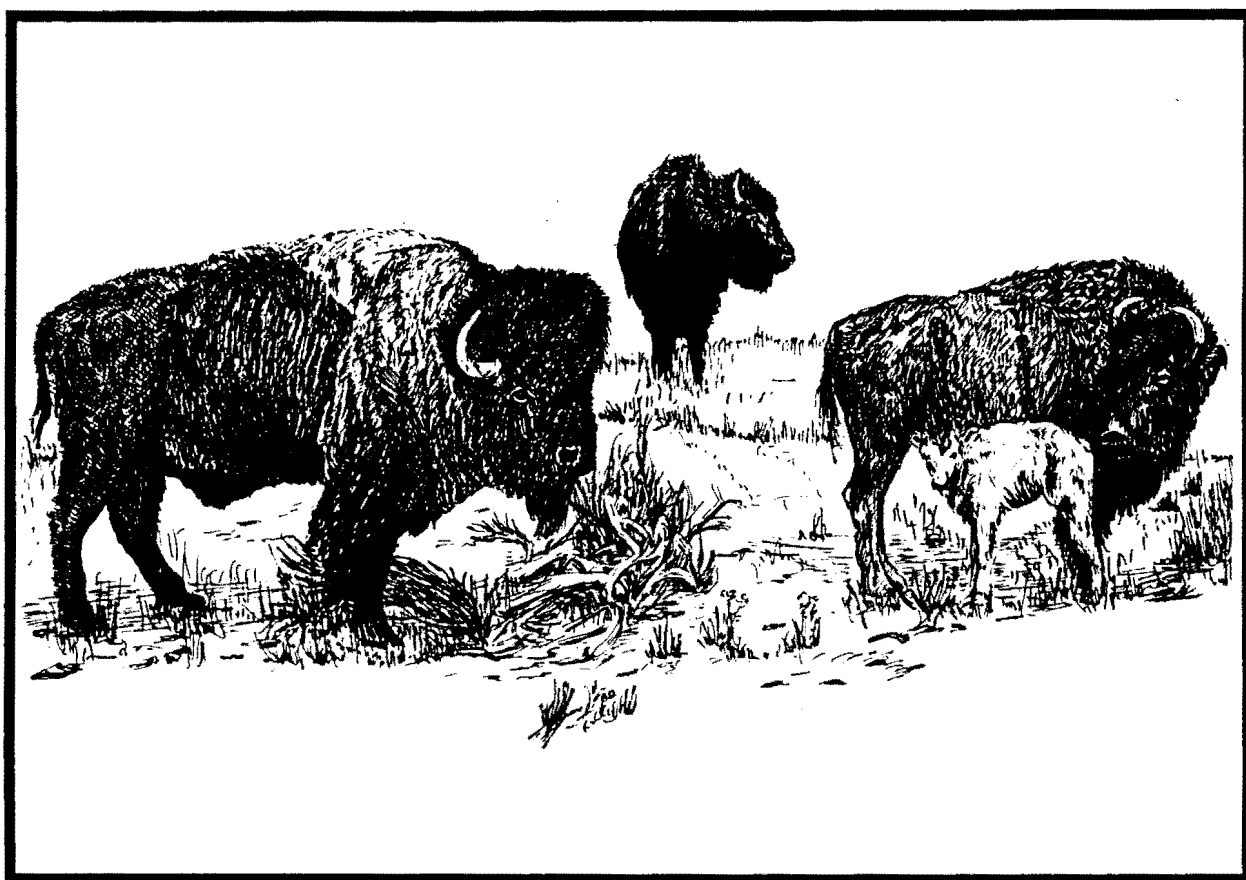

Alaska Department of Fish and Game
Division of Wildlife Conservation

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1 July 1989 - 30 June 1991

BISON

Susan M. Abbott, Editor



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LOCATION

Game Management Unit: 11 (12,782 mi²)

Geographical Description: Copper River

BACKGROUND

The Copper River bison herd originated from animals transplanted from the National Bison Range in Moise, Montana to Delta Junction, Alaska in 1928. In 1950, 17 bison were transplanted from the Delta herd to the Nabesna Road in northern Unit 11. These bison moved away from the transplant site and, by 1961, were established in the Dadina and Chetaslina River area where they have remained. The herd has numbered as many as 120 bison. Until recent years, herd growth was primarily limited by human harvests.

The first Copper River bison hunt was held in 1964 and was conducted as a registration permit hunt. Registration hunts have been held in all but 9 years since then. Hunters have harvested a total of 217 bison from this herd.

MANAGEMENT DIRECTION

Management Objectives

The management objective for the Copper River bison herd is to maintain the herd at a minimum of 60 overwintering adults by controlling the number of bison taken by hunters.

METHODS

We conducted aerial surveys to determine composition of the herd in spring after the calving period. Radio collars were maintained on 4 adult cows to facilitate locating the herd during surveys. In addition, we flew transects through the known bison habitat between the Dadina and Chesnina rivers to count additional animals not located with the radio-collared bison. Harvests and hunting pressure were controlled by registration permit. We monitored harvest by issuing all registration permits from the ADF&G office in Glennallen, and by requiring each permittee to report to the Glennallen office at the end of their hunt.

RESULTS AND DISCUSSION

Population Status and Trend

The Copper River bison herd was relatively stable during the late 1960s and 1970s, following a period of growth in the 1950s. Survey data suggested a lower herd size between 1981 and 1985, but bison numbers again increased between 1986 and 1988 (Table 1). Another herd decline occurred during winter 1988-89 and bison numbers have been low since. Because this herd inhabits an area that is heavily timbered, total counts were difficult to obtain. Variation in population estimates, attributable to survey conditions rather than actual changes in herd size sometimes occurs.

Population Size: We counted 73 bison during an aerial survey in June 1991 (Table 1).

Population Composition: We observed 60 adults and 13 calves during 1991 aerial surveys of the Copper River herd (Table 1). Although calf numbers increased in 1991, calf production was low between 1989-91, averaging only 8 calves per year. The lowest recruitment occurred in 1989 when we observed only 3 calves. An average of 60 adult bison were observed between 1989 and 1991, similar to the average of 58 between 1981 and 1985, but well below the average of 76 for 1986-88. During the late 1960s and 1970s, the average was 78 adult bison.

Distribution and Movements: The Copper River bison herd home range is bounded by the Dadina River on the north, the Copper River on the west, the Kotsina River to the south, and the Wrangell Mountains to the east. Few observations of bison or bison sign have been made north of the Dadina River or south of the Kotsina. Bison were observed occasionally along the western bank of the Copper River in Unit 13, but human disturbance in the Kenny Lake area appears to be preventing range expansion to the west. Seasonal distribution includes intensive use of the Copper River flood plain and bluffs during winter and spring, bison then move to higher elevations along the Dadina and Chetaslina Rivers during summer to feed on plants as they green-up later in the season.

Mortality

Harvest:

Season and Bag Limit. The scheduled season for resident and nonresident hunters in Unit 11 for the area east of the Copper River, south of the Nadina River and Nadina and Sanford glaciers, west of a line from Mount Sanford to Mount Wrangell to Long Glacier, and west of the Kotsina River was 5 October to 10 November. The bag limit was 1 bison every 5 regulatory years by registration permit. The Copper River bison hunt was cancelled by emergency order on 1 July 1989 and has not been reopened.

Board of Game Actions and Emergency Orders. During its spring 1989 meeting, the Board of Game changed the scheduled opening date for future Copper River bison hunts from 21 September to 5 October. The opening date was delayed two weeks to reduce opening day hunting pressure. By opening the season two weeks after the moose season closes, a mixed-bag moose and bison hunt is no longer possible and hunting pressure will probably decline.

The 1989 Copper River bison hunt was closed by emergency order on 1 July 1989 and has not been reopened. Poor recruitment and a low count of adults were the reasons for the closure. The minimum herd objective of 60 overwintering adults would not have been obtained had a human harvest taken place with only 63 adults and low calf recruitment.

Hunter Harvest: Table 2 contains a summary of harvest data. Hunters killed 6 bulls and 1 cow during the 1988 season, which was the last year a hunt was held. The 1988 hunting season was closed by emergency order in September after 7 bison were taken. This was the third consecutive year the season was closed after a 2- or 3-day hunt.

This herd is normally hunted in heavy timber, and mortality because of crippling loss probably occurs. Dense vegetation usually restricts hunters to shooting at bison from short ranges. Unless an animal is killed immediately, tracking in heavy timber without snow is difficult and wounded animals can be lost. The number of animals lost each year is not documented.

Permit Hunts. The Copper River bison hunt is administered as a registration hunt where an unlimited number of registration permits are issued on a first-come, first-serve basis. Permits are available only in Glennallen and all hunters must report hunt results there also. Registration permits are not issued until the day before the scheduled opening date, which will be 5 October the next time a season is held. The hunt may be closed by emergency order if the desired harvest is reached before the season closes on 10 November. The most recent harvest quota is 8 bison. Hunters must carry a portable radio and listen to daily local news announcements for emergency closure notification. Permit data for 1986-91 is summarized in Table 3.

Hunter Residency and Success. Hunter success data for past hunts are included in Table 4. This hunt has always been popular with local rural residents. During the last hunt held in 1988, 40% of the permittees were local residents.

Harvest Chronology. Table 5 summarizes harvest chronology.

Transport Methods. During the most recent hunts, river boats were the most popular method of transportation (Table 5). Aircraft use has declined in recent years because the season has closed before 5 October. Use of mechanized vehicles, including aircraft, except on the Copper and Dadina Rivers and 4 designated lakes, was prohibited during past hunts until 5 October.

Other Mortality: Winter severity and the potential for winter starvation was monitored by recording snow depths at the Dadina Lake snow station, close to the bluffs along the Copper River where the herd winters. Snow depths observed during winter 1989 were 80% above normal and resulted in a winter snow severity index rate of "severe." Deep snows occurred in early October 1989, two months earlier than usual, and remained until late April. Yearly snowfall has been high since then and the winters of 1990 and 1991 were also classified as "severe." One difference between years not indicated in the severity index was duration of the snowpack. In 1991 the deep snow condition did not last as long as the previous two years. Between 1985 and 1988 winter severity indices at Dadina Lake varied from "mild" to "moderate".

Another source of natural mortality is accidental death from falling off the steep bluffs that border the Copper River. During winter, bison feed extensively on the bluffs. Soil of the slopes is predominantly clay, which holds moisture and freezes. The frozen clay creates a steep slide with little, if any, secure footing for bison. During the 1988 hunting season, hunters reported finding three dead bison together at the base of a steep bluff along the Copper River. Cause of death was attributed to falling from the cliff. This was the second documented case of this type of mortality.

Wolves, and black and brown bears are abundant on the Copper River bison range. These predators are capable of taking bison, but research directed at determining predation rates on Copper River bison has not been conducted.

Habitat Assessment

Studies to evaluate habitat condition have not been conducted on the Copper River bison range. Field observations along the Copper River flood plain and bluffs, and at some sedge meadows, suggest heavy use in preferred locations. There is little evidence of dispersal from the current range. If the Copper River herd is range limited, movements of bison into ungrazed areas might be expected.

CONCLUSIONS AND RECOMMENDATIONS

The Copper River bison herd experienced severe recruitment failure in 1989 when only three calves were observed. It was not known if this was a reproductive failure or if high neonatal mortality occurred. This decline in recruitment was attributed to the severe 1989 winter, when snow-pack was deep from early October until April. The influence of deep snowpack on predation rates was unknown. Calf production and/or survival increased in 1990 and again in 1991 even though the winters were also severe based on total snow depths. The only detectable difference was the shorter duration of deep snow conditions in 1991. Herd size has not increased in response to increased recruitment. Additional mortality of yearlings and adults occurred either because of severe winters or increased predation.

Harvests by humans have always been an important factor in determining overall herd size. In years of poor recruitment or reduced numbers of adults, harvests by humans were lowered or eliminated. The effectiveness of this management strategy has changed. From 1964 through 1981, the yearly harvest quota was 15 bison. In response to reduced counts and an apparent decline in calf recruitment the yearly quota was reduced to eight. The Copper River bison hunt has been cancelled five times since 1981 (1982, 1985, 1989, 1990, 1991). Bison numbers appear to have recovered more slowly in recent years. We do not know if this was because of severe winters, range deterioration, or increased predation rates.

Hunter interest in the Copper River bison hunt has been high. During the last three hunts, the overall number of permits issued was lower than during late 1970s and early 1980s. Early closures limited hunter participation. Because of heavy hunting pressure on opening day and restricted access, hunters were crowded at more popular hunting spots along the Copper River. The Copper River bison hunt has been considered a quality hunting experience, but recent crowding of hunters and early closures threaten this status.

Before a hunt is held, the minimum number of adults present in the Copper River bison herd should be increased from 60 to between 80 and 90 overwintering bison older than calves. This increase depends on the occurrence of some milder winters. An increase in number of adult cows in the herd should result in higher annual calf production. In order to keep more cows in the herd it is necessary to carry a higher number of adults because it is not possible to hold a bulls-only hunt. Bison are hunted in timber and sex identification is impossible. If calf recruitment increases, the yearly harvest could be larger.

The current management goal seems to keep the herd at a level that can sustain a yearly harvest of only eight bison and then only if minimum natural mortality occurs. If adult cows are taken, calf production declines, necessitating a season closure for a year or more. Also, with a larger herd, an overharvest of a few animals would have less biological impact on the herd than is presently the case. Increasing the herd would make it less probable that periodic seasonal closures would be needed to rebuild numbers.

It is difficult to hold a hunt for less than eight animals. The logistic difficulties associated with successful hunters reporting to the Glennallen office within 24 hours of taking a bison and the department then notifying all hunters in the field of a closure increases the chances of exceeding the harvest quota. This has been the case during the last two hunts when heavy hunting pressure started on opening day. In the 1970s, when quotas were larger, hunters often killed a number of bison early in the hunt, before hunting pressure drove the bison from the river into dense timber. Because the quotas were larger, the early kill usually did not result in a season closure. The seasons often ran until the 10 November closure because animals were more difficult to take in timber. Chances of exceeding a higher quota in the first or second day of the season would be reduced.

Habitat conditions may preclude attaining the increased population objective if the range has deteriorated. The Copper River bison range has supported more than 90 bison in the past. Body and blood condition parameters obtained from captured cows during winters with normal snowfall suggested adequate forage was available. However, during severe winters with prolonged, deep snows, high calf loss and adult mortality can be expected.

To achieve the proposed goal of 80 or more overwintering adult and sub-adult bison, the hunting season should remain closed until the number of animals increases. The length of time required to reach this goal depends on the level of natural mortality and the amount of hunting allowed before the new herd objective is reached.

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Table 1. Copper River bison spring aerial composition counts and estimated population size, 1986-91.

Regulatory year	Adults ^a	Calves (%)	Total bison observed	Estimated population size ^b
1986/87	70	18 (20)	88	88
1987/88	83	17 (17)	100	100
1988/89	76	14 (16)	90	90
1989/90	63	3 (5)	66	66
1990/91	58	9 (13)	67	67
1991/92	60	13 (18)	73	73

^a Fixed-wing aircraft survey - no composition other than adults and calves.

^b Extrapolated estimates not calculated from total counts.

Table 2. Copper River bison harvest and accidental death, 1986-91.

Regulatory year	Hunter harvest						Grand total
	Reported			Estimated			
	M (%)	F (%)	Unk.	Unreported	Illegal	Total	
1986/87	2 (25)	6 (75)	0	--	--	--	8
1987/88	7 (78)	2 (22)	0	--	--	--	9
1988/89	6 (86)	1 (14)	0	--	--	--	12
1989/90 ^b	--	--	--	--	--	--	0
1990/91 ^b	--	--	--	--	--	--	0

^a 3 falling from bluffs of Copper River.

1 winter kill.

1 radio-collaring mortality.

^b No hunt

Table 3. Copper River bison harvest data by permit hunt, 1986-91.

Hunt No. /Area	Regulatory year	Permits issued	Percent did not hunt	Percent unsuccessful hunters	Percent successful hunters	Bulls (%)	Cows (%)	Unk	Total harvest
450	1986/87	70	37	82	18	2 (25)	6 (75)	0	8
450	1987/88	55	33	76	24	7 (78)	2 (22)	0	9
450	1988/89	38	32	73	27	6 (86)	1 (14)	0	7
475	1989/90 ^a	--	--	--	--	--	--	--	--
^b	1990/91 ^a	--	--	--	--	--	--	--	--

^a No hunt

^b No hunt scheduled, therefore no number assigned.

∞

Table 4. Copper River bison hunter residency and success, 1986-91.

Regulatory year	Local ^a resident	Successful			Unsuccessful			Total hunters
		Nonlocal resident	Nonresident	Total (%)	Resident ^b	Nonresident	Total (%)	
1986/87	4	4	0	8 (18)	36	0	36 (82)	44
1987/88	4	5	0	9 (24)	27	1	28 (76)	37
1988/89	1	6	0	7 (27)	19	0	19 (73)	26
1989/90 ^c	--	--	--	--	--	--	--	0
1990/91 ^c	--	--	--	--	--	--	--	0

^a Local means Units 11 or 13 residents.

^b Local residency data for unsuccessful hunters not available.

^c No hunt.

Table 5. Copper River bison harvest chronology percent by time period, 1986-91.

Regulatory year	Harvest period 9/21-27
1986/87	2 days - Closed by EO 9/23
1987/88	2 days - Closed by EO 9/23
1988/89	2 days - Closed by EO 9/23
1989/90	No hunt
1990/91	No hunt

Table 6. Copper River bison harvest percent by transport method, 1986-91.

Regulatory year	Percent of harvest							n
	Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	ORV	Highway vehicle	
1986/87	38%	--	62%	--	--	--	--	8
1987/88	22%	--	78%	--	--	--	--	9
1988/89	14%	--	86%	--	--	--	--	7
1989/90 ^a	--	--	--	--	--	--	--	0
1990/91 ^a	--	--	--	--	--	--	--	0

^a No hunt.

LOCATION

Game Management Unit: 11 (13,300 mi²)

Geographical Description: Chitina River

BACKGROUND

The Chitina bison herd originated from animals transplanted from the National Bison Range in Moise, Montana to Delta Junction, Alaska in 1928. In 1962, 29 cows and 6 bulls were transplanted from Delta Junction to May Creek. From this initial transplant the herd increased to as many as 56 bison in 1981, but has subsequently declined to 31.

The first Chitina bison hunt was held by drawing permit in September 1976. Permit hunts were held for 13 years between 1976 and 1988. During these permit hunts, sport hunters took a total of 57 bison from the Chitina herd.

MANAGEMENT DIRECTION

Management Objectives

The management objective for the Chitina bison herd is to maintain the herd at a minimum of 50 overwintering adults by increasing or decreasing human harvests when bison numbers exceed or fail to reach this herd goal.

METHODS

We conducted aerial surveys to determine composition of the herd in spring after the calving period. We flew transects through all known bison habitat in the lower Chitina Valley to obtain a direct count. Hunts were not held during this report period because management objectives were not met.

RESULTS AND DISCUSSION

Population Status and Trend

The Chitina bison herd was stable for the 10 years between 1976 and 1985 (Table 1). Between 1985 and 1989, the number of bison observed in the Chitina herd declined from

56 to 30 animals (46%) (Table 1). There has been little change observed in bison numbers since 1989 and the Chitina herd appears stable at a reduced level.

Population Size: We counted 31 bison during two aerial surveys in June 1991. The Chitina bison herd has not been this small since 1974-75.

Population Composition: We observed 28 adults and three calves during aerial surveys of the Chitina herd during 1991 (Table 1). Five fewer calves were present in 1991 than in the previous year. Calves comprised only 10% of the herd in 1991, which was the smallest calf crop observed since 1971. Calf production was higher in 1990 when calves comprised 22% of the herd.

Distribution and Movements: The Chitina bison herd usually ranges within the riparian and upland habitats below 2,000 ft. elevation along a 40-mile portion of the upper Chitina Valley. Although distribution varies considerably, the herd can usually be located between the Tana River and Barnard Glacier. During the past few years, the riparian zone near Bryson Bar has been heavily used and survey efforts have focused on this area.

Mortality

Harvest:

Season and Bag Limit. The scheduled season for resident and nonresident hunters for the Chitina bison herd was 6 September to 30 November. The bag limit was one bison every five regulatory years by drawing permit only. Up to 12 drawing permits may have been issued. The hunt area was that portion of the Chitina River east of the Lakina River and south and east of the Nizina River in Unit 11.

Board of Game Actions and Emergency Orders. In 1985, the Board of Game changed the designation of the Chitina bison hunt from a sport hunt to a subsistence hunt. Only local rural residents were eligible for permits. The Board reclassified the hunt as a sport hunt during its 1986 meeting. The number of bison counted during spring 1989 was well below the population objective. Because of the decline, the department cancelled the hunt in 1989 by emergency order and a hunt has not been held for the last three years.

Hunter Harvest. The Chitina bison hunt was cancelled by emergency order on 22 February 1989, and has not been reestablished. Table 2 provides a summary of past harvest data. Hunters killed four bulls during the 1988 season, which was the last year a hunt was held. Bison from the Chitina River herd have been poached in past years. The number of animals taken illegally and the impact on the herd is not known. However, in some years the illegal take probably equaled or exceeded the legal harvest. One local resident admitted taking one bison each year for winter meat, but has never been cited because of lack of evidence.

Permit Hunts. During the last hunt six drawing permits were issued for the Chitina bison hunt (Table 3). Although up to 12 permits have been authorized by the Board of Game, ADF&G reduced the number of permits issued for biological reasons. In 1988, there were 423 applicants for a drawing success rate of less than 2%. The number of applications submitted the last three hunts has ranged between 359 and 423.

Hunter Residency and Success. Hunter success data for past hunts are included in Table 2. Nonresident hunters have not received a permit during the last six hunts.

Harvest Chronology. Harvest chronology information does not exist.

Transportation Methods. Aircraft were used by all successful bison hunters during 1988 (Table 5). Of the 26 successful bison hunters reporting transportation methods since 1983, 24 (92%) used aircraft, 1 (4%) used a river boat and 1 (4%) used a dog team.

Other Mortality: Natural mortality rates have not been determined for the Chitina bison herd. Although instances of wolf predation on bison have been reported by trappers and local residents, the causes of natural mortality in this herd have not been investigated.

Habitat Assessment

Until 1980 the bison habitat in the upper Chitina Valley received substantial use from horses kept on two grazing leases in the area. Then, ADF&G made a cursory evaluation of forage utilization in bison habitat, resulting in tentative determinations that browsing and grazing were heavy, especially on horse grazing leases. It was also determined that the size of the bison herd should be held at 30 overwintering adults. Subsequently one grazing lease was cancelled and the number of horses using this area has been reduced.

In 1984, the National Park Service conducted a range study in the upper Chitina Valley (Miquelle 1985). This study found that grazing by ungulates on the Chitina bison range had not resulted in recent deterioration in plant condition. The range was determined to be recovering from earlier overuse when horses were abundant on the grazing leases. Miquelle (1985) also concluded that a bison herd of 50 animals did not adversely affect the habitat, and that the management objective of 30 overwintering bison could be increased. He also concluded that the range could never support a very large bison herd.

A subjective evaluation of affects of recent severe flooding on the Chitina bison range leaves the impression that considerable habitat has been lost. The most heavily changed area was the flood plain northeast of Bear Island. This was a heavily used riparian area before 1991. Recent flooding and rechannelization of the Chitina River resulted in sand bar replacement of roughly 50% of the previously vegetated habitat. It is impossible to predict the impact this habitat loss will have on the herd. At least a short-term reduction in available vegetation may have occurred. Given the heavy use of this area in the past

and its apparent importance to the herd, past use levels probably can not be maintained. The herd must change its feeding and movement patterns to find additional food.

CONCLUSIONS AND RECOMMENDATIONS

The Chitina bison herd declined by 26 animals between 1985 and 1989, then stabilized. Calf production was especially low last year. This reduction in recruitment may in part be a response to a habitat change that resulted from flooding and rechannelization of the Chitina River through important feeding areas near Bear Island. The impact of flooding and vegetation loss leads me to believe the carrying capacity has been reduced. Legal human harvests were eliminated in 1989 when the Chitina bison hunt was closed by emergency order. The Chitina bison hunt should remain closed until the herd approaches the minimum population objective of 50 bison. Then a drawing hunt for bulls only, with up to six drawing permits could be re-instituted.

LITERATURE CITED

Miquele, Dale. 1985. Food habits and range conditions of bison and sympatric ungulates on the Upper Chitina River, Wrangell-St. Elias National Park and Preserve. U.S. Dept. of Interior. Nat. Park Service. Ak. Region Research/Resources Management Report AR-8. Anchorage. 112pp.

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Table 1. Chitina bison spring aerial composition counts and estimated population size, 1986-91.

Regulatory year	Adults ^a	Calves (%)	Total bison observed	Estimated population size ^b
1986/87	36	5 (12)	41	41
1987/88	38	7 (16)	45	45
1988/89	34	5 (13)	39	39
1989/90	26	4 (13)	30	30
1990/91	28	8 (22)	36	36
1991/92	28	3 (10)	31	31

^a Fixed-wing aircraft survey - no composition other than adults and calves.

^b Extrapolated estimates not calculated from aerial counts.

Table 2. Chitina bison harvest and accidental death, 1986-91.

Regulatory year	Hunter harvest							Grand total
	Reported			Estimated			Accidental death	
	M (%)	F (%)	Unk.	Unreported	Illegal	Total		
1986/87	3 (75)	1	0	0	0	0	0	4
1987/88	3 (100)	0	0	0	0	0	0	3
1988/89	4 (100)	0	0	0	0	0	4 ^a	8
1989/90 ^b	--	--	--	--	--	--	0	0
1990/91 ^b	--	--	--	--	--	--	0	0

^a Radio-collaring mortalities

^b No hunt

Table 3. Chitina bison harvest data by permit hunt, 1986-91.

Regulatory year	Permits issued	Percent did not hunt	Percent unsuccessful hunters	Percent successful hunters	Bulls (%)	Cows (%)	Unk	Total harvest
1986/87	6	17	20	80	3 (75)	1 (25)	0	4
1987/88	6	17	40	60	3 (100)	0 --	0	3
1988/89	6	33	0	100	4 (100)	0 --	0	4
1989/90 ^a	0	--	--	--	--	--	--	0
1990/91 ^a	0	--	--	--	--	--	--	0

^a No hunt

Table 4. Chitina bison hunter residency and success, 1986-91.

Regulatory year	Local ^a resident	Successful			Unsuccessful			Total hunters
		Nonlocal resident	Nonresident	Total (%)	Local ^a resident	Nonresident	Total (%)	
1986/87	0	4	0	4	1	0	1 (20)	5
1987/88	1	2	0	3	2	0	2 (40)	5
1988/89	2	2	0	4	0	0	0 (0)	4
1989/90 ^a	--	--	--	--	--	--	--	0
1990/91 ^a	--	--	--	--	--	--	--	0

^a Local means Unit 11 or 13 residents.

^b No hunt.

Table 5. Chitina bison harvest percent by transport method, 1986-91.

Regulatory year	Percent of harvest							Unknown	n
	Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	ORV	Highway vehicle		
1986/87	100	--	--	--	--	--	--	--	4
1987/88	100	--	--	--	--	--	--	--	3
1988/89	100	--	--	--	--	--	--	--	4
1989/90 ^a	--	--	--	--	--	--	--	--	0
1990/91 ^a	--	--	--	--	--	--	--	--	0

^a No hunt.

LOCATION

Game Management Unit: Unit 19

Herd: Farewell

Geographical Description: All drainages of the Kuskokwim River upstream from Lower Kalskag

BACKGROUND

Eighteen animals transplanted from the Delta bison herd established the Farewell bison herd in 1965. Twenty additional bison were transplanted to the area from Delta in 1968 to supplement the existing herd. The first legal harvest from this herd occurred in 1972, after aerial surveys revealed that it could sustain nominal harvests. Since 1972, 20 drawing permit hunts were held and 287 bison were harvested.

The Farewell bison hunt has been administered as a drawing permit hunt, except in 1979 and 1984 it was administered as registration and "Tier II" subsistence hunts, respectively. From 1980 through 1983, 20 permits were allocated each year. From 1985 to 1988 the number of permits was increased to 40. During the 1989 and 1990 regulatory years 70 drawing permits were awarded, 40 for fall hunts and an additional 30 permits for spring (March) hunts. In the 1991, we awarded 80 permits, 40 for fall and 40 for spring.

MANAGEMENT DIRECTION

The Farewell bison herd is managed for the optimal sustainable yield of animals while providing uncrowded and aesthetic hunting conditions. The herd generally ranges on the 1977 Bear Creek burn or on the South Fork Kuskokwim River bars where availability of adequate forage is questionable. For that reason, the number of permits allotted for Farewell bison harvests has been increased in an attempt to arrest the herd's growth rate.

Management Goals and Objectives

Goals and objectives for the Farewell bison herd are to:

- maintain a minimum of 200 bison and determine the optimal sustainable harvest level
- conduct periodic aerial surveys of the range, size, and composition of the bison herd
- instrument and radiomonitor up to six bison in an attempt to more efficiently gather herd size, composition data, and habitat use patterns

- conduct late winter aerial surveys to determine extent of predation and/or starvation mortality
- work in cooperation with the Alaska Department of Natural Resources (DNR) and other landowners to complete a prescribed fire in the Farewell area in an attempt to increase seasonal bison forage abundance and availability
- administer and monitor the permit drawing hunts for the Farewell bison herd.

METHODS

We conduct aerial surveys annually to gather herd size and composition data. Because of difficulties recently encountered in locating herds, three adult cows were instrumented during summer 1991 using helicopter-supported darting techniques to facilitate group locations. Three additional transmitter collars are available but have yet to be deployed. For the past three years no total count of the herd has been obtained. Early spring flights have been conducted within the traditional range of the herd in an attempt to monitor extent of winter and predation mortality.

Plans to enhance habitat are being made. A formal controlled burn prescription will be in place by spring 1992 and, if weather parameters are met, a portion of the 1977 Bear Creek burn area will be subjected to a controlled burn.

Drawing permit hunts for Farewell bison have continued. Hunts were administered from the McGrath area office with permittees being assigned one of various 10-day hunt periods in August, September, or March. To reduce crowding and provide a high-quality hunting opportunity, no more than 10 hunters are allowed afield at any particular time. Hunters are required to check in at McGrath either by phone or in person before and after their hunts. Hunters are also required to complete and return a mail-out questionnaire after hunting. Questionnaire results and personal interviews form the data base to evaluate various aspects of the hunt.

RESULTS AND DISCUSSION

Population Status and Trend

Between 1968 (when aerial surveys were initiated) and 1988, the Farewell bison herd grew at an average annual rate of 10%. Since 1988 no complete surveys have been done, but we think that hunting and natural mortality factors have arrested the herd's growth.

Population Size: Although no complete census has been conducted since 1988, recruitment, hunting mortality, and limited herd size data indicate the population remains at 280-300 bison (Table 1). During repeated attempts each of the past three years, we

have not completely succeeded in counting herd size because of the herd's sporadic and unpredictable movements.

Population Composition: Five surveys of Farewell bison have been conducted (since 1989). During 1989, we recorded only 8% calves in the population ($n = 230$). However, we conducted that survey in early May before parturition was complete for the year. Composition surveys during 1990 and 1991 revealed from 16% to 26% calves in the herd, depending on survey timing (Table 1). The long-term average is 19.5% calves in the herd. Percent yearlings and percent bulls in the herd are not presently known.

Distribution and Movements: During winters, the Farewell bison herd scatters in small groups (10-40 animals) on the Bear Creek burn and surrounding ranges, taking advantage of the area's windswept grass and sedge forage. During summer these groups begin moving onto the South Fork Kuskokwim River floodplain, generally moving south toward the headwaters of that drainage. In recent years, bison have been seen as far upriver as Sled Pass (Hartman River/Stony River headwaters) and into Ptarmigan Valley (South Fork Kuskokwim River/Happy River headwaters). Bison have been infrequently observed as far west as the Windy Fork of the Kuskokwim River and north to within 20 km of Nikolai on the South Fork Kuskokwim River. A large lightning-caused burn during summer 1990 on the east side of the South Fork Kuskokwim has encouraged bison herd movements in that direction and may increase available forage.

Mortality

Harvest: Hunter harvest from the Farewell bison herd during the 1989 and 1990 regulatory years was 33 and 31, respectively. These years constitute the highest harvests on record (Tables 2 and 3). However, this reflects an increased number of available permits rather than increased hunter success rates. Hunter success rates during the 1990-91 season were the lowest (44%) in the past five years. During the 1990-91 season, 16 bulls and 15 cows were harvested. All bison were taken in Subunit 19C.

Season and Bag Limit.

	Resident	Nonresident
1 bison every 5 regulatory years by drawing permit only.	Aug. 22-Sept. 30 Mar. 1-Mar. 31	Aug. 22-Sept. 30 Mar. 1-Mar. 31

During the March 1989 meeting, the Alaska Board of Game approved the department's proposal to issue up to 100 drawing permits and extend the open season from 10 August through 31 March.

Hunter Residency and Success. Most applicants and permittees for the Farewell bison hunt are Alaska residents (Table 4). Unit 19 residents and nonresidents each constitute less than 5% of permittees. No foreign nationals have obtained permits.

Permit success averages about 50%. However, this figure includes all permit holders, both those who go afield and those who do not. During the past four regulatory years 20-30% of the permit holders have not attempted to hunt (Table 4). Thus, approximately two-thirds of the hunters who go afield are successful at bagging a bison.

Transport Methods. During the fall hunt (Hunt No. 451) initial access to the Farewell area is by aircraft (Table 5). During the past four years only one hunter used a boat for initial access. About half the hunters use all-terrain vehicles as a secondary access method. During the spring hunt (Hunt No. 452) the primary access method is aircraft. However, during the March 1991 hunt five of 18 (16%) successful hunters used snowmachines to get to the hunt area from McGrath. Generally hunters using aircraft to reach the hunting area in March use snowshoes or skis to stalk and retrieve bison.

Other Mortality: Until 1988 apparently little natural mortality occurred. However, since that time, six dead bison have been incidentally located while doing other work. Two of these kills were apparently from wolf predation. Two additional kills were attributed to starvation (winter kill); an adult cow and a 5- to 6-month-old calf. Cause of death of the two remaining kills was not determined, although I suspect they were wounded by hunters and not retrieved. Incidental reports of three additional deaths were received but not investigated and cause of death was not determined. No systematic surveys have been conducted to document the extent of natural mortality, although natural mortality now certainly affects the population.

Success rates vary by assigned hunt period (Table 6) but chronology of the harvest is probably affected more by weather conditions (directly affecting access) rather than bison vulnerability. However, hunter success rates are higher in spring (Hunt No. 452) than during fall (Hunt No. 451).

Habitat

Very little is known about range conditions for the Farewell bison herd. The herd spends winters on and adjacent to the Bear Creek burn where forage appears adequate. However, summer range is limited to river floodplains within the Alaska Range. Although no recent estimates of bison carrying capacity on summer range are available, high use or possible overuse is evident.

In cooperation with the Department of Natural Resources, a spring burn is being planned. This work will be conducted on a portion of the 1977 Bear Creek burn where grass and sedge growth appears to be declining and native black spruce is reinvading. Plans are not

firm on the time and extent of the burn, but the intent is to provide increased winter forage for bison and stimulate browse production for moose.

CONCLUSIONS AND RECOMMENDATIONS

Until 1988 we thought natural mortality was minimal within the Farewell bison herd. It is evident now, however, that hunter take is but one of the annual inimical factors affecting the herd. Total herd size must be monitored closely and permit numbers adjusted annually to manage the herd. Until range evaluations can be completed, the herd should not be allowed to exceed 300 animals. This will entail deploying additional radiocollars and periodically monitoring those transmitters to obtain herd size figures. The drawing permit hunt should continue to be administered from the McGrath area office to provide assistance to hunters and ensure timely and accurate hunt reports. A priority for Farewell bison herd management should be to encourage establishing a prescribed burning program in the Farewell area.

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Table 1. Farewell bison annual aerial composition counts and estimated population size, 1986-91.

Regulatory year	Adults	Calves (%)	Total bison observed	Estimated population size
1986-87	227	43 (16)	270	270
1987-88	61	20 (25)	81	300
1988-89	211	19 (8) ^a	230	300
1989-90	174	39 (18)	213	280
1990-91	107	20 (16)	127	280

^a Bison survey conducted in early May before parturition was complete, thus percent calves is unrealistically low.

Table 2. Farewell bison harvest data by permit hunt, 1987-91^a.

Hunt No. /Area	Regulatory year	Permits issued	Percent did not hunt	Percent unsuccessful hunters	Percent successful hunters	Bulls (%)	Cows (%)	Unk	Total harvest
451	1987-88	40	20	30	50	14 (70)	6 (30)	0	20
	1988-89	40	23	25	53	16 (76)	5 (24)	0	21
	1989-90	40	33	33	34	10 (71)	4 (29)	0	14
	1990-91	40	28	40	32	8 (62)	5 (38)	0	13
452	1987-88	--	--	--	--	--	--	--	--
	1988-89	--	--	--	--	--	--	--	--
	1989-90	20	27	10	63	8 (42)	11 (58)	0	19
	1990-91	30	17	23	60	8 (44)	10 (56)	0	18
Totals for	1987-88	40	20	30	50	14 (70)	6 (30)	0	20
all permit	1988-89	40	23	25	53	16 (76)	5 (24)	0	21
hunts	1989-90	70	30	23	47	18 (55)	15 (45)	0	33
	1990-91	70	23	33	44	16 (52)	15 (48)	0	31

^a Figures only depict legally harvested animals.

Table 3. Farewell bison harvest, 1986-91.

Regulatory year	Hunter harvest						
	Reported			Estimated			Total
	M (%)	F (%)	Unk.	Total	Unreported	Illegal	
1986-87	unk.	unk.		unk.	unk.	unk.	19
1987-88	14 (70)	6 (30)		20	0	0	20
1988-89	16 (76)	5 (24)		21	0	0	21
1989-90	18 (53)	15 (44)		33	0	0	31
1990-91	16 (52)	15 (48)		31	0	0	31

Table 4. Farewell bison hunter residency and success, 1987-91^a.

Regulatory year	Successful				Unsuccessful				Total hunters		
	Local ^b resident	Nonlocal resident	Nonres.	Unk.	Total (%)	Local ^b resident	Nonlocal resident	Nonres.		Unk.	Total (%)
1987-88	2	18	0	0	20 (50)	1	18	1	0	20 (50)	40
1988-89	2	19	0	0	21 (53)	1	17	1	0	19 (47)	40
1989-90	3	30	1	0	34 (49)	3	29	4	0	36 (51)	70
1990-91	5	26	0	0	31 (44)	0	39	0	0	39 (56)	70

* Figures are for all permittees, whether they hunted or not.

^b "Local resident" refers to hunters living in Unit 19.

Table 5. Farewell bison harvest percent by transport method, 1987-91.

Regulatory year	Percent of harvest		<u>n</u>
	Airplane	Boat	
1987-88	97	3	32
1988-89	100	0	31
1989-90	98	0	33
1990-91	84	0	31

Table 6. Farewell bison harvest chronology percent by time period, 1987-91.

Regulatory year	Harvest periods								<u>n</u>
	8/22-31	9/1-10	9/11-20	9/21-30	10/1-10	3/1-10	3/11-20	3/21-20	
1987-88	--	5	5	6	4	--	--	--	20
1988-89	--	6	7	4	4	--	--	--	21
1989-90	6	3	3	2	--	5 ^a	8	7	34
1990-91	3	3	3	4	--	7	5	6	31

^a Includes 1 illegal kill (multiple bag).

LOCATION

<u>Game Management Subunit:</u>	20D (5,720 mi ²)
<u>Herd:</u>	Delta
<u>Geographical Description:</u>	Central Tanana Valley near Delta Junction

BACKGROUND

The ancestors of modern bison first colonized North America after migrating from Asia to Alaska over the Bering Land Bridge (Reynolds et al. 1982). Subsequently, two subspecies developed: wood bison (*Bison bison athabasca*) in Alaska and parts of Canada, and plains bison (*B. b. bison*) in Canada and the contiguous United States. Bison were once the most abundant large mammal in Alaska, but became extinct about 500 years ago probably because of changing climatic conditions. Bison occurred along the Delta River near Delta Junction before their extinction in Alaska (D. Guthrie, pers. commun.).

In 1928, 23 plains bison were transplanted from the National Bison Range in Montana to the Delta River. By 1947, the herd had increased to 400 animals. Hunting began in 1950 and is one of the most popular permit drawing hunts in the state. Hunting is used to manage the herd size. Delta bison have been transplanted to other parts of Alaska to establish additional herds.

As agriculture developed on its established range, the Delta bison herd began to include hay and cereal grains in its fall and winter diets. In 1976, the State of Alaska made agricultural development a priority within the established range of the Delta bison herd, and large-scale agricultural land disposals began in 1978. Eventually bison began to impact fall agricultural harvests by feeding on crops before harvest.

In 1979, the Alaska Legislature established the 90,000-acre Delta Junction Bison Range (DJBR), south of the Alaska Highway and adjacent to the Delta Agricultural Project. The purpose of the DJBR was to perpetuate free-ranging bison by providing adequate winter range and altering seasonal movements of bison to reduce damage to agriculture. In 1984, the legislature appropriated \$1.54 million for DJBR development and increased the Delta bison permit hunt application fee from \$5 to \$10. Funds from the fee increase were intended for managing the DJBR. Since 1984, the appropriation funds have been used to develop 2,800 acres of bison forage on the DJBR, purchase equipment for forage management, and hire personnel to accomplish these tasks.

Bison damage to farms in the Delta Agricultural Project was significantly reduced in 1985 when the first substantial forage production occurred on the DJBR. DJBR forage development continued through 1990 and conflicts between bison and agriculture continue to be reduced.

MANAGEMENT DIRECTION

Management Goals and Objectives

Management goals and objectives for the Delta bison herd are to:

- manage bison forage on the DJBR to prevent bison depredation in the Delta Agricultural Project until 1 October annually.
- manage a precalving population of 325-360 bison with a herd composition of at least 35 bulls:100 cows.

In July 1991, the Alaska Department of Fish and Game (ADF&G) drafted a 5-year bison management plan to cover January 1991 through December 1994. We conducted public review of the draft plan through September 1991. We sent copies of the plan to numerous agencies and individuals. Public meetings were held with the Delta and Fairbanks Fish and Game Advisory Committees (DAC and FAC), the Salcha-Big Delta Soil and Water Conservation District (SWCD), and the Tanana Valley Sportsmen Association (TVSA). We received comments on the plan from nine individuals, the DAC, the FAC, the TVSA, the SWCD, the Alaska Division of Agriculture, the Interior Regional Council, and an organization called Citizens Against Bison Reduction. We will review public comments and write final goals and objectives at a later date.

METHODS

DJBR Management

During 1989, the DJBR was managed to prevent crop depredations in the Delta Agricultural Project. Established perennial grasses were fertilized on the DJBR with approximately 265 pounds/acre of N60-P50-K25-S10. Additional bison attractants on the DJBR were two 660-gallon stock tanks that were kept full of water and numerous 50-pound trace element salt blocks placed at various locations. Prescribed fires were conducted to burn perennial grasses and berm piles. A trail connecting the two areas of bison forage, the Gerstle and Panoramic Fields, was planted with a mixture of the annual grasses, oats and barley and the perennial grasses, ryegrass and brome grass.

The native grass *Calamagrostis canadensis* has begun to invade domestic grasses being managed for bison forage. Two methods to manage *Calamagrostis* include eliminating it or managing it as bison forage. A grant was received from the Alaska Division of

Agriculture for \$4,789 to study options for managing *Calamagrostis* as high-quality bison forage on the DJBR. We began tests to evaluate individual and combined effects of mowing, burning, and fertilizing on the forage quality of *Calamagrostis*. A 30-acre study area was established and stratified into three cutting regimes of 10 acres each (Karczmarczyk 1991a). Within each 10-acre block, 2.5-acre treatment areas were either burned, fertilized, burned and fertilized, or left as a control. We clipped forage samples weekly. Samples will be analyzed for percent crude protein, percent acid detergent fiber, digestibility, total digestible nutrients, and megacalories per pound of metabolizable energy.

Herd Management

Population Status and Trend: We estimated herd population size by aerial photocensuses. We located bison by visual searching and by locating aggregations that contained a radio-collared bison. Aggregations were counted visually if possible. We photographed aggregations that were difficult to count visually. These aggregations were counted from the photographs. The prehunt population size is considered the maximum number of bison counted during the photocensuses.

Population Composition: Herd sex and age composition data were collected by locating groups containing radio-collared bison on the ground and classifying bison in the aggregation. Sex and age were determined by observing bison with 8 X 40 binoculars or a 15-60 power spotting scope. Bulls were differentiated from cows by body size, pelage, horn shape, and presence of a penis sheath. Yearling bulls were differentiated from adult bulls by horn size and shape.

Distribution and Movements: We monitored fall bison movements by locating radio-collared cow bison. Locations were obtained from the ground by using a single antenna and listening for peak signal strength to determine the general location of the bison. Precise aerial locations were obtained by mounting a pair of antennae on an aircraft and locating the radio-collared bison.

Disease Management: We conducted a serologic survey by asking all bison hunters to collect approximately 30 ml of blood from the bison they killed. Blood samples were centrifuged and serum was removed by aspiration. Sera were frozen until tested for the following diseases: epizootic hemorrhagic disease, bluetongue, infectious bovine rhinotracheitis, bovine viral diarrhea, parainfluenza 3, brucellosis, and Q fever.

Harvest Management: Bison hunters were required to check out in Delta Junction after their hunt. We gave hunters a questionnaire asking the following questions: date of kill, location of kill, how many days they hunted, number of shots required, caliber of weapon and size of bullet, how much money they spent in Delta Junction, and how much money they would pay for a bison harvest tag if one were required. We estimated age of harvested bison by tooth replacement, tooth wear, and horn annuli. We measured horns

on large bulls according to the Boone and Crockett Club scoring system during the 1989-90 hunting season. During the 1990-91 hunting season, horns were measured on all bulls. We measured horns on all bison killed during the 1991-92 hunting season.

Economic Survey: During the 1990-91 hunting season, we used the contingent valuation method to conduct an economic survey of the worth of bison to hunters and their companions. Bison hunters were given a questionnaire regarding the monetary value they placed on hunting Delta bison, how much money they spent on their hunting trip, attitude, and demographic variables (Boyce 1991). Questions were presented to hunters as a hypothetical offer from the ADF&G to buy from them or sell to them a Delta bison hunting permit. The valuation questions were posed as the individual's willingness-to-pay (wtp) for a bison permit or their willingness-to-accept (wta) an offer to buy a permit. The questions were intended primarily for bison hunters, but questionnaires were also given to their hunting companions. A questionnaire copy is included in Appendix A.

Wtp and wta offers were randomly selected values ranging from \$0.00 to \$5,000.00. Wtp offers were made for either-sex permits only. Wta offers were made for both cow and either-sex permits. After responding to the fixed/random price, respondents were also asked an open-ended question to measure the maximum they would be willing to pay (if buying) or the minimum they would be willing to accept (if selling) for a permit.

We simulated an open market for the buying and selling of Delta bison permits using questionnaire responses. We used a bootstrapping method to generate 10,000 random draws with replacement from wtp and wta questionnaire responses (Boyce 1991).

RESULTS AND DISCUSSION

Population Status and Trend

Population size is regulated through the annual harvest by hunters. Maximum population size increased from 426 to 484 during this report period.

Population Size: In previous years, the size of the Delta bison herd has been reported as the precalving population estimate. We estimate precalving herd size from summer/fall censuses, minus known hunting mortality, and estimates of wounding loss and other natural mortality factors. The current population size is the maximum pre hunting herd size based on census results.

1989. We conducted photocensus flights on 30 July and 7 and 22 August. All bison counted during the 30 July census were on the Delta River. We counted bison on the Delta River and the DJBR during the 7 and 22 August counts. We estimated maximum herd size at 432 bison (Table 1).

1990. We conducted a photo census on 24 July 1990 and counted 440 bison located on the Delta River and the DJBR (Table 1).

1991. We conducted photo-census flights on 13 and 28 June 1991 and counted all bison on the Delta River during both counts. Census results were 426 and 467 bison. Herd size was estimated at 467. A captive herd of 25 bison escaped from Mr. Nick Columbo's farm on 11 August 1991 in the Clearwater area of Delta Junction. The escaped herd included 13 bulls, 11 cows, and 1 calf. The Delta ADF&G staff spent \$3,468 on salary and supplies from 12 August to 19 November 1991 attempting to help Mr. Columbo recover his bison. Eight bison were recovered including five bulls and three cows. Five of the eight returned to Mr. Columbo's facilities on their own and three were immobilized by ADF&G staff. On October 7, 1991 ADF&G declared the remaining free bison "feral" and they became the property of the state. Seventeen bison were thus added to the earlier population estimate of 467, resulting in a herd size of 484 bison (Table 1).

Population Composition:

1989. We collected sex and age composition data on 24 August 1989, and classified a sample of 225 bison. Calf survival to fall was apparently good with 50 calves:100 cows (Table 2). Survival to 18 months of age was good with 25 yearling bulls:100 cows. The ratio of bulls in the herd increased to 106 bulls:100 cows.

1990. We collected sex and age composition data on 10 and 11 September 1990, and classified 110 bison (Table 2). Calf survival to fall apparently remained high with 47 calves:100 cows. Survival to 18 months of age declined from 1989, but continued to be good with 19 yearling bulls:100 cows. The ratio of bulls in the herd continued to increase to 114 bulls:100 cows.

1991. We collected sex and age composition data on 9 and 25-27 September 1991, and classified 201 bison (Table 2). Calf survival to fall was significantly lower than previous years and declined to 29 calves:100 cows. Drought conditions and large numbers of grasshoppers on the summer range during summer 1990 may explain the poor physical conditions of cows which probably contributed to the drop in calf survival. These conditions could have resulted in poor forage quality and quantity on the summer range. The Delta Junction area also experienced unusually deep snow during winter 1990-91. The snow pack and water content measured by the Soil Conservation Service in the Delta Junction area during February 1991 was well above the 1961-85 average. The Fort Greely snow pack in February was 26 inches, with a water content of 5.6 inches, compared with the 1961-85 average of 14 and 2.6 inches, respectively (Clagett 1990). These factors may have resulted in fewer and/or in less viable calves born during spring 1991, resulting in lower calf survival.

Yearling bison survival to 18 months of age declined to about 50% of normal during 1991 to 10 yearling bulls:100 cows (Table 2). The dry summer of 1990 and deep snow

of winter 1990-91 may have caused the decline in yearling survival. The bull:cow ratio declined to 74 bulls:100 cows because of the increased number of bulls harvested during the 1990-91 hunting season.

Distribution and Movements: Bison continued to use the floodplain of the Delta River for calving and summer range. During June and July, the herd typically ranges along the Delta River between Black Rapids Glacier and the Washington Range on the Fort Greely Military Reservation. During July and August, the herd usually moves north along the Delta River to the mouth of Jarvis Creek. Between late July and early September, the herd migrates eastward, across the Richardson Highway, and onto the DJBR.

1989. The first group of 20 bison moved from the Delta River to the DJBR on 7 July 1989. A large group of bison moved from the DJBR onto the Delta Agricultural Project on 1 September 1989. Most agricultural grain crops in the area had been harvested and no depredations occurred.

1990. The first bison left the Delta River summer range and migrated to the DJBR on 3 July 1990. Between 16 and 24 July, several small groups of bison left the DJBR and moved briefly onto the Delta Agricultural Project. A large group of bison left the DJBR and moved onto the Delta Agricultural Project on 17 August 1990. After 17 August, bison moved continuously between the DJBR and the Delta Agricultural Project.

1991. Bison appeared to alter their use of the Delta River summer range during summer 1991. Both anecdotal information and data from radio-collared bison indicate that fewer bison used the west side of the Delta River than usual. Large numbers of bison apparently spent most of the summer on the Texas and Washington ranges of the Fort Greely Military Reservation, instead of on the west side of the river. We estimated that no more than 100 bison used the traditional summer and calving areas north of Buffalo Dome (M. Berger, pers. commun.) It is unclear at this time what caused decreased use of traditional summer ranges along the Delta River in 1991. Possibilities include the fact this may have been an unusual one-time occurrence. Herd size may have exceeded forage availability on the summer range, vegetative succession on the summer range may be altering the plant community to make the area less attractive to bison, the change could be a natural response to improved forage on the DJBR and Delta Agricultural Project, or the late hunting season may not be allowing the removal of bison that migrate early. As discussed later in this report, a research project has begun to evaluate the availability of bison forage on the Delta River summer range.

Bison migrated to the DJBR on 17 July 1991. By 1 August, at least 200 bison were using the Panoramic and Gerstle fields on the DJBR. Bison were first observed on the Delta Agricultural Project on 27 August.

Mortality

Harvest:

Season and Bag Limit. The resident and nonresident 1989-90 and 1990-91 bison hunting seasons were open from 7 October to 31 March. Participation in the hunt required drawing a lottery permit for Hunt 403 (either-sex bison) or for Hunt 404 (cows only). We assumed that most permittees with either-sex bison permits would shoot a bull. The following conditions applied to each permit:

1. Permittees were required to attend an orientation course before hunting.
2. Permittees were assigned specified time periods for hunting. Hunt period was determined by the order permits were drawn.
3. Permittees were required to use a rifle capable of shooting a 200-grain bullet with 2,000 ft.-lbs. of retained energy at 100 yards. Bows had to comply with 5 AAC 92.075(4) to be legal means of harvest. Crossbows are prohibited. Certain muzzleloading firearms qualified.

During the 1989-90 season, 30 permits were issued for Hunt 403 and 35 for Hunt 404 (Table 3). During the 1990-91 season, 70 permits were issued for Hunt 403 and 20 for Hunt 404. The bag limit was one bison every five years for each season.

Board of Game Actions and Emergency Orders. The Board of Game increased the maximum number of permits ADF&G was authorized to issue from 60 to 100.

Human-induced Mortality.

1989-90. Total mortality during 1989-90 is estimated at 65 bison (Table 4). Hunters killed 22 bulls and 38 cows during the 1989-90 hunting season and had a 98% success rate (Table 3). Hunters with either-sex permits killed 81% bulls and 19% cows. Additional mortality (Table 4) was estimated to be 7% wounding loss equal to five bison. Successful hunters averaged 2.3 days hunting to kill a bison and unsuccessful hunters averaged 8.0 days.

The most commonly used weapon during 1989-90 was a .338 caliber rifle. A mean of 2.0 shots were required to kill a bison. Of the most commonly used weapons, the .375 H&H required the fewest shots ($\bar{x}$ = 1.5) to kill a bison, and the .300 Weatherby required the most shots ($\bar{x}$ = 2.2).

1990-91. Total mortality during the 1990-91 season was estimated at 94 bison (Table 4). Hunters killed 59 bulls and 27 cows for a 97% success rate (Table 3). Hunters with either-sex permits killed 87% bulls and 13% cows. Two calves that died over winter and

an estimated wounding loss of six bison add to herd mortality. Successful hunters averaged 2.1 days afield to kill a bison and unsuccessful hunters averaged 7.0 days.

During the 1990-91 hunting season, a Fish and Wildlife Trooper was hired to monitor bison hunters during the first month of the season. Four hunters contacted the trooper and reported that they had wounded and lost a bison. The trooper located three of the bison and killed the animals for the hunters. In each case he reported the animals had received lethal wounds and would have eventually died. Based on his observations, he estimated overall wounding loss to be 5%-10% of the number of permits issued. Therefore, I estimated annual wounding loss to be 7% of the permits issued.

The most commonly used weapon during the 1990-91 hunting season was the .338 caliber which 19 hunters used. A mean of 2.6 shots were required to kill a bison with all calibers. Of the commonly used calibers, the .300 Winchester Magnum required the fewest number of shots per kill ($x = 1.7$), and the .30-06 required the most shots per kill ($x = 4.3$). One bison was killed with a .54 caliber black powder rifle and one was killed with a bow and arrow.

Permit Hunts. The number of applications for Delta bison permits increased from 9,705 in 1988 to 10,042 in 1989 and 11,690 in 1990. There were 11,057 applications in 1991. The hunter orientation procedure was changed to require less staff time during the 1989-90 hunting season. Hunt orientations began 7 October and were conducted once a week for 7 weeks at 3:00 p.m. on Mondays. Each hunter was given 19 weeks to hunt. No apparent reduction in hunter competence resulted from this change.

During 1990, the Alaska Legislature authorized the raffle of a Delta bison permit. The raffle was to be conducted by the ADF&G or a nonprofit corporation established to promote fish and game law enforcement. If a nonprofit organization conducts the raffle, it may keep proceeds equal to administrative costs plus 10%; the remainder of the proceeds are to be deposited in the Fish and Game Fund with the intent to fund management of the Delta bison herd. Alaska Fish and Wildlife Safeguard, a nonprofit group in compliance with the law, conducted the first raffle during 1990. Raffle tickets cost \$5 each; 7,410 tickets were sold and \$18,208.21 was deposited into the Fish and Game Fund for bison management. The 1991 raffle was also conducted by Alaska Fish and Wildlife Safeguard. In this raffle, approximately 6,600 tickets were sold and \$13,600.21 was deposited into the Fish and Game Fund for bison management.

Hunter Residency and Success.

1989-90. All bison hunters were Alaska residents. Local and nonlocal residents had similar success rates with 100% and 98% success, respectively.

1990-91. All bison hunters were Alaska residents. Local and nonlocal residents had similar success rates with 100% and 96% success, respectively. No nonresidents hunted during the 1990-91 season (Table 5).

Harvest Chronology.

1989-90. Most bison were harvested in two distinct periods during the hunting season. During the 1989-90 hunting season, 88% of the bison were killed during the first nine weeks from 7 October to 8 December 1989 (Table 6). Hunters resumed killing bison again during week 18 which began on 3 February, and 12% of the harvest occurred from 3 February to 31 March 1990.

Other Mortality: Natural mortality has not been quantified for the Delta bison herd but it is probably low. There are no records of predation on Delta bison even though coyotes, wolves, grizzly bears, and black bears occur in the area and may be killing a few bison. Weather is rarely a mortality factor; however, the deep snow of winter 1990-91 resulted in some overwinter mortality of calves as discussed earlier in this report.

Disease Management: Diseases transmitted from domestic livestock in the Delta Junction area pose the greatest potential for mortality to Delta bison. Cattle in the Delta Junction area are known to have infectious bovine rhinotracheitis, bovine viral diarrhea, bovine respiratory syncytial virus, infectious bovine kerato conjunctivitis, and parainfluenza III (PI3) (D. Quarberg, pers. commun.).

Bison continue to be free from most of these infectious diseases for which serum antibody tests are conducted. The exception is PI3 (Table 7) (Zarnke 1991). One hundred percent of bison have tested positive for PI3. However, by itself, this disease does not appear to pose a health problem to the herd at this time.

Diseases carried by the feral bison added to the herd in 1991 is unknown. These bison came to Delta Junction from the Mercer herd at Healy, Alaska, in March 1988. At the time of the bison's escape, no one, including Mr. Columbo, the State of Alaska Veterinarian, or the USDA Veterinarian had any records of serological testing for Mr. Columbo's bison.

Economic Survey of Bison Hunters

1989-90. Bison hunters reported spending an average of \$239 per hunter in Delta Junction during 1989-90. Most money per hunter was spent on lodging ($\bar{x}$ = \$106), followed by gasoline ($\bar{x}$ = \$58), meals ($\bar{x}$ = \$44), groceries ($\bar{x}$ = \$21), and miscellaneous expenses ($\bar{x}$ = \$10).

1990-91. Complete results of the economic valuation study conducted during the 1990-91 hunting season are listed in Appendix B. Eighty-nine questionnaires were received. Two

questionnaires were received too late to analyze and one respondent refused to answer the questions. We received usable questionnaires from 62 permittees and 24 hunting companion nonpermittees.

The average Delta bison hunting party during the 1990-91 season had 2.5 people and spent an average of \$791 on their hunt. The greatest expenditures were for taxidermy ($\bar{x}$ = \$298), transportation ($\bar{x}$ = \$130), and food ($\bar{x}$ = \$64).

Expenditures in Delta Junction averaged \$195 per hunting party. Greatest expenditures in Delta Junction were for lodging ($\bar{x}$ = \$83), gasoline ($\bar{x}$ = \$43), and food ($\bar{x}$ = \$36).

Hunters spent \$143,570 on chances to hunt Delta bison during the 1990-91 hunt season. This total equals \$110,570 spent on Delta bison permit application fees and \$33,000 spent on Alaska Fish and Wildlife Safeguard raffle tickets.

Hunters spent \$143,570 on chances to hunt Delta bison during 1990-91, and permittees spent an estimated \$67,235 on hunting-related expenses, for a total expenditure of \$210,805 to hunt 90 bison. Although the number of permits varies each year, \$2,342.28 was spent for each Delta bison permit issued during the 1990-91 hunting season.

Habitat

DJBR Habitat Improvement During 1989: A prescribed grass fire was conducted on 600 acres of arctared fescue on 19-20 June 1989 (Karczmarczyk 1990). Burning conditions were excellent as was consumption of accumulated dead grass. After the fire, fescue regrowth showed a 28% increase in metabolizable energy/pound as compared with new growth in unburned areas. Cost for conducting the burn was approximately \$500; however, costs were reduced by a significant amount of volunteer labor.

Approximately 500 acres of bluegrass were fertilized in the Panoramic Fields in early July. No fescue was fertilized because it was receiving little use by bison, which resulted in abundant decadent grass that hindered fertilizing. Cost for fertilizing was \$15,500.

The trail connecting the Panoramic and Gerstle fields was planted in late July with nugget bluegrass, arctared fescue, brome, and a cover crop of barley and oats. During fall 1989 bison began using the trail for the first time to travel from the Panoramic to the Gerstle fields.

Berm piles were burned in the Panoramic and Gerstle fields from 29 September to 5 October 1989. Over 90 miles of berm piles were ignited and consumption of the piles was nearly 90%. Many acres of fescue were also ignited from berm piles. Total cost for the burn was approximately \$30,000.

DJBR Habitat Improvement During 1990: Approximately 1500 acres of bison forage were fertilized in the Panoramic and Gerstle fields from late June to early August (Karczmarczyk 1991a). Forage was fertilized with N60-P30-K20-S10 at the rate of approximately 265 pounds/acre. Cost of the fertilizer application was \$35,000.

Portions of the Panoramic-Gerstle Trail that were not planted during 1989 were planted in summer 1990. Acreage was planted with a combination of the annual grasses, oats and barley, and perennial grasses, nugget bluegrass, and timothy. Water bars were constructed along portions of the trail to reduce soil erosion from runoff. The trail was used extensively during fall 1990 by bison traveling between the Gerstle and Panoramic fields.

Berm rows burned during 1989 were reconsolidated into round berm piles during 1990. Berm consolidation work cost \$45,000.

Field work was completed on the study area to investigate effects of mowing, burning, and fertilizing on forage quality of *Calamagrostis canadensis* to make it more palatable. Data will be analyzed and reported at a later date.

A mechanical weed wiper was used to apply the herbicide Roundup to several portions of the Panoramic Fields that were infested with *Calamagrostis*. Roundup was applied during the third week of August. Initial observations indicated a 75% kill rate on individual *Calamagrostis* plants.

DJBR Habitat Improvement During 1991: Approximately 500 acres of bluegrass were fertilized from 7 to 14 June with N60-P30-K20-S10 at the rate of approximately 265 pounds/acre (Karczmarczyk 1991b). Fertilizer application was confined to nugget bluegrass in the Panoramic and Gerstle fields. Fertilizer was applied earlier in the summer than in previous years in anticipation of earlier arrival of bison on the DJBR. In addition to stimulating bluegrass production earlier in the summer, early application also stimulated significant growth of *Calamagrostis canadensis*. Fertilizer costs totaled \$15,000.

Approximately 2,000 round berm piles were burned in the Panoramic Fields from 2 to 4 October to further eliminate berm piles from the DJBR. Cost of the burn was approximately \$3,000.

Effects of a 1990 application of the herbicide Roundup was evaluated for the control of *Calamagrostis canadensis*. Most plants treated with Roundup were growing in May 1991. This indicated that the kill observed the previous fall was confined to leaves and that the herbicide was not transported into the root system of the plant sufficiently to kill the entire plant. Therefore, it may be necessary to apply Roundup over several years to completely eliminate *Calamagrostis*, rather than using a one-time application (Karczmarczyk 1991b).

Assessment and Enhancement:

A graduate student from the University of Alaska Fairbanks began research during summer 1990 to evaluate bison summer range on the Delta River. The research is designed to determine bison diet composition, forage availability, and forage utilization. Results of this study will be reported at a later date.

CONCLUSIONS AND RECOMMENDATIONS

The Delta bison herd continues to do well and herd size estimates are currently above the herd size objective. Additional hunting permits must be issued if herd size is to be reduced to the stated objective. Although 100% of the herd has been exposed to PI3, the herd does not appear to have been exposed to any other serious livestock diseases at this time. However, the introduction of domestic bison into the herd is of some concern. Delta bison herd serology will continue to be monitored. DJBR development continues with remaining CIP funds. The greatest challenge to DJBR management at this time is controlling the native grass *Calamagrostis canadensis* or developing techniques to make it more palatable for bison. Work should continue to determine effective and efficient methods of controlling *Calamagrostis*. The change in use and migration from the Delta River summer range will be investigated to determine if current herd size exceeds summer range carrying capacity, or if some other factor is causing the change. The 1990-95 bison management plan should be finalized in the near future.

LITERATURE CITED

- Boyce, J. R. 1991. Economic valuation of the Delta Junction bison herd: results of pre-test survey. Unpubl. rep. 13pp.
- Clagett, G. P. 1990. Alaska annual data summary, water year 1990. Soil Conservation Service, Anchorage. 21pp.
- Karczmarczyk, P. F. 1990. Untitled memorandum. Alaska Dep. Fish and Game, Fairbanks. 8pp.
- _____. 1991a. 1990 Delta Junction Bison Range annual report. Alaska Dep. Fish and Game, Fairbanks. Unpubl. rep. 10pp.
- _____. 1991b. 1990 Delta Junction Bison Range annual report. Alaska Dep. Fish and Game, Fairbanks. Unpubl. rep. 10pp.
- Reynolds, H. W., R. D. Glaholt, and A. W. L. Hawley. 1982. Bison. Pages 972-1007 in J. A.

Chapman and G. A. Feldhammer, eds. Wild Mammals of North America: Biology, Management, and Economics. The Johns Hopkins Univ. Press, Baltimore. 1147pp.

Zarnke, R. L. 1991. Serologic survey for microbial pathogens. Alaska Dep. Fish and Game. Fed. Aid in Wildl. Restor. Prog. Rep. Proj. W-22-6, W-23-1, 2, 3, and 4. Juneau. 58pp.

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Table 1. Delta bison fall ground composition data and estimated population size, 1985-91.

Regulatory year	Adults		% Yearling bulls	% Calves	Total sample size	Estimated prehunt pop. size
	% Bulls	% Cows ^a				
1985-86	28	72	5	25	283	378
1986-87	38	62	7	24	119	361
1987-88	No data					
1988-89	42	58	8	21	141	426
1989-90	51	49	10	20	225	432
1990-91	53	47	7	18	110	440
1991-92	42	58	5	14	201	484 ^b

^a Includes yearlings.

^b Includes 17 domestic bison that escaped and were incorporated into the herd.

Table 2. Delta bison fall ground composition ratios counts and estimated population size, 1986-87 through 1991-92.

Year	Bulls/ 100 Cows	Yrlg bulls/ 100 Cows	% Yrlg Bulls	Calves/ 100 Cows	Percent calves in herd	Total sample size	Estimated prehunt pop. size
1986-87	44	10	5	47	25	119	361
1987-88	No data						
1988-89	72	17	8	45	21	141	426
1989-90	106	25	10	50	20	225	432
1990-91	114	19	7	47	18	110	440
1991-92	74	10	5	29	14	201	484 ^a

^a Includes 17 domestic bison that escaped and were incorporated into the herd.

Table 3. Delta bison harvest data by permit hunt, 1986-87 through 1990-91.

Hunt No. /Area	Regulatory year	Permits issued	Percent did not hunt	Percent unsuccessful hunters	Percent successful hunters	Bulls (%)	Cows (%)	Unk	Total harvest
403 ^a	1986-87	10	0	0	100	9 (100)	0 (0)	0	9
	1987-88	35	0	0	100	33 (100)	0 (0)	0	33
	1988-89	20	10	0	100	18 (100)	0 (0)	0	18
	1989-90	30	3	4	96	21 (81)	5 (19)	0	26
	1990-91	70	0	3	97	59 (87)	9 (13)	0	68 ^b
404	1986-87	55	0	0	100	6 (11)	47 (89)	0	53
	1987-88	15	0	0	100	2 (15)	11 (85)	0	13
	1988-89	30	0	10	90	3 (11)	24 (89)	0	27
	1989-90	35	0	0	100	1 (3)	33 (97)	0	34
	1990-91	20	5	5	95	0 (0)	18(100)	0	18
Totals for all permit hunts	1986-87	65	0	0	100	15 (24)	47 (75)	0	6
	1987-88	50	0	0	100	35 (76)	11 (24)	0	46
	1988-89	50	2	7	96	21 (47)	24 (53)	0	45
	1989-90	65	2	2	98	22 (37)	38 (63)	0	60
	1990-91	90	2	3	97	59 (67)	27 (31)	0	86

^a Hunt 403 was a bulls-only hunt for 1986-87 through 1988-89 and was an either-sex hunt from 1989 through 1990-91.

^b One bull was harvested for the Alaska Wildlife Safeguard raffle.

Table 4. Delta bison harvest and accidental death, 1986-87 through 1990-91.

Regulatory year	Hunter harvest						Grand total		
	Reported			Estimated					
	M (%)	F (%)	Unk.	Total	Unreported ^b	Illegal		Total	
1986-87	15 (24)	47 (75)	0	62	5	0	5	0	67
1987-88	35 (76)	11 (24)	0	46	4	0	4	0	50
1988-89	21 (47)	24 (53)	0	45	4	0	4	0	49
1989-90	22 (37)	38 (63)	0	60	5	0	5	0	65
1990-91	59 (67) ^a	27 (31)	0	86	6	0	6	2	94

^a One bull was harvested via the Alaska Wildlife Safeguard Raffle.

^b Estimated wounding loss equal to 7% of the permits issued.

Table 5. Delta bison hunter residency and success for hunters reporting for drawing Permit Hunts 403 and 404, 1986-91.

Regulatory year	Successful					Unsuccessful					Total hunters
	Local ^a resident	Nonlocal resident	Nonres.	Unk.	Total (%)	Local ^a resident	Nonlocal resident	Nonres.	Unk.	Total (%)	
1986-87	4	57	0	1	62 (100)	0	0	0	0	0 (0)	62
1987-88	1	44	0	1	46 (100)	0	0	0	0	0 (0)	46
1988-89	2	40	1	2	45 (94)	0	3	0	0	3 (6)	48
1989-90	3	57	0	0	60 (98)	0	1	0	0	1 (2)	61
1990-91	4	31	0	0	85 (97)	0	3	0	0	3 (3)	88

^a Local residents reside in Subunit 20D.

Table 6. Percent of harvest of Delta bison by time period, 1986-87 through 1990-91. Each harvest period represents one week, beginning 7 October and ending 31 March.

Regulatory year	Harvest periods																										n
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	
1986-87	7	13	9	16	20	0	7	9	9	0	0	2	7	0	0	0	0	0	0	0	0	0	0	0	0	0	45
1987-88	9	9	9	9	11	17	9	2	4	0	0	0	0	0	0	0	0	0	4	4	4	4	2	0	2	0	46
1988-89	4	4	13	2	11	13	11	0	2	2	0	0	2	4	0	0	0	0	4	4	4	7	9	2	2	0	45
1989-90	6	14	16	6	14	6	14	8	4	0	0	0	2	0	0	0	2	2	2	0	2	0	2	0	0	4	50
1990-91	2	6	13	14	13	7	13	9	2	2	1	1	1	0	1	1	0	0	0	1	2	1	2	5	0	1	86

Table 7. Serum antibody prevalence of 9 infectious disease agents in the Delta bison herd, 1984-90.

Agent	1984	1985	1986	1987	1988	1989	1990
Infectious bovine rhinotracheitis virus SN ^a (8) ^b	0/48 ^c	0/29	0/52	0/42	0/43	0/38	0/9
Bovine viral diarrhea virus SN (8)	0/48	0/29	3/52	0/43	0/43	0/38	0/9
Parainfluenza 3 virus HI (8)	41/41	28/29	52/52	38/38	42/43	38/38	9/9
Respiratory syncytial virus IFA (20)			0/52	0/43	0/43	0/38	0/9
Epizootic hemorrhagic disease virus ID (+)	0/48	0/229	0/52	0/43	0/10	0/33	0/10
Bluetongue virus ID (+)	0/48	0/29	0/52	0/43	0/10	0/33	0/10
<i>Brucella suis</i> IV bacterium BAPA (+); STT (50)	0/48	0/1	0/52	0/43	0/43	0/41	0/10
Q fever rickettsium CF (20)	1/48	0/29	0/50	0/39	0/6	0/33	0/8
<i>Leptospira interrogans</i> bacterium MAT (100)			5/52	4/42	0/10		

^a Test method: SN = serum neutralization test, HI = hemagglutination inhibition test, IFA = indirect fluorescent antibody test, ID = immunodiffusion test, BAPA = buffered acidified plate antigen test, STT = standard tube test, CF = complement fixation test, and MAT = microscopic agglutination test.

^b Number in parentheses indicates minimum titer necessary to be considered evidence of exposure to agent in question. (+) indicates that test is interpreted as simply either "positive" or "negative".

^c Number positive/number tested.

Economic Valuation of Delta Junction Bison Herd: Results of Pre-test Survey

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May 13, 1991

During the 1990-1991 Delta Junction bison herd hunting season a contingent valuation survey was conducted using the successful permit holders and their companions as a sample population. This survey is being used as a "pre-test" for a contingent valuation/market experiment to be conducted during the summer of 1991. This report summarizes the findings of the pre-test survey.

A total of 89 hunters returned surveys. Of these, two surveys were turned in too late to be included in the analysis and one refused to answer any of the questions. Of the remaining 86 hunters a series of questions were asked regarding the value that they placed on hunting for a Delta Junction bison, how much they spent while on their trip, a series of attitude questions, and some demographic variables. The valuation questions were posed as either willingness-to-pay (wtp) and willingness-to-accept (wta) questions, and were solicited by both asking if the respondent would accept or reject an offer and as an open end question. All surveys were written documents that were given to each hunter and his/her hunting party as they arrived in the Delta Junction Department of Fish and Game office. The return rate on actual hunters was over 60% (62 responding). It is not known how many non-permit holders were given surveys (24 responded).

Economic valuation questions

The wtp and wta questions were first presented to each respondent as an offer from ADF&G to buy from them or to sell to them a hunting permit for the 1990-1991 season. The respondent was then asked to state the maximum that they would be willing to pay (if buying) or the minimum they would be willing to accept (if selling) a permit. The survey was originally intended to be distributed only to the permit holders. However, as most permit holders hunted with a group of people, the survey was also distributed to the non-permit holders. Due to the way that the survey was designed, the non-permit holders (24 in number) were able to answer the entire questionnaire, but it was impossible to determine whether their answers pertained to a "cow-only" permit or an "either-sex" permit for the wta questions. This was not a problem for the wtp questions since they were only asked wtp questions about an either sex permit.

The offers made ranged from \$0 to \$5000. The distribution was somewhat skewed to the lower end because originally we made offers ranging from \$0 to \$1000. This was revised as we observed the initial results. A separate offer was made for the wtp and wta questions. That is, the respondent was given two different prices for the two different questions. Respondants were asked the same price for the cow-only and either-sex permits, however.

Respondants were also^{asked} wtp questions such as what they thought a "fair price" would be for a DJ bison permit and how much they would have to earn as a daily wage before they would not be willing to take the time off to go hunting for bison. These responses are not included in the analysis below.

The following table summarizes the results of the wta offers. The number of observations excludes the 24 non-permit holders. The "offer dollars" column is the offer made to the respondent. A "1" in the "accept/reject" column indicates that the offer would be accepted and a "0" that it would be rejected. The "permit type" column indicates which type the respondent actually holds. The first thing that is suggested by the data is that as the offer increases, the probability of accepting the offer appears to increase. Second, the probability of accepting an offer is higher if the permit holder has a cow-only permit than if the permit holder has a either-sex permit. The lowest offer taken for an either sex permit was \$1740 (\$450 for a cow-only). The data is sorted by ascending offer size.

WILLINGNESS-TO-ACCEPT BY PERMIT TYPE (N=62)

NUMBER OF PERMIT HOLDERS = 62
 NUMBER OF COW ONLY = 44
 NUMBER OF EITHER SEX = 18

EITHER SEX		COW ONLY		PERMIT TYPE	
OFFER	ACCEPT=1	OFFER	ACCEPT=1	COW ONLY=0	OBSERV
DOLLARS	REJECT=0	DOLLARS	REJECT=0	EITHER SEX=1	NUMBER
40	0	40	0	0	85
70	0	70	0	0	44
78	0	78	0	1	65
102	0	102	0	1	66
170	0	170	0	0	79
192	0	192	0	0	54
226	0	226	0	0	67
254	0	254	0	0	40
303	0	303	0	0	69
310	0	310	0	0	21
322	0	322	0	1	70
339	0	339	0	0	42
366	0	366	0	1	37
370	0	370	0	0	33
400	0	400	0	1	43
420	0	420	0	1	56
450	0	450	1	0	68
470	0	470	0	1	45
680	0	680	0	0	27
750	0	750	0	0	31
1120	0	1120	0	1	11
1120	0	1120	0	1	22
1200	0	1200	0	0	2
1330	0	1330	0	0	81
1360	0	1360	0	1	50
1580	0	1580	0	1	78
1580	0	1580	0	0	86
1740	1	1740	1	0	15
1740	0	1740	1	1	26
1750	0	1750	1	0	74
1780	0	1780	0	0	53
1900	1	1900	0	0	77
1960	1	1960	1	0	52
2027	1	2027	1	1	51
2060	0	2060	0	1	32
2090	0	2090	0	0	80
2130	1	2130	1	0	7
2380	1	2380	1	0	10
2390	0	2390	0	0	87
2670	0	2670	0	0	76
2780	0	2780	1	0	13
2970	1	2970	1	0	84
3050	0	3050	0	0	30
3190	0	3190	0	0	19
3230	0	3230	0	0	55
3240	0	3240	0	0	12
3490	0	3490	1	0	6
3530	0	3530	0	0	5
3580	1	3580	1	0	83
3980	0	3980	0	0	8
4040	1	4040	1	1	46
4140	0	4140	0	1	29
4250	0	4250	0	0	17
4270	1	4270	1	0	48
4460	0	4460	1	0	3
4470	1	4470	1	1	38
4590	1	4590	1	1	82
4710	1	4710	1	0	18
4830	1	4830	1	0	16
4840	0	4840	0	0	75
4890	0	4890	0	0	4
4990	0	4990	1	0	14

The next table summarizes the results of the willingness-to-pay offers. The "offer" column is the offer made to the respondent. The "accept" column (1=yes, 0=no) tells whether the respondent indicated whether or not he/she would have accepted the offer if it were a real offer. The "maximum wtp" column gives the responses to an open end question (which followed directly after the offer/acceptance questions) of "what is the maximum amount you would be willing to pay for an either-sex DJ bison permit." The column "consistent" asks whether or not the two responses were consistent (5 were not).

The most striking thing about this data set is the noticable increase in the propensity to accept the offer as the size of the offer decreases. The highest offer which was accepted was for \$3448. This individual also reported the highest amount for what they would be willing to pay, \$10,000.

Willingness-To-Pay for Either Sex Permit (N=86)

A **** indicates 'No Answer Given'

Number of 'No Answers' = 8

Number of 'Consistent' answers = 81

OBSERVATION	MAXIMUM WTP	OFFER (\$)	ACCEPT	CONSISTENT 1=YES, 0=NO
46	300	4950	0	1
78	500	4890	0	1
7	150	4780	0	1
77	10	4720	0	1
31	100	4650	0	1
84	300	4620	0	1
76	150	4470	0	1
86	25	4460	0	1
55	500	4350	0	1
18	100	4320	0	1
52	500	4060	0	1
85	1000	4060	0	1
15	1000	3710	0	1
49	2500	3670	0	1
22	10	3610	0	1
47	****	3520	0	1
14	300	3480	0	1
81	2000	3460	0	1
57	10000	3448	1	1
9	500	3380	0	1
83	500	3330	0	1
32	10	3100	0	1
73	100	3070	0	1
5	1000	2810	0	1
2	100	2770	0	1
11	700	2770	0	1
4	****	2580	1	1
28	5000	2580	1	1
74	150	2430	0	1
17	25	2380	0	1
51	750	2307	0	1
10	200	2100	0	1
27	10	1930	0	1
72	350	1733	0	1
24	****	1630	0	1
25	100	1630	0	1
38	100	1620	0	1
75	****	1610	0	1
19	100	1580	0	1
48	400	1580	0	1
12	****	1560	0	1
87	10	1510	0	1
50	2500	1460	1	1
26	1000	1420	0	1
30	****	1380	0	1
13	1000	1370	1	0
82	200	1260	0	1
39	500	1170	0	1
80	200	1120	0	1

(Willingness-to-pay, continued)

OBSERVATION	MAXIMUM WTP	OFFER (\$)	ACCEPT	CONSISTENT 1=YES, 0=NO
20	****	980	0	1
6	500	880	0	1
33	500	850	0	1
3	1000	680	1	1
41	500	500	1	1
29	10	500	0	1
40	500	493	1	1
21	100	400	0	1
60	250	371	0	1
70	100	371	0	1
45	100	370	1	0
44	10	370	0	1
43	500	350	1	1
65	400	343	1	1
79	250	340	1	0
54	150	323	0	1
58	250	237	0	0
59	250	237	1	1
66	250	237	1	1
16	500	230	1	1
61	750	225	1	1
69	750	225	1	1
63	1000	225	1	1
62	1000	225	1	1
36	0	200	0	1
56	0	200	0	1
71	250	198	1	1
68	0	148	0	1
8	200	130	1	1
1	25	110	1	0
67	250	74	1	1
42	500	56	1	1
37	250	50	1	1
35	25	25	1	1
23	400	20	1	1
53	2000	10	1	1
64	****	0	0	1

The apparent relationships between the offer and the probability of acceptance were verified statistically for each of the three models (cow-only wta, either-sex wta, and either-sex wtp). Each of these statistical models used income and education variables to control for randomness in the regression errors. Income was measured as the maximum of the category they checked (the categories were (in thousands) \$20, 30, 40, 50, 75, 100, and 100+) for annual income (using \$125,000 for the highest category). Education was measured in years of school, with "some college" set at 14, a B.A. at 16, an M.A. at 18, and a Ph.D. at 20 years, respectively. Other variables were not included in the analysis at this time.

The probit results support the conclusions that the acceptance/rejection responses do vary systematically with the size of the offer for all three models. The relative magnitudes of the either-sex and cow-only offer coefficients are also consistent with the either-sex permit having higher value. The probit results excluded data for which education or income data were not reported. The author has not translated these estimation results into actual demand curves at this time. Clearly, this step would be completed with the sample drawn during the market experiment survey analysis.

WTA (either sex permit) Probit Estimation (N=57)

ESTIMATES FROM PROBIT ANALYSIS OF VARIABLE: ACCEPT EITHER SEX WTA OFFER

Variable	Comparison	Probit Estimate	Std. Error	t-value	p> t
CONSTANT	1/0	-3.42866	1.4011	-2.45	0.014
ESOFFER	1/0	0.00043	0.0001	3.24	0.001
EDUCAT	1/0	-0.12992	0.4581	-0.28	0.777
INCOME	1/0	0.13763	0.0906	1.52	0.129

MEASURES OF FIT:

Likelihood Ratio Chi-square:	15.9682
with 3 d.f., prob = 0.001	
-2 Log Likelihood for full model:	56.5944
-2 Log Likelihood for restricted model:	72.5626
Percent Correctly Predicted:	73.6842

WTA (cow only permit) Probit Estimation (N=57)

ESTIMATES FROM PROBIT ANALYSIS OF VARIABLE: ACCEPT COW ONLY WTA OFFER

Variable	Comparison	Probit Estimate	Std. Error	t-value	p> t
CONSTANT	1/0	-3.58332	1.4515	-2.47	0.014
COW OFFER	1/0	0.00037	0.0001	2.65	0.008
EDUCAT	1/0	0.05954	0.4725	0.13	0.900
INCOME	1/0	0.12838	0.0926	1.39	0.165

MEASURES OF FIT:

Likelihood Ratio Chi-square:	11.1197
with 3 d.f., prob = 0.011	
-2 Log Likelihood for full model:	50.0908
-2 Log Likelihood for restricted model:	61.2105
Percent Correctly Predicted:	78.9474

WTP (Either Sex Permit) Probit Estimation (N=74)

ESTIMATES FROM PROBIT ANALYSIS OF VARIABLE: ACCEPT WTP OFFER

Variable	Comparison	Probit Estimate	Std. Error	t-value	p> t
CONSTANT	1/0	-2.63497	0.9697	-2.72	0.007
OFFER	1/0	-0.00093	0.0002	-3.80	0.000
EDUCAT	1/0	0.24719	0.0834	2.96	0.003
INCOME	1/0	0.00122	0.0075	0.16	0.870

MEASURES OF FIT:

Likelihood Ratio Chi-square:	35.9173
with 3 d.f., prob = 0.000	
-2 Log Likelihood for full model:	57.3355
-2 Log Likelihood for restricted model:	93.2527
Percent Correctly Predicted:	83.7838

Expenditure Patterns of Hunters

The respondents were also asked questions about how much money they spent during their trip to hunt DJ bison. The average hunter spent just under \$800 total on the hunt. This average may be low since not all respondents indicated that they spent anything while on the hunt. A total of \$68,000 was spent by the hunters who responded to the questionnaires. Of this, \$16,000 was spent in Delta Junction, \$16,000 was spent in transit to Delta Junction, and the remainder was spent on general expenses, the location of which was not given. The single most important expenditure was for taxidermy, indicating that the DJ bison hunt is valued as a trophy hunt. On average, each hunter spent almost \$300 on taxidermy, for a total of \$25,000 spent. The following table summarizes the expenditures by category and by location. The "average" row indicates the average expenditures by an individual, and the total gives the total expenditures by category. The "total" column indicates the total for that subcategory (the sum across the total row). In addition, 60 of the 86 respondents stated that they stayed in a hotel in Delta Junction while on their trip, and 74 stated that if unsuccessful the first time, that they would return. The average hunting party was 2.5 people. This data could be made more refined by expanding the travel outside Delta Junction area categories.

Summary of Expenses (N=86*)

General Expenses

	<u>SHELLS</u>	<u>NEW GUN</u>	<u>CLOTH- ING</u>	<u>HAND LOADNG</u>	<u>TAXI- DERMY</u>	<u>MEAT PROCESS</u>	<u>TOTAL</u>
Average	13.79	8.34	14.58	6.63	298.43	60.31	
Total	1186.00	717.00	1254.00	570.00	25665.00	5187.00	34579.00

Expenses in Delta Junction Area

	<u>TRANSP</u>	<u>FOOD</u>	<u>LODGNG</u>	<u>OTHER</u>	<u>TOTAL</u>
Average	43.35	36.34	83.35	31.92	
Total	3728.00	3125.00	7168.00	2745.00	16766.00

Expenses Outside Delta Junction Area

	<u>TRANSP</u>	<u>FOOD</u>	<u>TOTAL</u>
Average	129.74	64.22	
Total	11158.00	5523.00	16681.00

Total Expenses per individual

<u>MINIMUM</u>	<u>MAXIMUM</u>	<u>MEAN</u>	<u>STD DEV</u>	<u>TOTAL</u>
0.00	3242.00	791.00	647.09	68026.00

*includes 8 people who responded as having zero expenses.

Responses to Attitude questions

Once the respondent had been asked the first set of valuation questions, a set of "reactions to our offer" questions were asked. The respondent was asked to indicate whether they felt the statement was "definitely true", "probably true", "probably false", or "definitely false". The fourteen statements are given below, with the number responding in each category following.

The strongest reactions were to statement 6, "I might not of used my permit anyway" (71 of 86 saying "definitely false") and statement 7, "this was the first bison permit I had drawn" (67 of 86 saying "definitely true"). Just over half of the respondents indicated "definitely true" to statement 8, "I didn't think your offer was serious", although reactions to statements 9, "It was too much like a game; what I did wouldn't really make a difference", and 10, "I thought your offer was illegal", were much more mixed. Surprisingly, letting another hunter get the permit (instead of ADF&G just keeping it) would not have increased the chances of the person selling the permit (statement 14). Also, note the difference in response to statements 11 and 13. This may be a "wolves vs. moose" type of a response.

The statements:

1. I could easily hunt bison somewhere other than the DJ area.
2. I would have spend the money within the next few weeks if I had taken the offer.
3. I would have probably put the money in a savings account or saved it some other way.
4. The money would have helped me pay for some other hunting opportunity.
5. There are other things I would just as soon do as hunt bison during that time of year.
6. I might not have used the permit anyway.
7. This was the first bison permit I had drawn.
8. I didn't think your offer was serious.
9. It was too much like a game; I didn't think what I did would really make a difference.
10. I thought the offer was probably illegal.
11. I don't think wildlife should have dollars and cents placed on it.
12. I already had some difinite plans to go bison hunting at Delta Junction.
13. If wildlife has any dollar value placed on it, it should be as high as possible.
14. I would have been more likely to sell my permit if I knew that it would have been used by another hunter at Delta.

Number Responding to Each Answer Under "Reactions to Offer" (N=86)

STATEMENT	DEFINITELY TRUE	PROBABLY TRUE	PROBABLY FALSE	DEFINITELY FALSE	NO ANSWER
1	10	15	9	50	2
2	13	14	28	28	3
3	21	29	20	12	4
4	18	21	22	22	3
5	8	19	24	32	3
6	3	2	8	71	2
7	67	2	0	5	12
8	44	16	9	12	5
9	20	13	22	22	9
10	28	13	17	22	6
11	53	11	7	12	3
12	33	7	11	25	10
13	25	8	14	33	6
14	8	11	11	53	3

The respondents were also asked to indicate whether or not they agreed or disagreed with the following statements. The responses and a discussion follow.

1. If a hunter is willing to spend the money, he should be able to buy permits from others who are willing to sell them as long as the permits are first given out at random so that everyone has an equal chance to get them.
- * 2. The State provide more opportunities for persons to watch bison in the Delta Junction area.
3. For me, a bison is a trophy animal.
4. The privilege to hunt is something that should not be bought and sold.
5. The largest share of the cost of supporting the bison is borne by the farmers.
6. It is a good idea for researchers to try to determine the value of things such as wildlife.
7. I would resent having to buy a tag to hunt bison.
- * 8. Bison are such an important asset for Alaska that more should be done to work out problems with the farmers.
- * 9. Hunters should be willing to pay a farmer to hunt on his land.
10. The Fairwell bison herd near McGrath is a good alternative to the Delta bison herd.
11. The State should pay farmers for damage to their crops.
12. I don't think wildlife should have a dollars and cents value placed on it.
13. The privilege to hunt should be free to any person.
14. I would be willing to buy a tag to hunt bison.
15. Bison herds should be established elsewhere in the State.
- * 16. The State should regulate the Delta herd to minimize conflict with the Delta farmers.

Number Responding to Each Answer Under "Statements" (N=86)

Statement	STRONGLY AGREE	PROBABLY AGREE	PROBABLY DISAGREE	STRONGLY DISAGREE	NO ANSWER
1	7	9	9	57	4
2	11	20	29	23	3
3	57	15	6	6	2
4	67	10	5	2	2
5	14	30	23	15	4
6	23	26	15	20	2
7	28	11	21	23	3
8	56	24	3	0	3
9	7	20	24	33	2
10	5	26	26	22	7
11	14	31	22	17	2
12	51	16	8	9	2
13	42	13	17	12	2
14	24	32	14	13	3
15	50	29	3	2	2
16	11	41	17	15	2

The responses to statements 1, 4, 12, and 13 all indicate an apparent satisfaction with the present means of allocating bison permits and a strong repugnance for a market based allocation mechanism. Statements 8 and 16 indicate that more should be done to mitigate the conflict between the bison and the farmers in the Delta Junction area, but the responses to 9 and 11 indicate that few people think the farmers should be compensated for their damages. The responses to question 15 indicate that people favor establishing another bison herd elsewhere in the State; however, this statement made no indication of costs (in dollars or otherwise) of introducing another herd, so it is not surprising that this would be favored.

The respondents were also asked why they applied for a bison permit. The uniqueness of the hunt and the quality/quantity of the meat were the most important reasons. Almost half (42) responded "definitely no" to the reason "I only wanted to hunt one big game species this season," indicating that these are some fairly serious hunters. The reasons and the responses follow.

1. I felt that my chances of bagging a bison were better than for other species.
2. The season for a Delta bison permit would not conflict with my plans to hunt other game.
3. The people I hunt with really wanted to hunt the Delta Junction bison.
4. I felt that it would be easier to find a place to hunt, or to get permission on private land.
5. I only wanted to hunt one big game species this season.
6. I have always wanted to hunt bison.
7. I wanted the quality and/or quantity of meat.
8. I wanted the trophy.
9. Because bison hunting is unique.

Number Responding to Each Answer Under "Reasons to Apply" (N=86)

REASON	NUMBER RESPONDING				
	DEFINITELY NO	PROBABLY NO	PROBABLY YES	DEFINITELY YES	NO ANSWER
1	24	24	18	13	7
2	26	17	19	17	7
3	16	10	20	34	6
4	23	16	26	15	6
5	42	20	10	7	7
6	0	5	15	61	5
7	1	5	14	61	5
8	8	10	19	44	5
9	4	2	14	61	5

Respondants were also asked whether or not they used hunting clubs or places where a fee is charged. Almost all responded never (73) or seldom (9). 79 had never leased land for hunting and 76 had never bought land for that purpose. In addition, most hunters hunt primarily within the State: 45 persons had never purchased a non-resident hunting permit, 14 seldom did, 22 did in some years, 3 in most years, and one every year.

When asked about the quality of the Delta Bison hunt, 55 rated it "excellent", 23 "good", 5 "fair", and 0 "poor". The difficulty of bagging a bison was judged to be "about right" by 73 respondents, and most thought that it was "about right" in terms of numbers of other hunters, number of regulations, number of bison, and the number allowed to be taken and places available to take them.

Demographics

There were 71 males and 11 females indicating gender. The education breakdown is as follows: 2 had less than high school education, 17 had completed high school, 37 had some college, 14 had college degrees, 5 had M.S. or equivalent degrees, and 7 had Doctoral degrees. Employment statistics: 3 students, 70 employed, and 10 in various stages of retirement. Five people had incomes less than \$20,000 per year, 12 made between \$20-30,000, 10 between \$30-40,000, 12 between \$40-50,000, 18 between \$50-75,000, 14 between \$75-100,000, and 8 over \$100,000. No demographics on race were collected. All but one respondent were a resident of Alaska. The next table shows the relationship between income, education, and the open ended wtp and wta responses. Notice the positive correlation between education and income.

Income (\$1000) and Education (yrs) vs. WTP and WTA

A **** indicates 'No Answer Given'

Observations are sorted by income

OBSERVATION	INCOME (\$1000)	EDUCATION (years)	WTP (\$)	WTA (\$)
9	125	16	500	1000
26	125	18	1000	1000
28	125	16	5000	10000
50	125	16	2500	15000
83	125	20	500	300
45	125	20	100	****
49	125	18	2500	10000
48	125	18	400	1000
81	100	20	2000	1000
84	100	12	300	300
1	100	12	25	100
38	100	14	100	2500
4	100	16	****	****
5	100	18	1000	****
57	100	20	10000	10000
58	100	14	250	500
44	100	14	10	0
46	100	20	300	500
23	100	20	400	****
13	100	14	1000	100
67	100	16	250	800
66	100	14	250	500
12	75	12	****	****
17	75	14	25	****
22	75	16	10	****
11	75	20	700	1500
27	75	14	10	1500
60	75	12	250	1500
71	75	16	250	****
87	75	14	10	5000
7	75	16	150	****
30	75	14	****	****
55	75	14	500	4000
31	75	12	100	4500
32	75	14	10	****
76	75	12	150	8000
51	75	16	750	1000
33	75	16	500	8000
79	75	12	250	****
82	75	14	200	250
59	50	12	250	500
70	50	14	100	10000
52	50	14	500	500
77	50	14	10	10
43	50	12	500	1000
16	50	14	500	500
19	50	14	100	7500
8	50	14	200	****
85	50	12	1000	3000
6	50	14	500	5000
29	50	14	10	****
3	50	14	1000	5000
35	40	16	25	1000
36	40	11	0	0
74	40	14	150	0
37	40	14	250	500
80	40	14	200	3000
15	40	14	1000	1000
14	40	14	300	2500
10	40	18	200	400
24	40	16	****	****
25	40	14	100	2000

(Education and Income, continued)

OBSERVATION	INCOME (\$1000)	EDUCATION (Years)	WTP (\$)	WTA (\$)
40	30	4	500	1000
62	30	12	1000	1500
61	30	14	750	750
21	30	14	100	100
39	30	14	500	500
41	30	12	500	1000
54	30	12	150	80
64	30	14	****	****
42	30	14	500	1000
2	30	14	100	3000
72	30	14	350	600
68	30	16	0	****
65	20	14	400	1000
69	20	12	750	1500
63	20	14	1000	6000
53	20	14	2000	2000
73	20	12	100	5000
86	****	16	25	4500
56	****	12	0	0
78	****	6	500	****
18	****	12	100	1000

Simulated Market Experiment

The open ended bids were used to simulate a market for Delta Junction bison hunting permits. This was done so that something may be learned about what to expect when an actual market is run to compare with the contingent valuation study to be done in the summer of 1991. Several observations were not used in the market simulation. Any observation in which the respondent did not respond to the wtp or the wta question was dropped. In addition, any respondent who was inconsistent in his response to the offer made to him and his stated price was dropped. Finally, any respondent indicating a willingness to sell at price \$0 or at a price above \$99,000 was deleted. This left 57 sellers and 71 buyers in the "market". The highest price someone would be willing to pay was \$10,000, and the highest price someone demanded for a permit was \$15,000.

The willingness-to-pay bids were ranked from highest to lowest (the highest bidder would be the first to get to buy a permit) and the willingness-to-sell bids were ranked from lowest to highest (the lowest bidder would be the first to sell a permit). The fact that the wtp and wta bids were from the same people was ignored; that is, the bids were treated as coming from different people. With this sample, the "price" would be \$600, and 17 permits would change hands. The market equilibrium is shown in the figure on the next page.

Since the sample produced only one simulation of the "market," this was not sufficient to develop any statistical knowledge of it. Therefore, further simulation using the "bootstrapping" method of Efron (*Jnl. Am. Stat. Soc.*, 1979) was conducted. It was assumed that the sample of bids was representative of the population. Based on this assumption, random draws (with replacement) from the sample were repeated for the wtp and wta bids. The draw on the sample was then used to simulate the market again. This process was repeated 10,000 times (with draws of 50 from each population). The mean price was \$587.65, with a standard deviation of \$132.28. The distribution of prices is highly skewed, however, with \$500 being the price in over 60% of the cases, a price greater than \$500 in almost 40% of the cases, tending toward zero as the price passed \$1000.00. It may be useful in the market experiment to encourage people to not use whole numbers like \$1000 or \$500. This may be done by a prompt such as: "In writing down your price, please make sure

that if we had offered you \$20 or \$30 dollars more (or less as the case may be) that you would not 'regret' your the bid you have submitted."

The mean of the wtp open end bids was \$646.26 (N=75). The mean of the wta open end bids was \$2278.73 (N=71). (The standard deviations were not calculated, however, the sample follows.) The difference is quite large, \$1632.47. Thus the "endowment effect" that Kanneman and Knetsch (*Journal of Political Economy*, 1991) have observed is also present in this study. The difference is roughly equal to 1.6 times the expected value of a lottery for which ten dollars (the application fee) is put down on a one in one hundred chance gamble (roughly the odds of being drawn). This is not much higher than one would expect with a moderate amount of risk aversion. However, it does suggest that the wta bids may in fact be much higher than the respondents are really willing to pay. A very interesting post survey question during the market experiment would be to ask how many people have "regret" given the actual market price—that is, how many would have actually taken the price if they had known what it would be.

Summary

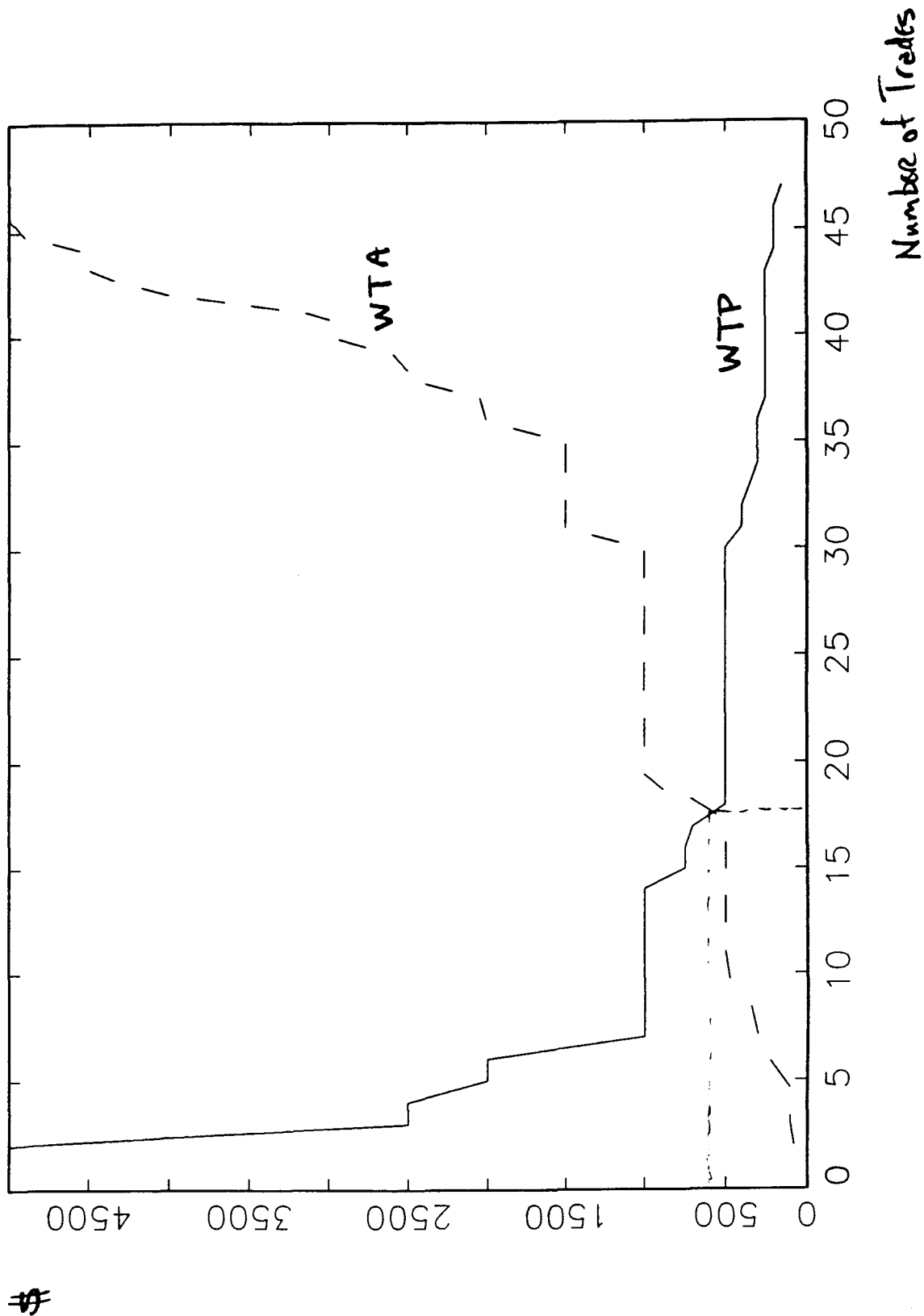
The pretest has shown that the basic method is working fairly well. That is, people seem to be responding in a sensible manner to the economic questions posed to them. Whether their answers are only accurate as relative measures, or whether they may also be used as absolute measures remains to be seen. This, of course, is what the market experiment will hopefully test.

The attitude questions are also of interest. Clearly there was some overlap, and some questions can be dropped. Other questions ("it was too much like a game; I didn't think that what I did would make a difference" and "if wildlife has any value placed on it, it should be as high as possible") can be split into two or more questions.

The response against trading permits is surprising to the author. It may be that the responses are due to a belief by the respondents that ADF&G is trying to figure out how to get more money out of the hunters. One way to test this is to break this set of questions into two parts: (a) where we ask "what if ADF&G auctioned the permits," and (b) what if we give them randomly and allow trading. This would sort out the two possible situations. That is, if they are afraid of high prices, they will oppose (a), but if they see the advantages of increased chances of getting a permit, they will support (b).

Finally, it is the belief of the author that questions regarding attitudes toward institutional arrangements should be included in all surveys (not just this one) since this is the only way that researchers will be able to get a feel for what sort of policy changes may have the support of the population. This information clearly could be of tremendous use in dealing with problems such as subsistence and other user conflicts in the future.

MARKET SIMULATION



Appendix B.

DELTA BISON HUNT ECONOMIC SURVEY

The remainder of this survey is to gather information regarding the economic value of bison.

Your answers will be held strictly confidential and will only be used for the purpose of estimating the economic value of wildlife.

Please try to answer every question since a single missing answer will decrease the value of all your answers. Answer what you believe to be true for you. The best answer is the one which most closely reflects your own feelings and beliefs or what you actually did.

The questionnaire has been divided into sections to make it easier for you to complete

Name of hunter _____
Address _____

Are you a permit holder? No _____ Yes, Either Sex _____ Cow Only _____

Are you a Resident _____ or Non-Resident _____

Did you take a bison? No _____ Yes, Male _____ Female _____

Date of harvest: _____ Location of harvest: _____

THIS SECTION ASKS YOU TO CONSIDER A HYPOTHETICAL QUESTION REGARDING HOW MUCH VALUE YOU PLACED ON YOUR BISON HUNT.

Assume that after receiving your bison permit, the Alaska Department of Fish and Game (ADF&G) offered you a check for \$_____.

Would you give up your permit in exchange for this check? In making your decision, assume that if you did send us your permit it would mean that your permit would be held by the ADF&G and would not be used by any other hunter. Sending us your permit would mean that you gave up your opportunity to hunt bison in the Delta area during the season.

If you had a real offer from us, would you have given up your permit for this price?

____ yes, I would have given up my permit at this price
 ____ no, I would not have given up my permit at this price

Did you have a hard time deciding to accept or refuse our offer, or was it pretty easy to decide?

____ it was very easy to decide
 ____ it was somewhat easy to decide
 ____ it was somewhat difficult to decide
 ____ it was very difficult to decide

If we made you the same offer again tomorrow or if you had to go back and decide again, do you think you would make the same decision?

____ it is very likely that I would make the same decision
 ____ it is somewhat likely that I would make the same decision
 ____ it is somewhat unlikely that I would make the same decision
 ____ it is very unlikely that I would make the same decision

If you received the Either sex permit, now assume that you received the Cow Only permit.
 If you received the Cow Only permit, now assume that you received the Either Sex permit.

Suppose the ADF&G had offered you a check for \$_____.

If you had a real offer from us, would you have given up your permit for this price?

____ yes, I would have given up my permit at this price
 ____ no, I would not have given up my permit at this price

Did you have a hard time deciding to accept or refuse our offer, or was it pretty easy to decide?

____ it was very easy to decide
 ____ it was somewhat easy to decide
 ____ it was somewhat difficult to decide
 ____ it was very difficult to decide

If we made you the same offer again tomorrow or if you had to go back and decide again, do you think you would make the same decision?

____ it is very likely that I would make the same decision
 ____ it is somewhat likely that I would make the same decision
 ____ it is somewhat unlikely that I would make the same decision
 ____ it is very unlikely that I would make the same decision

Now we would like you to assume you applied for a Delta bison permit this year but were not selected. If we offered you a valid Delta Either Sex permit to take one bison for \$_____, would you accept this offer?

_____ yes, I would pay this amount for a Delta Either Sex permit.

_____ no, I would not pay this amount for a Delta Either Sex permit.

We have made you an imaginary offer to issue you a hunting permit. You could take it or leave it. Suppose we did not make you an offer but let you set the price. How much would you pay for the permit? (PUT YOUR PRICE IN THE BLANK BELOW)

\$_____ is the highest amount that I would pay for a Delta Either Sex bison permit. I would take a permit if you offered me one for this amount.

Earlier, we made you an imaginary offer for your permit. You could take it or leave it. Suppose that we did not make you an offer, but let you set the price. How much would you be willing to take for your permit? (PUT YOUR PRICE IN THE BLANK BELOW, PLEASE ANSWER EACH QUESTION)

If the permit I hold is an EITHER SEX permit, \$_____ is the lowest amount I would take for my Either Sex permit. I would give up my permit if you offered me this amount of money for it.

If the permit I hold is an COW ONLY permit, \$_____ is the lowest amount I would take for my Cow Only permit. I would give up my permit if you offered me this amount of money for it.

WE ARE INTERESTED IN YOUR REACTION TO OUR OFFER. PLEASE INDICATE IF THE FOLLOWING ARE TRUE FOR YOU PERSONALLY.

T = Definitely True f = probably false
t = probably true F = Definitely False

I could easily hunt bison somewhere other than the Delta Junction Area.

T t f F

I would have spent the money within the next few weeks if I had taken the offer.

T t f F

I would probably have put the money in a savings account or saved it some other way.

T t f F

The money would have helped me pay for some other hunting opportunities.

T t f F

There are other things I would just as soon do as hunt bison during that time of the year.

T t f F

I might not have used my permit anyway.

T t f F

This was the first bison permit I had drawn.

T t f F

I didn't think your offer was serious.

T t f F

It was too much like a game; what I did wouldn't really make a difference.

T t f F

I thought the offer was probably illegal.

T t f F

I don't think wildlife should have a dollars and cents value placed on it.

T t f F

I already had some definite plans to go bison hunting at Delta Junction.

T t f F

If wildlife has any dollar value placed on it, I think it should be as high as possible.

T t f F

I would have been more likely to sell my permit if I knew that it would have been used by a bison hunter at Delta.

T t f F

IN THIS NEXT SECTION WE WOULD LIKE TO ASK YOU SOME QUESTIONS ABOUT BISON HUNTING AND HOW IMPORTANT IT IS TO YOU.

1. How many years have you applied for the Delta bison permit?

_____ every year _____ occasionally
 _____ most of the time _____ very seldom
 _____ about half of the time _____ this is my first time
 _____ total number of years which you have applied: _____

2. Have you applied for other bison permits in other areas?

_____ yes, total number of years _____
 _____ no

3. How many Delta bison permits have you received since you began hunting in Alaska?

_____ one
 _____ two
 _____ more than two
 _____ none

4. How many bison have you bagged in the Delta Junction area?

_____ none
 _____ one
 _____ two or more

5. How often have you hunted bison at places other than Delta Junction?

_____ no years
 _____ one year
 _____ two or more years

6. How many bison have you bagged at places other than Delta Junction?

_____ none
 _____ one bison
 _____ two bison
 _____ three or more bison

7. Do you have a particular person, or a group of persons that go with you on nearly all of your big game hunting trips? (CHOOSE ONE)

_____ yes, I have 1 hunting partner
 _____ yes, I have 2 hunting partners
 _____ yes, I have 3-5 hunting partners
 _____ yes, I have more than 5 hunting partners
 _____ no, I don't always hunt with any particular person(s)
 _____ I usually prefer to hunt alone

8. For some hunters, being with certain friends or a certain partner may be the most important part of hunting. Other hunters may hunt with different people on different occasions or hunt alone. Please check the single response below which best indicates your feelings about the people you hunt with. (CHOOSE ONE)

_____ for me, hunting with a certain person or group of persons is the most important part of a hunting trip.
 _____ for me, who I hunt with is important, but there are different people who I hunt with on different hunting trips.
 _____ for me, who I hunt with is moderately important, but I could enjoy hunting with most people.
 _____ for me, who I hunt with doesn't really matter; the hunt itself is most important.

9. Choose the one response that best describes your current hunting

_____ Now, I hunt for all types of game more than I used to.
 _____ Now, I hunt for all types of game as much as I ever did.
 _____ Now, I hunt all game less than I used to.

10. Has bison hunting taken the place of any other types of hunting you have done this year?

_____ no
 _____ yes: Which ones? (where appropriate, circle gun and/or archery)

_____ caribou _____ gun archery
 _____ moose _____ gun archery
 _____ dall sheep _____ gun archery
 _____ blk/grizzly bear _____ gun archery
 _____ other big game _____ gun archery
 _____ small game _____ gun archery
 _____ water fowl _____ gun archery
 _____ upland birds _____ gun archery

11. About how many of your friends are big game hunters?

_____ none _____ most
 _____ a few _____ all
 _____ some

12. How would you rate your skills in shooting at big game?

_____ below average
 _____ about average
 _____ above average

13. Overall, how would you rate yourself as a big game hunter?

_____ I am a below average big game hunter.
 _____ I am an average big game hunter.
 _____ I am an above average big game hunter.
 _____ I am an expert big game hunter.

THESE NEXT QUESTIONS ARE ABOUT YOUR HUNTING TRIP FOR BISON AT DELTA THIS FALL. PLEASE GIVE US YOUR BEST ANSWER FOR EACH QUESTION.

1. This fall did you take any trips to the Delta Junction area in which you would not hunt?

yes --- How many non-hunting trips? _____
no _____

2. What type of vehicle did you travel in on your bison hunting trip this fall?

standard sized car _____ pick-up truck _____
compact car _____ other truck _____
jeep, van, or camper _____ other vehicle _____

3. How many people, including yourself, did you travel with in this vehicle?

_____ people, including myself _____

4. Did you stay overnight on your bison hunting trip to Delta Junction this fall?

no _____ Did you plan to: _____ camp _____
yes _____ stay at hotel or motel _____
_____ stay with friend/relative _____
_____ other _____

5. If you did not tag a bison on your first bison hunting trip to Delta Junction this fall, did you (or would you) make a second trip?

yes, for a total of _____ trips _____
no _____

6. We would also like to know about the purchases you have made or expect to make for bison hunting this year. Please give us your best answer based on your current plans and past hunting experience.

How much have you spent or expect to spend on the following items for bison hunting at Delta Junction? (If you do not expect to spend any money on an item please put a 0 in the blank.)

shells	Expenses
new gun	\$ _____
new clothing for bison hunting	\$ _____
transportation to and from Delta Junction	\$ _____
transportation in Delta Junction	\$ _____
food and drink at the Delta area	\$ _____
other food and drink	\$ _____
overnight lodging at the Delta area	\$ _____
hand loading equipment or supplies	\$ _____
other expenses in Delta	\$ _____
taxidermy	\$ _____
meat processing	\$ _____

14. For some people bison hunting may be one of the most important experiences in their lives. To others, it may be just one of a number of interests they have, something which they enjoy but aren't strongly committed to. Please check the single statement below which best describes your feelings about bison hunting. (CHOOSE ONE)

_____ If I couldn't go bison hunting, I would probably find something else that was just as enjoyable.
_____ If I couldn't go bison hunting, I would miss it, but not as much as a lot of other things I now enjoy.
_____ If I couldn't go bison hunting, I would miss it more than most of the other interests I now enjoy.
_____ If I couldn't go bison hunting, I would miss it more than all of the other interests I have.

15. How often do you go to the Delta Junction area to watch bison but not hunt? (CHOOSE ONE)

almost every year _____
some years _____
only when I don't receive a bison permit _____
seldom _____
never _____

16. What other types of hunting do you participate in?

none _____
Place a check mark by each type of hunting you usually have done in recent years. (CHECK ALL THAT APPLY AND CIRCLE GUN AND/OR ARCHERY.)

_____ caribou	gun archery
_____ moose	gun archery
_____ dall sheep	gun archery
_____ blk/grizzly bear	gun archery
_____ other big game	gun archery
_____ small game	gun archery
_____ water fowl	gun archery
_____ upland birds	gun archery

17. Considering all of the activities you could potentially do, how many substitutes do you have for bison hunting? In other words, if you couldn't go bison hunting, how many other different activities are there that you would enjoy doing just as much?

_____ I have many substitutes for bison hunting.
_____ I have some substitutes for bison hunting.
_____ I have only a few substitutes for bison hunting.
_____ I have no substitutes for bison hunting.

THESE NEXT QUESTIONS ARE ABOUT YOUR HUNTING EQUIPMENT AND OTHER INVESTMENTS IN HUNTING.

- How many rifles do you own?
 _____ rifles
- Do you own a rifle that you use just for bison hunting?
 _____ yes
 _____ no
- For the following items of hunting equipment, please check each one that you own.
 _____ big game rifle
 _____ shotgun
 _____ hunting dog
 _____ boat
 _____ a vehicle that you use primarily for hunting
 _____ four-wheel drive vehicle
 _____ airplane
 _____ ATV
 _____ three or four wheeler
- Have you purchased any land in the last 10 years that you use for hunting?
 _____ yes
 _____ no
- How often do you hunt at a gun club or shooting preserve where a fee is charged?
 _____ every year
 _____ most years
 _____ some years
- Have you ever leased land for hunting?
 _____ every year
 _____ most years
 _____ some years
- Have you ever purchased a non-resident hunting license in any state?
 _____ every year
 _____ most years
 _____ some years

THESE NEXT QUESTIONS WILL BE ABOUT BISON MANAGEMENT AND THE DELTA BISON HERD MANAGEMENT.

- Overall, how would you rate the quality of bison hunting at Delta Junction?
 _____ excellent
 _____ good
 _____ fair
 _____ poor
- How would you rate the quality of bison hunting at Delta Junction in comparison with other places you have hunted bison.
 _____ Delta Junction is generally better than other places that I have hunted bison
 _____ Delta Junction is about the same as other places that I have hunted bison
 _____ Delta Junction is generally worse than other places that I have hunted bison
 _____ I have never hunted bison at places other than Delta Junction
- There are many factors which may affect your feelings about the quality of bison hunting at Delta Junction. For each item below please indicate how you feel about it with respect to Delta Junction.

	Too Many	About Right	Too Few
The number of other hunters at Delta Junction	M	R	F
The number of bison at Delta Junction	M	R	F
The bison hunting regulations	M	R	F
The number of bison you are allowed to take	M	R	F
The number of places to hunt at Delta Junction	M	R	F
- How would you rate the difficulty of bagging a bison at Delta Junction?
 _____ too hard
 _____ about right
 _____ too easy

NEXT, WE WOULD LIKE TO ASK YOUR OPINION ABOUT A NUMBER OF DIFFERENT STATEMENTS. FOR EACH STATEMENT PLEASE CIRCLE THE RESPONSE WHICH BEST INDICATES YOUR PERSONAL OPINION ABOUT IT.

SA = Strongly Agree
pa = probably agree
pd = probably disagree
SD = Strongly Disagree

If a hunter is willing to spend the money, he should be able to buy permits from others who are willing to sell them as long as the permits are first given out at random so everyone has an equal chance of receiving a permit.

The State of Alaska should provide more opportunities for persons to watch the bison in the Delta Junction area.

For me, a bison is a trophy animal.

The privilege to hunt is something that should not be bought or sold.

The largest share of the cost of supporting bison in the Delta Junction area is borne by farmers.

It is a good idea for researchers to try to determine the value of things such as wildlife.

I would resent having to buy a tag to hunt bison.

Bison are such an important wildlife asset for Alaska that more should be done to work out the problems with farmers in the Delta Junction area.

Hunters should be willing to pay a farmer in order to hunt on his land.

The Fairwell bison herd near McGrath is a good alternative to the Delta bison herd.

The State of Alaska should pay farmers for bison damage to their crops.

I don't think that wildlife should have a dollars and cents value placed on it.

The privilege to hunt should be free to any person.

I would be willing to buy a tag in order to hunt bison.

Bison herds should be established in other parts of the state.

The ADF&G should regulate the Delta bison population size to minimize conflicts with farmers.

THERE MAY HAVE BEEN MANY REASONS WHY YOU CHOSE TO APPLY FOR A DELTA BISON PERMIT THIS YEAR. BELOW ARE SOME POSSIBLE REASONS. FOR EACH ONE, PLEASE INDICATE WHETHER OR NOT THIS WAS AN IMPORTANT REASON FOR YOUR CHOICE.

N = Definitely Not
n = probably not
y = probably yes
Y = Definitely Yes

I CHOSE TO APPLY FOR A DELTA BISON PERMIT BECAUSE:

I felt that my chances of bagging a bison were better than for other species.

The season for a Delta bison permit would not conflict with my plans for hunting other game.

The people I hunt with wanted to hunt the Delta bison.

I felt that it would be easier to find a place to hunt, or get permission to hunt on private land.

I only wanted to shoot one big game species this season.

I have always wanted to hunt bison.

I wanted the quality and/or quantity of the meat.

I wanted the trophy.

Because hunting bison is unique.

Other? (PLEASE STATE)

WE HAVE ALREADY ASKED YOU SOME QUESTIONS ABOUT THE DOLLAR VALUE OF BISON HUNTING, BUT THERE ARE MANY WAYS THAT THESE QUESTIONS COULD BE ASKED. OTHER RESEARCHERS HAVE ASKED THEM IN DIFFERENT WAYS, AND WE WOULD LIKE TO GET YOUR REACTIONS TO A COUPLE OF THESE OTHER QUESTIONS. THESE QUESTIONS MAY SEEM UNUSUAL AND WILL ASK YOU TO PUT YOURSELF IN AN IMAGINARY SITUATION. PLEASE GIVE US THE BEST ANSWER YOU CAN FOR EACH OF THESE QUESTIONS.

1. Many kinds of recreation are provided by private industry which charge a price of admission. It may cost \$7.00 to get into a movie, \$30.00 to get a seat for a professional football game or \$200.00 per day to float down the Yukon River.

Think of your Delta bison permit as a "ticket" for admission. Given the price of admission to movies, football games, a river trip or other forms of recreation, what would be a reasonable price for your "ticket" to hunt bison at Delta Junction?

\$_____ is the highest price that I would consider to be a reasonable "price of admission" for bison hunting.

2. How many days were you away from home on this trip?

days spent traveling _____
days spent in the Delta Junction area _____

3. Assume you are employed at a job where you make \$100.00 per day. Would you be willing to take one day off work, losing one day's pay, to hunt bison at Delta Junction?

yes _____
no, it wouldn't be worth it. _____

If you made \$150.00 per day, would you be willing to take one day off work, losing one day's pay, to hunt bison at Delta Junction?

yes _____
no, it wouldn't be worth it. _____

How much would you have to be making per day before you would work rather than give up one day's pay to hunt bison at Delta Junction?

\$_____ per day

4. Since you have drawn a permit successfully this year, you are not eligible for a permit for another five years. If you could still be eligible to have your name drawn each year, what is the maximum you would be willing to pay for a Delta bison permit for this year? \$_____

IN THIS FINAL SECTION WE WOULD LIKE TO ASK YOU SOME QUESTIONS ABOUT YOUR BACKGROUND WHICH WILL HELP US COMPARE YOUR ANSWERS TO THOSE OF OTHER PEOPLE. WE WOULD STRESS THAT ALL OF YOUR ANSWERS ARE STRICTLY CONFIDENTIAL.

1. How old are you? _____ years old
2. Are you _____ male _____ female?
3. How many years of school have you completed?
1 _____ 2 _____ 3 _____ 4 _____ 5 _____ 6 _____ 7 _____ 8 _____ 9 _____ 10 _____ 11 _____ 12 _____
_____ some college _____ B.A. or equivalent _____ M.A. or equivalent
_____ Advanced degree (M.D., Ph.D., etc.)

4. What is your primary occupation? Please be as specific as possible. If retired, give your former occupation. _____

5. With reference to your primary occupation, are you currently:

_____ fully retired
_____ semi-retired, working part-time
_____ retired, working at a different job part-time
_____ none of the above

6. Please check the response that comes closest to your total immediate family income before taxes. If your parents claim you as a dependent for tax purposes, please give your parents' income.

_____ \$0 to \$19,999 _____ \$50,000 to \$74,999
_____ \$20,000 to \$29,999 _____ \$75,000 to \$99,999
_____ \$30,000 to \$39,999 _____ more than \$100,000
_____ \$40,000 to \$49,999 _____

7. Are you:

_____ single
_____ separated, divorced or widowed
_____ married
_____ other

8. How many children do you have? _____ children

9. Where do you presently live?

- _____ rural area
- _____ town (2499 population or less)
- _____ town (2500-4,999 population)
- _____ small city (5,000 to 49,999 population)
- _____ medium city (50,000 to 500,000 population)
- _____ large city (greater than 500,000 population)
- _____ suburb -- within 15 miles of a large or very large city

10. Where did you live (mostly) when you were growing up?

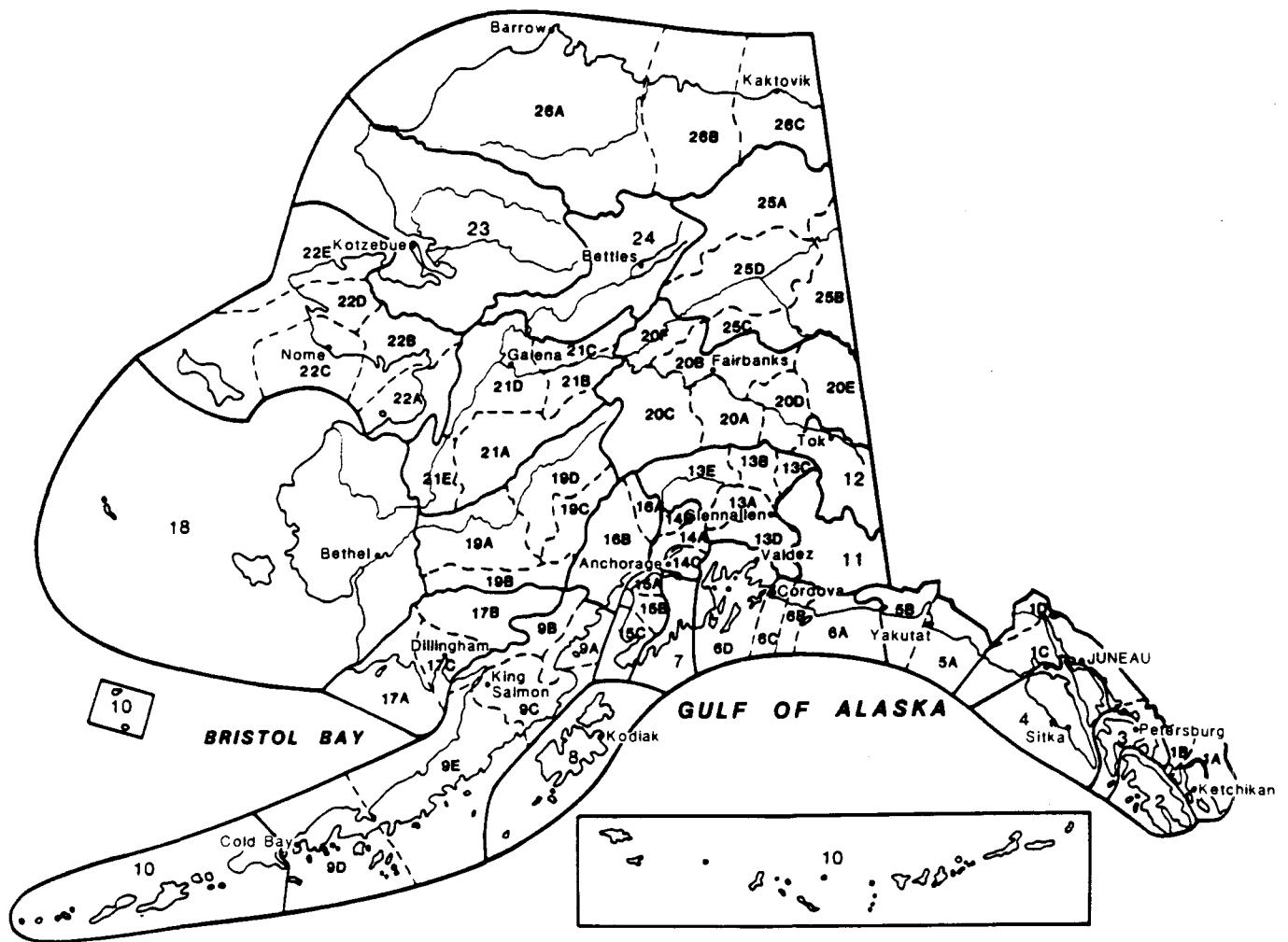
- _____ rural area
- _____ town (2499 population or less)
- _____ town (2500-4,999 population)
- _____ small city (5,000 to 49,999 population)
- _____ medium city (50,000 to 500,000 population)
- _____ large city (greater than 500,000 population)
- _____ suburb -- within 15 miles of a large or very large city

11. Are you now a member of one or more outdoor or conservation organizations such as the National Rifle Association, sportmen's clubs, Sierra Club, etc.?

- _____ no
- _____ yes Which one(s): _____

WE HOPE YOU HAVE FOUND THIS QUESTIONNAIRE
AN INTERESTING AND ENJOYABLE EXPERIENCE.
THANK YOU FOR YOUR HELP AND COOPERATION

Alaska's Game Management Units



Project funded by Federal Aid in Wildlife Restoration