

A PRELIMINARY SURVEY ON BEAVER
(*Castor canadensis*) IN CANYONLANDS NATIONAL PARK, UTAH



Department of Wildlife Science

Utah State University

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IN CANYONLANDS NATIONAL PARK, UTAH

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ABSTRACT

The influx and dispersal of tamarisk (Tamarix pentandra) along the Green and Colorado River bottoms of Canyonlands National Park is rapidly replacing the willow, the primary food of beaver (Castor canadensis).

A survey was carried out during the fall of 1976 and spring of 1977 to estimate current abundance and distribution of beaver within the Park boundaries. Attempts were made to determine whether or not tamarisk was being utilized by beaver or affecting their use of the area.

A total of 105 beaver dens were located within the Park boundaries. Of these, 64 dens were active and 41 were inactive. Habitat factors at active and inactive dens were evaluated to determine possible reasons for den abandonment.

INTRODUCTION

Plant communities along the river bottoms of the Colorado and Green Rivers of Utah are rapidly changing. This change is due to increasing growth of tamarisk (Tamarix pentandra), a non-native invader plant from western Europe. Canyonlands National Park Service biologists have become concerned as this plant is replacing the willow (Salix sp.), a native plant of these river bottoms. This abrupt change in river bottom flora has an effect on the native fauna and is causing changes in animal populations which are not understood. One of the more favorable mammal species which is thought to be dependent on the willow is the beaver (Castor canadensis). With willow being replaced by tamarisk, it is vital to know whether or not the beaver can use tamarisk as a source of food, as this could have a great impact on their survival.

The purpose of this study is to see to what extent beaver are still surviving along the river bottoms of Canyonlands National Park. It is hoped that this preliminary survey will provide information which may lead to management of tamarisk and/or to future research projects relating to beaver and their food supply in this area.

The area of Utah in which Canyonlands National Park is located has a very unique ecology. This environment is changing, and the survival of the beaver in this area is dependent on the ability of the beaver to adapt to these changes.

Geographic location and physiography

Canyonlands National Park is located in southeastern Utah (Figure 1). The boundary of the Park encompasses 525 square miles in the heart of the Colorado Plateau. The Park is part of one of the six subdivisions of this plateau.

The topography is characterized by broad plateaus, deep canyons, buttes, alcoves, caves, natural bridges, and arches. Wind and water erosion has carved these many forms from the sandstone, which is so abundant throughout the Park.

The primary watersheds in Canyonlands National Park are the Green and Colorado River drainages. The Green and Colorado Rivers, small streams, and flash flooding in the multitude of dry washes aid in the erosion process.

Climate

Canyonlands National Park has a relatively semi-arid climate. Temperature information (Tables 1 and 2) and precipitation information (Table 3) was collected from two sites near the areas of the Colorado and Green Rivers examined during the beaver study.

Annual precipitation for Canyonlands National Park seldom exceeds ten inches. With a Park of this size, it is possible for one section to experience precipitation of ten inches per year while another remote section might receive less than five inches.

River hydrology

The Green and Colorado Rivers, which meander through and drain Canyonlands National Park, flow continuously throughout the year. The large volume of water carried by these rivers does not permit the

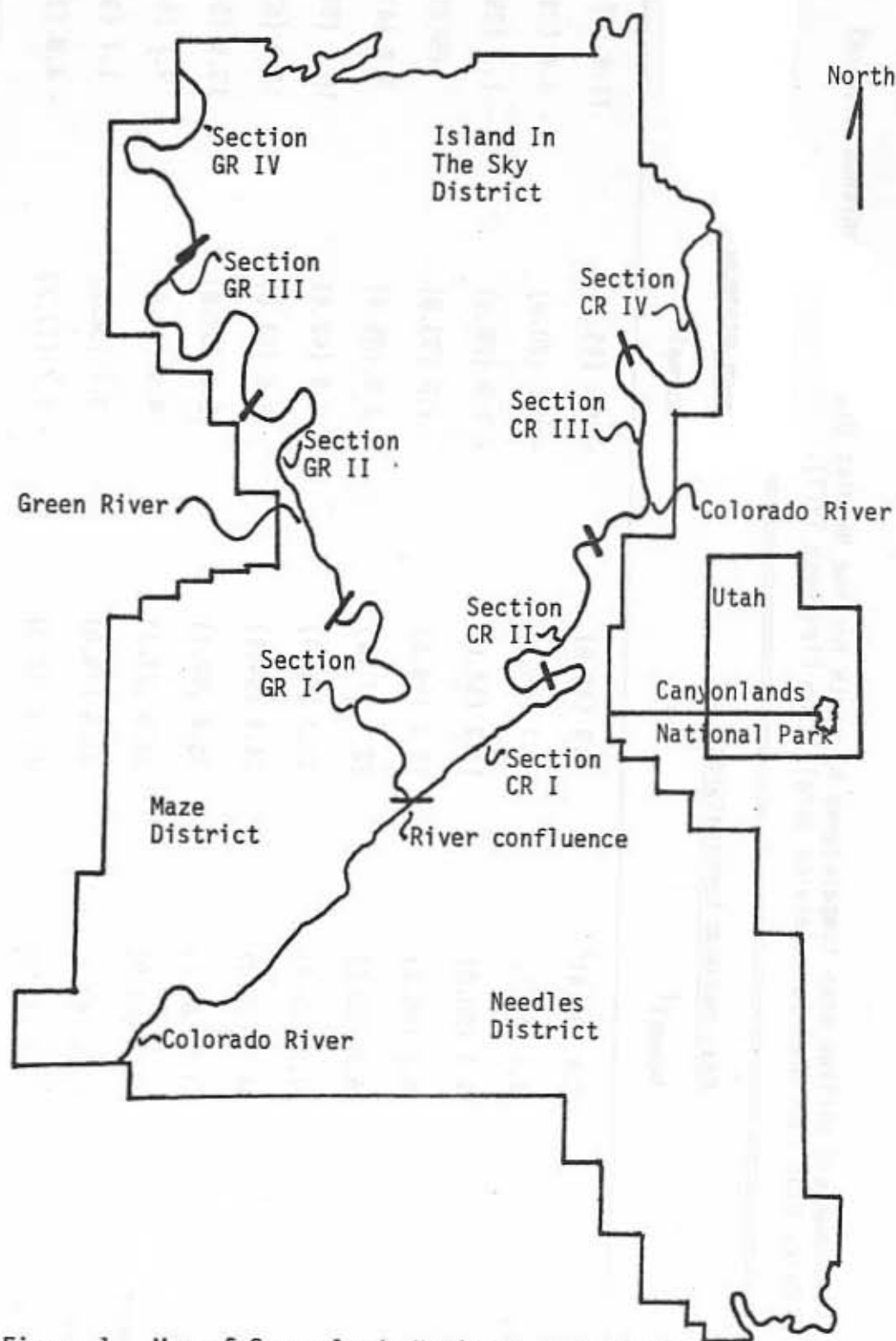


Figure 1. Map of Canyonlands National Park, Utah, showing area evaluated during beaver study.

Table 1. Maximum and minimum mean temperatures by month for the Needles District, Canyonlands National Park, Utah (National Park Service data) (From Clevenger 1977).

Month	Mean maximum temperatures (C°)		Mean minimum temperatures (C°)	
	Normal ¹	1975	Normal	1975
January	2.4 (36.4) ²	4.9 (40.8)	- 9.3 (15.3)	11.4 (52.5)
February	9.1 (48.3)	8.7 (46.7)	- 6.2 (20.9)	- 6.6 (20.1)
March	14.9 (58.8)	12.7 (54.8)	- 1.9 (28.5)	- 1.7 (29.0)
April	18.7 (65.6)	15.3 (59.5)	1.0 (33.8)	.28(32.5)
May	26.8 (80.2)	22.1 (71.7)	7.5 (45.4)	5.2 (41.3)
June	31.3 (88.4)	31.3 (88.4)	16.9 (62.4)	10.7 (51.3)
July	34.9 (94.9)	34.4 (94.1)	16.6 (61.8)	16.9 (62.4)
August	31.9 (89.4)	33.4 (92.1)	15.5 (59.8)	13.9 (57.0)
September	27.8 (82.0)	28.5 (83.3)	9.3 (48.8)	9.1 (48.4)
October	19.6 (67.3)	21.5 (70.8)	3.4 (38.2)	1.1 (34.0)
November	11.2 (52.2)	-11.3 (52.3)	- 2.7 (27.2)	- 4.8 (23.4)
December	----	----	----	----

¹1968-1974

²Values in parenthesis expresses in degree fahrenheit

Table 2. Maximum and minimum mean temperatures by month for the Island in the Sky District, Canyonlands National Park, Utah (National Park Service data) (From Clevenger 1977).

Month	Mean maximum temperatures (C°)		Mean minimum temperatures (C°)	
	Normal ¹	1975	Normal ¹	1975
January	2.6 (36.6) ²	1.6 (34.8)	- 6.7 (19.9)	- 8.1 (17.5)
February	10.7 (51.2)	5.3 (41.6)	- 3.2 (26.2)	- 3.7 (25.3)
March	11.9 (53.5)	10.1 (50.1)	.17(32.3)	- .8 (30.5)
April	16.1 (60.9)	13.5 (56.4)	2.9 (37.4)	.83(33.5)
May	24.2 (75.5)	20.2 (68.3)	10.5 (50.9)	6.9 (44.5)
June	30.0 (86.0)	27.0 (80.6)	14.9 (58.8)	12.7 (54.9)
July	32.2 (89.9)	32.2 (89.9)	18.1 (64.6)	18.6 (65.5)
August				
September	25.3 (77.5)	26.1 (79.1)	12.2 (53.9)	12.9 (55.3)
October	16.6 (61.9)	19.7 (67.5)	5.9 (42.5)	6.0 (42.8)
November	8.6 (47.5)	13.0 (55.4)	- .67(30.8)	- 2.6 (27.3)
December	2.6 (36.6)	2.2 (36.0)	- 6.1 (21.1)	- 6.1 (21.1)

¹1968-1974

²Values in parenthesis expressed in degrees fahrenheit

Table 3. Monthly precipitation for Island in the Sky and Needles Districts, Canyonlands National Park, Utah (1975 National Park Service data) (From Clevenger 1977)

Month	Precipitation ¹	
	Island in the Sky District	Needles District
January	2.5 ³ (100.0)	1.8 (72.0)
February	8.2 (90.2)	9.9 (89.9)
March	3.3 (89.4)	30.0 (84.7)
April	17.6 (0.86)	40.1 (62.1)
May	7.8 (65.4)	1.9 (00.0)
June	1.3 (00.0)	.7 (00.0)
July	7.3 (00.0)	3.9 (00.0)
August	.2 (00.0)	.1 (00.0)
September	.8 (00.0)	.8 (00.0)
October	16.8 (90.0)	1.2 (00.0)
November	20.4 (93.6)	7.3 (79.5)
December	-----	-----

¹ Snowfall expressed in parenthesis as percent of total precipitation

² Snowfall data not available

³ Data expresses in centimeters

beaver to engage in dam or lodge building. Subsequently, beaver in this area must burrow into the river banks if they are to survive and reproduce.

The volume of water which passes down either river may vary at different times of the year. Also, the beaver burrow site selection may be related to the rate of water flow in a given area. Beaver in the study area did not burrow into the river banks where fast water or small rapids were found.

Subsequent rise and fall of water level caused by varying volumes of flow may also erode the banks of each river. This effect would vary according to the actual vertical distances that the water level fluctuated in a given time period. Likewise, narrower sections of the river experience a greater vertical variance than wider sections with an increase in volume of flow. Tables 4 and 5 give water flow examples.

Flora

The plants of Canyonlands National Park endure drought, heat, and infrequent rains. Many of these plants are ephemeral in nature and can complete their life cycle in a brief period of abundant moisture. Except where abundant water is available, the plants are widely spaced.

The Green and Colorado River bottoms have about the same plant species, although the amounts may be different. A definite pattern of plant zones has developed along both river banks over the years. Starting at the river and moving inland, tamarisk is very common. Tamarisk may form an almost impenetrable thicket along the river banks. Peachleaf willow (Salix amygdaloides) and sandbar willow (S. exigua) are next to the river on occasion if the tamarisk has not edged them out. Three square rush (Scirpus americanus) may be found along the river

Table 4. Discharge, in cubic feet per second, for the calendar year 1974. (Mean values) Colorado River data from U. S. Geological Survey reports.

Day	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	5,070	5,500	5,350	6,110	10,800	18,400	8,700	3,440	1,820	2,890	4,240	4,020
2	4,620	5,400	6,330	6,650	11,000	16,500	7,690	3,250	1,920	2,870	4,260	3,580
3	4,610	5,100	8,600	6,370	12,300	14,700	6,980	3,100	2,010	2,900	4,460	3,500
4	4,370	5,100	7,670	5,830	13,000	13,700	5,830	3,100	1,990	2,920	4,490	3,730
5	4,220	5,000	6,310	5,090	14,500	12,500	5,320	3,120	2,020	3,010	4,200	4,160
6	4,620	5,400	5,860	4,630	15,000	12,100	4,730	3,000	2,060	3,060	4,620	4,260
7	4,800	5,500	5,870	4,550	15,800	12,800	5,100	2,900	2,140	3,020	4,550	4,270
8	5,310	5,400	6,050	4,670	17,100	12,000	5,150	2,900	2,180	3,100	4,770	4,490
9	5,420	5,000	6,030	4,360	18,900	11,100	4,800	2,900	2,150	3,140	4,810	3,670
10	5,580	5,200	6,200	4,210	22,000	10,600	4,000	3,100	2,180	3,090	4,740	3,190
11	5,420	5,000	6,340	4,220	24,400	9,810	3,930	3,800	2,120	3,080	4,420	3,630
12	5,390	5,100	6,210	4,190	24,700	9,380	3,880	3,680	2,150	3,130	4,490	3,360
13	5,610	5,400	6,050	3,920	23,700	9,700	3,660	3,400	2,210	3,240	4,450	3,790
14	5,410	5,400	5,780	3,940	23,200	10,900	3,410	3,100	2,360	3,420	4,240	3,820
15	5,360	5,400	5,310	3,970	19,500	12,000	3,340	2,800	2,630	3,480	4,380	3,860
16	5,760	5,390	5,370	3,820	16,500	13,200	3,460	2,500	3,110	3,490	4,460	3,750
17	5,500	5,500	5,560	3,740	16,300	13,600	3,550	2,300	3,540	3,480	4,300	3,430
18	5,180	5,540	5,940	4,030	17,900	14,100	4,280	2,300	3,560	3,410	4,200	3,940
19	5,370	5,560	6,160	4,760	17,100	13,900	5,900	2,250	3,510	3,380	3,980	3,980
20	5,320	5,580	6,430	5,680	17,100	14,500	6,030	2,200	3,430	3,320	4,260	4,040
21	5,610	5,580	6,480	5,810	17,000	14,300	5,600	2,160	3,360	3,290	4,240	3,980
22	5,320	5,500	5,940	5,500	15,000	13,900	5,490	2,090	3,250	3,250	4,230	3,920
23	5,090	5,400	5,600	5,530	13,000	13,800	6,080	2,280	3,220	3,400	4,410	3,650
24	5,070	5,380	5,180	5,710	11,800	13,000	6,620	2,040	3,210	3,770	4,330	3,140
25	4,650	5,080	5,350	6,740	11,700	12,400	6,450	2,020	3,030	3,570	4,380	3,520
26	4,720	4,870	5,080	8,530	11,700	11,700	5,920	1,980	2,900	3,530	4,000	3,400
27	4,590	4,880	4,840	11,900	12,500	11,200	5,110	1,970	2,920	3,600	4,360	2,480
28	4,280	5,110	5,010	13,400	14,900	10,800	4,650	1,930	2,850	3,930	4,410	3,050
29	4,000	-----	5,390	12,400	17,100	10,400	4,310	1,830	2,870	3,960	4,260	3,550
30	5,400	-----	5,440	11,900	18,100	9,580	4,230	1,880	2,890	3,990	3,590	3,550
31	5,400	-----	5,470	-----	18,800	-----	3,820	1,800	-----	4,060	-----	3,180
Total	157,070	148,270	183,190	182,160	512,420	376,570	158,020	81,020	79,600	103,780	130,530	113,880
Mean	5,067	5,295	5,909	6,072	16,530	12,550	5,097	2,614	2,653	3,348	4,351	3,674
Max	5,760	5,580	8,600	13,400	24,700	18,400	8,700	3,800	3,560	4,060	4,810	4,490
Min	4,000	4,870	4,840	3,740	10,800	9,380	3,340	1,800	1,820	2,870	3,590	2,480
AC-FT	311,500	294,100	363,400	361,300	1,016M	746,900	313,400	160,700	157,900	205,800	258,900	225,900
CAL YR 1974	Total	2,226,490	Mean	6,100	Max	24,700	Min	1,800	AC-FT	4,416,000		

Table 5. Discharge, in cubic feet per second, for the calendar year 1974. (Mean values) Green River data from U. S. Geological Survey reports.

Day	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	4,070	2,500	2,510	3,810	18,400	20,800	8,570	3,060	2,740	1,880	4,570	3,630
2	3,960	2,660	2,440	4,390	14,700	20,900	8,050	2,840	2,550	1,900	4,840	3,030
3	3,120	2,740	2,760	4,690	13,200	20,500	7,440	2,720	2,080	2,110	5,030	2,930
4	2,600	2,700	2,870	4,870	13,100	18,700	5,980	2,680	2,330	2,920	4,860	3,370
5	2,030	2,800	3,060	5,320	15,100	17,400	6,260	2,570	2,390	3,290	5,110	3,250
6	3,140	2,840	3,670	5,500	16,000	17,000	6,340	2,910	2,340	3,050	4,800	3,310
7	4,760	2,820	3,840	4,930	15,300	16,600	5,500	3,940	2,240	3,000	4,050	3,410
8	5,360	2,720	4,220	4,390	16,700	16,100	4,620	3,860	2,100	3,370	4,100	3,650
9	6,090	2,720	5,150	4,000	19,500	18,400	4,340	4,110	2,240	3,510	4,250	3,700
10	6,080	2,640	5,680	3,910	21,200	20,400	4,310	4,060	3,020	3,370	4,030	3,760
11	6,030	2,620	5,600	3,710	23,100	17,800	3,710	3,430	3,470	3,180	4,270	3,610
12	6,600	2,570	5,560	3,750	25,000	15,500	4,030	3,250	3,380	3,620	4,090	3,210
13	6,530	2,520	5,740	3,870	25,900	14,600	4,170	3,240	3,430	3,650	4,040	2,500
14	5,170	2,480	6,200	3,760	26,800	13,800	4,060	3,360	3,850	3,630	3,850	3,190
15	3,710	2,570	7,460	4,300	26,600	13,400	3,640	3,190	4,210	3,600	3,660	3,040
16	3,740	2,640	7,850	5,940	23,700	13,200	3,260	3,160	3,910	3,620	3,700	3,460
17	3,360	2,770	6,710	5,900	20,500	13,600	3,340	3,090	3,820	3,600	3,620	3,460
18	3,260	2,800	6,050	4,970	18,500	13,600	3,230	2,910	3,740	3,570	3,670	3,600
19	3,390	2,740	5,960	4,660	19,500	13,400	3,570	3,110	3,510	3,550	3,560	3,460
20	3,200	2,600	5,590	4,390	20,400	14,400	3,450	3,080	3,460	4,160	3,570	3,480
21	3,020	2,840	5,420	4,390	21,000	15,300	3,620	3,090	3,620	4,250	3,350	4,130
22	3,050	2,840	5,710	4,780	21,200	14,900	2,440	2,970	3,480	4,540	3,350	4,300
23	2,870	2,970	5,880	6,260	21,600	14,100	2,590	2,600	3,480	4,210	3,530	4,190
24	2,730	2,820	5,820	8,040	19,600	13,300	3,970	3,150	2,900	4,050	3,770	3,470
25	2,510	2,800	5,280	7,850	16,600	12,300	3,600	3,050	2,400	4,110	3,740	3,130
26	2,460	2,700	4,710	7,330	15,400	11,100	3,400	3,120	2,130	4,550	3,400	1,990
27	2,570	2,750	4,320	7,560	15,000	10,000	3,780	3,000	1,920	4,570	3,260	1,640
28	2,660	2,610	4,040	9,970	15,200	10,100	4,020	3,090	2,520	4,490	3,020	1,540
29	3,170	-----	3,860	14,600	16,800	9,520	3,550	2,980	2,050	5,720	2,690	3,690
30	2,670	-----	3,680	17,900	18,600	9,040	3,330	2,560	1,900	5,680	3,650	4,860
31	2,550	-----	3,670	-----	20,200	-----	3,300	2,810	-----	4,570	-----	2,970
Total	116,460	75,780	151,310	179,740	594,406	449,760	135,470	96,990	87,270	115,320	117,480	103,260
Mean	3,757	2,706	4,881	5,991	19,170	14,990	4,370	3,129	2,909	3,720	3,916	3,331
Max	6,600	2,970	7,850	17,900	26,800	20,900	8,570	4,110	4,210	5,720	5,110	4,860
Min	2,030	2,480	2,440	3,710	13,100	9,040	2,440	2,560	1,900	1,880	2,690	1,540
AC-FT	231,000	150,300	300,100	356,500	1,179M	892,100	288,700	192,400	173,100	228,700	233,000	204,800
CAL YR 1974	Total	2,223,240	Mean	6,091	Max	26,800	Min	1,540	AC-FT	4,410,000		

banks with new tamarisk. Beyond the willow and tamarisk, Fremont cottonwood (Populus fremontii) establishes itself.

Reedgrass (Phragmites communis) becomes prominent on the alluvial plain. On intermediate slopes, rabbitbrush (Chrysothamnus nauseosus gravealens) and blackbrush (Coleogyne ramosissima) are found. The steeper canyon slope is inhabited by saltbrush (Atriplex sp.), ephedra (Ephedra sp.), and prickly pear (Opuntia polyacantha). Although there are a multitude of other plant species present in the park, those noted above are most apparent.

Fauna

Several large herbivores inhabit Canyonlands National Park. These include mule deer (Odocoileus hemionus), pronghorn (Antilocapra americana), and bighorn sheep (Ovis canadensis). Smaller herbivores such as beaver (Castor canadensis), porcupine (Erethizon dorsatum), black-tailed jackrabbit (Lepus californicus), desert cottontail (Sylvilagus audubonii), Nuttall cottontail (Sylvilagus nuttallii), and various species of squirrels, chipmunks, prairie dogs, gophers, mice, and rats are distributed throughout the Park.

Small predators of the Park include such animals as Merriam's shrew (Sorex merriami), desert shrew (Notiosorex crawfordi), ringtailed cats (Bassariscus astutus), badger (Taxidea taxus), striped skunk (Mephitis mephitis), and the spotted skunk (Spilogale putoris). The red fox (Vulpes vulpes) and the gray fox (Urocyon cinereoargenteus) are also found here. Large carnivores include the coyote (Canis latrans), the bobcat (Lynx rufus), and the mountain lion (Felis concolor).

Raptors of this area include golden eagles (Aquila chrysaetos), bald eagles (Haliaeetus leucocephalus), great horned owls (Bubo virginianus), and numerous other species of hawks, falcons, and owls.

A great number of other bird species utilize the diverse habitat offered by the Park. Many are common summer residents but migrate in the fall. There are great numbers of transient birds, especially waterfowl. Bird checklists for the area are maintained by the National Park Service in Moab.

REVIEW OF LITERATURE

Two areas of literature were reviewed in relation to information collected in the field. These areas centered around habits, habitat, and especially food habits of beaver; and around characteristics and expansion rate of tamarisk.

Though the exact structure of beaver colonies is not known, Haas (1943) suggested that a colony be defined as a group of beavers that occupy a series of structures or a stretch of a stream in common. Haas also states that within a colony, beaver may or may not all live within the same burrow or den, and that several beaver may constitute one or more families.

Jenkins (1975) infers that beaver may utilize many types of vegetation (aquatic plants, grasses, forbs, ferns, shrubs, trees), many species of each of these types, and many different parts of some of these types (flowers, leaves, rhizomes of aquatic plants; bark, twigs, leaves of woody plants). He also feels they may be selective within each category of plants used and that availability comes to play an important role. Haas (1943) says the principle woody food of Utah beaver is willow and adds that they have been known to take almost every kind of plant. Hilfiker (1968) goes on further to say that there is no American plant so hard, so bitter, or so gummy that beavers will not eat and digest it. This would indicate that tamarisk could be utilized as food, which is an important issue in this report.

Experiments by the California Fish and Game Department on the management of Colorado River beaver establish that tamarisk, as well

as cattail (Typha latifolia), tule (Scirpus acutus), willow, cottonwood (Populus fremontii), arrowweed (Pluchea sericea), and water wally (Baccharis glutinosa) are utilized as food sources. Hensley (1948) indicates that beaver along the Colorado River at Lee's Ferry in Arizona cut and store tamarisk in food piles. Realizing that streamside habitat for the Colorado River in California and Arizona is somewhat identical to that found in southern Utah might indicate that the Utah beaver may also be utilizing tamarisk as a food source.

Reports show tamarisk to have spread from the south up the Colorado River in a northerly direction. There are no records of tamarisk on the Green of Colorado Rivers prior to 1925 (Christensen 1962). Christensen suggests that from 1925 to 1960 was a period of rapid spread and increased importance of tamarisk for this area. He noted that from 1935 to 1955 invasion was at its greatest degree. Early explorers who kept records on fauna and flora while traveling the Green and Colorado Rivers did not list tamarisk as being present (Bishop 1871-72; Darrah 1947a, b, c, d; Dellenbaugh 1926; Kelley 1947; W. H. Powell 1869; J. W. Powell 1875). Christensen (1962) presents an outline (Table 6) of expansion relating dates to tamarisk presence. His information came from reports from researchers such as Woodbury and Russell (1945) who described thickets along the streamside of the Colorado River in southern Utah. Their study encompassed the area near the mouth of San Juan River during the period of 1933-1938. Tamarisk was listed along with willow. Clover and Jotter (1944) also stated that tamarisk was reported as growing the entire length of the study area when they made floristic studies of

Table 6. Tamarisk range expansion along the Colorado and Green Rivers of Utah from 1776 to 1977. Table is a modification of information presented by Christensen (1962).

Date	Tamarisk in streamside vegetation	
	Colorado River	Green River
1776	Not recorded	Not recorded
1829	Not recorded	Not recorded
1869-72	Not recorded	Not recorded
1911	Not recorded	Not recorded
1925	Recorded on tributary of Colorado River (Virgin River, Nev.)	Not recorded
1933-39	Prominent	Present
1957-61	Second most important species	Widespread
1977	Most abundant species	Widespread

the Colorado Canyon and its tributaries from Green River, Utah, to Boulder Dam, Nevada, during 1938-39.

Woodbury et al. (1959), after studying Glen Canyon of the Colorado River, states:

"There are many areas of heavy cover of willow in which tamarisk has not so far established a foothold, but there are many other areas in which willow cover has been broken and tamarisk has occupied sites that are normal habitat for the willow. Where the two grow together, willow usually occupies muddier areas, while tamarisk occupies sandy areas."

It would appear that competition tends to restrict willows more and more to muddier banks and yield sandy areas to tamarisk. Most areas readily accessible to beaver are sandy, and these areas are steadily becoming dominated by tamarisk. Subsequent diminish of accessible willow will eventually bring about a change in food selection of southern Utah beaver, as well as a pronounced effect on the stream-side ecosystem of Utah's Green and Colorado Rivers.

OBJECTIVES

This preliminary survey on beaver was designed with the following objectives:

1. Survey beaver distribution and general abundance along the river bottom in Canyonlands National Park, Utah.
2. Examine relative abundance of beaver along the Green and Colorado River bottoms in Canyonlands National Park, Utah.
3. Make a brief analysis of tamarisk and willow utilization for beaver wherever possible.

METHODS

This survey was made by utilizing a 14-foot aluminum boat equipped with a 25-horsepower motor. The area studied included the river banks along the Green River from the northern boundary of Canyonlands National Park downstream to the confluence with the Colorado River. The second area studied extended from the Green River-Colorado River confluence upstream along the Colorado River to the Park boundary on the east. This survey included approximately 47 miles of the Green River shoreline and 31 miles of the Colorado River shoreline.

Data sheets were completed on each den sighting. Tributary information, date, weather, county, and other location information was recorded for each site. River description was recorded as width and fast or slow current. Den description included active status, house material, facing direction, distance from water, vertical distance from high water, vertical distance from present water level, size of den opening, and bank material. Bank vegetation was recorded in percentage terms within 100 yards of each den site. Feeding indications and any actual beaver sightings were also recorded. Additional comments were noted when pertinent material presented itself.

The classification of each den as to active or inactive status was made by using the following criteria:

Active den:

1. Burrow sides smooth, hair sometimes present along burrow walls.

2. An open burrow without cobwebs, roots, or other materials blocking entrance.
3. Beaver tracks present in burrow.
4. Recently cut vegetation near burrow entrance.
5. Presence of well-worn path and/or slide near burrow entrance.
6. Beaver sighted at burrow.

Inactive den:

1. Burrow deteriorating (erosion of top or sides).
2. Burrow overgrown with roots, covered with cobwebs, or filled with debris.
3. No physical signs of beaver in vicinity (tracks or slides).
4. No recent vegetation cuttings near burrow.

RESULTS

A total of 105 beaver bank dens were recorded for the Green and Colorado Rivers from their confluence upstream to the boundaries of Canyonlands National Park. This included 64 active bank dens and 41 inactive bank dens (Table 7).

Analysis of beaver activity on the Green River

There were 56 beaver bank dens located on the Green River. Active dens made up 44 of these dens, while inactive dens made up the remaining 12.

The individual sections on the Green River (Figure 1) showed a wide degree of variation in beaver activity. Active dens ranged from a low of 3 in section GR I (nearest the confluence), to a high of 25 in section GR IV (located farthest from the confluence). Expressed as active dens per mile, a range of 0.25 to 2.13 respectively was found. Values for sections GR II and GR III fell within these limits. Section GR IV was the most active section in relation to current beaver activity on the Green River. The number of active dens per section and the percentage of the Park's active beaver dens for section GR IV is not surpassed by any section on the Colorado River (Table 7).

The study sections on the Green River contained between 0.8 and 18.5 beaver per mile (Table 8). Although the actual number of beaver in a given section of river could not be determined in a survey of this nature, information taken from Payne (1975) gives information

Table 7. Active and inactive beaver bank dens along the Colorado and Green Rivers within Canyonlands National Park, Utah, 1976.

Section	Active beaver dens	Percent active dens	Active dens per mile	Inactive beaver dens	Percent inactive dens	Inactive dens per mile	Total dens	Percent of total river dens	Total dens per mile
<u>Green River</u>									
GR I	3	7	.25	0	0	0	3	5	.25
GR II	4	9	.34	1	8	.09	5	9	.43
GR III	12	27	1.02	6	50	.51	18	32	1.54
GR IV	25	57	2.13	5	42	.42	30	54	2.56
<u>Colorado River</u>									
CR I	3	15	.38	7	24	.91	10	20	1.30
CR II	2	10	.26	4	14	.52	6	12	.78
CR III	4	20	.51	10	34	1.30	14	29	1.82
CR IV	11	55	1.43	8	28	1.04	19	39	2.50

Table 8. Estimated minimum, maximum, and average number of beaver per section and per mile for the Green and Colorado Rivers in Canyonlands National Park, Utah, 1976.

Section	Minimum beaver per section	Minimum beaver per mile	Maximum beaver per section	Maximum beaver per mile	Average beaver per section	Average beaver per mile
<u>Green River</u>						
GR I	9.6	0.8	26.1	2.2	16.4	1.4
GR II	12.8	1.1	34.8	3.0	21.8	1.9
GR III	38.4	3.3	104.4	8.9	65.5	5.6
GR IV	80.0	6.8	217.5	18.5	136.5	11.6
<u>Colorado River</u>						
CR I	9.6	1.2	26.1	3.3	16.4	2.1
CR II	6.4	0.8	17.4	2.3	10.9	1.4
CR III	12.8	1.6	34.8	4.4	21.8	2.8
CR IV	35.2	4.6	95.7	12.4	60.1	7.8

from 28 authors relating to the relative number of beaver per den. This information was used to develop the information in Table 8. Actual beaver per section ranged from 9.6 to 217.5 beaver per section. Since these values were derived by using the active burrows, they reflect the low and high figures for sections CR I and CR IV, respectively.

Inactive dens on the Green River (Table 3) ranged from 0 for section GR I, to 6 for section GR III. Half of the Green River's inactive dens were found in section GR III. No definite reasons were established in relation to beaver den abandonment. The highest number of dens (30) per section was found on the Green River in section GR IV. This figure includes active and inactive sites. Section GR IV has the greatest amount of the total beaver dens in the Park. Because this section has the highest amount of beaver activity, certain assumptions might be made. These assumptions are as follows:

1. This section may contain more suitable niches for beaver, and subsequently, a higher degree of occupation by beaver.
2. This sampling area may also contain a greater amount of beaver food than the other sections surveyed.
3. This area may be preferred by beaver since it satisfies their individual preferences (width, water flow, water fluctuation, etc.).

The lowest number of bank dens for any section on the Green River was found in section GR I. A total of 3 bank dens was found in this section. All of these were active dens.

The distribution of the Colorado and Green River beaver populations in Canyonlands National Park, shows that beaver numbers increase as the distance is increased upstream from the confluence. Therefore, the

lowest beaver densities are found in sections CR I and GR I, and the highest in sections CR IV and GR IV.

Numerically, the Green River in Canyonlands National Park may be supporting a minimum number of 140 beaver along about 47 miles of river. The maximum number of beaver which would theoretically be along the river would be 382.

Analysis of beaver activity on the Colorado River

A total of 49 beaver burrows were located on the Colorado River. Of these, 20 dens were active and 29 were inactive (Table 7).

Active dens ranged from a low of 2 for section CR II, to a high of 11 for section CR IV. Section CR IV contained the highest amount of beaver activity on the Colorado River. Activity in this section was still lower than sections GR III and GR IV of the Green River.

Beaver densities for the Colorado River were estimated to be from 0.8 to 12.4 for beaver per mile, and from 6.4 to 95.7 for beaver per section (Table 8).

A greater percentage of the inactive dens were found along the Colorado River. Inactive dens for this survey are abandoned for reasons not yet established. The habitat is essentially the same for both rivers, although it is assumed that the Colorado River is being utilized to a greater extent by man.

Section CR IV has the largest number of active dens of any section along the Colorado River. This section of the Colorado River is second only to the Green River's section GR IV for active dens. The lowest total number of dens for any section on the Colorado River was 6 in section CR II.

In theoretical beaver numbers, the Colorado River could be supporting a minimum number of 64 beaver in 31 miles of river. The maximum theoretical value for the Colorado River would be 174 beaver living along the river from the confluence of the Green and Colorado Rivers upstream to the Park's boundary (Table 8).

Fourteen beaver were sighted during the survey. This low number of sightings is thought to be due to the daytime survey and the use of an outboard motor.

Burrow data analysis

Various parameters were examined at each beaver burrow. The amount of bank vegetation was a primary concern, especially tamarisk, in the vicinity of each burrow. A greater majority of the burrows had willow as the main plant species within their hundred yard range (Table 9). This was similar for both active and inactive sites.

Most of the active beaver dens along the Colorado and Green Rivers faced eastward (Figure 2). This is probably due to a greater amount of habitat facing this direction (rivers flowing south to southwest). The beaver apparently prefer the sunny bank whether it faces east or south. Most burrow openings were about 18 inches in diameter.

The majority of active dens examined were at about water level in the fall of 1976 (Figure 3). Old water marks on rocks, debris along banks, and other erosion marks on the bank suggested that both the Green and Colorado Rivers were approximately two feet below high water level. During the fall survey, the actual volume of water flowing down the Green River was about 3,335 cfs. At this time, the Colorado River was flowing at about 3,640 cfs. Tables 4 and 5 show these values

Table 9. Vegetation surrounding active and inactive beaver dens along the Green and Colorado Rivers of Canyonlands National Park, Utah (1976).

	Percent willow	Percent tamarisk	Percent reedgrass	Percent cottonwood
<u>Green River</u>				
Active dens	60	22	18	0
Inactive dens	71	25	4	0
<u>Colorado River</u>				
Active dens	57	32	6	5
Inactive dens	67	18	8	7

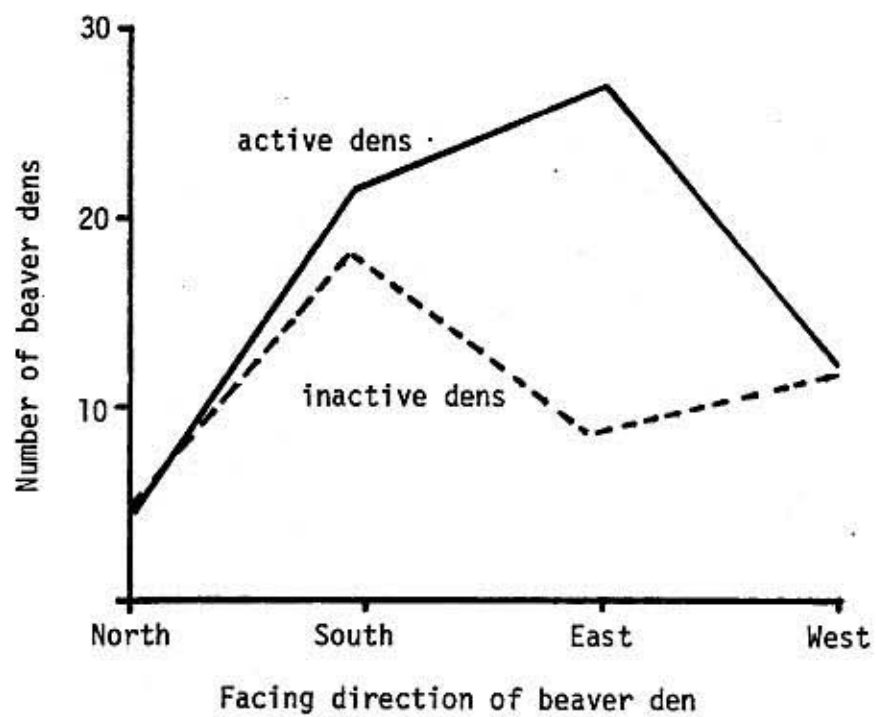


Figure 2. Facing direction of beaver dens on the Green and Colorado Rivers in Canyonlands National Park, Utah (1976).

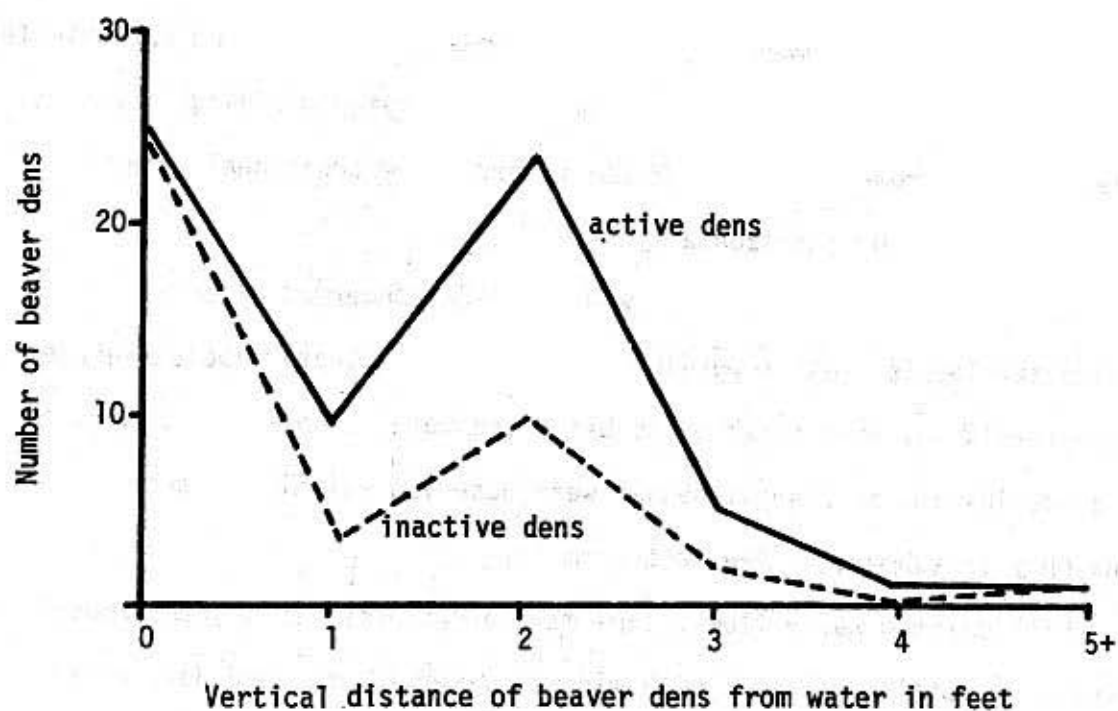


Figure 3. Vertical distance in feet from beaver den openings to water level at time of survey on the Green and Colorado Rivers, Canyonlands National Park, Utah (1976).

to be below the yearly and most of the monthly averages for each river. Also, the long range average daily discharge for both rivers was well above the discharge rate during the 1976 survey.

With most of the beaver burrows at about the 1976 fall water level, a rise to the average discharge or to a higher water level would bring about submergence of most of the burrows. Figure 4 shows this to be the situation, with a majority of the burrows being submerged approximately two feet. Fluctuation in water level due to varying discharge rates is greater for narrower sections of the rivers where additional water could not spread out horizontally.

Few burrows were found that would not be submerged or be at high water levels. It is possible that burrows situated above average water levels may have other exits below the water. This was thought to be a possibility as several beaver were observed swimming toward the bank only to submerge a few feet from it.

With maximum water flows, dens may be subjected to a great amount of erosion or washing action. With minimum water flows, more dens would be exposed, and beaver would probably be subject to increased predation. The beaver dens examined during this study were located on steep banks close to the water (Figure 5).

The width of the river was estimated at each beaver den. Figure 6 shows that most burrows, active and inactive, were situated where the rivers were approximately 80 yards wide. This value probably equals the average width of both the Green and Colorado Rivers. Also, beaver may utilize these areas more due to the lower water level fluctuations experienced at maximum and minimum discharge.

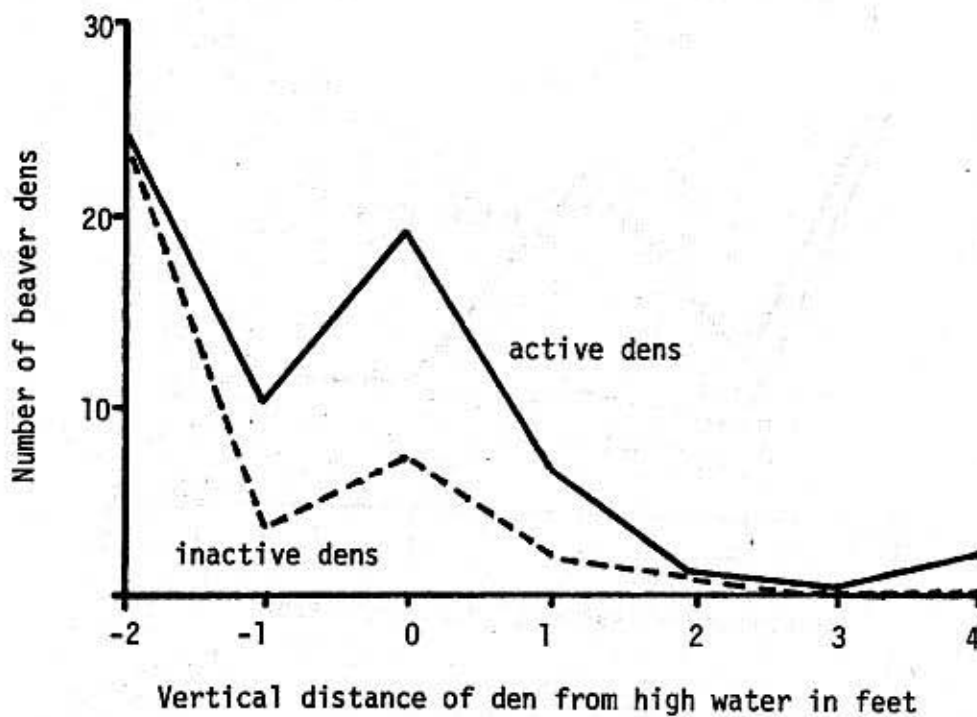


Figure 4. Vertical distance in feet from beaver den openings to estimated high water level on the Green and Colorado Rivers, Canyonlands National Park, Utah (1976).

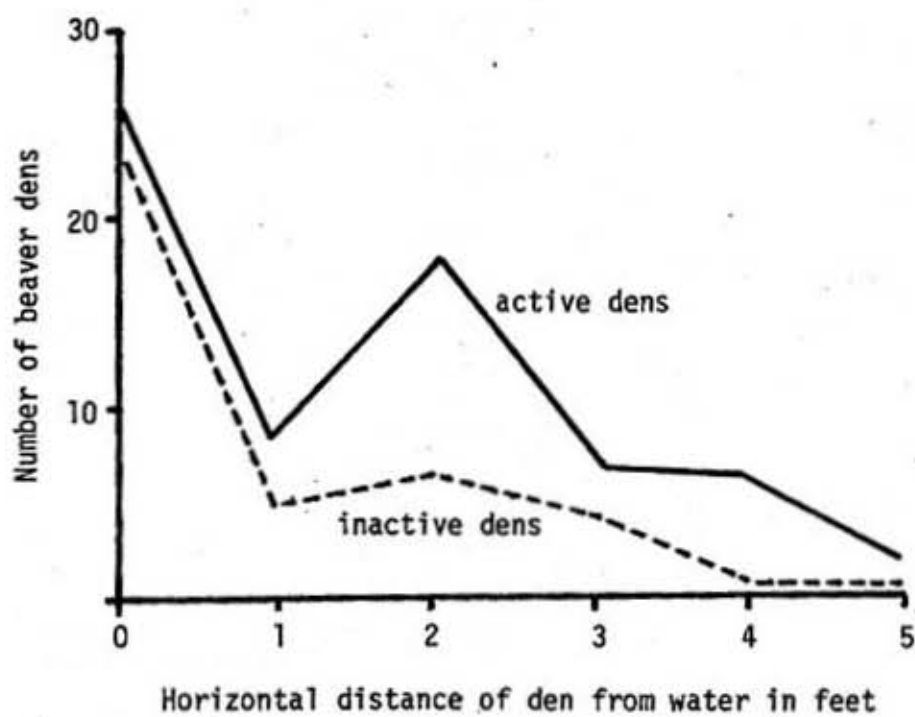


Figure 5. Horizontal distance in feet from beaver den openings to water level on the Green and Colorado Rivers in Canyonlands National Park, Utah (1976).

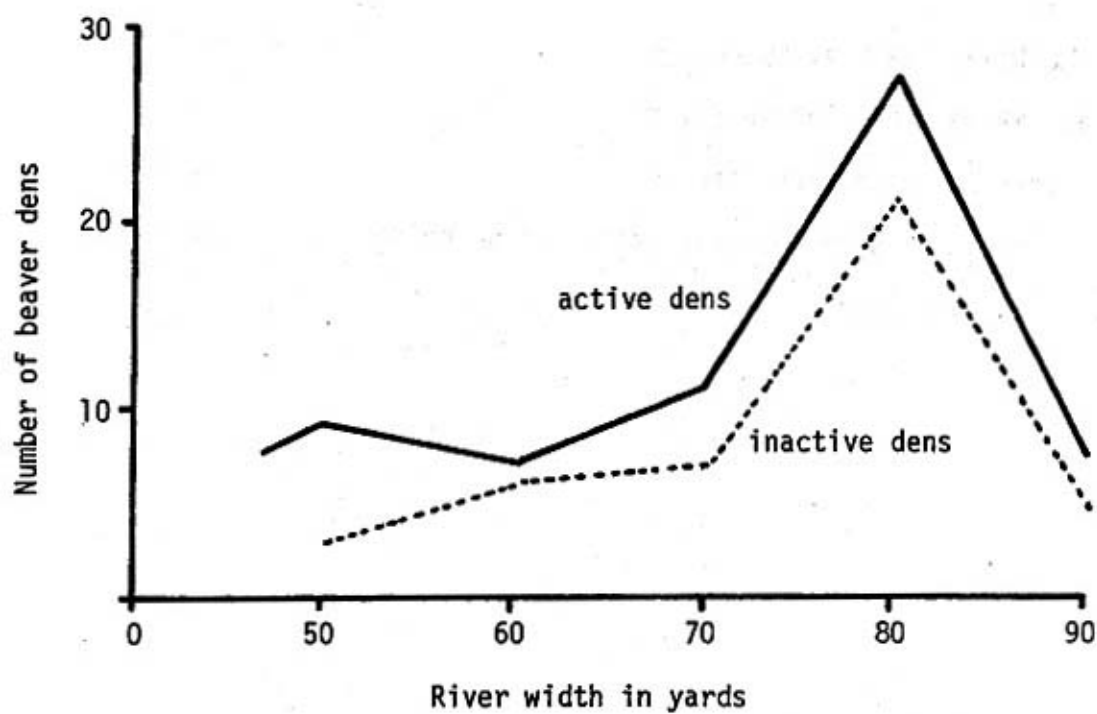


Figure 6. River width in relation to beaver dens located along the Green and Colorado Rivers in Canyonlands National Park, Utah (1976).

Vegatation utilization

Efforts were made to establish what beaver were utilizing as food. Willow was found to have been used extensively along both the Green and Colorado Rivers. It was often seen in food piles outside of the dens, cut and scattered along sandbars, and floating in both rivers. Much of the willow had been stripped of its bark, evidence of beaver feeding.

Cottonwood was being cut in several areas along the Green River, but not along the Colorado River.

Tamarisk was not utilized by beaver of this area. It is possible that it might be used in their dens, but no evidence of tamarisk utilization was found.

SUMMARY

1. A total of 56 beaver dens were located along the banks of the Green River, within the boundaries of Canyonlands National Park. This was made up of 44 active dens and 12 inactive dens.
2. Along the banks of the Colorado River within the boundaries of Canyonlands National Park, 49 beaver dens were located. Of this total, 20 dens were active and 29 dens were inactive.
3. Beaver dens were more numerous upstream from the confluence of the Green and Colorado Rivers toward the Park boundaries of Canyonlands National Park.
4. Willow was the dominant vegetative type found near beaver dens along the Colorado and Green Rivers in the Park.
5. No utilization of tamarisk by beaver was observed along the Green or Colorado Rivers in the Park.
6. Most dens were located about 2 feet from the high water mark, in banks against the river (less than 2 feet away), where the river was about 80 yards wide, the exposure was to the south or east in the Park and were about 18 inches in diameter.

RECOMMENDATIONS

1. That an examination of beaver river bank dens in Canyonlands National Park be made. This will be done during the summer of 1977.
2. That another survey be made at a future date in Canyonlands to help establish a trend relating to total number of beaver dens in this area and the percent of the dens that are active.
3. Records of tamarisk utilization by beaver should be kept. This may be especially important if the tamarisk continues to crowd out willow along the Colorado and Green River banks.
4. If the actual number of beaver inside Park boundaries is to be determined, an intensive trapping study should be initiated to determine the number of beaver per den and other life history parameters.

LITERATURE CITED

- Baars, D. L., and C. M. Molenaar. 1971. Geology of Canyonlands and Cataract Canyon. Four Corners Geological Society. 99 pp.
- Bishop, F. M. 1871-72. Letters of Captain F. M. Bishop to the Daily Pantagraph, 1871-72. Utah Hist. Quart. 15:239-253.
- Christensen, E. M. 1962. Rate of naturalization of tamarix in Utah. American Midland Naturalist 68:51-57.
- Clevenger, G. A. 1977. The effect of campgrounds on small mammals in Canyonlands and Arches National Parks, Utah. Unpublished M.S. Thesis. Utah State University. 52 pp.
- Clover, E. U., and L. Jotter. 1944. Floristic studies in the canyon of the Colorado and tributaries. American Midland Naturalist 32:591-642.
- Darrah, W. C. 1947a. George Y. Bradley's journal, May 24-August 30, 1869. Utah Hist. Quart. 15:31-72.
- . 1947b. Letters of O. G. Houland to the Rocky Mountain News 15:95-105.
- . 1947c. J. C. Sumner's journal, July 6-August 31, 1869. 15:113-124.
- . 1947d. Major Powell's journal, July 2-August 28, 1869. 15:125-131.
- Dellenbaugh, F. S. 1926. A canyon voyage: The narrative of the second Powell expedition down the Green-Colorado River from Wyoming, and the exploration on land, in the years of 1871-72. Yale Univ. Press, New Haven, Conn. 277 pp.
- Haas, P. 1943. A study of beaver populations of some Utah streams. Unpublished M.S. Thesis, Utah State Agricultural College, Logan, Utah. 50 pp.
- Hamblin, W. K., R. Matheny, J. K. Rigby, and S. L. Welsh. 1972. Guidebook to the Colorado River parts. Department of Geology. Brigham Young University. 91 pp.
- Hilfiker, E. L. 1968. What beavers eat. Pennsylvania Game News 39(8): 12-15.

- Hensley, A. L., and B. C. Fox. 1948. Experiments on the management of Colorado River beaver. *California Fish and Game* 34(3):115-131.
- Jenkins, S. H. 1975. Food selection by beavers. *Oecologia* 21:157-173.
- Kelley, C. 1947. Capt. Francis Marion Bishop's journal. In biographical sketches and original documents of the second Powell expedition of 1871-72. *Utah Hist. Quart.* 15:159-238.
- Lohman, S. W. 1974. The geological story of Canyonlands National Park. U.S. Government Printing Office. 126 pp.
- Payne, N. F. 1975. Trapline management and population biology of Newfoundland beaver. Unpublished doctoral dissertation. Utah State University, Logan, Utah. 178 pp.
- Powell, J. W. 1875. Exploration of the Colorado River of the West and its tributaries. Smithsonian Institution, Washington, D.C. 291 pp.
- Powell, W. H. 1869. Letter of W. H. Powell to the Chicago Evening Journal, July 3, 1869. *Utah Hist. Quart.* 15:90-92. 1947.
- Woodbury, A. M., and H. N. Russell, Jr. 1945. Birds of the Navajo Country. *Bull. Univ. Utah Biol. Ser.* 9(1):1-160.
- Woodbury, A. M., S. D. Durrant, and S. Flowers. 1959. Survey of vegetation in the Glen Canyon Reservoir Basin. *Univ. Utah Anthropological Papers*, No. 36 (Glen Canyon Ser., No. 5). 53 pp.

APPENDIX

Beaver Study Survey Form
Canyonlands National Park, Utah

Investigator: _____

Date: _____; Site number _____

Weather: _____

Location: River _____ Township _____;

Range _____ County _____;

Distance or other location information _____

River description: Width _____; Fast or slow water _____

Den description: Active _____; Inactive _____;

House material _____;

Facing direction _____; Distance from water _____;

Vertical distance from high water _____; Vertical

distance from present water level _____; Size of den

opening _____; Bank material _____;

Track sizes in inches _____.

Bank vegetation within 100 yards of den site: % Willow _____;

% Tamarisk _____; % Phragmites _____;

% Cottonwood _____; % Other _____

Feeding indications: Willow _____; Tamarisk _____;

Phragmites _____; Cottonwood _____;

Other _____

Beaver sitting in vicinity of den: Yes _____; No _____;

Comments: _____

