**Explanation Phase - Teacher Handout**

***Yellowstone Stability and Change: Ecosystem Research Conference***

Conference Location: Albright Visitor Center, Mammoth, Wyoming

(Please see Explanation - Student Handout for instructions and scoring rubric)

**Science Content background information**

The information below provides background knowledge of topics students may address in their “conference” presentation.

**Fire** is a key factor in shaping ecosystem processes and patterns, such as nutrient cycling and plant community composition and structure. While lightning may ignite dozens of forest fires during a single season, most go out naturally after burning less than half an acre or burning only a small group of trees. On rare occasions, low humidity and high wind-driven fires have burned through large areas of forests, as in 1988 when 50 fires burned a mosaic covering more than 800,000 acres in Yellowstone. Despite firefighters best efforts, these fires were finally extinguished by the first snows of the fall season. Wildfires do not generally affect the abundance of most wildlife species in Yellowstone. However, ungulate species, including elk experienced a high mortality in the winter after the 1988 fires. This may have been the result of burned forage, summer drought that restricted vegetation growth, and the severe winter that followed. (Yellowstone Resources and Issues Handbook, 2017)

**Climate** is a long-term meteorological condition that prevails in a region, with a decade as the minimum span of averages. **Weather** is the state of the atmosphere at a given time and place, and for the next few days to a month. Global temperature is the master force affecting climate. Everything else that climate affects – sea level rise, growing season, drought, glacial melt, extreme storms – is driven by changes in temperature. Weather stations have been maintained within the Greater Yellowstone Ecosystem (GYE), resulting in some of the longest running records of temperature and precipitation anywhere in the United States. There is overwhelming evidence that climate has changed in the past century and will continue to change in the future. Researchers looking at annual average temperatures report an increase of 0.31°F/decade within the GYE, consistent with the continuing upward trend in global temperatures. Snowmelt is critical to both the quality and quantity of water throughout Yellowstone. The interaction between snowpack, temperature, and precipitation involves a complex interchange between heat and light. Warming temperatures could limit snowfall by converting it to rain or by melting snow rapidly once it falls, thereby driving snowlines further up the mountains. Changes in the area covered by snow are especially important as snow reflects more solar radiation out to space. When land is exposed, sunlight is absorbed by the surface of the earth. This raises the overall surface temperature, which leads to more melting and less snow cover. Climate change is also affecting the frequency, intensity, and severity of wildfires; wide spread insect outbreaks leading to an increase in the number of dead or dying trees, provides additional fuel for wildfires fires; changes in moisture content results in vegetation or even loss of plant species that can not survive in drier environments; changing conditions for wildlife such as elk and pronghorn migration which is triggered by a number of factors including hours of daylight – a factor unaffected by climate change. However, early spring green-up could leave them migrating after their forage has lost much of its initial nutritional value, or earlier peak stream water flow could force them to change their migration routes. (Yellowstone Resources and Issues Handbook, 2017)

**Cougars, grizzly bear and wolves** roamed Yellowstone National Park. But by the 1920s these three dominant predators were either eliminated (wolf) or greatly reduced in numbers (cougar and grizzly bear). With the top predators gone, the elk population in Yellowstone grew to levels that exceeded the ecosystem’s carrying capacity. Elk were often found starved to death or in unhealthy conditions. In 1973, the US Fish and Wildlife Service listed the wolf (*Canis lupus*) as an endangered species and designated Greater Yellowstone as one of three recovery areas. Between 1995 and 1996 thirty-one grey wolves from Canada and northwest Montana were released in Yellowstone National Park. Wolves are highly social animals and live in packs. To help scientists learn about wolf behavior, all of the initially released wolves were collared. The average lifespan of a wolf living in the Park is 4-5 years while the average lifespan outside the park is 2-3 years. To ensure that scientists can gather current data on wolves in the park, additional wolves are collared each year. This long-term monitoring is helping scientists to understand predator-prey dynamics. Between 2009 and 2016 wolf numbers have fluctuated between 83 and 108. Since wolves were reintroduced into Yellowstone, the elk population has declined by roughly 50%. While some attribute this drop entirely to wolves, the elk population was in fact declining before wolves were reintroduced. Elk decline is related to a number of factors, including hunting, drought, and multiple carnivores in addition to wolves. (Yellowstone Resources and Issues Handbook, 2017; Yellowstone Science, 2016)

**Competition for Habitat.** Climate changeis anticipated to cause changes in the distribution and abundance of many species in Yellowstone leading to habitat competition. Bison are the largest terrestrial mammal in North America with males reaching 2,000 pounds and high survival rates. Wolves currently kill few bison because elk are more vulnerable prey. As a result, bison numbers increase rapidly when environmental conditions are suitable. Similar to elk, bison feed primarily on grasses, sedges, and other grass-like plants (more than 90% of their diet) but also eat forbs (weeds and herbaceous, broad-leafed plants) and browse (the leaves, stems, and twigs of woody plants) in open grassland throughout the year. High densities of bison can deplete quality forage. The Lamar Valley located in the northern Yellowstone range is home to a large number of elk. However, over the past twenty years, the number of bison (*Bison bison*), who call this area home, is increasing (See Exploration Graph3 handout) (Yellowstone Resources and Issues Handbook, 2017)

**Hunters** are predators, similar to the cougar, grizzly bear, and wolf. Since hunting within the National Park boundaries is illegal, hunters wait for elk to leave the protection of the park. Between 1976 to 1988, regulated fall season hunt of young adult females did not seem to reduce elk numbers as evidence by substantial growth of the northern herd. And because hunters killed relatively few calves, high calf survival offset the removal of young adult females. Since elk numbers were strong, a late season hunt was initiated. The late hunt alone removed substantial numbers of young adult female elk, harvesting between 940 – 3,320 elk annually. By the early 2000s the once predator-sparse environment of northern Yellowstone National Park was filled with record numbers of cougars, grizzly bears, and wolves preying on elk caves. Even after numbers for the top predators continued to increase, hunters continued to harvest substantial numbers of mainly young adult female elk during the late hunt. So while human hunters continued to harvest mainly young adult female elk and animal predators were killing mainly calves, the elk population showed a significant decrease. With continued declines in elk numbers, the State of Montana suspended the late hunt in 2009, while the fall hunt continues. Elk comprise approximately 90% of winter wolf kills and are important food for cougars and grizzly bears, and at least 12 scavenger species, including bald eagles and coyotes. However, the decline in hunting opportunities has fueled debate on the effects of predators on the north herd, with the hunting public questioning the maintenance of high predator densities at the expense of hunting opportunity. (Yellowstone Resources and Issues Handbook, 2017; Yellowstone Science, 2016)