California
Rice
Research Board

Issue #31, Summer 2014

Managing Rice with Limited Water

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This year is shaping up to be one of the driest on record for California and it is highly probable that agriculture water deliveries will be restricted. The question for rice growers is "what is the least amount of water I can grow rice with without hurting yields?"

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Water – the Great Unknown

There has been a lot of talk about water this year. I want to give a perspective on the facts that are available, the history of previous droughts, and the unknown areas that seem to resist inquiry. I do not propose to answer the questions that you and I might have – I wish I could – instead, I hope to offer some perspective.

History

The rhetoric on this drought makes you think this has not happened before. This is California, it has happened before. As shown in Figure 1, this year is water short, but not at historic levels. Up until late February, we were truly in a historic drought. The three storms in late February and March dramatically changed the picture. Are we in good shape? Of course not. We still stand at about half of our average precipitation and have virtually no snow pack.

Because lake levels for the 1977 and 1990 droughts are readily available, I will use those two years for comparison. Graphs 1 and 2 show the lake levels for Shasta and Oroville for the 1977, 1990 and 2014 years. You can see that presently the 1977 drought was clearly worse than the present drought. If we had not had the rains in March, the story would have been very different. It is important to note that both reservoirs have

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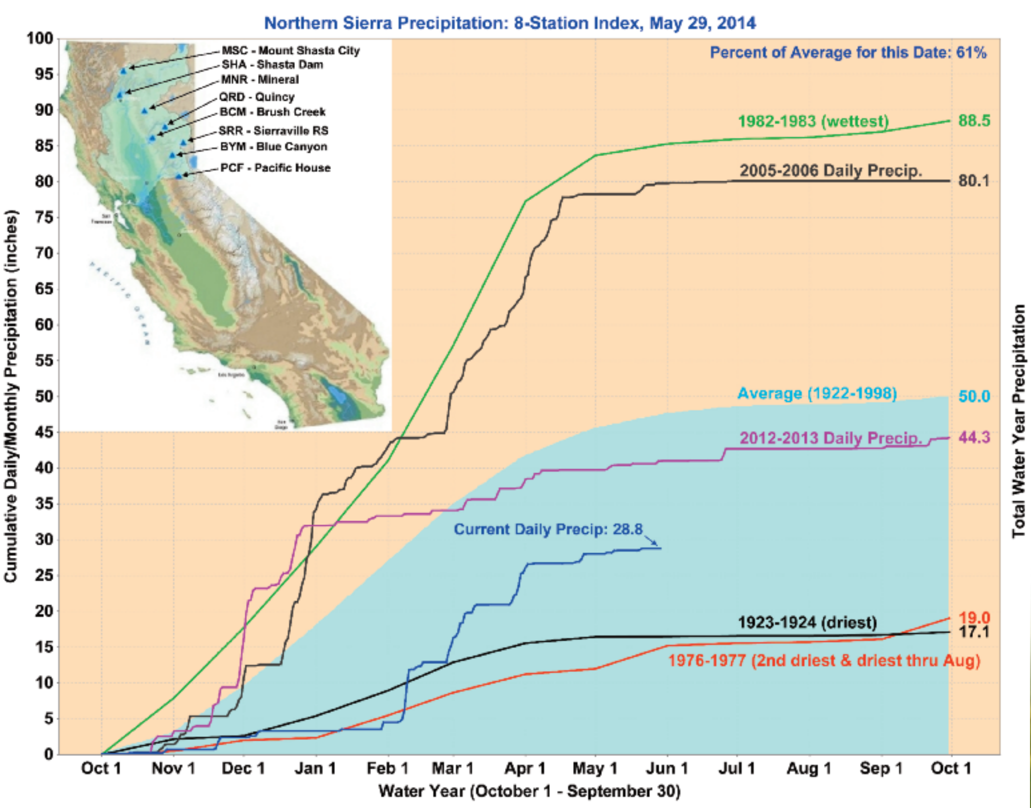
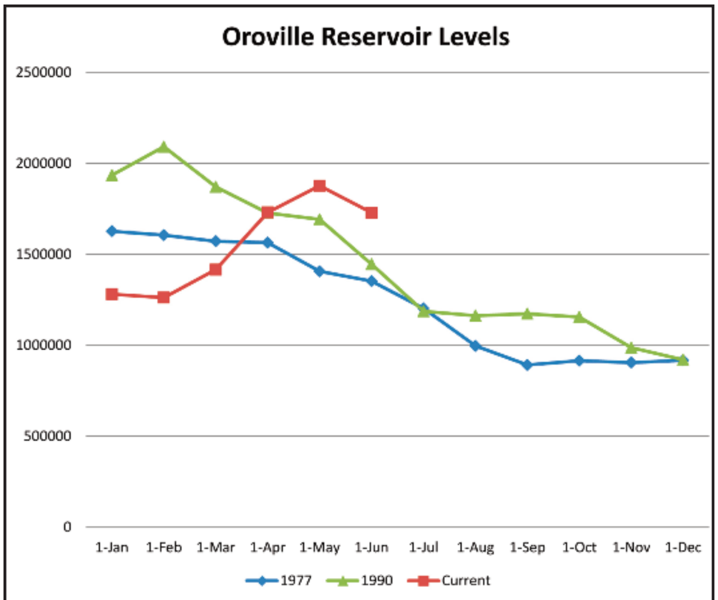


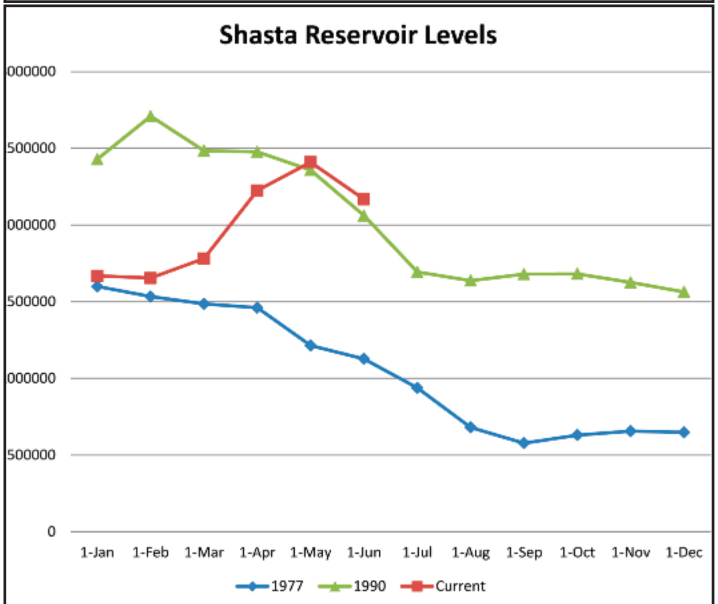
Figure 1

RES Field Day
August 27, 8:00 am

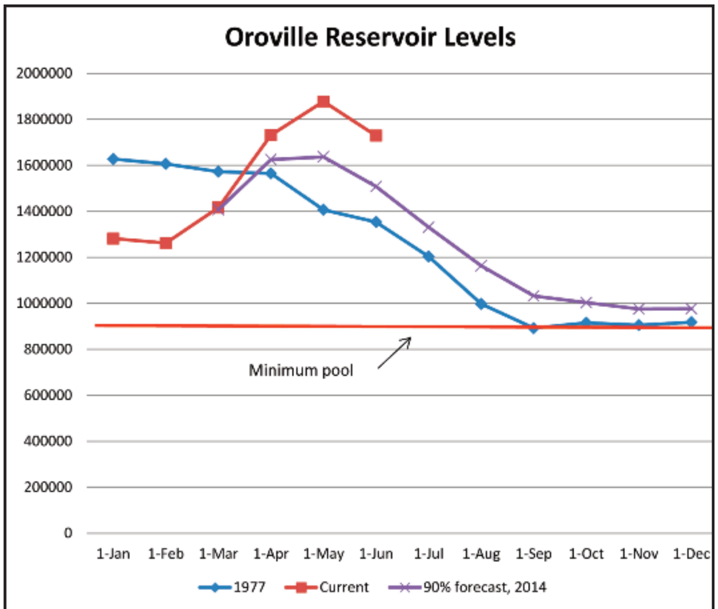
In This Issue



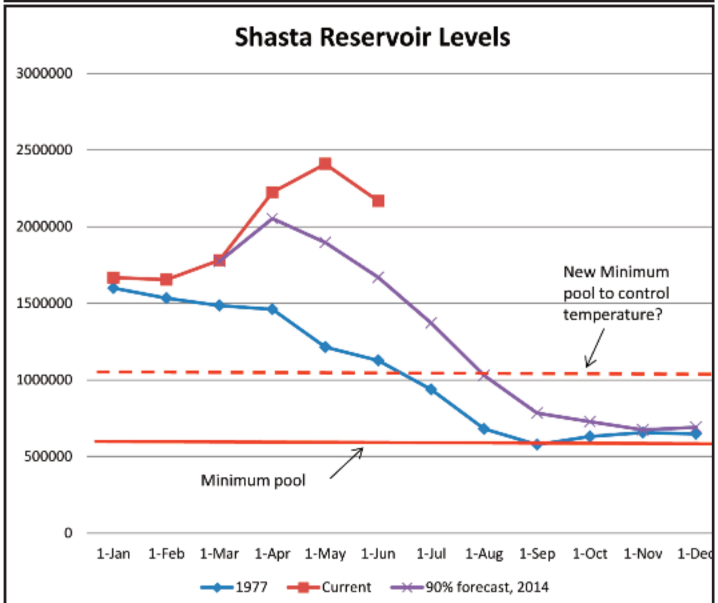
Graph 1



Graph 2



Graph 3



Graph 4

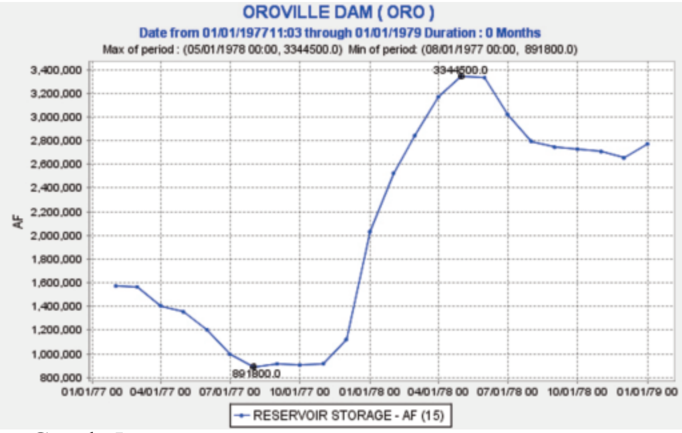
a limit on how much water can be removed. Once that point is reached, the minimum pool, no more water can come out even though there is water in the lakes. For Shasta, that limit is about 600,000 ac ft. For Oroville, the limit is about 900,000 ac ft.

Present

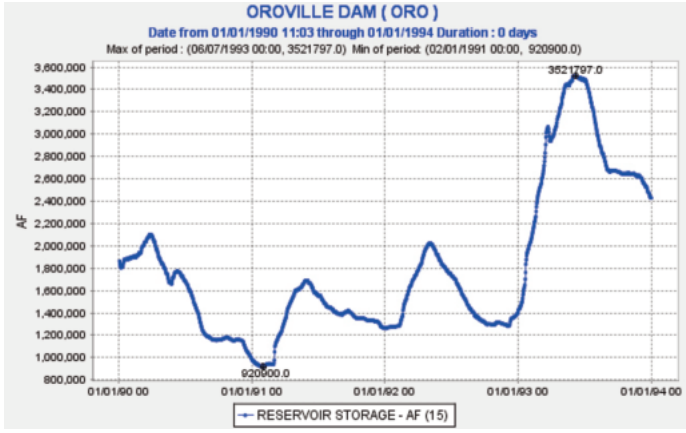
Right now, farmers in the North Valley are in reasonable shape for water. I say reasonable, because the Department of Water Resources lists Oroville in a Severe Drought and Shasta in an Extreme Drought. Projections by the State show both lakes nearly empty by the end of the season. Again, the rains in March made the projections a little better, but the outlook is still very little water left at the end of the year. Graphs 3 and 4 compare the water situation in 1977 and today. They also show the DWR projections from early April.

Northern California Water Association (NCWA) outlines how water in the Shasta system is used three times. Once water is used for the highest priority, it is passed on to be used by the next priority. The first priority is temperature control for winter-run salmon. There are specific temperature objectives for water released from Keswick down to Red Bluff and so water will be released to meet those objectives. The second priority is use by farms and habitat. There are many challenges with delivery reductions, water for fish and birds, and providing for neighbors in this priority. The third priority will be diversions for the Pacific Flyway and other bird habitat. GCID will be delivering water to the refuges at Delevan, Sacramento, and Colusa .

NCWA also outline the water handling differences in the Oroville/Feather



Graph 5



Graph 6

system. Again, water will be used three times. Priority one is a portion of the water is diverted from Termalito Afterbay by the Feather River Settlement Contractors (FRSC) for use by farms and habitat. These contractors work with DWR to schedule water for the benefit of SWP, Fish, and birds, as well as their neighbors. Second priority is water releases for temperature control for salmon rearing in the Feather River. The third priority will be providing water for the Pacific Flyway and other bird habitat. This would include water for Gray Lodge, Sutter National Wildlife Refuge and the Upper Butte Basin Wildlife area.

Unknown Items

There are two great unknowns: fish and Delta salinity. Issues with fish and water temperature are fairly familiar. Keep in mind that DWR's concern is for the fall salmon run and the water temperatures during that period. So it is reasonable to expect that some water will be kept back for use in the Fall. This is why the dotted line is shown on Shasta's graph 4. National Marine Fisheries wants a certain amount of water held for temperature control, so the actual minimum pool will be higher than the technical minimum.

The Delta salinity issue is a part of that equation. The amount of water passing a point (Emmaton) needs to be 2000-3000 cfs to keep salt water in the Delta and not upstream. I was surprised to learn that equals 118,800 – 178,500 ac ft/month passing into the Delta. Surely some of that water will be drainage from rice fields, yet with districts instituting a "no spill" policy, it seems like that would be a small percentage. Thus, the water must come from somewhere. This seems like an additional priority beyond the present triple use of the water. What is unclear is where it would fall on the priority list.

If you look at the reservoir levels in chart 3 and 4 and compare the rate that the lakes drop in 1977 and the projected drop, you see a very similar picture. Since there is only so much water, we can only use it at a certain, limited rate if we expect to arrive at September before running out. I have read lengthy reports and talked with water district managers, and the one question that I cannot get answered is what portion of the water will go for fish and keeping the Delta salinity level under control. Compared with 1977, this is the great unknown. Some portion of the water will be going for fish and the Delta, but what portion is unclear. All I can recommend is that you keep an eye on the lake levels.

The Future

The recovery from the drought year 2014 is ahead of us. Interestingly, how we come out of a drought is variable and unpredictable. In 1977-78, California came out of the drought with a bang (graph 5). In a mere five months the lakes went from empty to nearly full. After the 1990 drought we had two more lean years before a great recovery in 1993 (graph 6). How the winter of 2014-15 turns out is anyone's guess.

Managing Rice from page 1

The amount of water delivered to a rice field ranges from 4 to 7.7 acre feet (AF). Of this, evapotranspiratioin (ET, the amount of water that evaporates and transpires through the plant) is roughly 3 AF; percolation is less than 0.3 AF (due to heavy clay soils and impermeable hard pan); seepage ranges from 0 to 1 AF; and tail water drainage ranges from 1 to 4 AF. If there was no tail water drainage, then rice could be grown using 4.3 AF of water. Growing rice with less water than that will depend on the percolation and seepage characteristics of the field, variety, time of planting, and end of season drain management. Below are a few strategies to reduce the impact of the drought and lessen water use in rice fields.

• When rice plants and weeds reach the appropriate stage for foliar herbicide applications (e.g. propanil), instead of lowering the water level by draining the field, plan ahead and let the water subside so that weed coverage is appropriate.

• At panicle initiation, adjust your water depth to a maximum of 6 inches. This depth is enough to protect the developing panicles from cold temperature blanking.

• Before harvest, turn off the irrigation and allow the water to naturally subside rather than drain the field. Determining when the irrigation water can be turned off depends on how much water is in the field, climate, and soil properties (percolation and seepage). In fields with heavy clay soils, it is safe to not have standing water (soil still saturated) 24 days after 50% heading (when one-half of the panicles in a field have emerged) without risking yield loss and grain quality.

For more detailed information on how to manage water this year, a video presentation by UC Cooperative Extension Rice specialist Bruce Linquist is available on the UC Rice Blog (http://ucanr.edu/blogs/riceblog/index.cfm).

Rice for Medicine Delivery

NYTimes.com, By Yuriko Nagano, June 2, 2014

TOKYO — Yoshikazu Yuki and other researchers at the University of Tokyo are bioengineering rice in a bid to turn it into an easy and low-cost storage and delivery medium for drugs to combat common infectious and contagious illnesses.

The immediate target is to develop new treatments against cholera and rotavirus, two causes of severe and often fatal diarrhea. Cholera now kills as many as 120,000 people a year, according to the World Health Organization, while rotavirus is estimated by the organization to kill about 500,000 children a year under age 5, amounting to about 5 percent of all child deaths worldwide.

Vaccines or antibodies for both exist but require refrigerated storage, Mr. Yuki, an assistant professor of mucosal immunology, said in an interview. Bioengineering vaccines or antibodies into rice would allow them to be stockpiled easily, without the cost of cold storage, for up to three years at room temperature, he said. The rice could be ingested orally, ground into a paste and drunk, delivering the antibodies to the intestine, he said.

Mr. Yuki said his team figured out how to make a cholera vaccine using rice in 2007, and a rotavirus antibody last year.

The rotavirus treatment was developed from highly stable antibodies found in South American llamas that are uniquely resistant to heat and acid in the animal's stomach, said Lennart Hammarstrom, a professor of clinical immunology at the Karolinska Institute in Stockholm, who coauthored a paper with Mr. Yuki's team on the research program.

Both cholera vaccine and rotavirus antibody versions of the rice have been tested on laboratory mice, Mr. Yuki said. Clinical trials of the cholera vaccine are planned to start on a small group of people next year, to test for safety and possible side effects, and establish dosage ranges.

Plant-based drugs, however, are a rarity, said Fumio Takaiwa, senior researcher at the Functional Transgenic Crops Research Unit of Japan's National Institute of Agrobiological Sciences. "To clear the regulatory hurdles to bring the medication to market may be difficult," he said.

Mr. Yuki conceded it could take at least 10 years for his vaccine to reach the market.

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