El Niño Drives California Almond and Honey Production Nuts

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A. Mellifera and A. Cerana, also known as the honeybee, is considered to be responsible for 1/3 of our total agricultural food pollination and production. However these crops are increasingly subjected to extreme weather events including extreme temperature and precipitation levels from El Niño and possibly climate change. With recent concern over honeybee colony health, it is increasingly important to consider examining the effects of extreme weather events on honeybee ecology.

Honeybees are responsible for pollinating 100% of all almond crops globally. Honeybees are transported thousands of miles to aide in the pollination of large crops like, oranges, apples, alfalfa and almonds. Each blossom has to be visited by a honeybee several times in order to get fertilized by the pollen exchange, and develop seeds in the ovary of the plant. The average blossom needs to be visited at least seven times in order for fertilization to be completed through pollination.

The state of California is the leading exporter of almonds, dominating the industry with 90% of the total harvest internationally, creating a critical pollination relationship between the honeybees and almond producers.

With honeybee pollination at the root of the food chain, it is important to understand what determines a good year for the honeybee. The abundance of blossoms, from which to collect nectar is a key factor in determining honey production. Almonds happen to be a sensitive indicator of honeybee health, because honeybees are the sole pollinators of almond blossoms.

It's important to understand what determines a good year for almond blossoms, and likely that is related to weather and human impact factors. Recently, Colony Collapse Disorder (CCD) has made headlines, as the honeybee has a new threat to their survival. Scientists are interested in understanding the effects this collapse, and possible contributing factors could be weather related. A recent study released in 2007 illustrates in Image 1 the spread of CCD throughout the United States. In order to prevent disease, infestation and abandonment or collapse of a hive, we have to track and monitor the entire honeybee eco system.

So how does El Niño affect weather in California, and how does this weather change or anomaly affect the almond blossom supply of nectar for bees? And what is the total potential impact of an almond blossom season for a honeybee? How many lbs of pollen and nectar can honeybees collect from an annual almond yield? These are questions that could help scientists understand the honeybee and their nectar and pollen collection trends.

Examining weather data in the regions of honey production for California, is an easy way to compare El Niño events and anomalies, with the production of many crops in a region regularly impacted.

> North of central California, southerly surface winds related to the PNA pattern also contribute to coastal warming (Ramp *et al.*, 1997). These winds both bring warm subtropical air northward, and also drive on-shore ocean currents that converge at the coast to push the thermocline down.
>
> The unusually thick layer of warm surface water along the west coast causes near shore sea levels to rise by 15–30 cm during El Niño. (McPhaden)

El Niño/Southern Oscillation (ENSO) effects have been correlated to greater precipitation levels in California since 1850. However, understanding how almond nectar flows are impacted by El Niño events is an important aspect to developing correlations to El Niño effects on the honeybee.

Chico, California is the almond capital of California. Chico almonds are famous around the world, as 90% of the worlds entire supply of almonds is grown and produced in Chico, California. Image 2 shows the annual precipitation from 1998 through 2008 in Chico, California. The graph illustrates El Niño years with the color red, intensity is described by opacity. Stronger El Niño in 1998 is shown in 100% opacity as compared to other weaker El Niño years shown at 50% opacity. The image now clearly shows an increased yield in almonds due to El Niño anomalies.

So what does increased precipitation mean for almond blossoms and almond productions? Image 3 shows the average almond yield per acre from 1998 – 2008. This is an important aspect to consider, because honeybees are the sole pollinators for almond blossoms, and lack of pollination by honeybees could be indicated through lower almond yields. However, we can see that during El Niño seasons, almond crops as recorded by the USDA.

Table 1, shows the percentage of pollination of each crop by honeybees. Almonds are the only crop, which seem to have honeybees as their sole pollinators. So that means that if almond blossoms are doing good, then honeybees have to be doing good too, right? Wrong.

Image 4 shows that during El Niño seasons honeybee production still seems to be slipping. Yield per colony is dropping, and monthly reports from the National Honey Board still describe 30-40% annual losses in hives due to CCD. 2005 – 2006 was a strong La Niña season, and that could be why there is a higher spike in honey production for 2005. However, overall trends indicate honey production is declining. So is weather to blame if it is seems to be helping almond crops?

Possible causes and discrepancies for calculating the effects of El Niño on California honey production, is directly linked to the fact that honeybees collect nectar from several different nectar producing crops.

Honeybees collect pollen and nectar from several different sources throughout the year, and honey producers collect honey at different times, in order to take advantage of the different types of honey. For example, Orange honey comes from nectar collected from Orange trees by the honeybee, and then it is turned into Orange honey as it cures in the bee hive. Bee keepers collect the orange honey, just after the orange blossoms start to fade.

El Niño affects the growth of orange blossoms differently than those of almond blossoms, and the growth of all the natural blossoms which honeybees collect nectar from. So to adequately determine the effects of El Niño on honey crops, we would have to plot the production of each crop in which honeybee's collect nectar and pollen from, and then adjust those numbers to the percentage for which honeybees are responsible for their pollination. Again Table 1 could be used as some reference for this equation.

According to Jan Null, CCM at Golden Gate Weather Services, "With the exception of the strongly positive rainfall anomaly in Southern California during strong El Niños the presence of either El Niño or La Niña is not a guarantee of either a significantly wet or dry year in California." In fact human impacts on the environment may be affecting the impacts El Niño, increasing frequency and intensity.

Although we can't currently trace a link between changes in El Niño events and global warming, Trenberth believes, "There's got to be a connection. The very unusual nature of what's happening now is an indication of that. The ambiguity arises because we can't quite sort out which is the natural part and which is the global warming part. If we continue to do this experiment with our climate for the next 20 to 30 years--which we will--presumably the global warming signal will be the thing that we will continue to see."

Current trends calculating honey production in correlation to El Niño trends point to a multitude of contributing factors aiding the decline of honey producing colonies. A connection between the poor honey production from California colonies is due to a combination of problems including but not limited to, climate change, pesticide contamination, or other possible influences from human impacts on environment, like cell phone towers, roads, etc. However, climate change is still likely a major contributing factor as well.

Studying the impacts of weather and El Niño anomalies on honeybees is important for many reasons beyond protecting our sweet commodity we collect from our friendly female friends. Honeybees are a vital part of our agricultural ecosystem, and understanding how each and every crop is impacted by weather events, and understanding human impacts on our environment is key to finding sustainable solution to insect dependent agricultural production.

Image Index

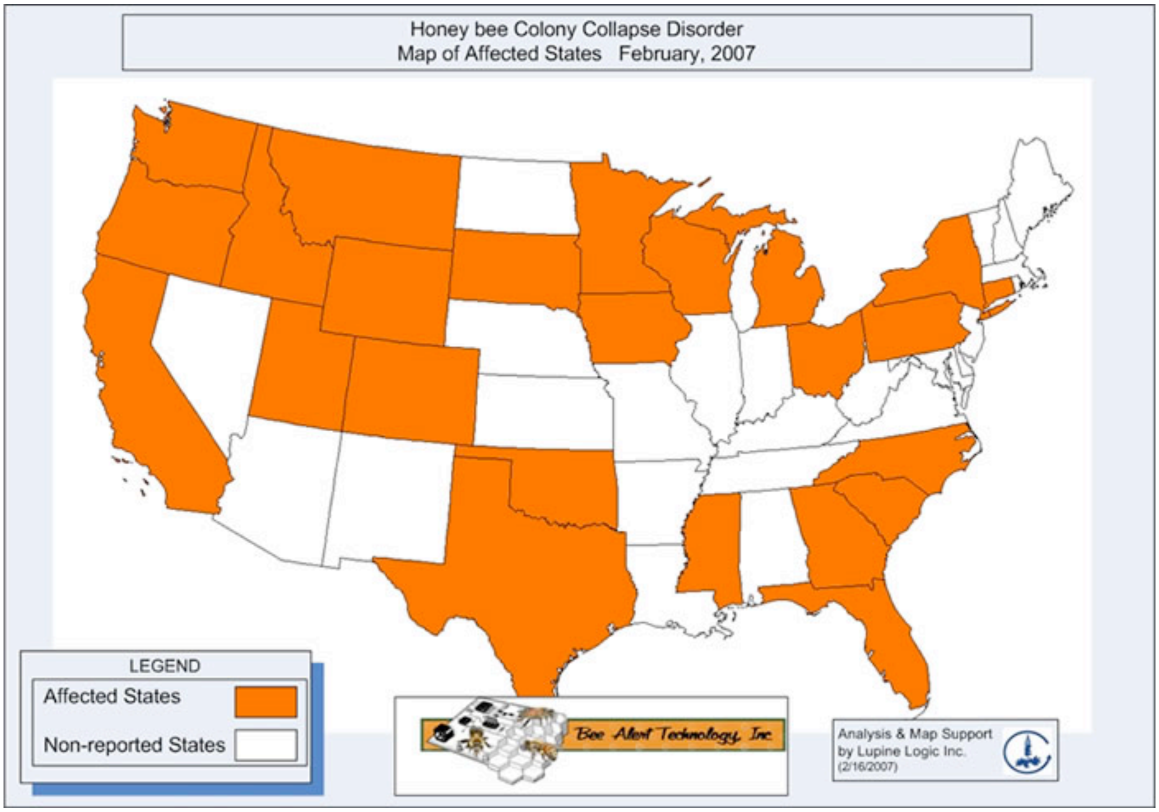

Image 1: Provided by Bee Alert Technology Inc. a non-profit funded by the National Science Foundation to study Colony Collapse disorder.

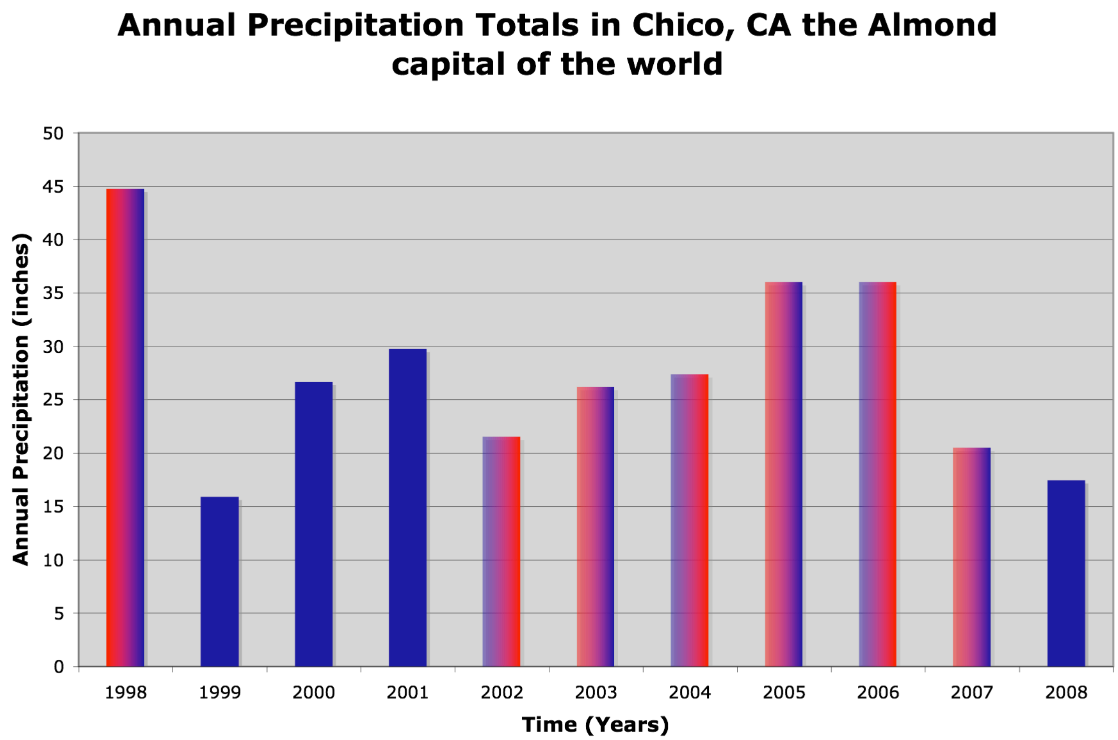

Image 2: Annual precipitation totals in Chico, CA 1998 – 2008. Red indicates El Niño event, opacity indicates strength. 100% opacity indicates a strong El Niño event, and 50% opacity indicates a weak El Niño event.

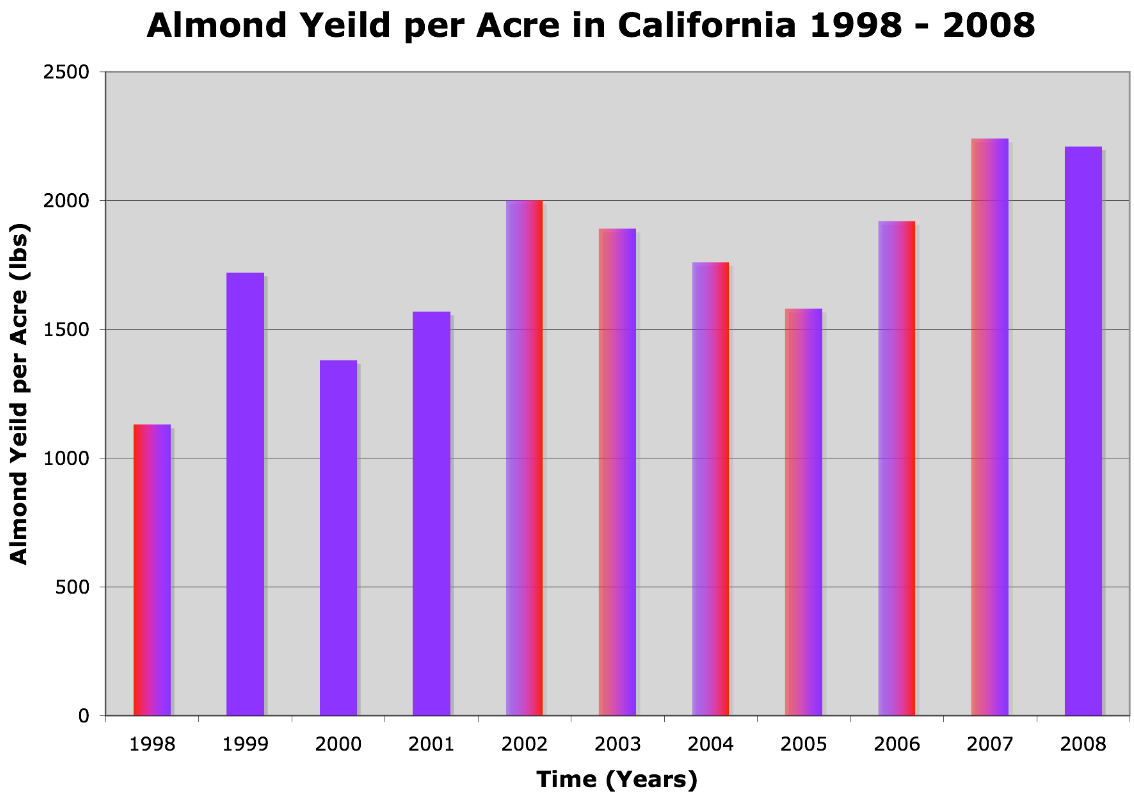

Image 3: Almond yield per acre in California 1998 – 2008. Red indicates El Niño event, opacity indicates strength. 100% opacity indicates a strong El Niño event, and 50% opacity indicates a weak El Niño event.

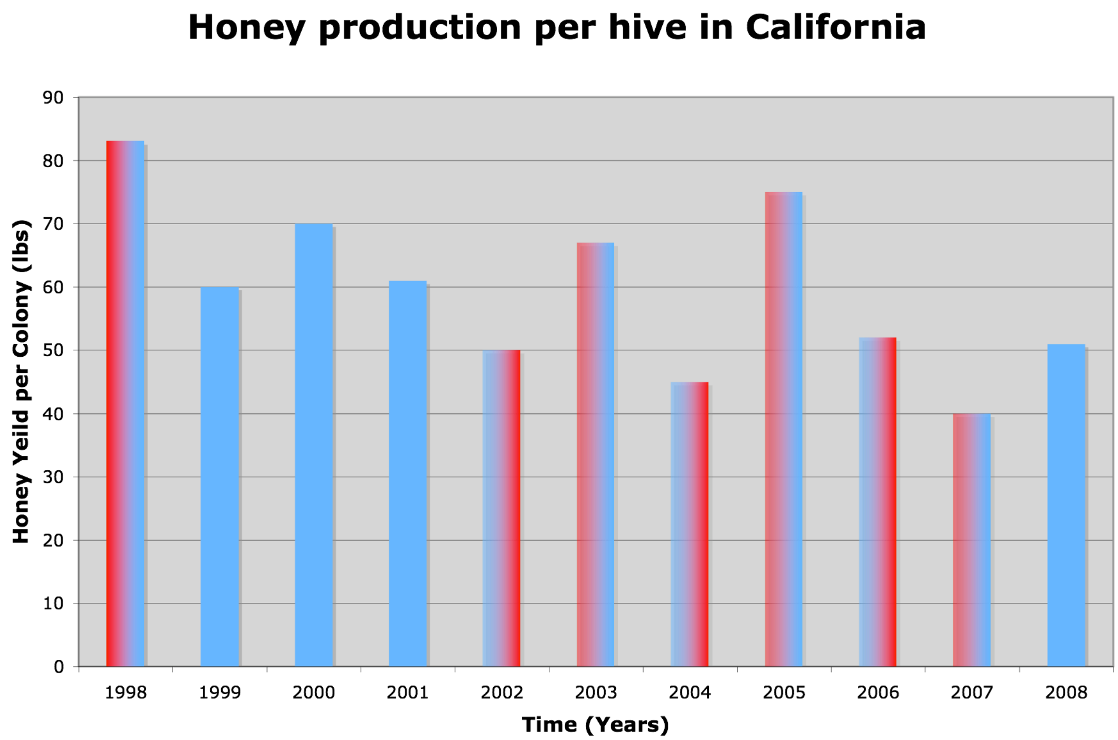

Image 4: Honey production per hive in California 1998 – 2008. Red indicates El Niño event, opacity indicates strength. 100% opacity indicates a strong El Niño event, and 50% opacity indicates a weak El Niño event.

Table 1. Estimated Value of the Honey Bee to U.S. Crop Production, by Major Crop Category, 2000 Estimates

Crop Category (ranked by share of honey bee pollinator value)	Dependence on Insect Pollination	Proportion of Pollinators That Are Honey Bees	Value Attributed to Honey Bees[a] ($ millions)	Major Producing States[b]
Alfalfa, hay & seed	100%	60%	4,654.2	CA, SD, ID, WI
Apples	100%	90%	1,352.3	WA, NY, MI, PA
Almonds	100%	100%	959.2	CA
Citrus	20% - 80%	10% - 90%	834.1	CA, FL, AZ, TX
Cotton (lint & seed)	20%	80%	857.7	TX, AR, GA, MS
Soybeans	10%	50%	824.5	IA, IL, MN, IN
Onions	100%	90%	661.7	TX, GA, CA, AZ
Broccoli	100%	90%	435.4	CA
Carrots	100%	90%	420.7	CA, TX
Sunflower	100%	90%	409.9	ND, SD
Cantaloupe/honeydew	80%	90%	350.9	CA, WI, MN, WA
Other fruits & nuts[c]	10% - 90%	10% - 90%	1,633.4	—
Other vegetables/melons[d]	70% - 100%	10% - 90%	1,099.2	—
Other field crops[e]	10% - 100%	20% - 90%	70.4	—
Total	—	—	**14,564**	—

Source: Compiled by CRS using values reported in R. A. Morse, and N.W. Calderone, *The Value of Honey Bees as Pollinators of U.S. Crops in 2000*, March 2000, Cornell University, at [http://www.masterbeekeeper.org/pdf/pollination.pdf].

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