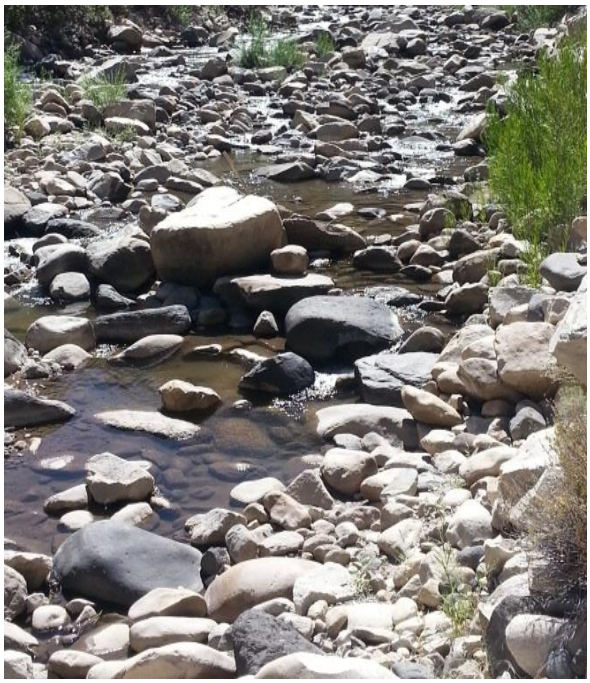
How drought in the Sierra Nevada and climate change are affecting streams – David Herbst

As you have hiked the trails of the Eastern Sierra this year you no doubt have seen the parched landscape and how little water there is in streams. How does this dry year affect stream habitats and aquatic life and what does the future portend?

A common misconception about global warming is that this results only rising temperatures in the atmosphere of the earth. With warmer temperatures though comes a host of other climatic effects, so the more catch-all term climate change is now used more often. As heat is trapped in the atmosphere under the building content of carbon dioxide gas from burning of fossil fuels, one of the most notable manifestations is an increased frequency of extreme conditions of drought and flood in some regions. The current severe drought that we are experiencing in California is a trend that is related to climate change. To understand how warming affects mountain streams, begin with the fact that flow is driven mainly by melting snow. But as temperatures rise, a greater fraction of precipitation falls as rain instead of snow and so runs off more quickly instead of the water being stored frozen in snow. The diminished snowpack also melts earlier than has been usual, and summer drought ensues, with extended low flows in rivers that may end in smaller streams drying altogether. Springs and meadows may provide some stored release of groundwater but these too must be recharged by a slowly melting snowpack that is disappearing. Using an understanding of how projected increases in temperature alter the timing and amount of snowmelt, mathematical models of how this affects water availability in the Sierra have shown that the critical-dry year type that we are experiencing would increase in frequency from about 1 in 5 years historically to 3 of every 5 years by the end of the century if not sooner. These projections apply mainly to the rivers of the west slopes of the southern Sierra, but the northern Sierra is forecast to lose snow more rapidly and have wet year types decrease from one-third of the time at present to just one-tenth of the time by the latter half of this century. The Eastern Sierra is more fortunate to have high elevations retaining snow for longer than other regions, but these too, will diminish as the snow line rises.

At the opposite end of extremes are the flood events that come from what climatologists call atmospheric river storms, known as the “pineapple connection” from meteorologists. These occur when warm wet winter storms come out of the tropical Pacific and deliver winter rains to high elevations where condensation and melting snow produce winter floods that can scour and wash out rivers as on New Year day in 1997 when highway 395 was destroyed in the West Walker River canyon. Climate models also show that these types of storms will become more frequent in the future even as stream flows on average are in decline.



Rain instead of snow also results in a shift to greater winter than summer runoff and this means less flow and hydroelectric power generated during the peak summer needs for agriculture and energy in California.

How are stream ecosystems altered? It is no surprise that stream areas contract in the low flows of a drought, but the type of habitat present also changes. Stream zones can broadly be defined as either deeper slow-moving pools or as swift shallow rocky riffles. Riffles harbor greater biological diversity and as food-resource areas produce larger and more varied insects and other invertebrates that are fed on by fish, amphibians, and by riparian birds and bats when the insects emerge as adults. Fish anglers know that pools just below riffles are favored areas for feeding by trout waiting for insects drifting down from riffles. As flows decline, the areas of pools increase at the expense of riffles, so there is a net loss of the productive and diverse riffle zones for aquatic life. With less flow and warmer temperatures these past summers have also shown an increase in algae and decomposing matter as they are concentrated and stagnate in deposits. As water warms it holds less oxygen, and sediments also accumulate and bury stream bottom habitat when flows cannot flush them out. Smaller invertebrates with the capability to tolerate poor water quality increase while larger ones succumb to the loss of habitat, with as yet unknown consequences to the food web that these organisms support. At extremes of late summer drought conditions, we are also seeing streams

throughout the Sierra going dry – some from above as snow disappears, and some from below as receding waters vanish below stream beds. On the plus side for many, the snowmelt ponds that support mosquitoes dry earlier so there are fewer of these insects to contend with, but other ponds and lakes are suffering loss of volume and area, especially of their productive nearshore shallow zones. As with our own dependence on water and when it comes, so will the fortunes and vitality of mountain and desert aquatic ecosystems rise and mostly fall in the age of climate change and drought.