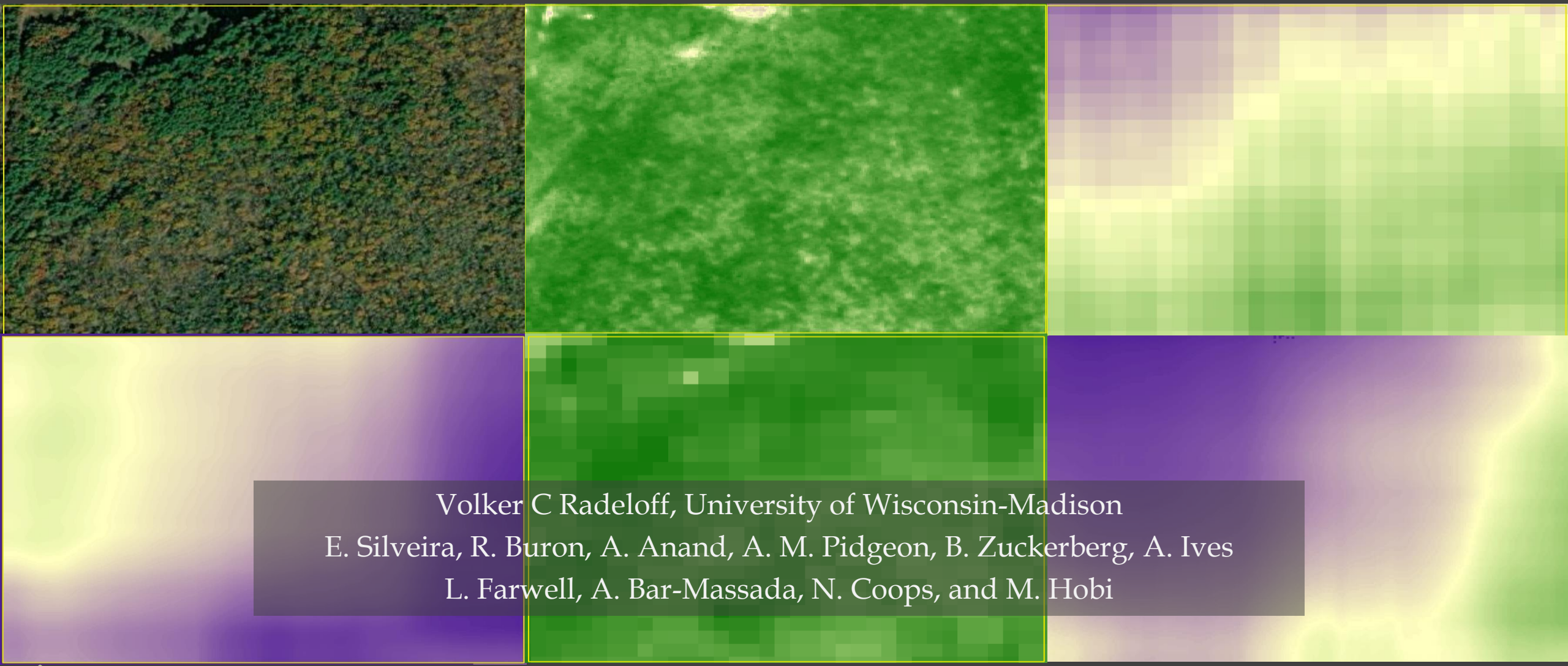
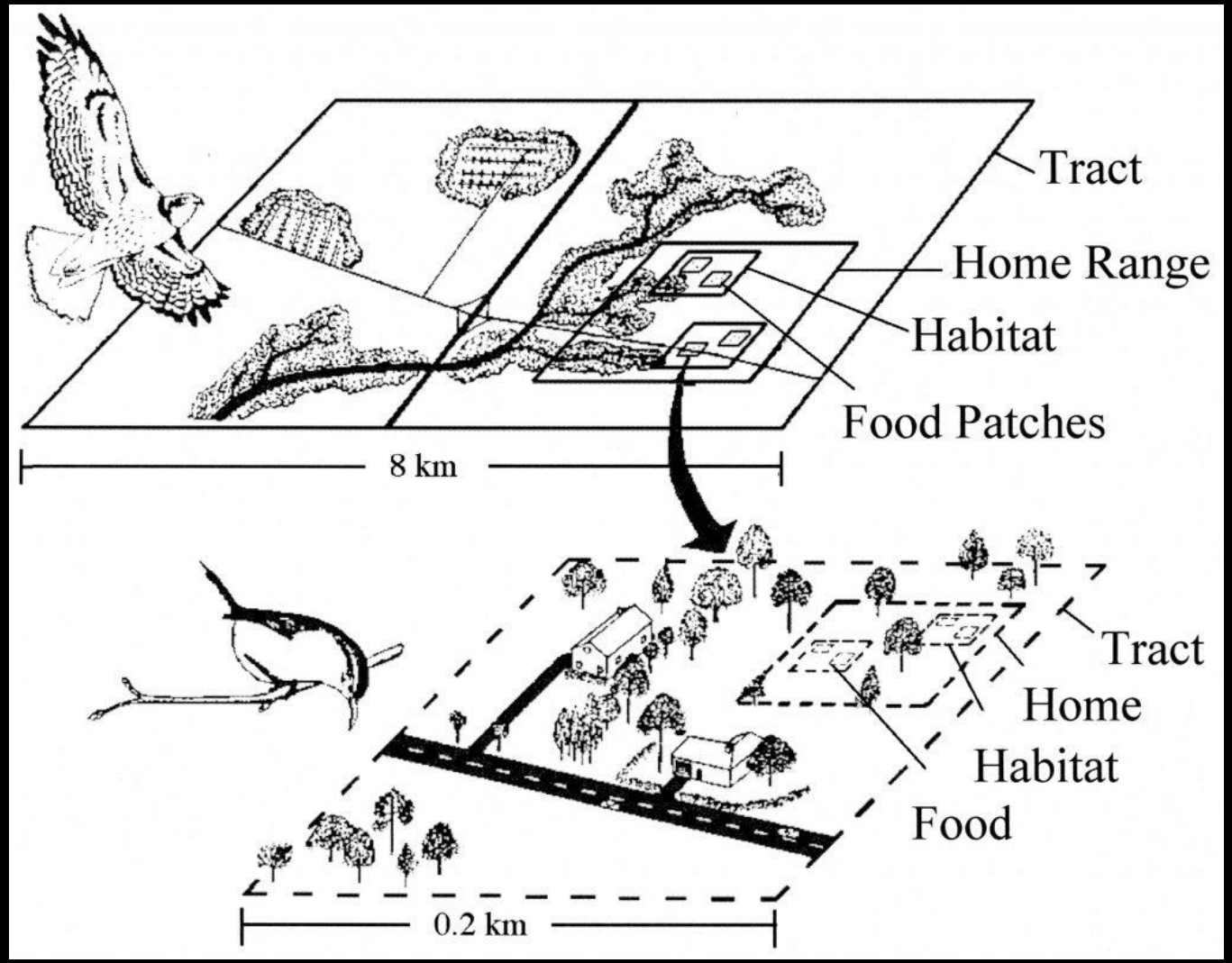
Multiple spatial scales, long-term trends, and synchrony of the dynamic habitat indices and bird populations

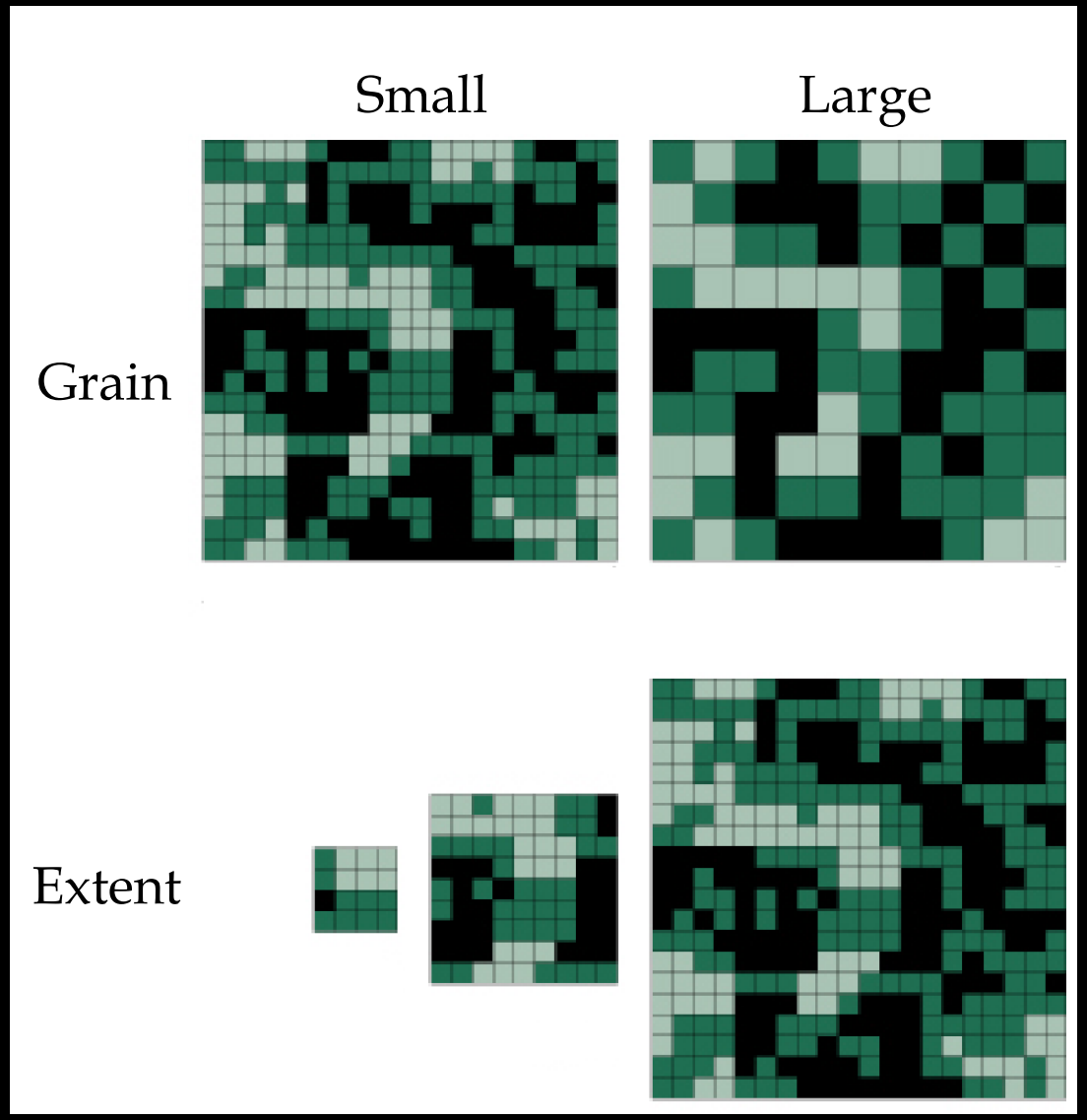


Volker C Radeloff, University of Wisconsin-Madison
E. Silveira, R. Buron, A. Anand, A. M. Pidgeon, B. Zuckerberg, A. Ives
L. Farwell, A. Bar-Massada, N. Coops, and M. Hobi

Introduction



Introduction

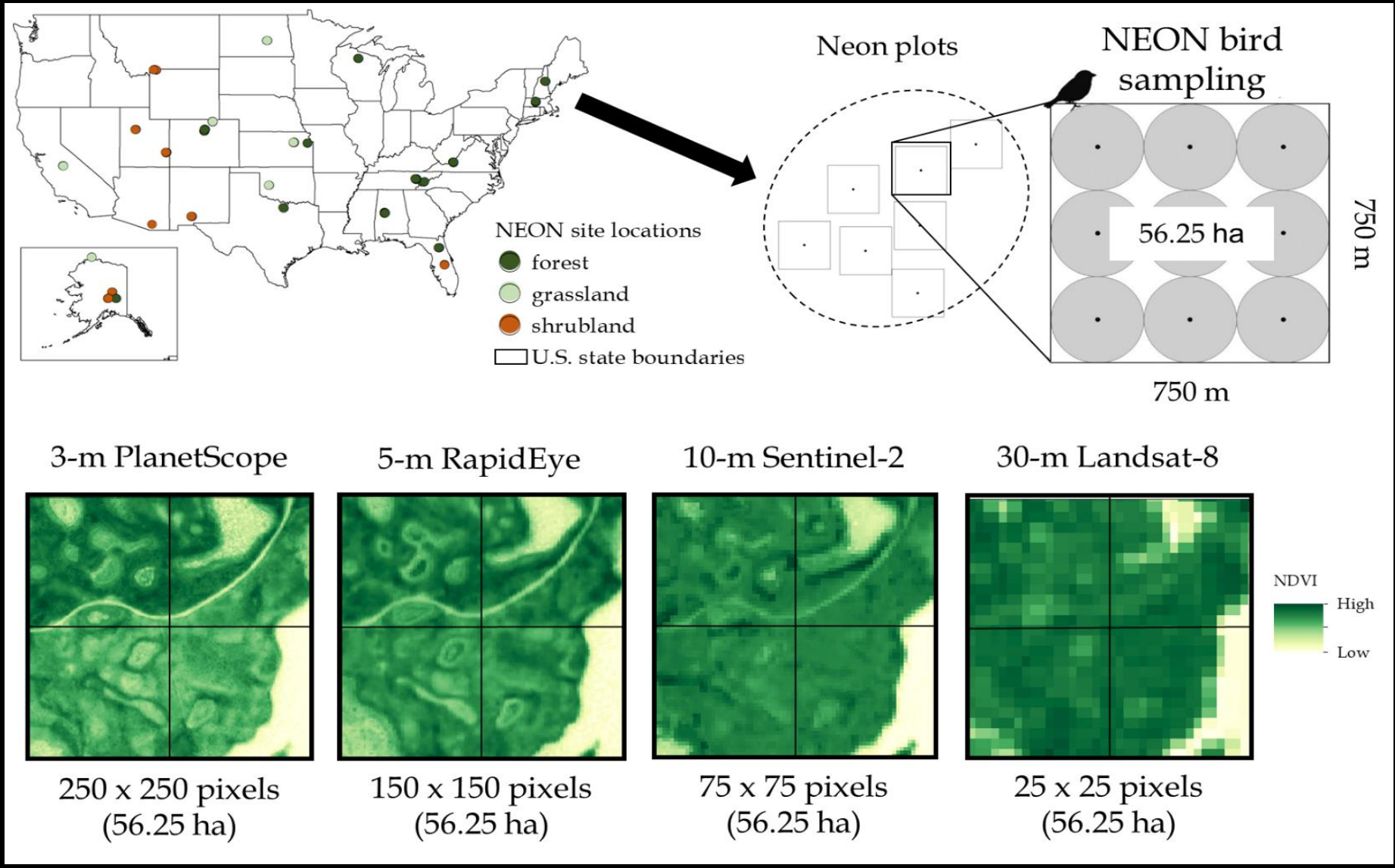


A. Hansen, MSU

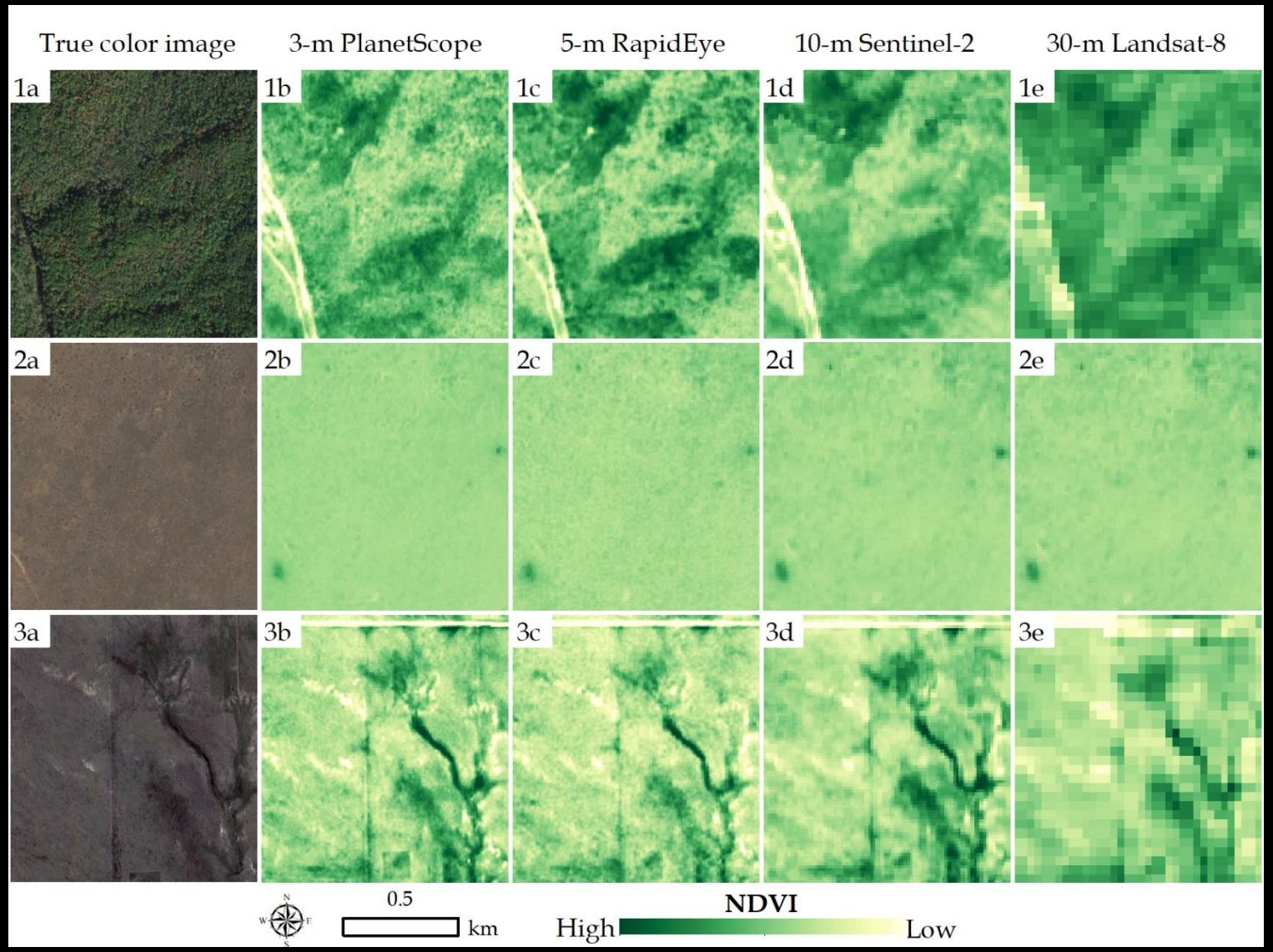
Outline

- Part I: Multi-grain habitat models
  - Can high-res imagery predict bird richness better than S2/L8?
  - Is there one optimal grain, or do multiple grains perform best?
  - Is the same grain best for different bird guilds?
- Part II: Scalograms
  - Can we synthesize habitat patterns from a range of extents?
- Part III: Conclusions

Methods


Neon plots
NEON bird sampling
NEON site locations
forest
grassland
shrubland
U.S. state boundaries
56.25 ha
750 m
750 m
3-m PlanetScope
5-m RapidEye
10-m Sentinel-2
30-m Landsat-8
NDVI
High
Low
250 x 250 pixels (56.25 ha)
150 x 150 pixels (56.25 ha)
75 x 75 pixels (56.25 ha)
25 x 25 pixels (56.25 ha)

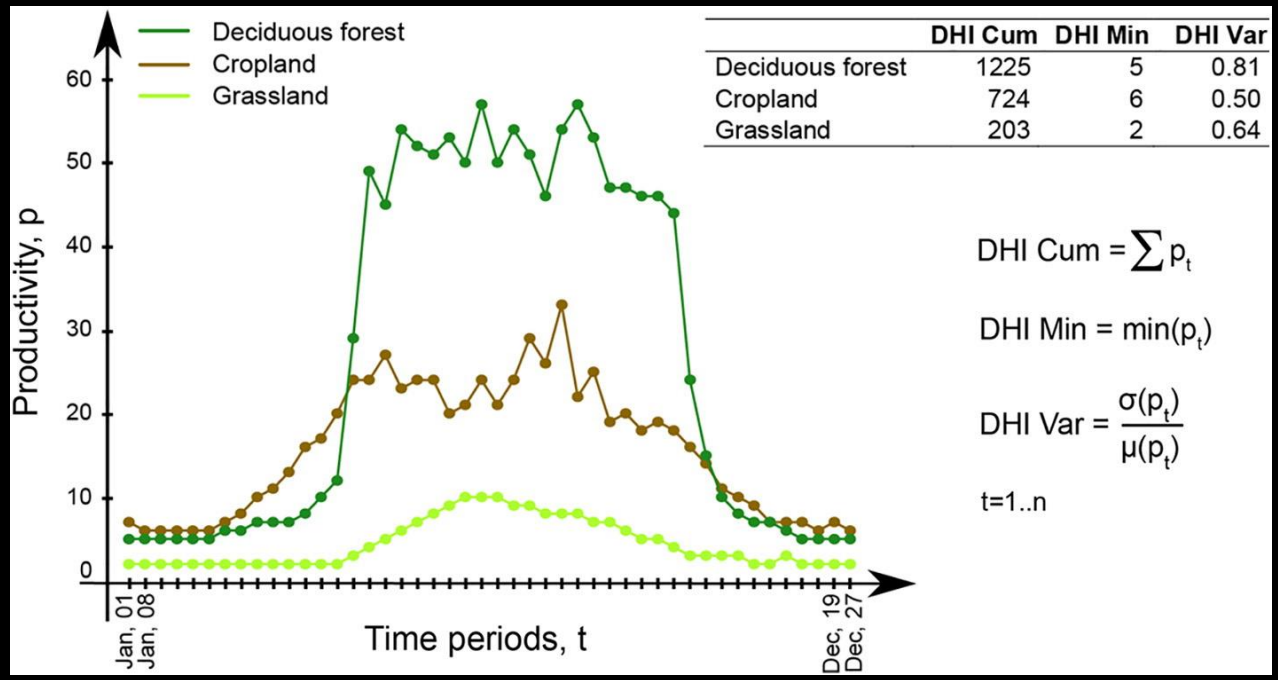
Results


True color image
3-m PlanetScope
5-m RapidEye
10-m Sentinel-2
30-m Landsat-8
1a
1b
1c
1d
1e
2a
2b
2c
2d
2e
3a
3b
3c
3d
3e
0.5
km
NDVI
High
Low

Methods

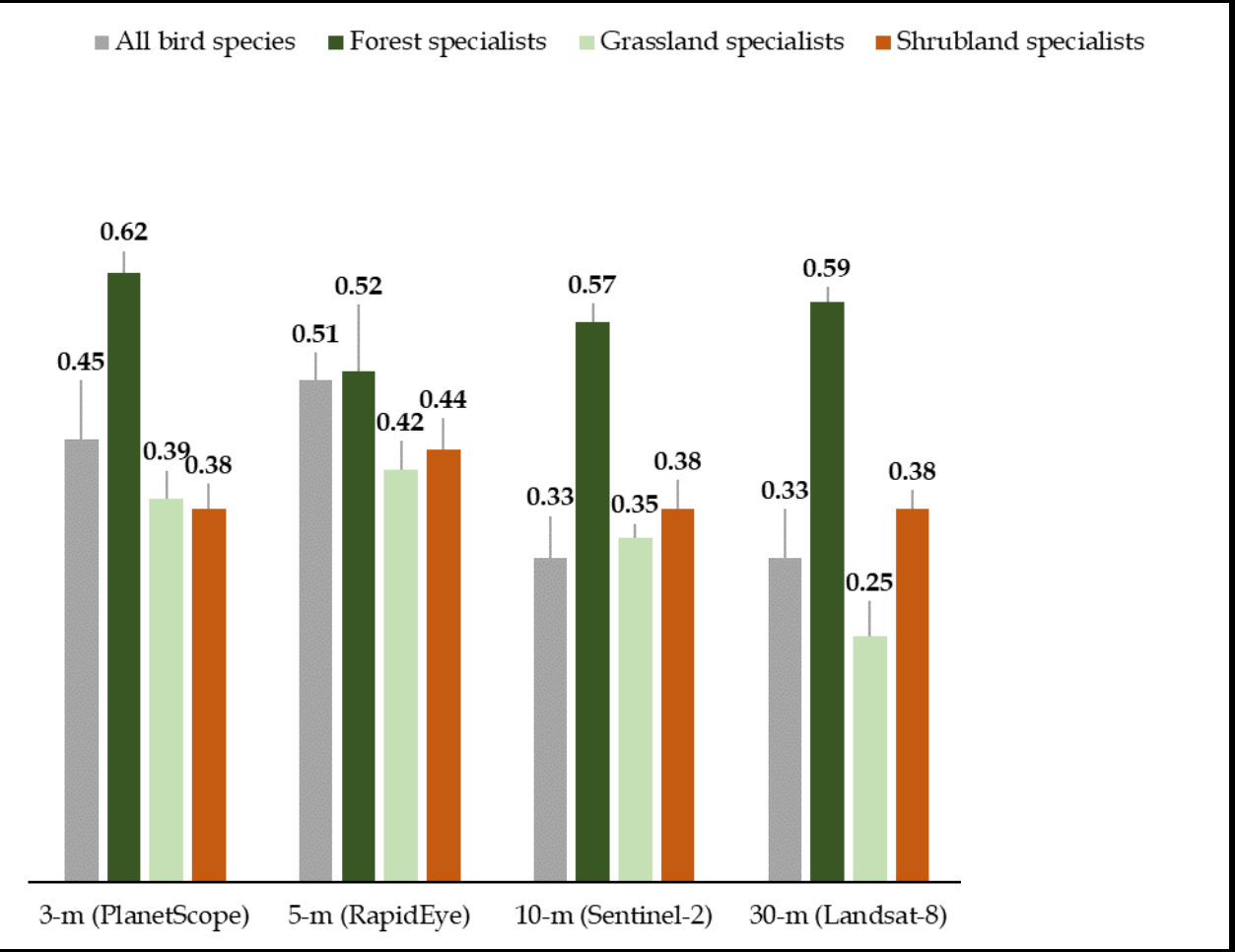
- Median monthly NDVI values from 2016-’20

- Dynamic Habitat Indices (DHIs)
  - Cumulative (sum)
  - Minimum (min)
  - Variation (CV)
- NDVI 90th percentile
- NDVI median

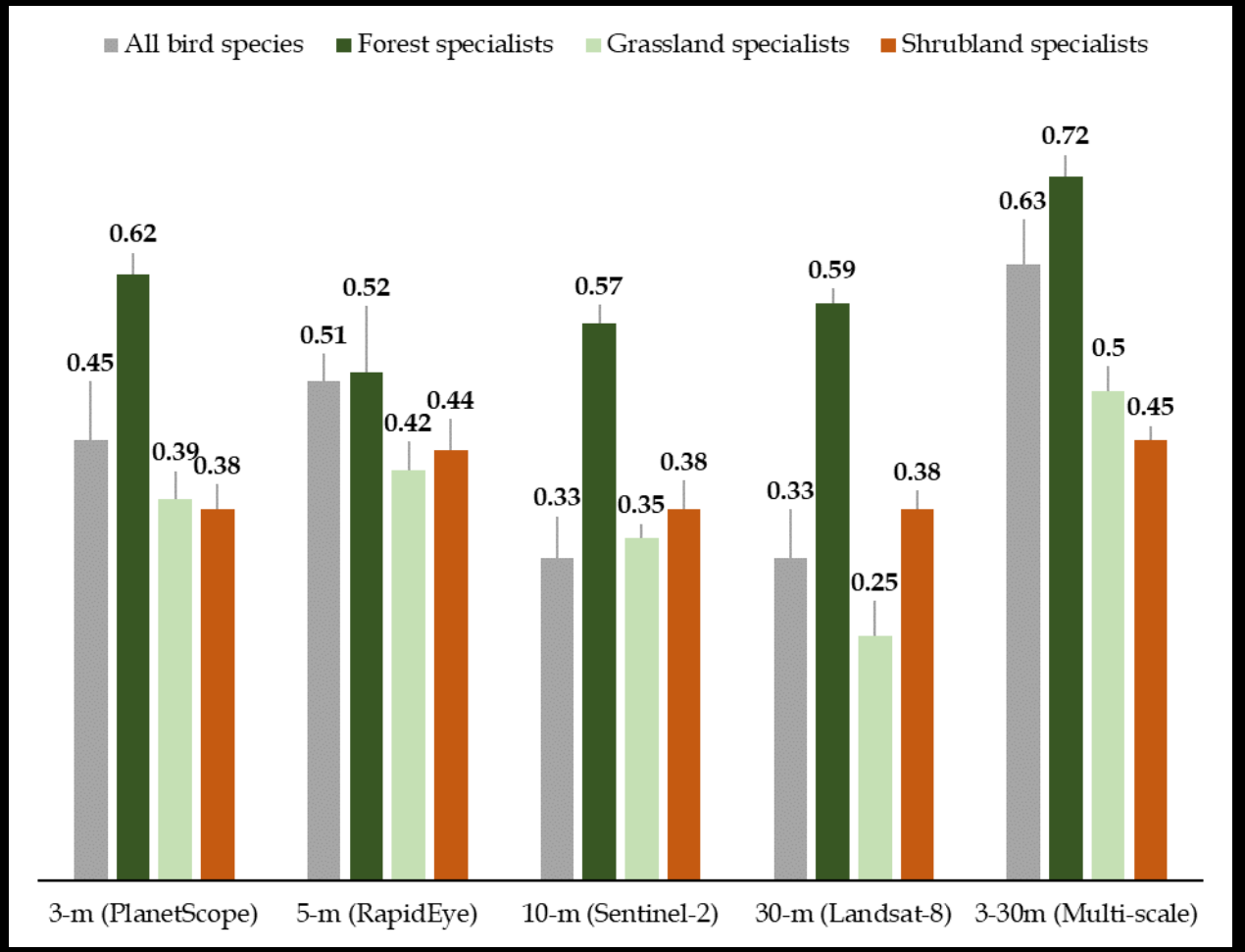


	DHI Cum	DHI Min	DHI Var
Deciduous forest	1225	5	0.81
Cropland	724	6	0.50
Grassland	203	2	0.64

Results


All bird species
Forest specialists
Grassland specialists
Shrubland specialists
0.45
0.62
0.39
0.38
0.51
0.52
0.42
0.44
0.33
0.57
0.35
0.38
0.33
0.59
0.25
0.38
3-m (PlanetScope)
5-m (RapidEye)
10-m (Sentinel-2)
30-m (Landsat-8)

Results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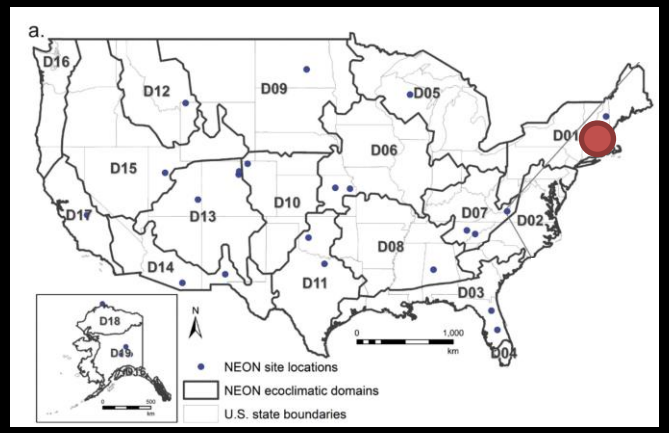
0.44
0.33
0.57
0.35
0.38
0.33
0.59
0.25
0.38
0.63
0.72
0.5
0.45
3-m (PlanetScope)
5-m (RapidEye)
10-m (Sentinel-2)
30-m (Landsat-8)
3-30m (Multi-scale)

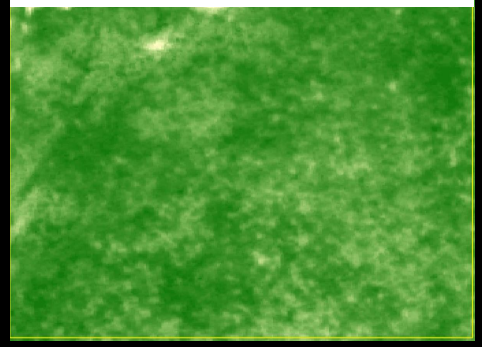
Results

(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

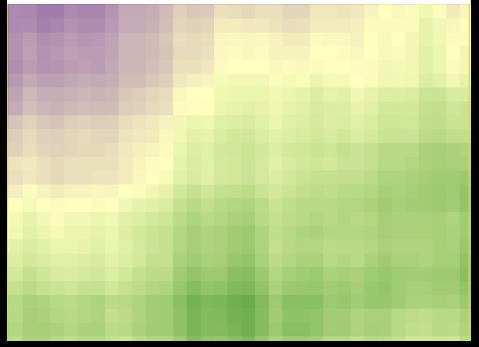


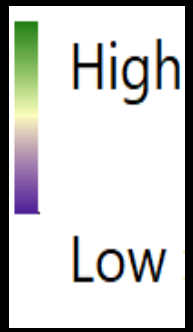
HARV 025: Deciduous forests

PS_NDVIp90_MEAN



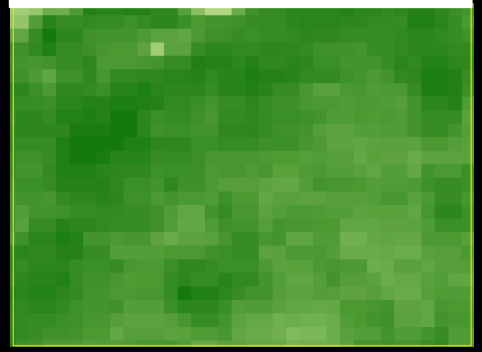
L8_MinDHI_HOM



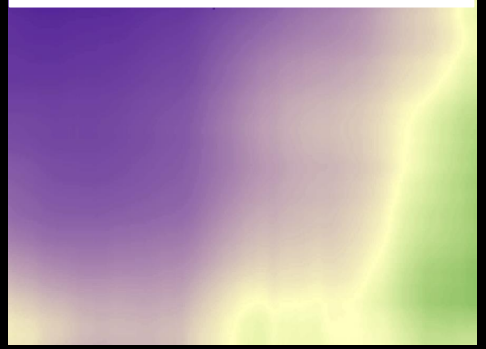


PS_MinDHI_SD

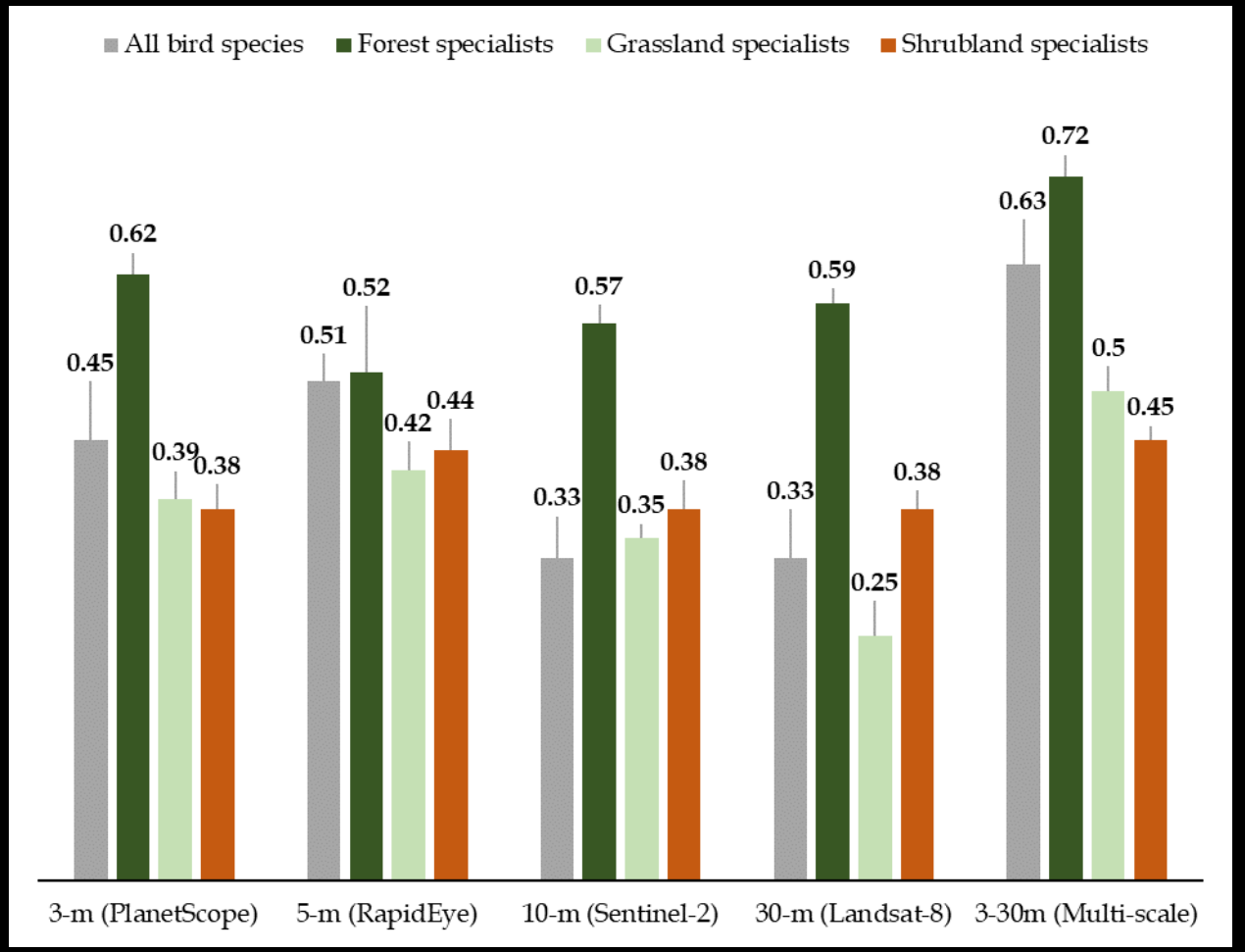
L8_NDVIp90_MEAN



RE_MinDHI_UNIF



Results


All bird species
Forest specialists
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0.45
0.62
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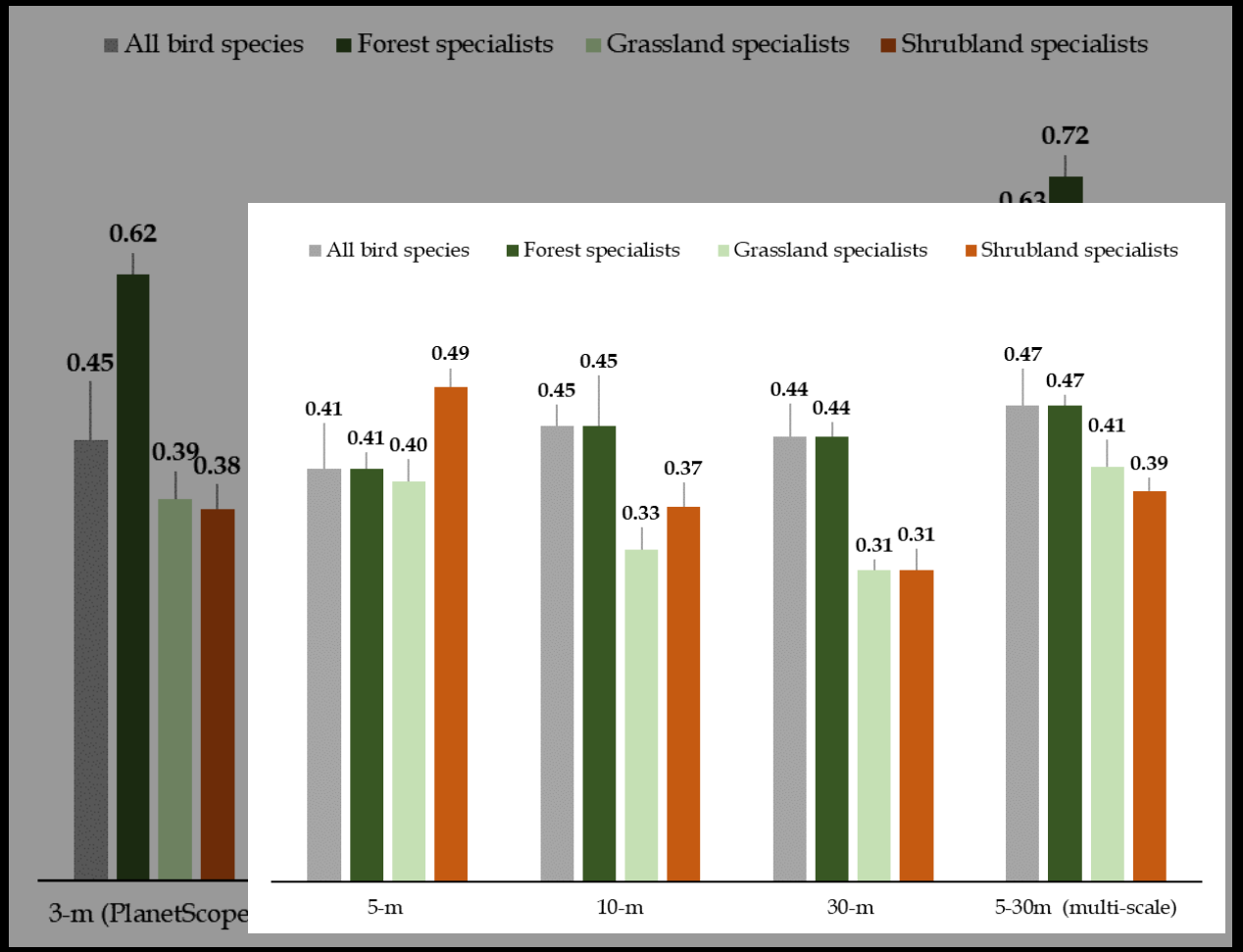
3-m (PlanetScope)
5-m (RapidEye)
10-m (Sentinel-2)
30-m (Landsat-8)
3-30m (Multi-scale)

Results


All bird species
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0.72
0.63
0.62
0.45
0.39
0.38
3-m (PlanetScope
All bird species
Forest specialists
Grassland specialists
Shrubland specialists
0.41
0.41
0.40
0.49
0.45
0.45
0.33
0.37
0.44
0.44
0.31
0.31
0.47
0.47
0.41
0.39
5-m
10-m
30-m
5-30m (multi-scale)

Results

1. Can high-resolution imagery predict bird richness better than S2/L8?

2. Is there one optimal grain, or do multi-grain models perform best?

3. Are the same grains best for different bird guilds?

Results

1. Can high-resolution imagery predict bird richness better than S2/L8?
   - Yes! RapidEye was best in univariate models for all-species.
   - PlanetScope/RapidEye single-grain multivariate models best for all guilds.

Results

1. Can high-resolution imagery predict bird richness better than S2/L8?
   - Yes! RapidEye was best in univariate models for all-species.
   - PlanetScope/RapidEye multivariate models best for all guilds.
2. Is there one optimal grain, or do multi-grain models perform best?
   - No! There is not one optimal grain.
   - Yes! Multi-grain models performed best for all guilds

Results

1. Can high-resolution imagery predict bird richness better than S2/L8?
   - Yes! RapidEye was best in univariate models for all-species.
   - PlanetScope/RapidEye multivariate models best for all guilds.
2. Is there one optimal grain, or do multi-grain models perform best?
   - No! There is not one optimal grain.
   - Yes! Multi-grain models performed best for all guilds
3. Is the same grain best for different bird guilds?
   - No! In univariate models, forest specialists best predicted by S2/L8, grassland specialists by PlanetScope/Rapideye, and shrubland specialist by any/all

Outline

- Part I: Multi-grain habitat models
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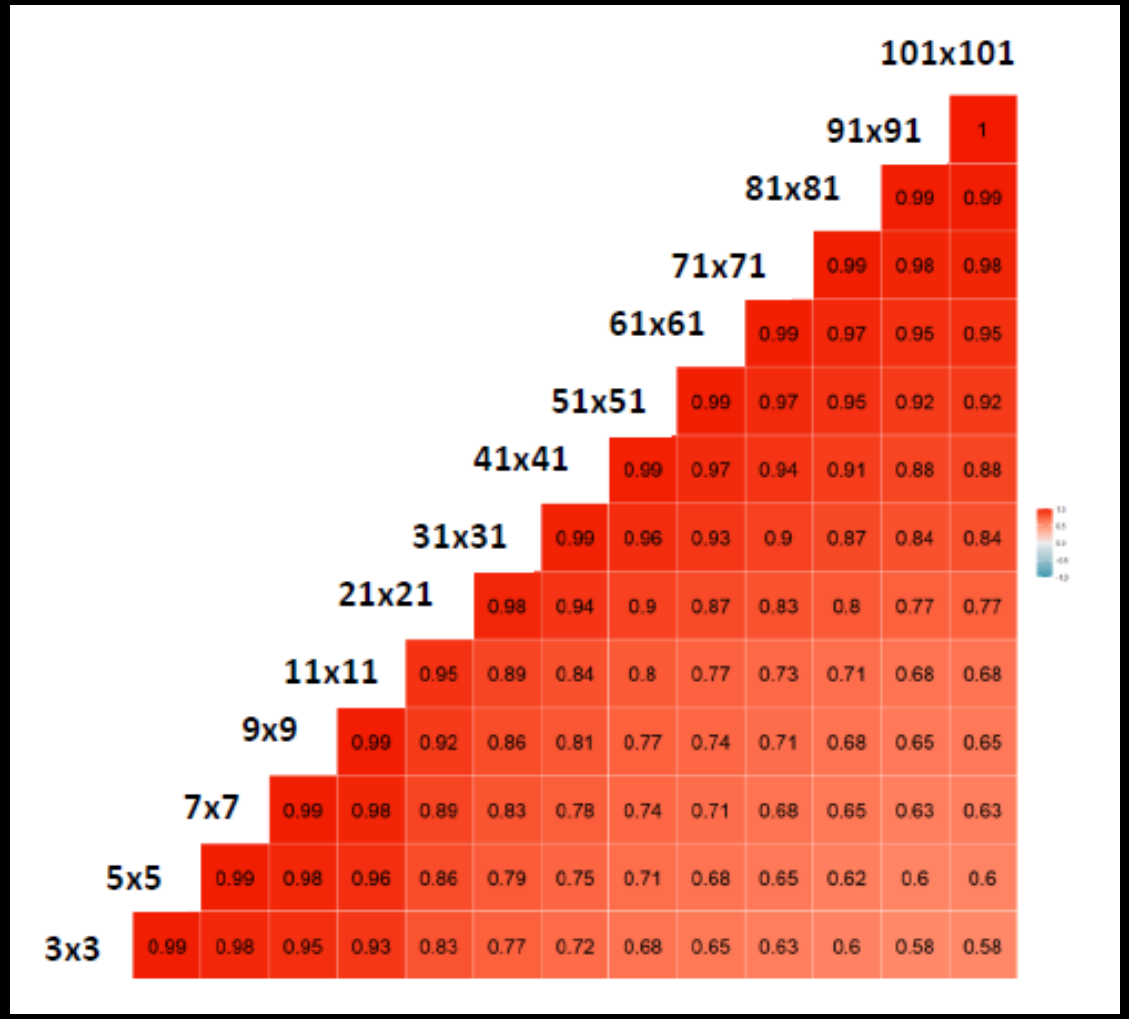
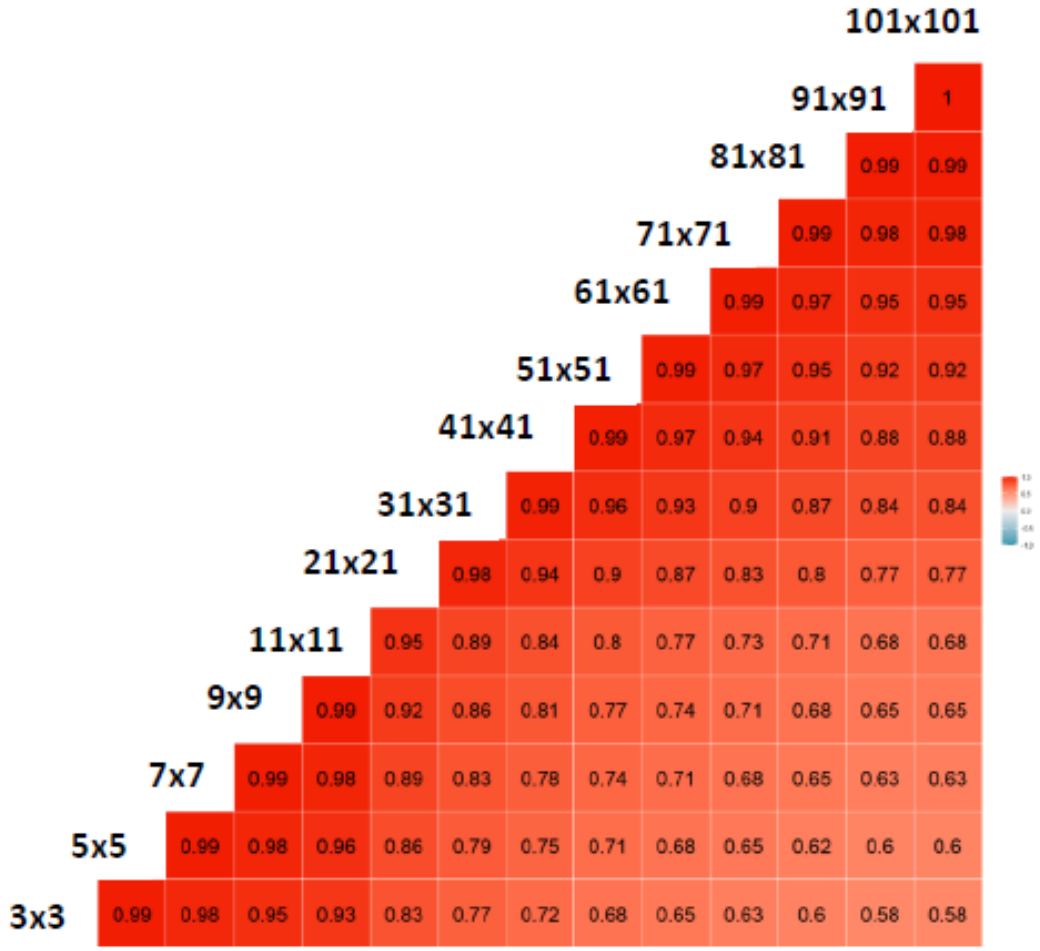
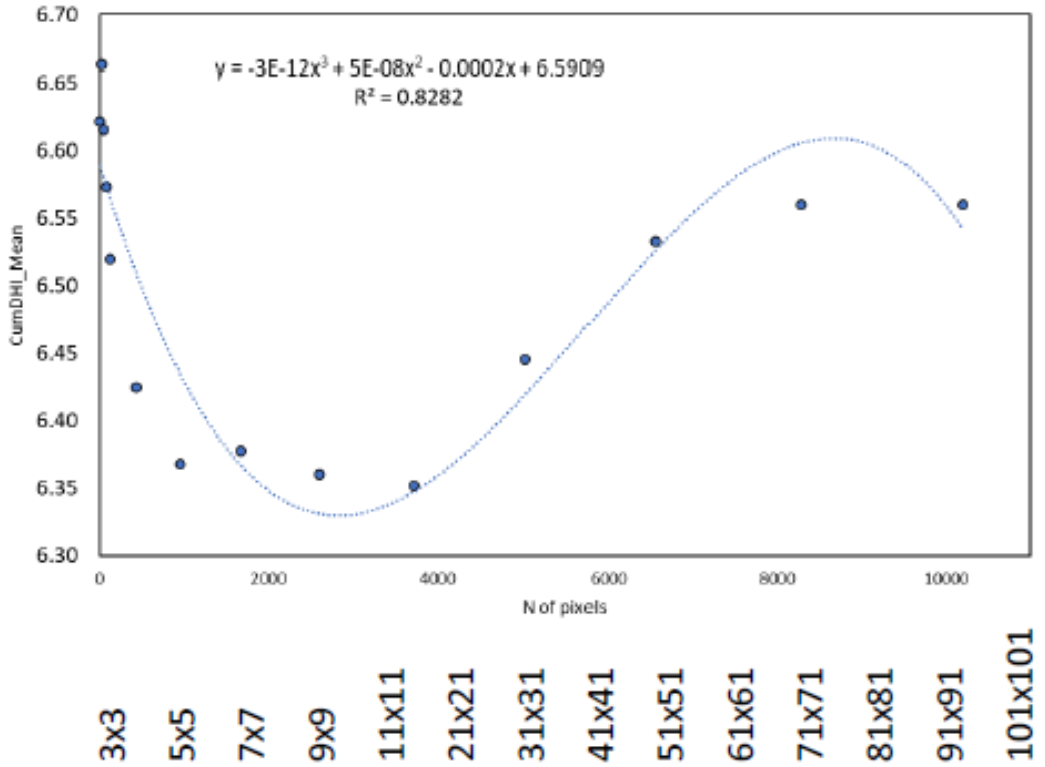

101x101
91x91 1
81x81 0.99 0.99
71x71 0.99 0.98 0.98
61x61 0.99 0.97 0.95 0.95
51x51 0.99 0.97 0.95 0.92 0.92
41x41 0.99 0.97 0.94 0.91 0.88 0.88
31x31 0.99 0.96 0.93 0.9 0.87 0.84 0.84
21x21 0.98 0.94 0.9 0.87 0.83 0.8 0.77 0.77
11x11 0.95 0.89 0.84 0.8 0.77 0.73 0.71 0.68 0.68
9x9 0.99 0.92 0.86 0.81 0.77 0.74 0.71 0.68 0.65 0.65
7x7 0.99 0.98 0.89 0.83 0.78 0.74 0.71 0.68 0.65 0.63 0.63
5x5 0.99 0.98 0.96 0.86 0.79 0.75 0.71 0.68 0.65 0.62 0.6 0.6
3x3 0.99 0.98 0.95 0.93 0.83 0.77 0.72 0.68 0.65 0.63 0.6 0.58 0.58

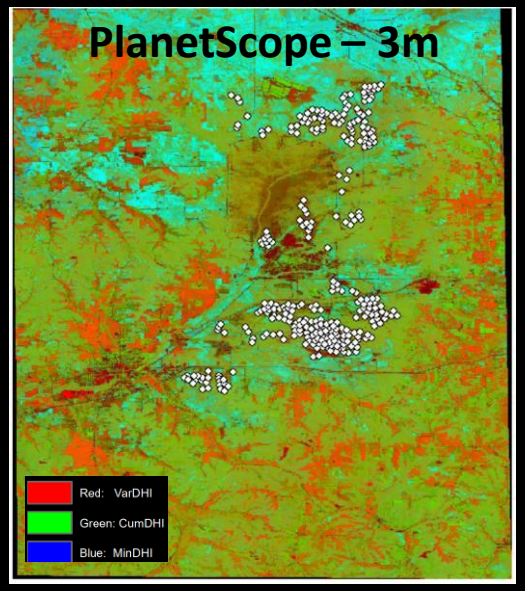
Results

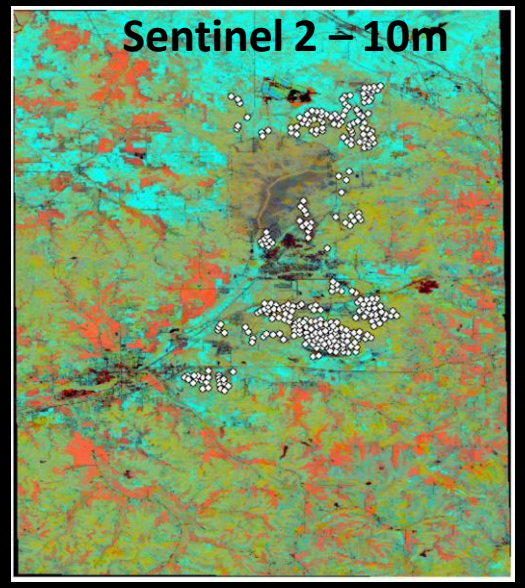


Scalogram

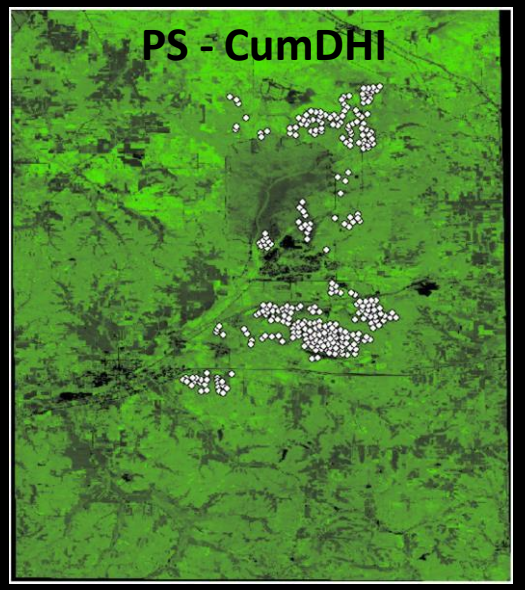


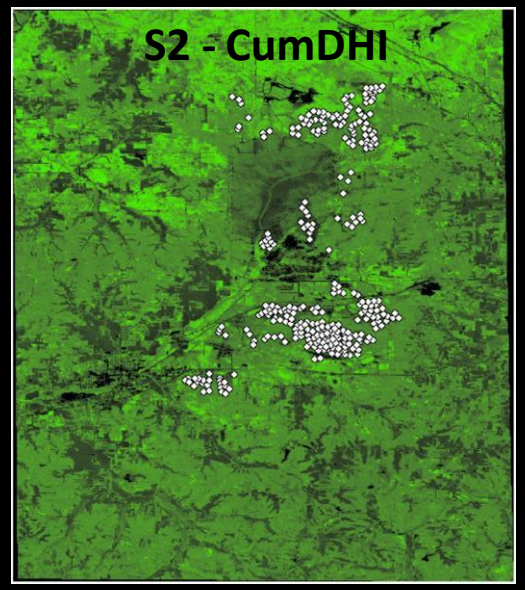
Results


PlanetScope – 3m
Red: VarDHI
Green: CumDHI
Blue: MinDHI


Sentinel 2 – 10m

Landsat 8 – 30m

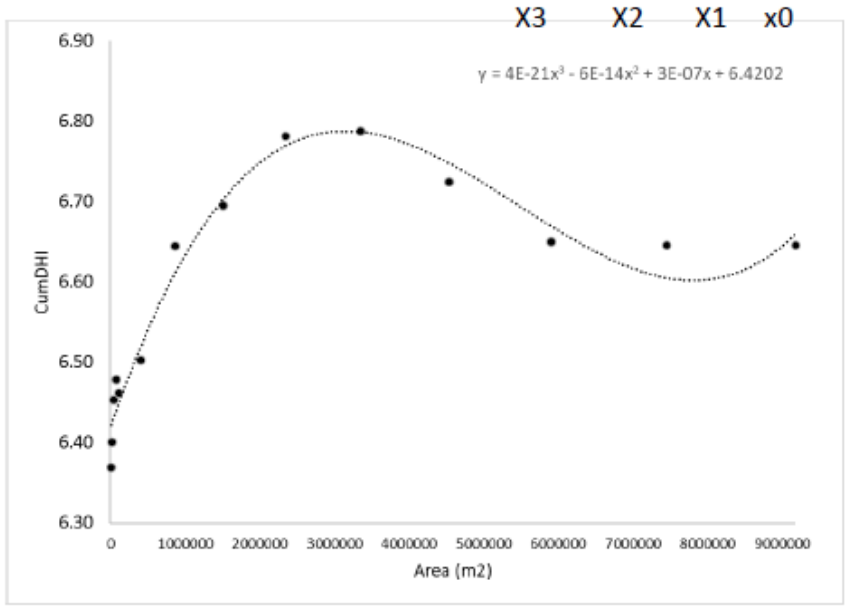

PS - CumDHI


S2 - CumDHI

L8 - CumDHI

Results

	BAOR	BHCO	BRTH	CCSP	CHSP	DICK	EABL	EAKI	EAME	EATO	EAWP	FISP	GCFL	GRCA	GRSP	HOLA	HOWR	INBU	LASP	MODO	OROR	OVEN	RBGR	REVI	RHWO	SCTA	UPSA	VESP
L8_CumDHI_MEAN_3	-0.05	0.16	-0.13	-0.15	-0.10	-0.19	-0.22	-0.22	-0.34	0.34	0.53	-0.08	0.23	0.06	-0.59	-0.32	-0.04	0.37	-0.23	-0.28	-0.12	0.68	0.47	0.56	-0.02	0.57	-0.30	-0.57
L8_CumDHI_MEAN_5	-0.05	0.17	-0.14	-0.16	-0.10	-0.21	-0.22	-0.23	-0.35	0.35	0.54	-0.08	0.25	0.04	-0.60	-0.32	-0.05	0.38	-0.22	-0.29	-0.12	0.69	0.48	0.57	-0.03	0.57	-0.31	-0.57
L8_CumDHI_MEAN_7	-0.05	0.17	-0.16	-0.17	-0.09	-0.23	-0.23	-0.25	-0.37	0.35	0.55	-0.09	0.27	0.01	-0.63	-0.34	-0.06	0.38	-0.22	-0.32	-0.14	0.69	0.49	0.58	-0.05	0.58	-0.32	-0.57
L8_CumDHI_MEAN_9	-0.06	0.16	-0.18	-0.17	-0.09	-0.24	-0.25	-0.25	-0.38	0.34	0.57	-0.10	0.29	-0.02	-0.64	-0.35	-0.08	0.37	-0.23	-0.33	-0.15	0.70	0.51	0.58	-0.07	0.59	-0.33	-0.56
L8_CumDHI_MEAN_11	-0.06	0.15	-0.19	-0.16	-0.08	-0.25	-0.26	-0.25	-0.39	0.33	0.57	-0.10	0.29	-0.04	-0.65	-0.36	-0.08	0.38	-0.23	-0.33	-0.15	0.70	0.51	0.58	-0.07	0.59	-0.34	-0.54
L8_CumDHI_MEAN_21	-0.04	0.17	-0.17	-0.16	0.00	-0.30	-0.25	-0.22	-0.41	0.35	0.56	-0.05	0.29	-0.01	-0.69	-0.40	-0.04	0.42	-0.21	-0.29	-0.14	0.65	0.50	0.53	-0.06	0.58	-0.37	-0.45
L8_CumDHI_MEAN_31	-0.03	0.16	-0.16	-0.18	0.02	-0.33	-0.25	-0.18	-0.42	0.33	0.54	-0.05	0.28	0.01	-0.69	-0.43	-0.04	0.41	-0.22	-0.30	-0.12	0.63	0.50	0.52	-0.07	0.57	-0.39	-0.39
L8_CumDHI_MEAN_41	-0.04	0.13	-0.15	-0.16	0.02	-0.32	-0.25	-0.16	-0.42	0.31	0.51	-0.05	0.27	0.02	-0.67	-0.44	-0.06	0.39	-0.22	-0.29	-0.10	0.60	0.48	0.49	-0.09	0.55	-0.40	-0.34
L8_CumDHI_MEAN_51	-0.04	0.13	-0.13	-0.13	0.03	-0.32	-0.24	-0.15	-0.42	0.30	0.49	-0.04	0.25	0.04	-0.65	-0.44	-0.05	0.38	-0.25	-0.27	-0.08	0.58	0.46	0.48	-0.09	0.53	-0.40	-0.31
L8_CumDHI_MEAN_61	-0.03	0.13	-0.12	-0.09	0.04	-0.33	-0.22	-0.13	-0.43	0.30	0.46	-0.02	0.24	0.07	-0.64	-0.43	-0.03	0.36	-0.26	-0.25	-0.06	0.56	0.44	0.47	-0.08	0.50	-0.39	-0.29
L8_CumDHI_MEAN_71	-0.03	0.13	-0.11	-0.06	0.06	-0.34	-0.19	-0.10	-0.43	0.28	0.42	-0.01	0.25	0.08	-0.61	-0.41	-0.01	0.34	-0.25	-0.24	-0.03	0.55	0.43	0.46	-0.08	0.47	-0.38	-0.26
L8_CumDHI_MEAN_81	-0.02	0.14	-0.10	-0.04	0.08	-0.35	-0.17	-0.08	-0.44	0.26	0.40	0.00	0.25	0.09	-0.60	-0.39	0.00	0.32	-0.24	-0.23	-0.01	0.53	0.42	0.46	-0.08	0.45	-0.36	-0.23
L8_CumDHI_MEAN_91	-0.01	0.15	-0.08	-0.03	0.09	-0.36	-0.15	-0.07	-0.45	0.25	0.38	0.00	0.24	0.10	-0.58	-0.37	0.02	0.31	-0.23	-0.22	0.01	0.51	0.41	0.45	-0.07	0.43	-0.34	-0.20
L8_CumDHI_MEAN_101	-0.01	0.15	-0.08	-0.03	0.09	-0.36	-0.15	-0.07	-0.45	0.25	0.38	0.00	0.24	0.10	-0.58	-0.37	0.02	0.31	-0.23	-0.22	0.01	0.51	0.41	0.45	-0.07	0.43	-0.34	-0.20

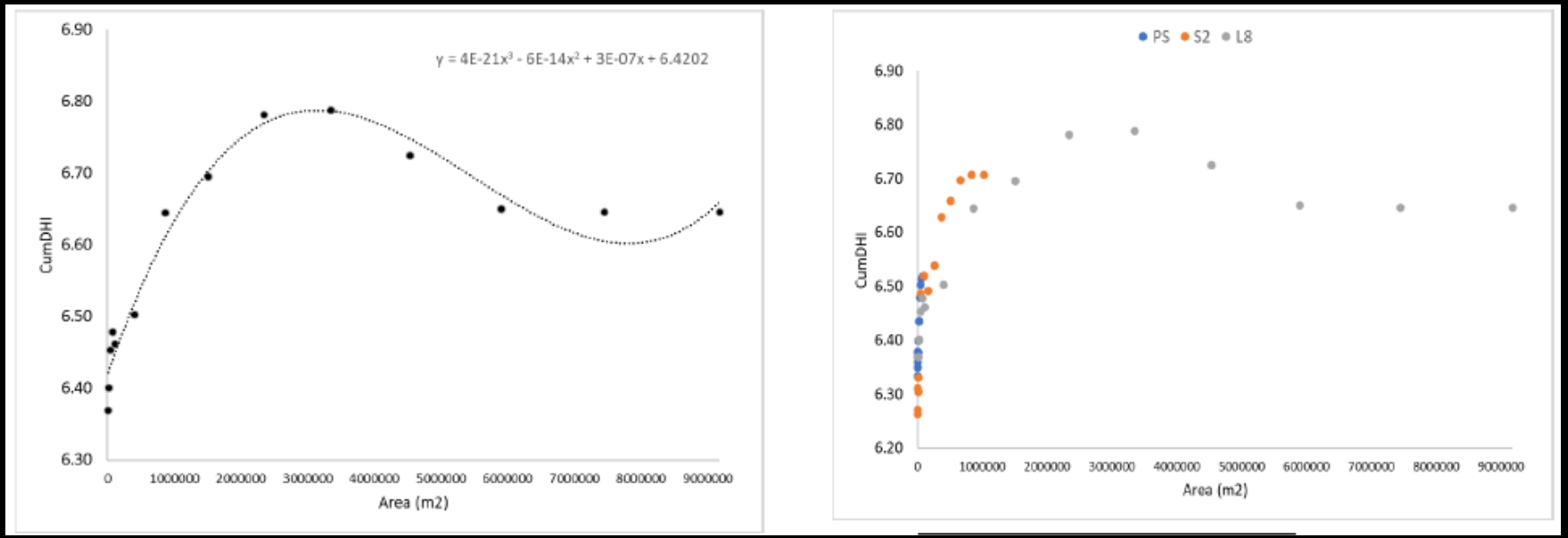


OVEN – Optimal scale (9x9 / 11x11) - $r = 0.7$

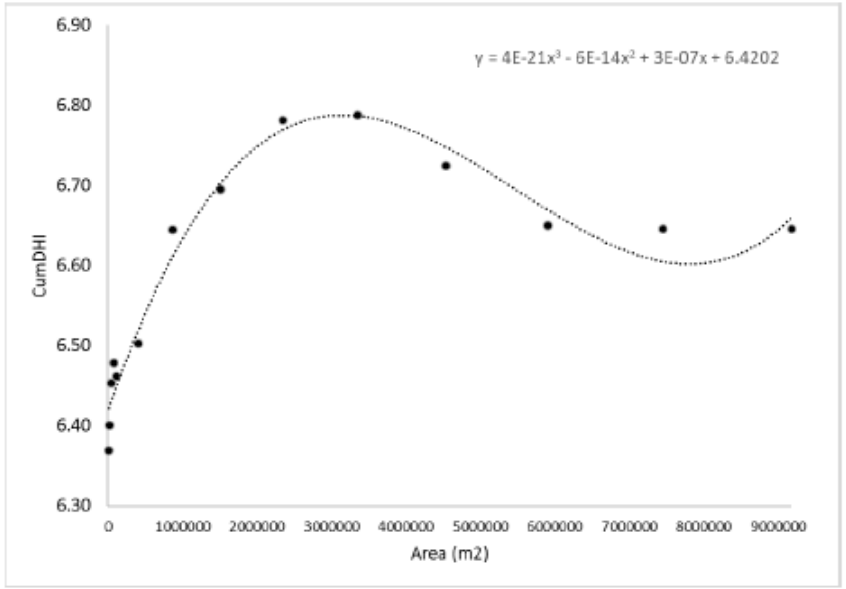
		OVEN
X3	L8_CumDHI_MEAN_3	-0.22
X2	L8_CumDHI_MEAN_2	0.26
X1	L8_CumDHI_MEAN_1	-0.34
x0	L8_CumDHI_MEAN_0	0.70

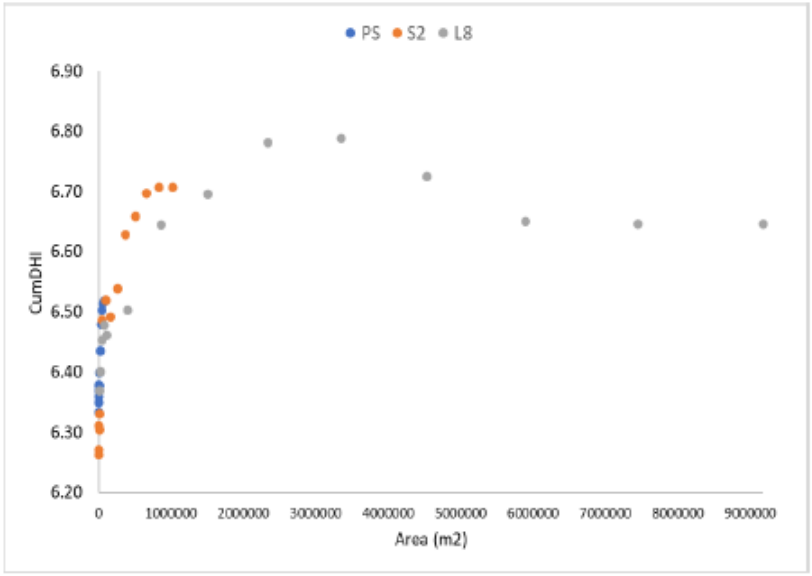
Multiple regression: r = 0.71

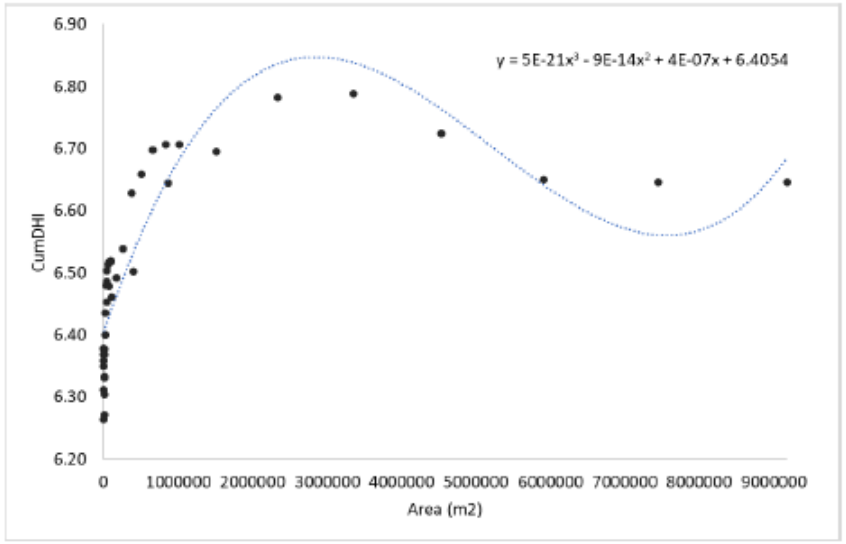
Results



Results





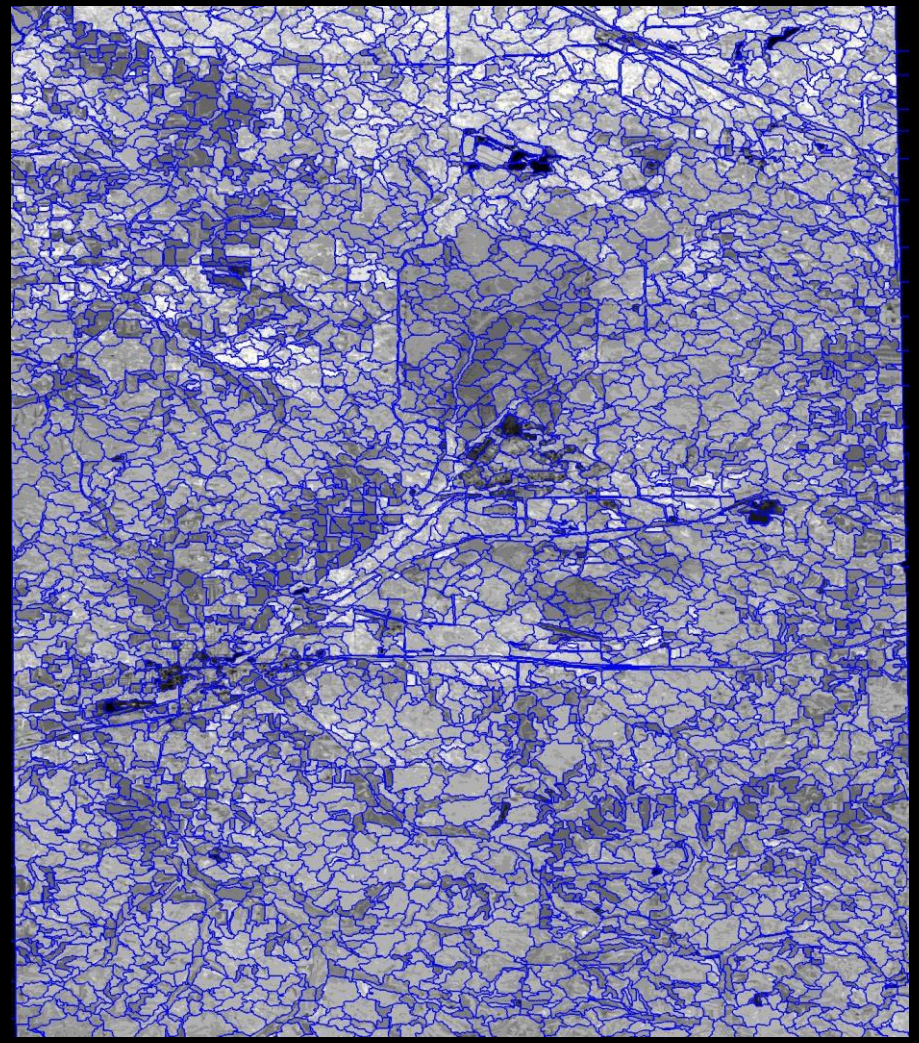


	OVEN
PS_S2_L8_cumDHI_MEAN_3	-0.14
PS_S2_L8_cumDHI_MEAN_2	0.19
PS_S2_L8_cumDHI_MEAN_1	-0.3
PS_S2_L8_cumDHI_MEAN_0	0.71

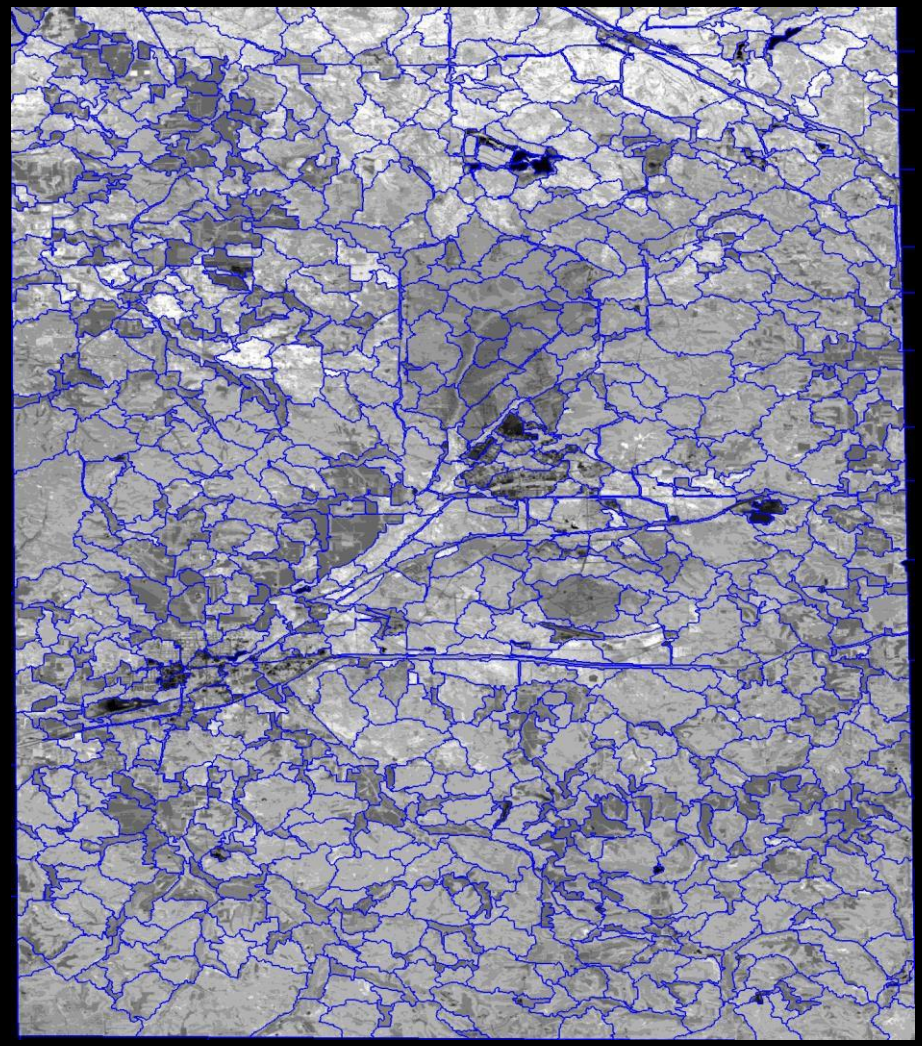
Multiple regression: r = 0.74

Results

Landsat 8 - Scale - 5



Landsat 8 - Scale - 10



Outline

- Part I: Multi-grain habitat models
  - Can high-res imagery predict bird richness better than S2/L8?
  - Is there one optimal grain, or do multiple grains perform best?
  - Is the same grain best for different bird guilds?
- Part II: Scalograms
  - Can we synthesize habitat patterns from a range of extents?
- Part III: Conclusions

Conclusions

Habitat selection in birds is:

- Hierarchical
- Multi-scale
- Variable among species

Conclusions

Habitat selection in birds is:

- Hierarchical
- Multi-scale
- Variable among species

Our habitat models should be too

THANK YOU!!!

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