Wildlife Crossing data for New Mexico Highlands Wildlands Network.

Use of Underpasses in general

♦". . . Parks Canada has constructed several underpasses, or large culverts under the highway, as well as a couple of overpasses, about **50 metres** wide. 'At best, it's been a mixed result,' states [Paul] Paquet. While coyotes, **elk**, and some **deer** have found the passageways useful, **wolves and grizzlies** have not. The highway for them is still a barrier." (Hunt, S. 1999. "Ecologist urges Banff National Park to take the 'high road'. <http://www.discovery.ca/Stories/1999/05/25/59.asp>)

♦ "In south Florida, the Department of Transportation (DOT) built nearly 30 underpasses in 1993 to allow **panthers** safe passage under the divided four-lane I-75 highway. DOT also developed and installed a smaller design suited for two-lane highways on State Road 29 north of I-75. So far, no panthers have been killed where crossings are in place, although habitat continuity has not been completely restored. Female panthers are reluctant to cross major roads, even using the underpasses." (Cerulean, S. 2002. Killer Roads. http://www.defenders.org/defendersmag/issues/winter02/killerroads.html)

♦"From 1 January 1995 to 30 June 1998 (excluding 1 April to 31 October 1996) 14,592 large-mammal underpass visits were recorded. **Ungulates** were 78% of this total, carnivores 5%, and human-related activities 17% (Table 2). Individual underpasses ranged from 373 visits to 2548 visits. Specific to wildlife, elk were the most frequently observed species (n = 8959, 74% of all wildlife), followed by deer (n = 2411, 20%), and then wolves (n = 311, 2.5%). The through-passage rate for wildlife species was high (mean 98, SD = 1.9). (Clevenger, A.P. and N. Waltho. 2000. "Factors Influencing Effectiveness of Wildlife Underpasses in Banff National Park, Alberta, Canada". *Conservation Biology* 14:47-56.)

♦ "Bears and Roads: Mitigation: Reducing the Impacts of Roads and Railways on **Bears**"
http://www.whyte.org/bears/mitigate.html

". . . in just over four years, **black bears** made 502 passes through the crossing structures and **grizzly bears** made 30. Adult female **grizzly bears** have made little use of the structures, though recent use of one underpass by an adult female is encouraging. The low use of crossing structures by adult female **grizzlies** is largely a function of the fact that very few adult females' home ranges include areas in the immediate vicinity of the twinned, mitigated sections of the TCH. If adult female **grizzlies** tend not to use habitats near the highway, how will they discover and learn to use the crossing structures?" (Clevenger 1999 and Gibeau 2000)

♦"Banff National Park's Crossing Structures"
http://www.mountainnature.com/Articles/CrossingStructures.htm

"Early results showed that the underpasses were very effective for **elk, deer**, and **coyotes**, but the large carnivore like **wolves**, **cougars**, **black and grizzly bears** were reluctant to use them. It is this research that led to the building of two overpasses during the second phase of highway twinning."

Animal Species	**Underpass**	**Overpass**	**Total**
Grizzly Bear	23	10	33
Black Bear	513	11	524
Wolf	1286	28	1314
Cougar	668	16	684
Coyote	2211	103	2314
Elk	18077	751	18828
Deer	7182	140	7322
Moose	1	10	11
Bighorn Sheep	1488	0	1488

♦"A safer passage: Group hopes to create corridor for wildlife near McArthur Lake" by Susan Drumheller
http://www.fs.fed.us/inpf/eco/projects/mcarthurlake/sr_article.html

"The Trans-Canadian Highway, a four-lane freeway that carries 25,000 vehicles per day, poses a huge hazard to wildlife in Banff National Park. The park built a dozen underpasses for wildlife 11 years ago, and two years ago added another 10 underpasses and two overpasses on a new section of highway. [Tony] Clevenger is in charge of a monitoring program that started just three years ago. So far, the data looks promising, if inconclusive. **One grizzly** bear has used an overpass, and **five grizzlies** have used the new underpasses in the past two years, some of which are just large culverts. In addition, nine more **grizzlies** used the older underpasses. As for **elk**, the park staff has counted 10,894 crossings by going out every couple of days to check raked areas for tracks at each site. As the animals adapt, the use increases, Clevenger said."

♦Use of highway underpasses by Florida panthers and other wildlife. M. L. Foster & S.R. Humphrey

"Black bears, gray wolves, lynx and coyotes crossed a fenced segment of the TransCanada Highway at will but used underpasses where they were convenient; wolves and coyotes learned to herd deer against the highway fencing (Waters 1988). ……Use of underpasses for foraging may have caused raccoons and wading birds to use wetter underpasses; deer and bobcats mainly used the drier ones…….Providing wildlife underpasses without fencing the right-of-way fails to solve collision problems. …..

♦"Permeability of the Trans-Canada highway to wildlife in Banff National Park: importance of crossing strucutres and factors influencing their effectiveness" by Anthony P. Clevenger
http://www.hsctch-twinning.ca/Environmental/icowet2_wcs.htm
***for tables see website**

For the 12-month period, the average number of monthly monitoring checks at the 11 structures was 8.5 and the average number of days between checks was 3.7 (range = 3.2 - 7.4 days). There were a total of 2,458 visits by wildlife to the underpasses (Table 2). Total number of species' track detections at the underpasses ranged from 148 (Carrot Creek) to 482 (Buffalo). Carrot Creek had the lowest total number of animal through-passes. The through-passage rate was highest at Buffalo, Cascade, Edith, Powerhouse and Vermilion underpasses. Through-passage rate was lowest at East gate (88%). There were a total of 170 failed passages (5%), i.e., where species did not travel through the underpasses. Monitoring checks recording no tracks occurred most often at Morrison Coulee and Carrot Creek. **Elk** were most frequently detected at the wildlife underpasses (n=1,338, 54%), followed by **deer** (n=538, 22%) and coyotes (n=373, 15%; Table 3). Among large carnivores, **black bear** tracks were found 97 times (4%) at the underpasses, **wolves** 77 times (3%) and **cougars** 29 times (1%). **One wolf pack** (Bow Valley pack) was responsible for practically all the underpass use (75 out of 77 through-passes), whereas one member of the Cascade pack used the underpasses twice during winter. Overall through-passage rate was high (mean = 98%, n=7), ranging from **cougars** and **grizzly bears** (100%) to **elk** and **deer** (96%). **Elk, deer** and coyotes used all of the underpasses, while **black bears** were found travelling through nine, **wolves** six and **cougars** five. Two radio-collared adult male **grizzly bears** used three different underpasses. Monthly crossing rates for all wildlife in the study area were low from December through April, increased sharply from May to July, and then decreased to September (Fig. 2). There was an abrupt increase in activity during November prior to the onset of winter. There were slight differences between large **carnivore** and **ungulate** crossing rates over the course of the year (Fig. 3 & 4). Crossing rates for both groups were lowest in winter. However, they differed in that large **carnivores** were more active than ungulates in early spring, whereas **ungulates** sustained higher crossing rates during the autumn compared to **carnivores**.

Dimensions, Location and Underpass Attributes

♦ "**Lynxes** are cautious and secretive and avoid large open areas. Even when hunting, they prefer some cover and won't typically cross openings more than 300 feet wide. . . ." ("Killer Roads" by Susan Cerulean
http://www.defenders.org/defendersmag/issues/winter02/killerroads.html)

♦ Underpasses should be located where wildlife naturally cross roads (Klein 1971; Hanna 1982; Singer and Doherty 1985; Waters 1988). Hanna (1982) found that crossing structures placed without regard to traditional paths failed; adding fences failed to direct deer to these crossings. **We believe that underpass placement based on knowledge of actual travel routes is more important in determining underpass use than other factors such as structural dimensions (Foster and Humprey 1994).** Ford (1980) and Ward et al (1980) found that deer used underpasses placed 1.61 and 1.77 km apart, respectively. An application placing crossing structures 2.69 km apart (Jensen 1977) was only partially successful; some deer evidently could not find the underpasses.

♦"Linking habitats and reducing roadkill: **Bear** underpasses in Florida"
http://www.tfhrc.gov/pubrds/marapr00/critters.htm

"The SR 46 underpass built by FDOT is a **bear-friendly**, dirt-floor box culvert, 14.3 meters (47 feet) long by 7.3 meters (24 feet) wide by 2.4 meters (8 feet) high. Work crews elevated the two-lane road over the crossing to give skittish animals a clear view across to the other side. They also planted rows of pines in the open pasture on one side of the road to guide bears to the culvert entrance. Bears did indeed use the SR 46 corssing. In fact, post-project research revealed that bears plus 12 other species, including bobcats, gray foxes, and **whitetail deer**, crossed through it."

♦ Clevenger and Waltho 2000
We found that underpass distance from the east gate (positive correlation) was the most significant underpass attribute affecting black bear performance ratios, whereas underpass length (negative correlation) was the most significant attribute affecting **elk** performance ratios (Table 3).

At the second scale of ecological resolution, species groups, we used PCA to identify two group types (Factor 1, Fig. 2). The two groups were readily identifiable as large predators/omnivores (hereafter referred to as carnivores) and ungulates. For carnivores the most significant underpass attribute influencing the group's performance was distance to townsite (positively correlated), followed by human activities such as hiking (negatively correlated), human use index (negatively correlated), and horseback riding (negatively correlated). Landscape and structural variables were the least significant attributes influencing the group's performance ratio (i.e., distance to nearest drainage, negatively correlated; underpass openness, negatively correlated; Table 4).

In contrast, we found that the most significant underpass attributes influencing ungulates were structural and landscape factors. Specifically, the rank order was 1, underpass openness (negatively correlated); 2, noise level (positively correlated); 3, underpass width (negatively correlated), and 5, distance to nearest drainage. Human activity attributes, although significant, were ranked lower: 4, horseback riding (negatively correlated), and 6, hiking (negatively correlated; Table 4).

At the third scale of ecological resolution, large mammals (i.e., all species together), we found that the most significant underpass attribute influencing the community's performance ratio was structural openness (negatively correlated; Table 4). Distance to townsites was the second most significant attribute (positive correlation), followed by human activity (human-use index, horseback riding, hiking, and biking, all negatively correlated)."
***For the tables, see article**

♦"Highways are a road to ruin for endangered species, research shows" by Sherry Devlin
http://lynx.uio.no/lynx/nancy/news/mojy986j.htm

"What does work? [Bill] Ruediger said bridges, if properly built, can give animals a way under a highway, along the river that the bridge was designed to span. Those crossings are the most natural and, if left unobstructed, are likely the most successful. Underpasses, built specifically for animals, also work, according to Ruediger. The Canadians are experimenting with large culverts, 4 meters high and 12 meters high, that provide passage under highways. **Deer and elk** started using the passageways almost

immediately; then came **grizzly bears**. Underpasses in Florida are known to provide passage for **panthers**, **black bears** and alligators."

♦"Road effects on wildlife: a research, monitoring, and adaptive mitigation study" by Anthony Clevenger
Progress Report 5 1 November 1998- 31 October 1999
http://www.worldweb.com/ParksCanada-Banff/roads

"**Elk** were the most frequently detected species at crossing structure, followed by **deer, sheep**, and coyotes."

". . . **cougars** used one metal culvert 26 times, one creek pathway underpass 39 times, and all seven open span underpasses anywhere from three to 40 times . . . **Grizzly bears** used one metal culvert once, one creek pathway twice, and three open span underpasses a total of seven times. **Wolves** used both metal culverts six times, both creek pathways six times, and all seven open span underpasses anywhere from one to 90 times (mean= 20 times)."

"With regard to the number of individuals using Phase 1 & 2 underpasses, three adults and one subadult **grizzly bear** crossed the Trans-Canada highway via the underpasses. Of the 10 times **grizzly bears** have used crossing structures, seven passes were attributed to three radio-marked adult males; of which one male made four of the seven passes. The majority of **wolf** use of the crossing structures is from the Bow Valley pack, remnant members of the pack, solitary wolves and pairs."

"**Wolves** had the highest avoidance rate on Phase 1 &2 . . . whereas in descending order, **lynx, elk**, and coyote had the highest avoidance rates on Phase 3A. **Ungulates** avoided entering old crossing structures 5% of the time, whereas they avoided the new crossing structures 15% of the time"

". . . Avoidance rates were highest for creek pathways (7%) on Phase 1 & 2 and the overall avoidance rate at the old crossing structures was 4%. On Phase 3A, avoidance rates were highest at box culverts (44%), followed by wildlife overpasses (29%) and creek pathways (24%). Avoidance was least frequent at metal culverts (2%). Wildlife avoided the Phase 3 crossing structures 25% of the time."

♦"Permeability of the Trans-Canada highway to wildlife in Banff National Park: importance of crossing strucutres and factors influencing their effectiveness" by Anthony P. Clevenger
http://www.hsctch-twinning.ca/Environmental/icowet2_wcs.htm
***for tables see website**

Factors influencing use
Correlations between underpass variables and the monthly crossing index for wildlife suggested that several variables were important correlates of underpass quality (Table 4). For large **carnivores**, the amount of human activity was significant and showed a strong negative correlation with underpass usage. Underpass length was positively correlated with large **carnivore** crossing indices but was not significant. Higher rates of passage were associated with divided underpass types and were significantly different from undivided types (P=0.07, two-tail test). All other variables showed weak correlations. Results from stepwise linear regression analyses of the crossing indices for large **carnivores** is summarized in Table 5. Underpass quality was best predicted by three attributes, levels of human activity, openness and underpass length, which together explained 60% of the variance. Human activity was the most important factor alone, accounting for more than half of the variance (30%). Correlations for the relationship between underpass use by **ungulates** and underpass variables suggested that two variables were important in determining underpass quality (Table 4). Level of human activity and underpass length were highly correlated with **ungulate** use, the former being positive whereas the latter negative. **Ungulates** were indifferent to underpass configuration, underpass type, and type of habitat in the vicinity of an underpass failing to show any correlations. Underpass quality for **ungulates** was best predicted by three variables, levels of human activity, openness and height, which combined accounted for 50% of the variance (Table 5). Level of human activity and underpass openness were the most important model components explaining 42% of the variation found. Underpass length did not explain significant additional variation."

Table 4. (a) Correlation coefficients for the relationship between use of nine underpasses by wildlife and underpass variables. (b) Mean values for underpass use (tested using Mann-Whitney). n=9 for both large carnivores and ungulates.

Variables	Large carnivores	Ungulates
(a) Length	0.47	-0.76***
Width	-0.10	0.26
Height	-0.09	-0.42
Openness	-0.02	0.16
Sound level	0.25	0.36
Human activity	-0.60**	0.75***
Distance to forest	-0.26	0.05
Distance to CPR	-0.04	0.13
(b) Habitat		4.7
0 Forest	10.6	NS
1 Forest/open mix	NS	3.5
	11.9	
Configuration		4.0
0 Divided	16.5	NS
1 Undivided	**	3.9
Type	3.0	
0 Open-span		4.3
1 Culvert	11.6	NS
	NS	2.7

	10.1	

*P<0.10, **P<0.05, ***P<0.01.

NS, not significant.

♦<http://www.mrwa.wa.gov.au/standards/guidelines_road_&_traffic_engine…/fauna_underpasses>
"Guide to the Design of Fauna Underpasses"
This website provides general information regarding construction of underpasses