CAPTURE AND RADIO TELEMETRY OF DESERT BIGHORN SHEEP IN WESTERN ARIZONA

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ABSTRACT: In October 1977, Southern California Edison and Arizona Public Service issued a five-year contract to Dr. E. Linwood Smith and Associates of Tucson, Arizona, to study potential impacts of a proposed 500 kV transmission line on desert bighorn sheep. The study is divided into three phases: 1) preconstruction baseline data acquisition, 2) construction-impact monitoring, and 3) post-construction impact evaluation.

The proposed line will transmit power from the Palo Verde Nuclear Power Plant, approximately 30 miles west of Phoenix, Arizona, to Edison's Devers Substation near Palm Springs, California. The line will traverse bighorn habitat in the Plomosa and Dome Rock Mountains of western Arizona.

In November 1977, 20 bighorn were captured and fitted with radio telemetry collars. Seventy percent of the collars on rams failed during the first year. Thus, in November 1978, in an attempt to replace nonfunctioning collars and to increase the study population, 18 bighorn were captured, three of which were originally collared in 1977. A total of 38 captures have been made; effective December 1978, 26 sheep had functioning radio-transmitting collars. Radio telemetry flights were flown every five days to monitor movement of collared sheep. During the first 12 months of study, over 1100 relocations were made.

This paper is designed to serve as an introduction to the study. Data on capture activities and preliminary trends resulting from telemetry monitoring are presented.

INTRODUCTION.

In 1975, Southern California Edison became a partner in the Palo Verde Nuclear Generating Station near Phoenix, Arizona. A 500 kV transmission line connecting the generating station and Edison's Devers Substation near Palm Springs, California, is needed by 1982 to transmit power to Edison's service territory.

Extensive biological studies conducted for the project environmental impact report indicated that there were no feasible transmission line corridors in Arizona that would avoid desert bighorn sheep *(Ovis canadensis mexicanus)* habitat. Discussions with wildlife biologists, and a thorough review of the literature revealed an insufficient knowledge of desert bighorn to realistically quantify the extent of impact which may be induced by the proposed transmission line project.

Desert sheep have been declining throughout most of their range in recent time (R.K. Weaver 1975; R.A. Weaver 1975; Tsukamoto 1975). For example, since 1950, sheep herds have disappeared from six formerly inhabited mountain complexes in Arizona (R. Smith, Arizona Game and Fish Department). Two reasons often cited for the decline are habitat loss and human encroachment. However, despite the level of concern for this species, surprisingly little data have been collected to quantify causes of declines and even less to determine whether or not certain human activities in sheep habitat are contributory.

Thus, to better identify the potential effects of human encroachment and habitat loss associated with a utility transmission line project, Southern California Edison and Arizona Public Service have contracted with E. Linwood Smith and Associates of Tucson, Arizona, to conduct a five-year study of desert bighorn in western Arizona. This study has three phases: 1) preconstruction base line data acquistion, 2) construction impact monitoring and 3) post-construction impact evaluation.

Important study elements include habitat assessment, monitoring of water availability, movement patterns, behavioral patterns, band size and composition, dietary preference by season and by sex and age as determined by fecal analysis, and monitoring of human activities in the study area.

This study is centered around the Plomosa-New Water Mountains and Dome Rock Mountains of western Arizona. The Plomosa and New Water Mountains are located approximately 40 miles east of the Colorado River. The Dome Rock Mountains generally parallel the Plomosas and are about 15 miles east of Blythe, California (Figure 1). It appears at this point in time that separate bighorn populations inhabit these mountains. There are approximately 200 square miles of desert bighorn sheep habitat in the study area.

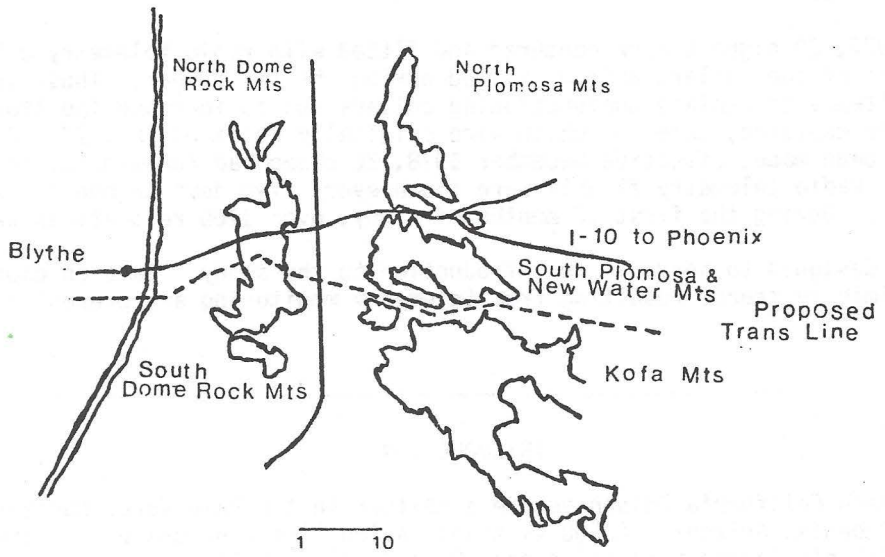

Figure 1. Study area of the Dome Rock and Plomosa Mountains of western Arizona.

The Plomosa-New Water Mountains are a rugged complex rising abruptly from the desert floor. They provide habitat for a large, sustaining bighorn population estimated to be in excess of 200 animals (Arizona Game and Fish Department). The Dome Rocks, in contrast, are less incised and have a much smaller population, probably less than 50 sheep (E.L. Smith personal communication).

CAPTURE AND COLLARING

The fundamental approach of this study centers around the aerial monitoring of movement of at least 20 desert bighorn affixed with radio transmitters. Between November 15 and 23, 1977, 20 bighorn, 10 of each sex, were captured and fitted with telemetry collars. Between November 20 and 28, 1978, an additional 18 sheep were captured, 15 of which were fitted with collars. Three of these 15 were originally collared in 1977. The 1978 capture activities were necessary as collars on one ewe and seven rams failed. These collar failures are discussed later.

In order to immobilize bighorn for collaring, all sheep were tranquilized with a combination of 2.5 mg of M-99 (Etorphine), 3.0 mg Stresnil (Azaperone) and 0.5 mg Atropine. The drugs were injected by a 3.0 cc dart fired from a CO_2 Cap Chur gun. All shooting was done by personnel from the Arizona Game and Fish Department.

Animals were darted from a helicopter. During the 1977 capture work a Bell B-1 series helicopter was employed; during 1978 a Hughes 500 C was used. The turbine-powered Hughes proved to be a much safer and more maneuverable ship. The Hughes also offered the advantages of having the shooter positioned on the same side of the craft as the pilot, and it covered more ground in less time than the Bell.

From the time of injection, the first observed reaction to the M-99 ranged from 1.75 to 10 minutes. Five animals (three ewes and two rams) were darted a second time and the observed reactions to the second injection occurred at 1.75 to 3.0 minutes. The mean time required for the animals to lie down after initial darting was 7.3 minutes with the range 5.0 to 10.0 minutes. Seven sheep did not lie dow and were forced down by the capture team. One young ram had to be collared, and data collected with the animal standing. A 13 year old ram had to be forced down even after being darted a second time.

Once color coded collars were affixed and data obtained, the animals were injected with Depo-penicillan and the dart wound treated with Terramycin salve. The animals were then injected with 1.25 mg of M50-50 (diprenorphine) to reverse the narcotizing affect of the M-99.

The initial reaction to M50-50 was observed within approximately 30 seconds as an increased respiratory rate. Within 1.0 to 1.5 minutes animals were helped to their feet and held, still blindfolded, until they demonstrated the ability to be released. The majority of animals moved off in the direction they were moving when they layed down and generally trotted over the nearest ridge. One ewe was carried about 30 feet prior to injection of M50-50 to locate here away from extremely hazardous terrain. Nearly all sheep were somewhat atoxic for a short time (0.5-2.0 minutes) following releases. Therefore, none were released in situations were atoxia could result in a serious fall.

Of the total 38 sheep captured, one died while under the influence of M-99. This was a 4-year-old ram originally collared in 1977 and recaptured in 1978 for collar replacement. During the 1977 capture, the sheep remained relatively active while narcotized with M-99. He did much the same in the second capture, and it is theorized that this was a nervous animal that became over-stressed during the capture. The animal was autopsied and the ram appeared to be in excellent health.

Table 1 lists the radio collar number, age, sex, date of capture, and approximate location of animals captured in 1977. Table 2 lists physical measurements taken during collaring activities.

COLLAR FAILURE

Between February and July, 1978 eight collars ceased functioning, seven of these on rams. If all factors were equal for both sexes, the probability of collar failure on seven rams and one ewe would be less than 1 percent. This suggests that ram related behavior was a probable cause for collar failure. Additionally, 85.7% of ram collar failures occurred at the end of the 1977 breeding season and during the 1978 rut (Figure 2). The three rams

TABLE 1. Distribution of radio collars by age, sex, date and general location of animals captured in 1977.

RADIO NO.	SEX	ESTIMATED AGE	DATE	GENERAL LOCATION
1	F	3-4	11/16/77	Plomosa Mts., North of I-10
2	F	5-6	11/16/77	Plomosa Mts., North of I-10
3	F	2-3	11/15/77	Plomosa Mts., North of I-10
4	F	1-2	11/15/77	Plomosa Mts., North of I-10
5	M	6-7	11/21/77	New Water Mountains
6	M	2-3	11/15/77	Plomosa Mts., North of I-10
7	M	8-9	11/16/77	Plomosa Mts., North of I-10
8	M	2-3	11/16/77	Plomosa Mts., North of I-10
9	M	5-6	11/17/77	Plomosa Mts., North of I-10
10	F	1-2	11/17/77	Plomosa Mts., South of I-10
11	F	1-2	11/18/77	Plomosa Mts., South of I-10
12	F	8-9	11/18/77	Plomosa Mts., South of I-10
13	M	5-6	11/21/77	Plomosa Mts., South of I-10
14	M	2-3	11/18/77	Plomosa Mts., South of I-10
15	M	10+	11/23/77	Dome Rock Mts., North of I-10
16	F	5-6	11/21/77	New Water Mountains
17	F	5-6	11/23/77	Dome Rock Mts., North of I-10
18	F	4-5	11/23/77	Dome Rock Mts., North of I-10
19	M	2-3	11/22/77	Dome Rock Mts., North of I-10
20	M	3-4	11/22/77	Dome Rock Mts., North of I-10

TABLE 2. A summary of measurements taken on Desert Bighorn Sheep during collaring activities, 15-23 November 1977. Left horn measurements are not listed as they are not significantly different than right horn measurements. All measurements are in centimeters.

RADIO	SEX	RB	RL	W	HF	Ta	Ea	To	SH	CG
1	F	16.5	29.8	-	36.0	11.3	10.8	136.8	76.0	98.4
2	F	16.2	39.4	-	38.2	10.9	-	147.5	83.2	103.0
3	F	14.9	31.4	-	32.0	11.1	11.6	149.0	75.1	90.6
4	F	13.3	27.2	-	36.2	11.2	10.6	142.6	78.3	91.2
5	M	34.9	81.9	50.8	38.0	12.3	11.6	152.0	79.0	103.3
6	M	33.0	69.8	49.5	40.2	11.3	11.4	149.4	-	100.1
7	M	35.6	67.0	54.0	38.3	10.2	10.5	150.2	82.0	104.6
8	M	29.5	67.6	52.4	41.0	13.6	11.4	149.0	81.3	101.6
9	M	37.1	79.7	-	39.4	10.2	10.8	167.0	85.1	111.0
10	F	14.6	27.0	-	33.1	11.5	11.8	148.0	73.6	95.2
11	F	13.6	28.9	-	36.5	10.4	11.2	138.0	-	88.9
12	F	13.6	25.0	-	35.3	8.5	11.0	140.0	74.5	91.7
13	M	34.3	70.2	51.4	40.0	13.2	11.7	164.5	89.5	104.0
14	M	33.6	63.5	45.1	39.0	12.2	10.9	145.0	85.5	98.4
15	M	34.0	82.5	42.2	35.8	12.0	10.6	155.0	74.0	104.5
16	F	15.2	31.1	-	25.1	10.2	11.5	144.0	77.0	102.0
17	F	14.6	26.5	-	33.5	10.7	11.5	139.0	73.0	93.0
18	F	13.6	25.0	-	31.6	9.5	10.5	136.0	72.0	93.0
19	M	32.4	63.5	49.5	37.0	11.0	12.0	146.0	-	-
20	M	34.3	60.3	47.6	35.8	12.5	11.2	152.0	74.2	101.0
$\bar{X}$	M =	33.9	70.6	49.2	38.4	11.8	11.2	153.0	81.3	103.2
$\bar{X}$	F =	14.6	29.1	-	33.7	10.5	11.2	142.1	75.8	94.7

KEY:

RB = Right Base
RL = Right Length
W = Maximum Width (rams only)
HF = Hind Foot
Ta = Tail
Ea = Ear
To = Total Body Length
SH = Shoulder Height
CG = Chest Girth

with functional collars at the end of 1978 were the youngest (two animals at three years) and the oldest (10+ years) and, therefore, possibly not actively involved in the rut. Thus, collar failure occurred on prime age rams and during the period of highest social interaction.

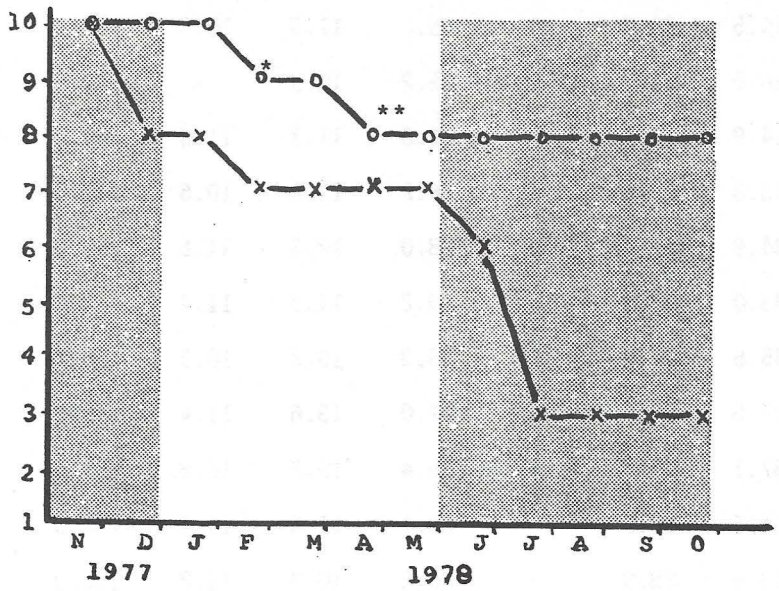

Figure 2. Timing of radio collar failures on ewes "o" and rams "+". Shaded area represents breeding season. *Ewe dead. **single ewe collar failure.

All temlemetry equipment employed was manufactured by Telonics, Mesa, Arizona. Collars were specifically designed for bighorn sheep. The collar canister was cushioned to protect the crystal against impact shock up to 100 G. However, with failure of seven of 10 ram collars, and with the hypothesis that failure was due to crystal breakage, new collars were designed for the 1978 recollaring. These collars have special high impact aerospace crystals designed to withstand 10,000-20,000 G. The crystals were also repositioned to reduce the angle of most likely impact.

Two nonfunctioning ram collars retrieved in November 1978 showed the collar canisters to be greatly damaged. Inspection of the collars by Telonics revealed that the crystals were indeed fractured.

CAPTURE OF PREGNANT EWES

To avoid high desert temperatures, capturing was scheduled during November which also coincided with ewe pregnancy. The stress of capture activities and drugs on the ewes and fetuses were of concern to the capture team. Ewes were carefully monitored during capture and followed closely after release.

Eight of the 10 ewes collared in 1977 were confirmed to be pregnant at the time of capture. Highly restricted movement patterns (determined via telemetry monitoring) on another ewe suggested the ewe gave birth in January; she was never sighted with a lamb, however. If she had a lamb it suffered early mortality. One of the known eight pregnant females died in February 1978, the cause of death is unknown and may have been due to poaching.

In November 1978, a pregnant ewe was hit with the dart in the upper posterior (below the kidney) portion of the abdominal cavity. This ewe gave birth in late December with no apparent ill effects to the ewe or the lamb.

Based upon the time of lambing and using 180 days as the gestation period (Geist, 1971), the stage of pregnancy at the time of capture is calculated for the seven ewes (Table 3). The percent of pregnancy of captured ewes at the time of collaring ranged from 12-76 percent ($\bar{x}$ = 48%). Lambing success indicates that neither ewes nor fetuses were adversely affected by the capture activities or by the drugs.

TABLE 3. Age of collared ewe, percent of pregnancy at time of capture and date of lambing.

ESTIMATED AGE OF EWE	CAPTURE DATE	PARTURITION DATE	PERCENT TERM CAPTURE
2.75	11/15/77	2/25/78	43.0
1.75	11/15/77	4/02/78	23.0
3.75	11/16/77	1/15/78	67.0
8.75	11/18/77	1/01/78	76.0
5.75	11/18/77	4/25/78	12.0
6.00	11/23/77	1/31/78	61.0
4.75	11/23/77	3/01/78	54.0

RADIO TELEMETRY MONITORING

Aerial monitoring of the study population began on December 1, 1977. Between December 1977, and December 1978, flights were flown every five days, each lasting 2-3 hours and covering the entire 200 square mile study area.

A dual yagi antenna system on a Cessna 172 was employed. One antenna, fixed in a vertical position on the right wing strut, was used for long range searching. The second antenna was fixed in a horizontal position to a long handle extended through the floor of the aircraft. This horizontal antenna could be rotated and was used for pinpointing specific sheep locations. The latter is accurate to within 100 meters of the animals' actual location.

Sheep locations were recorded on USGS topographic maps. A 1000 meter Universal Transverse Mercator grid was used to assign specific coordinates to each location. These data are being used to determine movement patterns and home range size of the various sex and age classes.

During this first year of telemetry monitoring, success of locating animals with functioning collars per flight ranged from 80 to 100 percent ($\bar{x}$ = 96%). Over 1100 relocations were made during this 12 month period. Ewes accounted for 58 percent of the total with monthly ranges of 35-58 relocations. Rams represented 42 percent with a range of 5-58 relocations. The difference in relocations by sex was due, at least in part, to the loss of functioning ram collars.

Experience thus far in this study indicates that telemetry monitoring is a viable and valuable methodology for obtaining data on dispersal and movement patterns. At this point, the first years' data are not fully evaluated. When two years of data have been obtained, analyzed and compared, the value of the telemetry system can be much better defined. Thus far, preliminary trends from the telemetry data indicate:

1. Rams have a greater mobility index than do ewes. Mobility in rams is highly variable.

2. Non-reproducing ewes have a greater mobility index than reproducing ewes.

3. Ewes occur at slightly higher elevations than rams during the non-breeding season.

4. Sheep were generally found at higher elevations when range conditions were optimal (March-May).

5. Both sexes display similar, generalized monthly movement patternsn.

6. During the hot summer months when available water is limited, sheep are localized around water sources and movement patterns are restricted.

Acknowledgements

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