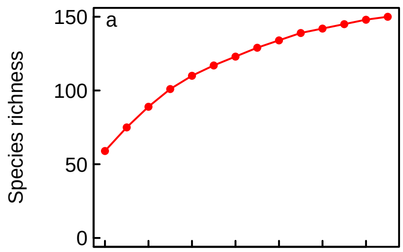
optimizing acquisition of spatial land units for conservation (e.g., Turner & Wilcove 2006; Moilanen *et al*. 2009). When the goal of restoration is the assembly of a group of species, a restoration design must take into account the full needs of those species over the duration of their life cycles. For obligate mutualists, this means largest number of occurrences of crop-visiting species, over unique combinations of sites, seasons, and bee visitors (similar to Kremen et al. 2002), the next three were selected in the same manner, and so on. Plant mixes based on a similar process have been used to create hedgerow enhancements at several sites in California (Kremen & M'Gonigle 2015). Comparisons to independently compiled "off the shelf" plant mixes would be helpful, but presently there are no such mixes in our study region for which we have sufficient pollinator visitation data.

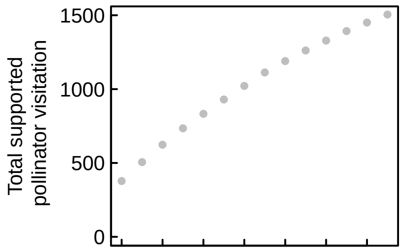
Results

Our dataset contains 76 plant and 181 pollinator species. Assuming equal plant frequencies within mixes, there are 70,300 mixes containing three plants, 218,618,940 mixes containing six plants, and 142,466,675,900 containing nine plants. Should one wish to vary plant frequencies, these numbers would become even larger. Thus, exhaustively examining potential mixes becomes computationally intractable as the mix size and complexity increase.

We first demonstrate that our method correctly identifies the optimal plant mix for scenarios where that mix can be found exhaustively. We do this in two ways. First, for our dataset, we can do this for mixes containing up to five plants. In doing so, we found perfect congruence between these mixes and those found using our model. Second, it is possible for some criteria to find the optimal plant mix of any size. For example, the mix that maximizes pollinator visitation, f_V, can be found by ranking plants according to their total occurrence and then selecting the top k. Again, we found perfect congruence between these mixes and those found using our model. For the remaining cases, we evaluated performance by comparing tool-selected mixes to a large number of randomly generated mixes. Our tool identified mixes that outperformed all randomly generated plant mixes by a large margin (Figure 1).

We found that mixes that optimize f_{VRT} and f_{VRB} perform almost as well in maximizing their constituent components (visitation, richness, and the timing of interactions, in the case of f_{VRT}, or phenological bloom continuity, in the case of f_{VRB}) as plant mixes that optimize only those components (Figure 2). For example, a nine species mix found by maximizing pollinator visitation, species richness, and the timing of plant–pollinator interactions (f_{VRT}) provides resources to 97.7% as many pollinator species as one that maximizes only pollinator species richness, f_R. Similarly, a mix that optimizes visitation, species richness, and the floral bloom periods (f_{VRB}) provides resources to 98.4% as many species as one that




Total supported
pollinator visitation
1500
1000
500
0

periods or flight seasons. Second, restoration may subsequently favor common species (Kleijn *et al.* 2015). Third, the list of eligible plants will not contain those on which specimens were never collected, potentially omitting interactions that are rare or have low detectability (e.g., nocturnal visitors). Additionally, visitation data do not indicate whether pollinators were foraging for pollen or nectar on a given plant species. To overcome these problems, planners would ideally begin with a list of all potential plant species across the landscape and their bloom periods and resources provided, all pollinator species and their flight periods, and an interaction matrix. While floral bloom periods could potentially be estimated, obtaining an interaction matrix is only possible using collections, as we have done here. Thus, the approach we have taken (sampling in nearby pristine and agricultural habitats) is a practical and economic option, with the acknowledgment that additional sampling might improve the end result.

In a recent paper, Russo *et al.* (2013) proposed a

Sarkar, S., Pressey, R.L., Faith, D.P. *et al*. (2006). Biodiversity conservation planning tools: present status and challenges for the future. *Annu. Rev. Environ. Resour.*, 31