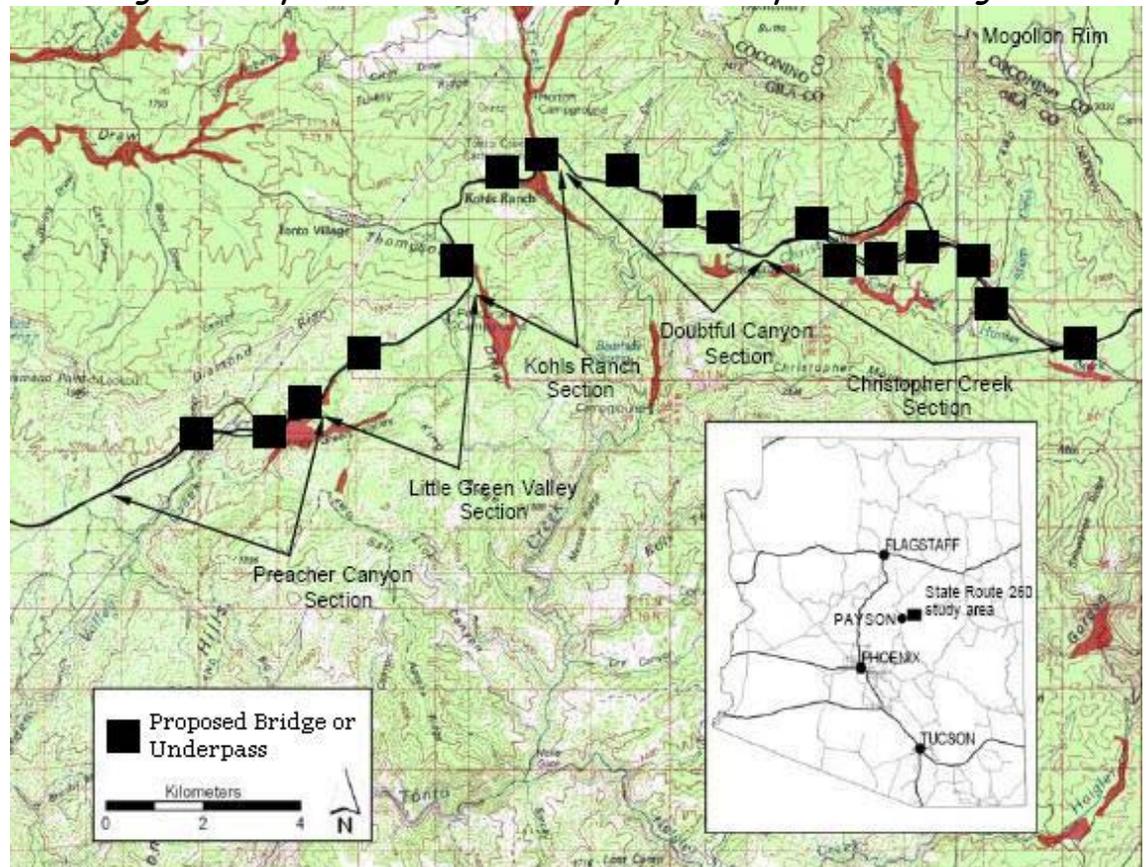


# How Do We Stop Wildlife-Vehicle Collisions?

The Arizona Department of Transportation has decided that wildlife-vehicle collisions are a serious issue in Arizona. One main area of concern is Highway 260 east of Payson. This 18.5-mile stretch of highway cuts right through the middle of prime elk habitat but is also experiencing a significant increase in highway traffic.

The proposed plan calls for increasing the size of this road from a two-lane to a four-lane highway while improving wildlife permeability (passage). It would incorporate 11 bridges and 6 underpasses (Figure 1).

**Figure 1: Map of State Route 260 Proposed Underpasses and Bridges**



The research has been performed and construction is ready to begin. However, concerns have been raised over the cost. Your team has been chosen to analyze the data with two goals in mind:

1. Evaluate and characterize wildlife movements, particularly elk, across State Route 260.
2. Research alternatives to bridges and underpasses that may reduce the costs.

The Arizona Department of Transportation has asked for a formal report in which you describe three ideal locations for bridges or underpasses as well as two cost-saving alternatives.

On the following pages, you will find information and data collected during this research project that is available for you to use as you make your decisions. Good luck!



## Ecology of Elk

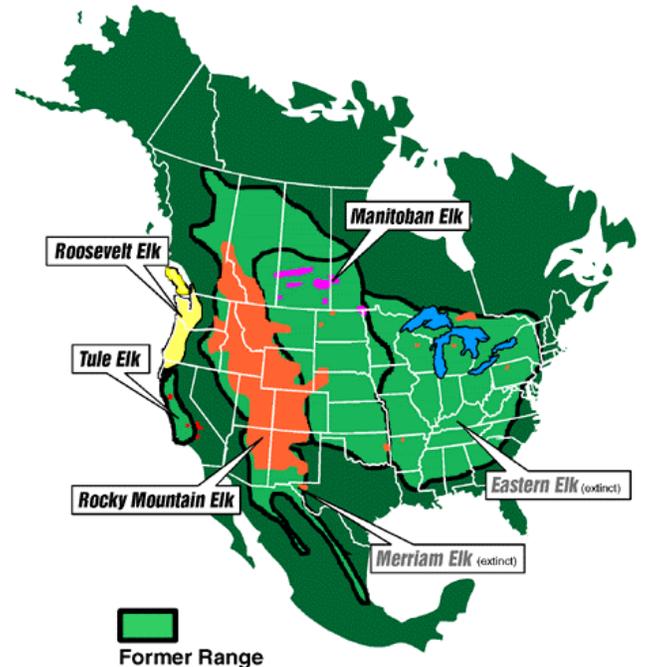
At one time, elk were the most widely distributed member of the deer family in North America. Their population size was estimated at 10 million. But that was before Europeans arrived. Just as with the buffalo, agriculture and market hunting took their toll on the elk. By 1922, the population had shrunk to 90,000, most of them living in Yellowstone Park, which became a reservoir to preserve them. As the Yellowstone elk reproduced, some were transplanted to bolster or begin herds in other parts of the country. Between 1912 and 1967, more than 13,000 elk were relocated. Eighty-three of them were sent to Arizona, and this small population is responsible for the 35,000 elk now in the state.

Elk have two distinct coats. They grow a heavy winter coat that is primarily dark brown across the head, belly, neck, and legs, and grayish brown on the sides and back. The rump is yellow with a dark brown stripe. They shed this coat in the spring, revealing the summer coat, which is usually a deep red-brown with no undercoat. They shed this coat as fall arrives.

One of the elk's most distinctive features is its antlers, which are shed every year. Adult males (bulls) shed their antlers between January and March, and the new antlers begin to grow soon after. By August, antler growth is complete. During this time of growth, the males have increased nutritional needs.

Most elk cows weigh between 450 and 600 pounds; bulls average 600 to 800 pounds. Some large bulls have been reported to weigh as much as 1,200 pounds. Elk are extremely fast and can run up to 40 miles per hour for short distances and 30 miles per hour for longer ones. They have been known to swim a distance of more than a mile. They can jump 8 to 10 feet into the air. An elk's life span is usually between 14 and 17 years, although some have reached the age of 25.

The elk breeding period is during the months of September and October. One bull elk may breed with as many as 30 females (cows), but the average is around 15 to 20. Calves are born about 8 months later, in late May. The calves weigh approximately 30 pounds. Twins are extremely rare. The mother's nutritional demands increase during gestation (pregnancy) and in the weeks following the birth, when she must produce milk to feed her calf. A few weeks after birth, the calf is able to run and join in the regular activities of the herd. At this time, herds may number in the hundreds.



*Information for this article was provided by the Arizona Game and Fish Department and the Rocky Mountain Elk Foundation.*

# Elk Movement Research

Researchers with the Arizona Game and Fish Department used global positioning satellite (GPS) telemetry to assess the movement of elk within the research area near State Route 260. Elk were captured and fitted with GPS receiver collars. These collars, which had a life of approximately 15 months, were programmed to report a fix (elk location) every four hours. From May 2002 to April 2004, a total of 33 elk (25 cows and 8 bulls) were studied. The scientists collected more than 101,000 GPS fixes. The following tables summarize the data they collected.

## Definitions

*Crossing* - any time an elk moved from one side of the road to another (the crossings are all inferred based on the elk's location between two consecutive GPS fixes)

*Weighted Crossing* - a number of crossings corrected to reflect the number of different elk that crossed at a given point and the evenness in the distribution of crossings among the different elk

*Approach* - any time an elk traveled within 0.15 miles of the highway but did not cross (based upon GPS fixes)

*Passage Rate* - a relationship between the number of times the elk approached the highway and the number of times they crossed (highway crossings/highway approaches)

## A Note About the Tables

All of the data included in the following tables were collected from May 2002 to April 2004 along the research area on State Route 260 (see Figure 1).

**Elk Movement Data** - The following data tables (1 - 5) deal specifically with the movement of elk around the research area.

**Table 1: Elk Crossings by Highway Section**

Highway Section	# of Miles	# of Elk	# of Elk Crossings	Crossings/Mile	Weighted Crossings	Weighted Crossings/Mile
Preacher Canyon	3.0	13	1298	432.7	1312	437.3
Little Green Valley	2.5	13	132	52.8	193	77.2
Kohl's Ranch	3.4	13	212	62.3	237	69.7
Doubtful Canyon	2.8	8	292	104.3	332	118.6
Christopher Creek	5.0	15	1070	214.0	1451	290.2

**Table 2: Average Number of Elk Highway Approaches and Crossings**

	Elk Gender		
	All	Cow	Bull
# of Highway Crossings	92.6	112.0	32.1
Highway Crossings/Day	0.22	0.28	0.06
Highway Approaches/Day	0.73	0.83	0.43
Highway Passage Rate	0.35	0.36	0.34

**Table 3: Frequency of Elk Fixes Found in Various Habitats**

		Proportion of Habitat Area where Elk are Found				
		Chaparral	Pinyon-Juniper	Ponderosa	Mixed Conifer	Riparian
Proportion of Total Habitat Area		0.16	0.12	0.46	0.22	0.04
Elk Gender	All	0.15	0.10	0.39	0.18	0.18
	Bull	0.12	0.07	0.42	0.19	0.20
	Cow	0.14	0.10	0.39	0.19	0.17

**Table 4: Highway Crossings and Passage Rates by Month**

Month	Bull		Cow	
	Crossing	Passage Rate	Crossing	Passage Rate
Jan	0	0.00	151	0.32
Feb	0	0.00	120	0.26
Mar	2	0.34	257	0.30
Apr	13	0.68	128	0.36
May	16	0.59	142	0.54
Jun	54	0.47	199	0.42
Jul	33	0.27	184	0.31
Aug	61	0.48	230	0.30
Sep	25	0.53	199	0.38
Oct	31	0.49	259	0.52
Nov	3	0.08	201	0.27
Dec	0	0.00	116	0.22

**Table 5: Proportion of Highway Crossings by Time of Day**

Crossing Time	12am	2am	4am	6am	8am	10am	12pm	2pm	4pm	6pm	8pm	10pm
Proportion	0.14	0.15	0.10	0.18	0.06	0.02	0.01	0.00	0.01	0.07	0.13	0.12

Note: Times represent the midpoint of a 2-hour time interval (i.e., 2am = 1am-3am)

**Elk-Vehicle Collision Data** - The following tables (6 - 9) deal with comparisons between elk movement and the number of collisions that occur

**Table 6: Elk Highway Crossings and Elk-Vehicle Collisions by Highway Section**

Highway Section	# of Elk Crossings	# of Elk-Vehicle Collisions
Preacher Canyon	1312	78
Little Green Valley	193	3
Kohl's Ranch	237	39
Doubtful Canyon	332	9
Christopher Creek	1451	98

**Table 7: Proportion of Elk-Vehicle Collisions and Highway Crossings by Month**

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Proportion of Crossings	0.06	0.05	0.11	0.11	0.06	0.10	0.09	0.12	0.09	0.12	0.08	0.05
Proportion of Collisions	0.06	0.06	0.04	0.07	0.06	0.05	0.08	0.08	0.16	0.20	0.13	0.07

**Table 8: Proportion of Elk-Vehicle Collisions and Highway Crossings by Time of Day**

Time	12am	2am	4am	6am	8am	10am	12pm	2pm	4pm	6pm	8pm	10pm
Crossing Proportion	0.14	0.15	0.10	0.18	0.06	0.02	0.01	0.00	0.01	0.07	0.13	0.12
Collision Proportion	0.12	0.07	0.08	0.08	0.04	0.01	0.01	0.00	0.00	0.11	0.31	0.16

Note: Times represent the midpoint of a 2-hour time interval (i.e., 2am = 1am-3am)

**Table 9: Proportion of Elk-Vehicle Collisions Occurring by Hours Away from Sunrise or Sunset**

Hours From Sunrise/Sunset	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0
Collisions	0.11	0.23	0.11	0.09	0.07	0.06	0.04	0.04	0.05	0.06	0.06	0.07

Note: Times represent how close the elk crossing occurred to sunrise or sunset (0.5 = half hour before or after sunrise or sunset)

### **Data Analysis Questions**

Use the following questions to help focus your ideas as you develop your report.

1. How much more likely is a female elk to cross the highway than a male elk? Does this make a significant difference in the passage rates of the two genders?
2. In which type of habitat are there more elk than would be expected based upon the area of that habitat?
3. At what time of year are the most elk crossing the highway? Does it vary depending on the gender of the elk? Why are they crossing during this time? Does this match the time when the most elk-vehicle collisions occur? Why or why not?
4. At what time of day do the most elk cross the highway? Does this match the time when the most elk-vehicle collisions occur? Why or why not?
5. Which highway section has the largest proportion of elk-vehicle collisions compared to elk crossings? Is this the same area that has the highest number of elk-vehicle collisions?

### **Formal Report**

You must now use this information to prepare a report for the Arizona Department of Transportation. The report must identify three locations where bridges or underpasses should be built and present any cost effective alternatives to deal with this situation rather than building 18 bridges or underpasses. In this report, you must address the following issues:

1. Describe the movement of elk across State Route 260. Be sure to focus on when and where the elk are moving. Use graphs if necessary.
2. Identify on the map, three locations where bridges or underpasses should be built. Be sure to explain why you selected these locations. Use graphs if necessary.
3. Analyze possible alternatives to bridges and underpasses. If possible, describe where alternatives are currently being used and how effective they are. Use graphs if necessary.
4. Identify two cost-saving alternatives that could be used in place of the bridges or underpasses. Describe how these would be used at these locations. Use graphs if necessary.

Use the links below (or your own Internet search) to find information about alternative solutions:

- Wildlife-Vehicle Accident Prevention Program: <http://www.wildlifeaccidents.ca/>
- Wildlife Crossings Toolkit: <http://www.wildlifecrossings.info/beta2.htm>
- Wildlife Protection - Keeping It Simple: <http://www.fhwa.dot.gov/environment/wildlifeprotection/index.cfm?fuseaction=home.viewTopic&topicID=1>
- Critter Crossings: <http://www.fhwa.dot.gov/environment/wildlifecrossings/index.htm>

## ***Research Report Rubric***

The following rubric will show you how your essay will be evaluated. Use it as you write.

<b>CATEGORY</b>	<b>4</b>	<b>3</b>	<b>2</b>	<b>1</b>
Accuracy of Facts (Content)	All supportive facts are reported accurately.	Almost all supportive facts are reported accurately.	Most supportive facts are reported accurately.	NO facts are reported OR most are inaccurately reported.
Adding Personality (Voice)	The writer has developed an academic voice appropriate for the audience.	There is some sense of academic discourse, but it may be inconsistent or weak at times.	The writer occasionally develops an academic voice, but generally it is weak and inconsistent.	There is no sense of voice in the essay.
Sequencing (Organization)	Details are placed in a logical order and the way they are presented effectively keeps the interest of the reader.	Details are placed in a logical order, but the way in which they are presented or introduced sometimes makes the writing less interesting.	Some details are not in a logical or expected order, and may distract or confuse the reader.	Many details are not in a logical or expected order. There is little sense that the writing is organized.
Word Choice	Writer uses appropriate words and phrases, and the placement of the words seems accurate, natural and not forced.	Writer uses appropriate words and phrases, but occasionally the words are used inaccurately or seem overdone.	Writer uses words that communicate clearly, but the writing lacks interest.	Writer uses a limited vocabulary that does not communicate strongly or capture the reader's interest. Jargon or clichés may be present and detract from the meaning.
Flow and Rhythm (Sentence Fluency)	All sentences sound natural and are easy-on-the-ear when read aloud. Each sentence is clear and has an obvious emphasis.	Almost all sentences sound natural and are easy-on-the-ear when read aloud, but 1 or 2 are stiff, awkward or difficult to understand.	Most sentences sound natural and are easy-on-the-ear when read aloud, but several are stiff, awkward or difficult to understand.	The sentences are difficult to read aloud because they sound awkward, are repetitive, or difficult to understand.
Citations	At least three citations are used and all are cited correctly.	At least three citations are used but one is not cited correctly.	Less than three citations are used or more than one is not cited correctly.	There are no citations.

