

Wildflower seed sales as incentive for adopting flower strips for native bee conservation: a cost-benefit analysis.

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Supplementary Tables S1-S3, S5-S8.

Table S1. Location, acres in vegetable production, farming methods, flower strip management practices, and honey bee hives present at each farm.

Farm	Location	Acres in cultivation	Farming methods	Flower strip planting bed preparation	Flower strip irrigation	Honey bee hives
1	N45°46.28; W111°17.72	3	Organic practices	InfraRed Transmitting (IRT) plastic mulch	Drip tape and overhead	-
2	N45°39.63; W110°56.85	6	Certified organic	Bare ground	Overhead	One hive in one year
3	N45°39.82; W110°56.95	10	Sustainable practices	Landscape fabric	Overhead	-
4	N45°39.92; W111°04.35	3	Certified organic	IRT plastic mulch	Drip tape and overhead	≤ 5 hives in all years

Table S2. Nine native perennial wildflower species planted in flower strips at four participating farms, planting densities, effort indices, and coefficients for cost-benefit analyses (P_F = proportion of plugs of each flower species, P_W = proportion effort weeding, P_H = proportion effort harvesting seed, P_C = proportion effort cleaning seed for each of four farms labeled 1-4). To maximize floral display, we planted five, six, or nine plugs into each plot (replicated three times), depending on the flower species and its growth habits.

Flower species	Plugs per strip	Weeding effort index ¹	Harvesting effort index ¹	P_F	P_W	P_H	$P_{C(1)}$ ²	$P_{C(2)}$ ²	$P_{C(3)}$ ²	$P_{C(4)}$ ²
<i>C. rotundifolia</i>	27	2	1	0.176	0.167	0.063	0.047	0.306	0.200	0.447
<i>E. speciosus</i>	15	1	2	0.098	0.083	0.125	0.260	0.255	0.229	0.256
<i>G. aristata</i>	15	1	2	0.098	0.083	0.125	0.232	0.256	0.128	0.384
<i>G. viscosissimum</i>	15	1	2	0.098	0.083	0.125	0.333	0.193	0.088	0.387
<i>H. maximiliani</i>	15	1	3	0.098	0.083	0.188	0.388	0.142	0.166	0.304
<i>H. villosa</i>	18	2	3	0.118	0.167	0.188	0.063	0.127	0.224	0.587
<i>M. fistulosa</i>	15	1	1	0.098	0.083	0.063	0.377	0.323	0.064	0.236
<i>P. confertus</i>	18	1	1	0.118	0.083	0.063	0.250	0.267	0.242	0.242
<i>P. hastata</i>	15	2	1	0.098	0.167	0.063	0.071	0.177	0.276	0.477
Total	153	12	16							

¹2014-2015 only (see methods)

²2014 only (see methods)

Table S3. Total time (h) invested and cost (USD) for each activity at each farm in each year (data needed for calculations whose results are in Supp. Table S4).

Year	Farm	Planting		Watering		Weeding		Seed harvesting		Seed cleaning		Seed packing (retail only)	
		Time (h)	Cost (\$)	Time (h)	Cost (\$)	Time (h)	Cost (\$)	Time (h) ¹	Cost (\$)	Time (h) ²	Cost (\$)	Time (h)	Cost (\$)
2013	1	2.999	35.99	0.333	4.00	3.000	36.00	-	-	-	-	-	-
	2	3.998	47.98	0.667	8.00	4.333	52.00	-	-	-	-	-	-
	3	7.999	95.99	1.000	12.00	7.000	84.00	-	-	-	-	-	-
	4	2.999	35.99	1.000	12.00	1.667	20.00	-	-	-	-	-	-
2014	1	-	-	-	-	3.083	37.00	15.583	187.00	38.837	466.04	24.862	298.34
	2	-	-	-	-	10.083	121.00	6.833	82.00	26.438	317.25	8.884	106.60
	3	-	-	-	-	20.500	246.00	7.167	86.00	20.032	240.39	6.988	83.85
	4	-	-	-	-	5.583	67.00	12.333	148.00	42.944	515.32	38.106	457.28
2015	1	-	-	-	-	2.667	32.00	15.583	187.00	33.770	405.24	7.805	93.67
	2	-	-	-	-	9.250	111.00	6.833	82.00	23.550	282.60	9.691	116.29
	3	-	-	-	-	11.833	142.00	7.167	86.00	15.540	186.48	4.434	53.21
	4	-	-	-	-	2.833	34.00	12.333	148.00	32.923	395.08	23.437	281.24

¹Estimated 2015 times using 2014 data (see methods).

²Estimated 2014 times using 2015 data (see methods).

Table S5. Total time (h) to clean seeds of each flower species across all four farms (data needed for calculations whose results are in Supp. Table S4).

Year	Flower species	Seed cleaning time (h)
2014	<i>C. rotundifolia</i>	5.50
	<i>E. speciosus</i>	8.75
	<i>G. aristata</i>	4.25
	<i>G. viscosissimum</i>	28.25
	<i>H. maximiliani</i>	42.50
	<i>H. villosa</i>	4.00
	<i>M. fistulosa</i>	15.75
	<i>P. confertus</i>	10.50
	<i>P. hastata</i>	8.75

Table S6. Retail seed packet value (USD), number of seeds per packet, number of seeds per unit weight, estimated weight (mg) of seed per retail packet, estimated packets filled per hour, and wholesale seed value (USD) for each wildflower species.

Flower species	Value of retail seed packets	Number of seeds in retail seed packets	Seeds per unit weight (oz, g, mg, lbs) ¹	Weight of seed per retail packet (mg) ²	Estimated packets filled per hour	Value of wholesale seed/PLS ⁵ pound
<i>C. rotundifolia</i>	\$2.50-3.99	1000	900,000 per oz	32	180	\$150.00 ⁶
<i>E. speciosus</i>	\$1.99	2000	85,335 per oz	652	240	\$150.00
<i>G. aristata</i>	\$3.99	100	345 per g	290	252	\$40.00
<i>G. viscosissimum</i>	\$1.95-2.49	50	50 per 500 mg	500	276	\$60.00
<i>H. maximiliani</i>	\$2.50	300	466 per g	644	216	\$28.00
<i>H. villosa</i>	\$3.99	100	70,000 per oz	40	324	\$130.00
<i>M. fistulosa</i>	\$3.99	200	70,000 per oz	83	264	\$150.00
<i>P. confertus</i>	\$3.99 ³	1000 ⁴	248,000 per oz	114	192	\$150.00 ⁶
<i>P. hastata</i>	\$3.99 ³	200 ⁴	153,000 per lb	590	216	\$150.00 ⁶

¹Determined using the Association of Official Seed Analysts (AOSA) rule book. When no information was available for the species of interest, we used the closest species available. When no similar species were available we used reported numbers of seeds per unit weight from various online seed companies that also sell seed in bulk (Prairie Moon Nursery, Native Ideals Seed Farm, Planet Natural, High Country Gardens, and Great Basin Seed).

²We used the reported number of seeds per unit weight for each forb species to determine the weight of seed per packet based on the number of seeds reported in retail seed packets.

³Value of retail seed packets for *P. confertus* was based on *Penstemon hirsutus* and value of *P. hastata* was based on *Pestemon eriantherus* (see methods).

⁴Number of seeds in retail seed packets for *P. confertus* was based on *P. hirsutus* and *P. hastata* was based on *Phacelia campanularia* (see methods).

⁵PLS (pure live seed) is calculated as: (% seed purity x % seed viability) ÷ 100. This is the metric by which all bulk seed is sold and is by the pound. It is a way to standardize quality among different seed lots.

⁶No bulk pricing was available for these three species. Thus, based on the level of seed harvesting difficulty, size of seed, and lack of commercial availability, we used the higher value of \$150 per PLS. The lack of availability may warrant even higher market values.

Table S7. Total seed viability (%) and adjusted weight (mg) of seed per retail packet for each year/farm/flower species (2014-2015) to obtain a minimum of 90% total seed viability per packet using the estimated weight of seed per retail packet (mg) from Supp. Table S6.

Year	Farm	Flower species	Total seed viability %	Adjusted weight per retail packet (mg) ¹
2014	1	<i>C. rotundifolia</i>	52.00	55.38
		<i>E. speciosus</i>	33.56	1748.51
		<i>G. aristata</i>	76.00	343.42
		<i>G. viscosissimum</i>	68.00	661.76
		<i>H. maximiliani</i>	96.00	644.00
		<i>H. villosa</i>	67.00	53.73
		<i>M. fistulosa</i>	51.33	145.52
		<i>P. confertus</i>	56.11	182.85
		<i>P. hastata</i>	59.40	893.94
2014	2	<i>C. rotundifolia</i>	24.00	120.00
		<i>E. speciosus</i>	26.44	2219.36
		<i>G. aristata</i>	68.00	383.82
		<i>G. viscosissimum</i>	74.00	608.11
		<i>H. maximiliani</i>	99.00	644.00
		<i>H. villosa</i>	62.00	58.06
		<i>M. fistulosa</i>	87.40	85.47
		<i>P. confertus</i>	41.00	250.24
		<i>P. hastata</i>	41.88	1268.06
2014	3	<i>C. rotundifolia</i>	20.00	144.00
		<i>E. speciosus</i>	47.83	1226.76
		<i>G. aristata</i>	70.00	372.86
		<i>G. viscosissimum</i>	78.00	576.92
		<i>H. maximiliani</i>	82.00	706.83
		<i>H. villosa</i>	46.25	77.84
		<i>M. fistulosa</i>	77.50	96.39
		<i>P. confertus</i>	64.57	158.89
		<i>P. hastata</i>	71.80	739.55
2014	4	<i>C. rotundifolia</i>	92.00	32.00

Year	Farm	Flower species	Total seed viability %	Adjusted weight per retail packet (mg) ¹
		<i>E. speciosus</i>	40.22	1458.90
		<i>G. aristata</i>	64.00	407.81
		<i>G. viscosissimum</i>	76.00	592.11
		<i>H. maximiliani</i>	99.00	644.00
		<i>H. villosa</i>	57.89	62.19
		<i>M. fistulosa</i>	91.33	83.00
		<i>P. confertus</i>	54.00	190.00
		<i>P. hastata</i>	67.50	786.67
2015	1	<i>C. rotundifolia</i>	40.00	72.00
		<i>E. speciosus</i>	48.50	1209.90
		<i>G. aristata</i>	76.00	343.42
		<i>G. viscosissimum</i>	82.00	548.78
		<i>H. maximiliani</i>	96.00	644.00
		<i>H. villosa</i>	36.50	98.63
		<i>M. fistulosa</i>	81.50	91.66
		<i>P. confertus</i>	28.50	360.00
		<i>P. hastata</i>	55.00	965.45
2015	2	<i>C. rotundifolia</i>	36.00	80.00
		<i>E. speciosus</i>	42.00	1397.14
		<i>G. aristata</i>	50.00	522.00
		<i>G. viscosissimum</i>	88.00	511.36
		<i>H. maximiliani</i>	98.00	644.00
		<i>H. villosa</i>	55.00	65.45
		<i>M. fistulosa</i>	90.00	83.00
		<i>P. confertus</i>	33.50	306.27
		<i>P. hastata</i>	20.00	2655.00
2015	3	<i>C. rotundifolia</i>	16.00	180.00
		<i>E. speciosus</i>	40.00	1467.00
		<i>G. aristata</i>	72.00	362.50
		<i>G. viscosissimum</i>	58.00	775.86
		<i>H. maximiliani</i>	96.00	644.00

Year	Farm	Flower species	Total seed viability %	Adjusted weight per retail packet (mg) ¹
		<i>H. villosa</i>	23.50	153.19
		<i>M. fistulosa</i>	78.50	95.16
		<i>P. confertus</i>	40.00	256.50
		<i>P. hastata</i>	73.00	727.40
2015	4	<i>C. rotundifolia</i>	70.00	41.14
		<i>E. speciosus</i>	16.50	3556.36
		<i>G. aristata</i>	58.00	450.00
		<i>G. viscosissimum</i>	84.00	535.71
		<i>H. maximiliani</i>	99.00	644.00
		<i>H. villosa</i>	60.00	60.00
		<i>M. fistulosa</i>	78.50	95.16
		<i>P. confertus</i>	60.00	171.00
		<i>P. hastata</i>	53.50	992.52

¹Weight of seed needed to obtain 90% total seed viability per packet.

Table S8. Weight (mg) of seeds collected and estimated number of retail seed packets filled for each year/farm/flower species (2014-2015).

Year	Flower species	Farm							
		1		2		3		4	
		Seed weight	Packets filled	Seed weight	Packets filled	Seed weight	Packets filled	Seed weight	Packets filled
2014	<i>C. rotundifolia</i>	8750	158	22244	185	3253	23	34892	1090
	<i>E. speciosus</i>	534890	306	229990	104	70310	57	387960	266
	<i>G. aristata</i>	526860	1534	50200	131	114560	307	430310	1055
	<i>G. viscosissimum</i>	35040	53	16020	26	18760	33	33400	56
	<i>H. maximiliani</i>	233960	363	158170	246	70450	100	645100	1002
	<i>H. villosa</i>	114400	2129	26640	459	34180	439	227260	3654
	<i>M. fistulosa</i>	129370	889	29870	349	7540	78	66560	802
	<i>P. confertus</i>	165390	905	139090	556	95034	598	256556	1350
	<i>P. hastata</i>	18890	21	9820	8	9310	13	95540	121
2015	<i>C. rotundifolia</i>	225	3	7157	89	2188	12	18194	442
	<i>E. speciosus</i>	201720	167	224480	161	183490	125	192020	54
	<i>G. aristata</i>	150030	437	82860	159	39410	109	189950	422
	<i>G. viscosissimum</i>	16730	30	23700	46	2390	3	42760	80
	<i>H. maximiliani</i>	325820	506	188420	293	126680	197	494900	768
	<i>H. villosa</i>	11610	118	52710	805	21240	139	198740	3312
	<i>M. fistulosa</i>	44260	483	39830	480	4490	47	30130	317
	<i>P. confertus</i>	48870	136	121550	397	88350	344	122090	714
	<i>P. hastata</i>	1580	2	1240	0	14370	20	19680	20