

DISAPPEARANCE RATE OF BOVINE FETUSES AT GRAND TETON NATIONAL PARK, STATE ELK FEEDGROUNDS AND AT THE NATIONAL ELK REFUGE



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♦ ABSTRACT

Brucellosis is a bacterial disease of cattle that has become established in elk and bison of the Greater Yellowstone Area. It causes elk and bison to abort and has the potential to be transmitted back to domestic cattle, which are now free of the disease. In this study we examined how long healthy bovine fetuses, as surrogates for aborted bison or elk fetuses, remained in the environment and could be available for contact by elk, bison, and cattle. Healthy bovine fetus carcasses were placed on state elk feedgrounds, the National Elk Refuge, and Grand Teton National Park to simulate an elk or bison aborted fetus. Fetuses were monitored until they disappeared due to scavenging. Fetuses took 26 hr on average to disappear from the National Elk Refuge, 46 hr at state elk feedgrounds, and 61 hr at Grand Teton National Park. Ninety percent of the fetuses could be expected to disappear from the National Elk Refuge within 60 hr (2.5 days); from state elk feedgrounds within 105 hr (4.4 days); and from Grand Teton National Park within 140 hr (5.8 days). Analysis of covariance showed that there was a significant difference in fetal disappearance rates depending on habitat type and site of placement. The dominant scavengers at all locations were coyotes (*Canis latrans*), but ravens (*Corvus corax*), magpies

(*Pica pica*), bald eagles (*Haliaeetus leucocephalus*) and golden eagles (*Aquila chrysaetos*) also frequently participated in scavenging. We found that aborted fetuses could potentially serve as a source of bacterial infection for several days. This study will be expanded to include greater numbers in the coming season.

♦ INTRODUCTION

Bovine brucellosis is an important disease of domestic and wild animals and occasionally of humans. There is much debate, disagreement, and controversy about this disease and its impacts in the Greater Yellowstone Ecosystem. The debate has become highly political and has implications for management of wildlife and livestock of the region.

A brucellosis outbreak occurred on a cattle ranch in Fremont County, Wyoming in 1988. The cattle herd had documented contact with both elk (*Cervus elaphus nelsoni*) and bison (*Bison bison*). A USDA brucellosis epidemiologist could not identify a bovine source for the outbreak, and a federal judge ruled that the outbreak had a wildlife source (Parker Land & Cattle Company, Inc. v U.S., 796 F. Supp. 477, 488 [D. Wyo. 1992]). In this case, because the

wildlife species responsible could not be determined, the accountable agency could not be determined. Still, the decision has implications for wildlife management agencies which could be held liable in the future for allowing the disease to be transmitted from wildlife to livestock.

In animals, the disease is transmitted by ingestion of *Brucella abortus* from contaminated fetuses, placentas, and associated fluids (Nicoletti, 1986). Bison of Yellowstone National Park have been known to be infected with brucellosis since 1917 (Katz, 1941; McCorquodale and DiGiacomo, 1985). More recently, brucellosis was diagnosed in bison of Grand Teton National Park (Williams et al., 1993). Bison experimentally infected with *B. abortus* abort, but the frequency of abortion in free-ranging bison is not known (Davis et al., 1990; Williams et al., 1997). Brucellosis caused abortion, retained placenta, and endometritis in a bison cow as well as epididymitis in a bison bull in Teton County, Wyoming. Additionally, 76% of the bison tested from this herd were serologically positive for brucellosis (Williams et al., 1993). Furthermore, it has been documented that brucellosis can spread from artificially infected bison to cattle when held in common paddocks (Davis et al., 1990). Still, the risks of transmission in a free-ranging situation are unknown.

While brucellosis in bison receives more media attention, a greater number of elk are actually infected with *B. abortus*. The disease affects elk herds that winter on feedgrounds in western Wyoming (Thorne et al., 1978a; Thorne et al., 1979). The elk of Yellowstone National Park and the National Elk Refuge in Jackson, Wyoming have been known to be infected since the 1930's (Rush, 1932; Thorne et al., 1978b). There are 23 feedgrounds in western Wyoming, where approximately 25,000 elk are fed. Brucellosis has been documented in elk on 18 of these feedgrounds and is assumed to be present on the remaining untested feedgrounds (Herriges et al., 1992; Thorne et al., 1991). Seroprevalence in adult cow elk is as high as 50% on some feedgrounds (Herriges et al., 1989). Abortion rate among naturally exposed naive elk is about 50%, and highly infected herds may lose 12% of their reproductive potential (Thorne et al., 1991).

Infected elk may co-mingle with cattle on summer ranges, during migrations, and occasionally may be in close contact with cattle on cattle winter feedlines (Thorne et al., 1979). Experimentally infected elk can transmit brucellosis to susceptible cattle when they are confined together under conditions of

prolonged close contact (Thorne et al., 1979), although the risk in a free-ranging situation is unknown.

The chances of brucellosis being transmitted from elk or bison to cattle under realistic field conditions have not been established. An important technique for evaluation of this question is through computer modeling. However, before reliable models for multispecies brucellosis problems can be developed, specific information is needed. One important gap in available data is the time over which an aborted fetus can serve as a source of *B. abortus* to other animals. A major factor limiting infectivity of an aborted fetus is how quickly it is scavenged and removed from the environment.

The primary objective of this study was to determine how long an aborted fetus may remain in the environment at various sites in northwestern Wyoming, specifically: state elk feedgrounds (SFs), the National Elk Refuge (NER), and Grand Teton National Park (GTNP).

◆ METHODS

Healthy bovine fetus carcasses weighing 2-26.8 kg were obtained from Monfort slaughter house near Greeley, Colorado and from Packerland slaughter house in Gering, Nebraska. Arrangements with veterinary inspectors at the slaughter houses were made to obtain 30-50 fetuses each year over the course of several weeks. Because fetal blood is quite valuable, these fetuses were purchased after blood had been removed. Each fetus came from cows serologically negative for *Brucella* antibodies. Additionally, all cows had passed the veterinary inspection and were deemed suitable for human consumption. All fetuses were handled with rubber gloves to avoid getting human scent on them. Fetuses were placed into plastic bags, weighed, and frozen until used.

The first field study was conducted in February and March of 1996 and 1997 to correspond with the time that most *Brucella* induced abortions in elk and bison are believed to occur. The study sites were four of the state of Wyoming elk feedgrounds (Camp Creek, South Park, Horse Creek, and Grey's River) and the NER in 1996 and six state feed grounds (Camp Creek, Horse Creek, Dog Creek, Fish Creek, Patrol Cabin, and Grey's River) and the NER in 1997.

To mimic an actual elk or bison abortion, each fetus was thawed and removed from the plastic bag at a site chosen to be a place where elk (or bison on the NER) congregate. Fetuses were placed in separate locations generally at least a kilometer apart. Two fetuses were placed at each SFs (except Fish Creek which had four); one was introduced to the SF in the morning and one in the evening (Fish Creek had three placed in the morning and one in the evening). In 1996, seven fetuses were placed on the NER over a 2 day period; three in the morning and four in the evening. In 1997, nine fetuses were placed on the NER over a 3 day period; five in the morning and four in the evening.

When possible, fetuses were monitored at a distance with binoculars and spotting scopes for several hours after being placed on the site. Fetuses were then examined with binoculars on a 4 to 12 hr basis. When the fetus could no longer be visualized remotely, we approached the area on foot until we were close enough to confirm presence or absence of the fetus. We also attempted to document the species involved in scavenging the fetus by remote visualization and by scats and footprints found at the site. Additionally, the area was carefully examined to make sure that the fetus was not dragged out of sight. We continued to monitor fetuses until they were completely scavenged.

In May of 1996 and 1997 we carried out a similar study in Grand Teton National Park using 15 fetuses each year. We monitored them as previously described. Fetuses were placed on or near areas where there was potential contact between cattle and bison and/or elk on legislatively authorized cattle grazing allotments and driveways. Fetuses were placed at least 2 km apart during this study. The general habitat type (grassland, sagebrush, or forest) was recorded.

Disappearance times were defined as the time from placement of the fetus until the time when it was confirmed to be gone. In some cases, fetus may have disappeared several hours before disappearance was documented. Data were analyzed by the mean disappearance rates for SFs, the NER, and GTNP. Additionally, disappearance rates were described using a probability distribution assuming an exponential distribution. This distribution will be verified with a goodness of fit test when additional data are collected in the coming year. Also, an analysis of covariance (ANCOVA) using the SAS statistical package was used to determine if there were differences between sites ($\alpha=.05$). The ANCOVA considered habitat type and fetal weights as covariates.

◆ RESULTS

Many of the bovine fetuses obtained were larger than elk fetuses at the appropriate stage in gestation. We were concerned that this could bias our results, but the ANCOVA showed that fetal weights did not significantly impact how quickly they disappeared ($p=.20$; H_0 :weight has an impact).

Coyotes were the dominant scavenger at all locations both years. In 1996 bald eagles, golden eagles and ravens consumed two entire fetuses on SFs and participated in scavenging a third. In 1997, bald eagles and ravens consumed one fetus on a SF; bald eagles, ravens and coyotes also shared in eating a fetus on the NER. Ravens often participated in eating parts of fetuses in all three locations, though coyotes were usually the final scavenger. In 1997 the species of scavenger was not determined on a fetus at GTNP that was scavenged and parts of the remains carried up a tree. Both years bear tracks were found near (within 0.5 km) a fetus, but no direct evidence of bear scavenging was noted. Black-billed magpies were often the first species to scavenge, though they did not usually consume significant portions of the fetus. In 1996 one fetus on GTNP appeared to be consumed entirely by elk and bison after being initially fed upon by ravens.

We also documented elk and bison orally contacting fetuses on several occasions. On SFs, we documented elk making many contacts with fetuses. In 1996 one fetus was contacted by over 100 elk and another by over 150 elk. In 1997, 47 elk were seen contacting one fetus, another one was contacted at least 21 times (on this fetus one elk was seen vigorously licking the fetus- it even appeared to chew on the hide), another fetus was contacted by at least 20 elk, but well over 100 elk passed very near it. Several fetuses were contacted by fewer elk- or were closely approached without being contacted. We were unable to monitor most of the fetuses at the NER closely enough to document contacts by elk. In 1997 no bison were observed directly contacting fetuses, though several times they were seen within 200 m. As previously mentioned, we believe that one fetus was eaten by elk and bison in GTNP in 1996. Moose were often seen within 0.5 km of fetuses. In one case on a SF, five moose bedded around a fetus, the closest moose bedded less than 3 m from the fetus, and moose tracks and moose pellets were right around the fetus. Thus it is quite likely that some moose contacted this fetus.

Mean time for a fetus to disappear was 26 hr at the NER, 46 hr at the SFs, and 61 hr at GTNP. Assuming an exponential distribution, we estimated that 90% of the fetuses disappear within 60 hr (2.5 days) from the NER, from SFs within 105 hr (4.4 days) and from GTNP within 140 hr (5.8 days).

The ANCOVA revealed significant differences in disappearance time of fetuses at the three sites ($p=.0073$). There was a significant difference in disappearance time between SFs and NER ($p=.0164$). The difference between the NER and GTNP borders on significance ($p=.0564$), and there was no significant difference between SFs and GTNP ($p=.7650$). Habitat type also made a significant difference in how quickly fetuses were scavenged ($p=.0001$) with fetuses disappearing fastest on grasslands, followed by forests, and remaining longest in sagebrush.

◆ DISCUSSION

There were significant differences in fetal disappearance time among our study sites. Thus, it may be necessary that each site be considered independently when evaluating the dynamics of brucellosis transmission. Different management schemes may be needed at each of the sites. Additional data may clarify if this is truly the case.

At all three sites, coyotes were the primary scavenger. Therefore, it was not surprising that fetuses at the NER disappeared faster. The NER is 10,000 ha with a postwhelping coyote density of 1.5/ square km (Camenzind, 1978). Coyotes at this location are completely protected. The NER is large enough for many coyotes to spend their entire lives within its boundaries. The SFs on the other hand are much smaller. Coyotes are generally protected on SFs, but they may be shot and trapped on the surrounding lands. This may reduce the coyote population on the SFs and also may make them more wary of human activity. Thus, coyotes may not approach fetuses as quickly on SFs which always have some degree of human activity during the winter. At GTNP coyotes are also protected, but coyote densities are probably lower than on the NER. Also, the variety of habitat types found at GTNP may prevent the fetuses from being removed as quickly as at the NER.

Removal time for fetuses was longer than expected. This information is important for understanding the risks of interspecific transmission. In

GTNP 10% of the bovine fetuses (as surrogates for elk or bison abortions) could be expected to remain in the environment for longer than 140 hr (5.8 days). Thus, there is the potential for an aborted fetus to serve as a source of infection for several days. Another important factor is bacterial availability and survival time on a fetus. We are currently gathering data on survival as part of a separate study. Our preliminary results to date indicate that the bacteria can survive in high numbers longer than the fetus will remain in the environment.

It also appears that the type of habitat in which an abortion occurs may have a significant impact on how quickly the fetus is scavenged. We believe that fetuses disappear more quickly on grasslands because they are more visible, both from the air and from the ground. In forests, visibility from the air is reduced, perhaps affecting avian scavenging. Visibility of fetuses in sagebrush may be lowest, increasing time required for scavenging. Avian scavengers were usually the first to arrive, thus visibility may be more important than scent in determining how quickly a fetus disappears. This is especially true if coyotes are attracted to areas of avian activity. Because fetuses disappear at different rates in different habitats it may be important to determine if abortions are more likely to occur in one habitat type over another.

Our observations of moose feeding near fetuses and in one case bedding down next to one and probably contacting it are very interesting. The moose which bedded around the fetus may have done so to protect it. Perhaps they did not recognize that it was a bovine fetus. In any case, if moose display this same reaction upon finding a brucellosis infected elk or bison fetus it should be fatal (Dieterich, 1981).

A potential problem with this study is that bovine fetuses may not be realistic surrogates for elk and bison fetuses. It is possible that scavengers prefer elk and bison fetuses and might avoid bovine fetuses, at least initially. The reverse may also be true- scavengers may prefer bovine fetuses. It is also possible that some human scent in the area would deter coyote scavenging. Our data from the NER suggest that this is not a problem.

Our data support the suggestion that abortions among elk and bison are relatively rare. Aborted fetuses on SFs are seldom found. The feeder at the Horse Creek SF has been feeding there for 17 yr and in that time has only found two elk fetuses (H. Schwartzman pers. com.). Prior to this work we believed the reasons that fetuses were found so rarely

was that they were scavenged quickly. However, this research suggests that fetuses aren't scavenged immediately at least at SFs and GTNP. If elk commonly aborted, more fetuses likely would be found each year. On the other hand, most feedgrounds have elk bedding areas which are only rarely visited by feeders. If elk tend to abort in these areas, fetuses are unlikely to be found regardless of how long they remain in the environment. At GTNP, even though fetuses may be present for relatively long periods after being aborted, the chances of them being found and reported are still quite low because of the varied terrain and habitats and large area involved.

This study also documented elk and bison contacting bovine fetuses. Many of the elk on SFs were observed closely and seen to sniff and lick the fetus. This confirmed that elk and bison contact a fetus providing a mechanism for transmission of disease if the fetus is contagious. We also documented one fetus which was probably eaten by elk and/or bison. We found no evidence of any scavenger large enough to consume the fetus at this site, yet there were both elk and bison hoof prints and feces near the site of fetus placement. Additionally, we documented both elk and bison contacting this fetus prior to its disappearance. We have observed captive elk consuming their own fetus after an abortion. We can not tell from this study if elk or bison would contact conspecific fetuses at the rate observed here. It may be a strange odor or site of a bovine fetus which attracted the elk and bison, and they may tend to ignore conspecific abortions. However, elk have been observed to investigate conspecific abortions (E.T. Thorne, pers. com.).

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