1964 Author unknown

A BRIEF HISTORY OF
FISH MANAGEMENT IN GLACIER NATIONAL PARK

On February 22, 1897, the area of what is now Glacier National Park was set aside as part of the Lewis and Clark Forest Reserve under authority of the Congressional Act of 1891, authorizing the President to set aside forest reserves in the forested lands of the nation. This entire area east of the Continental Divide including what is now the eastern half of Glacier National Park, was obtained by the United States Government from the Blackfeet Indian Tribe. The cost was 1.5 million dollars. The area north of the Great Northern Railway was designated the North Division and that south as the South Division. In 1905 the Lewis and Clark Forest Reserve was taken out of the Department of Interior and set up under the Department of Agriculture.

Glacier National Park was established in 1910, and the 1,500 square miles comprising the Park was turned back to the Department of Interior. No records are available to show any form of fish management during the thirteen years existance of the Lewis and Clark Forest Reserve. Very possibly, a few fish were stocked by individuals.

At the time the Park was established in 1910, native sport fish believed present in waters below barriers in the Columbia River watershed were the native West-slope Cutthroat, (Salmo clarki clarki), the Dolly Varden char (Salvelinus malma), and Rocky Mountain Whitefish (Coregonus williamsoni). In waters below barriers in the Hudson Bay Drainage, native sport fish were the Lake Trout (Salvelimus namaycush) in St. Mary and Waterton Lakes, Montana Blackspotted Cutthroat (Salmo clarki lewisi), the Northern Pike (Esox lucius), Rocky Mountain Whitefish, and the Dolly Varden. The Rocky

June, 1964

Mountain Whitefish, Lake Trout and Montana Blackspotted Cutthroat were believed native to waters below impassible barriers in the southeastern portion of the Park in the Missouri River drainage.

The presence of native species prior to 1900 has been recorded by such early explorer-biologists as Lewis and Clark, various naturalists with the Pacific Railroad Survey Parties, Cope (1879), Dr. Elliot Coues (1874), Carl H. Eigenmann (1892), Evermann (1893) and Evermann and Cox (1896).

During the summers of 1909 thru 1911, Morton J. Elrod of the University of Montana spent considerable time in the Park making studies of the lakes. His work was aimed at determining which lakes now barren would be suitable fish habitat. Elrod's work, which consisted of depth determinations and collections of fish food samples, is the first known aquatic research done in Glacier National Park.

In May, 1913, the Glacier Park Hotel Company was given permission to seine 35 pounds of whitefish daily from St. Mary Lake for purposes of serving their guests at Going-to-the-Sun Camp and the St. Mary Camp. This permit was revoked in August of the same year when ex-Secretary of War, Stimson, while visiting the Going-to-the-Sun Camp, discovered two unattended net sets at the mouth of Baring Creek containing some dead mackinaw.

In 1917, the Hotel Company was again permitted to take whitefish from St. Mary Lake and Sherburne Lake under more stringent restrictions such as prohibition of use of the gill net and supervision by the District Ranger. Netting by the Hotel Company was allowed into the thirties. Incomplete records do not indicate just exactly when this practice ceased.

During the years 1910 thru 1913, fish planting was carried out principally by individuals. Fish could be obtained by application to the U. S. Bureau of Fisheries with endorsement of a U. S. Senator. The number and species planted during these early years was never recorded except for a few fragmentary records.

From 1912 to 1917, the Great Northern Railway was quite active in stocking waters on the east side of the Park. The fish were secured from the State of Montana and the U. S. Bureau of Fisheries. The improved fishing was presumably to attract more customers to their chalets, hotels and trains.

In 1915, for the first time, the Superintendent received a small number of fish from the U. S. Bureau of Fisheries.

The first record fish were planted in 1912 when 96,000 brook and cutthroat were placed in four lakes. This included brook in Harrison Lake and Upper Two Medicine Lake and cutthroat in Swiftcurrent Lake. Also in 1912, an unrecorded number of rainbow were planted in Swiftcurrent Lake by the Great Northern Railway.

In 1913, 140,000 grayling were obtained by the Railroad from the State and planted in Two Medicine Lake. In 1915, 17,000 brook and rainbow were planted. In 1916, the total jumped to 675,000 cutthroat, brook, grayling, rainbow and salmon trout (chinook). The salmon trout, believed to be kokanee, were released in Swiftcurrent and Josephine Lakes. Large numbers of Kokanee are present today in these lakes.

By 1919, the number of fish stocked by the Park rose to 921,000, all of which were cutthroat, brook and rainbow. Also in 1919, the Glacier Park Fish Hatchery located at East Glacier Park went into operation. Most of the cutthroat fry stocked in the Park for the next twenty years were propagated from eggs supplied by the State of Montana and the Yellowstone Hatchery. This hatchery was abandoned about 1940 when the new hatchery at Creston began operation.

In 1920, 1,473,000 fry were stocked, including 278,000 rainbow and 415,000 grayling. In 1921, Chief Park Ranger J. P. Brooks did survey work on some fifty Park waters, his data being still valuable to this day.

In 1921, 1,891,400 rainbow, grayling brook and cutthroat were planted. In 1922, 1,867,700 rainbow, salmon trout (chinook), steelhead, grayling, brook and cutthroat were released. In 1923, the number was 1,783,600 rainbow, salmon trout, (chinook), mackinaw, brook and cutthroat plus 329,000 cutthroat eggs. By 1926, 3,226,000 fry and eggs were planted.

In the summer of 1925, R. A. Muttowski of the University of Detroit assisted by Ike N. Carter of the University of Idaho made fish food investigations of several of the larger heavily-fished waters. Generally, they found considerably less plankton but more insect life in the east side waters as compared with Lake McDonald. He specifically recommended that no fish fry be planted in any of the lakes and streams until after mid August in order to give the insect food and plankton a chance to develop.

In August, 1924, 100 fish cans of aquatic vegetation were removed from Lower Two Medicine Lake with smaller amounts from other sources and placed in all lakes in the Two Medicine and Cut Bank Drainages as well as in some of the lakes in the St. Mary and Swiftcurrent Drainages. The purpose was to stimulate greater fish growth and survival in these more barren waters. This practice is no longer followed in Glacier as we stress that only natural aquatic conditions exist to support sport fish populations.

Well over one million fry and eggs of various sport fishes were planted annually between 1927 and the initial years of World War II. Many years saw over two million planted and in 1932, 4,545,000 were introduced, most of which were Montana blackspotted cutthroat fry.

In 1935, A. S. Hazard, Associate Aquatic Biologist of the U. S. Bureau of Fisheries submitted a comprehensive report of his earlier fishery investigations in the Park in 1932 and 1933. He made many recommendations pertaining to fishing regulations, management and a detailed stocking plan. He advised:

1. A ten fish catch limit

2. A minimum size limit of 7"

3. Continued prohibition of use of live bait

4. Closing certain waters on September 15 to protect spawning brook char

5. Keeping inaccessable waters in their natural state - no stocking

6. No introduction of warm water fish species

7. Experimental plantings of cutthroat should be marked by tagging or fin removal to determine value of stocking

Between 1932 and 1934, survey parties of the U. S. Bureau of Fisheries under the direction of A. S. Hazard, J. E. Hancey and Leonard P. Schultz made detailed studies of the physical and biological features of most Park waters.

In 1935, a few kokanee began showing up in fisherman creels in McDonald Lake. At that time the species was unknown to anglers as fishing methods had not been devised to properly harvest it during summer months. It was therefore, considered by Park authorities a very undesirable exotic. Those kokanee became established from either the salmon trout plants in Lake McDonald in 1921 and 1922 or from gradual upstream extension of the kokanee's range from Flathead Lake where it was first introduced in 1914.

During the period 1912 thru 1944, the following number of the different species were stocked in Glacier National Park.

29,754,000	blackspotted fry	7,600,000	rainbow trout fry
2,363,000	" eggs	5,000,000	grayling fry
3,363,000	brook char fry	350,000	salmon trout (chinook) fry
58,000	steelhead fry	500,000	Lake Superior Whitefish fry
51,000	mackinaw fry	66,000	Golden trout eggs
13,000	landlocked salmon (Salmo sebago) St. Mary Lake in 1931		

On December 18, 1939, the National Park Service and the U. S. Bureau of Fisheries reached an agreement of cooperation. Several Park Service employees engaged in fishery activities were transferred to the Bureau of Fisheries. In this agreement, many of the National Park Services current fish management policies were first presented.

In February, 1940, the Glacier National Park Fish Hatchery at Creston, Montana went into limited operation under the management of the Fish Culture Division of the U. S. Fish and Wildlife Service. The Fish and Wildlife Service came into being earlier that year as the U. S. Bureau of Fisheries and the U. S. Biological Survey were united. By an act of Congress, the land and development was a part of Glacier National Park and by the same act, the product of the hatchery was to be used solely for the restocking of the waters of the Park. Actual stocking operations were to be carried out by Glacier National Park personnel. Only cutthroat trout, brook char and rainbow trout were to be raised.

In December, 1944, the hatchery was taken from National Park Service administration and transferred to the U. S. Fish and Wildlife Service. It is now known as the Creston National Fish Hatchery. It was stated at this time "and that such fish propogated at this hatchery, as may be in excess of the number to restock and maintain an optimum fish population in the waters of Glacier National Park at all times, may be utilized for restocking other waters."

Conservation Bulletin No. 22, Fishes of Glacier National Park by Leonard P. Schultz was published by the U. S. Government Printing Office in 1941. This publication is now out of print.

Ancil D. Holloway, Division of Game Fish and Hatcheries of the U. S. Fish and Wildlife Service was in the Park during the summer of 1944 conducting biological surveys of lakes and streams. In January, 1945, he submitted a detailed report included in which was management and stocking recommendations.

In 1946, the National Park Service and the U. S. Fish and Wildlife Service entered into a new memorandum of agreement. In this up-dated agreement, the Fish and Wildlife Service agreed to furnish technical assistance when requested and when funds were available. Assistance rendered was to keep within National Park Service policies regarding fish and wildlife management.

Fish stocking activities during immediate post war years were curtailed as compared with the pre-war period. In 1945, 148,000 cutthroat and brook were planted. In 1946, 159,000 cutthroat, brook and mackinaw were planted. The number in 1947 was 137,000 cutthroat and brook and 189,000 brook, mackinaw and rainbow in 1948. In 1949 the number jumped to over one million when 1,403,000 blackspotted cutthroat fry were released along with 200,000 rainbow, mackinaw and brook.

In 1949, Lewis R. Garlick, Fishery Management Biologist spent three weeks studying several "problem" lakes on the west slope of the Park. These lakes included Quartz, McDonald, Bowman and Kintla.

The high stocking intensity of 1949 continued thru 1952, after which less than 100,000 fingerlings per year have gone into Glacier's waters with the exception of 1959 and 1962 when 130,000 and 337,500 respectively were stocked. Only fingerling-size fish were stocked after 1952. Blackspotted cutthroat, rainbow and brook made up the bulk of these plants. In 1962, 160,000 grayling were obtained from the State of Montana and placed in Elizabeth Lake. The same year, the State furnished 5,200 native cutthroat which went into Stoney Indian Lake. No brook trout have been planted since 1957. Both the Elizabeth Lake and Stoney Indian Lake plants were made with Montana Fish and Game Department Aircraft.

A meeting was held at Park Headquarters on July 15, 1950 which was attended by officials of Glacier National Park and the Bureau of Sport Fisheries and Wildlife. It was felt by those attending that many years of heavy stocking of fish had failed to produce any notable sport fishery in the Park, and that a different approach to fishery management was needed.

The Superintendent emphasized two goals he would like to see attained. These were:

1. That angler's catches would one day be composed only of native wild fish uncontaminated by introduced species or races.
2. That Glacier National Park waters be studied to ascertain, (a) what fish are present; (b) what and where are the problem waters; and (c) what can be done to enhance the values of fishable waters in the best interests of both preservation and angler use.

Biologists O. L. Wallis of the National Park Service and W. M. Morton of the Bureau of Sport Fisheries and Wildlife agreed that the first goal would have to be a long range aim which would be difficult to attain in view of the fact that practically all Park waters had been stocked in the past and that most of the east slope waters in their native state had no known native species of fishes inhabiting them in the first place. However, the second goal could be attained if funds could be provided to support a resident fishery biologist, or temporary summer workers, who could conduct active fishery research and management work in the Park.

Although this has been the plea of Park Superintendent's for over forty years, the only time funds that have ever been alloted for such work were for Dr. A. S. Hazzard's studies in the early 1930's. These studies sponsored by funds provided by the U. S. Bureau of Fisheries resulted in a recommended stocking program for all waters, several fishery articles by Hazzard and the basic publication, "Fishes of Glacier National Park" by

Schultz (1941). As usual, funds were not forthcoming in recent years so very little field work was accomplished at Glacier National Park from 1959 through 1963.

On January 16, 1959 Aquatic Biologist O. L. Wallis put out a report on Evaluation of the Fishery Resources of Glacier National Park and the Needs for Interpretation, Research, and Management which contained many helpful suggestions which have been used in ensuing work.

Fishery Management Biologist W. M. Morton made brief physical and biological studies of most of the major fishing waters in the Park during each summer from 1958 through 1961. Early in 1959 he prepared, "An Inventory Outline of Trout Streams and Lakes in Glacier National Park, Montana" as a preliminary index for the preparation of a filing system for individual Park streams and lakes for ready reference in evolving future fishery management plans. He and Assistant Park Ranger A.D. Cannavina decided to concentrate on developing 1) a volunteer creel census system and 2) a detailed historical fishery inventory of all streams and lakes in the Park as a means of obtaining some of the answers called for in the Superintendent's second goal.

On July 14, 1961 in a memo to The Director, Morton presented a system of natural geographic drainages in the Park which would serve well as unit fishery management areas and proposed a series of review reports for each area reviewing all published information; stocking and creel census records available; and recommendations to be considered in managing the fisheries on each body of water in that area - for use by future fishery workers.

The first of this series of reports - on The Waterton Area I - was issued on August 15, 1961. The second on The Belly River Area II was issued on August 17, 1961 and the third on The Many Glacier Area III was completed on November 15, 1961. The reports were continued in 1963 and

1964 with both The St. Mary Area IV and Two Medicine Area V reports being completed by September, 1964. Review reports of the portion of Glacier National Park west of the Continental Divide are expected to be completed by mid 1965. These areas are The Middle Fork Area VI, The McDonald Area VII and The North Fork Area VIII.

At the request of Morton, a voluntary creel census was started in 1959 and has continued since. Angler interviews are often made by rangers to supplement the voluntary information. Creel forms are made available in conveniently located creel boxes as well as at ranger stations. Rangers collect the completed forms which are then forwarded to the Bureau of Sport Fisheries and Wildlife for compilation. Creel information, even of the voluntary type, has provided extremely valuable data necessary for proper management.

A new Memorandum of Understanding between the National Park Service and U. S. Fish and Wildlife Service dated June 15, 1960 made possible continued cooperation between these two agencies.

In October of 1962, Walter Allen then Asst. Hatchery Manager at the Creston National Fish Hatchery was appointed as Fishery Management Specialist for the Bureau of Sport Fisheries and Wildlife to cover the State of Montana. Shortly after, a full-time position of Fish and Wildlife Management Ranger was created in the Park. With such increased attention, fishery management investigations are progressing at a more rapid pace.

In 1963, nine of the heavily fished and accessible large lakes were surveyed and management recommendations made. It is planned to concentrate on certain back-country waters in the summer of 1964. In the meantime, both Mr. Allen's office in Kalispell, Montana, and Mr. Morton's office in Portland are working on the management unit reports.

Present cooperative efforts of the Bureau of Sport Fisheries and Wildlife and the National Park Service are directed toward formulation of a workable fishery management plan for all Park waters. Data taken from field biological surveys and the creel census program provide the basic information upon which this management plan will depend.

The management plan will dictate the following for a body of water:

1. Will it be open or closed to fishing?
2. If open - Will it be managed by (a) Regulations only or (b) Regulations and stocking.
3. If stocking is called for - What will the stocking plan consist of?
    a. Species to stock
    b. Frequency of stocking
    c. Number of fish to stock
    d. Size of fish to stock

An <u>Interim Fishery Management Plan</u> was formulated in 1963 and revised in 1964. It can be found on the following pages.

FISHERY MANAGEMENT PLAN (INTERIM)

Glacier National Park

The following fishery management guidelines will serve until a final fishery managment plan is evolved. These guidelines will be subject to annual review and revision in accordance with newly developed biological data, the availability of native fish for restocking, creel census data, and changes in fishing pressure on the various waters in the Park.

1. Only fish which are native to the North and Middle Forks of the Flathead River and its tributaries will be introduced into Park waters west of the Continental Divide.

2. Eastern brook char (Salvelinus fontinalis) will not be stocked.

3. Until such time as it is practical to effectively stock waters east of the Continental Divide with native cutthroat trout (Salmo clarki); periodic stocking of rainbow trout (Salmo gairdneri) will be made under the following conditions:

a. To maintain a reasonable fish population to meet the need for recreational angling in those lakes presently occupied by rainbow trout and then only when the continued stocking of this species will not threaten native fish species or other aquatic resources.

b. Creel census data must indicate declining fishing success and/or test nettings must indicate below-optimum fish numbers.

c. Biological investigations must indicate the existance of an adequate food supply and other favorable survival and growth conditions.

4. The Arctic grayling (Thymallus arcticus) is not native to Glacier' National Park. However, it is indigenous to similar mountain front waters east of the Continental Divide both north and south of the Park, and for this reason may continue to be stocked under the following conditions.

a. To maintain a reasonable level of fishing success.

b. Only in Elizabeth Lake and other lakes east of the Continental Divide which now contain Arctic grayling.

5. The Lake trout (Salvelinus namaycush) is native only to Waterton Lake and St. Mary Lake and may be stocked, when available, under the following conditions.

a. When necessary to maintain a reasonable degree of recreational angling and only when such stocking will not threaten the existance of other native aquatic organisms.

March, 1964

b. Only in Waterton Lake and St. Mary Lake.

6. Fishing pressure may be regulated by reducing creel limits, shortening the open season, and/or closing certain waters if necessary.

7. All fish management activities will conform to Service-wide policies for the protection and management of fish and wildlife resources as set forth in the <u>Administrative Manual,</u> Volume VI, Part 2, Chapter 5, pages 1 through 8.

Approved: Jack F. [signature]
Acting Superintendent

Date: March 5, 1964

Marnell
Glacier Nat'l Park

– Hist. fish mgt. 64

westslope s.c. clark.

golden trout?

grayling

salmon trout (chinook / kokanee?)

• Creston Hatch – 1940 – solely for Glacier Park
– records –
– stock used. – Yellowstone?
egg taking operation?

1950 – (p. 8)

O. L. Wallis – 59 publ. – (p. 9)

E. slope waters had no native fish?

– main fishery? – use?

– 62 – (p. 10) – new position
"F & W. Mgt. Ranger"

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Introduction of Trout
& the Planting of Eyed Eggs
in Lakes & Isolated Waters
of Glacier National Park

BULLSHIT

INTRODUCTION OF TROUT AND THE PLANTING OF EYED EGGS IN REMOTE AND ISOLATED WATERS OF GLACIER NATIONAL PARK

by

James P. Brooks,
Asst. Superintendent.
Glacier National Park. August 1925

The introduction of trout fry of different species to Glacier Park was begun in the early history of the Park; commencing shortly after the Park's creation, or about 1914. The waters then planted were the most accessible and the quantity of fish was of course, small. This was due to the bad roads and the small amount of fry obtainable at that time. The success attained from these initial plants; the rapid and prolific growth of the different species was remarkable. In fact the early visitors to Glacier Park were amazed at the quantity and size of the trout from these waters.

In 1921, my first year in Glacier, I made an extended trip, visiting most of the lakes and streams in the Park. At that time there were many lakes and streams barren of fish. I was deeply impressed with the possibilities of these virgin waters, if they could be stocked with trout. I was confronted with the problem of getting the fry into these almost inaccessible places. Some of these could be reached with pack horses, but in many cases, this method was useless as there were no trails within many miles of them. It would be a comparatively easy task to stock the lakes to which pack horses could be taken; but to plant the wilderness waters, the usual methods were not feasible.

I brought this problem to the attention of Mr. W. T. Thompson, Supt. of the U. S. Fisheries Station at Bozeman, Montana. Mr. Thompson suggested the introduction of eyed eggs to waters inaccessible by pack horses. In July, 1922, Mr. Thompson and our Rangers made the initial plant of black spotted (red throat) eggs, planting about one million. The method used was as follows: Eyed eggs were received at Glacier Park from the Yellowstone hatchery, transferred to small cases suitable for horse packing, and taken by auto truck to various disbursing centers. From here they were taken by pack horses to the ends of trails nearest the waters for which they were intended. Here they were transferred to still smaller packs and carried in on the backs of the men. This was not always an easy problem. Many difficulties were encountered by our workers. Icing the cases to retard the development of the eggs was a prime essential. Carrying this ice was a problem but this was overcome by carrying extra pack loads of ice. Dense alder thickets and jungle had to be penetrated. The man packs, weighing from forty to sixty pounds soon became a burden to the toiling men. Now and again a quarrelsome grizzly questioned our right-of-way through his huckleberry patch. These were only a few of the difficulties encountered. But in every instance the

the zeal of our force prevailed and the eggs were planted.

In planting the eggs we tried to select gravelly beaches or bars. We tried to simulate as nearly as possible the natural spawning habits of the fish. Skooping out a small amount of gravel in from one to three feet of water, we placed about five hundred eggs in this depression. These eggs were then covered with coarse gravel to a depth varying from one to three inches. In flowing streams we used a "V" shaped board to retard the flow of water while we were depositing and covering the eggs. In some instances, where gravel was lacking or unsuited to our purpose we planted the eggs without covering them, selecting shaded places in rocky clefts along the lake shores.

We were all keenly interested in learning what the results would be from this method of planting. We checked carefully on the barren lakes each year. In 1923 we were still unable to determine if our plants were successful. But in 1924 observations determined that the eyed-egg planting was a success. In that year schools of fish estimated to be about eight inches long were seen by the Rangers.

This method of planting remote and inaccessible waters has enabled us, in Glacier Park, to plant eight or more streams and about twelve lakes that otherwise would still be barren waters. These are now well stocked with fish awaiting the skill of the zealous angler.

Since the inauguration of this method of fish planting we have developed our system until now, with improved man packs and egg cases, we can reach any body of water, no matter how distant or difficult the way.

In all, about two million black spotted eggs have been planted during the last four years. I believe that other species could be handled in a similar manner. But it was our intention to concentrate on the black spotted for our remote waters, planting this kind only.

We all feel that the success of this venture is due to Mr. W. T. Thompson, who sponsored the idea. Without his valuable assistance and cooperation we could not have attained the results of which we are all justly proud.

FRY PLANTING.

Undoubtedly, all of you are familiar with the method of planting fry. And yet, I feel that it will interest you if I touch briefly on fry planting in Glacier Park. A hatchery is maintained and operated during the summer months, hatching most of the fry planted in the Park. We also received many shipments through the State of Montana and the Federal hatchery at Bozeman, Montana.

Let me illustrate our method of handling large quantities of fry. Just recently a U. S. Fisheries car arrived at Glacier Park with two hundred cans or about one hundred thousand large brook fingerlings. This is about five hundred fish to a can. Ten trucks were waiting at the Station and the cans were transferred to them. These trucks carried the cans of fish to the waiting pack strings many miles away. Four pack strings, of ten horses each, were used. The area covered in this plant alone, ranged from Glacier Park Station to the International Boundary Line and Canada. Eight to ten lakes and streams were planted. The fish car arrived at Glacier Park at five o'clock A.M. and by ten o'clock A.M. the car was entirely unloaded. Some of the assignments were taken by truck over one hundred miles and from there packed at least twenty miles to their destination. Some passed through Canada to reach our remote northern waters, traveling by truck, boat and pack string a distance of about one hundred and forty miles. In all, our losses incurred, were far less than one per cent, or practically nil. In handling the fry for northern waters, we have received splendid cooperation from the Canadian Park, adjoining us--Waterton Lakes Park.

We find that ice is essential in handling fry and fingerlings. Extra pack loads of ice are carried when packs are made into distant places. Screened in troughs are often used when fry have to be kept over night in transit. These are placed in flowing streams. In some of our plants, where it has taken two or three days, we have found these troughs to be of great value.

It is not unusual for anglers to catch trout weighing from five to eight pounds. This is especially true of Cut-throat, Rainbow and Brook. This indicates that there is an abundance of natural food in our waters but we have not been satisfied with this. We have introduced aquatic vegetation and fish food to many of the smaller lakes high up in the mountains where it appeared to us that there might be a scarcity of food as the numbers of fish increased.

Each year we see a heavier toll levied on our fish. The increasing number of tourists to our Park means that we must expand in this field of activity. This year we planted over two million fry and eggs but this is entirely insufficient to supply all our needs. When the development of the Glacier Park road system is complete, it will mean double the present number of tourists. To keep pace with these anglers' activities, we must prepare now and carry on the good work, with greater expansion along all lines of fish cultural activities.

- - - - - -

– paracite – ref. – excellent shape! large size?
ref – variation? –

2/1 N. Fk. Flathead

– Cerulean – 4700 ft. headwaters → Quartz (4416) – mid, lower – Quartz Crk.
– Logging – 3810 ft. – Logging Crk. drain – Grace L. above (hybrids)
– Quartz

Evangeline, headwater 5247 ft. barren – stocked – Camas – falls accessable by trails
Arrow ← 4070 ft.
Trout + Rogers Lake – Camas Crk. drainage

*Grace L. – unusual spotting pattern (prob. barren)
60 ft falls ½ mi. below – 1925 101,000 cutts stocked – spots appear larger, somewhat more irregular (large specimens)? –

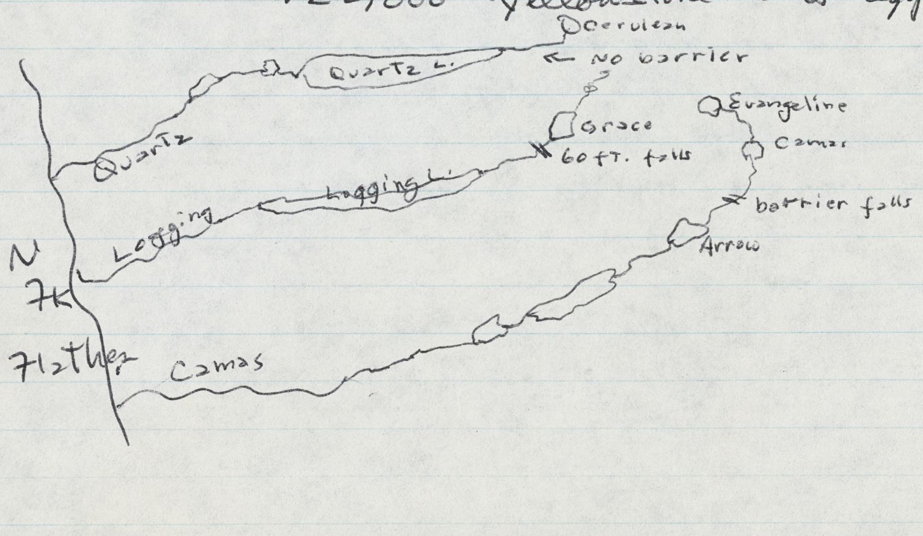
*– Logging – besides possible influence from Grace L., 202,000 Yellowstone fingerlings planted betw 1934–~~36~~ 1944.

* Cerulean L. – remote headwater lake of Quartz Crk. upper 7 mi. no trails – cutthroat + bull trout (S. confluentus) see canvas
cutts from Cerulean are deep cyan – blue –
No stocking records but unrestricted passage between Quartz & Cerulean

Tapeworm *Quartz L. – one stocking of 8,500 cutt. fry in 1940 also w/ striking blue cast to body –

* Evangeline L. – 1925 & 1935 90,000 eggs fry Yellowstone stocked. – low productivity, some fish thin

Tapeworm – *Arrow L. – waterfalls & cascades above Arrow block (Camas) upstream migration (to Evangeline). During 1920's–30's 122,000 Yellowstone cutts eggs & fingerlings stocked.



illustr. for table
for computer

final
- Rep. analyses, tax. char
compar. interpretation -

Rep. on 1978 collections of cutthroat trout from Glacier Nat. Park
R. B.
Apr. 1979

- for Glacier Nat. Park
- 10 copies.
Order No.
PX 1430.80377
4/27/78

Submit invoice in triplicate to Reg. Dir. R.M.N.P.S.
655 Parfet St.
Denver CO 80225

Introd.

- Park water heavily stocked --- hatchery - - provide for human use
-.. new policy - objectives - .. emphasis on preserv. of native ~~Trout~~ fauna
Obj - document occurrence ----
Prob. - is To locate pure pop ---
why never done?
Schultz - insoluble - " "

- Actually not as complex as was seen
- Prob. all non-native cutthroat stocked into Park were Yellowstone L. - distin by dif. - spotting, coloration, gill rakers, basibranch. teeth -
- Rainbows - scale, caeca, teeth -

Leo's plan - 5 samples of cutt. ( ) 5 pm
also compare gene loci elect. rophoresis W. Mont.
2 subsp. S. c. lewisi, S. c. bouvieri - dif. char. ...
- Only lewisi not all dissimilar - !

Methods. Mat -
total - 5 ... - 5 spec.
Specimens collected by Dr. Marnell 40', tissue extracted for elec., preserved in formalin.
~~After~~ washing transfer to isopropyl alcohol, specimens were examined for several taxonomic characters recorded for each spec..
Compared for correlation with spotting pattern ... Yellow. ... rates. - ~~Number~~ Most diagnostic character separating the two subsp. & useful to detect hybrid is the number of gill rakers on upper and lower first gill arch, both anterior and post (4 counts), and number of basibranchial teeth.
To obtain visual representation of data analysis, tax. charact. programmed ... ex. two tests ... - - - -.
During exam. Spec. ~~Res~~ were ~~examine~~ noted for parasitic tapeworm infection.

Results.

- Evangeline L. ~~has~~ judged to have pure pop. of native Yellowstone cutthroat trout.. Arrow Lake, in same drainage below Evangeline L. has been exposed to hyb. Two specimens from Arrow L. (A-16, A-17) are undoubtedly Yellowstone cutt. that must have moved downstream over time. Although some indicate - Arrow L. may be hyb - not a hybrid swarm
> 90% pure (lewisi - legal). don't mix pure - Others dor. appeared pu...
- Each sample discussed:
- Evangeline - - - - Yellowstone - characters change? -
Wernsman, Hickson introduced pop. - - - No parasites
- Arrow L. - - - - - - basibranch - rainbow (no record but)
- parasites! - 2 Yellowstone - why not more hybrid! - Must be favored - long establish. - but parasite infect. -

Schultz (41) based on ——

Rainbow trout & other sp. replacing native cutthroat.

Cutthroat trout abundant in Arrow & Quartz.

Racial difference among Glacier Park trout & adjacent regions do not form clear-cut problems of easy solution.

In Flathead drainage cutts resemble coastal S. c. clarki.

S. c. lewisi, Montana black-spotted trout most numerous in Park & larger spots.

In certain lakes trout very distinct (dif. subsp.) in spots - like S. c. stomias large, round. (do not know the source of the "stomias" type of trout introduced into Yellowstone Park) - Didn't know came from Yellowstone L.

"Stomias" type intergrades w/ lewisi type in most lakes and streams visited by us. - * In Grace L. (separated fr. Logging L. by fall) intermediate type exists.

- Discuss extreme variation in spotting & fail to correlate w/ scales, rakers, vert, fin rays - . - S. c. clarki (true lewisi) - stomias (Yellowstone) - S. c. lewisi (hybrids).

opinion of leading expert of time - influenced by environment

- Cutts - highly variable - great difficulties in recognizing subsp. & compounded by mixing.

Antipa, R. 1974. Food habits of lacustrine salmonids in Washington State in relation to infections with larvae of the bass tapeworm (Proteocephalus ambloplites). T.A.F.S. 103(4): 811-814. In rainbow, cutthroat trout & coho salmon. - ingestion of Cyclops (procercoid) feed on eggs. pleurocercoids in trout 1-4 mo. after feeding on Cyclops.

Becker, C.D. and W.D. Brunson. 1968. The bass tapeworm: a problem in northwest trout management. Prog. Fish Cult. 30(2): 76-83.

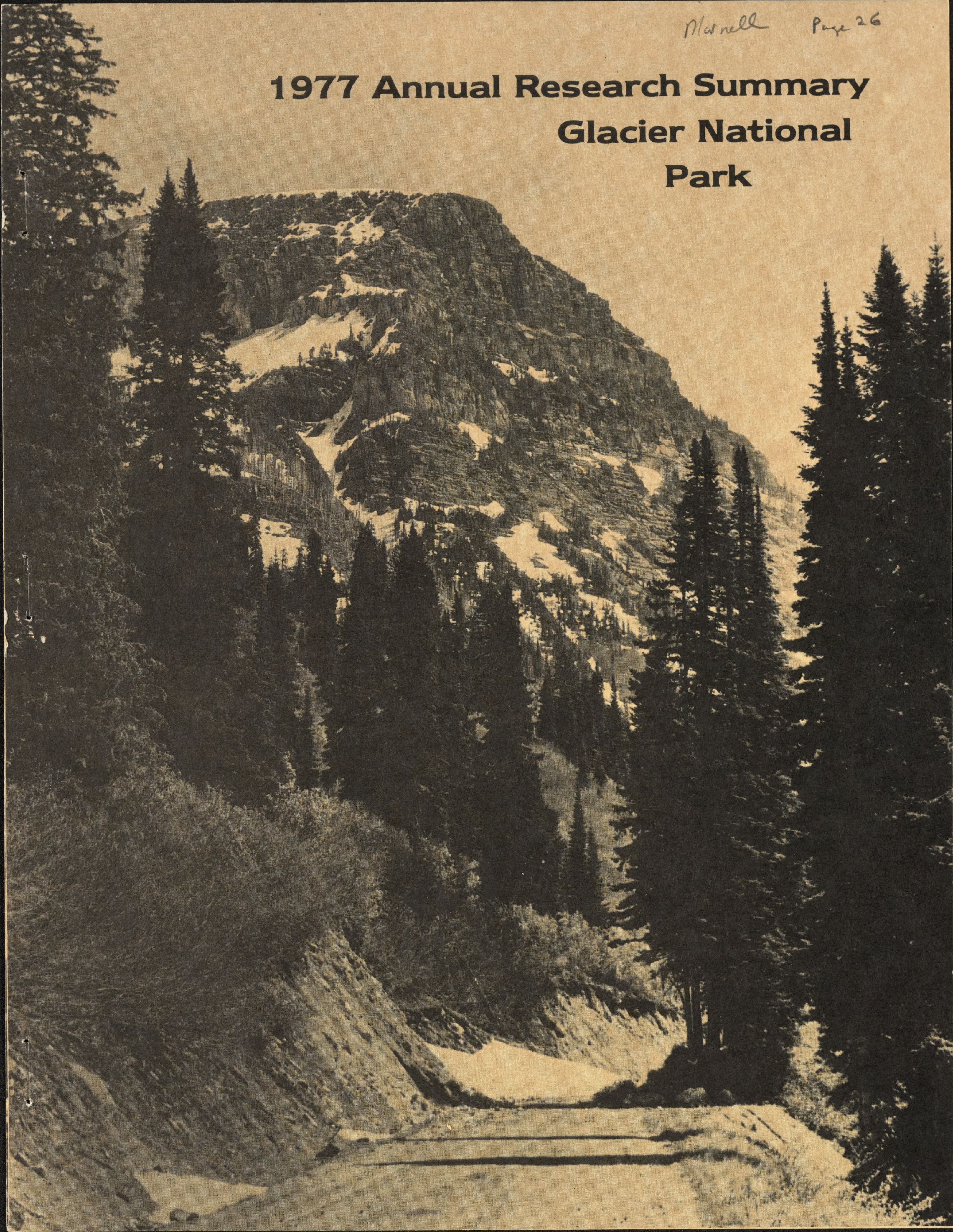
Plerocercoid infection in reproductive organs of centrarchids cause connective tissue to "castrate".

P. ambloplites now widely distributed - eastern, central states - from stocking infected fish (Hunter 28, Morrison 57) - Relatively unknown in Pacific Northwest - not been asc. w/ rainbow trout. - Only reported twice in salmonids (pleurocercoids of Proteoceph. amboplite) - in lake trout and brook trout.

In Washington - bass tapeworm in trout where bass also occur. - Centrarchids are definitive host. Copepods eat eggs (procercoid) - young trout eat copepods (pleurocercoids)

Marnell Page 26

1977 Annual Research Summary Glacier National Park



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1977 ANNUAL RESEARCH SUMMARY

— GLACIER NATIONAL PARK —

National Park Service Progress Report

K. L. McArthur, Editor
Research Division
Glacier National Park
West Glacier, Montana 59936

April 1978

INTRODUCTION

The primary purpose of Glacier National Park is to provide present and future visitors with the opportunity to see and appreciate the natural scenery and the native plant and animal life as it occurred in primitive America. This obligates the Park to maintain terrestrial and aquatic ecosystems in which the dynamic equilibrium among different forms of plant and animal life is not upset by modern man. It is the function of the Glacier National Park Research Division to obtain basic natural science information and to provide information on which park management plans can be based.

In addition to carrying out resident research, the Research Division administers contract and cooperative research studies and coordinates independent projects. For each study in this report, a research plan was submitted for review and approval by park staff. If collecting specimens in the park was satisfactorily justified in the study plan, a collecting permit was issued since the collection of any object in the park is otherwise prohibited by federal law.

This report summarizes the progress of research in Glacier National Park during 1977. It is sincerely hoped that the document will serve to strengthen communications among the scientific community and other people interested in natural science research. In addition, the report is intended to provide park managers and interpreters with a centralized source of current scientific data and evaluations relating to natural resources and their management.

Clifford J. Martinka
Supervisory Research Biologist
April 6, 1978

TABLE OF CONTENTS

Projects for which annual reports are not available:

Avifauna of the North Fork of the Flathead River floodplain, Glacier National Park — R. Eng (Contract)

Man's effects on stability of alpine and subalpine vegetation in Glacier National Park, Montana — E. Hartley (Independent)

Systematic analysis of the Gyrllollattidiae order of insects in western North America — J. Kamp (Independent)

Fungi and phanaerogams — M. Larsen (Independent)

CAVES OF GLACIER NATIONAL PARK

NEWELL CAMPBELL, Department of Geology, Yakima Valley Community College, Yakima, Washington 98907

JIM CHESTER, Montana State University, Bozeman 59715

RON ZUBER, Montana State University, Bozeman 59715

Results

Exploration and mapping of all of Glacier's caves were completed with the exception of a cave on Haystack Mountain. Geological and hydrologic studies were completed, and a biological inventory was made. More biological work should be done in Zoo Cave.

An aerial reconnaissance was made to determine if other large caves exist in the park; no significant leads were found. Until other caves are found, this study is complete.

GLACIOLOGIC INVESTIGATIONS OF SPERRY GLACIER

CHUCK DALBY, TOM GIGNOUX, JIM HORN, ROBERT R. CURRY, ANTHONY QAMAR, Department of Geology, University of Montana, Missoula 59812

R. A. RASMUSSEN, Atmosphere Research Station, Washington State University, Pullman 99163

Objectives

The objectives were (1) to define existing mass balance relationships for Sperry Glacier; (2) to develop techniques for mapping and dating snow and ice layers in Sperry Glacier, to analyze the chemistry of snow and ice layers up to 30 years old, and to investigate the relationship between atmospheric chemistry and the chemistry of recently accumulated snow and ice; and (3) to explore the possibility of using physical characteristics of small cirque glaciers in northwestern Montana as baseline monitors of changing atmospheric processes, ambient air quality, effects of anthropogenic aerosols, and changing climate.

Methods

Surface profile surveys of Sperry Glacier, conducted once every 2 years by the U.S. Geological Survey, provide information for determining changes in the volume of the glacier. Refraction and reflection seismic traverses conducted along the surveyed surface profiles provide additional information on depth/density relationships from which one may calculate the two-year average net mass balance of the glacier.

The relatively slow rate of movement of Sperry causes minimal deformation of the accumulated snow-ice mass, producing a "layer-cake" structure which allows relative dating of annual accumulation layers. Chemical analysis of these layers may provide information on atmospheric chemistry at the time of snow deposition.

Results and Discussion

Seismic refraction and reflection measurements of p-wave velocity and ice depth were made at several stations during 1977.

The velocity of p-waves in ice near the center of the glacier averaged 3.66 km/second; ice depth as determined by reflection was 112 m. This depth represents the ice thickness near the equilibrium line of the glacier and indicates the maximum depth of the lower glacier. Correlation of seismic depth measurements and gravity measurements on a grid of 12 stations will provide information on ice depth for representative portions of the glacier and allow determination of the glacier's volume.

A preliminary chemical survey in 1973-74 revealed a correlation between fluoride concentrations in different-aged snow-ice layers and the output of fluorides from the Columbia Falls aluminum plant. Recent attempts to further document this and other relationships between airborne pollutants and ice chemistry have been unsuccessful due to sampling problems.

Plans For 1978

Volumetric determination of Sperry Glacier will be completed and integrated with U.S. Geological Survey data to provide estimates of the glacier's mass balance. A cooperative agreement is being arranged with Los Alamos Testing Laboratories for detailed chemical analysis of ice samples to be collected during 1978. Additional study of the internal structure of the glacier is also planned.

GLACIAL GEOLOGY STUDIES AT BLACKFOOT GLACIER

BERNARD HALLETT, Department of Applied Earth Sciences, Stanford University, Stanford, California 94305

Objectives

The objective of this study was to learn more about fundamental physiochemical processes that occur under temperate glaciers. The primary goal of this research was to better understand how glaciers move and how they modify the landscape.

Methods

Extensive bedrock areas recently exposed by glacial retreat were studied, and particularly revealing portions were surveyed and plane-tabled. A set of high-resolution low-altitude aerial photographs of the Blackfoot Glacier area was utilized.

Results and Discussion

Much of the 1977 field season was spent developing a geomorphological map of an approximately 100 m × 200 m portion of the recently deglaciated bedrock directly north of the glacier. The principal aim of this map was to establish whether a network of former subglacial meltwater channels and water-filled cavities could be recognized and delineated. The map was quite successful and yielded the first definitive information on the geometry of an extensive subglacial hydraulic network. The way in which water flows under a glacier, in particular whether it flows as a continuous film or through a network of distinct channels, is a central consideration in the study of glacier dynamics — if subglacial waters are largely channelized, they cannot effectively lubricate the glacier/bed contact and, hence, cannot be responsible for major accelerations of glacier sliding.

This study is providing unique and timely clues about this important glaciological problem. Results are being summarized in two papers being prepared for the Ice-Rock Interface Conference to be held in Ottawa in summer 1978.

Plans For 1978

Field work will continue, extending the geomorphological map and systematic sample collection at Blackfoot Glacier. In addition, continuous records of glacier sliding in a subglacial cavity will be obtained.

SEISMIC AND GRAVITY STUDIES OF SPERRY GLACIER

JAMES HORN, Department of Geology, University of Montana, Missoula 59812

Objectives

The objective of the study was to determine the ice thickness of Sperry Glacier using two methods, seismic reflection and gravity anomaly. Comparison of the results will enable an evaluation of the use of gravity measurements on small, relatively shallow alpine glaciers. This may provide investigators of glacier mass balance with an important tool since gravity measurements can be conducted more easily and rapidly than can seismic measurements.

Results and Discussion

Data are presently being reduced. Seismic reflection data, though not yet fully reduced, have led to a seismic velocity approximation of 3.7 km/second. Using this velocity, the depth of the glacier at one station was determined to be 110 m.

Plans For 1978

The project will be completed by March 1978 and a final report submitted.

STROMATOLITES AND PALEOECOLOGY OF THE MIDDLE PROTEROZOIC BELT SUPERGROUP, GLACIER NATIONAL PARK

ROBERT J. HORODYSKI, Department of Earth Sciences, University of Notre Dame, Notre Dame, Indiana 46556

Objectives

A primary objective of this study is to evaluate the paleoenvironmental and time-stratigraphic significance of Proterozoic stromatolites. In addition, the tectonic and sedimentary history of the eastern margin of the Beltian depositional basin is being studied.

Methods

Glacier National Park provides possibly the best opportunity in the contiguous U.S. to carry out a study on Proterozoic stromatolites. Stromatolites are abundant and well preserved throughout the Beltian sequence exposed in the park. Their morphologic diversity and occurrence in units deposited under different depositional conditions makes this assemblage of stromatolites ideal for evaluating the usefulness of stromatolites. Both field and laboratory methods were used for this analysis.

Results

This study has resulted in the publication of four papers directly related to stromatolites occurring in Glacier National Park (Horodyski 1975, 1976a, 1976b, 1977a) and one paper in which fossil stromatolites are compared with modern analogues (Horodyski 1977b). Studies conducted during the summer of 1977 concentrated on the *Jacutophyton* cycles in the middle of the Siyeh Limestone. These stromatolite-rich cycles provide an excellent opportunity to evaluate the relative influence of environmental and biological conditions on stromatolitic macro- and microstructure (and, hence, in evaluating the usefulness of Precambrian stromatolites as paleoenvironmental and time-stratigraphic indicators) as they contain an abundant and diverse assemblage of stromatolites.

Stromatolites in these cycles have been studied at 20 localities of lateral changes in the *Jacutophyton* cycles, and their orientation suggests that paleocurrents were oriented oblique to depositional strike. The stromatolite *Conophyton*, and enigmatic group common in Proterozoic strata but absent from younger rocks, occurs in the *Jacutophyton* cycles, and current work is centering on the interpretation of this stromatolite.

Microfossils have been discovered in a black shale in the Appekunny Argillite. Although not well preserved, they are of interest as they occur in association with syngenetic sulfides, and they are being studied with the aim of evaluating the relationship between the microfossils and sulfide mineralization.

Plans For 1978

Jacutophyton cycles will be studied with the aim of completing regional studies on these cycles. Silicified stromatolites in the lower Siyeh Limestone will be studied subsequently.

Publications

Horodyski, R. J. 1973. Stromatolites and paleoecology of parts of the Middle Proterozoic Belt Supergroup, Glacier National Park, Montana. Ph.D. Thesis. University of California, Los Angeles. 264pp.

________. 1975. Stromatolites of the lower Missoula group (Middle Proterozoic), Belt Supergroup, Glacier National Park, Montana. Precambrian Research 2:215-254.

________. 1976a. Stromatolites from the Middle Proterozoic Altyn Limestone, Belt Supergroup, Glacier National Park, Montana. Pages 585-597 *in* M. R. Walter, ed. Stromatolites.

________. 1976b. Stromatolites of the upper Siyeh Limestone (Middle Proterozoic), Belt Supergroup, Glacier National Park, Montana. Precambrian Research 3:517-536.

________. 1977a. Environmental influences on columnar stromatolite branching patterns: examples from the Middle Proterozoic Belt Supergroup, Glacier National Park, Montana. Journal of Paleontology 51:661-671.

________. 1977b. *Lyngbya* mats from Laguna Mormona, Baja California, Mexico: comparison with Proterozoic stromatolites. Journal of Sedimentary Petrology 47:1305-1320.

CONTRIBUTIONS TO THE TAXONOMY OF THE *Oxytropis campestris* COMPLEX IN WESTERN NORTH AMERICA

WAYNE J. ELISENS, Department of Botany, The University of Alberta, Edmonton T6G 2E9

Objectives

The objectives were to determine the distribution and flavonoid composition of the chromosome races of selected populations of crazyweed (*Oxytropis campestris*).

Methods

A multidisciplinary approach was used to study this species, including morphological, cytological (chromosome studies), biochemical (flavonoid analysis), and phytogeographic techniques. Due to the wide distribution of the species in several different habitats (e.g., prairie, alpine, boreal, subarctic), extensive field collections of live, air-dried, and pressed material were made.

Results and Discussion

Three distinct chromosome races were discovered during the course of this investigation: 32, 48, and 96 chromosomes. The 96 race is confined to extreme northern Alaska, the Yukon, and the Northwest Territories. The 32 race is more widespread and is disjunct between the unglaciated areas of Alaska, the Yukon, and the Northwest Territories, and shortgrass prairie habitats of the prairie provinces of Canada and the northwestern U.S. Although occurring in "weedy" habitats of central and southern Alaska and the Yukon, the 48 race also occurs in montane areas of western North America.

The Glacier National Park population was found to have a diploid count of 48, in distinct contrast to surrounding lowland populations. Plants from the park, as well as plants from the Columbia River Basin in eastern Washington, have been placed in a separate taxon (*O. campestris* var. *columbiana*) due to distinctive morphological features. Thus, their separation on morphological grounds is corroborated using cytological techniques. Flavonoid profiles of the park samples indicate, however, a close biochemical connection between *O. campestris* var. *columbiana* and the prairie taxon, *O. campestris* var. *gracilis*.

Plans For 1978

Final synthesis of all data should be completed by 1 May 1978.

PLANT ECOLOGY STUDIES IN GLACIER NATIONAL PARK

ROBERT L. HALL, Plant Ecologist, Glacier National Park, West Glacier, Montana 59936

Objectives

The primary objectives were (1) familiarization with the resources of the park; (2) to learn about wildfire, which resulted in a study on the use of fire in controlling the exotic leafy spurge (*Euphorbia esula*); and (3) to learn about air quality of the park, resulting in the monitoring of ambient fluorides.

Methods

Evaluation of fire in controlling leafy spurge involved the use of 24 10×10-m plots. Two plots were used as controls and 2 for sampling fuel loads. The remaining 20 plots were paired and burned 1 or 2 times using various combinations of burning dates.

Fluoride data were obtained from 10 monitoring stations within the park, and additional data were supplied by the U.S. Forest Service and Anaconda Aluminum Company. Common St. John's-wort (*Hypericum perforatum*) and false solomon's seal (*Smilacina racemosa*) were noted to be good indicators of plant damage due to atmospheric fluoride.

Results

Data from the controlled burning experiment are still being analyzed. Preliminary fluoride analyses indicate that ambient fluoride pollutants are present in the airshed of the park.

Plans For 1978

Preliminary plans for 1978 include consultation on exotic plants and their management, continued monitoring of airborne fluorides and their accumulations in plants, a problem analysis and preliminary classification of park vegetation, and the initiation of studies on the ecological effects of insect infestations along the North Fork Flathead River.

DISTRIBUTION AND ECOLOGY OF HUCKLEBERRY

PATRICIA MARTIN, Border Grizzly Project, School of Forestry, University of Montana, Missoula 59812

Objectives

The objectives of this study were (1) to gather data on the geographic distribution of 4 species of huckleberry (*Vaccinium globulare*, *V. membranaceum*, *V. myrtilloides*, and *V. ovalifolium*), and (2) to determine the effects of fire, logging, and physical factors such as site and aspect on productivity.

Methods

A total of 175 *V. globulare* and/or *V. membranaceum* specimens were collected from areas throughout western Montana. Leaves, flowers, and berries of these plants will be measured and compared with those described by Hitchcock and Cronquist (1973) for the two species.

Two plants were collected at each of 30 permanent plots, including 4 in Glacier, designed to measure berry productivity.

Results and Discussion

Results obtained so far are based only on preliminary analyses.

No specimens appeared to possess all the characteristics described by Hitchcock and Cronquist (1973) for *V. membranaceum*, and no flowers such as those described for *V. membranaceum* were located. Many of the plants had characteristics of both *V. globulare* and *V. membranaceum*.

No specimens of *V. ovalifolium* were found in western Montana. Specimens of *V. myrtilloides* were found only in Glacier National Park.

Berry productivity plots in Glacier compared favorably with those sampled outside the park, with the exception of the Lower Quartz Lake plot. This plot is located in an old burn, and productivity was very low.

Plans For 1978

More plants will be collected in an attempt to locate good specimens of *V. membranaceum*, *V. myrtilloides*, and *V. ovalifolium*. Productivity plots sampled in 1977 will be sampled again, and more plots will be established.

Literature Cited

Hitchcock, C. L., and A. Cronquist. 1973. Flora of the Pacific Northwest. University of Washington Press, Seattle. 730pp.

HIGHER FUNGI OF GLACIER NATIONAL PARK

ORSON K. MILLER, JR., Department of Biology, Virginia Polytechnic Institute and State University, Blacksburg 24061

Objectives

The objective of this study was to examine the range and taxonomic relationships (using morphological, developmental, and environmental features) of higher fungi, primarily Basidiomycetes and Ascomycetes.

Results and Discussion

The rainy weather in late July and early August brought out some elements of the fungal flora not often seen. As a consequence, 29 new species were found in the park and Flathead Valley; many of these were also new records for the State of Montana. Especially noticeable was the relative unproductiveness of the high-elevation plant communities; this was attributed to the reduced snowpack.

Evidence was found indicating that the genus *Radiigera* should be placed in the family Geastraceae instead of Mesophelliaceae.

Publications

Askew, B., and O. K. Miller, Jr. 1977. New evidence of close relationships between *Radiigera* and *Geastrum* (Lycoperdales). Canadian Journal of Botany 55(21):2693-2700.

Miller, O. K., Jr. 1978. Mushrooms of North America.

ANALYSIS OF VEGETATION FOR FLUORIDE

C. E. TAYLOR, Anaconda Aluminum Company, Columbia Falls, Montana 59912

Objectives

The objective was to determine the presence and extent of fluorides in vegetation on the west side of Glacier National Park.

Results

Results are summarized in Table 1.

Table 1. Fluoride content (dry weight, ppm) by month in vegetation of Glacier National Park.

Plot no.	Pine					Grass			
	July		October			July		October	
	1976	1977	1975	1976	1977	1976	1977	1976	1977
4	5	3	10	4	-	5	16	10	-
4A	8	3	17	7	-	13	18	-	-
4B	4	4	12	9	-	38	24	-	-
9	1	1	5	0	4	1	6	-	-
10	6	3	4	2	3	10	15	-	-
13	0	1	10	6	-	12	7	-	-
15	3	1	40	16	7	15	20	20	-
17	1	2	6	11	3	3	4	17	6

(Continued)

Table 1. Continued.

Plot no.	Pine					Grass			
	July		October			July		October	
	1976	1977	1975	1976	1977	1976	1977	1976	1977
18	1	-	7	7	2	4	-	-	-
18A	7	-	5	8	9	2	-	-	-
18B	5	-	10	4	2	7	-	-	-
20	1	1	4	6	11	10	1	-	-
23	7	-	3	4	-	3	-	-	-
23A	3	2	4	3	3	7	1	-	-
23B	3	1	4	6	2	5	3	-	-
26	5	1	4	6	2	9	24	-	-

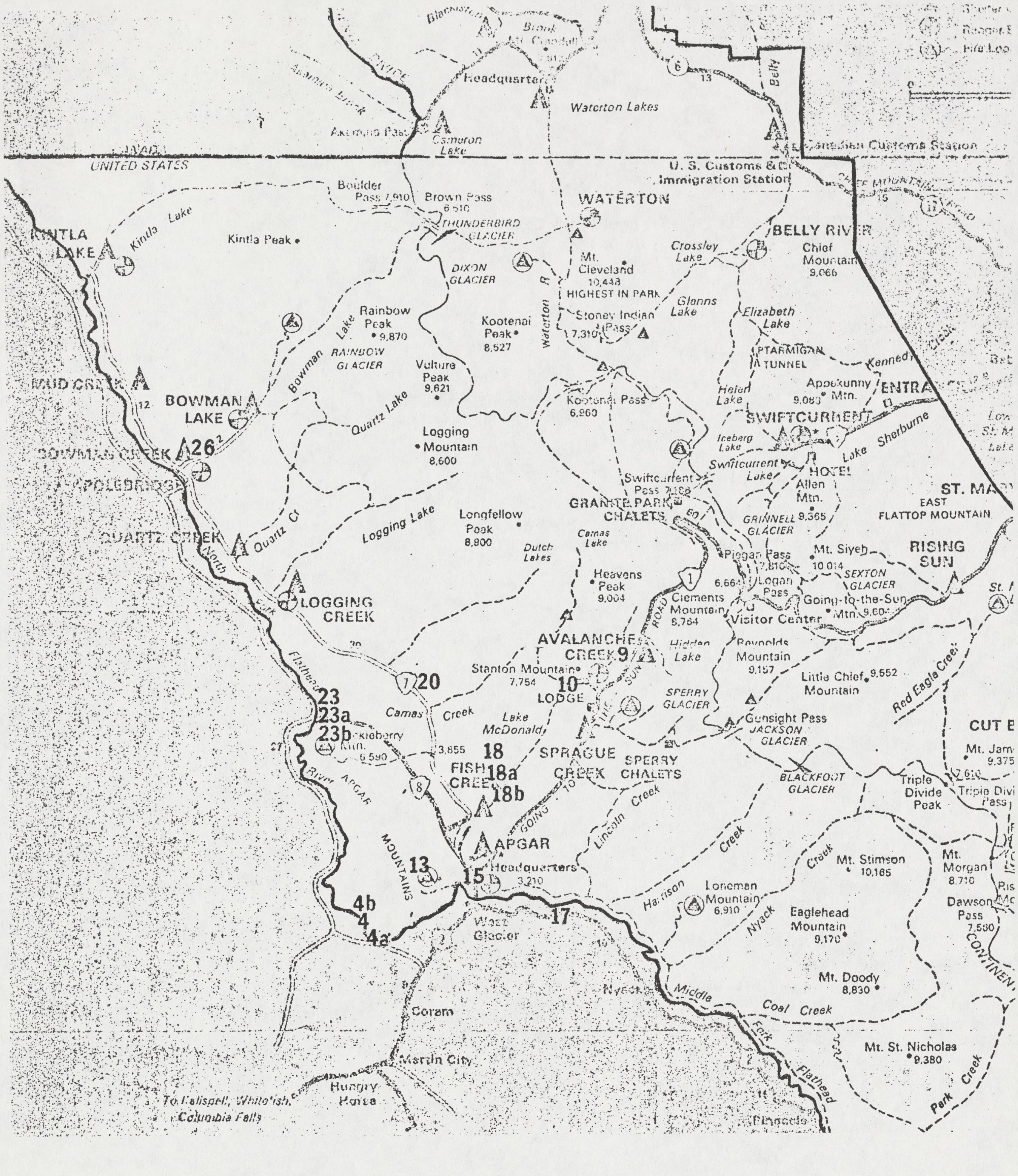


Fig. 1. Locations of sites for sampling of fluorides in vegetation, Glacier National Park

INFLUENCE OF ALTITUDE ON GROWTH AND DEVELOPMENT OF AQUATIC INSECTS

BRUCE C. COWELL, Department of Biology, University of South Florida, Tampa 33620

Objectives

The objective was to examine the influence of altitude on the growth and development of insects in selected lakes.

Results and Discussion

Similar insects could not be found in the three lakes; therefore, the project was terminated.

EVALUATION AND MONITORING OF HYDROLOGIC IMPACTS OF NONPOINT- AND POINT-SOURCE POLLUTION ON THE NORTH FORK FLATHEAD RIVER

CHUCK DALBY, Department of Geology, University of Montana, Missoula 59812

W. MARK WEBER, Department of Geology, University of Montana, Missoula 59812

Objectives

The objectives were (1) to determine relative watershed stability and sensitivity to increased sediment influx from potential fossil fuel development in the North Fork drainage, (2) to quantify and evaluate the nonpoint-source pollution potential of forested watersheds tributary to the North Fork, (3) to assess hydrologic impacts of land use practices, and (4) to provide hydrologic information needed for land use planning.

Methods

To determine relative watershed stability, the hydraulic geometry, fluvial geomorphology, sediment production and transport, and streamflow characteristics were quantitatively assessed. To quantify nonpoint pollution potential, suspended and bedload sediment transport in the Whitefish Range was measured, and sediment records of the border gaging station were analyzed. To assess hydrologic impacts of land uses, existing drainage basin disturbances are being quantitatively described using remote sensing. These will then be related to changes in fluvial geomorphology of the North Fork tributaries and mainstem.

Results and Discussion

The North Fork River appears to have reached a state of quasi-equilibrium. Certain reaches of the river do exhibit disequilibrium characteristics, however, which may be due in part to forest practices in tributary drainages of the Whitefish Range.

Fluvial geomorphology of west-side tributaries indicates a variety of degrees of equilibrium exists among the streams. Colts and Trail Creeks appear to be in equilibrium, while Hay

Creek, Whale Creek, and Red Meadow Creek exhibit varying degrees of disequilibrium. East-side tributaries tend to be in equilibrium, with local variation in form due to flood flow moderation by lakes, accumulation of channel debris, coarser sediment load, and varying hydraulic regimes.

In conclusion, the North Fork watershed's alluvial stream channels appear to be delicately balanced with respect to the natural flux of water and sediment through them. Changes in this flux caused by drainage disturbances cause corresponding disruption and reequilibration of the affected channel.

Extensive landscape modification due to development of fossil fuel resources may locally disequilibrate the mainstem North Fork and its tributaries, reflected in changes in bed elevation of the streams, elevation of the floodplain, width-to-depth ratio of the channel, and locus of erosion and deposition in pool and riffle segments of the stream course. The degree of change would depend on the magnitude of landscape disruption.

Plans For 1978

Field work for this project has been completed. Attempts are being made to model and predict the effects of increased sediment load on the hydraulic geometry of streams in the North Fork watershed. Data synthesis and evaluation will be completed by April, and a final report will be prepared as a master's thesis by May 1978. Title of the thesis will be "Hydrology of the Upper North Fork Flathead River: A State of the Watershed Report."

DISTRIBUTION OF FLUORESCENT *Pseudomonas* SPECIES IN SOIL AND WATER

CHARLES H. DRAKE, Department of Bacteriology, Washington State University, Pullman 99163

Objectives

Other investigators have stated that *Pseudomonas putida* is a soil species. Previous results from this investigation, however, indicate that this species predominates in richer soils and makes up only a minor portion of the flora of more pristine soils. The same pattern appears to occur with *P. fluorescens* in rivers and streams. The objective of this study was to gather information so that a conclusion could be substantiated.

Methods

Soil and water samples were collected in Glacier National Park; North Cascades, Washington; Blue Mountains, Oregon; Pullman, Washington; and Middle Snake River, Idaho. Samples were analyzed for *P. fluorescens*.

Results

Samples obtained in Glacier National Park contained the following counts of *P. fluorescens* per ml:

Location	Sample type	Count per ml	Remarks
Avalanche Creek	Water	49	
	Soil	4,280	Decomposing organic matter
Siyeh Creek	Water	116	
	Soil	10,000+	Shaded, damp
Baring Creek	Water	228	
	Soil	9,180	In deep shade
Tributary to Siyeh Creek	Water	10,000+	Cause unknown, may have been a carcass in stream above sampling point
	Soil	1,960	Low organic content

Similar results were found in the Snake River. The aquatic populations of these organisms appear to range from 50 to 250 per ml in oligotrophic waters, with higher densities found in eutrophic waters.

Plans For 1978

Samples will be collected from additional sites in the Rocky Mountains, the Southwest, and perhaps the west slope of the Cascade Mountains.

ECOLOGICAL RELATIONSHIPS OF TRICHOPTERA IN THE UPPER FLATHEAD RIVERS

RICHARD HAUER, Department of Biological Sciences, North Texas State University, Denton 76203

Objectives

The objectives of this study are (1) to document life history sequences of as many populations of caddis flies (Trichoptera) in the Flathead rivers as possible; and (2) to firmly document the dynamics of carbon (organic and inorganic), phosphorus, and inorganic sediments occurring in seston (plankton, nekton, sediment, and debris, collectively) drift and aggregated sediments, and their relationship to secondary production of caddis flies. The research is intended to provide evidence to support or reject the hypotheses that (1) caddis fly life histories are sequenced in relation to thermal and trophic criteria, and (2) secondary production of caddis flies is controlled by the clay-detritus aggregates that accumulate in the upper Flathead rivers.

Methods

Investigations to date have largely involved delineation of the diversity of caddis fly species in the North Fork, Middle Fork, South Fork, and main Flathead rivers. In October 1977, research efforts were expanded to encompass the structural components of the riverine ecosystem — temporal dynamics of seston drift and temporal dynamics of sedimentation, as well as the functional components of seston drift and sediments as they relate to carbon, phosphorus, and microbial growth.

Laboratory experiments have been initiated to rear caddis fly larvae to adults to establish positive species larvae-adult correlations and to determine the effects of temperature, photoperiod, and trophic relationships on life history phenomena.

Results

Significant findings to date include:

(1) Caddis flies have been virtually eliminated from the South Fork Flathead River, presumably due to inadequate thermal criteria to complete their life cycles.

(2) Species composition and rate of secondary production of benthic insects in the North Fork are significantly different from those in the Middle Fork.

(3) At least 20 genera of caddis flies have been identified in the forks of the Flathead River.

(4) Initial results indicate exceptionally low particulate and dissolved organic carbon are present in comparison to other large riverine ecosystems.

Plans For 1978

Efforts will continue to delineate caddis fly life histories, as well as the role of caddis flies in secondary production and the interrelationship of filter-feeding caddis flies to the quantity and quality of different-size fractions of seston drift.

INVENTORY AND SURVEY OF NORTH FORK FLATHEAD RIVER FISHERIES

JOE E. HUSTON, Montana Department of Fish and Game, N. Meridian Road, Kalispell 59901

ROBERT DOMROSE, Montana Department of Fish and Game, N. Meridian Road, Kalispell 59901

Objectives

The objectives of this study were to determine the migration patterns and spawning locations of salmonid species from Flathead Lake into the North Fork Flathead River drainage.

Results

Work in Glacier National Park was limited to Akokala and Kishenehn Creeks. Aerial and foot surveys of Kishenehn Creek in the park and British Columbia showed this stream was used for spawning by adfluvial dolly varden (*Salvelinus malma*) and is probably used by adfluvial cutthroat trout (*Salmo clarki*) as well.

A downstream fish trap was operated in Akokala Creek from 17 June through 24 September 1977. Total catch included 356 smolting cutthroat trout, 4 spent adfluvial adult cutthroat, 123 mountain whitefish (*Prosopium williamsoni*), and 1 spent adult largescale sucker (*Catostomus macrocheilus*).

Size of smolt cutthroat averaged 17.0 cm in length, ranging from 10.2 to 23.6 cm. Greatest numbers of smolts were caught between 23 June and 11 July. Smolt cutthroat were cold-branded with a $\overline{P}$ symbol and the left pelvic fin removed.

Of the 4 spent adult cutthroat trout caught, 2 had been tagged in the lower Flathead River near Kalispell, 1 in February and the other in April 1977.

Maximum stream temperatures ranged from 8°C on 23 August to 18°C on 23 July 1977. Minimum stream temperatures ranged from 6°C on 23 September to 12°C on 25 July 1977.

AQUATIC STUDIES IN GLACIER NATIONAL PARK

LEO F. MARNELL, Aquatic Ecologist, Glacier National Park, West Glacier, Montana 59936

Objectives

An Aquatic Ecologist was added to the resident park staff in mid-March 1977. Objectives during the first 9 months were: (1) orientation of the Aquatic Ecologist to the resources of the park; (2) review of past work done on park waters; (3) problem analysis and establishment of research priorities; and (4) acquisition of equipment.

Discussion

With all of the concerns being focused on the potential impacts of fossil fuel developments and timber-cutting on lands adjacent to the park, it seems ironic that past activities carried on within the park have been the major cause of disruption to the integrity of Glacier's aquatic resource. The principal influence has been fish stocking, an activity promoted in Glacier for more than half a century. This ultimately led to the establishment of exotic species in many park waters, including some where fish were historically entirely absent.

Of great concern is the widespread distribution of kokanee salmon (*Oncorhynchus nerka*), rainbow trout (*Salmo gairdneri*), brook trout (*Salvelinus fontinalis*), and lake trout (*Salvelinus namaycush*). The last species, while native to some waters of the southern Saskatchewan drainage, has been introduced elsewhere and is now well entrenched in several major lakes in the North Fork Flathead River watershed. Even more disturbing is the fact that the occurrence of this species and the Lake Superior whitefish (*Coregonus clupeaformis*) cannot be accounted for on the basis of available stocking records. Evidently a considerably amount of unauthorized stocking occurred over the years. This suspicion is supported by various accounts related to park personnel from long-time residents of the area.

Although legitimate questions can be raised about the welfare of several native species, including the Rocky Mountain whitefish

(*Prosopium williamsoni*) and the locally uncommon pygmy whitefish (*P. coulteri*), the most immediate concern is with the indigenous form of cutthroat trout (*Salmo clarki lewisi*), which has been severely impacted by the presence of exotic species. Cutthroat trout are notoriously intolerant of exotic competitors. Aside from direct competition for food and space with several alien fishes, such as kokanee, brook trout, lake trout, and possibly lake whitefish, direct predation may also be a factor in the case of the voracious lake trout. Significant pressures may be placed on cutthroat trout because exotic prey or forage species such as kokanee salmon and lake whitefish rapidly attain a large size and become unavailable as food items for predatory lake trout. This situation is compounded by the large expanses of sand bottoms, clear visibility, and lack of natural cover which characterize many of these lakes.

A further disruption is posed by disturbances to the genetic integrity of indigenous cutthroat trout populations. Genetic alterations have undoubtedly resulted from hybridization with introduced rainbow trout and from intergradation with non-native cutthroat subspecies such as the Yellowstone trout (*Salmo clarki* subsp.), millions of which were planted in Glacier's waters during past decades. Together, these factors constitute grounds for serious concern about the welfare of this unique species in the waters of Glacier National Park.

BEETLES, OTHER INSECTS, AND HIGH-ALTITUDE ECOLOGY OF GLACIER NATIONAL PARK

J. GORDON EDWARDS, Department of Biological Sciences, San Jose State University, San Jose, California 95192

Objectives

The objectives were (1) to study the insects of Glacier National Park, focusing on beetles and high-altitude insects; and (2) to explore mountain goat (*Oreamnos americanus*) trails and possible climbers' routes to provide information for future editions of the *Climber's Guide to Glacier National Park* and the proposed Continental Divide trail.

Results and Discussion

Weather during the summer of 1977 was extremely unfavorable for collecting insects. The number of rainy days was remarkable; such days are very poor for entomological studies. Therefore, most collecting was conducted on the prairies east of the mountains. Despite the weather, a large *Saperda calcarata* was found on an aspen trunk, apparently a new record for Montana although they have been found in British Columbia and Alberta.

Bad weather also inhibited investigations of new routes on the mountains. We did examine two new approaches to Mt. Reynolds, the ridge route up Mt. Oberlin, the west wall of Mt. Pollock, and various routes around Snow Moon and Fallen Leaf Lakes basin. No new goat trails were discovered, and no new additions to the Continental Divide trail were investigated.

Plans For 1978

A book on the common insects of the park and manuscripts on the long-horned beetles and scolytid beetles are being prepared.

SURVEY OF MONTANA BUTTERFLIES

STEVE KOHLER, Division of Forestry, Montana Department of Natural Resources and Conservation, 2705 Spurgin Road, Missoula 59801

Objectives

The objectives were to determine the distribution of butterfly species (Lepidoptera and Rhopalocera) occurring in the state and to develop a guide to the identification of the male and female of each species.

Results

Collecting during 1977 resulted in the establishment of 53 new county records for 36 species of Montana butterflies. Two collecting days in Glacier resulted in establishment of a new Flathead County record for *Chlosyne damoetas*, a high-altitude species of checkerspot butterfly. There are still only very limited species records for alpine habitats in the park.

Plans For 1978

It is anticipated that at least one more field season will be necessary to complete the project.

SYSTEMATICS AND EVOLUTION OF THE TRICHOMYCETES

ROBERT W. LICHTWARDT, Department of Botany, University of Kansas
Lawrence 66044

STEPHEN T. MOSS, Portsmouth Polytechnic, Portsmouth, England

Objectives

The Trichomycetes are a class of fungi that live obligately in the guts of arthropods. The objectives of this broad study were to (1) examine host specificity and distribution of the fungi, (2) examine their morphological features, especially reproductive processes, using light microscopy, (3) examine their ultrastructure using electron microscopy, and (4) obtain axenic (outside of the host) cultures of some additional species for experimental studies.

Methods

This portion of the study was concerned primarily with the Trichomycetes living in the aquatic larvae of blackflies (Simuliidae), midges (Chironomidae), and mayflies (Ephemeridae). Since very few species of Trichomycetes have been cultured axenically, most material for this study was obtained directly from living hosts.

Results

Collections in Glacier National Park's fast-flowing streams yielded the following species of Trichomycetes:

In blackfly larvae - *Harpella melusinae*
Harpella sp. (new)
Pennella angustispora
Smittium simulii

In midge larvae - *Paramoebidium* sp.
Smittium spp. (at least one may be new)
Stachylina minuta

In mayfly nymphs - *Paramoebidium* sp.
Zygopolaris ephemeridarum

Several of these species will be used in electronmicroscopic study. New host records were obtained, and two new species may have been discovered. Attempts to culture Trichomycetes axenically were not successful.

Plans For The Future

Fungi obtained will be studied over the next 2-3 years, and any significant results will be published.

PROTEIN VARIATION IN TAILED FROGS

CHARLES H. DAUGHERTY, Department of Zoology, University of Montana, Missoula 59812

Objectives

Once distributed continuously throughout the Pacific Northwest, tailed frogs (*Ascaphus truei*) are now restricted to moist mountain ranges. The objective was to determine the amounts of variation among tailed frog populations and to determine whether it is a function of local selective forces or of gene flow among the populations.

Methods

Individuals were collected from 7 populations throughout the species range in Oregon, Washington, Idaho, and Montana. Blood and tissue samples from the individuals were used in electrophoretic genetic analysis.

Results

Genetic divergence of the populations was found to correspond closely in magnitude and pattern to estimated times of geographic isolation of these populations based upon historic geologic events, thus supporting the importance of gene flow. Genetic similarity was lowest between those groups longest isolated and highest among geographically adjacent populations. Intermediate lengths of geographic isolation resulted in intermediate values of genetic divergence. Average heterozygosity within each population was correlated with the relative size of the mountain range in which it occurs.

These data support the idea that the amount of genetic variation is a function not of local population size but of the "mega-population" available to contribute genes to the local population via gene flow.

Plans For 1978

Electrophoretic analyses should be completed in about one year.

Publications

Daugherty, C. H. 1976. Freeze-branding as a technique for marking anurans. Copeia 1976(4):836-838.

_________, and F. W. Allendorf. 1977. Divergence of populations: preliminary evidence relating to the Ehrlich-Raven hypothesis from *Ascaphus truei*. Genetics 86(2):514-545.

_________, and _________. 1977. The taxonomic value of genetic distance: data from two amphibians. American Zoologist 17(4):973.

BEHAVIOR AND ECOLOGY OF HARLEQUIN DUCKS BREEDING IN GLACIER NATIONAL PARK

CRAIG R. KUCHEL, Cooperative Wildlife Research Unit, University of Montana, Missoula 59812

Results and Discussion

Behavior and ecology of harlequin ducks (*Histrionicus histrionicus*) on McDonald Creek were studied during the 1973-76 breeding seasons. Harlequins confined nearly all activities to swiftly running waters but also used stretches of the abandoned stream channel.

Males comprised 64 percent of the breeding population. Pairs were formed prior to arrival on the breeding grounds in early May. Home ranges were linear and consisted of approximately 1-2 km of stream habitat. Pairs were not territorial, and considerable overlap of home ranges occurred, especially at favored feeding sites. Density was approximately one pair per 1.1-1.5 km of stream.

Resightings of marked harlequins during successive breeding seasons indicated a high degree of breeding-site fidelity among females, and that females breeding for the first time returned to their natal breeding grounds. Previously undocumented copulatory behavior indicated possible phylogenetic affinities with goldeneyes (*Bucephala* spp.).

Most eggs were laid between 18 May and 8 June. During years when late runoff and high water levels imperiled newly hatched ducklings, still waters were used almost exclusively during the first month after hatching. During the final 2 weeks of the 55-day preflight period, broods shifted all activities to running waters. Females with broods avoided all areas frequented by humans.

Productivity was closely correlated with the timing and intensity of spring runoff. Survival of known juveniles to fledging was 83 percent in 1973, 40 percent in 1974, and 18 percent in 1975. Mean brood size and the number of broods hatching declined similarly during the 3 years. High juvenile survival in 1973 was attributed to a relatively snowfree winter and an early spring runoff. Flooding occurred during both 1974 and 1975. Floods affected production through nest washout and increased mortality of ducklings. Management suggestions stress recreating pristine conditions by restricting human access to vital habitats and allowing the stream's natural aging process to create new habitats.

Publications

Kuchel, C. R. 1977. Some aspects of the behavior and ecology of harlequin ducks breeding in Glacier National Park, Montana. M.S. Thesis. University of Montana, Missoula. 163pp.

LOCAL AND LONG-RANGE MOVEMENTS OF BALD EAGLES ASSOCIATED WITH AUTUMN CONCENTRATIONS IN GLACIER NATIONAL PARK

B. RILEY McCLELLAND, School of Forestry, University of Montana, Missoula 59812

DAVID S. SHEA, Research Associate, West Glacier, Montana 59936

Objectives

The objectives of the study are (1) to determine long-range movement patterns of bald eagles (*Haliaeetus leucocephalus*) arriving at and departing from the autumn concentrations in Glacier National Park, and (2) to record daily movement patterns of eagles in and near the park during autumn concentrations.

Methods

Bald eagles were captured with double-spring traps with jaws padded to prevent injury to the birds. Some traps had offset jaws, and those with strong springs were modified by wiring one side closed.

Traps were set in 10-15 cm of water. Salmon or whitefish baits were set approximately 45 cm from a trap set. Eagles were usually caught by the tarsus. No injuries other than occasional slight skin abrasions were experienced by captured birds.

A yellow Herculite marker was placed on each wing of captured eagles. Placement was in the natural break of feathers, between tertieries and scapulars. An 8-cm tag (streamer) was attached to the standard aluminum leg tag (U.S. Fish and Wildlife Service) affixed to one leg on each bird. Wing markers and leg tags utilized numbers M01 through M99, as assigned by the Bird Banding Laboratory, Laurel, Maryland. B. Graff served as photographer and recorder for the project.

Between 24 October and 29 December, census of bald eagle numbers were conducted once each week by McClelland, Shea, and Graff with assistance from the National Park Service and other individuals. Counts were made using the water route method established by McClelland (1973) and utilized by Shea (1973).

Results and Discussion

Ten bald eagles were captured and marked. Nine were immatures (2 young of the year) and 1 was an adult. Capturing attempts commenced 15 November and terminated 15 December. Because of public use of the blind, only 9 days were available for capture attempts. Capture efforts were disrupted on one morning by park visitors walking along the creek. Three marked birds were later resighted along McDonald Creek. Observers along possible migration routes have been contacted and are watching for marked birds.

A series of measurements was recorded for each captured eagle. Average weight was 4.7 kg; the range was 4.3-6.4 kg. Average wingspread was 202 cm; the range was 192-215 cm.

Ten censuses were conducted during 1977. The maximum count was 444 bald eagles (309 matures, 135 immatures) on 30 November. This was a new record for maximum count in this area. This large number indicates that more than the first estimate of 25 birds may need to be marked.

Conclusion

The results of this first-year feasibility study speak for themselves — we can capture and mark bald eagles along McDonald Creek without serious harm to the birds or unacceptable disruption of the concentration. Visitor management must be carefully coordinated with research plans if disturbance of eagles is to be kept to an acceptable minimum.

Plans For 1978

Contingent upon National Park Service approval and necessary funding, the project will continue in autumn of 1978, involving intensified effort to capture, mark, and track eagles.

Literature Cited

McClelland, B. R. 1973. Autumn concentrations of bald eagles in Glacier National Park. Condor 75(1):121-123.

Shea, D. S. 1973. A management-oriented study of bald eagle concentrations in Glacier National Park. M.S. Thesis. University of Montana, Missoula. 82pp.

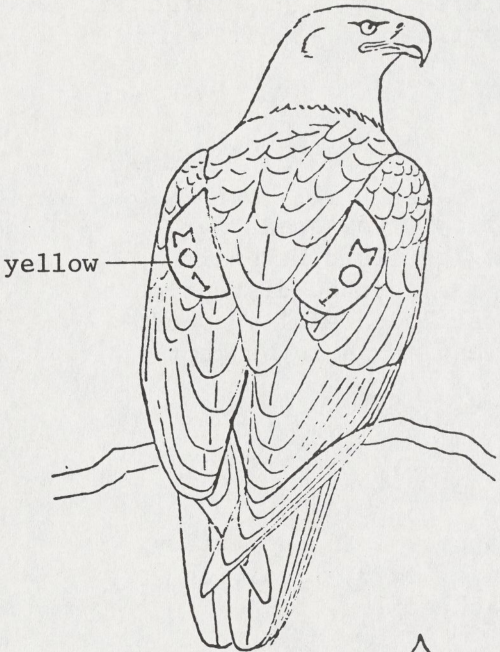
INFORMATION REQUESTED ON

WING-TAGGED BALD EAGLE SIGHTINGS

Bald Eagles are being captured and marked along McDonald Creek, Glacier National Park, northwestern Montana. This site is a temporary stop for the eagles on their way south to wintering areas.

A bright yellow wing marker (3 by 5½ inches) is placed next to the body on each wing, and a bright yellow marker (3 inches long) is attached to one leg. The accompanying sketches show the locations of the markers on the birds, while perched and in flight. All three markers are numbered M01 to M99. It is important to report numbers if possible, particularly the presence of the "M", because birds recently marked in Colorado have similar wing markers, but numbers C01 to C99. The Colorado birds have no leg markers.

Sightings of marked birds will help determine migration routes, wintering areas, and nesting areas.

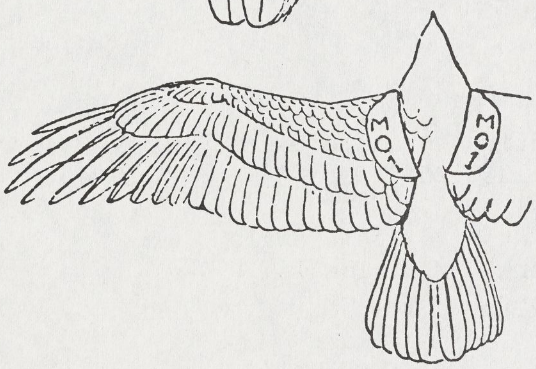


INFORMATION NEEDED

1. Was the eagle an adult (white head and tail) or an immature (various combinations of dark and light body plumage)?
2. Marker number.
3. Exact location where eagle was observed.
4. Date and time of sighting.
5. Activity of the bird.
6. Were other eagles nearby, and how many?
7. Observer's name, address, and telephone number.

Please report sightings to:

<u>Bald Eagle Project</u>
Glacier National Park
c/o Riley McClelland or Dave Shea
West Glacier,
Montana 59936
Phone: 406-888-5441
or
1612 Bel Air
Missoula,
Montana 59801
Phone: 406-728-1780
&
Bird Banding Lab
Laurel, Maryland 20811



HABITAT PARTITIONING AND NICHE OVERLAP BETWEEN BIGHORN SHEEP AND MOUNTAIN GOATS

WILLIAM S. BROWN, School of Forestry and Environmental Studies,
Yale University, New Haven, Connecticut 06520

Objectives

The objectives are (1) to develop quantitative models of the structural habitat requirements of bighorn sheep (*Ovis canadensis*) and mountain goats (*Oreamnos americanus*), (2) to use these models to evaluate areas of maximum and minimum habitat overlap, and (3) to make inferences about the evolutionary pressures which resulted in the habitat specializations of each species and the extent to which competition between the two species was a driving force in their evolution.

Methods

Bighorns and mountain goats will be observed during all months along fixed routes which cover a wide variety of exposures, topographic features, vegetation characteristics, and surface geology. The location of each animal or group will be recorded and thereby described in terms of a wide array of habitat characters. Potential covariates such as weather conditions and the presence or absence of predators will also be recorded. At the end of the first field season, preliminary results will be used to develop pairwise nomograms. These will be used to identify the areas of greatest overlap which may indicate either potential competition or microseparation. Subsequent observations will incorporate data on potential determinants of microseparation.

On completion of field work, all data on the distributions of each species will be subjected to principle components analysis, discriminant function analysis, and multiple regression. The first two techniques should permit comparison of separation along significant environmental gradients. Multiple regression will generate a habitat model for each, and mapping of residuals should suggest areas in which the analysis has been less than complete.

Results and Discussion

Work began in early September 1977. September and October were devoted to reconnaissance, delineation of study areas, refinements in data collection, logistical preparation for the winter, and consultations with park personnel. Routine observations, begun in mid-November, have continued at two-week intervals. Insufficient data have been gathered to permit any conclusions. It is of interest to note, however, that mountain goat distribution in the immediate post-rut period appears to have changed dramatically from what it was during the rut, when goats were routinely observed in close proximity to bighorns. Goats have apparently dispersed to higher elevations and, despite moderately severe weather through December, use of "known" winter concentration areas appears low.

Plans For 1978

Current plans call for routine observations to continue through the winter. Observation will resume in mid- to late June, with monthly censuses of an expanded study area to continue through October. A second winter observation period is planned for 1978-79. Whether a second summer's observations will be made in 1979 will depend on the quality and quantity of data gathered in summer 1978.

ECOLOGY OF THE ROCKY MOUNTAIN GOAT IN GLACIER NATIONAL PARK AND THE SWAN MOUNTAINS, MONTANA

DOUGLAS H. CHADWICK, P.O. Box 175, Polebridge, Montana 59928

Objectives

The objectives were to define population characteristics, habitat relationships, social behavior, and management requirements for mountain goats (*Oreamnos americanus*) in Glacier National Park, and to compare the park population with the population in the Swan Mountains, 125 km south of the park.

Results and Discussion

Data collected indicate that the nature of the terrain and food supply in mountain goat habitat ultimately regulate mountain goat population characteristics.

Individuals in small groups apparently possess only a slight selective advantage over solitary animals but a more substantial advantage over members of large groups. In certain respects, mountain goats are closer to a semi-gregarious species than a typical herd animal. This is expected for a species with a patchy food resource and dense cover, cover being in the form of topography rather than vegetation.

Recurrently intense resource competition and movement patterns necessary to exploit shifting forage supplies have led to organization of herds by a dominance hierarchy rather than a territorial system. Aggressive intolerance, expressed through high rates of agonistic interaction, appears to be the primary mechanism limiting group sizes and dispersing groups within ranges.

Within successionally stable plant communities, mountain goat populations appear to be regulated through density-related mortality in subordinate classes commensurate with climatically induced resource shortages.

Publications

Chadwick, D. H. 1974. Mountain goat ecology—logging relationships in the Bunker Creek drainage of western Montana. M.S. Thesis. University of Montana, Missoula. 262pp.

_________. 1976. Ecological relationships of mountain goats (*Oreamnos americanus*) in Glacier National Park. AIBS Conference on Science and Research in the National Parks 1. 21pp.

_________. 1977. The influence of mountain goat social relationships on population size and distribution. Proceedings of the International Mountain Goat Symposium 1.

_________. 1977. Ecology of the Rocky Mountain goat in Glacier National Park and the Swan Mountains, Montana: final report. Glacier National Park, West Glacier, Montana. 54pp.

BEAR INFORMATION SYSTEM

JANE KAPLER, Glacier National Park, West Glacier, Montana 59936

Please note that this is not a research project but rather a technical-support project designed for data collection that should serve both Research and Resources Management. The project was given its original impetus and support from the Fourth International Conference on Bear Research and Management through the Research Division. Systems analysis and program development were supported by the Research Division through May; data collection and entry were funded and carried out routinely through the summer by the Protection Division (Resources Management), with assistance from the National Park Service Divisions of Natural Resources and Data Systems.

Objectives

The objectives were (1) to collect reports of bear activity, incidents, and management actions; (2) to validate reports and store them on computer; (3) to produce daily, weekly, and yearly lists of new reports; and (4) to develop the capability to search data in response to requests from researchers, managers, and field rangers.

Results and Discussion

More than 1,100 bear reports were received, validated, and stored. These had a large incidence of error, especially in drainage and management area codes. Errors were also found in tag entries, report type, and number of bears seen in each age class. Erroneous data were recorded, in large part, because of the many rough edges in users' training, orientation to, and documentation of the system. This can be improved with some effort early next spring. However, careful checking must be carried out on a day-to-day basis if the data stored are really to be worth analyzing.

New reports were listed each day and distributed to the subdistricts. Each week, a list of all reports for the week was distributed. At the end of the season, the following master lists were produced:

(1) All data in the order stored, with extra data fields so that codes can be added and keypunched from the printout.

(2) All data in chronological order according to subdistrict and drainage.

(3) All verified grizzly bear reports in chronological order according to subdistrict and drainage.

(4) All tagged bears in chronological order according to subdistrict and drainage.

The last two of these searches used a subroutine called SEARCH which is written according to search criteria specified by users (usually 1 or 2 lines of FORTRAN). The user chooses the report format either in serial order or according to subdistrict and drainage; the program using that format is recompiled incorporating the user's special criteria and then run from a load module which can be saved for reuse.

In conclusion, in one form or another, the main objectives of this project were realized. While the system is far from perfect, it nevertheless provides for systematic data gathering and verification, organized output according to an easily readable format, and special searches as needed. Principal weaknesses were in original definition of needs and in data verification through the season.

Publications

Joslin, G., and J. Kapler. 1978. A computerized system for recording and recalling grizzly bear reports. Proceedings of the International Conference on Bear Research and Management 4. (In press)

SMALL MAMMAL UTILIZATION OF FLOODPLAIN HABITATS ALONG THE NORTH FORK FLATHEAD RIVER

CARL H. KEY, Cooperative Wildlife Research Unit, University of Montana, Missoula 59812

Objectives

The objectives were (1) to quantify density, species composition, and habitat selection of small mammal populations along the North Fork Flathead River; (2) to explore relationships between the small mammal fauna and wider-ranging medium-sized carnivores; and (3) to establish permanent plots and procedures for future monitoring of this mammal community.

Methods

Six plots in representative floodplain habitats were selected north of Polebridge in Glacier National Park. Four of these were snap-trapped for 29 consecutive days in 1976 and 12 consecutive days in 1977. Two parallel lines of 20 trap stations spaced at 15 m with 2 traps per station were used on each plot. A line of sunken-can shrew traps was placed between the two snap-trap lines. One 5.8-ha plot was live-trapped using a 16×16 grid, and 1 3.0-ha plot was live-trapped with a single line of 23 traps. Live-traps were spaced at 15-m intervals. Mammals collected by snap-trapping were weighed and measured. Most were examined internally to determine reproductive history.

Winter surveys of medium-sized carnivores were conducted in 1977 by traversing prescribed routes at regular intervals and recording mammal tracks.

Percent cover of understory, exposed substrate, and shrubs were determined for each trap station by randomly locating 4 0.5-m^2 quadrats (understory) and 1 16-m^2 quadrat (shrub). Density and basal diameter of trees was estimated at each trap station using a 100-m^2 quadrat.

Results and Discussion

Summer trapping showed floodplain habitats to be highly productive for small mammals. This trend is typical of animal populations inhabiting early successional communities. The most abundant small mammal was the deer mouse (*Peromyscus maniculatus*); densities increased from 1.5 mice/ha to 5.5 mice/ha by the end of the summer. Adult deer mice tended to be concentrated in open gravel-sand areas in early summer. Immatures invaded old-age cottonwood stands in late summer.

Five other cricetid rodents were captured. In order of decreasing abundance, they were: long-tailed meadow mouse (*Microtus longicaudus*), western jumping mouse (*Zapus princeps*), red-backed mouse (*Clethrionomys gapperi*; found only in spruce stands but relatively abundant there), meadow mouse (*Microtus pennsylvanicus*), and heather vole (*Phenacomys intermedius*).

Shrews were found primarily in spruce habitats; only 2 were found on areas which received annual flooding. Roughly 75 percent of the shrews captured were vagrant shrews (*Sorex vagrans*), and 25 percent were masked shrews (*S. cinereus*). One pygmy shrew (*Microsorex hoyi*) was captured in riparian habitat, making this the first record for Glacier National Park.

Other small mammals encountered include yellow pine chipmunk (*Eutamias amoenus*; common in all habitats except spruce), northern flying squirrel (*Glaucomys sabrinus*), Columbian ground squirrel (*Spermophilus columbianus*), red squirrel (*Tamiasciurus hudsonicus*; abundant in spruce), and northern pocket gopher (*Thomomys talpoides*).

Winter census work revealed high use by coyotes (*Canis latrans*), beaver (*Castor canadensis*), mountain lions (*Felis concolor*), short-tailed weasels (*Mustela erminea*), and mink (*Mustela vison*). Snowshoe hares (*Lepus americanus*), river otters (*Lutra canadensis*), lynx (*Lynx canadensis*), marten (*Martes americana*), long-tailed weasels (*Mustela frenata*), and red squirrels were also encountered in winter.

Plans For 1978

Multivariate data analysis will continue with preparation of a master's thesis through March 1978.

GRIZZLY BEAR POPULATION STUDIES, GLACIER NATIONAL PARK

CLIFFORD J. MARTINKA, Supervisory Research Biologist, Glacier National Park, West Glacier, Montana 59936

Objectives

Objectives were to obtain quantitative data on the population dynamics and management of grizzly bears (*Ursus arctos*) in Glacier National Park.

Methods

Population parameters were monitored through reported and verified sightings of grizzlies by the investigator and other qualified observers. Grizzly bear/human relationships were monitored through documentation of molestations, property damages, and personal injuries.

Results and Discussion

Conversion of the park sighting report system to computer processing format was completed during 1978. Programming to include ecological research analysis is currently being developed. Monitoring data and evaluations will therefore be presented in the 1978 progress report.

The grizzly population continues to inhabit the park in a predominantly wild and natural state. Changing behavior in relation to increasing human visitation may be causing increased confrontation rates. Mitigating management is required to neutralize or reverse the trend.

Publications

Martinka, C. J. 1971. Status and management of grizzly bears in Glacier National Park, Montana. Transactions of the North American Wildlife and Natural Resources Conference 36:312-322.

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_________. 1974. Population characteristics of grizzly bears in Glacier National Park, Montana. Journal of Mammalogy 55(1): 21-29.

_________. 1974. Ecological role and management of grizzly bears in Glacier National Park, Montana. Proceedings of the International Conference on Bear Research and Management 3:147-156.

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UNGULATE WINTER ECOLOGY STUDIES IN GLACIER NATIONAL PARK

CLIFFORD J. MARTINKA, Supervisory Research Biologist, Glacier National Park, West Glacier, Montana 59936

Methods

Population parameters of wintering ungulates were monitored during routine observation trips to winter ranges.

Results and Discussion

Monitoring of elk (*Cervus elaphus*) and mule deer (*Odocoileus hemionus*) populations continued for the eleventh year. The elk population appears to be relatively stable, while mule deer numbers have progressively increased. Elk productivity has increased; mule deer productivity fluctuates in response to changing winter conditions. Natural losses are low among elk and more frequent among mule deer. Population health is considered excellent in terms of adaptive efficiency. This is particularly evident in reproductive strategies which favor the birth and survival of physically superior young.

Conclusions

Wintering ungulates studied are regulating their own numbers without biologically significant damage to their habitats. Social interactions in relation to environmental stress and habitat composition apparently form the nuclear complex of the regulatory process. Niche differentiation in relation to environmental gradients causes predictable patterns of ungulate distribution in time and space.

Plans For 1978

Monitoring of wintering ungulate populations will continue, along with tabulation, analysis, and interpretation of data for the 1967-77 period.

<u>Publications</u>

Martinka, C. J. 1969. An incidence of mass elk drowning. Journal of Mammalogy 50(3):640-641.

_________. 1970. Winter foods of white-tailed deer in Glacier National Park, Montana. Proceedings of the Annual Conference of the Western Association of State Game and Fish Commissioners 50:410-415.

_________. 1976. Fire and elk in Glacier National Park. Proceedings of the Tall Timbers Fire Ecology Conference and Intermountain Fire Research Council Fire and Land Management Symposium 14:377-389.

_________. 1978. Ungulate populations in relation to wilderness in Glacier National Park, Montana. Transactions of the North American Wildlife and Natural Resources Conference 43. (In press)

WOLF ECOLOGY PROJECT

URSULA MATTSON, Field Assistant, East Glacier, Montana 59434

ROBERT R. REAM, School of Forestry, University of Montana, Missoula 59812

Objectives

Wolves (*Canis lupus*) are very rare in Montana and Wyoming, but specimens collected in 1964, 1968, and 1974 indicate that the *C. l. irremotus* subspecies still exists. There have been many apparently valid reports in recent years, but we can presently only conjecture about wolves' social structure, territories, home ranges, movements, and prey requirements. The objective of this study was to learn as much as possible about the wolves without disturbance to the few remaining individuals.

Methods

Field assistants U. Mattson and R. Harris collected information on wolves along the east slope of the Continental Divide in Glacier National Park and surrounding lands. This was done through (1) interviews of park employees and local people, and (2) field surveys for wolf tracks and sign. A method to aid the field investigator in distinguishing wolf from dog tracks was developed by R. Harris and R. Ream.

Results

A total of 105 wolf reports, spanning several years, were collected by these methods. Of these, 36 were within the park. Two areas of wolf activity were identified:

(1) St. Mary northward to Waterton National Park. Reports indicate that 2-6 wolves may be associating with the Belly River-Waterton herd of about 250 elk (*Cervus canadensis*), especially during fall and winter months. Three remote drainages may serve as a refuge from human activity for the wolves in this area.

(2) The southeast portion of the park from Fielding to East Glacier. Several wolves occupy U.S. Forest Service and National Park Service land in this area. They frequently cross Highway 2 and are seen by motorists and railroad workers.

HABITAT ECOLOGY OF GRIZZLY BEARS IN THE NORTH FORK FLATHEAD RIVER DRAINAGE OF GLACIER NATIONAL PARK

ROBERT A. RIGGS, Department of Wildlife Resources, University of Idaho, Moscow 83843

Objectives

The objectives of this study were to determine seasonal forage preferences and habitat use patterns of grizzly bears (*Ursus arctos*) in the North Fork Flathead River drainage, to examine relative importance of the different successional stages of vegetation, and to predict and explain changes in habitat use patterns.

Methods

Plots were established in 13 communities on the floodplain or immediately adjacent upland. Vegetation was examined at intervals during the growth period. Bear scats were collected and feeding sites analyzed. One female grizzly was collared with a radiotransmitter and intensively monitored from 15 September to 30 October.

Results

Wet meadows and other floodplain bottomlands without conifer overstory were more productive of understory vegetation than were conifer- or bunchgrass-dominated communities with the exception of the spruce (*Picea engelmannii*)-dominated floodplain community, which appeared to be more productive than some wet meadows. Food species utilized by bears in spring were found to be more available in wet meadows and other floodplain communities than in adjacent upland communities.

Growth of known bear foods and many other understory species (except shrubs) began earlier in meadows and unforested bottomlands than in forested communities. Plants which commonly occurred on both forested and unforested sites appeared to be more productive and faster-growing on unforested sites.

Monitoring of the radio-collared bear revealed that movements by the bear were almost entirely restricted to late afternoon and early evening. Movements were associated with travel to or from subalpine basins characterized by climax spruce and mountain ash (*Sorbus* spp.) stands, which were used primarily from late afternoon to early morning. Periods during which the bear did not move were associated with use of dense lower-elevation stands of larch (*Larix occidentalis*) or spruce.

Plans For 1978

Field work and analysis of data collected in 1977 will continue.

WINTER ECOLOGY OF BIGHORN SHEEP

ROBERT A. RIGGS, Department of Wildlife Resources, University of Idaho, Moscow 83843

Results and Discussion

Wildfire on the Many Glacier bighorn (*Ovis canadensis*) winter range has increased the availability of plant communities characterized by relatively high productivity of preferred forage species. Bighorn numbers on this range increased following lungworm (*Protostrongylus stilesi*) epizootics. The population presently appears stable, with relatively high population quality compared to other populations described in the literature.

Bighorns at Many Glacier were observed and the winter range was examined during the winter of 1975-76. Mature rams exhibited significant aggregation patterns when they were about to move off the range, while other sex/age classes did not. Young rams appeared to learn the locations of midwinter seasonal ranges from ewes rather than from older rams.

Wintering bighorns used all grassland communities occurring on the range, and depended heavily on each community during at least one week of the study. Fire-induced seral communities were selected more than climax grassland communities. Bighorns appeared to select sites based on weather conditions rather than forage availability.

Positive correlations were found between proportional availability and proportional utilization of preferred forage species, and the utilization of certain species was found to be affected by the availability of alternate forage species. Proportional utilization of bluebunch wheatgrass (*Agropyron spicatum*) and elk sedge (*Carex geyeri*) were found to be predictable based on availability of these species relative to one another.

Publications

Riggs, R. A. 1977. Winter habitat use patterns and populations of bighorn sheep in Glacier National Park. M.S. Thesis. University of Idaho, Moscow. 87pp.

GRIZZLY BEAR - HUMAN CONTACTS IN GLACIER NATIONAL PARK

THOMAS W. STUART, Department of Forestry and Conservation,
University of California, Berkeley 94720

Objectives

The objective was to determine optimal patterns of overnight backcountry use in the northern half of Glacier National Park in such a way that the tradeoffs among management objectives were identified.

Methods

Three indices — dangerous, non-dangerous, total — for contacts between humans and grizzlies (*Ursus arctos*) were generated for travel along trails in the study area. These indices included data from 585 recorded grizzly observations during 1968-75 and a systematic sampling of the trail network at 2,682 points. Index value calculations also incorporated data on habitat types, elevation zones, trail visibility, off-trail travel difficulty, the proportions of injuries caused by sows with young, and differential sightings of grizzlies over the course of the season.

Management models were formulated as linear programs. Five objectives were considered: solitude at backcountry campsites, volume of backcountry use, and the 3 indices of human-grizzly contacts. Two types of management models were used: one viewed all contacts between humans and grizzlies as something to be avoided, while the other minimized only dangerous contacts.

The linear programs contained 5,065 variables, each representing a distinct overnight backcountry trip during a specific time period. Solutions were obtained by optimizing one objective while parametrically varying constraints in the linear program, allowing generation of all non-inferior solutions.

Results and Discussion

Results showed that even with optimal use patterns, increasing backcountry use will produce increases in the level of trail-related contacts with grizzlies. At present use levels, this increase in contacts will be more than proportional to the increase in visitation, even if the behavior of grizzlies is unaltered by the higher use. More restrictive campsite capacities could be employed, providing more solitude at backcountry campsites, with only modest increases in trail-related contacts.

Shifting a management objective to trying to prevent dangerous contacts between humans and grizzlies, rather than all contacts, shows substantial promise. This arises from both expected decreases in a measure of dangerous encounters and increases in non-dangerous viewing opportunities. Significant payoffs are identified for not allowing increases beyond the current level of use.

In conclusion, parametric linear programming appears to be a valuable tool for multiobjective analysis. Use of this solution technique for the linear programming management models that have been developed would prove to be quite valuable in addressing a number of issues relating to backcountry management. The development of contact rates specific to locations and time periods would enhance the value of these models.

Publications

Stuart, T. W. 1977. Multiobjective analysis of wilderness travel in grizzly bear habitat using parametric linear programming. Ph.D. Dissertation. University of California, Berkeley.

__________. 1978. Exploration of optimal backcountry travel patterns in grizzly bear habitat. Proceedings of the International Conference on Bear Research and Management 4. (In press)

__________. 1978. Management models for human use of grizzly bear habitat. Transactions of the North American Wildlife and Natural Resources Conference 43. (In press)

PATTERNS OF HABITAT UTILIZATION BY THREE SPECIES OF ALPINE HERBIVORES

ROBIN W. TYSER, Department of Zoology, University of Wisconsin, Madison 53706

Objectives

The objectives were to quantitatively assess comparative resource use patterns, factors dictating these patterns, and management applications for hoary marmots (*Marmota caligata*), pikas (*Ochotona princeps*), and Columbian ground squirrels (*Spermophilus columbianus*) in alpine areas of Glacier National Park.

Methods

Systematic behavioral observations were made on foraging behaviors, burrow characteristics, and rock sizes used for alert postures.

Results and Discussion

Coexistence of pikas, ground squirrels, and marmots may well result from their distinctly different resource use patterns. Key habitat features for each species appear to be:

Pika - Talus rocks larger than 0.2 m in diameter for burrow construction and surveillance; strip of meadow vegetation 10-20 m in width surrounding talus slide for foraging.

Ground squirrel - Essentially restricted to meadow areas; rocks occasionally used for burrow construction and surveillance postures.

Marmot - Large boulders in talus and widely dispersed in meadow areas for burrowing and surveillance; large meadow areas for wide-ranging foraging movements.

Foraging and burrowing patterns were found to be virtually identical at the study site, which is inhabited by all three species at fairly high densities, and at other talus slopes inhabited by predominantly one species. Thus, interspecific competition does not appear to be playing a significant role in these species' habitat use patterns. Each species may be selecting different food items because of different harvesting efficiencies and different metabolic demands that are related to body size.

In addition to the offering of food to these animals by humans, salt deposition in human urine may also significantly alter normal habitat use patterns of these animals in some areas of the park.

Plans For 1978

A thesis is being prepared and should be completed by summer.

GRIZZLY BEAR DENS IN THE BORDER GRIZZLY AREA

TERRY J. WERNER, Border Grizzly Project, School of Forestry, University of Montana, Missoula 59812

Objectives

The objectives of this study were to map and describe dens of grizzly bears (*Ursus arctos horribilis*) with respect to critical habitat, regional comparisons,and comparisons with black bear (*U. americanus*) dens.

Methods

Dens were located during winter, or by air or on the ground following verbal reports. Dens located on the ground in winter were marked in order to relocate the sites during summer for ecological and vegetation measurements and also to change the collars of radiocollared bears if necessary. Den sites were evaluated with respect to habitat type, geologic formations, and land types.

Results

Three probable grizzly dens were reported in Glacier National Park during 1977. All dens were at or near timberline, above 1,950 m elevation, and in open areas. Aspects included western and southern exposures. No vegetation data have yet been recorded for these den sites.

Outside the park, dens were found on all but northerly aspects, above 1,800 m elevation, and on a mean slope of 65 percent. Beds, comprised mainly of beargrass (*Xerophyllum tenax*), were found in 50 percent of the dens. Seventy-eight percent of the dens were located in open areas, and all timbered den sites were within 40 m of open areas. Mean measurements of dens were as follows:

Entrance - 81 cm high × 72 cm wide

Tunnel - 95 cm high × 120 cm wide × 148 cm long

Chamber - 81 cm high × 71 cm wide × 112 cm long

Soil and root systems provided the stability needed for cohesion. Cryochrept loamy skeletal soil was predominent. Alpine fir (*Abies lasiocarpa*) provided support on timbered den sites; beargrass, huckleberry (*Vaccinium globulare*), and grouse whortleberry (*V. scoparium*) provided support for dens in open areas.

All habitat-typed den sites were in the *Abies lasiocarpa* series, and 83 percent occurred within or above the upper subalpine habitat types. Most dens (80 percent) were found in the Siyeh geologic formation, with inclusions of lower or upper Piegan formation. All dens were located in late-stage alpine headwall. These sites are typically on alpine-glaciated slopes with greater than 60 percent slope.

Plans For 1978

Studies of dens within and outside of the park are continuing. Probable and known den locations will be visited, and vegetation and ecological data at these sites will be collected, analyzed, and interpreted.

Publications

Werner, T. J., and C. J. Jonkel. 1977. Grizzly dens in the Border Grizzly Area. Pages 3-11 *in* Border Grizzly Project Annual Report. University of Montana, Missoula.

INFLUENCE OF WILDFIRE AND LOGGING ON GRIZZLY BEAR HABITAT

PETER E. ZAGER, Border Grizzly Project and Department of Botany, University of Montana, Missoula 59812

Objectives

The objective is to analyze the vegetation of all areas intensively used by grizzly bears (*Ursus arctos*), especially the fire- and/or logging-induced seral areas. From this, the relationship between vegetation on burned areas and that on logged areas will be assessed.

Methods

Areas intensively used by bears were located through observation and radiotelemetry of bears. Vegetation was sampled on these areas using the modified reconnaissance methods of Arno and Pfister (1977). If the area was logged and/or burned, paired samples were taken, one on the site and one in the adjacent undisturbed forest, thus providing a control for comparison of species composition, cover, and abundance of various bear foods. Type of disturbance, time since disturbance, and amount and type of site preparation were also noted for each stand.

Results

Data are presently being analyzed, focusing on calculations of constancy and coverage of bear foods in logged vs. unlogged and burned vs. unburned stands. A Bray-Curtis polar ordination and association tables are being used to assess the relationships of each stand with every other stand. Insight into logging disturbance and vegetation recovery gained will be used to determine whether or not logging simulates burns insofar as bear foods are concerned.

Plans For 1978

Data collection will continue through the 1978 field season.

United States Department of the Interior
NATIONAL PARK SERVICE
GLACIER NATIONAL PARK
WEST GLACIER, MONTANA 59936

IN REPLY REFER TO:
N1423

September 18, 1978

Dr. Robert J. Behnke
Department of Fishery and
Wildlife Biology
Colorado State University
Fort Collins, Colorado 80521

Dear Bob:

Enclosed are some materials including the classic 1925 memo about fish stocking in Glacier National Park. I'm not sure whether to laugh or cry — I rubber-stamped it in a fit of rage!

Note in the 1964 paper that mention is made of "Lake Superior whitefish" having been stocked. I have not been able to locate any record of such stockings. It is possible that Burlington Northern Railroad instigated this along with Mackinaw stocking. Their line runs directly to an area having numerous hatcheries for these two species. Perhaps this winter I will uncover additional information as I dig deeper into the old records.

My plan is to leave for Fort Collins on Saturday, October 21, arriving Sunday night. I will transport about 175 cutthroat trout specimens to your office Monday morning. Please let me know generally who my seminar audience will be. I plan to talk about fisheries conflicts in the national parks as an introduction to the research we are doing on cutthroat trout.

See you next month.

Sincerely yours,

Leo

Leo F. Marnell
Aquatic Ecologist

United States Department of the Interior
NATIONAL PARK SERVICE
GLACIER NATIONAL PARK
WEST GLACIER, MONTANA 59936

IN REPLY REFER TO:
N1423

November 6, 1978

Dr. Robert J. Behnke
Department of Fishery and
Wildlife Biology
Colorado State University
Fort Collins, Colorado 80521

Dear Bob:

I had an uneventful trip home and encountered nothing more than light snow showers. I hope your meeting in the Ozarks went well.

Enclosed for your information are some notes relating to the 1978 collections. Pertinent facts about specific trout populations are included. Hopefully these will be useful during your examinations. A map of Glacier Park is also enclosed to give you a better understanding of the park drainages.

I have asked Steve Phelps in Missoula to complete his electrophoresis studies by January 15; much of the work has already been done since he began receiving tissue samples in August. If your examinations could be completed by late March, it would enable me to report the 1978 results prior to initiation of the 1979 field season.

Sometime in the next few weeks, I will ship you one of the few cutthroats I was able to collect from Grace Lake. These had the unusual spotting patterns similar to the Strawberry Reservoir hybrids we discussed. I was unable to preserve most of the Grace Lake specimens due to their large average size. I did, however, remove the entrails from several and pack them out in ice. I'd like to know what you think about the pigmentation in these fish.

Concerning the scale mounting project, the local Montana Fish and Game office has volunteered to take care of the 1978 scales, so there is no need to pursue that. However, the state biologists acknowledge the desirability of comparing scale development with otolith readings. Evidently there are some situations in this area where discrepancies occur. I wonder if it would be worthwhile to consider having a CSU student attempt to examine otoliths from the preserved specimens. Perhaps 10 could be looked at from each lake (instead of the full 30) for comparative purposes. There are some drawbacks to this idea. As you noted, the otoliths may not be usable in the preserved specimens. Also, it might require a more advanced student to undertake this kind of project. Let me know what you think on this matter.

One final item I neglected to mention during my visit. I would like, if possible, to recover the plastic specimen chests on my next trip to Fort Collins. I have a limited number of these, and they are ideal for the field. Perhaps you could transfer the fish to glass as they are examined.

Have a nice holiday season—will see you next spring.

Sincerely yours,

Leo

Leo F. Marnell
Aquatic Ecologist

Enclosures

P.S. Keep me in mind if I can assist with the Trout Symposium next fall.

United States Department of the Interior
NATIONAL PARK SERVICE
GLACIER NATIONAL PARK
WEST GLACIER, MONTANA 59936

Allendorf -S.F. Bull. ~~Mornell~~
- write rep. ?
- Invoice ?
- discuss parasites.

IN REPLY REFER TO:

N1423 March 6, 1979

Dr. Robert J. Behnke
Department of Fishery and Wildlife Biology
Colorado State University
Fort Collins, Colorado 80523

Dear Bob:

Thanks for your note of February 22 with comments on the status of your examinations of cutthroat trout collected last summer. Your preliminary conclusions agree closely with the electrophoretic results from Allendorf's lab. Some differences, however, are apparent in the Arrow Lake specimens. The electrophoretic analyses indicated possible hybrid influence in a few fish; you'll note in my comments about Arrow Lake (page 2 of 1978 field notes) that three juvenile specimens were collected which appeared to be Yellowstone cutthroats. Steve Phelps, who is doing the lab work for Fred, feels that two of these were Yellowstone cutthroats and the other was a hybrid. Additionally, a few adult fish from Arrow Lake showed protein anomalies which are interpreted as hybrid-caused. Since you have examined only about half of the specimens, I suspect you have not come upon the Arrow Lake fish in question. You will recognize the juvenile Yellowstone cutthroats immediately when you get to them. If time permits, I would suggest a little extra attention to the Arrow Lake specimens since it appears that this may be our best opportunity to assess hybrid potential between the two cutthroat subspecies. Clearly both types are present in the Camas Creek drainage.

I also noted the tapeworm you mentioned. In fact, I collected several from the Quartz Lake specimens; unfortunately the vial was broken during transportation of my equipment out by pack stock. I imagine there will be opportunities to collect them again this summer.

I did not send the Grace Lake specimens as planned. My brand new freezer quit, evidently in early December, and the specimens were pretty well gone by the time I discovered the problem. I will resample Grace Lake next summer and provide fresh specimens for examination.

My support funds have been cut substantially this fiscal year, and at this time I am uncertain about our ability to maintain support for you and Fred. I have expressed my deep concern and, quite frankly, my disgust about this situation, but so far I don't know what the outcome will be. Since you and Fred have availed yourselves to participate in our program at bargain prices, I will continue to apply pressure for support of your work. I'll let you know as soon as I have received any definite word.

My spring trip to Fort Collins is also questionable due to budgetary problems. Tentatively, I hope to get down for a few days in late April or early May.

Finally, Bob, I would appreciate some kind of a summary of your data from the cutthroat examinations, if possible, by April 10. I am committed to a progress report by May 1. If you cannot meet the April deadline, possibly I could call for a verbal discussion of your results pending completion of your write-up, in order to meet my May 1 commitment.

Sincerely yours,

Leo

Leo F. Marnell
Aquatic Ecologist

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Dr. Robert J. Behnke
Dept. of Fishery & Wildlife Biology
Colorado State University
Fort Collins, CO 80523

K5

July 13, 1988

Dear Bob,

Attached is an entertaining account of fish stocking in Glacier Park during the good old days. It is from the Kalispell paper, ca. 1917. It is interesting to note how hard those chaps worked to foul things up. I didn't realize hatcheries were operating in the region (Anaconda, Bozeman) as early as some of the dates given.

Under separate cover I am sending you one complete set (four binders) of the Morton reports. The data are unpublished (typewritten) and represent a synthesis of all available fishery data for Glacier Park through 1968. Morton appears to have done a fairly thorough job of reviewing old records, newspaper accounts, stocking data, etc. Evidently Bob Wasem contracted Morton to do this work after he retired from the USFWS.

I have the original in my office and a duplicate set has been placed in the GNP library at Headquarters. Another copy is located at the University of Montana library at the Flathead Lake Biological Station. You have the only other set. I apologize for the oversize binding used; it was the only size available at the park.

Regards,

Bozeman Hatch - Madison R.
ca 1915 cutts RB Odell Cr
grayling
Transition
hybrids
(lewisi)

- croppie
- bullheads

7/12/88
From Beth

199

David Ross' Strenuous and Exciting Experiences while Planting Trout Fry in the Remote Waters of the Glacier National Park.

Kalispell Journal
Nov. 15, 1917

The following article is from the pen of Mr. David Ross, of this city, and was written at the request of Major M. D. Baldwin for incorporation in the annual report of the State Fish Commission to be published shortly. Major Baldwin and his fellow commissioners are to be congratulated upon securing a report of Mr. Ross' activities in the fish propagating line.

Hon. D. M. Baldwin, Fish Commissioner, State of Montana.

Dear Sir: Complying with your suggestion I herewith give you in detail the disposition of certain trout fry taken by me from the Somers Fish hatchery and placed in the public waters of this state by myself during the past two years and my reasons for takng an active interest in so doing.

As you know, beginning with 1909, I have actively interested myself in stocking the streams of Flathead county with game fish. In that year I secured from Mr. Dean, the superintendent of the Anaconda Fish Hatchery, 35,000 eastern brook trout fry for planting in Lake Ronan. With the assistance of Mr. Ralston, the then game warden of this county, afterwards the superintendent of the Glacier National Park, these fry were successfully placed in Lake Ronan, and I believe were the first eastern brook trout ever placed in that lake. These fish were brought to Kalispell in the State Fish Car, transported to Somers over the G. N. railway, then by boat over Flathead lake to Dayton and by team to Lake Ronan. To keep these fish alive all of that time required some work, attention and unceasing vigilance, as anyone who has undertaken the care of doing this well knows.

Beginning with this my interest was awakened to the replenishing of the waters here, as fishing had become almost a negligible thing owing to the wholesale fishing without restriction and nothing done looking to the restocking of the waters.

Following this I made successive applications for fry to the United States Fish Commissioner at Washington, D. C. annually, and have stocked for the first time with eastern brook trout and rainbow such places as Flathead river, Stillwater river, Whitefish river, Spring creek, Whitefish lake, Mill creek, Upper Ashley creek, Trueman creek and several other places I have forgotten. I had the active co-operation of several of my friends who had cars, like Mr. Tansel, Mr. Harry Keith, Mr. E. Givens, Wm. O'Connell, Mr. VanDuzer, who all very cheerfully and without any charge, donated their time and assisted me in placing the fry in the different waters, not once but repeatedly and sometimes in the most inclement weather; at first we had no cars to draw upon and the fish had to be transported in wagons or spring wagons drawn by horses. This was something of a task as in nearly every instance the fish had to be transported some miles, but all worked cheerfully and with an eye solely to the betterment of the fishing for the benefit of all lovers of the sport. With the coming of our fish hatchery at Somers, the locating of which, as you know I took an active part in getting it where it is, and with the coming of the automobile into general use, with the organizing of the Fish and Gun Clubs in different places, and your active work in stirring up interest, latterly the work of distributing the fry has been taken up by these organizations and there is no trouble in getting any quantity of fry placed in the various waters in this vicinity by our local fishermen.

Four years ago I conceived the idea of introducing the land locked salmon of Maine, Salmo Sebago, in our waters here, knowing they were considered by fishermen the finest of game fishes, so I took the question up with the Department of Fisheries at Washington, D. C., but discovered the sentiment was strongly against furnishing these fish for western waters, owing to their scarcity and the fact that it had never been demonstrated they were adapted to the western waters. At first my application was turned down, but with the help of my good friend, Ashby Conrad, we appealed to Senator Walsh, who took a personal active interest in the matter, and the result was, a quantity of eggs were shipped to the government fish hatchery at Bozeman, and in 1914 five thousand fry of this variety of fish, Salmo Sebago, from Sebago lake, Maine, were delivered to me here in Kalispell, and on October 1, 1914, were taken up by train and placed by myself in Whitefish lake at Vista, the postmaster, Mr. Tillet, and two other gentlemen from Whitefish coming up from there in a motor boat, assisting me in carying the fish from the train to the water. This I call a red letter day for the fishing in this locality, as these fish are sought for by fishermen the world over, and it is rare luck to get a supply to stock any body of water with, they being measureably scarce and ardently sought for by the fishermen of the east. I have been asked why I selected Whitefish lake instead of Flathead lake or Lake McDonald for these fish; the reason was because Whitefish lake was the only lake of the three where the conditions were right for these fish, a shallow stream at the head for them to use and harbor in for the first two years of their existence; a shallow, gravelly bottomed stream eight or more miles long for them to spawn in at the outlet of the laake they frequent, and a lake not too large for the home waters. There is nothing to prevent them from spreading to the other waters of this vicinity as all of these ^are connected^ waters and fish swim. Some ignorant persons have tried to say that these fish prey upon other trout; my best information is that this is not more true than of any other variety of the Salmonidae family, all fish will prey upon their kind in the absence of other sufficient food, but the natural food consists of bugs, worms, crustaciae and the like, and in Twin lakes, Colorado, where the land locked salmon are found, together with every other variety of trout, upon exhaustive examination or research by the government, it has been found the Salmo Sebago live as little upon other fish as any other variety of trout, their principal food being grasshoppers, bugs, worms, etc.

Now coming to the matter first indicated in this letter, that is, the disposition of the fry secured from the Somers fish hatchery during the past two years: Seeing the interest awakened in the local fishermen regarding the stocking of the waters around Kalispell, I had about concluded to take no further active interest in securing fry for that purpose, as the work is arduous and usually comes at a time when you least wish it, and generally no thanks connected with it, but in making a trip through the Glacier National Park with my family in 1915, we came to Gunsight lake, a beautiful sheet of water on the 13th of August. While sitting on the porch of the Chalet there, talking with a gentleman whose name I do not feel at liberty to mention without asking for such permission, I asked if there was any fishing to be had in this lake; a row boat being there and I had my fishing tackle with me, I desired to go fishing. He shook his head and said no. I asked the reason why such a beautiful sheet of water so well adapted to the harboring of trout was not stocked with them. He said there was a falls some 80 feet high and several not so high, between that lake and St. Marys, over which the fish could not get up to Gunsight lake, and that no one with sufficient interest in the matter had undertaken to put any fish in there. I remarked that I had been taking an active interest in such work purely from a sportsman's standpoint, and would be glad to assist in stocking this lake with trout. He said if I would he would co-operate with me in the way of seeing that the fish were transported up there, but doubted my ability to secure the fish for that purpose, as petty jealousies hitherto had prevented the securing of trout fry for that purpose in the Park. I told him of my success in the past in securing trout fry for the stocking of other waters less favorably located and that I believed this would be no exception. He replied that he hoped I was right and that I would succeed in getting the fish; On my return to Kalispell I interviewed Mr. Dean, superintendent of the Somers fish hatchery and I found that it was true, the sentiment of the state officials connected with the fish hatchery was against furnishing fry to stock the waters in the Glacier National Park, but after discussing the matter at length, calling attention to my unselfish labors in the past in the matter of stocking the public waters with fish from the state hatcheries and the large number I had secured from the government fish hatchery and placed in the waters of this part of the state, he finally consented to let me have 10,000 of the rainbow variety for placing in Gunsight lake, and on August 24th, 1915, I took these 10,000 up to Glacier Park station by train, from there to St. Marys by automobile, then by boat across St. Marys lake to Going-to-the-Sun camp, and from there by burro pack train to Gunsight lake. The weather was hot, being my first attempt to take fry such a long distance, I was very much exercised for fear something would go wrong and I would lose the fish, but Mr. Dean gave me careful instructions, furnished me with ice for the train trip to Kalispell where I secured more ice. I secured the loan of a proper thermometer from the Kalispell Mercantile Co., and by unceasing attention I arrived at Glacier Park with the fish in excellent condition. After eating lunch the fish were placed in a touring car and the trip to St Marys was made without incident, there more ice was secured and a special trip was made across St Marys lake by boat; at Going-to-the-Sun, in addition to the burros necessary to carry the fish, we had one with panniers to carry ice, the day was awfully hot and on the way to Gunsight lake we stopped to ice up twice; it was ten p.m. when we arrived there, and placing the fish in a row boat, we took them about half way up the lake to the mouth of a stream of water flowing in there on the north side of the lake, and placed them in the water. Before getting them there however, we had to have an accident. When we arrived at the lake several so-called guides were standing around, and one of them being over-officious, loosened the rope with which the cans were secured to the pack saddle and one fell, the lid came off and quite a faw of the fish were spilled upon the gravel, but securing a lamp and a dust pan, by quick work, being only a few feet from the water's edge, we saved all but half a dozen, which we discovered the next morning lying upon the gravel, dead. Outside of these not more than a dozen fish were lost on the entire trip. On this trip I was accompanied by Mr. Noble, the then General Passenger agent of the Great Northern, now the manager of the Glacier National Park Hotel company, to whose active interest and assistance was due the successful transportation of these fish to their destination. I learned from him there were several other lakes and streams in the park region without fish, owing to the waterfalls which intervened between them and the waters below over which the fish could not ascend. Forgetting my resolution not to do any more of this kind of work, and knowing the streams near Kalispell were now being taken care of by others, I became imbued with the ambition to stock these different places where no fish had ever been before. Learning that the upper Two Medicine lake was one of them, on October 1st, 1915, I secured 6,000 rainbow trout from the Somers fish hatchery and taking them by train to Glacier Park station, I was met by automobile and with the fish taken to the middle Two Medicine chalets where the fish were placed upon horses and transported up to the upper Two Medicine lake, about six or seven miles above the Two Medicine chalets and above a falls some 360 feet high; this was the worst trip I was destined to make; no one accompanied me except the guide or packer, a Mr. McGee, the roads were in a fierce condition from Glacier Park to the Two Medicine chalets being muddy, rutty, and in places it seemed as if the car would not get through, but we did. It was 5 o'clock, evening, when we left the chalets, it showed evidences of a storm and it was suggested I wait until morning, but knowing the danger of delay to the fish, I said no, I would push on and get them

in that night, so we started and got along all right until we came to the trail that led off to the Dawson pass. Here the guide, who evidently did not know the way, turned off on this trail, we got about a mile when I saw we must be going wrong. I called a halt and questioning him, found we were indeed on the wrong trail and we had to go back that mile to get on the right road. By this delay it was dark when we arrived at the upper Two Medicine lake. We got off the trail again and went to the brink of the falls instead of along the trail. We turned the horses up along the shore and going perhaps a quarter of a mile or so from the falls along the north shore, I put the fish in a quiet little bay. By this time it was storming hard, rain and snow, but fortunately from the west our way lay east. Starting back we soon came to the timber and then it was pitch dark, we could not see our horses' heads; the horses evidently were used to mountain travel, for mine put its head down to the trail and seemed to smell its way down. I could tell the position of its head by the position of its shoulders. In this way we traveled until we got about half a mile below the upper end of the Middle Two Medicine lake, here something scared the lead horse off the trail we thought it was a bear, and the horse scramble up the side of the mountain along which we were traveling. The horse having a bell on its course could be followed. I held the horse ridden by the guide, while he went up through the wet brush after the pack horses. After a time they were gotten back to the trail and we went on. This cost us half an hour, then to cap the climax a low hanging limb knocked my hat off and it was so dark I could see nothing. Dismounting I fell over a stump, tripped again and slid several feet down the side of the mountain below the trail, getting back to the trail I got my match safe and by striking matches I located my hat, then remounting we made our way slowly to the chalet tired and hungry. We had not stopped to eat before starting with the fish on the pack train, but the good lady in charge of the chalet had things in the hot oven and with a good cup of coffee we were soon feeling all right.

That night a blizzard came on and all the next day until about five o'clock I was storm staid at the chalet. It was a novel and interesting experience to me to be caught in a snow storm on top of the Rockies within a good shelter where I could look out across a body of water at the storm; about five there was a lull in the storm, and Mr. Graves, assistant Park supervisor, having a couple of saddle horses there, he and I decided to try it for Glacier Park station. As soon as we got down off the mountain side to Trick falls the storm ceased and the sun shone and in good time we arrived at the Glacier Park hotel. That night I came home though urged to stay to attend the closing ceremonies of the hotel for that year. Learning that Lake Mary Ellen Wilson had never been stocked with fish nor had any in it ever I had an ambition to stock that lake, but the next spring being so backward I found it impracticable to do so until late in the season, but finding there were some eastern brook trout available at the hatchery, with your kind assistance I secured a consignment of 12,000 and took them up to the Cutbank chalet and put them in the river at that point. These fish I had intended to take up and put in the Swift Current river above Lake McDermot, but owing to the impassable condition of the roads I had to put them in the place where I did. This trip was made in June and taken by automobile from Glacier Park station. I was accompanied by Mr. Griffin of the Glacier Park hotel Co. and also by Mr. Aasman the auditor. Again the first week in July, 1916, I took another consignment of eastern brook trout and some of the Lake Whatcom salmon up with the intention of putting them into Lake McDermot and the Swift Current, but on arriving at Glacier Park I found that a rain storm of the night before had washed out roads and bridges and I was compelled to put them into the Cut Bank

Continued on page 8.

McDermot was the original name for Swiftcurrent Lake in the Many Glacier Valley - Leo M. 7/88

Planting Trout Fry

Continued from Page one.

and Two Medicine rivers. These were taken in by auto from Glacier Park station. On July 15th, 1916, I secured 15 cans of eastern brook trout from the hatchery and took them up to Lake McDermot. Owing to the train being late I held the fish here in Kalispell two hours, then between Nyack and Paola the cylinder head blew off of the engine and another engine had to be secured, so between the two the train was late getting into Glacier Park, but nothing daunted a car was secured and we started for Lake McDermot. Arriving at the 28 mile post a tire blew out, but an extra one being on the car we soon were on the way again. On arriving at the 50 mile post another tire blew out, and there we were without an extra tire. Two of the hotel boys being along as assistants in case of need, they volunteered to walk in to Many Glacier after a tire. This they did, the distance being five miles, in an hour, not however before we tried to get in telephonic communication from the road camp and Sherburne lake camp with Many Glacier. Being after 8 o'clock the telephone office was closed. I staid with the fish to keep them properly attended to and the mosquitos attended to me, it was ten o'clock before a tire arrived, and it was after eleven before we arrived at Many Glacier; there we secured a wagon and the fish were taken up the Swift Current river and midnight when they were put in. The [illegible] trip in the wagon was over logs, stumps, over brush piles and fallen trees, in gullies and down hillsides, but we got there and safely put the fish in the water after a carry by hand of several hundred feet from the closest point we could get the wagon to the water. We arrived at the hotel about one a.m., but found a nice lunch awaiting us, we having had nothing to eat since leaving Glacier Park. It was always my policy to get the fish in first —eat and sleep afterwards. I came to Glacier Park the next day and home that night. Again in August I secured another consignment of eastern brook trout from the hatchery for Lakes Grinnell and Josephine, above Lake McDermott, again there was a delay in the train service and I was several hours late in getting up to Glacier Park, but an auto was waiting and we arrived at Many Glacier hotel about 5 o'clock. Here a wagon was waiting, loading in a boat and the fish onto the wagon, we started for Lake Josephine, it being represented that we could get from Lake Josephine to Lake Grinnell in a boat. We arrived at Lake Josephine all right and placed a portion of the fish in that lake, six cans. We then put the remaining six cans in a boat and started them up for Lake Grinnell. At the head of Lake Josephine the boatman informed us for the first time they could not take the boat up to Lake Grinnell. We were in a quandary as we had no ropes or pack saddles. Finally we hit upon the plan of taking the bridle reins off of the horses and tying the cans to the pommel of the saddles. We only had two horses so we put two of the cans of fish into the other four, leaving the two empty cans in the boat under which we placed the lunch we had brought along. In this way we transported the fish up to Lake Grinnell and safely placed them in the water, arriving back near the boat we heard a sound like a bell, we could not make out what it could be, but coming in sight of the boat we saw a young black-tail deer maneuvering around there and it evidently was trying to get at the lunch we had left under the cans and in doing this had rattled the cans together making a sound like a bell. The deer kept ahead of us for a mile or more down the trail, when it disappeared in the woods. On the 13th day of September, 1916, I secured 9,000 eastern brook trout from the Somers fish hatchery and without anything untoword occurring, took them up to Lake Mary Ellen Wilson and placed them in that lake. The trip was made by train from Somers to Belton, by auto from Belton to Lake McDonald, by boat from Apgar's to Lewis' and from there to Lake Mary Ellen Wilson by pack train. This was the best trip of any I made, everything worked smoothly, we left Lewis' at 11:30 a.m. and arrived at to place the fish in the water and eat the lake at three, stopping long enough lunch we started back at 3:30 and arrived at Lewis' hotel at 7 p.m. The boat not making the trip down at night as usual, I staid all night there and came down the next morning. No one accompanied me upon this trip except the man in charge of the horses, whose name I have forgotten. This trip, by stocking Lake Mary Ellen Wilson was, it might be said, the culmination of my desire to stock the waters up in the Rocky mountains and it was my intention to not do any more in this line, but learning there was an unnamed lake above Lake McDermot which had never been stocked with fish, this spring, 1917, I secured 15,000 rainbow trout from the Somers fish hatchery and put them in that lake. This was done by train from Somers, then by auto to Many Glacier and from there to this lake by wagon. This trip was made without incident excepting the task of clearing fallen trees out of the way, of which there were several.

I might mention in this report the trout I secured last year from the U. S. government and put into these waters. Last year I handled 135 cans and this year have 27 assigned to me, all from the Bozeman hatchery. Of the 135 cans handled last year 20 of them were put into Spring creek east of Rose crossing. These were rainbow trout. At this time I wish to make mention that in 1910 and 1911 I secured from the government consignments of bull heads, crappy, blue gill sunfish and small mouth black bass and placed them in Emmert's lake or Hodgens slough. When I was a little boy I used to go fishing for sunfish and crappy, and it was this that led me to introduce them into the waters here for the benefit of the boys of this velley. They are a harmless and at the same time a very gamy fish, as they will take a fly and fight like the mischief if given half a chance. The bull heads are the finest of eating and the small mouth black bass are superior to the large mouth as a game fish.

DAVID ROSS.

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