State of California
The Resources Agency

SPECIAL REPORT ON DRY YEAR IMPACTS IN CALIFORNIA

FEBRUARY 1, 1976

DEPARTMENT OF
WATER RESOURCES

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FOREWORD

This special report by the Department of Water Resources is presented in response to widespread concern over the lack of rain and snow in most of the State during the current water year.

Most of the irrigated farms and the towns and cities should not face any major problems. The physical systems and facilities that have been constructed over the years by private individuals and by local, state and federal agencies will function as they were intended: to furnish the needed water supplies.

The report shows that most municipal and agricultural water supply systems are designed to carry over water from one year to the next, in recognition that the "normal" and "average" conditions we've come to expect in recent years are in fact composites of both wet and dry years.

However, we can only control and manage nature to a limited extent. Those who rely on rainfall directly for irrigation - dry farmed grain and vast acreages of pasture, for example - are being damaged by current drought conditions. Winter recreation has been severely limited by lack of snow.

This fact emphasizes the need for all Californians - city dweller and farmer alike - to save water and practice water conservation on a regular basis, not just in years such as the present.

We wish to thank the State Departments of Conservation, Fish and Game, Food and Agriculture, Navigation and Ocean Development, and Parks and Recreation, and the Office of Emergency Services for their cooperation in preparation of this report.

Ronald B. Robie

Director
February 1, 1976

SPECIAL REPORT
ON
IMPACT OF A DRY YEAR

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THE DRY YEAR, 1975-76

The State of California usually has any kind of water year except a normal year. This variability is illustrated in Figure 1, "Seasonal Precipitation at Sacramento." Precipitation so far this year has been far enough below normal to rank as one of the record dry periods.

Of the ten years in this century that rank as the driest through the month of January, seven have gone on to be notably dry years and three have had sufficent precipitation after February 1 that very few recall that the year started out to be dry. Those who do remember include those who suffered from dried up rangeland and small grain crops or from lack of snow for winter recreation.

Some of the impacts of the lack of precipitation have already occurred and are discussed in this report. Future impacts will depend on the amount of precipitation during February, March, and April. This report assumes two possible precipitation conditions for the remaining months of the water year and discusses possible future impacts for each. One would have lower quartile precipitation for the reminder of the year, that is, the precipitation will not exceed that for the lowest one-quarter of the years of record. The other condition would have normal precipitation for the remainder of the year. The report also contains a discussion of the impacts if lower quartile precipitation occurs during the remainder of this year and next year also has only lower quartile precipitation.

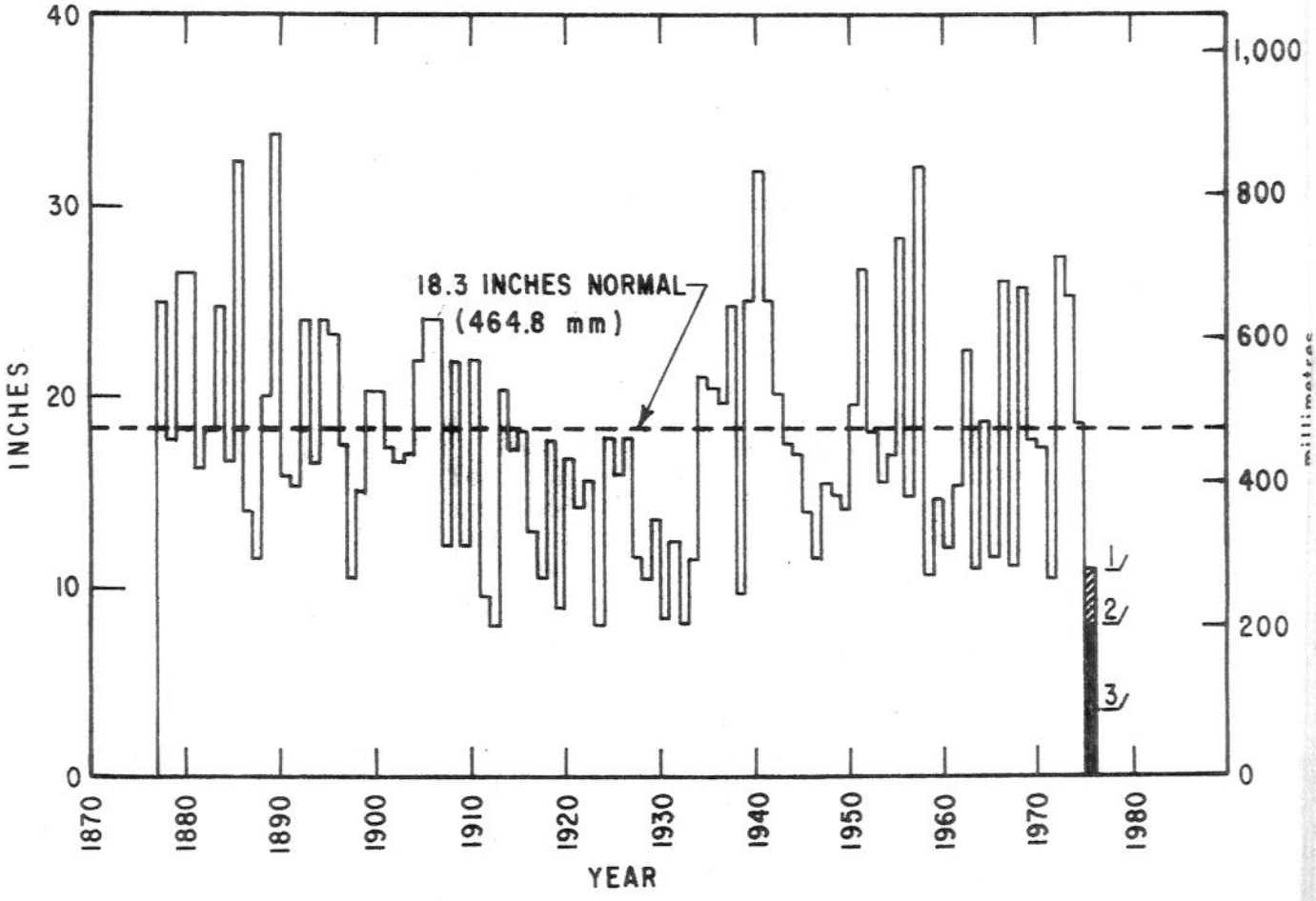
The report shows the impact that has already occurred on agriculture, winter recreation, and fire suppression due to the dry period throughout the first of February. It also projects the effects under the assumed conditions on agriculture, municipal and industrial water supplies, recreation, fish and wildlife, forestry, and energy for the remainder of this year and for next year if that should also prove to be dry.

The Statewide Picture Today

The Water Year 1975-76 from its beginning October 1, 1975, to the present, February 1, 1976, has been one of the driest years of record. Both precipitation and snowpack are far below normal in all parts of the State. This has resulted in flow in most of the smaller streams at decreasing rates since November 1, a period when the flow would ordinarily increase. The only bright part of the water picture is that there are a number of large reservoirs which were filled during the abundant runoff in the spring of 1975. These reservoirs still have about normal quantities of water in storage for this time of year.

FIGURE 1

SEASONAL PRECIPITATION AT SACRAMENTO



1/ 1975-76: TOTAL OF OBSERVED PRECIPITATION THROUGH JANUARY AND ASSUMING NORMAL PRECIPITATION FEBRUARY THROUGH JUNE, 11 INCHES (279mm).

2/ 1975-76: TOTAL OF OBSERVED PRECIPITATION THROUGH JANUARY AND ASSUMING LOWER QUARTILE PRECIPITATION FEBRUARY THROUGH JUNE, 8 INCHES (203 mm).

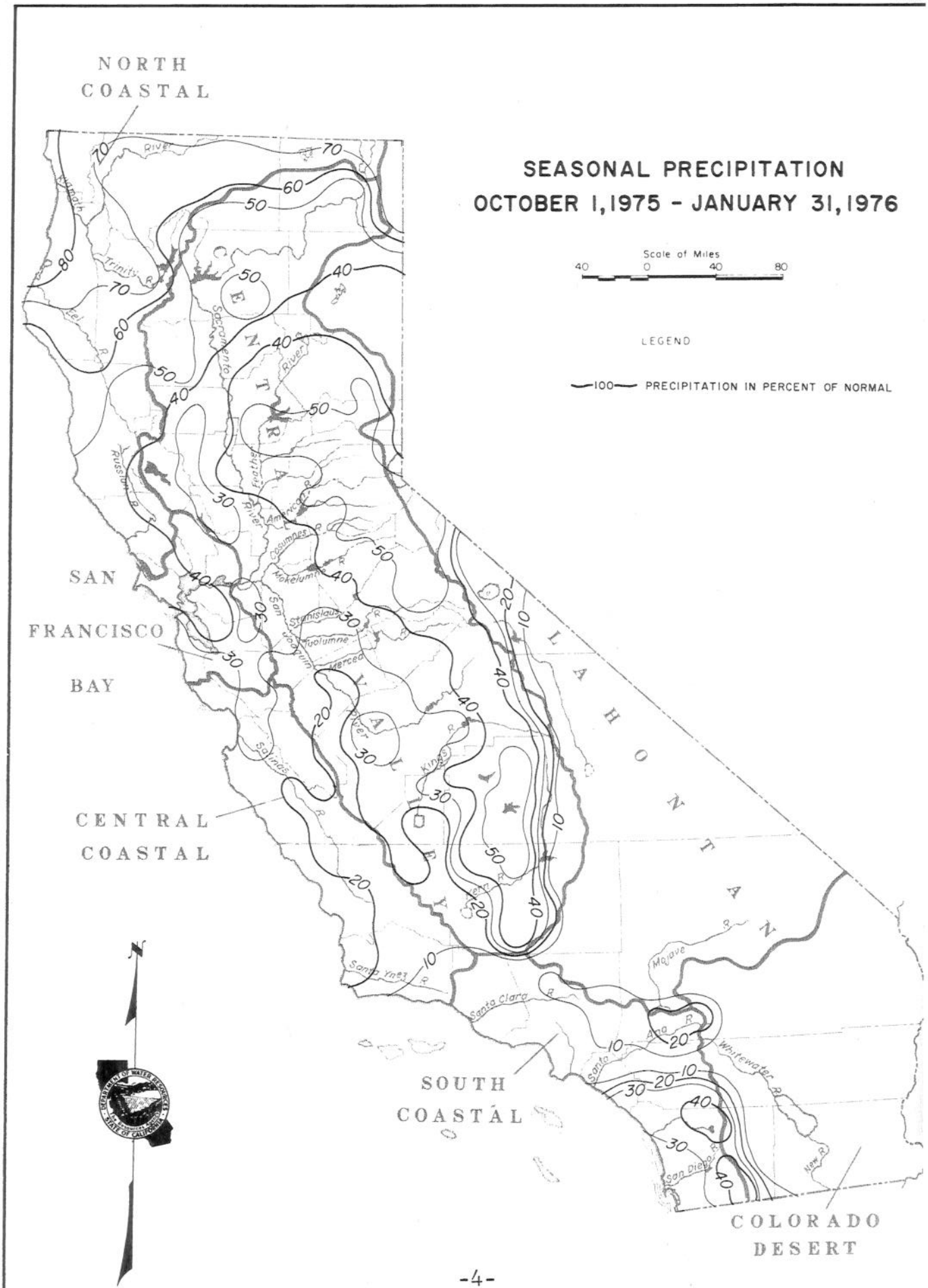
3/ 1975-76: TOTAL OF OBSERVED PRECIPITATION JULY 1, 1975 THROUGH JANUARY 31, 1976 3.57 INCHES (91 mm).

Precipitation - The only month this year that had good precipitation was October and unfortunately October, even at best, does not produce very much water. November, December, and January have all been dry over most of the State. One exception through December was the Smith River in the northwest corner of the State. In addition, some of the small coastal drainages to the south had about normal precipitation until the first of January. An area around Lake Tahoe had sufficient precipitation early in the year to be near normal at the first of January but was well below normal in snowpack since most of the precipitation fell as rain. Even those fortunate areas fell below normal during January. Precipitation ranges from about a high of 80% of normal in the extreme northwest to as low as 10% in Southern California as shown on Figure 2, "Seasonal Precipitation, October 1, 1975 - January 31, 1976." Precipitation at Central Valley Stations ranges from about 30% of normal in the Southern San Joaquin Valley to about 45% in the Northern Sacramento Valley. Precipitation in the Sierra Nevada is about 50% of normal at most locations.

Reservoirs - The large reservoirs in the Sacramento Valley have about 95% of the amount of water in storage that is normal for this time of year and those in the San Joaquin Valley about 105% of normal. This is about equal to the 10 year average. Table 1 shows the amount of water in storage in the reservoirs and a comparison with other dry years.

Snow Accumulation - The least favorable situation is the scarce snowpack. The State depends on the melting snowpack for water in many of the larger streams in the April through July period. Snow accumulation is only about 25% of normal for this date in the basins draining into the Sacramento Valley and about 13% of normal in the San Joaquin basins. The snowpack for February 1, 1976 is shown in Table 2. Snow Surveyors, even at some of the very high altitude snow courses, found themselves carrying their skis and walking on dry ground during the late January Snow Survey.

Soil Moisture - Storage of moisture in soil is less well known than other forms of water storage but is of great importance to dry farm agriculture and native vegetation. Grain planted on land fallowed last spring in areas of higher rainfall, such as Northern California, might attain normal yields if rain occurs soon. Grain planted on land that was not fallow last summer and therefore dependent only on the precipitation that has fallen will not be worth harvesting in many areas. Deep rooted native plants also have access to some moisture carried over from last spring. Shallow rooted range grasses, however, depleted the moisture within reach of their roots from last spring and have only the water from this winter's precipitation, which has been inadequate to maintain normal growth.



CALIFORNIA COOPERATIVE SNOW SURVEYS

TABLE I

STORAGE IN MAJOR RESERVOIRS AT END OF JANUARY 1976 AND COMPARISON WITH DRY YEARS 1947 & 1963

AREA AND DRAINAGE BASIN	RESERVOIR	OPERATOR	CAPACITY (1) * ACRE-FEET	STORAGE AT END OF JANUARY (ACRE-FEET)				
				10-YEAR AVERAGE 1966-1975	1947	1963	1976	PERCENT OF AVERAGE
NORTH COASTAL AREA								
KLAMATH RIVER	UPPER KLAMATH(2)	US BUREAU RECLAMATION	584,000	330,800	238,900	293,300	331,700	100
KLAMATH RIVER	CLEAR LAKE(2)	US BUREAU RECLAMATION	526,800	272,600	216,000	125,500	300,000	110
TRINITY RIVER	CLAIR ENGLE	US BUREAU RECLAMATION	2,448,000	2,018,900	(8)	2,179,900	1,864,800	92
RUSSIAN RIVER	LAKE MENDOCINO	US CORPS OF ENGINEERS	122,500	68,800	(8)	83,100	72,500	105
SAN FRANCISCO BAY AREA								
CALAVERAS CREEK	CALAVERAS(3)	CITY-CO SAN FRANCISCO	100,000	65,200	44,500	59,000	52,700	81
CENTRAL COASTAL AREA								
SAN ANTONIO RIVER	SAN ANTONIO	MONTEREY CO FCWCD	350,000	201,200(6)	(8)	(8)	291,600	145
NACIMIENTO RIVER	NACIMIENTO	MONTEREY CO FCWCD	350,000	184,900	(8)	149,000	196,500	106
SANTA YNEZ RIVER	CACHUMA	US BUREAU RECLAMATION	204,900	181,200	(8)	183,800	171,700	95
SOUTH COASTAL AREA								
COYOTE CREEK	CASITAS	CASITAS MUNICIPAL WD	254,000	174,200	(8)	47,400	214,600	123
PIRU CREEK	LAKE PIRU	UNITED WATER CON DIST	101,200	39,900	(8)	24,200	16,200	41
PIRU CREEK	PYRAMID(3)	CALIF DEPT WATER RES	171,200	165,400(5)	(8)	(8)	165,400	100
CASTAIC CREEK	CASTAIC(3)	CALIF DEPT WATER RES	323,700	253,600(5)	(8)	(8)	253,600	100
---	PERRIS(3)	CALIF DEPT WATER RES	131,500	92,900(5)	(8)	(8)	92,900	100
TRIB CAJALCO CREEK	LAKE MATHEWS(4)	METROPOLITAN WATER DIST	182,000	152,500	(3)	141,900	83,600	55
SAN JACINTO RIVER	LAKE ELSINORE	CALIF DEPT PARKS AND REC	125,000	(9)	42,900	0	8,600	--
SAN LUIS REY RIVER	HENSHAW	VISTA IRRIGATION DIST	203,600	11,900	115,900	5,900	3,200	27
SAN DIEGO RIVER	EL CAPITAN(3)	CITY OF SAN DIEGO	116,500	23,800	33,200	7,600	8,900	37
CENTRAL VALLEY AREA								
SACRAMENTO RIVER	SHASTA	US BUREAU RECLAMATION	4,552,000	3,402,000	2,102,000	3,191,600	2,990,800	88
CLEAR CREEK	WHISKEYTOWN	US BUREAU RECLAMATION	241,100	210,700	(8)	(8)	203,400	97
N FK FEATHER RIVER	LAKE ALMANOR	PAC GAS AND ELEC CO	1,308,000	735,500	465,100	320,200	667,600	91
BUCKS CREEK	BUCKS LAKE	PAC GAS AND ELEC CO	103,000	57,600	72,700	80,200	35,000	61
FEATHER RIVER	OROVILLE	CALIF DEPT WATER RES	3,537,600	2,350,500(6)	(8)	(8)	2,656,500	113
NORTH YUBA RIVER	NEW BULLARDS BAR	YUBA CO WATER AGENCY	961,300	521,600(6)	(8)	(8)	273,200	52
SOUTH YUBA RIVER	SPAULDING SYSTEM	PAC GAS AND ELEC CO	137,400	45,000	47,600	69,300	21,300	47
BEAR RIVER	CAMP FAR WEST	SO SUTTER WATER DIST	103,000	104,600	(8)	(8)	104,600	100
M FK AMERICAN RIVER	FRENCH MEADOWS	PLACER CO WATER AGENCY	133,700	69,900	(8)	(8)	78,400	112
RUBICON RIVER	HELL HOLE	PLACER CO WATER AGENCY	208,400	104,400(6)	(8)	(8)	149,500	143
SILVER CREEK	UNION VALLEY	SACRAMENTO MUN UD	271,000	142,300	(8)	55,000	115,800	81
AMERICAN RIVER	FOLSOM	US BUREAU RECLAMATION	1,010,300	593,500	(8)	612,100	533,800	90
STONY CREEK	BLACK BUTTE	US CORPS OF ENGINEERS	160,000	57,700	(8)	(8)	24,800	43
CACHE CREEK	CLEAR LAKE	YOLO COUNTY FCWCD	420,000	269,800	32,500	215,000	72,000	27
PUTAH CREEK	LAKE BERRYESSA	US BUREAU RECLAMATION	1,600,000	1,552,300	(8)	1,348,500	1,535,400	99
N FK MOKELUMNE RIVER	SALT SPRINGS	PAC GAS AND ELEC CO	139,400	30,900	5,100	27,000	5,100	17
MOKELUMNE RIVER	PARDEE	EAST BAY MUN UD	210,000	189,900	149,300	199,100	187,500	99
MOKELUMNE RIVER	CAMANCHE	EAST BAY MUN UD	431,500	261,900	(8)	(8)	301,700	115
CALAVERAS RIVER	NEW HOGAN	US CORPS OF ENGINEERS	325,000	169,200	(8)	(8)	141,300	84
STANISLAUS RIVER	MELONES	PAC GAS AND ELEC CO	112,600	51,400	25,000	32,300	21,100	41
CHERRY CREEK	CHERRY LAKE	CITY-CO SAN FRANCISCO	268,800	100,500	(8)	80,200	113,200	113
TUOLUMNE RIVER	HETCH HETCHY	CITY-CO SAN FRANCISCO	360,400	146,500	90,200	116,900	132,200	90
TUOLUMNE RIVER	DON PEDRO	TURLOCK-MODESTO ID	2,030,000	755,800(6)	(8)	(8)	1,398,700	185
MERCED RIVER	LAKE MCCLURE	MERCED IRRIG DISTRICT	1,026,000	535,100(6)	(8)	(8)	613,800	115
SAN JOAQUIN RIVER	MAMMOTH POOL	SO CALIFORNIA EDISON CO	122,700	40,100	(8)	49,400	20,600	51
MONO CREEK	THOMAS A EDISON	SO CALIFORNIA EDISON CO	125,000	49,600	(8)	59,500	42,000	85
STEVENSON CREEK	SHAVER LAKE	SO CALIFORNIA EDISON CO	135,300	38,400	13,800	54,800	46,300	121
SAN JOAQUIN RIVER	MILLERTON LAKE	US BUREAU RECLAMATION	520,600	389,600	314,200	270,700	354,900	91
SAN LUIS CREEK	SAN LUIS(3)	US BUREAU REC-CALIF DWR	2,038,800	1,872,900(6)	(8)	(8)	1,790,400	96
HELMS CREEK	COURTRIGHT	PAC GAS AND ELEC CO	123,300	40,900	(8)	56,300	49,400	121
N FK KINGS RIVER	WISHON	PAC GAS AND ELEC CO	128,000	31,400	(8)	17,200	46,000	146
KINGS RIVER	PINE FLAT	US CORPS OF ENGINEERS	1,001,500	610,100	(8)	346,300	473,900	78
KAWEAH RIVER	TERMINUS	US CORPS OF ENGINEERS	150,000	23,900	(8)	21,700	12,600	53
KERN RIVER	ISABELLA	US CORPS OF ENGINEERS	570,000	191,200	(8)	97,600	171,600	90
LAHONTAN AREA								
LITTLE TRUCKEE RIVER	STAMPEDE(2)	US BUREAU RECLAMATION	226,500	126,100(6)	(8)	(8)	147,500	117
TRUCKEE RIVER	LAKE TAHOE(2,7)	US BUREAU RECLAMATION	744,600	556,600	483,600	175,000	499,000	90
OWENS RIVER	LAKE CROWLEY	LOS ANGELES DEPT WP	183,500	140,700	140,300	113,400	140,300	100
COLORADO DESERT AREA								
COLORADO RIVER	LAKE POWELL(2,7)	US BUREAU RECLAMATION	25,002,000	11,321,900	(8)	(8)	20,045,000	177
COLORADO RIVER	LAKE MEAD(2,7)	US BUREAU RECLAMATION	26,102,000	17,206,800	17,207,000	22,676,000	20,267,000	118
COLORADO RIVER	LAKE MOHAVE(2,7)	US BUREAU RECLAMATION	1,810,000	1,652,000	(8)	1,682,000	1,609,400	97
COLORADO RIVER	LAKE HAVASU(2,7)	US BUREAU RECLAMATION	619,000	540,400	626,100	538,200	537,800	100

(1) Total capacity to nearest hundred acre-feet.
(2) Interstate reservoir used jointly by California and adjacent states.
(3) Includes foreign water.
(4) Stores only imported Colorado River water.
(5) New reservoir -- average considered equal to current storage.
(6) Less than 10-year average.
(7) Data based on active or usable capacity tables.
(8) Reservoir not in existence.
(9) Data not available.

* 1,000 ACRE-FEET = 1.2355 CUBIC HECTOMETRES.

TABLE 2
SNOWPACK FEBRUARY 1, 1976

In Percent of April Average

North Coast Area	
Shasta River	31%
Scott River	31%
Trinity River	29%
Sacramento Valley Area	
Sacramento River	27%
McCloud River	15%
Pit River	27%
Feather River	17%
Yuba River	15%
American River	14%
Mokelumne River	9%
Cosumnes River	1%
San Joaquin Valley Area	
Stanislaus River	17%
Tuolumne River	13%
Merced River	8%
San Joaquin River	11%
Kings River	7%
Kaweah River	10%
Tule River	9%
Kern River	1%
Lahonton Area	
Surprise Valley	39%
Truckee River	13%
Lake Tahoe Basin	21%
Carson River	20%
Walker River	12%
Mono Lake Basin	10%
Owens River	5%

Drainage from the soil to streams and use by plants this fall has reduced soil moisture to such an extent that several inches of precipitation will be required in most areas of the State before appreciable streamflow would occur.

Historical Perspective

Both the economy of the State and water storage and distribution facilities have changed so much in the last 25 years that many of the effects experienced in earlier dry years can no longer be expected, but some useful comparisons are possible. At this time in 1975, a dry year, although not nearly as severe as the present season, seemed likely. However, heavy precipitation beginning early in February and continuing well into May turned a comparatively dry year into a good water year.

Serious or potentially serious dry years have occurred frequently in California, notably 1918-19, 1919-20, and 1923-24 in the more distant past and in recent history 1946-47, 1947-48, and 1962-63. The dry period 1928-34 had a great impact on the State with 6 dry years in a row, even though any one of the years alone would not have caused serious problems. This series of dry years motivated action on the part of water users and managers to improve the reliability of their water supplies so that such problems would not occur again.

The driest year of record in most parts of California was 1923-24. It was one of the few years that was drier on February 1 for most parts of the State than is the case this year. However, from Bakersfield south, 1975-76 has been even drier. Figure 3 presents comparisons of precipitation at selected stations in California with some dry years in the past.

Dry farm crops and rangeland suffered severely in 1923-24, and much irrigated agriculture also experienced substantial water deficiencies. The drought led to formation of the Rivers Problems Committee in the San Joaquin Valley, and the appointment of a water supervisor to closely watch for wasteful practices and to stop waste. Ground water was the main source of supply at that time since the reservoirs in the Sierras which we know today were not in existence.

At that time many districts depended on streams with little or no regulatory storage except nature's snowpack reservoir. Streamflow was very low and many streams and springs that ordinarily flow year round became dry. Figure 4 presents snow accumulation by area for this year compared with some historic dry years. Table 1 also compares reservoir storage for 1975-76 and for 2 prior dry years.

FIGURE 3A

MONTHLY PRECIPITATION PATTERN FOR SELECTED DRY YEARS

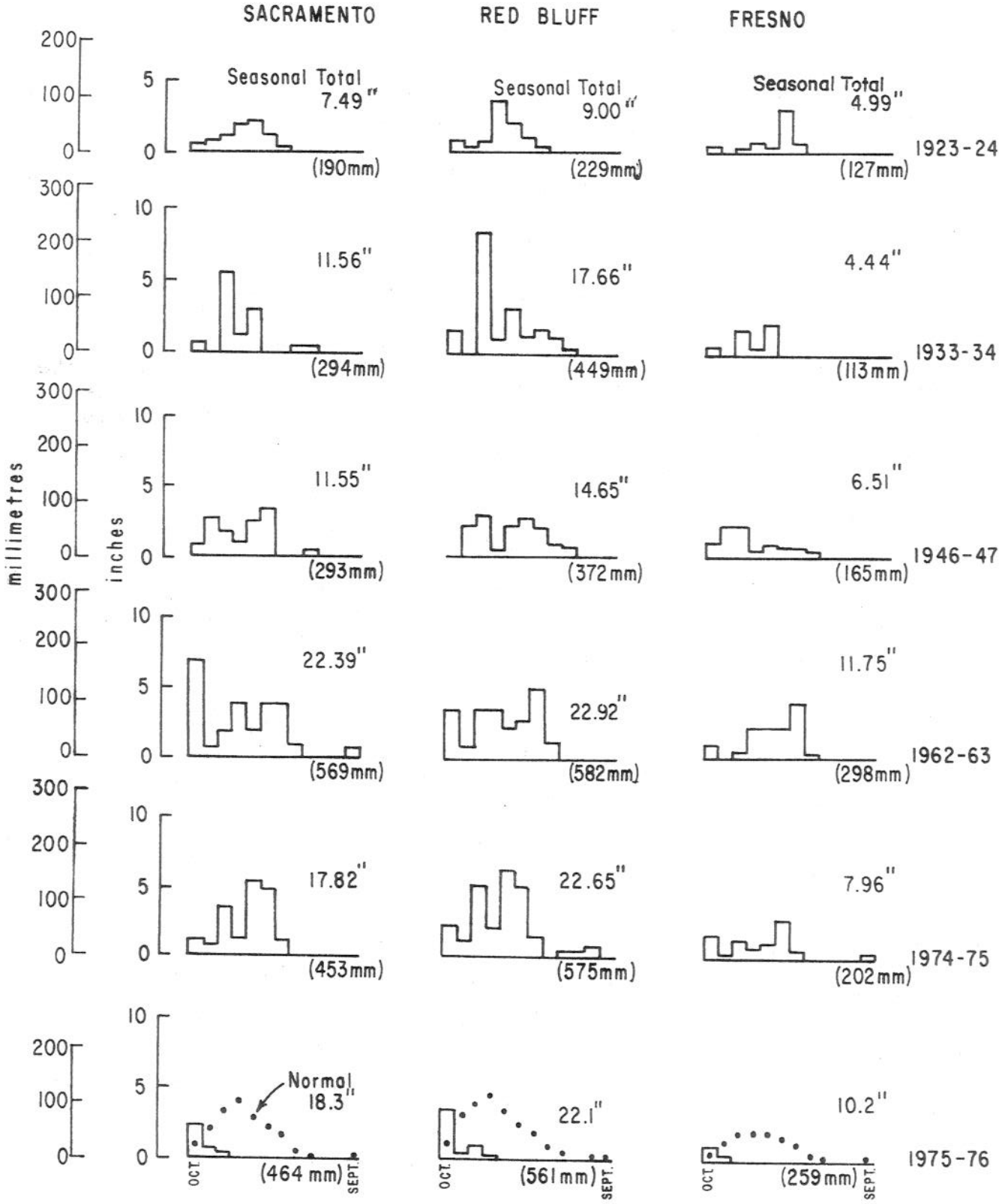


FIGURE 3B

MONTHLY PRECIPITATION PATTERN FOR SELECTED DRY YEARS

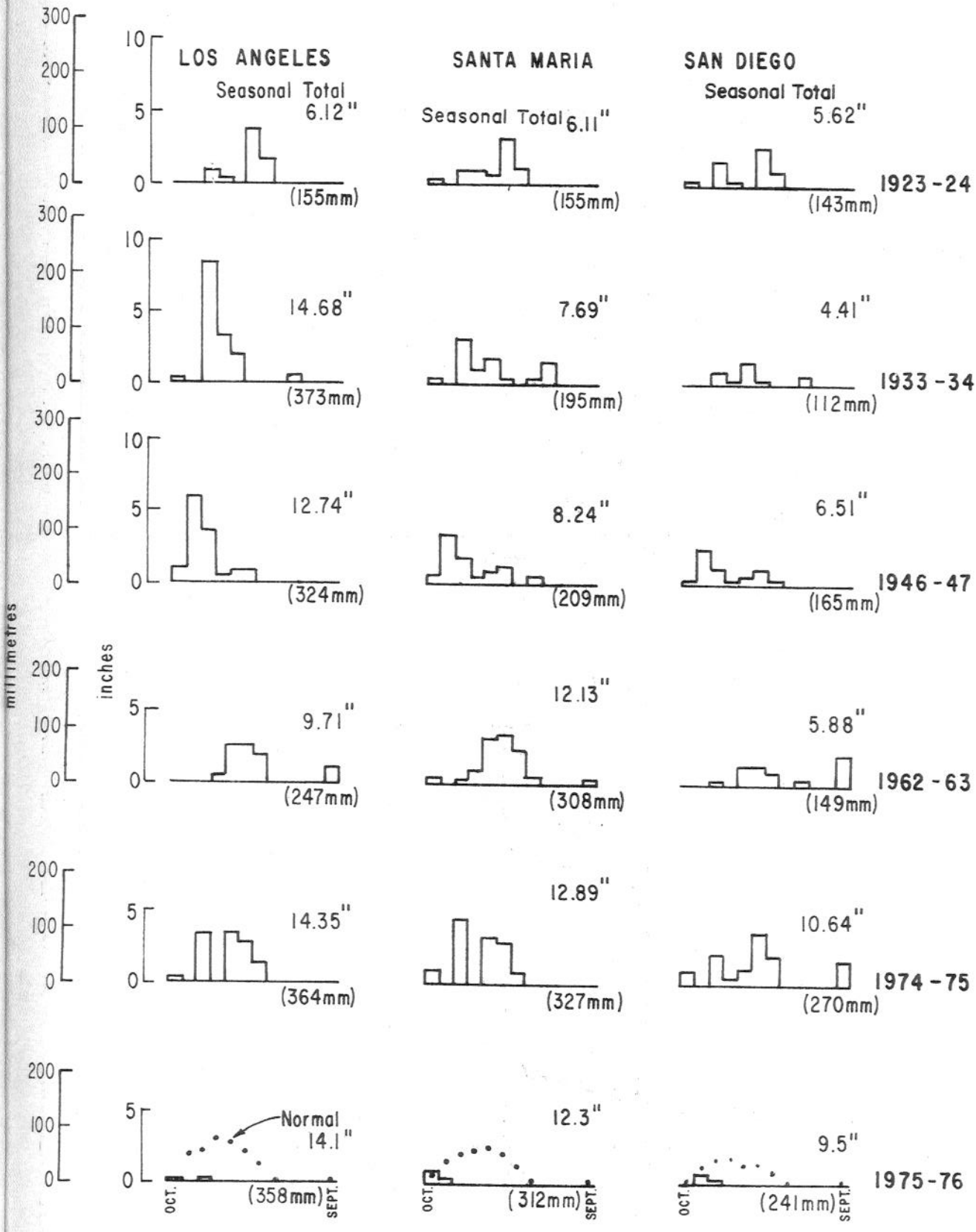
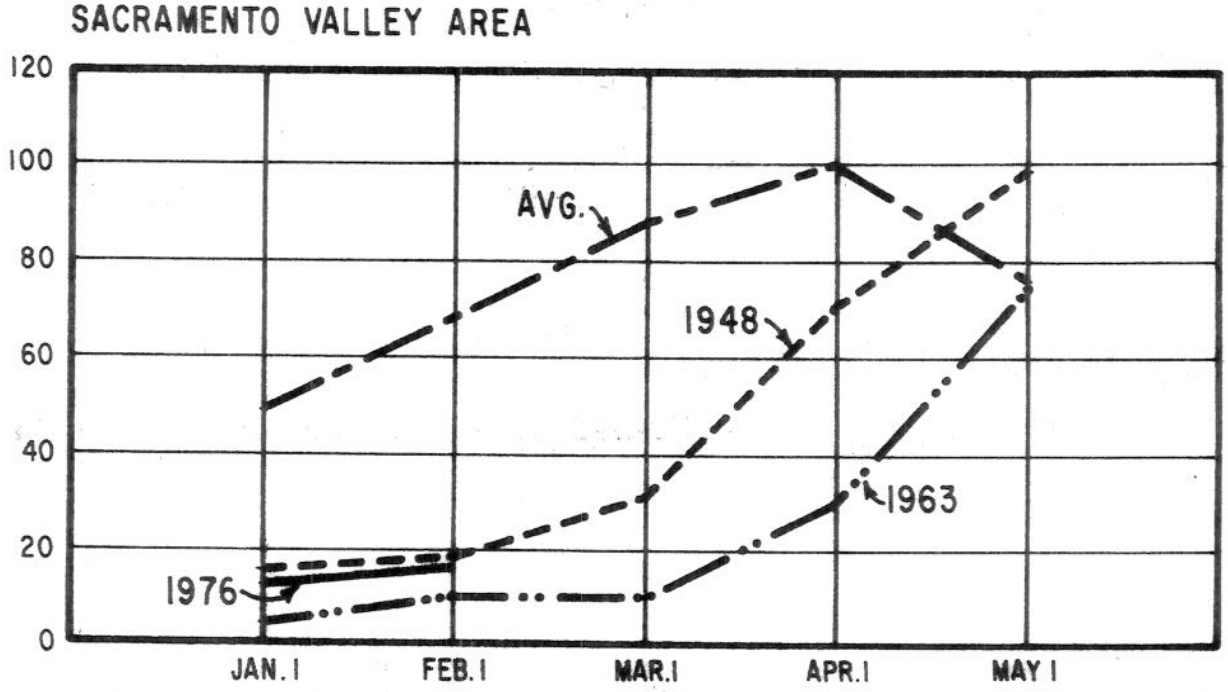


FIGURE 4A

SNOWPACK ACCUMULATION
WATER CONTENT IN PERCENT OF APRIL 1 AVERAGE



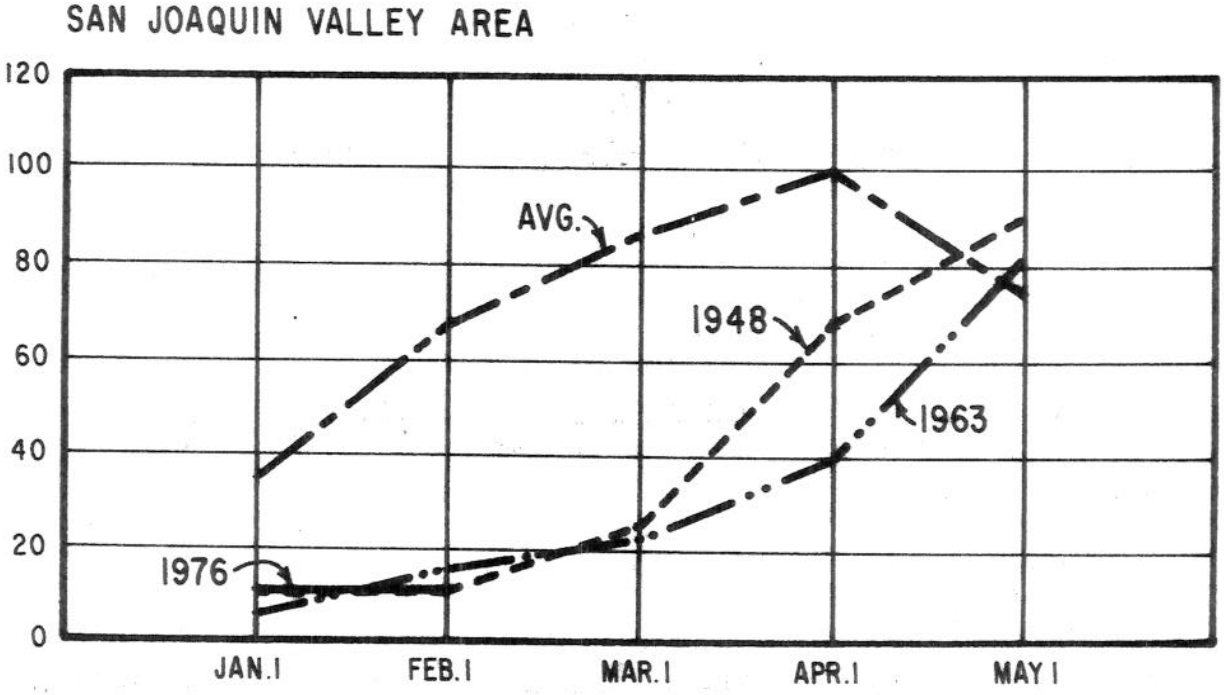
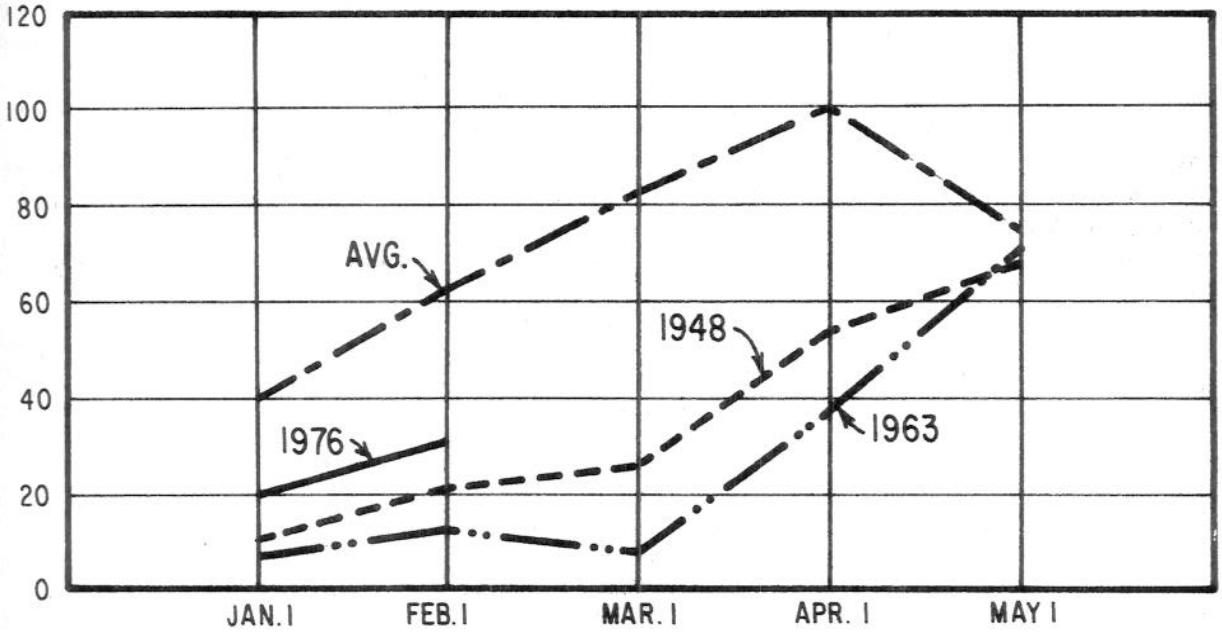


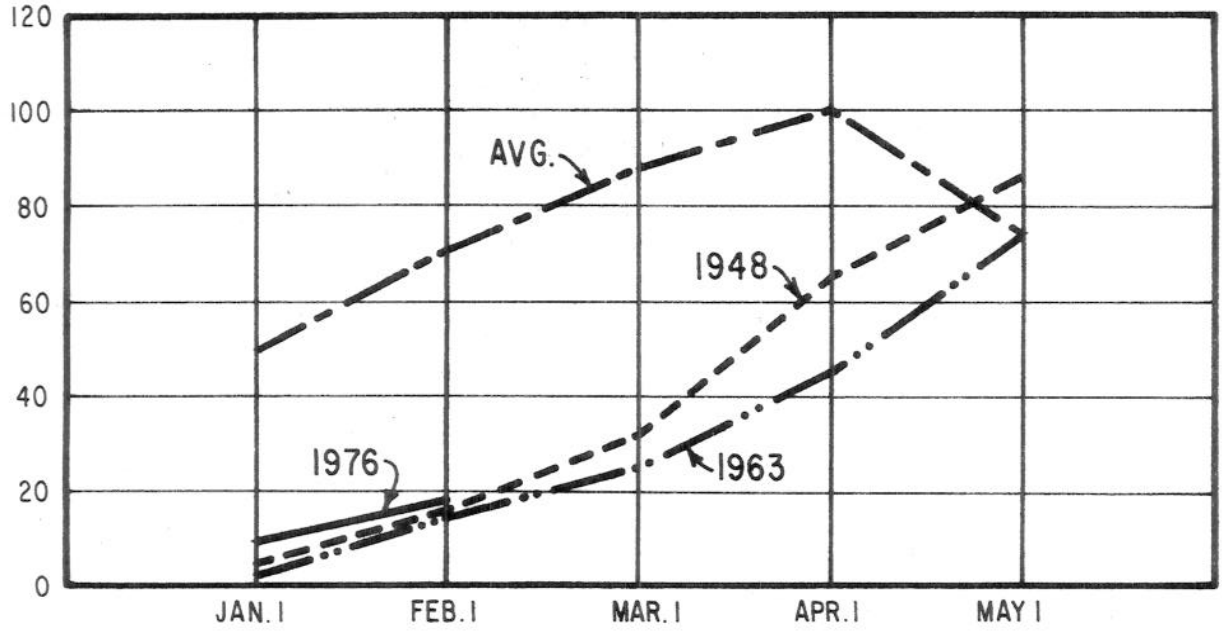
FIGURE 4B

SNOWPACK ACCUMULATION
WATER CONTENT IN PERCENT OF APRIL 1 AVERAGE

NORTH COASTAL AREA



LAHONTON AREA



The 1928-34 dry period probably had the greatest impact because of the cumulative effects on the dry farmed community coupled with the increased irrigated agriculture which suffered from lack of streamflow to divert for crops. The State Water Plan of 1930 proposed the beginning of what is now the Central Valley Project. The State did not have the financial capacity to proceed with construction and by the mid-30s it was clear that the proposed large water projects such as Shasta Dam were needed. The Federal Bureau of Reclamation began in the 1940s to build many of the Central Valley dams that are supplying agricultural and other needs this year. The dry years in the late 40s and again in the 60s caused less impact because of the larger number of water storage projects. The invention of the deep well turbine about 1910 and its expanded use in the middle of this century made ground water more readily available, in both dry and wet years.

The relationship between water supply and electrical energy came home to California in 1946-47. That year was notable for both its adverse impact on agriculture and for the brownouts resulting from a deficient supply of electrical power. Much of the electrical power in Northern California at that time was supplied by hydroelectric plants as contrasted with the present situation where about 80 percent of the electricity is generated by steam plants fueled by fossil fuels and nuclear energy. Following the 1946-47 water year 1947-48 also began as a dry year and great concern was felt for agriculture, public water supply for many communities, and availability of electrical power. Fortunately, heavy rains began in February and, as in 1974-75, those concerns were washed away.

Areas in California not served by these large surface water storage projects or from the large ground water basins have, and will continue to have, problems in a dry period. The climate of this State is extremely variable as illustrated in the histogram of the precipitation pattern at Sacramento, Figure 1. Surface storage reservoirs and conjunctive use of ground and surface water, coupled with good water management, is necessary to bridge the dry years much as our flood control reservoirs and levee and bypass systems take care of the wet flood years.

IMPACTS

The major impact of lack of precipitation thus far in the 1975-76 water year has been felt by dry farmed agriculture. Winter sports losses are second in magnitude. Estimates of further impacts are discussed for two conditions this spring: 1. if precipitation is normal the rest of the year, and 2. if it is in the lower quartile (not greater than the best of the lowest 25% of the years of record). The estimated percent of average runoff of 4 major streams under these two conditions is shown in Table 3. In addition, the impacts are estimated if this year's precipitation continues at the lower quartile and is followed by lower quartile precipitation in 1976-77.

Agriculture

A report by the Department of Food and Agriculture, January 28, 1976, contains an estimate of $310 million of agricultural loss thus far because of the dry season.

Table 3

1975-76 Water Year Projected Flows
in Percent of Average

Basin	Project flow percentage based on normal precip. and snow accumulation after Feb. 1, 1976	Projected flow percentage based on 50% of normal precip. and snow accumulation (Approximate lower quartile) after Feb. 1, 1976
Shasta Inflow (Includes Pit, McCloud, Sacto. R.)	67%	53%
American R. Inflow to Folsom	50%	30%
Kings R. Inflow to Pine Flat	52%	23%
Kern R. Inflow to Isabella	57%	32%

Dry Farmed Areas - The 1.2 million acres (500,000 hectares) of dry farmed grain and nearly 20 million acres (8,000,000 hectares) of dry farmed rangeland areas in California have already been hard hit by the lack of precipitation to date. These areas lie in the foothills of the Sierra Nevada from Fresno to Redding, along the upper and western portions of the Sacramento Valley and in the higher elevation mountain valleys throughout the northern part of the State. Minor amounts of dry farmed land can be found elsewhere.

Grain - Winter grain, planted on ground that was fallowed last spring to preserve soil moisture, is beginning to show moisture stress. Grain, planted on land that was not fallowed, has either failed to germinate due to lack of rain and to cool fall temperatures, or if it did germinate most was lost due to lack of moisture to sustain growth. Soil moisture is at the wilting point. Immediate rains could save some northern valley grain. A continuation of lower quartile precipitation would mean no dry farmed grain crop this year. Economic damage in foothill counties would be serious.

If 1976-77 is dry following a lower quartile year this year, the winter and spring dry farmed grain crop would again be lost. Serious economic situations would develop locally.

Rangeland - Native pasture supports cattle and sheep throughout the State. The lack of precipitation has caused forage to be extremely low this year. Many springs and farm ponds used for stock watering are dry, so that livestock cannot make the best use of what little forage is available on the range. This has resulted in cattle being marketed in large numbers and thus lowering cattle market prices. Even some breeding stock is being sent to slaughter where cost of supplemental feed is uneconomic. Supplemental feeding is being carried out to sustain those not being marketed. Some sheep operators in Kern County have already moved sheep to mountain pasture. Some cattlemen are facing bankruptcy.

If rains are normal this spring, it would take 6 to 8 weeks for forage to grow sufficiently to allow resumption of grazing on natural pasture. Forage would then only be about 50% of normal and the cattle and sheep industry would sustain considerable loss. Nutrient content as well as amount of forage is and would be affected.

If spring rains should not come, losses in the cattle and sheep industry could be monumental, in the hundreds of million dollars.

A continuation of a dry next year would take a lesser toll because the animal populations would already be severely reduced. Those remaining would face the supplemental feeding problem and economics of the individual operator would

determine whether the risk could be further sustained. The lower cattle prices already being experienced would be higher for several years to come, reflecting the lower animal populations.

Irrigated Areas - Precipitation provides about 25 to 30 percent of the irrigated crop needs in the Sacramento Valley and about 10 percent in the San Joaquin Valley. Since much of this supply will not be available this year, application of more water will be required if the crops are to receive a full supply.

The impact of the dry period thus far on irrigated agriculture has been felt most widely on orchards, many of which have required irrigation to supply water that would ordinarily be met by precipitation. Some grain on irrigated land and irrigated pasture has also been supplied irrigation water this winter. In general future impacts will be localized since the water carried over from last year in large reservoirs is adequate to meet essential requirements in most areas.

California State Water Project - The Project delivers two classes of water to its water supply contractors - "firm" entitlement water and "non-firm" surplus water. The Project has an adequate supply of water in its reservoirs to meet the 1976 contractual entitlements (including the surplus water amounts scheduled in December) of its contractors. Recent requests for additional surplus water were not approved because of the present dry water supply conditions. However, recent requests for additional surplus water for February only will be delivered providing an equivalent reduction is made in deliveries later in the year. If water supply conditions improve sufficiently during the remainder of the runoff period, additional requests for surplus water may be approved.

If precipitation the remainder of this year is below normal and next year's water supply is below normal as well, the project will still be able to meet its contractual commitments.

One unusual situation in the State Water Project service area is in the Tulare Lake Basin Water Storage District. In wet years much of the land in this district is subject to flooding when the runoff from the Kings, Kaweah, and Tule Rivers are high. In exceptional years the Kern River also contributes to the flooding of the area. Thus, much of the district land usable for agricultural production is unavailable during part of those years. Conversally, during dry years most of the land is available for cultivation the entire year and water requirements are at a maximum. Thus, demand for Project water increases significantly in the drier years. In 1972, the State Water Project was able to supply a large amount of additional water.

Although similar demand exists again this year the State Water Project probably will not be able to provide the additional quantity that is desired.

Federal Central Valley Project - The Central Valley Project of the U. S. Bureau of Reclamation will be able to meet its contractual water supply commitments the remainder of this year regardless of whether precipitation continues below normal or is normal for the remainder of the year. The Bureau of Reclamation is limiting commitments for supply of surplus (class 2 water) to not more than the quantities earlier agreed to. The Central Valley Project will also be able to meet its delivery requirements next year even if this year continues below normal and 1976-77 is a lower quartile year.

Operators of this project and the State Water Project are carefully coordinating the operation of the two projects to insure efficient use of water. This coordinated operation also provides benefits to other water users in the areas affected by the projects.

Colorado River - Areas in Southern California irrigated with water from the Colorado River are also fortunate, since storage on the river is at 48 million acre-feet (60×10^9 cubic metres), only 1.5 million acre-feet (1.9×10^9 cubic metres) below the all-time high. While runoff this year is expected to be a little below normal, the good storage situation alleviates any concern in California for supply from the Colorado river this year and also for next year, even if it should be a dry year.

Local Projects - Most of the water projects supplied by streams in the Sierra Nevada Mountains have expanded their reservoir storage capacity since 1950 sufficiently to meet their requirements in a dry period without serious shortages.

Some of the irrigation districts that obtain water from streams in California's coast range are not so well off. Although there are three reservoirs on Stony Creek, the amount of water in storage is low and the service area in Glenn County may have difficulty this year. It will almost certainly be short of water next year if 1976-77 is also dry. Until this year Yolo County had to depend on water stored in Clear Lake and on ground water, which has resulted in a greatly variable supply. Fortunately, its new Indian Valley Reservoir on the north fork of Cache Creek was completed last year and has approximately 100,000 acre-feet (12×10^7 cubic metres) of water in storage. However, the district may still have a problem this year since continuation of the dry period would prevent it obtaining water from Clear Lake. A second dry year following this year would have a very serious impact on agriculture in Yolo County.

Ground Water Supplies - No problems are expected in areas served by major ground water basins. Some areas in Lake County near Clear Lake depend on shallow ground water basins for agricultural water. These basins have received little recharge

(water percolating down to refill the underground basins) and may not be able to meet requirements. Similar problems may be faced by agriculture that depends on water from a number of small shallow ground water basins in the coastal areas south of San Francisco.

Irrigation in many parts of the State depend on ground water as a sole supply, or as a supplement to a limited surface water supply. A good deal of activity to replace or recondition wells and to drill new wells is already underway. Well drillers are beginning to be concerned about adequate supplies and equipment for these new wells and, in some cases, availability of skilled drillers to meet expanded demands. Wells that were in need of repair or replacement last year, will probably fail next summer under the stress of above normal usage and accelerated lowering of water tables.

Urban and Industrial Areas

Water agencies supplying urban and industrial users throughout the State are analyzing their situations. A question has arisen as to how much water people use in a dry year compared to a year when rainfall is average or above. Logically, people would use more water to keep green areas green because of the lack of rainfall to meet some of the need. If water use in a dry year is appreciably higher than usual, some communities who do not expect to have a problem may experience problems in water quantity or delivery rates.

Communities served by large surface water systems are not currently having any problems, nor do they expect to have any problems even if the balance of the year is also dry. These systems include the Hetch-Hetchy Aqueduct of the City and County of San Francisco, the Los Angeles Aqueduct of the Los Angeles Department of Water and Power, the Colorado River Aqueduct of the Metropolitan Water District of Southern California, the Mokelumne Aqueduct of the East Bay Municipal Utility District, and others with moderately large reservoir storage such as that of the Sonoma County Water Agency.

Ground water serves most communities in the Central Valley and many in Southern California, including the desert communities. No problems are expected in these supplies even if the year remains dry.

However, those communities throughout the State which depend on local streamflow, small reservoirs, or shallow ground water basins may already be experiencing problems. Table 2 presents information on current problem areas for which we have information. These range from wells going dry to reservoirs at dangerously low levels. If rainfall is low through the spring, some local communities not included in the table or individual residences away from towns will probably experience water shortages. Water rationing is already being contemplated for

late spring and summer in many communities. Use curtailment, such as no car washing and lawn watering only on certain days, is being considered.

If this year remains dry and 1976-77 is also dry, some additional problems would occur. These are presented in Table 4 and include foothill and mountain domestic wells going dry, the need to truck water to some small communities, and severe rationing and use restrictions. Such problems will occur in localized areas but may be generally prevalent in the north and central coastal areas and in desert communties using springs rather than stored ground water. The only major water system considering any action, the Los Angeles Department of Water and Power, is contemplating a public education program to conserve water. Much can be done to cut water use by an alert public which is convinced that a real problem exists. A real opportunity now exists for developing meaningful water conservation programs in local communities.

Recreation

The dry year impact to date on winter recreation is both positive and negative. The subnormal seasonal snow depth has had a large negative impact on the snow skiing activity. Ski operators are suffering; use has fallen off tremendously, and motels are reporting weekend vacancies where in former years they were full. Ski operators have had to reduce work force, and there are a reduced number of lifts in operation during the week.

The City of Sacramento reports a record use of golf courses. Houseboat activity is greater than normal, and Sunday pleasure driving is greater than normal due to the pleasant weather. Lake Tahoe recreation reports indicate tennis courts are being utilized where in former years they were buried under several feet of snow. In general, people are turning to the other recreation activities abnormally early in the year.

To date the only recreation related boating problem has been at Folsom Lake. At Brown's Ravine Marina, the low reservoir stage has bottomed out the marina site, but there has been no difficulty with lake boating in other respects or at other boat launching and marina systems in the State. River boating has been sustained by natural flows and reservoir and power releases. Visitor days at recreation areas is reported above average.

If a lower quartile water supply occurs through the spring, reservoir stages will be too low at about 20 percent of the boat launching ramps in inland lakes. Such limited launching facilities coupled with exposure of lake shores would reduce visitor days about 20 percent. Use of shower facilities would probably be curtailed in some parks, mostly in the central and north coastal areas.

TABLE 4

Municipal and Industrial Water Supply

Problem Areas

Area	Current Problems	If Spring 1976 is Normal	If Spring 1976 is Dry	If 1976-77 is Also Dry
Monterey Peninsula				Some curtailment of non-critical uses, i.e. golf courses, may be necessary.
Foothills, East side San Joaquin Valley	No current problems.		Some foothill wells may go dry.	Some foothill wells will go dry.
Morro Bay Area	Situation is drastic due to high domestic use. Will need voluntary cooperation.	No severe problems. Some conservation in order.	Water rationing possible. May need to use agricultural wells for supply if Public Health permits.	Water rationing probable. May use agricultural wells if Public Health permits.
L. A. Dept. Water and Power Service area	No problems.	No problems.	No problems.	Public Education Program for conservation, restrict outdoor use.
Goleta County Water District	No problems.	No problems.	No problems.	No current plans to handle this situation.
Desert Communities	Water table will continue to lower.	Water table will continue to lower at an accelerated rate.		No current plans to alleviate overdraft of ground water.
Clear Lake Resorts	No Problems.	Algae problems if Clear Lake doesn't fill.	Severe algae problems, boat launching, tourists down.	Tourist industry will be low.
Marin Municipal Water District	Reservoirs 56% filled instead of 80%. Facing problem now, considering water curtailment in mid-February.	No severe problems; conservation measures in effect.	Rationing will be required. Will run out of water October-December 1976.	Extreme problems would occur.
Town of Occidental (Sonoma Co.)	No current problems.	No problems.	Will probably truck water this summer.	Truck water.
Santa Cruz	Already pumping wells which normally not used until June 1.	No problems.	Residents will have a 30% deficiency.	Severe rationing and use restrictions.
Santa Rosa	No current problems.	No problems.	Could require rationing.	Probably require rationing.
Petaluma	No problems.	No problems.	Rationing likely.	Rationing probable.
Valley of the Moon	Some wells going dry.	No problems.	Rationing likely.	Rationing probable.
Upper Sonoma Valley	No problems.	No problems.	Rationing likely.	Rationing probable.
Carmet, Salmon Creek and Jenner areas	No problems.	No problems.	Rationing expected.	Severe rationing expected.

If precipitation is normal for the balance of the water year, no recreational difficulty of any kind is expected in the State.

If 1976-77 is a dry year following a dry 1975-76, reservoir stages will be too low for boat launching at 30 to 40 percent of boat launching ramps. Large reservoirs such as Oroville and Shasta will be less affected. These conditions plus less aesthetic lake shore conditions could cut normal visitor days by an estimated 40 to 50 percent at inland reservoirs. Water use in state parks would probably be restricted to drinking and cooking, especially in the central and north coast areas which are heavily used. Since the State Department of Parks and Recreation began management of reservoir recreation in 1956, it has not experienced a condition as dry as two lower quartile years in a row and, therefore, has no direct experience to draw on in anticipating problems. The severe fire hazards which may occur could require closure of some parks in high risk areas, and fire restrictions could be necessary for most parks. If severe fires result, this would affect quality of recreation in subsequent years because of the natural environment destroyed and facilities lost.

Fish and Wildlife

Reduced reservoir releases and low natural streamflows to date have reduced spawning success of salmon and steelhead and will reduce the survival rate of juvenile fish. These losses will result in fewer adult salmon and steelhead three to four years from now. Other fish and wildlife resources have not been appreciably affected to date.

If a lower guartile water supply is experienced through June 1976, stream angling for trout, particularly in mountain streams, would be substantially better than normal this spring but would fall to less than normal late in the season and in the following year. Angling in natural mountain lakes would be normal. There would be reduced stocking of trout in streams in mid- and late- summer months due to low water levels. Additional losses of nursery area for juvenile salmon, striped bass, and steelhead would result in very noticeable lessening of runs in subsequent years. Upland game and nongame birds would suffer from reduced food supplies. Quail may not nest successfully if a very dry spring occurs. Deer would have less natural forage, and some losses due to malnutrition and attendant poor fawn production and survival could be expected. Desert Bighorn Sheep and other desert wildlife could be affected seriously because of reduced or no flow in springs. Waterfowl would not be seriously affected since water conditions are favorable in Canada where most reproduction occurs. However, local reproduction may be reduced substantially. In addition, some losses of waterfowl are being experienced due to fowl cholera and botulism. Endangered

species throughout the State will be closely monitored but no major problems are anticipated. If local water supplies should run short, such species would be moved or water supplied artificially.

If the balance of the water year is normal, no problems are anticipated other than the anadromous fishery losses sustained before February 1.

If a second dry year should occur, one serious effect on fish could be from the aftermath of increased overgrazing of rangeland and forest fires, which cause streams to carry a subsequent high sediment load. All stream fisheries would be reduced substantially in subsequent years due to very greatly reduced spawning, loss of young fish, and reduced fish stocking programs. Deteriorated habitat conditions from poor production of grass, forbes, and browse species plus increased fires and overgrazing would cause losses of some wildlife species. Reservoir fish populations would be reduced in proportion to reduction in lake surface areas as reserviors are drawn down. Fish in natural high mountain lakes would not be greatly affected. Major problems in desert wildlife survival would continue.

Water Quality

Quality of water is adversely affected in dry years by increased mineral content and by salt water intrusion in estuaries.

Sea Water Intrusion into Sacramento-San Joaquin Delta - Outflow of fresh water from the rivers which are tributary to the Sacramento-San Joaquin Delta and releases from federal and state reservoirs serve to repel intrusion of salinity from the ocean into the Delta. Salinity protection is needed for fish, wildlife, agricultural, municipal, and industrial uses. An outflow index of about 6000 cfs (approximately 195 cubic metres per second) is required to provide satisfactory water quality for both state and federal water project diversions and Delta needs. This outflow will satisfy the requirements under the State Water Resources Control Board's Decision 1379, which governs the operations of the State Water Project. This outflow index will be sustained by releases from reservoir storage if necessary.

Stream Water Quality - Our records indicate that dissolved mineral concentrations in the major streams flowing to the Central Valley and coastal valleys generally increase as flows are reduced. The concentration of constituents in these streams can be expected to show a 10 to 50 percent increase. Quality in streams immediately below storage reservoirs will not change appreciably from other years. The effect of these quality changes will be so small that most agricultural or urban users will not be able to recognize the poorer quality.

Energy

The below normal runoff in streams, together with retention of as much water as possible in storage in reservoirs for other uses, has severely cut hydroelectric production of power thus far. If precipitation for the remainder of this year is at the lower quartile, 28 million barrels ($392,000,000) of oil above normal requirements will be needed to offset the lowered production of hydroelectric power. In addition, increased ground water pumping will require additional power. If precipitation is normal for the balance of the year, the requirement for additional oil would be reduced by about eight million barrels ($112,000,000). If 1976-77 is also dry, the loss of hydrcelectric power in that year would also require above normal electrical production from other sources. The additional oil used would equal or exceed the 28 million barrels estimated for this year.

Forest Management

The lack of precipitation has caused the Division of Forestry to extend the fire season indefinitely in Southern California instead of terminating it in mid-December. The fire season was reopened in mid-January in the Central Coast area. The fuel conditions in the Southern Sierras are becomming critical. Additional costs to date have approached a quarter of a million dollars in fire watch and fighting costs, even though contracts with counties have placed much of the cost on the counties. Domestic water is being hauled to some conservation camps.

If normal rains begin, normal fire operations could be resumed. However, the summer season would be dryer than usual and could cause a longer and more serious fire season.

If only lower quartile precipitation is received this spring, the Northern Sierra and the North Coast fire seasons would be reopened early and the seasons probably extended until rains are received next fall. The extreme dry conditions and increased proportion of dead material in the fuel mix this summer could cause closures of national forests and the attendant areas, affecting all uses of the areas. Recreation and timber harvesting could be affected where fire danger is severe.

The natural resistance of forests to disease and insects is weakened by the lack of moisture. An increase in insect epidemics would be anticipated.

An extension of the lower quartile precipitation through 1976 would magnify the problems anticipated this summer. In addition, fires will burn hotter, spread more quickly, and be much more difficult to control. Personnel for fire fighting could be a problem since the severe danger will likely result in a greater number of fires.

The aftermath of increased fires would affect recreation use and particularly fisheries for years to come.

WHAT CAN WE DO TO SAVE WATER IN A DRY YEAR?

Conservation

There are several measures that are underway at various places in the State to meet the impact of a deficient water supply. One of the first steps was to cut back hydroelectric power production so that the water going through the generators could also be diverted for use or storage in water deficient areas or to meet Delta outflow requirements.

Conservation of water in a dry year can be accomplished by making less water do the job (possibly with some inconvenience), but is mainly accomplished by cutting out waste of existing supplies.

Most conservation in the urban areas can be accomplished more readily than in agricultural areas in the time frame. Both urban and agricultural conservation methods are discussed separately below since they differ from each other. Common to both is the need to make people aware that a problem exists through the media and through direct contact.

Urban Conservation - The Urban Water Conservation Conference held on January 16-17, 1976 in Los Angeles by the Department of Water Resources explored existing means for residential conservation such as low-flow shower heads, efficiency of water use in landscaping, cleaning of outdoor areas with nonwater using devices, and detection and repair of leaks in waterlines in homes and in delivery systems. Three motivation techniques discussed included rationing, increasing the price of water, and public education. Building code changes can be effective in the long run, but not in the time frame of the current dry year.

Public education is required and the public will respond when it is convinced that a need to conserve really exits. Changes in the cost of water and in price structures can be effective.

Methods which can be used if we are to save water in a dry year are:

a. Place weighted plastic bottles, water dams, or other specific devices in toilets to reduce the gallons per flush.

b. Repair leaky faucets.

c. Minimize lawn watering and have no flooded gutters.

d. Cut down on outdoor washing of cars and eliminate washing of paved areas.

e. Reduce use of water for golf courses and parks.

f. Have a full load before turning on the washing machine and the dishwasher.

g. Install low-flow shower heads.

Implementation of all of the above methods of saving water are dependent on getting the word to the public so it can cooperate.

Agricultural Conservation - Public education is also necessary to stimulate water conservation by the agricultural community. Significant savings of water must be initiated very early to be effective. Many farming systems are already very efficient and the opportunities for real savings are limited.

While rationing by project or by districts could motivate users, the specific ways of saving water include:

a. Line leaky canals.

b. Plant lower water-using crops.

c. Contact Farm Advisors on how to increase individual farm efficiency and save water.

d. Agricultural water users in the vicinity of a waste treatment plant may find opportunities to make new or expanded use of reclaimed waste water.

Another way of making the surface water supplies go farther is for those farmers who have wells to use them to the fullest, refraining from use of the short supply of surface water. Local districts should assess their resources, needs, and problems early, get the word out to water users, and arrange that district wells and those of individuals are readied for the dry summer. At the same time allocate available surface supplies to permanent crops such as orchards and vineyards and to those users who do not have access to ground water.

Increased Ground Water Use

Throughout most of our valley agricultural areas, both surface water and ground water is available. Economics sometimes dictates the mix of the two supplies in an area or on an individual farm. However, in an extremely wet or an extremely dry year, other factors may control. In wet years, surface water is used to a maximum extent and ground water recharge facilities are used to place excess water underground. In dry years, the available surface supplies are used and the additional demand is met by pumping the ground water.

Already this year many agencies are readying wells for use. In the western portion of Fresno and Consolidated Irrigation Districts owners are already refurbishing wells that have not been in use since 1962 for use this year. In Kern County, wells not used the past three to five years are being readied.

Drillers and pump companies report they are increasing their inventories in anticipation of the reactivation of wells, the need to lower pump bowls in some areas and for some additional new drilling.

All available wells can be used to the maximum extent in order to meet water needs, with sharing of supplies with those who do not have access to ground water on-farm.

Colorado River Imports

The storage on the Colorado River is presently about 48 million acre-feet (60×10^9 cubic metres) (the highest of record was 49.5 million acre-feet (60×10^9 cubic metres) in August 1975).

The Bureau of Reclamation estimated on January 1, 1976, that the flow into Lake Powell this year would be about 7.5 million acre-feet (9.3×10^9 cubic metres) as compared to the average inflow of 8.3 million acre-feet (10.2×10^9 cubic metres). The estimated inflow is updated monthly through June by the Bureau.

The basic entitlement for California set by the U. S. Supreme Court is 4.4 million acre-feet (5.4×10^9 cubic metres) annually. Because other states did not utilize their entitlement, California was able to import 5.3 million acre-feet (6.5×10^9 cubic metres) during calendar year 1974, and it is estimated that about 4.9 million acre-feet (6.1×10^9 cubic metres) was imported during calendar year 1975. Based on the present storage, additional water could be furnished California at this time to meet its dry year needs upon approval by the Secretary of Interior.

Emergency Assistance

Depending on the severity of the emergency there could be several means of assistance. The minimum would be what a community or county might provide locally, ranging to a full scale disaster declaration by the President, which then opens many avenues of assistance.

When the U. S. Department of Agriculture Secretary declares Natural Disaster Areas; these are some of the programs available:

Crop Loss - PL 93-86 provides financial assistance to wheat, grain, and cotton farmers suffering losses when they are prevented from planting by conditions beyond their control.

Emergency Livestock Feeding - Assistance at beneficial prices to livestock owners in the emergency area.

Farmers Loans - Emergency loans can be made to farmers in the affected area.

Rail Freight Rate Reduction - Lowering of rail rates for hauling of feed.

When the Administration of the Small Business Administration determines a need, low interest loans can be made to agro-business in emergency areas.

When an emergency is declared by the President, the Disaster Relief Law, PL 93-288, becomes available which has much broader areas of assistance than the regular programs, such as: Property Tax Relief, Emergency Feeding and Housing, Emergency Repair of Essential Facilities, and etc.

Also with the Presidential Declaration, comes the authority for the Federal Disaster Assistance Administration to direct agencies to respond to the immediate needs in emergency areas.

Because the activities relating to emergency assistance cover such a broad spectrum, individuals or agencies should contact their Farm Advisor for information.

CONVERSION FACTORS

English to Metric System of Measurement

Quantity	English unit	Multiply by	To get metric equivalent
Length	inches (in)	25.4	millimetres (mm)
		.0254	metres (m)
	feet (ft)	.3048	metres (m)
	miles (mi)	1.6093	kilometres (km)
Area	square inches (in^2)	6.4516×10^{-4}	square metres (m^2)
	square feet (ft^2)	.092903	square metres (m^2)
	acres	4046.9	square metres (m^2)
		.40469	hectares (ha)
		.40469	square hectometres (hm^2)
		.0040469	square kilometres (km^2)
	square miles (mi^2)	2.590	square kilometres (km^2)
Volume	gallons (gal)	3.7854	litres (l)
		.0037854	cubic metres (m^3)
	million gallons (10^6 gal)	3785.4	cubic metres (m^3)
	cubic feet (ft^3)	.028317	cubic metres (m^3)
	cubic yards (yd^3)	.76455	cubic metres (m^3)
	acre-feet (ac-ft)	1233.5	cubic metres (m^3)
		.0012335	cubic hectometres (hm^3)
		1.233×10^{-6}	cubic kilometres (km^3)
Volume/Time (Flow)	cubic feet per second (ft^3/s)	28.317	litres per second (l/s)
		.028317	cubic metres per second (m^3/s)
	gallons per minute (gal/min)	.06309	litres per second (l/s)
		6.309×10^{-5}	cubic metres per second (m^3/s)
	million gallons per day (mgd)	.043813	cubic metres per second (m^3/s)
Mass	pounds (lb)	.45359	kilograms (kg)
	tons (short, 2,000 lb)	.90718	tonne (t)
		907.18	kilograms (kg)
Power	horsepower (hp)	0.7460	kilowatts (kW)
Pressure	pounds per square inch (psi)	6894.8	pascal (Pa)
Temperature	Degrees Fahrenheit (°F)	$\frac{tF - 32}{1.8} = tC$	Degrees Celsius (°C)