Update for Wildlife-Vehicle Collision and Crossing Mitigation Plan for Hwy 93S in Kootenay and Banff National Park

Final Report

by

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16. Abstract This manuscript is an update for a highway mitigation plan that was prepared in March 2008. The current manuscript reports on a presentation of the highway mitigation plan to Park staff, a field visit in October 2009, an update on potential mitigation measures, and additional data and interviews with Park staff.		
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DISCLAIMER

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1. INTRODUCTION

1.1. Background

In 2008 a study was conducted to identify mitigation measures aimed at reducing wildlife-vehicle collisions and providing safe crossing opportunities for wildlife along Hwy 93S through Kootenay and Banff National Park (Huijser & Paul, 2008; Huijser et al., 2008a). The current manuscript provides an update to these reports.

1.2. Project Goals and Objectives

The objectives of this project were to:

- Present the results from the 2008 study to personnel from Parks Canada in the Radium Hot Springs area. Note: The 2008 presentation was mostly for management staff in the Lake Louise area.
- Conduct a field site review with Park personnel. Note: the 2008 study took place in the winter months when there was substantial snow cover that reduced visibility.
- Provide an update on the availability and effectiveness of potential mitigation measures aimed at reducing wildlife-vehicle collisions and providing safe crossing opportunities for wildlife.
- Review additional road mortality data and wildlife observation data.
- Conduct interviews with Park personnel with regard to their opinions on the suggested mitigation measures.

These objectives are reported on in the following chapters.

2. PRESENTATION TO PERSONNEL FROM PARKS CANADA

Dr. Marcel Huijser presented the results of the 2008 study to personnel from Parks Canada on 20 October 2009 in the Radium Hot Springs area. The 45 minute presentation allowed for a questions and answers session as well as general discussion after the presentation.

3. FIELD SITE REVIEW WITH PARK PERSONNEL

Dr. Marcel Huijser conducted a field site review with Alan Dibb (Parks Canada) on 21 October 2008. Discussions focused on the following topics:

- The expected outcome of the proposed mitigation measures.

  The success parameter of the project will likely be related to the potential reduction in wildlife-vehicle collisions rather than conservation objectives for threatened, endangered, or relatively rare species.

- The prioritization of the proposed mitigation zones.

  The road section where most wildlife-vehicle collisions have been reported is between km reference posts 26.3-26.8 (500 m) and, a combination of road sections between km reference posts 32.4-42.6 (10.2 km) (Huijser et al., 2008a (see Table 10)). It is considered good practice to mitigate longer road sections rather than short road sections and not have a high number of transitions from mitigated road sections to unmitigated road sections to reduce confusion to drivers about whether certain road sections have been mitigated. Depending on the mitigation measures that may be selected, and depending on the actual implementation costs, the available budget may allow for about 4-10 km of road length to be mitigated. For these reasons, mitigation efforts in the road section between km reference posts 32.4-42.6 have priority over the road section between km reference posts 26.3-26.8. While the start point for the implementation of the mitigation measures is flexible within the road section between km reference posts 32.4-42.6, it is recommended that different implementation phases apply to road sections that are adjacent to each other to reduce transitions between mitigated and unmitigated road sections and associated confusion to drivers.

- The nature of potential mitigation measures.

  Since the overall success parameter of the project will likely be related to the potential reduction in wildlife-vehicle collisions, the majority of the resources should probably be devoted to mitigation measures that are robust and that are known to lead to a substantial reduction in wildlife-vehicle collisions. However, a relatively small proportion of the available resources may be devoted to more experimental mitigation measures.

- Research and/or monitoring is recommended, especially for mitigation measures that may be experimental in nature (e.g. animal detection systems, increased maximum speed enforcement, vegetation management in right-of-way, alternative road striping etc.). The following is recommended with regard to such research and/or monitoring:

  - Use replicas so that a sample size is obtained, allowing for statistical analyses. Ideally, replicas would be on randomly selected road sections. This may conflict with best management practices to have mitigated zones generally be adjacent to each other to minimize transitions between mitigated and unmitigated road sections and associated confusion to drivers. If replicas are not obtained, then the results will be descriptive in nature only; the number of wildlife-vehicle collisions may be lower, the same, or higher, but we cannot tell whether a potential change is associated with the type of mitigation measure that was implemented.

- Conduct power analyses to estimate the required sample size. Basically, large differences and consistent effects (the direction as well as the extent of the effect) are relatively easy to detect compared to smaller differences with more variable effects. Thus, the smaller the effect ones wishes or needs to detect, and the larger the variability in the data, the larger the required sample size. If the sample size is too low compared to the expected effect and variability of the data, then one cannot expect to detect a difference in the response parameter between the various treatments. Thus the conclusion would be that while there may be an effect, the sample size was inadequate given the expected effect and the variability of the response parameter. The conclusion is not that there was no effect.
- Consider a BACI approach. A BACI approach compares response parameters Before and After a road section has been mitigated, and also compares response parameters between unmitigated Control road sections and mitigated Impact (or treatment) road sections. This approach allows for a comparison in time (Before/After) as well as space (Control/Impact), correcting for potential changes in conditions over time (e.g. changes in deer population size or distribution).

4. UPDATE POTENTIAL MITIGATION MEASURES

1.3. General

A report to US Congress and a Best Practices Manual on mitigation measures aimed at reducing wildlife-vehicle collisions were published recently (Huijser et al., 2008b; c). These reports confirm that wildlife fencing in combination with wildlife under- and overpasses and animal detection systems are among the most effective measures to reduce wildlife-vehicle collisions. In addition, the manual shows many practical considerations for the implementation of selected mitigation measures. Furthermore, cost-benefit analyses showed that selected mitigation measures aimed at reducing collisions with large ungulates can help society safe money on road sections where a certain number of collisions is known to occur (Huijser et al., 2009a).

1.4. Wildlife Fencing and Wildlife Underpasses and Overpasses

A manual on wildlife underpasses and overpasses has been published recently (Clevenger and Huijser, 2009). This manual focuses on practical considerations for the implementation of selected mitigation measures and has species specific recommendations.

1.5. Animal Detection Systems

An important report on the reliability of animal detection systems was published (Huijser et al., 2009b). The study showed that five out of nine animal detection systems tested met the suggested norms for reliability. However, animal detection systems should still be considered experimental and still require frequent monitoring of their reliability and system repairs. In addition, other studies that have recently reported on the effectiveness of animal detection systems include:

- Dodd and Gagnon (2008) found that drivers reduced their speeds substantially when presented with activated warning signals associated with an animal detection system that was installed at a gap (30 m (100 ft) wide) in an electric wildlife fence along State Route 260 in Arizona, USA. The average vehicle speed decreased from 62.7 mi/h (100.9 km/h) (warning lights off) to 50.7 mi/h (81.6 km/h) (warning lights on). Crash data showed that elk-vehicle collisions were reduced from 11.7 per year on average to 1 per year after an animal detection system was installed (1 year of data post-installation). This was a 91% reduction in collisions with large animals. Note that increased driver alertness is likely to have accompanied the lower vehicle speed and that increased driver alertness only needed to be maintained over a very short road section (30 m (100 ft) wide). Driving similar speeds over longer road sections (e.g. about 100 km (62 mi)) without time or location specific warning signs that would raise driver alertness for a specific time period at a specific location, cannot be expected to reduce wildlife-vehicle collisions substantially.

- Dai et al. (2009) investigated the reliability and effectiveness of an animal detection system installed along a 1.6 km (1.0 mi) long section of US Hwy 191 near Pinedale, WY, USA. The results indicate that the system had a greater effect on driver speeds during the earlier data collection periods, and that the effectiveness on vehicle speed may reduce over time. Crash rates (i.e. number of crashes per million vehicle miles traveled) show a downward trend, but a before and after analysis did not show a significant decrease in animal-vehicle collisions after the system was installed.
- Huijser et al. (2009c) investigated the effectiveness of an animal detection system along a 1.6 km (1.0 mi) long section of US Hwy 191 between West Yellowstone and Big Sky, Montana, USA. Speed measurements showed that passenger cars, pick-ups, vans, and trucks with two units or more all had lower vehicle speed with the warning signs activated compared to warning signs off. The number of collisions with large wild animals was 58-67% lower than expected, but because of the variability in the number of collisions and only one year of post installation collision data, the researchers could not test whether this reduction was significant.

Anecdotal data from other sites show the following:

- A site with the system near Clam Lake, WI has experienced two elk-vehicle collisions between 19 December 2006 (when the system became operational) and fall 2007 (Clam Lake Elk News 2007). During this same period the previous year there were five elk vehicle collisions; suggesting a 60% reduction in collisions with large animals.
- About 50% fewer white-tailed deer than expected were hit at a site near Marshall, MN (see Huijser, et al. 2006) between April 2007 (when the animal detection system became operational) and January 2008 (CBS 2008). Before the system became operational between 40 and 80 white-tailed deer were hit on the one-mile-long road section equipped with the system (Star Tribune 2007).

1.6. Other Potential Mitigation Measures

Two lane roads that are widened (e.g. wider lanes, wider shoulders, wider clear zones, longer sight distances, fewer curves) typically have fewer overall crashes after they have been widened (Vokurka and Young, 2008). However, one type of crash, animal-vehicle collisions, tends to increase, presumably because drivers may have increased vehicle speed on the wider road (Vokurka and Young, 2008). Drivers typically drive the speed that they think is safe, and the operating speed is typically dictated by the design of a road rather than the posted maximum speed limit. Therefore it may be interesting to explore if measures can be implemented that influence the perception of drivers with regard to what they consider a safe speed. Specifically, the width of a lane can be made narrower through striping, without affecting the actual width of the road (Figure 4.1). While no data are available on the effectiveness of this measure, wider striping that takes up space in the middle of the road between the two travel directions, as well as striping on the side of the road, may encourage drivers to keep vehicle operating speed below the design speed of a road.

However, the painted surface area may need to be similar to current striping practices to not increase the danger to drivers, especially motorcyclists, because of the potentially more slippery surface of the painted areas. In addition, striping needs to follow national standards to avoid confusion on how to interpret the striping. In The Netherlands new striping patterns were introduced starting in 2008 as a way to communicate the maximum speed limit to drivers; specific striping patterns are associated with specific speed limits. While this measure may decrease vehicle speed, may increase overall safety, may decrease animal-vehicle collisions, and may be deployed over relatively long road sections at relatively low costs, the author of this report does not expect a substantial decrease in the number of animal-vehicle collisions as a result of this measure. Reducing current operating speed on Hwy 93 South (85 percentile is 111 km/h) to a speed that is closer to the posted speed limit (90 km/h) may still result in a speed that is too high to reduce animal-vehicle collisions substantially.

Figure 4.1: Wider and double striping along the edges and center of a road in The Netherlands resulting in narrower lanes, and potentially lower vehicle speeds, without reducing the actual width of the road (© Marcel Huijser).

5. REVIEW ADDITIONAL WILDLIFE MORTALITY AND WILDLIFE OBSERVATION DATA

The mitigation plan that was prepared in 2008 (Huijser et al., 2008) was based on wildlife-vehicle collision data and wildlife observation data from 1978 through 2007. This chapter contains data on wildlife vehicle collision data and wildlife observation data that was not included in the 2008 mitigation plan. The available budget did not allow for a reanalysis of the data. Instead the maps containing the data were discussed with Park personnel. The data from white-tailed deer and deer spp. were set apart as they are so numerous that they would obscure the location of the observations for the other species.

The maps on the following pages relate to:

- Figures 5.1-5.5: Wildlife-vehicle collision data (excluding white-tailed deer) (January 2008 – 23 September 2009).
- Figures 5.6-5.10: White-tailed deer-vehicle collision data (including deer spp.) (January 2008 – 23 September 2009).
- Figures 5.11-5.14: Wildlife observation data (excluding white-tailed deer) obtained through driving surveys (June 2007 – 29 September 2009). Note: the survey in the Kootenay Valley was initiated in June 2007 while the survey in the Vermillion Valley was not initiated until 22 May 2008. Therefore the data from the two valleys are not directly comparable in the current format.
- Figures 5.15-5.18: White-tailed deer observation data (including deer spp.) obtained through driving surveys (June 2007 – 29 September 2009). Note: the survey in the Kootenay Valley was initiated in June 2007 while the survey in the Vermillion Valley was not initiated until 22 May 2008. Therefore the data from the two valleys are not directly comparable in the current format.
- Figures 5.19-5.22: Incidental wolf observation data (January 2008 – 26 September 2008).

General comments regarding the wildlife-vehicle collision and wildlife observation data:

- Two years of additional data (2008, 2009) is unlikely to substantially change the identification of the mitigation zones (based on 33 years) as well as the prioritization of the mortality clusters (based on 10 years) (Huijser et al., 2008).
- White-tailed deer-vehicle collisions and observations continue to dominate the data, particularly in the northern section of the Kootenay Valley. Bighorn sheep-vehicle collisions continue to be abundant in and around Radium Hot Springs.
- The 12 reported moose-vehicle collisions are noteworthy as they have a relatively high likelihood of resulting in human injuries and fatalities (Huijser et al., 2009).
- The two reported grizzly bear- and six reported wolf-vehicle collisions are noteworthy as it may indicate a problem with regard to their population survival probability in Kootenay National Park.

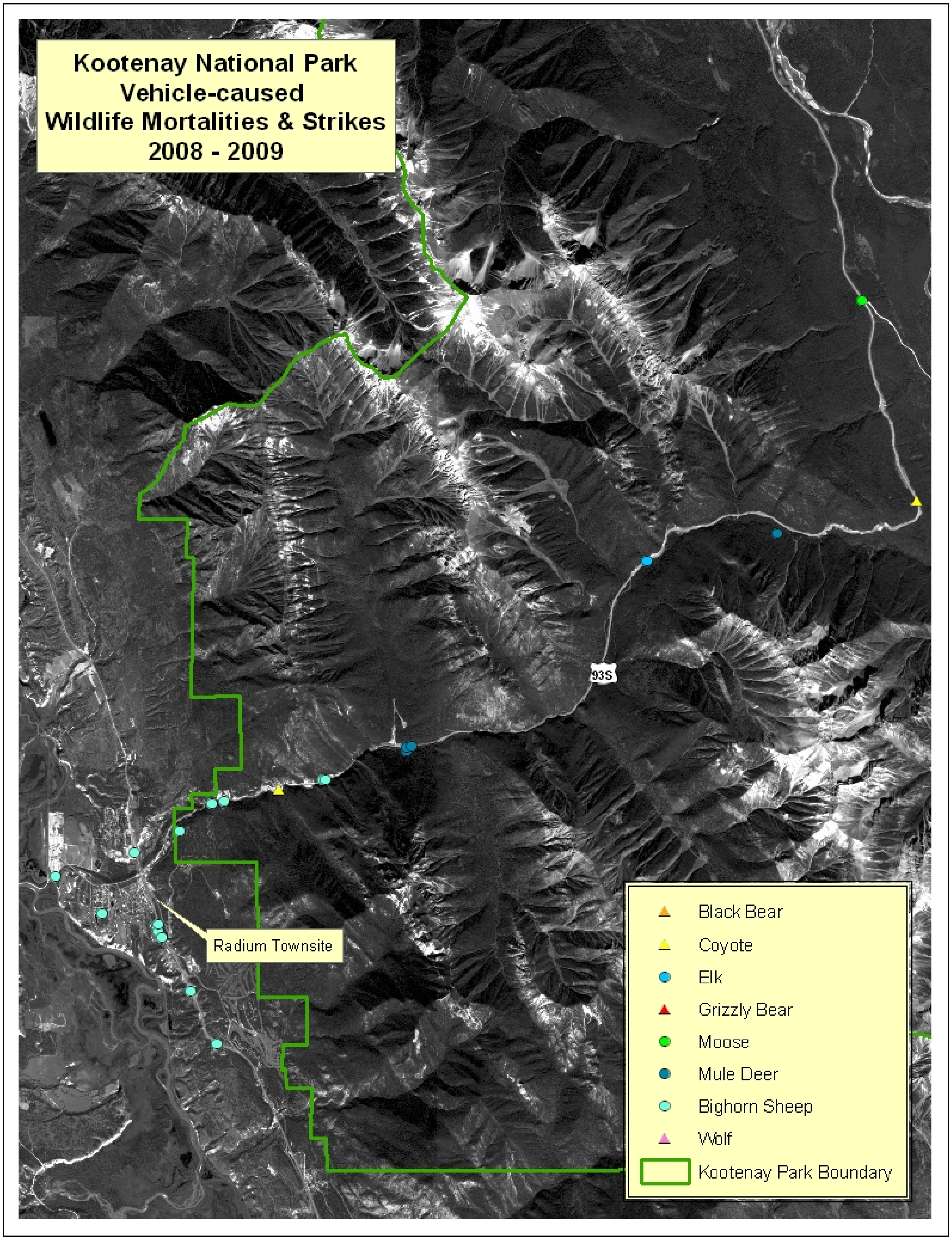

Figure 5.1: Wildlife-vehicle collisions (excluding white-tailed deer) between January 2008 and October 2009 in the area in and around Radium Hot Springs and Sinclair Canyon (Source: Shelagh Wrazej, Parks Canada).

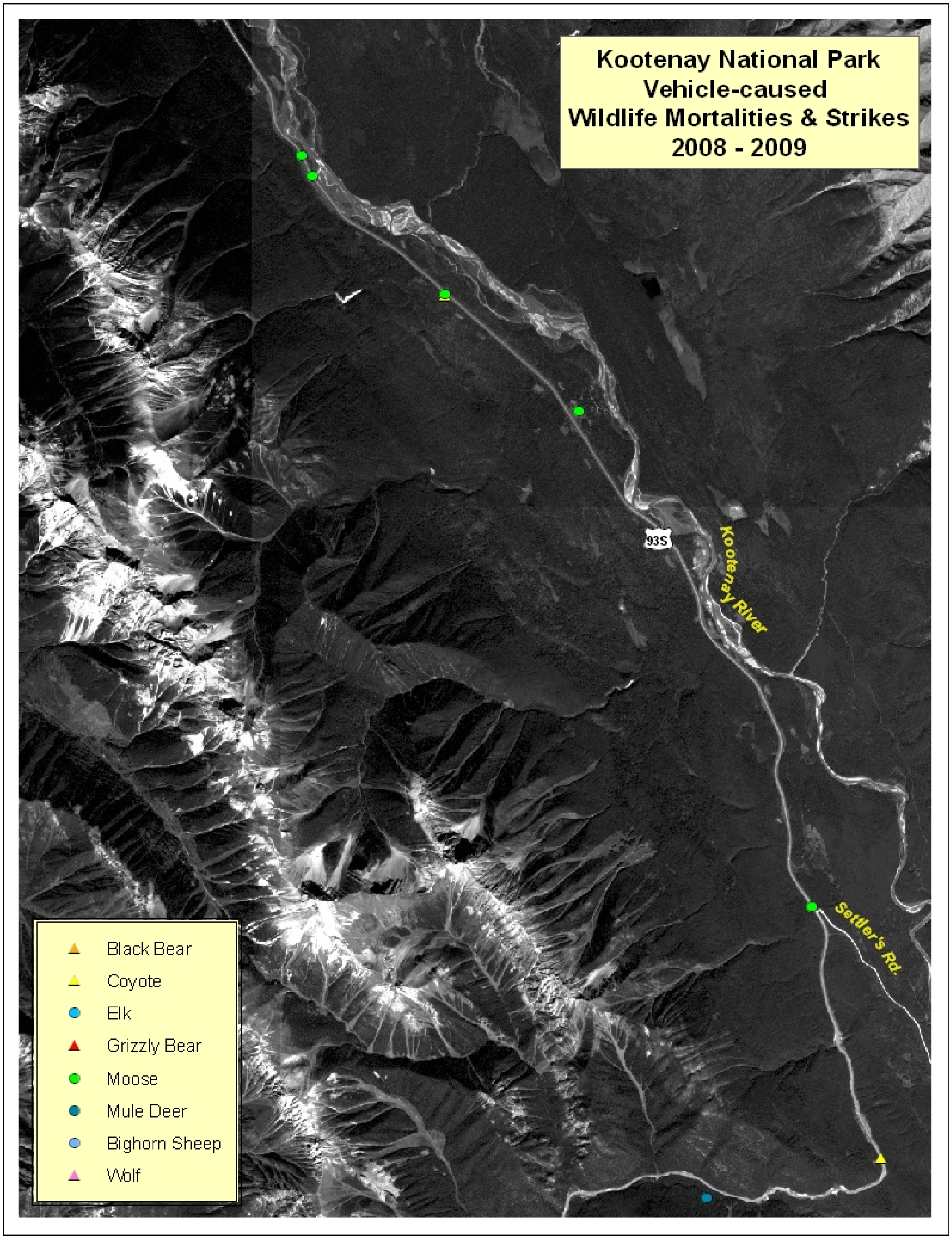

Figure 5.2: Wildlife-vehicle collisions ((excluding white-tailed deer) between January 2008 and October 2009 in the southern Kootenay Valley (Source: Shelagh Wrazej, Parks Canada).

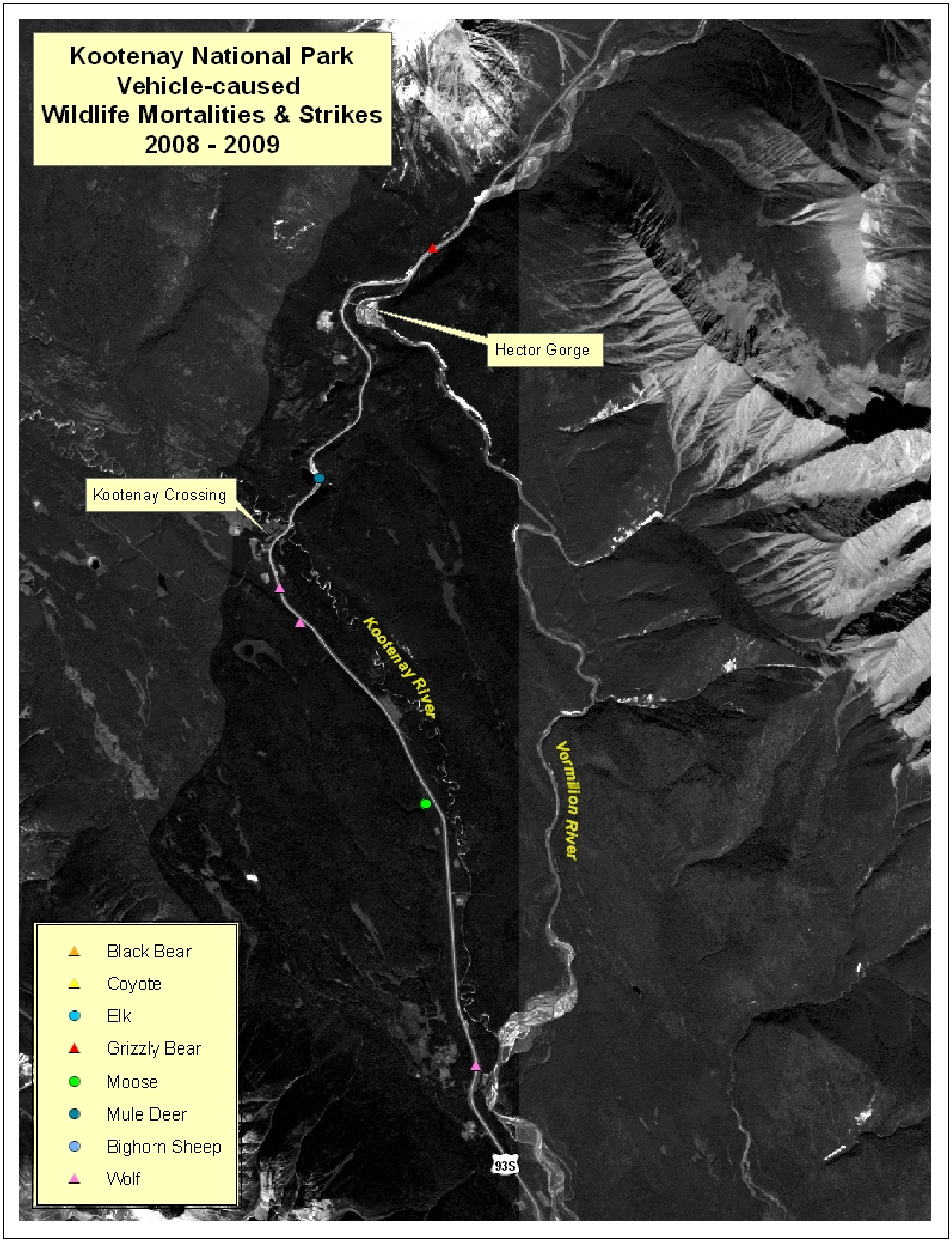

Figure 5.3: Wildlife-vehicle collisions (excluding white-tailed deer) between January 2008 and October 2009 in the northern Kootenay Valley (Source: Shelagh Wrazej, Parks Canada).

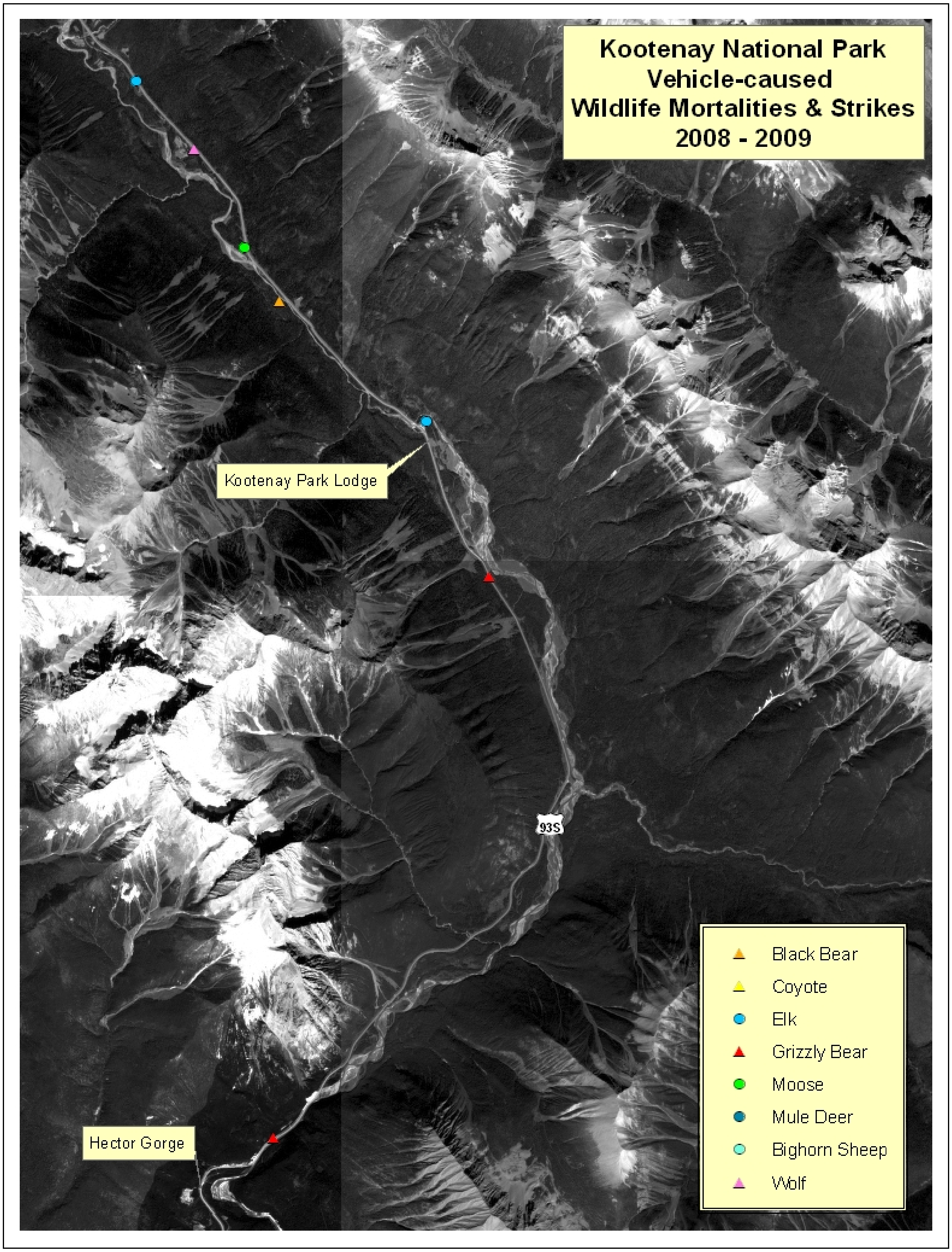

Figure 5.4: Wildlife-vehicle collisions (excluding white-tailed deer) between January 2008 and October 2009 in the southern Vermilion Valley (Source: Shelagh Wrazej, Parks Canada).

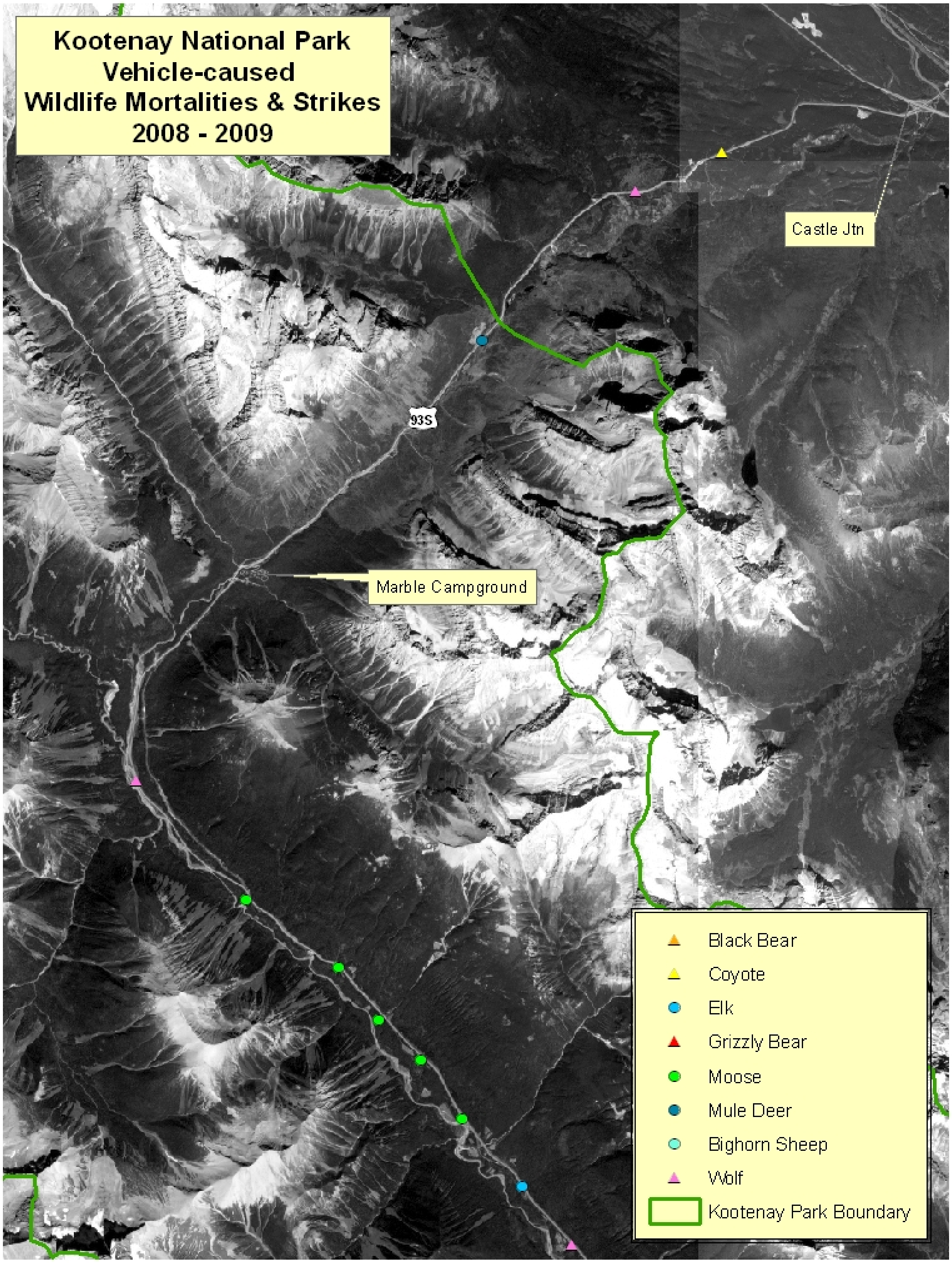

Figure 5.5: Wildlife-vehicle collisions (excluding white-tailed deer) between January 2008 and October 2009 in the northern Vermilion Valley (Source: Shelagh Wrazej, Parks Canada).

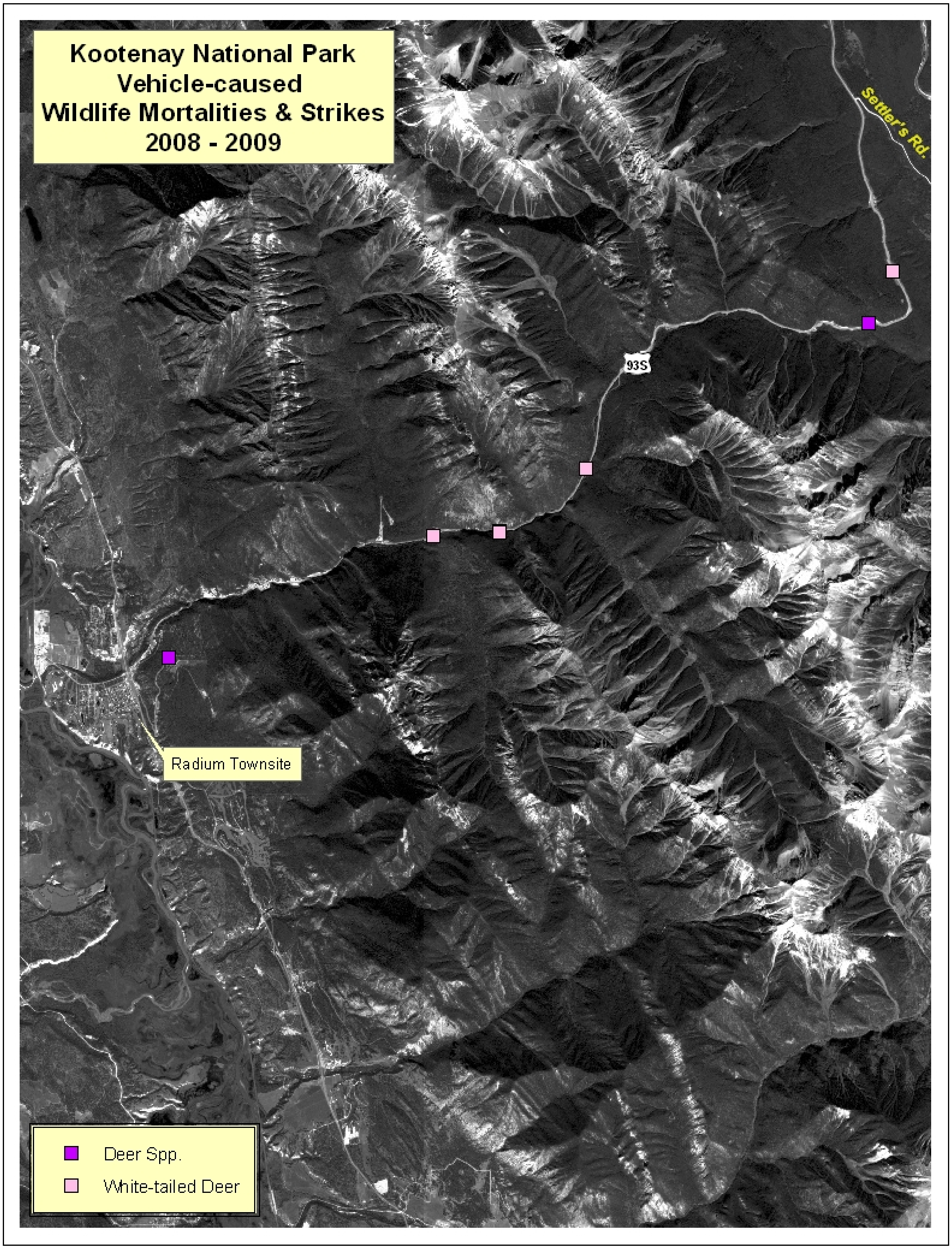

Figure 5.6: White-tailed deer-vehicle collisions between January 2008 and October 2009 in the area in and around Radium Hot Springs and Sinclair Canyon (Source: Shelagh Wrazej, Parks Canada).

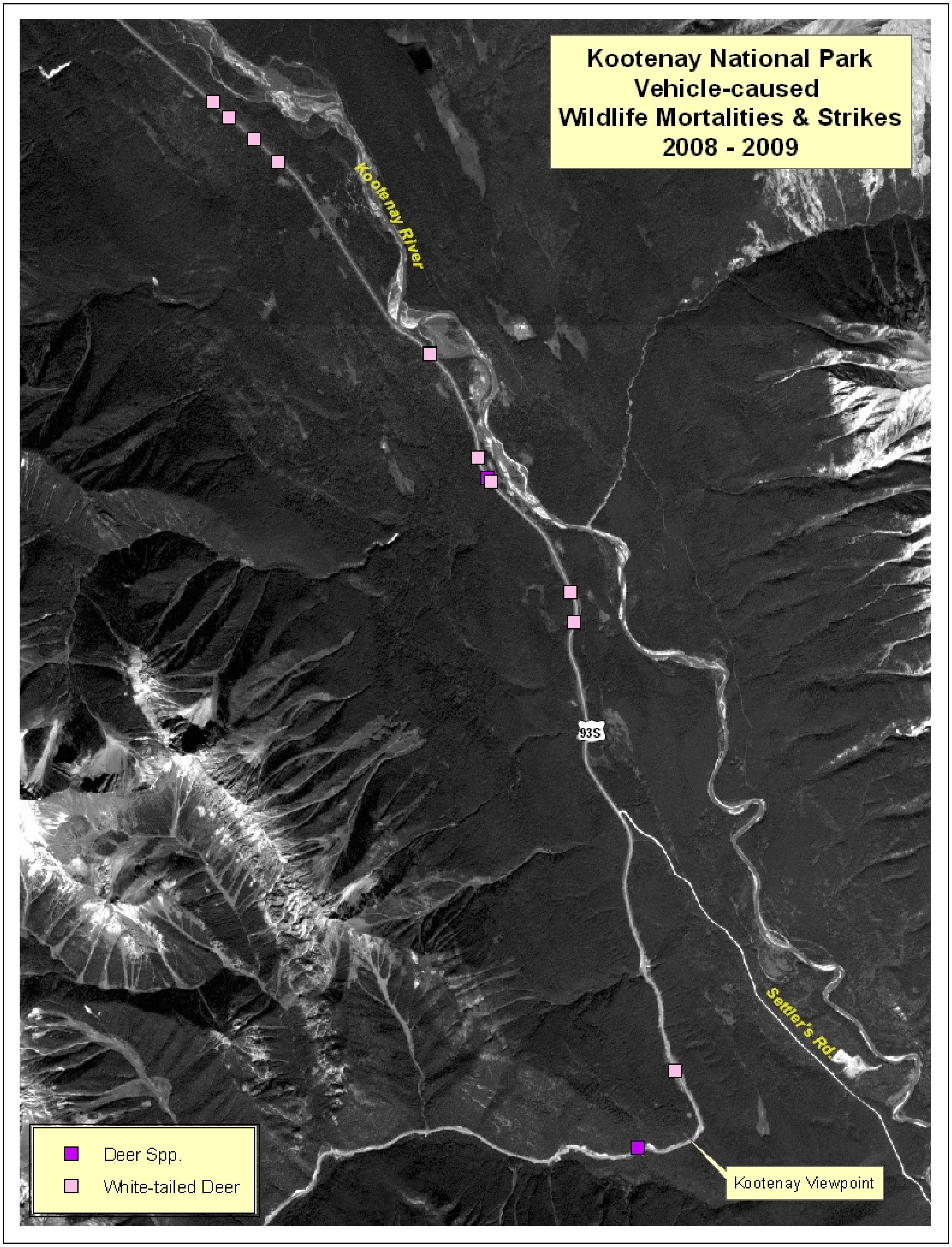

Figure 5.7: White-tailed deer-vehicle collisions between January 2008 and October 2009 in the southern Kootenay Valley (Source: Shelagh Wrazej, Parks Canada).

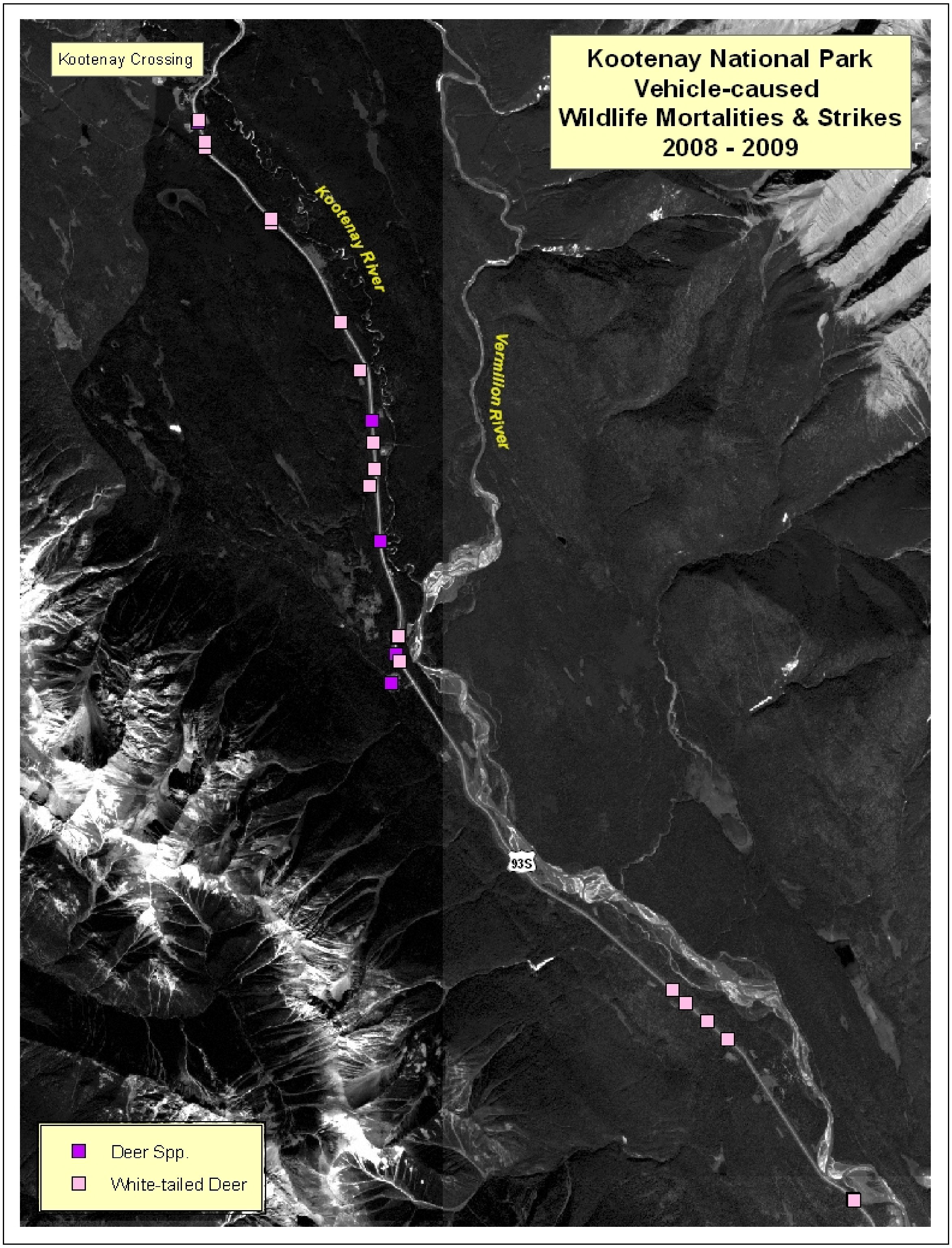

Figure 5.8: White-tailed deer-vehicle collisions between January 2008 and October 2009 in the northern Kootenay Valley (Source: Shelagh Wrazej, Parks Canada).

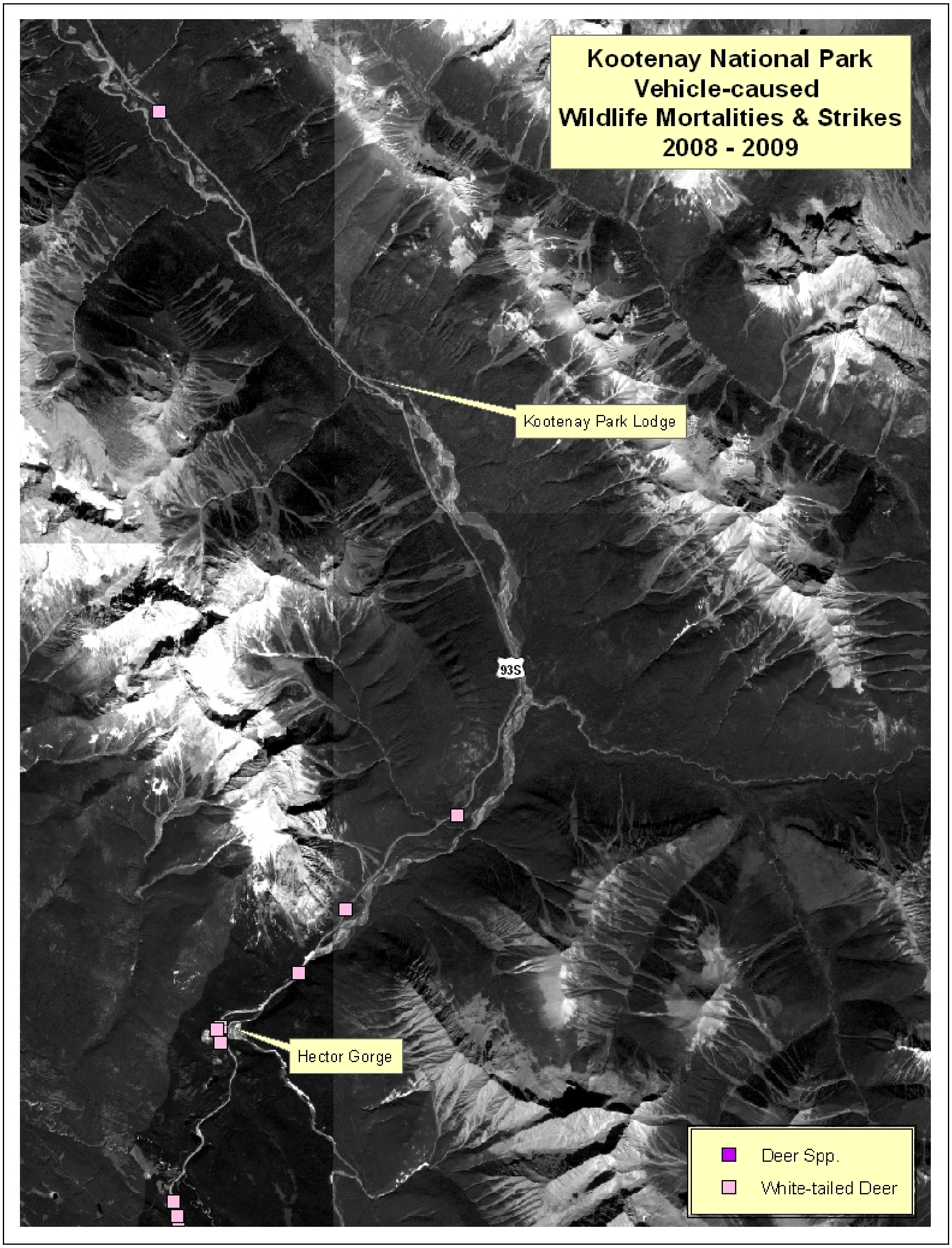

Figure 5.9: White-tailed deer-vehicle collisions between January 2008 and October 2009 in the southern Vermilion Valley (Source: Shelagh Wrazej, Parks Canada).

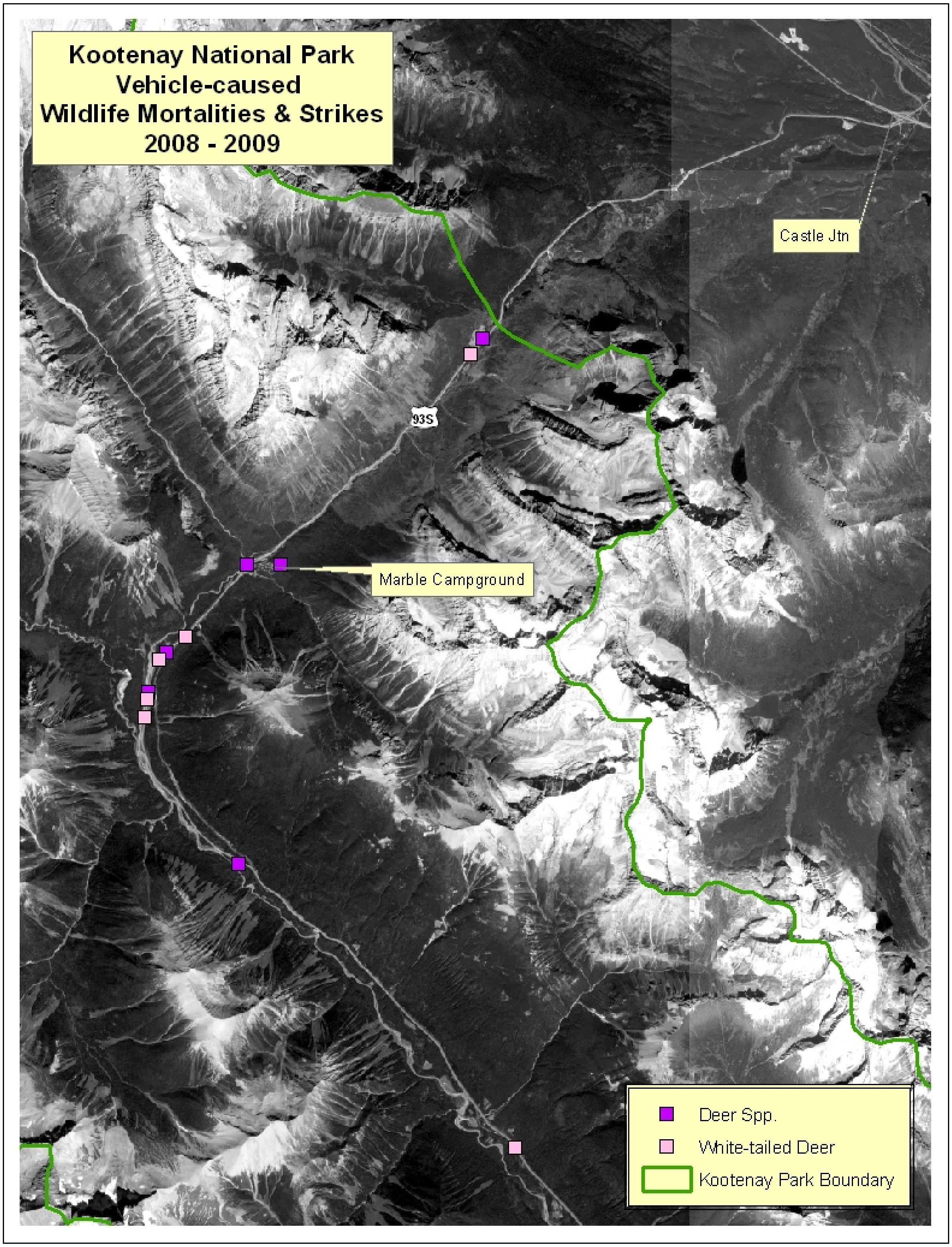

Figure 5.10: White-tailed deer-vehicle collisions between January 2008 and October 2009 in the northern Vermilion Valley (Source: Shelagh Wrazej, Parks Canada).

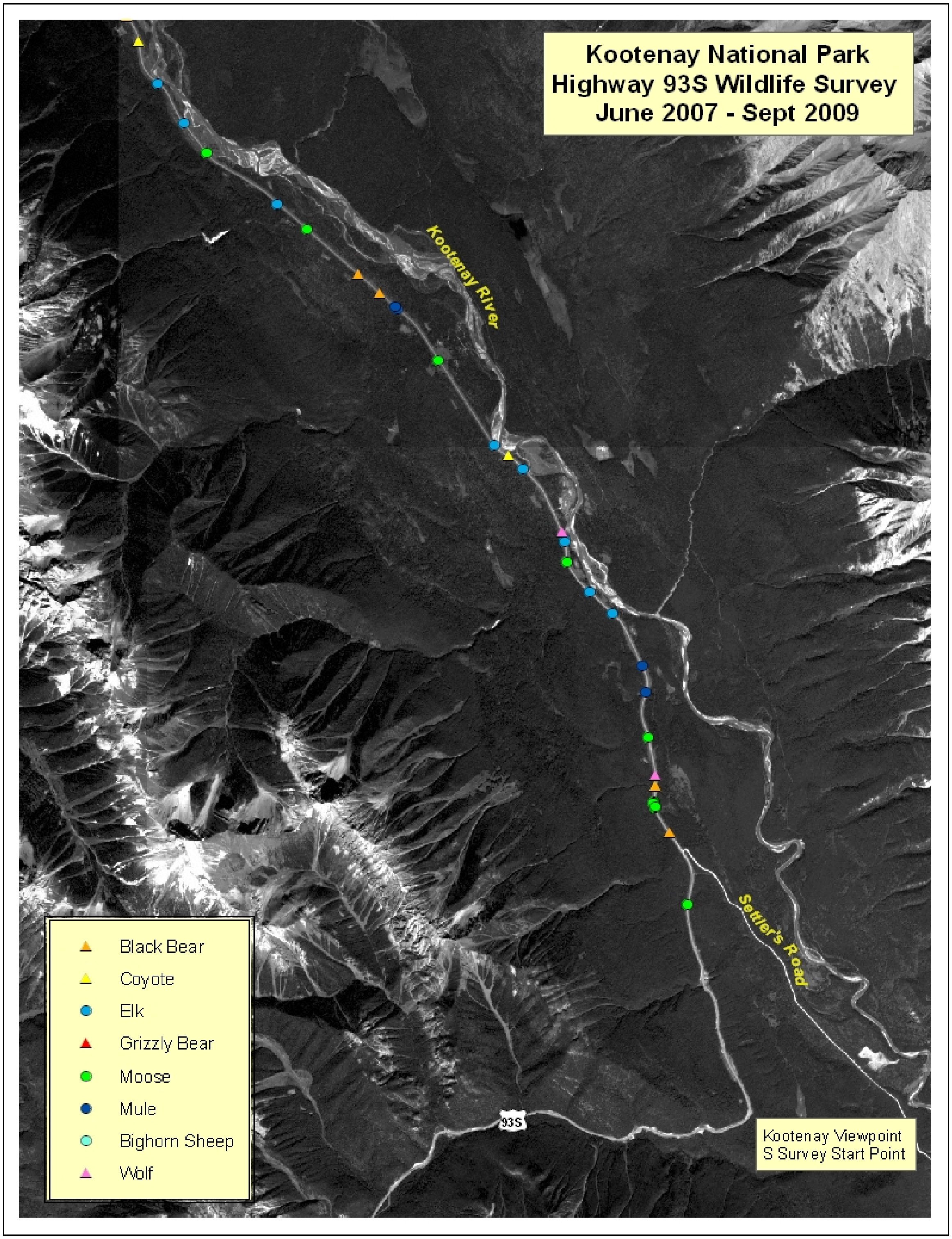

Figure 5.11: Wildlife observation data (excluding white-tailed deer) obtained through driving surveys between June 2007 and September 2009 in the southern Kootenay Valley (Source: Shelagh Wrazej, Parks Canada).

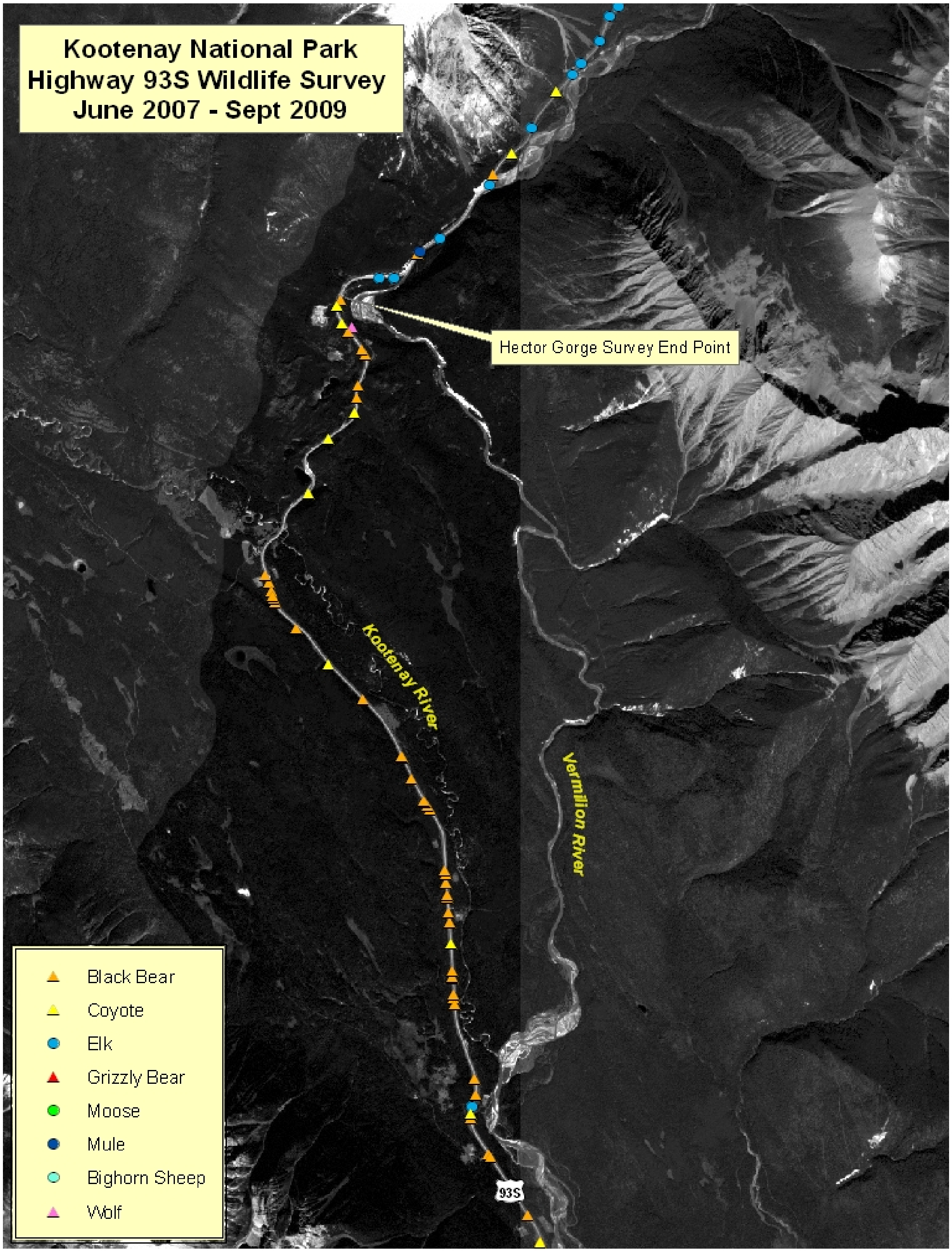

Figure 5.12: Wildlife observation data (excluding white-tailed deer) obtained through driving surveys between June 2007 and September 2009 in the northern Kootenay Valley (Source: Shelagh Wrazej, Parks Canada).

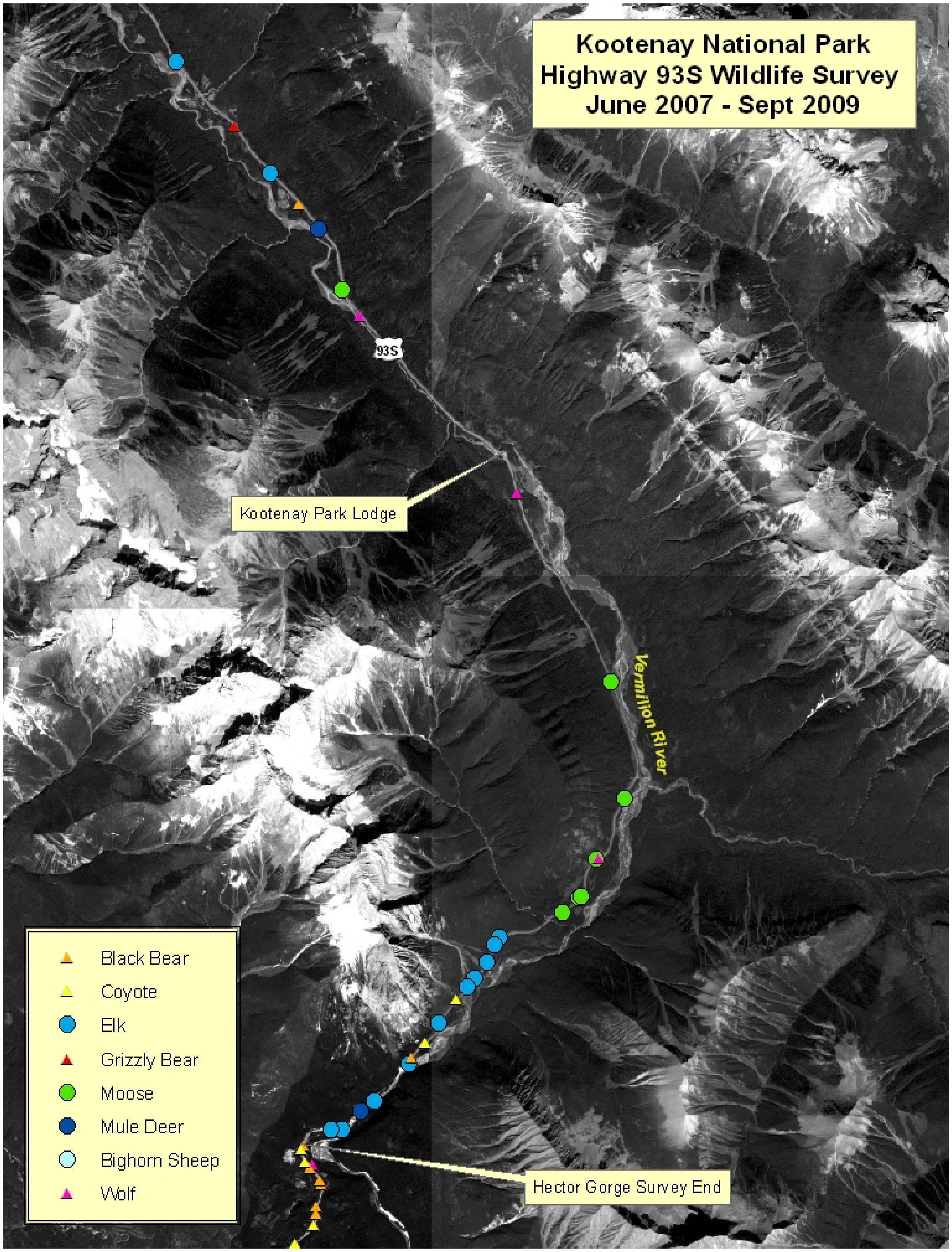

Figure 5.13: Wildlife observation data (excluding white-tailed deer) obtained through driving surveys between June 2007 and September 2009 in the southern Vermilion Valley (Source: Shelagh Wrazej, Parks Canada).

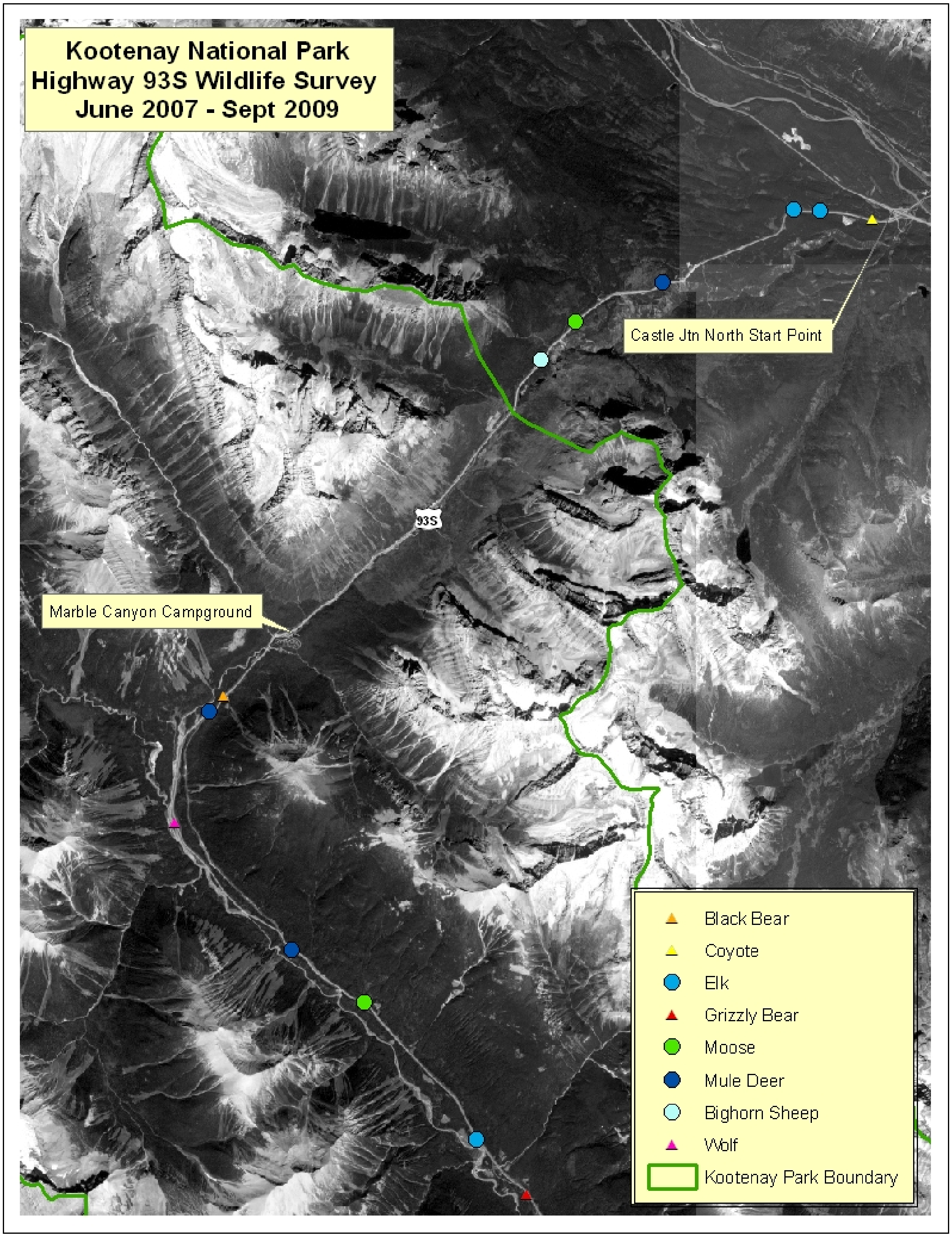

Figure 5.14: Wildlife observation data (excluding white-tailed deer) obtained through driving surveys between June 2007 and September 2009 in the northern Vermilion Valley (Source: Shelagh Wrazej, Parks Canada).

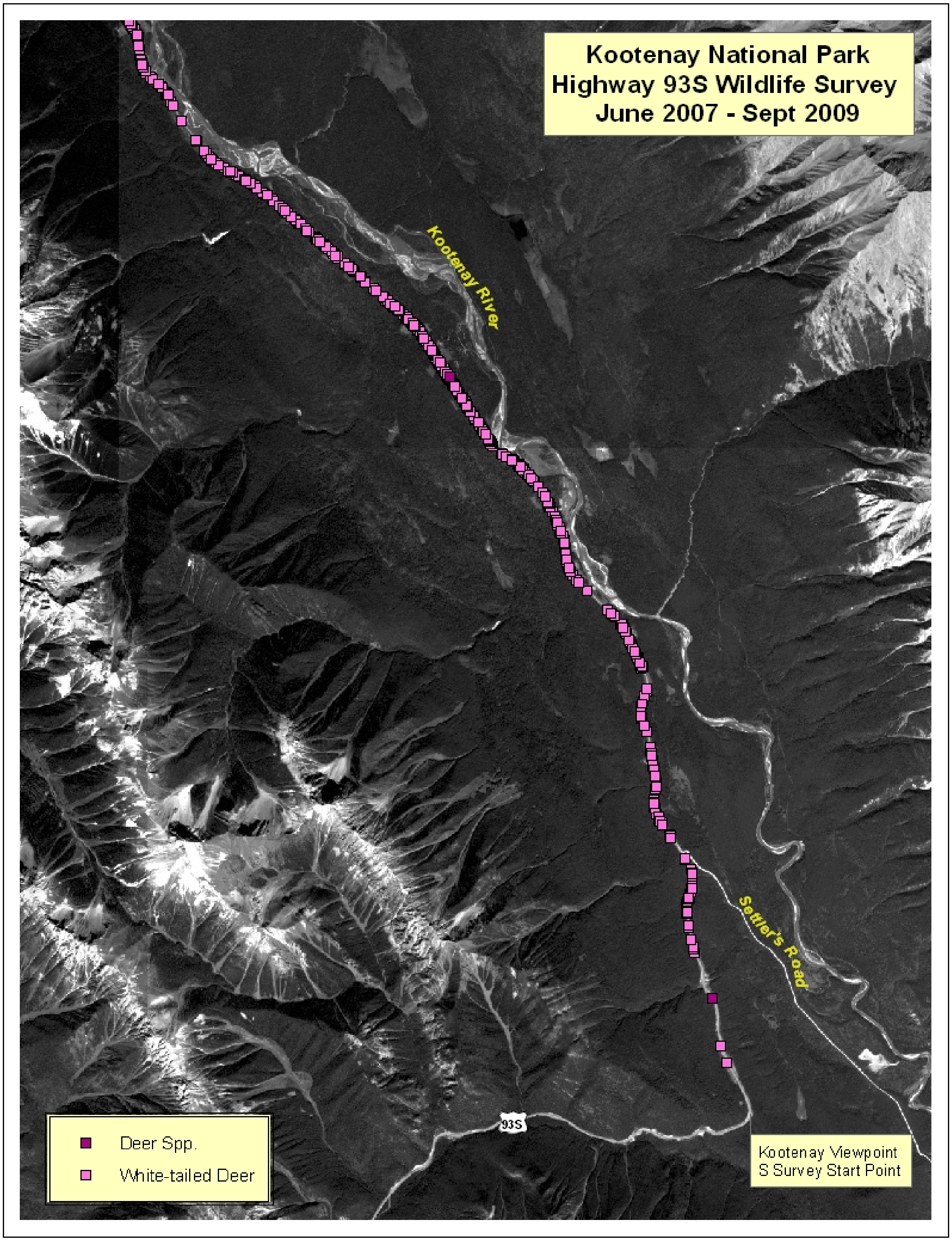

Figure 5.15: White-tailed deer observation data obtained through driving surveys between June 2007 and September 2009 in the southern Kootenay Valley (Source: Shelagh Wrazej, Parks Canada).

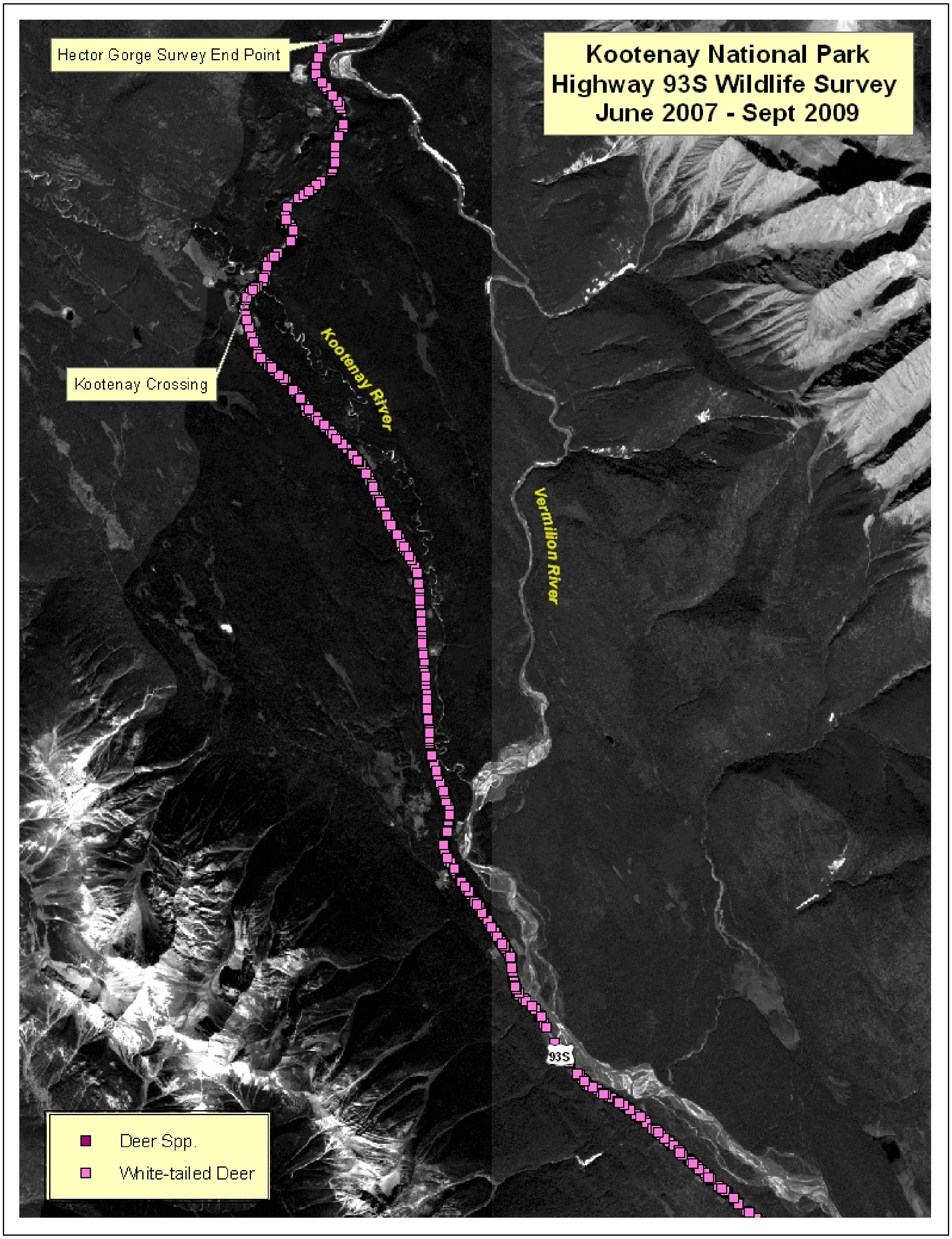

Figure 5.16: White-tailed deer observation data obtained through driving surveys between June 2007 and September 2009 in the northern Kootenay Valley (Source: Shelagh Wrazej, Parks Canada).

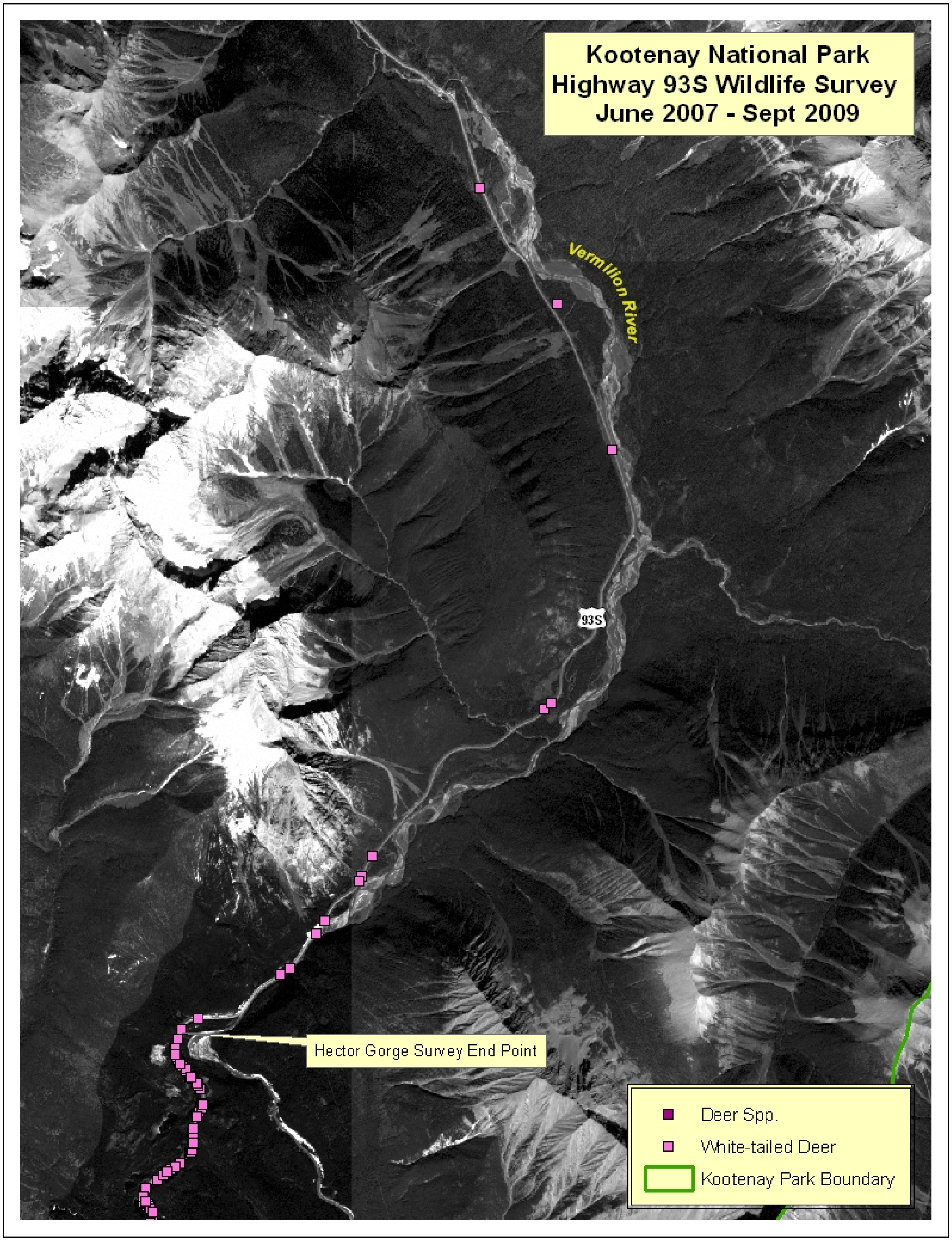

Figure 5.17: White-tailed deer observation data obtained through driving surveys between June 2007 and September 2009 in the southern Vermilion Valley (Source: Shelagh Wrazej, Parks Canada).

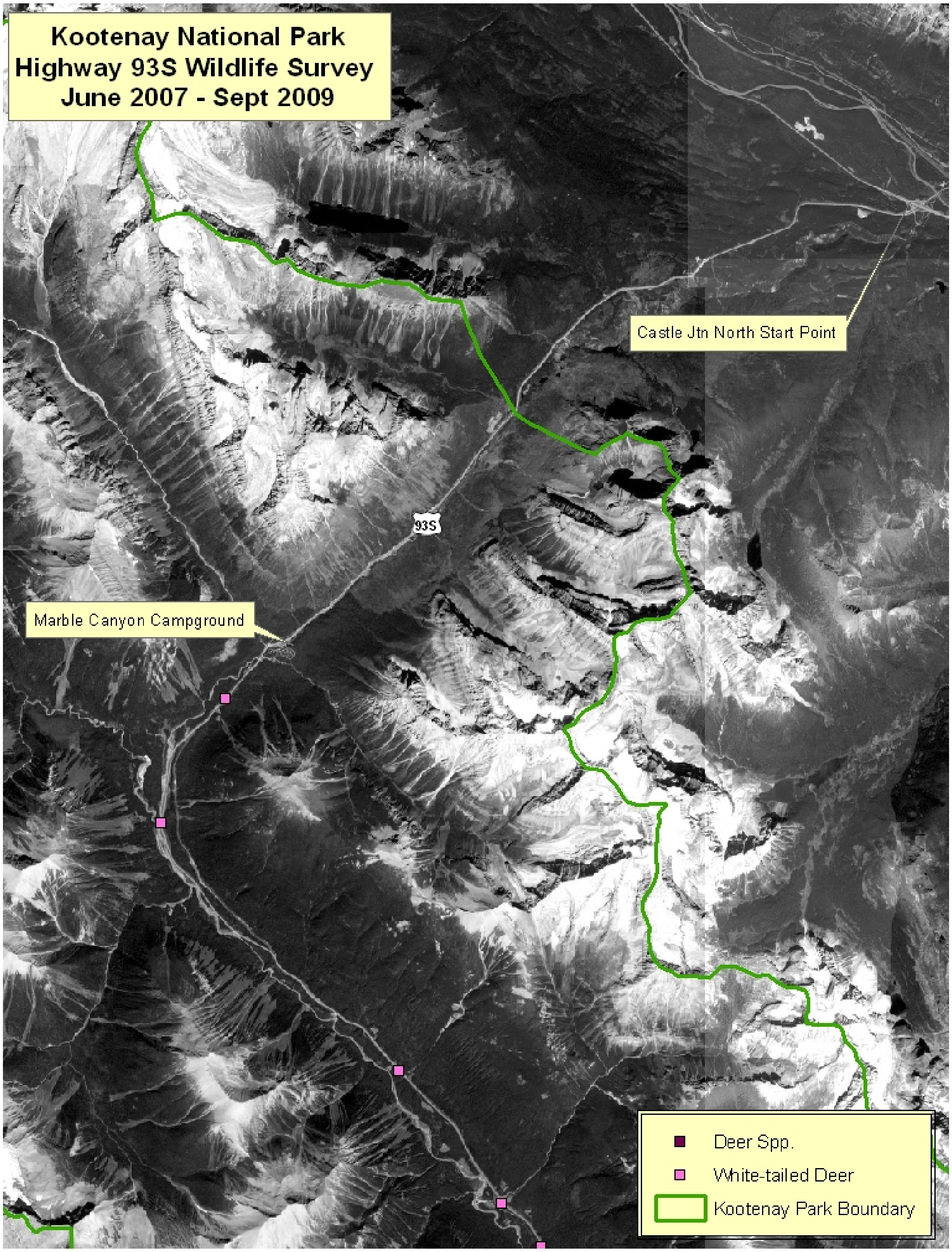

Figure 5.18: White-tailed deer observation data obtained through driving surveys between June 2007 and September 2009 in the northern Vermilion Valley (Source: Shelagh Wrazej, Parks Canada).

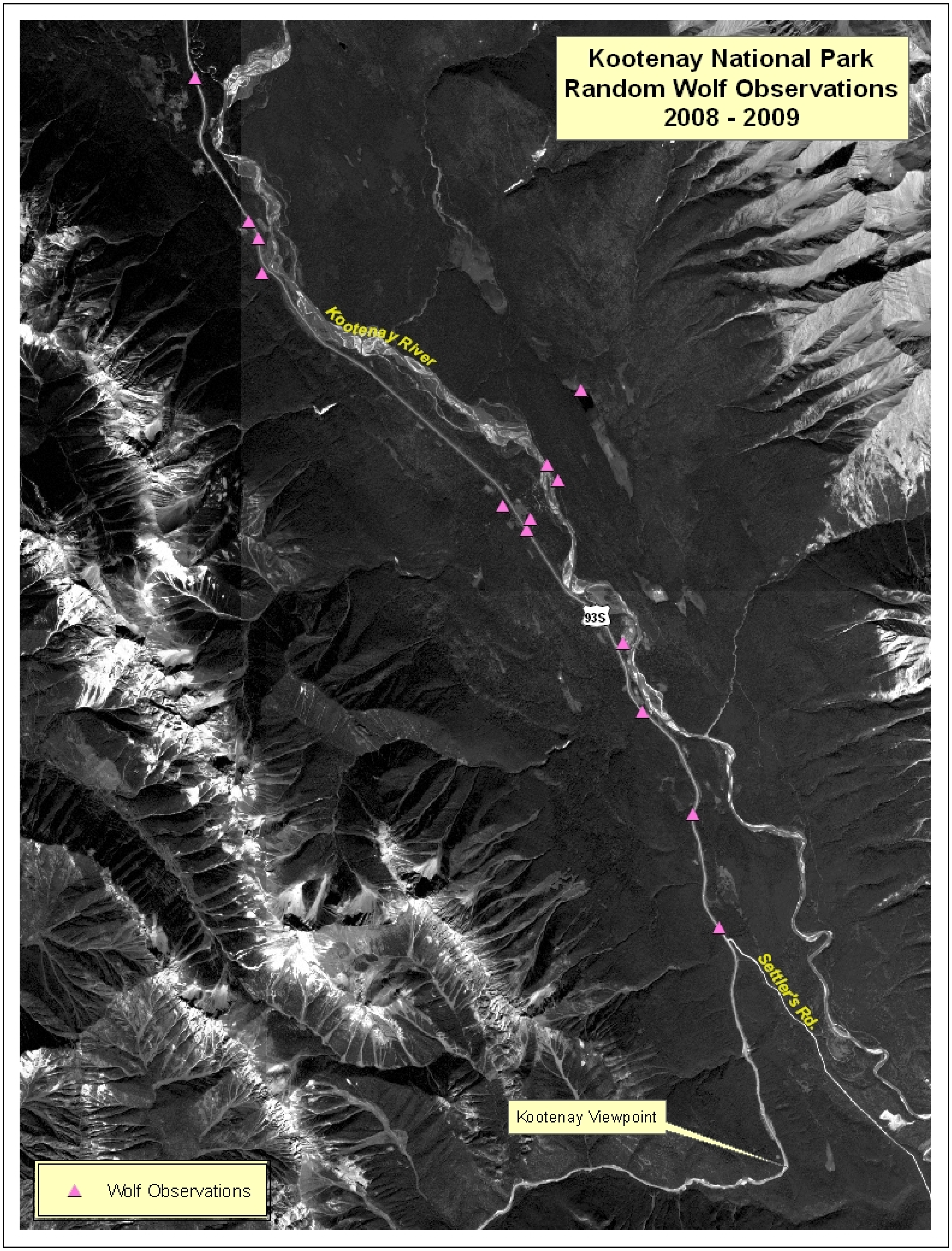

Figure 5.19: Incidental wolf observation data between January 2008 and October 2009 in the southern Kootenay Valley (Source: Shelagh Wrazej, Parks Canada).

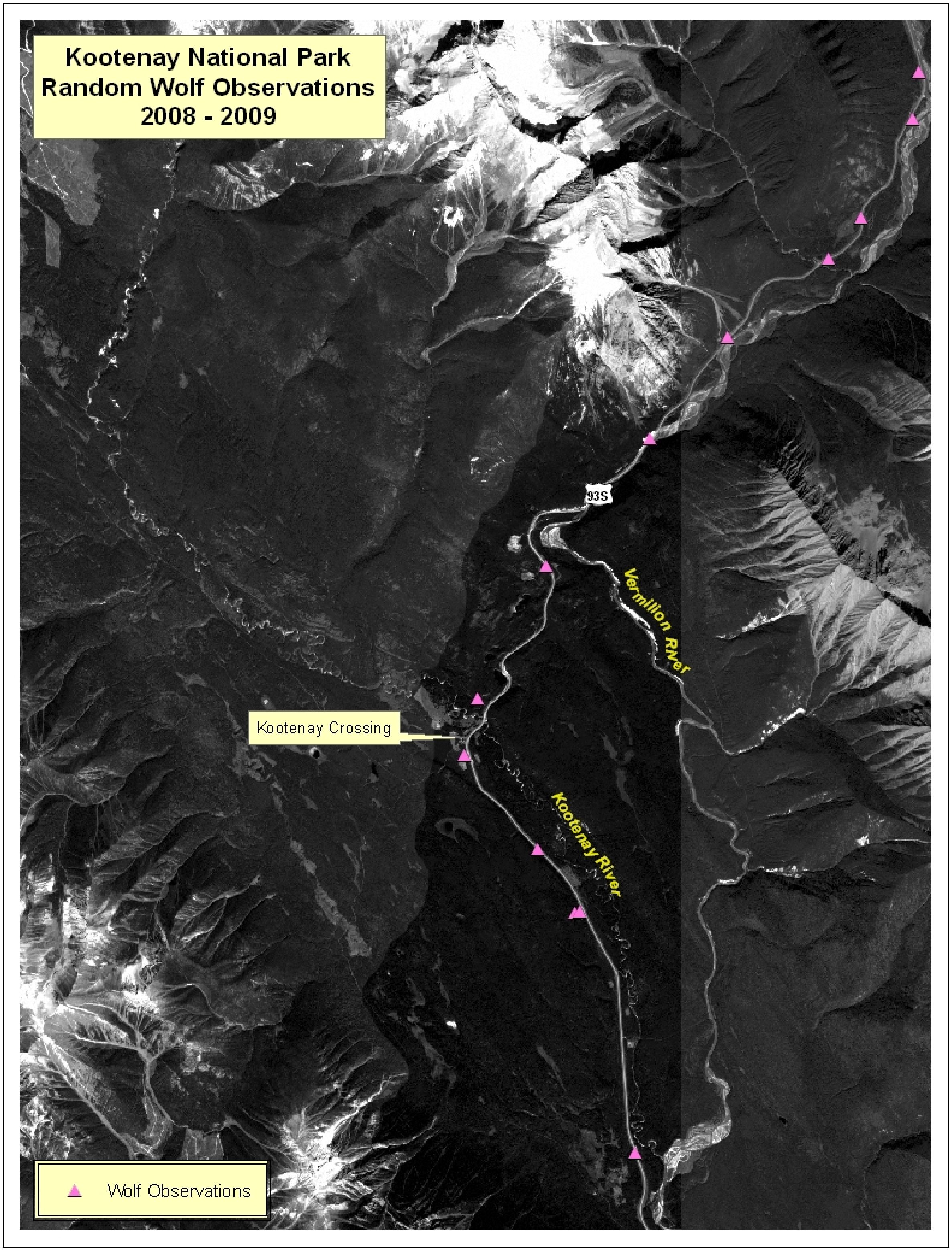

Figure 5.20: Incidental wolf observation data between January 2008 and October 2009 in the northern Kootenay Valley (Source: Shelagh Wrazej, Parks Canada).

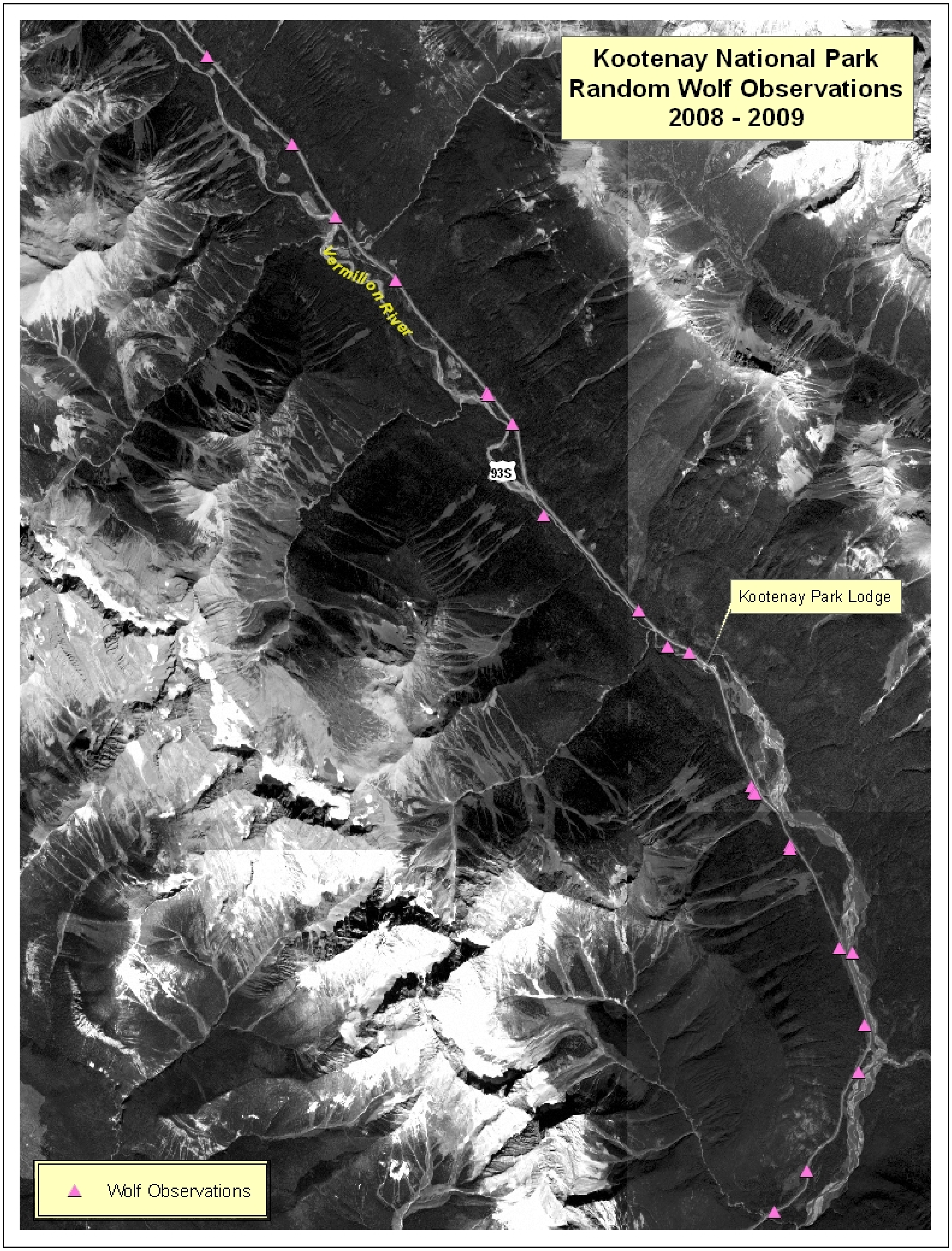

Figure 5.21: Incidental wolf observation data between January 2008 and October 2009 in the southern Vermilion Valley (Source: Shelagh Wrazej, Parks Canada).

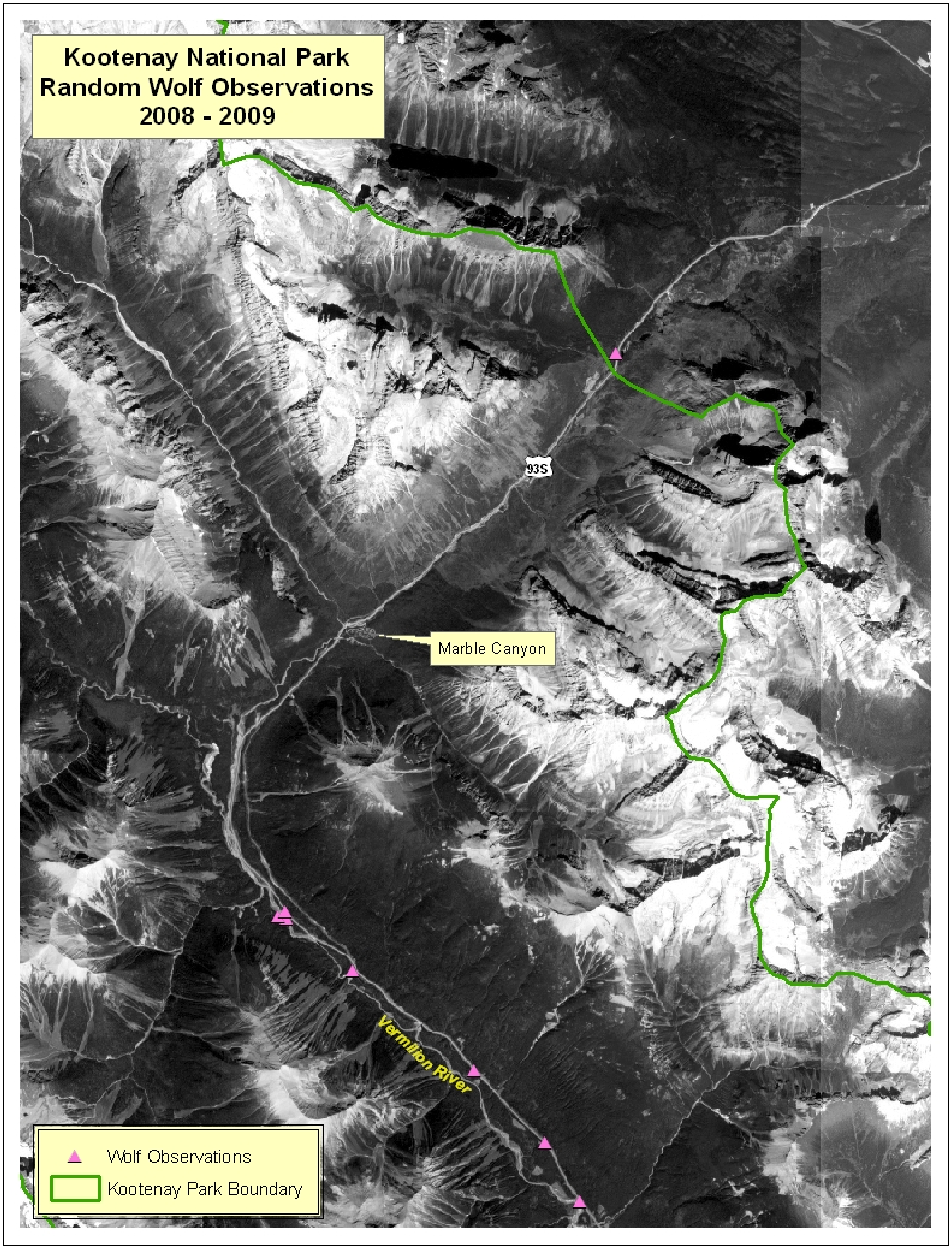

Figure 5.22: Incidental wolf observation data between January 2008 and October 2009 in the northern Vermilion Valley (Source: Shelagh Wrazej, Parks Canada).

6. INTERVIEWS WITH PARK STAFF

Interviews were conducted with three Park staff with regard to the acceptableness of the current wildlife-vehicle collision situation, specific mitigation measures such as wildlife fencing in combination with wildlife underpasses and overpasses, potential speed management through wider striping, and other comments related to wildlife-vehicle collisions, traffic safety and potential mitigation measures (Table 6.1).

Table 6.1: Summaries of interviews with Park staff.

	Harold Abbott	Glenn Kubian	Drew Sinclair
Current situation acceptable?	Perhaps acceptable as collisions with white-tailed deer, which are by far the most numerous species hit, may not be a conservation issue.	The primary species involved in vehicle collisions at the south end of Kootenay National Park is white-tailed deer. The loss of these animals does not seem to be significant from an ecological perspective. The risk to human safety from these collisions does not appear to be significant either as they seldom result in significant, if any, human injury. Therefore fencing of the highway is not defensible from either an ecological or human safety perspective.	Perhaps not acceptable to have wildlife road mortality in a National Park.
Wildlife fencing in combination with wildlife underpasses and overpasses	(Potential) problems with fences: 1. No access to area beyond fence (monitoring, sampling, dragging off carcasses, launching boats). 2. Negative effect on landscape aesthetics.	(Potential) problems with fences: 1. Negative effect on landscape aesthetics (intrusive, decrease access opportunities, and negatively affect visitor experience). 2. Causes a division of the ecosystem, especially because the road splits the Park almost perfectly in two because of the shape of the Park resulting in maximum impact. 3. Will result in increased vehicle speeds and associated risk to public safety as a result of an increased sense of separation/safety provided by fence.	(Potential) problems with fences: 1. Negative effect on the enjoyment of wildlife (increased distance to road, reduced visibility). 2. Fence requires maintenance, for which there may not be a budget. Under- and overpasses: While originally skeptical, now convinced about the use by wildlife.

Animal detection systems	Perhaps suitable for short road sections. Implement in test section first. Reliable systems are essential as everything depends on driver confidence in the warning signs and subsequent driver response. Systems may promote "scanning for wildlife" behavior, including in road sections where no system is present, perhaps extending the road sections that benefit from animal detection systems.	Not a practical solution for the entire road length in the Park. Perhaps suitable as a test at hotspots for carnivores.	A promising technique, especially in combination with fences (fence ends, fence gaps), but concerns about the robustness and the maintenance that may be required.
Wider striping (see chapter 4)	May work.	May work, perhaps combine with rumble strips.	May work, but beware of commercial truck traffic as the lane width and truck width correspond, and line crossing is likely with narrower lanes, especially in curves. Concerns with slippery surface of painted sections and the wear because of increased line crossing by the tires.
Other measures/comments	Horsepower of vehicles has much increased, and cars have become too comfortable, encouraging higher, perhaps unsafe speeds. Large trucks are typically not affected by deer collisions, causing a loss of caution of drivers. There is a culture to label all wildlife-vehicle accidents as "no fault accidents" which is not always correct and may encourage careless driving.	Perhaps target road sections that are important for species with relatively low population density such as carnivores (e.g. wolves, bears) and moose. Try other measures before fencing: 1. Reduce the attractiveness of the vegetation in the right-of-way (reduce width of grass-herb strip in right-of-way, stop mowing and plant shrubs to speed up the succession, time mowing to benefit native and non-palatable species and negatively affect species that are attractive to ungulates). 2. Speed management (law enforcement, physical modifications to the road (reduce design speed)). 3. Stop mowing program in right of way. Increase alternate valley bottom habitat for	The wildlife-vehicle collisions appear to be associated with a good economy (until recently), recreational weekend traffic, protection through bars (kangaroo racks) mounted on car bumpers, and no or little enforcement of the maximum speed limit). More speed enforcement may help control speed, but may only result in a small reduction in wildlife-vehicle collisions. The vegetation in the right-of-way has grown up because mowing and cutting equipment is not available to the extent that it was in the past. The reduction of sight distance is believed to have increased wildlife-vehicle collisions, and the sight distance should be restored by more mowing and cutting, re-establishing the original width of the grass herb vegetation,

		ungulates through use of prescribed burns.	especially in the south. Some wildlife warning signs have worn out (not readable). Other signs are no longer noticed by regular drivers as they have been in those locations for too long, and other signs (e.g. the elk signs) are no longer relevant because elk have much reduced in numbers since the 1980s.

In addition to the three interviews summarized in Table 6.1, Kris McCleary and Lori Horrocks discussed wildlife-vehicle collisions in the Park, the larger context of the issue, and potential mitigation measures with Dr. Marcel Huijser.

From the interviews and discussion it appears that:

- Park staff have different opinions as to what the problem is with wildlife-vehicle collisions. Most Park staff appears to agree that human safety has not been a major concern, at least not in recent years. While this may be true for the Park, the larger datasets (Huijser et al., 2008b; 2009a) show that collisions with large ungulates are increasing and that they are a considerable safety concern. Conservation concerns may warrant mitigation measures according to the interviewees. However, not everyone thinks that white-tailed deer, the most numerous species in the road mortality data set, qualify for mitigation measures and the interviewees would like to see mitigation efforts targeted to more "sensitive" species such as bears, wolves, and moose. Other Park staff is mostly concerned with the ecological integrity of the Park that is affected by mass road mortality and the potential trophic effects on carnivores such as wolves. While it may not be possible to have everyone agree on the reasons for potential mitigation measures and its specific objectives, it is important to clearly state these reasons and objectives before a mitigation plan is finalized or implemented.

  The following may provide some perspective on the status of white-tailed deer in Kootenay National Park (partially based on interview with Alan Dibb):
    - White-tailed deer have been present in the park since records began
    - While white-tailed deer are more numerous now than in the past, and while elk and mule deer numbers in the Kootenay Valley have declined, this does not necessarily mean that white-tailed deer are to be valued less than e.g. elk, mule deer, or carnivorous species.
    - Road mortality is believed to have at least partially contributed to the decline of mule deer and elk since the 1980's. Therefore the recovery of mule deer and elk may also be at least partially dependent on reducing road mortality through mitigation measures.
    - White-tailed deer are an important prey species, e.g. to wolves, and massive unnatural (road) mortality affects the integrity of the ecosystem.

- The presence of white-tailed deer carcasses along the road may cause habituation to the road corridor by wolves and other carnivores (e.g. scavenging for road killed white-tailed deer), and expose these carnivores to dangers associated with the road, including potential wildlife-vehicle collisions. In addition, white-tailed deer probably have an effect on the vegetation composition and structure of Kootenay National Park, especially in the Kootenay Valley. As such they can be expected to be important to the ecosystem.
- The 2008 report (Huijser et al., 2008a) identified and prioritized road sections for potential mitigation measures regardless of the conservation status of a species. While white-tailed deer are one of the most abundant species currently, the mitigation zones were identified on a 33 year long data collection period covering at least some of the dynamics of the ecosystem, including fluctuations in the population size of certain species. The prioritization of the road sections is more heavily influenced by white-tailed deer as the prioritization was based on a ten year period. However, the 2008 report is based on all species and it does not target white-tailed deer specifically as all species were weighed equally in the process that identified and prioritized the road sections that may require mitigation measures.
- Should mitigation measures be targeted at relatively rare species only (e.g. wolves, bears, moose), then road mortality data and observation data on animals seen alive from the road corridor may not be sufficient to identify the road sections that may need to be mitigated. Modeling of animal movements of the species concerned, with or without data specifically collected in Kootenay National Park, and population survival probability modeling would be more appropriate methods.

- Even though wildlife fencing is highly effective in reducing wildlife-vehicle collisions, fencing also has substantial drawbacks that have been clearly articulated by the interviewees. If fencing is included in the final mitigation plan, the negative side effects of fencing should be acknowledged and mitigated where possible. One of the most important issues that has to be addressed is providing for safe crossing opportunities for wildlife in combination with wildlife fencing. Wildlife underpasses and overpasses can provide such safe passages and are not considered a problem by the staff that was interviewed.

  While it is important to recognize the potential negative side effects of specific mitigation measures, it is also fait to recognize the current effects of roads and traffic. Unmitigated roads have a range of effects that may not always be easily noticed or recognized. The road and the roadsides have taken away (natural) habitat and the space impacted can be seen readily identified in Kootenay National Park. In addition, road killed animals are also highly visible. However, the barrier effect of roads and traffic and the zone adjacent to the road with reduced habitat quality are not necessarily very visible. Some animals may attempt to cross the road but return unsuccessfully while others stop trying, reducing the connectivity between the populations on either side of the road. Furthermore, light, noise, chemical pollutants, human presence and other factors associated with roads may reduce the habitat quality for section species in a zone adjacent to the road and the right-of-way. Depending on the parameter concerned and the species, the affected zone may be a few meters up to several kilometers wide. The barrier effect of a road and the road effect zone increase with growing traffic volume.

It is also important to recognize that the suggested mitigation measures (Huijser et al. 2008a) relate to about 60% of the road length of Hwy 93 South in Kootenay and Banff National Park and not to the entire length of Hwy 93 South. Furthermore, a phased approach has been recommended. If the phased implementation of mitigation measures is associated with monitoring and research, lessons learned may be implemented for later phases. The anticipated funding levels may only allow for 5-10 km (3.1-6.2 mi) of road to be mitigated of the 103 km through Kootenay and Banff National Park. The road sections with the highest priorities (see Huijser et al., 2008a) would be a section of about 10 km south of Kootenay Crossing (32.4-42.6 km reference posts) and a 500 m section near McCleod Meadows (26.3-26.8 km reference posts). Continued monitoring of road killed animals and animals seen alive on or near the road would provide insight in whether mitigation measures may also need to be implemented elsewhere at some point in the future, outside the mitigation zones identified in the 2008 report (Huijser et al., 2008a).

While the 2008 report (Huijser et al., 2008a) provides a full rationale for the identification and prioritization of road sections that may require mitigation, figure 6.1 shows the costs per km per year for Hwy 93 South associated with wildlife-vehicle collisions.

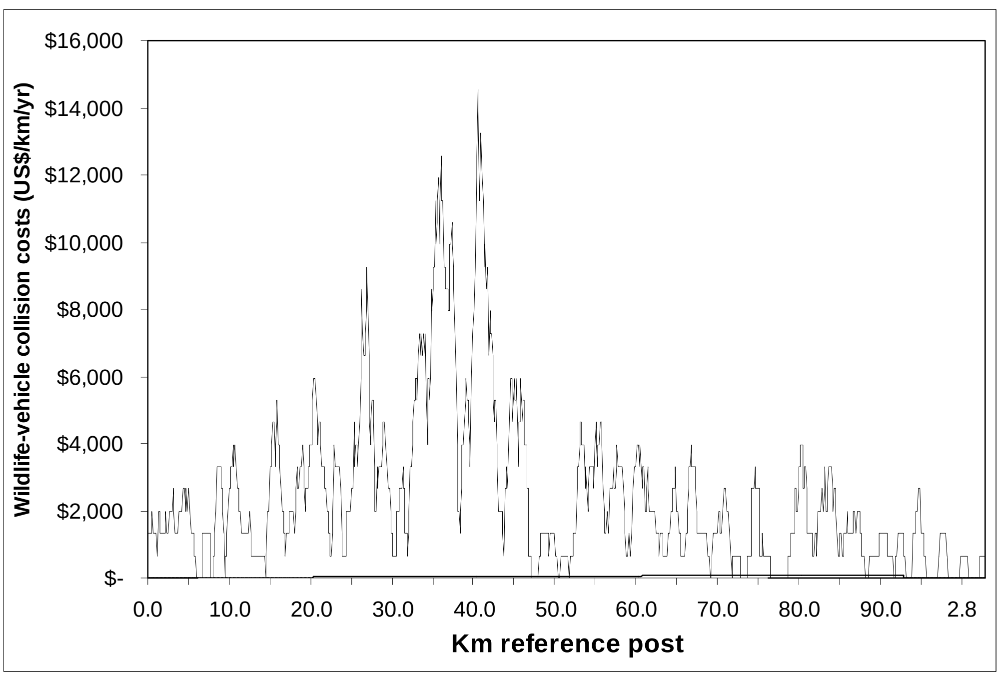

Figure 6.1: Costs per km per year (in US$) associated with wildlife-vehicle collisions along Hwy 93 South in Kootenay and Banff National Park. Note: This graph was based on the 1998-2007 data (see Huijser et al., 2008) and the costs for each species was assumed similar to that for the average deer-vehicle collision (US$6,617) (Huijser et al., 2009a).

- Animal detection systems may be implemented on a few selected short road sections as a test. Wide scale implementation should depend on test results. The 500 m long section near McCleod Meadows (26.3-26.8 km reference posts) may be appropriate. In addition, animal detection systems may be implemented at gaps in fences or at fence ends.

- An experiment with wider striping may be considered but is not expected to result in a substantial reduction in wildlife-vehicle collisions.

- There are differences in opinions on how the grass-herb vegetation and sight distance affect deer-vehicle collisions. According to some wide grass-herb vegetation strips contribute to the problem through providing attractive foraging habitat in an otherwise largely mature forest, while others think wide grass-herb vegetation strips reduce the problem through increased sight distance.

  While increasing the width of the grass-herb vegetation strip in the right-of-way is likely to increase sight distance for drivers, the effects on white-tailed deer are not certain (Huijser & Paul, 2008). White-tailed deer and white-tailed deer-vehicle collisions are associated with edge habitat, a transition from cover (e.g. forest) to more open habitat (e.g. grass-herb vegetation). Pushing the forest edge back may not necessarily reduce white-tailed deer-vehicle collisions though, as the grass-herb vegetation itself is a main attractant to the white-tailed deer. While the grass-herb vegetation is important to white-tailed deer, white-tailed deer are more of a browser (i.e. eat shrubs and trees) compared to for example elk who graze more. Moose are stronger browsers than deer. So, wider grass-herb vegetation strips may attract more elk and fewer moose, and allowing shrubs and trees to grow closer to the road may attract more moose and fewer elk. The effect on deer is hard to predict though.

- Speed management is supported by the staff that was interviewed, despite the fact that it may not reduce wildlife-vehicle collisions substantially.

  In order to obtain a substantial reduction in wildlife-vehicle collisions vehicle speed may have to be reduced until about 70 km/hr (45 mi/hr) (Huijser & Paul, 2008). Currently the posted speed limit is 90 km/hr (56 mi/hr) and operating speed is 111 km/hr (85^{th} percentile). The posted speed limit should be relatively close to the design speed of a road in order to avoid speed dispersion (i.e. some drivers obey the posted speed limit, while others drive the speed they consider safe based on the design of the road). Speed dispersion is associated with an overall increase in accidents and should be avoided. Therefore the posted speed limit cannot be reduced without also lowering the design speed of the road, or influencing people's perception on what a safe speed is for the conditions that are present (e.g. narrower lanes through striping, see Chapter 4). Massive and consistent enforcement of the current speed limit may reduce operating speed and get it closer to 90 km/hr. However, given the design speed drivers may experience the enforcement as "unjust" and the resulting speeds are likely to still be too high to obtain a substantial reduction in wildlife-vehicle collisions. In addition, unless the enforcement is automated, the staff time dedicated to the enforcement of the speed limit is unlikely to be kept at a high level for many years, allowing a return to high operating speeds.

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