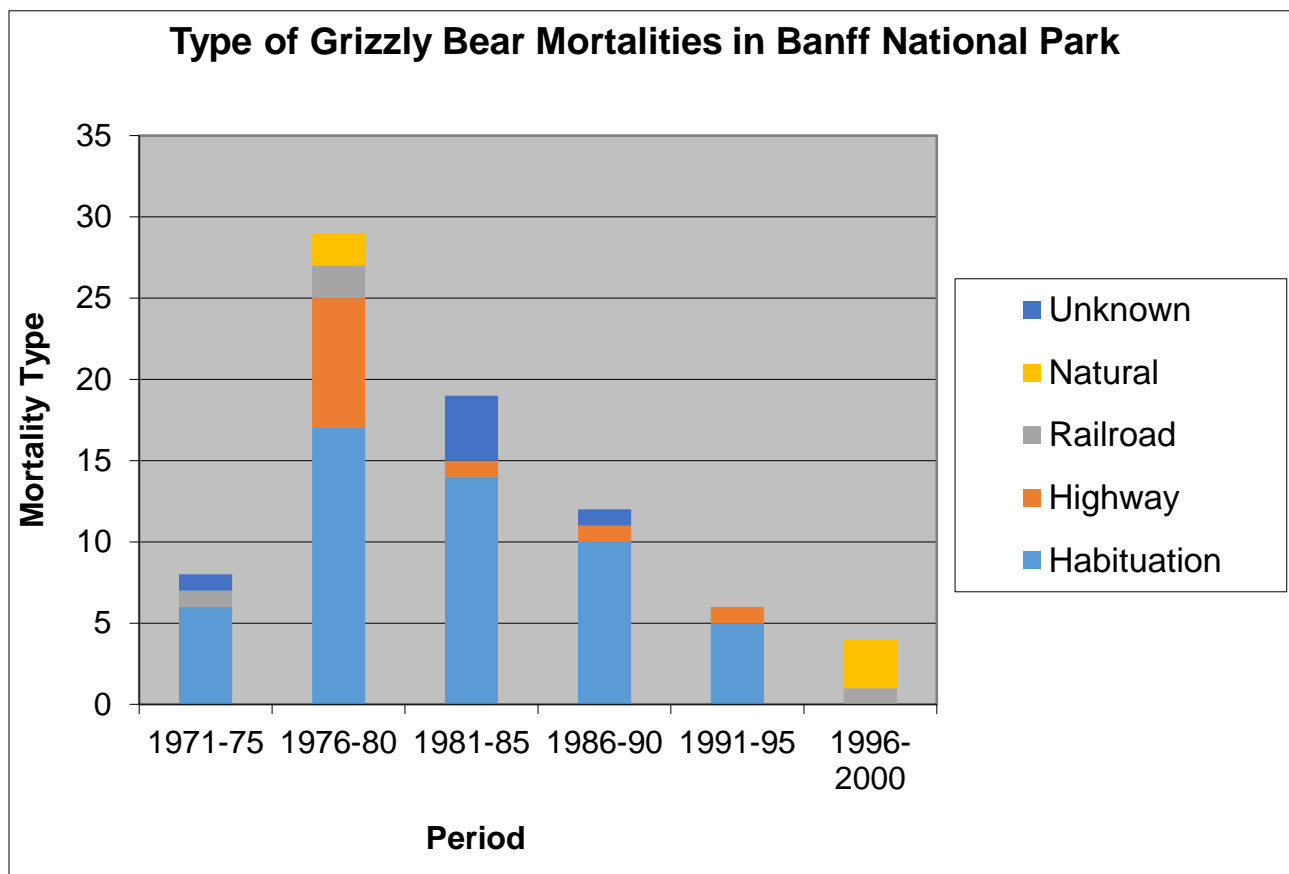**TEACHER'S SOLUTION**
Type of Grizzly Bear Mortalities in Banff National Park

1)

Period	Mortality Type					Totals	Average # of Mortalities / year
	Habituation	Highway	Railroad	Natural	Unknown		
1971-75	6	0	1	0	1	8	1.6
1976-80	17	8	2	2	0	29	5.8
1981-85	14	0	0	0	4	18	3.6
1986-90	10	1	0	0	1	12	2.4
1991-95	5	1	0	0	0	6	1.2
1996-00	0	0	1	3	0	4	0.8
Totals	52	10	4	5	6	77	2.56

2)

Teacher Key to Written Questions:

3) Based on the data, what is the greatest cause of grizzly bear mortalities?

Habituation: when a bear becomes conditioned by humans through positive reinforcement (feeding bears, stopping to take photographs of bears, attracting bears by being careless with garbage or food etc. are all examples of positive reinforcement)

4) What reasons might have contributed to the peak in mortalities in the late 1970's?

Banff National Park was managed differently in the late 1970s than it is today. People used to allow bears to approach cars for photos. There were no fences on the highway. Garbage wasn't properly stored in bear-proof garbage bins; in fact, bears used to feed at the Banff Dump. When the dump closed in the late 70s, the habituated bears may have had more human encounters while searching for food. Park managers also killed several bears after a mauling that involved only one bear (they couldn't find the "culprit").

5) What factors may have caused the decrease in mortalities in the late 1980's and early 1990's?

Factors such as the fencing along the side of the Trans-Canada Highway, better education of park visitors and campers, and the use of bear-proof garbage bins.

6) Within Banff National Park the grizzly bear death rate for the most recent period we have data for (1996-2000) is 0.8 deaths/year. In your opinion, is this mortality rate too high for a bear population to remain in Banff Park for the years to come? What else do you have to know in order to answer such a question?

To answer this question, we need to know the birth rate (see the next section).

Use the following data to answer questions # 7, 8 and 9.
Between 1994 and 1999, 17 female bears in Banff National Park had the following cubs:

Bear #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
# of cubs	3	4	2	1	3	4	5	5	1	2	1	0	2	0	0	0	0

7) What is the average number of cubs born per year during this period?

There were 33 known grizzly bear cubs in the park: $33/5 = 6.6$ cubs/year.

8) What is the average number of cubs born per bear per year?

6.6 cubs/year divided by 17 females = .039 cubs/bear

9) Many cubs will not survive to adolescence. Only about 70% will survive to adulthood. Take the total number of cubs per year from question 7 and multiply it by .70 to get the number of cubs who survive to become adults. This is the *natality rate*.

6.6 cubs/year x 0.70 = 4.60 cubs/year will survive to adulthood

Comparing Mortality (death) and Natality (birth) Rates
10) Based on the mortality and natality rates in BNP, should the bear population increase or decrease over time?
<center>(m>n = ⬇pop; m<n =⬆pop)</center>
m (2.56) < n (4.56) = population should increase over time.

11) Biologists feel that the grizzly population in BNP is decreasing, not increasing. This is because the mortality rate (2.56 bears/year) does not represent the *actual* number of mortalities. Many deaths are undocumented or occur outside the park boundaries. Based on an increased mortality rate of 5.0 bears/year and a natality rate of 4.6 bears/year, what will happen to the grizzly bear population over time?

The bear population will decrease. If this trend continues, bears will become extirpated (locally extinct) in Banff National Park.

12) Biologists estimate that the current population of grizzly bears in Banff National Park is 70. Use the numbers in the question above to find out how many bears there will be 25 years from now.

Growth rate*(# of years) + current population = future population (*Growth rate = BR – MR)

{(4.6 – 5) X 25} + 70 = 60 bears

13) You have just done an extrapolation, where you take a certain rate and project it forward in time in order to make a prediction. Can you think of any problems in making such a prediction?

Yes. Problems exist when making extrapolations because they presume that factors such as habitat effectiveness remain constant. In the unlikely event that developed land becomes restored, the population may actually increase despite the prediction made. On the other hand, if wild areas become developed and visitor use increases, the population prediction of the Banff Park grizzlies could be much smaller than 60. Also, a smaller population of bears in 25 years might have trouble finding each other! Similarly, the population might start to suffer from inbreeding as it grows smaller. Both of these would hasten the decrease in population over time. This positive feedback loop is known as the "Extinction Vortex."

14) Compare the following two species. Identify which is an r-selected species and which is a k-selected species.

Grizzly Bears are k-selected; snowshoe hares are r-selected

15) How do you think human alterations/interventions affect the populations of r- and k-selected species?

R-Selected: Sometimes the changes can help a species, sometimes they are destructive. Destroying or poisoning the habitat has a wide-ranging effect (ex. Frogs). In some cases, however, the environment is altered in ways that enlarge the region a species inhabits (ex. mice or cockroaches). When conditions are changing, r-selected organisms tend to respond favourably. R-selected species also have the ability to increase their populations rapidly.

K-Selected: K-selected organisms have evolved to live within the carrying capacity of their environments, and when that environment changes, they and the environment suffer (ex. grizzly bears). The ecosystem is out of balance, and the number of the animals who live in it needs to be readjusted. K-selected individuals, because they are born only periodically, also affect the environment if they die prematurely. As numbers of animals drop, the loss of individuals becomes more and more significant. K-selected organisms have no mechanism by which they can suddenly increase their numbers. This is why small, rapidly maturing animals (r-selected) tend to be the survivors after global catastrophes.

16) Do you think that r-selected or k-selected species are more likely to be endangered? Discuss your reasons.

With a few exceptions (amphibians, Banff Springs Snail), k-selected species are more likely to be endangered because they are greatly affected by changes in their environment. They are less able to adapt to changes and a low birth rate means that it is difficult to "rebuild" the population if it has been compromised.