

# STATUS OF THE CALIFORNIA COOPERATIVE SNOW SURVEYS PROGRAM

by Dave Hart and Frank Gehrke

## INTRODUCTION

The original idea for presenting a history of the Snow Survey Program in California was to give Western Snow Conference members an update on developments in the only non-Soil Conservation Service (SCS) coordinated state snow survey program. This is important also because of the increasing divergence between the two programs in the way that water supply forecasts are made. So necessity required this to be less a history than it is an update on the California Cooperative Snow Survey Program (CCSS). Because the state of California coordinates the snow surveys and dissemination of data used in the forecasting procedures for most other agencies in California, we have a history that at times parallels that of the other western states but that in other ways is quite unique.

As the most populous state and the state with the largest economy in the United States, California exerts tremendous pressure on all of its resources, and water is foremost among them in terms of its critical importance to our economy. In looking at the evolution of the snow survey program over time, it is apparent that the California Cooperative Snow Surveys Program (CCSS) is itself a good example of coping with extremes: extremes of climate, population and the demands these factors place on the ability of water managers to do their job effectively. The CCSS Program in California has developed into an increasingly important and credible resource for water managers who need reliable information.

What I wish to cover are developments in the California Program since Harlowe Stafford's excellent Western Snow Conference paper in 1959. That paper is the best all-around review of technical developments for the period of 1900 to 1959 for all the western states, including California. I would like to briefly recap that earlier history for those who are unfamiliar with events before the 1960's.

Most of us are familiar with the work of Dr. James Church at the University of Nevada, Reno whose pioneering work in snow hydrology is still the foundation for water supply forecasts of today. Snow surveying in California began with Dr. James Church's investigations on the relationship between the snowpack and the annual spring rise of Lake Tahoe. The first snowcourses as we now know them, were set up and measured in the Lake Tahoe Basin in 1909. By the time the CCSS Program was officially begun in 1929, there were already fifty snowcourses being measured on a regular basis. Most of these courses were located in the Lahontan area of California, on the eastside of the Sierra Nevada, and provided data for inflow into Lake Tahoe and the Mono Lake and Owens River Basins. Figure 1 shows when snow courses were added chronologically.

The CCSS Program has its beginning in 1929 when it was funded by the State Legislature for \$30,000 for its first years of operation. Those early years were mainly taken up with setting up a network of snowcourses, many of which are still being measured. The impetus for the creation of the program came from various agencies that were in the business of using the water directly or generating power. The early forecasts were made by a committee as part of the Nevada Cooperative Snow Surveys in conjunction with the University of Nevada, Reno.

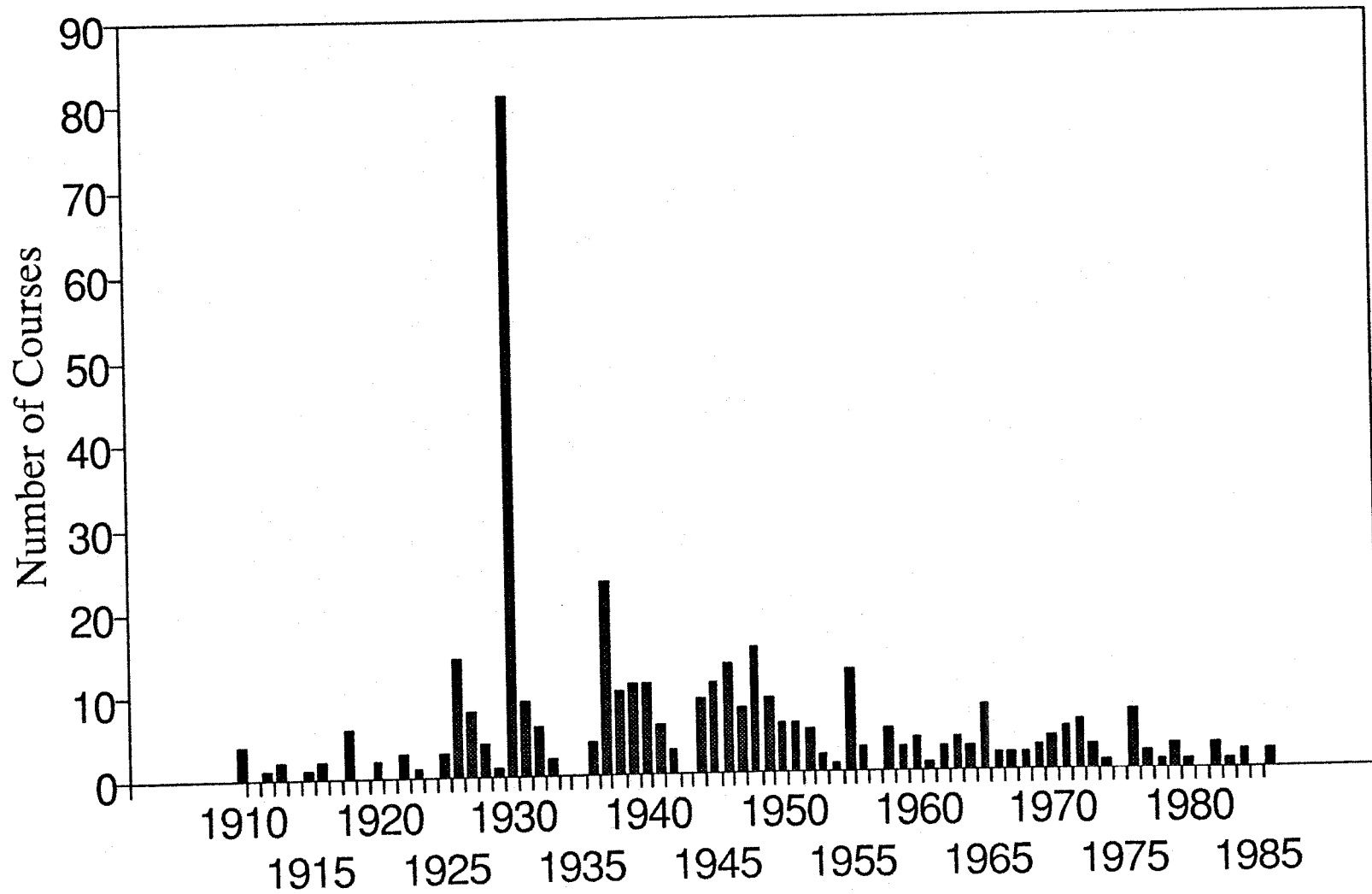
1929 was not the best year to begin any kind of new spending program and the original allocation of \$30,000 lasted through the 1933 water year for a total of four seasons. Although no money was allocated, because of the severe economic situation, the many cooperating agencies that had been making snow surveys continued to do so on their own. The data was forwarded to the State Department of Public Works which in turn made it available to the Nevada Surveys for their forecasts of eastside streams. It was a staff decision in the Department of Public Works not to let the Program die for a lack of money. They can be credited with maintaining records that allowed the Program to rebound vigorously when allocations were resumed.

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Dave Hart is Field Activities Coordinator for the California Cooperative Snow Surveys Program, Department of Water Resources. Frank Gehrke is a forecast hydrologist for the program.

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Figure 1  
Number of Courses Established by Year



In 1935, the State Legislature reallocated funding for the Snow Surveys Program in time for the 1936 water year. At the same time, the U. S. Department of Agriculture took over the coordination of snow surveys in the other western states, including Nevada. Both programs have operated uninterrupted and cooperatively up through the present time.

Organizationally, the CCSS began in the California Department of Public Works, and was transferred to the newly created Department of Water Resources in 1955. Since then, the program has been in various divisions within the Department of Water Resources (DWR), including Operations and Maintenance, Planning and currently, Flood Management.

Between 1936 and 1959, as detailed in Harlow Stafford's paper there were many improvements in forecasting methods, most of which are still used. The use of manually collected snow survey data remained unchanged in nearly every way, with the exception of access to sites, until the mid-1960's with the introduction of the early snow pillow pioneered at Mt. Hood in Oregon by the SCS.

### **BACKGROUND ON SNOW SURVEYS GOES SYSTEM**

In 1965, the CCSS installed and began testing various snow pillow configurations and carried out other snowrelated research. The SCS, Corps of Engineers and Sacramento Municipal Utilities District (SMUD), among others, were already using snow pillows and were exploring others means of measuring snow remotely. The CCSS felt it was necessary to move in a similar direction and, as a result, spent several years testing and developing different snow pillow configurations. The heli-arc'd, stainless steel tank, manifolded together to provide 80 square feet of surface area is now being used world-wide.

In 1978, the California Department of Forestry (CDF) fire dispatch center personnel and CCSS staff in DWR initiated a joint effort to operate a GOES network. CDF would use the GOES network to collect fire weather information and DWR would collect snow, temperature and precipitation data. The ground receive station and 6 data collection platforms (DCP) were purchased by CCSS in September of 1978 for installation in the fall of 1979.

A capital outlay program was the source of funds for the first 24 DCPs installed, with cooperating agencies picking up the costs of field installation and hardware items. Capital outlay money was no longer available in F.Y. 1986 and since then, all costs have been reimbursable. The CCSS program has continued to provide personnel time, administrative support, research and development and other material resources in support of snow sensor improvements.

In 1965 it was hoped that forecasting with sensor data would ultimately replace snow course measurements and the need to send personnel into the mountains to manually collect data. This goal is now regarded by CCSS staff and many others in California as overly optimistic. The sensors have proved their value for updating first of month forecasts but, at present, do not provide data that is strictly interchangeable with snow course data.

### **CALIFORNIA COOPERATIVE SNOW SURVEYS PROGRAM ORGANIZATION**

Since the early days of the CCSS Program, there has been no budget allocation for field data collection. All costs for field data collection are paid through voluntary contributions or are borne directly by cooperating agencies. Many of the cooperating agencies that initially participated in the program from its inception in the late 1920s are still active today. There are forty cooperating agencies who make voluntary cash contributions for snow data collection, contribute in-kind services or both. These organizations, shown in Table 1, include twenty-three public agencies, six private organizations and corporations, three municipalities, two state agencies and six Federal agencies. Fifteen of these organizations contribute cash which is matched in varying degrees by the U. S. Forest Service and National Park Service. Cash contributors include both private and public organizations.

The CCSS Program staff of seven is responsible for coordinating all data collection, forecasting activities and administrative tasks connected with cooperating agencies. In 1986, five CCSS Program positions were moved into two other functional units. The California Data Exchange Center (CDEC) took three data collection and field maintenance positions and the water supply forecasters became part of the newly expanded Forecasting Unit. The Forecasting Unit now includes both water supply and flood forecasting functions. CDEC was created with the

**Table 1**

**COOPERATING AGENCIES**

**Public Agencies**

Buena Vista Water Storage District  
Central California Irrigation District  
East Bay Municipal Utility District  
Friant Water Users Association  
Kaweah Delta Water Conservation  
District  
Kern Delta Water District  
Kings River Conservation District  
Lower Tule River Irrigation District  
Merced Irrigation District  
Modesto Irrigation District  
Nevada Irrigation District  
North Kern Water Storage District  
Northern California Power Agency  
Oakdale Irrigation District  
Omochumne-Hartnell Water District  
Oroville-Wyandotte Irrigation District  
Placer County Water Agency  
Sacramento Municipal Utility District  
South San Joaquin Irrigation District  
Tri-Dam Project  
Tulare Lake Basin Water  
Storage District  
Turlock Irrigation District  
Yuba County Water Agency

**Private Organizations**

J.G. Boswell Company  
Kaweah River Association  
Kings River Water Association  
St. Johns River Association  
Tule River Association

U.S. Tungsten Corporation

**Public Utilities**

Pacific Gas and Electric Company  
Southern California Edison Company

**Municipalities**

City of Bakersfield Water Department  
City of Los Angeles  
Department of Water and Power  
City and County of San Francisco  
Hetch Hetchy Water and Power

**State Agencies**

California Department of Forestry  
& Fire Protection  
California Department of Water Resources

**Federal Agencies**

U.S. Department of Agriculture  
Forest Service(14 National Forests)  
Pacific Southwest Forest and Range  
Experiment Station  
Soil Conservation Service  
U.S. Department of Commerce  
National Weather Service  
U.S. Department of Interior  
Bureau of Reclamation  
Geological Survey, Water Resources  
Division  
National Park Service(3 National Parks)  
U.S. Department of Army  
Corps of Engineers

**Other Cooperative Programs**

Nevada Cooperative Snow Surveys  
Oregon Cooperative Snow Surveys

goal of making the vast amount of data that is collected by the Division of Flood Management for flood forecasting and flood warnings more widely available to other agencies and the public. CDEC provides a vehicle for disseminating the CCSS Program forecast and other data as well.

The data collection effort includes snow course data from 310 sites, and daily telemetered snow sensor information from 116 locations. In California, the daily sensor data is not from a homogeneous source, rather it comes from a variety of sources. Forty-seven (47) of these stations are on the Department's GOES satellite system. Thirty are SCS Meteor-Burst stations. The other thirty-eight (38), which are owned and operated by cooperating agencies, use line of site VHF or microwave telemetry. The data from these various agencies is made available to the CDEC database by direct computer hookup, or is manually entered after being received by telephone or fax systems.

Program staff also collect daily precipitation data from 63 stations, monthly precipitation from approximately 300 stations, daily streamflow data from 15 major streams. The cost of collecting all of this hydrologic data is well over \$2.0 million annually. The investment in telemetered snow sensors alone is over \$1.0 million, most of it having been made in the last ten years. All of this has been done by the cooperating agencies acting on their own or through the Snow Survey Program.

In 1990, the most recent improvement in timely reporting of snow information consists of having the snow surveyors enter their course data directly into a microcomputer through a telephone modem link. This eliminates time on the telephone, transferring data from person to person, and many other delays or errors that creep into data when it's handled by many different people. Data received in the CCSS office is then downloaded to the CDEC computer for dissemination and further analysis.

### **WATER SUPPLY FORECASTING IN CALIFORNIA**

Collecting snow, precipitation and streamflow data is only the first step as we all know. The product of all this effort is CCSS Program forecast. Many other agencies and consultants make their own independent forecasts during the winter. Over the years, the level of interest in the forecast has increased in proportion to growth in population and agricultural development. As more facilities for moving water from the northern half of the state to the southern half came on line, more attention began to be focused on water quality problems in the Sacramento-San Joaquin Delta and San Francisco Bay. In 1978, the State Water Resources Control Board Decision 1485 tied water quality standards to the forecasted flow and the coincidence of the extreme 1976-77 drought changed the way the State Water Project operates under extended or extreme drought conditions and raised interest in the forecast to a new level.

The CCSS forecast is of interest not only to the major state and Federal water project operators, but to many local irrigation, water conservation districts, municipalities and other water managers who simply need to know how far apart their best guess is from ours. Many of these program cooperators also make their own, independent forecasts. In some cases, there are three or four forecasts being issued for a single river basin. CCSS Program forecasts are scrutinized and critiqued during and after the season. All of the runoff forecasts generated for western slope streams have at least one alternate forecast made by another agency. Weekly updates for the major streams were begun in 1969. Frequent contact with the Program cooperators contributes to a team spirit among the cooperating agencies in generating the best possible forecast with the available data and knowledge.

Small improvements in forecasting precision can have significant economic impacts as can significant errors. For example, the decision to activate groundwater pumps for supplemental water in the San Joaquin Valley can cost millions of dollars. The decision to make the investment is based on the forecast in February. You can be sure that close attention is paid to the water supply forecasts under such circumstances and that the CCSS forecasters are reminded of their errors when they miss.

Even though manual snow course data is expected to remain the baseline source of snowpack information for the foreseeable future, the effort to use the snow sensor data and improve our overall record is of highest importance to the Program and its cooperating agencies. The incorporation of daily snow sensor data into the weekly updated forecasts is a valuable supplemental tool for providing information to anyone who needs to make a decision on projected water supply conditions and needs to make their decision on the latest possible information.

## CONCLUSION

The CCSS Program is finishing its sixtieth year of operation. It has been successful in coordinating the efforts of many different agencies to meet the collective need for water supply information. New methods for forecasting and measuring snow are emerging and will be incorporated to the extent that they prove themselves over time. The CCSS Program has adopted new methods as they become available and are proven effective. We fully expect to continue to be part of the process in finding solutions to many of the problems in snow measurement and water supply forecasting.

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