Table S1. Land cover sources for the fourteen land cover classes used to model monarch roost occurrence in southern Ontario. SOLRIS is the Southern Ontario Land Information System version 3 (MNRF 2019) and ACI is the Annual Crop Inventory (AAFC 2020).

Land cover variable	*Original source*		
	SOLRIS	**ACI**	**Lindsay 2022**
Open water	Open water		
Wetland	Marsh, fen, bog, swamp	Wetland[2]	
Forest	Forest, coniferous forest, mixed forest, deciduous forest, plantation, hedgerow	Forest (undifferentiated), coniferous, broadleaf, mixed[2]	
Sparse forest	Treed dunes, treed cliff and talus, treed alvar, sparse treed, tallgrass woodland		
Shrubland	Shrub alvar	Shrubland[2]	
Grassland, pasture, and forage	Open tallgrass prairie, tallgrass savannah	Grassland, pasture / forage[3]	
Row crops		Cereals, oilseeds, pulses, vegetables, fruits, berries[3]	
Natural barren	Beach/bar, sand dune, cliff and talus, alvar, bedrock		
Parkland	Built up area - pervious		
Rural roads	Transportation[1]		
Urban roads	Transportation[1]		
Anthropogenic	Built up area - impervious		
Goldenrod			Goldenrod presence[4]
Unclassified	Undifferentiated		

[1]Designated as urban if the road fell within the urban area boundaries and rural if the road fell outside the urban area boundaries (Statistics Canada 2016 Census – boundary files).

[2]Took precedence over 'Undifferentiated' SOLRIS classification.

[3]Took precedence over 'Undifferentiated' and 'Tilled' SOLRIS classifications.

[4]Took precedence over all SOLRIS and ACI classifications.

Table S2: A list of the boosted regression tree models, sorted by data source (Environment and Climate Change Canada (ECCC) and Journey North (JN)), used to model the distribution of monarch roosts across Ontario, Canada.

Model_ID	Tree_complexity	Learning_rate	Bag_fraction	Number_of_trees	CV_AUC	AUC	CV_deviance	Mean_null	Dev_explained
ECCC1	5	0.001	0.5	2650	0.89663	0.9823	0.769591	1.386294	0.444858
ECCC2	5	0.001	0.5	5550	0.94899	0.9996	0.554801	1.386294	0.599795
ECCC3	5	0.001	0.5	5950	0.94886	1	0.57211	1.386294	0.58731
ECCC4	5	0.001	0.5	3550	0.92949	0.9932	0.641043	1.386294	0.537585
ECCC5	5	0.001	0.5	3100	0.92221	0.9909	0.682968	1.386294	0.507343
ECCC6	5	0.001	0.5	4100	0.93974	0.994	0.658242	1.386294	0.525178
ECCC7	5	0.001	0.5	3400	0.93972	0.9938	0.652928	1.386294	0.529012
ECCC8	5	0.001	0.5	3250	0.93902	0.9904	0.63405	1.386294	0.542629
ECCC9	5	0.001	0.5	3050	0.91895	0.9919	0.678294	1.386294	0.510714
ECCC10	5	0.001	0.5	5500	0.95126	0.9994	0.571103	1.386294	0.588036
ECCC11	5	0.001	0.5	3650	0.95126	0.9969	0.61082	1.386294	0.559386
ECCC12	5	0.001	0.5	3200	0.91222	0.9905	0.750616	1.386294	0.458545
ECCC13	5	0.001	0.5	2900	0.90418	0.9871	0.719563	1.386294	0.480945
ECCC14	5	0.001	0.5	3150	0.90935	0.9884	0.723639	1.386294	0.478005
ECCC15	5	0.001	0.5	3850	0.91713	0.9965	0.692964	1.386294	0.500132
ECCC16	5	0.001	0.5	2700	0.90048	0.9863	0.766438	1.386294	0.447132
ECCC17	5	0.001	0.5	3250	0.88642	0.989	0.821275	1.386294	0.407575
ECCC18	5	0.001	0.5	3000	0.88787	0.9865	0.847229	1.386294	0.388854
ECCC19	5	0.001	0.5	4300	0.93383	0.9988	0.624528	1.386294	0.549498
ECCC20	5	0.001	0.5	4100	0.93409	0.9956	0.666117	1.386294	0.519498
JN1	5	0.001	0.5	4100	0.89565	0.9874	0.836468	1.386294	0.396616
JN2	5	0.001	0.5	2300	0.85545	0.9627	0.964277	1.386294	0.304421
JN3	5	0.001	0.5	2450	0.86196	0.9625	0.96241	1.386294	0.305768
JN4	5	0.001	0.5	3600	0.86912	0.9846	0.88406	1.386294	0.362286
JN5	5	0.001	0.5	3300	0.88483	0.9824	0.860844	1.386294	0.379033
JN6	5	0.001	0.5	2950	0.86412	0.9766	0.931328	1.386294	0.328189
JN7	5	0.001	0.5	3200	0.8777	0.9757	0.913712	1.386294	0.340896
JN8	5	0.001	0.5	2750	0.84895	0.9616	0.972692	1.386294	0.298351
JN9	5	0.001	0.5	2400	0.85153	0.9585	0.990089	1.386294	0.285802
JN10	5	0.001	0.5	3000	0.86851	0.9794	0.921961	1.386294	0.334946
JN11	5	0.001	0.5	2850	0.8817	0.9765	0.872023	1.386294	0.370968
JN12	5	0.001	0.5	2950	0.88943	0.973	0.880316	1.386294	0.364986
JN13	5	0.001	0.5	3050	0.84482	0.973	0.977763	1.386294	0.294693
JN14	5	0.001	0.5	2450	0.85698	0.9633	0.942291	1.386294	0.320281
JN15	5	0.001	0.5	2700	0.85433	0.969	0.961741	1.386294	0.306251
JN16	5	0.001	0.5	3250	0.8596	0.9774	0.936094	1.386294	0.324751
JN17	5	0.001	0.5	4150	0.87952	0.9849	0.888131	1.386294	0.359349
JN18	5	0.001	0.5	2900	0.87673	0.9753	0.894444	1.386294	0.354795
JN19	5	0.001	0.5	2800	0.8452	0.9676	0.985313	1.386294	0.289247
JN20	5	0.001	0.5	3000	0.86782	0.9746	0.917253	1.386294	0.338342

Table S3. The buffer sizes (meters) within which each land cover class was tabulated for each boosted regression tree model used to model the distribution of monarch roosts in Ontario, Canada. ECCC represents the Environment and Climate Change Canada models and JN represents the Journey North models.

Model	Open water	Wetland	Forest	Sparse forest	Shrubland	Grassland, pasture, forage	Agriculture	Natural barren	Parkland	Rural roads	Urban	Goldenrod	Unclassified	Urban roads
ECCC1	500	100	500	100	200	200	100	200	100	100	300	100	100	100
ECCC2	500	500	400	400	400	200	100	300	300	100	300	200	200	500
ECCC3	500	100	500	100	100	200	100	300	100	100	300	200	200	200
ECCC4	500	100	400	200	100	100	100	100	100	100	300	100	200	200
ECCC5	500	100	500	300	400	100	100	100	300	200	300	100	200	200
ECCC6	500	300	500	300	100	100	100	300	100	100	100	200	200	200
ECCC7	500	500	400	300	100	500	500	100	100	100	300	200	200	200
ECCC8	500	100	400	200	100	200	100	200	100	100	300	200	200	100
ECCC9	500	200	500	400	200	200	100	300	100	100	300	100	200	200
ECCC10	500	100	500	300	500	200	100	300	100	100	300	100	200	100
ECCC11	500	100	400	100	200	200	100	200	100	100	300	100	200	200
ECCC12	500	200	400	500	100	500	100	200	100	100	300	100	100	100
ECCC13	500	100	400	500	500	100	100	500	100	100	300	100	200	200
ECCC14	500	500	500	400	400	200	100	200	400	100	200	100	100	500
ECCC15	500	100	400	500	100	200	100	200	100	100	300	200	100	200
ECCC16	500	200	500	300	100	100	100	400	400	100	500	200	100	200
ECCC17	500	300	400	100	400	200	500	200	300	100	300	100	100	500
ECCC18	500	300	400	500	100	200	100	200	200	100	300	100	200	200
ECCC19	500	100	500	500	200	500	100	300	500	100	300	100	200	200
ECCC20	500	200	500	300	200	200	100	200	100	100	300	200	200	200
JN1	500	300	500	100	500	500	400	200	100	100	300	100	500	500
JN2	500	500	500	100	500	500	400	500	500	100	300	100	100	400
JN3	500	300	500	100	500	500	200	500	400	100	300	200	500	300
JN4	500	100	500	100	500	500	400	300	500	100	300	200	200	400
JN5	500	100	300	100	500	500	500	500	400	100	300	200	500	200
JN6	500	200	500	100	500	500	500	500	500	100	100	100	100	400
JN7	500	300	500	100	500	500	200	400	400	100	100	300	200	400
JN8	500	200	500	100	500	500	400	200	500	100	300	300	300	200
JN9	500	500	500	100	500	500	500	200	500	100	400	300	100	200
JN10	500	200	500	100	500	200	400	500	400	100	200	500	200	200
JN11	500	300	500	100	500	500	500	500	500	100	300	500	100	200
JN12	500	500	500	100	500	500	100	500	400	200	400	500	100	400
JN13	500	500	500	100	500	500	500	500	500	100	200	100	100	400
JN14	500	500	500	100	500	500	100	500	400	100	200	400	100	200
JN15	500	500	500	100	500	500	100	500	500	100	400	100	100	400
JN16	500	300	500	100	500	500	400	500	500	100	300	100	200	400
JN17	500	300	500	100	500	500	100	500	400	100	100	100	200	400

JN18	500	300	400	500	300	500	100	500	400	100	200	300	500	400
JN19	500	300	500	100	500	500	400	300	400	100	300	100	100	300
JN20	500	500	500	100	500	500	200	200	400	100	400	200	100	200

Table S4. A correlation matrix of the explanatory variables used to build the boosted regression tree models. Table S4a shows the correlations values for the Environment and Climate Change Canada model and Table S4b shows the correlations values for the Journey North model. R values are in top right cells and standard deviation in the bottom left cells. GPF = grassland, pasture, and forage.

4a	Aspect	Great Lakes	Internal water	Slope	Open water	Rural roads	Urban	Goldenrod	Unclassified	Urban roads	Wetland	Forest	Sparse forest	Shrubland	Grassland, pasture, and forage	Agriculture	Natural barren	Parkland
Aspect		-0.36	-0.10	-0.47	-0.07	-0.18	0.01	-0.15	-0.11	-0.06	0.22	-0.08	-0.08	0.20	0.34	-0.30	-0.13	0.24
Great Lakes	0.04		0.08	0.22	0.43	-0.09	0.30	0.25	-0.16	-0.02	-0.21	0.02	0.10	0.10	-0.30	0.19	0.19	-0.87
Internal water	0.05	0.07		0.06	-0.05	-0.05	0.00	0.37	-0.01	-0.06	0.07	0.07	0.00	-0.06	-0.15	0.02	0.03	-0.08
Slope	0.03	0.08	0.06		0.03	-0.05	0.06	0.08	-0.10	0.02	-0.17	-0.03	0.05	-0.09	-0.19	-0.05	-0.03	-0.17
Open water	0.05	0.07	0.04	0.04		0.00	0.13	0.02	-0.22	-0.15	-0.06	-0.07	0.07	0.11	-0.12	-0.06	-0.09	-0.43
Rural roads	0.06	0.06	0.04	0.03	0.06		-0.02	-0.15	0.53	-0.13	-0.26	-0.05	-0.08	-0.14	-0.20	-0.08	-0.04	0.16
Urban	0.06	0.09	0.04	0.06	0.05	0.05		0.18	-0.05	-0.05	-0.28	-0.08	-0.07	0.24	-0.20	-0.11	0.06	-0.20
Goldenrod	0.04	0.06	0.06	0.04	0.04	0.02	0.06		-0.05	-0.05	-0.15	-0.03	0.06	0.04	-0.11	-0.11	-0.09	-0.16
Unclassified	0.06	0.04	0.05	0.02	0.03	0.11	0.06	0.04		-0.06	-0.18	-0.03	-0.06	-0.10	-0.16	-0.06	0.10	0.26
Urban roads	0.06	0.06	0.02	0.05	0.03	0.02	0.05	0.03	0.02		-0.13	-0.03	-0.04	-0.07	-0.15	0.04	-0.08	0.02
Wetland	0.04	0.05	0.06	0.02	0.06	0.02	0.04	0.03	0.02	0.04		-0.03	-0.05	-0.17	-0.28	-0.13	-0.20	0.07
Forest	0.05	0.06	0.08	0.04	0.04	0.01	0.02	0.06	0.01	0.01	0.05		-0.02	-0.05	-0.06	0.31	-0.03	-0.08
Sparse forest	0.03	0.06	0.02	0.03	0.05	0.01	0.03	0.04	0.01	0.01	0.02	0.00		-0.05	-0.09	-0.04	-0.06	-0.08
Shrubland	0.05	0.07	0.05	0.02	0.05	0.03	0.07	0.05	0.03	0.02	0.03	0.01	0.02		-0.16	-0.11	-0.07	-0.03
GPF	0.05	0.05	0.03	0.02	0.04	0.02	0.04	0.03	0.02	0.02	0.03	0.01	0.01	0.03		-0.12	-0.14	0.20
Agriculture	0.01	0.03	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.04	0.01	0.11	0.01	0.01	0.01		0.03	-0.22
Natural barren	0.03	0.04	0.02	0.02	0.02	0.04	0.03	0.01	0.07	0.02	0.02	0.02	0.01	0.01	0.02	0.01		-0.06
Parkland	0.05	0.00	0.06	0.08	0.07	0.08	0.08	0.07	0.05	0.06	0.06	0.06	0.07	0.06	0.06	0.02	0.04	

4b	Aspect	Great Lakes	Internal water	Slope	Open water	Rural roads	Urban	Goldenrod	Unclassified	Urban roads	Wetland	Forest	Sparse forest	Shrubland	Grassland, pasture, and forage	Agriculture	Natural barren	Parkland
Aspect		-0.30	-0.03	-0.44	0.05	-0.43	0.09	-0.14	-0.43	-0.03	0.07	0.01	0.03	0.33	0.36	-0.18	-0.17	0.25
Great Lakes	0.04		0.07	0.08	0.22	0.40	-0.01	0.08	0.32	-0.07	-0.28	-0.07	-0.15	-0.08	-0.19	0.10	0.21	-0.87
Internal water	0.03	0.05		-0.01	-0.05	-0.10	0.12	0.27	-0.03	-0.03	0.14	0.00	0.00	0.03	-0.17	-0.05	0.13	0.00
Slope	0.04	0.07	0.03		-0.06	-0.02	-0.08	0.02	-0.09	-0.02	-0.06	-0.01	-0.04	-0.13	-0.18	0.15	0.07	-0.05
Open water	0.03	0.04	0.03	0.02		0.02	0.07	0.08	-0.18	-0.09	-0.08	-0.04	-0.03	-0.03	-0.07	0.12	0.01	-0.19
Rural roads	0.03	0.04	0.03	0.03	0.03		-0.05	-0.09	0.68	-0.10	-0.26	-0.04	-0.09	-0.29	-0.36	-0.07	-0.01	-0.37
Urban	0.04	0.06	0.04	0.02	0.05	0.03		0.03	-0.07	-0.04	-0.14	-0.04	0.03	0.19	-0.23	-0.06	0.04	0.05
Goldenrod	0.03	0.05	0.05	0.03	0.04	0.02	0.03		-0.09	-0.02	-0.10	0.03	0.04	0.02	-0.10	0.00	-0.05	-0.04
Unclassified	0.02	0.04	0.02	0.01	0.02	0.03	0.02	0.03		-0.08	-0.21	-0.03	-0.07	-0.22	-0.29	-0.05	0.08	-0.29
Urban roads	0.04	0.03	0.02	0.02	0.02	0.01	0.03	0.02	0.01		0.02	-0.01	0.01	-0.07	-0.13	-0.02	-0.05	0.03
Wetland	0.03	0.04	0.06	0.03	0.02	0.02	0.04	0.02	0.02	0.04		0.02	0.09	-0.19	-0.32	0.07	-0.11	0.27
Forest	0.03	0.00	0.04	0.03	0.00	0.00	0.00	0.14	0.00	0.01	0.07		-0.01	-0.04	-0.05	0.02	-0.02	0.07
Sparse forest	0.04	0.03	0.08	0.01	0.05	0.02	0.08	0.05	0.02	0.03	0.06	0.00		0.05	-0.10	-0.02	-0.04	0.13
Shrubland	0.03	0.04	0.03	0.01	0.03	0.02	0.05	0.02	0.02	0.02	0.02	0.00	0.05		-0.21	-0.06	-0.12	0.09
GPF	0.03	0.04	0.02	0.01	0.03	0.01	0.02	0.02	0.02	0.01	0.02	0.00	0.03	0.02		-0.06	-0.18	0.12
Agriculture	0.02	0.03	0.01	0.04	0.02	0.01	0.01	0.02	0.00	0.01	0.01	0.07	0.01	0.00	0.01		-0.01	-0.09
Natural barren	0.03	0.03	0.02	0.03	0.02	0.01	0.03	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.00		-0.15
Parkland	0.04	0.00	0.04	0.06	0.05	0.04	0.04	0.05	0.04	0.03	0.05	0.03	0.03	0.05	0.04	0.02	0.03	

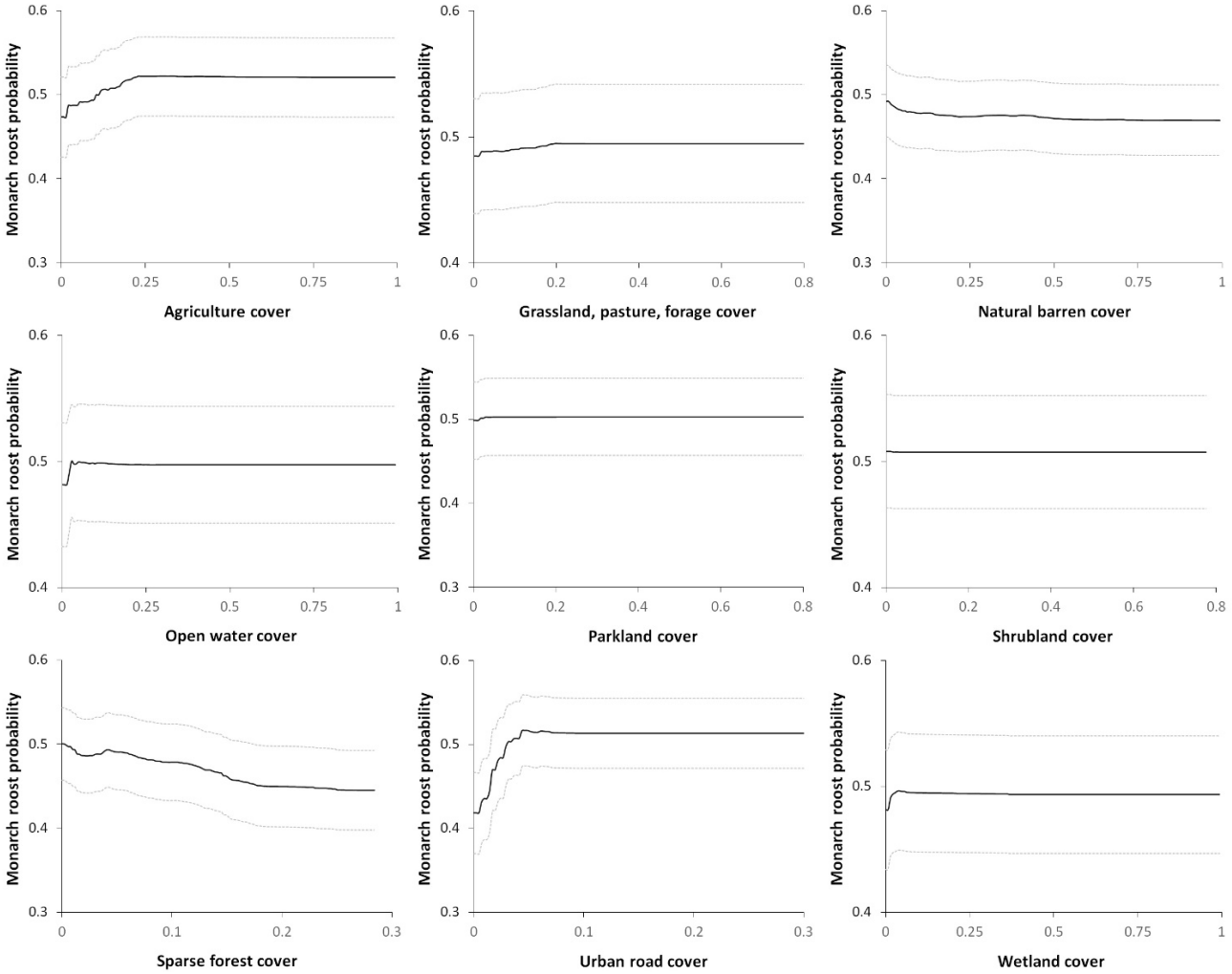

Fig. S1. Partial dependence plots, not included in Figure 2, of the explanatory variables used to model monarch distribution in Ontario, Canada using the Environment and Climate Change Canada roost data.

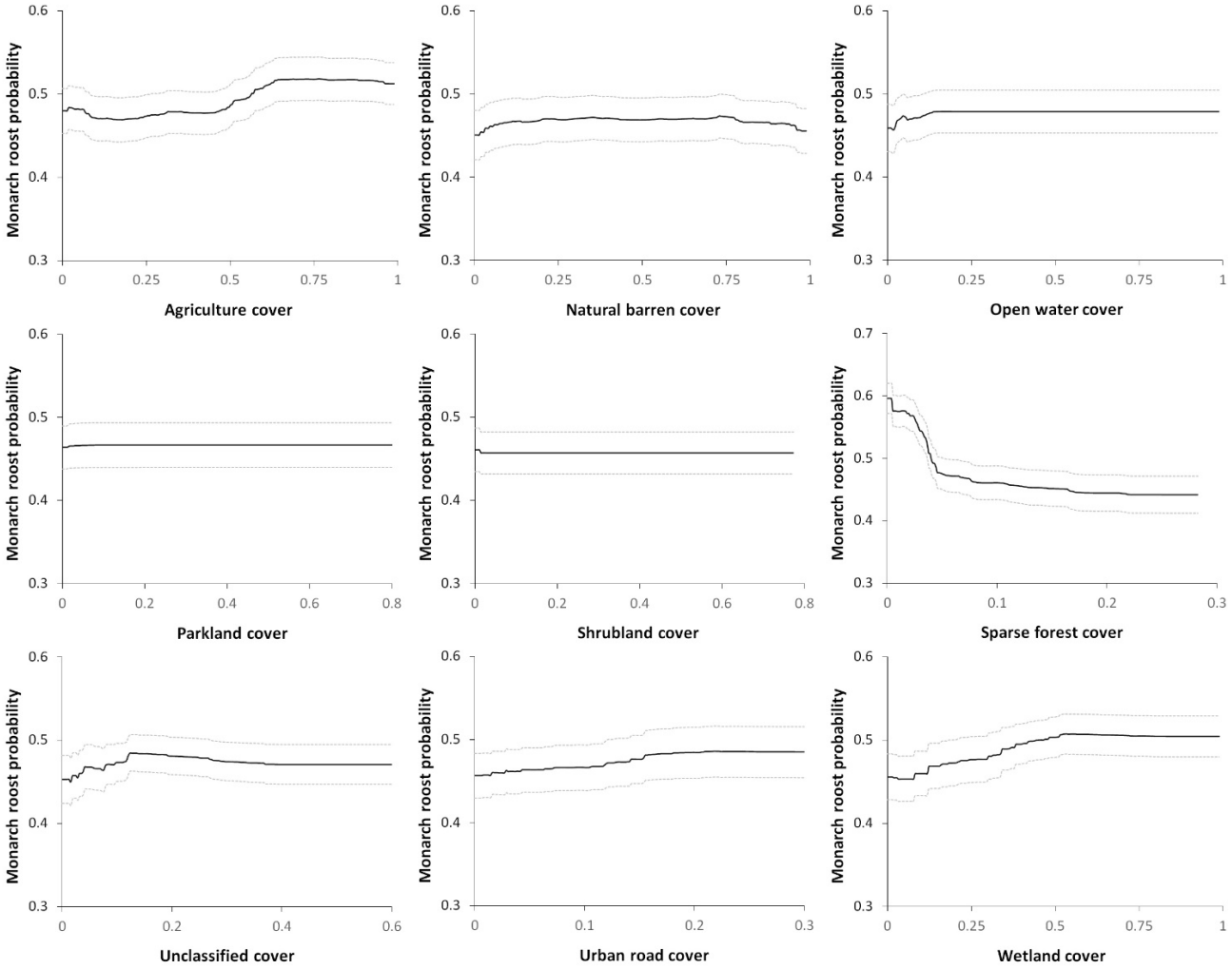

Fig. S2. Partial dependence plots, not included in Figure 3, of the explanatory variables used to model monarch distribution in Ontario, Canada using the Journey North roost data.