Journal of Rural Studies 65 (2019) 161–171

Contents lists available at ScienceDirect

Journal of Rural Studies

journal homepage: www.elsevier.com/locate/jrurstud

Where have all the flowers gone? Honey bee declines and exclusions from floral resources

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ARTICLE INFO

Keywords:
Access
Exclusion
Beekeeper
Honey bee
Land use policy
Political ecology

ABSTRACT

This article considers the social drivers that shape beekeepers' lost access to floral resources, and how this contributes to honey bee and beekeeper vulnerability. Most large-scale beekeepers in the United States are migratory and depend on access to private land to produce honey and healthy bees—a surprisingly tenuous arrangement for producers who add over $17 billion to U.S. agriculture. This dynamic often places beekeepers in asymmetrical power relationships with both landowners and state entities that tend to favor property owners and farmers over migrant beekeepers. Consequently, land use policies often do not favor beekeepers or honey bees. Through three empirical cases in the Midwest, I show the varied processes and mechanisms that play a role in excluding beekeepers from floral resources. As beekeepers lose access to forage for honey production and face greater precarity, they increasingly turn to commercial pollination and manufactured pollen inputs—both of which can have negative impacts on honey bee health.

1. Introduction

Seth Roberts remembers beekeeping with his grandfather 25–30 years ago, when making honey in Minnesota was easy. They would sometimes have as many as five or six boxes of honey, called honey supers, stacked on top of the main colony box. He had to back up his old Chevy pickup and stand on the tailgate just to take the top off and get into the hive. "Every one of those boxes would be chock full. Now you put two to three supers on in a year, and even with your strongest hive in the best area you get three boxes of honey" (Interviewee 3). Another commercial beekeeper who grew up in a beekeeping family in Idaho used to get 150lbs per hive as a kid, and then it went down to 60lbs. Now, he says, "It's shocking if you can make more than 30lbs a colony" (Interviewee 2).

This situation reflects the plight of many commercial beekeepers in the United States. Despite the fact that honey bee (*Apis mellifera)* colony numbers have stayed fairly consistent since the early 2000's, honey production has declined from 171 million pounds to around 156 million in 2015 (USDA-NASS, 2017a). In interviews, many beekeepers attributed the decline in production to diminishing bee forage, i.e. bee-friendly flowers, particularly in the Midwestern Corn Belt where over 45% of the nation's honey is produced each year (USDA, 2018a). This has placed a lot of stress on commercial beekeepers, many of whom have shifted their operation focus from honey production to commercial almond pollination as a result (Lee et al., 2017). While this decision has helped keep beekeeping operations in business, it presents challenges for both beekeepers and their honey bees.

Understanding some of the factors that shape forage change can give important context to researchers investigating honey bee declines, and honey bee vulnerability more broadly. Between 1947 and 2005, the United States experienced a 59% decline in honey bee colonies, from 5.9 million to 2.4 million honey producing colonies (VanEngelsdorp et al., 2008, p. 2). Since 2006, beekeepers have lost nearly 30% of their managed colonies each year, though they state that losses greater than 16.5% are not economically viable (Kulhanek et al., 2017, p. 334). These losses are not just experienced in the United States; Europe has seen a 25% decline in honey bee colonies and a weakened beekeeping industry as well (Potts et al., 2010b, p. 16).

For beekeepers and bee-reliant agricultural industries, it has become crucial to understand what causes these annual losses and how to mitigate them. Honey bee pollination contributes directly and indirectly to the production of over ninety key crops in the United States, including berries, apples, melons, almonds, and alfalfa—a service estimated at $17 billion a year (Calderone, 2012, p. 13). After over a decade of research, the findings have narrowed honey bee declines down to several primary drivers: a nexus of agrichemicals and pesticides (R. M. Johnson et al., 2010; Mullin et al., 2010; Zhu et al., 2014), the parasitic *Varroa destructor* mite and other pests and diseases (DeGrandi-Hoffman et al., 2014), and the decline of diverse, high quality pollen (Di Pasquale et al., 2016, 2013).

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https://doi.org/10.1016/j.jrurstud.2018.10.007
Received 19 March 2018; Received in revised form 15 October 2018; Accepted 17 October 2018
Available online 07 November 2018
0743-0167/

A more recent consideration in research on bee health is the effect of habitat and forage loss on wild and managed bee populations. Ecologists brought attention to the effect of habitat loss on native pollinators before honey bee losses became widely documented in 2006 with the advent of Colony Collapse Disorder (CCD) (Kremen et al., 2002; Potts et al., 2010a). Yet research on how diminished access to forage may impact beekeepers and honey bees has only recently become a point of focus: for example, how land use change in the Northern Great Plains has significantly reduced access to honey forage for beekeepers (Otto et al., 2016, 2018) and how the decline of this forage might affect honey bee health (Hellerstein et al., 2017).

This paper contributes to research on forage change and its effects on managed honey bees in the United States, by investigating the mechanisms that shape beekeepers' access to forage. I argue that as beekeepers lose access to forage through various economic, legislative, land management, and social processes, both honey bees *and* beekeepers become increasingly vulnerable. When beekeepers lose access to forage lands, they increasingly have land-use conflicts with landowners, environmentalists, policy makers, and even other beekeepers in their efforts to re-secure access. These conflicts have created a growing source of stress in the beekeeping industry, and as a result, many beekeepers use manufactured pollen substitutes to make up for the lost nutrition, and increasingly turn to commercial pollination for income. Evidence suggests that both practices can have negative impacts on honey bee health (e.g. Cavigli et al., 2016; Fleming et al., 2015).

Commercial beekeeping in the United States requires beekeepers to seasonally relocate their colonies so that bees have constant access to blooming forage. Such broad tracts of land are rarely owned by the beekeeper. Thus, each forage site requires the negotiation and maintenance of new social relationships (personal, economic, juridical, and political) that will either "constrain or enable" access to forage (Ribot and Peluso, 2003, p. 154). In addition, honey bees travel through landscapes without attention to property rights or landscape borders. This means that the survival of beekeeping—and managed honey bees—depends largely on beekeepers' ability to maintain access to property they do not own, to produce stinging insects whose foraging habits are unpredictable and uncontrollable. This is a surprisingly tenuous economic arrangement for an industry whose pollination services add a significant contribution to United States agriculture.

This paper extends the emerging field of critical social science on bees and beekeepers through an engagement with theories of access (Ribot and Peluso, 2003) and its converse, exclusion (Hall et al., 2011). An access and exclusions framing of changing forage availability pays attention to the web of social relations between beekeepers and landowners—as well as state, non-governmental organizations (NGOs), and corporate entities—to explain how beekeepers have gained, maintained, and lost access to forage, and the subsequent effects these processes have had on honey bee health and beekeeper precarity. This analysis adds to theories of access and exclusion by demonstrating how the migratory nature of the commercial beekeeper creates a unique set of barriers to access within the context of the United States' industrial agricultural system, making it increasingly difficult to produce bees.

I begin the discussion with an overview of critical bee and beekeeper-centered social theory, and a review of scholarship on theories of access (Ribot and Peluso, 2003) and exclusion (Hall et al., 2011). I summarize commercial beekeepers' annual management tasks and the role that forage plays in commercial honey bee management, to help contextualize what is at stake for beekeepers as they lose access to diverse, non-toxic forage for their honey bees. I also discuss the mobility of the honey bee and the challenge this can pose for maintaining access to forage sites. I then detail three cases in which beekeepers have been excluded from forage sites in the Midwest—a key region for honey production—and highlight the powers and processes that shape these exclusions. I follow with a focus on the consequences of these exclusions from forage, particularly how beekeepers have turned to manufactured pollen and nectar inputs and commercial pollination for income. Finally, I highlight beekeepers' efforts to regain access to forage lands and discuss the implications of these findings.

2. Methods

The qualitative data for this paper came from in-depth, semi-formal interviews with 41 commercial beekeepers, 12 researchers that support the beekeeping community, and 8 government officials who work in county, state, and federal offices. Beekeepers were chosen to represent a range of operation sizes. A 500-colony operation is considered commercial (Kulhanek et al., 2017); beekeeping operations ranged from 1000 to 90,000 (the largest in the industry), with the average size around 1000 to 3000 colonies. In the United States, beekeepers estimate that there are around 1600 commercial beekeepers, with approximately 380 operations[1] providing pollination services (DOL-BLS, 2014) and managing the majority of the nation's approximately three million colonies (Johnson and Corn, 2015; USDA-NASS, 2017a).

Commercial beekeepers typically fall into three main categories: queen breeders, honey producers, and pollination service providers, with many beekeeping operations doing some element of each category to varying degrees. The discussion of beekeepers in this paper focuses on the management tasks of migratory honey producers and pollination service providers, as large-scale queen breeders tend to have geographically-fixed operations. The interview data for the cases in Section 5 came from 19 interviewees in the Midwest, 17 of whom were beekeepers. A table in the Appendix gives basic details about the interviewees including operation size, interview date, and the state in which the beekeeper primarily produces honey. Names used in this paper are pseudonyms. Interviewees quoted from multiple interviews have dates next to their quotes.

Interview questions asked about beekeepers' annual management practices, how their management practices had changed over the past two decades (or since they started commercial beekeeping), and their perspectives on what played a role in those changes. Interviews ranged from 90 minutes to three or more hours and were conducted during colony inspections, in trucks driving to apiary sites, and sometimes over the phone. Interview data was primarily collected from 2015 through 2018, but my engagement with the beekeeping community started in 2013 and continues through the present, with participant observation at numerous conferences, beekeeper meetings, daylong workshops, and many informal conversations and community gatherings.

3. Literature review

3.1. Social science literature on honey bees and beekeepers

In his research on how modern honey bees have become technologies of national defense, Kosek (2010) engages with the question of honey bee declines and argues:

> It is not enough to ask, 'What is happening to the bee to cause this crisis?' Instead, there is a more fundamental question: How has the changing relationship between bees and humans brought the modern bee into existence in a way that has made it vulnerable to new threats? (*ibid.* p. 651)

Kosek details some of the 'remakings' of the modern honey bee over the last century that reflect this changing relationship between honey bees, beekeepers, and the agricultural communities that rely on their pollination services. Social and ecological drivers have shaped honey bees' exoskeleton, their nervous systems, digestive tracts, and collective social behavior. Kosek points out that there are "many sites (from

[1] There is no reliable statistic on how many commercial pollination operators exist in the United States, because the USDA does not collect data on commercial pollinators, only on honey producers with over five colonies.

federal laboratories to the backyards of beekeepers), as well as many pressures (from industrial agriculture to global climate changes), involved in the remaking of the bee" (*ibid.* p. 651).

Recent social science research has aimed to highlight some of the sites and pressures that have remade honey bees into a more vulnerable species. Single-cause explanations about what contributes to honey bee vulnerability—such as a particular pesticide or mite—are increasingly considered insufficient given the varied complexities of environmental and political change (Phillips, 2014). This complexity highlights the need for critical inquiry into bee issues outside laboratory settings, through an analysis of honey bees' role within modern agriculture as both exploited subjects and vital pollination technologies (Nimmo, 2015), as well as knowledge politics about beekeeper expertise and its lack of inclusion in the debate about the drivers of bee declines (e.g. Maderson and Wynne-Jones, 2016; Suryanarayanan and Kleinman, 2013).

Honey bees' constant exposure to pesticides on agricultural landscapes has led to extensive ecological research and debate on agrochemical toxicity for bees. This research has also motivated scholarship on knowledge politics and pesticides, particularly about contestations between beekeepers and regulators on the toxicity of neonicotinoids and ignorance produced when beekeepers' expertise is not deemed relevant by regulatory agencies (Kleinman and Suryanarayanan, 2012; Suryanarayanan and Kleinman, 2013, 2017).

This dismissal emerges as a result of numerous dynamics. One reason is EPA's reliance on particular "epistemic forms" in its assessment of pesticide toxicity. Epistemic forms are the standard research norms that shape how actors produce ignorance and knowledge in various intellectual fields (Kleinman and Suryanarayanan, 2012, p. 492). A key epistemic form that guides EPA pesticide regulation is the set of Good Laboratory Practices (GLP) protocols, which require a traditional approach to isolating causal variables and establishing experimental controls (*ibid.* p. 503). In addition, the EPA is guided by an "imminent hazard"—rather than a precautionary—approach that prioritizes determining *acute* risks to humans, animals, and non-target insects when registering and labeling pesticides (*ibid.* p. 506). As a result of these epistemic forms, the EPA does not require pesticide manufacturers to test sublethal and chronic effects of pesticides on adult honey bees or honey bee larvae—nor do they count as valid beekeepers' experiences with chronic and sublethal toxicity in their hives. This has produced ignorance about whether neonicotinoids are sublethally toxic to honey bees—and has allowed their continued application.

Suryanarayanan and Kleinman's collective body of research, as well as that conducted by Maderson and Wynne-Jones (2016), highlights not only the 'hierarchies and exclusions' of knowledge in policy making (Maderson and Wynne-Jones, 2016, p. 94), but also the way that social processes shape regulation, science, and ultimately land management practices that either hinder or protect honey bees. These processes emerge, in part, because the system of industrial agriculture prioritizes growers' objectives over beekeepers' (Suryanarayanan and Kleinman, 2017). This has led to asymmetrical relationships between beekeepers and growers where: "migrant bees and nomadic beekeepers are serving grower clientele, not the other way around. And beekeepers are the ones who largely have had to adjust in response to growers' changing practices of cropping and pest management" (*ibid.* p. 71).

These power asymmetries between beekeepers and land managers not only shape honey bees' exposure to pesticides, but also beekeepers' access to non-toxic forage sites and apiary locations more broadly. Though some urban communities have welcomed managed bees (Moore and Kosut, 2013), other beekeepers struggle to keep honey bee colonies in population-dense urban environments, where neighbors are wary about being stung by bee swarms (Edwards and Dixon, 2016). Commercial beekeepers and honey producers also face conflicts over access to public lands, due to conservation efforts that position beekeeping as antithetical to public forest management (Phillips, 2014; Watson, 2017). These limitations to access are particularly challenging for beekeepers, many of whom feel an intimate connection to their honey bees (Maderson and Wynne-Jones, 2016; Moore and Kosut, 2013; Phillips, 2014), and yet also rely on them for their livelihood.

What emerges from this scholarship is evidence that supports Kosek's (2010) claim that the changing relationship between humans and bees has contributed to honey bee vulnerability. And yet it also demonstrates how changing relationships between *humans and the land* contribute to honey bee declines as well. As cities increasingly urbanize, diverse agroecosystems simplify, and monoculture agriculture proliferates, floral resources will diminish and conflicts will continue to increase between land managers and migratory beekeepers.

3.2. *A theory of access to and exclusion from floral resources*

Political ecology scholarship has a rich history of investigating conflicts around access to land-based resources, bringing attention to the mechanisms that drive environmental change such as declining bee populations (Peet et al., 2011; Robbins, 2012; Watts and Peet, 2004). Ribot and Peluso define access as "the *ability* to benefit from things", extending beyond property's definition as "the right to benefit from things" (2003, p. 153). By focusing on the *ability* to access land resources rather than the *right*, analysts have a broader set of tools to understand and contextualize conflicts over land resources that occur between landowners and land managers and resource users who have historically had access to land without legal property rights.

Conflicts over access to natural resources are intimately bound up with power and authority (Sikor and Lund, 2009), and investigations into property dynamics allow insights into state formation and governance as well (*ibid.* p. 3). Drawing from Ribot and Peluso's definition of access, Hall, Hirsch, and Li (2011) bring attention to the role that state formation and governance play, as well as other powers, in resource exclusions. Their 'Powers of Exclusion' framework positions exclusion as the converse of Ribot and Peluso's definition of access. Where access analyses highlight mechanisms that constitute "the means, processes, and relations by which actors are enabled to gain, control, and maintain access to resources" (Ribot and Peluso, 2003, pp. 159–160), exclusion analyses highlight the actors, social dynamics, and political economic mechanisms actively *preventing* smallholders from the resources they need to sustain their livelihoods (Hall et al., 2011, p. 8). Though the framework has largely been used to discuss conflicts in Southeast Asia (Filer et al., 2017; Friis and Nielsen, 2016; Howson, 2017), I engage it here to contextualize land use conflicts that beekeepers face, and likely other mobile producers, such as pastoralists, gatherers, and foragers who do not own the land or resources needed for production.

The authors detail four powers of exclusion at work in Southeast Asia: regulation, force, the market, and legitimation (Hall et al., 2011, pp. 15–19). *Regulation* is often—but not exclusively—associated with state and legal mechanisms that shape who gets access to land and how it can be used. *Force* excludes through direct violence or the threat of it and is carried out through state and non-state actors. The *market* can exclude by limiting access to land through price mechanisms that incentivize land management practices that have excluding consequences. Finally, *legitimation* discursively establishes the normative grounds through which these processes become socially acceptable and entrenched. The authors also mention several other powers of exclusion not detailed at length in their book, two of which I highlight here: *new knowledge and technologies* such as agrochemicals that can contaminate floral resources (*ibid.* p. 197), and *environmental changes* that reduce access to resources such as the reduction of bee forage due to drought (Thomson, 2016) and climate change (Le Conte and Navajas, 2008). Exclusion can be understood as localized processes that result from interactions between these larger-scale powers.

Hall et al. (2011) detail seven localized processes that drive exclusions in rural settings. Though their study site is Southeast Asia, most of the processes are surprisingly relevant in the case of beekeepers and land access in a North American, industrial agriculture context. The processes of *licensed exclusion* (*ibid.* p. 27), through which governments grant formal legal titles to land, and *self-exclusion* (*ibid.* p. 71), through which small holders exclude themselves from resources, are less relevant to the cases in this paper. The next five, however, are quite relevant. *Ambient exclusions*, where communities are excluded from landscapes in support of conservation initiatives (*ibid.* p. 60), can occur when government entities and NGOs exclude beekeepers from public lands or conservation sites to maintain habitat and forage for native pollinators. *Volatile exclusions* (*ibid.* p. 87), where communities lose access to land converted to monoculture production for boom crops, result when farmers in the U.S. Midwest convert range and prairie landscapes that beekeepers use for honey production to participate in a corn and soy boom. *Post-Agrarian exclusions*, where land is converted to non-agrarian uses (*ibid.* p. 118), unfold as suburban and urban development displace agriculture and rangeland forage that beekeepers rely on for honey production (Naug, 2009). *Intimate exclusions,* when neighbors and kin exclude one another from land access (Hall et al., 2011, p. 145), can take place when one beekeeping operation expands and seeks more forage sites and intentionally or inadvertently pushes other beekeepers off of their previous sites. Finally, *counter-exclusions* can occur when communities resist dispossession and assert control over land they once had access to (*ibid.* p. 170), such as beekeepers and bee advocates working through social and political networks to limit the use of bee-toxic agrichemicals on site.

To these seven processes of exclusion, I add an eighth: *Toxic exclusions*. Toxic exclusions develop when resources that producers rely on are contaminated, such as when nectar and pollen are polluted by pesticides. What is unique about toxic exclusions is that the resource is often still technically accessible (e.g., bees can still gather contaminated pollen unless acutely poisoned) but accessing the resource would be harmful for the resource user or their livestock (bees, sheep, cattle, etc.). Toxic exclusions often result from a nexus of powers such as new technologies like pesticides that growers apply to their crops, which are often legitimated through scientific research and regulation; for example, the EPA's registration process that only requires chemical companies to test a pesticides' acute toxicity on adult honey bees (Kleinman and Suryanarayanan, 2012). As market forces create crop booms and regulatory bodies subsidize or support them, agricultural landscapes simplify and often require new tools for pest management like bee-toxic agrochemicals. I detail a toxic exclusion beekeepers face in Section 5.2.

It is important to note that though exclusion is often framed negatively, it is the inevitable outcome of land relations and thus has a double edge (Hall et al., 2011, p. 7): in order for someone to have access to a finite resource, access must be denied to someone else. These dilemmas make solutions to access conflicts particularly challenging. Drawing from access theory and the Exclusion Framework can help contextualize how land use changes have affected beekeepers and other mobile producers in varied global contexts and how these changes are driven by and bound up in processes of governance, market forces, discursive legitimation, environmental change, and the introduction of new production technologies.

4. Beekeeper mobility and the maintenance of access to forage

4.1. The challenge of maintaining access to forage

Maintaining access to forage sites is one of the primary activities of most beekeeping operations. Ribot and Peluso define *maintenance of access* as a process that requires “expending resources or powers” to keep access to that resource open (2003, p. 159). Honey bees need access to food year-round, particularly from early spring through late fall, when they have hopefully amassed enough honey and pollen stores to last the colony through winter. Beekeepers may need to move their colonies every few weeks to months depending on which plants are blooming, which requires them to navigate a new set of social relations, local ecologies, and multi-scaled bureaucracies at each location. Each forage site is likely on someone else's land. Beekeepers are typically paid to keep their bees on site if they are providing crop pollination services, but otherwise beekeepers maintain their access primarily through a gift economy including jars of honey and boxes of fruit—-though sometimes they also pay monetary rent. Besides finding sites with floral abundance for honey production, maintaining access also means assuring landowners' neighbors that the millions of bees housed next door will not negatively impact their daily lives.

Around 76% of all commercial beekeepers start their calendar year with almond pollination in February (Goodrich and Goodhue, 2016, p. 6). Almond acreage has tripled in California over the past thirty years from 400,000 to 1.3 million acres (CDFA, 2018; USDA-NASS, 1998), and almonds are reliant on bee pollination to produce a crop. The current recommendation is to have about two colonies per acre to maximize pollination (Carman, 2011, p. 9); as such, the industry currently requires around two million colonies for its annual bloom—two-thirds of all colonies in the United States (USDA-NASS, 2017a). As a result of almond pollination, pollination services are now commercial beekeepers’ top income source, supplying over 41% of their annual revenue (Lee et al., 2017).

After almond pollination, most beekeepers will move on to the next pollination contract or work on increasing colony numbers through ‘splits’, where beekeepers take one full colony and split it into two or three, adding a new queen to each new colony. Some beekeepers skip further pollination services after almonds and take their bees straight to honey forage after their spring splits. For honey production, beekeepers must have an intimate knowledge of regional geography, to know where and when different pollinator-friendly species bloom. They must pay attention to water availability and rainfall because honey bees need a water source and rainfall affects floral bloom. Beekeepers must also attend to shipping logistics. Trucking 2000 colonies of bees requires over four semi-trucks (each semi can haul 450 colonies) and shipping bees comes with its own set of concerns: labor costs, weather issues (keeping bees cool or warm during shipping), state border inspections, and the occasional dreaded truck tip-over that can kill millions of bees (Egel, 2017).

These geographic and logistical processes dovetail with a key component of maintaining forage access: the negotiation of social relations (Ribot and Peluso, 2003, p. 172). A beekeeper must manage relationships with the landowners, property managers, and federal land managers who have forage sites, as well as the management practices (such as agrochemical applications) on those sites. Finally, beekeepers must protect themselves against ‘rogue’ beekeepers whose activities undermine the community: beekeepers who crowd forage sites by placing colonies too close to established beekeepers' sites, or those who actually steal other beekeepers' colonies during almond pollination, for example, to take advantage of the income from almond bloom (Rocha, 2017). Other rogue activities might include poor beekeeping management that results in pathogen and disease transmission among other nearby colonies, or colony ‘robbing’ where a hungry colony invades other nearby colonies for food, potentially weakening the invaded colony. Poor management can also result in honey bee swarming behavior, which can frustrate locals and weaken their perception of beekeepers as well (Edwards and Dixon, 2016).

4.2. How honey bee mobility challenges forage access

Honey bees typically fly between a half a mile to three miles for forage but can fly up to five and a half miles from their colony site to forage (Hagler et al., 2011; Pahl et al., 2011). They do not observe property lines or arrangements, of course, which makes it quite difficult to exclude them—or any pollinator—from any given landscape and the floral resources embedded within. Because bees are invisible from a distance and cannot be branded or marked like other livestock, it is difficult to know if a beekeeper's bees are 'trespassing' on land they do not technically have access to, or if a forage area is overstocked.

Honey bees can also paradoxically challenge a beekeepers' access to forage in several ways. They can be exposed to toxic chemicals on an orchard, or pests and pathogens in nearby colonies (such as *Varroa* mites) and can bring these chemicals, pests, and pathogens back and weaken or decimate a colony. Perhaps most problematic though, is the nuisance that honey bees can pose for land managers. A grower or farmer might apply agrochemicals and kill off a substantial portion of a beekeeper's colonies (often bees located on a neighboring farm). This could lead to bad press, a lawsuit, or restrictive regulations on pesticides that limit landowners' on-farm management practices. This obstacle, or at least the specter of it, plays a major role in the sense of a power asymmetry between beekeepers and landowners, since complaining about agrochemical use might get a beekeeper kicked off a forage site or blacklisted by other growers or land managers in the community.

5. Three cases of exclusion from forage in the Midwest

As a result of these various processes, beekeepers frequently face exclusion from forage sites. A focus on the way that access is structured by power relations (Ribot and Peluso, 2003) is essential to understanding the social world of beekeepers and the exclusions they face. Because beekeepers are often migratory, and therefore transient, they regularly find themselves in asymmetrical power dynamics with the growers, landowners, and land managers whose land they rely on for forage (Suryanarayanan and Kleinman, 2017, p. 71). This makes it difficult for them to advocate for their needs or situate themselves within a particular community:

> We're bee guys, so we're just nearly human. We're the hookers of agriculture. We show up wearing a veil, we come at night, we take their money, and we're gone." (Interviewee 1; August 7, 2015)

This beekeeper went on to detail an encounter he had in the Midwest when he tried to speak out at a local town hall. A local banker told him he was "just a six-monther" (meaning, he only lived in the town for six months a year)—even though he has been coming to the same town for over forty years. This transience, even when it recurs annually for decades, makes beekeepers vulnerable to exclusion from land they once had access to.

The following three cases of exclusion occur in the Prairie Pothole Region (PPR) in the United States Midwest. The PPR is composed of prairie grasslands, thousands of shallow wetlands (i.e. potholes), and an expanding agricultural landscape. As a result of this unique geography, the PPR is home to migratory birds and waterfowl (Johnson et al., 2005), native pollinators, and other diverse species. These lands have also been an ideal site for honey production for generations; currently, nearly forty percent of the nation's commercially managed colonies are brought to this region each spring and summer (Otto et al., 2016). The PPR's abundance of bee resources is diminishing, however, as federal agricultural and energy policies, pesticide practices, and conservation efforts result in three distinct beekeeper exclusions that I detail below.

5.1. Volatile exclusion from forage due to a crop and soy boom

The first exclusion is a *volatile* exclusion, where beekeepers have lost access to millions of acres of forage lands as the result of a corn and soy boom in the Midwest. The PPR has attracted beekeepers for generations in large part because of the Conservation Reserve Program (CRP). The CRP is a cost-share program administered by the Farm Service Agency (FSA) under the USDA, and was established in the 1985 Farm Bill. Landowners are paid an annual rental fee to voluntarily set marginal or unused farm land aside for conservation for ten to fifteen years, and to plant species that will help reduce erosion, provide habitat for wildlife, and improve water quality–ecosystem services with values that exceed CRP land rental costs (Johnson et al., 2016). As of 2018, CRP enrollment is around 22.7 million acres (USDA, 2018b), with a designated funding of $2 billion annually (Stubbs, 2014, p. 1).

Beekeepers can produce honey on CRP lands in large part because enrolled landowners are restricted from growing crops, haying, and grazing cattle on the land. This allows bee-friendly flowering plants, such as various clover species, to bloom and provide floral resources throughout the spring and summer. This abundance of pasture and rangelands, in addition to cultivated crops such as alfalfa, sunflower, and canola, has played a key factor in North and South Dakota's strong honey production (Otto et al., 2016). In 2017, North and South Dakota were the top two honey-producing states in the country, producing nearly 58 million pounds of honey–around one-third of the United States' total production (USDA-NASS, 2017a).

Though the CRP has helped maintain an abundance of forage sites for commercial beekeepers, agricultural and energy policies threaten their future use. One of the greatest factors that recently diminished CRP acreage was weakened support in the 2014 Farm Bill, which reduced the CRP enrollment cap from 32 million acres to 24 million acres—a 25% reduction in acreage available to beekeepers for honey production (Stubbs, 2014). These reductions occurred alongside another more complex challenge to the program: a corn and soy crop boom that has incentivized farmers to move marginal and CRP lands into corn and soy production.

Crop booms take place when land managers rapidly convert large areas of land to mono-cropped or nearly mono-cropped production—often supported by rising crop prices, state support, and new growing techniques (Hall et al., 2011, pp. 87–88); the resulting land use transformations last at least a year or more. Two key US federal policies helped support this boom: the 2005 Bush-era Energy Policy Act, which authorized the renewable fuel standard (RFS), and the 2007 Energy Independence Act (EISA), which expanded and extended the RFS (Bracmort, 2018). The RFS requires a percentage of corn-based ethanol and biofuels to be mixed with petroleum-based transportation fuel. This amount must increase annually, from 4 billion gallons in 2006 to 36 billion gallons in 2022 (*ibid.* p. 2). The legitimation given to support the ethanol mandate was to reduce greenhouse gas emissions and strengthen the US renewable fuel sector.

Following the enactment of the RFS and EISA policies, corn prices rose from around $2 a bushel for corn in 2006 to $7 in 2013 and soy prices went from around $5 a bushel in 2006 to $15 a bushel in 2013 (USDA-NASS, 2015). These high commodity prices made federal CRP rental payments less competitive for farmers from 2008 through 2014; many farmers did not re-enroll in CRP once their contract expired (Stubbs, 2014). Around 2013, the corn and soy boom began to diminish and the commodity price has since dropped to an average of $3.50 a bushel for corn and $9 for soy (USDA-NASS, 2017b), which has made CRP rental payments more competitive again. However, CRP acreage has been enrolled to its maximum acreage, and farmers can no longer participate in the program unless the acreage is expanded in the 2018 Farm Bill. One researcher reflected on the implications of diminished CRP lands for bee health:

> What we are doing is swapping bee forage lands for food deserts. We are taking high quality forage lands out of our system and putting in its place crops that have no nutritional value for honey bees. (Interviewee 18; May 21, 2018)

Crop insurance programs have also encouraged farmers to convert marginal lands such as wetlands and rangelands into cultivated crops (Claassen et al., 2011). The 2014 Farm Bill increased funding in crop insurance through the Price Loss Coverage (PLC) and Agricultural Risk Coverage (ARC) programs. Farmers who enrolled in these programs received payments if the revenue from their commodity crops dropped below a price point benchmark; which made farming marginal lands more attractive, since the farmer would earn some income even if the crop failed.

Likely as a result of these policies and insurance programs, approximately 1.9 million acres of wetlands and 5.3 million acres of 'highly erodible' lands were converted from 2008 to 2012 (Cox and Rundquist, 2013), further reducing forage lands for commercial beekeepers (Hellerstein et al., 2017; Otto et al., 2018):

> The problem is that…the federal government comes up with rules that drive changes that were unintended. I believe that agriculture needs federal crop insurance, but it has also driven some landowners into making poor short-term decisions [like] taking that grassland and converting it into corn row production, because they know that the federal crop insurance provides county level yield prices. (Interviewee 17)

As long as federal funds continue to provide commodity insurance and financial support to farmers who engage in risky land use practices like farming marginal lands, beekeepers will continue to see shrinking access to the pasturelands they require for forage and honey production each year (Otto et al., 2018). This case demonstrates how market and regulatory powers helped fuel a crop boom that has contributed to beekeepers' exclusion from bee forage lands. The next two exclusionary processes have developed as a direct result of the processes discussed in this case, demonstrating how exclusionary processes can have cascading, domino-like effects that result in additional exclusions.

5.2. Toxic exclusion from forage due to pesticide use

When farmers convert prairie lands to corn and soy production, they do not simply diminish forage for beekeepers, they also replace it with a suite of bee-toxic agrochemicals. In this case, we see how *volatile exclusions* from a corn and soy boom result in secondary *toxic exclusions*. Farmers adopt new pesticides to treat boom crops, which contaminate beekeepers' primary resources: nectar and pollen. This has motivated some beekeepers to avoid the region entirely during periods of agrochemical application and subsequently lose access to the forage being sprayed as well as the nectar flow from other blooming flowers in the region.

Bee-toxic agrochemicals on pollen and nectar sources are one of the most long-standing and pernicious forms of exclusion beekeepers have faced. While honey bees are not technically excluded from foraging on treated nectar and pollen, consuming bee-toxic chemicals can lead to the sub-lethal poisoning of a colony that a beekeeper might see with a fungicide or systemic insecticide, or the acute poisoning and subsequent death of affected worker bees—such as the result of getting hit with an organophosphate pesticide.

While an extensive body of literature documents the harmful effects of insecticides on pollinators, a particular class of agrochemicals have been increasingly used in corn and soybean plantings that are acutely and sublethally toxic for honey bees: the suite of systemic insecticides called neonicotinoids. Neonicotinoids have become one of the most widely used insecticides worldwide since their introduction in the early 1990's (Stokstad, 2007); they translocate throughout the target plant and become toxic to herbivorous insects (and potentially other organisms) that feed on the plant (Simon-Delso et al., 2015). They became popular in large part because of their lower toxicity for fish and other vertebrate species compared to organophosphate and carbamate insecticides, as well as their varied modes of application, ranging from seed coatings to foliar sprays (Goulson, 2013, p. 978).

Neonic-coated seeds are most often planted in the Midwest and are applied to 80–100% of all corn and 34–44% of all soybean hectares in the form of foliar sprays and seed applications (Douglas and Tooker, 2015, p. 5088). Since corn and soy acreage total over 171.4 million acres (89.6 and 81.8 million acres for soy and corn respectively), this means that between 95 and 121 million acres of corn and soy are treated with neonicotinoid insecticides (USDA & USDA-NASS, 2018). Seed applications are particularly tricky for beekeepers: manufacturers coat corn and soy seeds with neonic pesticides and talc, and when these seeds are planted, the neonic-laced talc can become airborne and land on pollen and nectar sources that honey bees and other pollinators access for honey production and pollen (Krupke and Long, 2015). Research indicates that this aerial dust can cause direct mortality in honey bees (Marzaro et al., 2011). Neonicotinoids can have sub-acute effects as well: they impair honey bees' ability to navigate back to the colony (Henry et al., 2012), depress their immune capacity to resist pests and disease (Brandt et al., 2016), and increase "queenlessness" (loss of the colony queen) over time (Tsvetkov et al., 2017).

Some beekeepers who typically go to the Midwest for honey production have had to adjust their migration schedules to avoid seed planting season because they are concerned about acute exposure to neonicotinoids. As a result of the combination of agrochemicals and forage loss, one beekeeper describes the PPR as "the least worst place" to produce honey (Interviewee 1). Another beekeeping operation detailed how neonicotinoids affect their bees:

> Queens in colonies with neonicotinoids don't lay eggs as effectively. The field force is getting affected. They have homing issues and the colonies dwindle over time. Overall the whole hive goes down. It reminds me of how the nobility would gradually poison each other over time in Medieval studies. (Interviewee 4 & 5)

This operation now refers to the region as the 'poisonous prairies'. Another beekeeper stated, "It's death to bring bees [to North Dakota] earlier than the 15th of May" (Interviewee 2), before corn plantings typically end. However, some beekeepers do not have the option of staying out of the Midwest until the seed plantings are finished:

> A lot of beekeepers don't [go to the Midwest during seed planting season]. But then some guys…that's what they do—they don't have any other choice. And those guys will often have bee kills. (Interviewee 6)

Agrochemicals are also a source of tension between beekeepers and landowners, as speaking out (publicly or in-person) against bee-toxic chemical use can result in a beekeepers' exclusion from a forage site. This asymmetry is even more acute when beekeepers are not being paid for a pollination contract but are on a land owner's property to make honey. The concern for maintaining good relationships with landowners informs how beekeepers talk about pesticides to the public. One firm described an interaction with a journalist when asked about how pesticide use affects honey bees:

> [We] had to say [to the journalist] numerous times, 'Look, we care about our farmers and respect them and don't have any problem with what they do. [We] had to say it several times, because if the word gets out that you have any kind of issue [with agrochemicals] you can say goodbye to your forage sites and your relationship with that landowner. (Interviewee 4 & 5)

Neonicotinoids' toxicity is also a source of contention between beekeepers. Some beekeepers have not experienced losses due to corn seed planting, and express frustration with those who lobby to ban neonicotinoids because they fear that farmers will return to older, acutely toxic chemicals like organophosphates on their row crops:

> 20–35 years ago methyl parathion [an organophosphate] was a real issue. They'd spray it and it would kill meadow larks and baby deer and you'd see mountains of dead bees. Beekeepers are really afraid of returning to those days. (Interviewees 4 & 5)

> What would you rather have, neonicotinoids—on which the jury is still out—or the older pesticides that were deadly? The worst thing ever, or better than what came before? (Interviewee 1; March 1, 2017)

Other beekeepers, however, feel that this line of thinking supports the interests of agrochemical companies over beekeepers' needs. One beekeeper described a beekeeping convention where Bayer Chemical advised beekeepers to keep their bees in winter holding yards until corn growers have planted their seeds:

> The problem is that this planting can range anywhere from April through June. This is prime buildup for bees—they need to access dandelion, apple trees, etc. They need to build up the colonies during the prime time [Bayer is] telling [beekeepers] to stay away. A lot of beekeepers do stay away till after they plant corn. A hobby beekeeper doesn't have this option, however. A monarch butterfly or a rusty patch bumblebee doesn't have this option. It's an exercise in absurdity except that there's money to be made. (Interviewee 8)

This case demonstrates how one exclusionary process, lost access to forage due to a crop and soy boom, can result in a secondary exclusionary process: the poisoning of the floral resources that remain. Here we see the exclusionary powers of environmental change and new technologies intersect with regulatory and market powers that supported the boom and pesticide technologies to create an additional exclusion for honey-producing beekeepers.

5.3. Ambient exclusion from forage due to conservation practices

As forage lands diminish, contestations over remaining forage have emerged between native bee advocates and beekeepers. This case highlights competing claims over these CRP lands, specifically, over which seeds should be included in the seed mixes that vegetate these sites. It demonstrates how conservation agencies legitimate honey bee exclusion through honey bees' classification as a "non-native" or "invasive" bee species and ecological research demonstrating forage competition between the different species.

Despite the challenges described in the first two cases, beekeepers and other pollinator advocates have had some success in addressing the increased dearth of forage in the Midwest. In 2014, the Obama administration submitted a federal memorandum requiring the establishment of a pollinator task force to increase and improve pollinator habitat (The White House, 2014). They also allocated millions of dollars in technical and financial assistance to ranchers to help plant pollinator forage through the USDA National Resources Conservation Service (NRCS) and the Environmental Quality and Incentives Program (EQIP) (USDA 2014).

At first glance, it would appear that conservation organizations and beekeepers might have a strong alliance and would work jointly towards creating pollinator habitat. Yet some beekeepers feel that native-pollinator organizations have co-opted public concern and funding around honey bee declines and are now using it to support native bees[2] and exclude beekeepers from forage they have had access to in the past. A number of beekeepers expressed concern that the NRCS—which has been tasked with overseeing the selection of seeds for the seed mixes—is closely tied to native pollinator advocacy organizations. They fear that pro-native pollinator priorities will dominate pastureland restoration, such as planting only native seeds on CRP and EQIP lands.

Beekeepers are frustrated by the emphasis on native bees and nativity in seed mixes for CRP land in particular, when CRP plots have historically been working lands that fluctuate in and out of production:

> It's a huge debate. We're tired of fighting. We're fighting native bee folks because they're anti-managed species. They're anti non-native. I really think that what it comes down to is this: they're just making a living. They found a way to make a living off an issue. [Native bee advocates] get people all riled up about native issues and keeping things pure and pristine as it was three-hundred years ago. (Interviewee 6)

Beekeepers worry that this focus on ecological nativity will limit which seeds are included in the CRP seed mixes, particularly if sweet clover seeds are left out of the mixes. Sweet clover is one of the most beneficial flowers for honey production (Tilley et al., 2008). However, because it is an introduced species that can spread rapidly, it is also viewed as a weedy invasive plant that competes with desirable native species (*ibid.* pp. 1–4).

On the other side of the debate, ecologists express concern that public interest centers largely on an industrialized agricultural insect, and that policy must also support native pollinators, whose populations are also declining (Koh et al., 2016; Kopec and Burd, 2017). This pushback against honey bees centers on three primary arguments. The first is that research indicates that honey bees compete for forage with native bees (Geldmann and González-Varo, 2018; González-Varo and Vilà, 2017), particularly during times of drought (Thomson, 2016) or in areas with sensitive or endangered bee species (Henry and Rodet, 2018). A second reason is concern over pest and pathogen transfer (Fürst et al., 2014). Commercial honey bees are exposed to many pathogens during their time pollinating orchards, particularly while in almonds (Cavigli et al., 2016). When honey bees come into contact with other native pollinators—while foraging on public lands, for example—these diseases may be passed between species (Fürst et al., 2014). The third argument is that agriculture has become highly dependent on one species of pollinator to the exclusion of native pollinators. This overreliance on a single species makes farmers more vulnerable as honey bee health becomes increasingly tenuous (Kremen et al., 2002).

Given native pollinators' tenuous status and potential competition for resources between native pollinators and honey bees, native bee advocates and researchers have a strong impetus to push a conservation agenda that favors native pollinator species moving forward—even if that means that managed honey bees must be excluded from forage sites they have historically had access to for honey production (Geldmann and González-Varo, 2018).

Yet not all ecologists believe nativity should be prioritized in CRP seed mixes. One government research ecologist in the PPR stated: "to say that honey bees are not natural is to say that humans and livestock production are not natural" (Interviewee 18; March 3, 2018). This ecologist pointed out that the PPR has a long history of animal and human presence and thus CRP lands might not be ideal sites for native prairie restoration:

> The CRP lands are still working landscapes—meaning that they can produce hay, they are a version of fallow land, they are still productive, and they are owned by farmers, rather than seen as public lands that have been reserved to restrict human presence/footprint. So, since these lands are owned by farmers and used by industry at will, it makes sense for the beekeeping industry to also have access to those lands. (Interviewee 18)

The conflict between beekeepers and native bee advocates highlights a complex access conflict over forage between competing state, public, and ecological interests. On the one side, honey bee's economic contribution to agriculture is easier to quantify, which can legitimize conserving land for honey bees. On the other hand, native bees provide essential ecological functions and pollination services that can provide insurance against honey bee losses (Garibaldi et al., 2013; Winfree et al., 2007)—but their populations diminish in intensified farming systems (Kremen et al., 2002). These cases demonstrate the double-edged nature of exclusion (Hall et al., 2011): both honey bees and wild pollinators require access to these floral resources and provide important pollination services, but advocating for access for one pollinator community may end up excluding the other from a key site for forage.

[2] Honey bees are not native bees. They were brought to the United States from Europe in the 1600's (Horn, 2005).

6. Consequences of forage change

6.1. Transition to commercial pollination and manufactured inputs

Lost access to forage has socio-ecological consequences for beekeepers and their honey bees, due in part to a greater reliance on commercial pollination, as well as increased competition for forage sites between beekeepers that lead to intimate exclusions. Many of the beekeepers interviewed used to earn around ten to twenty percent of their income from commercial pollination twenty years ago. Now, those beekeepers get at least forty-five percent, sometimes more, of their annual income from pollination contracts because they cannot make enough money from honey production to keep their operations afloat:

> I can't keep the bees alive in Michigan. Before I switched up my bee plan and came out here and tried almond pollination—it was just my grandpa and I and we were only raising honey. We were having, on average, a 75% loss rate every winter. *75% of our bees would not survive the winter.* And the 25% on average that survived were so weak and beat up that you couldn't make splits out of them…The honey crop isn't what it used to be. I can remember growing up as a kid, some of the hive averages we used to get—those days are gone. (Interviewee 3)

While almond pollination has helped many beekeepers economically, they also acknowledge the detrimental effects that commercial pollination can have on honey bee health. Two million colonies from around the country condensed into the Central Valley for six weeks of bloom leads to high pathogen transfer between honey bee colonies (Cavigli et al., 2016). In addition, honey bees exposed to pesticides during commercial pollination are more susceptible to pests and parasites (Pettis et al., 2012; Seeley and Smith, 2015) and this exposure can have both acute and sub-lethal effects on the colony, making it harder for the colony to survive. In addition, migratory management can cause oxidative stress and lead to a significant decrease in the lifespan of migratory bees (Simone-Finstrom et al., 2016). However, the reliable income from almond pollination and the lost income from honey production mean that many beekeepers feel they need almond pollination to fund their operations each year, despite the risk it poses to their bees.

As beekeepers face diminishing forage and dependency on commercial pollination, they also increasingly rely on inputs. To make up for the dearth of diverse pollen and nectar sources, beekeepers feed their bees manufactured pollen patties, which may not be as nutritious as actual floral pollen (Gregory, 2006; Huang, 2012). Operations also feed sucrose syrup to honey bees to supplement for nectar. At one operation that ran around 3000 colonies, I saw a large metal tanker truck full of sugar syrup to feed their honey bees after almond bloom. This, the beekeepers informed me, is the norm. Not only are these supplements expensive for beekeepers—feed inputs alone can take up about 15–20% of the outgoings in an operation—the lack of diverse and non-toxic pollen is also problematic for honey bee health (Di Pasquale et al., 2016).

6.2. Intimate exclusions between beekeepers

As forage lands diminish, beekeepers of varied operation sizes have described moments of *intimate exclusion* (Hall et al., 2011, p. 145), where other beekeepers have taken over or crowded a forage site they have had for years. One beekeeper in North Dakota noted that the colony crowding in his region started happening around 2010. This beekeeper, who has been in the region for decades, also ended up losing a forage site to another beekeeper that was new to town:

> Most landowners are pretty loyal—but not always. I thought I had a good relationship with one guy. We had five locations [on the landowner's property] and then all of a sudden [the landowner] booted us off and he didn't even want to talk about it. It really bothered us because we would've liked to resolve the problem since we've been going there for ten years. (Interviewee 6)

Reduced and competitive access to forage can also result in overstocking, where too many colonies are placed in one forage site. According to beekeepers, this can lead to lower honey yields for all the beekeepers trying to produce honey on those locations. Beekeepers in North Dakota from 1976 to 1978, for example, averaged around 116lbs per colony (USDA-ESCS, 1978). Today, the honey average is close to 76lbs (USDA, 2018a), though most commercial operators that I interviewed put their colony average closer to 30–50lbs. A mid-sized operation blamed the almond industry's expansion for the overstocking trend in North Dakota:

> Almond pollination was the second gold rush. Around the 2000's, people started coming to North Dakota with nowhere to go in the summer after the [almond] bloom. They'd leave semis full of bees on farmer lands and farmers would call and complain about it…A lot of those guys are just looking for a place to put their bees during the summer and care less about making honey. (Interviewee 4 & 5)

Another beekeeper described how he had mentored a fledgling beekeeper for a year, and then the following year the mentored beekeeper—who had learned the other beekeepers' forage locations—-placed colonies in adjacent sites across the road without asking (Interviewee 12). As a researcher, I had several beekeepers refuse to take me to forage sites or tell me where they were located because they were afraid other beekeepers might find out. This air of competition over disappearing forage has led to a building sense of distrust and secrecy over the scraps of land that remain.

6.3. Counter-exclusions: beekeepers' efforts to regain access to forage lands

The consequences of access loss are not all dire for beekeepers. Exclusions from land are iterative, socially determined processes. This presents many challenges for beekeepers, which most of this paper has attended to. However, it also creates unique opportunities for beekeepers to direct their efforts to *counter exclusions*, where they regain access or create new spaces of access for honey bees. Though there are numerous examples, I focus on a few that are relevant to the cases in this paper.

The first *counter-exclusion* centers on limiting honey bees' agrochemical exposure. Some beekeepers feel that agrochemicals are the greatest threat to their honey bees and have directed their efforts towards changing grower practices and pesticide policy. Beekeepers have worked with the industries they pollinate for, such as the almond industry, to help educate growers on honey bee best management practices that farmers and growers can practice while on site (CDPR, 2018). Some have also successfully made changes through litigation, such as a recent case between beekeepers and the EPA that requires EPA to change their label review policy on neonicotinoids (Ellis v. Housenger, 2017).

However, beekeepers are very aware that they are dependent on industrial agriculture for their annual income, so not all beekeepers put their efforts into addressing pesticide use. A number of beekeepers acknowledged that while agrochemical use can indeed be problematic for honey bees, they would rather solve that problem with landowners directly. As a result, the second *counter-exclusion* consists of beekeepers' efforts to create access to new forage sites through policy changes such as personally lobbying congressional offices to increase CRP allocations, or through establishing collaborative relationships with landowners and managers to plant bee forage sites. By focusing on creating new forage, beekeepers bypass broader conflicts over on-site agrochemical use. Creating new forage enrolls the landowner in a cooperative project, rather than a prohibitive one. Getting a grower to 'buy in' to planting forage can also create an incentive to talk about issues like forage and agrochemical use:

> When you have bees or forage on the property, you rarely lose bees to pesticides, because we have conversations with the grower or landowner before a spray event would normally happen. (Interviewee 2)

These small-scale negotiations do not address the large-scale mechanisms that drive beekeeper exclusions. Yet because some of the exclusionary processes that beekeepers face occur as the result of land management practices (such as pesticide application), beekeepers often appeal to their relationship with land managers to sway them towards bee-friendly management practices, to perhaps offset some of the other stressors honey bees face on agricultural lands:

> Forage is the one thing that we can control and impact that can begin to address the death of a thousand paper cuts [that pollinators are currently experiencing]. If you have highly nutritious forage and habitat and it's healthy and available, it puts the bees and other pollinators in a better position to handle all the other stressors, all the other paper cuts, that they get throughout the year. (Interviewee 17)

These counter-exclusions demonstrate how beekeepers' relationships with landowners make their access both tenuous *and* negotiable. Though they may not always be successful, they at least have the opportunity to inspire pollinator-friendly land management practices, thus procuring or maintaining the access they need to keep their honey bees, and their commercial operations, alive for another season.

7. Conclusion

Pollinator crises—both honey bee and native bee—do not happen in an apolitical vacuum. A political ecology framing that focuses on the powers and processes that shape beekeepers' exclusion from forage makes three things clear. The first is that the survival of commercial beekeeping depends largely on beekeepers' ability to negotiate a constantly shifting and economically precarious terrain of social relations to maintain access to forage. The second is that the vulnerability of managed honey bees and the precarity of commercial beekeepers are interconnected. The third is that addressing honey bee vulnerability requires a more complex approach than simply figuring out which chemicals are killing bees or which miticide will best mitigate damage caused by *Varroa* mites. Critical social science research on the entwined political, economic, social, and environmental forces that shape the context in which beekeepers manage bees can bring new insight into factors driving bee losses.

As discussed, beekeepers lose access to floral resources through a variety of exclusionary powers and processes: **Case one** highlighted a volatile exclusion from a crop boom, driven by regulatory and market powers which reduced allocated acreage for conservation land, and incentivized farmers to transition CRP land into corn and soy production. Regulatory policies such as crop insurance programs, while valuable, have the unintended side effect of encouraging farmers to farm marginal lands that beekeepers once accessed for honey production. **Case two** explored a toxic exclusion resulting from the crop boom, as new pesticide technologies result in environmental changes: the pollution of floral resources with neonicotinoid dust. Beekeepers then avoid the Midwest during seed planting season and miss out on prime honey production forage. **Case three** focused on the ambient exclusion of honey bees, spurred by conservation efforts to support native pollinators. These exclusions are legitimatized by research indicating competition between honey bees and native bees, and by positioning honey bees as 'invasive' or 'livestock'. As a result of disappearing access, many beekeepers have experienced intimate exclusions when neighboring beekeepers crowd or take over their forage sites. Beekeepers may subsequently turn to manufactured pollen supplements and commercial pollination as a result—both of which can contribute to honey bee vulnerability (Cavigli et al., 2016; Gregory, 2006).

This analysis demonstrates that Hall et al.'s Exclusions Framework (2011) applies not only to land conflicts in Southeast Asia, but to a North American context as well. Beekeepers are subject to exclusionary forces in part because they do not own the land they need for production in the United States. Thus, they are constantly vulnerable to land management decisions made by land owners and land managers on public lands.

Another reason beekeepers' access to land may be so tenuous could be in part because their physical presence and pollination services—like that of all pollinators—is largely invisible and can be difficult to quantify or fully appreciate (Phillips, 2014). This invisibility can give a sense that land is 'empty' and that activities on that land will have little consequence, which can lead to practices that are detrimental to bees and other pollinators. Hall, Hirsch, and Li note that "large-scale agricultural schemes…depend on a concept of empty land…just waiting for productive investment. But such land is hard to find" (2011, p. 204). In this paper, I have aimed to show that even the vast swaths of privately-owned agricultural lands, such as the corn and soy fields in the Midwest, are *not* empty—or at least not yet. There are beekeepers, honey bees, and numerous other pollinators on or near these lands, accessing floral resources and pollinating the bloom that remains.

Note

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Conflicts of interest

The author has no conflict of interest.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Acknowledgements

Thank you to several readers for their insights and intellectual contributions to this paper: Derek Hall, Maywa Montenegro de Wit, Clint R.V. Otto, Jeff Vance Martin, Patrick Baur, and Abigail Martin, as well as my anonymous reviewers. Also, many thanks to Nancy Peluso's Land Lab and the Sayre Lab Group for feedback on earlier drafts. Finally, I am deeply grateful to the beekeepers and research participants who spent hours sharing their insights with me, and to Denise Qualls, Sharon Roessler, Keki Burjorjee for their fieldwork support.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jrurstud.2018.10.007.

Appendix. Table of Interviewees

Interviewee	Role	Operation size	Primary Honey Location	Interview Date
1	Beekeeper	Large scale	North Dakota	Multiple
2	Beekeeper	Large scale	North Dakota	Multiple
3	Beekeeper	Mid-scale	Minnesota	16-Mar-17
4,5	Beekeeper	Mid-scale	North Dakota	10-Aug-17
6	Beekeeper	Large scale	North Dakota	28-Sep-17
7	Beekeeper	Mid-scale	Minnesota	3-Mar-17
8	Beekeeper	Mid-scale	Minnesota	27-Apr-17
9,10	Beekeeper	Mid-scale	Minnesota	3-Mar-17
11	Beekeeper	Mid-scale	Minnesota	20-Mar-17
12	Beekeeper	Mid-scale	California	6-Apr-17
13	Beekeeper	Large scale	Montana	8-May-17
14	Beekeeper	Mid-scale	Mississippi	27-Apr-18
15	Beekeeper	Mid-scale	Idaho	28-Feb-17
16	Beekeeper	Mid-scale	North Dakota	9-May-17
17	Beekeeper	Small scale	Nebraska	30-Aug-17
18	Researcher	N/A	North Dakota	Multiple
19	Researcher	N/A	South Dakota	13-Mar-17

Note: Small-scale commercial operations were categorized as 500 to 1000 colonies, mid-size operations as 1000 to 5000 colonies, and large-scale operations as greater than 5000 colonies. These categories were suggested by several beekeepers and researchers but were kept broad enough to maintain beekeepers' anonymity.

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