conservation

MDPI

Article

You Reap What You Sow: A Botanical and Economic Assessment of Wildflower Seed Mixes Available in Ireland

Claudia Barry and Simon Hodge *

School of Agriculture and Food Sciences, University College Dublin, D04 N2E5 Dublin, Ireland
* Correspondence: simon.hodge@ucd.ie

Abstract: Planting wildflower seed mixes has become popular with individuals and community groups aiming to promote wildlife and enhance local biodiversity. Recently, however, these seed mixes have been criticized with respect to the origin of the seeds and the species they contain. There is a growing awareness that the unintended planting of exotic species may disrupt native ecological networks, introduce aggressive weeds, or facilitate the establishment of invasive species in new localities. In this study, we purchased two packets of twelve brands of wildflower seeds available in Ireland from stores or online suppliers. In total, the 24 packets contained 69,409 seeds weighing 304 g, and represented 92 plant species in 23 families. Only 25% of the seed packets purchased in Ireland originated from Ireland, and only 43% of the plant species we identified are considered native to Ireland. To reinforce this point, the most frequent species, *Phacelia tanacetifolia*, which occurred in nine of the twelve brands, is not a native Irish plant species. Multivariate analysis identified no obvious grouping of seed mixes based on their intended target group (e.g., bees, butterflies, wildlife), which might be expected had manufacturers followed scientific guidance describing which plants are preferred by which pollinator group. The creation of patches of diverse floral habitats in gardens and urban settings can significantly benefit wildlife and human wellbeing. Our results, however, reinforce the need for caution before using wildflower mixes in attempts to restore or recreate natural or semi-natural plant communities.

Keywords: bees; butterflies; floral subsidies; flower strips; invasive species; native plants; pollinators

Citation: Barry, C.; Hodge, S. You Reap What You Sow: A Botanical and Economic Assessment of Wildflower Seed Mixes Available in Ireland. *Conservation* **2023**, *3*, 73–86. https://doi.org/10.3390/conservation3010007

Academic Editor: Todd S Fredericksen

Received: 5 December 2022
Revised: 18 January 2023
Accepted: 20 January 2023
Published: 24 January 2023

1. Introduction

There have been multiple recent reports describing significant global declines in wild insect pollinators, with accumulating evidence of decreased abundance, shrinking geographical ranges, and reduced species diversity [1–4]. At a European level, declines in hoverflies (Syrphidae), butterflies (Lepidoptera), and bees (Apidae) have all been identified [5–7]. The outlook for Ireland appears similarly bleak, with 50% of bumblebee species and 45% of solitary bees showing evidence of waning population sizes and/or distribution [8]. The threats contributing to pollinator declines are numerous and inter-related, but include habitat loss, agricultural intensification, agrochemical pollution, and the introduction of pests, diseases, and invasive competitors [3,9–11]. Loss and fragmentation of natural and semi-natural habitats can reduce, modify, or isolate nesting and floral resources, and result in habitat or diet specialists, or species with smaller foraging ranges, being unable to adapt to new conditions [12,13].

In order to reverse the current trends in pollinator declines, strategies involving multiple complementary approaches, including the re-establishment of semi-natural habitat and provision of dietary supplements, are generally considered to be the most effective. In Ireland, for example, the All-Ireland Pollinator Plan (AIPP) now lists almost 200 science-based actions that can be performed by all sectors of society (e.g., individuals, community groups, businesses, regional councils) to help maintain and enhance pollinator communities [14]. A key component of many pollination conservation initiatives is the creation of areas of habitat that contain a high abundance and diversity of flowering plants. These

florally-rich patches or strips deliver a variety of nectar and pollen, provide host plants for lepidopteran larvae, and supply nesting resources such as empty stems and foliage required by stem-nesting bees.

In agricultural settings, pollinator conservation measures include the preservation of hedgerows, the creation of florally-rich meadows, and increasing the floral diversity of forage crops by the inclusion of clovers and other flowering plants in multi-species swards. The creation of wildflower strips in field margins and headlands is often specifically promoted via agri-environmental schemes, and these field edge flower plantings have been demonstrated to have clear positive effects on pollinator abundance, diversity, and reproduction [15–17]. Additional ecosystem service benefits may also occur because of enhanced pollination of the focal crop, and the presence of other beneficial invertebrates, such as parasitoid wasps and predatory beetles, that can reduce infestations of crop pests [18,19]. By enhancing pollinator nutrition, it has been suggested that floral plantings can also help mitigate the negative impacts of pesticide exposure encountered in agricultural landscapes [17].

In domestic or urban settings, areas of florally-rich habitat can be created using blends of flower seeds that are now readily available from commercial seed merchants, gardening centres, general stores, and online sellers. These seed packets are affordable and convenient: they usually contain a wide variety of seeds and eliminate the need to spend large amounts of time and money purchasing individual plant species. Members of the public or community groups motivated to become involved with pollinator conservation have readily embraced these mixed seed packets as simple and effective habitat-creation tools [20,21], and there is ample evidence that the florally-rich resources produced by sowing these seed blends enhances pollinator abundance and diversity. For example, Blackmore and Goulson [22] recorded 25 times more flowers, 50 times more bumblebees, and 13 times more hoverflies in urban areas planted with wildflower seeds compared with mown grassland. Similarly, Griffiths-Lee et al. [23] found that sown 'mini-meadows' in domestic gardens resulted in double the number of bumble bees and solitary bees. As an indicator of how popular wildflower seed mixes have become, packets are often given away free as a means of engaging the public with conservation initiatives [24].

More recently, however, several reports and online articles have raised concerns with the uninhibited, 'blanket' use of mixed seed blends, and the potential ecological and agricultural harm they might cause [21,25–29]. The wording on these seed packets generally suggests they contain 'wildflowers', and that the plants produced are wildlife friendly, a theme reinforced by images of large, colourful flowers along with bees, butterflies, and other insects on the packaging [30]. This labelling can, however, be misleading, and is likely designed to entice well-intentioned consumers aiming to create wildlife-friendly habitat in their gardens [21]. In an Irish setting, it has been highlighted that many mixed seed packets are imported, contain species that are not native to Ireland, and/or the seed is not sourced in Ireland [21,26,28]. This situation can result in problems for both insects and plants: native populations of pollinators have generally evolved to interact with native plant species, and seeds with local provenance will tend be better adapted to local conditions and cope better with local pests and diseases [21,25,31]. Even when the packets contain native plants, sowing these species in areas where they do not normally occur can obscure natural habitat associations and biogeographic patterns. Similarly, although the species might be native, the seed might be of ornamental or agricultural cultivars, and bred for vibrant or unusual flower colour, flower size, or seed productivity, compared with native wild forms [21,29]. Finally, even when all the seeds are of native (or naturalized) plants, the subsequent species assemblage they produce might never be found under natural conditions [27,29,30]. In the extreme case, seed packets have been recalled due to the discovery of highly invasive weeds, such as blackgrass (*Alopecurus myosuroides*), that can be both a serious agricultural pest and threaten native flora [25,27,32].

There are now several publications listing species of flowering plants that are attractive to pollinating insects, including plant species used in agri-environment schemes and those

intended for smaller-scale garden or community use; many of these lists still include both native and non-native plant species [33–36]. Often these plant lists specify which flowers are attractive to different pollinator taxa, usually based on what plant species or families appear to induce higher visitation rates, or increase the abundance of honey bees, bumble bees, hover flies, butterflies, and so on [23,37–40]. It might be hypothesized, therefore, that if seed mix producers were following this scientific evidence, then different brands of seeds aimed at producing habitat that is attractive to the same pollinator group would have seed blends of similar species compositions.

The primary objective of this study was to provide an assessment of the contents of different brands of wildflower seed mixes readily available in Ireland. The different brands were compared in terms of seed weight and seed count, the number of species present, and, subsequently, their value for money. By determining the species composition of each packet, we were able to determine which flowering species occur most frequently, and the degree to which these wildflower mixes contain species that are native to Ireland. Finally, to assess whether there was any evidence that seed packagers were producing blends based on scientific evidence, we used multivariate analysis to assess whether seed mixes that indicated similar conservation aims on the packaging contained seed blends with similar species compositions.

2. Materials and Methods

2.1. Seed Packets

To locate different brands of commercially-produced wildflower seed mixes available in Ireland, we visited garden centres, supermarkets, general retail stores, and online sellers. The aim was to buy small, individual packets of seed intended to cover small patches of ground in private or community gardens. Therefore, large boxes of seeds, or quantities aimed at agricultural or landscape use, or for the planting of large 'meadows' or wildlife areas in parks or amenity situations, were avoided. In total, twelve brands of seeds were obtained, with two packets of each brand being purchased (Table 1). The name of the brand, where the seed packets were purchased, and the price of the seed packets were recorded. Seed packets were classified according to key words present in the name of the seed mix that gave some indication of their intended function, such as 'bee', 'butterfly', 'wildlife', and 'wildflowers'.

The seeds were sorted and the number and weight of seeds of each species in each packet were recorded. The weight of any waste material in each packet (e.g., empty seed husks, seed debris, dirt) was also recorded. As many seeds as possible were identified directly to species, which was guided by the species listed on the packaging or provided by online sellers. Seeds that could not be identified directly were germinated (see below) and allowed to produce seedlings, and these seedlings were then identified using the PlantNet app, *Collin's Wildflower Guide* [41], *Webb's an Irish Flora* [42], and *The Wildflowers of Ireland* [43,44]. These seedling identifications were then cross referenced with images of the seeds for verification. Species that could be identified to species level were classed as native or non-native to Ireland by reference to Seawright [45] and Devlin [44]. The proportion of native plant species in each brand of seeds was then calculated using the total number of identifiable species in the two packets.

2.2. Seed Germination

Germination trials were carried out to determine the quality of seeds in each brand. Ten seeds of each species from each seed packet were placed in a plastic Petri dish (9 cm diameter) lined with moist tissue paper. If there were fewer than 10 seeds available, then all the seeds were placed in the Petri dish minus one, which was retained for identification should none of the seeds germinate. The Petri dishes were sealed with Parafilm and placed in a dark cupboard for 7 d. On Day 7, the Petri dishes were removed from the cupboard and the number of seeds that had germinated was counted: seeds were classed as germinated if there were visible roots and/or shoots present.

Table 1. Summary of twelve wildflower seed mixes purchased in Ireland in 2022. Name of seed brand, where purchased (ol—online purchase), country where produced, mean number of species per packet, mean number of seeds per packet, mean weight of seed per packet (n = 2 packets per brand). The percentage of species native to Ireland was calculated using the total species in both packets, and only considered those seeds that could be identified to species level.

Brand Code	Name	Store	Country	Species	Native (%)	Seed Count	Seed wt (g)	Germ. Rate (%)
BEE1	Annual Bee Meadow Seed Mix	Fruit Hill Farm (ol)	IRE	22	25	10,724.5	43.6	74.62
BEE2	Johnson's Mixed Bumblebee Friendly Flowers	Tesco, Dublin	UK	18.5	16	696.5	7.5	70.89
BEE3	Thompson & Morgan Honey Bee Mix	Mr. Middleton, Dublin	UK	11	25	230	5.3	77.91
BUT1	Blooming Native Butterfly & Bee Native Wildflower Seed Mix	Connecting Nature (ol)	IRE	23.5	67	3715.5	3.9	61.67
BUT2	Unwin's Nature's Haven Butterfly Mix	Woodies, Dublin	UK	20.5	38	1546	9.4	69.83
WFL1	Thompson & Morgan Wildflowers Mixed	Mr. Middleton, Dublin	UK	19.5	43	915.5	8.2	60.74
WFL2	Wildflower Mix	Irish Seed Savers (ol)	IRE	15.5	50	7469.5	9.3	41.03
WFL3	De Ree Wildflowers Mixed	Home Store, Dublin	UK	20.5	53	966.5	8.4	65.87
WFL4	Wildflower Mix: Elegance	Seeds Ireland (ol)	NL	8	12	5308.5	26.5	74.83
WFL5	Wildflower Mixture Seeds	Irish Plants Direct (ol)	NL	25	29	1172.5	13.5	72.16
WDL1	Johnson's Wildlife Mixture	Tesco, Dublin	UK	19	73	1436.5	8	36.63
WDL2	Country Value Wildlife Mix	Irish Plants Direct (ol)	UK	20	10	593	9.4	70.52

When seeds could not be identified directly, germinated seeds were transferred into 7 × 7 cm plastic pots containing a mixture of Westland Garden Soil and vermiculite. These pots were maintained in a glass house at Rosemount Environmental Research Station, University College Dublin, Ireland, and allowed to grow to a sufficient stage that allowed the seedlings to be identified.

2.3. Data Analysis

Microsoft Excel was used to collate and organize data, perform simple calculations (e.g., grams of seed per unit cost), and produce all figures, whereas statistical tests were performed using Genstat v21 (VSN International Ltd., Hemel Hempstead, UK). Relationships between price of each packet with total seed count, total seed weight, number of species, and proportion of native plant species were assessed using Spearman's rank correlation coefficient. Similarly, the relationships between species number with total seed count and total seed weight were also examined using Spearman's rank correlation. Differences in seed count, seed weight, species number, and proportion of native species among different countries of origin (Ireland, UK, Netherlands) were assessed using one-way ANOVA, with response variables first being $\log_{10}$ transformed.

Multivariate analyses, using only the data for seeds that could be identified to species level, were performed using Community Analysis Package v4 software (Pisces Conservation Ltd., Hampshire, UK). Non-metric multi-dimensional scaling (NMDS) analyses were carried out to determine whether seed packets marketed as bee, butterfly, wildlife,

or wildflower mixes showed similarities based on plant species composition. Differences between these groupings were also assessed using analysis of similarity (ANOSIM; [46,47]), which produces an indication of statistical significance by comparing the relative within- and between-group similarity with that obtained by 1000 random permutations of the raw data. Similarity percentages analysis (SIMPER) was then performed to see which plant species were primarily responsible for within-group similarity (and between-group dissimilarity). These multivariate analyses were carried out on four versions of the raw data: simple presence or absence of each plant species within each brand, the number of seeds of each species per packet (square-root transformed), the weight of seeds of each species per packet, and the relative germination success, where this was equal to the product of the seed count and germination rate of each species in each brand.

3. Results

3.1. Seed Packet Contents and Value-for-Money

The 24 seed packets contained a total of 69,409 seeds which weighed a total of 304.2 g. The average number of seeds per packet ranged from 230 (BEE3) to 10,724 (BEE1), and the seed weight ranged from 3.9 g (BUT1) to 43.6 g (BEE1; Table 1). Only one brand, WFL3, contained no waste material in the packet, whereas 12.4% of the packet contents of BUT1 (by weight) consisted of empty seed husks, seed debris, and dirt.

The most species-rich brand was WFL5 which contained a mean of 25 species, whereas WFL4 contained an average of only 8 species (Table 1). Apart from WFL4, all the remaining brands contained an average of over 10 species per packet, with six of the twelve brands containing an average of $\geq$20 species (Table 1). There was no relationship between the number of species a brand contained and the total seed count ($r_S = 0.17$, $n = 12$, $p = 0.588$) or the weight of seed ($r_S = 0.18$, $n = 12$, $p = 0.589$). The overall germination rate was relatively high, with ten of the twelve brands having a mean germination success higher than 60%, and six of these having a germination success higher than 70% (Table 1). Only WFL2 and WDL1 had an overall germination rate lower than 60%, with 41.0% and 36.6%, respectively (Table 1).

In terms of cost, there were no significant relationships between price and seed count, seed weight, number of species, and proportion of native plant species ($r_S < |0.35|$, $n = 12$, $p > 0.275$ in all cases). At the time of purchase, WDL2 was the cheapest brand at EUR 1.99 per packet, whereas BUT1 was the most expensive at EUR 5.50 per packet (Table 2). BEE1, which contained the most seeds and the greatest seed weight, was also the best value for money, costing EUR 3.50 per packet and working out at 3064 seeds per euro and 12 g of seed per euro. In terms of seed count, BEE3 was the worst value for money at 69.9 seeds per euro, although this was offset somewhat by the high germination rate (Tables 1 and 2). In terms of seed weight, BUT1, which only contained 3.9 g of seed and was the most expensive brand, was, consequently, the worst value for money with only 0.7 g of seed per euro (Tables 1 and 2). On average, WFL3 provided the most (10.3) species per euro, and was followed closely by WDL2 with 10.1 species per euro. The fewest species per euro was 1.7, which occurred in brand WFL4 which also contained the fewest number of species on average (Tables 1 and 2).

3.2. Taxonomic Composition of Seed Mixes

In terms of higher taxonomic levels, the seed packets contained 23 plant families, with the commonest five families (Apiaceae, Asteraceae, Fabaceae, Boraginaceae, Brassicaceae) occurring in ten or more of the twelve brands (Table 3). Of these common families, Asteraceae was the most frequently occurring in all twelve seed brands, and was also the family represented by the largest number of species (18) (Tables 3 and 4). The Fabaceae was also well represented in the seed mixes, with 14 species occurring in ten brands (Tables 3 and 4). There were five families that occurred in only one brand each: Amaryllidaceae, Limanthacaea, Solanaceae, Primulaceae and Rosaceae (Table 3).

Table 2. Summary of value-for-money measures for 12 mixed wildflower seed mixes purchased in Ireland in 2022. Price is per packet at time and place of purchase (see Table 1).

Code	Price (EUR)	Species/EUR	Seeds/EUR	Seed wt/EUR (g)	Waste/Packet (% by wt)
BEE1	3.50	6.3	3064	12.5	1.2
BEE2	3.60	5.1	193	2.1	4.7
BEE3	3.29	3.3	70	1.6	6.9
BUT1	5.50	4.3	676	0.7	12.4
BUT2	4.00	5.1	386	2.4	3.6
WFL1	4.29	4.5	213	1.9	4.7
WFL2	3.25	4.8	2298	2.9	5.2
WFL3	2.00	10.3	483	4.2	0.0
WFL4	4.80	1.7	1106	5.5	2.0
WFL5	3.49	7.2	336	3.9	2.4
WDL1	3.60	5.3	399	2.2	4.8
WDL2	1.99	10.1	298	4.7	3.8

Table 3. Plant families found within twelve wildflower seed mixes purchased in Ireland in 2022. See Table 1 for details of each brand. Values given are numbers of species within each family found within two packets of seed of each brand.

Family	Brand											
	BEE1	BEE2	BEE3	BUT1	BUT2	WFL1	WFL2	WFL3	WFL4	WFL5	WDL1	WDL2
Amaranthaceae	1		1									
Amaryllidaceae						1						
Apiaceae	4	1	2	1	1	4		1	2	3	1	1
Asteraceae	3	5	2	4	7	7	4	5	3	7	5	4
Boraginaceae	2	3	2	2	4	1	1	2	1	3		4
Brassicaceae	2	1	2	1	2	1	3	2		2		3
Caprifoliaceae				1		1					1	
Caryophyllaceae	1	1		1			1		1	2	1	1
Fabaceae	3	2		7	1	1	4	5		3	2	1
Lamiaceae					1	3						
Limnanthaceae										1		
Linaceae		1						1		1		1
Malvaceae	1	1	1	1	1			1		1	1	1
Orobanchaceae				1		1						
Papaveraceae		2		1			1	1		2		2
Plantaginaceae		1		1	1					1	1	
Polygonaceae	2	1	1	1		1			1			1
Primulaceae					1							
Ranunculaceae	2		1	1			1			1		
Rosaceae				1								
Rubiaceae					1						1	
Scrophulariaceae							1	1			1	
Solanaceae											1	

There was a total of 92 distinct plant species in the 24 wildflower seed packets, although 12 of these species could not be identified from seed or by attempting to germinate and produce seedlings (Table 4). Three of the ten most commonly occurring plant species belonged to the family Asteraceae (*Centaurea cyanus, Cichorium intybus,* and *Calendula officinalis*), two belonged to the family Boraginaceae (*Phacelia tanacetifolia* and *Echium vulgare*) and one belonged to each of the families Polygonaceae (*Fagopyrum esculentum*), Malvaceae (*Malva sylvestris*), Caprifoliaceae (*Agrostemma githago*), Brassicaceae (*Sinapus alba*), and Apiaceae (*Anethum graveolens*) (Table 5).

Table 4. Plant families and species found within twelve brands of wildflower seeds purchased in Ireland in 2022. Species names in **bold** indicate species is native to Ireland. Frequency is the proportion (%) of seed brands (from 12) in which each species was found.

Family	Species	Freq.	Family	Species	Freq.
Amaranthaceae	***Chenopodium album***	17	Fabaceae	***Anthyllis vulneraria***	8
Amaryllidaceae	***Allium vineale***	8		*Lathyrus* spp.	17
Apiaceae	*Anethum graveolens*	67		***Lotus pedunculatus***	25
	Carum carvi	8		*Lupinus luteus*	8
	Coriandrum sativum	42		***Lupinus perennis***	8
	Daucus carota	42		*Lupinus polyphyllus*	8
	Foeniculum vulgare	17		*Melilotus officinalis*	25
Asteraceae	***Achillea millefolium***	25		***Trifolium incarnatum***	33
	Bellis perennis	17		***Trifolium pratense***	25
	Calendula officinalis	50		***Trifolium repens***	25
	Centaurea cyanus	75		*Trifolium rubens*	25
	Centaurea nigra	33		***Trifolium subterraneum***	8
	Chamaemelum nobile	8		*Trigonella foenum-graecum*	8
	Cichorium intybus	50		*Vicia villosa*	17
	Cirsium dissectum	8	Lamiaceae	*Hyssoppus officinalis*	8
	Coreopsis grandiflora	17		*Ocimum basilicum*	8
	Coreopsis tinctoria	33		***Origanum majorna***	8
	Cosmos bipinnatus	17		***Salvia officinalis***	8
	Glebionis coronaria	33	Limnanthaceae	*Limnanthes alba*	8
	Helianthus anuus	8	Linaceae	*Linum usitatissimum*	33
	Helminthotheca echioides	25	Malvaceae	*Malva sylvestris*	75
	Leucanthemum vulgare	33	Orobanchaceae	***Rhinanthus minor***	17
	Pulicaria dysenterica	17	Papaveraceae	*Eschscholzia californica*	25
	Rudbeckia hirta	8		*Papaver rhoeas*	42
	Zinnia elegans	8		*Papaver somniferum*	8
Boraginaceae	*Borago officianalis*	25	Plantaginaceae	***Plantago lanceolata***	42
	Cynoglossum amabile	33	Polygonaceae	*Fagopyrum esculentum*	50
	Echium vulgare	58		***Rumex acetosa***	8
	Myosotis arvensis	8		***Rumex pulcher***	8
	Phacelia tanacetifolia	75	Primulaceae	***Primula vulgaris***	8
Brassicaceae	***Capsella bursa-pastoris***	8	Ranunculaceae	***Aquilegia vulgaris***	17
	Iberis amara	8		*Nigella damascena*	17
	Isatis tinctoria	25		*Nigella sativa*	8
	Lobularia maritima	17		***Ranunculus acris***	8
	Raphanus raphanistrum	25	Rosaceae	***Agrimonia eupatoria***	8
	Sinapus alba	33	Rubiaceae	*Asperula orientalis*	8
Caprifoliaceae	***Knautia arvensis***	8		***Galium verum***	8
Caryophyllaceae	*Agrostemma githago*	42	Scrophulariaceae	***Verbascum thapsus***	25
	Scabiosa columbaria	17	Solanaceae	*Petunia* spp.	8
	Silene latifolia	17			
	Vaccaria hispanica	17			

Phacelia tanacetifolia, an exotic species in Ireland, was the most common species in terms of the number of packets in which it occurred, the total number of seeds, and the weight of seeds. *Malva sylvestris*, *Centaurea cyanus* and *Anethum graveolens* were also prevalent, occurring in seven or eight of the twelve brands (Table 5). *Anethum graveolens*, *Papaver somniferum*, *Pulicaria dysenterica*, and *Trifolium incarnatum* were common in terms of seed number with an average of over 2000 seeds of each species across the twelve brands. *Trifolium incarnatum*, *Fagopyrum esculentum*, *Coriandrum sativum*, and *Anethum graveolens* were also considered common in terms of the weight of the seeds with an average of over 10 g of seed of each species across the twelve brands (Table 4). The three species that occurred in the top 10 based on all criteria (frequency, seed number, and seed weight) were *Phacelia tanacetifolia*, *Centaurea cyanus*, and *Anethum graveolens*.

Table 5. The most common plant species occurring in wildflower seed mixes available in Ireland based on the number of brands in which the species occurred, the total number of seeds per packet, and the total seed weight (g) per packet. Names in **bold** represent native Irish plant species.

Rank	Brands (from 12)		Seed Count		Seed Weight (g)	
1	*Phacelia tanacetifolia*	9	*Phacelia tanacetifolia*	11,018	*Phacelia tanacetifolia*	25
2	*Malva sylvestris*	9	*Anethum graveolens*	7132	***Trifolium incarnatum***	23
3	***Centaurea cyanus***	8	***Papaver somniferum***	5535	*Fagopyrum esculentum*	22
4	*Anethum graveolens*	8	***Pulicaria dysenterica***	5150	*Coriandrum sativum*	21
5	***Echium vulgare***	7	***Trifolium incarnatum***	4773	*Anethum graveolens*	21
6	*Calendula officinalis*	6	*Trifolium repens*	2960	***Centaurea cyanus***	14
7	*Fagopyrum esculentum*	6	*Carum carvi*	2332	*Calendula officinalis*	14
8	*Sinapus alba*	6	*Papaver rhoeas*	2199	*Agrostemma githago*	12
9	*Cichorium intybus*	5	***Leucanthemum vulgare***	2166	*Malva sylvestris*	8
10	*Agrostemma githago*	5	***Centaurea cyanus***	1914	*Vaccaria hispanica*	7

3.3. Multivarate Analysis of Seed Species Composition

The suite of NMDS analyses did not indicate there were any particularly distinct clusters of brands based on plant species composition and the proposed function of the seed blend (e.g., to promote bees, butterflies, wildlife, wildflowers; Figure 1). In support of this, the ANOSIM procedures also indicated there were no significant differences in species composition among the four classes of seeds ($p > 0.6$ for all four analyses).

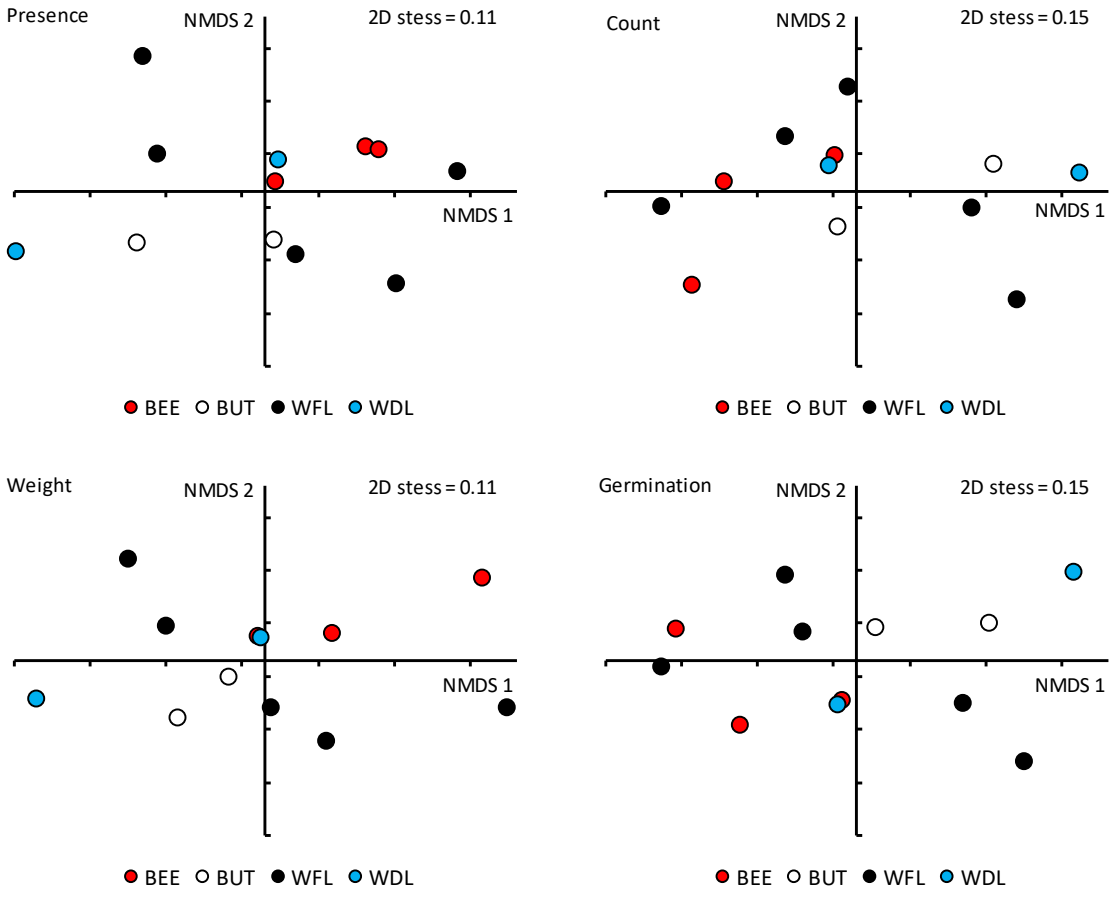

Figure 1. NMDS plots comparing composition of wildflower seed mixes based on presence or absence of each species, the seed count, the seed weight, and potential composition of final flowering mix based on germination rate of each species in each brand. BEE—bee-targeted brands; BUT—butterfly-targeted brands; WDL—wildlife targeted brands; WFL—wildflower mixes with no obvious target species/group on packaging.

Over all four NMDS analyses, the more generic, 'wildflower' and 'wildlife' seed mixes were well spread in terms of the NMDS Axis and Axis 2 scores (Figure 1). The NMDS plots (Figure 1) suggested there could be some separation of the seed mixes aimed at 'bees' and those aimed at 'butterflies', and pairwise comparisons of these two groups performed as part of the ANOSIM procedures provided moderate evidence that this might be the case ($0.3 > p > 0.1$). SIMPER analyses suggested that brands aimed for 'bees' were dominated by *Phacelia tanacetifolia*, *Fagopyrum esculentum*, *Centaurea cyanus*, *Sinapus alba*, and *Anethum graveolens*. Conversely, brands aimed for butterflies were dominated by *Trifolium repens*, *Centaurea nigra*, *Centaurea cyanus*, *Malva sylvestris*, and *Echium vulgare*. Although there was some inconsistency among the SIMPER analyses on the different data sets, the separation of the bee and butterfly groups generally arose because of the prevalence of *Phacelia tanacetifolia* and *Trifolium incarnatum* in the bee brands, and prevalence of *Trifolium repens* and *Papaver rhoeas* in the butterfly brands.

3.4. Seed Origins

Information was available on the packaging for all brands indicating where the seeds were packaged but not the provenance of the actual seeds. More than half (7/12) of the brands purchased in Ireland originated from the UK, two were from the Netherlands, and only three brands were packaged in Ireland (BEE1, BUT1, WFL2). There were no differences among countries of origin in terms of seed weight, species number, and proportion of native species ($F_{2,9} < 1.7$, $p > 0.24$ in all cases). There was, however, a difference among countries in terms of seed number, with the brands packaged in Ireland containing significantly more seeds than those packaged in the UK ($F_{2,9} = 10.7$, $p = 0.004$).

Of the 80 plant species that were identified, only 35 (~43%) were judged to be native to Ireland (Table 4). Of the ten most frequent species, only two, *Centaurea cyanus* and *Echium vulgare*, are considered native to Ireland by Seawright [45] and Devlin [44] (Table 4). In terms of seed number and seed weight, five native Irish species were ranked in the top ten: *Pulicaria dysenterica, Trifolium incarnatum, Trifolium repens, Leucanthemum vulgare*, and *Centaurea cyanus* (Table 5).

None of the seed brands contained 100% native Irish plant species, with the proportion of species considered native ranging between 10% and 73%. Brand BUT1, which is packaged in Ireland and advertised as a 'native wildflower seed mix', contained the highest number of native plants with 15 species, although this was still only 67% of the 24 total species that were identified in that brand. WLF1 had the largest proportion of native species with 73% of species considered Irish natives (Table 1). The three brands whose labelling suggested they were aimed at producing flowers for attracting bees contained 25% or less native Irish plant species. WFL4, purchased from a website called *Seeds Ireland* but where the packaging of the seeds we purchased was carried out in the Netherlands, contained the lowest proportion (12.5%) of native Irish plant species.

4. Discussion

The results of this study illustrate the large variation in seed number, seed weight, species diversity, and value for money among wildflower seed mixes available to consumers in Ireland. Price ranged from EUR 2.00 to EUR 5.50 per packet, and they contained from 230 to over 10,000 seeds and between 8 and 25 species. We concede that our sample of only twelve brands is only a small proportion of the many brands available, and that we have not included other formats, such as large boxes of seeds used to create mini-meadows, landscape mixes, and 'bee bombs'. Additionally, obtaining data from only two packets of seeds per brand did not allow us to fully examine 'within-brand' variation. Nevertheless, the results add further impetus to growing concerns regarding the provenance and biogeographic status of the species contained in these wildflower mixes, and the ecological 'naturalness' of the plant assemblages they create.

Customers buying these seed mixes can generally obtain information on the weight or number of species included in the packet, and therefore gauge value for money. Information

on how many species were contained in the packet, which species were present, and whether these species are native to Ireland was less available. In some cases, it may have been possible to determine which species were present using images on the packaging, although these images were not always available [27]. The germination rate of seeds also varied considerably, highlighting that the success of wildflower mixes is a function of both the species composition and plant establishment. Consequently, even when planting wildflower seed mixes with the same seed composition, the final floral assemblages may differ, and may not contain all the species listed or produce plants in the same proportions as stated in the seed blend [35,39].

Another issue of concern was the difficulty in finding information relating to seed origin, as, although the majority of seed packets stated the country in which the seeds were packaged, none specifically stated the country of seed origin. For Irish consumers attempting to obtain seeds of Irish origin, as recommend by several conservation organizations, this situation could be perplexing. This problem can sometimes be further exacerbated when buying seeds from online suppliers, where website names such as *Seeds Ireland* and *Irish Plants Direct* might suggest seeds are of Irish origin when they are actually supplied from other European countries such as the Netherlands and the UK.

The most common plant families included in the seed mixes were the Asteraceae, Apiaceae, and Fabaceae. These families frequently dominate seed mixes aimed at pollinators, with different pollinator groups showing preferences for flowers within these three families [48] For example, bumble bees often show strong preferences for clovers and other legumes in the Fabaceae, whereas hover flies (Syrphidae) have been shown to exhibit preferences for members of the Apiaceae [22,35,36,39]. *Phacelia tanacetifolia*, a species in the borage family native to Mexico and south-western USA, was the most common plant species across all twelve brands. *Phacelia* is often referred to as a 'bee plant' [45], and included in seed mixes for agri-environmental schemes as well as community use. Warzecha et al. [49] found that *P. tanacetifolia* was one of the top four key species in wildflower seed mixes intended for pollinators, and supported 80% of flower visitors in sown wildflower patches. Other key flowering species for pollinators, as determined by Warzecha et al. [49], that were also found in the current study are *Achillea millefolium*, *Fagopyrum esculentum*, *Malva sylvestris*, *Daucus carota*, *Echium vulgare*, *Calendula officinalis*, *Linum usitatissimum*, and *Centaurea cyanus* [49]. Nevertheless, many plant species known to be attractive to pollinators in Ireland, such as *Taraxacum* spp., *Lamium* spp., and *Leontodon* spp., were not identified in any of the packets we examined [38].

Given that several previous studies have demonstrated a disparity among floral preferences of different pollinator taxa, any generic pollinator seed mix would benefit from containing a high diversity of plant species, belonging to a range of families [37]. Additionally, it could be hypothesized that, based on the same evidence, pollinator-specific seed mixes would have floral compositions based on the preferences identified for each taxon [23,35,39]. The results of our NMDS and ANOSIM analyses, however, provided no evidence that seed mixes that stated similar conservation aims on the packaging contained seed mixes with similar species compositions. For example, despite there being evidence of negative associations between butterflies and Asteraceae, ten different Asteraceae species were present in the two butterfly-targeted brands [39]. Similarly, although bumblebees often show clear preferences for Fabaceae, the bee-targeted brands in this study contained very few species in this family. It appears, therefore, that the targeted seed mixes we examined offered little indication of being designed based on scientific evidence of pollinator–plant interactions, and this may represent another issue of misrepresentation to consumers who wish to create habitat for a specific pollinator group.

Overall, only 43% of the 80 species we identified in the wildflower seed packets sold in Ireland were actually native to Ireland, and no brand contained 100% native species. In our seed packets, three species, *Phacelia tanacetifolia*, *Anethum graveolents*, and *Centaurea cyanus*, were all considered 'common' based on all three measurements we used (frequency, seed count, seed weight) but of these, only *C. cyanus* is native to Ireland. In

the extreme, one brand of seeds, described as a 'wildflower mix' and obtained from an online seller called *Seeds Ireland*, contained only one native Irish species. These findings, although disappointing, were not surprising, as several previous commentators on the use of wildflower seed mixes in Ireland have highlighted the prevalence of non-native species (e.g., [21,26,27]. Even when species native to Ireland were present in the packets, as no information on seed origin was provided, we feel it highly unlikely that the seeds were of Irish provenance. In effect, any labelling or packaging describing these seed blends as 'native' or 'wildflowers' could be construed as being highly misleading, and one of the strongest recommendations we would make at this time is that at least the word "wild" is removed from labelling [27]. If the seed blends are described simply as "mixed flowers", there are no longer any suggestions that the species they contain are native wildflowers, or that they will re-create natural plant communities. An alternative approach would be to establish a regional or national Irish certification system, similar to the 'vegetal local' initiative in France, that guarantees the region of origin of seeds and provides a means of traceability to help conserve genetic diversity and provide locally-adapted plants for restoration of local ecosystems (www.vegetal-local.fr; accessed on 19 January 2023).

Whether the plant species are native or not, these seed mixes provide a convenient method of rapidly creating areas of flowers of different taxa, colours, and sizes, that are available over the course of the year and are attractive to a diverse community of pollinator groups [50–52]. Thus, the value of the seed mixes to different stakeholders (e.g., farmers, community groups, individuals, landscape gardeners, restoration ecologists) also requires some consideration. In farmland floral strips, the aim is generally not to create or re-establish a native plant community but to provide resources for pollinating insects and promote ecosystem services. Consequently, many of these agricultural seed blends contain non-native species (e.g., *Phacelia tanacetifolia*, buckwheat, borage) that are known to attract pollinators [18]. Additionally, wildflower mixes based on legumes, even if these are non-native or agricultural cultivars, would still provide agricultural benefits by fixing nitrogen as part of fallow rotations [21,36]. For conservationists, the primary aim might be restoration of a florally-rich semi-natural habitat, and to create a mix of native species in a self-sustaining plant community [53]. The seed blends used to create these semi-natural habitats, such as traditional hay meadows, will, however, often contain agricultural cultivars and non-native archeaophytes such as cornflowers and corn marigolds [36].

In many areas of western Europe, many people already live in highly modified landscapes where few natural plant communities still exist, and it must be remembered that the creation of wildflower areas or 'mini meadows' on waste land or road verges is not there only to benefit wildlife but also serves to improve the wellbeing of the people who interact with that space [29,54]. Where conservationists might aim to create a 'wild' habitat that enhances the diversity of native flora and fauna, community groups may be more focused on developing a site that is aesthetically attractive, not over-grown, and represents a space that can be used safely for wider community participation, socializing, recreation, and education [55]. In the latter case, the overall aim of creating such sites might not be to exactly emulate a natural ecological plant assemblage, but provide an acceptable alternative that benefits both wildlife and the local human community. The presence of ancient introductions, such as corncockles, cornflowers, and poppies, or the inclusion of non-native species with long-lasting, high visual impact, should not detract from the benefits to human wellbeing that these florally-rich spaces provide [29,30,33,56]. Given that small urban vegetation patches can make significant contributions to local floral species richness [57–59], and that non-native plant species often integrate into local plant-pollinator networks, in many cases a balance could be found that meets these various social and ecological objectives [55,60]. Ultimately, even though a 'wildflower' mix might contain non-native plant species this does not necessarily imply the floral assemblage produced has no value for wildlife conservation, and there is a risk that over-demonizing these products might deter members of the public from creating wildflower spaces at all.

Author Contributions: Conceptualization C.B. and S.H.; methodology S.H. and C.B.; formal analysis S.H.; investigation C.B.; writing—original draft preparation C.B.; writing—review and editing C.B. and S.H. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Data Availability Statement: Data are available from corresponding author on request.

Acknowledgments: We thank the UCD technical staff for help with laboratory facilities, and the staff at UCD Rosemount Environmental Research Station for the use of glasshouse facilities and assistance with seedling maintenance. We also thank Noeleen Smyth for help with seedling identification and helpful discussion on an earlier draft of the manuscript.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Balfour, N.J.; Ollerton, J.; Castellanos, M.C.; Ratnieks, F.L. British phenological records indicate high diversity and extinction rates among late-summer-flying pollinators. *Biol. Conserv.* **2018**, *222*, 278–283. [CrossRef]
2. Dicks, L.V.; Breeze, T.D.; Ngo, H.T. A global assessment of drivers and risks associated with pollinator decline. *Nat. Ecol. Evol.* **2021**, *5*, 1453–1461. [CrossRef] [PubMed]
3. Potts, S.G.; Biesmeijer, J.C.; Kremen, C.; Neumann, P.; Schweiger, O.; Kunin, W.E. Global pollinator declines: Trends, impacts and drivers. *Trends Ecol. Evolut.* **2010**, *25*, 345–353. [CrossRef] [PubMed]
4. Schweiger, O.; Biesmeijer, J.C.; Bommarco, R.; Hickler, T.; Hulme, P.E.; Klotz, S.; Kühn, I.; Moora, M.; Nielsen, A.; Ohlemuller, R.; et al. Multiple stressors on biotic interactions: How climate change and alien species interact to affect pollination. *Biol. Rev.* **2010**, *85*, 777–795. [CrossRef]
5. Keil, P.; Biesmeijer, J.C.; Barendregt, A.; Reemer, M.; Kunin, W.E. Biodiversity change is scale-dependent: An example from Dutch and UK hoverflies (Diptera, Syrphidae). *Ecography* **2011**, *34*, 392–401. [CrossRef]
6. Nieto, A.; Roberts, S.P.M.; Kemp, J. *European Red List of Bees*; Publication Office of the European Union: Luxembourg, 2014.
7. Van Swaay, C.; Cuttelod, A.; Collins, S.; Maes, D.; López Munguira, M.; Šašic, M. *European Red List of Butterfies*; Publication Office of the European Union: Luxembourg, 2010.
8. Fitzpatrick, Ú.; Murray, T.E.; Byrne, A.W.; Paxton, R.J.; Brown, M.J.F. *Regional Red List of Irish Bees*; National Parks and Wildlife Service (Ireland) and Environment and Heritage Service (N. Ireland): Dublin, Ireland, 2006.
9. Brittain, C.A.; Vighi, M.; Bommarco, R.; Settele, J.; Potts, S.G. Impacts of a pesticide on pollinator species richness at different spatial scales. *Basic Appl. Ecol.* **2010**, *11*, 106–115. [CrossRef]
10. Dicks, L.V.; Viana, B.; Bommarco, R.; Brosi, B.; Arizmendi, M.D.C.; Cunningham, S.A.; Galetto, L.; Hill, R.; Lopes, A.V.; Pires, C.; et al. Ten policies for pollinators. *Science* **2016**, *354*, 975–976. [CrossRef]
11. Goulson, D.; Nicholls, E.; Botías, C.; Rotheray, E.L. Bee declines driven by combined stress from parasites, pesticides, and lack of flowers. *Science* **2015**, *347*, 1255957. [CrossRef] [PubMed]
12. Bommarco, R.; Biesmeijer, J.C.; Meyer, B.; Potts, S.G.; Pöyry, J.; Roberts, S.P.M.; Steffan-Dewenter, I.; Öckinger, E. Dispersal capacity and diet breadth modify the response of wild bees to habitat loss. *Proc. R. Soc. B Biol. Sci.* **2010**, *277*, 2075–2082. [CrossRef]
13. Steffan-Dewenter, I.; Tscharntke, T. Butterfly community structure in fragmented habitats. *Ecol. Lett.* **2000**, *3*, 449–456. [CrossRef]
14. AIPP. *All-Ireland Pollinator Plan 2021–2025*; Series No. 25; National Biodiversity Data Centre: Waterford, Ireland, 2021.
15. Campbell, A.J.; Wilby, A.; Sutton, P.; Wäckers, F.L. Do sown flower strips boost wild pollinator abundance and pollination services in a spring-flowering crop? A case study from UK cider apple orchards. *Agric. Ecosyst. Environ.* **2017**, *239*, 20–29. [CrossRef]
16. Lowe, E.B.; Groves, R.; Gratton, C. Impacts of field-edge flower plantings on pollinator conservation and ecosystem service delivery—A meta-analysis. *Agric. Ecosys. Environ.* **2021**, *310*, 107290. [CrossRef]
17. Rundlöf, M.; Stuligross, C.; Lindh, A.; Malfi, R.L.; Burns, K.; Mola, J.M.; Cibotti, S.; Williams, N.M. Flower plantings support wild bee reproduction and may also mitigate pesticide exposure effects. *J. Appl. Ecol.* **2022**, *59*, 2117–2127. [CrossRef]
18. Haaland, C.; Naisbit, R.E.; Bersier, L.F. Sown wildflower strips for insect conservation: A review. *Insect Conserv. Divers.* **2011**, *4*, 60–80. [CrossRef]
19. Grass, I.; Albrecht, J.; Jauker, F.; Diekötter, T.; Warzecha, D.; Wolters, V.; Farwig, N. Much more than bees—Wildflower plantings support highly diverse flower-visitor communities from complex to structurally simple agricultural landscapes. *Agric. Ecosys. Environ.* **2016**, *225*, 45–53. [CrossRef]
20. Lawrence, N. Ecological Benefits of Gardening Wildflowers. 2014. Available online: Phys.org/news/2014-05-ecological-benefits-gardening-wildflowers.html (accessed on 20 July 2022).
21. Stout, J.C. Wildflowers—To Plant or Not to Plant? 2019. Available online: Pollinators.ie/wildflowers-to-plant-or-not-to-plant/ (accessed on 20 November 2022).
22. Blackmore, L.M.; Goulson, D. Evaluating the effectiveness of wildflower seed mixes for boosting floral diversity and bumblebee and hoverfly abundance in urban areas. *Insect Conserv. Divers.* **2014**, *7*, 480–484. [CrossRef]
23. Griffiths-Lee, J.; Nicholls, E.; Goulson, D. Sown mini-meadows increase pollinator diversity in gardens. *J. Insect Conserv.* **2022**, *26*, 299–314. [CrossRef]

24. Kerr, K.C.R.; Harricharan, A.K. Assessing the impact of complimentary wildflower seed packets as an outreach tool for promoting pollinator conservation at a zoo. *Appl. Environ. Edu. Comm.* **2021**, *20*, 92–106. [CrossRef]
25. AIPP. Why We don't Recommend Wildflower Seed Mixes. 2022. Available online: Pollinators.ie/wildflower-seed/ (accessed on 11 July 2022).
26. Buckley, Y. Why 'Wildflower' Seed is a Prickly Issue. 2021. Available online: Pollinators.ie/why-wildflower-seed-is-a-prickly-issue/ (accessed on 10 November 2022).
27. Smyth, N. Spreading Seeds of Doubt—Fake 'Wildflower' Mixes. 2021. Available online: Pollinators.ie/spreading-seeds-of-doubt-fake-wildflower-mixes/ (accessed on 11 October 2022).
28. Fitzpatrick, Ú. Why I don't Plant Wildflower Seed. 2021. Available online: www.pollinators.ie/why-i-dont-plant-wildflower-seed/ (accessed on 1 November 2022).
29. Walker, K. Wildflower Seed Sowing: Pros and Cons. Botanical Society of Britain and Ireland. 2022. Available online: Bsbi.org/wildflower-seed-sowing-pros-and-cons (accessed on 11 July 2022).
30. DNFC. Dublin Naturalists' Field Club: The Case against 'Wildflower' Seed Mixtures. 2021. Available online: Dnfc.net/wp-content/uploads/2021/07/Wildflower-Mixtures-LR.pdf (accessed on 11 July 2022).
31. Bucharova, A.; Lampei, C.; Conrady, M.; May, E.; Matheja, J.; Meyer, M.; Ott, D. Plant provenance affects pollinator network: Implications for ecological restoration. *J. Appl. Ecol.* **2022**, *59*, 373–383. [CrossRef]
32. Teagasc. Beware of Wildflower Mixes as You Might Get More than You Paid for. 2021. Available online: www.teagasc.ie/news--events/news/2021/blackgrass.php (accessed on 22 June 2022).
33. RHS. Royal Horticultural Society: Plants for Pollinators. British Wildflowers. 2019. Available online: www.rhs.org.uk/plantsforpollinators (accessed on 1 November 2022).
34. Nichols, R.N.; Goulson, D.; Holland, J.M. The best wildflowers for wild bees. *J. Insect Conserv.* **2019**, *23*, 819–830. [CrossRef]
35. Nichols, R.N.; Holland, J.M.; Goulson, D. Can novel seed mixes provide a more diverse, abundant, earlier, and longer-lasting floral resource for bees than current mixes? *Basic Appl. Ecol.* **2022**, *60*, 34–47. [CrossRef]
36. Nowakowski, M.; Pywell, R.F. *Habitat Creation and Management for Pollinators*; Centre for Ecology & Hydrology: Wallingford, UK, 2016.
37. Harmon-Threatt, A.N.; Hendrix, S.D. Prairie restorations and bees: The potential ability of seed mixes to foster native bee communities. *Basic Appl. Ecol.* **2015**, *16*, 64–72. [CrossRef]
38. Russo, L.; Fitzpatrick, Ú.; Larkin, M.; Mullen, S.; Power, E.; Stanley, D.; White, C.; O'Rourke, A.; Stout, J.C. Conserving diversity in Irish plant–pollinator networks. *Ecol. Evolut.* **2022**, *12*, e9347. [CrossRef] [PubMed]
39. Scheper, J.; Bukovinszky, T.; Huigens, M.E.; Kleijn, D. Attractiveness of sown wildflower strips to flower-visiting insects depends on seed mixture and establishment success. *Basic Appl. Ecol.* **2021**, *56*, 401–415. [CrossRef]
40. Kuppler, J.; Neumüller, U.; Mayr, A.V.; Hopfenmüller, S.; Weiss, K.; Prosi, R.; Schanowski, A.; Schwenninger, H.-R.; Ayasse, M.; Burger, H. Favourite plants of wild bees. *Agric. Ecosys. Environ.* **2023**, *342*, 108266. [CrossRef]
41. Streeter, D.; Hart-Davies, C.; Hardcastle, A.; Cole, F.; Harper, L. *Collin's Wild Flower Guide*, 2nd ed.; Harper Collins: New York, NY, USA, 2016.
42. Parnell, J.; Curtis, T.; Cullen, E. *Webb's an Irish Flora*; Cork University Press: Cork, Ireland, 2012.
43. Devlin, Z. *The Wildflowers of Ireland: A Field Guide*, 2nd ed.; Gill Publishers: Dublin, Ireland, 2021.
44. Devlin, Z. Wildflowers of Ireland. 2022. Available online: http://www.wildflowersofireland.net/ (accessed on 22 July 2022).
45. Seawright, J. Irish Wildflowers. 2008. Available online: www.irishwildflowers.ie/index.html (accessed on 26 July 2022).
46. Clarke, K.R. Non-parametric multivariate analyses of changes in community structure. *Aust. J. Ecol.* **1993**, *18*, 117–143. [CrossRef]
47. Henderson, P.; Seaby, R. *A Practical Handbook for Multivariate Methods*; Pisces Conservation Ltd.: Hemel Hemstead, UK, 2008.
48. Nikolić, M.; Stevović, S. Family Asteraceae as a sustainable planning tool in phytoremediation and its relevance in urban areas. *Urban For. Urban Green.* **2015**, *14*, 782–789. [CrossRef]
49. Warzecha, D.; Diekötter, T.; Wolters, V.; Jauker, F. Attractiveness of wildflower mixtures for wild bees and hoverflies depends on some key plant species. *Insect Conserv. Divers.* **2018**, *11*, 32–41. [CrossRef]
50. Bottero, I.; Hodge, S.; Stout, J. Taxon-specific temporal shifts in pollinating insects in mass-flowering crops and field margins in Ireland. *J. Pollinat. Ecol.* **2021**, *28*, 90–107. [CrossRef]
51. Havens, K.; Vitt, P. The importance of phenological diversity in seed mixes for pollinator restoration. *Nat. Areas J.* **2016**, *36*, 531–537. [CrossRef]
52. Schlaepfer, M.A.; Sax, D.F.; Olden, J.D. The potential conservation value of non-native species. *Conserv. Biol.* **2011**, *25*, 428–437. [CrossRef] [PubMed]
53. Wilkerson, M.L.; Ward, K.L.; Williams, N.M.; Ullmann, K.S.; Young, T.P. Diminishing returns from higher density restoration seedings suggest trade-offs in pollinator seed mixes. *Restor. Ecol.* **2014**, *22*, 782–789. [CrossRef]
54. Mody, K.; Lerch, D.; Muller, A.-K.; Simons, N.K.; Bluthgen, N.; Harnisch, M. Flower power in the city: Replacing roadside shrubs by wildflower meadows increases insect numbers and reduces maintenance costs. *PLoS ONE* **2020**, *15*, e0234327. [CrossRef] [PubMed]
55. Bretzel, F.; Vannucchi, F.; Romano, D.; Malorgio, F.; Benvenuti, S.; Pezzarossa, B. Wildflowers: From conserving biodiversity to urban greening—A review. *Urban For. Urban Green.* **2016**, *20*, 428–436. [CrossRef]
56. Vega, K.A.; Küffer, C. Promoting wildflower biodiversity in dense and green cities: The important role of small vegetation patches. *Urban For. Urban Green.* **2021**, *62*, 127165. [CrossRef]

57. Norton, B.A.; Bending, G.; Clark, R.; Corstanje, R.; Dunnett, N.; Evans, K.L.; Grafius, D.; Gravestock, E.; Grice, S.M.; Harris, J.; et al. Urban meadows as an alternative to short mown grassland: Effects of composition and height on biodiversity. *Ecol. Applic.* **2019**, *29*, e01946. [CrossRef]
58. Donkersley, P.; Witchalls, S.; Bloom, E.H.; Crowder, D.W. A little does a lot: Can small-scale planting for pollinators make a difference? *Agric. Ecosys. Environ.* **2023**, *343*, 108254. [CrossRef]
59. Hoyle, H.; Norton, B.; Dunnett, N.; Richards, J.P.; Russell, J.M.; Warren, P. Plant species or flower colour diversity? Identifying the drivers of public and invertebrate response to designed annual meadows. *Landsc. Urban Plan.* **2018**, *180*, 103–113. [CrossRef]
60. Kovács-Hostyánszki, A.; Piross, I.S.; Shebl, M.A. Non-native plant species integrate well into plant-pollinator networks in a diverse man-made flowering plant community. *Urban Ecosyst.* **2022**, *25*, 1491–1502. [CrossRef]