Relationships between the Pacific Decadal Oscillation and New Mexico Annual and Seasonal Precipitation

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Introduction

The Pacific Decadal Oscillation (PDO) is a term coined by Nate Mantua and co-authors in a paper entitled: *A Pacific Interdecadal Climate Oscillation with Impacts on Salmon Production* in 1997. The PDO is derived from monthly sea surface temperature (SST) anomalies in the North Pacific Ocean, poleward of 20 degrees latitude. Relationships between the PDO and the El Niño-Southern Oscillation (ENSO) that centers its manifestation in the equatorial Pacific are not presently understood.

In this paper, I will refer to the PDO as the index that is derived from the monthly SST anomalies in the region of the Pacific poleward of 20 degrees latitude.

When one studies the derived PDO over the period of a century, it's quite convincing that the PDO is a very real cycle (fig 1). The PDO cycle also has a much longer time interval than the ENSO cycle.

While the existence of the PDO seems to be pretty clear, the impacts of the cycle are not as clear, and haven't been especially well documented for individual climatic regions of the country. The purpose of this paper was to determine impacts the PDO has on precipitation variability in New Mexico.

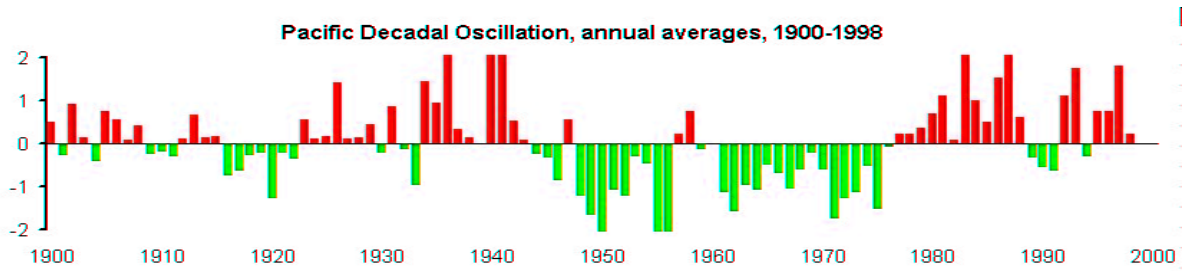

Figure 1

Methodology

The relationship between the PDO and New Mexico precipitation was studied in several ways. Data sets for the PDO (as well as figure 1) were obtained from the University of Washington web page. An annual PDO average was calculated for each year from 1900 through 1999. Average precipitation for each of eight climate divisions (fig 2) was calculated, for each of those years, using data obtained from the National Climatic Data Center (NCDC). Precipitation was also

Figure 2

calculated for each of the seasons. Years were determined for which the PDO varied substantially from zero. In this paper, one standard deviation of PDO values (1900-1999) was centered about the mean value (+0.04) to represent normal conditions. Outside of this range, the PDO was categorized as Asignificantly negative@ or Asignificantly positive.@ ASignificant Negative PDO years@ were determined to be years in which the average PDO was less than -0.73. ASignificant Positive PDO years@ were determined to be years in which the average PDO was greater than +0.82. Years were determined for which the average PDO was outside of the range from -0.73 to +0.82. The positive and negative PDO years are shown in table 1, along with the PDO average for those years:

Table 1

Negative PDO Years	**Average PDO**	**Positive PDO Years**	**Average PDO**
1920	-0.907	1926	+1.160
1948	-0.874	1934	+1.183
1949	-1.228	1936	+1.731
1950	-1.810	1940	+1.769
1951	-0.769	1941	+1.994
1952	-0.866	1981	+0.918
1955	-1.948	1983	+1.648
1956	-1.804	1984	+0.838
1961	-0.818	1986	+1.239
1962	-1.158	1987	+1.821
1964	-0.770	1992	+0.928
1967	-0.734	1993	+1.417
1971	-1.291	1997	+1.461
1972	-0.922		
1973	-0.804		
1975	-1.102		
1999	-1.063		

For the one hundred years included in the study, 30 years were determined to be either Asignificantly positive@ or Asignificantly negative.@ Of those 30 years, 13 were determined to be Asignificantly positive,@ and 17 years were Asignificantly negative.@

An average annual precipitation was computed for each climate division based on data obtained from the National Weather Service=s cooperative observer network, and any aviation observation stations with long-term records. Approximately 175 stations were used in these calculations. Precipitation was considered to be normal for years in which the average for the division was within one half standard deviation of the long-term average. The remainder of the years were classified according to Aabove-normal@ or Abelow-normal@ status. This was also done for a

Astatewide@ composite of all the climate divisions. The same methodology was employed for seasonal precipitation, with values plus or minus half a standard deviation designated Anormal.@

An attempt was also made to quantify precipitation during significantly positive or negative years. Average precipitation was calculated for each year and compared to long term averages. Ratios were also computed to compare the average precipitation during significantly negative and significantly positive years. The same methodology was employed to investigate seasonal precipitation for each of the eight climate divisions.

Results for Annual Precipitation

Tables 2 and 3 show the number of years with normal, above-normal, and below-normal precipitation for each climate division during the significantly positive and negative PDO years.

Table 2 (Significantly Negative PDO Years)

Precip.	Div. 1	Div. 2	Div. 3	Div. 4	Div. 5	Div. 6	Div. 7	Div. 8	ALL
Above	1	1	3	2	2	2	2	2	15
Below	6	8	7	5	6	9	8	9	58
Norm.	10	8	7	10	9	6	7	6	63

Table 3 (Significantly Positive PDO Years)

Precip.	Div. 1	Div. 2	Div. 3	Div. 4	Div. 5	Div. 6	Div. 7	Div. 8	ALL
Above	7	5	6	10	6	7	8	7	56
Below	0	1	4	0	1	1	2	1	10
Norm.	6	7	3	3	6	5	3	5	38

It=s readily obvious that significantly positive PDO years favor above-normal precipitation, and significantly-negative PDO years favor below-normal precipitation. During negative PDO years, the dry years outnumbered the wet years nearly four to one, when all divisions were considered for those years in which precipitation varied from normal. During positive PDO years, wet years outnumbered dry years between five and six to one, when all divisions were considered for those years in which precipitation varied from normal.

Table 4 shows the average precipitation for each climate division during significantly positive and significantly negative PDO years, as well as long-term average precipitation for all years (1900-1999). The table also shows the ratio of precipitation between the negative and positive PDO years.

Table 4(Precipitation averages and percentage of normal during positive/negative PDO years)

Precip.	Div 1	Div 2	Div 3	Div 4	Div 5	Div 6	Div 7	Div 8	ALL
+ PDO	13.78	18.07	18.31	16.17	11.45	19.50	17.19	13.18	15.96
%Normal	122.7	110.7	115.5	124.7	122.7	116.3	127.8	122.2	119.6
- PDO	9.90	14.92	14.77	11.88	8.34	15.18	11.80	8.95	11.97
%Normal	88.1	91.4	93.1	91.6	89.3	90.6	87.7	83.0	89.7
Norm.	11.23	16.32	15.86	12.97	9.33	16.76	13.45	10.78	13.34
-/+ Ratio	71.8%	82.5%	80.7%	73.5%	72.8%	77.8%	68.6%	67.9%	75.0%

It=s readily apparent every climate division received more precipitation than normal during the positive PDO years, and less precipitation during the negative PDO years. Climate divisions 1, 4, 5, 7, and 8 all averaged more than 120 percent of the normal precipitation during the positive PDO years. Least affected was climate division 2, the north-central mountains bordering Colorado. The statewide average for positive PDO years was 119.6 percent of normal.

During negative PDO years, the state has averaged 89.7 percent of normal precipitation. It appears that climate division 8 (southwest desert) suffered greatest, with precipitation averaging only 83 percent of normal.

By looking at the ratio of negative PDO years to positive PDO years, one might be able to et a sense of the magnitude of change that can be expected when the cycle reverses. Looking at the ratio, it=s apparent the amount of change increases southward in New Mexico. Ratios of slightly more than 80 percent along the Colorado border from north-central through northeast New Mexico (divisions 2 and 3) show less dramatic effects of the PDO cycle compared to climate divisions farther south. In divisions 7 and 8 (the southeast and southwest), precipitation during negative PDO years averages less than 70 percent of the average during positive PDO years. The statewide average ratio of precipitation between the negative and positive PDO years is 75 percent.

Results for Seasonal Precipitation

Seasonal precipitation was investigated for each climate division and determined to be normal, above-normal, or below-normal. The long-term average centered about one standard deviation provided the range of normal precipitation. For each climate division, the number of years for each season was determined for each category. For winter, two calculations were made for each climate division. One calculation was for those winters that were in progress at the beginning of a year determined to be a positive or negative PDO year. Another calculation was made for those winters that were determined to begin at the end of a year determined to be a positive or negative

PDO year. For purposes of this paper, the seasons were determined in the following manner: Spring was March through May; Summer was June through August; Autumn was September through November; and Winter was December through February. Tables 5-14 show the results of the seasonal analyses.

Table 5 (Spring Season - Negative PDO Years)

Precip.	Div 1	Div 2	Div 3	Div 4	Div 5	Div 6	Div 7	Div 8	ALL
Above	3	3	3	2	3	1	1	3	19
Below	8	7	8	9	8	7	8	8	63
Norm.	6	7	6	6	6	9	8	6	54

Table 6 (Spring Season - Positive PDO Years)

Precip.	Div 1	Div 2	Div 3	Div 4	Div 5	Div 6	Div 7	Div 8	ALL
Above	7	2	3	5	6	6	6	6	41
Below	0	2	1	0	2	1	0	1	7
Norm.	6	9	9	8	5	6	7	6	56

Table 7 (Summer Season - Negative PDO Years)

Precip.	Div 1	Div 2	Div 3	Div 4	Div 5	Div 6	Div 7	Div 8	ALL
Above	4	4	6	4	3	5	5	4	35
Below	7	6	7	9	8	7	7	8	59
Norm.	6	7	4	4	6	5	5	5	42

Table 8 (Summer Season - Positive PDO Years)

Precip.	Div 1	Div 2	Div 3	Div 4	Div 5	Div 6	Div 7	Div 8	ALL
Above	4	2	7	7	4	3	4	4	35
Below	2	5	4	3	4	5	3	5	31
Norm.	7	6	2	3	5	5	6	4	38

Table 9 (Autumn Season - Negative PDO Years)

Precip.	Div 1	Div 2	Div 3	Div 4	Div 5	Div 6	Div 7	Div 8	ALL
Above	3	2	3	5	4	3	2	4	26
Below	8	11	9	6	9	9	8	9	69
Norm.	6	4	5	6	4	5	7	4	41

Table 10 (Autumn Season - Positive PDO Years)

Precip.	Div 1	Div 2	Div 3	Div 4	Div 5	Div 6	Div 7	Div 8	ALL
Above	6	6	4	6	5	6	5	5	43
Below	2	3	4	2	4	2	4	3	24
Norm.	5	4	5	5	4	5	4	5	37

Table 11 (Winter Season (a) - Negative PDO Years)

Precip.	Div 1	Div 2	Div 3	Div 4	Div 5	Div 6	Div 7	Div 8	ALL
Above	2	4	4	3	2	5	5	2	27
Below	8	9	4	8	8	7	6	9	59
Norm.	7	4	9	6	7	5	6	6	50

Table 12 (Winter Season (b) Negative PDO Years)

Precip.	Div 1	Div 2	Div 3	Div 4	Div 5	Div 6	Div 7	Div 8	ALL
Above	3	3	2	4	2	5	3	4	26
Below	6	8	4	8	7	6	9	7	55

Norm.	8	6	11	5	8	6	5	6	55

Table 13 (Winter Season (a) Positive PDO Years)

Precip.	Div 1	Div 2	Div 3	Div 4	Div 5	Div 6	Div 7	Div 8	ALL
Above	5	6	5	7	6	5	5	5	44
Below	4	3	2	3	3	5	3	4	27
Norm.	4	4	6	3	4	3	5	4	33

Table 14 (Winter Season (b) Positive PDO Years)

Precip.	Div 1	Div 2	Div 3	Div 4	Div 5	Div 6	Div 7	Div 8	ALL
Above	9	7	3	8	7	6	5	6	51
Below	1	2	5	2	3	3	5	2	23
Norm.	3	4	5	3	3	4	3	5	30

Table 15 (All Seasons for Negative PDO Years)

Precip.	Div 1	Div 2	Div 3	Div 4	Div 5	Div 6	Div 7	Div 8	ALL
Above	15	16	18	18	14	19	16	17	133
Below	37	41	32	40	40	36	38	41	305
Norm.	33	28	35	27	31	30	31	27	242

Table 16 (All Seasons for Positive PDO Years)

Precip.	Div 1	Div 2	Div 3	Div 4	Div 5	Div 6	Div 7	Div 8	ALL
Above	31	23	22	33	28	26	25	26	214

Below	9	15	16	10	16	16	15	15	112
Norm.	25	27	27	22	21	23	25	24	194

Discussion of Seasonal Results

Spring

When looking at the amount of time precipitation falls into categories of normal, above, and below normal, it's apparent that the spring weather during positive PDO years was significant. When the precipitation was outside of the normal range, wet springs outnumbered the dry years 41 to 7 for all divisions. Precipitation fell in the normal range 56 seasons, or 54 percent of the time. Divisions 1, 4, and 7 experienced no (zero) dry years during positive PDO years. Division 2 (north-central mountains near the Colorado border) was the only division to show no effect, with 2 wet springs, 2 dry ones, and 9 in the normal category.

Negative PDO years produced dry springs more often than not by a ratio of over three to one. For all climate divisions combined, dry springs outnumbered wet ones 63 to 19. Fifty-four seasons were considered normal, which was approximately 40 percent of the time. Divisions 6 and 7, constituting roughly the southeast quarter of the state, exhibited the greatest effect from negative PDO years, with dry springs outnumbering wet springs 15 to 2 in those divisions combined.

Summer

Of all the seasons, summer was least affected by whether the PDO was positive or negative for the year. Positive PDO years favored above-normal precipitation, but by a small margin. Wet summers outnumbered dry ones 35 to 31, with 38 falling into the normal range. Divisions 2, 6 and 8 (the mountains and southwest desert) actually had more dry summers than wet ones during positive PDO years, while division 5 (central valley) broke even.

The tendency for dry summers during negative PDO years was a bit more apparent, with dry summers outnumbering the wet ones 59 to 35 for all divisions combined. Forty-two summers fell into the normal range.

Autumn

Tables 9 and 10 show the effect of positive and negative PDO years on autumn precipitation. For all climate divisions, dry years outnumber wet ones 69 to 26, with 41 seasons falling in the normal range. The effect of negative PDO years on autumn precipitation was especially apparent in division 2 (north-central mountains), where dry years outnumbered wet ones 11 to 2. Meanwhile, division 4 (west-central mountains) was relatively balanced between the wet and dry years.

During positive PDO years, wet autumns outnumbered dry ones nearly two to one. However,

there appeared to be little effect in the Eastern Plains (divisions 3 and 7), as well as the Central Valley (division 5).

Winter

Recall winter precipitation was determined for those winters which were already in progress at the beginning of the negative/positive PDO year, as well as those winters that began at the end of a negative/positive PDO year. These two winters are referred to, respectively, as winter (a) and winter (b) in tables 11 through 14.

For negative PDO years, winters (a) and (b) exhibited little difference. For both winters (tables 11 and 12), dry seasons outnumbered wet ones slightly more than two to one. For winter (a), the least difference was noted in divisions 3, 6, and 7. This area comprises the Eastern Plains and central mountain chain, or roughly the eastern half of New Mexico. This pattern wasn=t noted for winter (b), although division 6 (central mountains) exhibited more balance than the other divisions.

Tables 13 and 14 show that positive PDO years favored above-normal precipitation, especially in the winters (b) that began at the end of a positive PDO year. Winter (b) was especially interesting in that wet winters that began at the end of positive PDOs almost exclusively favored western and central New Mexico. Division 1 (northwest) only experienced one dry winter in 13 years. In divisions 1, 2, 4, 5, 6, and 8 (all of west and central New Mexico), wet winters outnumbered dry ones 43 to 13 for winter (b), with 22 falling into the normal range. This was in marked contrast to the Eastern Plains (divisions 3 and 7), where dry winters (b) actually outnumbered wet ones 10 to 8, with 8 falling in the normal range.

All Seasons Combined

Tables 15 and 16 show the results of all seasons combined. For negative PDO years (table 15), dry seasons outnumbered wet seasons approximately 2.3 to 1. The greatest ratio was in division 5 (central valley), where dry seasons outnumbered wet ones nearly three to one.

For positive PDO years, divisions 1 (northwest) and 4 (west-central mountains) stood out, with wet seasons outnumbering dry ones over three to one. Effects of a positive PDO were least in divisions 2 (north-central mountains) and 3 (northeast plains). For all divisions combined, wet seasons outnumbered dry ones nearly two to one.

Seasonal Precipitation Quantified

Monthly and seasonal precipitation in the Southwest U.S. exhibits great variability. During any Anormal@ year it=s not unusual to have some months in which less than 20 percent of normal precipitation falls, and others with precipitation that exceeds 200 percent of normal. Consequently, besides examining the number of seasons with above-normal, below-normal, or normal precipitation, average precipitation was calculated for each climate division during

positive and negative PDO years, and compared to the long-term averages.

Tables 17-21 show the percentage of normal precipitation for each climate division and each season, along with a ratio of averages during negative PDO years to averages during positive PDO years.

Table 17 (Spring Season) (%)

	Div 1	Div 2	Div 3	Div 4	Div 5	Div 6	Div 7	Div 8	ALL
B PDO	78.7	85.5	88.7	71.0	72.0	75.1	69.2	73.1	78.7
+ PDO	142.9	115.7	130.7	160.4	141.6	142.8	163.4	175.0	142.2
Ratio	55.0	73.9	67.9	44.3	50.9	52.5	40.6	41.8	55.4

Table 18 (Summer Season) (%)

	Div 1	Div 2	Div 3	Div 4	Div 5	Div 6	Div 7	Div 8	ALL
B PDO	94.1	97.0	98.7	91.8	95.9	96.5	97.9	93.5	96.0
+ PDO	106.2	98.5	101.0	104.8	103.8	95.6	107.6	101.9	101.8
Ratio	88.6	98.5	97.8	87.6	92.4	101	91	91.7	94.2

Table 19 (Autumn Season) (%)

	Div 1	Div 2	Div 3	Div 4	Div 5	Div 6	Div 7	Div 8	ALL
B PDO	90.2	82.7	85.0	97.9	87.5	85.6	80.8	93.0	87.5
+ PDO	122.7	116.1	124.8	127.8	130.1	127.9	122.6	125.0	124.4
Ratio	73.7	71.2	68.1	76.6	67.4	67.0	65.9	74.4	70.4

Table 20 (Winter (a)) (%)

	Div 1	Div 2	Div 3	Div 4	Div 5	Div 6	Div 7	Div 8	ALL
B PDO	86.4	92.2	97.0	88.8	86.0	93.3	97.1	87.2	90.7
+ PDO	124.3	117.3	133.1	130.4	134.9	112.7	137.7	136.7	126.5
Ratio	69.5	78.6	72.8	68.1	63.8	82.8	70.5	63.4	71.7

Table 21 (Winter (b)) (%)

	Div 1	Div 2	Div 3	Div 4	Div 5	Div 6	Div 7	Div 8	ALL
B PDO	80.2	91.9	86.3	90.2	82.9	92.3	82.6	93.2	88.1
+ PDO	139.6	123.7	105.6	145.1	130.2	121.9	116.9	137.1	127.5
Ratio	57.5	74.3	81.8	62.1	63.4	75.7	70.7	68.0	69.1

Discussion of Seasonal Precipitation Quantities

The effect of the PDO cycle is profound when one studies the quantity of precipitation New Mexico receives during the positive and negative phases of the cycle that lie outside one standard deviation of the mean value. Tables 17 through 21 show that this effect was most pronounced during the spring, and least noticeable during the summer.

Table 17 shows that the state received only 78.7 of the normal spring precipitation during the negative PDO years, but a whopping 142.2 percent of the normal spring precipitation during the positive PDO years. The ratio of precipitation between negative and positive PDO years was 55.4 percent for the state. This ratio is especially noteworthy in divisions 7 and 8. Spring rains are extremely important in these two divisions, because of the agriculture (ranching and farming) operations. The ratio between positive and negative PDO years in these divisions was, respectively, only 40.6 and 41.8 percent. Spring precipitation in these two divisions exemplify the Afeast@ and Afamine@ cycle. Meanwhile, there was less difference farther north between the dry and wet springs. The highest ratios between the dry and wet springs were in divisions 2 (north-central mountains) and 3 (northeast plains), where there are also agricultural activities at that time of year.

Divisions 4 (west-central mountains), 5 (central valley), 7 (southeast plains) and 8 (southwest desert) suffered most during negative PDO years. Precipitation averaged less than 75 percent of normal in those divisions. Divisions 2 and 3, in the north-central and northeast, suffered the least, with precipitation between 85.5 and 88.7 percent of normal. Those same two divisions (2 and 3) were also least affected during positive PDO years, especially division 2, which averaged 115.7 percent of normal precipitation. Meanwhile, some of the divisions that suffered the most

during negative PDO years benefitted the most during positive PDO years. Divisions 4, 7, and 8 all averaged greater than 150 percent of normal spring precipitation during the positive PDO years. Division 8 averaged 175 percent of normal. Of course, one thing to keep in mind with the drier climate divisions in New Mexico is that normal precipitation is a small amount. Consequently, the range that division 8 exhibited between negative PDO and positive PDO years (73 to 175 percent of normal) translates into a difference of about one inch of precipitation. However one inch of precipitation in the southwest desert is 10 to 15 percent of the average annual precipitation.

One effect of positive PDO years on spring precipitation in the mountainous climate divisions (primarily 2, 4, 6) would certainly be to increase the amount of spring snow melt for numerous applications. A complete study of this issue related to the PDO would need to include the climate divisions of southern Colorado. A good portion of the spring precipitation in division 2 (north-
central mountains) is in the form of snow, although divisions 4 (west-central mountains) and 6 (central mountains) tend to see a change from snow to rain during the second half of the spring.

Summer exhibited less of a ratio between negative and positive PDO years than the other seasons. Most affect by the negative PDO years were the climate divisions in western New Mexico. Divisions 1 (northwest), 4 (west-central mountains), and 8 (southwest desert) all received less than 95 percent of the normal summer precipitation during negative PDO years. All divisions farther east received between 95 and 99 percent of the normal summer precipitation during negative PDO years. Divisions 1 (northwest), 4 (west-central mountains), and 7 (southeast plains) were most favored during positive PDO years. Even so, division 7, the most favored, received only 107.6 percent of normal precipitation during positive PDO years. Consequently, the only division with a ratio of less than 90 percent between negative and positive PDO years was division 1, with a ratio of 88.6 percent. One division (6) was actually slightly wetter during the negative PDO years. Divisions 2 (north-central mountains) and 6 (central mountains) actually have better (wetter) summers when the PDO is neither significantly negative or positive.

Table 19 shows the results of significant negative and positive PDO years on New Mexico autumn precipitation. Autumn precipitation differences between negative and positive PDO years was not as pronounced as spring, but far more noticeable than summer. It=s apparent all divisions suffered less precipitation during negative PDO years and received more during positive PDO years. The ratios between the negative and positive PDO years averaged 70.4 percent, with a range from 65.9 percent in division 7 (southeast) to 76.6 percent in division 4 (west-central mountains). This was the smallest range of ratios of all the seasons.

The overall effect on the state of significantly negative and positive PDO years on winter precipitation was similar to autumn, regardless of looking at winters that were ending early in a PDO year or winters that had just begun at the end of a PDO year. Table 20 shows the results for winter (a), that is, those winters that were ending early in a significant PDO year. It=s interesting to note the western portion of New Mexico suffered most during negative PDO years, with winter precipitation averaging less than 90 percent of normal. Meanwhile, the Eastern Plains

faired best (divisions 3 and 7), averaging 97 percent of normal. During positive PDO years, all divisions received greater than 110 percent of normal precipitation, but divisions 3 (northeast), 4 (west-central mountains), 5 (central valley), 7 (southeast), and 8 (southwest desert) all exceeded 130 percent of normal. The greatest differences between the good and bad years were in divisions 5 (central valley) and 8 (southwest desert), where the ratios between negative and positive PDO years was between 63 and 64 percent.

Winter precipitation at the end of a significant PDO year (table 21) showed a similar statewide average for the negative PDO years (88.1 percent versus 90.7 percent), but the pattern from east (wetter) to west (drier) did not hold true. Divisions 1 (northwest), 5 (central valley), and 7 (southeast) all averaged between 80.2 and 82.9 percent of normal precipitation during the negative PDO years. Divisions 6 and 8 (central mountains and southwest desert) faired a little better, with averages of 92.3 and 93.2 percent.

Winter precipitation averaged 126.5 percent (statewide) for winter (a), and 127.5 percent for winter (b), showing no appreciable difference.

Summary/Conclusions

There is a strong relationship between the Pacific Decadal Oscillation and precipitation in New Mexico. From table 2, it can be seen that dry years outnumbered wet years nearly four to one for significantly negative PDO years whenever precipitation was either above or below normal. For all divisions combined, dry division-years outnumbered wet ones 58 to 15, with 63 falling in the normal range (plus or minus one-half standard deviation from the mean precipitation). During significantly positive PDO years (table 3), wet years outnumbered dry years between five and six to one. For all divisions combined, wet division-years outnumbered wet ones 56 to 10, while 38 fell into the normal range.

The effect of the PDO cycle increases generally from north to south in New Mexico. Ratios of negative to positive PDO precipitation averages shows this quite well. Table 4 shows that this ratio ranges from just above 80 percent in divisions 2 and 3 (north-central mountains and northeast plains) to less than 70 percent in divisions 7 and 8 (southeast plains and southwest desert). The statewide average is 75 percent.

Seasonal precipitation during significant PDO years is especially affected during the spring and least affected during the summer. Spring seasons during positive PDO years are especially noteworthy, with wet springs outnumbering the dry ones nearly six to one (table 6). The ratio between spring precipitation during negative and positive PDO years (table 17) is very significant, with a statewide average of only 55 percent. This affect is especially noteworthy in the south and southwest, where divisions 4, 7, and 8 all had ratios of less than 45 percent. This has profound ramifications for those agricultural regions in those divisions.

If historical data from the 20th century can be used to forecast conditions in the 21st century, one might conclude the following: Precipitation totals during the next negative phase of the PDO will

likely be approximately 75 percent of those during the most recent positive PDO cycle. If it is true that a negative phase of the PDO cycle began in the late 1990s, then it is likely precipitation totals for New Mexico between the late 1990s and the 2020s may only average 75 percent of those totals from the middle 1970s through the middle 1990s. If this forecast is accurate, it may have profound effects on New Mexico. Water issues in New Mexico have been significant throughout recent history, and the importance of these issues will increase dramatically as the population continues to grow. These figures are especially important during periods of rapid growth or great changes in the state. New Mexico experienced rapid changes and substantial population growth during the positive PDO phase that began in the middle 1970s. Anyone who judges the period from the middle 1970s through the middle 1990s to be Anormal@ may find the negative phase of the PDO cycle to be especially harsh in terms of water yield. In fact, it=s very possible a negative phase of the cycle began in the late 1990s.

There are certainly some caveats in this entire process of extrapolating history forward. One Abiggie@ might well be global warming. If the globe is warming, all bets are off. Some global warming models suggest New Mexico will continue to get wetter as the globe heats up. However, considering the ramifications and huge impacts a drought similar to the 1950s (or worse) would have on the Southwest United States, prudent is just too mild a word to use here for the planning and contingency plans that should be implemented.

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