workers were recovered from hives placed next to conventional fields. It is unclear what caused these differences. Because so little corn pollen was recovered from foragers returning to our hives and that relatively low amounts of clothianidin were in the corn pollen, we suspect that the difference in number of workers per hive was not due to field treatment. Development of corn plants at organic sites was slower than that at conventional sites, and hives were therefore placed in organic fields approximately a week later than in conventional corn fields. This staggered placement of hives in conventional vs. organic fields might have resulted in hives that differed in worker production. In addition, it rained (~9.6–19.5 mm) on both evenings when bees were collected (21:00–22:00) from conventional sites, whereas it rained (~18.6 mm) only one of two evenings during collections at organic fields (Anonymous 2014). Given that bumble bees may seek shelter under foliage if it is raining and may not immediately not return to their nest (Benton 2006), the additional rain at conventional sites may have meant fewer foraging workers had returned to their hives when they were collected. Whatever the cause, multi-hives from both conventional and organic sites appeared healthy, having approximately 200 workers and drones, multiple queens, and 500 brood cells (eggs, larvae, pupae), suggesting that the lower number of workers detected at conventional fields was not biologically significant.

Because we were working with independent growers, our study lacked strict treatment designations, particularly in our conventional fields. Conventional fields were all consistent in that corn was grown from seeds that express Bt Cry toxins, and were treated with neonicotinoids and fungicides, but specific pesticide treatments used were not identical. Our study therefore might be considered more along the lines of a monitoring study or "quasi-experiment". This admittedly results in uncertainty about conclusions. Nonetheless, information that is useful to pollinator risk assessment can be gleaned from our study. It is important to remember that the ecotoxicological risk assessment process is iterative and involves multiple lines of evidence; laboratory, semi-field, field, monitoring, and modeling studies all have value and all come with different uncertainties. Studies like ours conducted in real agricultural settings provide important exposure and effects data, while being an economical complement to well-controlled laboratory or semi-field studies.

It is also important to emphasize that the result of our study do not necessarily transfer to other cropping systems. For example, bumble bees would likely forage more heavily on canola (oil seed rape) (Turnock et al. 2007; Stanley et al. 2013) than corn, for which neonicotinoids are also used widely as a seed treatment. This would result in increased exposure to neonicotinoids in pollen and nectar, and therefore potentially greater risk, although previous field studies with neonicotinoid seed-treated oil seed rape and sunflower suggests that dietary exposure to these crops is of low risk to bumble bees (Tasei et al. 2001; Thompson et al. 2013). A key component of our study was to quantify exposure of bumble bees to corn pollen. This is significant given the ubiquity of bumble bees throughout temperate holarctic regions (Michener 2007), the dominance of corn (maize) in many of those same landscapes across North America and Europe (FAO 2014), and the widespread use of neonicotinoid seed treatments on corn/maize seed (Jeschke et al. 2011). Thus, despite the potential for bumble bees nesting around corn fields to be heavily exposed to pollen from corn containing neonicotinoid insecticides, we have shown that exposure to corn pollen is probably low in landscapes where other forage is available, resulting in low risk to bumble bees.

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Conflict of interest The authors declare that they have no conflicts of interest.

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