Webinar Transcript: Honey bees on the Move: From Pollination to Honey Production and Back

Today our presenter is Jennifer Bond, Deputy Director of Outlook and Economic Analysis in the Market Trade Economics Division. She has been at the Economic Research Service since July 2012 and has worked with our Feed Grains, Specialty Crops, Wheat, and Pollinator Health Research teams. During her career, Jennifer's work has covered a range of topics including commodity market analysis, consumer demand, cooperatives, industrial organization, agricultural finance, and pollinator health.

Thanks for joining us today, Jennifer – the floor is yours…

Wonderful, thank you all, thank you for that introduction, Valerie, and good morning or good afternoon to everyone joining us online depending on your location. You may get a sense from my background that I've got a varied career, and that is certainly true, but I have been working in pollinators for almost a decade and really enjoying fruitful collaborations with individuals from academia but also colleagues here at USDA.

Today's presentation is based on the most recently released reports by ERS's Pollinator Health team. And yeah I'd like to apologize some of you may be hearing an echo and our team is letting us know that they're working to eliminate that echo so please bear with us and hopefully we'll be done with that fairly quickly.

Today, I'd like to talk a bit about the integration of honey and pollination markets and before we move into the meat of our presentation I'd like to take a moment to acknowledge the rest of my collaborators Claudia Hitaj, David Smith, Kevin Hunt, Agnes Perez, and Gustavo Ferreira. Some have moved on to retirement, some have moved on to international adventures, and others are with us here at USDA and continue to work in the pollinators space.

So, you may be asking yourself why pollinators are important to me. There we go and uh it's known that up to a third of the world's food crops rely at least in part, oh and I think our echo has gone wonderful, at least on the pollination services of insects more broadly and that may be a little bit difficult to wrap our heads around but if you could perhaps picture your diet on wind it would largely be grains, oats, things of that nature. But insect pollinated crops although they're not the bulk of world food crops they provide a lot of color and nutrition. So, think about berries and vegetables. So, it makes a for a more colorful and flavorful meal to have some pollinated crops involved. Now some of these crops that utilize insects are wholly dependent upon honeybees, or other insects, to set fruit or nuts. Others simply see enhanced production perhaps enhanced yields or a production period. That is true across a wide variety of crops and we certainly see how that is reflected in the use of commercial pollination services. That industry itself has grown pretty significantly over time and the revenue generated from commercial pollination services has grown such that it's nearly equivalent with the revenue that beekeepers receive from honey production, the thing that they're probably most iconically identified with. So

how do beekeepers service these pollination contracts and produce honey? Oftentimes they travel around taking their hives, otherwise known as colonies, around the country to meet this growing demand for services.

So, while we acknowledge that bees are definitely an important part of our food system and that many of our hives are on the move throughout the year, there are some questions about the number of hives or colonies that are moved, the routes that are traveled, and the distances that are traversed. Prior to NAS collecting survey data on this, it was not particularly well quantified or documented. In 2014, the pollinator health team did try to put together kind of a rough map based on beekeeper input and bloom times for pollinated crops. And that served us some of the inspiration for the work that we'll see later today. And we've tried to upgrade those maps with the vast amount of quantitative data that NAS provided. And we believe that this information is really pretty critical to our understanding of how travel can affect the provision of pollination services, how it can affect honey production how that may also, in turn, affect colony losses. Not to mention how it affects crop production for some of those tasty food items that we spoke about earlier. Something that is known and has been brought to light and other research is that honeybees do face a variety of stressors to their health and have sustained significant colony losses in the past. Now colony numbers haven't necessarily decreased and that's perhaps a credit to beekeepers who have learned to manage some of the afflictions that hives have encountered and also been very proficient in learning how to split hives and maintain those hive numbers. Some of those stressors include things like mites, disease, pesticide exposure, a lack of forage, but also long-distance travel which is germane to our work today as we're talking about moving hives long distances around the country to do various things.

So, some of those things that we specifically were able to understand prior to our work is that honeybees pollinate geographically diverse crops. They- we knew that they moved, and we were able to demonstrate that in our early maps. The degree to which they moved was something that we learned through our research, but the basics are that the pollination season really starts with the almond bloom that takes place in California. And that bloom starts while hives are typically in a period of dormancy, so typically in winter. And so those hives need to be woken up and made ready to provide pollination services and this is no small feat. The almond bloom requires a large number of hive speed brought into California being brought out of dormancy and the demands of this industry, for pollination services, have actually increased pretty significantly over time too as the almond industry has grown. So, for example, 10 years ago there's about 750,000 bearing acres of almonds and in 2020, here I have most recent data for, we're up to 1.2 million. So not quite a doubling but a pretty significant increase in the number of varying acres and as expected an increase in demand for pollination services. And that is reflecting the amount of service fees that are collected. And in fact, almost 80 percent of all U.S. pollination fees that are collected, as indicated by NAS, are attributable to almond pollination service fees. Following distantly, and quite distantly, by apple and blueberry pollination service fees.

All right, moving to our next slide. Another way to look at that and give you an idea of the tremendous impact of the almond industry and the pull that that sector has in the provision of pollination services. A vast majority of this pollination service revenue is generated in California alone and most of that is from almonds. And so for the entire industry you see that California itself, which pulls in a lot of revenue for almonds, comprises 85% of that total with some of these other states, such as Washington and Oregon, the Pacific Northwest area which is where there is a concentration of revenue from almond pollination, blueberries, and more. They are really quite distantly behind California with 4 and 1 percent. And then the rest of all states, besides Michigan and Wisconsin, comprised of seven percent of total pollination service revenue generated.

Okay something interesting that we found we knew some of the basics we started this research the NAS data was really effective in helping us get a sense, of course that was paired with census data, as to the level to which crops depend or utilize pollination services and in a sense called a dependency ratio. So, we were able to determine what share of the total planted area or total bearing acres utilized pollination services and that gave us a percentage. So, what percentage of the acres use pollination services which could be described as a dependency. So, what share of those acres were dependent upon commercial honeybee pollination? And interestingly, that really did vary quite a bit by region and by crop. Some of the reasons for that might be that crop physiology and other factors are influencing some of the dependency, cultivator selection may matter, the type of apple tree grown in the east coast may vary slightly from the type of tree that has grown out in the west coast, the availability of other abiotic processes such as wind may also vary and impact the efficacy of insect pollination or the need to pollinate with commercial honeybees. There may also be variations in the availability of non-apis pollinators, so non-honeybees, and that could certainly be a factor in determining variation by region and across crops as well. Interesting what we see, and this supports with our understanding of economics, lower levels of pollination service for use so a lower dependency ratio or a lower share of the total planted acres, let's say that use pollination services, those tend to be associated with a lower pollination service fee. So, you know, reduced demand for service would, in turn, be associated with perhaps lower pollination service fees if there is lower demand for those. Fees themselves, as are pretty clear in the case of almonds, are a function of timing and competition for hives and there is a strong demand for those hives at a very specific time during the almond bloom and then as those hives travel elsewhere, um there's that concentration in California, but because there's such a concentration there, there may not be as great of demand as there is hives available shortly thereafter. And so we do tend to see a drop in those pollination service fees subsequent to the almond bloom.

So, I want to give you a little bit better idea of functionally what this means. And this may be a little bit hard to see but this is a table that is drawn directly from our report, that's accessible on the ERS website. And here you can see that, let's say in the case of cucumbers- I'll highlight those for a minute. So, cucumbers vary pretty significantly in their reported dependency on commercial honeybee pollination. So, in the south region, that's including Florida and Louisiana,

only about 14% of the planted cucumber acres utilized commercial pollination services. And the fee associated with that was about $16.00. So, you know, comparable to not having a really strong demand for pollination services. However, in the Northeastern region there is quite a bit more demand for pollination services, 45% of those acres planted there were cucumbers utilize commercial services, we estimate. And consequently, that increased demand helped to, perhaps, boost that pollination service fee number instead of the $16.00 we saw in the south region, we're up to $67.00 in the Northeastern region. Another crop where there's some pretty significant regional variation, watermelon. So, in the Pacific Northwest region nearly 99% of watermelon planted area utilize commercial pollination services and only about 34% in the Northwest, or Northeast region rather.

So there's clearly some things going on in the market that are influencing demand for pollination services, and some of those are beyond the scope of this of this paper here, but we hope that they encourage further research so that we can understand the dynamics associated with this industry. So here is our next slide, and this is the total amount paid for pollination services by region, and here again we can see the very strong influence of California on total figures. The Region 6 and Region 7 includes California and Hawaii and that is far and away the leader in the total acres pollinated. So for the latest year that we had data, 1.1 million acres were pollinated in that region and in that year there was less than a million acres of almonds, there were some additional non-almond acres pollinated, but clearly the bulk of what was being pollinated was almond acres. And the price per acre was close to $240.00 that year. I understand that prices have fluctuated some since then, but most recently the California beekeeper's association indicated that the prices that were estimated for the 2020 year were again above $200.00 per hive. Colonies used clearly here again the impact of the almond bloom on demand for colonies, almost two million hives being used into 2017. And then the total cost for pollination here again underscores the incredible revenue generation in that California area that's in Region 6 and Region 7.

So another way to put it, and we all appreciate visuals, this one was put together by Kevin Hunt, who's a geographer and did wonderful work with the data that NAS provided us on where colonies were traveling to and from throughout the year. So, we have some spatial movements and some time movement that we'll be sharing. So, this map here refers to July 1st, 2017 to January 1st, 2018. So, during that period where were the colonies moving from and where were they moving to? And here again we can see the very very strong draw of California just ahead of the almond bloom, in winter pulling hives out of the Great Northern Plains so that's South Dakota, Montana, North Dakota, of course and pulling hearts from as far away as the Northeast and the Southeast and then certainly coming down from the northwest as well. So really all over the country hives are being taken out of dormancy and moved into California to support the almond bloom.

So obviously, the California almond bloom is a very influential determinant in figuring out where hives are going to be moving. But another factor that is affecting movements is honey production and that's closely linked to forage resources. And we know that managed honeybees

collect nectar and pollen from flowering plants and they, in turn, use that to produce some honey. And that is stored, as you can see in this picture, in things called frames from which the beekeepers can harvest the honey as well as the beeswax. And commercially pollinated crops do have some nectar and pollen potentially, but they do vary in their ability to support honey production. And so, beekeepers oftentimes move their hives into foraging grounds so that their bees can have access to more abundant supplies of commercial honey producing plants, so things like clover and more. And a lot of that forage area resides in that Great Northern Plains area. And North Dakota is certainly an area where there's a tremendous amount of honey production. After hives are moved into California for the almond bloom, some move up to the Pacific Northwest and rotate if you, you know, move a few states do some pollination and then over into that Great Northern Plains area, for what may be characterized as a summer vacation, if you will. And so, they go, and they forage, and they produce honey. So much so that North Dakota alone in 2020, $61 million worth of honey was produced, and that is more than twice the amount of runner-up California which produced about $24 million dollars worth of honey. So really underscores the impact of those forage resources in North Dakota for honey production.

And one of the reasons why North Dakota is favored for forage grounds and for supporting honey production is that there's a lot of forage resources there, in part due to the high number of CRP, or Conservation Reserve Program, acres that are located in that area it's estimated that in the Great Northern Plains total there's a concentration of about 21% of the total CRP acres located in that area. And some, but of course not all, of that land is really prime honeybee forage. And beekeepers are said to seek out places with high quality forage, but also a low risk of chemical exposure, and a lot of times CRP land really meets that criteria. But North Dakota is also pretty well known for its large expansions of pollinator friendly grasslands and wetlands, especially in the Prairie Pothole region, which is a in the area to go put hives and allow them to forage and have that spring break we talked about.

So now that we're familiar with some of the factors that are encouraging beekeepers to move their hives, the California almond bloom, and then going into the Northern Plains to forage, I think it's probably important that we highlight that following those honeybees, although we know these large movements um happen, is a little bit more tricky. And we'd love to be able to quantify their movements to a greater degree. Being statisticians of course we're looking for numbers and thankfully NAS has helped us with that. And starting in 2015 they began to do greater surveying of commercial beekeepers in this regard. And that allowed us to have a look at location data by quarter and that was later expanded to include what was being pollinated and pollination service fees that were charged. And so that really allowed for us to combine that quarter of- our data rather across quarters and combine that with census data and see how many acres of what was being planted, or was bearing in that year, get a sense of the dependency, of the use, and just really be able to better quantify the movements of colonies over space and time.

And here again, what we found is akin to what we expected. And what we were able to find is at those two events the influx in the California for the almond bloom and then the outflow to the

great plains really dominate hive movements. As noted, before hives removed prior to the almond bloom which starts in February. And I looked up the average temperature in the DC area, the low 50s about that time of year. But where they're moving these hives to, the average temperature is about 70 degrees. So, after the bees make their move there, they have some warmer temperatures and they're able to be brought out of that dormancy and get ready to pollinate. There are certainly residential colonies in California, but not enough to fully address the demand for the pollination services fees from the almond industry. After pollinating, some of those hives do stay resident pollinating alfalfa, melons, sunflowers, squash, and many other crops, but a lot of them do move and continue that kind of nomadic journey to the north. And then also some move all the way back out to the east and that next big movement is that outflow to the northern great plains. And we can see that in that about 90% percent of the colonies that were in the Northern Great Plains during the summer quarter, they were not in place there on January 1, so they had moved into that area most likely to have access to those forage resources.

So, I credit again to Kevin Hunt who provided these- these maps with the wonderful NAS data we can see that a little bit more visually. The first map in the upper- upper left hand corner you can see that influx of hives from the northern plains, from as far away as Maine to California, to service those almonds contracts. And then later in the summer that big exodus out of California, possibly to the Pacific Northwest, but again all the way back to as far away as Maine with a real concentration going to those forage rich grounds in the Great Northern Plains.

Okay, so I know that the official start of summer was, I believe June 20th, so we're just really- really at the start of pool season and other fun things. But beekeepers are surely already thinking ahead to what happens when the summer is over. And when the temperatures start to cool in the Great Northern Plains area, which can be a pretty significant temperature drop they are, the Great Northern Plains are located in the north, it gets chilly there. The beekeepers need to find a safe haven for their bees, they don't necessarily do great just being left out in really cold temperatures. So, there are some ways to protect hives that do remain resident in the Great Northern Plains. Some innovative solutions include storing them and potato storage areas, maybe even underground, but the majority of them move out of the area. Some go back to California, some go to the south and the southeast, but generally seeking protection and warmer climates.

So all of these movements, and really I guess there's three main events that are characterizing the movements of pollinators: the movement to California, movement to forage grounds, and then the post summer vacation move out to the different areas for finding safe haven for overwintering. And we'd like to know what this translated to in terms of time on the road and distances traveled. And as we say in this slide, what we found is these busy bees really do log a lot of miles on the road. And we do have just snapshots of where these hives are, at one point in time, uh four times a year and so we're estimating a little bit here. So, we don't necessarily get the inter-temporal movements so if a hive was moved within one quarter within one state, we may miss that data. So, we are able to tease out, you know, approximately how many miles colonies were moved for a full year, but we do think that this may be underrepresenting to some

degree. But on average, for colonies that were moved, they were moved about 1,153 miles. So, to put that in context, it is summer and so it's a car trip season that would be the near equivalent of about a 20-hour drive for you and me going about 55 miles an hour. So that's a long way to go and it does potentially impact the pollinators on the way.

We wanted to give you a little bit more detail on how far some of these bee's travel and where they travel to and from. And in this chart here, you can see the percent of honeybee colonies that were moved by the average distance traveled between two points in time during the year. And this first chart shows you that information from January 1st, 2017 to July 1st, 2017. And here we can see the outflow, if you look at that tallest yellow column in the middle the outflow of honeybee hives from California to North Dakota. That's a very large proportion of the colonies that were moved and you can see about how far they were they were moved, so a little bit more than 1,100 miles on average. So that that's one of those kinds of defining movements for the annual bee migration. Some hives, it's a smaller proportion. You can see all the way on that far right-hand side there's that west to east coast movement. So some hives possibly in position for the California almond bloom or move more than 2,000 miles all the way back to the east coast to maybe pollinate blueberries up in- up in Maine, or go down to Florida, maybe to go visit some orange groves. It's hard to say exactly but there are certainly some bees that are more traveled than others. And there are still others too that travel a little bit less, but there's a real concentration around that 1,100 miles. And a lot of movement from California to those Northern Plain States.

So, another indicator of the migration, this is a little bit different time of year, this is July 1st, from 2017 to January 1st, 2018. And from here, we can see that movement of hives from other areas, from overwintering grounds, into California for the almond bloom. So we can see that, you know, fairly significant proportion of hives, so between oh 15% and 20% are coming from South Dakota to California, and then North Dakota down to Texas, and then North Dakota down to California, to service those- those pollination service contracts there. And those hives that moved during that time period moved an average of more than a thousand miles. There again you can see the east to west coast migration on the far right hand side, and there are some, you know, a noticeable amount of hives, a noticeable percent, but probably no more than a total of 5% that move in excess of 2,000 miles. Most are moving around that 1,100 mile mark.

So now that we're thankfully using the NAS data are able to do a little bit more analysis of where hives move and how long they do travel in terms of distance and we- we wanted to kind of delve a little bit into the impact of colony health on long distance travel. And for this we look to the literature, and we can certainly see many studies, including some done by researchers at USDA, that indicate that hives are indeed impacted by travel. And impacted specifically by things such as their environmental conditions, so the lack of air flow perhaps, lack of forage while they're commuting, maybe some reduced ventilation, to possibly some excessive temperatures as well. Some of that can be mitigated, we understand, based on proper stacking techniques as well so there's some things that the beekeepers can do to help manage their hives as they are being

transported. What um a study in 2012 found was that, you know, that aside, you know the transportation management aside, the bees are affected by food gland development so that may impact their ability to get nutrition from the crops that they forage on. There's also a finding in 2014 that showed that among bees that were traveling, they had an increased prevalence of fungal pathogens. So, these bees, you know, perhaps were a little bit more beset by some of the diseases that challenge pollinators. There's also an indication of reduced lifespan and higher oxidative stress levels and hives that move around the country quite a bit.

Okay so in light of this, um certainly there's opportunities to garner pollination service fees by traveling, there's also opportunities to make honey and earn revenue from that, but there's also some- some trade-offs here. And those uh are pretty clear that beekeepers make some pretty complex hive management decisions. And they can be summarized as when, whether, and where to move hives. And we've seen some strong trends but, of course, there's some customization there too. But the things that the beekeepers are- are oftentimes thinking about are these four here: the production of honey, servicing of pollination contracts, finding access to nutritious forage for their bees, and then also finding a place to safely store their hives over the winter ahead of the start of the pollination season. So again, moving hives is costly but it certainly does create some personally appropriable benefits to beekeepers, some of the revenue. But it also creates benefits to farmers too who benefit from enhanced production and there's also the provision of things such as ecosystem services. Those environments for the benefit of- benefits to the environment. Not to mention to you and me who gets perhaps a more varied diet, more colorful diet, based on the crops that are made more abundant through the provision of pollination services.

So, in consideration of all this and perhaps it is interesting individually. I, as a researcher, absolutely love data so it was fun to dig into this. But there is an impact for individuals and that of course is that honeybees and their health are essential to the production of numerous food crops that we consume ourselves. And as we know, and have mentioned at the onset of this presentation, around the country honeybees are used to enhance fruit set, nut set to help support yields for a variety of crops, although with varying levels of intensity and with varying use across different regions. Growing demand for pollination service fees is a result of expanded production of almonds but also generally increased consumption per capita of fresh fruits and vegetables and that increased demand has supported generally higher pollination service fees. What we also know is that an increasing number of hives are traveling a fairly long distance to pollinate crops and that, based on the literature, is associated with potentially higher hive stress, and increased vulnerability disease, and some pathogens. So, an interesting additional fact is that per capita demand for honey is generally rising. And that honey is the product of generally foraging in that Northern Plains area and other- other areas that are rich in forage. But at the same time as demand for honey and demand for forage resources is increasing, we're also seeing expanded cultivation in those traditional forage areas of corn and soybean acres. In fact, soybean acres have increased really pretty significantly over the last 10 years in the North Dakota area. I

think they started close to, I think, 3 million about 10 years ago, we're up close to 7 million acres of soybeans presently up in that area. That's a state that has about 40 million acres under agricultural cultivation, so that's a pretty significant share of cultivated acres and a pretty important forage supplying region. We also acknowledge that CRP land is increasingly important to pollinator health and honey production. So, in conclusion, our consumption of honey is closely tied with the movements and our consumption of sort of value-added fruits vegetables and more is also closely tied with those pollinator movements. So perhaps it makes us a little bit additionally concerned about the impact of travel on bees and maybe curious about the trade-offs and the decision-making- the decisions that beekeepers make. Say as they contemplate where, and when, and how, to move their hives.

So, with that I'd like to conclude my presentation today and invite questions. I've put a link to the report on this final slide but also put up here my email information and links to USDA's pollinator resources. So, thank you for your time.

Thank you, Jennifer, as a reminder for all our listeners: please use the chat feature located at the bottom left hand corner of your screen to submit any questions you may have. All right Jen, for our first question: can you explain how commercial honeybees are transported?

Oh, I'd be happy to. So, this isn't something that we- we documented in the paper, but it's pretty well known. If you go online you can see some really interesting pictures of flatbed trucks that have upwards of hundreds of honeybee hives and they are encouraged to arrange this in such a way as to provide some proper air flow to assistive temperature regulation and more. And I had referenced that story by Mitcher and her team at ARS they followed a team a group rather of more than 408 hives that were on a flatbed truck. So, they were loaded for transportation to pollination sites and then there's netting that's oftentimes put around them to keep the bees with the hives as they travel around the country.

Thanks Jennifer, our next question is: What is the role of other insects, besides honeybees, in pollinating crops? Thanks Jen, our next question is: What is the role of other insects besides, honeybees, in pollinating crops?

Oh, thank you very much. I apologize, I think I was on mute. There's a wonderful study by Raider about, that was published in the Pursuits of the National Academy of Science, and they, and others too, and there's actually work at USDA on this, it did show that these are an important source of pollination services, commercial honeybees are, but that can be augmented by the pollination services provided non-commercially by native pollinators. Sometimes those are bees, sometimes those are other types of insects too, and so there's a growing body of literature there but suffice to say that there is more than just honeybees that provide pollination services.

Thanks Jen, all right here's another question: Do commercial honeybees traveler- travel further now than they used to? If so, why?

So, we didn't necessarily track how far hives moved across different years. We had some limited data to be working with. But we can see that, from the data, that there are more colonies traveling year over year to California and that's driven by demand to support um the almond bloom. And then again, most of those are coming from out of state so there's more hives moving from outside of California to support that process. So, it's conceivable that there are more hives traveling from further away, however, that's possibly an extension of this study. My former colleague, Peyton Ferrier, did write more extensively about this in the 2018 report that the was titled, *The Economic Effects and Responses to Change in Honeybee Health,* so I encourage folks to have a look at that report for some additional information.

Okay next question: Jen, what share of bee colonies are actually moved versus stationary for their entire life? Are most moved or is this movement a smaller share of total U.S. colonies?

Oh, that's an excellent question. So, our NAS data referred only to commercial beehives that were moved. And so, it's a little bit hard to say what proportion, I imagine that that shifts a bit over time with changing prices for honey and pollination services too. But we were finding, you know, close to two million hives were being moved. So, I think that the NAS honey report would have some additional resources on the total number of hives. But it's a little bit beyond my expertise to answer that, although I think it's a good question.

All right Jennifer, here's another question: Is there any study or interest about, or on, urban beekeeping

Oh I'm- I'm not familiar with the names of individual studies on urban beekeeping. But I have found that the USDA pollinator site has wonderful resources NRCS, AMS, APHIS, others have some additional bee and pollinator related resources that might more specifically address some of those questions.

Thank you, Jen, for answering that. Your next question is: Can you explain why pollination service fees have continued to increase even as honey producing hive numbers have rebounded?

Sure, I - I can take a stab at that. Although, I would also encourage folks to take a look at Peyton Ferrier's 2018 report where he really delved into some of the factors driving pollination services fluctuations over time. And it is the case that hive numbers have been relatively stable. We went through a period of time, in the early 2000s, when the industry was afflicted by something called Colony Collapse Disorder, and there was reduced numbers of hives. Subsequently, beekeepers have had some improved management techniques and have been able to split hives to, perhaps, a greater degree than they were before. And at that same time there is growing demand for pollination services. So, hive numbers have stayed relatively stable, but we are having increasing demand from, especially almond acreage, so increasing demand with a relatively stable supply of hives, may be slightly increasing, provide support for pollination service fee prices going up.

Thank you, Jen, how big are commercial beekeepers? 100 hives? 2,000 hives?

That's a really good question I'll look for more information on that, I'm not sure. I had thought it was perhaps five or more, but that might be some self-identification so let me investigate that. I would also direct folks to the um the NAS colony loss survey too as they may have some more definitions there of what constitutes a commercial beekeeper.

All right, here's another question: do commercial honeybees travel- travel further now than they used to? If so why?

And here again we've got some limitations of our data. We were really appreciative to have the NAS data and then the survey for two years. But we've- we've lost that that data feed, so it's unclear as to whether um we were capturing a moment in time, and that 1,100 miles traveled was extra-long that year, or not. We suspect that because there's increased demand for pollination services in California that more hives are coming into California, but we can't say for sure unless there's more documentation that hives are traveling further, or from further away to service those contracts.

Thanks Jennifer, your next question: is what are some of the best sources of bee forage?

That's a great question and I'm actually looking at my window now. It's the bees and other insects' kind of buzzing around the garden which because the summer is, its kind of a full bloom right now. So, they seem very happy with whatever is blooming, but in fact what we find looking online is that some flowering crops are more suitable for pollen and nectar collection which is what bees eat. And some of the most favored foraging crops include dandelions and lavender. Let's see we also see things like yarrow and sunflower. I had that picture of clover in my presentation too, clover is also popular forage. Daisies, rosemary, snapdragon, and more. So quite a number are pretty popular with them but I'd say those first three are among- are among the best.

Thank you, Jennifer. Looks like we have time for one more question: is ERS also studying treatment-free beekeeping versus commercial beekeeping?

So not at this time. There is a pollinator health working group though at USDA and I can say that there are dozens of researchers across USDA's various organizations studying different aspects of pollinator health. And a lot of that work is available on the USDA website. It certainly, there's lots of different aspects of pollinator health that are appealing to investigate from an economist perspective. I will say that we don't tend to collect our own data. We work with partner organizations such as NAS, in particular, to analyze the kind of data that they collect.

All right, that's all the time we have for today. Jennifer, thank you for sharing your report with us today and thank you to all our listeners for joining us. As a reminder, a recording and transcript of today's webinar will be available on the ERS website next week. Thanks again everyone, and I hope you have a wonderful rest of your day.

Thank you, everyone.