and for the investigation of the marine life of this coast. This means, of course, a laboratory of marine biological research, not large or expensive, but thoroughly equipped in all respects for its work. It is not necessary that all these requirements should be found at one locality, but they should be so closely and conveniently associated as to be brought under one direction. The requirements for each of the above classes of work may be briefly indicated as follows: For marine research and for hatching there will be required a suitable site above the chance of damage by storm or tide, with available supply of salt water. For the study of methods of oyster culture will be needed an area of 100 to 200 acres of low-lying marsh lands, on the coast line, easily convertible into storage and rearing ponds. If this lies on the banks of a landlocked bay, from which the salt water may be conducted by canals into the ponds and which is not subject to roiling by storms, this is of course desirable.

If the requisite conditions for such a composite station could not be found sufficiently closely associated, I was instructed to make investigations in the interior of the State looking toward the selection of a site suitable for the culture of fresh-water species alone.

The requirements for the culture of fresh-water species of fish for this region are, briefly:

1. A constant supply of about 1,000 gallons of pure water per minute.
2. Not less than 20 to 30 acres of land. This land should lie so that the water may be obtained from the source of supply by means of gravity if possible. The land should be of such a character as to render the construction of ponds upon it an easy matter, and the fall should be sufficient to permit the ready drainage of any one of the series of ponds whenever occasion requires. Furthermore, there should be no danger of contamination from freshets or other causes.
3. The location should afford good railroad facilities.

The determination of the abundance, condition, and definite range of each and every species of fish and the character and abundance of their food supply is a question not only of great scientific interest but one of the utmost economic importance in its bearing upon the intelligent and successful propagation of useful food-fishes. The physical, chemie, and biotic forces which go together to constitute the fish environment of any given stream must be clearly understood before that stream can be intelligently stocked with any additional species. These forces may be so adjusted as to render the introduction of the proposed species fatal to one or more kinds of valued food-fishes already found in the stream; or, on the other hand, the great abundance of some indigenous species of carnivorous fish might render it impossible for the species which it is proposed to introduce to ever become well established.

In carrying out my instructions visits were made to Galveston and Corpus Christi, on the coast, and Houston, Palestine, San Antonio, New Braunfels, San Marcos, Austin, and Fort Worth, in the interior. It is believed that the investigations at Galveston and Corpus Christi are sufficient to determine whether the coast affords any suitable location or not, and so many excellent locations for a fresh-water station were found in the interior as to render further explorations unnecessary.

On the whole, it may be said that no point on the coast examined offers entirely satisfactory conditions for the establishment of a combined fresh and salt water station, but the Swan Lake site, near Galveston, might prove fairly suitable.

It was intended to make a careful study of the Trinity River Basin, giving attention to the various streams in this drainage area; the nature and volume of the water of each; the general character of the vegetation, both in the streams and along the banks; the geologic features of the country: the character and abundance of the fish found in each stream, and the presence of crustacean and other life in the waters which may serve as food for fishes. While some work of this character was done on the Trinity River, inclement weather necessitated the deferment of its completion.

Temperatures were taken with a Wilder's standard thermometer and are given in Fahrenheit degrees. The seining was done with Baird collecting seines of small size, except at Galveston and Corpus Christi, where we availed ourselves of the services and larger nets of the local fishermen.

ACKNOWLEDGMENTS.

I desire to make mention of the many courtesies shown us by the citizens of the various places visited by us. At Galveston we were assisted greatly in our work by the kind and thoughtful attention of many of the most prominent citizens of that place, among whom I should mention especially Mr. Fred. McC. Nichols, Mr. F. L. Dana, the secretary of the board of trade, and Mr. Julius Runge, president of the Galveston Packing Company. Through the kindness and hospitality of Mr. Nichols, we were enabled to visit several of the artesian wells on the mainland and to make a careful exploration of Dickinson Bayou.

At Houston our party received many courtesies from Maj. M. Looscan, Maj. A. C. Herndon, and Mr. Geo. A. Bringham, all of the board of trade, and from Messrs. Robert E. C. and Harvey T. D. Wilson. Through the kindness of these gentlemen we were enabled to make very careful investigations in Harris County.

At San Antonio we were assisted in visiting the springs by Mr. Joseph Hettler,

park commissioner of that city. At Austin, Mayor John McDonald, Mr. J. B. Lubbock, ex-State fish commissioner, and other gentlemen extended us facilities which aided us materially in our investigations there. We are also indebted to Mr. John A. Grant, third vice-president and general manager of the Texas and Pacific Railroad, and to officials of the International and Great Northern Railroad, for various favors.

ITINERARY.

I left Washington, District of Columbia, October 25, and proceeded to Neosho, Missouri, where I was met by the Commissioner, Hon. Marshall McDonald, and Dr. J. T. Scovell, of Terre Haute, Indiana. After spending three days, acquainting ourselves with the workings of the Government fish-hatchery at Neosho, we proceeded to Galveston, Texas, where we arrived November 2. The Commissioner left for Washington on November 4, and on the same day we were joined by Dr. R. R. Gurley, of the U. S. Fish Commission. We remained at Galveston and vicinity until November 15, when we went to Houston. On November 16 and 17 we examined Buffalo Bayou at various places, and Big White Oak Bayou near the city. On the 18th we drove to Sims Bayou, and the next day we went by rail and wagon to Clear Lake, near Websterville. On November 22 we went to Palestine, and during the next three days examined Trinity River, Long Lake, and Neches River, in that vicinity. We were joined here by Mr. J. A. Singley, of the Texas State Geological Survey, he having been directed by the State geologist, Dr. E. T. Dumble, to accompany us for the purpose of studying the molluscan fauna of the State. On November 26 we went to Corpus Christi, where we remained until December 1, upon which date we went to San Antonio. Remaining one day at San Antonio, we next visited New Braunfels, San Marcos, and Austin, spending one day at each place. From Austin we went to Fort Worth on December 6, where we remained one day. Owing to the unusually cold and disagreeable weather it was thought advisable to close the work here.

WATERS EXAMINED.

The following is a classified list of the waters examined:

I. <i>Galveston Bay</i> : 1. Highland Bayou. 2. Dickinson Bayou. 3. Swan Lake. 4. Clear Lake and Creek. 5. Buffalo Bayou. (a) Sims Bayou. (b) Big White Oak Bayou. (c) Hunter Creek. (d) Kilper's Ponds. 6. San Jacinto River. 7. Trinity River. (a) Long Lake. II. <i>Neches River</i>.	III. <i>Corpus Christi Bay</i> : 1. Nueces River. IV. <i>San Antonio River</i> : 1. San Antonio Springs. 2. San Pedro Springs. V. <i>Guadalupe River</i> : 1. Comal Springs. 2. Comal Creek. 3. San Marcos Springs. 4. San Marcos River. 5. Rio Blanco. VI. <i>Colorado River</i> : 1. Barton Spring. 2. Barton Creek.

REPORT OF THE INVESTIGATIONS.

GALVESTON BAY.

Investigations were made at various places in the vicinity of Galveston for the purpose of determining whether the conditions necessary for the culture of fresh-water fishes, salt-water fishes, and oysters could be found combined in one place. This, of course, means a location on or near the bay where salt water can be gotten under control and where fresh water can also be obtained. With this object in view visits were made to Dickinson, Fairwood, Hitchcock, and Highland, all on the mainland across the West Bay from Galveston: to Swan Lake and Moses Lake, on the mainland northwest of Galveston; and to South Galveston on the island.

FRESH WATER.

The only possibility of obtaining fresh water at any of these places is by means of artesian wells. There are not fewer than sixteen artesian wells on the mainland in the vicinity of Dickinson, Highland, Hitchcock, and Fairwood. The deepest of these is 768 feet, and the most shallow about 80 feet.

One well at the Ramie experimental farm on the Nicholstone estate, having a 2-inch strainer, flows 40 gallons per minute. The temperature of the water is 78°.

Another well near Dickinson flows about 25 gallons per minute; temperature, 78°.

At Fairwood is a well 576 feet deep, with a 2-inch strainer, which flows not less than 52 gallons per minute. The temperature is 78.5°. No analysis of this water has been made, but it is palatable and seems approximately pure. There is some carbureted hydrogen and a trace of iron.

Judge Wheeler's well, near Hitchcock, is 768 feet deep, has a 2-inch strainer, and flows about 48 gallons per minute. The temperature is 78°.

The Tacquard well, near Hitchcock, is 710 feet deep, has a 2-inch strainer, and flows 100 gallons per minute. The temperature is 79°. The height to which the water will rise above the surface at this well was found to be about 20 feet.

The Gulf, Colorado and Santa Fé well at Hitchcock is 726 feet deep. It has a 5-inch strainer, 30 feet long, and flows 97,000 gallons per day, or 67 gallons per minute. An analysis made April 23, 1890, by W. D. Church, chemist for the Atchison, Topeka and Santa Fé Railroad, Topeka, gave the following results:

Organic matter.....	Trace.
Silica	.350
Alumina and oxide of iron	.250
Bicarbonate of calcium.....	3.499
Bicarbonate of magnesium.....	1.500
Bicarbonate of potassium and sodium.....	17.221
Sodium chloride.....	9.660
Total solids (grains) per United States gallon.....	32.480

The temperature at outlet of pipe was 79°; density, at 15° C., 1001.91.

The South Galveston well is 800 feet deep, and has a 3-inch pipe with a 2-inch strainer. It flows 37 gallons per minute, and the temperature of the water as it comes from the pipe is 79.5°. The density at this temperature was 1002, which, reduced to 15° C., gives 1004.24.

At Judge Wheeler's residence, near Hitchcock, a fish pond has been made which receives its water supply from the artesian well. Black bass and sunfish have been placed in this pond, where they seem to thrive very well. The water of the Wheeler well does not seem to differ materially from that of the other wells of this vicinity, and it is probable that such species of fresh-water fishes as would be cultivated at the station contemplated would do fairly well in ponds supplied from any of these wells.

I understand that water has been gotten in every place on the mainland where wells have been bored, so it is quite certain that water of this character could be obtained along the mainland in the vicinity of the bay. To obtain the requisite supply would probably require three or four wells sunk to a depth of over 700 feet, and each should have at least a 3-inch strainer.

SALT WATER.

Galveston Bay is shut off from the Gulf by Bolivar Peninsula and Galveston Island, between which is the Bolivar Channel. This channel is about 2 miles wide and is the entrance to the bay. The greatest length of the bay is from northeast to southwest, and is approximately 35 miles. The width between Bolivar Point and Swan Lake is about 7 miles. Above these points the bay widens out greatly, sending an arm known as East Bay to the eastward. Including East Bay, it is here not less than 27 miles wide. Above this it constricts again between Edwards and Smith Points, where it is less than 8 miles wide. Above Redfish Bar, lying between Edwards and Smith Points, is really the main part of the bay, the greatest width of which is about 14 miles, on a line running northwest from Smith Point to Morgan Point at San Jacinto Bay. Extending westward from the east end of Galveston Island, and separating it from the mainland, is West Bay. At the northeast end of the bay is a small bay known as Turtle Bay, shut off from the main bay by the delta of the Trinity River. At the northwest corner, lying above Morgan Point, is San Jacinto Bay, into which the San Jacinto River and Buffalo Bayou empty. About 10 miles down the west shore is the mouth of Clear Creek, the outlet of Clear Lake. Seven miles farther down is the mouth of Dickinson Bayou, just below which is Moses Lake; and 5 miles below this, or about 6 miles northwest from Galveston, is Swan Lake. Just north of Galveston, and between Swan Lake and Bolivar Point, are Pelican Spit and Pelican Island.

Through the greater part of the bay the depth of water is given as from 1 foot to 11 fathoms. According to the U. S. Coast Survey Chart (No. 204) of Galveston Bay—

There is usually one high and one low water here in each lunar day. The highest tides occur when the moon's declination is greatest, either north or south, and they are slightly increased when the greatest declination falls near the time of new or full moon. When the moon's declination is near zero, small tides usually appear twice a day for two or three days. The following table is made from average values:

Place.	Rise and fall of tides.		
	Mean.	At moon's greatest declination.	At moon's zero declination.
	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>
Galveston entrance	1.1	1.6	0.8
Pelican Spit	1.1	.....	.....
Redfish Bar	0.5	.....	.....

It is high water about seven or eight hours after the moon's meridian passage when the moon's declination is greatest south, and nearly twenty hours after when it is greatest north; but these intervals are uncertain by several hours. The effects of the winds are often greater than the real tides, and the time and the height of the apparent tides are greatly dependent on them.

The waters of Galveston Bay seem well adapted to the oyster. Oysters of good size and quality were seen about the wharves at Galveston, at Swan Lake, Moses Lake, Dickinson Bayou, Virginia Point, and other places.

The Galveston Packing Company was organized two or three years ago at Galveston for the purpose of developing the oyster industry at that place. This company has located 6,000 acres in the bay, principally in the vicinity of Pelican Island, of which they have planted 440 acres. Three thousand bushels of shells were planted upon one tract of 10 acres. Upon these shells a good set was obtained. These oysters were about eighteen months old at the time of our visit, and were very abundant and of excellent quality.

The density of the water here was 1021.66;* the temperature at surface, 72.5°, November 9, at noon.

Just off the outlet of Swan Lake the density was 1018.30; temperature at the surface at 10 a. m., November 10, 62°. Just inside of Swan Lake the density was 1017.30. Swan Lake is a shallow body of salt water, covering 600 or 700 acres. It has two outlets into the bay, one about 100 feet wide, the other about half as wide. Between these two narrow outlets is a low mud island which no doubt is flooded frequently at high tide. Oysters are quite abundant in this little lake, and we noticed two or three boats tonging oysters here. I paid special attention to this lake, as it seemed to present many of the conditions required for the station under consideration.

Swan Lake is quite shallow and, according to Mr. Parr, who lives upon the shore, is rapidly filling up. He says the lake is less than half as large as it was eighty years ago, when his father first settled upon it, and that it has decreased much in size during the last forty years, or within his own memory. The shores are, in the main, very low, particularly at the north end and on the east and southeast, where they are marshy. At the north end one or two small creeks flow into the lake, but I do not imagine the amount of water they carry in can be very great. At Mr. Parr's place, on the west side of the lake near the south end, the shore is several feet high, and apparently never subject to overflow. The greater part of the shore, however, is certainly flooded occasionally.

The low-lying land just north of Mr. Parr's, near the upper end of the west side of the lake, could be easily converted into ponds suitable for the study of methods of oyster-culture. Whether the water often becomes roiled I was not able to learn, nor do I know how injurious occasional flooding of the ponds would prove. Flood-gates could be constructed at the outlet of the lake by means of which the water coming in with the tide could be stored and fed out to the ponds between tides.

The tide is so little at this place that it could scarcely be depended upon for giving a gravity supply, consequently pumping would have to be resorted to. It is probable that water for the fresh-water ponds could be obtained by sinking artesian wells. These ponds could be constructed on the higher land near the south end of the lake.

*The density, as given in this report, is that of the water reduced to 15° C.

This location is about 3 miles from the railroad station at Virginia Point. It would seem to me that such a composite station as is contemplated could, with reasonable safety, be established in the vicinity of Swan Lake. The cost of getting sufficient water, salt and fresh, the doubt as to whether the artesian water would prove satisfactory, and the danger of flooding and roiling from storms, are questions that would have to be carefully considered.

The country in the vicinity of Moses Lake, Clear Creek, and Highland Bayou was also examined, but in no one of these places could the desired conditions be found, the danger of fresh-water flooding in each case being too great.

A visit was also made to South Galveston, on the island 10 miles southwest from the city of Galveston. At this point the South Galveston Land Company has recently struck water that seems fairly fresh. The depth of the well is 800 feet. With a 2-inch strainer the flow is 37 gallons per minute. The temperature of the water was 79.5°, and the density was 1004.24.

There is but little, if any, saline taste to the water, and it might prove suited to fresh-water fishes. There is considerable gas (probably CH_4) dissolved in this water, as was evidenced by the fact that a slight explosion was obtained upon applying a burning match at the end of the horizontal pipe through which the water was led from the well. Upon issuing from the pipe the water is quite murky, but very soon clears by the escaping of the contained gas or gases.

On the West Bay side of the island, a short distance from this well, are two narrow bays extending obliquely into the island. Each of these contains approximately 40 acres. The land adjacent to each is low, but probably high enough to prevent flooding, except during very heavy storms. Either of these small bays could be quite easily supplied with gates at the mouth and its water thus brought under control. Ponds could be constructed near them that would probably answer fairly well for oyster culture. Higher ground can be found near by, suitable for the fresh-water ponds. Mr. Gray, the president of the South Galveston Land Company, says the company will give the Commission one of these bays and all the land it may need. This location does not seem as desirable, however, as the one at Swan Lake—the land not lying so satisfactorily and the water being less fresh than that which could probably be gotten at Swan Lake.

Mr. Fred Nichols offers a site near the mouth of Dickinson Bayou. The land there seems safe from overflow, and salt water could be gotten by pumping from the bayou. It is quite certain, however, that this bayou at times becomes too fresh for salt-water culture. Fresh water could be secured here, as elsewhere upon the mainland, by means of artesian wells. Mr. Nichols would no doubt donate all the land needed.

Dickinson Bayou.—This bayou is about 18 miles long and empties into Galveston Bay about 15 miles north of Galveston. In its lower portion its waters are salt except at the time of heavy rains, and the water is more or less brackish nearly throughout the course of the stream. The depth probably ranges from 4 to 18 feet. The water is rather warm and is stained more or less by vegetable matter in the stream. The current is sluggish and the banks and bottom are of mud in most places. The shores are low and are well covered with vegetation. There is a heavy growth of timber, the principal trees being several species of oak, elm, hackberry, ash, box elder, etc. The most characteristic and striking feature of the timber along Dickin-

son Bayou is the long moss (*Tillandsia usneoides*), which covers nearly every tree. In the immediate vicinity of Nicholstone the large oaks are magnificent with the long festoons of this interesting epiphyte. A number of small creeks or brooks flow into this bayou, but they are usually quite narrow and not deep. At the time of our visit they were nearly dry except here and there where were found pools 1 to 4 feet deep, filled with stagnant, bad-smelling water. These pools have muddy bottoms and are full of logs and snags.

In the lower part of the bayou are found many of the salt-water fishes of the bay together with oysters, shrimps, and many other salt or brackish water forms. In the upper portion were species of several genera of fresh-water fishes, such as *Micropterus*, *Lepomis*, *Ictiobus*, *Pimephales*, *Notemigonus*, and the like. In some places species of these fresh-water genera were found mixed with soles, *Gambusia*, and other Cyprinodonts.

This stream was examined at Nicholstone and for several miles both above and below that place.

Clear Creek is a stream very much like Dickinson Bayou. It rises in Harris County, south of Houston, and flows east to Galveston Bay about 7 miles above the mouth of Dickinson Bayou. Near its mouth it flows through Clear Lake, a small sheet of somewhat brackish water. Its banks are lined with a heavy growth of moss-covered oaks and other trees. Its fish life is essentially of the same character as that of Dickinson Bayou.

In Clear Lake, which is near the mouth of the creek, are found the various species of brackish-water fishes common to the region, and oysters are found in some parts of the lake.

Houston.—Considerable time was given to an examination of the waters about this city. It became readily apparent that the streams in the vicinity of Houston could not be depended upon for fresh water, as they are all more or less subject to sudden rises, when their waters become more or less muddy. The only stream we saw that is probably an exception to this is Hunter Creek west of Houston several miles. Excellent water, however, could be gotten by means of artesian wells, of which there is quite a number in and about Houston. One at the creosoting works is 670 feet deep. With a 6-inch pipe it flows about 100 gallons per minute. The temperature of the water at this well is 73°, and it is apparently fresh and suitable for fish. Another well, belonging to Mr. Jacob Kilper, in the western part of the city, was examined. Mr. Kilper has constructed a number of ponds here which are supplied chiefly from the artesian well. Carp that were placed in these ponds some years ago have done well. Eight or ten other species of fish have found their way into these ponds and seem to find the water satisfactory. Among these species are *Dorosoma cepedianum*, *Notemigonus chrysoleucus*, *Channobryttus gulosus*, *Lepomis pallidus*, and *Gambusia patruelis*.

About 3 miles southeast from Houston is a tract of land known as the Kownslar Place, lying on Buffalo Bayou, which would prove a very suitable site for the station should artesian water be considered satisfactory. This land lies about 25 feet above Buffalo Bayou and slopes very suitably for the purposes for which it would be used. The Texas Transportation Railroad runs within an eighth of a mile of this place, and an electric line will be built to it very soon. Should this land be deemed suited to our purposes I am assured by prominent citizens of Houston that it could be obtained on terms satisfactory to the Commission.

Buffalo Bayou.—This bayou heads in the western part of Harris County, flows eastward past the city of Houston, and empties into the northern part of Galveston Bay. In general, it may be said to be a rather narrow, sluggish stream, usually pretty deep, and navigable as far as Houston, to which place the effect of the tide extends. There is very little current, and the bottom is of mud full of snags. Throughout its entire course it flows through sand or clayey country, there being little or no hard rock anywhere. Indeed, wells sunk to a depth of 700 feet in this country do not strike any solid rock. The water is moderately clear and cool. The banks are well wooded, the principal kinds of trees being pine, cedar, oak, magnolia, elm, sycamore, etc. *Tillandsia usneoides* is not common here.

We fished Buffalo Bayou at Shepherd's dam, about $2\frac{1}{2}$ miles west of Houston or about 60 miles above its mouth. The stream at this place is about 20 feet wide and 3 feet deep. There are holes which are much deeper. The water was very low, as there had been no rains for some time. At times this stream is said to rise as much as 26 feet above low-water stage. We also fished at a point about 6 miles above Houston. Fish were quite abundant in this stream, both as to species and individuals. Such brackish-water genera as *Gambusia* and *Gerres* were found with such fresh-water forms as *Lepomis*, *Etheostoma*, *Aphredoderus*, and *Notropis*.

The temperature of the water at 11 a. m., November 17, was 61°; air, 49°; air at 8:30 a. m. was 45°.

Sims Bayou.—This is a small stream rising on the prairie southwest of Houston about 10 or 12 miles and flowing northeast to Buffalo Bayou, a few miles below Houston. The lower portion of the stream is lined on each side by a strip of timber, chiefly pine, while the upper part is through prairie land. This stream in dry weather becomes reduced to long, muddy pools. One of these which we examined was about 400 yards long, 10 to 40 feet wide, and 1 to $2\frac{1}{2}$ feet deep. During times of drought these pools supply drinking water to great numbers of cattle on the surrounding grazing lands, and as a result the banks and bottom are tramped and cut up and rendered very miry. The water is, of course, more or less foul. Its temperature at noon, November 18, was 58°, that of the air being 47°. At 6 o'clock in the morning the temperature of the air was 45°.

Fish were found to be quite abundant here, the most common species being the pirate perch, sunfish, war-mouth, and *Gambusia*. A few crawfish, turtles, frogs, and a small bivalve (*Sphaerium transversum* Say) were taken.

Big White Oak Bayou rises a few miles northwest of Houston and joins Buffalo Bayou at the town. It is a small creek which, at the time we saw it, was dried up into pools less than 10 feet wide and but a few inches deep. Oaks and other trees cover its banks. The bottom is muddy and full of snags. Not many species of fish were found here—minnows, suckers, and a few darters being the principal forms.

Hunter Creek is another small stream, a few miles in length, flowing into Buffalo Bayou from the north, about 8 or 9 miles west of Houston. This creek is very different from the other streams of this part of Texas, in that its water is exceedingly clear and rather cold. The temperature at 4 p. m., November 20, was 55°, the air being 70°. There is a good deal of limestone in the region through which it flows, and in this are numerous small springs whose uniting waters form the creek. The banks are usually rather high and steep, and are well wooded. The bed of the stream is 10 to 20 feet

wide, but the water is usually in pools 2 to 4 feet deep, connected by shallow reaches but a few inches in depth. Over these shallow reaches there is considerable current.

A good deal of *Chara* was seen in one large pool, and a few bunches of *Nuphar* were noticed. Logs and snags filled the stream. But few species of fish were found, the most abundant being *Notropis venustus* and *Micropterus salmoides*.

San Jacinto River.—This is a small river rising north of Houston and joining Buffalo Bayou at its mouth. In the mouths of these two streams and in San Jacinto Bay—the small arm of Galveston Bay into which they empty—are the chief fishing-grounds for the Houston market. Among the species from that locality seen in the market were buffalo, channel cat, fork-tailed cat, yellow cat, war-mouth, fresh-water drum, calico bass, big-mouthed black bass, yellow bass, and several species of sunfish. The amount of valuable food brought daily to Houston from this place is enormous. The number of pounds of the two species of *Ictalurus* greatly exceeds that of any other species.

Trinity River.—The Trinity is one of the most important rivers in Texas. It rises near the northern line of the State and flows in a very tortuous course for about 1,000 miles southeast to Galveston Bay, into the northern part of which it empties. The Indian name of this stream was Arkokisa, thought by some to be a corruption of Orquinsaco. La Salle called it the River of Canoes. We examined the Trinity River at Fort Worth, Dallas, Palestine, and Riverside. It is, through the greater part of its course, a rather sluggish stream, whose banks are moderately high and well wooded. We examined it most carefully in the vicinity of Magnolia Point, about 10 miles southwest of Palestine, November 23. At this place the stream was about 60 feet wide, 2 feet in average depth, and flowed with a 2-foot current. This indicates a discharge of about 14,400 cubic feet per minute. Both above and below Magnolia Point the current is less swift and the stream is deeper and wider. This is a very low stage of water, but during the spring rains, from March to May, the river rises very greatly, sometimes as much as 30 or 40 feet, thus rising above its rather high banks and flooding much of the adjacent land.

The shores are composed of sand and clay, with some ledges of sandstone and clay ironstone. This is especially the case on the left bank just below the ferry. In many places the shores are greatly eroded, forming numerous gullies or ravines coming down to the river. Generally the shores are covered with a pretty heavy growth of timber, willows of large size being most abundant. Besides these there are oaks, hickories, gums, and a few others. The bottom of the stream is muddy in some places, in others sandy or pebbly, and generally full of snags. The water is probably never very clear; its temperature at noon, when the air was 51°, was 53°.

The Trinity River is perhaps as good a fish stream as any of those of Texas flowing into the Gulf. We obtained no less than 30 species from it, the principal genera represented being *Leptops*, *Ameiurus*, *Noturus*, *Ictalurus*, *Ietiobus*, *Minytrema*, *Morostoma*, *Notemigonus*, *Hybognathus*, *Hybopsis*, *Notropis*, *Phenacobius*, *Cliola*, *Dorosoma*, *Zygionectes*, *Micropterus*, *Channobryttus*, *Pomoxis*, *Lepomis*, and *Etheostoma*.

Long Lake.—A few miles below Magnolia Point is Long Lake. This is evidently a portion of a former bed of the Trinity River. It lies near the river and is a little over a mile in length and 100 yards in average width. During the dry season it is 12 to 15 feet deep in the deepest places. Its shores are 6 to 10 feet above the surface of

the water and are well covered with a good growth of small timber, chiefly post oak, with some hickory, gum, and mulberry. The bottom is of sand in most places, the north shore being a sandy beach sloping gradually to deep water. This small lake is well supplied with valuable food-fishes, and is a favorite fishing-place for the people of Palestine. Large-mouthed black bass, crappie, gaspergon, war-month, sunfish, channel cat, and buffalo are all abundant here. Crawfish, shrimps, and a large mussel (*Anodonta corpulenta*) were quite common.

NECHES RIVER.

This stream rises in the northern part of the State, near Canton, and flows southeast to Sabine Bay, into which it empties. It is much the same kind of a river as the Trinity, except that it is smaller. We examined the Neches River in the vicinity of the Palestine and Rusk Railroad Bridge, about 14 miles east of Palestine. Recent rains had put the river up out of its banks and made it about 300 feet wide and perhaps 8 feet deep. At low water it is here probably less than 30 feet wide. There was not much current and the water was muddy. The temperature of the water was 49.5° when that of the air was 63°. The banks are not high, and are of red clay and sand, there being some sandstone and clay ironstone in places. The banks are well timbered, oaks, pines, gum, and button willows being the most abundant. Collections were made in the river and in small ponds and a small branch near by. The fish found are essentially the same species as found in the Trinity River. A good many fresh-water shrimps and several crawfish were taken.

CORPUS CHRISTI.

Four days were spent at this place, but, as there seems to be no possibility of obtaining fresh water here, we did not examine the bay thoroughly. Corpus Christi Bay, however, and Matagorda Bay above it, are among the best oyster grounds on the Texas coast. Near the town is an oyster reef 3 miles long, which is used as a wagon road across an arm of the bay. The oysters on this reef are very abundant and of good quality. The Givens Oyster Company, organized at Corpus Christi about two years ago, is building up a large business. They obtain most of their oysters from Matagorda Bay.

SAN ANTONIO RIVER.

This river has its origin in a number of very large springs about 3 miles north of the city of San Antonio, upon the beautiful grounds of Col. Brackenridge. These springs come out in several places, close together, from a ledge of Cretaceous limestone. The minimum flow from the entire group of springs has been estimated at 22,500 gallons per minute, and the maximum at as great as 180,000 gallons. The average flow for the year is probably not less than 90,000 gallons per minute. The flow varies a great deal, and is said to be greatest following heavy rains in the Devil River region, 200 miles or more in the interior. The temperature of the water in all the springs of the group is about the same, being about 75° at noon, December 2. The water is very clear and, like all limestone water, appears blue in the deep places. The water from all these springs soon unites to form San Antonio River, a swiftly flowing stream, 20 to 40 feet wide and 2 to 8 feet deep.

Many species of water plants were found in the stream, certain kinds being very abundant in places. Suitable fish food, such as insect larvæ and small mollusks and crustaceans, appeared to be abundant. Among the mollusks noticed are *Physa haley*, *Limnæa desidiosa*, *Planorbis lentus*, and *Planorbis liedmanni*. One dead shell of a species of *Unio*, probably *Unio undulatus*, was found.

These waters seem well adapted to the usual species of fish of southern Texas, no less than a dozen species being found, among them black bass, sunfish, suckers, catfish, and eels. Crawfish were abundant.

About the springs and along the stream flowing from them is a heavy growth of trees, including oaks, elm, and pecan, the oaks being densely covered with *Tillandsia usneoides* and another beautiful epiphyte, *Tillandsia recurvata* Pursh.

There is another group of springs just in the north part of the city; these are called San Pedro Springs, and they flow perhaps half as much water as the San Antonio group. The ground about these springs belongs to the city and constitutes San Pedro Park, one of the most attractive of the numerous parks of San Antonio. The stream from San Pedro Springs, like that from San Antonio Springs, flows through the city, and the two come together south of the city.

The city gets its water supply from San Antonio Springs. Just below the springs are two pump-houses, where the water is pumped by water power to a reservoir a short distance east. This reservoir is said to be 150 feet above the city. To the north and west of the reservoir the land has a gradual slope down to the level of the river and lies in such a way as to make it a very suitable place for ponds. The water can be supplied from the reservoir and the ponds could be easily drained.

Just above the main group of San Antonio Springs is a small stream known as Olmos Creek, which is formed by numerous springs coming out along its banks. I did not learn of this creek until after leaving San Antonio, and was therefore not able to give it an examination, but I am informed by Mr. R. H. Russell, who is interested in the land, that, in his judgment, the conditions on Olmos Creek are very favorable. The land and water rights could probably be had here upon satisfactory terms.

GUADALUPE RIVER.

This stream is of moderate size, rising in southern central Texas and flowing southeast, by New Braunfels, to San Antonio Bay. We examined the Guadalupe in the vicinity of the wagon and railroad bridges near New Braunfels. The stream here is, at low water, from 75 to 150 feet wide and from 1 to 3 feet deep. The current is very swift in most places. The bed is in many places the Cretaceous limestone of the region; other reaches have the bottom covered with gravel; in a few places, where the current is less swift, there is some mud, and various pieces of *Algae* and other water vegetation occur here.

Like most all the streams of this part of Texas the Guadalupe is fed chiefly by numerous springs issuing from the Cretaceous limestone along its course. As a consequence the water is usually exceedingly clear. During heavy rains, when there is considerable direct surface drainage, these streams, of course, become muddy for a short time. The temperature of the water at 4 p. m., December 3, was 68°, the air being 58°. Such fishes as minnows, darters, sunfish, and catfish were fairly abundant. Crawfish were also found in considerable numbers.

The Comal Springs.—There are a great many springs in the vicinity of New Braunfels, the principal group being known as the Comal Springs. There are several springs in this group situated upon the land of Mr. Joseph Landa, a little over a mile northwest of New Braunfels. The largest of these flows, perhaps, as much as 50,000 gallons per minute, and is certainly a magnificent spring. The other springs of the same group flow at least as much more.

The main spring comes out near the foot of a limestone hill, and after running rapidly for a short distance over a pebbly bottom and in a narrow channel it widens out into quite a pond with mud bottom and filled with vegetation. This pond also receives the water from numerous other springs, and has its outlet in Comal Creek (or the Rio Comal), which, after a course of 2 or 3 miles, joins the Guadalupe River. The water of these springs is, of course, very clear. The temperature is 75°.

About 2 miles north of the town is another group of springs, smaller than that just described. The amount of water is abundant, however, and very suitable for fish-cultural purposes. Suitable land could be had in the vicinity of either of these clusters of springs, so situated as to enable the water to be gotten readily under control.

Fishes are very abundant in the Rio Comal and the small streams flowing from the various springs to form that stream. The species represented are the same as those found in the Guadalupe, already mentioned. Among the small mollusks found in and about these streams we noted *Planorbis bicarinatus* Say and *Goniobasis alexandrensis* Lea. Each of these was quite abundant.

San Marcos River.—This river and the springs in the vicinity of San Marcos were examined December 4. The river has its rise in a number of springs at the foot of a limestone ledge or hill just above the town. All these springs together form a large deep stream, from the bottom of which, near the upper end, wells up the principal spring. The water here is not less than 12 or 15 feet deep, and the water boils up with such force and in such enormous quantity as to keep the surface of the river visibly convex immediately over the spring. Some distance below a dam has been built, which furnishes power for running a large mill and for the electric-light plant of the town.

The temperature of the water here, like that in all the springs of this part of Texas, is about 75°. Many water plants are found in the stream, particularly above the dam, and such species of fish as the large-mouthed black bass, sunfish, and various species of Cyprinoids are abundant.

The water of these springs is no doubt well fitted in every way for the culture of the various species of fish that are suited to the streams of Texas.

Just below the dam on the right bank of the stream, and right at the edge of the town, is a tract of land of some 25 acres, which lies exceedingly well for the purposes contemplated. Water can be carried in pipes from the dam to any part of the tract. The slope is sufficient for the easy construction of the ponds.

San Marcos is centrally located and has satisfactory railroad facilities.

Not far below the town the San Marcos River receives the Rio Blanco from the east. This stream is quite deep in places, and much like the San Marcos in general features.

Colorado River.—This is a large stream rising in the north central part of the State and flowing southeast to Matagorda Bay. We made investigations along this river in the vicinity of Austin. Just above the city and on the right side of the river is a large spring, known as Barton Spring. Barton Creek, which is formed by this and a

number of smaller springs, is quite a good-sized stream. It has been dammed and furnishes an abundance of power for a flouring mill.

When the Texas State Fish Commission was in existence the station and ponds were located on the bank of this creek. The water was gotten upon the grounds by means of a small turbine wheel at the dam. This land could no doubt be had now for hatchery purposes and would seem to be very suitable ground, unless, indeed, the acreage be insufficient.

In a report by Jos. P. Frizell, on the proposed dam and waterworks for the city of Austin, it is stated:

The Colorado, above Austin, flows in a deep cut or cañon worn in the limestone rock. It is skirted by limestone bluffs rising often to the height of 150 feet above the bed of the river, broken by the erosion of tributary streams. No extensive meadows or bottom lands exist. The river, in its normal condition, occupies but a small part of the channel in the rock, the remainder being occupied by alluvial deposits to the depth of average high water. In great floods the river spreads from bluff to bluff.

At this point, about 2 miles above Austin, the city has begun the construction of an immense dam for the purpose of furnishing water to the city and power to many manufactories and other industries requiring it.

Mr. Frizell further says:

The channel in the rock is at this point about 1,150 feet wide at a height of 60 feet above the summer level of the river. The cross section of the channel is not far from level on the bottom, and is bounded by nearly perpendicular walls of rock rising to the height of a little over 60 feet on the city side of the river, and 125 or more on the other side. The river bed proper occupies not more than one-half of this width, the remainder of this being alluvial deposit, rising to the height of 40 or 50 feet above the river bed. The situation here is admirably well suited to the development of water power by a dam about 60 feet in height, the perpendicular face of rock rising to about that height, and thence receding from the river in a gentle slope, forming a bench on which the canal or feeder could be constructed, the alluvial strip of ground between the canal and river furnishing sites for pumping and power stations, and any other establishments requiring power.

The Colorado, at Austin, drains some 40,000 square miles, and, of course, carries, at times, an enormous flow of water. The highest flood, within the memory of the people now living, was some 45 feet above low water, and from the best data I can obtain the flow of the stream was some 250,000 cubic feet per second.

This dam is now well under way, and will be completed within a year or two.

About 2,000 feet below the dam, on the left bank of the river, is a tract of land very suitable for a station. Still farther down, less than three-eighths of a mile, is another equally good tract. The top of the dam will be at least 10 feet above the highest part of either of these tracts. All this land slopes gently toward the river and lies beautifully for the laying out of ponds. Ordinarily water taken from the dam would prove suitable, but at times when the river is roily, water could be gotten from the large reservoir to be constructed on the high hills above the dam. The city would doubtless make satisfactory arrangements and guarantees as to water rights.

If land can be had on reasonable terms, the location would prove very desirable.

NOTES ON TEXAN FISHES, WITH DESCRIPTIONS OF NEW SPECIES.

The brief time allowed for the preparation of the first part of this report was not sufficient for a critical study of all the material collected. Only the species of Cyprinoids and Cyprinodonts have been thus far carefully studied, and it has seemed best to publish in this connection the results of the study of only those two families, reserving for another paper the report upon the other fishes collected. In that paper will also be given illustrations of the various new species here described.

1. *Campostoma anomalum* (Raf.).

One specimen, 4 inches long, from the San Marcos River near San Marcos. Head, $4\frac{3}{4}$; depth, $5\frac{1}{8}$; eye, 4; D. 9; A. 7; scales, 8-54-7. Compared with specimens from the Yellow River, at Plymouth, Indiana, the Texas specimen has the scales smaller (7-46-5 in the Yellow River specimens), the lateral line less decurved, interrupted on about 10 scales of the caudal peduncle, reappearing upon the last 4 or 5 scales.

The types of *C. formosulum* Girard came from San Antonio, and have the scales about the same as the Indiana specimens.

2. *Dionda episcopa* Girard.

One specimen $2\frac{3}{4}$ inches, and one $1\frac{1}{2}$ inches long, from the Comal Spring, New Braunfels. Head, $4\frac{1}{2}$; depth, $4\frac{1}{3}$; eye, 3; D. I, 8; A. I, 8; scales, 7-40-4; teeth, 4-4; grinding surface well developed; intestine long; peritoneum black.

Body rather slender, head moderate; origin of dorsal over ventrals, a little nearer tip of snout than base of caudal, its base two-thirds its height or one-half length of head.

Color in alcohol, dark olive above, covered with numerous fine, dark specks; side, with a broad plumbeous band, running from tip of snout through middle of eye to base of caudal, where it ends in a black blotch, this band for the most part lying just above the lateral line; lower jaw, suborbital, lower opercular region, and body below lateral line, pale but with a few scattered dark punctulations.

In his "Researches upon the Cyprinoid Fishes Inhabiting the Fresh Waters of the United States West of the Mississippi Valley,"* Girard establishes the genus *Dionda* and described as new ten species belonging in it (*Dionda episcopa*, *serena*, *texensis*, *papalis*, *argentosa*, *chrysis*, *plumbea*, *melanops*, *couchi*, and *spadicea*). The first seven of these species were described from Texas waters, the next two from Mexico, while the last one named was from Fort Smith, Arkansas. In 1885 all the types of these species that could be found either in the U. S. National Museum or in the Philadelphia Academy were studied by Dr. Jordan, who gave† the following identifications:

Girard's species.	Jordan's identifications.
<i>Dionda episcopa</i>	<i>Dionda episcopa</i> Grd.
<i>Dionda texensis</i>	Do.
<i>Dionda argentosa</i>	Do.
<i>Dionda serena</i>	<i>Dionda serena</i> Grd.
<i>Dionda papalis</i> ‡	? <i>Dionda serena</i> Grd.
<i>Dionda chrysis</i>	<i>Dionda serena</i> Grd.
<i>Dionda melanops</i>	<i>Dionda melanops</i> Grd.
<i>Dionda couchi</i>	? <i>Dionda melanops</i> Grd.
<i>Dionda plumbea</i> ‡	? <i>Zophendum</i> ? <i>plumbeum</i> Grd.
<i>Dionda spadicea</i> ‡	? <i>Zophendum</i> ? <i>plumbeum</i> Grd.

‡ The types of those indicated by a (‡) can not be found and are probably lost.

* Proc. Acad. Nat. Sci. Phila. 1856.

† Proc. U. S. Nat. Mus. 1885, 121.

Girard's types of *Dionda episcopa* consist of two specimens, each about $3\frac{1}{4}$ inches long, collected in the Pecos River by Capt. J. Pope, and bear the U. S. N. M. No. 45. They are still in fair condition and resemble very closely my specimens from the Comal Spring; in the types, however, the head is a trifle longer, the depth some greater, the dorsal appears to be a little farther forward, and the eye is not quite so large.

The types of *D. texensis* bear the U. S. N. M. No. 44, and consist of two specimens, 2 and $2\frac{3}{4}$ inches long, respectively, from the Nueces River; they can not be distinguished from *D. episcopa*.

The type of *D. argentosa* is a single specimen, $2\frac{3}{4}$ inches long, No. 32 U. S. N. M., from San Felipe Creek. This specimen is in poor condition; it does not seem to be identical with *D. episcopa*, but is a heavier, stouter species; head, $3\frac{1}{5}$; depth, $3\frac{3}{4}$; eye, $3\frac{2}{3}$; dorsal less anterior.

3. *Hybognathus nuchalis* Ag.

This species was found to be very abundant in certain places. The collection contains 143 specimens from the Neches River, east of Palestine; 43 from the Trinity, at Magnolia Point; and 10 from Big White Oak Bayou, at Houston.

Many of the Neches River specimens have the lower jaw covered with small cystic tumors, caused by the presence of psorosperms of some species of *Myxosporidia*, appearing as small whitish elevations. Some of these specimens were found to be infested about the intestines with a trematode of some species. These parasites are now being studied by Dr. R. R. Gurley, of the U. S. Fish Commission, who expects to be able to report upon them at no distant date.

4. *Cliola vigilax* (B. and G.).

This is one of the most widely distributed species of the family of minnows: we found it in abundance at each of the following places: Neches River, 14 miles east of Palestine; Trinity River, at Magnolia Point; Long Lake near Magnolia Point, Hunter Creek, Big White Oak Bayou, and Buffalo Bayou near Houston; San Marcos River, San Marcos; and Guadalupe River, near New Braunfels.

These specimens do not differ apparently from more northern specimens. The individuals from the vicinity of Houston are unusually large.

5. *Notropis cayuga atrocaudalis*, var. nov.

Head, $4\frac{2}{5}$; depth, $4\frac{2}{5}$; eye, $3\frac{1}{5}$, a little greater than snout; D. I, 8; A. I, 7; scales, 7-36-4, about 13 before dorsal; teeth, 4-4, strongly hooked, grinding surface developed.

Body moderately elongate, not much compressed, back little elevated; head short and bluntly conic, snout shorter than eye; caudal peduncle short and deep; origin of dorsal slightly behind ventrals, nearer caudal peduncle than snout; anal small, its longest rays shorter than head; lateral line complete.

Color in alcohol: Above olivaceous, profusely covered with fine brownish punctulations, thickest around border of scales, not crosshatched; side with a black band half width of eye, following direction of lateral line and ending in a black spot at base of caudal; this band also extends across cheek through eye and around snout; top of head dark, snout above the black band pale; lower half of head pale, opercles silvery.

The 17 specimens upon which this description is based were obtained in the Neches River, east of Palestine, Texas, November 24, 1891. They very closely resemble *N. cayuga* Meek, but I hesitate to identify them with that species on account of the somewhat longer snout and the complete lateral line.

U. S. FISH COMMISSION EXPLORATIONS IN TEXAS.

6. *Notropis deliciosus* (Girard).

Moniana deliciosa Girard, Proc. Acad. Nat. Sci. Phila. 1856.

This appears to be an abundant species in southern Texas, as indicated by the specimens in the collection, viz:

Kilper's Pond, Houston	1
Big White Oak Bayou, Houston	2
Buffalo Bayou, Houston	9
Hunter Creek, Houston	31
Rio San Marcos, San Marcos	26
Guadalupe River, New Braunfels	82
San Antonio River, San Antonio	76

Numerous specimens examined give the following measurements: Head, $4\frac{1}{5}$ to $4\frac{3}{5}$; depth, $4\frac{1}{5}$ to $4\frac{3}{4}$; eye, 3; D. I, 8 or 9; A. I, 8; scales, 6-36 or 37-3, 13 or 14 before the dorsal.

Body slender, head moderate; snout rather blunt, less than eye or interorbital width; the mouth not large, subinferior, oblique, lower jaw included; origin of dorsal slightly behind base of ventrals, midway between tip of snout and base of caudal fin, high, the longest rays, which are the anterior ones, nearly as long as head; anal base short, its longest rays $1\frac{2}{5}$ in head.

Color in alcohol: Scales above lateral line with numerous fine black specks, thickest along border of each scale, forming cross-hatching, darkest along middle line of back, a black blotch on back in front of dorsal and another on caudal peduncle at beginning of caudal fin; base of dorsal fin dusky; top of head and upper jaw dark; a few dark specks on upper part of opercle, the lower portion and the lower jaw pale; side with a broad plumbeous band, about one scale wide, lying along lateral line, this dusted over with fine, darker punctulations. This color description applies more especially to the San Antonio specimens. Those from the other places, especially those from about Houston, are much paler, but the general pattern of coloration is the same. Many of the females of the San Antonio lot contained well-developed eggs.

7. *Notropis nux*, sp. nov.

This species is based upon specimens from the following places:

Neches River, Palestine	10
Trinity River, Palestine	1
Long Lake, Palestine	1

Head, 4 to $4\frac{1}{5}$; depth, $4\frac{1}{2}$; eye, 3 to $3\frac{1}{5}$; D. I, 8; A. I, 7 or 8; scales, 6-37 or 38-3 or 4, 13 or 14 before the dorsal; teeth, 1, 4-4, 2 in the Long Lake specimen, apparently only 1, 4-4, 0 or 1 in the others; grinding surface developed and somewhat crenate, especially in the Neches River specimens.

Body rather slender, somewhat elevated, head subconic, snout rather blunt, a little decurved; mouth moderate, oblique, maxillary not reaching orbit, lower jaw slightly included; eye rather large, about 3 in head, equal to snout, also to interorbital width; caudal peduncle long and slender, its least depth $2\frac{1}{2}$ in head. Origin of dorsal fin over insertion of ventrals, nearer snout than base of caudal, height of fin equals length of head, base short; anal smaller; pectorals short, not reaching ventrals, which, in turn, do not reach the anal; caudal long and widely forked; lateral line complete, nearly straight; peritoneum pale, with a few brown spots.

Color in spirits: Greenish above, covered with numerous fine, brownish punctulations, thickest along edges of scales, forming cross-hatching extending about one-fifth way down the side; trace of a dark vertebral line; side with a somewhat distinct plumbeous band, heaviest on caudal peduncle and ending in most specimens in a small but distinct caudal blotch; this band also extends across opercles, through the eye and upon the snout; between this band and the cross-hatching of the back is a pale yellowish area, about one scale wide with a few scattered specks showing under the lens; body below lateral line pale, with few specks except about base of anal fin and along under side of caudal peduncle where they are numerous: fins with few very fine dark points.

Etymology: Latin, *nux*, nut; in allusion to the Neches River, as Neches is said to mean *nut*.

8. *Notropis nocomis*, sp. nov.

Head, $4\frac{1}{4}$ to $4\frac{1}{2}$; depth, $4\frac{3}{4}$ to 5; eye, 3 to $3\frac{1}{4}$; D. I, 8 or 9; A. I, 8; scales, 6-36-3; teeth, 1, 4-4, 1, small, hooked, the grinding surface narrow, apparently a little crenate; peritoneum silvery, with a few small dark specks.

Body rather slender, but little elevated; head heavy, resembling that of *Cliola vigilax*; snout blunt and rounded, about equal to eye; mouth small, inferior, horizontal, lower jaw included and overhung by the rounded snout; maxillary short, not nearly reaching orbit; eye large, equal to interorbital width; preorbital broad; caudal peduncle long and slender, its least depth less than half length of head. Dorsal inserted directly over the ventrals, high, the longest rays 4 times in length of body, one-fifth longer than head, or twice length of fin, reaching middle of anal when depressed, the free margin nearly straight; anal resembling dorsal in shape, but smaller, its longest rays as long as head; pectorals short, not reaching ventrals; ventrals scarcely reaching anal fin; lateral line complete, nearly straight.

Color in alcohol: Yellowish, upper parts of body with numerous fine brown punctulations, chiefly margining the scales so as to form cross-hatching; lower parts plain yellowish; a dark lateral band, faint on the anterior half of side, plainest on caudal peduncle; no caudal spot; fins, under the lens, show a few fine specks; top of head dark, snout pale.

This species is described from about 130 specimens, each about $2\frac{1}{2}$ inches in total length, taken in the Trinity River at Magnolia Point, near Palestine, Texas, and five examples from the San Marcos River at San Marcos, Texas. These specimens are indistinguishable by me from specimens collected at New Braunfels, Texas, in 1884, by Drs. Jordan and Gilbert, and referred to in Jordan's Catalogue of 1885 under the manuscript name *Notropis nocomis*. In the paper on their Texas collection, these authors concluded that their specimens were identifiable with Girard's *Moniana deliciosa*, and consequently gave no description. I obtained numerous specimens at San Marcos, New Braunfels, and elsewhere, of what agrees well with the types of *Moniana deliciosa* Grd., with which I have compared them, but they are quite a different fish from that for which I adopt the name *nocomis*. In *Notropis nocomis* the head is heavier and broader, the snout is much more blunt, the mouth smaller and more nearly horizontal, and the lower jaw is shorter and included. I have, therefore, thought best to describe this form as a new species, adopting for it the manuscript name of Jordan and Gilbert.

In the Trinity River, at Magnolia Point, this species was found in great numbers on a ripple when the current was pretty strong.

One specimen, 2½ inches long, from Buffalo Bayou, I refer to this species for the present, though it presents some differences. The body is a little more slender, the mouth some larger and less inferior, and the color is darker; the dark lateral band is well developed and extends across the opercles and around the snout. These color differences, however, might well be due to the quite different characters of the streams from which the specimens came.

The specimen from Buffalo Bayou measures as follows: Head, 4¼; depth, 5¼; eye, 3, greater than snout; D. 1, 8; A. 1, 8; scales, 6-38-3; teeth, 1, 4-4, 1. Height of dorsal fin greater than length of head.

9. *Notropis lutrensis* (B. and G.).

Neches River east of Palestine.....	1
Trinity River, Magnolia Point, near Palestine.....	180
San Marcos River, San Marcos	537
Gnadalupe River, New Braunfels.....	40
San Antonio River, San Antonio.....	4

This species is, as shown above, exceedingly abundant in the Trinity and San Marcos rivers, and is quite common at each of the other localities where specimens were found by us. This is one of the most variable and most widely distributed of the Southwestern Cyprinoids.

10. *Notropis venustus* (Girard).

Cyprinella venusta Girard, Proc. Acad. Nat. Sci. Phila. 1856, 198, and Mex. Bd. Survey, 54, Pl. xxxi, Figs. 1-4, 1859 (Rio Sabinal, Texas, collected by Dr. C. B. Kennerly).

Notropis venustus Jordan and Gilbert, Proc. U. S. N. M. 1886, 14 (Red River, Fulton, Ark.); 19 (Lampasas River, Belton, Tex.); 20 (Colorado River, Austin, Tex.).

This, one of the most attractive of Cyprinoids, is an abundant species in many of the streams examined by us. The following specimens are in the collection:

Neches River, east of Palestine, Texas	3
Trinity River, Magnolia Point, Texas	2
Buffalo Bayou, Houston, Texas	12
Big White Bayou, Houston, Texas	19
Hunter Creek, Houston, Texas.....	73

The specimens from about Houston are very fine and large, some of them being as much as 4 inches long. The black caudal spot is larger and not so far back upon the caudal fin as shown in Girard's figure.

11. *Notropis swaini* Jordan and Gilbert.

Alburnus megalops Girard, Proc. Acad. Nat. Sci. Phila. 1856, 193 (San Felipe Creek, Texas).

Alburnellus megalops Girard, Mex. Bd. Survey, 52, Pl. xxix, figs. 1-4, 1859 (San Felipe Creek, Texas). (Name preoccupied in this genus.)

This species is abundant in Texas, and specimens were obtained by us at the following places:

San Marcos River, San Marcos, Texas.....	21
Comal Creek, New Braunfels, Texas	36

Drs. Jordan and Gilbert obtained this species in Comal Creek, San Marcos River, and the Colorado River at Austin.

Head, 4 to $4\frac{1}{4}$; depth, 4 to $4\frac{2}{3}$; eye, $2\frac{1}{5}$ to 3, greater than snout; D. I, 8; A. I, 8 or 9; scales, 7-38-3, about 14 before the dorsal; teeth, 1, 4-4, 1 or 2, somewhat hooked and with evident grinding surface.

Body moderately elongate, compressed, back little elevated; head rather heavy, snout short and obtuse, mouth large, oblique, lower jaw slightly projecting. maxillary extending to below level of pupil; eye quite large, greater than width of interorbital space or length of snout; caudal peduncle moderate, its least depth equal to distance from tip of snout to middle of eye; fins not large, dorsal inserted behind the ventrals; origin of anal behind last rays of dorsal; lateral line continuous, slightly decurved.

Color: Upper third of body pale yellowish, with numerous small brown specks arranged chiefly parallel with the borders of the scales, not presenting a true cross-hatched appearance; top of head dark, snout, region about the nostrils, and supra-ocular region paler; a dark dorsal line from nuchal region to caudal fin; lower two-thirds of body silvery, the upper part being more or less plumbeous forming a broad band well defined above, but less so below; lower third of caudal and forward to tips of ventrals plain yellowish; opercles and cheeks very silvery; breast and lower jaw pale.

12. *Notropis dilectus* (Girard).

Alburnus dilectus Girard, Proc. Acad. Nat. Sci. Phila. 1856, 193 (Arkansas River, near Fort Smith).

Four specimens of what I for the present refer to this species were obtained from Long Lake, near Palestine; one from Neches River, east of Palestine; and several hundred specimens, the largest about $2\frac{3}{4}$ inches long, from the Trinity River at Magnolia Point. Drs. Jordan and Gilbert obtained specimens of what they referred to Girard's *dilectus* from the Sabine River, Long View, Texas; Saline River, Belton, Arkansas, and from the Arkansas River near Fort Smith.

Girard's original description of the species is as follows:

1. *Alburnus dilectus*, is about three inches and a half in total length; the head forming a little less than the sixth part of it. The greatest depth is nearly equal to the length of the head. The diameter of the circular eye is contained a little more than three times in the length of the side of the head, and less than once in advance of its anterior rim. There are ten longitudinal rows of scales between the insertion of the ventrals and the base of the dorsal. The lateral line is upon the fourth row from the ventrals upwards. The color is uniform yellowish red with a lateral silvery streak.

The types of this species consist of two specimens, 3 and $3\frac{2}{5}$ inches long respectively, and are numbered 71, in the U. S. National Museum catalogue. They are in very good condition, and present the following measurements: Head, $4\frac{1}{2}$ ($5\frac{1}{2}$) and $4\frac{1}{4}$ ($5\frac{1}{4}$); depth nearly equal to length of head; eye, $3\frac{1}{2}$ in head in each, longer than snout.

The specimens obtained by us may be described as follows: Head, 4 to $4\frac{1}{3}$ (5 to $5\frac{1}{3}$); depth, $4\frac{3}{4}$ to 5 (6 to $6\frac{1}{4}$); eye, 3 to $3\frac{1}{5}$; scales, 7-38-3.

Body slender, compressed, scarcely elevated; head narrow; eye large, greater than snout, equal to width of interorbital space; mouth rather large, quite oblique, maxillary reaching orbit.

Dorsal much nearer base of caudal than snout, considerably behind ventrals, high, its anterior rays longest, free margin straight; anal larger than dorsal, free margin concave; caudal deeply forked; pectorals short, not reaching ventrals, which are also short, not reaching anal. Lateral line somewhat decurved. Peritoneum silvery, with numerous dark-brown specks. Color, very pale yellowish, side with plumbeous band very indistinct on anterior third of side, plainest on caudal peduncle; back and sides down to lateral line covered sparsely with small dark specks arranged mostly along

border of scales, largest just above lateral line; top of head dark, snout pale, lips dark-edged; a row of somewhat larger specks along median line of back from occiput to caudal fin; body below lateral line plain yellowish without any specks except a single row at base of anal fin on each side, usually quite distinct in most specimens; entire side of head silvery; fins, especially dorsal and anal, with a few small dark points. The specimens from Long Lake are a little more heavily spotted than those from the river.

13. *Notropis fumeus*, sp. nov.

Allied to *Notropis dilectus* (Grd.). Head, $4\frac{1}{2}$ to $4\frac{4}{5}$; depth, $4\frac{1}{5}$ to 5; eye, 3 to $3\frac{1}{3}$; D. I, 8; A. I, 11; scales, 7-40-3; teeth, 2, 4-3 (?) 2, hooked.

Body slender, greatly compressed, dorsal and ventral outline gently arched; head moderate, conic; snout pointed, shorter than eye; eye large, equal to interorbital width; mouth rather large, oblique, lower jaw projecting, scarcely included, maxillary scarcely reaching orbit; caudal peduncle long, compressed, its least depth equal to distance from tip of snout to middle of pupil; lateral line complete, considerably decurved. Origin of dorsal behind ventrals, nearer base of caudal than tip of snout, its height less than length of head; anal larger, its base $1\frac{1}{2}$ in head; pectorals short, not reaching ventrals; ventrals short, just reaching vent. Peritoneum pale silvery, with some small dark specks.

Color: Dark yellowish above, thickly covered with small dark-brown specks; the majority of these are very small, but interspersed among them are a good many of larger size, spots most numerous in certain lines forming distinct cross-hatching; a dark line along middle of back; side with a broad, dark plumbeous band, overlaid with numerous rather large brown spots, thickest and darkest toward caudal peduncle; this band also extends across opercle and around the snout; lower jaw with anterior half darkened by numerous specks; lower parts, pale silvery, with few or no specks except at base of anal fin, which has a rather heavy row on each side, in some specimens continuing along under side of caudal peduncle to caudal fin; dorsal, anal, and caudal with some black on membranes, pectorals edged with black.

This species is based upon 4 specimens, each a trifle over 2 inches in length, taken in Hunter Creek, about 9 miles from Houston, Texas, November 20, 1891. It very closely resembles *N. dilectus* (Grd.), and may prove to be not specifically distinct from that species; the lateral line is, however, more decurved, the scales seem to be some smaller and the color is markedly different in the distinctness of the broad plumbeous lateral band.

14. *Notropis notemigonoides*, sp. nov.

Head, 4 to $4\frac{1}{4}$; depth, $4\frac{1}{4}$ to $4\frac{1}{2}$; eye, $3\frac{1}{4}$ to $3\frac{1}{2}$; D. I, 8; A. I, 10 or 11; scales, 10-41-3, about 29 before the dorsal; teeth, 2, 4-4, 2, hooked, grinding surface moderately broad, plainly crenate.

Body slender, greatly compressed, somewhat elevated; head conic, snout pointed, about equal to eye; mouth large, oblique, lower jaw slightly projecting, maxillary reaching orbit; eye rather large, equal to snout, but a little less than interorbital width; caudal peduncle long and compressed, its least width only half diameter of orbit. Fins moderate, dorsal inserted behind ventrals a distance equal to diameter of eye, much nearer base of caudal fin than snout, its rays about as long as head, free margin straight; anal with longer base but shorter rays; pectorals falcate, not reach-

ing ventrals; ventrals short, scarcely reaching anal; caudal long and deeply forked. Scales rather small and closely imbricated, very small and crowded before the dorsal; lateral line complete, greatly decurved, as in *Notemigonus*.

Color in spirits: Pale yellowish above, silvery below; upper half of body sprinkled over with numerous small, dark-colored spots, thick enough along median line of back to form a narrow dark vertebral band from occiput to base of caudal fin; the spots on anterior part of side so arranged as to form about sixteen obtuse angles fitting into each other, the angles opening forward, thus >>, these markings being upon alternate scales; a silvery band on caudal peduncle overlaid with fine dark specks; top of head dark, snout pale, but with many fine punctulations; tip of lower jaw with some small specks; sides of head silvery; all the fins except the pectorals with many fine dark points, most numerous on dorsal and caudal. This curious species of *Notropis* bears a very close superficial resemblance to *Notemigonus chrysoleucus*, but of course its generic relationship is with the *Notropes*.

This species is based upon the following specimens: Three specimens, 2 to 2½ inches long, from Neches River, 14 miles east of Palestine, Texas, November 24, 1891, and 3 specimens of about the same size, from Sims Bayou, near Houston, Texas, November 18, 1891. The specimens from Sims Bayou, like all other fishes from that place, are very much bleached, but show the same general pattern of coloration as those from the Neches River.

15. *Phenacobius mirabilis* (Girard).

Eroglossum mirabile Girard, Proc. Acad. Nat. Sci. Phila. 1856, 191 (Arkansas River, Fort Smith).

Two specimens from the Trinity River at Magnolia Point, near Palestine. Also taken by Drs. Jordan and Gilbert in the Sabine River at Longview, Texas, and the Arkansas River near Fort Smith.

16. *Hybopsis æstivalis marconis* J. and G. (Pl. xxxv.)

Hybopsis æstivalis marconis Jordan and Gilbert, Proc. U. S. N. M. 1886, 22 (San Marcos River).

Head, 4½; depth, 5½; eye, 3½, less than snout, but equal to interorbital width.

We found this fish very abundant in the San Marcos River below San Marcos, and in the Guadalupe River near New Braunfels. It seems to be like *Hybopsis hyostomus*, a fish of the rapid, open stream, as we found it only where the water was pure and clear and the current very swift. At a single haul with a 12-foot seine in the Guadalupe River, between the two bridges near New Braunfels, several hundred fine specimens were taken.

17. *Opsopœodus osculus*, sp. nov.

I refer to this species specimens from the following places:

Neches River east of Palestine, Texas, November 24, 1891	20
Long Lake, Palestine, Texas, November 25, 1891	2
Buffalo Bayou, Houston, Texas, November 16, 1891	4
Kilper's Ponds, Houston, Texas, November 21, 1891	4
Sims Bayou, Houston, Texas, November 18, 1891	48
Dickinson Bayou, Nicholstone, Texas, November 14, 1891	4

Head, 4½ to 4¾; depth, 4½ to 5; eye, 3; D. I, 10; A. I, 8; scales, 6 or 7-38 to 41-3 or 4; teeth, 4-4 or 4-5, more or less serrate and hooked, the pharyngeals small and weak; peritoneum silvery, with small brown specks.

Body rather slender, little elevated, head subconic, its depth at eye but half its length, snout blunt, shorter than eye; mouth very small, almost vertical, scarcely any

lateral cleft; scales moderate, rather deeper than long, those in front of dorsal small; breast naked; lateral line complete, somewhat decurved. Origin of dorsal slightly behind that of ventrals, nearer snout than base of caudal, its height equal to length of head, pointed, the free margin nearly straight, inclined to be concave; anal small, its base one-half length of head, about equal to the dorsal in height.

Color of Neches River specimens pale, the upper parts of the body with numerous fine brown specks arranged chiefly along edge of scales so as to give a regular cross-hatching, this covering the caudal peduncle; middle of side with a plumbeous band about one scale wide, extending also across cheek and upon snout; two rows of small spots above and parallel with the plumbeous band and one below it, not distinct in some specimens; top of head dark, an indistinct line from nape to origin of dorsal fin; lower parts of body plain except on posterior portion where the cross-hatching extends to under side of caudal peduncle; no spot at base of caudal; fins plain or with a few scattered punctulations on dorsal and anal, no evidence of the large black area found on dorsal fin of *O. emiliae*.

The specimens from Long Lake, Dickinson Bayou, Buffalo Bayou, and Kilper's Ponds agree in color with those from the Neches River, while all the specimens from Sims Bayou are nearly uniform pale yellowish throughout, there being no markings anywhere except a very faint lateral band and a few scattered punctulations discernible only under a lens; dorsal and anal wholly plain. The pale, bleached appearance of the specimens from Sims Bayou is quite certainly due to the peculiar character of the place in which they were found, it being a shallow, isolated, and stagnant pool with mud bottom, containing scarcely any vegetation and lying exposed on the open prairie. Thousands of cattle from the surrounding prairie come to this pool for water during the dry season, and, in consequence, the banks are much cut up and the water is more or less foul. These conditions, of course, have their effect upon the fishes found there, and all the species obtained there by us present the same faded appearance.

This species is quite close to *O. emiliae* Hay, but may be distinguished from it by the less depth of the head, the more pointed dorsal and anal fins, and by the very different coloration. A specimen of *O. emiliae* from Mayfield Creek, Kentucky, collected by Mr. A. J. Woolman, has the depth at the eye half length of head, and the free margin of the dorsal, as well as that of the anal, is convex, while in the Texas specimens it is straight or even concave, due to the greater length of the first three rays. These small differences, together with the entire absence of the large black spot on the dorsal fin which constitutes such a noticeable feature in the coloration of *O. emiliae*, and the presence (except in the bleached specimens) of a much more distinct plumbeous lateral band than is found in any of the specimens of *O. emiliae* that I have examined, do not permit me to believe that the two are specifically identical. To regard the Texas specimens as being *O. emiliae* would require, it seems to me, either that the lateral band should be obsolete or that there should be some evidence of the presence of the black area on the dorsal fin; for it would seem that conditions which would result in *intensifying* one of these color markings would not *obliterate* the other.

This species differs from the other of the two known species of this genus (*O. bollmani*, recently described by Dr. Charles H. Gilbert, from Buckhead Creek, Georgia), in having the lateral line complete and in not having the black caudal spot so conspicuous in that species.

18. *Notemigonus chrysoleucus* (Mitch.).

Numerous specimens of this widely distributed minnow were taken at each of the following places: Neches River, 14 miles east of Palestine; Long Lake and Trinity River, near Palestine; Sims Bayou, Kilper's Ponds, and Big White Oak Bayou, at Houston; and Dickinson Bayou, near Dickinson.

19. *Cyprinodon variegatus* (Lacépède).

Thirty specimens of this species were obtained at Galveston, 3 from Dickinson Bayou, and 10 from Corpus Christi. It is abundant both at Galveston and Corpus Christi. This is the form described by Baird and Girard as *C. gibbosus*, but our specimens do not seem to differ materially from northern ones.

In our study of this and related species we had occasion to compare specimens of *Cyprinodon carpio* Günther and *C. mydrus* Goode & Bean, and can not see any tangible differences.

20. *Fundulus similis* (B. & G.).

The collection contains 14 specimens from Galveston and 2 from Corpus Christi. It is an abundant species at each place.

21. *Fundulus heteroclitus* (L.).

A dozen specimens from Corpus Christi, 2 from Dickinson Bayou, and 14 from Galveston, at each of which places it is abundant.

22. *Fundulus pallidus*, sp. nov. (Pl. xxxv.)

One specimen, $1\frac{3}{4}$ inches in total length, taken in Galveston Bay, near Swan Lake, Texas, November 10, 1891. Head, $3\frac{1}{2}$; depth, 4; eye, $3\frac{1}{2}$; D. 12; A. 11; scales, 31-11, about 16 before the dorsal.

Body, stont; head, heavy; caudal peduncle long and much compressed; snout, short and blunt, shorter than eye, which is two-thirds the width of the interorbital space; humeral scale not enlarged, two rows of scales on the cheek; mouth rather small, little oblique, teeth pointed, in more than one series, the outer enlarged. Dorsal fin over the anal, its origin midway between base of caudal and posterior edge of opercle, or midway of total length, its ray short, about $1\frac{4}{5}$ in head; anal rays about equal in length to those of dorsal.

Scales median, not firmly attached, 31 in longitudinal series, 11 in transverse from dorsal to anal, about 16 before the dorsal.

Color, pale yellowish; sides with about 13 narrow, dark, vertical bars, much narrower than the pale interspaces, not extending on the back or belly; scales sparsely covered with fine dark punctulations, few on the vertical fins and head; a large oblong black spot on the back immediately in front of dorsal fin.

This species is allied to *Fundulus similis* Baird and Girard, but the head is less pointed, the snout very much shorter, it being shorter than the eye, while in *F. similis* it is $1\frac{1}{2}$ times the eye, the dorsal has one more ray and the anal two or three more, the color is paler, the bars less distinct, there is no dark dorsal line as in the other, while the pronounced black spot in front of the dorsal is not found on *F. similis*.

23. *Fundulus xenicus* Jordan and Gilbert.

Fundulus xenicus Jordan and Gilbert, Proc. U. S. N. M. 1882, 255 (Pensacola); Synopsis, 1882, 892.

Adinia multifasciata Girard, Proc. Acad. Nat. Sci. Phila. 1859, 117.

Four specimens of this interesting little species were taken in Galveston Bay. Head, 3; depth, $2\frac{1}{2}$; eye, 3; snout, 3; D. 12; A. 12.

Body greatly compressed, the back elevated, profile from snout to dorsal nearly straight, this forming an acute angle with the ventral line from snout to anal fin; caudal peduncle very deep, its greatest depth $1\frac{1}{4}$ in head; dorsal large, its origin in front of anal, the longest rays nearly as long as head. The dusky blotch said to be below and behind the eye is not evident.

24. *Zygonectes funduloides*, sp. nov. (Pl. XXXV.)

This species is described from two specimens, each $1\frac{1}{2}$ inches long, from Dickinson Bayou, Dickinson, Texas, November 13, 1891. Head, $3\frac{1}{3}$; depth, $4\frac{1}{2}$; eye, $3\frac{1}{4}$; D. 9 or 10; A. 9; scales, 35-11, 24 before the dorsal.

Body moderately robust, width at pectorals a little greater than greatest depth of head; snout rather blunt, equal to eye; interorbital width $1\frac{2}{3}$ times diameter of eye; caudal peduncle deep and compressed; mouth not large nor greatly oblique; teeth pointed, the outer series being somewhat enlarged; peritoneum pale. General color in spirits, dark olivaceous, sides with 10 to 14 dark vertical bars which are usually two to three times as wide as the intervening silvery ones; in one specimen the bars extending from the dorsal to the anal are about equal in width to the silvery interspaces; whole body, including all the fins, profusely dusted over with minute brownish spots which are very numerous on back and top of head; a narrow, dark line extending from nape to origin of dorsal.

Dorsal fin small, slightly in front of anal, its origin midway between posterior edge of opercle and base of caudal fin, the longest rays about equal to base of fin, or half length of head.

If the characters which are used to distinguish the genus *Fundulus* from *Zygonectes* are really of generic value, the small size of the dorsal fin would put this species in *Zygonectes*, though the position of the fin is rather that of *Fundulus*. I have compared these specimens with numerous young individuals of *F. heteroclitus* collected by Dr. H. M. Smith at St. George Island, Maryland, and find them very similar in general appearance; in *Z. funduloides*, however, the dorsal is placed further back, and has fewer rays (9 or 10 instead of 12), the anal is smaller (9 instead of 11); the pattern or coloration is the same, but the contrasts are more marked, and instead of the dark dorsal band found in this species the young of *F. heteroclitus* have a small dusky area at base of dorsal in front; the young have an ocellus upon last rays of dorsal, which is not found in the other species.

25. *Zygonectes pulvereus*, sp. nov. (Pl. XXXVI.)

This species is based upon the following specimens:

Nine specimens, $1\frac{3}{5}$ to 2 inches long, from Dickinson Bayou, Dickinson, Texas, November 13 and 14, 1891.

One specimen, $1\frac{1}{2}$ inches long, from Buffalo Bayou, Houston, Texas, November 16, 1891.

One specimen, $1\frac{1}{2}$ inches long, from the mouth of Oso Creek, Corpus Christi, Texas, November 28, 1891.

Head, $3\frac{1}{2}$; depth, $4\frac{1}{2}$; eye, $3\frac{1}{2}$; D. 10 (11 in one specimen); A. 10 (occasionally 9); scales, 35-11, about 22 before the dorsal.

Body stout, heavy forward; head broad and flat, the snout short and blunt; caudal peduncle long, deep, and greatly compressed; eye moderate, $1\frac{1}{2}$ in interorbital width, greater than snout; humeral scale not enlarged, four rows of scales on cheek; mouth rather small, but little oblique; teeth pointed, in more than one series, the outer enlarged and canine-like; peritoneum pale. Dorsal slightly in advance of anal, its origin midway between tip of caudal and anterior rim of orbit, or about midway between base of caudal and opercular opening; anal small, its longest rays $1\frac{1}{2}$ in head.

Color in alcohol, olivaceous, profusely sprinkled or dusted all over except on breast with very fine brown punctulations, so abundant on back as to obscure the individual specks; median line of back with a black stripe from occiput to dorsal fin; sides with 10 to 12 or more brown spots of larger size, these sometimes arranged somewhat definitely in two longitudinal lines, in the upper one of which the spots are confluent in some examples, forming large, oblong blotches; all the fins except the ventrals with numerous very small brown specks.

This species resembles *Z. jenkinsi*, but differs from it in the larger dorsal, much smaller anal, smaller scales, the much shorter snout, the heavier or broader head, and in the coloration. The localities from which the types were obtained would indicate that it is an inhabitant of water that is but little brackish or almost fresh.

26. *Zygonectes jenkinsi*, sp. nov. (Pl. XXXVI.)

This species is based upon 21 specimens, ranging in length from $1\frac{1}{2}$ to $2\frac{1}{2}$ inches, collected in Dickinson Bayou, near Dickinson, Texas, November 14, 1891, and 11 examples from Galveston Bay, Galveston, Texas, collected a day or two earlier.

Head, $3\frac{1}{2}$; depth, $4\frac{1}{2}$ ($4\frac{1}{5}$ to 5); eye, $3\frac{1}{2}$ ($3\frac{1}{5}$ to $3\frac{2}{5}$); D. 8 or 9; A. 12 (11 to 13); scales, 33-10, 18 before the dorsal. Body moderately elongate, head depressed, wide between the eyes, pointed, the snout about one-fourth greater than eye, which is contained $1\frac{1}{2}$ times in interorbital width; mouth rather large, little oblique; teeth in more than one series, the outer enlarged, pointed, and slightly curved inward; humeral scale small, three rows of scales on cheek. Fins medium, dorsal slightly behind anal, midway between tip of caudal and posterior rim of orbit, the distance from tip of snout to origin of dorsal being twice the distance from that point to base of caudal fin; dorsal and anal low, their longest rays half length of head; base of anal $2\frac{1}{2}$ in head; pectorals $1\frac{3}{4}$ in head; ventrals short, $1\frac{1}{2}$ in pectoral; caudal fin truncate, about as long as head; peritoneum black.

Color, pale olivaceous, covered except on breast with numerous minute dark-brown specks, arranged chiefly along the edges of the scales, thus giving the sides and back a checkered or cross-hatched appearance; in addition to these fine punctulations, there are usually 15 to 30 larger spots more or less definitely arranged in two rows lying along or above the axis of the body; in some examples these spots are absent or blended so as to form short, indistinct vertical bars; in most specimens there is a very obscure lateral band about one scale in width; fins plain or with few very minute punctulations; top of head dark.

Related to *Z. rubrifrons* Jordan, but differing from it in the following particulars: The body is more slender, the head is shorter, the dorsal and anal are larger, and the color markings are quite different. Compared with specimens of *Z. henshalli* Jordan,

it is more slender, the snout is longer and more pointed, and the color is not the same; from specimens of *Z. cingulatus* Cuv. and Val. from Pensacola, the differences are seen to be about the same as those which distinguish it from *Z. henshalli*; from the types of *Z. auroguttatus* Hay, it differs chiefly in the greater number of anal rays and the less distinct crossbars.

I name this species for Prof. O. P. Jenkins, of Leland Stanford Junior University, in recognition of his work upon the fishes of the Sandwich Islands.

27. *Zygonectes notatus* (Raf.).

Specimens of this widely distributed species were obtained at the following places:

Neches River, east of Palestine	27
Trinity River, at Magnolia Point	2
Long Lake, near Magnolia Point	15
Buffalo Bayou, Houston	7
Big White Oak Bayou, Houston	23
San Antonio Springs, San Antonio	5

These Texas specimens do not differ apparently from examples collected in Indiana.

28. *Zygonectes escambiae* Bollman.

Zygonectes escambiae Bollman, Proc. U. S. N. M. 1886, 463 (Escambia River, Flomaton, Ala.).

From a pond on the bank of the Trinity River, at Magnolia Point, we obtained 5 specimens that I refer to this species.

Head, 4; depth, 5; eye, $2\frac{3}{4}$, greater than snout; scales about 38–10, 20 before the dorsal; dorsal, 7 or 8, slightly behind the anal; anal, 9. Sides with about 10 brownish or chocolate lines made up of a spot on each scale; in two of the five examples these lines are more nearly continuous than in the others; between these are smaller spots hardly forming lines; the individuals with the spots most distinct are probably males.

Compared with the types of *Z. escambiae*, these specimens are more slender, the spots come nearer to forming continuous bands, and the fins are all plain, compared with the types of *Z. craticula* Goode and Bean, which are from Indian River, Florida; the snout is shorter and less pointed, the lower jaw projects less, and the longitudinal lines are less marked. Specimens of *Z. craticula* collected at Titusville, Florida, by Mr. R. E. Earll, show about 10 dark crossbars not developed on any of the other specimens examined except on one collected at Westville, Florida, by Dr. O. P. Hay, and identified by him as the *Z. nottii* of Agassiz. *Zygonectes escambiae* Bollman closely resembles *Z. craticula* Goode and Bean, and it may be that they are both identical with *Z. nottii* Ag. The briefness of Agassiz's description of *Z. nottii* makes it very difficult to identify that species with certainty, and it is perhaps best to let the names stand as above.

29. *Lucania parva* (B. and G.).

Cyprinodon parvus Baird and Girard, 9th Smithsonian Report, for 1854, 345 (Greenport, Long Island).

One specimen of this interesting little fish was taken in Sims Bayou, at Houston, 3 in Dickinson Bayou, 4 in San Antonio Springs, and 4 at Corpus Christi.

This species at first glance much resembles *Gambusia patruelis*, and, in collecting, is apt to be mistaken for that species.

30. *Gambusia patruelis* (B. and G.).

Heterandria patruelis Baird and Girard, Proc. Acad. Nat. Sci. Phila. 1853, 390.

Gambusia gracilis Girard, Proc. Acad. Nat. Sci. Phila. 1859, 121 (Matamoras).

Gambusia humilis Günther, Cat. Fish., vi, 335, 1866 (Matamoras).

Haplochilus melanops Cope, Proc. Amer. Phil. Soc. 1870, 457 (Neuse River).

Zygonectes atrilatus Jordan and Brayton, Bull. U. S. N. M., xii, 84, 1878 (Neuse River, North Carolina.)

Zygonectes brachypterus Cope, Jordan and Gilbert's Synopsis, 341, 1882 (Trinity River and other streams of Texas).

This species is represented in the collection from Texas by the following specimens:

Neches River, east of Palestine	1
Trinity River at Magnolia Point	2
Long Lake, near Magnolia Point	2
Buffalo Bayou, Houston	8
Hunter Creek, Houston	10
Kilper's Ponds, Houston	38
Big White Oak Bayou, Houston	5
Sims Bayou, Houston	48
Dickinson Bayou, Dickinson	36
San Antonio Springs, San Antonio	15
Comal Creek, New Braunfels	127
Rio San Marcos, San Marcos	68

All the specimens from the first seven localities show the dark suborbital spot very distinctly. All the specimens from Sims Bayou are very pale and there is no suborbital spot in any of them, but all the fishes gotten from this place present a bleached appearance, due, no doubt, to the character of the water in which they were found, which was a muddy and foul pool left by the drying up of the greater part of the stream. Of the specimens obtained from Dickinson Bayou, 4 show the spot while the others are plain. All these specimens were also quite pale. The 15 specimens from San Antonio are quite dark, and the majority show the dark suborbital spot. The majority of the numerous specimens from New Braunfels show the spot, though in some it is quite faint and in others it is wholly absent. All these specimens are quite dark and resemble those from San Antonio. Those from San Marcos are rather pale and but few of them show the suborbital spot.

There do not seem to be any good reasons for separating *G. humilis* from *patruelis*, even as a geographical form.

In many of the female specimens from San Antonio and New Braunfels the embryos are quite large, fully $\frac{1}{4}$ inch in length, showing that the species produces its young in midwinter in southern Texas. Specimens collected by Dr. Hugh M. Smith, at St. George Island, Maryland, July 1, contained immature eggs, while others collected at the same place by him August 11 contained young apparently ready for extrusion.

31. *Mollienesia latipinna* Le Sueur.

One specimen of this attractive species was taken at Corpus Christi, 2 at Galveston, 42 at Dickinson Bayou, and 1 from Hunter Creek, near Houston.

LIST OF CRUSTACEA COLLECTED.

[By Mary J. Rathbun, Department of Marine Invertebrates, National Museum.]

The collection of Crustacea of which a list is given below was made by Prof. B. W. Evermann, of the U. S. Fish Commission, during the months of November and December, 1891, while engaged in an investigation of the fresh and salt waters of eastern Texas, with a view to the establishment of a hatchery. While the collection contains no new species, it is interesting from the fact that it extends the limits of many species and furnishes new localities for others. Those species which have not been hitherto recorded from a locality so far south, are as follows: *Panopeus depressus*, *Callinectes hastatus*, *Tozeuma carolinensis*, *Palæmonetes vulgaris*, *Palæmonetes exilipes*, *Palæmon ohionis*. *Hippa emerita* (not *talpoida* Say) has not been found further north than Cuba and Mexico. The species whose range includes Texas but which have not been previously recorded from there, are *Libinia dubia*, *Panopeus herbstii*, *Arenæus cribrarius*, *Petrolisthes armatus*, *Alpheus heterochaelis*, and *Squilla empusa*.

BRACHYURA.

1. *Libinia dubia* Milne-Edwards.
Corpus Christi; Shamrock Point, Corpus Christi.
2. *Panopeus herbstii* Milne-Edwards.
Galveston Bay.
3. *Panopeus texanus* Stimpson.
Shamrock Point, Corpus Christi.
4. *Panopeus depressus* Smith.
Galveston Bay.
5. *Callinectes hastatus* (Say).
Galveston Bay; jetty, Galveston; Swan Lake, Galveston; Corpus Christi; Shamrock Point, Corpus Christi; Dickinson Bayou. The specimens are all small, except one large male from Galveston Bay.
6. *Arenæus cribrarius* (Lamarck).
Corpus Christi Bay.
7. *Sesarma cinerea* (Bosc).
Swan Lake, Galveston.

ANOMURA.

8. *Petrolisthes armatus* (Gibbes).
Galveston Bay.
9. *Hippa emerita* (Linné ?) Fabricius.
Galveston Bay; Swan Lake, Galveston. Easily distinguished from *talpoida* by the following characteristics: The median lobe of the front is more triangular; the lateral lobes much longer and narrower. Second joint of outer antennæ with the median spine very long, much exceeding the eyes, directed slightly outward; while in *talpoida* the spine is much shorter and directed inward. Third point of outer maxillipeds longer and narrower than in *talpoida*, the inner margin being straight or slightly concave for its anterior two-thirds instead of convex as in *talpoida*; the lobe

at the antero-internal angle much longer. In the specimens under discussion the terminal joint of the third pair of legs is lanceolate, but this is not characteristic of the species.

MACRURA.

10. *Tozeuma carolinensis* Kingsley.
Shamrock Point, Corpus Christi.
11. *Alpheus heterochaelis* Say.
Galveston Bay; jetty, Galveston Bay.
12. *Palæmonetes vulgaris* (Say).
Galveston Bay; Swan Lake, Galveston; Corpus Christi; Dickinson Bayou. The specimens agree in having the tip of the rostrum devoid of spines.
13. *Palæmonetes exilipes* Stimpson.
Neches River, fourteen miles east of Palestine; Magnolia Point, Trinity River; Kilper's Pond, Houston; Big White Oak Bayou, two miles south of Houston; Corpus Christi. While as a rule the rostrum has seven or eight teeth above and two below, one specimen has nine above and three below, and several specimens with eight above have three below. The single specimen from Corpus Christi is the only one in which the rostrum exceeds the antennal scales.
14. *Palæmon ohionis* Smith.
Long Lake, Palestine; Magnolia Point, Trinity River; Big White Oak Bayou, two miles south of Houston.
15. *Penæus setiferus* (Linné).
Galveston Bay; jetty, Galveston Bay; Swan Lake, Galveston; Corpus Christi.
16. *Penæus brasiliensis* Latreille.
Galveston Bay; Swan Lake, Galveston; Corpus Christi Bay; Corpus Christi.
17. *Cambarus clarkii* Girard.
Swan Lake, Galveston. One young male.

STOMATOPODA.

18. *Squilla empusa* Say.
Jetty, Galveston Bay.

U S COMMISSION OF FISH AND FISHERIES
MARSHALL McDONALD, COMM.

MAP OF
EASTERN TEXAS
TO ACCOMPANY
A REPORT UPON INVESTIGATIONS
MADE IN TEXAS 1891
BY
BARTON W EVERMANN

NOTE —
Base map copied from
U S Fish Route map.

Route of Explorations indicated thus
Localities where examinations were made

DICKINSON BAYOU, UPSTREAM FROM NICHOLSTONE; DICKINSON, TEXAS.

TRINITY RIVER NEAR MAGNOLIA POINT, TEXAS.

MOSENFELDER CO. N.Y.

FISH POND AT SAN PEDRO SPRINGS, SAN ANTONIO, TEXAS.

SAN MARCOS RIVER AT THE MILL, SAN MARCOS, TEXAS.

MOSSEY & CO. N.Y.

SAN MARCOS SPRING, SAN MARCOS, TEXAS.

MONTANA, CO. N.Y.

SAN MARCOS SPRING, SAN MARCOS, TEXAS. (WAVER PRODUCED BY SPRING WELLING UP FROM BELOW.)

MOSSENGER, N.Y.

1. *HYBOPSIS AESTIVALIS MARCONIS* J. and G. About twice natural size.

2. *FUNDULUS PALLIDUS*, sp. nov. About three times natural size.

3. *ZYGONECTES FUNDULOIDES*, sp. nov. About three and a half times natural size.

1. ZYGONECTES PULVEREUS, sp. nov. About three times natural size.

2. ZYGONECTES JENKINSI, sp. nov. About three times natural size.

52D CONGRESS, }
1st Session. }

SENATE.

{ MIS. DOC.
{ NO. 192.

REPORT

OF THE

COMMISSIONER OF FISH AND FISHERIES

RELATIVE TO

THE SALMON FISHERIES OF ALASKA.

JULY 5, 1892.—Referred to the Committee on Fish and Fisheries
and ordered to be printed.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1892.

KARLUK PENINSULA, SHOWING CANNERIES, SEINING OPERATIONS, AND KARLUK RIVER.

REPORT ON THE SALMON FISHERIES OF ALASKA.

BY MARSHALL McDONALD,
U. S. Commissioner of Fish and Fisheries.

U. S. COMMISSION OF FISH AND FISHERIES,
Washington, D. C., July 2, 1892.

Hon. LEVI P. MORTON,
President United States Senate.

SIR: In obedience to a resolution of the Senate of the United States, directing the Commissioner of Fish and Fisheries "to communicate to the Senate any information in his possession relative to salmon fishing in Alaska, its extent, and whether the methods employed in catching salmon are likely to diminish the supply and eventually exterminate the salmon; together with his opinion as to what measures should be adopted for the protection and preservation of the salmon industry in Alaskan waters," I have the honor to transmit herewith a brief report, discussing the subject under the following captions:

1. Origin and development of the Alaskan salmon fisheries.
2. Statistics of the fisheries.
3. Present condition of the fisheries.
4. The methods and apparatus employed.
5. The protective regulation of the fisheries, including recommendations as to further legislation in reference to them.

Appended to this communication, and making a part of it, is a paper upon the life history of the salmon, by Dr. T. H. Bean, ichthyologist of the Commission. For convenience of reference I have also appended a bibliography, as far as could be ascertained in the limited time at my disposal, of publications relating to the salmon of Alaska and adjacent waters.

ORIGIN AND DEVELOPMENT OF THE ALASKAN SALMON FISHERIES.

The marvelous abundance of several species of salmon in Alaskan waters has been long known, but in consequence of the remoteness of this region and its inaccessibility, the abundant supply in rivers nearer markets, and a disposition on the part of buyers to underrate Alaskan products, its fishery resources have not been laid under contribution for market supply until within a few years, during which we have seen, as the result of reckless and improvident fishing, the practical destruction of the salmon fisheries of the Sacramento and the reduction of the take on the Columbia to less than one-half of what it was in the early history of the salmon-canning industry

on that river. At present the streams of Alaska furnish the larger proportion of the canned salmon which find their way to the markets.

The pioneer in the early development of the salmon-canning industry in Alaskan waters was the Alaska Commercial Company, which in 1887 established a cannery on Karluk River on the west side of Kadiak Island, and packed about 13,000 cases of salmon. The enterprise proved exceedingly profitable, and operations were rapidly extended so that the pack of this company on the Karluk River in 1888 aggregated 101,000 cases of 48 pounds each, representing a catch of over 1,200,000 bluebacks or red salmon in the estuary of a small stream, with a volume and drainage area not exceeding that of Rock Creek (the small stream flowing through the Zoölogical Park and discharging into the Potomac River within the city limits of Washington, D. C.). The enormous production of this year was secured by entirely obstructing the river by running a fence across so that no fish could pass up, and by continuing canning operations without intermission until late in October, when most of the fish were dark and unfit for food.

The immense pack made by the Alaska Commercial Company in 1887 and 1888, the fame of which quickly extended to San Francisco, had two important results. The attention of Congress was directed to the inevitable disaster that would overtake the salmon fisheries of Alaska unless prompt measures were taken to restrain the improvident and destructive methods employed for the capture of the salmon. Accordingly, upon the recommendation of the Commissioner of Fisheries, an act for the protection of the salmon fisheries of Alaska was introduced into Congress and became a law on March 2, 1892, as follows:

AN ACT TO PROVIDE FOR THE PROTECTION OF THE SALMON FISHERIES OF ALASKA.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the erection of dams, barricades, or other obstructions in any of the rivers of Alaska, with the purpose or result of preventing or impeding the ascent of salmon or other anadromous species to their spawning-grounds, is hereby declared to be unlawful, and the Secretary of the Treasury is hereby authorized and directed to establish such regulations and surveillance as may be necessary to insure that this prohibition is strictly enforced and to otherwise protect the salmon fisheries of Alaska; and every person who shall be found guilty of a violation of the provisions of this section shall be fined not less than \$250 for each day of the continuance of such obstruction.

SEC. 2. That the Commissioner of Fish and Fisheries is hereby empowered and directed to institute an investigation into the habits, abundance, and distribution of the salmon of Alaska, as well as the present conditions and methods of the fisheries, with a view of recommending to Congress such additional legislation as may be necessary to prevent the impairment or exhaustion of these valuable fisheries, and placing them under regular and permanent conditions of production.

SEC. 3. That section 1956 of the Revised Statutes of the United States is hereby declared to include and apply to all the dominion of the United States in the waters of Bering Sea; and it shall be the duty of the President, at a timely season in each year, to issue his proclamation and cause the same to be published for one month in at least one newspaper, if any such there be, published at each United States port of entry on the Pacific coast, warning all persons against entering said waters for the purpose of violating the provisions of said section; and he shall also cause one or more vessels of the United States to diligently cruise said waters and arrest all persons, and seize all vessels found to be, or to have been, engaged in any violation of the laws of the United States therein.

Approved, March 2, 1889.

This act, though authorizing and directing the Secretary of the Treasury to establish such regulations and surveillance as should be necessary to insure that the pro-

hibition would be enforced, neither prescribed the machinery nor appropriated the means to carry it into effect. Some restraint has doubtless been imposed upon attempts at violation of the law where they are likely to come under observation, but it is probably violated without hesitation or scruple where the chance of discovery is casual or remote.

STATISTICS OF THE FISHERIES.

The immense take of salmon in the estuary of the Karluk River in 1887 and 1888, had the additional result of attracting attention to a field promising such extravagant returns for the capital invested. More than 30 new canneries were established during the season of 1889. Five were located on the sand-spit at the mouth of the Karluk River, and 3 others so near as to draw their supplies from that source. Over 350,000 cases of red salmon, representing 4,000,000 of fish, were taken from this insignificant rivulet in 1889, and sent into the markets of the world. During this season there were 36 canneries in operation in Alaska, and the value of the salmon pack amounted to \$3,375,000.

The following table, showing the Alaskan salmon pack from 1883, when systematic canning operations were first instituted, to 1890, after they had probably reached their largest development, is very interesting as well as suggestive; interesting, as illustrating the wonderful wealth of the waters; suggestive, because we know that it has been accomplished by irrational and destructive methods, and by improvident, willful, and contemptuous disregard of natural laws, whose aid and unobstructed operation are essential to the maintenance of a continuing and productive salmon fishery in Alaska.

The Alaska salmon pack from 1883 to 1890.

Year.	Number of cases.	Year.	Number of cases.
1883.....	36,000	1887.....	190,200
1884.....	45,000	1888.....	298,000
1885.....	74,850	1889.....	675,000
1886.....	120,700	1890.....	610,747

A review of the statistics of the salmon pack of Alaska from 1883 to 1890, compiled from data gathered by the division of fisheries of the U. S. Fish Commission, shows that the total yield of the salmon fisheries of this region from 1883 to 1890, both inclusive, was 2,050,497 cases of 48 pounds each, representing an aggregate production of 28,706,958 salmon within the period mentioned. During the first three years the pack was small, viz, 36,000 cases in 1883, 45,000 cases in 1884, and 74,850 cases in 1885. After this the increase in production was phenomenal, and in 1889 had reached the enormous amount of 675,000. Production in the subsequent years receded slightly, but the aggregate for 1890 and 1891 did not fall much short of the pack of 1889. Of the entire Alaskan yield, about one half is taken from the estuary of the Karluk River. Adding the product of 1891 to the aggregate for previous years, we have a total yield of canned salmon since 1883, when regular canning began, amounting to nearly 2,750,000 cases, and a total value of \$11,000,000.

Besides the canned salmon, the rivers of Alaska yield annually nearly 7,000 barrels of 200 pounds each of salt salmon. When we add to the above production the enormous quantities of salmon which are consumed by the natives, in the fresh and dried condition, we shall be able to form some adequate idea of the immense value of the Alaskan salmon, and the importance of fostering and establishing conditions of permanence for this great resource.

In 1889 the salmon fishery gave employment to 66 vessels, including 13 steamers, 13 barks, 2 brigs, and 1 ship. Thirty-six canneries were in active operation, not counting a number of small establishments whose pack was light, and incidental to general trading with the natives. The capital stock of these canning companies ranged from \$75,000 to \$300,000. The estimated capital was \$4,000,000, and the value of the pack \$3,375,000.

PRESENT CONDITION OF THE FISHERIES.

OBSTRUCTIONS IN THE RIVERS.

Early in April, 1890, information reached the Commissioner of Fisheries in regard to a salmon trap, the construction of which had been determined upon by four cannery firms located on the Nushagak River. About 25 miles from the mouth of this river is a tributary known as Wood River, into which most of the salmon entering the Nushagak make their way for the purpose of spawning in the two large lakes at its head. Believing that such action was a violation of the act of Congress approved March 2, 1889, providing for the protection of the salmon fisheries of Alaska, the Commissioner transmitted the information to the Secretary of the Treasury with the suggestion that the necessary steps be taken by some of the Treasury officials in that region. The matter was referred to the chief of the Revenue-Marine division with the recommendation that if possible the captain of one of the Revenue-Marine steamers cruising in Alaskan waters be directed to make an investigation, and, if necessary, have the obstructions removed and the guilty parties arrested and prosecuted.

On April 12 the chief of the Revenue-Marine division returned the correspondence to the Commissioner of Fisheries with the information that the commanding officers of the Revenue-Marine steamers cruising in Alaskan waters during the ensuing season would be instructed to enforce the law for the protection of the fisheries as far as circumstances would permit. He suggested also that the commanding officer of the Fish Commission steamer *Albatross* be instructed to investigate the complaint and enforce the law if found necessary. Inasmuch as the Commissioner of Fisheries did not have authority to give directions for the enforcement of the law, he wrote to the chief of the Revenue-Marine division on April 17 that if the Secretary desired to confer the necessary authority upon the commanding officer of the *Albatross*, Lieut. Commander Z. L. Tanner, U. S. Navy, he would take pleasure in forwarding the same. On the following day, therefore, the acting Secretary of the Treasury, Hon. George S. Batcheller, forwarded to the Commissioner of Fisheries the following order, clothing the commander of the *Albatross* with the necessary authority to act in the matter, inclosing at the same time copies of Treasury circular of March 16, 1889, in relation to the matter.

TREASURY DEPARTMENT, OFFICE OF THE SECRETARY,
Washington, D. C., April 18, 1890.

SIR: You are hereby clothed with full power and authority to enforce the provisions of law contained in act of Congress approved March 2, 1889, providing for the protection of the salmon fisheries of Alaska, which prohibits the erection of dams, barricades, or other obstructions in any of the rivers of Alaska, with the purpose or result of preventing or impeding the ascent of salmon or other anadromous species to their spawning-grounds.

Respectfully, yours,

GEO. S. BATCHELLER,
Acting Secretary.

Lieut. Commander Z. L. TANNER,
*Commanding U. S. Fish Commission Steamer Albatross,
 San Francisco, Cal.*

TREASURY DEPARTMENT, OFFICE OF THE SECRETARY,
Washington, D. C., March 16, 1889.

TO COLLECTORS AND OTHER OFFICERS OF THE CUSTOMS:

The following provision of the act approved March 2, 1889, entitled "An act to provide for the protection of the salmon fisheries of Alaska" is hereby published for the information and guidance of all concerned:

"That the erection of dams, barricades, or other obstructions in any of the rivers of Alaska, with the purpose or result of preventing or impeding the ascent of salmon or other anadromous species to their spawning-grounds, is hereby declared to be unlawful, and the Secretary of the Treasury is hereby authorized and directed to establish such regulations and surveillance as may be necessary to insure that this prohibition is strictly enforced and to otherwise protect the salmon fisheries of Alaska; and every person who shall be found guilty of a violation of the provisions of this section shall be fined not less than \$250 for each day of the continuance of such obstruction."

Collectors and other officers of the customs, and officers under the jurisdiction of this Department who may be assigned to duty in Alaska, will see that the requirements of said section are strictly observed, and that no dams, barricades, or other obstructions are placed in any of the rivers of Alaska with the purpose or result of preventing or impeding the ascent of salmon or other anadromous species to their spawning-grounds; and should any such dams, barricades, or other obstructions be discovered, to warn the persons who erected the same to immediately remove them and thereafter report the persons (with statement of facts) to the United States attorney of Alaska for prosecution under the said section, and also to forward duplicate reports to this Department for its information.

Officers of the Revenue-Marine Service on duty in Alaskan waters are hereby required, so far as practicable, to assist officers of the customs in Alaska in seeing that the requirements of the statute are strictly enforced.

HUGH S. THOMPSON,
Acting Secretary.

On April 23 a letter of instructions was forwarded to Lieut. Commander Tanner, calling his attention to the existence of a trap or dam on Wood River, as also to the order of the Secretary of the Treasury directing the Revenue-Marine steamers to enforce the law as far as circumstances would permit, and to the request that the steamer *Albatross* make an investigation and carry out the provisions of the law in case of its violation. Lieut. Commander Tanner was directed to make this one of the first objects of his cruise in Bering Sea, and to comply with the instructions of the Secretary of the Treasury as fully as possible. The report of Lieut. Commander Tanner, after making the investigation, was as follows:

UNALASKA, ALASKA TERRITORY, *June 15, 1890.*

HON. MARSHALL McDONALD,
U. S. Commissioner of Fish and Fisheries, Washington, D. C.:

DEAR SIR: I have the honor to inform you that the *Albatross* anchored in the Nushagak River on June 3. I visited the four canneries located on that stream the following day. They use gill nets

almost exclusively in taking salmon, although three of them have a small trap in the immediate vicinity of their establishments. They are all dry at low tide, and when fish are found in them men go in and pick them up from the ground.

The fourth cannery had a trap formerly, but did not find it profitable. Nothing that can be called an obstacle to the free passage of salmon exists in the Nushagak River.

I learned from Mr. J. W. Clark, one of the projectors, and others, that a union trap was in process of construction in Wood River, and in order to ascertain the character and present condition of the work I took Mr. P. H. Johnson, who has charge of the enterprise, and Mr. Clark, in one of the ship's boats, and steamed to the point indicated, which I found to be about 20 miles above its mouth.

Wood River at that point is a stream of pure cold water between 700 and 800 feet in width and 10 feet deep at low tide; rise, 3 to 4 feet.

The work of trap-building was in progress, a group of ten piles having been driven about 300 feet from shore, and lying on the bank were a portion of the nets required to mount the finished structure. Operations were not sufficiently advanced to enable me to judge their intention, and I can only give the plan as detailed to me by the builders. Mr. Clark stated that the plans contemplated two 40-foot square traps, with wings extending to the shore on either side, an open channel of 100 feet being left in midstream for the passage of the salmon; that he had joined the enterprise with the stipulation that this passage should be left unobstructed at all times.

In reply to a question, he said that he had lived in the country many years as a fur-dealer, and the thickly populated region on Wood River contained many of his best customers; hence he would have no hand in anything that would injure them. An obstruction in the river preventing the run of salmon would result in actual starvation to the majority of the natives.

Mr. P. H. Johnson, the prime mover in the affair, described the plans precisely as Mr. Clark had done. He considered the traps as an experiment involving too much money to be expended by either of the canneries singly; hence, he had endeavored to interest all four, and finally succeeded, Mr. Clark having joined them with the provision that a free passage of at least 100 feet should be left in the middle of the river. He said this stipulation was agreed to willingly, as they never had an idea of barricading the stream. The inclosed sketch shows the plan as given to me by the gentlemen mentioned; and the blue prints [not reproduced] give an accurate idea of the present state of the structure. It will be observed that, while a 100-foot channel will serve for the ascent of salmon, complete barricade of the stream can be accomplished with a net of that length, 12 to 15 feet in depth. Whether this simple appliance will be used depends, in the absence of a Government inspector, upon the canners themselves.

Very respectfully,

Z. L. TANNER,
Lieutenant Commander, U. S. Navy, Commanding.

NOTE.—The river is at this point about 750 feet wide; depth at mean low water, 10 feet; rise, 3 to 4 feet.

UNALASKA, ALASKA TERRITORY, *June 18, 1890.*

Hon. MARSHALL McDONALD,

U. S. Commissioner of Fish and Fisheries :

DEAR SIR: In looking over my letter regarding the construction of traps in Wood River it occurs to me that I may not have explained my action very definitely. It is generally understood here that the act of March 2, 1889, does not prohibit the ordinary use of the trap, and that when a practicable channel is left for the passage of salmon they may lawfully be used. As I did not feel fully competent to argue the point I advised them to keep within the law, as the Government intended to enforce it strictly and would exact the full penalties for its infraction.

If it is the intention of the act to prohibit the use of traps, I would respectfully suggest that it be so stated in a Treasury circular. It would simplify matters very much if the Treasury Department would state definitely what the canners may or may not do under the act of March 2, 1889.

Very respectfully,

Z. L. TANNER,

Lieut. Commander, U. S. Navy, Commanding.

This correspondence was referred to the ichthyologist of the Commission, who made the following report:

U. S. COMMISSION OF FISH AND FISHERIES,

Washington, D. C., July 24, 1890.

Col. MARSHALL McDONALD,

U. S. Commissioner of Fish and Fisheries :

SIR: After having considered the letters of Lieut. Commander Z. L. Tanner, U. S. Navy, dated June 15 and 18, 1890, referring to the construction of a trap in Wood River, Alaska, I respectfully offer my opinion that such a contrivance for the capture of salmon is of the nature of an obstruction which would impede and, in all probability, prevent the ascent of salmon to their spawning-grounds. It is, therefore, clearly a violation of the act approved March 2, 1889, a portion of which is quoted herewith:

[PUBLIC No. 158.—An act to provide for the protection of the salmon fisheries of Alaska.]

“*Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the erection of dams, barricades, or other obstructions in any of the rivers of Alaska, with the purpose or result of preventing or impeding the ascent of salmon or other anadromous species to their spawning-grounds, is hereby declared to be unlawful, and the Secretary of the Treasury is hereby authorized and directed to establish such regulations and surveillance as may be necessary to insure that this prohibition is strictly enforced and to otherwise protect the salmon fisheries of Alaska; and every person who shall be found guilty of a violation of the provisions of this section shall be fined not less than \$250 for each day of the continuance of such obstruction.*”

It has been demonstrated that traps in salmon rivers will speedily exterminate the salmon. Newfoundland furnishes a satisfactory illustration of this fact. So well is this matter understood that British Columbia forbids altogether the capture of salmon in narrow reaches of streams, and the rivers are guarded to see that the close time and other regulations are observed; the length of nets and their size of mesh are fixed by law; even the offal from canneries is not allowed to lie in the way of ascending fish.

The Alaskan salmon firms are in the territory to get fish. They prefer to get them without injury to the future of the business if possible, but get them they must or be overcome by financial disaster. In their efforts to win success they have often stretched nets across the mouths of small streams and prevented the salmon from going up until a sufficient number had collected to make a good seine haul possible. They have erected traps in rivers in such a way as to stop every salmon from ascending and, in some cases, actually built impassable barricades to prevent the ascent of fish entirely until the demands of the canneries were satisfied. Even when fishing regulations were adopted by mutual agreement among the firms interested, individual infractions of the rule were only too frequent.

The trap men on Wood River are building upon the well-known habit of the quinnat (or king salmon) of following along the shores in shallow water to escape from enemies. All the conditions, both natural and invented, will favor the entrance of salmon into the great inclosure at the end of the leader of netting. In all probability few salmon will swim in midchannel and reach the upper

waters and lake sources of the river, and it will always be possible to cut off this remnant in the manner suggested by Lieut. Commander Tanner and actually practiced by fishermen on occasions, that of stretching a seine across the open water. If the Government should interpret its act so as to allow the use of traps, in spite of the unfortunate outcome of such appliances in neighboring countries, it should then prescribe regulations for the conduct of the fishery and appoint agents to see that the laws are enforced. If these matters are left solely to the discretion of the individuals having a financial interest in the fishery there will soon be no salmon to protect.

Very respectfully,

T. H. BEAN,
Ichthyologist, U. S. Fish Commission.

The papers relating to the obstruction of Wood River were transmitted to the Secretary of the Treasury by the Commissioner of Fish and Fisheries with the following letter:

WASHINGTON, D. C., July 31, 1890.

THE SECRETARY OF THE TREASURY, *Washington, D. C.:*

SIR: Referring to your communication of April 18 last, forwarding to Lieut. Commander Z. L. Tanner, U. S. Navy, commanding the Fish Commission steamer *Albatross* on the Pacific coast, a letter clothing him with full power to enforce the provisions of the Alaskan salmon law, with special reference to obstructions which it was reported were to be constructed in the Nushagak and Wood rivers, I have the honor to transmit herewith for your consideration several documents bearing upon that subject, namely:

Copies of two letters from Lieut. Commander Z. L. Tanner, with their inclosures, dated Unalaska, Alaska, June 15 and 18, and a copy of a letter from Dr. T. H. Bean, ichthyologist of the U. S. Fish Commission, dated July 24.

Lieut. Commander Tanner reports having visited the Nushagak and Wood rivers on June 3. He found no obstructions in the former river, but in the Wood River two traps were in process of construction, with wings leading to the shore and leaving a passageway in the middle of the river 100 feet wide. Not feeling competent to judge if these traps formed an obstruction to the ascent of salmon within the meaning of the law, Lieut. Commander Tanner did not feel justified in carrying out the provisions of the law without further instructions from Washington.

Dr. T. H. Bean, whose letter is inclosed, may be considered as one of the foremost authorities in this country respecting the habits of the Alaskan salmon. He paid special attention to that subject during two official visits to Alaska, the last visit having been made a year ago, in obedience to instructions from Congress contained in the act of which the law now referred to forms a part. In his opinion the building of the traps in Wood River according to the plan submitted by Lieut. Commander Tanner should be regarded as an infringement of the law, and in that opinion I fully concur.

Should you desire to have further instructions respecting this matter sent to Lieut. Commander Tanner, I shall be pleased to transmit the same without delay, although, on account of the imperfect mail arrangements with Unalaska, I fear they may not reach him before the close of the season.

Very respectfully,

M. McDONALD,
Commissioner.

To the foregoing communication the Acting Secretary of the Treasury made the following reply:

TREASURY DEPARTMENT, OFFICE OF THE SECRETARY,
Washington, D. C., August 13, 1890.

HON. MARSHALL McDONALD,

U. S. Commissioner of Fish and Fisheries, Washington, D. C.:

SIR: I respectfully acknowledge the receipt of your letter dated July 31, 1890, with the following inclosures:

Copies of two letters from Lieut. Commander Z. L. Tanner, U. S. Navy; one sketch and two blue prints of Wood River, Alaska, and one letter from Dr. T. H. Bean, ichthyologist, U. S. Fish Commission.

The correspondence above mentioned has been carefully reviewed, and you are informed that it is the decision of this Department that the erection of traps as described by Capt. Tanner, or any other

permanent fences, dams, or barricades in any of the rivers of Alaska, whether they extend wholly or only in part across said stream, is an impediment to the ascent of salmon or other anadromous species to their spawning-grounds, and is clearly a violation of the act of March 2, 1889.

The Department will be pleased if you will inform Lieut. Commander Tanner of its decision in this case and instruct him to warn the parties who erected said traps, or any others of like nature that may come to his notice, to immediately remove the same, and thereafter to report the persons, with statement of facts, to the United States attorney of Alaska for prosecution under act March 2, 1889, and also to forward a duplicate of his report to this Department for its information.

Respectfully yours,

O. F. SPAULDING,
Acting Secretary.

The following communication was therefore transmitted to Lieut. Commander Tanner, advising him of the ruling of the Treasury Department:

WASHINGTON, D. C., *August 15, 1890.*

Lieut. Commander Z. L. TANNER,
Commanding Fish Commission Steamer Albatross,
Unalaska, Alaska:

DEAR SIR: Your letters of June 15 (179) and 18 (182), relative to your visit to the Nushagak and Wood rivers in respect to reported obstructions to the ascent of salmon, came duly to hand and were referred to the Secretary of the Treasury for his information. In connection with them, I also transmitted to the Secretary of the Treasury a report by Dr. Bean based upon your letters and describing the inevitable effect of the construction of such traps as those now being constructed in the Wood River. A copy of Dr. Bean's report is herewith inclosed, and also a copy of a letter just received from the Acting Secretary of the Treasury, in which a decision is rendered that the Wood River traps are a violation of the act of March 2, 1889.

Should this communication reach you in time you will proceed to carry out the request of the Treasury Department as stated in the letter of the Acting Secretary.

Very respectfully,

M. McDONALD,
Commissioner.

LIMITATION OF THE SALMON CATCH BY AGREEMENT OF THE CANNERS.

The restrictions and embarrassments imposed upon the operations of the canneries by the act of Congress prohibiting the erection of barriers to the ascent of salmon in the rivers, and the decision of the Secretary of the Treasury that the erection of traps or any other permanent fences, dams, or barricades in any of the rivers of Alaska, whether extending wholly or only in part across said streams, was an impediment to the ascent of salmon and other anadromous species to their spawning-grounds, and therefore unlawful, changed the methods and apparatus of the fisheries, but brought no relief or immunity from the threatened disaster, since the methods substituted exclude the salmon from their spawning-grounds as effectually as if permanent obstructions were maintained in the rivers.

The pack of 1891 fell but little short of the enormous pack of 1889, and the accumulated stock of 1889, 1890, and 1891, being in excess of the demands of the market, had its natural result in causing a break in prices, which proved disastrous to many of the canneries and led to a combination of interests for the purpose of reducing production. An agreement to limit the catch was entered into by the canners of Alaska and British Columbia, which was put in operation the present season.

This limitation of the salmon catch by agreement places a check upon excessive fishing in Alaska. The effect will be conservative, although the measure was actuated

by selfish motives and may be abrogated at any time when prices recover under the stimulus of increased demand.

Before the opening of the salmon fishery in 1891 it was reported that 600,000 cases of canned salmon were in San Francisco warehouses and that in London about 400,000 cases which had passed into second hands were still on the market. This represents about two-thirds of the total average annual output of the Pacific coast. Finding that the market was overstocked and the price of canned salmon reduced in consequence, so that in many cases business became unprofitable, the canners decided to make a combination and curtail the fishing in the season of 1892. The output of the canneries of Alaska and the Pacific coast canneries for 1891 has been tabulated as follows:

	Cases.
Columbia River	390,000
Outside Oregon Rivers	20,000
Puget Sound	20,000
Fraser River	225,000
British Columbia and elsewhere	235,000
Alaska	800,000
	<hr/> 1,680,000

It was expected that the organization of the canners would include those of California and British Columbia as well as Alaska. The first subject of agreement was the reduction of the output to one-half of the usual quantity. By this means the canners hope to improve the trade, especially in the English market. The canners are under heavy bonds to keep the agreement and at the end of the season to declare under oath the amount of their packs. Of the thirty-seven canneries in Alaska only nine will be operated, and the men usually employed in the other establishments will not be hired. The same reduction will be made in California and British Columbia. In Alaska the intention was to operate two canneries at Karluk, two on the Nushagak, one at Chignik Bay, one at Cook Inlet, one either at Loring or Chilkat, one at Alitak Bay, and one at Copper River. The Alaskan output is to be limited to 400,000 cases.

The following agreement was entered into March 25, 1892, between the salmon-canners of Fraser River, Skeena River, Rivers Inlet, and elsewhere in British Columbia:

Whereas, on account of the overproduction of canned salmon on this coast, the markets of all salmon points in the United States, Canada, and Great Britain are overstocked with canned salmon, and it is desirable in the mutual interests of the parties to this agreement that some limitation in the pack of the coming season should be agreed to, in order that the supply of and demand for that article may be equalized; the several parties hereto have agreed to limit the pack of canned salmon at the canneries owned, controlled, or operated by them and each of them respectively upon the terms and in proportion hereinafter mentioned, as follows, viz: That the reduction in the pack of canned salmon during the season of 1892 shall be upon the Fraser 50 per cent upon the capacity of each cannery, and on the Skeena River and northern points 25 per cent upon the capacity of each cannery.

The salmon-canners on Kodiak Island constitute the following eight companies: The Karluk Packing Company, the Kodiak Packing Company, the Aleutian Island Fishing and Mining Company, the Hume Packing Company, the Arctic Packing Company, the Royal Packing Company, the Russian-American Packing Company, the Alaska Improvement Company.

The capital is upward of \$2,000,000. In 1890 they employed 550 men to can 260,000 cases of salmon of 48 pounds each. In 1891 they proposed to reduce the force of men to 160, and still increase the take of salmon. They agreed to employ the same force of fishermen and to appoint a superintendent to see that each day's catch was equally divided among the eight companies. Each cannery was to be allowed the privilege of using private labels as before. The object of this consolidation was not to raise the price of the salmon, but to reduce the cost of taking it, in order to compete with the other thirty canneries and make money. In 1889 three canneries were located on Chignik Bay, and their catch was enough to pay only one, so they employed only one force of fishermen, and the yield in 1890 showed the wisdom of the plan. The title of the association is "The Board of Managers of the Karluk Canning Companies." The president of the board is Leon Sloss, jr., of the Alaska Commercial Company, and the secretary, Leon Maison, of the firm of Geo. W. Hume & Co. The following account of the organization and its operations in 1891 was furnished by Mr. Wm. H. Brommage, of Alameda, California.

Early in 1891 representatives of the various canneries in Alaska held a meeting under the title of "The Board of Managers of the Karluk Canning Companies" with the object of devising means to conduct fishing operations with less expense than usual, intending to put up 250,000 cases. They formed a combination as follows: The Arctic and Kodiak, the Hume and Aleutian Island, the Karluk and Royal, the Alaska Improvement and Russian American.

The pack was to be divided according to the capacity of each cannery; for example: Arctic and Kodiak, $\frac{7.2}{25.0}$; Hume and Aleutian, $\frac{7.5}{25.0}$; Karluk and Royal, $\frac{5.8}{25.0}$; and Alaska Improvement and Russian American, $\frac{4.5}{25.0}$. Independent of this, the Kodiak, Russian American, and Royal Packing Companies combined and were to put up fish caught at Little River and Afognak, which was not to be included in the Karluk pack. They employed 61 white men. The larger combination employed 160 men for Karluk, wages \$60 for round trip and \$12.50 per thousand fish.

Mr. Brommage made inquiry at the headquarters of the Board of Managers of the Alaska Canning Companies on February 24, 1892, and found that 800 men were looking for employment and that only 100 would be engaged, and that only the most experienced of them would be selected. These would be distributed to all the different stations in Alaska. He was informed that only 20 men would be sent to Karluk.

APPARATUS AND METHODS OF THE FISHERIES.

Gill nets, traps, and seines are employed in the capture of salmon, but the greatest bulk of the catch is made by haul seines, which sweep the estuaries of the small rivers, in which the larger part of the salmon catch is made, or are laid out from and landed on the beach proper immediately adjacent to the mouth of the river. One seine follows another in such rapid succession as to cover all approaches to fresh water, and the movement of the salmon into the rivers is as effectually arrested as if permanent barriers were maintained across the entire width of the stream. Gill nets may be used with the same results by stretching them from bank to bank. Traps, indeed, may be so skillfully located in accordance with the habits and movements of the salmon as to form effectual barriers to the upward movement of salmon in the rivers, though invading only in part the channel. Any or all of the different methods

here indicated may be employed with such persistence and under such conditions as completely to arrest the movement of the salmon into and up the streams.

The methods at present practiced by the canneries for obtaining a supply of salmon have an influence in bringing about the impoverishment of these important fisheries which can only be understood by a clear apprehension of their relations to the habits and migrations of the species which are the object of the fishery. A separate paper prepared by Dr. T. H. Bean, ichthyologist of the Commission, upon "The Life History of the Salmon," is therefore appended to and made a part of this report. The account of the distribution, migrations, habits, times, and essential conditions of natural reproduction there given will furnish the explanation and reason for such recommendations of further legislation as may be submitted.

SPECIES OF SALMON OF ECONOMIC VALUE.

The species of salmon found in Alaska in quantities sufficient to constitute an economic resource are: The red salmon (*Oncorhynchus nerka*), the king salmon (*Oncorhynchus chouicha*), the silver salmon (*Oncorhynchus kisutch*), the humpback salmon (*Oncorhynchus gorbusha*), the dog salmon (*Oncorhynchus keta*), the steelhead (*Salmo gairdneri*), and the dolly varden (*Salvelinus malma*).

The Red Salmon.—This species at present constitutes the principal motive and object of canning operations. The southern limit of its range is the Columbia River, in which it is known as the blueback salmon. Its range extends northward to the Yukon River, and it makes its appearance in southern Alaskan waters early in June, the run beginning later as we proceed farther to the north. Schools of salmon continue to arrive until October and, after tarrying a short time in the coast waters, begin to ascend to their spawning-grounds, which are in the cold, snow-fed lakes from which issue the headwaters of the streams which are frequented by this species for the purpose of reproduction. The run is confined chiefly to the smaller streams, such as the Karluk, in which they crowd in numbers absolutely incredible to one who is not an eye-witness, and actually force each other out of the water in their eager struggles to reach the sources of the rivers and deposit their spawn.

The King Salmon.—This is the principal canning species of the Columbia and other rivers of Oregon and California, but at present it has relatively little importance in the Alaskan salmon fisheries. It is distinctively the salmon of the larger rivers, like the Yukon, on which the canning industry has not yet attained much development. It is, however, an abundant species, and with the growth of the canning industry on the larger rivers will attain great commercial importance.

The Silver Salmon.—This species is in great request for canning in the Puget Sound region, but is not held in much esteem by the canners of Alaska, because it becomes soft very soon after its capture and can not be kept like the red salmon. It spawns in the fall of the year, but does not make its appearance on the coast until shortly before canning operations close for the season, and, consequently, the opportunity for natural reproduction is more favorable than for the red salmon or king salmon. The species is abundant now, and under present conditions of the fisheries will doubtless maintain itself. The flesh, though not highly colored, is probably not inferior in table qualities to that of the red salmon, and in the future, with the extension of canning operations, it will doubtless be utilized more extensively than at present.

The Humpback Salmon.—This is the smallest, the most abundant, and most widely distributed species of the Alaskan salmon. It arrives on the coast of Kadiak from the 1st to the 10th of July, and continues to run for about five weeks, the height of the spawning season being early in August. It does not ascend far from salt water, and usually enters streams which are too shallow to cover its back fins. This species is not much used at present for canning purposes, but is dried by the natives in great quantities for winter use, and moderately large numbers are salted for the San Francisco and other markets. When fresh run its flesh is not inferior in edible qualities to that of the red salmon, and has a beautiful red color, but rapidly deteriorates after it enters the estuaries of the rivers. This species, from its abundance and wide distribution, will attain great commercial importance when its good qualities are better known.

The Dog Salmon.—This species occurs very abundantly in the small rivers and creeks of the islands and the main land. It makes its appearance at Kadiak about the middle of June and continues abundant for a month, after which the numbers rapidly diminish. It leaves the coast with the first appearance of ice. The flesh of this species will hardly ever be in request for canning, but it is one of the most important species to the natives, who dry it for winter use.

REPRODUCTION AS RELATED TO METHODS.

The species of salmon above enumerated, though differing in their seasons of reproduction and in their spawning habits and requiring different conditions and environment, are all subject to the restraint of one common law: they must have access to their natural spawning-grounds in the rapids of the rivers or in the cold, snow-fed lakes from which they issue; and in this natural law is to be found the suggestion of such legislation as may be necessary "to maintain the salmon fisheries under permanent conditions of production."

Whether these fisheries shall continue to furnish the opportunity for profitable enterprise and investment depends upon the policy to be inaugurated and maintained by the Government. Under judicious regulation and restraint they may be made a continuing source of wealth to the inhabitants of the Territory and an important food resource to the nation; without such regulation and restraint, we shall have repeated in the Alaskan rivers the story of the Sacramento and the Columbia; and the destruction in Alaska will be much more rapid because of the small size of the rivers and the ease with which salmon can be prevented from ascending them. For a few years there will be wanton waste of that marvelous abundance, which the fishermen—concerned only for immediate profit and utterly improvident of the future—declare to be inexhaustible. This season of prosperity will be followed by a rapid decline in the value and production of these fisheries, and a point will be eventually reached where the salmon-canning industry will be no longer profitable.

PROTECTIVE REGULATION OF THE FISHERIES.

Whatever may be the particular regulations and requirements it shall be found necessary to impose in the prosecution of the salmon fishery in order to maintain the supply, it is essential they should provide either that a considerable proportion of the run into the rivers shall be permitted to pass up and accomplish natural reproduction in the lakes and tributary streams, which afford feeding-grounds for the young salmon

during the period of their sojourn in fresh water, or that artificial propagation of the young and their distribution to the headwaters of the streams shall be prosecuted on a scale adequate to compensate for the interference with and the curtailment of natural reproduction by the operation of the fisheries.

If it be the policy of the Government to depend upon natural reproduction to maintain supply, this can be made effectual only by the enactment and enforcement of such regulation of the fisheries as will assure adequate reproduction under natural conditions. The different agencies which may be invoked, either separately or in conjunction, to accomplish this end are:

- (a) A weekly close season from Saturday evening to Monday morning.
- (b) A close season during September and October of each year.
- (c) The establishment of national salmon parks or salmon reservations, as proposed by Dr. Livingston Stone.
- (d) Absolute prohibition of the capture of salmon by the use of nets or other apparatus within 100 yards of the mouth of any river.
- (e) The prohibition of the use of more than one seine in the same seine berth.
- (f) The leasing of the privilege of taking salmon and the limitation of the catch, in accordance with the recommendation of the Commissioner of Fish and Fisheries, based upon continued and careful investigations of the conditions of the fisheries.

The establishment of a weekly closed season will assure that some proportion of the run will succeed in reaching their spawning-grounds, will of course have a conservative influence in keeping up supply, will render slower the depletion of the waters, and will probably prevent the extermination of the salmon.

The establishment of a close season during September and October will permit the schools of salmon approaching the coast during this period to enter the rivers and spawn unmolested. The conservative influence of this measure will depend of course upon the number of salmon which approach the coast only after the opening of the close season.

The establishment of national salmon parks or salmon reservations, as proposed by Dr. Livingston Stone in a paper read before the American Fisheries Society, would be an important factor in maintaining production and could be accomplished with relatively little cost. The importance of this agency as a means of maintaining the supply is so interestingly and forcibly presented by Dr. Stone in the article referred to that it is deemed appropriate to reproduce it here as published in *Forest and Stream* of June 16, 1892:

A NATIONAL SALMON PARK.

[A paper read before the American Fisheries Society.]

Who would have thought thirty years ago that the creation of a national park in this country would be the means of rescuing the buffalo from extinction? Who thought then that anything was needed to rescue the buffalo? The buffalo roamed in myriads over the plains and mountain slopes of the central portions of the United States and were so innumerable that, with the exception of a few far-sighted persons, no one thought that this noble race of animals was even in danger. The supply seemed inexhaustible and the species at least safe from extinction.

How soon we found out our mistake and how suddenly the change came. The note of alarm had hardly been sounded long enough to be distinctly comprehended over the country before the buffalo were gone—all gone practically, except a few straggling survivors which, if they had not found refuge

in Yellowstone Park, would have been gone, too, long before this. The Yellowstone National Park saved them. It saved the wild race from extinction, and, if nothing else should ever be accomplished by the creation of the park, this alone would, in the writer's estimation, justify its existence.

But if any one had said thirty years ago, "Let us form a national park in the buffalo region for a protection and refuge for the buffalo," the proposition would have been laughed down from one end of the country to the other. It would have been thought a most ridiculous expedient, a scheme too foolish and crazy to be even seriously entertained. Nevertheless, the creation of the National Park has accomplished this very object, and has been, I think it may be safely said, the only means of accomplishing this most important object, the preservation of the American buffalo.

Now what this paper is going to propose will appear, doubtless, just as ridiculous, just as foolish and crazy, as the formation of a park for the preservation of the buffalo would have been thought thirty years ago. It is nothing less than the creation of a national park for the preservation of our salmon.

I hear already from all directions the question "What do the salmon need a park for? Are there not plenty of places of safety for them already in all the rivers and streams of this country, not to mention the pathless ocean, where man can not follow them?"

It looks so at first sight, I admit; but let us try to find these places of safety if they exist, and then see how it looks. We certainly can not find them on the Atlantic coast, where the scanty yield of the only two American salmon rivers—the Kennebec and the Penobscot—is only a drop in the bucket compared with the total consumption of salmon. Passing over to the Pacific coast, we find only the Sacramento, the Columbia, and the lesser streams on the Washington and Oregon coast, and in all these the salmon are about as safe as the fur seals were last year in Bering Sea.

I will say from my personal knowledge that not only is every contrivance employed that human ingenuity can devise to destroy the salmon of our west-coast rivers, but more surely destructive, more fatal than all is the slow but inexorable march of those destroying agencies of human progress, before which the salmon must surely disappear as did the buffalo of the plains and the Indian of California. The helpless salmon's life is gripped between these two forces, the murderous greed of the fishermen and the white man's advancing civilization, and what hope is there for the salmon in the end? Protective laws and artificial breeding are able to hold the first in check, but nothing can stop the last.

To substantiate this statement, which may seem exaggerated, let me inquire what it was that destroyed the salmon of the Hudson, the Connecticut, the Merrimac, and the various smaller rivers of New England, where they used to be exceedingly abundant? It was not overfishing that did it. If the excessive fishing had been all there was to contend with a few simple laws would have been sufficient to preserve some remnants at least of the race. It was not the fishing, it was the growth of the country, as it is commonly called, the increase of the population, necessarily bringing with it the development of the various industries by which communities live and become prosperous. It was the mills, the dams, the steamboats, the manufactures injurious to the water, and similar causes, which, first making the streams more and more uninhabitable for the salmon, finally exterminated them altogether. In short, it was the growth of the country and not the fishing which really set a bound to the habitations of the salmon on the Atlantic coast.

Let me illustrate this same statement more in detail by presenting the testimony of the salmon rivers of the Pacific coast. Take for an example the Sacramento. When the first rush of gold-seekers came to California in 1849, every tributary of the Sacramento was a fruitful spawning-ground for salmon, and into every tributary countless shoals of salmon hastened every summer to deposit their eggs. When the writer went to California in 1872, only twenty-three years later, not one single tributary of the Sacramento of any account was a spawning-ground for the salmon except the McCloud and Pitt rivers in the extreme northern part of the State, where the hostility of the Indians had kept white men out. It was not fishing by any means that had caused the disappearance of the salmon, for the miners did very little fishing in those times; but it was the débris from the quartz mines which drove the salmon out, ruining the spawning-grounds and rendering the river uninhabitable for the salmon.

This was in 1872. In 1878 the writer took 14,000,000 of salmon eggs from the summer run at the United States salmon station on the McCloud River. In 1883 the Southern Pacific Railroad Company (then the Central Pacific) extended their line northward up the Little Sacramento, crossing the mouth of Pitt River, into which the McCloud empties, a mile or two above.

So disastrous to the salmon was the effect of the road building along the Little Sacramento and the mouth of the Pitt that that year it was with great difficulty and only by very hard work that we

succeeded in getting barely 1,000,000 salmon eggs, and the next year Prof. Baird, in disgust at what he considered the unpardonable indifference of the Californians, discontinued taking salmon eggs at this station. Since that time sawmills of immense capacity have been erected at the head of the Little Sacramento and the McCloud, and have done very effective work in increasing the now alarming scarcity of the spawning salmon of the Sacramento.

I think these instances are sufficient to show that what the friends of the salmon have to fear more than overfishing is the growth or development of the country always attendant upon an increasing population, but the fatal consequences of which to the salmon it is impossible to avoid. Nothing can stop the growth and development of the country, which are fatal to the salmon. For instance, there was no power in the world that could have prevented the mining on the Feather, the Yuba, the American Fork, or the other spawning streams of the salmon; nothing could have stopped the building of the railroad up the Little Sacramento or the erection of the sawmills on the upper McCloud. They came along naturally and inevitably in the march of events, and they could not be withstood; and nothing was left for the salmon but to suffer the consequences and disappear as by a decree of fate.

Now actual fishing in the salmon streams can be regulated by law and rendered comparatively harmless, but the country will continue to grow more and more populous, and the fatal march of civilization will proceed as irresistibly as ever. That can not be held back, and unsafe as the salmon are now in our Atlantic and Pacific coast rivers, they will become more and more unsafe every year; all of which goes to show that there is no safe place for the salmon within the limits of the United States proper.

This leaves us only Alaska. Now, how is it with the salmon streams of Alaska? Not even there are the salmon safe. Countless myriads of salmon formerly filled all the rivers and streams of the long Alaskan coast, and they were nearly 2,000 miles from the destroying hand of civilized man, but they were not safe even on those distant shores. The ubiquitous canneryman found them, and he already has his grip on the best and most fruitful of the Alaskan rivers. The pressure of the world's demand on the world's supply of canned salmon renders it necessary for the salmon-canner to occupy more distant and less fruitful fields every year, and it is only a question of time when all the Alaskan salmon streams are given over to the canneries, and when that time comes no one will claim, I think, that the salmon are safe in Alaska.

One or two illustrations are sufficient. The Karluk River, on Kadiak Island, is probably the most wonderful salmon river in the world. On August 2, 1889, the cannery nets caught on Karluk Beach, at the mouth of the river, 153,000 salmon by actual count. A short time after, the writer went up the Karluk River in a bidarka—the skin boat of the natives—expecting to see myriads of salmon spawning and thousands on their journey to the spawning-grounds, but instead of the wonderful sight we anticipated, our whole party, I think, saw less than a dozen in the river till we reached the lower spawning-grounds, and then, to our astonishment, we saw only a few scattering fish spawning, such as one might expect to see in the most commonplace salmon river in the world; 153,000 salmon caught in one day at the mouth of the river, and none to speak of going up the river to reproduce their species. Every one can draw his own inference. The fact is significant enough.

On another river, a large one, the Nushagak, where vast numbers of salmon were taken at the mouth one summer for canning, we were told that the succeeding winter the natives living up the river were brought to the verge of starvation because the salmon which they had always depended on for their winter's food were so scarce. Of the thousands and thousands of salmon that usually ascend the river to spawn, not enough spawners escaped the nets at the mouth to keep the natives on the upper waters from starving. This fact speaks for itself also.

So much for the safety of salmon in Alaska in general, but it would yet seem that on the uninhabitable shores of the Arctic Ocean the salmon might find a place of refuge; but not even there can they stay unmolested, for parties were planning three years ago, the writer was told, to establish canneries on the affluents of the frigid and forbidding Arctic. So we see that our salmon are not safe even in Alaska, their last refuge, and if not there, they are not safe anywhere within the limits of our broad land.

But now the question comes up, "Will not protective laws and artificial breeding make the salmon secure enough?" My answer is that good laws and artificial breeding will do a good deal toward it, but not enough. Good laws can prevent overfishing, but no laws can arrest the encroachments on the salmon rivers of increasing populations and their consequent fatal results to the salmon. No laws could possibly have been enacted which for instance would have stopped the manufacturing enterprises

on the Connecticut, or the vast water traffic of the great metropolis at the mouth of the Hudson, which doubtless drove the salmon out of these rivers. Protective laws may regulate the salmon fishing of the Sacramento, but no laws can stop the mining, the logging, and the railroad building that are destroying the spawning-grounds of the tributaries of the Sacramento. It is not in the power of law enactments to save the salmon from all their dangers.

Artificial breeding can do a great deal, and has done a great deal, but it can not be relied upon for a certainty. In the first place, it is very uncertain where one can find a suitable place for hatching salmon. The writer traveled over 4,000 miles up and down the Columbia and its tributaries, from the Continental Divide to the Pacific coast, looking for a good place for salmon hatching, first in 1877 for the Oregon and Washington cannery men, and afterward in 1883 for the U. S. Fish Commission, and found only two places in that great stretch of country which were suitable; one on the Clackamas River, where the writer built a hatching station, and the other on the Little Spokane, a few miles from Spokane Falls, which is still unoccupied.

There is in all the great State of California but one stream suitable for salmon hatching on a large scale, and on this stream, strange as it seems, there is but one spot that meets all the requirements of the case, and that is the place that the writer selected and built upon on the McCloud River in 1872, and named Baird, in honor of the distinguished Commissioner under whose direction the work was done. Allow me to add by way of confirmation that subsequently the State fish commissioners of California, after hunting all over the State for another place for hatching salmon, have given it up, and now get their supply of salmon eggs from the Government station at Baird.

The above instances illustrate the difficulty of finding suitable places for hatching salmon on a large scale; and not only is it not easy to find such places, but they can not be relied on to a certainty when they are found, for they are always in danger from logging, mining, railroad building, lumber manufacturing, and other causes, which yearly become more imminent and dangerous as the country gets settled up and the population increases, and which threaten at any time to destroy their efficiency.

We must come to the conclusion, then, that even with the help and support of protective laws and artificial breeding, our salmon, like the buffalo of thirty years ago, are not safe. The destroying agencies of advancing civilization drove the buffalo to the last ditch, so to speak, and then the last survivors, or almost the last, were slain. They were obliged from sheer necessity to come to feed where from all directions the hand of man was raised against them. Whether they turned to the north or to the south, to the east or to the west, they went to their certain death, and in an incredibly short space of time they practically disappeared.

The story of our salmon is analogous. They are obliged to come inland to breed. They are compelled from sheer necessity to come up the rivers into the very midst of their human enemies. They can not stay in the ocean like other fishes of the sea, where they are safe from the hand of man, but they must necessarily come, one might say, into his very grasp, and, like the buffalo, whether they turn to the north, south, east, or west they go into the very jaws of death; for what hope is there for a salmon to escape after he has entered a river, if man chooses to employ his most effective agencies for his capture? There is none. The salmon is doomed. There is no altar of refuge for the salmon in this country any more than there was for the buffalo.

Ought not something to be done then? Ought this state of things to continue? The salmon of the United States are one of our most valuable possessions. As a matter of ordinary prudence, ought not the country to have some place, if it is possible, where the salmon can come and go in safety? If a stock-raiser saw that his cattle were daily diminishing because they had no spot where they were safe from beasts of prey, what kind of man should we think he was if he did not very soon fix a place where they would be safe? We should, to draw it mildly, think he was very improvident and negligent. Is it any less improvident and negligent for this country not to provide a place for its rapidly diminishing salmon where they will be safe? It seems to the writer that not a day ought to be lost, but that if it is possible to provide a place where our salmon can resort unharmed and remain safely within their allotted time, it should be given them without hesitation. If there is such an asylum of refuge within our borders, by all means secure it for the salmon and let the salmon have it for an eternal heritage.

Is there such a place within the limits and jurisdiction of the United States? The writer can say from personal knowledge that there is one place at least. Most fortunately for us Americans there is in our Alaskan possessions just such a place as is wanted—probably more than one—and so exceptionally fortunate is America in this respect that it is not likely that this side of the frozen and uninhabit-

able shores of the Arctic it can be duplicated many times in the possessions of all the nations of the earth combined, which significant circumstance, allow me to add in passing, goes to show how near the world has reached the extreme limit of its salmon supply.

The locality which the writer has in mind is an island in the North Pacific about 750 miles nearly due west of Sitka. Its name is Afognak, and it is the northernmost of the two largest islands of the group called the Kadiak Islands. It lies just north of latitude 58° and between 152° and 153° west longitude. It is a small island, probably not over 50 miles across at its widest part, but there are several streams flowing from various points of the island to the surrounding ocean that at the proper season contain salmon innumerable. It is no exaggeration to say that salmon swarm up these streams in countless myriads. When the writer was on the island in 1889 the salmon were so thick in the streams that it was absolutely necessary in fording them to kick the salmon out of the way to avoid stumbling over them. I know that this story is an old salmon chestnut, but it illustrates as well as anything the wonderful abundance of salmon in the Afognak streams; and it can be easily believed when it is remembered that about a month earlier 153,000 salmon were caught in one day at the mouth of the Karluk, which is a river only 60 feet wide where it empties into the ocean. But there is no need of consuming time in proving the abundance of salmon at Afognak Island. It is a matter of record. The salmon are there in as great numbers as could be wished. All the varieties also which inhabit the Pacific Ocean come to Afognak. The list is as follows; it is a royal catalogue:

1. The red salmon, the "blueback" of the Columbia (*Oncorhynchus nerka*).
2. The king salmon, the "quinnat" or "spring salmon" of the Columbia (*O. chouicha*).
3. The silver salmon, the "silversides" of the Columbia (*Oncorhynchus kisutch*).
4. The humpback salmon (*Oncorhynchus gorbuscha*).
5. The dog salmon (*Oncorhynchus keta*).
6. The steelhead, the "square-tailed trout" of the tributaries of the Columbia (*Salmo gairdneri*).
7. The Dolly Varden (*Salvelinus malma*).

It is easy to see what a paradise for salmon this island is, and what a magnificent place of safety it would be if it were set aside for a national park where the salmon could always hereafter be unmolested. But the abundance and variety of its salmon are not the only recommendations that Afognak Island has for a national park. It has several others, which may be enumerated as follows:

1. The island is inhabitable all the year round, with a comparatively even temperature. Although so far north, the winter's cold is not excessive, probably not equaling that of parts of New England. It is cooler than New England in summer, it is true, but there is much less variation of temperature between summer and winter.

2. The rivers of Afognak still exist in all their original purity and fruitfulness. No overfishing has left them barren. No mills have polluted their primeval purity. No railroads have frightened the salmon away from them. No mining has disturbed their native spawning-grounds. As salmon rivers they are still in their original glory. To quote a not inappropriate line of Byron, "Such as Creation's dawn beheld" them, they are rolling now. Consequently, nothing need be done nor any expense incurred in putting the rivers in order for asylums of refuge for the salmon.

3. No complications now exist or can come up in future in regard to land titles in the island. The United States Government owns the land already, like the rest of Alaska, by direct purchase from Russia, and has never parted with any of its exclusive rights of ownership. No State or Territory or company or individual owns an acre of it. Consequently the United States Government can set aside the island for any purpose whatever, without interfering with any prior rights or titles, or incurring any risk of litigation.* Alaska is already one great reservation.

4. The island will probably never be wanted for anything else. The summer season is so short that no crops can be raised there, and it is not likely that for many generations, if ever, the land will be wanted by permanent settlers, and it is now inhabited only by a few Aleuts and half-breed families who would not be interfered with. There would be no injustice done to individuals by making a reservation of the island.

5. Last but not least, artificial hatching can be instituted there at any time, if it is ever thought best, and on a vast scale if desired; and unlimited numbers of the eggs of the various kinds of salmon noted above can be obtained for distribution and sent to all other parts of the country where they may be needed.

* There are two canneries operating in the southern part of the island, but there would probably not be great difficulty in making satisfactory arrangements with them.

The above considerations seem to indicate that Afognak Island possesses all the qualifications required for a place of safety for our Pacific Ocean salmon without presenting any objections to its being reserved by the Federal Government for salmon, or in other words converted into a national salmon park.

The writer, however, would not urge the claims of Afognak or any other place to this distinction as against those of any locality that may be found to be better fitted for it. This island has been brought forward merely as showing that one place at least is known that would answer the purposes of a salmon park. There are doubtless others in our Alaskan possessions. There are possibly better ones. If a better place can be found, let us take it. If not, let us take Afognak Island; but at all events let some place be selected and set aside by the authority of the National Government. If not Afognak Island, let it be some other place. Provide some refuge for the salmon, and provide it quickly, before complications arise which may make it impracticable, or at least very difficult. Now is the time. Delays are dangerous. Some unforeseen difficulties may come up which we do not dream of now, any more than we did a few years ago of logging on the Clackamas or railroad building on the upper Sacramento.

If we procrastinate and put off our rescuing mission too long, it may be too late to do any good. After the rivers are ruined and the salmon are gone they can not be reclaimed. Exaggerated as the statement seems, it is nevertheless true that all the power of the United States can not restore the salmon to the rivers after the work of destruction has been completed. The familiar nursery rhyme about the egg applies here with peculiar fitness:

"Humpty Dumpty sat on a wall,
Humpty Dumpty had a great fall.
All the king's horses and all the king's men
Could not set Humpty as before."

That is the whole thing, so to speak, in an nutshell. After the salmon rivers are ruined all the king's horses and all the king's men, that is to say, all the power of the Government "can not set them as before."

Let us act then at once and try to do something for the salmon before it is too late. Dangerous complications may come suddenly upon us which we can not foresee. How little we foresaw the danger to the buffalo and the fur seals. How suddenly the disastrous results came. Even if not impracticable, it may cost large sums of money to do hereafter what may be done now for nothing. No expense need be incurred at present. All that is required is to have Afognak Island or some other suitable place set aside by national authority, as Gen. Grant set aside the McCloud River Reservation during his administration, and it can be left to future events to decide whether it is expedient to expend any money on the reservation, a subject that can be safely left, we all know, in the hands of our efficient Commissioner of Fish and Fisheries. There seems to be no impropriety in the United States having a national salmon park, but on the contrary it appears eminently proper that a great natural salmon country like ours should have set apart some safe repository and fruitful breeding-grounds for this noble fish.

Consider for a moment what the salmon has done for us, and then think how mercilessly we have treated him. Our salmon has been to us a source of national revenue, enjoyment, and pride, and what return have we meted out to him? He has been hunted pitilessly with hooks and spears, with all kinds of nets and pounds, with wheels and guns and dynamite, and there is not a cubic foot of water in the whole country where he can rest in safety. The moment he comes in from the ocean he meets the gill nets and the pounds at the mouth of the river, the sweep seines further up, the hook everywhere, and at last on his breeding-grounds, which at least ought to be sacred to him, he encounters the pitchforks of the white man and the spears of the Indian.

Let us now, at the eleventh hour, take pity on our long-persecuted salmon and do him the poor and tardy justice of giving him, in our broad land that he has done so much for, one place where he can come and go unmolested and where he can rest in safety.

Allow me to add in closing that it seems to me highly appropriate that this society, which represents with such intelligence and ability all the fishing interests of every kind of this country, should take the initiative in a matter in which those interests are so closely concerned. The writer trusts that it will, and ventures to predict that, if its efforts in that direction should happily be rewarded by the creation of a national salmon park, it would become an enduring monument to the usefulness of the society that would last as long as the nation lasts.—LIVINGSTON STONE.

Absolute prohibition of the capture of salmon by the use of any kind of nets or traps within 100 yards of the mouths of the rivers would assure that some proportion of each run of salmon would succeed in entering the streams and reaching the spawning-grounds.

The prohibition of the use of more than one seine in the same berth would prevent that actual and effective obstruction of the approaches to the rivers which is now accomplished by the use of seines in pairs sweeping the same area, and succeeding each other so continuously as to capture every fish coming within the seine berth.

The above requirements, reasonably and uniformly enforced, would probably be sufficient to maintain regular conditions of production and render permanent this great food resource. Should they be supplemented by recourse to artificial propagation on an adequate scale, it will be possible not only to maintain the present supply, but probably greatly to increase the annual production. The enforcement of the regulations and requirements, above indicated, would, however, demand constant and minute supervision and the employment of a large personnel and a difficult administration.

It is believed that better results and more satisfactory administration could be accomplished by limiting the catch in each stream to its actual productive capacity under existing conditions, and by leasing the privileges of taking the salmon to the highest bidders. The lessees of any river would see that there was no trespassing upon privileges for which they paid. The limitation of the catch being kept safely within the natural productive capacity of the stream, greater care would be exercised by the canners, the quality of the products would be improved, and stability of prices assured by reason of the fact that the total production would be approximately known in advance of the season.

The number of cases packed would be a matter of easy and accurate ascertainment by the Government agent charged with that duty. Should the funds obtained from the lessees be applied first to the administration of the regulations of the fishery, and the balance devoted to systematic fish-culture, it is probable that the revenues from these fisheries will not only suffice for their rational management, but will permit and provide for such extensive fish-cultural operations as will not only maintain present conditions and production, but also greatly increase the annual output.

Very respectfully,

MARSHALL McDONALD,
Commissioner.

FIG. 1. THE KING SALMON (*Oncorhynchus tshawytscha*).

FIG. 2. THE RED SALMON (*Oncorhynchus nerka*). Sea-run.

FIG. 3. THE RED SALMON (*Oncorhynchus nerka*). Breeding male.

FIG. 1. THE SILVER SALMON (*Oncorhynchus kisutch*).

FIG. 2. THE RED-THROATED TROUT (*Salmo mykiss*). Adult.

FIG. 3. THE RED-THROATED TROUT (*Salmo mykiss*). Young.

FIG. 1. THE STEELHEAD (*Salmo gairdneri*). Adult.

FIG. 2. THE RAINBOW TROUT (*Salmo irideus*). Young.

FIG. 3. THE RAINBOW TROUT (*Salmo irideus*). Adult male.

FIG. 1. THE BROAD WHITEFISH (*Coregonus richardsoni*).

FIG. 2. THE LAURETTA WHITEFISH (*Coregonus laurettae*).

FIG. 3. THE SMALL WHITEFISH (*Coregonus pusillus*).

FIG. 1. THE CAPELIN (*Mallotus villosus*).

FIG. 2. THE SMELT (*Osmerus dentex*).

FIG. 3. THE SURF SMELT (*Hypomesus olidus*).

LIFE HISTORY OF THE SALMON.

BY TARLETON H. BEAN, M. D.,

Ichthyologist, U. S. Fish Commission.

The greatest wealth of Alaska is represented by its fishes, and among these by far the most important are the members of the salmon family and other closely related forms, such as the whitefishes, grayling, smelt, and capelin. The salmon alone represent an annual value for canning purposes of about \$3,000,000, derived almost entirely from three species. The undeveloped resources which may be obtained from the salmon-like fishes have undoubtedly equal importance with the material now utilized.

In the distribution of the *Salmonidae* Alaska received a generous share. Seventeen of the known species, or about one-sixth of the entire number, occur in its waters. Lying entirely within the area in which the family is indigenous, plentifully supplied with long water courses, rapid snow-fed streams, and cool, deep lakes glistening in mountain valleys, over beds of clean gravel and boulders intermingled with sheltering water plants, free from obstructions to the movements of the migratory species, its invitation to the salmon to come in and possess the waters and multiply therein was readily accepted.

The largest salmon of the world are credited to this Territory, and there is no doubt that in Cook Inlet king salmon which weigh over 100 pounds are occasionally taken, but this is far above the average weight of the species. The most abundant salmon in Alaska are the red salmon and the little humpback, and it is these species which figure in the wonderful tales concerning rivers which contain more fish than water, tales which sound incredible to those who have never visited Alaska, but which in many cases are strictly true.

The salmon have been traced as far north as Hotham Inlet, and one species is found well to the eastward of Point Barrow. It is quite probable that this species, the little humpback, extends its migration to the Mackenzie.

The rivers and lakes of Alaska contain five species of whitefish, the largest one (*Coregonus richardsoni*, Pl. VII, Fig. 1), sometimes reaching a weight of 30 pounds. For many years this was believed to be identical with the common whitefish of our Great Lakes fisheries, but it differs from this in many particulars. The species was known to the Russians as the "*muksun*." In the report of the Commissioner of Agriculture for 1870, page 386, Dall refers to it as the "broad whitefish," which, he says, "is usually very fat and very good eating. It abounds in both winter and summer, spawning in September in the small rivers falling into the Yukon." This is the species which Milner named *Coregonus kennicotti*, in honor of Robert Kennicott. Capt. E. P. Herendeen, of the Signal Service expedition to Point Barrow, found this whitefish in Meade River in October, 1882. This stream is a tributary of the Arctic Ocean to the eastward of Point Barrow. The southern limit of this species is not known, but it

probably extends at least as far south as the Bristol Bay region. The great size and fine quality of its flesh make it one of the most important food-fishes of the Territory.

The round whitefish, shad-waiter, or chivey of New England (*Coregonus quadrialateralis*, Pl. VIII, Fig. 2), extends through the upper Great Lakes region, the Northwest Territory, and other parts of British Columbia, into Alaska. Specimens have been obtained as far north as the Kuwuk, or Putnam River, a tributary of Hotham Inlet. This fish does not reach a large size, seldom exceeding 2 pounds in weight, but it is very abundant and palatable, and consequently is an important food resource.

A third species, called *Coregonus lauretta* (Pl. VII, Fig. 2), abounds from the Bristol Bay region to Point Barrow. It is a little larger than the round whitefish, but seldom exceeds 3 pounds in weight. It resembles the so-called lake herring (*C. artedii*) of the Great Lakes, and is an excellent food species.

The fourth species is known as the humpback whitefish, and was named in honor of Mr. E. W. Nelson (*Coregonus nelsoni*, Pl. VIII, Fig. 1). It bears considerable resemblance to one of the Siberian species, from which, however, it can be readily distinguished. As food for man it has little value, but enormous quantities are consumed by the dogs. This species is found in all parts of the Territory from the peninsula of Alaska northward. Breeding males have a very large hump developed on the nape, which is compressed to a thin edge.

The fifth species of whitefish (*Coregonus pusillus*, Pl. VII, Fig. 3) is the smallest of all, and has the reputation of being more bony than any of the others. It is used chiefly by native traveling parties and as food for dogs. This fish seldom exceeds a foot in length and its average weight is less than 1 pound, but it extends over a large part of Alaska, and is represented by a vast number of individuals. As far as our information goes, it is found in all parts of the Territory except the southeastern portion.

The largest and handsomest fish of this category is the so-called Mackenzie River salmon or *inconnu* (Pl. VIII, Fig. 3), which is known to the Russian-speaking people as the *nelma*. This species is intermediate between the whitefish and the salmon. It has a strongly projecting lower jaw, on account of which the additional name of shovel-jawed whitefish has been applied to it. This beautiful species attains to a length of 5 feet, and individuals weighing 50 pounds are recorded. It occurs in the rivers during the greater part of the year, is in the finest condition in the early summer, and is "full of spawn from September to January, when it disappears." The species is known to occur from the Kuskokwim to the Kuwuk. The largest individuals are recorded from the Yukon. It is found also in the Mackenzie. A closely related species is found in the Volga and other rivers of Russia, and is attributed also to the Obi, Lena, and Colima, which flow into the Arctic Ocean.

The grayling (*Thymallus signifer*, Pl. VI, Fig. 3) is a very common fish in Alaska, especially in the northern portion of the Territory, and it is one of the most attractive of all the Alaskan fishes. At one time the grayling had the reputation of being the only fish in the fresh waters of Alaska that could be caught with hook and line. It is known also as the "blanket fish," and occurs southward at least to the Nushagak region, where McKay found it "very abundant in small rivers and lakes." He speaks of it as "a good food-fish, much sought after by the natives in the fall, along with the whitefish and the great smelt." The high and beautifully colored dorsal fin of this species, the rich purple luster of the sides, and the jet black spots not far behind the head, make it one of the most conspicuous and beautiful species of the fresh waters.

The red-spotted brook trout of California, also known as the dolly varden (*Salvelinus malma*, Pl. VI, Fig. 2), is one of the best known and most abundant fishes of Alaska. In the sea-run condition, when its sides are uniform silvery and do not show the red spots, it is called the salmon trout, and, preserved in brine, forms a staple article of commerce. In Alaska the species increases in size northward. Individuals measuring 30 inches in length and weighing 8 or 10 pounds are frequently obtained. Natives of northern Alaska make waterproof clothing from the skin of this trout. The dolly varden abounds in all parts of the Territory, even in the Aleutian Islands and in the extreme northern limits. It is known to occur also in the Mackenzie and in the tributaries of the Saskatchewan—this basin apparently representing its eastern limit. The dolly varden takes the artificial fly very freely. On one of the islands of the Shumagin group several hundred individuals were so captured in one hour by a party from the United States steamer *Albatross* in 1889. Salmon eggs prove very effective also in taking this trout. The species is very destructive to the eggs of the various kinds of Pacific salmon. The young trout are destroyed in enormous numbers by gulls, terns, and other aquatic birds.

The lake trout (*Salvelinus namaycush*) or namaycush, tuladi, togue, lunge, etc., of the Great Lakes, New England, Labrador, Idaho, and British America (Pl. VI, Fig. 1), has been obtained in the Putnam or Kuwuk River, where it reaches a fine state of development. The southern limit of this species in Alaska is not known. This is the largest trout of North America and the most widely distributed. Its great size and the good quality of its flesh render it a very important species wherever it is known. This is one of the most variable of the North American trout in color, and much confusion has arisen from this circumstance. Individuals from the Kuwuk are similar in appearance to Labrador specimens, differing only in being slightly darker.

The rainbow trout of California (Pl. V, Figs. 2 and 3) appears to extend northward into southeastern Alaska, but is very little known in the Territory, and, consequently, is not of much importance there. One specimen of this trout was taken at Sitka by Capt. Beardslee in 1880, and is now preserved in the U. S. National Museum.

Gairdner's trout (Pl. V, Fig. 1), known also as the steelhead salmon, or "*soom-gah*" of the Russians (*Salmo gairdneri*), reaches a very large size in Alaska, and extends northward at least to the Bristol Bay region. At Sitka this species is called "*Ah-shut*" by the Indians. We found gravid females at that place in June. This trout generally finishes its spawning before the arrival of the salmon, and is charged with the destruction of salmon eggs in large quantities. The species has not much importance commercially, although it reaches so large a size, attaining to the proportions of the Atlantic salmon, which it resembles in shape and color; but small quantities are dried by the natives and at the various fishing stations. This is the trout which is shipped from the Columbia River early in the spring to markets on the east coast, and sold in the fresh state under the trade name of "*Kennebec salmon*." Its distinction from the rainbow trout is difficult, and the two may prove to be identical. It will undoubtedly become an important species before many years. At the present time it is practically a waste product of the salmon fisheries of Alaska, and the same may be said of the dolly varden.

Clark's trout (Pl. IV, Figs. 2 and 3), recently styled the red-throat (*Salmo mykiss*), is very abundant in Alaska, extending northward at least to the Bristol Bay region. In the streams it can be readily taken with various baits, and greatly increases the

pleasures of angling. As a food-fish its quality is excellent, and it reaches a weight of 20 pounds or more. The species is black-spotted, the spots being larger and less numerous in Alaskan individuals than in most of the varieties which range southward in the Rocky Mountain region. The crimson streak around the throat is a conspicuous and characteristic color mark in all the many forms of this well-known trout.

Before passing to a review of the Pacific salmon we must recall the fact that Alaska has a bountiful supply of small fishes closely related to the larger *Salmonidae*. A true smelt (Pl. IX, Fig. 2) and two kinds of surf smelt (one of these on Pl. IX, Fig. 3) are among the common fishes, the first being a food-fish of considerable value. The capelin (Pl. IX, Fig. 1), abounds on all parts of the coast, and is one of the most important food species of the cod and salmon. The eulachon, or candle-fish, is extremely abundant in southern Alaska, and is considered one of the finest pan-fishes known. A kind of fat is expressed from it which the Indians use as a substitute for butter, and which some pharmacists employ in the place of cod-liver oil. The species is so full of oil that when dried it will burn with a bright flame.

These smaller representatives of the salmon family have at present little commercial value, but they will figure eventually and very prominently among the resources of Alaska. In addition to their value as food for man, they play a very important part in attracting the larger commercial fishes of the salmon family to certain localities.

It may be well to state that the herring of Alaska is one of the finest species of the genus *Clupea*, and is universally known as one of the fishes upon which the salmon subsist. The herring visits all parts of the coast of Alaska, running up into the bays in schools, sometimes covering an area of many square miles. It comes into the shallow waters of the bays to deposit its eggs, reaching Cook Inlet for this purpose early in July, so that its appearance in force coincides with the height of the salmon runs. The capelin is also found early in the summer, and we know that salmon are very eager in their pursuit of this fish. The little sand lance, or lant, is also present in the bays in wriggling masses at the period when salmon abound.

The marine life of the Alaskan salmon is unknown from the time the young, in their newly-acquired silvery dress, leave the fresh-water nursery to become salt-water sailors, until they have ended their cruise, obtained their liberty, and come ashore, when, as in the case of so many other salt-water sailors, their serious trouble begins. Salmon remain in fresh water until the second or third spring of their existence, and not having a bountiful supply of food, they grow very slowly and seldom exceed 8 inches in length when they start seaward. In the ocean they feed on the capelin, the herring, and a small needle-shaped fish called the lant. They are reputed also to consume large quantities of pink-fleshed crustaceans, and to derive from them their attractive color. Opposed to this theory is the fact that many other sea fishes whose food consists almost entirely of such crustaceans are never pink-fleshed.

There is no such fishery at sea for any of the Pacific salmon as there is in the Baltic for the Atlantic salmon. After the great schools have broken up and the scattered fish come into the bays, some of the species can be caught on a herring-baited hook by trolling. The king and silver salmon are captured in this way.

As a rule the fish remain at sea until they are about ready to deposit their eggs, and then approach the coast in great masses. A few young males accompany the schools every year, and may or may not return to sea without entering the rivers. The adult fish come up from the sea at a certain time of the year, the king salmon arriving

first in the month of May in southern Alaska and about the 6th of June in Norton Sound. The dog salmon and the red salmon appear in June, the humpbacks in July, and the silver salmon in August. The length of their stay at the river mouths before ascending and the rate of ascent to the spawning-grounds depend upon the urgency of the breeding condition. In the long rivers the king salmon travels from 20 to 40 miles a day; this species and the red salmon are reported to be the greatest travelers. The silver and dog salmon, however, are recorded by Dr. Dall as traversing the Yukon at least 1,000 miles. As a rule, they frequent the smaller streams, and the little humpback runs into mere rivulets.

From the time the salmon enters fresh water it begins to deteriorate in flesh and undergoes remarkable changes in form and color. Arriving as a shapely fish, clad in shining silvery scales, and with its flesh pink or red, it plays around for a little while between salt water and fresh, and then begins its long fast and its wearisome journey. No food is taken, and there are shoals, rapids, and sometimes cataracts to surmount; but the salmon falters not, nor can it be prevented from accomplishing its mission by anything but death or an impassable barrier. Its body soon becomes thin and lacerated, and its fins are worn to shreds by contact with the sharp rocks. In the males a great hump is developed on the back behind the head, and the jaws are lengthened and distorted so that the mouth can not be closed. The wounded fish are soon attacked by the salmon fungus, and progress from bad to worse until they become unsightly. In the mean time the body colors will have varied from dark gray in the humpback, with the lower parts milky white, to a brilliant vermilion in the red salmon, contrasting beautifully with the rich olive-green of its head. The excessive mortality of salmon during the ascent of the streams and on the breeding-grounds has led to the belief that none of the spawning fish leave the fresh-water alive. There is a substantial basis for this view in the long rivers, and it is doubtless true that a journey of 500 miles or more is followed by the death of all the salmon concerned in it.

The nest is a very simple affair, or it may be wanting. The humpback struggles and crowds up a few rods from the sea, and deposits its eggs between crevices in the boulders covering the bottom, or sometimes they are strewn in thin layers over a large area in shallow water without covering of any kind. The king salmon seeks the headwaters of streams, and excavates a nest in clear, shallow, gravelly rapids. The dog salmon spawns in small rivers and creeks.

The silver salmon does not usually ascend streams to a great distance, and I have seen it return to salt water alive, after spawning. The nest is made among gravel and stones, from which all dirt and slime have been removed. Both sexes take part in the building operation, and the male especially guards the nest. Turner states that the silver salmon use their snouts in collecting material for the nests, and he has seen them with the nose worn off completely.

The red salmon spawns around the shores of deep, cool lakes, and in their tributaries, preferring waters whose highest temperature rarely exceeds 55 degrees. The nest is a shallow, circular pile of stones, some of which are about as large as a man's hand and some of them smaller. The eggs are placed in crevices between the stones.

The enemies of the salmon are numerous. Small fish, called sculpins, or miller's thumbs, swarm in the nests, and eat large quantities of the eggs. Trout devour great numbers of eggs and young salmon. Gulls, terns, loons, and other birds gorge themselves with the tender fry. When the young approach the sea they must run a cruel

gamtlet of flounders, sculpins, and trout; and in the ocean a larger and greedier horde confronts them. There the adults are attacked by sharks, seals, and sea lions. Before they have fairly entered the rivers huge nets are hauling them to the shore almost every minute of the day, during six days in a week. When they return to their spawning-grounds, bears are waiting to snatch them from the water and devour them alive. The salmon, it appears, would have been better off had it never been born in fresh-water, where its dangers are cumulative and deadly.

The King Salmon (*Oncorhynchus chowicha*). Plate II, Fig. 1.

The largest and finest of the Alaskan salmon is the king, or chowichee, known also as the Takon, Columbia River, chinook, and quinnat. This valuable fish occurs in the large rivers as a rule, but it runs into some of the small streams also, notably the Karluk, and some of the rivers emptying into the eastern part of Cook Inlet. The Yukon and the Nushagak are the greatest king salmon rivers. The species is found less abundantly in the Ugashik, Kuskokwim, and Kvichuk. Its average weight is over 20 pounds, and individuals of 100 pounds or more are recorded. At St. Paul, Kadiak, in 1880, Mr. B. G. McIntyre stated he had weighed one which registered 87½ pounds without its viscera; he believed the entire fish would have weighed 100 pounds.

The flesh of the king salmon is paler in color than that of the red salmon, but superior to all others in flavor. The salted bellies are considered a great delicacy. The principal uses of this fish are as fresh fish and for canning purposes. In Alaska it has not yet acquired the importance belonging to it on the Columbia River, chiefly because of the distance from San Francisco to the Alaskan king salmon rivers and the difficulties of fishing in those waters.

This species is the first to arrive on the shores in the spring. It makes its appearance in southern Alaska in May, and Mr. E. W. Nelson found it in Norton Sound, the northern limit of its known migration, early in June. The time of its coming into Norton Sound corresponds with the breaking up and disappearance of the ice. Mr. Nelson observed that "the largest of these salmon run during the few days just preceding and following the breaking up of the ice, and thence on until the end of the season they decrease gradually in size and quality." In the Yukon the season lasts only about a month. Capt. L. P. Larsen states that the king salmon is the first to appear in the Nushagak; here the run is short, scarcely continuing into August. At the Karluk they arrive late in May. Very few were seined there during August. On the 4th of August, 1889, a fine male of about 35 pounds, with the spermaries little developed, was seined on the beach. In its stomach I found forty-five capelin. Mr. Charles Hirsch states that the species is only an occasional visitor at Karluk.

The king salmon continues to enter some of the rivers for the purpose of spawning until August. The height of the season, however, is reached by the middle of July in most localities. This fish travels up the rivers farther than any other species except the red salmon. In the Yukon it ascends far above Fort Yukon, more than 1,500 miles from the mouth of the river. Dr. George M. Dawson records its occurrence in the Lewes River as far as the lower end of Lake Marsh, where it was found in considerable numbers early in September. According to Indian authority it pushes on almost to the headwaters of the tributaries to the Lewes on the east side.

The king salmon does not ascend rivers rapidly unless the spawning period is close at hand. It generally plays around for a few days, or even a couple of weeks, near the river limit of tide-water. After entering the fresh water to begin its journey

to the headwaters of the stream it moves rapidly until it finds suitable gravelly bottom in clear water. No food is taken in fresh water. When a barrier to its ascent is met I am told that the fish charges at it repeatedly and persistently without regard to the consequences to itself. The nest-building habits have been so often described that it is unnecessary to repeat them here. The spawning takes place, as before remarked, near the headwaters of streams in clear, shallow rapids. As far as we can learn, only those fish that ascend the streams short distances return to the ocean after spawning, and September is the month in which the spent fish go down to the sea. Mr. Turner mentions a female weighing 38 pounds, which had spawned and returned to the sea and was caught at Unalaska, September 25, 1878; it was in fine condition for eating.

There is no reason why the king salmon should not return down the Karluk, as the distance is very short and the fatigue of the journey upstream is very slight. There is ample testimony of a conclusive nature to the effect that after a king salmon ascends 500 miles from the sea it never returns to it alive.

Mr. Charles Hirsch says that the Karluk natives watch for the king salmon in May, and set up a great shout as soon as they discover it. Like the other species, it can be seen about $1\frac{1}{2}$ miles off shore in great schools, but before coming nearer the schools break up. There is no salt-water fishery for this salmon in Alaska, except along the beaches.

No falling off has been observed in the supply of the king salmon; in fact the number used is very small in comparison with that of the red salmon.

The Dog Salmon (*Oncorhynchus keta*). Plate III, Fig. 3.

This is one of the least important of the Alaskan salmon to Americans, but one of the most valuable to the natives. Its flesh is comparatively pale, and it deteriorates so rapidly in fresh water as to prove very unattractive to white people. Mr. Daniel F. Bradford states that after remaining in fresh water twenty-four hours the fish turn black, become covered with slime, and are unfit for food. The jaws become enlarged and distorted, and the flesh unpalatable. In the fresh-run condition the flesh has a beautiful red color, resembling that of the red salmon, but not so brilliant. Early in July the red color of the skin is somewhat remarkable in being interrupted at intervals along the sides, causing a sort of resemblance to bands. The average weight is about 12 pounds, but some individuals reach 20 pounds.

This species is found chiefly in the small rivers and creeks, and is usually very abundant in all parts of the Territory as far north as Hotham Inlet, and probably Point Barrow. In the rivers of California and British Columbia it is said to appear seldom or never in the spring, but in Alaska it makes its appearance on the coast in great schools about the middle of June and continues abundant for nearly a month, after which it decreases rapidly in numbers, disappearing usually about the time of the forming of the ice.

In the small streams falling into Alitak Bay, with only a few exceptions, this fish and the little humpback are the principal salmon, and the natives dry them for winter use in large quantities. The Sturgeon River, according to Mr. Charles Hirsch, never contains any but dog salmon and humpbacks. In the Karluk River the dog salmon is only an occasional visitor. At St. Paul, Kadiak, Mr. Washburn says that the *Hyko* arrives about July 1, and there is only one annual run. On the 30th of August, at Karluk, a haul of a large seine yielded forty dog salmon and only one red salmon.

Early in July the fish-drying frames of the natives on the shores of Cook Inlet are red with the flesh of the drying dog salmon, or *Hyko*. The natives cut off the head, split the fish in halves, and remove the backbone, allowing the two halves to remain fastened at the tail. The sides are gashed at short intervals in order to facilitate the drying. The fur-traders lay in a large stock of this dried salmon, which is known to the trade as *ukali*.

The Silver Salmon (*Oncorhynchus kisutch*). Plate IV, Fig. 1.

The silver salmon is considered an excellent fish in the Puget Sound region, but is not so highly esteemed in the northern part of Alaska. It is used to some extent for canning, but is far less important for this purpose than the red salmon. It reaches a weight of about 30 pounds; the average weight in Alaska is less than 15 pounds. In Alaska, as in the Puget Sound region, it is a fall-running fish. It does not ascend the streams to any great distance, and I have seen spent fish of this species coming down alive in the fall to within easy reach of salt water. Whether the species actually leaves the fresh water after spawning is uncertain. There is a conflict of observation on this subject. Mr. J. W. Clark, agent of the Alaska Commercial Company at Nushagak, a very reliable and intelligent man, states that he has seen silver salmon come down the river alive in the spring. In some other Alaskan rivers, Capt. Lansburg, superintendent of the Thin Point cannery, has seen only black and lank-looking salmon of this species during the winter.

At Afognak the species arrived August 5, 1889, but there was no extensive run till about the end of the month. A small silver salmon was seen at Karluk August 4. The species was not abundant there, however, until early in September, when about 7,000 were caught at one haul of the seine. It was about this time that one of Capt. L. P. Larsen's men at Karluk hooked a very large silver salmon, probably weighing over 30 pounds. This species is only an occasional visitor at Karluk. When it runs there it generally begins about the last of August, according to Mr. Charles Hirsch. Mr. Washburn informed me that it arrives at St. Paul late in August or in September, and that there is only one annual run. A few fish of this species are found in the small river in Olga Bay, near the cannery of the Arctic Packing Company. It has been stated by Mr. Daniel F. Bradford that silver salmon do not furnish 10 per cent of the pack at the fisheries. In the river at Thin Point, a small and very shallow but constant stream, both silver and red salmon are found, the latter predominating. The season closes here early in September.

The silver salmon make their nests among the gravel and stones, from which they clean all dirt and slime. They use their snouts in collecting material for the nests, and Mr. L. M. Turner states that he has seen them with the snout worn off past the muzzle. After the spawning season, and during their stay in fresh water, they continue to be very much emaciated and in poor condition generally.

No decrease has been observed in the supply of this salmon as far as we are informed. Its late arrival in most localities limits the season during which it can be caught, and this serves as a sort of protection for the species.

The Humpback Salmon (*Oncorhynchus gorbuscha*). Plate III, Figs. 1 and 2.

This is the smallest, most abundant, and most widely distributed of the Alaskan salmon. Its average weight is about 5 pounds, and individuals weighing 10 pounds are very uncommon. It may be recognized readily by its excessively small scales, and, in

the breeding season, by its greatly distorted jaws and enormous hump. It is found in all parts of the Territory. Its range is known to extend several hundred miles to the eastward of Point Barrow, and probably includes the Mackenzie. Speaking of its extraordinary abundance, Mr. Turner has aptly remarked that "they appear at the surface of the water like the pin-drops of an April shower."

Mr. Charles Hirsch has informed me that from about the 6th of July, 1880, there was in the Karluk River, continuing for five weeks, a glut of humpback salmon which kept all other salmon out of the river. It was impossible to pull a boat across the stream, owing to the great quantities of salmon. A haul was made with a 15-fathom seine at 6 a. m., and the men were dressing fish from that haul until 6 p. m. About 140 barrels were dressed. These were loaded in bulk into a small schooner, and then the men were occupied three hours in clearing the seine, in which the remaining salmon were about 4 feet deep. In the season of 1891 not more than 100 of these salmon were caught at Karluk up to the close of the fishing, October 5.

The humpback arrives at St. Paul, Kadiak, about the 10th of July, and there is only one run a year. From the statement of Mr. Hirsch, above referred to, it will be seen that it makes its appearance on the western side of the island at about the same time. Mr. Turner records the date of arrival at St. Michael as about the 25th of July and the period of running about five weeks. Mr. Nelson's earliest specimens were taken at St. Michael July 24. He says they are rather numerous until the end of July, with more or less common stragglers until late in the fall. The writer found humpbacks in good condition in Plover Bay, Siberia, about the middle of August.

The species continues to enter the rivers usually for a period of about five weeks, but is not regular in its appearance. The enormous run in the Karluk, mentioned above, was exceptional, for the fish seldom enters that river. In the Yukon, during some years, according to Mr. Nelson, only a few are taken, and at other times they are present in such excessive numbers in the lower part of the river that the fish-traps must be emptied several times a day.

This salmon is much addicted to jumping out of the water. In the vicinity of St. Paul, Kadiak, one of the commonest sights was this breaching of the humpback salmon. Fishermen at this village say that the sea-run humpback often contains a small fish, which, from their description, must be the capelin.

In the Karluk River, as already mentioned, the species continued to enter for five weeks, and then dead fish began to float down the stream, and this continued about a month. It does not go far from salt water and frequently enters streams which are too shallow to cover its fins. Its business in the fresh waters is simply to deposit its eggs, after which, apparently, it dies on the spawning-grounds or is carried to sea in a dying condition. Spawning takes place within a few rods of the sea. It is a common thing to see large areas of the bottom entirely covered with the eggs, either lying unprotected on the gravelly bottom or partly concealed in crevices between moderately large stones. In Afognak River the eggs were cast among stones about half as large as a man's fist.

There are no signs of diminution of the supply of this fish. A small number are salted annually, and the natives dry large quantities for winter use.

In the fresh-run condition this is one of the most palatable salmon in Alaska, and the time is not far distant when it will be a very important species for canning. The

flesh is somewhat paler than that of the red salmon, yet it has a beautiful color. Properly introduced into the markets this would become a very valuable fish, and its wonderful abundance would establish a great industry.

The height of the spawning season in the Kadiak streams is evidently about the middle of August. In Alexander Creek, near the Larsen Cove cannery of the Arctic Packing Company, Messrs. Robert Lewis and Livingston Stone found the humpbacks spawning in vast numbers August 15. Mr. Lewis took some of the eggs and fertilized them with the milt of the males. The eggs are larger than those of the red salmon, but smaller than king salmon eggs and not so bright red. On the 22d of August, 1889, this fish was observed in the small streams at the head of the west arm of Uyak Bay trying to run up the rapids in order to spawn. The current in some places was so swift as to wash the fish away. Eggs were very plentiful between the crevices of the stones. On the 24th of August Alexander Creek was full of humpbacks in all stages of emaciation and decay. In Alitak Bay, September 9, the fish were nearly all dead in the creeks, and Snug Harbor contained many dying humpback salmon floating seaward tail first. Messrs. Booth and Stone found Afognak River well filled with spawning humpbacks August 30. The two tributaries of Afognak River also contained them in great numbers. Mr. Booth found the fish most abundant in the neighborhood of holes excavated in the egg-sized gravel of the bottom, intermingled with stones of 3 or 4 pounds in weight.

After the great run in the Karluk, already referred to, the fish came down dead or in a dying condition for a whole month and the beaches were strewn with dead salmon. The distortion of the humpback during the breeding season is remarkable and the injury to its fins, and other exposed portions of the body, is excessive. The last stages of this species are repulsive to look upon, but before the extensive emaciation and sloughing away of the skin has taken place the colors of the breeding fish are rather pleasing, the lower parts becoming milky white, contrasting beautifully with the darker color of the sides and back. This white color sometimes extends upward toward the middle line with interruptions.

The Red Salmon (*Oncorhynchus nerka*). Plate II, Figs. 2 and 3.

This is the blueback of the lower Columbia River, the *Sauqui* or *Sukkegh* of the Frazer River, and the *Krasnaya Ryba* (or redfish) of the Russians. It does not seem to exist south of the Columbia River. Northward it is found as far as the Yukon, and it occurs also in Japan and Kamshatka.

Although next to the smallest of the Pacific salmons this is now the most important species for canning and salting, and its flesh is so red as to win for it a reputation not warranted by its edible qualities. It approaches the shores early in the spring and enters only snow-fed streams. The red salmon is not caught, like the king and silver salmon, by trolling in the bays. When it comes into the mouths of the streams, to ascend for the purpose of spawning, the fishing begins.

The size of the red salmon varies with the locality and season. Some runs contain much larger fish than others. At Karluk the fish will average nearly 4 pounds apiece without the head, fins, tail, and viscera. The whole fish will weigh 7 or 8 pounds. In 1889 it was estimated that 13 fish would make a case (48 pounds) of canned salmon; in 1891 the number to the case was stated to have been 15. Individuals of 15 pounds are occasionally seen, but they are uncommon.

Like the king salmon, the red salmon travels long distances up the rivers, pushing on to their sources; but it is chiefly a lake spawner, while the king salmon prefers the headwaters of the principal rivers to their small tributaries.

Red salmon arrive at St. Paul, Kadiak, according to Mr. Washburn, agent of the Alaska Commercial Company, in June, and there is only one annual run. This gentleman also states that there is a little run of small red salmon in Little Afognak River as early as April 1, but the principal run comes in June or July. In a river just 10 miles distant from the Little Afognak the first run does not arrive until about May 20. At Karluk, in 1889, and around Kadiak generally, the species arrived late, and the catch up to the end of July was small everywhere. Turner records the 1st of May as the time when the natives of Attu Island prepare weirs (*zapor* of the Russians) to obstruct the passage of the red salmon to their spawning-grounds. The species does not appear to be common on the coast of Norton Sound, according to Mr. Nelson, but is more abundant in the Lower Yukon, the main run occurring about the middle of August and lasting sometimes only two or three days, but usually a week or ten days.

At the end of August, 1889, the red salmon were still running into Karluk River, but had greatly diminished in numbers and had become so dark in color as to be unfit for canning. In 1890 the run continued at Karluk very late, and a large portion of the catch was obtained in October and early in November. At Afognak the run usually lasts only during the first three weeks of July, although they first appear about the middle of June, and a few small ones occasionally come about the 1st of April. The runs of fish appear to vary a good deal from year to year. Some of the fishermen at St. Paul believe that every fourth year is a good salmon year. Mr. Hirsch says that in Cook Inlet, the Niulielic, Kusilov, Kenai, and Sushitua rivers all have salmon runs, but the kind of fish varies from year to year. An unexpected run of humpbacks may prevent the red salmon altogether from entering its chosen river.

Mr. Hirsch also says that in coming from the sea the red salmon approach from all directions. They have been seen about $1\frac{1}{2}$ miles distant from the land, and when they approach nearer the schools break up. This species is very much given to jumping entirely out of the water, and it is not unusual to see a dozen or more in the air at a time. At Karluk the fish play around in the kelp beds, especially when frightened by the seines, and here they are perfectly safe from the fishermen. They do not linger long in salt water after arriving on the coast. Fresh-run fish sometimes go into the river with the tide and out again the same day with the ebb.

Young fish occasionally accompany the adults, but all I examined proved to be males. On the 13th of August, 1889, I obtained a male red salmon 11 inches long to the root of the tail. This example contained numerous intestinal worms.

It is asserted by Mr. Hirsch and others, who have had much experience with the red salmon, that no spawning fish of this species ever leave Karluk River alive. Natives of Karluk say that they can catch salmon any time during the winter through the ice on Karluk River and lake. They assert, also, that all the red salmon die in the spring, most of them in April.

After entering the rivers the red salmon may return to the salt water, but if the spawning season be near at hand and the spawning-grounds remote, they travel up the stream very rapidly. I have seen them playing about in the rapids, apparently

resting, during the ascent of the Karluk. Numerous beds of eel-grass and other aquatic plants furnish attractive hiding-places in which the fish sometimes linger.

The red salmon ascends to the lake or lakes which the river drains, and it is said that this species will not enter a river which does not arise from a lake. The distance traveled in the Karluk is less than 20 miles, and the principal lake is 8 miles long. Red salmon spawn in this lake and in the short and rapid rivers connecting each of its arms with smaller tributary lakes. They ascend long rivers, like the Columbia, more than 1,000 miles, to reach the spawning lakes.

This salmon begins spawning soon after its arrival on the coast, and this varies with the locality. The season usually begins in June, and fish which have not yet spawned continue to arrive as late as the beginning of September. Spawning takes place in August, as the writer knows from personal observation. Dead fish and others which have spawned and are already dying are very abundant about the middle of this month. In Karluk Lake, near the sources of the river, ripe red salmon were speared by the natives August 17, 1889. On the 18th of the same month large numbers of dead salmon of this species, and plenty of both sexes which were spent and nearly dead, were found in the rivers connecting Karluk Lake with its tributary lakes. In all of the little streams falling into Karluk Lake, in which red salmon were found, dead fish were moderately common; and there was an abundance of young salmon about 1½ inches long, which must have been hatched from eggs deposited during the preceding fall. Mr. Charles Hirsch stated that "in March or April the Karluk River is solid full for a whole month of salmon fry going down to sea."

I have seen salmon nests at the head of Karluk Lake in shallow water near shore between the mouths of two streams. The nest is a hollow circular pile of stones, and the eggs are placed in the crevices between the stones. In the river connecting the east arm of Karluk Lake with its tributary, additional nests of salmon were observed. In some cases streams fall down into Karluk Lake over bluffs which are too steep for the salmon to ascend, and the fish were spawning at the mouths of such streams.

Extensive changes take place in the color of the red salmon as the spawning season approaches. After a period in fresh water the skin becomes dark and the beautiful red color of the flesh gives place to a paler tint. In this condition the fish has no commercial value. According to Mr. Bradford, the arrival of dark-red salmon in quantities later in the season at Karluk indicates a decrease in the run. In the height of the spawning season the sides are suffused with a brilliant vermilion, and the head is a rich olive-green, contrasting sharply with the color of the body. The male develops a hump nearly as large as that of the humpback, and its jaws are greatly enlarged.

The eggs and young of the red salmon have many enemies, and the percentage of fish naturally developed from eggs must be exceedingly small. Every salmon nest has its greedy horde of little fresh-water sculpins (otherwise known as miller's thumbs), blobs, and bullheads (*Uranidea* spp.), always in readiness to consume the fresh eggs. The shoal waters around the shores of Karluk Lake, and the shallow streams into which the red salmon finds its way for reproduction, contain myriads of these destructive little sculpins. Another source of destruction to the eggs is found in the dolly varden trout (*Salvelinus malma*), which is only too common on the spawning-grounds of the salmon and consumes large quantities of eggs. The waters referred to contain, also, a great many sticklebacks (*Gasterosteus* sp.), some of them of very large size, which probably destroy eggs.

Chief among the destroyers of the young fish are terns, gulls, ducks, and loons, which are very common in that region. I have shot terns and gulls near the south end of Karluk Lake, and upon holding them up by the legs small salmon dropped out of their mouths. Towards the end of August, 1889, the shallow parts of Karluk River were visited by hundreds of gulls, chiefly young of *Larus glaucescens* and *L. brachyrhynchus*, which were feeding upon young salmon. Bears consume large quantities of the breeding fish. They may be seen standing at the edge of the stream, where the water is shallow, and occasionally striking salmon with their claws and throwing them on the shore, where they are eaten alive. I have seen red salmon partly eaten, but still alive, lying on the shore after the retreat of the bears, which were disturbed while feeding. Other enemies of the salmon attack it in the sea; among them are the salmon shark (*Lamna cornubica*), porpoises, and sea lions. All species of salmon are more or less covered with parasitic *copepods*. The estuary of Afognak River is generally left bare at low tide, and great numbers of salmon are thus stranded, many of which die before the next tide rescues them.

Red salmon are seen in salt water off the mouths of the rivers in large schools in the spring. No attempt has been made to take them until they come to the shore.

The catch of red salmon has been increasing, owing to the greater number of persons engaged in the fishery and the superior effectiveness of the implements used in its capture. The size of seines has been greatly enlarged, and the number of boats and seines largely augmented. There was, early in the season of 1889 and in previous seasons, injudicious obstruction of the ascent of spawning fish in the Karluk River. At one time an impassable weir, similar to the *zapor* of the Russians, was placed in this river. I have also seen the remains of pound nets made of wire netting, which interfered so seriously with the ascent of the fish that they were dismantled by unknown parties and were not reestablished.

The Steelhead (*Salmo gairdneri*). Plate v, Fig. 1.

This large black-spotted trout is known also as hardhead and Gairdner's trout. The Russian name is *Soomga*. In some of our eastern markets it is sold as "Kennebec salmon" before the Atlantic salmon has come in from the sea. In the Rogue River, Oregon, the fishermen call it Rogue River trout.

It sometimes reaches a weight of 30 pounds, and individuals of that size bear a close resemblance to *S. salar*. It is found from Monterey, Cal., to Bristol Bay, Alaska, and is very abundant in some parts of the Gulf of Alaska. This trout has been considered a winter spawner, but females full of ripe eggs were seen by me near Sitka, June 10, 1880. Spent fish of this species are frequently taken with the spring run of the king salmon, so that in all probability the usual spawning time is late in the winter or very early spring.

This species, according to Mr. Charles Hirsh, arrives at Karluk in August in small numbers. I have seen a moderately large number of steelheads at Karluk on September 4, but their abundance was nothing in comparison with that of other species. It is seldom used at Karluk. A few small individuals are dried there by the natives.

The spawning habits of the steelhead are scarcely known. Mr. B. F. Dowell has recorded its arrival in May in Applegate Creek, Oregon, for the purpose of spawning. At the falls in the Willamette River, at Oregon City, Mr. Waldo F. Hubbard, of the U. S. Fish Commission, reported a few ripe females about the middle of May, 1892,

but during the remarkably high water the fish passed over the obstructions and no eggs were secured. At Sitka I was told that it spawns in lakes not far from the sea, and immediately after spawning goes into the salt water.

In the opinion of Mr. Dowell the steelhead is "delicious in flavor."

The Red-throated Trout (*Salmo mykiss*). Plate IV, Figs. 2 and 3.

Clark's trout has recently been called the red-throated trout on account of the characteristic crimson streak around the throat. It is a large and extremely variable species, and its distribution is nearly or quite as extensive as that of the lake trout. One of its varieties is found in streams of the Sierra Madre, Mexico, at an elevation between 8,000 and 9,000 feet, in the southern part of Chihuahua, near the boundaries of Durango and Cinaloa. In Alaska it has been traced as far north as the Kuskokwim River, and doubtless extends still farther.

As a food-fish the red-throated trout is excellent and the species grows to a large size, individuals weighing 20 pounds being recorded. Although not now an important commercial fish in the Territory, it furnishes food for the natives and is taken in large numbers by anglers.

In the Rocky Mountain region it is represented by numerous varieties and is well known to fishermen and tourists. These are generally known as Rocky Mountain trout and may be readily distinguished by their black spots and the crimson dash on the throat. In the mountain lakes and streams of Colorado the trout come down to a point where the summer temperature reaches 60° to 65°. In the basin of the Colorado they are associated with small dace-like minnows, upon which they feed. They prefer clear streams with gravel bottoms. The species is not migratory.

In the Yellowstone National Park this trout occurs in both the Atlantic and Pacific watersheds, having traversed the waterway over Two-Ocean Pass.

The typical red-throated trout of Alaska differs materially in color from its Rocky Mountain representatives, having comparatively few large, roundish, black spots on the body, chiefly above the lateral line and evenly distributed along the surface; the head has a few black spots; the dorsal and caudal have a moderate number of black blotches which are usually oblong in shape.

Parasitism in the Rocky Mountain trout has been discussed by Dr. Yarrow in papers referred to below, and more recently by Dr. Jordan and Prof. Linton in the ninth volume of the U. S. Fish Commission Bulletin.

Gordon Land, fish commissioner of Colorado, has obtained eggs from this species on June 21 and they were hatched in 25 days in water varying in temperature from 52° Fahr. at night to 62° at midday; the eye-spots were plainly visible in 17 days from the time of taking the eggs. Mr. Land states that this trout is "easily taught to feed and will readily take food from the bottom as well as in transit."

An excellent account of the life history of the red-throated trout was published by Dr. H. C. Yarrow in the Report of the U. S. Fish Commission, Part II, 1874, in advance of its appearance in the Zoölogy of the Wheeler Survey Report in 1875. Under the name *Salmo virginalis* he treats particularly of the spawning, feeding, and movements of the species. From inquiry and personal observation he fixed the maximum length of the fish at 3 feet and the weight 15½ pounds; but the average

length is about 14 inches and the weight $1\frac{1}{2}$ pounds. The following extracts have been rearranged from Dr. Yarrow's description:

In shape there is very little difference between the male and female, though near the breeding season the female is the larger and more brilliant in color. This increased brilliancy of color affects both sexes, but is noticeable in a more marked degree in the female. About breeding time the eyes are brighter, scales more brilliant, and the superficial blood vessels more fully engorged than ordinarily; the movements are more rapid, a celerity being displayed quite at variance with its usual somewhat sluggish habits. As far as could be ascertained, the spawn has not been observed to run from this fish when captured, either by the line or net, for the reason, most likely, that the gravid female is seldom taken just prior to or during the time of spawning. It first enters the mouths of mountain streams and rivers to spawn about the middle of March, remaining until the middle of May, by which time the majority have fulfilled their reproductive functions. In coming on to the breeding-grounds all sizes are found together, young and old, little and big. During the spawning season no very observable changes take place in the trout, except those mentioned above, and also that the under part of the cheek of the female becomes very bright. As a rule, it may be stated that in general appearance the male is much less bright than the female at this season, and smaller.

Before spawning, the nests are made in the sand or gravel by a rotary motion of the tail of the male. The eggs are exuded by the female into this cavity, which is sedulously guarded by the male until the process is completed, when the latter deposits the milt which is to impregnate the eggs. No further care is taken by either after the deposition of the impregnating substance. Most of the spawning is done in the rivers, but the process takes place in the lakes also to some extent. It is not known at what age this fish begins to breed nor what period of time the process continues. The act of spawning exerts an injurious effect on the flesh of the fish, rendering it poor and insipid. In addition, many of the fish seeking the upper parts of the rivers to fulfill their reproductive duties do not survive the severe bruises and other injuries they meet with in their journey past the rocks and through the rapid currents of the mountain streams. The water in the locality in which the trout spawns has never been noticed to be whitened by the milt, but it does present a translucent pinkish appearance after the event.

The temperature of water most favorable for hatching appears to be the coldest obtainable, the eggs in many cases being laid directly on the bottom of ice-cold mountain springs. The color of the spawn is whitish pink, each egg just previous to spawning being the size of No. 4 shot. In July the eggs are not larger than No. 12 or dust shot. The eggs when spawned always sink to the bottom, where they remain unless eaten or carried away by the swift current. The eggs are hatched in March, April, and May, but the number of days required by the process is not known. The spawn and young fish suffer greatly from the attacks of other fish, aquatic reptiles, and even from the large fish of their own species, these seeming to have no affection for their young. Mr. Peter Madsen states it as his opinion that the female in spawning ejects only a portion of her eggs, as he has found, on dissecting the trout after the spawning season, eggs of various sizes, some very small and others full grown.

After spawning the trout invariably swim in schools from one part of the lake to the other in search of food, a solitary fish at such time being seldom seen. In traveling the trout is nearly always accompanied by its friendly companions, the mullet, sucker, etc., which share with it the danger of attack by man and birds. It is rather a singular fact that the very young trout is seldom seen or taken either by hook or net, and I am unable to account for the same unless it is that it resorts to unknown localities until a larger growth is obtained. Its food, so far as known, consists principally of small insects.

The trout is very voracious, devouring other fish smaller than itself, particularly a species locally known as "silversides," or "leather-sided minnows" (*Clinostomus tania*, Cope), of from 2 to 6 inches in length; on dissection, I found the stomach of the trout crammed with these little fish. Grasshoppers, too, are a source of diet to the trout, with flies and other insects, while they do not disdain even snakes and frogs of tolerably large size. The favorite localities for feeding in the summer are close to the mouths of rivers, the water of which from the mountains is ice cold, from 10 to 12 feet deep, and the current very swift.

This fish winters in the deepest waters of the lakes, as most of the mountain streams to which it resorts in spring and summer are shallow and very cold. In summer it swims low in the water—it is thought, to avoid the extreme heat of the sun. The male and female, large and small, run indiscrimi-

nately together, the presence of this fish in any particular locality being indicated by the presence of flocks of birds hovering over the water.

Large captures are easily made with a hook, and I have taken 30 to 40 pounds weight in a single hour's fishing. The hooks used are large steel ones, with a snood or snell of piano wire, which is strong and flexible. The best bait is minnow and grasshopper, although this trout will bite at almost anything. In Panquitch Lake a fish's eye is considered a very tempting bait.—(Dr. H. C. Yarrow, Report Wheeler Survey, vol. v. Zoölogy, pp. 686-691).

The Rainbow Trout (*Salmo irideus*). Plate v, Figs. 2 and 3.

The rainbow trout is not known to extend far into Alaska, but specimens have been obtained at Sitka by Capt. L. A. Beardslee, U. S. N. It is sometimes found in salt water, but spends most of its life in the streams. It is a valuable food-fish and grows to a large size, reaching 2 feet in length and about 8 pounds in weight.

At the Baird station of the U. S. Fish Commission spawning takes place in the small creeks tributary to the McCloud River, from January to May. The eggs are about one-fifth of an inch in diameter and vary in color from light straw to deep salmon-red. A 2 pound trout yields about 800 eggs. In water at 54° F. the eye-spots show in 12 days and the period of incubation lasts 26 days. The outline of the embryo can be seen through the shell four or five days before the eye-spots appear.

The rainbow trout derives its name from the broad red or crimson band which extends along the side and on the head; this contrasting with the rich silvery gray of the body and the iridescence of the sides gives the fish a beautiful appearance. In the spawning season the color of the body becomes much darker, the flesh paler, and the red stripe turns to crimson.

This species feeds chiefly on salmon eggs during the season and upon dead salmon. It is very fond, also, of the larvæ of the caddis fly. Mr. Loren Green believed that these trout stir up the bottom of the river with their tails when searching for food. According to Mr. Stone they have the peculiarity of swimming partly on one side when in search of food, with one eye inclined downward, so that they see what is on the bottom. In very hot weather they feed chiefly at night.

The fishing lasts from the middle of May to the last of November, June and July being the best months.

A disease has sometimes appeared among the rainbows, which has caused great mortality. Specimens of the diseased fish were examined by Prof. S. A. Forbes, who attributed the deaths to encysted parasites located principally in the kidneys, but also affecting the liver and spleen.

The Lake Trout (*Salvelinus namaycush*). Plate vi, Fig. 1.

The lake trout is the largest trout of the world and one of the largest, if not the largest, of the salmon family. It is indigenous to North America, occupying the northern portion of the continent, extending south to Silver Lake in Pennsylvania and Henry Lake in Idaho, and most highly developed and most abundant in the Great Lakes region, and extending northward to the Arctic Ocean on both sides of North America. In Alaska this trout is very abundant in the rivers and lakes of the northern part of the Territory. It has been found as far north as the Pitme River or Kuwuk River, which falls into Hotham Inlet, and extends southward to the peninsula of Alaska. In color, the Kuwuk specimens resemble examples of the same species from Labrador, differing only in being slightly darker.

The color variations in this trout are remarkable: some examples are nearly black, others are brown with vermilion spots, still others are gray, with chain-like markings. In the Great Lakes the usual color is brownish gray, profusely dappled with whitish blotches. On account of its wide range, it naturally runs into many varieties of form and color, and adult individuals differ greatly in size in different localities. It is said that individuals weighing 120 pounds have been taken, but the average weight in the Great Lakes will probably not exceed 15 pounds, and an example weighing 80 pounds is regarded as the largest one ever taken in Lake Superior. The extreme weight above mentioned is given on the authority of Dr. Richardson, whose observations were made in Arctic North America. The Alaskan examples which I have seen were comparatively small, but Mr. Townsend and others who obtained these specimens state that the species grows to a large size in that Territory.

The lake trout is a voracious and predatory species. It associates with the white fish and lake herring, which constitute the principal part of its food. It devours other species of fish of suitable size, including the burbot or lake lawyer. Among the singular articles which have been found in the stomach of this trout are "an open jackknife (7 inches long, which had been lost by a fisherman a year before at a locality 30 miles distant), tin cans, raw potatoes, chicken and ham bones, salt pork, corn cobs, spoons, silver dollars, a watch and chain, and in one instance a piece of tar rope 2 feet long. In the spring wild pigeons are often found in their stomachs. It is thought that these birds frequently become bewildered in their flight over the lakes, and become the prey of the trout."

The lake trout appears to spawn only in the lakes, and not in rivers tributary to them. In lakes Michigan and Superior spawning takes place late in October, on rocky shoals and reefs, in water 70 to 90 feet deep. The eggs are said to be deposited in clefts in the rocks, into which they settle and remain until hatched. The young make their appearance in January or early in the spring, in water of a temperature of 47° Fahr. The hatching has been known to take place about the end of January. The late James W. Milner found some hatching-grounds at the head of Lake Huron, in depths of from 7 to 90 feet on rock bottoms. In a female weighing 24 pounds he counted 14,943 eggs.

In Lake Michigan Mr. Milner found that the lake trout, except in the spawning season, remains in the deepest part of the lake, and in their fall migrations they do not ascend the rivers nor are they found in outlets of the lakes. In northern Lake Michigan the fish are caught through the ice in winter in depths of more than 180 feet. The Indians of Sault Ste. Marie spear the lake trout through the ice, first decoying them within reach by means of a decoy of wood or lead roughly shaped like a fish.

In Alaska the lake trout becomes very plump, and on account of its great size and the good quality of its flesh it is a very important source of food for the natives. It has not at present any importance in the commercial fisheries, but must become a valuable market species in the future.

The Dolly Varden Trout (*Salvelinus malma*). Plate VI, Fig. 2.

This handsome species bears a very close resemblance to the sea trout of Labrador. It is known to commerce under the name of salmon trout. The Russian name of the species is *goletz*, and in Kamchatka it is the *malma*. In western Montana it is known as salmon trout and bull trout, the latter name being current also in California.

The name dolly varden was in use for it at Soda Springs, Cal., at least as early as 1872. The McCloud River Indians call it the *Wye-dar-deek-it*. In the McCloud its weight varies from 2 to 15 pounds. According to Mr. J. B. Campbell—

It frequents the river from the junction (with the Pitt) to the spring, there being none above the spring and few near the river mouth. If one takes hold of the dolly varden it slips away nearly like an eel. The species is very destructive to other trout, or any kind of fish. It spawns in September and November. The eggs are about one-half the size of those of the common (rainbow) trout. The fish are very difficult to obtain. They will live in a small place where the common trout would not. I have kept them in a pond about 6 feet square for a month, where the rainbows would kill themselves in a short time. They appear to be more hardy.

The average weight of this trout in the sea fishery at Kadiak is about 2½ pounds. It reaches a length of 30 inches, and individuals weighing 8 pounds are often taken. It increases in size to the northward.

The dolly varden is a migratory species and passes much of its time in the sea near the river mouths; it enters the rivers late in the fall and descends in the spring. Mr. Washburn says that it arrives at St. Paul in April. It remains in the bay near St. Paul throughout the summer. Mr. Charles Hirsch states that it reaches Karluk in the latter part of May and runs through the whole season. Dolly vardens of a pound or more can be found in the streams at any time during the summer. Mr. E. W. Nelson found them at Unalaska early in June, and in the Yukon in the same month, but he says they are most numerous in the fall just before and after the streams freeze over. They enter the rivers and go up to their headwaters for the purpose of spawning. The spawning season is in winter and may begin very early in this part of the year. A female, opened on the beach at Karluk August 2, 1889, contained eggs which seemed to be nearly ripe.

Individuals taken at sea sometimes have capelin in their stomachs. In Karluk River, near its mouth, I have seen them feeding on eggs of the red salmon, which had been thrown into the water from the fish-cleaning houses. On the 5th of August I found a female dolly varden with very small ovaries; this example was long and slender. On August 16 a spent or sterile *malma* was found above the rapids in a little stream tributary to Karluk River. At the head of Karluk Lake, August 19, was discovered a very much emaciated trout of this species, which was struggling in the water and nearly dead. The inside of its mouth was full of large lernæan parasites.

The dolly varden spends the entire summer in salt water near the mouths of the rivers after it has reached a certain age; younger individuals remain in the rivers and lakes. Many thousands of these trout are caught in the seines hauled for salmon, and fisheries exist for this species alone in various localities. It is put up in pickle and sold in San Francisco. The demand there, however, is limited.

No serious diminution of the supply of this trout has been observed. There is great destruction of the fish, however, at Karluk in the seining for red salmon, where thousands of dolly vardens are taken and left lying unused on the beach. Something should be done to prevent this waste of good fish.

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BY TARLETON H. BEAN, M. D.,
Ichthyologist, U. S. Fish Commission.

Owing to lack of time it was found impossible to furnish a complete bibliography of publications relating to the *Salmonidæ* of Alaska and adjacent regions. A more detailed catalogue, however, is in course of preparation for publication in the Bulletin of the U. S. Fish Commission for 1892. In the compilation of the following list of papers free use has been made of the "Bibliography of the Fishes of the Pacific Coast of the United States to the end of the year 1879," by Theodore Gill. The "Partial List of Charts, Maps, and Publications relating to Alaska and the Adjacent Region from Puget Sound and Hakodadi to the Arctic Ocean, between the Rocky and the Stanovoi Mountains," by W. H. Dall and Marens Baker, to which reference is made below, will furnish many additional titles.

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 Fish, pp. 156-171, and pl. xxviii, pl. xxxiii. *Salmo consuetus*, Yukon River (167, pl. 32); *Salmo dermatinus*, Yukon River (169, pl. 33, f. 3-5).

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No. 1. Report upon Fishes collected on the Survey. By Charles Girard, M. D.; pp. 9-34, with plates XXIIa, XXIIb, XXVa, XXVb, XLa, XLVI, LXII, LXVI, LXVIII, LXX, LXXIV.
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[Fishes noticed at pp. 202-203.]
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[N. sp. *Salmo Gibbsii* (1), *Salmo truncatus* (3), *Salmo gibber* (6), *Salmo confluentus* (8), *Salmo canis* (9).]
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[§ 1-4, n. sp. "*Fario Neuberrii*, or else *Salmo Neuberrii*" (225).]
- 1859—33d Congress, 2d Session. Senate. Ex. Doc. No. 78. Reports of Explorations and Surveys, to ascertain the most practicable and economical route for a railroad from the Mississippi River to the Pacific Ocean. Made under the direction of the Secretary of War, in 1853-6, according to Acts of Congress of March 3, 1853, May 31, 1854, and August 5, 1854. Volume X. Washington: Beverly Tucker, Printer. 1859.
- 1859—Explorations and Surveys for a railroad route from the Mississippi River to the Pacific Ocean. War Department. Fishes: By Charles Girard, M. D. Washington, D. C., 1858. [xiv, 400 pp., with plates VII-VIII, XIII-XIV, XVII, XVIII, XXII, XXVI, XXIX, XXX, XXXIV, XXXVII, XL, XLI, XLVIII, LIII, LIX, LXI, LXIV, LXV, LXXI.]
- 1860—Salmon Fishery on the Sacramento River. By C. A. Kirkpatrick. Hutchings's California Magazine, v. 4, pp. 529-534, June, 1860.
- 1860—30th Congress, 1st Session. Senate. Ex. Doc. Reports of Explorations and Surveys to ascertain the most practicable and economical route for a railroad from the Mississippi River to the Pacific Ocean. Made under the direction of the Secretary of War, in 1853-5, according to act of Congress of March 3, 1853, May 31, 1854, and August 5, 1854. Volume XII. Book II. Washington: Thomas H. Ford, Printer. 1860.
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No. 5. Report upon the fishes collected on the survey. By Dr. G. Suckley, U. S. A. (pp. 307-368, with pl. I, XI, XV, XVI, XIX, XX, XXXII, XXXIII, XLII, XLIII, XLIV, L, LI, LV, LX, LXIII, LXVII, LXIX, LXXII, LXXV, viz:
Chapter I. Report upon the Salmonidæ. pp. 307-349.)
[N. sp. *Salmo Masoni* (345).]
[This volume also appeared with the following title page and modifications:—]

- 1860**—The Natural History of Washington Territory, with much relating to Minnesota, Nebraska, Kansas, Oregon and California, between the thirty-sixth and forty-ninth parallels of Latitude, being those parts of the final Reports on the Survey of the Northern Pacific Railroad Route, containing the Climate and Physical Geography, with full Catalogues and Descriptions of the Plants and Animals collected from 1853 to 1857. By J. G. Cooper, M. D., and Dr. G. Suckley, U. S. A., Naturalists to the Expedition. This edition contains a new preface, giving a sketch of the explorations, a classified table of contents, and the latest additions by the authors. With fifty-five new plates of scenery, botany, and zoology, and an isothermal chart of the route. New York: Baillière Brothers, 440 Broadway. 1859. 4°. xvii, 26+72+viii, 399 pp. (+1-4 pp. betw. 368 and 369), 61 pl., 1 map.
- 1861**—Salmonidæ of Frazer River, British Columbia. By C. Brew. *Edinburg New Philos. Journ.*, v. 13, p. 164, 1861.
- 1861**—Notices of Certain New Species of North American Salmonidæ, chiefly in the collection of the N. W. Boundary Commission, in charge of Archibald Campbell, Esq., Commissioner of the United States, by Dr. C. B. R. Kennerly, Naturalist to the Commission. By George Suckley, M. D., late Assistant Surgeon, U. S. Army. Read before the New York Lyceum of Natural History, June, 1861. *Ann. Lyc. Nat. Hist. New York*, v. 7, pp. 306-313, 1862.
[N. g. and sp. *Salmo Kennerlyi* (307), *Salmo brevicauda* (308), *Salmo Warreni* (308), *Salmo Bairdii* (309), *Salmo Parkei* (309), *Oncorhynchus*, n. g., 312, *Salmo Campbelli* (313).]
- 1862**—Notices of certain new species of North American Salmonidæ, chiefly in the collection of the N. W. Boundary Commission. By George Suckley, M. D. See 1861, June.
- 1863**—The Resources of California, comprising Agriculture, Mining, Geography, Climate, Commerce, etc., etc., and the past and future development of the State. By John S. Hittel—San Francisco: A. Roman & Company. New York: W. J. Middleton. 1863. [12°, xvi, 464 pp.]
[Zoology, chap. vi (pp. 140-146); fishing (pp. 313-317).]
- 1865**—Vancouver Island and British Columbia. Their History, Resources, and Prospects. By Matthew Macfie, F. R. G. S., five years resident in Victoria, V. I. London: Longman, Green, Longman, Roberts, and Green, 1865. [8°, xx pp. (including blank leaf and frontispiece), 1 l., 574 pp., 2 maps.]
Chapter V. General Resources of Vancouver's Island. Pp. 131-171. Fisheries. pp. 163-171.
- 1866**—The Naturalist in Vancouver Island and British Columbia. By John Keast Lord, F. Z. S., Naturalist to the British North American Boundary Commission. In two volumes. London: Richard Bentley, New Burlington street, Publisher in ordinary to Her Majesty.
Volume I. Fishes, pp. 1-199. *Salmonidæ*, pp. 36-100; Volume II, pp. 351-352.
- 1866**—Catalogue of the Fishes in the British Museum. By Albert Günther. . . . Volume sixth. London: printed by order of the trustees. 1866.
Also entitled: Catalogue of the Physostomi, containing the families Salmonidæ, Percopsideæ, Galaxidæ, Moruyridæ, Gymnarchidæ, Esocidæ, Umbridæ, Scombresocidæ, Cyprinodontidæ, in the collection of the British Museum. . . . London: printed by order of the trustees. 1866. [8° xv, 368 pp.]
[N. sp. *Salmo lordii* (148).]
- 1868**—The Natural Wealth of California. Comprising early history; geography, topography, and scenery; climate; agriculture and commercial products; geology, zoölogy, and botany; mineralogy, mines, and mining processes; manufactures; steamship lines, railroads, and commerce; immigration, population, and society; educational institutions and literature; together with a detailed description of each county; its topography, scenery, cities and towns, agricultural advantages, mineral resources, and varied productions. By Titus Fey Cronise. San Francisco: H. H. Baneroft & Company. 1868. [8°, xvi, 696 pp.]
Chapter VII. Zoölogy. pp. 434-501.
Fishes. [By J. G. Cooper, M. D.] pp. 487-498.
Fisheries. p. 680. *Salmonidæ*: *Salmo Scouleri*, *Masoni*, *stellatus*, *iridea*, *pretiosus*.
[The list of fishes was evidently prepared by Dr. J. G. Cooper, although only general acknowledgment for assistance was rendered in the preface. It was acknowledged by Dr. Cooper, as author, in the communication to the California Academy of Sciences, indicated above. Inasmuch as this was intended to be a complete enumeration of the fishes of California, the names are reproduced here.]

- 1870—Alaska and its Resources. By William H. Dall, director of the Scientific Corps of the late Western Union Telegraph expedition. Boston: Lee and Shepard. 1870.

[Contains many references to the fish of the Territory throughout; Chapter VI, Part II, is devoted entirely to fisheries and other resources, while the Appendix (p. 579) gives list of the fishes of Alaska.]

- 1870—Über einige Plenroectiden, Salmoniden, Gadoiden und Blenniiden aus der Decastris-Bay und von Viti-Levn. Von Franz Steindachner und weil. Prof. Dr. Rudolph Kner. Sitzb. K. Akad. Wissensch., B. 61, Abth. i, pp. 421-447, pl. 1, 1870.

[Species identified as common to Decastris Bay and the American coast.]

- 1871—The Food Fishes of Alaska. By William Healy Dall. Rep. Comm. Agric., 1870, pp. 375-392, 1871.

[14 species specified: no new species described.]

- 1872—Forty-second Congress, second session. Senate Ex. Doc. No. 34. Message from the President of the United States, communicating, in compliance with a resolution of the 19th of January, 1869, information in relation to the resources and extent of the fishing-grounds of the North Pacific Ocean, opened to the United States by the treaty of Alaska. [Washington: Government Printing Office. 1872.—8°, 85 pp.]

On p. 2 entitled "The Fisheries and Fishermen of the North Pacific." By Richard D. Cutts.

- 1873—A contribution to the Ichthyology of Alaska. By E. D. Cope. Jan. 17, 1873. Proc. Am Phil. Soc. Phila., v. 13, pp. 24-32, 1873. [Extras, March 11, 1873.]

[17 species enumerated: n. sp. *Salmo tules*, *Spratelloides bryoporus*, *Xiphidium cruoreum*, *Centronotus latus*, *Chirus balius*, *Chirus ordinatus*, *Chirus trigrammus*, *Ammodytes alascanus*, *Gadus periscopus*, *Gadus auratus*, *Bathymaster signatus*, *Pleuronectes arcuatus*.]

- 1873—Remarks on the Fisheries of British Columbia, by the Agent (James Cooper) of the Department of Marine and Fisheries at Victoria. In: Ann. Rep. Dept. Marine and Fisheries, Canada, for the year ended the 30th June, 1873, appendix V. pp. 205-206.

- 1873—Report on the Prybilov Group or Seal Islands of Alaska. By Henry W. Elliott, Assistant Agent Treasury Department. Washington: Government Printing Office. 1873. [4to, 16½ folios, not paged, with text parallel with back, and extending from bottom to top, 50 phot. pl.]

Chapter VIII. Fish and Fisheries.

- 1874—Report of the Commissioners of Fisheries of the State of California for the years 1872 and 1873.—San Francisco: Francis & Valentine, printers and engravers, 517 Clay street; 1874. [8°, 28 pp.]

- 1874—United States Commission of Fish and Fisheries. Part II.—Report of the Commissioner for 1872 and 1873. A—Inquiry into the decrease of the Food-Fishes. B—The propagation of Food-Fishes in the waters of the United States. With supplementary papers. Washington: Government Printing Office. 1874. [8°, 5 pl., cii, (1), 808 pp., 38 pl., 3 maps folded.]

Report of the Commissioner. pp. i-xcii.

Appendix B.—The Salmon and the Trout (species of *Salmo*). pp. 89-384.

III.—On the North American species of Salmon and Trout. By George Snedley, surgeon, United States Army. (Written in 1861.) pp. 91-160.

VI.—Report of operations during 1872 at the United States Salmon-Hatching Establishment on the McCloud River, and on the California Salmonidae generally; with a list of specimens collected. By Livingston Stone. pp. 168-215.

XII.—On the Speckled Trout of Utah Lake, *Salmo virginalis*, Girard. By Dr. H. C. Yarrow, U. S. A. [etc.]. pp. 363-368.

XIII.—Miscellaneous notes and correspondence relative to Salmon and Trout. (pp. 369-379), viz:—

D—On the edible qualities of the Sacramento Salmon. [By S. R. Throckmorton.] pp. 373-374.

E—On the Salmon Fisheries of the Sacramento River. [By Livingston Stone.] pp. 374-379.

- 1874—Remarks on the Salmon Fisheries of British Columbia. In Rep. Comm. Fish. Canada for 1874. pp. 165-170.

- 1874—On the edible qualities of the Sacramento Salmon. By Livingston Stone. Forest and Stream, v. 1, p. 331, Jan. 1, 1874.

- 1874—Preparing Salmon on the Columbia River. By Charles Nordhoff. Forest and Stream, v. 1, p. 397, Jan. 29, 1874. (From Harper's New Monthly Magazine.)
- 1874—On the Speckled Trout of Utah Lake—*Salmo virginalis*, Girard. By Dr. H. C. Yarrow, U. S. A. Am. Sportsman, v. 4, pp. 68, 69, May 2, 1874.
- 1874—California Salmon; its rapidity of growth. [By Livingston Stone.] Forest and Stream, v. 2, p. 260, June 4, 1874.
- 1874—Will the Columbia Salmon take the Fly? [Anon.] Am. Sportsman, v. 4, p. 166, June 13, 1874.
- 1874—The Salmon Fisheries of Oregon. [By A.] Forest and Stream, v. 2, p. 290, June 18, 1874.
- 1874—Sacramento Salmon vs. Eastern Salmon. [By Livingston Stone.] Am. Sportsman, v. 4, p. 198, June 27, 1874.
- 1874—Ichthyic Fauna of Northwestern America. [By Mortimer Kerry, *pseudon.* J. M. Murphy.] Forest and Stream, v. 2, pp. 356, 357 ($\frac{1}{2}$ col.), July 16, 1874.
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- 1874—Oregon Salmon Fisheries. [From "Portland Oregonian."] Am. Sportsman, v. 4, p. 378, September 12, 1874.
- 1874—Salmon Fisheries on the Columbia. Am. Sportsman, v. 4, p. 412, September 26, 1874.
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- 1874—Annual Record of Science and Industry for 1873. Edited by Spencer F. Baird, with the assistance of eminent men of science.—New York: Harper & Brothers, publishers, Franklin Square. 1874. [12°.]
Shipments Eastward of California Salmon, p. 433.
Taking California Salmon with the Hook, p. 461.
- 1875—The Oregon Salmon Fisheries. [Anon.] Forest and Stream, vol. 5, p. 230, Nov. 18, 1875.
- 1875—On what do Salmon Feed? [Editorial from E. J. Hooper's observations.] Forest and Stream, vol. 5, p. 280, Dec. 9, 1875.
- 1875—What do Salmon eat? By R. Tallant. Forest and Stream, vol. 5, p. 308, Dec. 23, 1875.
- 1875—A report on the condition of affairs in the Territory of Alaska. By Henry W. Elliott, special agent of the Treasury Department. Washington: Government Printing Office. 1875. [8°, 277 pp.]
Chapter VIII.—Fish and Fisheries. The Fisheries of Alaska. pp. 165–167.
[This is essentially a second edition of the report of Mr. Elliott, published in 1873.]
- 1875—Extract from the Annual Report of the British Columbian Agent of the Department of Marine and Fisheries (James Cooper, esq.), dated at Victoria, 28th July, 1875. In Rep. Comm. Fish., 1875, or Suppl. No. 4, Ann. Rep. Minister Marine and Fisheries, Canada, pp. 219–224.
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[The figure appears to represent *Hysifario kennerlyi*.]
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[The smelt called *Hypomesus olidus* is *H. pretiosus*.]
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