### Monitoring Changes in Almond Pollination Rental Fees

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**Abstract:**

The objective of this study is to indirectly measure the health of the honey bee industry by analyzing California almond pollination market data. This study surveyed honey bee brokers over the four year period from 2010-2013 to gain information about the quantity, quality and price of colonies placed. We find that pollination rental prices continue to rise. When the quality of a colony is considered, the magnitude the rental price increases become more apparent.

**Introduction:**

Honey bees play a vital role in the agricultural economy within the United States and abroad. Farmers use honey bees to pollinate berries, fruits, vegetables, and nut crops adding an estimated $15 billion in crop value within the United States (CCD Steering Committee USDA 2007). Managed bee colonies are particularly important for almond crops because almonds are completely dependent on them for pollination (USDA 2013). In order to obtain bees for pollination, almond farmers rent bee colonies from bee brokers for the almond bloom, which starts in February. The brokers coordinate with beekeepers to obtain an adequate supply of healthy hives to meet the demand of the almond growers. Brokers contract with beekeepers as from all over the country and as far away as Florida to supply bees for the almond pollination.

Bee rental agreements called pollination contracts are structured differently depending on the arrangement between the almond grower and beekeeper. Pollination contracts are set up as early as June. As a result, the rental price is relatively fixed prior to the almond bloom. However, some contracts provide bonuses to beekeepers for providing high quality hives. The Almond Board of California recommends that almond growers provide bonuses for colonies that are graded higher than 8 frames (Ribotto 2010). A good contract specifies the minimum and average number of frames of bees per colony. It also specifies the dates the hives will be brought to and removed from the orchard as well as the placement of the hives within the orchard (Almond Board of California 2012).

The demand for almonds is increasing. In order to meet increasing demand almond growers are expanding their orchards. The number of bearing acres of almonds in California has been nearly doubled in the past 20 years. During the four years of our survey from 2010-2013 the number of bearing acres increased by about 9.5% (United States Department of Agriculture National Agricultural Statistics Service 2013). Brokers recommend that almond growers stock 2 8-frame colonies per bearing acre of almonds (Traynor 2013). Therefore the expansion of bearing almond acreage puts upward pressure on demand for managed bee colonies.

Beekeepers’ ability to meet the demand for bee colonies has been hampered over the last 8 years as many bee colonies have succumb to the new and mysterious ailment, Colony Collapse Disorder (CCD). In 2006, beekeepers lost as many as 30-90% of their colonies, much higher than the 5-10% winter losses experienced prior to 2005. The average lose rate since 2006 has been around 30% with about a third of those losses attributed to CCD (USDA 2013). According to the results of the Bee Informed Partnership Management Survey, 31.1% of managed colonies were lost over the winter ending in 2013 compared to 21.9% in 2012, 30% in 2011 and 34% in 2010 (vanEngelsdorp, et al. 2013). Other bee pests including varroa mite and nosema parasite have caused declines in the supply of honey bees. Concurrently, wild pollinator populations have also declined (Committee on the Status of Pollinators in North America 2007). The reduction in the supply of domestic bees as well a decline in available substitutes has put upward pressure on colony rental prices.

Survey data from the California State Beekeeping Association indicates that the price of renting bees for almond pollination was increasing at a modest rate until 2005 when it increased from $70 to $138 in 2006 (Sumner 2006, Heintz 2012). According the California State Beekeeping survey, the rental price has continued to rise up to $151 in 2010 (Figure 1).

Sumner points out the market forces pushing the rental price upward in the years up to 2006 included a decrease in supply of bees as a result of bee disease and an increase in demand for bees for pollination in almonds as a result of the expansion of the almond market. In addition, Sumner observes that demand for almond pollination is expanding at a faster rate than demand for pollination in other crops and almond nectar does not produce honey that is desirable for human consumption. As a result, beekeepers that supply almond growers with bees require a greater portion of their income from almond pollination rentals to maintain their bees, which puts upward pressure on almond pollination rental fees. Increases in diesel price also put upward pressure on almond pollination fees since transportation is a major component of beekeepers costs particularly for beekeepers who truck their hives for the east cost for the almond bloom (Rucker, Thurman and Burgett 2012).

The objective of the Bee Informed Partnership survey is to fill in the gaps in the available survey data. The survey covers the four year period from 2010-2013.

How does this differ from other surveys????

The BIP adds to existing pollination survey data by collecting information about stocking rates of colonies per acre as well as information about the grades for colonies placed.

**Methods:**

The Bee Informed Partnership collected the almond pollination market data through phone interviews with bee brokers. The broker contact information was collect by????????. The Bee Informed Partnership interviewers read brokers read an implied consent before conducting the survey. The interviewers informed the brokers that they were not required to answer all of the questions and could opt out of answering any questions they were not comfortable with. Brokers who wished to complete the survey were asked the following questions:

1. How many colonies did you place in almond orchards this year?
2. How many colonies did you place in almonds last year?
3. Given an unlimited supply, how many colonies could you have placed in almond orchards this year?
4. If an additional almond orchard with 100 acres needed bees from you this past season, would you have been able to supply those bees?
5. What % of the colonies that you placed in almonds were “field run”?
6. What was the average number of colonies you placed per acre?
7. What was the highest number of colonies you placed per acre?
8. What was the lowest number of colonies you placed per acre?
9. What was the average number of colonies you placed per acre last year?
10. How many different beekeepers (including yourself) did you place colonies for this year?
11. How many different almond growers did you place colonies for this year?
12. How many beekeepers that you broker for (including yourself) had difficulty meeting the number of colonies they committed for pollination?
13. How many colonies, that were committed for pollination, were you and/or those beekeepers you broker for short?
14. What was the average grade of the colonies you placed?
15. What was the average price you received per placed colony?
16. What was the lowest price received?
17. What was the highest price received?
18. What percentage of the hives that you broker for are managed year round in California exclusively?
19. What percentage of the almonds growers that you supplied with bees this year, did you supply bees to last year as well?
20. What percentage of beekeepers that you brokered for did you broker for last year as well?

We took a subsample of the responding brokers who completed the survey in all 4 years. Using the panel data subsample of the survey we were able to look at fluctuations within the pollination market. We analyzed the answers to questions 4 through 9 and 14 through 17 by taking the colony weighted average of these responses. To determine the colony weighted average, each broker was weighted by the number of colonies he or she placed during the survey year. The colony weighted average is a more accurate measure of the overall industry average than a simple average since the size the brokers’ operations vary significantly (in 2013 the smallest broker operation in the subsample placed 2,155 colonies while the largest placed 92,000 colonies). The number of colonies placed by a broker is reflective of the broker’s operation size.

Another obstacle in our analysis is that bee colonies vary in quality. Colonies are graded based on number of bees in the colony. These grades are calculated in terms of the number of frames the bees that inhabit the hive. We find that the quality of the colonies placed varies over the survey period. The quality variation makes it difficult to compare supply and prices across time periods. We cope with this obstacle by analyzing supply of bees on a frame basis and by creating a quality adjusted colony rental price.

Traditionally the supply of bee is considered at the colony level. This is done for practical purposes because it would be difficult to estimate the number of bees used for pollination. However, most colonies placed for pollination are graded which helps to approximate the number of bees within the colony. Using colony grade in combination with the number of colonies placed, we estimate of the supply of bee that contributes to pollination services by looking at the bee supply on a frame basis. We estimate the total number of frames provided by taking the average grade of the colonies placed by each broker times the number of colonies that the broker and sum the results.

In order to deal with the impact of quality variation on rental price, we created a quality adjusted colony rental price measure. First, we calculated the per frame price by taking each brokers average rental price divided by the average grade of the colonies the broker placed. Then we took the colony weighted average of the per frame price. The quality adjusted colony rental price is simply the colony weighted per frame price times 10. The factor of 10 reflects the average colony grade during the survey period. Using the quality adjusted colony rental price helps us remove price movement that occurs as a result of changes in colony quality between years.

**Results:**

BIP collected 23 responses in 2010 and 2011, 16 responses in 2012 and 20 responses in 2013 (for summary statistics for the full sample see table 6-11). Thirteen bee brokers gave responses in all three years. This subsample represents approximately 33-43% of the total number of bee brokers in the industry (30-40 brokers). Here we examine the survey results from the subsample of bee brokers to determine trends in the almond pollination markets over the period from 2010 to 2013.

The number of colonies placed for almond pollination has varied over the survey period (table 2). In 2013, the number of colonies placed by the 13 brokers surveyed was 262,161 representing about 19% of the estimated 1.4 million colonies used for California almond pollination each year (USDA 2013). The largest change in the number of colonies placed occurred between 2010 and 2011 with an 11.6% increase in the colonies placed. Between 2011 and 2012 the number of colonies placed declined 1.9%. In 2013, the number of colonies placed was about the same as the previous year.

For an alternate view of the supply of bees provided for pollination services by the surveyed brokers we estimated the number of frames of bees the brokers supplied for pollination. The changes in supply of frames are similar to the changes in the supply of colonies between 2010-2012. In 2013, the number of frame of bees supplied decreased 19% as compared to 2012 while the number of colonies supplied increased by 0.1% during the same period. This result indicates that looking at the number of colonies placed alone does not paint a complete picture of the true supply of available pollinators. (Test used??)

The increase in the number of colonies placed over the time period is modest considering the substantial increase in the number of almond bearing acres over the survey period (table 1). We find that the number of colonies placed per acre is relatively stable over the survey period at around the recommended 2 colonies per acre in both the subsample and the full sample (table 3 and table 8). However, the quality of those colonies was not consistent over the survey period. The highest colony grade in the subsample over the survey period was 10.6 in 2013 and the lowest grade was 9.3 in 2012 (table 2).

In all four years at least some of the beekeepers the brokers worked for were short bees. In 2013, the largest shortage occurred with beekeepers having 30,997 fewer colonies available than were committed in pollination contracts (Is this really a shortage? Explian?). This number represents approximately 27% of all colonies placed by the subsample of brokers surveyed in 2013. The percent of colonies overcommitted relative to the number of colonies placed, was markedly lower in 2010-2012 going no higher than 11.6%. Details of these figures are presented in table 4. In 2013, bee brokers also reported that they were less able to respond to requests for more bees. In response to the question “If an additional almond orchard with 100 acres needed bees from you this past season, would you have been able to supply those bees?” only 30.8% of brokers responded yes in 2013 as compared with 92.3% in 2011 and 2012 (no data were available for 2010).

Given the survey result that almond growers on average placed 2 colonies per acre we predict that the demand for colonies in 2013 was about 1.62 million or twice the number of bearing acres of almonds. This represents an approximate 40,000 colony increase in demand over 2012. Given this 2.5% increase in demand it is surprising that colony rental price did not increase more that then the $0.44 (1.2%) it did between 2012 and 2013 (table 5). As illustrated in figure 1, the weighted average price in was $154.60, $154.16, $152.80 and $137.77 in 2013, 2012, 2011, and 2010 respectively. Therefore, the increase in price between 2010 and 2013 was about 12.2%.

The rental price was stable between 2012 and 2013 despite an increase in demand for colonies and a shortage of supply. This price stability may be explained in part by changes in average quality. We adjusted for the changes in colony quality between years with our frame adjusted colony rental price measure. The frame adjusted colony rental price was $174.77 in 2013 as compares to $146.19 in 2012, which is about a 16.6% increase in price between the two years (see table 5 and figure 1). When looking at frame adjusted price, we find a 19.5% price increase between 2010 and 2013 as compared with the 12.2% increased when unadjusted prices are observed. This frame adjusted price increase is more consistent with the supply and demand changes we observed over the survey period.

**Discussion:**

Although the per colony rental price for almond pollination has been relatively stable over the observed survey period, the rental cost has risen significantly over the years prior to the survey period. The availability of pollinator units for California almonds has been relatively stable on the colony basis in recent years. However, further exploration of the data indicates that it may be necessary to reevaluate the effectiveness of using colonies as a measure of availability since the grade of colonies placed can vary considerable from year to year. Measuring pollinator availability on a per frame basis provides further insight into the health of the honey bee industry. When grade adjusted prices are used to examine colony rental price we find that the rental price increased 19.5%. Increases in the rental price of colonies were expected as a result of increased acreage of bearing almonds over the survey period and bee shortages in 2013. As almond acreage continues to expand, we expect further increases in the cost of renting bees for pollination.

**Conclusion:**

The results of our analysis indicate that it would be beneficial to consider colony grade when evaluating changes in almond pollination markets. When we examine quality adjusted colony rental prices we find that there is more fluctuation in almond pollination pricing between years than with unadjusted prices. Also, colony grade should be considered when quantifying the supply of bees for almond pollination. We demonstrate one method of accounting for changes in colony quality by looking at the frame level supply of bees rather than the colony level.

**Acknowledge:**

We would like to that the brokers for their responses and continued support of research on almond pollination markets. We would also like to thank the USDA??? for its grant support.

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Tables:

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| --- | --- | --- | --- | --- | --- | --- |
| **Table 1**  **Almond Acreage, Production, and Value in California 2010-2013** | | | | | | |
| Year | Bearing | Non-Bearing | Yield Per Acre | Production | Price Per Pound | Value of Production |
| Acres | | Pounds | Million Pounds | Dollars | $1,000 |
| 2010 | 740,000 | 85,000 | 2,220 | 1,640 | 1.79 | 2,903,380 |
| 2011 | 760,000 | 75,000 | 2,670 | 2,030 | 1.99 | 4,007,860 |
| 2012 | 790,000 | 80,000 | 2,390 | 1,890 | 2.20 | 4,107,400 |
| 2013 | 810,000 | --- | 2,470 | 2,000 | --- | --- |
| Value and price based on edible portion of almond crop.  Data taken from the USDA NASS 2013 California Almond Forecast. | | | | | | |
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| **Table 2** | | | | | |
| **Quantity and Quality of Pollinator Units Placed in California Almond** | | | | | |
| Year | Total Number of Placed Colonies | Change in number of colonies placed over previous year | Average Colony Grade | Estimate Total Number of Frames Supplied | Change in the Number of Frames Supplied over the Previous Year |
| Question | 1 |  | 14 | | |
|  |  |  | Average weighted by number of colonies placed | | |
| 2010 | 239,234 | --- | 9.7 | 2,391,218 | --- |
| 2011 | 267,049 | 11.6% | 10.1 | 2,726,848 | 14% |
| 2012 | 261,872 | -1.9% | 10.6 | 2,688,186 | -1% |
| 2013 | 262,161 | 0.1% | 9.3 | 2,185,992 | -19% |
| n=13 | | | | | |

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| **Table 3**  **Colonies Placed Per Acre** | | | | **Frames Per Acre** |
| Year | Colony Weighted Average | Max | Min | Colony Weighted Average |
| Question | 6 | 7 | 8 |  |
| 2010 | 2.00 | 3 | 0.25 | 19.4 |
| 2011 | 2.00 | 3 | 0.75 | 20.2 |
| 2012 | 2.06 | 3.5 | 0.25 | 21.8 |
| 2013 | 1.91 | 3 | 0.50 | 17.8 |

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| **Table 4** | | | | | |
| **Shortage Statistics** | | | | | |
| Year | Total Number of Colonies Short | Average Number of Colonies Short as a Percentage of Total Colonies Place by the Broker | Total Number of Beekeepers Short | Percentage of Beekeepers Short | Percentage of brokers who could have supplied another 100 acre farm |
| Question | 13 |  | 12 |  | 4 |
| 2010 | 21,880 | 9.1% | 43 | 35.8% | No Data |
| 2011 | 24,647 | 11.6% | 39 | 22.8% | 92.3% |
| 2012 | 6,360 | 5.1% | 18 | 10.5% | 92.3% |
| 2013 | 30,997 | 27.1% | 75 | 41.7% | 30.8% |
| n=13 |  |  |  |  |  |

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| **Table 5**  **Colony Rental Prices** | |  |  |  |  |  |
| Year | Average Price Per Colony | Min | Average Min | Max | Average Max | Frame adjusted colony rental price |
| Question | 15 | 16 |  | 17 |  |  |
| 2010 | $137.77 | $60.00 | $ 127.74 | $180.00 | $ 151.24 | $146.19 |
| 2011 | $152.80 | $110.00 | $140.01 | $177.00 | $158.25 | $152.72 |
| 2012 | $154.16 | $135.00 | $141.91 | $177.00 | $163.91 | $149.83 |
| 2013 | $154.60 | $95.00 | $137.83 | $200.00 | $164.49 | $174.77 |
| n=13 | | | | | |  |
| average weighted by number of colonies placed | | | | | | |
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| **Table 6** | | |
| **Quantity Pollinator Units Placed in California Almond**  **Full Sample** | | |
| Year | n | Total Number of Placed Colonies |
| 2010 | 23 | 429,584 |
| 2011 | 23 | 412,824 |
| 2012 | 16 | 319,072 |
| 2013 | 19 | 413,161 |

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| **Table 7** | | |
| **Quality Pollinator Units Placed in California Almond**  **Full Sample** | | |
| Year | n | Average Colony Grade |
| 2010 | 22 | 8.57 |
| 2011 | 23 | 9.53 |
| 2012 | 16 | 9.24 |
| 2013 | 19 | 8.15 |

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| **Table 8** | | | | |
| **Colonies Placed Per Acre**  **Full Sample** | | | | |
| Year | n | Colony Weighted Average | Max | Min |
| 2010 | 22 | 2.03 | 4.00 | 0.25 |
| 2011 | 23 | 2.02 | 3.25 | 0.75 |
| 2012 | 16 | 2.10 | 3.50 | 0.25 |
| 2013 | 19 | 1.98 | 3.50 | 0.50 |

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| **Table 9** | | |
| **Shortage Statistics**  **Full Sample** | | |
| Year | n | Total Number of Colonies Short |
| 2010 | 23 | 55040 |
| 2011 | 23 | 51697 |
| 2012 | 16 | 7680 |
| 2013 | 20 | 46873 |

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| --- | --- | --- | --- | --- | --- | --- |
| **Table 11** | | | | | | |
| **Colony Rental Prices in Dollars**  **Full Sample** | | | | | | |
| Year | n | Average Price Per Colony | Min | Average Min | Max | Average Max |
| 2010 | 23 | 138.45 | 60.00 | 124.00 | 180.00 | 153.70 |
| 2011 | 23 | 149.20 | 110.00 | 139.22 | 250.00 | 154.33 |
| 2012 | 16 | 154.29 | 135.00 | 141.75 | 177.00 | 162.30 |
| 2013 | 19 | 154.87 | 95.00 | 145.82 | 200.00 | 160.12 |
| average weighted by number of colonies placed | | | | | | |

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| --- | --- | --- |
| **Table 10** | | |
| **Shortage Statistics**  **Full Sample** | | |
| Year | n | Total Number of Beekeepers Short |
| 2010 | 21 | 125 |
| 2011 | 23 | 59 |
| 2012 | 15 | 22 |
| 2013 | 20 | 135 |

**Figures:**

Hi Mr/Mrs. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, this is \_\_\_\_\_\_\_. I am calling as part of the Bee Informed partnership, a consortium of bee researchers who want to gauge the availability of pollinator units in California Almonds.

Is now a good time to talk? Yes – proceed

No – when can I call back

I’m calling you because I understand that you broker bees for placement in California almonds. I hope you will be willing to answer some questions about the availability and quality of pollinating units in Almonds. We hope to do similar surveys in future years too as a way to indirectly measure the health of the honey bee industry.

In all this survey is composed of 20 questions and it should take about 10 minutes to complete.

Your participation in this survey is completely voluntary and you should feel under no obligation to participate. If you do decide to participate you should feel free to refuse to answer any questions or stop the survey altogether at any time. Your decision to participate or not, as well as the answers you provide should you want to participate, will be kept strictly confidential. Any reports coming out of this study will not identify you in any way, and we will never share any information with anyone that will link any of your personal information with the answers that you give.

So do you think you will be willing to participate in this survey.

Yes – proceed

No – Ok thanks for your time.

Ok great. Since this survey will ask some questions about your business it is governed by certain laws designed to protect your rights and freedoms. We are therefore required to ask you a couple of questions to be sure we are permitted to include your responses in this study and also give you some information regarding your rights and what we will do to protect your privacy.

First I need to confirm you are at least 18 years old.

Yes – proceed

No – Oh, thanks for your interest but unfortunately we are not able to include your responses in this survey.

OK – great. We realize that you may want to ask researchers more questions about this survey, so I want to give you the opportunity to take down Dennis vanEngelsdorp’s, the lead investigator for this study, phone number in case you have some follow up questions. Do you want this number? 717-884-2147.You should also feel free to call the Penn State office that oversees this kind of research if you have questions or comments. Do you want their number? (814) 865-1775.

Ok lets get started.