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The Evolution of Federal Programs for Beekeepers and Pollinator Data

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Introduction

Will there be enough pollinators to sustain the needs of agriculture into the near future? This straightforward question exposes critical gaps in the data on how farms obtain pollination services, how much they pay for them, and what factors affect pollination service supply. Prior to the emergence of Colony Collapse Disorder (CCD) in 2006, no systematic survey data tracked honey bee colony loss rates. Prior to 2015, no national-level data tracked either the cost and use of pollination services to farms or the movement of managed honey bees by beekeepers. This knowledge gap mainly reflects the complicated and localized structure of markets of pollination markets, the historically small contribution of pollination service fees to beekeeper revenue, and the fact that farms sometimes receive pollination services—from either managed honey bees or native pollinators—for free.

In the absence of national data on pollination services fees or colony loss, researchers have extrapolated from either regional data on pollination fees or changes in the number of honey-producing bee colonies (as measured in the long-standing U.S. Department of Agriculture *Honey* report (2018b)) as a way to gauge whether agriculture potentially faced pollination shortfalls. As we describe later, both approaches have shortcomings. Regional data may give an unbalanced picture on how much the typical farm utilizes and pays for colony rentals because the two main previous surveys had been from regions (the Pacific Northwest and California) where pollination service demand was the highest. The *Honey* report's colony figure, on the other hand, captures honey market conditions (rather than pollination market conditions) by omitting colonies not producing honey. Since 2015, new data from the National Agricultural Statistics Service (NASS) in the *Honey Bee Colony Report* and *Cost of Pollination Report* have provided much more detail on how pollination service markets have responded to colony loss and how pollination service utilization and fees have varied by region and crop.

This article describes how the federal support programs and data reporting surrounding beekeeping have historically focused on the industry's production of honey as a sweetener. The rise of pollination fees for almonds in 2004, the designation of CCD in 2006, and the recording of elevated colony loss rates since 2007 spurred a change of focus for support programs to address, in part, the risk of colony loss to beekeepers and to collect better data. These data have shown that, despite winter loss rates remaining high, honey bee colony numbers have been relatively stable since the 1990s and that large pollination fee increases have been mostly constrained to almonds, a crop that provides 82% of the pollination service revenue collected by beekeepers. Despite the creation of these new data sources, the extent to which farms rely on wild versus managed pollinators outside of formal honey bee colony rental agreements needs greater research; the development and implementation of surveys of wild pollinators also remains a challenge (U.S. Government Accountability Office, 2016).

The Historical Focus on Honey Production rather than Pollination Markets

Throughout most of the twentieth century, data on beekeeping measured the production quantity and value of honey and, to a lesser degree, beeswax. Since the 1870s, the USDA's Census of Agriculture recorded the number of “swarms of bees” owned by farms, along with their honey yields, the number of pounds of honey produced per colony. In 1900, 4.1 million colonies were maintained on 12.8% of the 5.9 million U.S. farms. Pre-twentieth-century honey yields at the national level were far lower than modern ones with 23.8 pounds per colony (in 1870) being the maximum recorded before 1900. In contrast, the maximum between 1900 and 1949 was 46.3 pounds (in 1940) and 83.7 pounds between 1950 and 1999 (in 1998).

In 1939, NASS began surveying beekeepers annually on honey production and yields, reporting 4.5 million U.S. colonies in its yearly *Honey* report (U.S. Department of Agriculture, 2017). Then, World War II vastly increased demand for both honey as a substitute for rationed sugar and beeswax as a sealant used in various armaments, leading various federal departments to encourage beekeeping on the home front (Hoff, 1995). Colony numbers rose from 4.4 million in 1940 to 5.9 million in 1947, the year after real honey prices had reached their historic peak.

The sharp falloff in post-war honey prices led to the creation of the Honey Program in 1949, justified in part by the needs of farms for crop pollination (Hoff, 1995; Muth et al., 2003). Under this program, producers could either sell their honey directly to the government at a support price or borrow against their honey in a loan based on the honey’s support price value. Because borrowing producers could later forfeit their honey to the government if they could not find a higher market price, these loans obligated the government to acquire the honey when prices fell below the support price.

For the first 30 years of the program, support prices were set well below market prices. Even as demand fell sharply with the end of sugar rationing, government acquisitions were insignificant. Between 1947 and 1972, colony numbers fell in all but two years, eventually reaching 4.1 million. Improved honey prices in the 1970s helped stabilize and expand colony numbers through the remainder of the decade. Then, double-digit inflation in combination with adjustments to the formulas used to set support prices caused the support price to exceed the market price after 1979 (Muth et al., 2003). Beekeepers selling or forfeiting honey to the federal government led to program acquisition as high as 65% of domestically produced honey, even as imports surged into the United States. The Food Security Act of 1985 scheduled gradual reductions in support levels and restructured the program to make loan deficiency payments rather that purchases or forfeiture acquisitions, which eliminated government acquisitions. Program utilization fell sharply. In 1993, the Honey Program was denied appropriation from the federal budget, and it was finally eliminated in 1996 legislation. Between 1985 and 1996, U.S. colony numbers fell from 4.3 to 2.6 million, although a statistical adjustment in 1986 to exclude small beekeepers from the *Honey* report survey obscures the exact size of this decline (see Muth et al., 2003, on this issue). Since 1996, colony numbers in the *Honey* report have largely stabilized. Colony numbers dipped to 2.3 million by 2008 but recovered and increased to 2.8 million in 2017.

Federal support since the Honey Program’s demise has taken three main forms: trade protection from honey imports, compensation for colony losses, and weather-based insurance. On trade protection, China agreed to voluntarily restrict its honey exports to the United States from 1995 to 2000. After the agreement’s expiration, an antidumping tariff was imposed on imports from China (which is still in place) and Argentina (which was smaller and removed in the mid-2000s). Moreover, from 2001 to 2008, revenue collected under the anti-dumping tariff was to be redistributed back to U.S. producers under the Continued Dumping and Subsidy Offset Act (CDSOA) of 2000 (also known as the Byrd Amendment after its sponsor). Legal issues delayed actual distribution of funds well beyond 2008 so that total CDSOA honey producer payments averaged $7 million between 2007 and 2019 (U.S. Customs and Border Protection, 2018).

On colony loss compensation, in 2010, the Emergency Livestock Assistance Program (ELAP) began compensating beekeepers for colony losses exceeding a normal (annual) mortality rate of 15% of all colonies resulting from disaster events or CCD. Until 2017, ELAP payments were capped, which caused payments for individual claims to be pro-rated by the available amount across all claims. For 2017, payment caps were removed, but in 2018 the normal mortality rate for claims purposes was raised to 22% (U.S. Department of Agriculture, 2018a). In fiscal year 2018, ELAP payments to beekeepers totaled approximately $38 million (Stubbs, 2018). Concerning apicultural insurance, in 2017, the USDA expanded a pilot program that subsidized beekeeper premiums for insurance, where payments are made if a weather index indicates the presence of drought conditions, an event that lowers honey yield. In 2019, about 57% of all colonies were insured, with subsidies totaling $25 million (U.S. Department of Agriculture, 2019). For perspective, total beekeeper income in 2017 was $695 million (U.S, Department of Agriculture, 2017).

Since the inception of the Honey Program, supporters had emphasized the important role honey bees played in crop pollination and linked supporting the honey price to supporting crop pollination (Hoff and Willett, 1994; Muth et al., 2003; Muth and Thurman, 1995). Despite Cheung (1973) showing that, despite common misconceptions, beekeepers can and did charge farms for pollination services, scant data quantified how much pollination income beekeepers earned on average. Amid the Honey Program's curtailment, a federally financed survey in 1988 showed that pollination services income made up only 10.9% of beekeeper revenue, while honey sales and government payments (tied to honey production) comprised 52.7% and 27.7% (Hoff and Willett, 1994). Moreover, only 22% of beekeepers reported any pollination service income, and the pollination share of beekeeper revenue was much higher in the West (18.3%) and Northwest (15.4%) than in the Northeast (4.8%), Southeast (3.6%) and Midwest (1.8%).

As with pollination services fees, colony loss rates showed a similar knowledge gap (at least for latter researchers) because, at the time, no systematic data on colony loss rates were being collected. The same survey analyzed by Hoff and Willett (1994, p. 25) addresses this gap somewhat, reporting:

> *Beekeepers experiencing winter kill reported that about 20 percent of their colonies were affected in 1988. Of the affected colonies, 35 percent incurred 50 percent or more loss of bees.*

The fact that the survey's "winter kill" rate does not necessarily indicate that those colonies experienced a complete loss of the population illustrates how definitional concerns can create difficulties in interpreting isolated colony loss reports. Although colonies are found by beekeepers that are completely nonviable (i.e., "dead outs"), existing colonies in a state of imminent collapse without intervention or newly split colonies failing to establish themselves may also potentially be classified as losses within some frameworks.

The 2006 discovery of CCD spurred the Bee Informed Partnership (BIP) to collect continuous, systematic, and well-documented data on winter loss rates beginning the following year. While loss rates were nontrivial in earlier periods, they had not been regularly surveyed. Based on the knowledge of industry experts, a 15% rate of winter loss became accepted as the "historically typical" rate of colony loss rate as new BIP survey data showed winter loss rates exceeding 30% in three of the first four years of collection. BIP later added summer loss rates to its surveys in 2011 and, while these rates also seem high, a comparable historic baseline loss rate has not emerged in the literature.

Given the greater importance of pollination service revenue to West Coast beekeepers, it should be unsurprising that the first surveys of pollination service fees through colony rentals occurred in the Pacific Northwest (PNW) in 1989 and then in California in 1993 (Burgett, Rucker, and Thurman, 2009). The PNW survey showed that a beekeeper rented out an individual colony 2.4 times each year, on average, serviced 5.5 different crops, and operated in 6.8 counties. Certain crops—almonds, plums, and early cherries—paid considerably more for colony rentals throughout the survey's timespan, reflecting differences in both the seasonality of the crop's bloom and its honey-making potential. For instance, in every year between 2002 and 2008, early-blooming cherries paid at least 2.3 times more per colony than late-blooming cherries. Because beekeepers and their colonies are capable of moving thousands of miles if the colony rental price is high enough (as it has become with almonds), extrapolating whether colony loss could increase the scarcity of pollination service is difficult with only regional surveys. National measures of bee utilization were needed: What share of farms rented bees for pollination services and at what cost? Did farms ever adjust stocking rates in response to colony rental prices? Did farm practices that affected pollinator health ever influence the prices beekeepers charged for colony rentals?

Between 2004 and 2008, three events further exposed the need for better data. First, between 2004 and 2006, average pollination fees rose sharply for almonds. Second, CCD was identified in 2006 as a specific set of symptoms associated with the otherwise unexplained colony losses and quickly gained media attention. Third, BIP surveys stated winter colony loss rates of 31.8% and 36% in 2007 and 2008. Subsequent media reports worried that high colony loss rates might threaten the survival of honey bees generally and, with it, the production of pollinator-dependent crops (Walsh, 2013). Rising pollination service fees were cited as evidence of a looming pollination shortage, despite large fee increases being limited mostly to almonds. Little data detailed which farms used managed pollinators, either owning or renting honey bees or relying on native pollinators (which have also showed worrying signs of decline). Estimates of the potential effects of pollinator loss often included considerable extrapolation. Despite lacking clear data on whether existing honey bee colonies were being fully utilized for pollination services, some authors worried that the growth of honey bee stocks were not keeping up with agricultural demand for pollination (Aizen and Harder, 2009).

Crops rely vitally on pollinators, but this reliance is not uniform. Pollinator dependency is a statistic measuring a crop's reduction in yield in the absence of all insect-facilitated pollination. Many estimates of the value of pollinators to crop production use this metric to extrapolate the total loss of agricultural production associated with a total loss of pollinators. By construction, however, a crop's pollinator dependency says little about the effect of marginal losses in pollinators, the stocking rate crops need to achieve full pollination, the differences in their pollination requirements across crop varieties (i.e., recommended blueberry stocking densities range from 0.5 to 2.5), or the cost of renting pollination services (Muth and Thurman, 1995; Melhim, Daly, and Weersink, 2016; Pritts and Hancock, 1992). As an economic identity, colony rental costs paid by farmers are equal to pollination revenue earned by beekeepers. Higher pollination fees, particularly for almonds since 2004, seemed likely to at least partially offset the higher costs beekeepers bore from having to replace lost colonies or move them further distances.

New USDA Data on Pollination Markets

Following a coordinated 2014 initiative across federal agencies to address pollinator health problems, NASS began collecting three new surveys describing conditions in pollination service markets. Two honey bee colony surveys of beekeepers record their loss rates, causes of colony stress, and colony replacement rates as well as tracking the location of colonies. The large beekeeper survey occurs quarterly; the small beekeeper survey annually. The third, cost of pollination survey recorded the number of paid and unpaid managed honey bee colonies used for pollination, acreage requiring pollination, and expenditures on honey bees, alternative pollinators, and habitat improvement. From these data, one could also infer stocking densities (the number of colonies placed per acre) and price differences across locations. Two public reports released key summary data. Researchers, however, could potentially access and link the underlying survey responses for individual farms and beekeepers to other NASS data, including the Census of Agriculture, which itself added questions for beekeepers on aggregate pollination service revenue, and the *Honey* report, which also added questions on beekeeper production costs (mite treatments, feed cost), colony replacement stock (queens, package bees and "nucs," i.e., nucleus colonies), and pollination service revenue.

These surveys filled some critical knowledge gaps. First, the estimate of total farm expenditures on honey bee colony rentals from the surveys was considerably less than a previous estimate made by multiplying available estimates of crop pollination costs (typically conducted by co-operative extension services at the state level) by total acreage of that crop (Bond, Plattner, and Hunt, 2014; Ferrier et al., 2018). Since crop budgets are undertaken on an ad hoc basis and are specific to a crop's region and variety, the underlying budgets themselves may only record a crop's pollination costs where their costs and utilization is highest. When first measuring farm costs of pollination in 2015, NASS comprehensively surveyed 31 crops types but only obtained sufficient data to report on 20.

Second, almonds drive pollination service revenue, making up 82% of all beekeeper revenue from pollination services. Because pollination service revenue now comprises 41.1% of beekeeper revenue, a full third of all beekeeper revenue comes from almonds alone. Pollination services fees for almonds ($165 per colony in 2015) have been about three times higher than the average of fees charged to all other crops ($54.8 per colony). However, this large revenue share is not attributable solely to high fees. Almonds account for 61% of all colony rentals and 52% of all crop acres renting honey bee colonies (Ferrier et al., 2018). The almond bloom drives patterns of colony movement and forces crops with similar bloom times to pay similarly high fees. Relatedly, in 2015, California contained 60% of U.S. colonies during the first quarter but only 26% in the third quarter (U.S.

Department of Agriculture, 2016). In 2015, outside of almonds, colony rental costs represent only 1% or 2% of farm production costs (Ferrier et al., 2018).

Third, while colony loss rates remain elevated, the number of honey bee colonies varies seasonally and does not show clear signs of declining numbers on a year-to-year basis. This finding stems from the close correlation of colony losses with colony additions, typically made through splitting existing colonies (Ferrier et al., 2018). By splitting existing colonies, beekeepers seem to be able to rebuild colony stocks following high loss rates within the course of a year. Splitting, in the context of the bee's life cycle, causes colony numbers to vary seasonally. As one might expect, summer is the peak colony season; from 2015 to 2017, July colony counts averaged 15% higher than January colony counts.

While these new public reports have been informative unto themselves, the underlying survey data also shows great promise for further analysis because the underlying NASS data can be merged so long as confidentiality is maintained. For example, both the cost of pollination survey (of crop producers) and the honey bee colony survey (of beekeepers) can be merged with Census of Agriculture survey data (of all farm operations) in years (like 2017) when they overlap. These merged data may potentially inform questions such as whether mixed-use or organic farms are less likely to contract for pollination services or whether levels of colony loss are higher for different types of beekeepers. Unfortunately, NASS suspended the cost of pollination survey in 2018; further inquiries on pollination services markets may be forced to rely on regional studies and have limited ability to address how pollination market utilization changes in response to economic and environmental factors.

Conclusion

Honey bee colony loss rates remain high. Understanding and reducing colony loss will remain a priority for beekeepers, entomologists, and the biological sciences community generally. New NASS datasets provided the first national-level view of pollination service fees, colony movements, and beekeeper costs of replacing lost colonies. In showing stable pollination fees and restocking costs, these data paint a less dire picture of the effects of honey bee health problems on agricultural production than some alarmists have portrayed. Moreover, the data show how the almond industry's continually growing need for the pollination services has reshaped the entire revenue structure of beekeeping.

Additional Information

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For More Information

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