FORECASTING THE DATE OF LOW FLOW (200 cfs) ON EAST CARSON RIVER, NEVADA

By

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INTRODUCTION

In the preceding paper, Mr. Johnson has described the need for, and the benefits derived from, forecasts of the date of low flow (200 cfs) on the East Carson River in Nevada. Seasonal volume forecasts of the East Carson, near Bardnerville, have been issued by the Soil Conservation Service since 1948. In 1949, the date of low flow forecast was initiated. In 1954 and 1960, the low flow forecast procedures were reviewed and further revised.

Low flow forecast results to date have been quite satisfactory with increased accuracy as longer records have become available. Most forecast error on the East Carson is due, in large measure, to the variation of spring precipitation and temperature which cannot be predicted in advance.

The original forecast procedure, which was used from 1949 to 1954, was based on snow survey data versus date of low flow. In 1955, this original procedure was brought up to date to include additional years of snow survey data that had accumulated. From 1949 to 1959, the forecast date was published on April 1 only and in narrative form rather than a specific date.

In February 1960, two new forecase procedures were developed. The first, or early season procedure, is used on March 1, April 1 and May 1. It utilizes snow survey information only. After May 1, the second or late season procedure is used. It utilizes peak flow and the number of days after April 1 that flow is reached.

These procedures are discussed in detail in the following sections.

FORECAST PROCEDURES

The East Carson Watershed, above Gardnerville, comprises an area of 344 square miles in Nevada and California. Elevations range from 5,000 feet at the gaging station to 11,429 feet at Sonoma Peak, California. Its principal source of water is derived from snow which falls during the winter months in higher reaches of the east slope of the Sierra Nevada Mountains. The average date of occurrence of a low flow of 200 cfs is July 23. The East Carson River has dropped to 200 cfs as early as June 23 and as late as August 28.

There are no federal reservoir storage facilities on the East Carson above Gardnerville. There are several privately owned reservoirs serving the area. Figure 1 shows the East Carson Watershed and the snow courses in the area which are used in forecast procedure 1.

Procedure 1 - Early Season

This procedure is based on a simple correlation which relates April 1 snow water content to date of low flow.

Preliminary studies indicated a good correlation between April-July streamflow volume and date of 200 cfs flow. However, April-July streamflow volume is not available until after July 31. Rather than base the date of low flow forecast on an estimated volume forecast, it was decided to directly relate snow data to the date of low flow. The resultant correlation proved to be reasonably high.

Table 1 summarizes the data used, and forecast equation obtained as well as measures of the reliability of Procedure No. 1.

On March 1, the snow course values are increased by their normal March 1 to April 1 snow water increments before inserting them into the forecast procedure. On April 1 and May 1, the April 1 snow course values are used.

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FIGURE 1

MAP OF EAST CARSON WATERSHED

NEVADA

Location Map

MINDEN

GARDNERVILLE

Echo Summit

Twin Lakes

Lo. Up Carson Pass

Carson Pass

Tragedy Springs

EAST
CARSON
RIVER

Blue Lakes

Forecast Point

Snow Courses

0   5   10

Scale - miles

N

Pacific Valley

Highland Mdws.

Poison Flat

NOTE: Snow courses used are
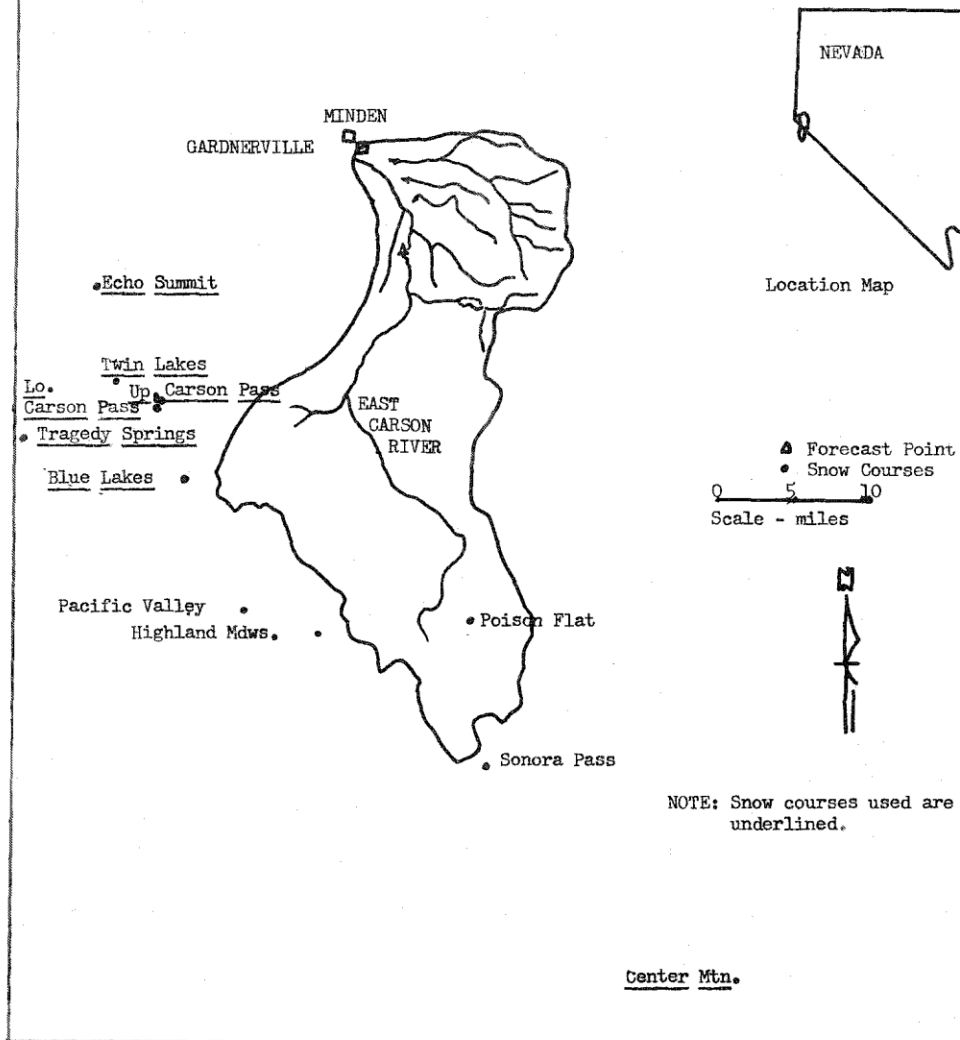   underlined.

Sonora Pass

Center Mtn.

TABLE 1

EARLY SEASON FORECAST PROCEDURE NO. 1

DATE OF LOW FLOW (200 cfs) - EAST CARSON nr. GARDNERVILLE, NEVADA

Water Year	(X) April 1 Snow Avg.[1] (inches)	Date E. Carson Dropped to 200 cfs	(Y) Coded Date[2] E. Carson Dropped to 200 cfs (days)	Estimated Y (days)
1940	41.8	7-17	47	56
1941	40.1	7-26	56	54
1942	42.1	8-3	64	56
1943	46.2	8-1	62	60
1944	29.0	7-16	46	43
1945	40.2	7-30	60	54
1946	39.1	7-14	44	53
1947	29.3	7-1	31	43
1948	25.6	7-20	50	40
1949	37.3	7-8	38	51
1950	43.2	7-20	50	57
1951	25.4	7-16	46	39
1952	73.6	8-28	89	88
1953	34.0	8-5	66	48
1954	31.3	7--5	35	45
1955	27.7	7-17	47	42
1956	51.1	8-12	73	65
1957	32.7	7-24	54	47
1958	56.0	8-6	67	70
1959	26.4	6-28	28	40
Average	38.6	7--23	52.6	

$Y = 1.00 X + 14.0$ $\qquad$ $r = 0.80$
Standard error of estimate = 9.3 days
Average error = 7.6 days

[1] Upper Carson Pass S.C. - Lower Carson Pass S.C. - Tragedy Springs S.C. - Echo Summit S.C. - Center Mountain S.C. - Twin Lakes S.C. - Blue Lakes S.C.

[2] Coded Value
June 1 = 0 - June 30 = 30 - July 1 = 31 - July 31 = 61 = August 1 = 62 = August 31 = 92

Procedure 2 - Late Season

This procedure is based on a two variable multiple correlation which relates peak flow and number of days after April 1 that peak flow occurs to date of 200 cfs flow.

Peak flow, on the East Carson, occurs about mid-May. It has occurred as early as mid-April to as late as mid-June.

From May 15 on procedure No. 2 is used. By then, through the assistance of the Surface Water Branch of the U. S. Geological Survey, daily flow data is available from which the peak flow and date of peak flow can be obtained.

Table 2 summarizes the data used and forecast equation obtained, as well as measures of the reliability of procedure No. 2.

Discussion of Forecast Results

As was pointed out by Mr. Johnson, the April-July runoff volume of the East Carson is of importance and value to Carson Valley ranchers. How this runoff will come out, i.e. its distribution, is even more important. When the river drops to 200 cfs, junior or late water rights can no longer be served.

Table 3 shows the forecast results from 1949 to 1960. During the period 1949 to 1954, accuracy was poor. In fact, if the average date July 23 had been forecast every year the average error would have been 15 days compared to 22 days average error by the forecast procedure.

During 1955 to 1959, the change to the forecast procedure developed in 1954 brought about an improvement. Namely, 8 days average error by the forecast procedure compared to 13 days average error using the average date.

One year of performance is available for error analysis on the forecast procedures developed in 1960. On March 1, April 1 and May 1, the error of forecast procedure No. 1 was 14 days. Use of the average date would have resulted in error of 30 days. On June 1, the error of forecast procedure No. 2 was 8 days.

Introduction of a spring precipitation factor and a temperature factor into the present procedures is contemplated in the near future. It is planned to try a Spril precipitation factor in the May 1 forecast of procedure No. 1 and both precipitation and temperature factors in procedure No. 2. There is a strong likelihood that these variables would further improve the forecast accuracy.

TABLE 2

LATE SEASON FORECAST PROCEDURE NO. 2

DATE OF LOW FLOW (200 cfs) - EAST CARSON nr. GARDNERVILLE NEVADA

Water Year	(X_1) No. days after April 1 peak Flow observed (days)	(X_2) Peak Flow (cfs)	(Y) Coded Date [1] E. Carson Dropped To 200 cfs	Estimated Y (days)
1940	54	1,770	47	48
1941	42	2,060	56	52
1942	55	2,550	64	67
1943	62	2,540	62	68
1944	38	1,350	46	34
1945	37	2,370	60	59
1946	36	1,660	44	41
1947	36	1,610	31	40
1948	56	1,570	50	44
1949	44	1,760	38	46
1950	61	2,020	50	56
1951	57	1,730	46	48
1952	67	3,130	89	84
1953	80	1,870	66	56
1954	50	1,500	35	41
1955	71	1,840	47	53
1956	55	2,700	73	71
1957	63	1,880	54	53
1958	49	2,610	67	67
1959	43	909	28	25
Average	52.8	1,971	52.6	

$Y = .218X_1 + .024 X_2 - 6.2$

$R = 0.95$

Standard error of estimate = 4.8 days

Average error - 4.7 days

[1] Same as coding in Table 1

TABLE 3

FORECAST RESULTS

DATE OF LOW FLOW (200 cfs) - EAST CARSON nr. GARDNERVILLE, NEVADA

Water Year	Forecast Date of Low Flow 200 cfs as published April 1[1]	Avg. Date[2]	Coded Avg. Date[3]	Observed Date	Observed Date Coded	Forecast error in days
1949	last week July	7-27	57	7-8	38	+19
1950	last full week July	7-26	56	7-20	50	+ 6
1951	middle June	6-15	15	7-16	46	-31
1952	late part Aug.	7-25	55	8-28	89	-34
1953	middle July	7-16	46	8-5	66	-20
1954	last week July	7-28	58	7--5	35	+23
					Avg.	22
1955	2nd week July	7-13	43	7-17	47	- 4
1956	nr. 1st day Aug.	8-1	62	8-12	73	-11
1957	2nd week July	7-10	40	7-24	54	-14
1958	(not published)			8-6	67	---
1959	1st days July	7-2	32	6-28	28	+ 4
					Avg.	8

		Specific Date	Coded Date			
1960 March 1	July 1-15	7-7	37	6-23	23	+14
April 1		7-7	37	6-23	23	+14
May 1		7-7	37	6-23	23	+14
June 1		7-1	31	6-23	23	+ 8

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1949-1954 - Fron original forecast procedure
1955-1959 - From 1954 revision of original forecast procedure
1960      - From forecast procedures developed in 1960
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[1] As published in Nevada Snow Survey & Water Supply Outlook Reports

[2] An average date selected by reference to calendar. For example - the last full week in July 1950 was Sunday, July 23 through Saturday July 29. Wednesday July 26 was selected as the average date for forecast accuracy analysis purposes.

[3] Coded as in Table 1.