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CLIMATE OF EUREKA, CALIFORNIA

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UNITED STATES
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TABLE OF CONTENTS

CLIMATE OF EUREKA, CALIFORNIA
A 110 Year Summary

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I. STATION LOCATION AND HISTORY

Eureka, California, was established in May 1850, by the Union and Mendocino Companies, and incorporated on April 18, 1856. After a hotly fought election with the city of Arcata, Eureka became the county seat in 1856.

The city, located in Humboldt County, lies along the east and south sides of Humboldt Bay, ranging from two to three miles east of the Pacific Ocean. Situated on the northwest coast of California, Eureka is approximately 300 miles north of San Francisco.

The National Weather Service Office in Eureka is located at 40.48 degrees North latitude, and 124.11 degrees West longitude with a station elevation of 20 feet above mean sea level.

Humboldt Bay is from one-half mile to 4 miles in width and has a length of 14 miles, giving it a tidal area of close to 28 square miles. Humboldt Bay is the only sizable bay on the California coast north of San Francisco and south of Portland, Oregon. The entrance to the bay is about seven miles to the southwest of the National Weather Service Office.

Weather reports from California's northwest coast began on July 27, 1882, as Sergeant J. R. Williams of the U. S. Army Signal Service began sending three daily weather reports by telegraph from the Cape Mendocino Light House to the San Francisco office. These reports were taken at 7 AM, 3 PM, and 11 PM, Washington, D.C. time. The San Francisco office issued warnings which were then wired back to the observer for local display as needed.

Sergeant Williams was relieved by Serg't (the then abbreviation) John J. Mc Lean during November of 1882. A year later, in November of 1883, Serg't A. P. Leavitt took up the duties. He spent his entire military career at the Cape Mendocino Signal Office before leaving in November of 1886 as a Private!

On December 1, 1886, the first Eureka office was established by the U. S. Army Signal Service at the Buhne Building, located just south of Humboldt Bay at Second and G Streets.

On July 1, 1891, the Weather Bureau was formed under the new U. S. Department of Agriculture, which had replaced the former Commissioner of Agriculture in 1888.

The Signal Service honorably discharged its NCO's from active duty and many remained with the new Bureau as civilian employees.

The Eureka Weather Bureau Office moved into its second office, in the U. S. Post Office and Court House, at 5th and H Streets, on January 1, 1911.

In 1916, under pressure from various Chambers of Commerce along the Lower Eel River, the Eureka office began the Eel River Flood District. Three wire weight gages were installed along the Eel River; one at Fernbridge, the second at Garberville, and the third at Dos Rios in Mendocino County.

Due to the increases in services to the field of aviation, June of 1940 saw the Weather Bureau reassigned to the Department of Commerce.

After the disastrous flooding on the north coast during December of 1964, the State of California's Department of Water Resources established the Eureka Flood Center on November 1, 1965.

The Center was collocated with the Weather Bureau's office, to affect a joint cooperative effort to minimize the dangers of the floods that occur on the north coast rivers.

Under a governmental realignment in July of 1970, the Weather Bureau was transferred to the new National Oceanic and Atmospheric Administration, still under the Department of Commerce. It was renamed the National Weather Service.

On October 16, 1994, the Eureka National Weather Service Office moved into its present office on Woodley Island. Located in Humboldt Bay, the new office is about one-half mile north of the previous downtown site. The Eureka Flood Center also moved to the new location.

In regards to the early establishment of Eureka's river flood forecasting responsibilities, the following notes were taken from Form No. 1014 - Met'l; Jan 16th through 20th 1919 as follows.

Jan 16th 1919..."A Southwest storm warning effective at 7:30 AM was issued by the San Francisco office this morning, but not received here until 10:10 AM, on account of wire trouble. Upon receipt, it was promptly repeated to display stations and the flags displayed locally. Though the verifying velocity did not occur at Eureka, this warning was abundantly justified. Strong Southerly winds and excessive rains occurred during the night of 16"-17", with floods in the principle streams."

Jan 17th 1919..."Eel River floods. There was a moderately heavy rainfall during the day yesterday and Eel River rose steadily but not at an unusually rapid rate. Communication with the up-river gaging stations was irregular and was completely cut off after 2 PM at which hour a stage of 18 feet was reported at Dos Rios. The intensity of the storm

increased as night came on and during the night of the 16"-17" excessive rains occurred throughout the Eel watershed. At Dos Rios, 3.10 inches of rain fell during the 24 hours ending at 8 AM, at Garberville 4.55 inches during the same period of time, at Fernbridge 2.49 inches and at Eureka, 3.18 inches measured at 5 AM today. These excessive rains brought about a rapid acceleration of the rate at which the streams were rising, and by 8 AM a stage of 16.4 feet had been reached at Fernbridge; 25 feet at Dos Rios, and 18 feet at Garberville.

However, the reports from Dos Rios and Fernbridge were delayed by wire trouble until about 10 AM, while the Garberville report did not arrive until 3:22 PM. **With only one up-river reading available (Dos Rios), and making the first flood forecast ever attempted for this stream, a conservative warning "stage exceeding eighteen feet at Fernbridge" was issued at 10:30 AM, the reading at that place being then slightly under seventeen feet.** At 3 PM it had risen to 18.9 feet at Fernbridge, and at 5 PM the maximum of 19.3 feet was attained.

Meanwhile the Garberville report (showing a rapid decline on the South Fork) had been received, and at 5:30 PM, the following statement was issued, ""Upper rivers falling rapidly. Crest of rise passing Fernbridge. Flood waters will recede materially by Saturday morning.""

Jan 18th 1919..."The flood in the lower Eel river valley receded slowly during the night but the river was still above the flood stage at 8 AM (16.1 feet at Fernbridge)."

Jan 19th 1919..."The flood waters in the lower Eel river valley continued to subside, but, heavy rains having fallen late night and the river having raised to 20.7 feet at Dos Rios, inquiring persons were advised that the fall would be checked before tonight and be followed by a slight rise."

Jan 20th 1919..."Additional rains have caused another slight rise in the river at Fernbridge (as was indicated yesterday) and the gage there read 13.3 at 8 AM today.

It is not expected that the flood stage of 15 feet will be reached on this rise, as Dos Rios reported river falling at 3 PM, and the weather only partly cloudy, with North wind. Late reports state that the river began to fall during the day."

Thus began the Eureka office's efforts to minimize the effects of the flooding that storms bring to the northwest California rivers and streams.

II CLIMATOLOGICAL AND TOPOGRAPHICAL SUMMARY

The weather of the greater Humboldt Bay Region, including Eureka and the immediate coastal strip, is characterized as Mediterranean (being mild and with minimal temperature changes). The summers are dry and foggy, the winters wet.

Being in such close proximity to the ocean and bay, the Eureka Region experiences high relative humidity throughout the year as shown in the following table showing monthly averages. The times are Pacific Standard. The humidity generally reaches its highest levels in the late night and early morning hours when the coastal stratus and fog are most prevalent. At these times, the humidity averages 87 percent. During the late morning and early evening hours, the humidity decreases to an average of 78 percent.

The coastal range mountains extend south from the state of Washington, to near the San Francisco Bay Region.

The coastal hills surrounding the Humboldt Bay begin at Patrick's Point to the north, then extend to the southeast, then to the south, and finally to the southwest ending at Cape Mendocino. The tops of these hills range from about 1500 to 2500 feet, with Kings Peak to the south of Eureka, topping out at 4087 feet. The ring of hills greatly modifies the rainfall and the temperatures of the whole Humboldt Bay region. These hills are generally arranged in a northwest to southeast direction to the north and east of Eureka, and almost west to east to the south.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
4 AM	87	87	87	88	89	90	92	93	92	91	88	87	89
10 AM	79	77	74	75	76	78	82	84	82	81	79	80	79
4 PM	77	76	75	75	76	77	79	80	79	79	78	77	77
10 PM	83	83	82	83	85	86	89	90	89	88	84	83	85

Within this range lay the Humboldt Bay Region, which includes most of the population centers of Humboldt County. This Region is sheltered from the brunt of the heavier rainfall and wide temperature extremes by a surrounding range of coastal hills.

The immediate coastal plain is very narrow, extending from a little north of Mc Kinleyville, around the Humboldt Bay Region, and south to the lower Eel river valley.

There are two major rivers within the local Region. About nine miles north of Eureka the Mad River empties into the Pacific Ocean, while about 15 miles to the south, the Eel River meets the ocean.

There are several other smaller coastal rivers and streams that empty into the ocean as well. There are six small creeks, and sloughs emptying into Humboldt Bay. These river valleys show a greater variance in rain and temperature values, but do not affect the weather at Eureka or the immediate bay Region to any degree.

As storms move in from the Pacific Ocean, the winds ahead of the systems are generally from the southeast to southwest. Over the Humboldt Bay area, the hills generally deflect the winds south to southeast. However, with the incoming winds nearly perpendicular to the coastal range, the hills exert their greatest influence on the systems by forcibly lifting the incoming systems up and over the local Region. This leaves much of the down wind area, including Eureka and the immediate coastal Region, under a rain shadow.

Eureka's overall average of 38.50 inches is among the lowest on the north coast. Just to the west across the bay at Samoa, the overall average is only 33.05 inches.

This rain shadow is easy to see by comparing the following averages. Patrick's Point State Park, 24 miles north of Eureka, has an overall average of 60.79 inches of rain. Scotia, 23 miles south of Eureka, averages 47.20 inches of rain. Further inland at Willow Creek, 29 mile to the east, 48.34 inches of rain is the norm.

After the frontal activity passes onto the east, the winds are generally from the north to northwest. Again, the hills exert their influence on the local weather by channeling the colder air away from the coastal Region and into the surrounding coastal river valleys and inland regions.

With the cold and unstable air that follows many of the winter systems, Eureka experiences most of the thunderstorm activity that is reported at the station. During this time, Eureka receives its majority of hail and/or ice pellets.

Thunderstorm activity in the summer is extremely rare in Eureka, generally being fueled by the Arizona Monsoon. Most of the summertime activity occurs over the Trinity Alps to the east, and over South Fork Mountain to the southeast.

The colder air behind any frontal activity is constantly being modified by the ocean. Due to the California current flowing south along the coast, the sea surface temperature averages 50 to 52 degrees in the winter months. These moderate ocean temperatures help

protect Eureka and the immediate coastal Region from the more frigid temperatures which can accompany storms originating in the Gulf of Alaska.

The ring of hills also helps to lock in the marine effects in the summer when the sea surface temperatures warm to an average 55 to 57 degrees, helping to give Eureka and the surrounding area extensive fog and low clouds.

During the summer and fall, when the stratus and fog are more prevalent, the fog and stratus generally retreat offshore late in the morning to early in the afternoon, and then returns during the night, generally just before sunrise. This marine layer is usually from 800 to 1500 feet deep. There are periods when the day to night cycle is unbroken, and the entire area remains under continuous low clouds and fog for days on end.

Most of the summertime record high temperatures in Eureka occur during the times an offshore flow develops. This offshore flow generally develops when the inland valleys are under the influence of a thermal low-pressure trough.

As the thermal low moves west towards the coast, and is centered south of Eureka, the stratus and fog disappear and pleasant weather prevails over much of the Region.

The following list shows the various meteorological records that have been established in the past 110 years. The record rainfall of December 1996 is not included in this report.

Eureka, CA - NWS
Station Records

Temperatures

Maximum Temperature	87 Deg F on Oct 26 1993
Coldest Maximum Temperature	33 Deg F on Feb 08 1900
Highest Daily Average Temperature	73 Deg F on Sep 21 1939
Minimum Temperature	20 Deg F on Jan 14 1888
Warmest Minimum Temperature	63 Deg F on Aug 27 1894 Feb 26 1980, Jan 18 1981
Lowest Daily Average Temperature	28 Deg F on Jan 14 1888

Rain

		Amount (Inches)	Date (s)
05	Minute maximum	0.30	Jan 12 1979
10	Minute maximum	0.43	Jan 12 1979
15	Minute maximum	0.51	Nov 11 1926
20	Minute maximum	0.76	Feb 07 1978
30	Minute maximum	0.81	Feb 07 1978
45	Minute maximum	1.01	Dec 05 1952
60	Minute maximum	1.20	Oct 29 1950
80	Minute maximum	1.37	Oct 29 1950
100	Minute maximum	1.57	Oct 29 1950
120	Minute maximum	1.72	Oct 29 1950
150	Minute maximum	2.16	Oct 29 1950
180	Minute maximum	2.53	Oct 29 1950
1	Calendar day maximum	5.04	Oct 29 1950
2	Calendar days maximum	7.11	Feb 03 - 04 1950
3	Calendar days maximum	8.52	Oct 27 - 29 1950
4	Calendar days maximum	9.65	Feb 01 - 04 1890
5	Calendar days maximum	10.12	Oct 25 - 29 1950

10	Calendar days maximum	13.99	Jan 21 - 30 1903
15	Calendar days maximum	17.24	Jan 22 - Feb 05 1890
30	Calendar days maximum	26.69	Jan 09 - Feb 07 1890
60	Calendar days maximum	39.44	Dec 08 1889 - Feb 05 1890

Greatest in a calendar month	19.42	1902
Greatest in a calendar year	67.23	1893
Greatest in a Jul - Jun season	74.10	1889 - 1890
Greatest in a Oct - Sep season	74.39	1889 - 1890

Greatest number of consecutive days with measurable precipitation...

26 days 11.02 inches Dec 25 1935 - Jan 19 1936

Least in a calendar month	00.00	many
Least in a calendar month	21.17	1929
Least in a Jul - Jun season	17.56	1976 - 1977
Least in a Oct - Sep season	19.17	1976 - 1977

Greatest number of consecutive days ~~with~~ WITHOUT measurable precipitation...

81 days May 31 1940 - Sep 01 1940

Snow

24 hour maximum	3.4 Ins	Jan 13 1907
Greatest storm total	5.9 Ins	Jan 12 - 15 1907
Greatest in a calendar month	6.9 Ins	Jan 1907
Greatest depth on ground	3.4 Ins	Jan 13 1907

Pressure

Highest mean sea level pressure	30.71 Ins 1039.96 Mbs	Dec 09 1923
Lowest mean sea level pressure	28.91 Ins 979.01 Mbs	Feb 22 1891

Wind

Highest Gust	69 MPH	Jan 21 1981 Nov 13 1981
Fastest Mile	59 MPH	Jan 25 1914

III. RAINFALL SUMMARY

During the rainy season, generally November through March, Eureka receives over 75 percent of its average rainfall. Most of the rain normally falls in December and January, as shown in the chart below.

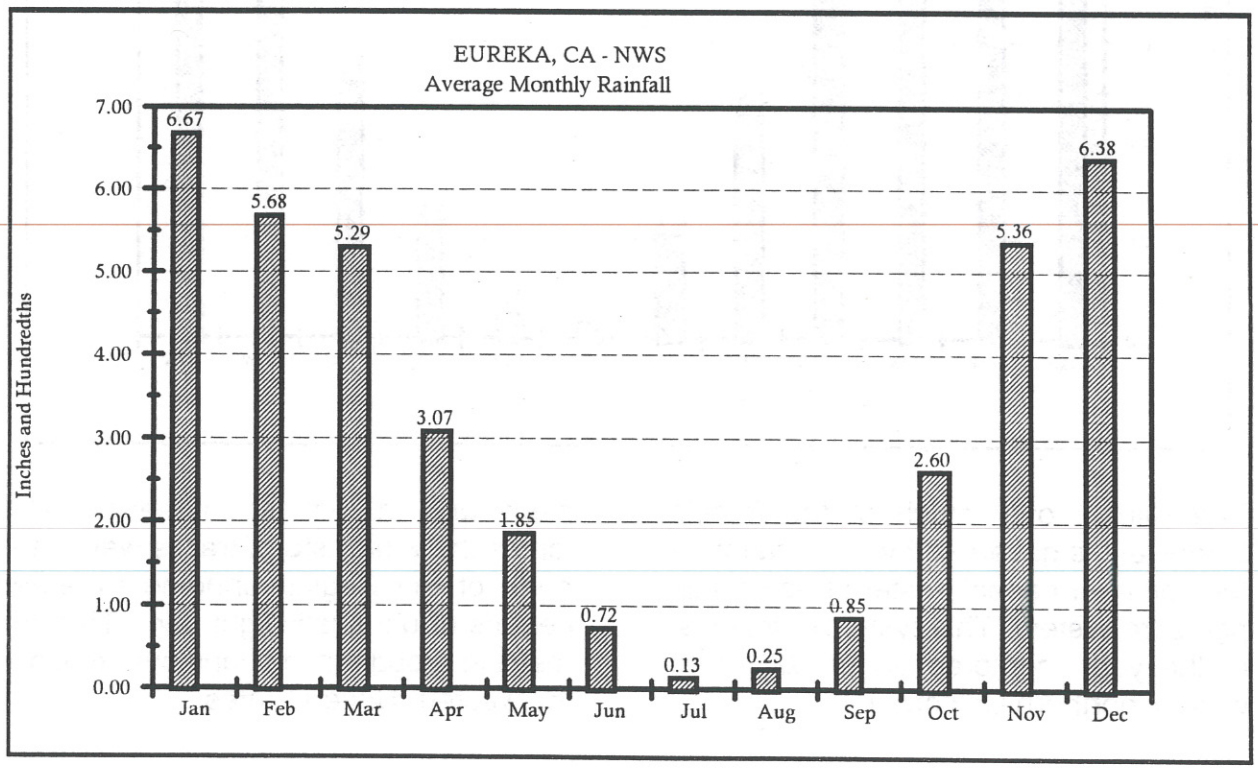
The average annual rainfall for Eureka's one hundred ten year history is 38.87 inches. This is one of the lowest, if not the lowest, averages in northwest California.

As there is minimal uplifting along the immediate west facing beaches, the rainfall for the local Region is dramatically less over Humboldt Bay and the immediate area to the west of the bay.

There is a marked increase in the rainfall pattern in as little as one-half mile of the station, suggesting the rain shield is indeed limited to the immediate bay area. This increase is attributed to the increasing elevation of the Region away from the bay.

Not included in this summary, is the record breaking rains in December of 1996, when Eureka received 21.26 inches of rain. This set a record for the month of December and is the wettest month in Eureka's history.

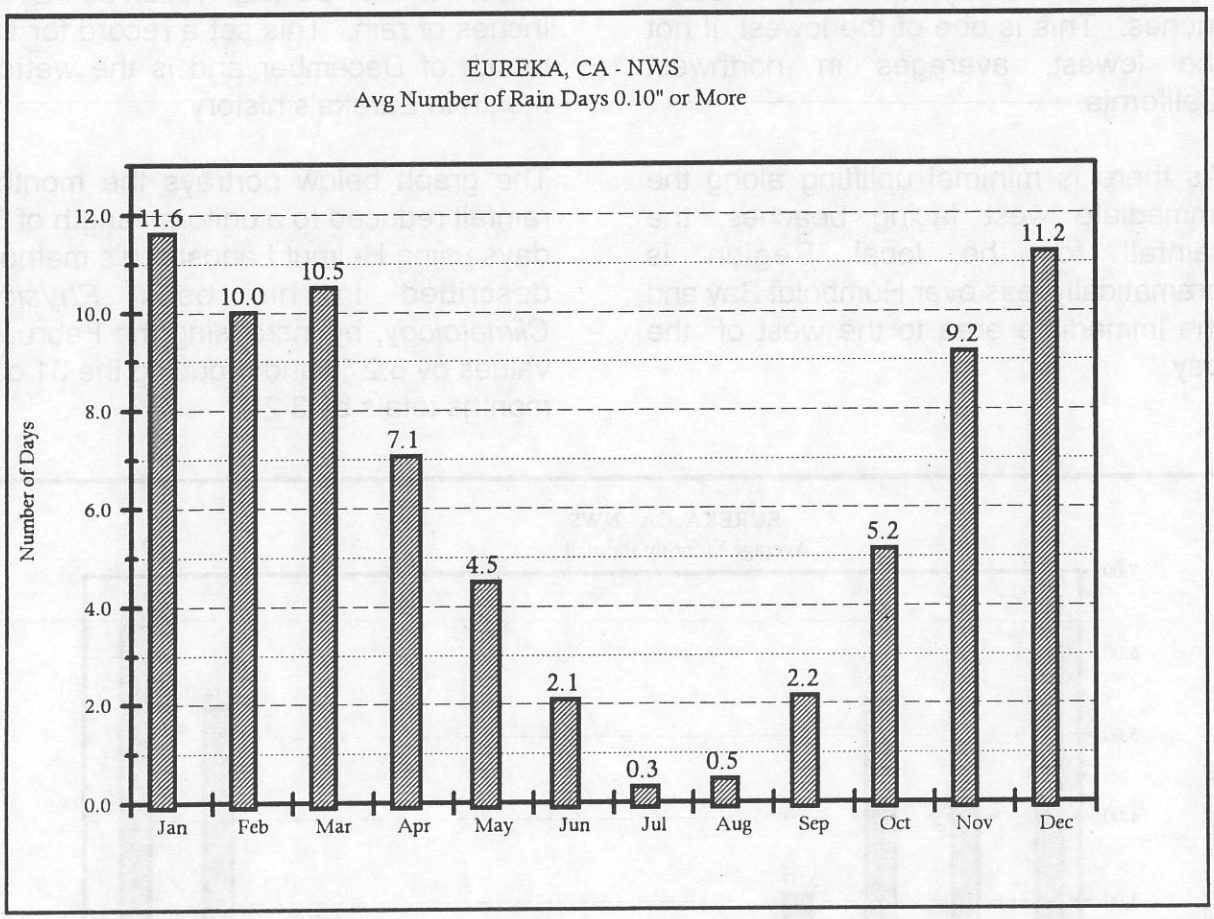
The graph below portrays the monthly rainfall reduced to a uniform length of 30 days using Helmut Landsberg's method, described in his book *Physical Climatology*, by increasing the February values by 6.2 % and reducing the 31 day months totals by 3.2%.



The chart below shows how many rainy days Eureka experiences.

A rainy day is defined as any day one tenth of an inch of rain is reported. As with the average monthly rainfall graph, the majority of the rain days occur in the November to March time frame.

During the winter season, the high pressure is displaced to the south allowing the winter storms that form in the Bering Sea and the Gulf of Alaska to reach the Pacific Northwest and northern California. There have been periods however, when this pattern is disrupted and the high pressure system remains in



The rainfall over much of the Pacific Northwest is governed by the location of the semi-permanent eastern Pacific high pressure system. This system is, for most of the year, centered about 600 miles west of northern California.

place and in fact, strengthens. This forces the winter storm tracks well to the north of the Region bringing extended periods of unusually light rain. This can result in drought conditions over much of the western United States.

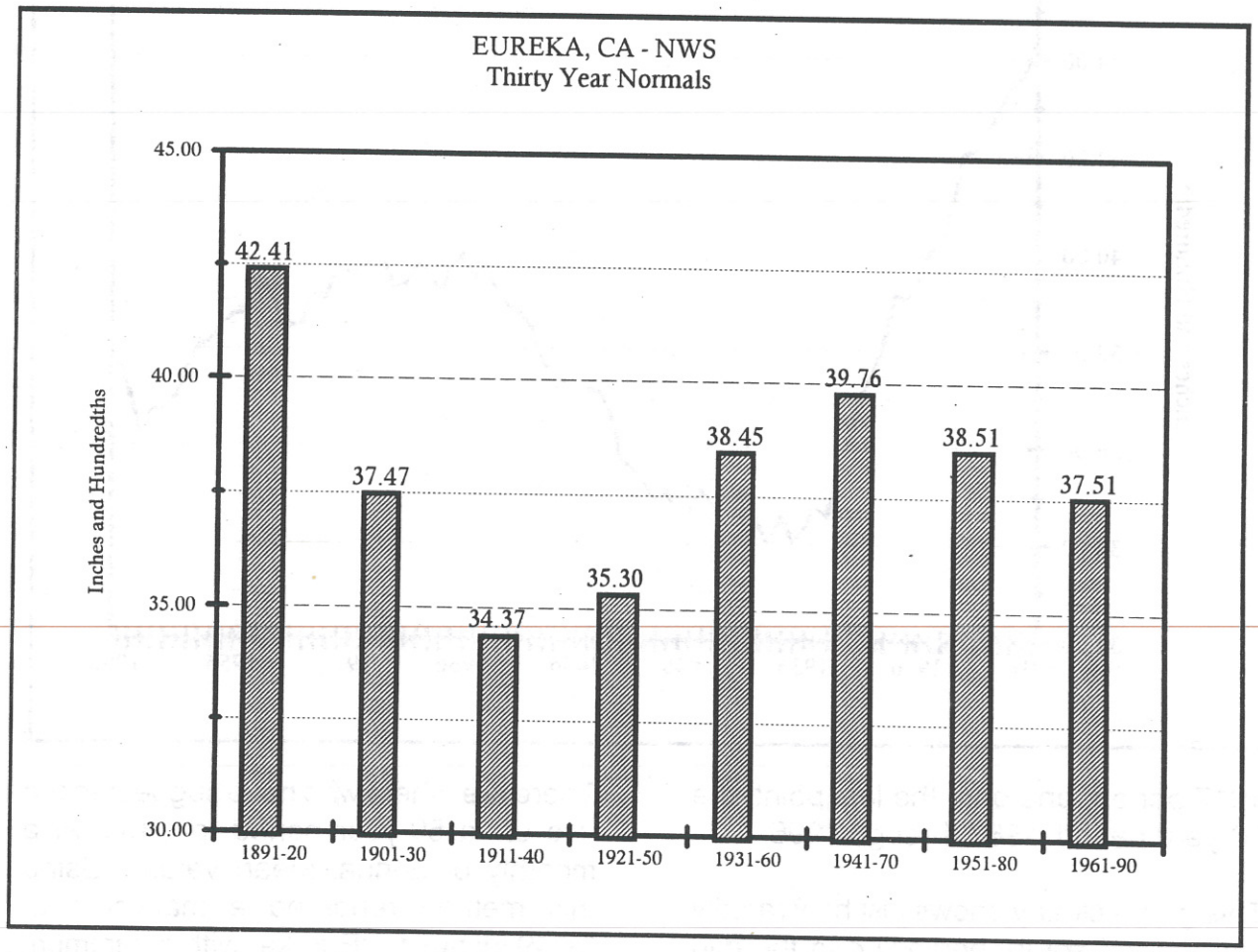
Drought conditions such as these can last 20 years or more, having been shown to occurred often in the past. The last prolonged drought occurred in the 1920's and 30's. Some periods have lasted longer than 50 years as indicated by the study of tree rings.

A. Rainfall Normals

Many of Eureka's monthly and annual rainfall records occurred near the turn of this century. This may be a sign of climatic change, or more likely, a normal cyclic event.

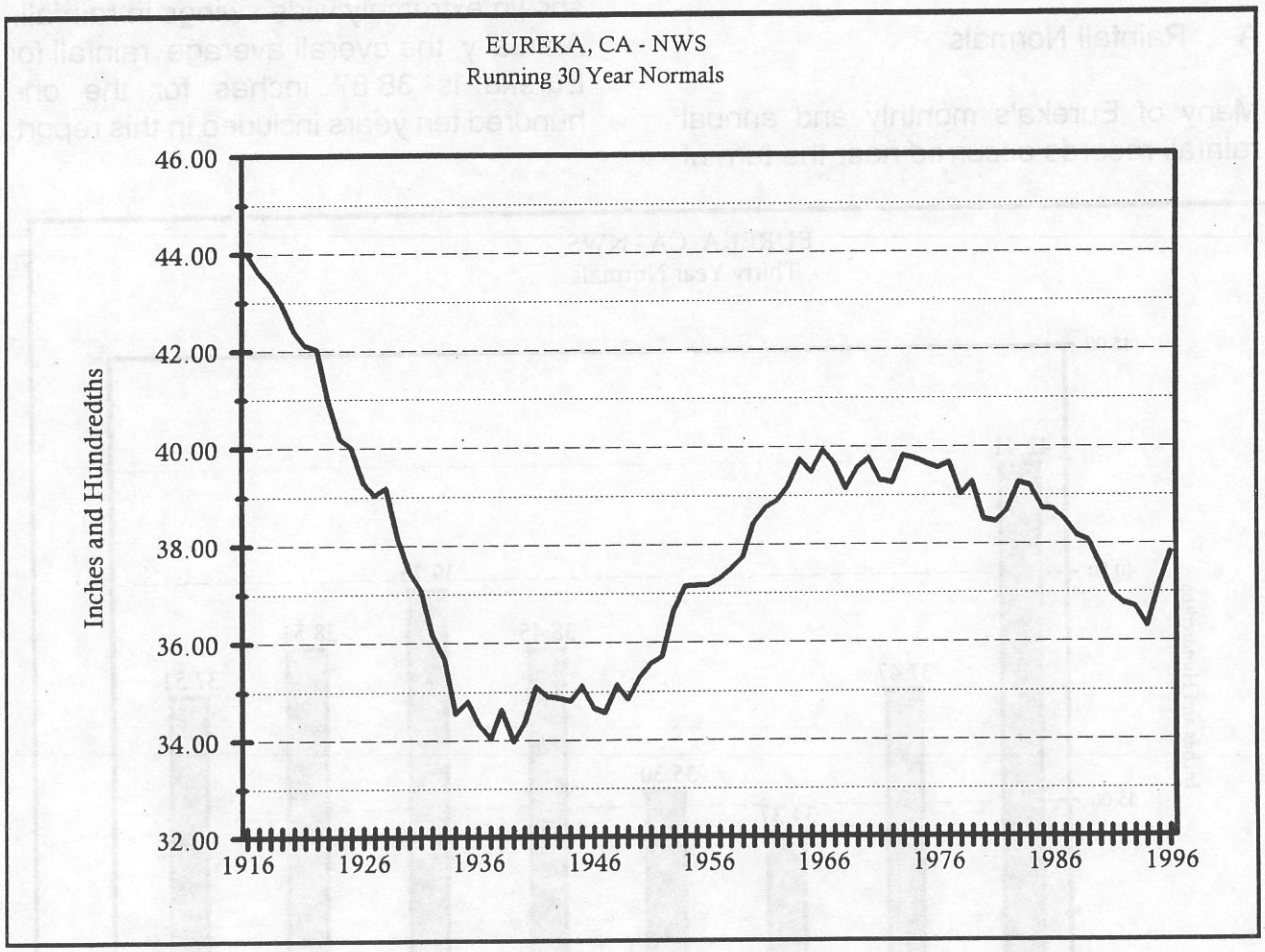
The chart below shows just how much, and how quickly, the 30-year normal rainfall has varied over time in Eureka.

With the 30-year normals ranging from over 41 inches to a low of less than 34 inches, the data for the Eureka office has shown extremely wide swings in rainfall. Annually, the overall average rainfall for Eureka is 38.87 inches for the one hundred ten years included in this report.



There are indications that data from the Cape Mendocino station was included in the early years to aid in establishing the monthly averages and the initial 30-year normals.

Those reports were not used in the preparation of this report. All data in this report are from the three weather offices in Eureka. The following graph depicts a running 30- year normal. The first point represents the 30-year normal ending in 1916. The second point is for the 1888-1917 period, and onto the last point, the 30-year period, 1967 through 1996.



This graph clearly shows just how rapidly the drought set in, beginning in the mid 1920's and lasting through the mid 1930's. It was during this time that Eureka experienced its driest year ever.

With the 30-year normals ranging from a high of 44.00 inches, to a low of 33.97 inches, demonstrates just how quickly the climatic values can vary.

It's been suggested by H. J. Critchfield in his book, *General Climatology*, data of at least 35 years be used to obtain mean values.

There are others who have suggested the use of a 50-year period to arrive at a monthly or annual mean value. Using this method rendered a maximum of 39.49 inches for Eureka, with a minimum of 36.26 inches.

The 50-year means greatly mask the rapid onset and ending of the variations that many are looking for.

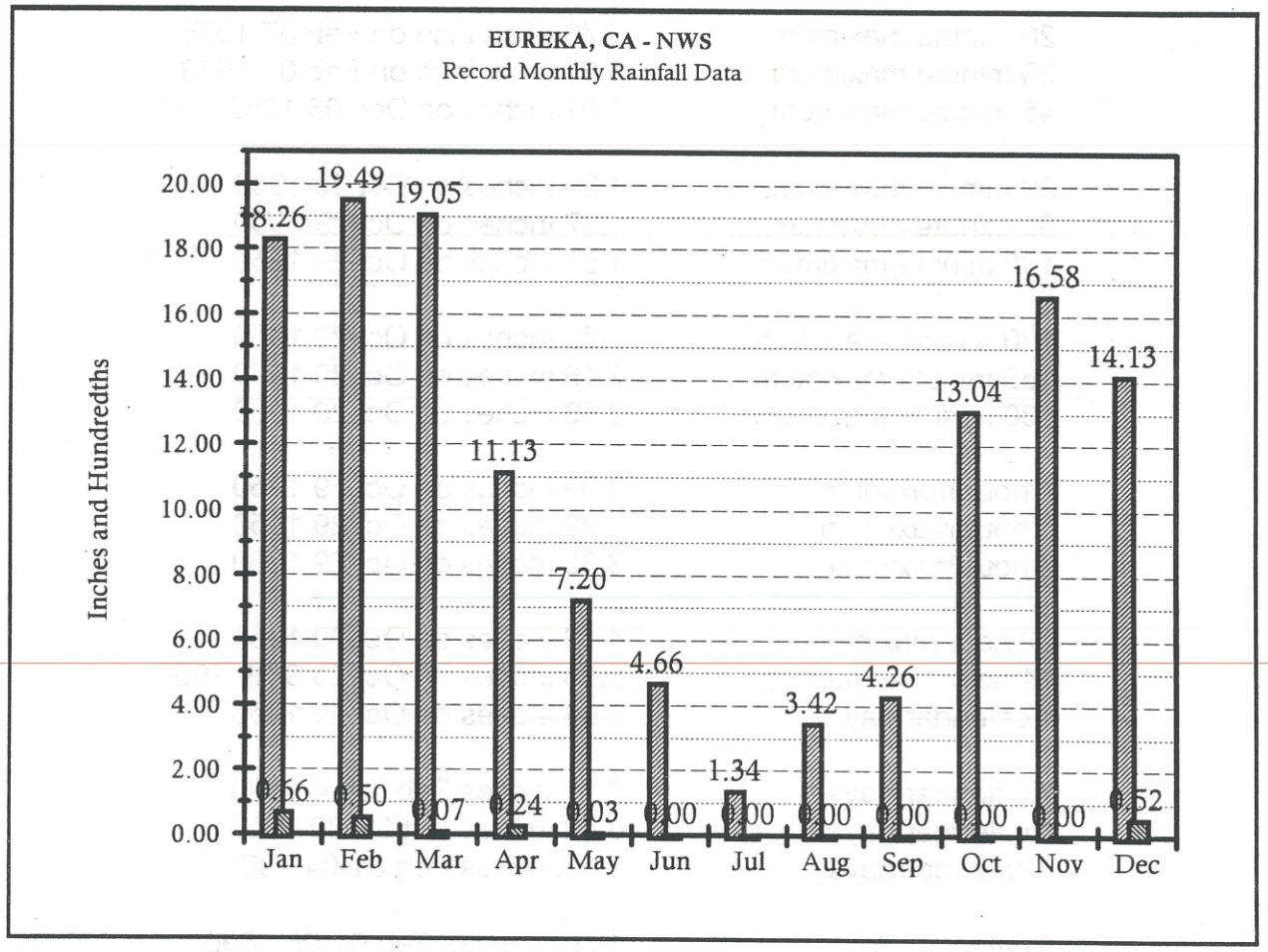
It was in the late 1870's that the now familiar 30-year normal was introduced.

B. Rainfall Records and Averages

The record rainfall in a calendar year was 67.23 inches which fell in 1983. The minimum rainfall of 21.17 inches was recorded in 1929.

The October through September season record maximum rainfall of 74.39 inches fell in 1889-90, and the minimum of 19.17 inches was reported in 1976-77.

The greatest number of consecutive days with measurable rain is 26 days, from December 25, 1935 through January 19, 1936. During this period, 11.02 inches of rain was recorded.



For the July through June season, the maximum record of 74.10 inches fell in 1889-90, while the minimum record of 17.56 inches fell in 1976-77.

The greatest number of consecutive days without any measurable rain is 81 days. This occurred from May 31, 1940 through September 01, 1940.

Below is a listing of the maximum rainfall for the stated period of time that has been recorded at the Eureka office at Fifth and H Streets, using a tipping bucket rain gage and the data being recorded on a triple register.

05 minute maximum.....	0.30 of an inch on Jan 12 1979
10 minute maximum.....	0.43 of an inch on Jan 12 1979
15 minute maximum.....	0.51 of an inch on Nov 11 1926
20 minute maximum.....	0.76 of an inch on Feb 07 1978
30 minute maximum.....	0.81 of an inch on Feb 07 1978
45 minute maximum.....	1.01 inches on Dec 06 1952
60 minute maximum.....	1.20 inches on Oct 29 1950
80 minute maximum.....	1.37 inches on Oct 29 1950
100 minute maximum...	1.57 inches on Oct 29 1950
120 minute maximum...	1.72 inches on Oct 29 1950
150 minute maximum...	2.16 inches on Oct 29 1950
180 minute maximum...	2.53 inches on Oct 29 1950
4 hour maximum.....	3.06 inches on Oct 29 1950
5 hour maximum.....	3.22 inches on Oct 29 1950
6 hour maximum.....	3.33 inches on Oct 29 1950
12 hour maximum.....	4.36 inches on Oct 29 1950
24 hour maximum.....	5.83 inches on Oct 28 & 29 1950
1 calendar day.....	5.04 inches on Oct 29 1950
2 calendar days.....	7.11 inches Feb 3 & 4 1890
3 calendar days.....	8.52 inches Oct 27-29 1950
4 calendar days.....	9.65 inches Feb 01-04 1890
5 calendar days.....	10.02 inches Feb 01-05 1890
6 calendar days.....	10.04 inches Jan 30-Feb 04 1890
8 calendar days.....	12.41 inches Jan 28-Feb 04 1890
10 calendar days.....	13.99 inches Jan 21-30 1903
15 calendar days.....	17.24 inches Jan 22 Feb 05 1890
30 calendar days.....	26.69 inches Jan 09-Feb 07 1890
60 calendar days.....	39.41 ins Dec 08 1889-Feb 05 1890