"SOUTHERN CALIFORNIA COASTAL PROPAGATION PHENOMENON"

Ed Sack, W3NRG

During the Summer of 2001, W3NRG set up a PSK^31 BEACONet station[1] on 28.131 mh at his QTH in Coronado, California. Almost immediately, the station began to record the BEACONet signals of KF6XA whose Maidenhead locator code placed that station in Temecula, California. What made this reception interesting was that the distance between the two stations, 63 miles, is not characteristic of 10 meter ground wave propagation and there are at least three "mountains" in the path that obscure the simple line of sight.

The BEACONet PSK^31 signal protocol includes a preamble of approximately 30 characters followed by a "payload" consisting of station call letters, number of times per hour the beacon is being transmitted, a station configuration code, the Maidenhead locator and a cyclical redundancy check signature (CRC.) Stations are or have been active in various parts of the United States and in Europe and Australia. The recommended transmission timing is between six and twelve times per hour. Software is available to record the reception of signals which pass the cyclical redundancy test and, in certain cases, even send reports over the internet automatically at menu selectable times.

The station equipment for the BEACONet activity usually consists of a personal computer, a transceiver, an interface and an antenna. (Simplified setups have been developed which eliminate the need for the personal computer.) Gathering data over an extended period of time requires, of course, that the station equipment be dedicated to the program.

Early on in the KF6XA to W3NRG data collection process we recognized a definite time dependency on the number of confirmed reports received by W3NRG. We published our early data in a QST article in June 2002.[2] A profile of the terrain between the two stations is shown in that article. The reviewers of the article provided various explanations for the propagation that was being observed.

In response to that article, we received a communication from Bob Gonsett, W6VR, that directed us to a paper[3] which reported that the "unusual" propagation we were experiencing had been first observed in the course of some experiments conducted during World War II. The authors of that article attributed the effect to a sharp transition layer between the colder surface air (colder due to the cooling effect of the ocean implied) and a warm air layer (warmer due to the heating effect of the sun implied.) They hypothesized that he fact that the demarcation between these layers was unusually sharp resulted in the refraction of signals originating well to the north of San Diego into the Point Loma/Coronado area (where the author's QTH is located.)

Early in 2002, KF6XA and W3NRG decided to continue the collection of propagation data for a minimum of 12 months in order to record the effects of seasonal variation. Whereas they had experimented with different transceivers and antennas in their station setups before that time, they elected to standardize on the same transceivers and antennas so as to minimize the effects of those variables. The transceivers in use are the Radio Shack HTX-10's and the antennas are 10 meter Ham Sticks.

KF6XA's beacon was set to transmit 8 times per hour. This provides 192 opportunities for signal capture per day or 5,760 per thirty day month. W3NRG used a program called UI-Path[4] to record the confirmed captures and has preserved the data in tabular form for future analysis. While theoretically there were over 70,000 data points available in a 12 month period, there were occasions when one or the other of the two participants was traveling and the experiment was shut down for a week or so. However, there was no month in the period of May 2002 to April 2003 when there was not sufficient data to provide a solid look at the propagation conditions for that particular month. The lowest number of days in a month when data was recorded occurred in August 2002 when only 11 days of data was available. The maximum number occurred in December 2002 when we have data for every day. The average number of days per month for which data was recorded from May 2002 to April 2003 was 21 days.

The sequence of figures provided in Figure 1 show the profile of confirmed reception of KF6XA transmissions by W3NRG over a period of one year. We have experimented with various approaches to the characterization of this data including time of reception maximum, time of reception minimum, hours with reception above a certain fraction of the maximum, hours below a certain fraction of the maximum, hours when there was no reception at all, etc. So far, the most manageable characterization has been the number of hours in 24 over the period of a month when reception was 70% or more of the reception during the best hour for that month and number of hours in 24 over the period of a month when the reception was 30% or less of the best hour for that month. That data is shown in Figures 2 and 3. Note that the January through April data is from year 2003 while the May through December data is from year 2002.

What may be observed from the data is that beginning in May, the around the clock reception of KF6XA by W3NRG increases significantly. Then, as the summer wanes and fall begins a pronounced daily variance develops between the number of better reception hours and number of poorer reception hours.

Of particular interest is shape of the bar charts in September and October versus that observed for November through April. In the two former months, the peak capture times are during the morning hours whereas in the latter six months those hours tend to be the times of minimum capture.

A fair question to be asked is "Just how strong is the effect?" If the "best hours" just reflected a few captures then the significance of Figures 2 and 3 might be diminished. As noted above, KF6XA transmits 8 times per hour. Hence a "perfect" hour would tally 8 CRC captures. We elected to count the number of days of each month when there 7 or more captures per hour against the "potential" of 8. That count as a percent of the total days for which data was available is shown in Figure 4.

As is evident, most months show percentages of 70% or more. While not tabulated at this time, visual analysis of the data shows many hours during the year in which all 8 transmissions were successfully captured and many days in which 7 to 8 captures occurred in four hours or more of the 24 hour period. We conclude, therefore, that the propagation effect may be characterized as "strong."

One not professionally trained in the science of radio wave propagation can quickly get into trouble by trying to propose a model for a particular observation. However, if we accept the suggestion of those who reported on the effect in the World War II literature, we can conclude that the demarcation layer between the lower, colder air and the higher, warmer air stays at the right altitude and with the right degree of definition such that KF6XA's signal is refracted into W3NRG's antenna over the 24 hour period during much of the summer but that the signal is not so well refracted for the entire period during the other seasons.

What is not yet known, of course, is why the refraction effect is greatly diminished in certain seasons and in certain hours of the day. Is the demarcation between the colder surface air and the warmer upper air less distinct at those times or is the altitude at which that demarcation is occurring not ideal to bend KF6XA's signal into the W3NRG location?

It is also interesting to contemplate where else such an effect may be observed. Does it take a unique combination of a relatively cold body of water adjacent to a semi-arid, semi-tropical plain, for example to create the effect?

Of course, there are other factors that must be considered. KF6XA and the author have asked themselves the following questions. Could it be that the capture rate is heavily biased by strong QRM or QRN? The software that captures the BEACONet signal is operated in a scan mode. If there are strong interfering signals, does it linger too long in the process of deciding that the interfering signal is not a PSK^31 transmission and thus miss the KF6XA transmission? If the interfering signals are causing the receiver AGC control to reduce gain, does that have an effect on the capture rate?

The main sources of the QRM and QRN appear to be local. We can think of no reason why these sources would be stronger in one season than another and indeed, watching the waterfall suggests that they are present year round.

We have also begun a series of experiments to determine what effect interference is having on the capture rate. In one set of experiments we counted the number of confirmed captures over a period of time using a transceiver with no special I.F. band limiting and compared it with the captures in a similar period of time with a receiver set to have a very narrow I.F. bandwidth. We were fortunate that at the time of the experiments the interference was strong enough that the waterfall was periodically turning "all yellow." However, the capture rate was 90% in both cases which would suggest that interference was not having a major effect on the rate. (The experiment also confirms once again the robust nature of PSK^31 transmissions in an otherwise "busy" band.)

In fairness, we did these experiments during the time of year when the capture rate is high. Unfortunately we have not had a chance to do them yet when the capture rate is low. Logic suggests that the impact of interference during times of weak propagation would reduce the reported capture rate, which does not contradict the finding that there is a very definite path effect around the clock and around the seasons.

We have also tried to correlate the reception experience with the immediate (short term) weather conditions. So far, there is no strong evidence of correlation to the presence of the local marine layer or rain or higher or lower clouds. That correlation may be there but it appears to have less of an effect than the seasonal factors.

The collection of data is ongoing. Figure 5 shows the bar charts for the months of May and June 2003. This additional data confirms the earlier findings. Sooner or later something may interfere with the experiment but the longer we can accumulate data the more valuable it may be to those who might wish to create a more analytical model for this interesting propagation artifact.

References

1. "BEACONet" by Ev Tupis, W2EV, QST, May 2002, p38.
2. "Collecting Propagation Data on 10 Meters using BEACONet^31" by Ed Sack, W3NRG, p37.
3. "Radio Wave Propagation" by Chas. Burroughs and Stephen Attwood, Academic Press, Inc. 1949
4. "UI-PATH" by Andy Pritchard, G7OCW, is available from **welcome.to/uiview**

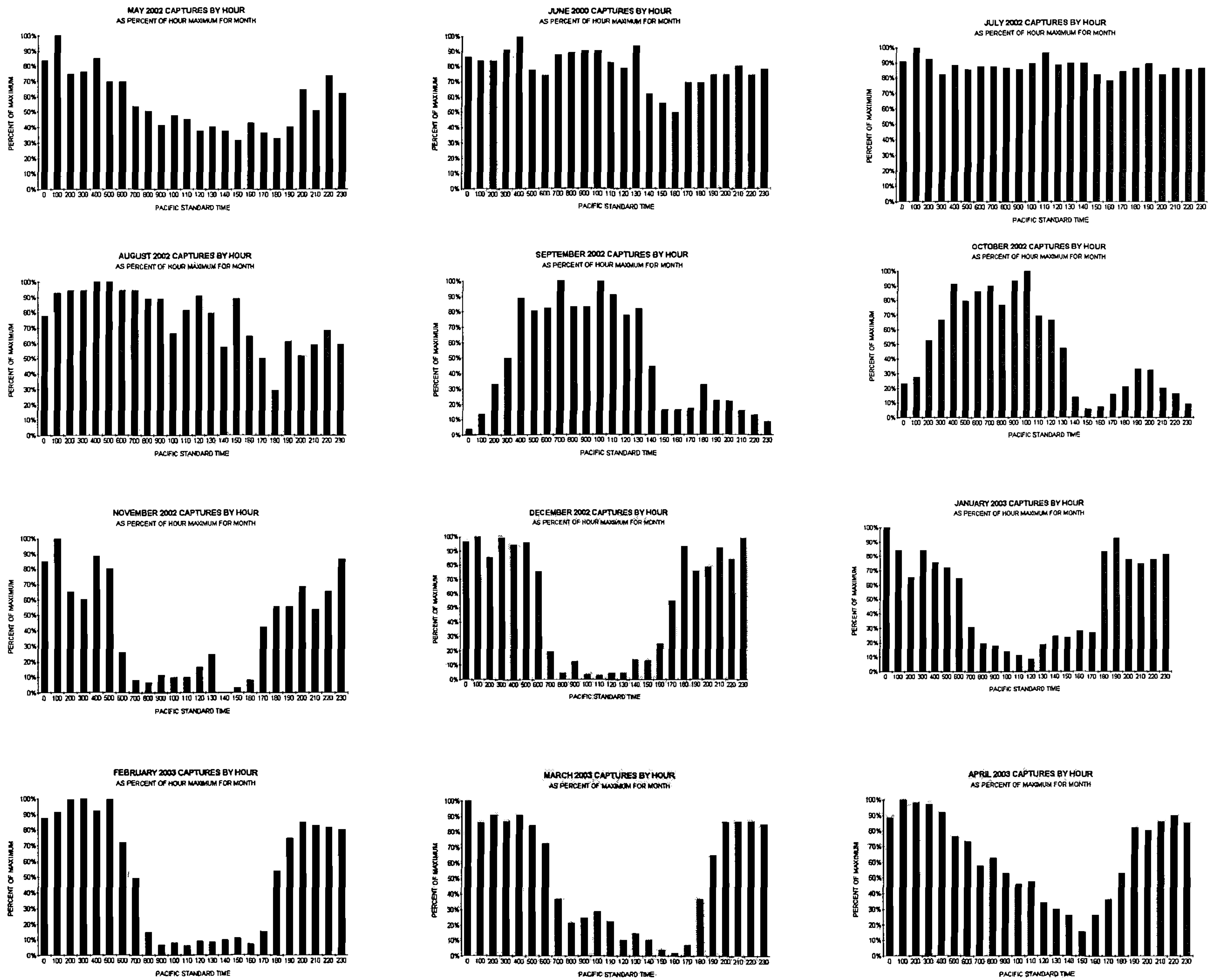


Figure 1. BEACONet Signal Captures by Hour as Percent of Hour Maximum for Month for Period May 2002 through April 2003

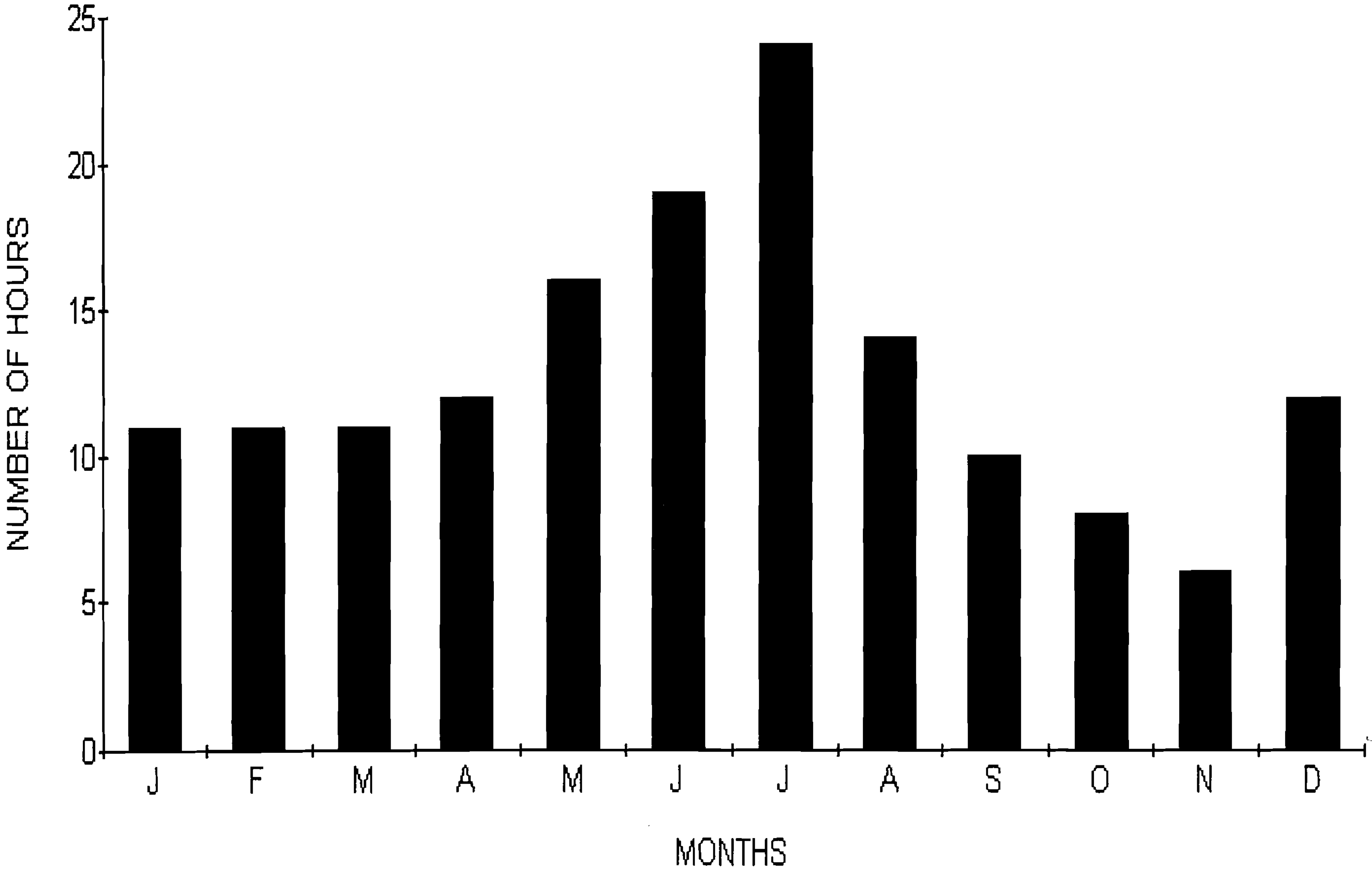


Figure 2. Number of Hours in 24 over the Period of a Month when the Capture was 70% or more of the Best Hour shown in Figure 1 for that Month .

Note: May to December data is for year 2002 and January to April data for year 2003

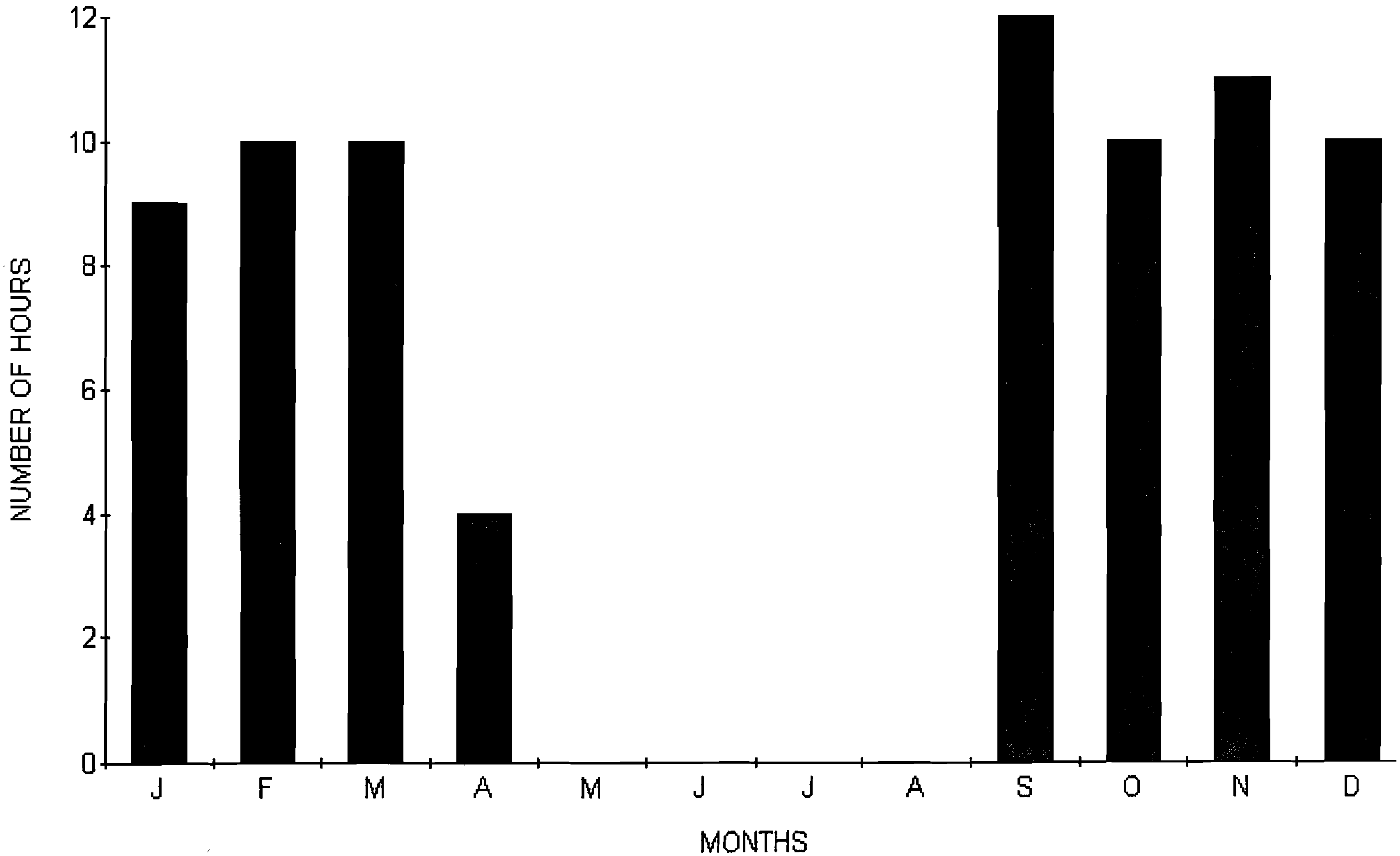


Figure 3. Number of Hours in 24 over a Period of a Month when the Capture was 30% or less of the Best Hour shown in Figure 1 for that Month

Note: May to December data is for year 2002 and January to April data for year 2003

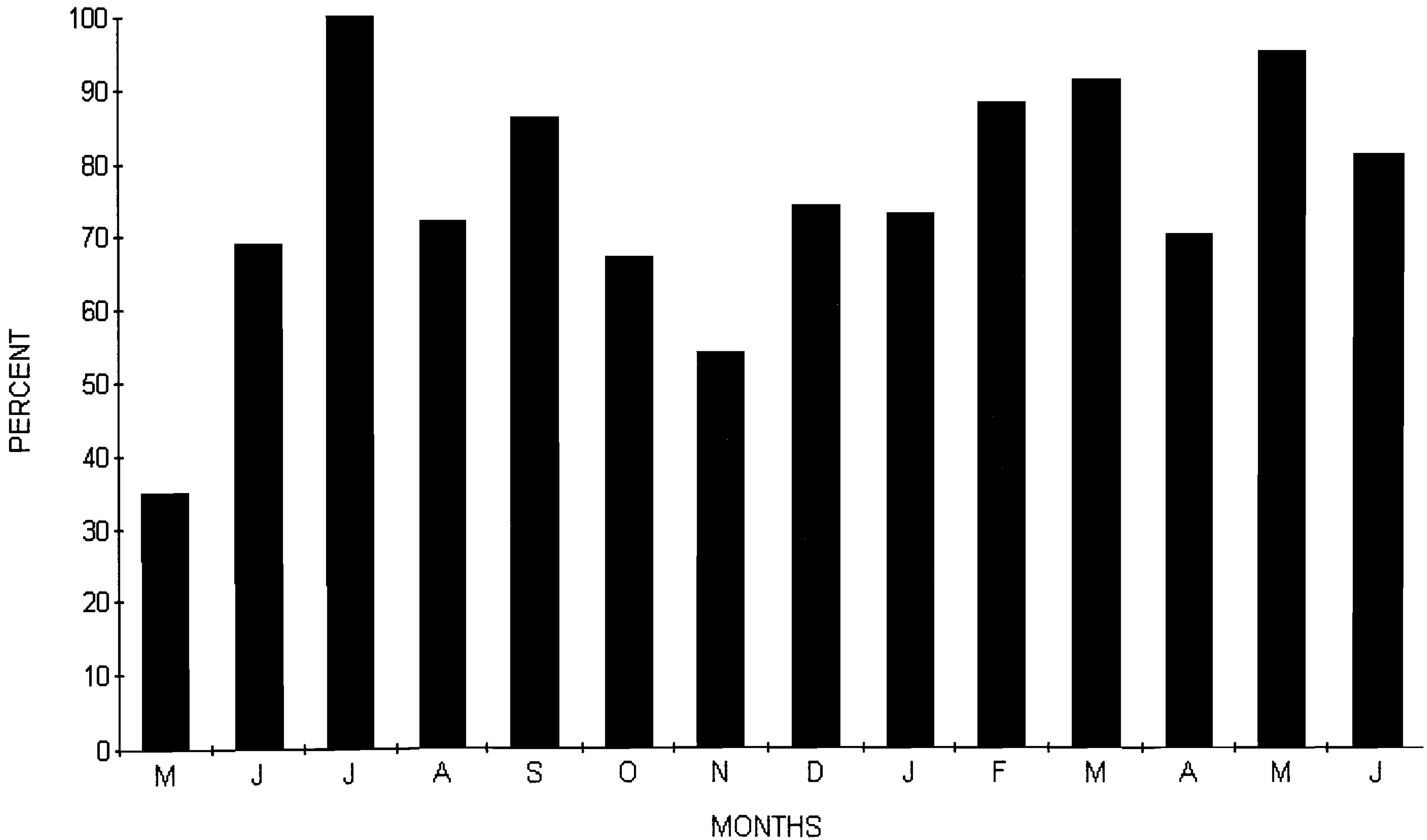
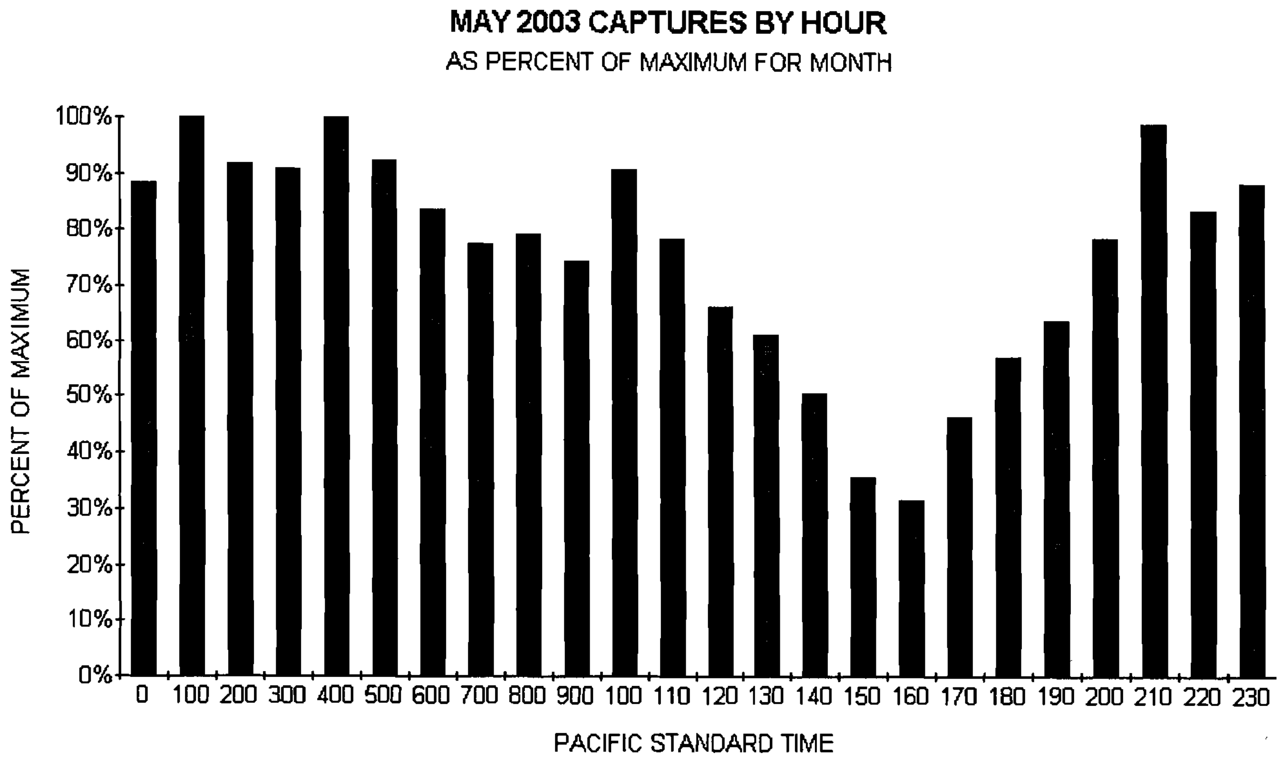


Figure 4. Number of days in the Month as a Percent of the Total Days in the Month when the Capture Rate was 7 per hour out of the Maximum of 8 opportunities per hour, or better.



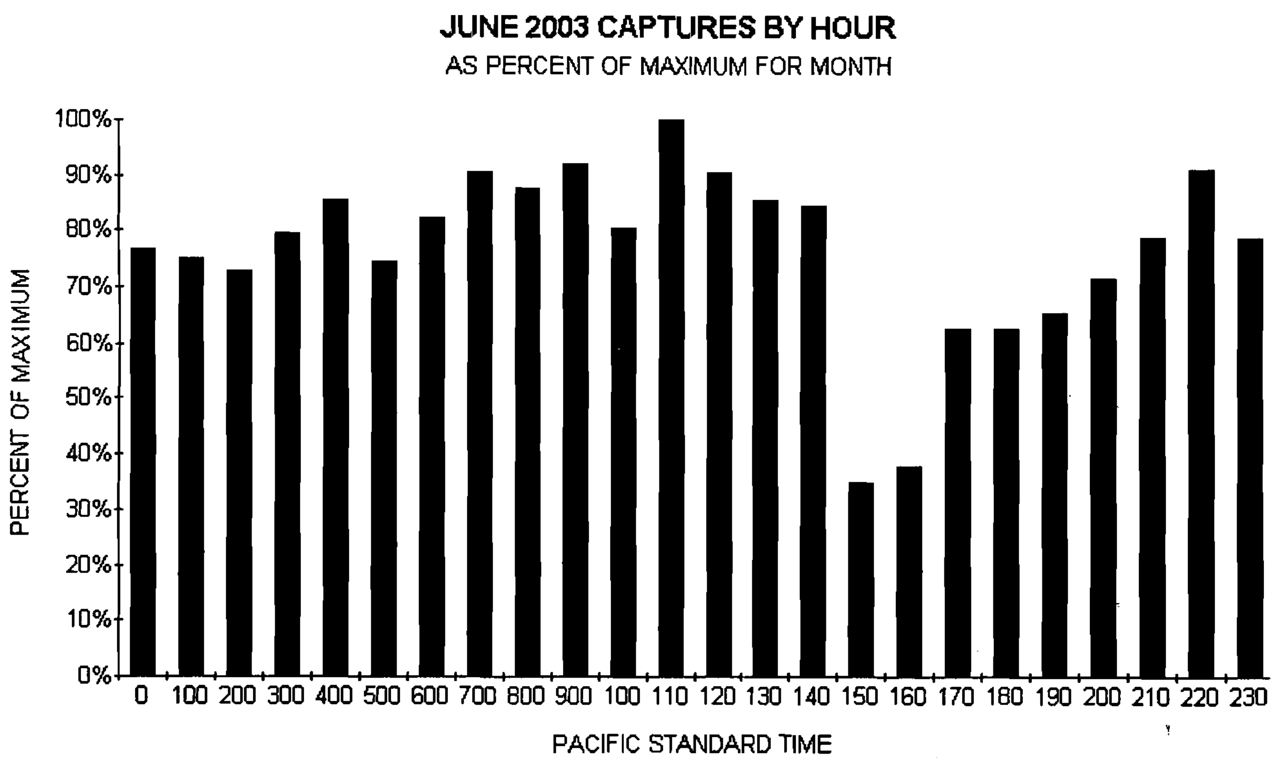


Figure 5. May and June 2003 Data Conforms to May and June 2002 Findings.