

It's Raining

But things aren't always what they seem

James Fischer

Its raining as I type this.
Its Saturday morning.
Its supposed to be an apiary day.
Its pouring.
Again.
It happens a lot.

But how often? A quick internet search for "weekend rain" yielded many references to a paper I did not notice in 1998¹. The paper, printed in the very prestigious science journal *Nature* and written by two Arizona State University climatologists, concluded that rain IS more likely to occur along the U.S. Atlantic coast on the weekend?

Their theory was that air pollution, which is well-known to follow a weekly cycle of increasing during the work-week, and then dropping off on weekends, was "seeding" the clouds, and causing the more-frequent weekend rain.

I live in the eastern U.S., but I had never heard anything about this. How could a story this "big" not have been mentioned by every weather reporter in the country? The journal *Nature* is a respectable peer-reviewed scientific publication, not prone to printing unsupported conclusions or ambiguous data.

Is hobby beekeeping doomed to suffer, forcing beekeepers to rush from job to apiary on weekday evenings? What about baseball games? Should I sell my bicycle now, before everyone finds out about this?

A brisk ransacking of several precarious stacks of magazines and journals that I keep telling my wife that I plan on reading "real soon now"³ produced the August 6th, 1998 issue of *Nature*.

"When observing bee populations, nectar plants, or rainy days, 'Seasonal Cycles' must be considered in the data."

The paper looked legitimate. The data looked good. They looked at 50 years of records, which is a lot of weeks. It started to look like I needed to rig up a combination bee veil and umbrella, or start forgetting about spending quiet weekend mornings with the bees, and work my hives on Tuesday through Thursday.

The paper presented three different sets of data – daily carbon monoxide and ozone measurements from an island off the coast of Nova Scotia, daily satellite data for rainfall over the Atlantic Ocean, and hurricane data. In all three cases, the data, when sorted by day of the week, showed marked differences between weekends and weekdays.

It was a clear seven-day cycle.

While annual weather cycles are the expected results of seasonal change, weekly cycles could only be the result of human impact. Only humans follow a cycle of activity based upon the concept of "weeks."

"The weekly cycle is man-made," said one of

the paper's authors in an interview with *Discover* Magazine. "It has no counterpart in nature. Heat-absorbing pollutant particles could warm surrounding air, driving it upward to create more clouds and rain. Pollutants could also increase rainfall at the edges of a hurricane, preventing heat from concentrating in the center and thus weakening the storm. These are some of the biggest storms on the planet, and the idea that we're affecting them is a little bit frightening."

How had this escaped notice? I sat down at a keyboard (It was raining, remember? My only other option was to clean the garage.) and logged onto a citation database, which tracks which scientific papers are referred to by other scientific papers.

This is a fairly good "sanity check," since a good paper, like a good judicial ruling, is cited more often than a lousy one.

One title jumped off the computer screen at me – "The Warmest Day of Any Week Tends to Occur on the

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¹ <http://www.nature.com/nsu/980813/980813-2.html> Nature Science Update - "Another wet weekend" Aug 11, 1998

² Randall S. Cerveny and Robert Balling Jr., 1998: "Weekly cycles of air pollutants, precipitation and tropical cyclones in the coastal NW Atlantic region" *Nature*: 394, 561 - 563

³ Science does not explain why my wife tolerates this, but neither does it explain why she tolerates me.

First or Last Day of That Week?⁴ Kevin J. Coakley, who works in the Statistical Engineering Division of the National Institute of Standards and Technology, wrote a paper with a title that seemed to have gone even further, finding a weekly cycle of temperature variation! How had I also missed this? How had everyone I know missed it? As luck would have it, the full text of the paper was available online...

...but the paper explained that Coakley's findings were the same regardless of which day he picked as the "first day" of the week! Don't turn the page, keep reading, this DOES have bearing on beekeeping. It has bearing on any scientific work that deals with "trend" data like growth of populations of bees or *Varroa* mites.

Still with me? Good. In other words, when Coakley picked Sunday as the "first day of the week," then Saturdays and Sundays stuck out as the warmest days of the week. But if he picked Thursday as the "first day of the week," Wednesdays and Thursdays emerged as the warmest days of the week.

How? Why?

It is an obscure statistical artifact called "Serial Correlation."

Coakley explained in his paper that this statistical anomaly pops up because things like daily temperatures don't vary randomly. They rise or fall steadily over periods that are longer than one week.

The technical phrase for this is "day-to-day temperatures are positively correlated." As an example, if the temperature rises steadily for a while (as it does every Spring), no matter which seven days you pick, the last day of any period you pick would be the warmest. This would happen regardless of whether your "week" started on a Sunday or a Thursday.

Likewise, as the temperature drops steadily over time in Fall, the warmest day of any seven-day period would be the first day.

Does this apply to rain? Yes, since seasonal variations make for "wetter" and "drier" periods with cycles that are much longer than a week, just like seasonal variations in temperature.

A second paper contradicted the "weekly cycle" of precipitation more directly. "Weekly Precipitation Cycles along the Northeast Corridor?"⁵ Looked at 20 years of precipitation data from seven sites along the east coast of the U.S. The study was unable to find any weekly cycles in precipitation intensity or frequency, and clearly stated their efforts to avoid "Serial Correlation" in the data.

What does this mean to beekeepers, aside from the reassuring knowledge that, despite appearances, it really does not rain more often on weekends?

Well, think about bee populations, pest populations, the number of nectar-producing blooms,

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and the seasonal changes that drive beekeeping.

All aspects of beekeeping are clearly subject to gradual cycles of "increase" and "decrease," trends that follow the seasons, just like temperature does. These cycles are long term, often longer than the length of most projects that study bees. Both data collection and manipulation of colonies in studies have arbitrary "start" and "end" points.

It may seem overly pedantic to use the term "Serial Correlation" when the plain-English translation would be "natural seasonal variation," but the effect described in the 'Nature' paper was not a result of the "facts" or "the data," but, apparently, the methods used in the statistical analysis of the "facts." The effect mislead the researchers, and the many highly-qualified people who review and critique papers prior to publication in "peer-review."

Those of us who work in the sciences are familiar with the many ways that the same set of results from a study can be interpreted, but it is rare to find exactly opposite conclusions being drawn from data that is "clear and compelling," not subject to argument, experimental error, or different measurement methods.

The lesson is that even when you stay out of the rain, sometimes the choices made in statistical analysis alone can render even seemingly impressive data "all wet."⁶

Or, as Lord Ernest Rutherford, winner of the 1908 Nobel Prize in Chemistry, said:

"If your experiment needs statistics, you ought to have done a better experiment."⁷ **BC**

James Fischer keeps bees in Virginia where over seven inches of rain fell in May. He has a want-ad in the classified section seeking gopherwood and breeding pairs of animals.

⁴ <http://ams.allanpress.com/amsonline/firstrequest-get-pubfile-1620-0477-0a1-02-0273.pdf> Kevin J. Coakley, 2000: "The Warmest Day of Any Week Tends to Occur on the First or Last Day of That Week" Bulletin of the American Meteorological Society: Vol. 81, No. 2 pp 273-283

⁵ DeLisi, Mark P., Alan M. Cope, Jason K. Franklin, 2001: "Weekly Precipitation Cycles along the Northeast Corridor?" Weather and Forecasting: Vol. 16, No. 3, pp. 343-353.

⁶ Note that no specific bee-related research is pointed out as making this type of error. No bee researchers were harmed in the production of this article.

⁷ N. T. J. Bailey: "The Mathematical Approach to Biology and Medicine" Wiley, 1967