**Exploration Phase – Teacher Handout 2**

**Graph Information**

Background Information and Talking Points for each Graph

**Graph #1.** is a fitted trend line of the abundance of elk in the northern Yellowstone range from 1923 to 2015. The graph contains shaded areas indicating uncertainty about the trend (similar to error bars in other scientific graphs). As a class, students should discuss the meaning of shaded areas and the association to actual numbers. Engage students in discussions that bring their attention to possible causes in fluctuation in elk populations. Some interesting timeframes could include: weather patterns influence forage quality and availability, the fires of 1988 and subsequent severe winter, the 1995 reintroduction of wolves, and the increase in cougar and grizzly bear numbers.

**Graph #2.** is a three-bar graph indicating wolf populations in the entire Yellowstone park, the northern range only, and only in the Park’s interior. Engage students in a discussion about similarities and difference between bar and line graphs. Talk about fluctuations in wolf populations and possible causes. Reasons of decreases in wolf numbers may include: 65% of wolves are killed by rival packs. In 2005, 2008, and 2009 outbreaks of canine distemper killed two-thirds of the pups in Yellowstone. Because wolves are highly social animals and live in packs, they also die from infectious canine hepatitis, canine parvovirus and bordetella. Sarcoptic mange, an infection caused by a mite, reached epidemic proportions among wolves on the northern range in 2009. Each year wolves are run over and killed by vehicles. The Park’s wolf population has declined substantially since 2007, when the count was 171. Most of the decrease in wolf numbers has been in the wolf packs on the northern range, where it has been attributed primarily to the decline in the elk population and available territory.

**Graph #3.** is a line graph representing wolf, elk and bison counts in the northern range of Yellowstone. For Yellowstone, wolves’ predation rate (% of elk population killed by wolves) is a poor predictor of elk population growth rate because wolves are one of many factors (e.g. other predators, human harvest, climatic conditions) influencing elk survival. Wolf predation rate has increased in recent years. This increase in the proportion of the elk population killed by wolves is due to the smaller elk population, rather than an increase in kill rate (i.e., how frequently wolves kill elk). It is interesting to point out that the number of bison now calling the northern range home has had a steady increase since 2000, causing habitat competition with elk (Yellowstone Science, 2016).

**Graph #4.** Yellowstone is known for its beautiful stands of quaking aspen (*Populus tremuloides*). Aspen is noted for its ability to regenerate vegetatively by shoots and suckers (shoots from underground roots or stems) rising along its long lateral roots. Root sprouting results in many genetically identical trees, in aggregate called a “clone”. Because elk feed on the bark of aspen, aspen are often used as a measure to determine changes in elk feeding patterns. Studies have linked a decline of quaking aspen to heavy elk browsing. A decline in the number of aspen stands may cause substantial reductions in biodiversity on the landscape because aspen communities support a rich diversity of bird, butterfly, and plant species. However, previous aspen studies have not identified the amount of browsing or elk population size that affects aspen regeneration. This graph represents data from a study that measured annual growth and sapling heights. The scientists examined trends in the elk population size on the winter range in Northern Yellowstone.

**Figures 4A-C** illustrate the relationship between browse pressure (amount of elk grazing) and quaking aspen heights for three stands on the Northern Yellowstone Range. These three stands were highly browsed in the early 2000’s. Black lines represent the browse pressure and red lines represent the sucker growth. Graphs A and B show a distinct inverse relationship between the amount of browse pressure from elk and the height of aspen. Challenge students to provide a plausible explanation for the difference in graph C. Have them predict, using the current trend, what the graph lines could look like in ten years.