# Scenario 1: “Some Like it Hot”

In this scenario annual temperature increases approximately 5 F by 2035. To put that in perspective, Durango’s temperature becomes similar to the current climate of Grand Junction or Delta, CO. By 2035, every summer will be warmer than 2002 and 2012 – years when we experienced excessive heat waves. At elevations below 7,000 ft, for at least two weeks during the summer, nighttime lows will not dip below 68 F (a typical tropical night), and summer will expand by a month. **Annual precipitation will decline by 10% and there will be more frequent drought years.** Roughly every fifth year, we experience droughts similar to 2002 and 2012 (in these years, precipitation was 40% below average).

**FIRE**

The average fire season will lengthen by one month and the average total area burned in any given year will increase 16 times. Not every year will be an exceptional fire season but average fire frequency, intensity, and size will increase. Fires in the San Juan region have been larger and more intense since 2000, with the 2002 Missionary Ridge fire burning 70,000 acres, destroying 56 homes, and with the 2013 West Complex Fire burning nearly 110,000 acres. Nearly 50% of Mesa Verde National Park has burned since 2000. These fires occurred in drought years similar to what we might expect every five years under this scenario. Under these conditions, pinyon-juniper in some places will not regenerate post-fire and will transition to a shrub dominated system. The largest burns will be in coniferous forests, including spruce-fir, mixed-conifer, ponderosa pine, and pinyon-juniper. These areas are likely to transform into aspen, mountain shrublands, or grasslands. While the growing season increases by three weeks, with less precipitation, understory herbaceous growth (fine fuels) does not necessarily increase.

**DROUGHT**

In this scenario we have less annual precipitation and increased evapotranspiration. This decreases available water by nearly 20% (from today’s baseline), as every 1.8 F of temperature increase effectively causes another 5% decrease due to evapotranspiration increasing. Thus, Durango’s annual precipitation becomes similar to the current precipitation that Ignacio receives. Spring snowpack will decline, although the 20% decrease in monsoon precipitation will have as large, if not larger, impact on vegetation. Snowline shifts up by 1200 feet; note the bottom of Durango Mt ski resort is at 9000 feet and very near snowline today. In addition, the average timing of snowmelt will shift a full three weeks earlier, due to temperature changes and more frequent dust-on-snow events (which will occur every year). Higher than average peak spring flows followed by reduced summer flows will reduce the amount of water available for fish, riparian vegetation, migratory birds, and grazing animals, especially during summer. Endangered fish may suffer from lower in-stream flow and increased stream temperature. Less precipitation in winter and summer will significantly decrease surface water and shallow ground water. Seeps and springs associated with shallow groundwater will decline and species composition will be greatly altered. For example, cottonwood trees will dieback, invasive species will increase, and associated fauna will decline. Annually, a water deficit will occur at all elevations and will be most pronounced in summer and fall.

**INSECTS**

Tree mortality due to insect and disease outbreaks will greatly increase with a hot and dry climate, more so than in any other scenario. For example, in 2002-2003, due in part to drought, SW Colorado experienced a 53% pinyon pine die-off due to ips beetle. In some pinyon-juniper forests, the species composition will change to nearly all juniper. Species that rely on pinyon pine (e.g., Pinyon-jay, Gray vireo, and Mexican spotted owl) and spruce-fir (e.g., Lynx, boreal owl, and snowshoe hare) will decline due to lack of food or shelter. Aspen trees at lower elevations will experience die-back associated with increased temperatures and decreased soil moisture. However, aspen stands at upper elevations may increase as coniferous trees decline due to fire and beetle kill. Heat and moisture stress will make it challenging for coniferous forests and wetlands to maintain their current condition, function, and species composition at their present locations. Shrubland ecosystems will likely expand.

# Scenario 2: “The seasons, they are a changing”

In this scenario, annual temperature increases 2 F by 2035. To put this in perspective, temperatures in Durango will resemble current temperatures in Cortez and Wolf Creek Pass will resemble Silverton. **Summer will expand by a week. Annual precipitation will increase by 10%** (in terms of soil moisture and stream flows a 5% increase in precipitation is needed to offset a 2F increase in temperature with its associated higher rate of evapotranspiration). Drought years, such as 2002 will occur every 15th year, similar to today’s frequency however the intensity and severity will increase.

**CHANGE**

While a 2 F temperature increase with negligible change in precipitation sounds close to business as usual, ecosystems will change in subtle ways. For example, the ratio of warm season to cool season grasses will change, and we will likely see declines in western wheat grass, needle and thread grass, while blue grama and galleta grass will expand. The snowline will shift upwards by 600 feet. As a result, the current vegetation in the 8,500-9,000 ft band will begin to shift from mixed conifer or aspen towards a ponderosa pine forests. Due to increased snowfall, overall runoff will increase by 10%, while warmer temperatures will mean that runoff will occur a week earlier. In this scenario, warmer summers similar to 2002 (5 F above normal) will occur once every decade. Fire risk in this scenario is the lowest of any scenario but fires will be present, and intermittent dry conditions may cause severe fire hazards because of high fuel loads. These high fuel loads are a result of increased winter, spring, and summer precipitation producing more foliage. A 2 F increase in temperature will increase the annual area burned by 3-4 times. Pinyon pine nut production will be reduced 50% with a 2 F increase in summer temperatures. While pinyon pine seedlings may have the ability to sprout at higher elevations, it is important to note that pinyon pines need 75 years or more to become good seed producers. Numerous species rely on pinyon pine seed crop production; therefore, this decline will reduce the populations of birds and small mammals that rely on pinyon pine nuts.

**WEEDS**

We will have greater than normal winter snowpack above 10,000 ft and spring, summer, and fall precipitation will increase at all elevations. The increase in year-round moisture coupled with a moderate increase in temperature will promote invasive species (more so than any other scenario). Current invasive species such as leafy spurge, knapweed, and yellow toadflax will expand into low to montane elevations and new invasive species, e.g., Japanese brome or purple loosestrife will likely move into the area. Rangelands will become degraded by invasives, and we see knapweeds and leafy spurge expand into rangelands that have never had a serious weed problem. Further, invasive species will out-compete the native vegetation and create a high density of fine fuels for future fires, especially at the lower elevations.

**WATER**

We will still experience droughts; however, they will be less frequent than in the other scenarios. In this scenario, disease and insect outbreaks are less likely than the other scenarios, however, insect outbreaks will still increase, as the droughts that do occur will be more intense than droughts experienced during the 20th century. When we do experience a beetle outbreak, the recovery time may be quicker than in the other scenarios. Seeps, springs, and other groundwater dependent wetlands will increase or experience very little change in this scenario. There will be some drought years that impact low elevation wetlands but for the most part wetlands will benefit from the years of increased annual precipitation. The upper elevation wetlands will do exceptionally well and possibly expand due to the greater snowpack above 10,000 ft. Higher soil moisture will likely eliminate or reduce wetland invasive species. Cottonwoods will likely experience good years where expansion is possible.

# Scenario 3: “Feast or Famine”

In this scenario, annual temperature will increase approximately 3 F by 2035. To put that in perspective, Pagosa Springs’ temperature will be similar to the current temperature of Ignacio. Average annual precipitation does not change; however, we will experience **larger year to year fluctuations in precipitation, with some very wet years and some intense drought years,** ascompared to our current pattern and the other scenarios. Winter precipitation will increase, but precipitation will decline in the other seasons. When droughts occur, they will be more intense but generally less than two years long. Roughly every tenth year we will experience a drought similar to those we experienced in 2002 and 2012 (years when precipitation was 40% below average).

**FEAST**

The growing season will expand by 2 weeks and during wet years vegetation growth will be exceptional with trees, shrubs, and ground cover greatly increasing. The frequency of severeEl Nino and La Nina events will double to an average of once every seven years. We experienced severe El Nino years in this region in 1982/83 and 1997/98 with annual precipitation at roughly 20% above average. Invasive species will do well under El Nino conditions but decline in La Nina conditions (drought years). The annual fire risk is lower in this scenario than the hot and dry scenario. Large fluctuations between wet and dry years will increase fuel growth during wet years. This means that when a fire does occur, the severity, intensity, and size could be very high, and in a bad fire year the average area burned will increase 11 times. Year to year, summer monsoons will be more variable than they are currently. During very wet monsoon years, the black stain fungus will expand, weakening or killing pinyon. Large spring floods will be more likely as earlier rain on snow events will cause abrupt snowmelt. Dust-on-snow events, coupled with warmer spring temperatures, will also increase the chance of spring flooding, especially during El Nino years. The largest flooding events will generally occur in the fall, associated with monsoons. During these floods, there will be severe erosion in small streams as water runs over banks and culverts.

**FAMINE**

Intense droughts will more frequently follow extreme wet years. Bark beetles will expand during these drought years, causing extensive conifer mortality. The difference between this scenario and the hot and dry scenario is that multi-year droughts will be less likely, thus the bark beetle dieback may not be as severe as in the hot and dry scenario. It is important to note that most conifer forests can regenerate more easily following beetle outbreaks than fires because bark beetles do not kill the young trees. However, insect kill in mature trees will diminish seed production. This reduction in seed crop will hurt the animals that rely on conifer seeds. In the event that a fire occurs after a beetle outbreak, tree regeneration is nearly impossible. The large fires associated with drought years will result in younger forests, more open structure, more early successional species, and more invasive species. Large landscape scale disturbances, such as fire and insect outbreaks, will fragment coniferous forests and negatively impact species such as lynx, snowshoe hares, pinyon jays, and other species that rely on large intact functioning forests.

Seeps, springs, and other groundwater dependent wetlands may experience a moderate decline, especially below 9,500 feet, where precipitation will fall as rain rather than snow. Increased evapotranspiration, driven by higher temperatures, will reduce soil and stream moisture. Consequently, species that can handle drier soil conditions, for example sagebrush and shrubby cinquefoil, will flourish; invasive species such as cheatgrass and knapweed will likely increase, especially at the lower elevations.