JACKSON HOLE BIOLOGICAL RESEARCH STATION
ANNUAL REPORT
1976

Oscar H. Paris, Director
UNIVERSITY OF WYOMING
Laramie, Wyoming

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PREFACE

Dr. Oscar Paris accepted a position with the U.S. Nuclear Regulatory Commission in Washington, D.C. in August of 1976. During his tenure as Station Director much was accomplished to improve the quality of the Station's research program, strengthen the Station's cooperation with Federal, State and private organizations and to upgrade the Station's physical facilities. The University is grateful for his efforts and wishes him success in his new position. Successful continuation of the Station's program and preparation of this Annual Report with little perturbation has been largely due to the highly competent assistance provided the Acting Director by Ms. Priscilla Moree, Administrative Secretary in the Department of Zoology and Physiology and by Vice President for Research, E. Gerald Meyer. Finally, to the many other individuals who contributed in various ways to make 1976 a productive year, your efforts were appreciated.

Kenneth L. Diem
Acting Director

ACKNOWLEDGMENTS BY THE FORMER DIRECTOR

First I wish to express my appreciation to Dr. Kenneth Diem for giving me this opportunity to thank those who were of especial assistance to me during my last year as Director of the Jackson Hole Biological Research Station. Ms. Marty Wagner Paris, as always, was of inestimable help to me in administering the Station, and I continue to be very grateful for her support. Bill Gordon served commendably as the Station Assistant during the summer of 1976; his keen sense of responsibility, his strong motivation, his dedication to the Station, his willingness to work hard, and his pleasant disposition were particularly noteworthy. David Hales assisted in the hard chores required to get the Station in full operating condition at the beginning of the 1976 summer season; I am grateful for his hard work and capable assistance. Nobel Gregory provided his usual invaluable help with many problems involving the physical plant and grounds. Ms. Priscilla Moree, with her customary efficiency and competence, kept the Station's accounts, handled our budget, advised me on budgetary matters, and typed the Annual Report; I am extremely indebted to her.

Superintendent Robert Kerr and many of his staff at Grand Teton National Park assisted me and numerous investigators at the Station in a great variety of ways. For the Station personnel as well as myself I want to express deep appreciation for GTNP's interest, support, and assistance. Working with the fine staff of GTNP has been a source of much satisfaction and pleasure to me. I am also grateful for the interest shown in the Station by U.S. National Park Service Director Gary Everhardt and Chief Scientist Theodore Sudia.

Finally, let me note the two things which made Marty and me saddest when we left Wyoming: leaving our dear friends in Jackson Hole and in Laramie, and leaving the Jackson Hole Biological Research Station. But I take much comfort in the fact that the University has appointed Ken Diem to succeed me; with Ken as Director, the future of JHBRS rests in very capable hands.

Oscar H. Paris
Bethesda, Maryland
February 3, 1977

ADVISORY BOARD

The Inter-Disciplinary Research Committee

INTRODUCTION

This Fourth Annual Report of the Jackson Hole Biological Research Station summarizes the research and associated activities conducted at and through the Station during 1976. Sixteen projects, 11 continuing and 5 new, were carried out at the Station emphasizing local research application and/or research on the unique features of the area.

The National Park Service through the Rocky Mountain Regional Office, Grand Teton National Park and Yellowstone National Park continued to actively support the Station. Their financial assistance and varied logistic assistance greatly aided several projects and the Station. Additional financial assistance for selected research projects was provided by the Station's long-time supporter, the New York Zoological Society. Varied project assistance was also provided by the Teton National Forest, the National Elk Refuge and the Wyoming Game and Fish Department.

The major facilities improvement project begun in 1973 was essentially completed in 1976. One cabin re-roofing is all that remains to be accomplished in the future.

Between June 9 and August 20, 11 weekly seminars were presented by resident investigators.

RESEARCH PROJECT REPORTS

REPORT ON THE 1976 STUDY PHASE OF THE INVESTIGATION OF COMMUNICATION SYSTEMS IN FREE-RANGING WILD UNGULATES

Margaret Altmann
Department of Psychology
University of Colorado

Due to severe complications following major surgery of the principal investigator in the spring of 1976, the planned research program had to be curtailed.

The principal investigator, Margaret Altmann and the research associate, Betty Erickson, were at work and in residence at Moran from June 30 to September 7, 1976. Observations and collection of data were carried out during the whole period, but research evaluation will not be attempted at this date but will be included in a future report.

It is planned to continue the long-range study of the Communication Systems in Free-Ranging Wild Ungulates in the 1977 season.

A pilot study on the impact of roadside fencing on big game migration and distribution patterns which was also started during 1976 will be included in the plan for research in 1977.

PARASITES OF UNGULATES IN THE JACKSON HOLE AREA: SCARABAEOID BEETLES ACTING ON LUNGWORM, *Dictyocaulus viviparus*, LARVAE IN ELK FECES SEASON OF 1976

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University of Wyoming
Project Number

Prevalence of *Dictyocaulus viviparus* lungworm in elk was previously determined, (1968-74) by elk fecal analyses during spring, summer and winter of each year and by elk lung dissections during the fall hunting season. Percentages positive for and numbers of *D. viviparus* larvae in elk feces was monitored during the fall hunting season of 1975. Fifteen percent (5 of 33) of the elk checked were positive for *D. viviparus* according to lung dissections conducted during the period of November 15-18, 1975, in Teton Park.

Winter work was planned for early February 1976, but was not carried out due to severe weather creating unfavorable traveling conditions.

During late May and early June, 1976, 100 of about 1,000 herd of elk in Teton Park were checked by fecal analysis for lungworm larvae. Seventy-two percent were positive for the lungworm.

Prevalence of infection is very high during the spring but invariably decreases during the summer and fall months. During December and January the prevalence of Dictyocaulus sp. is low (e.g. 8 - 16% '68, 1971, '73.

Elk fecal material was collected at about 10,000 feet elevation from 18 of 90 elk on or near Big Game Ridge, and the Snake River Ridges N.W. of Harebell Cabin, August 3 and 4. Twenty-two percent of the elk sampled were positive for the lungworm species. It is interesting to note that during the same week (Aug. 7-9) 50 percent of the elk (mostly cows) near Signal Mt. in Teton National Park at about 6,500 feet elevation were positive for *Dictyocaulus sp.* larvae in feces.

Experiments with Aphodius spp. beetles as micropredators of *Dictyocaulus viviparus* larvae were conducted as a part of the new project on interaction of dung beetles and the elk lungworm larvae in elk feces.

Data shown in Table I indicate the micropredatory or, perhaps, the accidental decimatory action of the beetles when they are exposed to lungworm larvae on the surface of elk feces. It would appear that small dung beetles (e.g. *Aphodius homisus* and *A. fimetarius*) ingest lungworm

larvae as the beetles ingest feces and/or other proteinaceous-carbohydrate material in feces. As few as 20 beetles spread elk fecal material over the soil surface so that a 3-pellet (6 g.) sample which previously occupied a 2-4 cm square area on vegetation or soil, will, after beetle action, occupy 6-12 cm areas but the depth of the fecal mass will decrease from 2-4 cm to .5-1 cm.

During the 4 experiments conducted at the station, the beetles decreased the numbers of lungworm larvae by 77-92%. Lesser decreases than these have been shown to be significant at the 1% level.

During the month of November, additional fecal material and/or elk lungs will be collected during the hunter harvest. More data should be gathered concerning fecal analyses on individual elk where the lungs of that same animal are available for dissection. In this way, the accuracy of fecal analyses/or lungworm prevalence can be determined. We previously found that fecal analyses are always conservative as an estimate of lungworm prevalence.

By February, 1977, another check, via fecal analyses, should be conducted on elk on the National Elk Refuge in Jackson. Further beetle-lungworm larvae research cannot be continued until May of 1977. The value of further work is obvious.

Table I. Action of *Aphodius spp.* Beetles on numbers of *Dictyocaulus viviparus* larvae in elk feces: Laboratory conditions.

Trial no.	No. of *Dictyocaulus* larvae/g. feces	Hours Interaction	*Dictyocaulus* control (no beetles)	*Dictyocaulus* princ (20 beetles)	% dec. in larval no's due to beetle action
1	72	24	48	6	87
2	180	24	80	18	77
3	500	72	265	24	90
4	100	24	75	6	92

ECOLOGY OF THE BEAVER IN GRAND TETON NATIONAL PARK, WYOMING

Thomas C. Collins
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University of Wyoming

This is a report of continued investigations of population characteristics and habitat relationships of beavers in Grand Teton National Park. This study was supported by the New York Zoological Soceity and the Northern Rocky Mountain Cooperative Park Study Project. I wish to acknowledge the valuable assistance of personnel of Grand Teton National Park and the Wyoming Game and Fish Department, Dr. Oscar H. Paris, former Director of the Jackson Hole Biological Research Station from which this study was conducted, Dr. Jack C. Turner, and numerous friends and associates who aided in field investigations.

Study Objectives

A. Enumeration and evaluation of population characteristics including abundance, distribution, territoriality, age structure, natality, mortality, dispersal, and behavior.

B. Estimation of habitat relationships including use patterns, food habits and selectivity, beaver-moose food resource overlap, limiting factors, and faunal relationships.

Methods

Beavers were live trapped and ear tagged for recognition of individuals in behavioral observations, for analysis of movements, and for estimations of colony size, age structure, natality, and mortality. A starlight night scope facilitated behavioral observations at night.

Annual cutting rates of woody vegetation were correlated with availability, distance from water, and diameter size classes by quadrat sampling and measurements of cut and uncut stems of woody vegetation. Food availability at three sites was determined in a similar manner but also using canopy coverage techniques. Beaver-moose food resource overlap was measured by a modified closest-neighbor sampling technique. Food habits were estimated by microanalysis of fecal contents.

Results and Discussion

A total of 103 beaver colonies were located in Grand Teton National Park representing over 500 beavers. The Snake River Floodplain provides the largest habitat source for beavers in the Park and supported 51 colonies between 1974 and 1976. An estimated 2000 to 3000 beavers occupy the Park. The average colony size was found to be 5.2 beavers and the abundance of beavers on the major streams in the Park was 0.9 colonies/km.

Eighty-three beaver carcasses from around the State were examined to generate age/weight correlation curves. Growth is rapid from birth to three years of age, after which time growth rate declines. Ninety-one beavers were live trapped and tagged between 1974-76, 88 of which were in Grand Teton National Park (Figure 1). A sex ratio of 126:100 (males to females) was found for the live trapped population. Forty-nine percent of these were adults (beavers two years or older), 29 percent yearlings (one to two years old), and 22 percent kits (to one year). Usually, colony offspring leave the family group at two years of age but there was evidence that some three year olds were with parent colonies. This possibly relates to the unexploited nature of these populations and the lack of available habitat for dispersing beavers. An average of 2.1 kits per colony was observed for those colonies with offspring. This may not reflect natality rate since considerable mortality could occur between birth and weaning. An average of 2.0 yearlings per colony indicates possible low mortality between one and two years of age. Major causes of mortality were observed to be disease, drowning of newborn at high water, road kill, damage control on private lands within the Park, and predation by coyotes.

Beaver populations on most of the streams in the Park appear at carrying capacity resulting in territorial packing. That is, the colony boundaries butt against those of neighboring colonies and home range is thus synonymous with the territory. When there is unoccupied space between colonies, territorial boundaries remain stationary but home ranges expand resulting in an area of home range overlap between two or more colonies.

Use patterns studies demonstrated that beavers select or prefer to cut certain plant species and certain size classes of each species. Distance of movement to cut a preferred plant is associated with the size class of the plant. For example, beavers will travel greater distances to cut a four to ten cm aspen than to cut smaller size classes. There is evidence to indicate that beavers enhance succession to climax vegetation by the removal of subclimax trees and shrubs.

Figure 2 shows the relative frequency of forage classes in the diet of beavers between May and October. There is a definite seasonal shift in food habits associated with availability of forbs and graminoids (grasses and grass-like plants). Linear correlation of utilization of forbs and graminoids (% frequency in deit) with availability (% cover) is statistically significant.

The major limiting factor for beaver populations on the major streams in the Park is the availability of winter dwelling sites. At low stream flows, over 60 percent of the beaver population on the Snake River, Buffalo River, and Pacific Creek are forced to abandon summer dwellings. At low stream volumes winter dwelling sites are scarce and most colonies are forced to re-establish in precariously eroding bank dens. These dens are then abandoned the following spring when stream volume increases.

Recommendations

It is probable that the Park beaver population is a source for filling vacant habitat of exploited populations outside the Park. The ramifications of this situation for management of both or either of these populations are numerous. Several population characteristics of the Park beavers appear unique to this population and are undoubtedly associated with unexploited conditions. Three years of data are insufficient to judge the significance of some of these unique characteristics. Since 88 beavers in the study area are presently ear tagged, a minimum of effort in future years of study would provide relatively greater data than obtained in the first few years of this study. Therefore, it is suggested that this study be continued over the next two years on a much reduced time schedule but sufficient to obtain pertinent data that could not be obtained in three years of study.

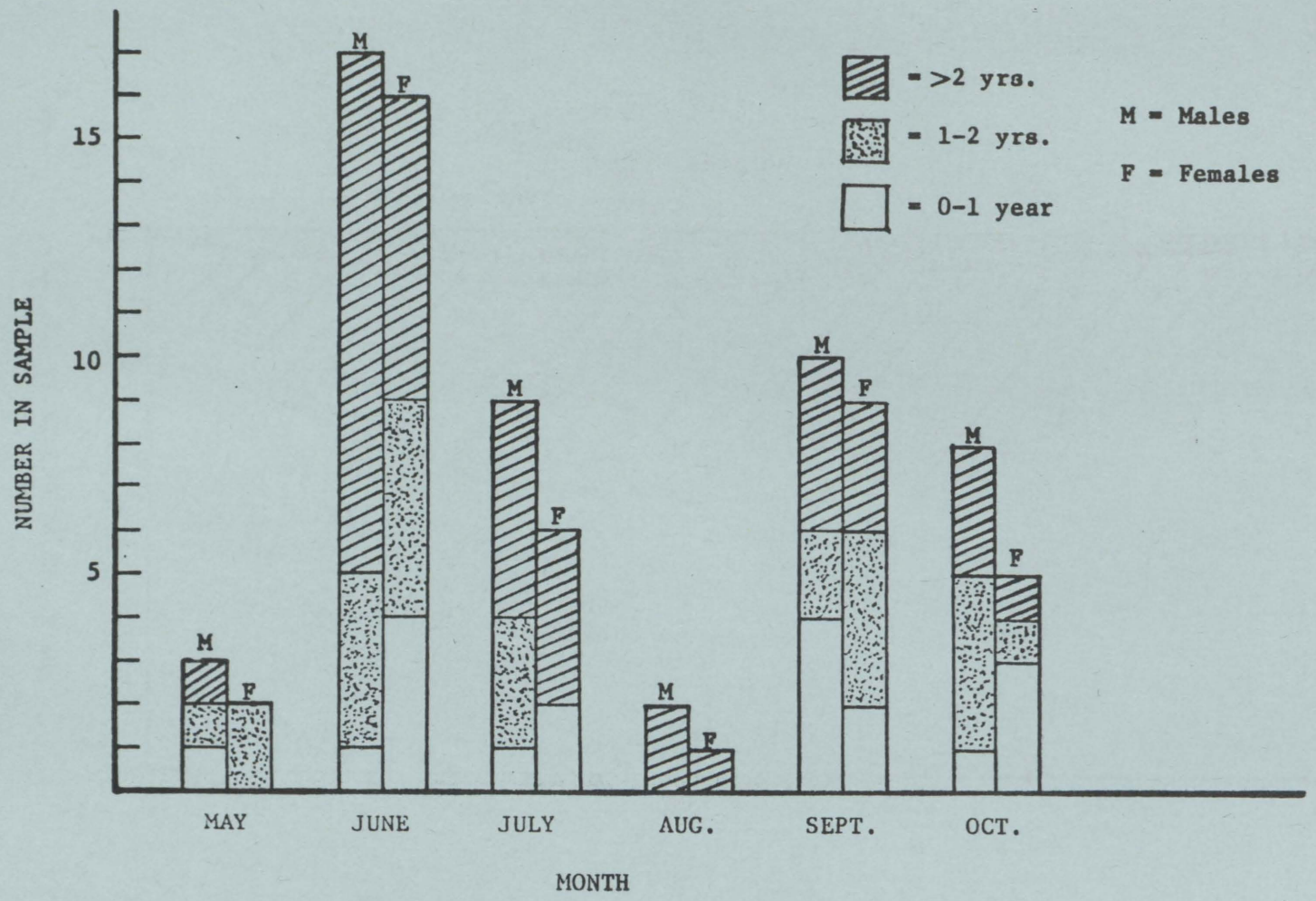

Figure 1. Sex and age class of live-trapped beavers in Grand Teton National Park, 1974-76.

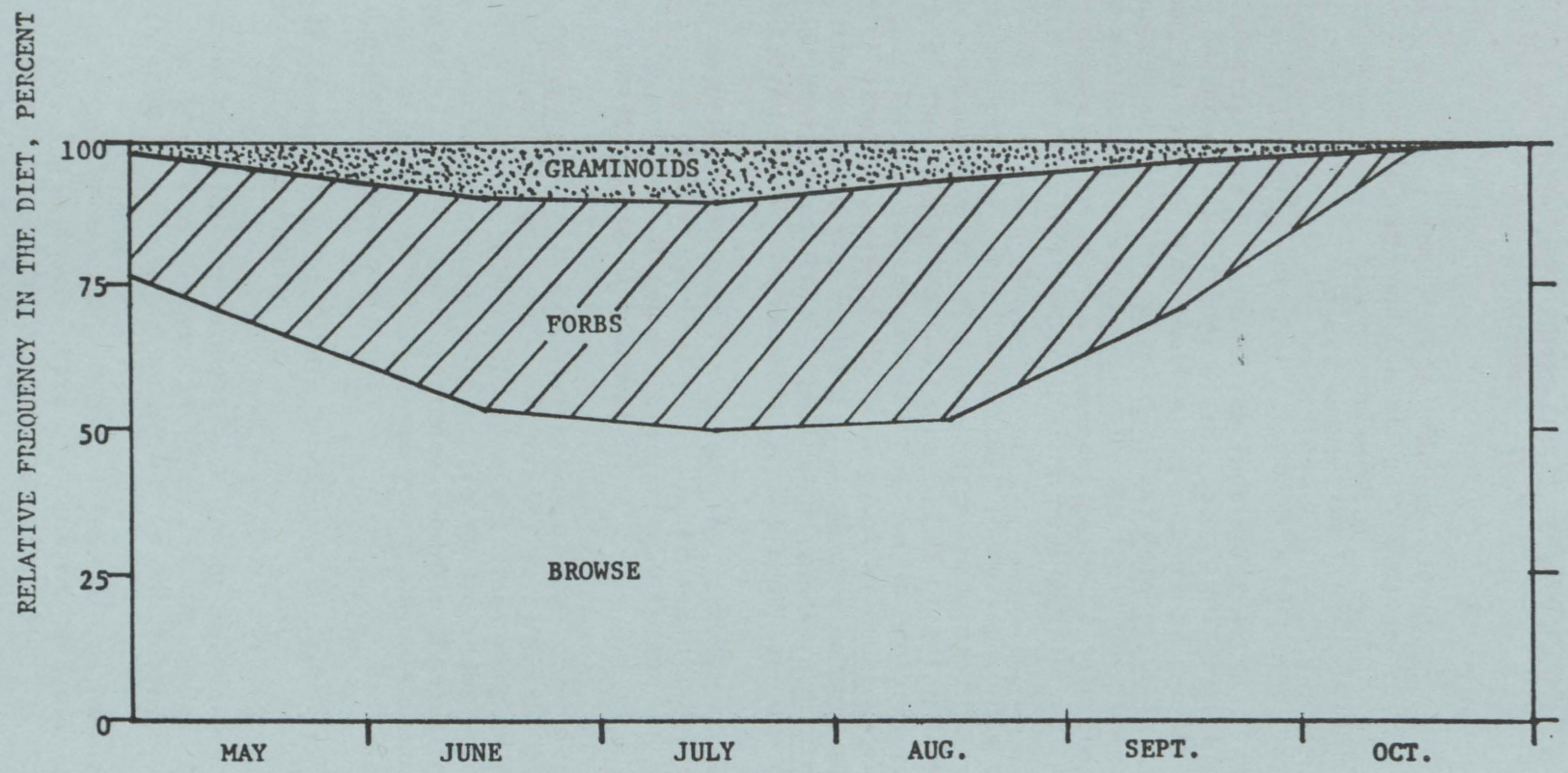

Fig. 2. Seasonal changes in the relative frequency of different forage classes in the diet of beavers in Grand Teton National Park as determined by fecal analysis microtechniques.

SOCIAL DYNAMICS OF THE MONTANE VOLE, *MICROTUS MONTANUS*, AND THEIR POPULATION CONSEQUENCES

November 1976

Frederick J. Jannett, Jr.
Ecology and Evolutionary Biology
Cornell University
Project Number 183

The social structure of a mammalian species is a basic feature of its life history. Although a knowledge of the social system is a prerequisite to understanding various reproductive and endocrinologic phenomena seen by other workers studying *Microtus*, *Mus*, and *Peromyscus* in the laboratory, behavior and sociality of *Microtus* in the field have been overlooked because they are difficult to study and because emphasis in microtine research has been placed on the microtine population "cycle."

There are two primary areas of interest in my work: the description of the social system and how it changes with changing density; and the documentation of the initiation and cessation of breeding seasonally and of the reproductive parameters which I believe are related to the social environment. Other aspects of the biology of *M. montanus* concurrently being investigated are survivorship, scent gland development, and patterns of cranial and dental variation. Population trends in *M. longicaudus* are being monitored, as is reproduction in the shorttail weasel (*Mustela erminea*).

During September and October *M. montanus* was sampled at seven sites. *Microtus longicaudus* was sampled at four sites in the vicinity of the Research Station and at one location in Bridger-Teton National Forest. A small sample of female weasels was made in November.

Microtus montanus was also removal trapped from four gridded areas. The largest of these two grids differed dramatically in the numbers of animals present. In one grid (204 stations) eight voles were trapped in the first two days. In the other grid (196 stations) 376 voles were trapped in the first two days. In the first instance the vole population has shown a decline over a period of at least two years, whereas in the second area the population has remained high.

Additional observations of dyadic encounters between field-trapped voles were made in the laboratory.

A small group of voles was brought back to the laboratory colony. Two albino *M. montanus* were trapped in 1976, and the genetic basis for this pelage variation is now being worked out in the laboratory.

I thank the Theodore Roosevelt Memorial Fund of the American Museum of Natural History for a grant-in-aid of research, and the Jackson Hole Biological Research Station for the loan of traps.

Work done in GTNP and supportive projects:

Gourley, R. S. and F. J. Jannett, Jr. 1975. Pine and montane vole age estimates from eye lens weights. J. Wildlife Management, 39: 550-556.

Jannett, F. J., Jr. 1975. The "hip glands" of Microtus pennsylvanicus and M. longicaudus (Rodentia: Muridae), voles "without" hip glands. Systematic Zoology, 24: 171-175.

_____. Dosage response of the vesicular, preputial, anal, and hip glands of the male vole, Microtus montanus (Rodentia: Muridae), to testosterone propionate. Manuscript.

_____. Prenatal and postnatal growth and development and the developmental molts of Microtus montanus nanus in the laboratory. In preparation.

_____. Changes in the corpors and uteri of female voles, Microtus montanus, following parturition. In preparation.

_____ and J. Z. Jannett. 1974. Drum-marking by Arvicola richardsoni and its taxonomic significance. American Midland Naturalist, 92: 230-234.

_____ and _____. Convergent evolution in the behavior of a shrew and a rodent. Manuscript.

Jannett, J. Z. The response of the flank glands and drum-marking of Arvicola richardsoni (Rodentia: Muridae) to castration, ovariectomy, and testosterone administration. Manuscript.

TRUMPETER SWAN PRODUCTIVITY IN GRAND TETON NATIONAL PARK, WYOMING

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University of Nebraska
Lincoln, Nebraska

This is a report of some of my activities carried out during the summers of 1974 through 1976 in Grand Teton National Park, which were associated with field work in the gathering of materials for a book on the ecology and behavior of sandhill cranes and trumpeter swans in the park. Only one month (May 22 to June 22) was spent in the park during 1976, and thus no data on swan productivity were obtained in that year. Data on the park's swan production for the years prior to 1974 were obtained from the card files of the National Park Service and have been organized in such a way as to make them comparable to similar data by J. Halladay from Yellowstone National Park (Proceedings of the Third Trumpeter Swan Society Conference, 1973), and published data from Red Rock Lakes National Wildlife Refuge (North American Fauna No. 63, 1960) and from Alaska (Wildlife Monographs No. 26, 1971), and R. Page's unpublished data from Red Rock Lakes (Ph.D. dissertation, University of Montana, 1974).

Observations

Habitats Used by Breeding Swans

During the years since 1970, eight areas have been used successfully for breeding by swans in or immediately adjacent to Grand Teton National Park, as shown in Table 1. Of these, the Christian Pond location has been most regularly successful, and indeed has been utilized by swans on a yearly or nearly yearly basis since at least as early as 1957 (see summary in 1975 Annual Report). Presumably the same pair has been present all this time; if so, the birds have been nesting there for 20 years or more. This pair has also been the most successful of those nesting in the park, at least in recent years. The pairs at Pinto Ranch and Sawmill Pond have also been relatively successful; the Sawmill Pond pair has nested there since at least as long ago as 1964, but in 1976 did not appear. Likewise the pair that nested on Cygnet Pond in the 1960's no longer does so, but a pair is sometimes still seen using that area. The pair using Hedrick Pond has not nested there since 1973; the male of that pair was killed by a poacher in 1974. The sizes of the areas used for nesting in the park varies considerably, and averages slightly more than 30 acres, or very close to the average territorial size reported for Red Rock Lakes birds.

Breeding Success

Data for the Park from the period 1969 through 1974 indicated that about seven territorial pairs were present during that period, and that about half of these raised one or more cygnets to late summer (Table 2). The number of cygnets raised per successful brood was, however, relatively low (2.14 average), which is comparable to data reported by Page for Red Rock Lakes in recent years. Cause of this substantial brood mortality is still extremely uncertain, but it is appreciably greater than that reported for the Alaskan population. One possibly contributing factor for the loss of young, which seems to occur very shortly after hatching, is the frequent periods of sub-freezing weather as late as mid-June, when hatching normally occurs. The possible influence of dietary factors in the survival of cygnets is unknown, but few if any cygnets are likely to be lost to predation in the park.

A similar estimate of breeding success can be obtained by determining an adult:cygnet ratio in late summer, as shown in Table 3 for Grand Teton National Park during the 12 years between 1960 and 1974 for which such data were available in Park files. The resulting ratio of 3:15 adults per cygnet is a relatively favorable one by comparison with Halliday's reported figures for Yellowstone National Park during a similar period and with Banko's data from Red Rock Lakes National Wildlife Refuge for the year 1954, when population levels of swans at the refuge were at their maximum. Obviously these ratios reflect not only breeding success of nesting birds, but also the incidence of non-nesting by adults and the presence of sub-adult birds in the population.

Summary

The Grand Teton Park population of swans appears to be small but stable, and probably most or all of the park's suitable habitats are now being used by swans. Sources of egg and cygnet mortality are very difficult to judge, but appear to be no greater than in other areas of the general region. A few of the swan pairs, such as those at Christian Pond, have become highly tolerant of human presence, although in general trumpeter swans tend to be highly wary of humans as well as intolerant of other swans in the near vicinity. Disturbance at Christian Pond, which is perhaps the most productive and diversified of all pond habitats in the park in terms of abundance and diversity of breeding aquatic birds, should thus be kept at a minimum.

Table 1. Swan Breeding Habitats, Grand Teton National Park, 1970-75.

	Total Yng. Raised	Years of Success	Approximate Acreage
Christian Pond	14	4/6	30
Pinto Ranch	9	4/6	20
Sawmill Pond	6	3/6	5
Two-Ocean Pond	5	3/6	15
Swan Lake	5	2/6	35
Elk Ranch Reservoir	2	1/6	100
Hedrick Pond	1	1/6	25
Glade Creek	1	1/6	10

Table 2. Trumpeter Swan Breeding Success, Various Areas.

	Ave. Total Pairs	Ave. Total Broods Raised	Ave. Total Cygnets Raised	Broods Per Pair	Cygnets Per Pair	Cygnets Per Pair
Grand Teton Nat. Park ('69-74)	ca. 7.5	3.7	7.5	0.47	1.0	2.14
Red Rock Lakes N.W.R. ('71-73)	33.7	10.7	24.0	0.32	0.71	2.24
Alaska (1968)	666	251	923	0.38	1.38	3.60

Table 3. Breeding Success Based on Late Summer Adult:Cygnet Ratios.

	Ave. No. of Adults	Ave. No. of Cygnets	Ratio of Adult:Cygnets
Grand Teton Nat. Park (12 yrs, '60-74)	21.5	6.8	3.25:1
Yellowstone Nat. Park (1960-1970)	52.4	5.0	10.5:5
Red Rock Lakes N.W.R. (1954)	352	28	12.5:1
All of U.S.A. (1954)	580	82	6.8:1

ANALYSIS OF COYOTE VOCALIZATIONS

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Research on coyote vocalizations have included McCarley's (1975) description of long-distance vocalizations and Lehner's (1976) descriptive lexicon of vocalizations including a discussion of their behavioral context. The research reported on here is one phase of continuing research to determine the function of the lone howl, group howl and group yip-howl vocalizations.

Methods

The period July 3 - August 11, 1976, was spent conducting field studies in Grand Teton National Park and on the National Elk Refuge. The Jackson Hole Biological Research Station, Moran, Wyoming, provided housing. The study was conducted as two separate, but related research projects.

Broadcasts of Lone Howl and Group Yip-howl

Thirty playback sites were randomly selected from the 44 sites used in 1975 at which vocal responses were received. Each site was sampled twice. A sample consisted of broadcasting one vocalization, listening for 15 minutes, broadcasting the other vocalization and listening for five minutes. The vocalization to be played first on the first sample was randomly selected. On the second sample the order was reversed. Time between samples averaged 14 days (range 2-30 days). Broadcasts were always made at night between 22.02 and 04.25 hrs. The electronic broadcast system consisted of a Uher 4000 Report-L audio taperecorder with BASF DP-26 tape, a Realistic MPA-20 amplifier and a Realistic PA-12 trumpet speaker. Responses were recorded on a Nagra IV-L taperecorder with an Electro-Voice microphone and a Torngren parabolic reflector. Written records of responses were also maintained. In addition, during each sample environmental light levels were measured horizontal to the ground in the four cardinal directions at a height of two feet with a Gamma Scientific photometer.

Observational Playback

Three groups of coyotes (designated A, B and C) holding adjacent territories on the National Elk Refuge were observed during the daylight hours throughout the study period. Three vocalizations were selected for playback to individuals or groups from different locations within their territories. The three vocalizations were: (1) unfamiliar lone howl, (2) unfamiliar group yip-howl, and (3) familiar group yip-howl from group B. Playback was made by one researcher who was hidden from view of the coyotes while the other researcher observed the behavior of the coyotes from a distant location with the aid of a spotting scope. Mr. Michael C. Wells was my research assistant throughout the study.

Results

The results of the vocalization broadcasts are shown in Table 1. Barks and bark-howls are alarm and threat vocalizations that were given only after we were approached closely by coyotes and apparently identified as an unusual and unexpected source of vocalizations; these vocalizations were not included in the analysis. Vocal responses were generally given to like vocalization-broadcasts; that is, group yip-howls were given most often in response to group yip-howl broadcasts, and lone howls to lone howl braodcasts. However, this is significant only at the 90% level ($x^2 = 3.03$, df = 1, $p < 0.10$). The ratio of 'response' to 'no response' was compared for broadcasts made when the mean light level was above and below 1.0×10^{-3} ftc. Significantly more responses were given to broadcasts made when light levels were above 1.0×10^{-3} ftc. than to those below. I believe this is a result of increased activity of the coyotes rather than the higher environmental light level per se.

Forty-four vocalization playbacks were made to coyotes under observation. Additional playbacks were made 23 times following an initial playback. Additional playbacks were the same or different vocalizations depending on the observer's assessment of the coyote's behavior and his judgement as to what vocalization would be most appropriate. The responses of the coyotes to these playbacks are shown in Table 2. This project can be considered only as a research probe at this point, and the results are only preliminary and tentative. However, there are four results worthy of emphasis: (1) all the attacks and 80% of the approaches were made to unfamiliar vocalizations; (2) most (7 of 8) of the group yip-howl responses were given to group yip-howl playbacks; (3) the animals appeared to be able to discriminate between lone howls of group members and non-group coyotes; and (4) location of playback in the territory did not appear to be as important in determining an individual's response as did the ongoing behavior or social status of that individual.

Conclusions

The broadcast experiments weakly supported the hypothesis that the lone howl and group yip-howl are qualitatively different vocalizations. The entire behavioral response of coyotes to playback during the day is extremely variable but the results do suggest that important variables affecting the responses are: vocalization type, familiarity of vocalization, social status and ongoing behavior of the recipient coyote(s).

Literature Cited

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McCarley, H. 1975. Long-distance vocalizations of coyotes (*Canis latrans*). J. Mamm. 56(4): 847-856.

Table 1. Coyote vocalizations elicited by 60 broadcasts of lone howls and group yip-howls, Jackson Hole, Wyoming, July-August, 1976.

Vocalization Broadcast	No. of Responses					Total No. Responses	No. of broadcasts in which no response was received
	Bark	Bark-howl	Lone Howl	Group Howl	Group Yip-howl		
Lone Howl	3	3	26	6	8	46	34
Group Yip-howl	1	1	20	4	17	43	31
Totals	4	4	46	10	25	89	65

Table 2. Responses of individual coyotes to broadcasts of selected vocalizations, National Elk Refuge, Jackson, Wyoming, July-August, 1976.

Vocalization Played	Coyote Group	Vocal Responses					Withdrawl	Approach	Attack	No Response
		Bark	Bark-howl	Lone Howl	Group Howl	Group Yip-howl				
Lone Howl (unfamiliar)	A	1	1				1P*	8	2	12 + 1P
	B						1			1
	C			9	2	1		2		3 + 1P
	Total	1	1	9	2	1	1 + 1P	10	2	16 + 2P
Group Yip-howl (unfamiliar)	A	1	3	11		2	1	3	5	4
	B			2P		1	1P	1		1P
	C							2		1
	Total	1	3	11 + 2P		3	1 + 1P	6	5	5 + 1P
Group Yip-howl (familiar)	A	1	1	1		2	3 + 1P	4		3
	B									
	C			3	1	2				1
	Total	1	1	4	1	4	3 + 1P	4		4
Totals		3	5	24 + 2P	3	8	5 + 3P	20	7	25 + 3P

*"P" denotes pup.

GENETIC VARIABILITY IN CUTTHROAT TROUT

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During the summer of 1976 an investigation into the nature of genetic variability in the cutthroat trout (Salmo clarki) was initiated. The results presented here are the product of only one summer's data, and will be subject to rigorous testing in the next two summers. This project has been supported in part by a New York Zoological Society Scholarship and a National Science Foundation Energy-Related Traineeship. I wish to thank Pete Hayden of Grand Teton National Park, Max Rollefson, Jon Erickson, and John Kiefling, of the Wyoming Game and Fish Commission, and John Varley and Ron Jones of the U.S. Fish and Wildlife Service for their cooperation in collection of cutthroat trout. I would also like to thank Drs. R. M. Kitchin, H. Bergman, and G. T. Baxter, of the Department of Zoology and Physiology, University of Wyoming for their help in organizing this research project.

Introduction

The family Salmonidae is composed of the trouts (Salmo), chars (Salvalinus) and salmons (Oncorhynchus), and whitefish (Coregonus). This entire family has been exploited to the extent that pure forms exist only in a few isolated areas. Grand Teton and Yellowstone National Parks provide such a pristine condition for the cutthroat trout.

One of the priorities of modern fish managers is to maintain and reestablish native fish. This study will provide data on the genetic structure of pristine salmonid populations. Fish managers should be able to use this data to evaluate reestablishment projects elsewhere, and to provide guidelines for picking brook stock for future culture and reestablishment programs. This data should also provide information valuable to managers regarding the integrity of distinct cutthroat trout populations in Northwest Wyoming.

Objectives

A. Evaluate the hypothesis that exploitation has reduced the genetic variability in cutthroat trout populations.

B. Evaluate the hypothesis that sympatry should result in disruptive selection causing differentiation of cutthroat trout gene pools.

C. Determine if chromosome variation in cutthroat trout is a somatic phenomenon or a population based polymorphism.

D. Determine, using Hardy-Weinberg genetic equilibrium, if the large and fine spotted cutthroats are interbreeding.

Methodology

Cutthroat trout were collected at five localities during the summer of 1976. Yellowstone cutthroats were collected from the Pelican Creek fish trap (a lake population N=30), and LeHardy's Rapids (a river population N=30). Large spotted Snake River cutthroats were collected on Dime Creek (a small tributary to the upper Snake River North of Jackson Lake N=10), and from the main body of the Snake River just below Jackson Lake (N=30). Fine spotted cutthroat trout were collected in the Black Tail Springs (N=12).

Cytogenetic analysis, which involves injection of colchicine, and an in-vivo incubation was completed on a limited number of specimens. (Dime Creek N=5, LeHardy's Rapids N=6, Pelican Creek N=3, Snake River N=17, Black Tail Springs N=0). Whole blood was taken from the remaining fish, via caudal vein puncture, and the fish returned to the water. Sera and hemolysate were separated and frozen in liquid nitrogen. Electrophoretic analysis is presently underway in Laramie, Wyoming at the University of Wyoming.

Preliminary Results

Chromosomal analysis has been completed on 27 individuals. The modal chromosome number for each population was 64, with 104 chromosome arms. This is in disagreement with Simon's earlier report of 64 chromosomes and 106 arms. Variation in chromosome number seems to be a prevalent phenomenon in cutthroat trout. The most perplexing situation is the considerable intra-individual variation. This variation may arise as the result of inversions, acrocentric fussions and fissions, and chromosome loss. It is the present opinion of the author that this variation is not surprising, and may be part of an underlying preadaptive mechanism for polyploidization, and gene duplication prevalent in salmonid fish. Because the numbers of fish from each population is at present low, it is too early to draw any conclusion about population polymorphisms. It is of interest that there are individuals in the Snake River whose modal chromosome is 2N=62, with 104 arms, rather than 2N=64, with 104 arms. This indicates that the possibility for an underlying population based polymorphism is good, and needs further study.

The electrophoretic analysis is at present underway. Staining and techniques have been worked out for tetrazolium oxidase, malate dehydrogenase, esterase, alpha-glycerolphosphate dehydrogenase, acetylcholinesterase, transferrin, and hemoglobin. No conclusions are yet available.

Future Studies

From the preliminary results it is obvious there is a need for additional study. Cytogenetic analysis should be performed on at least 15 to 20 individuals per population. This will provide a sufficient sample to detect a population polymorphism. Collection of an additional 30 electrophoretic samples per population should enlarge that portion of the study sufficiently. In addition to sera and hemolysate, muscle samples will be collected. Sera and hemolysate will be run fresh at JHBRS, and muscle frozen and analyzed in Laramie.

AN EVALUATION OF ELK AND CATTLE ON THE CHEMICAL AND MICROBIOLOGICAL WATER QUALITY OF FLAT CREEK, TETON COUNTY, WYOMING

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Objectives:

The National Elk Refuge in Jackson Hole, Wyoming (administered by the Bureau of Sport Fisheries and Wildlife) covers an area of 23,754 acres and provides winter range for approximately 60 percent of the Jackson Hole elk herd. When deep crusted snow prevents the elk from grazing normally, a supplemental feeding program is put into operation. In order for Teton County to meet the 1983 National Goal on water quality (PL 92-500) it is important to determine to what extent the winter feeding of elk is influencing the water quality of Flat Creek which flows through the National Elk Refuge.

The purpose of the present study will be to determine to what extent the winter feeding of elk is influencing the water quality of Flat Creek and to aid in the development of management policies for the Teton County Section 208 Waste-treatment Management Planning Program and National Elk Refuge personnel.

The objectives of the present sutdy are:

1. To determine the influence of elk populations on aquatic indicator bacterial populations in Flat Creek.

2. To determine the influence of elk populations on selected water chemistry parameters.

3. To examine elk fecal material from winter and summer ranges for the presence or absence of bacteria that are pathogenic for man and to test for such microorganisms in natural waters.

4. To evaluate the water quality potential of Flat Creek as a municipal water supply for Jackson, Wyoming.

Procedures:

Location of study sites: The main study area (Fig. 1) is Flat Creek and adjoining creeks and springs on the National Elk Refuge. Other study areas include two locations on Flat Creek below the town of Jackson and one site on Spring Creek between the East and West Gros Ventre Buttes. The sample stations

On Flat Creek below the town of Jackson are located above and below the South Park Elk Refuge enabling one to determine the influence of elk on this section of Flat Creek. The Spring Creek station is influenced by cattle grazing as are the two Flat Creek stations below the town of Jackson. Although there are cattle on the National Elk Refuge at Twin Creek Ranch they are not free ranging, so essentially the main influence on Flat Creek above the town of Jackson will likely be due to elk.

The sample sites shown on Figure 1 are as follows:

F-1 - Flat Creek as it enters the National Elk Refuge.

F-2 - Flat Creek where the public access road on the Refuge crosses it.

F-3 - Flat Creek adjacent to the National Fish Hatchery.

F-4 - Flat Creek approximately 1 mile south of Fish Hatchery.

F-4A - Nowlin Creek where it joins Flat Creek.

F-5 - Miller Springs on Elk Refuge.

F-6 - Flat Creek as it exits the National Elk Refuge.

F-7 - Flat Creek as it flows under South Park Road (above South Park Elk Refuge).

F-8 - Flat Creek as it flows under Highway 187 (below south Park Elk Refuge).

S-1 - Spring Creek as it flows under Highway 22.

Sampling: Samples at sites F-1, F-3, F-4, F-4A, F-5, F-6, F-7, F-8 and S-1 were collected and analyzed three different times during the period beginning 8/4/76 and ending 10/13/76. During this period elk were not present on the National Elk Refuge and water from the Gros Ventre River was no longer being diverted into Flat Creek. Discharge at this time was still above winter lows but was below peak flows experienced in previous sampling periods. Samples collected on 9/22/76 of this sampling period were obtained during a heavy rain shower and reflect conditions of a typical storm runoff period. Samples collected on 8/4/76 and 10/13/76 however, reflect stable conditions in which there is very little influence on the water quality by extraneous factors, i.e. large elk populations or diverting water, and provide background data with which other sampling periods may be compared. Sites S-1, F-7 and F-8 were probably influenced to some degree, during the last sampling period, by cattle being moved to winter feeding grounds in the South Park and Spring Gulch areas. However, the number of cattle present did not reflect winter conditions which has a greater cattle population.

Results:

The results of each sampling date can be seen in Table 1 and Figure 2. In general bacterial counts (total coliform, fecal coliform, fecal streptococci and standard plate count) are comparable to counts obtained during September and October of last year. Bacterial counts did increase on sites located on

the elk refuge during sampling period 9/22/76 (Fig. 2). This corresponds with the storm runoff witnessed during that period. Sites below the town of Jackson and on Spring Creek however, showed either no major change or a decrease in bacterial numbers during the same sampling cycle. Total phosphates and nitrates were the nutrients which best corresponded with the storm runoff. Physical factors such as turbidity, residue and conductivity as well as B.O.C., pH, alkalinity and minerals did not appear to be affected by the storm runoff.

As the water temperature decreased and flow rates approached those of winter, bacterial counts (in particular fecal coliform) approached counts comparable to last winter. Fecal coliform:fecal streptococci ratios (FC/FS) were below 0.7 for sites on the elk refuge. The FC/FS ratio increased below the town of Jackson and on Spring Creek but remained below 0.7 except for the final sampling period. As before bacterial counts, minerals, nutrients and physical parameters increased as Flat Creek flowed through the elk refuge then increased dramatically below the town of Jackson and beyond the sewage treatment plant.

Discussion:

As before, one sees an increase in bacterial numbers as well as minerals and nutrients in Flat Creek as it passes through the National Elk Refuge lands. There is also a dramatic increase in bacterial numbers during a storm indicating that there is indeed storm runoff. The increase in fecal coliforms indicates that the increase in bacterial numbers during a storm is due, at least in part, to the fecal material left by the elk during the winter months. However, it should be pointed out that even during peak runoff periods bacterial counts on sites located on the refuge are considerable lower than counts obtained in Flat Creek below the sewage treatment plant during stable periods, i.e. no runoff.

Comparing bacterial counts during a dry period with no diversions and no elk present with counts obtained during the winter when elk are present on the refuge tends to indicate a "natural" background level of bacteria in the water. This background level is probably due to a number of factors such as bank erosion, waterfowl and fishing or other activities that might disturb the bottom sediments.

Below the town of Jackson on Flat Creek one sees an increase in bacterial counts as well as nutrients and minerals. This dramatic increase is most likely due to the sewage treatment plant as explained by the following observations. One: the bacterial counts in lower Flat Creek were not effected by the storm runoff, as on the elk refuge, indicating that the major contaminating source is probably not due to runoff from agricultural lands. Two: bacterial counts as well as nutrients and minerals did not appear to fluctuate as cattle are moved to and from the winter range indicating contamination from some other source. Three: the FC/FS ratios increased in Flat Creek below the sewage treatment plant and increased from site F-7 to F-8 indicating human

contamination. Although the FC/FS ratio is usually below 0.7 this indicates an infiltration problem at the sewage treatment plant which would lower the FC/FS ratio.

The effect of cattle on the water quality of Flat Creek is probably comparable to that of the elk on the refuge. Undoubtedly the water is influenced by the cattle as witnessed by an increase in bacterial counts in Spring Creek during storm runoff and when cattle are brought back onto the winter range. However this influence on the water quality again, is not comparable to the influence the sewage treatment plant has on the water.

Looking at the biochemical oxygen demands for Flat Creek and other physical parameters, it is evident that the drainage does have the capacity to withstand the cattle and elk operations that occur in the valley as well as the sewage treatment plant (although the latter is highly undesirable from the sanitation point of view).

Conclusions:

Based on the one year's data obtained so far it is evident that the elk and cattle do have an influence on the water quality of Flat and Spring Creeks. However at this time it appears that this is not necessarily an undue stress on these streams and that they can probably handle the pollution which they receive. It is apparent that the major influence on Flat Creek is 1) the sewage treatment plant and runoff from the town of Jackson and 2) the diversion of Gros Ventre water into Flat Creek.

Acknowledgments:

We thank Don Redfearn and Bob Pearson of the National Elk Refuge for their cooperation and assistance in this project. The help of Richard Meyers of the National Park Service and Al Galbraith of the U.S. Forest Service is also greatly appreciated.

The use of laboratory facilities at Grand Teton National Park Headquarters at Moose, Forest Service Headquarters in Jackson and Jackson Hole Biological Research Station is also acknowledged.

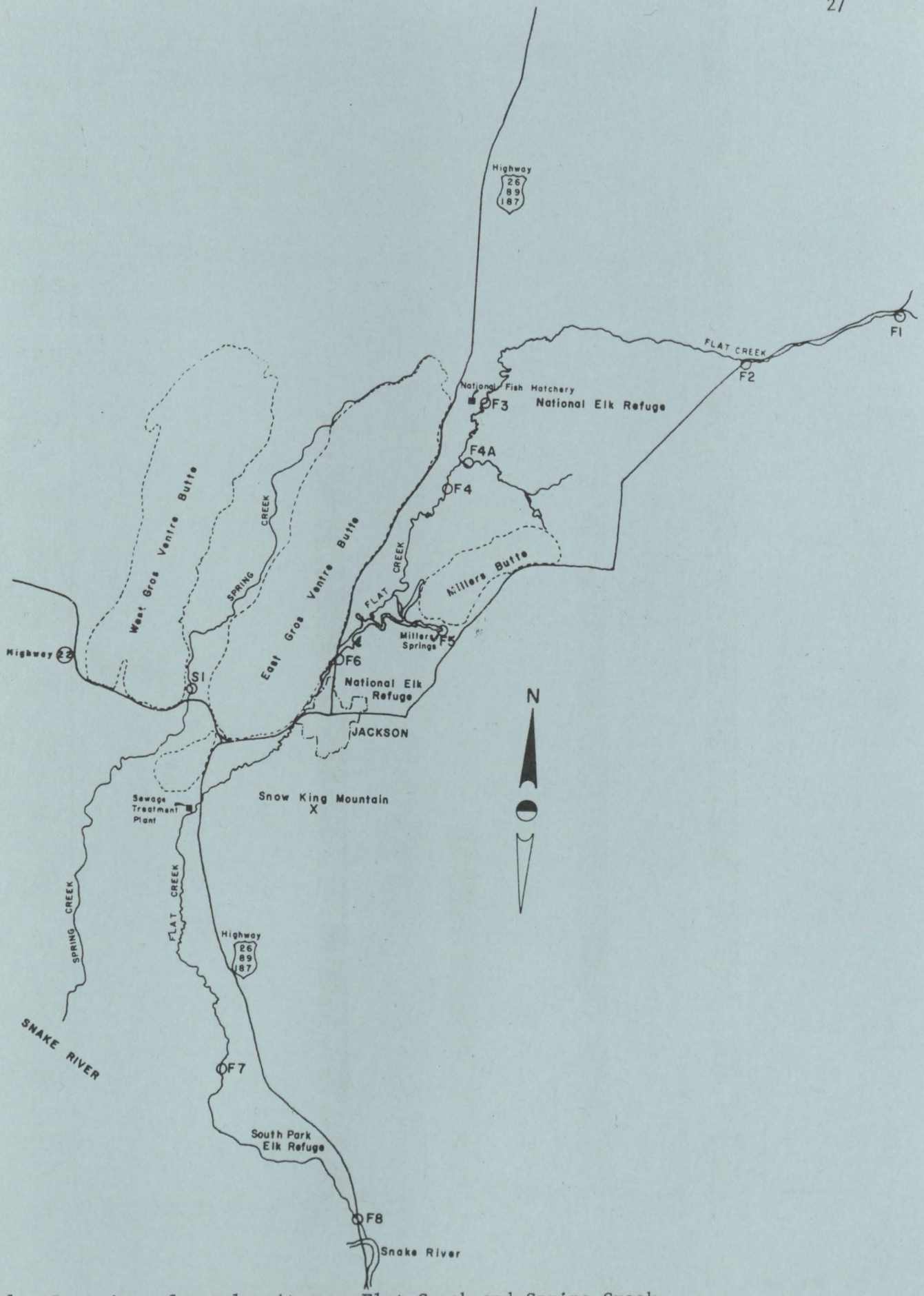

Fig. 1. Location of sample sites on Flat Creek and Spring Creek.

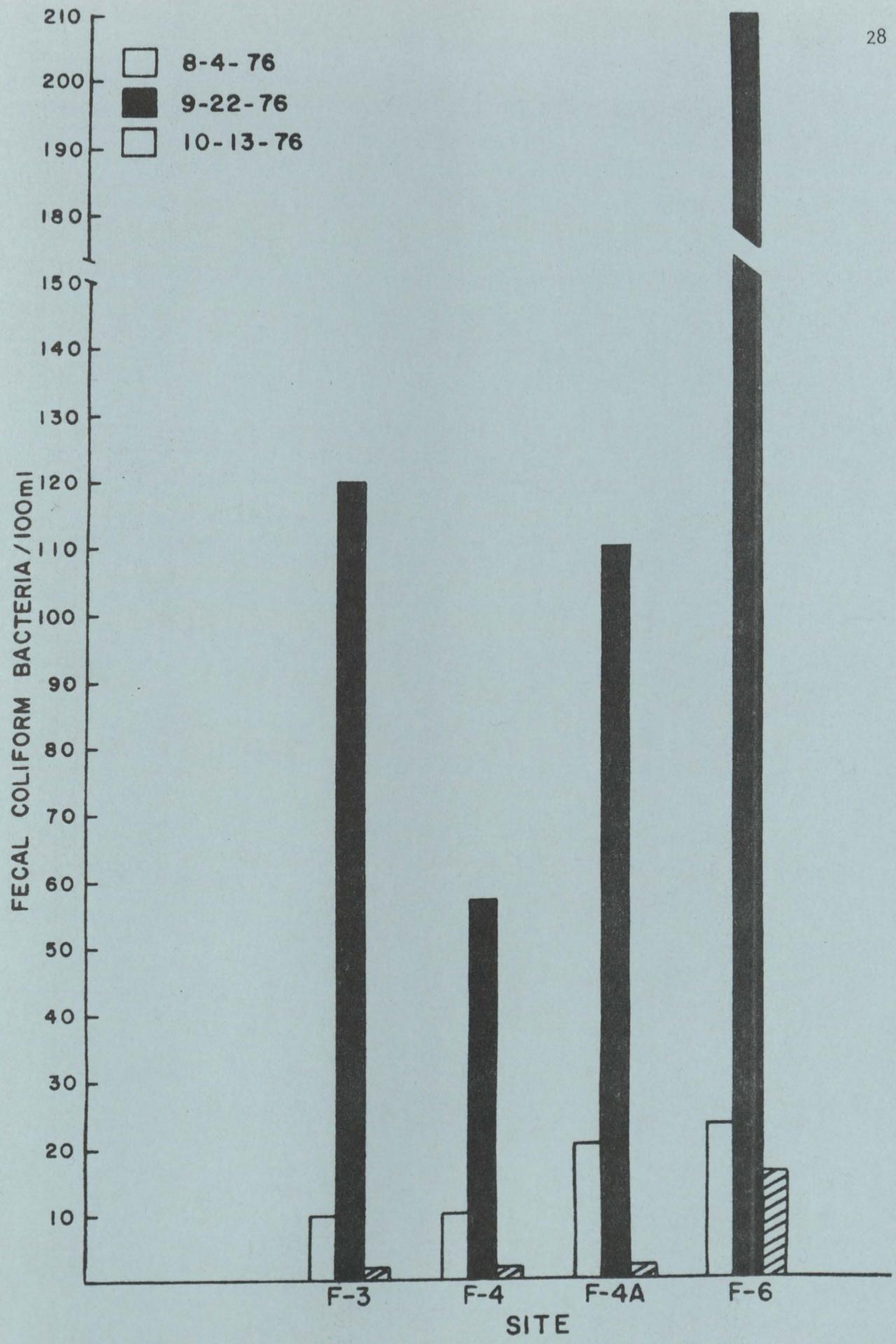

Fig.2 . Fecal coliform bacterial populations at sites F-3, F-4, F-4A and F-G for various sampling dates during this quarter.

Table 1. Chemical, physical and microbiological parameters obtained during the months starting 8/4/76 and ending 10/13/76

Site	Date	Total Coliform #/100 ml	Fecal Strep #/100 ml	Fecal Coliform #/100 ml	Standard Plate Count #/ml	FC/FS	Temp °C	pH	Specific Conductance	D.O.	B.O.D.
F-1	8-4-76	23	55	<1	130		8.6	8.3	203	8.7	.70
	9-22-76	27	59	<1	340		9.1	8.3		8.4	.90
	10-13-76	24	57	<1	100		4.6	8.2	224	9.4	.80
F-3	8-4-76	46	60	10	440	.167	10.0	8.0	296	9.2	.90
	9-22-76	270	280	120	3.3×10^3	.428	9.5	7.9		8.2	1.05
	10-13-76	<1	40	2	410	.050	5.8	8.2	281	9.5	.72
F-4	8-4-76	100	100	10	980	.100	9.5	8.0	320	9.1	1.30
	9-22-76	160	190	57	1.7×10^3	.300	9.3	7.9		8.2	1.14
	10-13-76	140	88	2	830	.023	5.8	8.1	295	9.6	.72
F-4A	8-4-76	75	120	20	680	.167	10.0	7.9	321	8.8	1.10
	9-22-76	220	390	110	3.6×10^3	.282	9.4	7.9		8.0	1.75
	10-13-76	90	110	2	700	.018	5.9	8.1	301	9.4	.81
F-5	8-4-76	5	17	<1	43			7.7	464		
	9-22-76	7	66	<1	410		9.7	7.6		7.7	1.31
	10-13-76	<1	<1	<1	70		9.4	7.8	459	7.5	.29
F-6	8-4-76	82	240	23	770	.096	9.5	7.9	337	8.4	.30
	9-22-76	310	650	210	1.4×10^3	.323	9.8	7.9		7.7	1.37
	10-13-76	80	170	16	1.3×10^3	.094	6.2	8.1	310	8.8	.83
F-7	8-4-76	2.8×10^3	1.5×10^3	410	5.2×10^3	.273	11.4	7.9	398	6.5	1.00
	9-22-76	400	900	280	4.8×10^3	.311	11.0	7.9		6.8	.83
	10-13-76	TNTC	2.2×10^3	1.9×10^3	2.9×10^3	.864	5.8	8.0	371	8.1	.63
F-8	8-4-76	1.8×10^3	940	480	8.6×10^3	.511	11.7	7.9	415	6.8	1.70
	9-22-76		300	70	2.5×10^3	.233	11.4	8.0		6.8	2.19
	10-13-76	4.2×10^3	1.1×10^3	1.1×10^3	2.0×10^3	1.00	6.2	8.0	394	7.9	.72
S-1	8-4-76	200	230	54	2.0×10^3	.235	8.8	7.7	438	6.8	1.10
	9-22-76	260	280	40	3.1×10^3	.143	9.8	7.7		6.1	1.22
	10-13-76	890	70	270	2.4×10^3	3.86	5.4	7.8	454	6.8	.56

Table 1. Continued

Site	Turbidity NTU	Alkalinity meq/l	Alkalinity mg/l $CaCO_3$	Hardness as $CaCO_3$	Ca mg/l	Mg mg/l	SO_4 mg/l	NH_3 mg/l-N	NO_3 mg/l-N	Ortho PO_4 mg/l-P	Total PO_4 mg/l-P	Residue non-filterable mg/l
F-1	.40	2.16	108	108	29.68	8.27	2.58	.005	.016	.001	.008	<1
	.25	2.27	113	118	32.80	8.66	3.55	.007	.041	.006	.016	<1
	.80	2.38	119	125	34.40	9.48	3.57	.008	.033	.005	.018	<1
F-3	.90	3.10	155	162	43.76	12.79	5.53	.005	.012	.001	.011	<1
	1.00	3.01	151	155	47.20	8.90	4.23	.006	.018	.001	.021	2
	.77	3.05	153	156	44.00	11.24	4.21	.006	.017	.002	.019	<1
F-4	.60	3.40	170	174	54.32	9.29	5.25	.005	.008	.002	.016	<1
	.50	3.17	159	164	46.16	11.72	5.40	.006	.022	.003	.021	<1
	.76	3.18	159	161	49.20	9.29	5.68	.006	.022	.002	.021	<1
F-4A	.40	3.53	176	180	50.16	13.33	4.74	.005	.005	.001	.016	<1
	.45	3.24	162	168	50.48	10.21	6.62	.006	.016	.002	.024	<1
	.66	3.21	160	164	46.08	11.92	6.57	.006	.019	.002	.018	<1
F-5	.03	2.91	146	248	71.68	16.68	101.32	.006	.112	.017	.024	<1
	0.00	2.91	145	249	80.32	11.82	101.26	.006	.118	.017	.034	<1
	.02	2.93	146	249	67.20	19.65	98.81	.006	.119	.017	.032	<1
F-6	1.00	3.56	178	188	61.68	8.17	7.80	.005	.003	.001	.016	2.5
	.80	3.15	158	168	53.12	8.66	9.88	.007	.012	.002	.064	2.5
	3.60	3.24	162	166	49.60	10.31	10.39	.012	.015	.002	.041	20
F-7	3.50	3.80	190	218	62.40	15.17	32.76	.078	.026	.051	.095	20
	1.60	3.98	199	226	69.04	12.99	35.25	.014	.070	.037	.036	3.0
	2.60	3.41	170	201	54.24	15.81	32.52	.032	.031	.061	.095	5.0
F-8	3.30	3.97	198	226	69.44	12.79	33.33	.025	.032	.043	.081	8.5
	.70	3.78	189	246	71.12	16.59	50.30	.007	.044	.029	.052	1
	1.80	3.57	178	213	59.92	15.37	35.07	.015	.038	.059	.090	5.0
S-1	.70	3.90	195	236	87.52	4.23	46.97	.005	.019	.026	.041	1
	.70	3.83	192	230	69.12	13.91	51.55	.012	.052	.018	.041	4.0
	.85	3.94	197	232	76.88	9.78	49.09	.011	.056	.017	.042	7.5

SOME EFFECTS OF FIRE SUPPRESSION AND PRESCRIBED BURNING ON BIRDS AND SMALL MAMMALS IN SAGEBRUSH

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Introduction

Ecosystems in northwestern Wyoming have remained relatively unperturbed by fire for the last 70-80 years. Recently a fire management plan was implemeneted in the Teton wilderness allowing natural fires to burn, and similar plans are being developed for other wilderness areas in Wyoming and central Idaho. Large portions of these areas consist of sagebrush (*Artemisia tridentata*) communities where natural fires frequently occur.

Prescribed burning in sagebrush is also an expanding program in this region. Burning is often used to reduce sagebrush densities, increase forage production for livestock and improve certain wildlife habitat. Plans to use prescribed fire to simulate the ecological effects of a natural fire regime in Jackson Hole are also being developed. These plans are based on the contention that fires are necessary to maintain diversity within many ecosystems of the Jackson Hole region, and the exclusion of fire has resulted in increased areas occupied by sagebrush communities.

Studies of the effects of fire in sagebrush on consumers, including both invertebrates and vertebrates, are virtually non-existent. Even for some of the more conspicuous groups like birds, the best available information on response to shrub habitat alteration comes from studies on the effects of herbicides.

This study was designed to explore the response of bird and small mammal density and diversity to fire. Field operations were based from the JHBRS at Moran, Wyoming.

Results

Bird and small mammal communities were studied in a fire suppressed sagebrush ecosystem and on two sagebrush prescribed burns, one spring burn and one fall burn. Breeding bird density and diversity were positively correlated with increasing vegetation cover and diversity, and were directly related to the destruction of suitable nesting habitat. Non-breeding birds were inversely related to increasing vegetation structure due to more favorable hunting and foraging conditions following the removal of sagebrush and litter by the fire.

Total bird density was reduced following both burns and returned to preburn levels three years after spring burning and two years following fall burning. Total bird species diversity was significantly higher ($P < .05$) during the first postburn year on both burns, and returned to control values after two years. Seasonal changes in total diversity on both burns were due to non-breeding bird species richness.

The contribution of non-breeding birds to the total avifauna based on occurrence and abundance was highest in the early post-fire stages and decreased with time. Bird communities on the burns were less similar (based on occurrence and abundance) to avifaunas on the unburned control and became more similar with time.

This study indicates that changes in bird density and diversity following prescribed burning of sagebrush are short-lived, suggesting that the bird community in a fire suppressed mountain big sagebrush ecosystem is highly resilient to fire perturbation.

Small mammal species composition, total density and biomass changed little in the unburned sagebrush while individual species capture rates varied considerably. Stomach contents analysis indicated that the small mammal community is generalized (diversified) in its food habits although individual species are somewhat specialized.

Following spring burning the number of small mammal species, total density and biomass were slightly lower than control levels, and returned to unburned levels after three years. Small mammals shifted their food habits slightly in response to an increased availability of food types on the burn.

Species richness was greatly reduced on the fall burn in the first postburn year. Species with specific niche requirements were unable to sustain populations on the fall burn. Two years after burning, four species were captured, although only two (*Peromyscus maniculatus* and *Spermophilus armatus*) were caught in live traps. Total small mammal density increased dramatically in the first postburn year and decreased during the second year but was still significantly higher ($P \leq .10$) than the unburned density. These large increases were due to increased numbers of transient individuals from the surrounding habitat. Food use patterns on the fall burn were similar to those on the spring burn where small mammals utilized their preferred food types in relation to its abundance or availability. These results support the contention that total small mammal numbers are not depleted by fire, but that there is a chnage in species composition.

(Supported by funds from the Eisenhower Consortium for Western Environmental Forestry Research, Yellowstone Environmental Studies Center, Northern Rocky Mountain Cooperative Park Study Program, The Old West Regional Commission and the New York Zoological Society.)

EFFECTS OF ENVIRONMENTAL VARIABLES ON SOME PHYSIOLOGICAL RESPONSES OF *MICROTUS MONTANUS* UNDER NATURAL CONDITIONS
(summary for 1976)

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Introduction

Multiannual cycles in population density are known for a number of microtine rodents. However, factors that govern various phases of the cycle are poorly understood. In other words, little is known to what degree environmental factors and physiological responses of the animals contribute to such cyclicity. The purpose of the present study was essentially fourfold:

A. Characterization of environmental variables that might affect *Microtus* populations at three or four different times of the year.

B. Investigation of growth, maturation, and reproductive activity of *Microtus montanus* under natural conditions.

C. Study of maturation molts and seasonal pelage changes in *Microtus montanus* in relation to sex, age, and reproductive status.

D. A correlation of the information obtained in #1-3 above. It is hoped that the results will help to elucidate causes underlying the multiannual fluctuations in population density of microtine rodents.

Materials and Methods

Microtus montanus were livetrapped and sacrificed as soon as possible after capture. Age estimation for all animals was based on weight, total length, and pelage characteristics.

Reproductive organs, the spleen, and the adrenal glands were collected and preserved in Lillie's buffered neutral formalin for future histological study. Flat skins were prepared from all animals. All tissues are currently being processed at the Department of Biological Sciences, University of New Orleans.

Field Observations

In 1976 field observations were carried out at the Research Station over two study periods: spring (16-21 May), and summer (11 July - 11 August). The fall study period, planned for the first two weeks in October, had to be cancelled when the principal investigator had to be scheduled for major surgery at a directly conflicting time.

Spring and summer study period

During spring meltoff many of the meadows in the study area become temporarily flooded. Since Microtus must therefore also retreat to higher ground, they tend to become concentrated only in small pockets throughout their habitat. Consequently, trapping success in the spring is probably more a measure of the success with which these pockets can be located rather than a measure of the true population density.

In 1976 spring began relatively early. Sixty percent of the females trapped at this time were pregnant with their first litter. Backdating (on the basis of embryo size) revealed that breeding on a population-wide basis began during the second week in May. This is a significant fact in terms of the population growth of Microtus. Data from previous years indicate that any voles born after approximately the first week in July will not reach sexual maturity in the year of their birth. Rather, they would have to overwinter, and then become a part of the breeding population the following spring. Microtus have a gestation period of 21 days; females can remate in post partum estrus. Consequently, if a female were to be capable of producing three litters before the first week in July, she would have to start spring breeding no later than the first week in May. In the spring of 1976 Microtus started breeding on a population-wide basis early enough to permit the production of two litters that would mature in 1976. Isolated animals might have been breeding even early enough to permit the production of three such litters. This is in sharp contrast with the exceptionally late spring of 1975. At that time Microtus started breeding very late. Most of the females probably succeeded in producing only one litter (some, at the very most, two) before the first week in July. The timing of the onset of spring breeding affects the Microtus population density in three ways. First, if three, rather than two, litters are produced, there is the sheer increase in numbers within that time span. Second, the ability to produce a third litter before early July does not merely represent the addition of just a litter. Laboratory data have revealed that litter size in Microtus increases with each successive litter, up to the fifth litter (Negus and Pinter 1965). Consequently, the addition of a second or of a third litter represents the addition of a litter that is larger than the one immediately preceeding it. Third, and most significant, is the fact that the production of litters before the first week in July does not merely represent the addition of numbers. Rather, this represents the addition of breeders - these are young that will become breeders in the year of their own birth; they will contribute offspring to the population in the year of their birth. Therefore, to reiterate: the number of Microtus born before the first week in July represents not only an increase in the absolute numbers of voles for that year; it represents an increase in the size of the breeding population for that year. Furthermore, based on laboratory and field observations it is known that a female Microtus can conceive her first litter when she is between four and five weeks of age. It is also known that mean litter sizes will probably range between three and five. Assuming a 50:50 sex ratio, it is possible, with the help of rather simple arithmetic to project the numbers that could be attained if a breeding population produced one,

two, or three litters that would enter the breeding population in the year of their birth. A case in point is the outcome of the 1975 breeding season. Due to the abnormally late onset of that spring, only one, and certainly no more than two, litters matured and bred in the year of their birth. The result was rather dramatic. In the fall of 1974 there had been every indication that in 1975 there would be an increase in the population density (especially since a decrease in density - not a true "crash" - had occurred from 1973 to 1974). Because of the late spring and the consequent delay in the onset of breeding, the population density turned out to be lower in 1975 than it had been in 1974. Conversely, the early onset of breeding in the spring of 1976 resulted in a population density that by the end of the summer readily exceeded the density of 1974 (although it never reached that of 1973). This increase took place despite the fact that whereas the mean litter size for subadult females was 5.6, for adult females it was only 5.5. However, the adult females made up 75% of the breeding female population. It also indicated that these were animals that had been contributing to the population since the beginning of the breeding season.

Doubtless the fluctuations in the population density of Microtus are affected by numerous variables. Nevertheless, it has become quite apparent that it is the reproductive success that will, in a large measure, determine the dynamics of the multiannual cycle of population density of microtines. Furthermore, it is also clear that the reproductive responses of these rodents are basically a reflection of their environment. In other words, environmental variables exert a profound effect on microtine population dynamics by governing the reproductive responses of the animals.

Probably two of the most important environmental variables known to affect reproduction and sexual maturation in Microtus are photoperiod and diet (Negus and Pinter 1966; Pinter and Negus 1965; Pinter 1968; 1968a). The seasonal changes in the reproductive responses of these rodents under natural conditions, as observed during the course of the present study, can be explained on the basis of such laboratory findings. Gonadal recrudescence in the spring probably occurs in response to the lengthening photoperiod.

However, it is not until the appearance of the first vegetative growth that reproduction begins on a population wide basis. This explains the variability in the onset of breeding from one year to the next. As yet unidentified substances in new green plants have a stimulating effect on the reproductive responses (including sexual maturation)in Microtus. It is also the interaction of photoperiod and of nutrition that may explain the failure of young, born after the first week in July, to mature in the year of their birth. Such young are growing up at a time of decreasing photoperiod. Green plant food is still plentiful. As some of the preferred plant foods of Microtus reach their fruiting stage and begin to dry, the substances in these plants that exert a stimulating effect on the reproductive system are knwon to disappear from these plants. However, Microtus are opportunists when it comes to food selection. They continue to select whatever green vegetation may be available, for as long as it

it remains available. It is noteworthy that if breeding occurs during the fall, it is confined only to full adult animals. It would seem, therefore, that once the reproductive system has been activated by photoperiod (and by tropic substances in green plants), it is not readily suppressed by shortening daylength and a decrease in the availability of green plant food. On the other hand, a decreasing photoperiod and the drying of vegetation effectively delays or even totally prevents sexual maturation of voles born and reared under these conditions.

It is not difficult to envision the adaptive significance of the reproductive responses of Microtus. One might view the variables, photoperiod and nutrition (say, in the spring), as being the coarse and the fine adjustment, respectively, on the microscope. In the spring it is photoperiod (actually, the increase in daylength) that initiates gonadal recrudescence of the reproductive system, very much the same as the coarse adjustment on the microscope brings a slide into general focus. However, photoperiod is a "constant" variable - at a given geographical point, on a given date, there will always be the same number of hours of light and of darkness. On the other hand, local climatic conditions are far more variable from year to year. It is obvious that a reliance strictly on photoperiod as a cue for the initiation of reproduction might have disastrous repercussions on the outcome of the reproductive effort (although a tiny proportion of the animals may achieve gonadal competence and actually begin breeding solely in response to photoperiod). Consequently, Microtus have evolved the capability of using a second cue - the onset of spring vegetative growth - as the ultimate signal. As a result, reproduction on a population-wide basis is triggered by the availability of green plant food, the same as the fine adjustment on a microscope brings the slide into ultimate sharp focus. As a result, young will be produced as soon as - or, only when - conditions are optimal for their survival, growth and maturation (indeed, laboratory studies have demonstrated that young born under a long photoperiod and provided with new green vegetation in their diet, will grow and mature significantly more rapidly than those young which lack one or both of these environmental resources, Pinter and Negus 1965; Pinter 1968). Consequently, by utilizing a coarse adjustment (photoperiod), and the ultimate fine adjustment (diet) Microtus have evolved a highly effective mechanism that permits them a very fine degree of adptation to a changing environment.

Conversely, the failure of late born young to mature in the year of their birth prevents the production of large numbers of further young just before winter, when food and suitable habitat may become a severe limiting factor. Incidentally, laboratory studies have also shown that a winter pelage can be produced only by sexually quiescent individuals - another adaptive advantage for the cessation of reproductive activity in the fall (Pinter 1968a).

All of the above is not to say, however, that multiannual cycles in population density of microtine rodents are governed solely by environmental variables acting on the reproductive performance of these animals. Clearly there are other means whereby the environment can and does act on a population, affecting both, the length as well as the amplitude of a given cycle. Furthermore, environmental variables may be superimposed on something far more basic - that is, the genetic quality of the individual. In other words, it is quite conceivable that there is a genetic difference between animals that constitute the population during different phases of the cycle.

Next year (1977) should prove extremely interesting. For the first time since 1969 the potential exists for the Microtus to achieve a high peak in population density. However, this potential at the moment resides solely in the number of animals. It will be realized only if it is combined with the appropriate set of climatic circumstances. In 1977 these should include an early spring, and abundant rainfall during June and the first part of July (a drought during these months in the summer, as in 1973 and 1974, severely depresses the growth of the herbaceous vegetation and, in turn, causes a similarly severe inhibiton of reproduction). There should also be no catastrophic climatic conditions that might decimate the numbers of Microtus before the onset of the breeding season (as in later winter - early spring of 1972, when an unseasonable "heat wave" caused extensive meltoff and subnivean flooding, followed by a hard freeze; there is evidence that large numbers of Microtus probably died from exposure). Consequently, once again it will be the environmental variables, acting principally through the reproductive response of Microtus, that will be the main factor in determining the amplitude and the length of the multiannual cycle currently under investigation.

The views expressed in this report have been presented in sections earlier, as data became available during the course of this study, and gradually permitted their formulation (Pinter 1974; 1976; 1976a).

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THE ROCKY MOUNTAIN BIGHORN IN GRAND TETON NATIONAL PARK

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This is a summary of a preliminary survey of the bighorn sheep population of Grand Teton National Park during July, 1976.

The National Park's data on bighorn in the park are sparse, with approximately fifty-five reported observations between 1936 and 1975 on file at Park Headquarters, Moose, Wyoming. However, through the courtesy of Mr. Garvice Roby, Wyoming Game and Fish Department, Jackson, Wyoming, records of winter aerial observations from 1969 and 1976 were consulted. From those observations, and from further consultation with park service personnel, a decision was therefore made to concentrate my investigation in areas of the northern portion of the park, within the area extending from Snowshoe Canyon on the south to the northern park boundary, and from Jackson Lake on the east to the western park boundary.

The specific areas of interest were Ranger Peak, Doane Peak, Owl Peak, Moose Basin Divide, Red Mountain and Forellen Peak (see U.S.G.S. map: Grand Teton National Park). Approximately fifteen days were spent in the field during three backpack trips between July 5th and August 1, 1976. Ranger, Doane and Owl Peaks were surveyed by telescope; Moose Basin Divide and the range divide at the head of Moose Basin were investigated directly, where some possible sheep signs (old tracks and scat) were found.

The remainder of the field time was spent in the Berry Creek drainage and around Red Mountain. Forellen Peak was also surveyed by telescope. No evidence of bighorn was found in these areas.

Within the limits of this brief study, it might be recommended that summer investigation of the bighorn of Grand Teton National Park may be impracticable, and that aerial surveys during the winter may be a more workable approach.

I would like to gratefully acknowledge the assistance of the Jackson Hole Biological Research Station, Grand Teton National Park, Dr. William Barmore, Mr. Robert Wood, Mr. John Carr (personnel of Grand Teton National Park), and Mr. Mike Whitfield (of Driggs, Idaho).

THE PERCEPTION OF THE FLOATING EXPERIENCE BY THE PRIVATE FLOATER ON THE SNAKE RIVER IN GRAND TETON, NATIONAL PARK, WYOMING

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This is a report on the preliminary findings and procedure of our study conducted in Summer 1975 in cooperation with the National Park Service for a management plan of the Snake River.

Introduction

In Grand Teton National Park, one of the most exciting experiences that a visitor can have is floating the Snake River; even though not far removed from the road while floating, one has the impression of being deep in the wilderness. In the past decade private floating within the Park boundaries has increased six-fold, and this use is expected to continue to increase in the future. This study is investigating the recreational social carry capacity, the amount and kind of use an area can support over time without causing an unacceptable change in the experience, of the Snake River by investigating the two user groups, the commercial floater and the private floater.

Specific Objectives

A. A comparison of the perceived overall satisfaction with the floating experience by the user groups, i.e. commercial versus private.

B. A perception analysis of those qualities that constitute a quality floating experience (i.e. sights, sounds, and crowding).

C. To analyze the floaters' management preferences (i.e. access, camping, stopping along river, launching, etc.).

D. To determine the behavior habits of the private floater.

E. To determine the personalogical data on the user groups.

Progress to Date

Names and addresses of 230 private floaters were collected during the expected peak floating period within the park. Contacts were made at 3 of

the 4 access points to the Snake River within the Park. The access at the dam site was not included since its use is almost non-existent. All floaters (230) who agreed to participate were mailed questionnaires on or before September 10, 1976. The responses are now being received. Based on our return rate, we expect to receive approximately 75% of our questionnaires.

A similar analysis was conducted in 1974 on commercial floaters. The results of that study will be compared to the results of this year's investigation. The anticipated completion date is December, 1976. The total analysis, private floater responses from 1976 as well as the comparison of commercial floaters from 1974 to the private floaters in 1976 will be presented to the Supertintendent of Grand Teton National Park in order to assist in the development of a master plan for the management of the Snake River.

SUMMARY OF THE 1976 JACKSON HOLE ARCHAEOLOGICAL PROJECT

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During the 1976 field season, we continued the previous year's ethnobotanical and plant resource investigations, the site survey, and test excavated six archaeological sites.

A. Reeve:

Ethnobotanical research stressed survey of plant communities adjacent to archaeological sites. As anticipated, sites were generally oriented to areas of high vegetative productivity. Camassia quamash was apparently an important food plant throughout northern Jackson Hole, as illustrated by the correspondence of extensive camas meadows and prehistoric sites at Soldier Meadow. Other food plants restricted to areas of settlement in northern Jackson Hole include Valeriana edulis, Sagittaria cuneata, Sium suave, Potentilla anserina, and several species of Allium.

Within southern Jackson Hole, the association of Calochortus nuttallii, and the Juniperus scopulorum belt with the distribution of archaeological sites was investigated. The archaeological chronology of southern Jackson Hole suggests the initial use of sego lily habitats at approximately 4000 B.P., corresponding to the end of the Altithermal. Substantial shifts in vegetation patterns should be recognized from future pollen studies, with the behavior of juniper possibly reflecting conditions favorable to the abundance of sego lily. Identification of specific exploitive technologies has also progressed with this research.

High altitude environments of the northern Teton Range provided a third area of botanical collecting and pollen sampling. Limestone formations between 8200 and 9500 feet elevation support extensive parklands dominated by such potential food plants as Ligusticum filicinum, Valeriana edulis, Frasera speciosa, Hedysarum occidentale, Epilobium angustifolium, Angelica arguta, Polygonum bistortoides, and Claytonia lanceolata. Also interesting, Lewisia pygmaea was found near each large archaeological site, a relationship noted for high altitude sites throughout the Pryor Mountains, Montana (Loendorf, personal communication). The major concern of pollen research is to describe the history of plant communities, shifts in the tree-line or periods of neoglaciation probably affecting plant species and therefore the adaptive alternatives of hunting and gathering societies. A 2.5 meter sample was taken from Owl Creek Lake at 9150 feet.

B. Chernick:

An intensive survey was undertaken in the three northernmost canyons (Webb, Owl and Berry Creeks) in order to define the nature and extent of prehistoric occupation in the Teton high country. Our field work reveals a consistent patterning of site location. The well-known Lawrence site at the base of the three canyons and located on the north shore of pre-dam Jackson Lake is understood to be the major lower elevation base camp site in the northern Tetons. In addition, high elevation base camp sites have been located on Hominy Peak, near Conant Pass, off the eastern slope of Red Mountain, and in the Moose Basin. Other, smaller sites were found on the traverse between Conant Pass and the Forellen Peak saddle, on the saddle proper, and along the Moose Basin Divide. These indicate habitual intramontane movement by aboriginal groups. However, at lower elevations there is a marked difference of site patterning among the three canyons. Only Berry Creek Canyon exhibits ample evidence of prehistoric activity; Owl and Webb Canyons are essentially devoid of archaeological material, except for a few random scatters of flaked stone.

Projectile point typology reveals that these archaeological remains represent a considerable time span. Point types from the Lawrence site encompass an +8,000 year time interval, and a large side-notched point from a site at 9200 feet has been assigned a date of ca. 6,000 B.P. Post-altithermal types are most abundant in the higher elevations but, curiously, we have not as yet found any evidence for a high country occupation clearly datable to later than ca. A.D. 1300. The presence of different projectile point types widely separated in time but located on the same sites indicates that the site distribution outlined above is the result of a stable prehistoric adaptation of high country conditions.

Our data suggest several preliminary conclusions. First, the dichotomous arrangement of base camp sites at the Lawrence site and at the mountainous heads of the canyons suggests that aboriginal groups adjusted their economic activities to two altitudinal zones. The Berry Creek drainage is viewed as the major access route between these two zones. Secondly, the consistent scatter of sites throughout the high altitude zone, some in relatively inaccessible areas, is indicative of a purposeful pursuit of specific economic resources indigenous to that zone. Future research will concentrate on determining the relative importance of bighorn sheep, mule deer, productive high country herb meadows and lithic raw material sources in the adaptive strategy evidenced by the patterning of the northern Tetons archaeological sites.

C. Marceau:

Southern migration routes were investigated; however, due to the extensive areas involved and the limited manpower available these routes were only minimally surveyed with an eye to areas which ought to be extensively walked during the summer 1977 field season.

Previous data suggested the exploitation of Calochortus nuttallii utilizing unifacially flaked tools of Tensleep quartzite. To test this hypothesis other areas were chosen in locations removed from the quartzite source at Blacktail Butte: (1) those slopes forming the eastern boundary of the National Elk Refuge and (2) those drainage systems which feed into Flat Creek south of the town of Jackson, i.e. Wilson, Horsethief, and Game Creek Canyons. Evidence gathered from these locations hints that a working hypothesis might now be advanced such that any locally occurring lithics which exhibit signs of having been unifacially flaked were used in the exploitation of sego lily as a plant food.

Future research will be conducted to ascertain the similarities in manufacturing technology and patterns of wear of unifacially flaked tools taken from sites in the southern valley, as for example from the Blacktail Butte series, the base of the Gros Ventre foothills and regions south to the Hoback drainage in an attempt to identify and/or isolate a sego lilly exploitive technology.

While plant resources seem to predict the location of most sites, this approach breaks down in certain areas of the valley. For instance, west of the Snake River several sites have been recorded near the outlets of the lakes at the base of the Teton range. Test excavations suggest large mammals were not the key factor for site location and plant resources are limited. Survey disclosed that sites occur along potential spawning streams also within this region. Cutthroat trout (Salmo clarkii Richardson) may have been a primary resource here and future research will be directed to resolving this issue.

D. Wright:

Excavations were conducted at Jenny Lake I (48 TE 414). The site produced two cultural levels. Surface finds included serrated corner notched points C-14 dated elsewhere in a time range of 1230-1290 B.P. The upper level had one corner notched point. The lower contained the base of a lanceolate point, but is still undated. A Scottsbluff basalt point was found on the surface. Jenny Lake II (48TE 576) is a late Shoshone encampment and produced three small side notched, basal notched points. One hearth was C-14 dated to less than 220 B.P. We suggest a date of ca. A.D. 1800. String Lake (48 TE 575) included one hearth; a C-14 sample was submitted, but the date has not been received. The Hunt site, just north of Wilson, showed considerable evidence of slope wash above a depth of ca. 20 cm. Below this charcoal was recovered in association with an obsidian biface. The lithics indicate that considerable tool preparation was done on the site. A C-14 sample will be submitted. Corridor 5 is adjacent to Soldier Meadow noted above. Tools and chipping debris were limited, but camas roasting pits were excavated. A C-14 sample has been submitted. Corridor 6 had no depth and no associated features. Excavation reports are now being prepared.

Last year we reported that several C-14 samples had been submitted. The resultant dates are: Two Ocean Lake 1 on the camas roasting pits, 320, 420, and 1840 radiocarbon years (these correct to A.D. 1520, 1430, and 175 respectively using the bristlecone pine correction); the firepit at Gros Ventre 1, 310 radiocarbon years (= corrected to A.D. 1580).

Research supported by National Park Service Contract No. CX-6000-5-0181 and Purchase Orders PX-6115-6-0122 and PX-12005-1081.

SEMINARS

June 10, 1976	"Avian Population Responses to Prescribed Burning in Sagebrush" John M. McGee Department of Zoology & Physiology The University of Wyoming
June 17, 1976	"Ecology and Population Trends of Trumpeter Swans in North America" Dr. Paul A. Johnsgard School of Life Sciences University of Nebraska, Lincoln
July 1, 1976	"EPA Sponsored Water Quality Research in Teton County" Sidney (Bo) Stuart Department of Microbiology Montana State University
July 8, 1976	"Five Needle Pines in the Jackson Hole Area" Dr. Alan Beetle Plant Science Division, College of Agriculture The University of Wyoming
July 15, 1976	"The Role of the Senses in the Hunting Coyote" Michael Wells Department of Zoology & Entomology Colorado State University
July 22, 1976	"Ecology of Beaver on the Snake River Floodplain" Tom Collins Department of Zoology & Physiology The University of Wyoming
July 29, 1976	"Coyote Conversations: Vocalizations of Canis Latrans" Dr. Philip Lehner Department of Zoology & Entomology Colorado State University
August 5, 1976	"What's Cooking Under Grand Teton and Yellowstone National Parks?" Dr. Robert Smith Department of Geology and Geophysics University of Utah
August 12, 1976	"Investigation of Regulatory Mechanisms in Pine Marten Populations" Dr. Tim W. Clark Department of Biology Idaho State University
August 19, 1976	"Pineal Organs and the Distribution of Animals" Dr. Charles L. Ralph, Department of Zoology & Entomology Colorado State University

FINANCIAL REPORT

1975-76

Item	Budgeted	Reappropriated from 1974-75	Total	Expended
Assistants, P/T	14,125.00		14,125.00	14,124.28
Contractual	1,146.00		1,146.00	1,146.00
Contractual/Repairs	500.00		500.00	496.12
Travel	468.00		468.00	468.00
Supplies	2,052.00		2,052.00	2,052.00
Equipment	1,119.00	33.48	1,152.48	1,152.48
Fixed Charges	100.00	72.00	172.00	72.00
	19,510.00	105.48	19,615.48	19,510.88

Rent received in the amount of $1,441.00 was placed in the General Fund of the University of Wyoming

Grants-in-aid totaling $1,235.00 were awarded to investigators by the New York Zoological Society.

1976-77

Item	Budgeted	Reappropriated from 1975-76	Total	Expended*
Personal Services	2,724.00		2,724.00	2,724.00
Assistants	11,401.00		11,401.00	5,539.12
Other Services & Charges	2,346.00		2,346.00	1,215.25
Supplies	3,052.00		3,052.00	2,375.78
Equipment	1,719.00	138.07	1,857.07	138.07
Rentals, Lease, etc.	100.00		100.00	-0-
Travel	868.00		868.00	-0-
	22,210.00	138.07	22,348.07	11,992.22

*Expended to date (2-1-77)

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and
New York Zoological Society

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