Southern Oscillation Index Statistical Correlation with Spring Runoff in the Western US

Natural Resources Conservation Service
National Water and Climate Center
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Background:
The USDA, NRCS National Water and Climate Center (NWCC) has completed an analysis of the correlation of the Southern Oscillation Index (SOI) with spring and summer volume runoff in the western U.S. The results are shown in Figure 1 and Table 1 attached. Basins with a significant correlation (greater than 0.35 or less than -0.35), may require additional monitoring and analysis during Water Year 1998 depending on specific water management needs.

What is El Nino/Southern Oscillation (ENSO)?
"ENSO" stands for "El Nino / Southern Oscillation". The acronym arose in the climate research community, and reflects an attention bias toward the warm phase of the entire cycle. El Nino is just one phase of an irregular fluctuation between warmer than usual and colder than usual ocean temperatures in the Eastern Pacific. The cold phase has recently come to be known as "La Nina". The El Nino/La Nina "cycle" does not occur with strict periodicity. Historically, an El Nino usually recurs every 3-7 years, as does its (cold) La Nina counterpart.

The overlying atmosphere is tightly coupled to ocean temperatures and circulation patterns. An atmospheric pressure signal is seen throughout the tropics that is strongly linked to El Nino and La Nina. When barometric pressure is higher than usual in the western Pacific near Indonesia, pressure is lower than usual in the subtropical Pacific near Easter Island and Tahiti. This global-scale pressure signal, identified 70 years ago, is known as the "Southern Oscillation." Surface barometric pressure at Darwin, Australia and the island of Tahiti are strongly anti-correlated: when one is higher than usual, the other is lower than usual. The difference, Tahiti minus Darwin, suitably normalized, is referred to as the Southern Oscillation Index (SOI), and is frequently used as a convenient, simple and reasonably accurate tool to monitor the status of El Nino/La Nina.

Because more attention has been devoted to El Nino, and noting the association between the Southern Oscillation in the atmosphere and El Nino (and La Nina) in the ocean, the research community began to refer to the combination as ENSO (El Nino/Southern Oscillation). This moniker is somewhat asymmetric: El Nino pertains to just one of the two phases of the Southern Oscillation. It would be perhaps more accurate to refer to El Nino as the warm phase of the Southern Oscillation, and to La Nina as the cold phase of the Southern Oscillation. The term "ENSO" is, however, firmly engrained.

Data Sources:
Southern Oscillation Index values were obtained from the NOAA Climate Prediction Center at their Internet address http://nic.fb4.noaa.gov/data/cddb/cddb/soi [from the second table labeled ”Standardized Data, Sea Level Pressure, (Standard Tahiti - Standard Darwin)”] available from water year 1951 to September 1997. Streamflow volumes were obtained from the NWCC Centralized Forecast System, from water years 1951 - 1997.

Calculation Methodology and Results:
Single and multiple month (summed) SOIs were correlated with spring streamflow volumes at key basin streamflow points. Representative streamflow points, flow periods analyzed, and SOI-streamflow correlation values are shown in Table 1. The values given are for the SOI period (sequence of months) that gave the highest correlation with streamflow. The table contains only those basins that have a correlation greater than 0.35 or less than -0.35.

General Interpretation:
Figure 1 summarizes the results graphically. River basins with correlations greater than 0.35 are shown in red, basins with correlations less than -0.35 in blue, basins with little or no SOI-spring runoff correlation are shown in yellow, and the white indicates areas not analyzed and/or streams that are not water supply forecast points.

Basins with correlations less than -0.35 (blue) tend to have higher than average streamflow during El Nino years (when the SOI is negative, as it is now), and lower than average streamflow during La Nina (when the SOI is positive). Basins with correlations greater than 0.35 (red) tend to exhibit lower than average streamflow during El Nino years and higher than average streamflow during La Nina. Basins with significant SOI correlations (blue and red areas) will require further monitoring as the water year progresses.

For More Information:
Please contact the Water and Climate Services Team at the NWCC located at http://www.wcc.nrcs.usda.gov or send an e-mail to info@wcc.nrcs.usda.gov. ENSO description courtesy of Kelly Redmond, Regional Climatologist, Western Regional Climate Center http://www.wrcc.sage.dri.edu/enso.

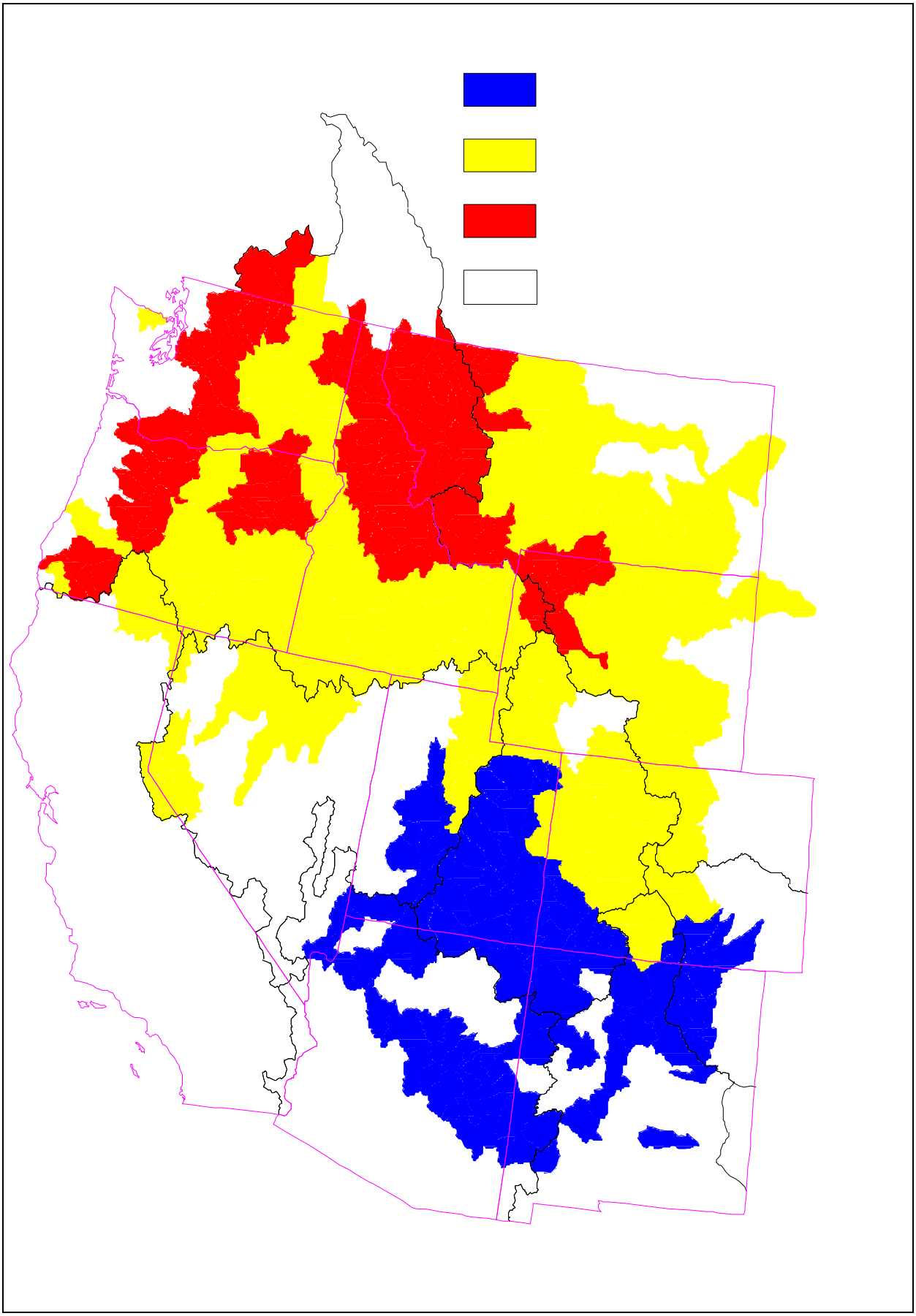

Figure 1. Correlation of the Southern Oscillation Index (SOI) with spring and summer volume runoff

STATE/BASIN	RUNOFF PERIOD	SOI PERIOD	CORRELATION
ARIZONA			
Gila	Jan-May	Oct-Dec	-0.49
Salt	Jan-May	Oct-Dec	-0.49
COLORADO			
Purgatoire	Apr-Sep	Oct-Dec	-0.58
Dolores	Apr-Jul	Oct-Dec	-0.41
Animas	Apr-Jul	Oct-Dec	-0.36
IDAHO			
St. Joe at Calder	Apr-Jul	Sep-Dec	0.56
NF Clearwater (Dworshak Res)	Apr-Jul	Jul-Dec	0.67
Salmon at Salmon	Apr-Jul	Aug-Sep	0.40
MONTANA			
Fisher nr. Libby	Apr-Jul	Apr-Sep	0.67
Lower Willow Inflow	Apr-Jul	Apr-Sep	0.61
Blackfoot nr Bonner	Apr-Jul	Apr-Sep	0.58
Bitterroot at Darby	Apr-Jul	Aug-Sep	0.58
Clarks Fork nr. Belfry	Apr-Jul	Aug-Sep	0.52
Hungry Horse Inflow	Apr-Jul	Apr-Sep	0.50
Swan River nr. Bigfork	Apr-Jul	Aug-Sep	0.50
Yellowstone at Corwin Spgs.	Apr-Jul	Aug-Sep	0.49
Big Hole River nr. Melrose	Apr-Jul	Aug-Sep	0.48
Boulder nr. Big Timber	Apr-Jul	Aug-Sep	0.47
Yaak River nr. Troy	Apr-Jul	Apr-Sep	0.42
Marias nr. Shelby	Apr-Jul	Jul	0.40
St. Mary nr. Babb	Apr-Jul	Apr-Sep	0.38
Madison nr. Grayling	Apr-Jul	Aug-Sep	0.37
Missouri at Toston	Apr-Jul	Apr-Sep	0.36
Clark Fork abv. Missoula	Apr-Jul	Apr-Sep	0.35
NEW MEXICO			
Pecos	Mar-Jul	Oct-Jan	-0.52
Zuni	Jan-May	Oct-Dec	-0.46
Rio Hondo	Mar-Jul	Oct-Dec	-0.45
Rio Chama	Mar-Jul	Oct-Nov	-0.41
Lower Rio Grande	Mar-Jul	Oct-Dec	-0.38
Canadian	Mar-Jun	Nov-Jan	-0.37
OREGON			
Rogue River @ Grants Pass	Apr-Jul	Sep	0.46
North Umpqua @ Winchester	Apr-Jul	Sep	0.43
NF John Day at Monument	Apr-Jul	May-Sep	0.36
Little Deschutes near LaPine	Apr-Jul	Sep-Dec	0.36
Blue Lake Inflow	Apr-Jul	Oct-Dec	0.57
UTAH			
Sevier River @ Hatch	Apr-Jul	Oct-Jan	-0.60
Virgin	Apr-Jul	Oct-Dec	-0.56
Minersville Reservoir Inflow	Apr-Jul	Oct-Jan	-0.56
Recapture Creek	Mar-Jul	Sep-Nov	-0.55
Beaver River near Beaver	Apr-Jul	Oct-Dec	-0.48
Vernon Creek near Vernon	Apr-Jul	Oct-Nov	-0.46
Duchesne	Apr-Jul	Nov-Dec	-0.45
Muddy Creek	Apr-Jul	Oct-Nov	-0.39
Cottonwood Creek	Apr-Jul	Oct-Dec	-0.37
WASHINGTON			
Yakima at Cle Elum	Apr-Jul	Sep-Dec	0.53
Skagit at Newhalem	Apr-Jul	Jun-Oct	0.49
Chelan at Chelan	Apr-Jul	Jun-Oct	0.47
WYOMING			
Wind River nr Dubois	Apr-Jul	Aug-Sep	0.53
Snake above Palisades	Apr-Jul	Jun-Sep	0.48
Buffalo Bill Resv Inflow	Apr-Jul	Aug-Sep	0.44
Boysen Reservoir Inflow	Apr-Jul	Aug-Sep	0.36

Table 1. Representative basins with significant SOI-Spring/Summer Runoff correlation.