Economic Outlook for the 2018 Almond Pollination Season

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As 2017 winds down, many almond growers are likely beginning to think about the upcoming 2018 almond pollination season. What will honey bee colony strength, winter mortality rates, and almond pollination fees look like this year? The following article summarizes some factors that may provide insights into your 2018 almond pollination decisions. In addition, I outline contractual components that you may consider for 2018 and future almond pollination seasons.

USDA (United States Department of Agriculture) estimates that there were 1 million bearing almond acres in 2017. According to the USDA Cost of Pollination Survey, 1.7 million colonies were used in almond pollination in 2016, with an average of 1.9 colonies/acre. This suggests colonies demanded for almond pollination in 2018 will likely be around 1.9 million, approximately 73 percent of the total U.S. honey bee colony population on January 1, 2017.

The supply of colonies for California almond pollination relies heavily on out-of-state apiary shipments which have been steadily increasing with almond acreage. According to apiary shipment numbers provided by the California Department of Food and Agriculture (CDFA), 1.7 million colonies were shipped into California for the 2017 almond pollination season. As of November 15, 2017, approximately 522,000 colonies have been shipped into California for the 2018 almond pollination season. This is a decrease of about 14 percent from colony shipments that had arrived in California by November 15, 2016.

The primary influence on the supply of available colonies for almond pollination is colony health throughout the U.S. Colony health issues can impact both the strength of colonies (approximate number of bees/hive) and the total number of colonies that survive the winter. **Figure 1** (***page 5***)shows a heat map of the number of colonies shipped into California for 2017 almond pollination from each state. The top five states shipping colonies into California included North Dakota, Idaho, Florida, Oregon, and Texas. The next paragraphs highlight a few natural disasters that occurred during the summer and early fall which could impact available colonies for almond pollination from some of these top shipping states.

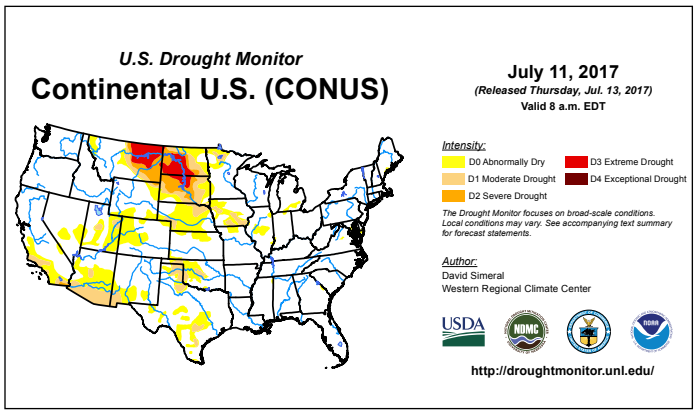
Figure 1: Honey Bee Colony Shipments into California for Almond Pollination by State of Origin, Season 2017

Source: Apiary Shipments through California Border Protection Stations, CDFA Plant Health and Pest Prevention Services.

A drought occurred this summer throughout major honey producing states of North Dakota, South Dakota, and Montana (see **Figure 2**). This drought limited the availability of natural food sources, so many colonies had to be supplemented with protein patties and sugar, which is less than ideal for colony health. Additionally, beekeeping operations in this area were likely affected by low cash flows due to lower than average honey production, which may inhibit their ability to purchase quality inputs to maintain or improve colony health. This area shipped over 510,000 colonies to California for the 2017 pollination season, amounting to 30 percent of the total honey bee colony shipments. As of November 15, 2017, approximately 366,000 colonies have arrived in California from these states for 2018 almond bloom. Comparing shipments prior to November 15 for the 2017 and 2018 almond pollination seasons, colony shipments from this region have decreased by 15 percent for the upcoming season. High winter mortality rates and low colony strength due to this drought could have considerable impacts on the supply of available colonies for almond pollination.

Hurricanes Harvey and Irma brought high winds, rainfall, and substantial flooding in Florida and Texas. These states provided 18 percent of the colonies for California almond pollination in 2017. It remains unclear how many colonies in these areas were affected, but if it is a large amount, it could decrease the supply of colonies available for almond pollination. So far, comparing this year's shipments to those prior to November 15 for the 2017 almond pollination season, there has been a 58 percent decrease in colony shipments from these states. This appears to be a significant decrease, however most colonies from Florida and Texas arrive within one or two weeks of almond bloom. This significant decrease may in part reflect beekeepers' decisions to delay shipment until closer to bloom.

Figure 2: United States Drought Monitor July 11, 2017

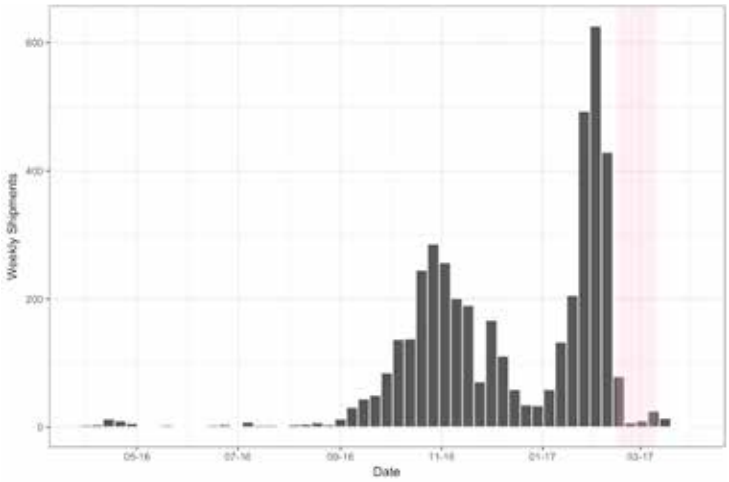


A final supply issue to note is a change in the regulations of bee shipments into California. Due to numerous bee sting incidents at California's Border Protection Stations (BPS), bee shipments that are rejected due to inadequate cleaning will no longer be allowed to be cleaned for re-entry at the BPS. Any rejections must be cleaned off-site and then return to the BPS and be re-inspected to enter California. This may cause substantial delays, so it is important to make sure your beekeepers are aware of this change so they may get their loads properly cleaned before departure. **Figure 3** shows weekly bee shipments into California, with the 2017 almond bloom period highlighted. Most bee shipments are coming in within a week or two of almond bloom, so delays could be costly, especially if you have early blooming orchards.

Per-Colony Fees

Figure 4 (*page 6*) shows actual and projected almond pollination fees reported by members of the California State Beekeeper's Association. The 2017 average fee was $184.43. The highest fee reported was $200 and the lowest $165. The average projected fee for 2018 was $190 per colony. Overall, per-colony almond pollination fees have been increasing on average since 2006, so almond growers can expect to pay fees around $185-200 per colony for the standard 8-frame average for the 2018 season. Variation in fees will exist based on contracted and delivered colony strength. (For detailed information on colony strength in almond pollination

Figure 3: Histogram of Weekly Apiary Shipments into California for 2017 Almond Pollination Season (Almond Bloom Period Highlighted)



Sources: Apiary Shipments through California Border Protection Stations, CDFA Plant Health and Pest Prevention Services; Blue Diamond Grower's Crop Progress Reports.

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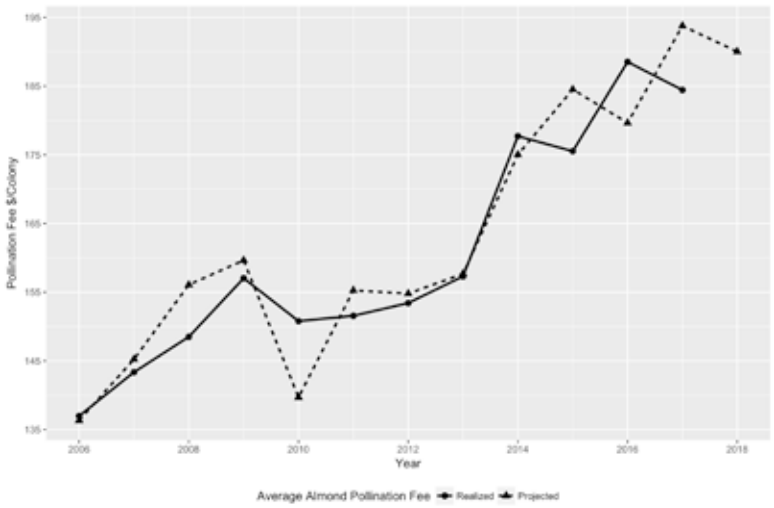
Figure 4: California State Beekeeper's Association Survey Average Projected and Realized Almond Pollination Fees, 2006-2018



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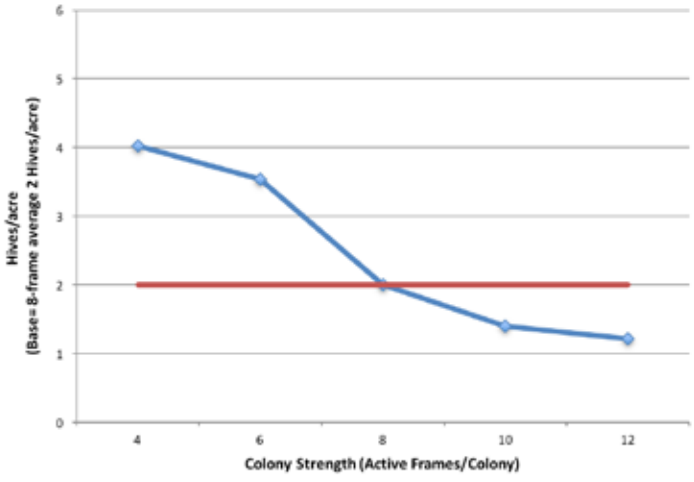
see Goodrich and Goodhue (2016).)

As almond bloom approaches and the supply disruptions from the previously mentioned natural disasters are realized, strong colonies may become hard to find. This may drive almond pollination fees upward from the projected range. It is important to communicate with your beekeepers about their anticipated colony strength and total colony numbers available for almond pollination. If your beekeeper is unable to meet the colony strength requirements of your contract, it is helpful to keep in mind that colony strength and the number of hives per acre can be substituted. **Figure 5** shows the pollination equivalents at varying hive densities and colony strengths using the rule of thumb and standard colony strength requirement as a base. Lower colony strength requires additional hives per acre for the same amount of pollination to take place, however these lower strength colonies should involve lower per-colony fees.

Figure 5: Honey Bee Hives/Acre and Colony Strength Pairs that Pollinate the Equivalent of 2 Hives/Acre with 8 Active Frames



Source: Eischen, Graham, Rivera & Traynor (2007) The effect of colony size and composition on almond pollen collection.
Note: This graph represents equivalence in weight of pollen collected, not almond yield. Should not be interpreted as a measure of optimal stocking density!

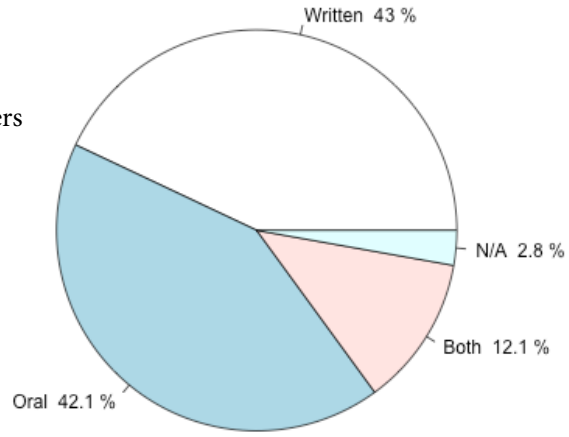
Almond Pollination Contracts

Almond growers and beekeepers have many different choices when it comes to the structure of their almond pollination agreements. Some may prefer a formal written contract with many explicit contract provisions, and others prefer an informal oral agreement based on experience with and an underlying trust of the other party involved. The following paragraphs include a discussion of different contract formats and components based on findings from a survey I conducted with almond growers at the 2015 Almond Conference. The survey asked 114 almond growers about the contract provisions typically used in their almond pollination agreements.

Contract Form: Written vs. Handshake

One of the most important contract decisions is whether to require a formal written contract, or rely on a handshake agreement. Based on almond growers' responses of the basic type of agreement used in 2015, formal written and handshake (oral) agreements were used to about the same extent. **Figure 6** shows that in 2015, 43 percent of respondents used pollination agreements in a formal written form, 42 percent of respondents used pollination agreements that were informal oral agreements and 12 percent of respondents used a combination of written and oral agreements during 2015.

Figure 6: Form of Pollination Agreement, 2015 (N=107)



Both types of agreements have their advantages and disadvantages for almond pollination. Written agreements are more easily enforceable in a court of law, while informal agreements allow more flexibility and show a trustworthy relationship between grower and beekeeper. However, as almond pollination fees continue to increase, it may be time to consider switching to a more formal agreement that lays out specific terms and conditions for almond pollination in case disputes do arise.

Colony Strength Requirements

Early literature on pollination markets suggests the industry standard colony strength requirement was a 4-frame average in the 1970s (Cheung, 1970). Today the standard is an 8-frame average, so colony strength has become more important over the years as the pollination efficiencies of stronger colonies have been realized. Nearly 45 percent of survey respondents stated that their largest pollination agreement contained a minimum average frame count specification of 8 frames. However, there were some deviations from this standard. Sixteen percent of growers reported minimum average frame count requirements above 8, and 17 percent of growers reported minimum average frame count requirements below 8. Over 14 percent of respondents required no minimum average frame count.

Higher colony strength requirements mean more inputs for the beekeeper, so these higher costs must be reflected in the pollination fee. **Figure 7** shows box plots of the growers' reported almond pollination fees by the minimum average frame count required in the contract. The white square denotes the average for each category, while each black dot represents a price/colony strength observation. It is easily seen in this figure that there are many observations for minimum averages of 8-frames, and far fewer for the other frame count categories. Average fees seem to be higher for those frame requirements of 8 and above, however I did not find statistically significant differences, likely because of the small sample size of other frame count categories. This figure suggests that higher frame count contracts involve premiums over the standard pollination fee.

Additionally, I asked growers about whether or not they offered a per-frame bonus to incentivize beekeepers to provide high strength colonies. For example, a per-frame bonus contract would give a base pollination fee per colo-

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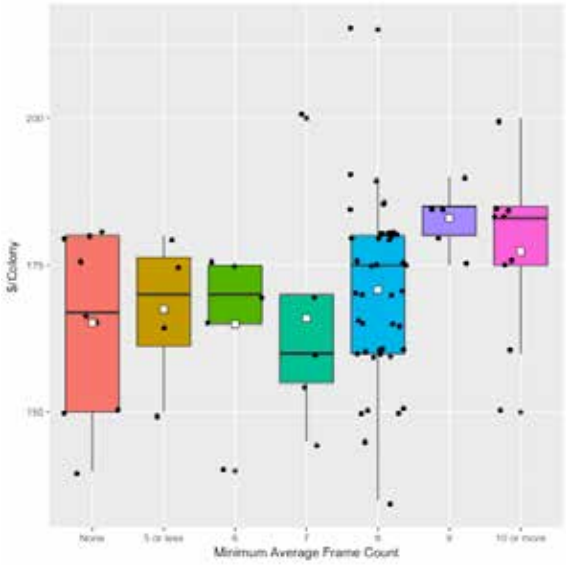
Figure 7: Per-Colony Almond Pollination Fees by Minimum Average Frame Count Requirement, 2015 (N=82)



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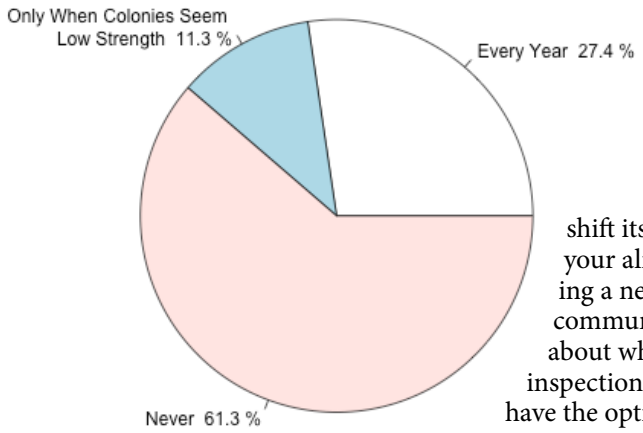
ny for an 8-frame average and if the beekeeper provides colonies of more than an 8-frame average the beekeeper would receive a bonus per colony for the number of frames he/she is above the 8-frame average. Just over 20 percent of respondents offer such incentive contracts.

Colony Strength Inspection and Enforcement

Colony inspections by a third party may be required in almond pollination agreements to verify that minimum colony strength requirements have been met, or to provide beekeepers with their bonuses for delivering high colony strength. As seen in **Figure 8**, most respondents (61 percent) stated that they never pay a third party to perform inspections to verify colony strength, while nearly a third stated that they pay for a colony strength inspection to be performed every year. A smaller portion of respondents (11 percent) pay for a third-party inspection to verify minimum requirements have been met only in years when they believe colony strength is low.

Figure 8: Frequency of Third Party Colony Strength Inspection (N=106)



Colony strength inspection can be an explicit clause in the pollination contract, or it can be implicit. For example, of the respondents who pay a third party to perform colony strength inspections every year, 38 percent stated they had a clause related to inspection specifics in their pollination contract while the other 62 percent have no explicit clause regarding colony strength inspections.

Colony strength inspections have the potential to be costly for you and your beekeeper. Every time a hive is opened, there is a chance the colony's queen can be accidentally harmed. If a queen is killed during inspection, the colony will shift its focus from foraging in your almond orchard to producing a new queen. It is important to communicate with your beekeeper about when and if a colony strength inspection will be performed so they have the option to monitor.

Survey respondents were also asked what actions they could take according to their pollination agreements if a beekeeper provided colonies below the minimum average frame count requirement. **Table 1** shows the percentage of respondents who selected each action. Less than 1 percent of respondents would have taken no action if colony strength was too low, so unsurprisingly colony strength is an important element of almond pollination transactions. Most of the respondents reported that if colony strength was too low, they would communicate with their beekeeper to bring more colonies to compensate for the low strength (74 percent), and over 40 percent of respondents said that low colony strength in one year would impact future pollination contracts with that beekeeper. Approximately 22 and 28 percent of respondents said that they would impose a per-frame or fixed monetary penalty for low colony strength, respectively. When faced with low colony strength, relatively few respondents would remove the colonies and find another pollination provider (8 percent) or impose some other penalty (<3 percent).

Table 1: Percentage of Respondents by Stated Actions Allowed by Pollination Agreements in Response to Low Delivered Colony Strength (N=105)

Action	Percentage
No Action	0.9
Communicate with Beekeeper to Bring More Colonies to Compensate	73.8
Impose Per-Frame Penalty (For Number of Frames Below Average)	22.4
Impose Percentage of Total Pollination Expense or Fixed Penalty	28
Remove Colonies and Replace with Others	8.4
No Longer Contract With in Future	41.1
Impose Another Penalty	2.8
Not Applicable	5.6

Note: Respondents were allowed to select multiple actions, so these percentages sum to more than 100 percent.

Survey respondents were asked about the strength of the majority of initially delivered colonies to their almond orchards relative to their pollination contract's colony strength requirement in 2015. Only two percent of respondents said that most delivered colonies were below the colony strength requirement, so it seems that the incentives and/or enforcement worked well for the surveyed growers in acquiring desired colony strength in 2015.

Other Contract Components

Additional clauses in pollination agreements other than colony strength requirements can outline conditions that may be beneficial for you and your beekeeper. Survey respondents selected various other clauses that were included in their 2015 almond pollination agreements. **Table 2 (*page 10*)** reports

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Knowledge grows

Reliability

Sustainability and quality

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the percentage of respondents, with both written and oral agreements, who indicated that their agreement contained a specific clause. The three most common clauses used in respondents' pollination agreements related to (1) beekeepers having access to colonies after initial colony placement, (2) pesticide application while colonies are in the almond orchard and (3) late colony placement. Over one third of respondents did not have any of the listed contract clauses in their pollination agreements.

Nearly 38 percent of respondents with an oral pollination agreement had at least one of these clauses, so it is possible to discuss some of these issues with your beekeeper even if you don't have a formal written agreement. Your beekeeper may be willing to give you a discount if you can provide certain amenities, such as locked orchard gates to deter bee theft, well-maintained roads, or a portion of payment up front to help cover some of their transportation or preparation costs. This last suggestion has the added value of securing the beekeeper into the contract.

Table 2: Percentage of Respondents Whose Contracts Included Various Clauses (N=95)

Clause	Percentage
Pesticide Application	0.9
Colony Theft	73.8
Colony Collapse Disorder (CCD)	22.4
Late Colony Placement	28
Bloom Percentages for Approximate Move-in/Move-out Dates	8.4
Beekeeper Access After Colony Placement	41.1
Inspection Specifics	2.8
Unpaid Balances	5.6
Minimum Number of Colonies per Drop	
None of the Above	

Note: Respondents selected all provisions in their pollination agreements so the percentages sum to more than 100.

Summary

As you begin making decisions for 2018 almond pollination, keep in mind that it has the potential of being a rough year in terms of health and colony numbers for many beekeepers. Increasing hive density in your orchard as a substitute for colony strength may allow you more flexibility if strong colonies become scarce. Communication with your pollination provider is key to a successful 2018 pollination season, as well as maintaining a secure supply of pollinators going forward.

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