RAYMOND M. LEE - POST-CAPTURE SURVIVAL ESTIMATES FOR BIGHORN SHEEP

James C. deVos, Jr., Arizona Game and Fish Department, 2221 W. Greenway Rd., Phoenix, AZ 85023
Raymond M. Lee, Arizona Game and Fish Department, 2221 W. Greenway Rd., Phoenix, AZ 85023
Len H. Carpenter, Wildlife Management Institute, 4015 Cheney Dr., Ft. Collins, CO 80526
Heather A. Whitlaw, LGL Alaska Research Associates, Anchorage, AK 99508

Abstract: Bighorn (*Ovis canadensis*) populations declined through much of their range in North America because of introduction of livestock diseases and parasites where the bighorn were naïve to these organisms, unregulated harvest, competition with livestock, habitat fragmentation, and other lessor causes. Early efforts to re-establish populations were limited by lack of suitable capture methods. From the 1970s to the present, considerable research has been conducted to develop capture methods that had low capture-related mortality. Three methods are currently used to capture bighorn; darting with chemical compounds, drop netting, and aerial net gunning. We estimated survival rates from 306 bighorn captured by Helicopter Wildlife Management (HWM) and a total of 405 bighorn captured by Arizona Game and Fish Department (AGFD) with known post-capture fates. Survival estimates ranged from 0.942 for aerial net gunning to 0.983 for aerial darting. Survival estimates were significantly different only between aerial net-gunning and aerial darting.

Bighorn entered North America by crossing the Bering land bridge approximately 70,000 to 10,000 years ago (Kurten and Anderson 1980) and populations became widespread in much of western North America (Brown 1989). Buechner (1960) suggested that bighorn occupied most mountainous areas as far east as North Dakota, Nebraska, the Trans-Pecos region of Texas, and as far as northern Mexico and much of the Baja peninsula. Although Seton's (1929) estimates are probably high, he did document widespread bighorn presence in the New World.

Most researchers and naturalists who investigated population densities between 1900 and 1960 (Mearns 1907, Seton 1929, Russo 1956, Buechner 1960) documented widespread declines with many local extirpations due to the introduction of pathogenic diseases and parasites, unregulated harvest, competition with livestock, habitat fragmentation, and other lessor causes. Like many other hunted species that had undergone considerable population declines, public concern with the decline of bighorn prompted wildlife management agencies to begin management programs to repopulate historic habitat. At the heart of these recovery efforts were capture and relocation programs.

Although some bighorn capture efforts date to the early 1920s (Yoakum 1963), it was not until the 1950s that many bighorn relocation programs were initiated. Early efforts relied on physical restraint applied at areas where bighorn concentrated such as salt licks or water sites. It is often difficult to determine mortality rates from early reports, however, where mortality rates are reported, they are often high. Further limiting the success of some of these efforts (Weaver 1973) was the high commitment of human resources to accomplish a few captures. Over a 2-summer period (1956-1957), over 2,000 person-hours were expended to capture 17 bighorn on the Kofa Game Range, with 6 mortalities and only 5 animals being capable of release.

Because of high mortality rates and labor commitments required to capture bighorn, most capture efforts after about 1970 eliminated mechanical restraint and used chemical immobilizers (Weaver 1973). Research efforts to develop new capture methods that provided a high level of human safety, high survival rates, and afforded the opportunity to efficiently capture large numbers of bighorn continued. Eventually, aerial darting with Etorphine® (deVos and Remington 1981), drop nets (Schmidt et al. 1978, Fuller 1984), and net gunning (Remington and Fuller 1989, Krausman et al. 1985) have become the standard methods for capturing bighorn.

To evaluate if these methods achieved the goal of high bighorn survival, post-capture, we compiled data from captures for each of these methods and used these databases to estimate survival rates for each method.

METHODS: We compiled data from 2 sources; captures using net gun captures completed by HWM and captures using net guns, aerial darting, and drop netting completed by the AGFD. The HWM database consisted of 306 bighorn from 20 separate captures. The AGFD database consisted of 405 bighorn with 107 captured by drop nets, 115 by aerial darting, and 183 by net guns. We did not compare the HWM database to the AGFD database because of differences in how the data were collected. The HWM database monitored survival for 10 days where the AGFD included all animals that died within 30 days of capture.

Survival rate estimates were calculated using the computer software MICROMORT (Heisey and Fuller 1985). We tested for significance among the 3 capture methods represented by the AGFD database using Z-testing as recommended by Nelson and Mech (1986). Differences were deemed significant when $P<0.05$.

RESULTS: Data from the HWM captures indicate that 21 of 306 bighorn died during or within 10 days post capture for a survival rate of 0.932. Of this total, 9 died during capture (mortality rate = 2.9%), with 12 (mortality rate = 3.9%) being found dead within 10 days of capture.

The estimated post-capture survival rate was highest for aerial darting (2 of 115; 0.98), intermediate for drop netting (4 of 107; 0.962), and lowest for net gunning (10 of 183; 0.942) (Table 1). When analyzing for differences between the capture types, the only significant differences among the 3 methods was between aerial darting and helicopter net-gunning ($Z = 2.015$; $P<0.03$).

DISCUSSION: Public scrutiny of wildlife management programs has increased recently. Practices that result in high mortality have been deemed unacceptable and in some cases have resulted in public initiatives to prohibit some agency practices (deVos et al. 1999). Further, high mortality can adversely affect the success of project objectives as study animals are lost. Therefore, wildlife managers need to select capture methods that optimize bighorn survival.

We have evaluated survival rates for the 3 methods currently used in bighorn management programs and found that all methods have high survival rates. In our experience, each of these techniques has advantages and limitations. The selection of a capture technique should be based on project objectives, terrain, and personnel training. It is also important to recognize that each of these techniques do not work in all situations. Other consideration to be used to select a capture method would be targeted sex and age ratios and the need for genetic diversity. Aerial capture methods allow selection of specific age and sex ratios, where drop netting captures large numbers a bighorn at 1 time and sex and age ratios are determined by the bighorn that come under the net. Aerial captures may also optimize genetic diversity. Bighorn can be captured from several areas, minimizing the level of genetic relatedness.

We conclude that the methods we evaluated provide safe and effective bighorn captures. Given the high probability of bighorn survival after being captured, restoration efforts should continue to be successful in building bighorn populations in vacant historic habitat.

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Table 1. Survival estimates for bighorn captured using aerial darting, drop-netting, and aerial net gunning. Data were compiled from capture records maintained from clients of Helicopter Wildlife Management (HWM) and from Arizona Game and Fish Department (AGFD) records where survival status was known.

Data Source	Capture Method	Number Captured	Number Dead	Survival Rate[1]
HWM	Aerial net-gunning	306	21	0.932
AGFD	Aerial darting	115	2	0.983
AGFD	Drop-netting	107	4	0.963
AGFD	Aerial net-gunning	183	10	0.942

[1] Survival rate estimates for HWM data are based on a 10-day period post-capture. The AGFD survival rates are based on a 30-day period post-capture.

QUESTIONS, ANSWERS AND COMMENTS - RAY LEE PRESENTATION

WALT VAN DYKE, OREGON: How big a population do you have to have before you need to avoid transplanting out, and how many sheep do you take?

RAY LEE: We've been fairly fortunate to have is relatively high populations, the Kofa approaches 1,000 and fluctuates between 900 and 1,000. The Black Mountains population is probably between 1,000 and 1,500. Those are probable source stocks. We did a transport from a source of 300, and as far as I'm concerned, that's as low as we want to go for the source population. We try not to remove more than five percent of the population, and five percent means five percent of the females.

VAN DYKE: What's the transplant size you're looking for?

LEE: Typically, we're looking at 30 animals on the upside.

STACEY OSTERMANN, CALIFORNIA: Under what circumstances do you give fluids?

LEE: We find during the drop net captures the animals are not stressed to the point that we give fluids at all. We have them available. If we have an animal, we're taking its rectal temperature. If the rectal temperature goes up above 105°, we'll start watching them closely. If it goes up above 106°, we'll start giving them fluids.

We find on our net gun captures, the animals almost always come in with a slightly elevated rectal temperature. At that point, we always watch for temperature rise. It will rise up to a point, we start fluid treatments, and it starts coming down at that point. Fluids we give are lactated ringers solution.

NIKE GOODSON, UTAH: In the last presentation, they said they had a recommendation of a limiting amount of 371 square kilometers in desert habitat for predicting successful transplants. I wondered if, from your experience, that number makes sense to you?

LEE: I think as I read the slide that it's the southern Colorado deserts that he had 371 kilometers. To me that's the uppermost range of the desert bighorn. I'll go ahead and address it in that fashion.

If we can come with 200 contiguous square miles, however close that is to 371, that's what we're looking for.

Only two of our transplants totally failed. We feel they failed due to there not being enough habitat for them, not being enough escape terrain, and not being quite enough contiguous habitat. When we scored the two areas, they were great, absolutely fantastic. They weren't big enough and really what we in Arizona consider to be the most important factor for bighorn sheep reintroductions is contiguous habitat.