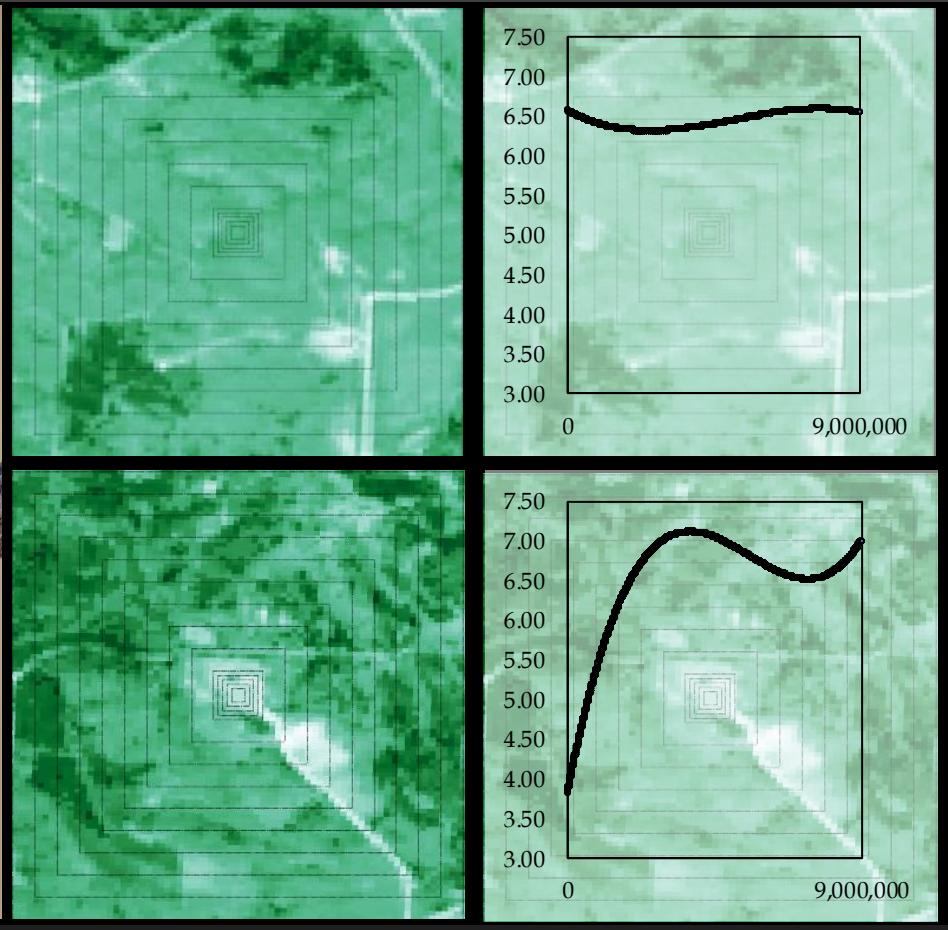
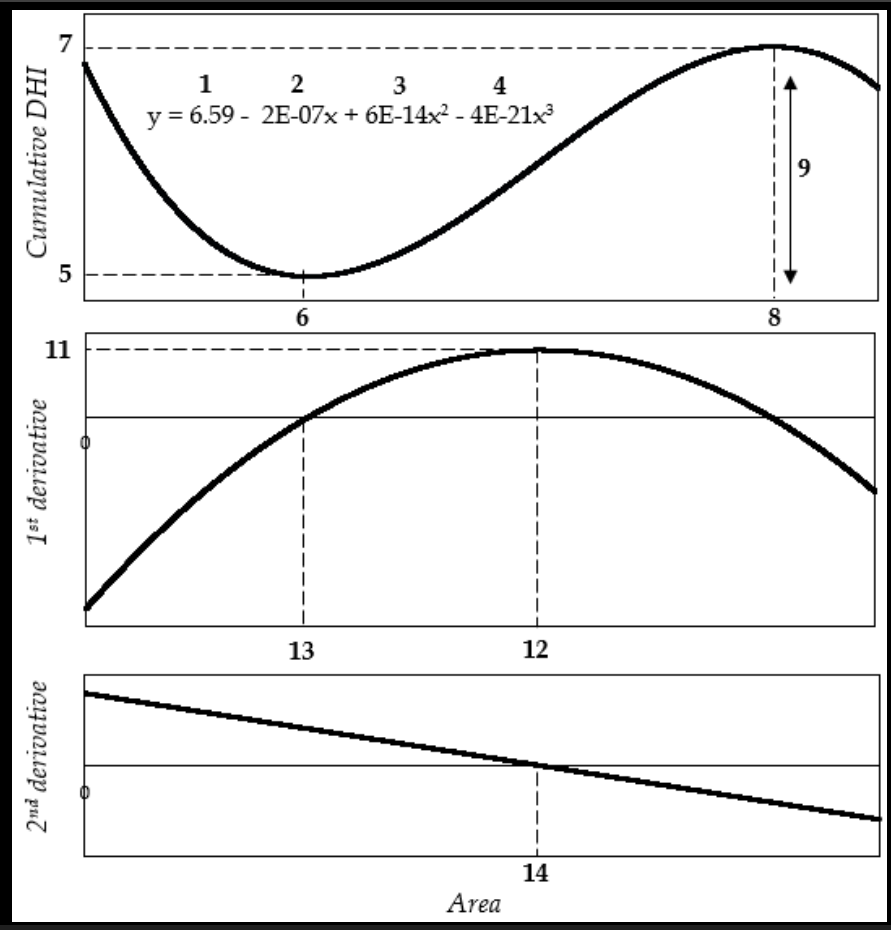
Multiple spatial scales, long-term trends, and synchrony of the dynamic habitat indices and bird populations

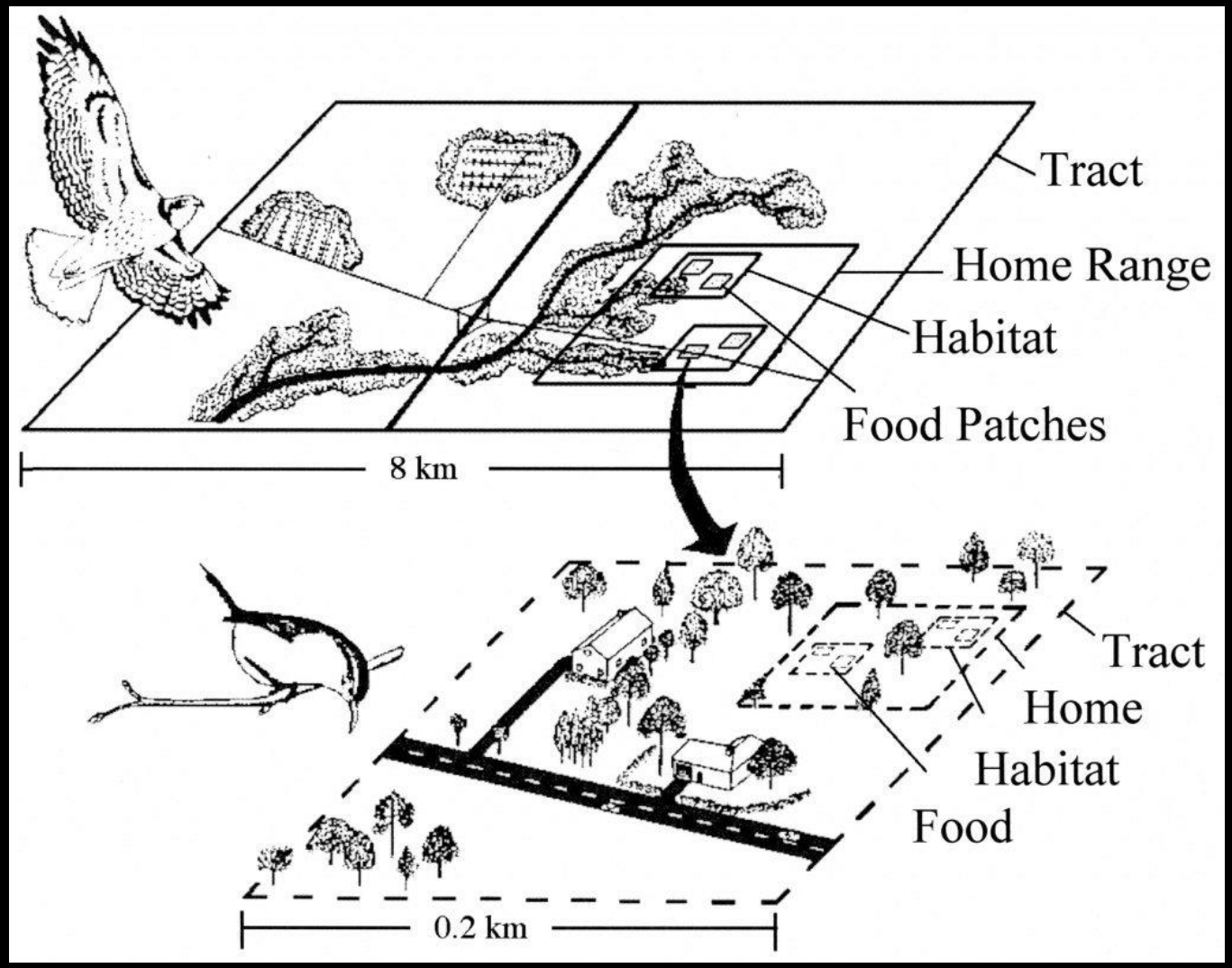




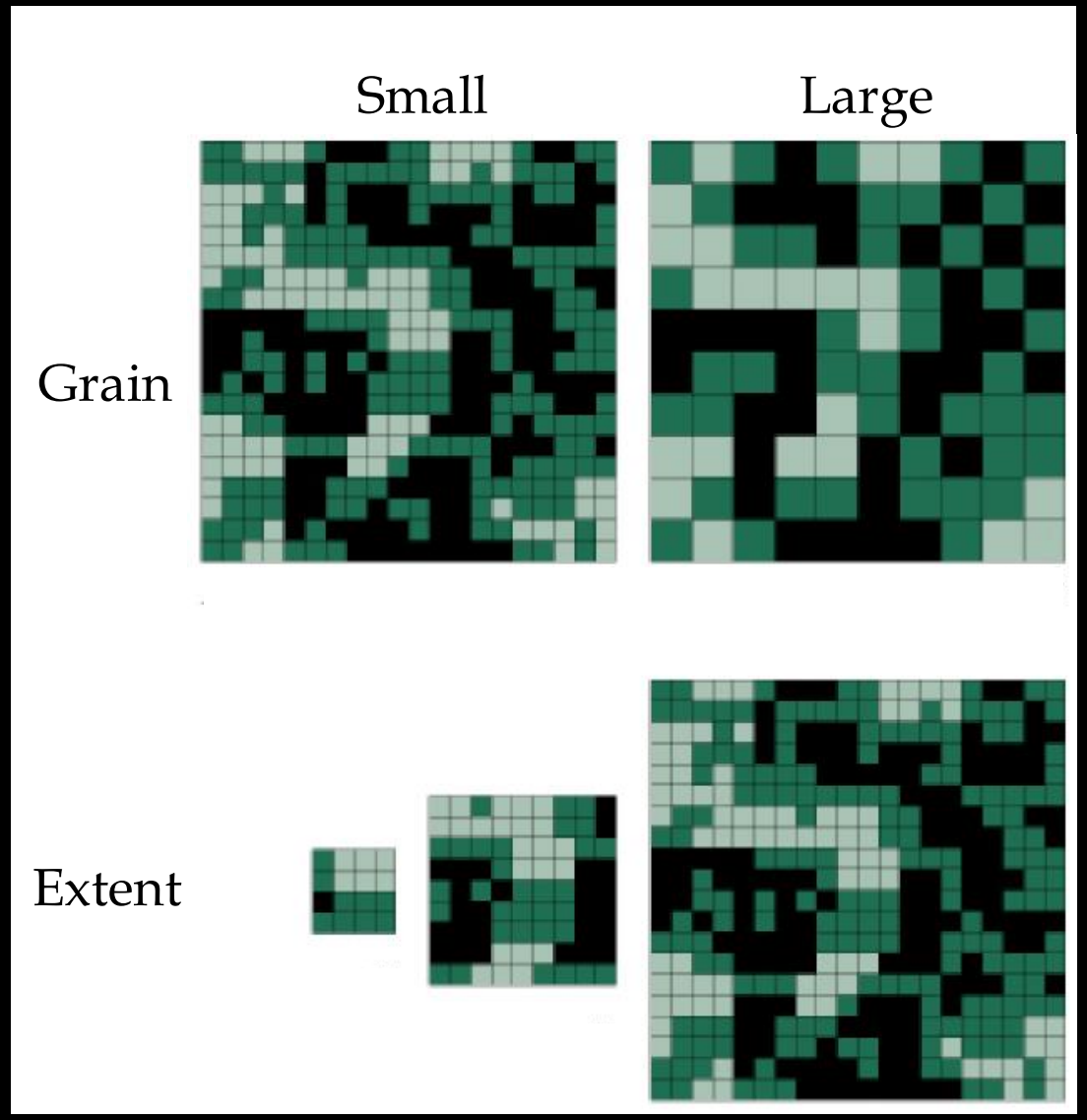
Volker C Radeloff, Eduarda Silveira, University of Wisconsin-Madison

R. Buron, A. Anand, A. M. Pidgeon, B. Zuckerberg, A. Ives, L. Farwell, A. Bar-Massada, N. Coops, and M. Hobi

Introduction



Introduction

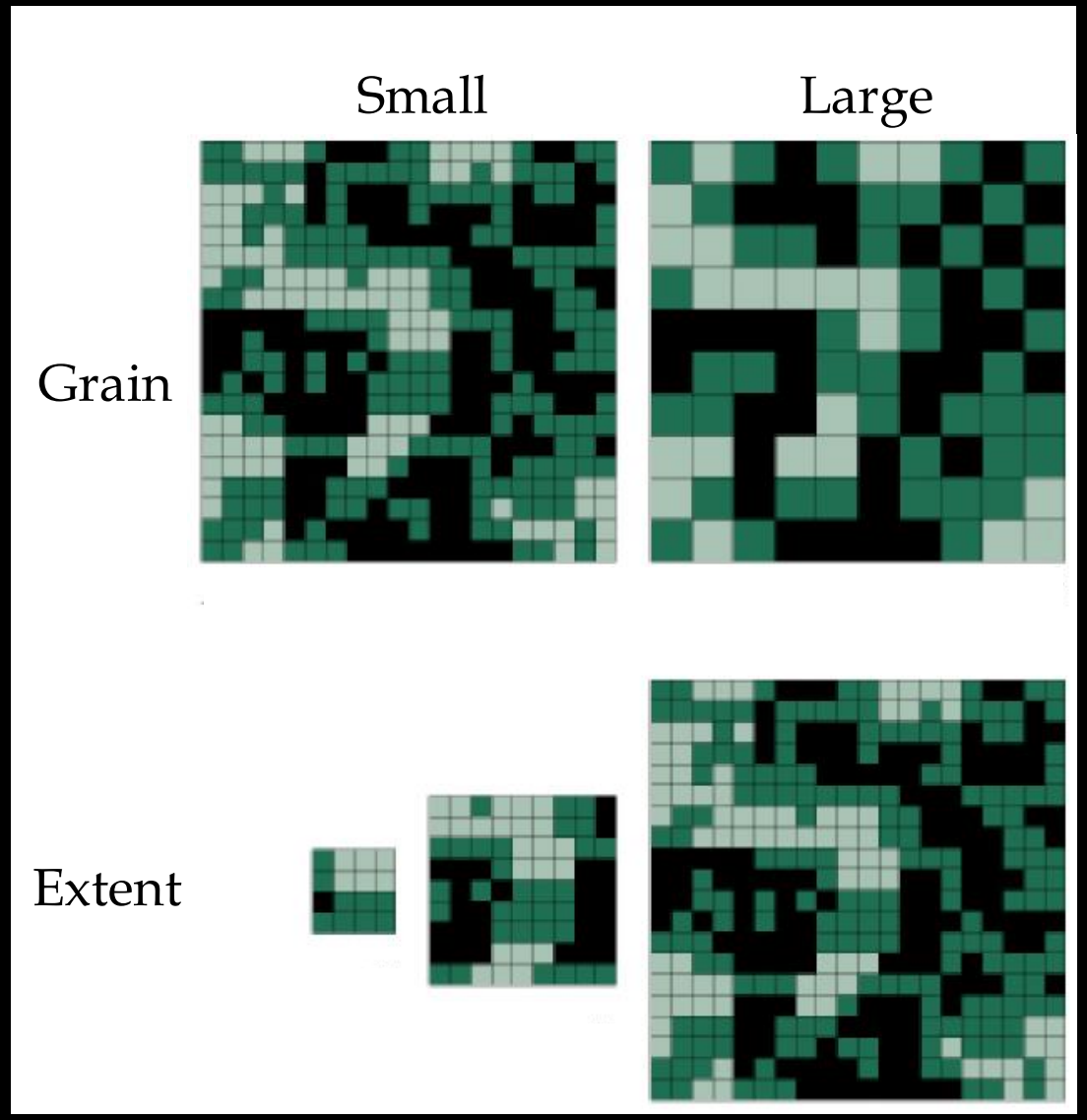


A. Hansen, MSU

Introduction

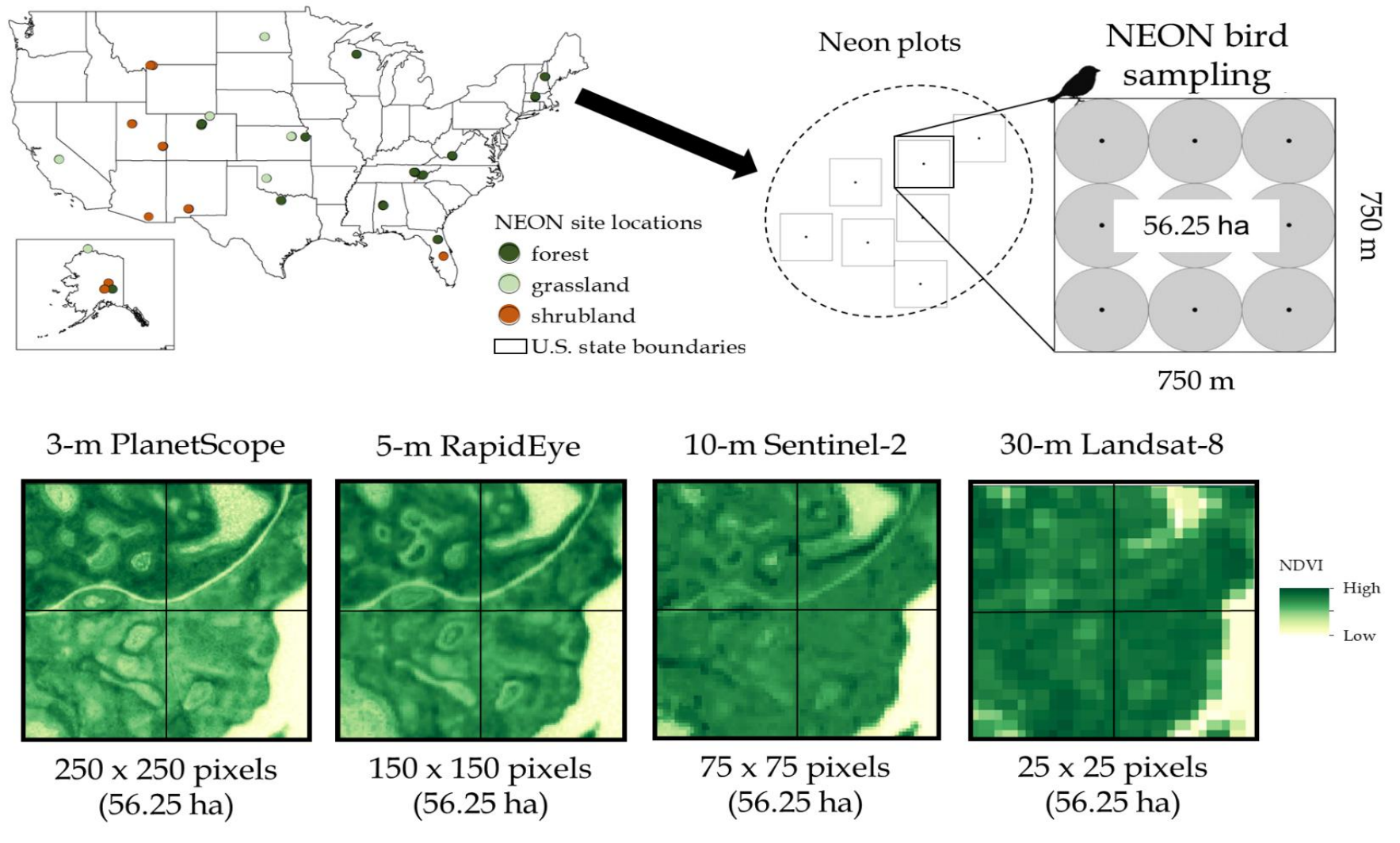
Part I

Part II

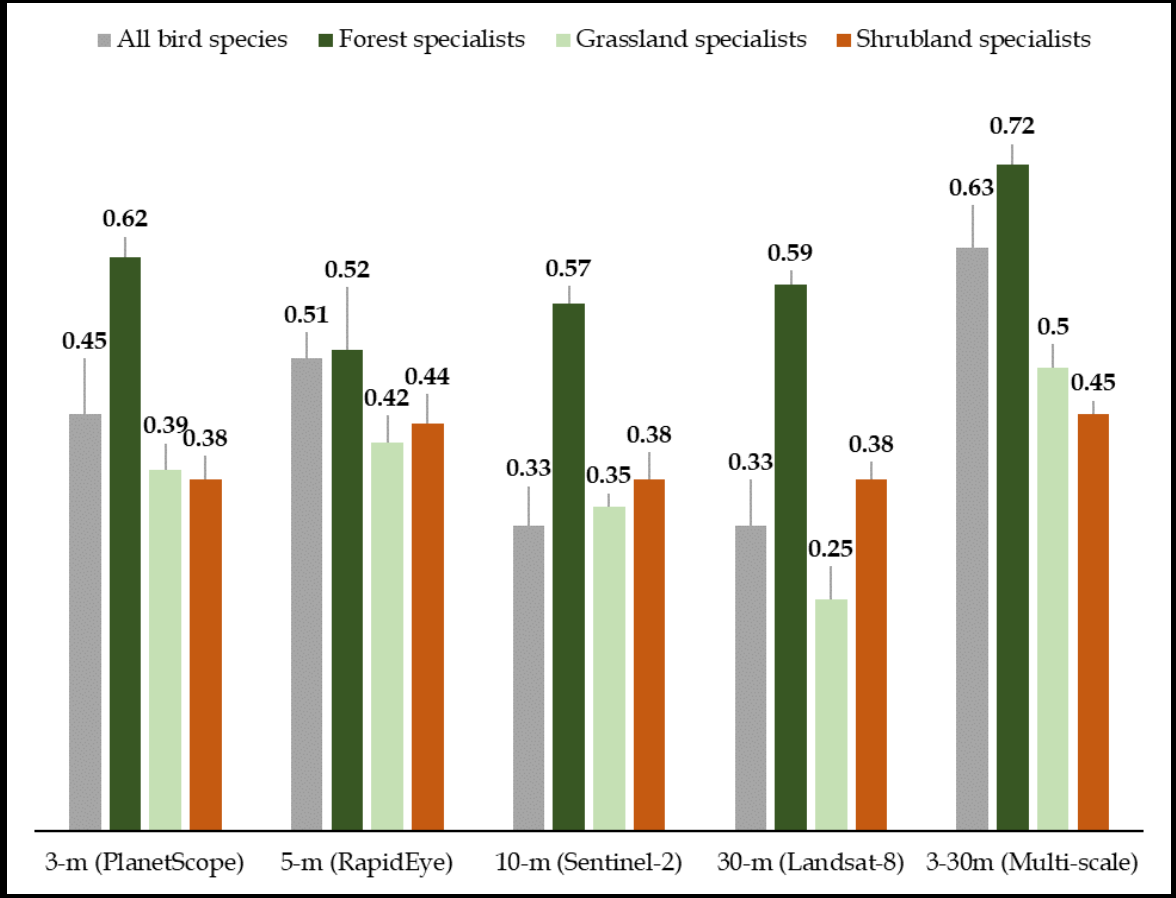


A. Hansen, MSU

Part I: Multi-grain habitat models



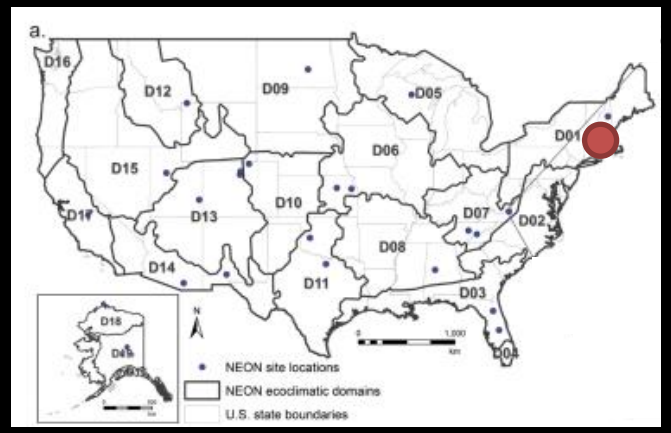
Part I: Multi-grain habitat models



Silveira, E. M. O., A. M. Pidgeon, L. S. Farwell, L. S. Hobi, M. L. Razenkova, B. Zuckerberg, N. C. Coops, and V. C. Radeloff. Multi-grain habitat models that combine satellite sensors with different resolutions explain bird richness patterns best. ***Remote Sensing of Environment***, *revised manuscript in review*.

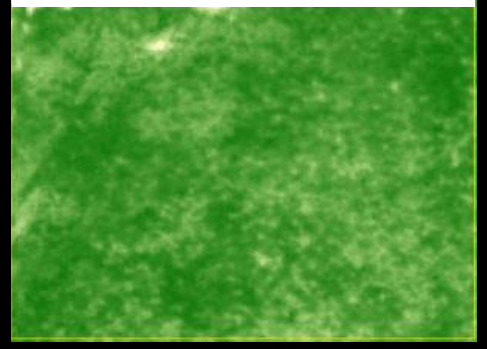
Part I: Multi-grain habitat models

(Int)	L8_MinDHI_HOM	L8_NDVIp90_MEAN	PS_MinDHI_SD	PS_NDVIp90_MEAN	RE_MinDHI_UNIF	adjR^2
-8.325	-8.373	-17.42	108.2	40.5	73.89	0.72

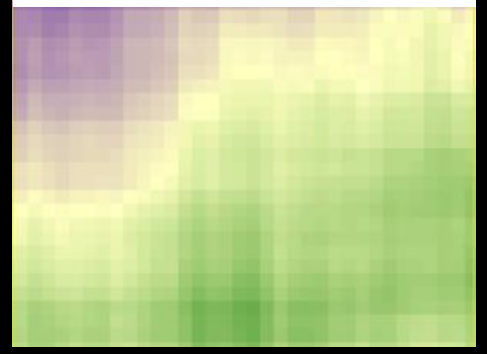


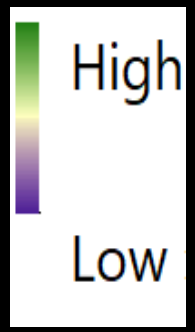
HARV 025: Deciduous forests

PS_NDVIp90_MEAN



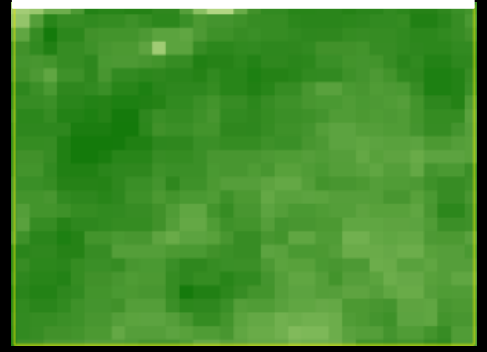
L8_MinDHI_HOM



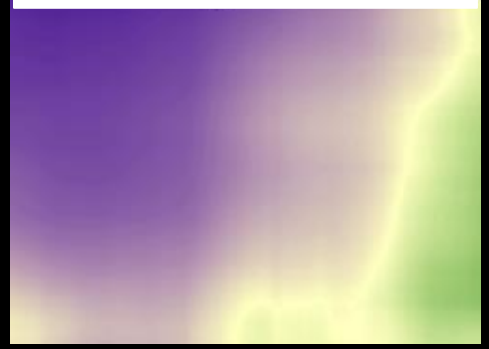


PS_MinDHI_SD

L8_NDVIp90_MEAN



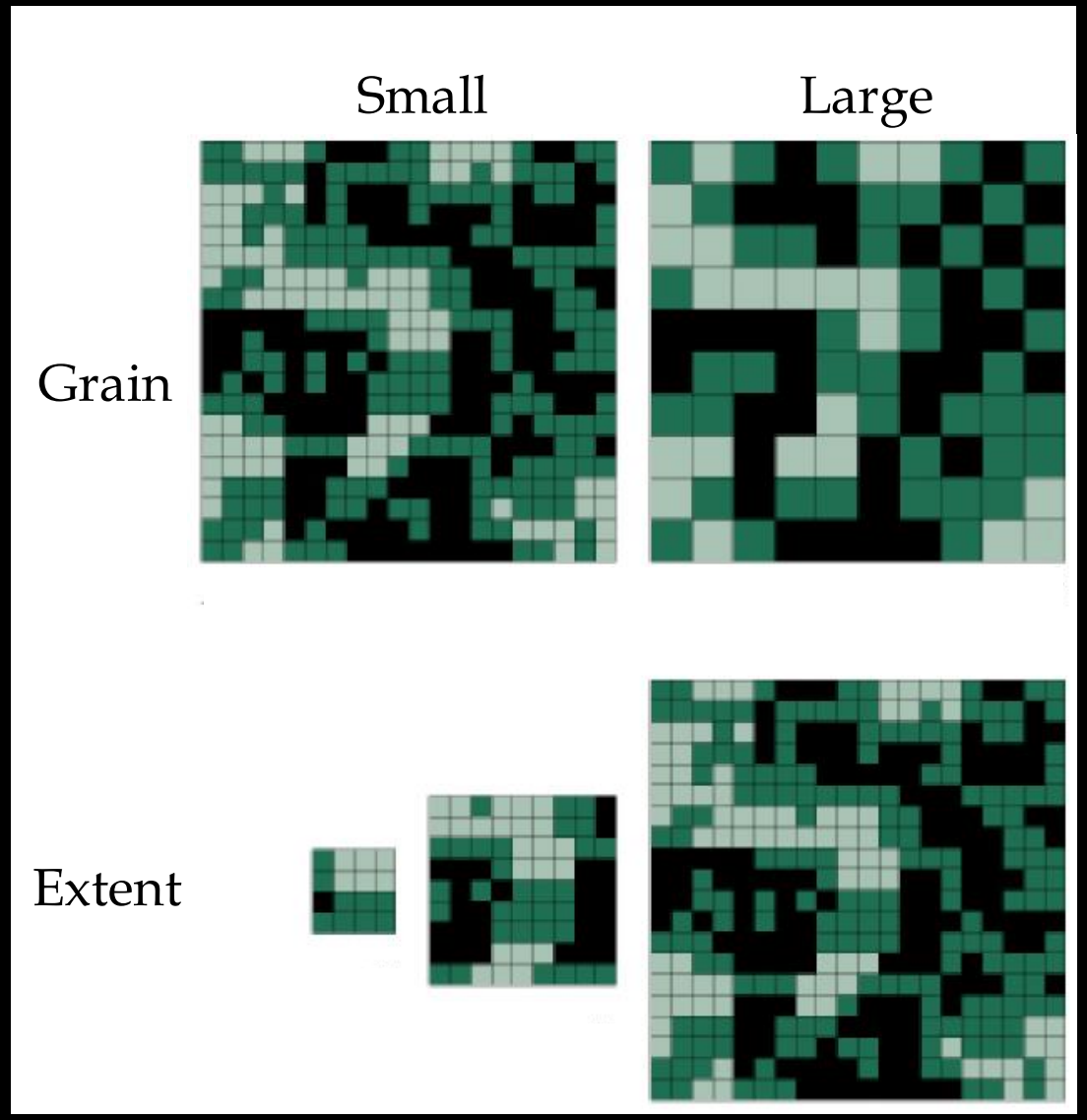
RE_MinDHI_UNIF



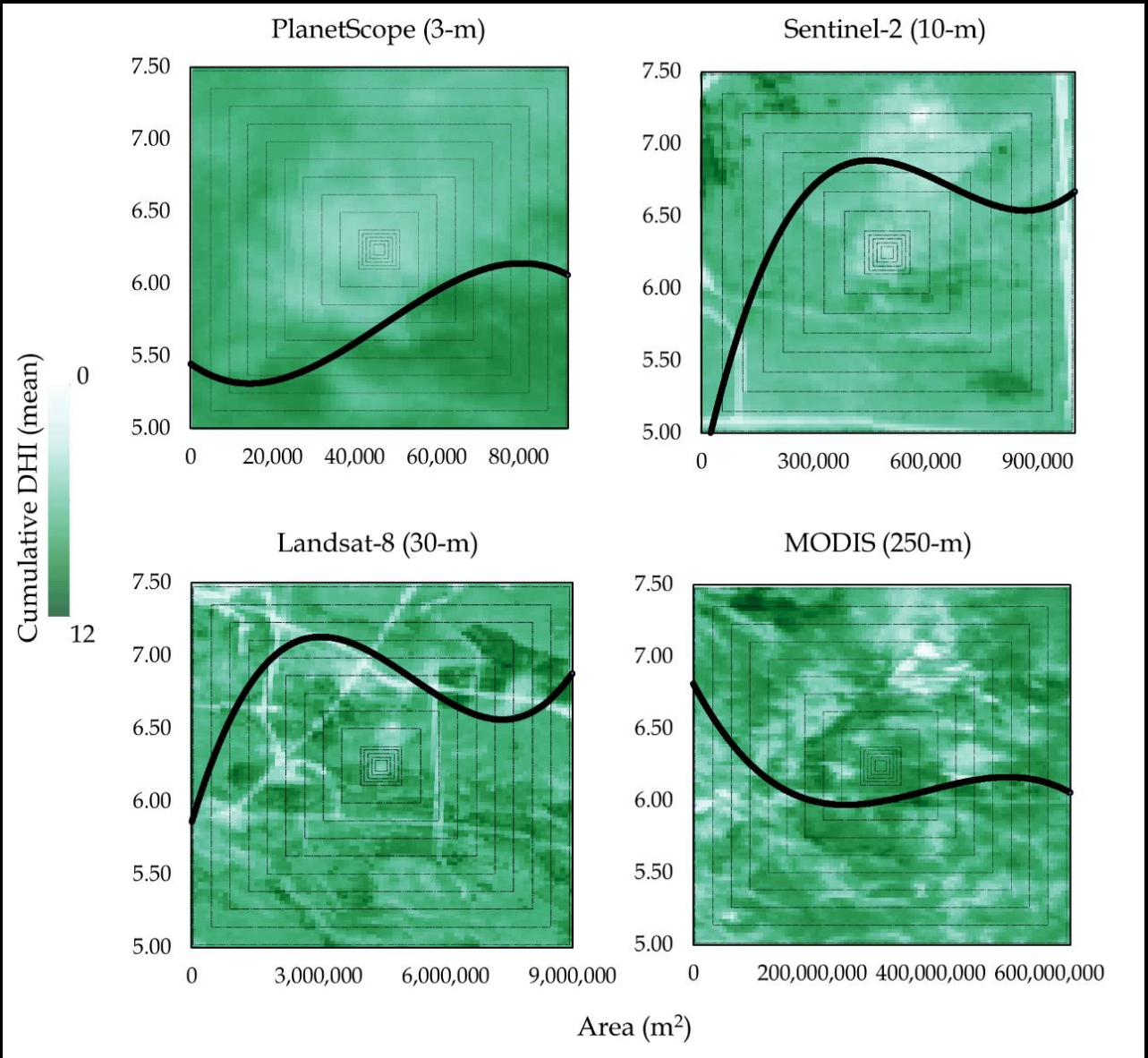
Part I: Multi-grain habitat models

Part I

Part II

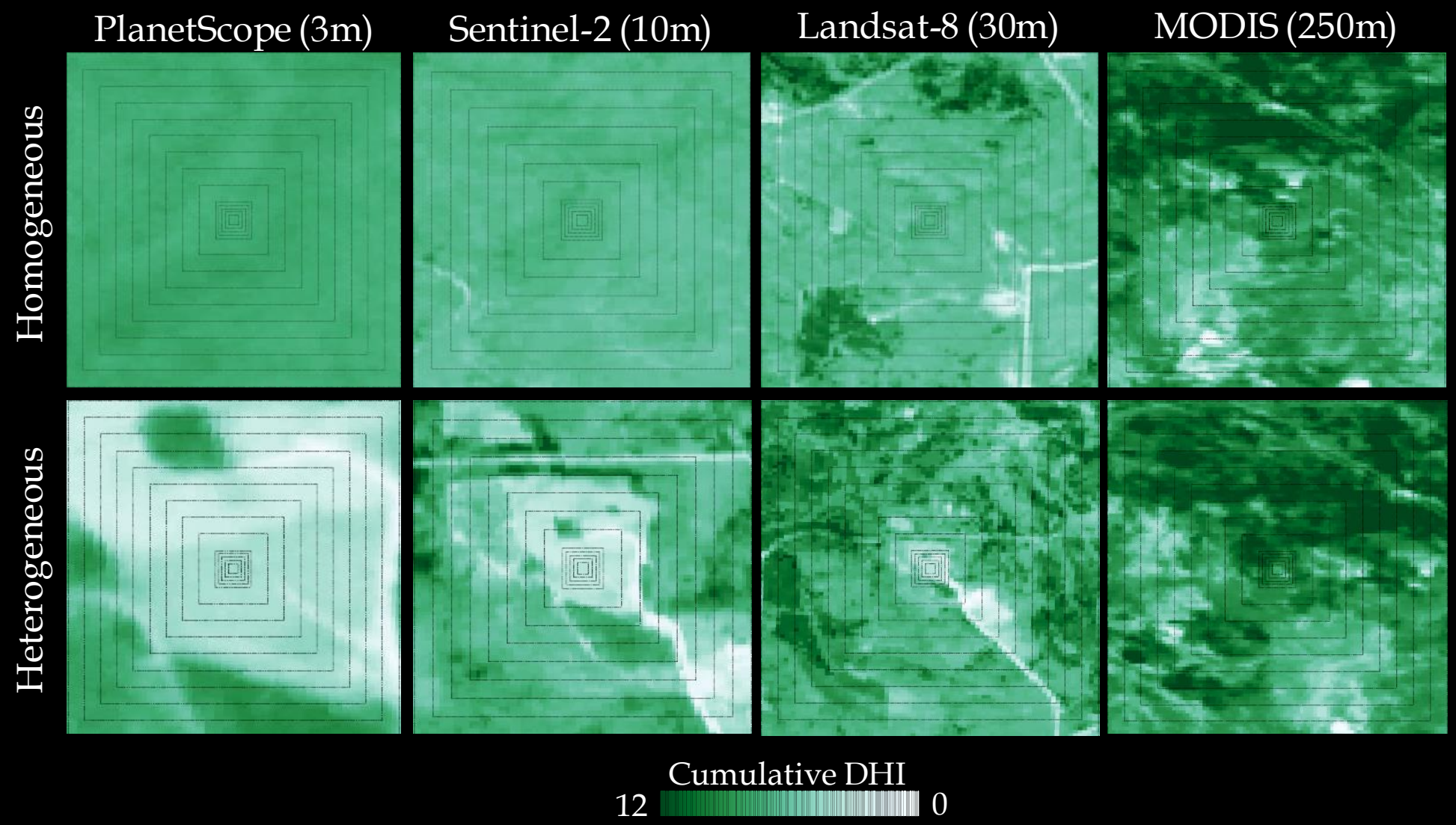


Part II: Multi-extent habitat models with scalograms

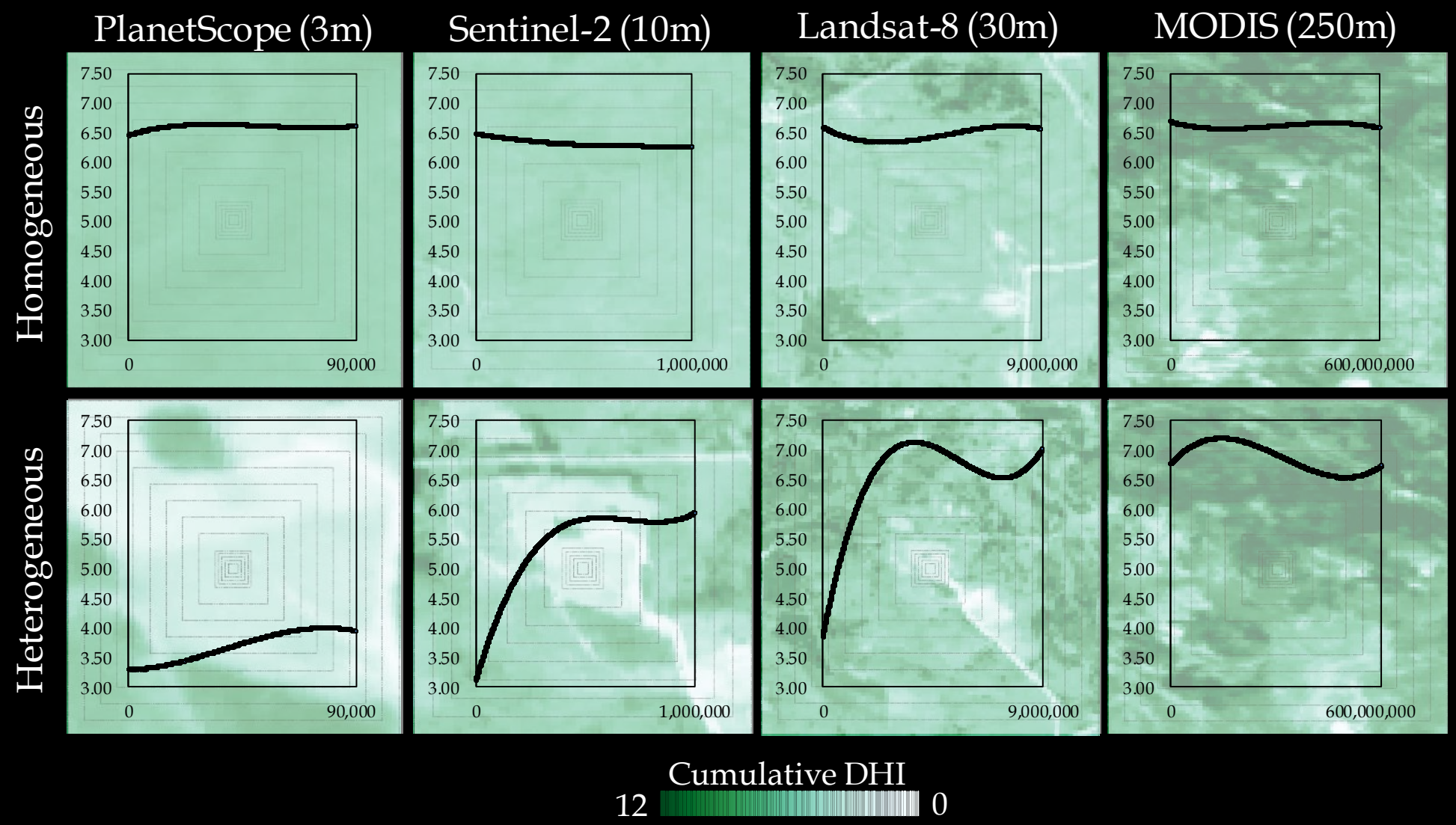


Window Size	Planet-Scope (m²)	Sentinel-2 (m²)	Landsat 8 (m²)	MODIS (m²)
3x3	81	900	8,100	562,500
5x5	225	2,500	22,500	1,562,500
7x7	441	4,900	44,100	3,062,500
9x9	729	8,100	72,900	5,062,500
11x11	1,089	12,100	108,900	7,562,500
21x21	3,969	44,100	396,900	27,562,500
31x31	8,649	91,100	864,900	60,062,500
41x41	15,129	168,100	1,512,900	105,062,500
51x51	23,409	260,100	2,340,900	162,562,500
61x61	33,489	372,100	4,536,900	232,562,500
71x71	45,369	504,100	5,904,900	315,062,500
81x81	59,049	656,100	5,904,900	410,062,500
91x91	74,529	828,100	7,452,900	517,562,500
101x101	91,809	1,020,100	9,180,900	637,562,500

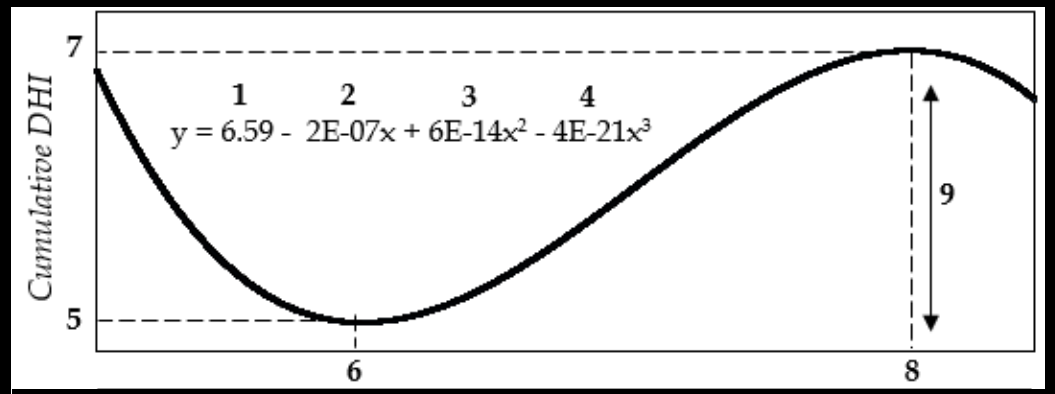
Part II: Multi-extent habitat models with scalograms



Part II: Multi-extent habitat models with scalograms

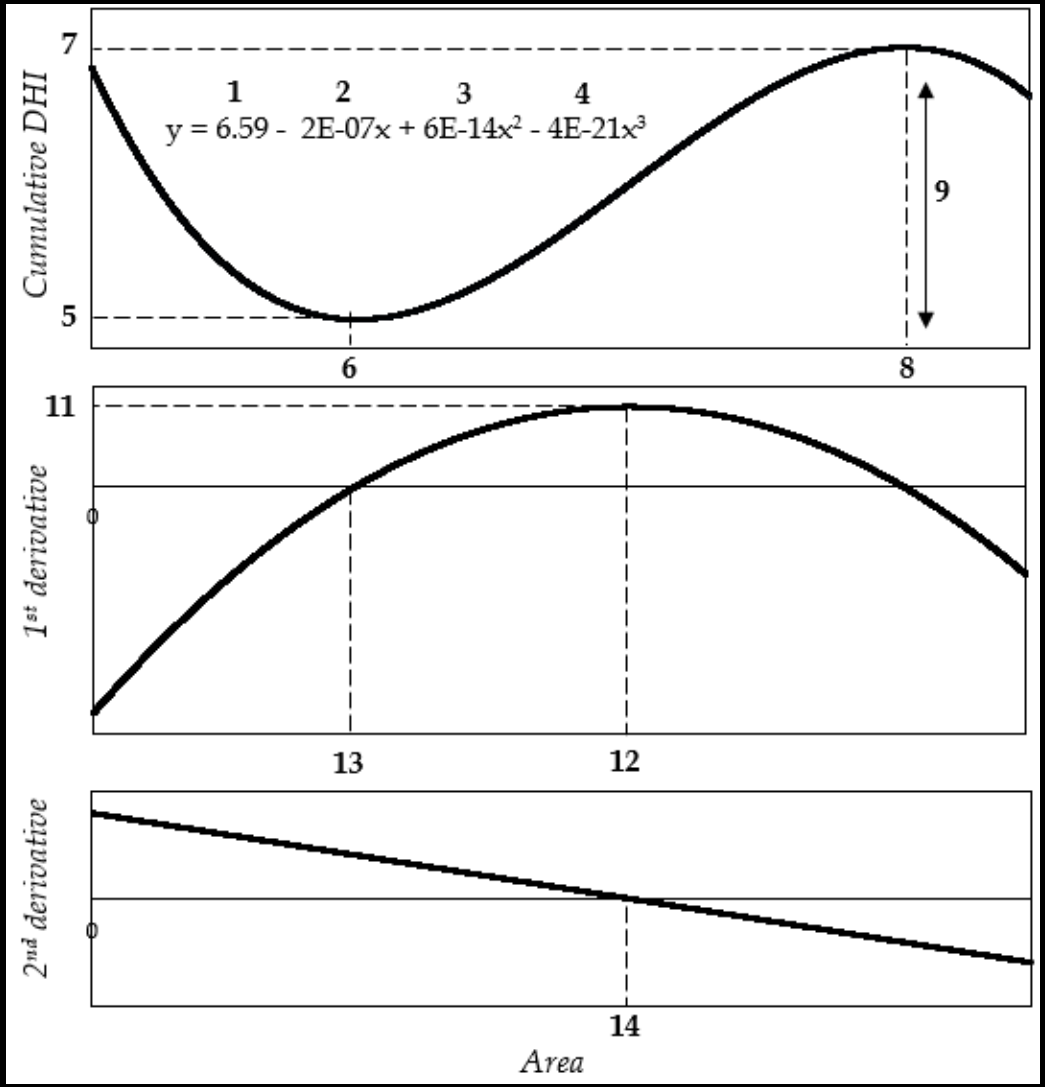


Part II: Multi-extent habitat models with scalograms



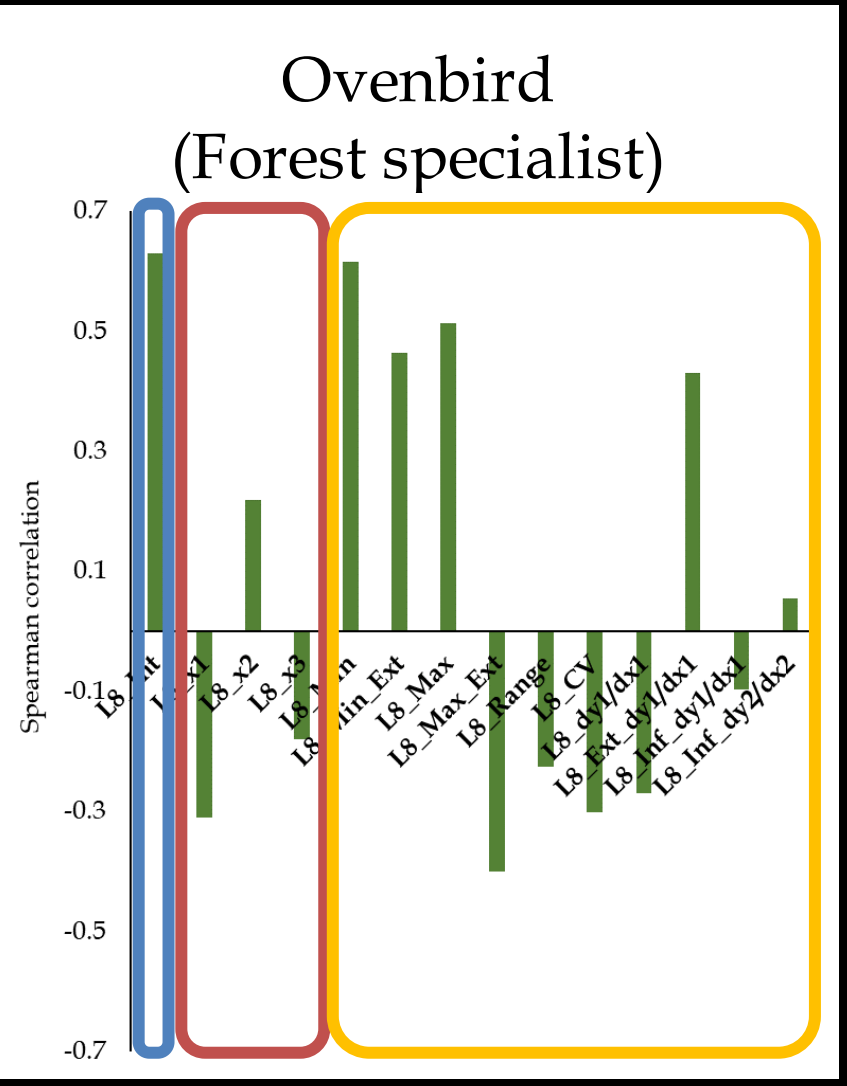
ID	Scalogram measures	Description
1	Int	Intercept. The CumDHI of the focal pixel
2	x	Linear trend of CumDHI with increasing window size
3	x^2	Non-linear effects
4	x^3	Complex non-linear effect

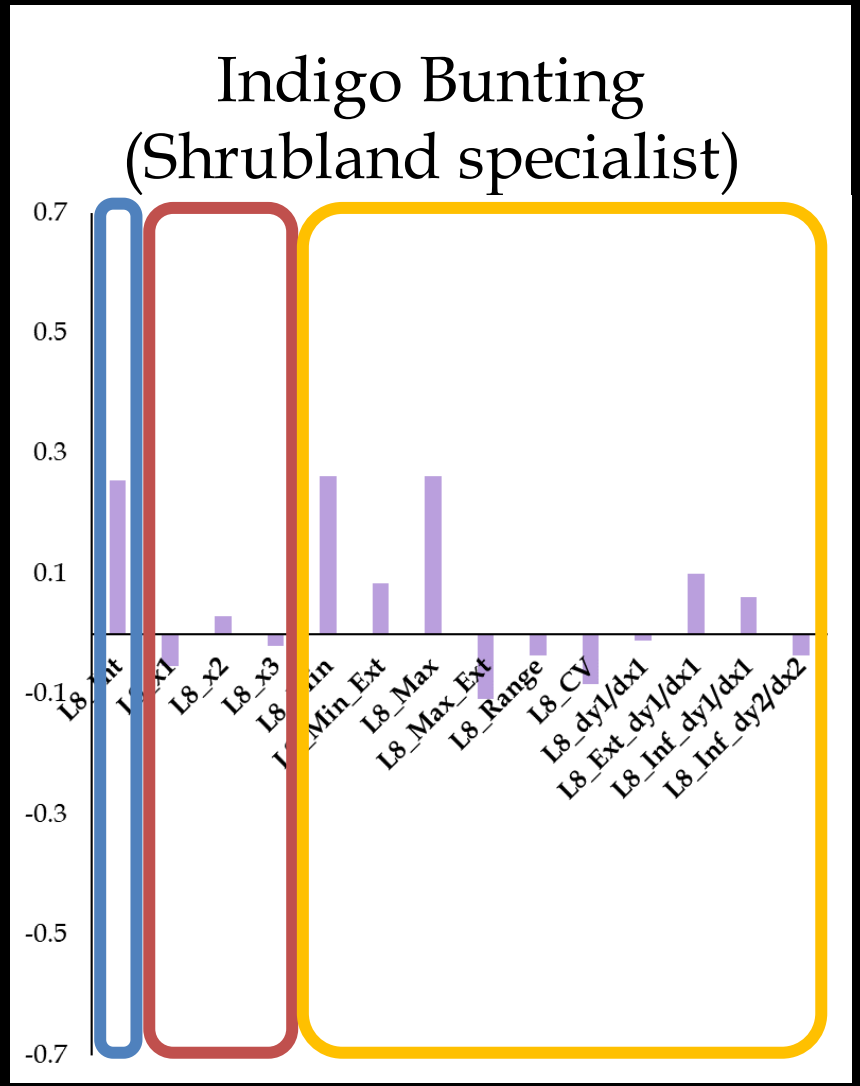
Part II: Multi-extent habitat models with scalograms

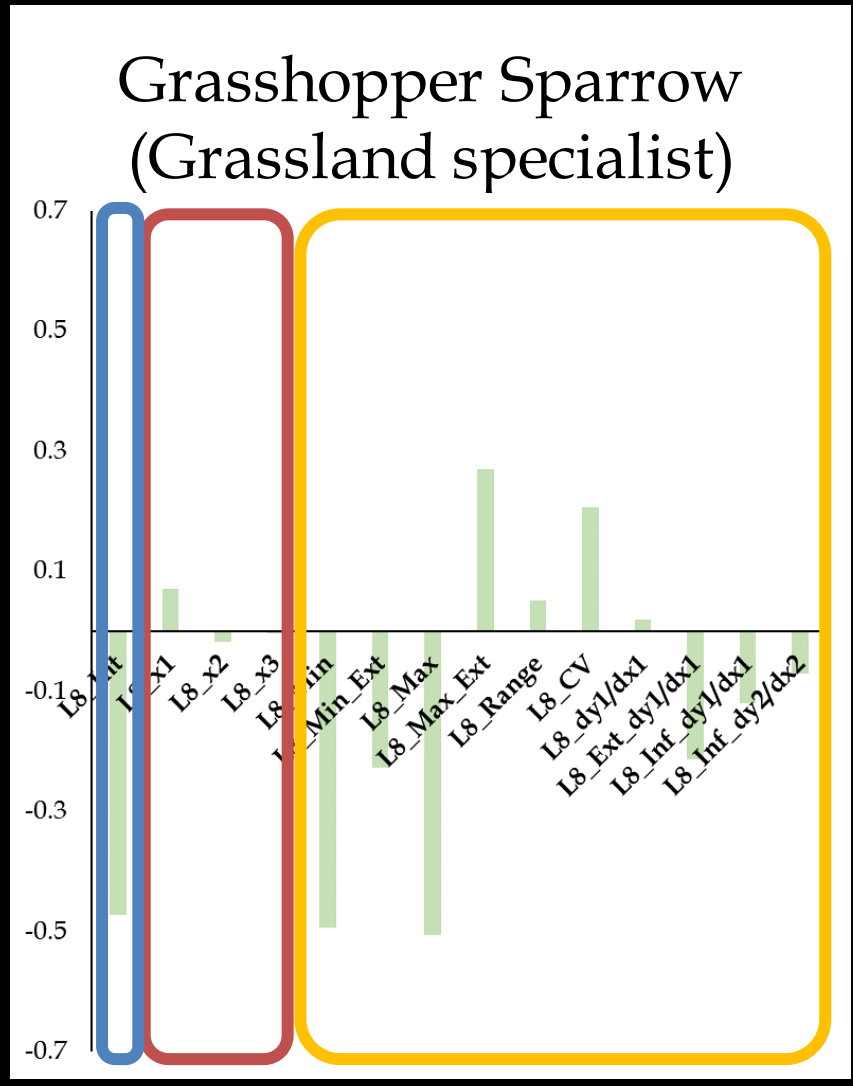


ID	Scalogram measures	Description
1	Int	Intercept. The CumDHI of the focal pixel
2	x	Linear trend of CumDHI with increasing extent
3	x^2	Non-linear effects
4	x^3	Complex non-linear effect
5	Min	Minimum CumDHI among extents
6	Min_Ext	Extent at which CumDHI is minimum
7	Max	Maximum CumDHI among extents
8	Max_Ext	Extent at which CumDHI is maximum
9	Range	Range of CumDHI among extents
10	CV	Coefficient of variation of CumDHI among extents
11	dy1/dx1	1ST derivative. Maximum slope of the scalogram
12	Ext_dy1/dx1	Extent at which scalogram slope is maximum
13	Inf_dy1/dx1	Extent at which the first derivative is zero
14	Inf_dy2/dx2	2nd derivative: inflection point

Part II: Multi-extent habitat models with scalograms







Part II: Multi-extent habitat models with scalograms

Ovenbird Abundance Models

PlanetScope (3-m)

	Int	Inf_dy2/dx2	Int	Ext_dy1/dx1	Min	x1	R^2
1	0.40				0.49		**0.45**
2	0.40	-0.08			0.49		**0.46**
3	0.40		-0.26		0.75		**0.45**
4	0.40	-0.11		-0.08	0.48		**0.47**
5	0.40				0.49	0.04	**0.45**
6	0.40			-0.04	0.49		**0.45**

Sentinel-2 (10-m)

	Int	CV	Max	dy1/dx1	Ext_dy1/dx1	Min	x3	x2	R^2
1	0.40				0.23	0.52			**0.54**
2	0.40			0.12	0.21	0.53			**0.54**
3	0.40				0.14	0.51			**0.52**
4	0.40				0.21	0.51		-0.11	**0.53**
5	0.40				0.20	0.50	0.10		**0.53**
6	0.40	-0.18	0.49		0.17				**0.53**

Landsat-8 (30-m)

	Int	CV	Int	Max	Ext_dy1/dx1	Min	Range	R^2
1	0.40				0.17	0.41		**0.46**
2	0.40		0.49					**0.43**
3	0.40	0.11			0.16	0.48		**0.48**
4	0.40				0.18	0.44	0.08	**0.47**
5	0.40			0.11	0.18	0.31		**0.47**
6	0.40			0.11	0.18	0.31		**0.47**

MODIS (250-m)

	Int	CV	Inf_dy1/dx1	Int	Max	dy1/dx1	Max_Ext	Min	Range	R^2
1	0.40	-0.54		-1.52	1.09	-1.18	-0.22			**0.46**
2	0.40	-0.90		-0.53		-1.31	-0.20	1.96	2.27	**0.47**
3	0.40	-0.90		-1.53	1.08	-1.31	-0.20		0.46	**0.47**
4	0.40	-0.90		-1.53	1.36	-1.31	-0.20	-0.50		**0.47**
5	0.40	-0.90		-1.53	1.36	-1.31	-0.20	-0.50		**0.47**
6	0.40	-0.56	-0.05	-1.62	1.13	-1.24	-0.25			**0.47**

Part II: Multi-extent habitat models with scalograms

Ovenbird Abundance Models

PlanetScope (3-m)

	Int	Inf_dy2/dx2	Int	Ext_dy1/dx1	Min	x1	R^2
1	0.40				0.49		**0.45**
2	0.40	-0.08			0.49		**0.46**
3	0.40		-0.26		0.75		**0.45**
4	0.40	-0.11		-0.08	0.48		**0.47**
5	0.40				0.49	0.04	**0.45**
6	0.40			-0.04	0.49		**0.45**

Sentinel-2 (10-m)

	Int	CV	Max	dy1/dx1	Ext_dy1/dx1	Min	x3	x2	R^2
1	0.40				0.23	0.52			**0.54**
2	0.40			0.12	0.21	0.53			**0.54**
3	0.40				0.14	0.51			**0.52**
4	0.40				0.21	0.51		-0.11	**0.53**
5	0.40				0.20	0.50	0.10		**0.53**
6	0.40	-0.18	0.49		0.17				**0.53**

Landsat-8 (30-m)

	Int	CV	Int	Max	Ext_dy1/dx1	Min	Range	R^2
1	0.40				0.17	0.41		**0.46**
2	0.40		0.49					**0.43**
3	0.40	0.11			0.16	0.48		**0.48**
4	0.40				0.18	0.44	0.08	**0.47**
5	0.40			0.11	0.18	0.31		**0.47**
6	0.40			0.11	0.18	0.31		**0.47**

MODIS (250-m)

	Int	CV	Inf_dy1/dx1	Int	Max	dy1/dx1	Max_Ext	Min	Range	R^2
1	0.40	-0.54		-1.52	1.09	-1.18	-0.22			**0.46**
2	0.40	-0.90		-0.53		-1.31	-0.20	1.96	2.27	**0.47**
3	0.40	-0.90		-1.53	1.08	-1.31	-0.20		0.46	**0.47**
4	0.40	-0.90		-1.53	1.36	-1.31	-0.20	-0.50		**0.47**
5	0.40	-0.90		-1.53	1.36	-1.31	-0.20	-0.50		**0.47**
6	0.40	-0.56	-0.05	-1.62	1.13	-1.24	-0.25			**0.47**

Part II: Multi-extent habitat models with scalograms

Ovenbird Abundance Models

	Int	L8 Ext_dy21/dx1	MOD CV	MOD Max	MOD dy1/dx1	PS Inf_dy2/dx2	S2 Ext_dy1/dx1	S2 Min	R^2
1	0.40	0.13	-0.20	0.18			0.14	0.25	**0.68**
2	0.40	0.13		0.19	-0.22		0.15	0.22	**0.67**
3	0.40		-0.14	0.16			0.16	0.37	**0.66**
4	0.40	0.14	-0.21	0.18		--0.07	0.13	0.24	**0.69**
5	0.40	0.23	-0.17	0.27	-0.23		0.16		**0.67**
6	0.40			0.16	-0.14		0.16	0.35	**0.65**

Part II: Multi-extent habitat models with scalograms

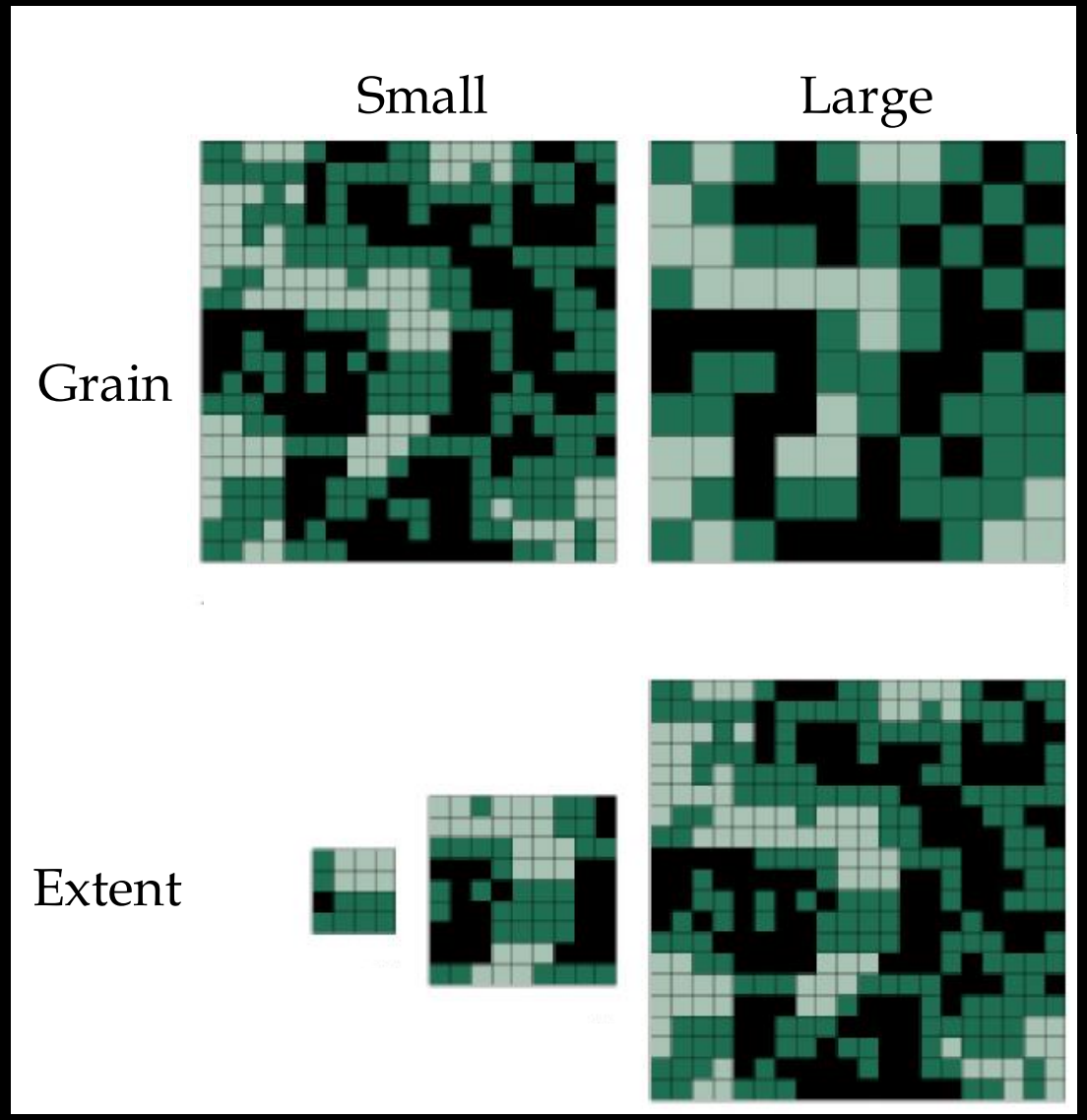
Ovenbird Abundance Models

	Int	L8 Ext_dy21/dx1	MOD CV	MOD Max	MOD dy1/dx1	PS Inf_dy2/dx2	S2 Ext_dy1/dx1	S2 Min	R^2
1	0.40	0.13	-0.20	0.18			0.14	0.25	**0.68**
2	0.40	0.13		0.19	-0.22		0.15	0.22	**0.67**
3	0.40		-0.14	0.16			0.16	0.37	**0.66**
4	0.40	0.14	-0.21	0.18		--0.07	0.13	0.24	**0.69**
5	0.40	0.23	-0.17	0.27	-0.23		0.16		**0.67**
6	0.40			0.16	-0.14		0.16	0.35	**0.65**

Conclusions

Part I

Part II



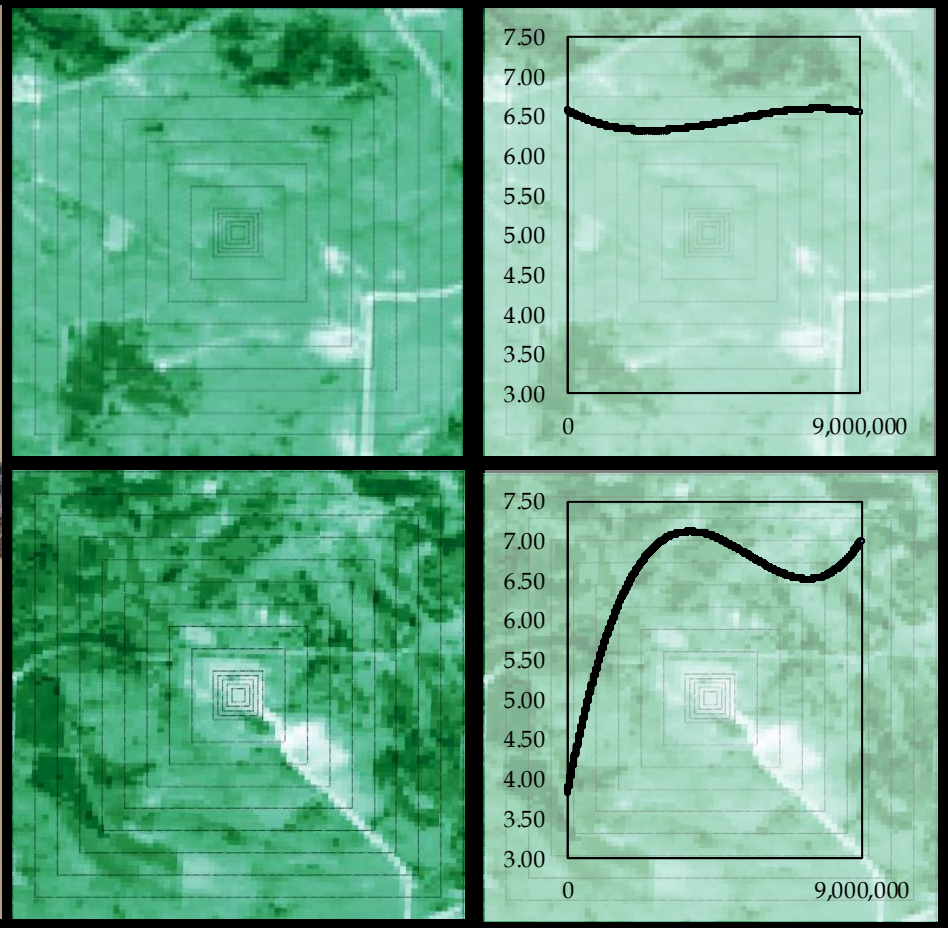
Conclusions

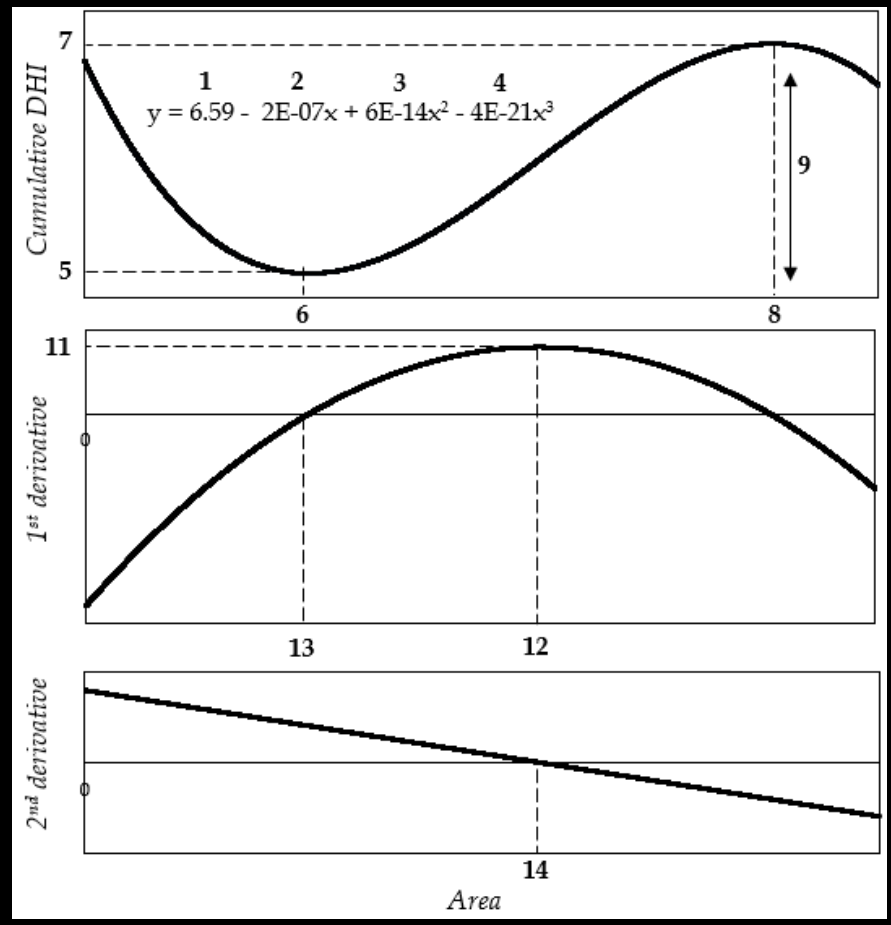
Habitat selection in birds is:

- Hierarchical
- Multi-scale
- Variable among species

Our habitat models should be too

THANK YOU!!!





radeloff@wisc.edu http://silvis.forest.wisc.edu