East Vail Workforce Housing Subdivision

Independent Review

Prepared for:

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Introduction and Purpose:

Kirsten Bertuglia, Town of Vail Environmental Sustainability manager hired me on June 26, 2019 to provide an independent review of the East Vail Workforce Housing Subdivision Environmental Impact report.

I am a retired wildlife biologist. I worked for the Colorado Division of Wildlife from July 1972 to August 2002. I have a B.S. Degree in Wildlife Biology from Colorado State University and graduated in 1968. In 1972 I was hired by the Colorado Division of Wildlife as a trainee. In 1973 I was assigned as a Wildlife Conservation Officer, now known as a District Wildlife Manager, for the Rifle South District. In 1979 I took a promotion to be the game damage specialist for the NW Colorado region. In 1985 I was reassigned to the newly created position as an Area Terrestrial Biologist for the Glenwood Springs area that included the Roaring Fork, Crystal, Eagle and Upper Colorado river drainages. During this time, I became familiar with the wildlife in the Vail Valley. One of the projects that I worked on was the Gore Range Bighorn Sheep study. DWM Bill Andree and I were the key people managing this study. This is the first, and as far as I know, the only bighorn sheep study of this herd that used radio collared sheep. I have also worked on many other bighorn sheep herds and projects in the NW region. Since the results of the Gore Range Bighorn study were not cited or discussed in the Environmental Impact Report and the Wildlife Mitigation Plan for the East Vail Workforce Housing Subdivision, I have a written a brief summary of this study to provide additional information about bighorn sheep associated with proposed development (Appendix A).

I did not have a lot of time to do this review since Kirsten needed the final report by the morning of July 5, 2019. This did not allow me time to do an on-site visit of the proposed development. Due to other time constraints, I only had a couple of days during this period to work on this report. However, I am quite familiar with this area since I worked in this area a lot during my career. I have assisted with other comprehensive deer, elk, lynx and mountain goat studies in the Vail Valley and surrounding area. I have hiked, ridden horseback and flown many wildlife surveys (fixed wing and helicopter) in the area as the as Terrestrial Wildlife Biologist. In my review, I will focus on what I feel are the significant wildlife issues discussed in the documents. The writing style will be more of a popular article rather than a scientific report with lots of literature references. I will be relying mostly on my professional knowledge and judgement that I developed over my 30-year career and other experiences. Also, I will focus most of my attention on the main species of concern for this proposed project - bighorn sheep.

Bighorn Sheep Biology, Ecology and History:

While the documents that I reviewed contained a lot of good, detailed information about the scope of the project, the physical features of the land and general information about the local wildlife. I do not think that it provided some of the more basic information about the biology and ecology of bighorn sheep that I feel most readers of this report would need to understand the potential impacts and issues of bighorn sheep regarding this development.

There are two main groups of bighorn sheep (Ovis canadensis) in North America: "desert" and "Rocky Mountain" bighorn sheep. Both are very similar except that the desert sheep sub-species may differ more from environmental factors rather than genetics. Bighorns range from low elevation deserts to the higher peaks in North America and from Mexico to the Northern Canadian Rockies. Like all big game they need the same basic things: food, water, cover and space. What is different about bighorns is their cover is "rocky escape cover" in close

juxtaposition to food and water. Bighorn sheep avoid forested areas but prefer more open habitat with good sight distances to spot predators from a long distance away. When threatened, they run to the cliffs and steep slopes to seek the protection of their "cover".

Bighorns are primarily grazers, eating mostly grass plants along with some forbs and they will browse on shrubs especially in the winter. They are diurnal and will feed 3-5 times during the day and then bed down to chew their cuds. They will seek out well established and frequently used bed grounds at night on cliff faces or other steep areas.

Bighorns have strong fidelity to well established home ranges and migration patterns that have developed over many years and generations.

During most of the year bighorns are segregated by sex. Older rams form bachelor groups and move off to established areas while the ewes, lambs and some younger rams seek out different areas. During the rut in late November and early December both sexes are together, and the rams fight to establish themselves as the prime breeders. They are polygamous.

The main predator of bighorn sheep are mountain lion which are capable of lots of stealth and can pursue sheep onto their steep, rocky escape cover. Coyotes, bobcat and bears can also be predators, and Golden Eagles have been known to kill small lambs on the lambing cliffs.

Bighorns can become habituated to various forms of human activity such as hiking, biking and cars/highways. Hunted populations and sheep that do not have close association to humans tend to show a higher avoidance to people.

Bighorns were one of the most common ungulates in Colorado prior to European settlement. They were the preferred protein source of the early market hunters to supply the miners in the late 1800s. In 1887 the Colorado government became so alarmed by the rapid decline in the bighorn population that they closed the whole state to sheep hunting and it remained closed until 1953 (Bear and Jones 1973).

In the 1990s biologists determined that bighorns were extremely susceptible to various forms of pneumonia (Pasteurella spp.), and it was proven that the vector for this disease was close association with domestic sheep. Domestic sheep are old world species that evolved over 25,000 years to be resistant to most forms of pneumonia, but they are carriers. Since they are closely related species, when domestic sheep graze near bighorn sheep they tend to mix, and the deadly pneumonia can be passed to bighorns. This can be especially deadly to lambs. Domestic sheep were brought into Colorado and other western states in the late 1800s and this has become the biggest management issue facing bighorns today.

Bighorn sheep are designated as the State animal for Colorado. The Gore Range herd is special since it is a native herd vs. one that has been reintroduced. Many native herds of sheep have been extirpated in Colorado probably as a result of disease or habitat loss. In 1946 the Colorado Game and Fish Department supplemented this herd with six ewes and one ram. On May 5, 1946 44 sheep were counted in the Booth Creek area.

Methods:

I reviewed the two documents prepared by Western Ecological Resources. Inc.: Environmental Impact Report, East Vail Workforce Housing Subdivision (I will refer to this report as **EIR**) and Wildlife Mitigation Plan for the East Vail Workforce Housing Subdivision, Town of Vail, Colorado (I will refer to this report as **WMP)**

I prepared a summary of the 1989-94 Gore Range Bighorn Sheep Study.

I consulted with retired CPW DWM Bill Andree and Julie Mao CPW biologist about questions, clarification and potential impacts from this development.

Results and Discussion:

I will attempt to address issues in the two reports that I feel are significant to the impacts to wildlife in this project area, especially to bighorn sheep. I will state if I agree with Certified Biologist Richard Thompson's assessment or not and suggest other alternatives or recommendations. I will mostly organize my comments to follow the same order that they appear in the document. Some comments are combined from multiple sections of the reports. I will bring up some issues that are not directly related to the project but may have an important effect on the health and viability of the wildlife in this area. Some of these issues and recommendations are beyond the responsibility of the developer and are primarily off-site.

Environmental Impact Report, East Vail Workforce Housing Subdivision (EIR)

2.6.1.1 Habitat Present and 5.6 Cumulative Impacts to Wildlife Resources – I concur that the 5.4-acre (2.7 acres direct loss) development is a small part of the overall habitat in the Vail Valley. However, the area is impacted by cumulative impacts that transformed this area from an undeveloped area in the early 1960's to what it is today. The development now stretches from the base of Vail Pass on both sides of I-70 to Squaw Creek, a distance of over 17 miles (I-70 mile posts 163-180). Cumulative impacts are like nails in the coffin, while each one is maybe small and insignificant, eventually the coffin will be nailed shut and irreversible damage and wildlife extinction could occur. Each project that is developed from this day forward will be getting us closer to the final nail. Retired Vail DWM Bill Andree's comments about cumulative effects of habitat loss, increasing recreational activity and other factors are having a negative effect on the local elk, mule deer and bighorn sheep (Andree 2017).

I also concur that forested habitats are not desirable and beneficial for bighorn sheep but are essential for other big game species such and deer, elk and black bear. These are tradeoffs that land managers need to consider.

2.6.1.2 Factors Currently Reducing Wildlife Effectiveness –

I concur that I-70 and the frontage road is a huge issue and is 24/7/365 impact. Bighorn sheep have can habituate to the predictable and constant noise and smells. I also agree that when normal traffic flows are interrupted by car stopping along the road to view bighorn sheep, etc., this creates a disturbance to wildlife. Bill Andree (prsnl. commun.) reported that when he observes these sheep along the highway, they are also bunched up and appear to be under stress.

Human recreation is a random and unpredictable event that can cause increased stress on wildlife. Studies have been done using radio telemetry heart rate monitors on wildlife and one of the largest stressors appears to be a person on foot. If the person has a dog, the impact is even greater. The CPW has indicated that human recreation in the project area is one of its major concerns regarding the impact to the bighorns. I concur with this statement.

Fire suppression and habitat deterioration – fire is a natural process on the landscape and historically created the natural mosaics and age diversity of plant communities that were beneficial for habitat and wildlife. Since the early 1900s, this cycle has been interrupted by fire suppression and this had a detrimental effect on the land. Land managers have attempted to

incorporate more controlled burns and let-burn philosophy back into their management, but this is sometime met with public resistance and legitimate concerns about the urban interface areas making the risks too large. Aspen stands are relatively fireproof but will sometime burn. Many aspen stands are only present for a short period of time (early seral stage) then transform into coniferous forest. Other stands appear to be a climax stand, and this may be the case in the project area. Dead and down aspen and trees does negatively impact the use of these habitats for most wildlife species. Also, clear cutting aspen can sometimes stimulate regrowth of aspen and the result can be a younger and denser stand. This type of management would be detrimental to bighorn sheep that prefer open area to trees. It is unfortunate that the 1998 USFS habitat plan was not able be implemented in the Booth Creek area. In my opinion, habitat projects focused in areas close to rocky escape cover (Booth Creek cliffs) could have the most positive impact on the bighorns in this herd.

2.6.2 Focal Species

I feel that the preservation of the Booth Creek bighorn sheep winter range is the most significant issue for this development. This is the only mapped area for bighorn sheep winter range for this herd. Thompson notes that the CPW has not defined dates of the winter use. It appears that from a small sample of radio collared ewes (N=4) from the 1990s study (Appendix A) that the four radio-collared ewes spent the first part of the winter in the Black and Slate Creek drainages (early December to early/mid-February) on the North end of the Gore range and then made a dramatic, mid-winter migration to the Booth Creek winter range (see Table 1 in the Appendix). This migration has probably been established for many years and generations of sheep. Therefore, the Booth Cr. winter range must be extremely important to these animals or they would not be making this risky migration. I would suggest that the Booth Creek bighorn winter range is probably the most critical factor for the herd's long- term viability and this area must be protected. Winter range for all big game species in Colorado is usually considered the most limiting factor to population size. It is usually the smallest area in their home range and the most critical for their survival. It is also possible that some sheep may stay on these northern winter ranges (Black and Slate Cr.) and not migrate. I recommend that the Colorado Parks and Wildlife might want to do further research into this hypothesis.

Thompson also suggests that the severe winter range boundaries are not accurate. I agree and I also recommend that the rocky cliff and slide area on the west side of Booth Cr. be mapped in the winter range and as a winter concentration area. I have observed groups of rams bedded on these cliffs and feel that it is probably the main bedding and rocky escape cover for the sheep that winter in this area. This area appears to be the main winter range for rams in this herd. I have included an aerial photo and a polygon drawn around this area. The current winter range map only includes the lower portion of this area (see Fig 6).

Thompson suggests that the natural mineral lick areas are not mapped accurately. These should be updated as well. Mineral licks are very important to bighorn sheep. Sheep can be drawn into areas that are not safe, suitable habitat to obtain salt. Apparently, this is already happening as on the existing rock berm area. It may be wise for the USFS and CPW to consider establishing some salt licks in appropriate habitat on top of the cliffs. This could also prevent sheep from taking the risky move to lick salt on the edge of the frontage road (see page 21 EIR). This should not cause any concern about using illegal bait by bighorn sheep hunters. Rams would not usually be present in this area during the hunting season. Thompson provides some other considerations about salt placement for bighorn sheep in WMP section 9.3.2.6.

Thompson comments that during his study approximately 277 acres of the 1,800 acres of mapped winter range was utilized. This data may be useful to the CPW to redefine the boundaries of the winter concentration area.

Thompson comments that the sheep preferred the Booth Creek cliffs and that this is the most heavily used and important block of winter range in the mapped area. I concur and feel that this is because the sheep feel the safest in this area that is near the rocky escape cover. While sheep will travel through timbered areas that lack rocky escape cover, they do so at a high risk of predation and will probably not include these areas in their core home ranges.

On page 9, Thompson commented that the minimum number of sheep during the winter of 2017-18 was based on the highest count of 41 sheep. On the previous page (8) Thompson makes the point that "the present population of 41 sheep" inferring that this is a total population number. I want to clarify that this is a minimum population size based upon the highest count during the study. Numerous studies have proven that it is very difficult to impossible to count all the animals in a population. The CDOW conducted a research project to count all the deer in several 160 acres fenced paddocks, in the Piceance Cr. area, using an observer in a helicopter. Biologist were only able to count on average 2/3 of the known number of deer in the fenced areas. It is very possible the sheep population could be more than double this number (41 sheep). There are many reasons for inaccurate wildlife counts especially in a large and rugged area such as the Gore Range where the animals can occur almost anywhere.

CPW biologists commented the loss of the 5.4-acre parcel of habitat due to the development was not the biggest impact but the potential for displacement and reduced habitat effectiveness on the nearby winter range below the Booth Cr. cliffs and in the NAP area. I concur. This is a very sensitive place. Human presence in this area will impact the sheep and this should be avoided.

2.6.2.2 and 4.6.1.2 Peregrine Falcon – The nesting site is located 0.36 miles from the closest point on the East Vail Parcel and this is closer than the recommended 0.5 miles recommended for protection of nesting site. I concur with Thompson and do not feel that this proposed development will be an issue since the I-70 corridor and other developments are much closer to the nesting area. The pair has successfully fledged at least two young during 2011-17. Suggest that monitoring continue and determine if there is a nesting failure, like in 2018, and elucidate potential causes.

2.6.2.3 Elk – Thompson commented that the approximately 15 elk that wintered in this area during the 2017-18 study were in the highest elevation winter ranges in the Gore Creek Valley. The East Vail interchange is located at approximately 8,400 ft in elevation. This is very high for most elk to winter. Elk will usually only winter in these areas if they contain steep south facing slopes that do not accumulate a lot of snow. Thompson points out correctly that this winter range would be used mostly early in the winter and during mild winters. I also concur that this is still important winter range for elk due to the massive amount of winter range lost down valley due to the cumulative effects of over 50 years of development. I also concur that elk will be mostly nocturnal when using these areas. I also concur that the elk winter range map should be updated to include all the habitat in this area down to the frontage road.

2.6.2.4 Black Bear – Serviceberry shrubs do have mature fruit prior to Aug. 15. After this period, bears readily seek out other ripe fruits such as chokecherry and acorns gorging upon them almost 24 hours to build up critical winter fat reserve. Bears in this area are probably being attracted by the human food and trash that has not been properly secured.

4.6 Wildlife Resources - Concerning the 14.6-acre parcel that will remain undeveloped. I recommend that this parcel be put into a permanent conservation easement. Without this protection, future projects could be developed on the parcel and the mitigation values would be negated. While this parcel is rather steep, anything could be developed given enough money.

It appears that most of this parcel is in aspen woodland. Thompson says that it, "would be enhanced as big game (bighorn sheep and elk) winter range." If it is going to be enhanced for bighorn sheep, I recommend that the trees be removed, and the landscape opened to support more grass, forbs and shorted shrubs. Currently, I would consider this to be poor bighorn sheep winter range. Even if it is cleared of trees, it is still a long way from rocky escape cover and probably would only be used marginally. Elk would probably continue to use this area during the cover of night.

4.6.1.1 Bighorn Sheep – I concur that the effectiveness of the approximately 1.7 acres of sheep habitat along the cut slopes above the frontage road would be reduced, but I would suggest this area would be lost to sheep. Thompson suggests that the sheep may still enter that area to forage under cover of darkness. I believe that this will not happen. It is my impression that sheep are diurnal and feed during the day and bed down at night. However, elk may use this habitat during the night. (Fitzgerald et. al. 1994)

I have concerns about the enforcement of the sheep related rules that I discuss in the WMP section.

Wildlife Mitigation Plan for the East Vail Workforce Housing Subdivision, Town of Vail, Colorado (WMP)

3.1.1.2 Results of the East Vail 2017-18 Winter Sheep Study – Thompson reported that during the study, sheep used the 5.4-acre development parcel on two occasions and a single animal traveled through the Natural Area Preservation (NAP) portion of the development parcel. I suggest that this is not surprising since the parcel, in its current condition, is mostly an aspen woodland forest and the area is located a fair distance from rocky escape cover. This area could be enhanced as bighorn sheep range if the standing trees and jackstrawed, dead and down timber were removed. The tall serviceberry shrubs would also hinder sight distance that would make it less suitable for bighorn. Cutting down the aspen forest might be short lived. This could stimulate re-growth of a younger and more vigorous stand of aspen. While this would be very beneficial to elk and deer, it could make it worse for bighorns.

3.2.4.4 Mountain Lion - Retired CPW DWM Bill Andree suggests that the Vail Valley, "mountain lions have seen an increase in their population levels over the last decade" (Andree 2017). This could be detrimental to the bighorn sheep that are very susceptible to lion predation.

7.8 Unit Numbers – Clustering and concentrating the development onto the 5.4-acre parcel, including the rock fall berm 2.3-acres rock fall berm, the 17.9-acre NAP and building the development close to frontage road will reduce the wildlife impacts and is a better option than spreading the same development out on the whole 23.3 acre parcel.

Not having any trails onto private open space, closing use of the Booth Creek rockfall berm road, possible closure of the TOV open space, no on-site use of the National Forest Service lands north of the rockfall wall, no sidewalk along the Frontage Road, no dogs, no drones, resident education about living with wildlife and enforcement for non-compliance (penalties)

would all be beneficial to reducing human impacts from the development. Some of these restrictions would have to be worked out with the Town of Vail and the USFS.

7.9 Internal Parks – the small community park and BBQ shelter at an internal location at the center of the site will reduce human impacts on the adjacent lands and is better option than upper level outside decks, especially facing to the open space areas to the North.

7.11 Maintaining Sheep Movements above the Frontage Road – The 1.7-acre cut bank below the development and above the frontage road has been used by the sheep. It is doubtful, with all the development pressure from above and the cars below, that the sheep will feel secure in using this area again and this area will probably be lost as sheep winter range. As pointed out earlier, nocturnal animals such as elk might wander into this area in the quiet and dark of night, but sheep will be on their bedding grounds at this time.

7.12 Fencing – I am going to take issue with the recommendation from my former employer, CPW. Building a fence along the rock fall berm will not prevent people who want to get to the protected and closed area of the berm or further north onto the USFS lands. The fence will have to start and end some place and it will just be a matter of walking around it and facing the punitive fines that could result. This will impede the wildlife from using the berm and could force them onto the frontage road despite the planned use of "jump gates." The berm could be useful to wildlife such as elk at night and possibly bighorn sheep during the day. After the rock berm was built to protect the homes in the area west of the here, I noticed bighorn sheep using this area. Apparently, this is still going on today. I suspect that this is due to the steep south-facing slopes that shed snow more readily and using a different mixture of grasses and improved soil fertility from imported topsoil and fertilizers. Instead of spending money on this fence, I recommend taking the money and spending it on off-site enhancement to the habitat near the Booth Creek cliff.

8.0 Project-related Wildlife Effects – I concur that the 14.6-acre parcel that will remain undeveloped could be improved to benefit wildlife such as elk and bighorn sheep. Creating more open habitat with a more vigorous understory of grasses and less decadent shrubs would be beneficial. As stated earlier, I recommend that this area be permanently protected in a conservation easement that would prohibit future development.

I also concur and have stated earlier the best benefit: cost ratio to improve the habitat for bighorn sheep will be off-site and closer to the rocky escape cover and away from the development and frontage road. Much of this would probably involve cutting and stacking of aspen logs and then burning them during the early part of the winter, after the first snowfall. This is expensive work but effective and it has been done in numerous places around the west including Rocky Mountain National Park and along the urban interface. There will be a very low risk starting a larger wildland fire. There is very low probability that the bighorn sheep will be in this area at this time and it will be a short-term impact.

9.1.1 On-site Enhancement – I concur that the habitat on the NAP parcel can be enhanced for deer and elk. This will not be a one-time project and over time, 10-15 years, a re-treatment will be necessary. It would be beneficial for wildlife if provisions are made in the development permit to fund future habitat work on this parcel. Thompson recommends a similar funding proposal in 9.3.1.4.

I am doubtful that cutting aspen and reducing the height of serviceberry and chokecherry will benefit black bear. Black bears seek out ripe chokecherries and will straddle the tall shrubs between their front legs and wallow them down to glean all the fruit. However, reducing the

height to them to make the browse more available to elk and sheep would benefit these species.

I concur with Thompson about leaving a thick buffer zone west of the Pitkin Creek trail.

9.1.2 Off-site Enhancement – Reviving the 1998 USFS habitat enhancement plan for the bighorn sheep winter range could result in huge benefits for the sheep. Most of the effort will probably be focused around the Booth Creek cliffs east of Booth Creek. If the area west of Booth Creek is not included, I recommend that if should be and especially the area around the cliff and slide area (Figure 6). This would be very beneficial to the rams that tend to winter in this area.

9.2.1 Wintering Sheep – Scheduling the dirt work, foundation and framing projects during the late spring and summer would be beneficial to the wildlife. Likewise, working during the day light hours would allow the wintering elk to be more comfortable using this area at night.

Building the fence to exclude humans to the rock berm area would reduce the effectiveness of the east-west migration corridor for wildlife. Recommend that the berm be well posted with sturdy "no trespassing/access signs" and this be strictly enforced.

9.2.3 Other Construction-related Mitigation – I concur with all these measures.

9.3.1 Requirement for the Developer of the East Vail Worksforce Housing Parcel – I think all of these are beneficial recommendations and should be part of any HOA agreement and strictly enforced.

9.3.2.2 Pet Control – I concur with these recommendations but request that #2 be changed to only allow two dogs under the weight of 15-lbs. or one dog over the weight of 15-lbs.

9.3.2.3 Resident Education regarding Black Bears – I concur with all of this. Black bears have become a huge problem in resort communities around the state. Thompson is correct in his assessment of the problem and it is always related to trash and human supplied food sources. This will result in trauma to the bear to be captured, ear-tagged and transplanted. Under current CPW policy, on the second strike the bear will be put down. Remember "a fed bear is a dead bear."

9.3.3 Enforcement – I appreciate the detailed process for enforcement of the rules. Violations that occur on the TOV lands will be more enforceable under the criminal codes of the municipality. The violations that occur on the development lands and enforced by the developer, Housing Management, and the HOA could be more problematic. This will be more peer to peer enforcement and civil vs. criminal fines. Hopefully, the adaptive management process will work to correct any problems that might develop over time. The USFS should be encouraged to designate a winter closure on their lands in this area to protect the sheep winter range from human interference. This has been done successfully in other areas of the White River National Forest such as the lower Avalanche Creek bighorn sheep winter closure south of Carbondale.

Conclusion:

I concur with Thompson (section 9.3.2) that "the East Vail Workforce Housing parcel is located adjacent to the most important block of bighorn sheep winter range in the valley." I also suggest that this winter range is the most limiting factor to this sheep herd and that this is the only known late season winter range for these sheep. Anything that diminishes the quantity, quality or

effectiveness of this area will be detrimental to this herd. This is the only herd of bighorn sheep in the Vail valley and it probably represents a population of around 100 sheep that fluctuates from year to year based mostly on winter severity. The loss of this native sheep herd, that has probably existed in this area for thousands of years, would be a tragedy not only to the residents but the whole state of Colorado. If the Town of Vail approves this development, the measures proposed in the EIR and WMP should be adopted and the restriction on the human use of the area should be followed and enforced. Follow up monitoring, habitat enhancement and adaptive management is also necessary to ensure the sustainability of this herd.

Gore Range Bighorn Sheep Study 1989-1994

Summary by Gene Byrne, Wildlife Biologist

Introduction and Purpose: This is a summary of the bighorn sheep study that was conducted by the Colorado Division of Wildlife (DOW) in the Gore Range and Eagle's Nest Wilderness. The summary was completed to share the study results for the review of the East Vail Worksforce Housing Subdivision since these results were not documented in the environmental impact report (EIR).

The objective of the study was (Schoep 1990):

1) Estimate the population size
2) Identify seasonal ranges and migration corridors
3) Estimate herd age and sex ratio
4) Estimate survival rates and causes of mortality
5) Determine bighorn sheep habitat preferences

Methods:

A total of 24 sheep (15 ewes, 5 lambs and 1 ram) were captured and marked, eight with radio collars. Clover traps were helicoptered to the top of the first cliff in the Booth Creek sheep winter range in 1989. The traps were located so that they could be easily viewed from the frontage road. The traps were baited with salt blocks. All the captured sheep were marked with ear tags in each ear with a different color scheme so the biologist could ascertain individuals by color even if we could not read the numbers. Eight sheep were radio collared with VHS radios that had mortality sensors: 6 ewes in 1989, 1 ram in 1990 and 1 ewe in 1991. During the period 5/22/1989 to 12/6/1993 a total of 38 flights were conducted to re-locate the radio collared sheep and record the location, group size, habitat descriptions and other parameters. The DOW used their Cessna 185 to make the flights. Also, during the flights other random sheep and wildlife observations were noted. Another clover trap was carried up the slopes on the west side of the Booth Creek drainage to try and capture some of the rams that tended to winter in this area. No sheep were captured in this trap. In the summer of 1989 and 1990, temporary employees Dan Stubbs and Dave Schoep respectively were hired to do ground surveys in the Gore Range and collect additional information on this sheep herd (Byrne 1994).

Results and Discussion:

Movements and Seasonal Ranges: We collected 188 aerial relocation and 60 ground relocation data points on the 6 ewes and 1 ram radio collared sheep. The radio collar on the lone ram (G3) quit after approximately 16 months but several ground observations of him were made over a year after the collar malfunctioned.

Some truly amazing movements were documented by these sheep. All four of the surviving radio collared ewes made incredible mid-winter migrations. The sheep would spend the early

part of the winter from early December to around mid-February in the Slate and Black Creek drainages and then they would head south to the Booth Creek cliff to spend the remainder of the winter. Some of the sheep would then return to lambing areas in Slate and Black Cr. between May 21- June 15. These migrations were probably made along the top of the ridge in the highest part of the Gore Range while there was deep snow and avalanche danger. On one flight, I was able to get visual locations on several of the ewes as they were making their treacherous journey heading south along the highest spine of the Gore Range.   See Table 1 for dates when these sheep were last known to be in the northern Slate and Black creek winter ranges and when they were first detected at the southern Booth Creek winter range cliff area.

We were able to get several visual locations on the radio ram even though the radio collar quit working. The ram was originally collared on 2/17/1990 on the Booth Cr. cliffs. It was observed on 9/27/1991 in Pitkin Cr. by a sheep hunter. Bill Andree saw him again in Sept 1992 in Pitkin and Bighorn Cr. and Bill McEwen saw him during the spring of 1993 in the Booth Creek area. While we do not have good data on ram movements and seasonal ranges, based upon this one sheep and other observations, the rams appear to summer in the South end of the Gore Range in the Pitkin, Bighorn and Deluge Cr. drainages. Then they probably head north into the Slate-Black Creek drainages during the late-November for the rut. Eventually, the rams appear to return to the Booth Cr. area and appear to favor cliffs on the west side of Booth Cr. Sometimes they are observed along the frontage road in the area of the road cuts.

Mortality: These are native sheep that have evolved here and have probably persisted in this area for thousands of years. As such, these sheep know their seasonal ranges very well and can navigate this extremely rugged terrain very successfully. We did document some mortality during the study:

Ewe G4 was collared on 4/16/1989 and found dead on 5/23/1989 in the Booth Cr. cliffs. She probably died due to the stress of capture.

Ewe G7 was captured on 3/9/1990 and was found dead on 4/30/1990. She also probably died as the result of capture stress.

Ewe G8 was captured on 4/3/1991 and the damaged and bent radio collar was discovered in an avalanche chute on Guyselman Mt. No remains of the sheep were found but it is suspected that she died in an avalanche the previous winter sometime after 11/13/1992.

One ewe's (G7) radio collar fell off less than 2 months after she was collared. However, it did not survive and was recaptured the following year but only 2 months of data was collected from the radio collar.

Minimum Population Estimates (highest documented number sheep for one group or at one time/location):

> 1989: Aug. 10. 1989 – 43 sheep, helicopter survey of Gore Range – Gene Byrne, Observer
>
> 1990: April 30, 1990 – 45 sheep observed from fixed wing airplane survey – Gene Byrne, Observer
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> 1991: April 3, 1991 – 35 sheep Booth Creek area, both sides – Andree and Byrne
>
> 1992: 18 rams, minimum number observed by Andree during sheep season – Bill Andree

1993: May 10, 1993 – 13 sheep both sides of Booth Cr. – Byrne

I have attached a document that shows the explanation of sheep observations in the database. This includes the date ranges for each activity code: summer range, winter range, lambing, etc.

I am also attaching 6 maps of the movements of the sheep that survived greater than one year and did not lose their collars. It would be possible and beneficial if the CPW would re-analyze this dataset using the modern mapping software and overlay it on topographic maps to better visualize these areas and habitat parameters.

Literature Cited

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Fitzgerald, J.P., C.A. Meaney, D.M. Armstrong. 1994. Mammals of Colorado – Ovis canadensis section. Denver Mus. Of Nat. History. Univ. Press of CO. 467 pp.

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Bighorn Sheep and Mountain Goat Observation Database Explanation

I. D. No.   The unique I.D. number that is assigned to each individual animal i.e. "G1".

FREQ.   The frequency of the radio collar i.e. 148.221 MHZ.

LOC NO   The sequential number of each relocations, both ground and aerial, made on the animal. The trap date and location is numbered "0".

ACT CDE   Activity code - this corresponds to the activity period code for a particular relocation time of the year. The following codes are used:

Code	Period	Activity Period Dates
S	Summer	June 16 - Sept 15
F	Fall Tran.	Sept 16 - Nov. 20
R	Rut	Nov. 21 - Dec. 20
W	Winter	Dec. 21 - April 15
T	Sprg Tran.	April 16 - May 20
L	Lambing	May 21 - June 15

DATE   The date of the relocation.

TIME   The time of the relocation. Military time is used i.e. 800 for 8:00 am and 1400 for 2 PM.

VIS   A visual was made on the animal - yes or no.

Met   Method - A (air) or G (ground) relocation.

GRP SIZE   Size of the group if a visual was made.

HABT TYPE   Habitat Type - enter one or more of the following codes:
                A Alpine
                C Coniferous
                G Grass
                S Shrub
                P Aspen (Populus)
                J Pinon/Juniper
                T Talus (rock)
            If the animal was on the edge or close to an edge, enter the two types i.e. A - C (Alpine & Coniferous). The first code should be the predominate type, therefore in the case above the animal appeared to selecting the alpine over the coniferous type. This is strictly a judgment call.

ASP   Aspect - this was determined by map inspection and recorded to the nearest 45 degrees i.e. NE, S, NW etc.

SLPE   Slope - was determined using the USGS slope gauge.

13

ELEV   Elevation of the relocation in feet to the nearest 100 feet.

U.T.M. X   The Universal Transverse Mercator location for the "X" coordinate. All UTMs are for zone 13 unless otherwise stated. Locations determined by map inspection are usually rounded off to the nearest 25 meters. Aerial locations that are determined using the LORAN Navigation system are usually entered to the nearest meter, although the accuracy is probably ± 500 meters.

U.T.M. Y   Same as above except for the "Y" coordinate.

COMMENTS   A very brief statement, 60 characters or less, of the description of the location, other collared animals in the group, unusual circumstances, sex and age composition, etc.

DAYS LAST LOC.   Number of days since the last relocation was made.

DIST LAST LOC (Km) The distance in kilometers the animal has moved since the last relocation.

14

Fig. 1. Map showing the relocation data for ewe G1 in the Gore
Range since 4-27-89. Collar may have failed after 4-27-92.

BIGHORN SHEEP — GORE RANGE
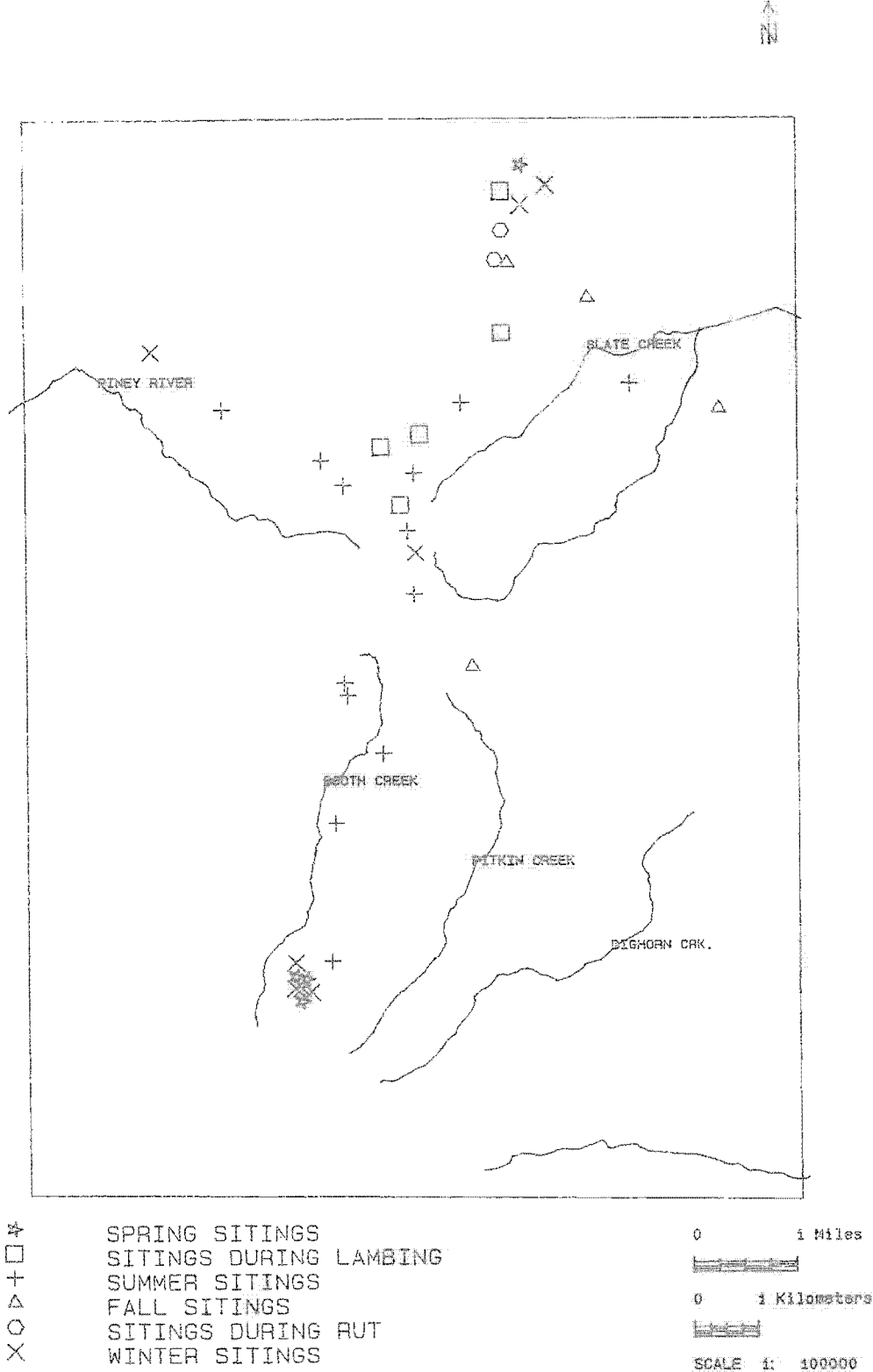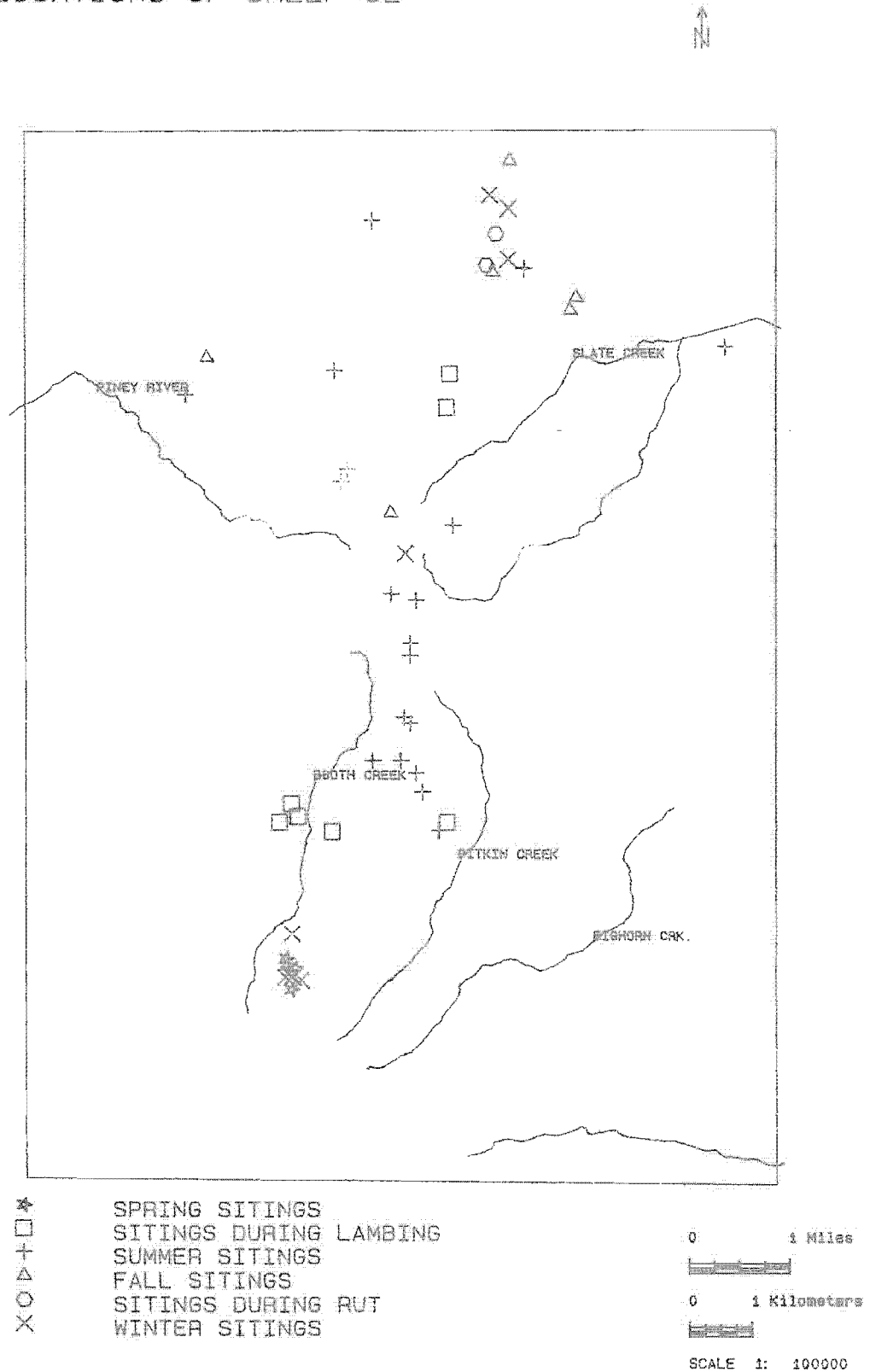LOCATIONS OF SHEEP G1

SPRING SITINGS
SITINGS DURING LAMBING
SUMMER SITINGS
FALL SITINGS
SITINGS DURING RUT
WINTER SITINGS

0   1 Miles

0   1 Kilometers

SCALE 1: 100000

15

Fig. 2. Map showing the relocation data for ewe G2 in the Gore
Range since 4-27-89.

BIGHORN SHEEP — GORE RANGE
LOCATIONS OF SHEEP G2

SPRING SITINGS
SITINGS DURING LAMBING
SUMMER SITINGS
FALL SITINGS
SITINGS DURING RUT
WINTER SITINGS

0   1 Miles

0   1 Kilometers

SCALE 1: 100000

16

BIGHORN SHEEP — GORE RANGE
LOCATIONS OF SHEEP G3

SLATE CREEK

RINEY RIVER

BOOTH CREEK

PITKIN CREEK

BIGHORN CRK.

0   1 Mile

0   1 Kilometer

SCALE 1: 100000

N

✳   SPRING SITINGS
□   SITINGS DURING LAMBING
+   SUMMER SITINGS
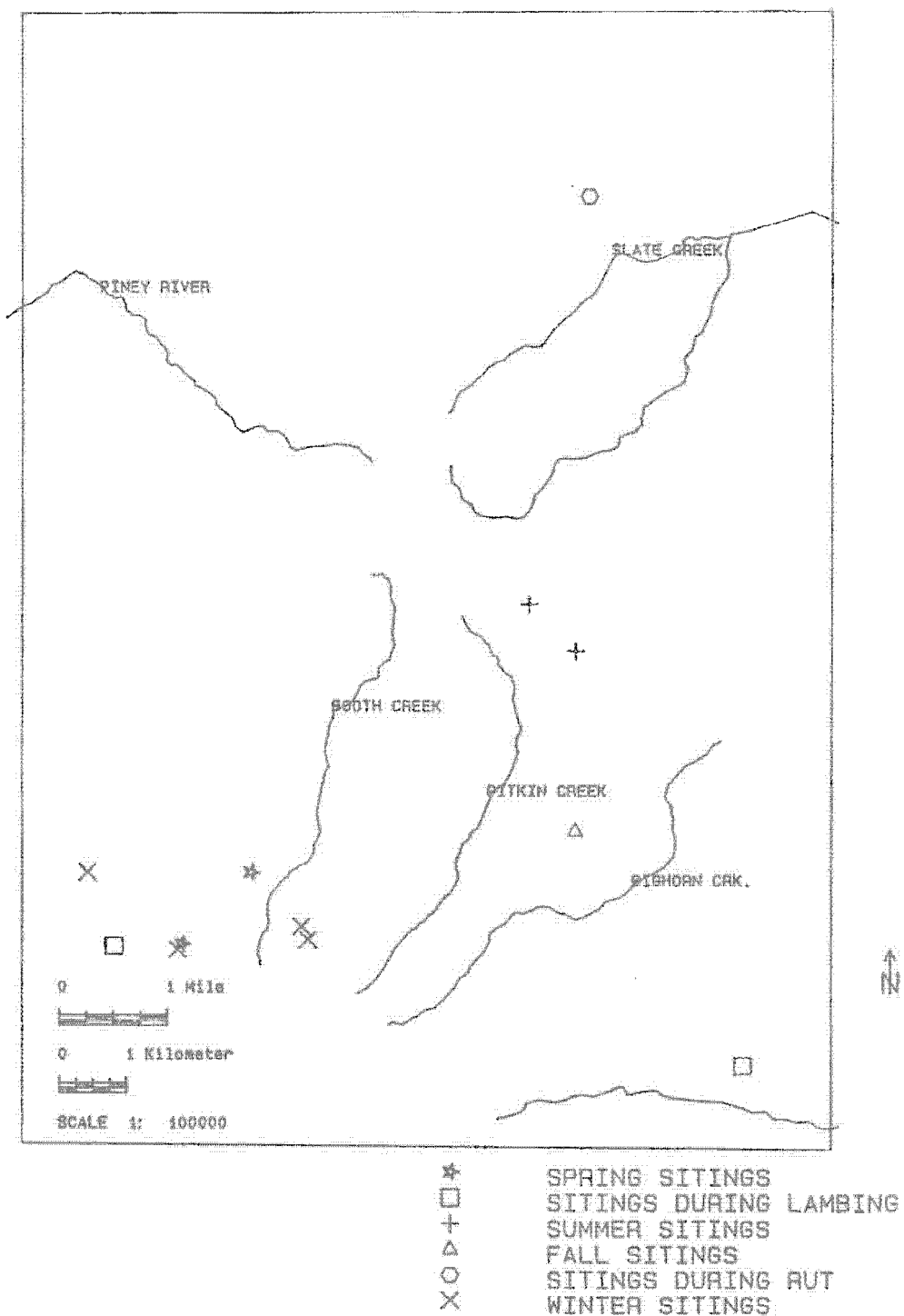△   FALL SITINGS
○   SITINGS DURING RUT
✕   WINTER SITINGS

Fig. 3. Map Showing the relocation data for ram G3 in the Gore
Range since 3-9-90 to 5-24-91, after this date the collar
evidentally malfunctioned.

17

BIGHORN SHEEP — GORE RANGE
LOCATIONS OF SHEEP G5

N

RINEY RIVER

SLATE CREEK

BOOTH CREEK

PITKIN CREEK

BIGHORN CRK.

✷	SPRING SITINGS
☐	SITINGS DURING LAMBING
+	SUMMER SITINGS
△	FALL SITINGS
○	SITINGS DURING RUT
✕	WINTER SITINGS

0   1 Miles

0   1 Kilometers

SCALE 1: 100000

Fig. 4. Map showing the relocation data for ewe G6 in the Gore
Range from 4-12-89 to 12-21-92.

BIGHORN SHEEP – GORE RANGE
LOCATIONS OF SHEEP G6

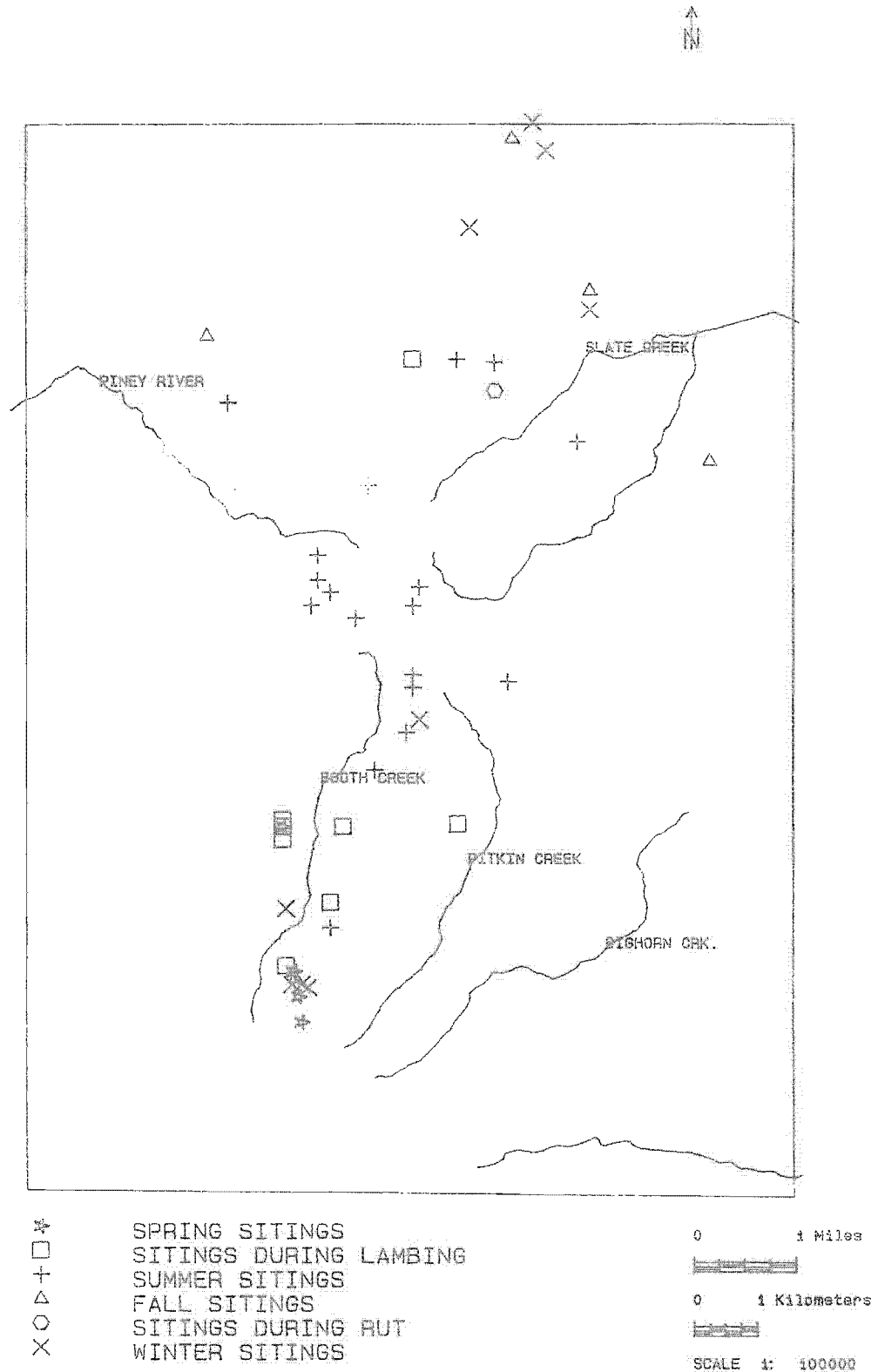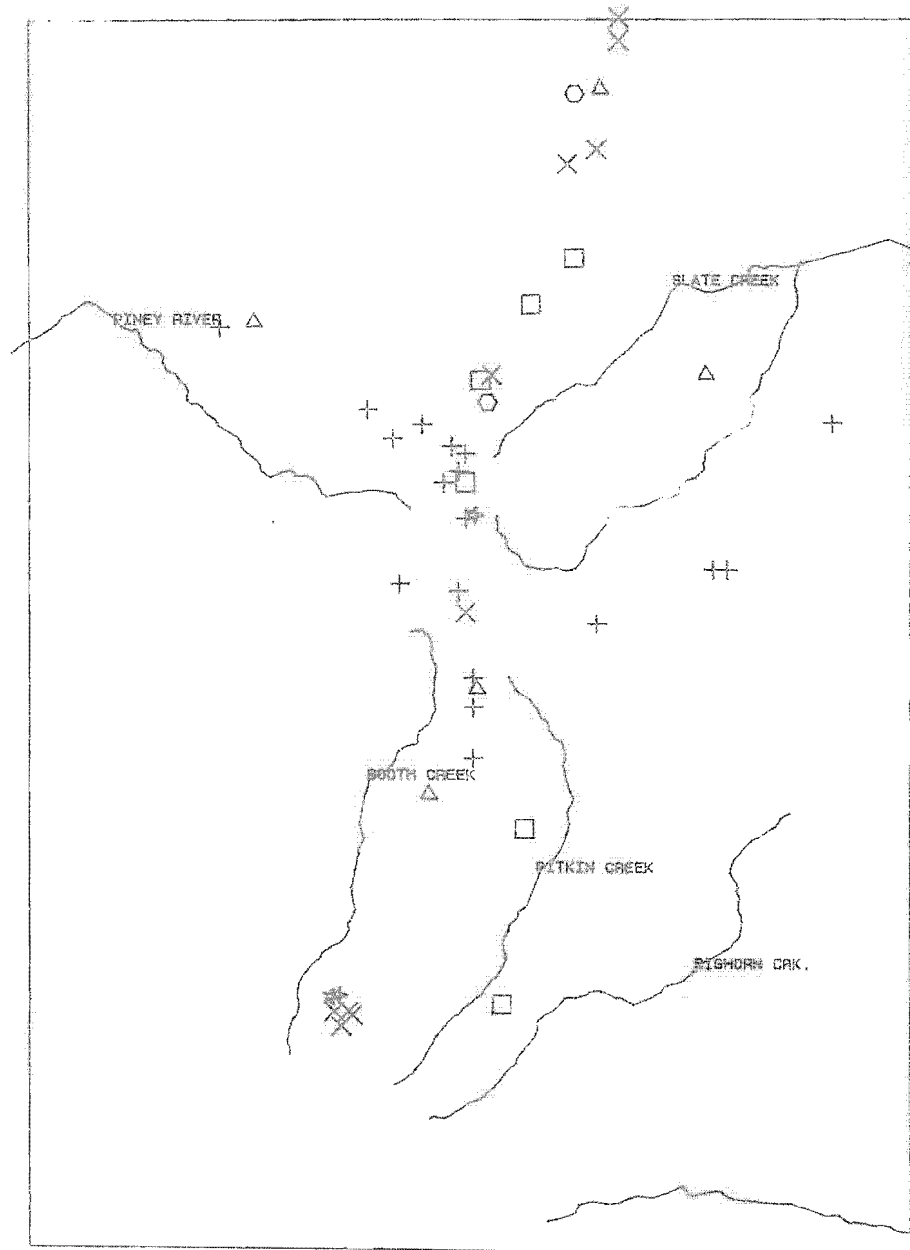19

Fig 5. Map showing the relocation data for ewe G8 in the Gore
Range from 2-11-91 to 12-21-92.

BIGHORN SHEEP — GORE RANGE
LOCATIONS OF SHEEP G8
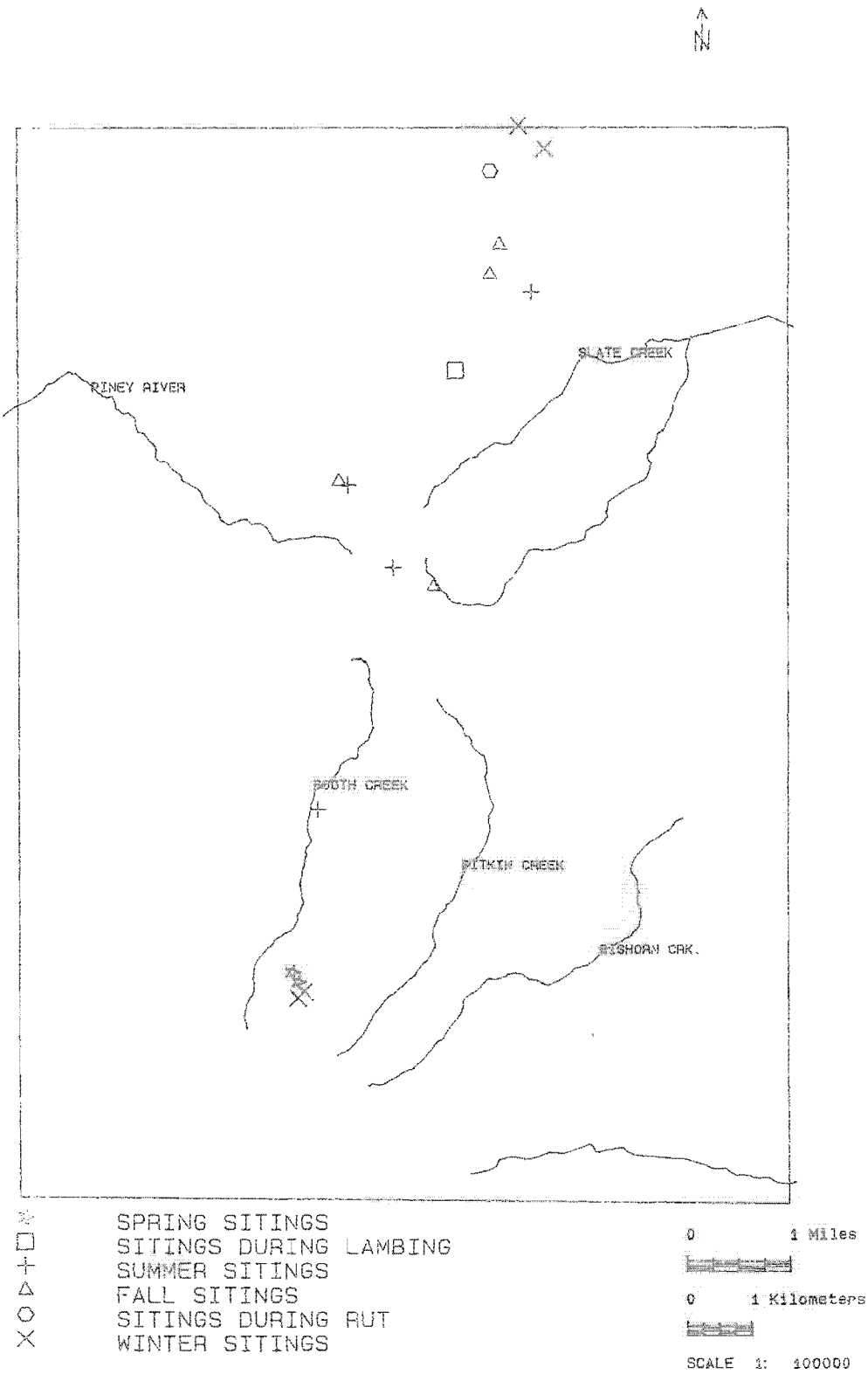
SPRING SITINGS
SITINGS DURING LAMBING
SUMMER SITINGS
FALL SITINGS
SITINGS DURING RUT
WINTER SITINGS

0   1 Miles

0   1 Kilometers

SCALE 1: 100000

20

Figure # 6
W Booth Cr

Ram winter congregation area Cliffs

Legend

N

6

So 2000 ft
South Frontage Rd E

Fall Ridge Rd

Golf Ln

Vail Valley Dr

Elkhorn Dr
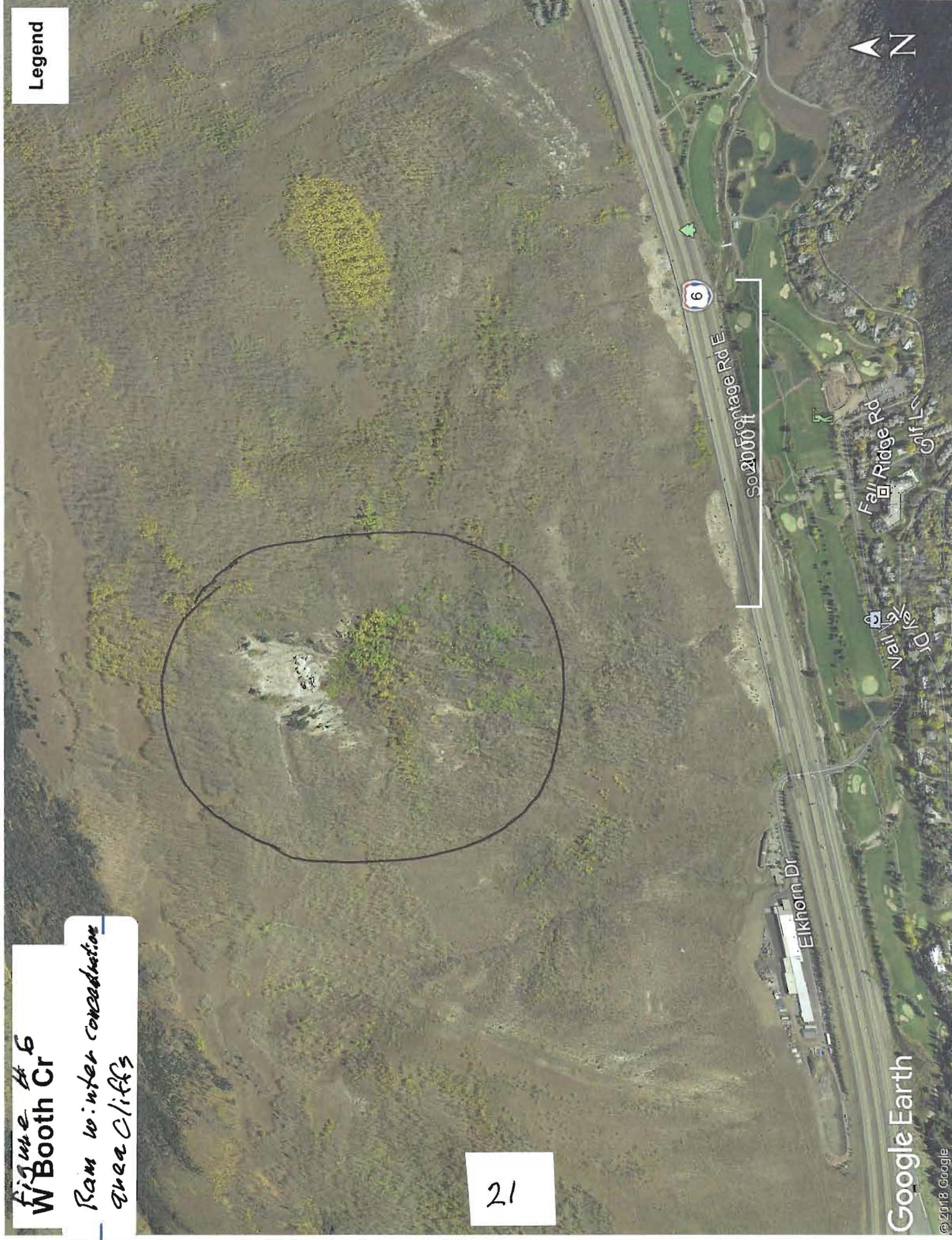
21

Google Earth

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Table No. *I* Winter movements dates for radio collared bighorn sheep in the Gore Range. "Last Date on North Winter Range" is the last date the sheep was on detected on the non-Booth Creek winter ranges.

Sex	ID	Last Date on North Winter Range	Location of N Winter Range	First Date Detected On Booth Cr.
Ewe	G1	2/6/1990	Slate Cr.	2/17/1990
		4/19/1991	Black Cr.	7/1/1991
		12/4/1991	Black Cr.	1/29/1992
Ewe	G2	2/6/1990	Slate Cr.	2/17/1990
		1/22/1991	Black Cr.	4/3/1991
		12/4/1991	Black Cr.	1/29/1992
		12/21/1992	Brush Cr.	3/2/1993
Ram	G3	11/29/1990	Slate Cr.	1/22/1991
Ewe	G5	2/6/1990	Pitkin-Booth Cr Ridge	2/17/1990
		1/29/1992	Black Cr.	3/13/1992
Ewe	G6	2/6/1990	Slate-Black Cr.	2/17/1990
		1/29/1992	Black Cr.	3/13/1992
		3/2/1993	Guyselman Mt.	5/12/1993
Ewe	G8	1/29/1992	Black Cr.	3/13/1992