

Testing the Dynamic Habitat Indices from MODIS for biodiversity and conservation

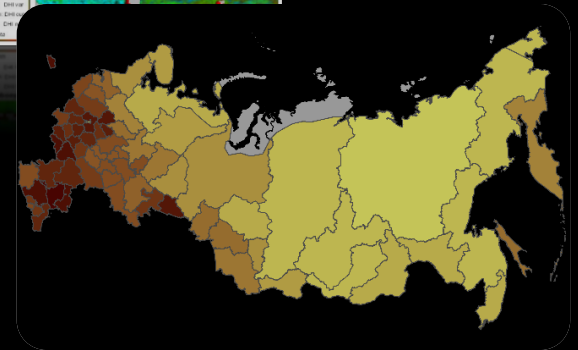
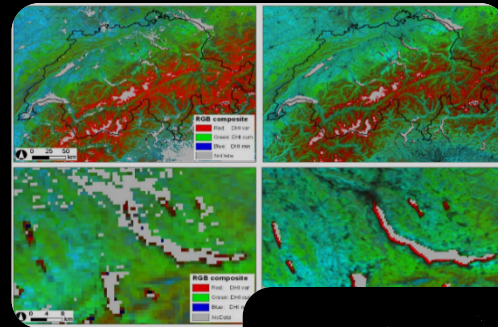
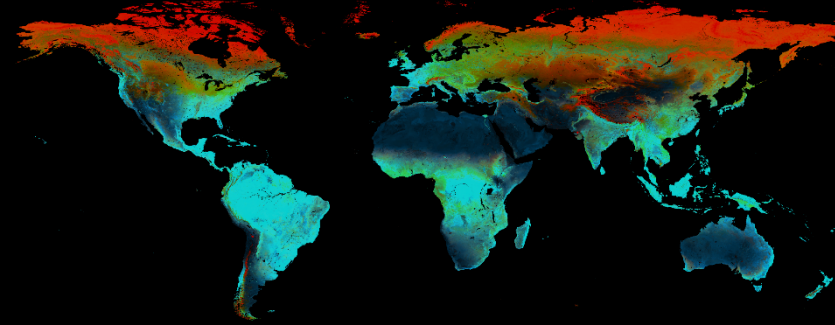
Volker C. Radeloff, M. Hobi, M. Dubinin, E. Razenkova, L. Zhu,
University of Wisconsin-Madison

A. Allen, B. Borisov, T. Brooks, M. Clayton, N. Coops, C. Graham, T.
Ives, D. Koselov, J. Marin, A. Pidgeon, G. Rapacciuolo

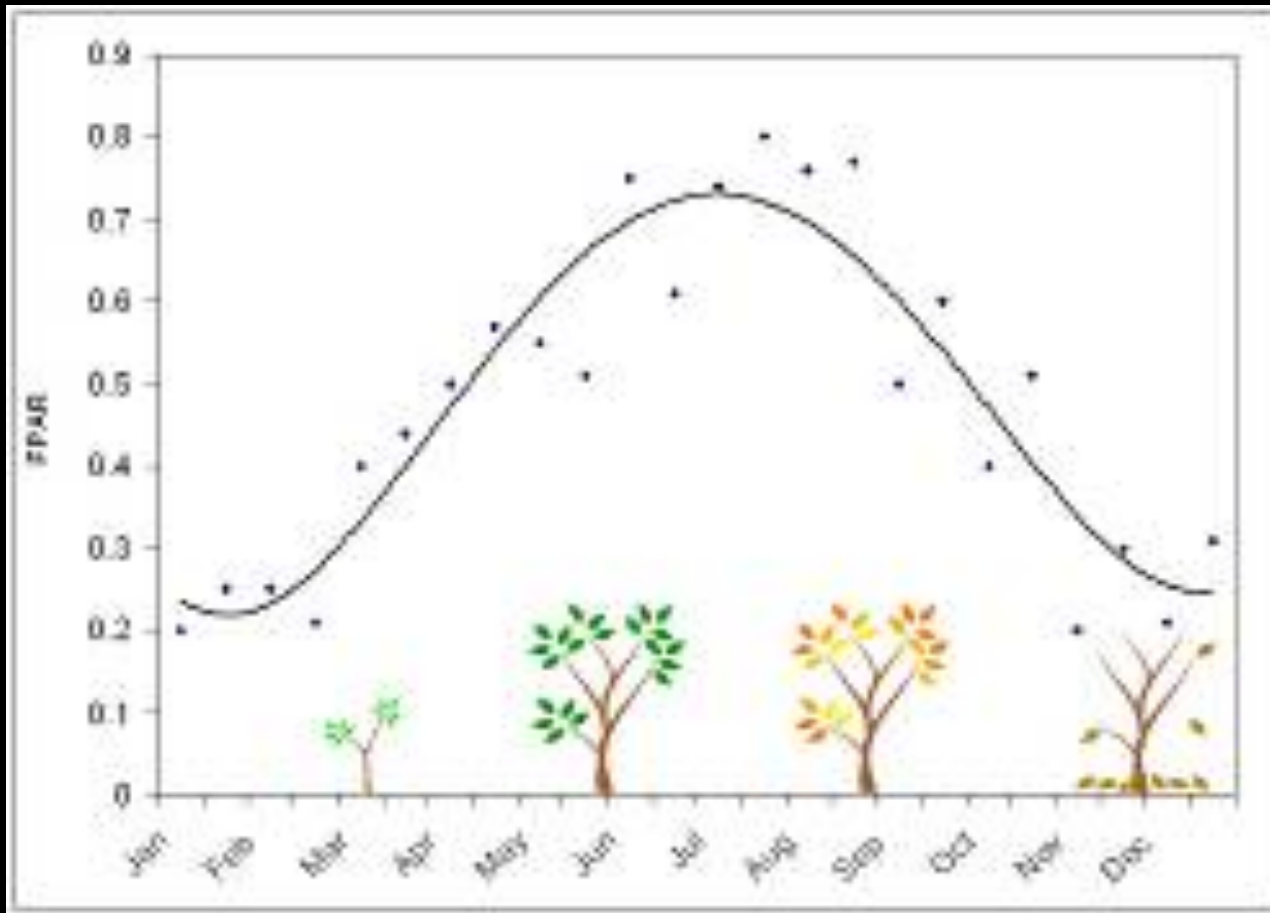
NASA Biodiversity and Ecological Forecasting
Science Team Meeting, 5/24/2017

Outline

- I. Background: the Dynamic Habitat Indices
- II. Datasets: Composite and annual DHIs
- III. Proof of concept: DHIs and biodiversity



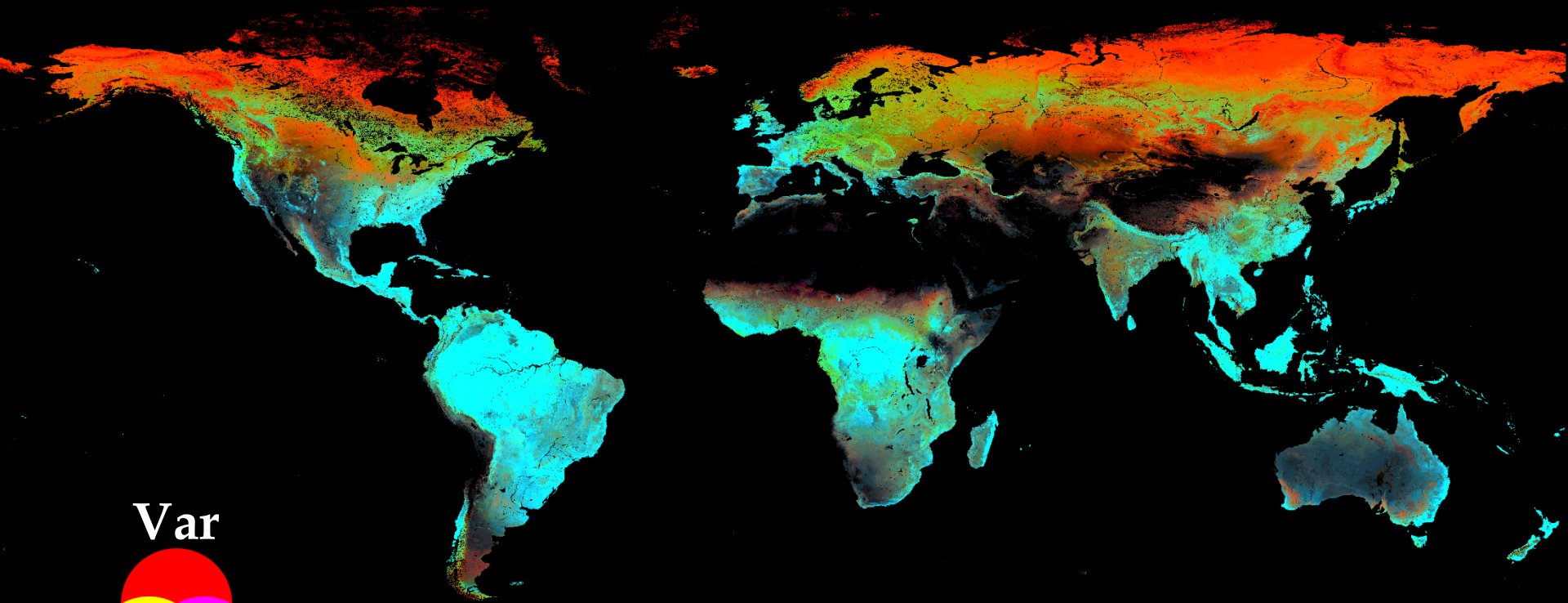
The Dynamic Habitat Indices



The Dynamic Habitat Indices

Ecology		DHIs
Available energy hypothesis		Cumulative productivity
Environmental stress hypothesis		Minimum productivity
Environmental variability hypothesis		Coefficient of variation

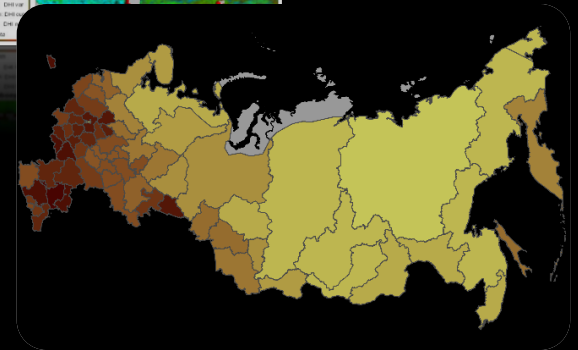
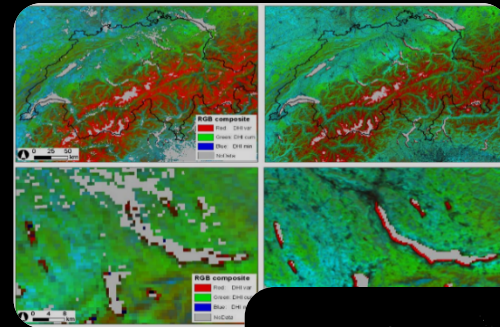
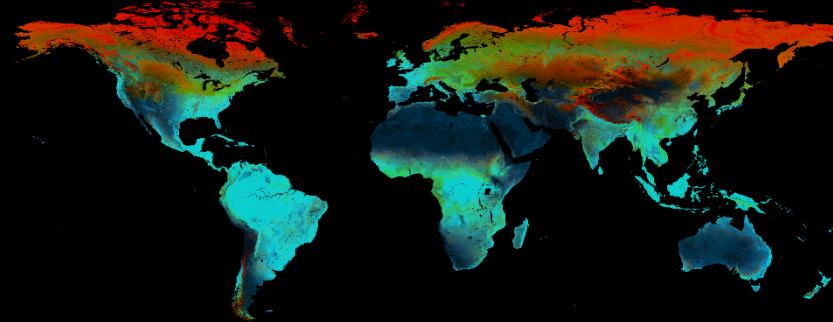
The Dynamic Habitat Indices



FPAR DHIs

Outline

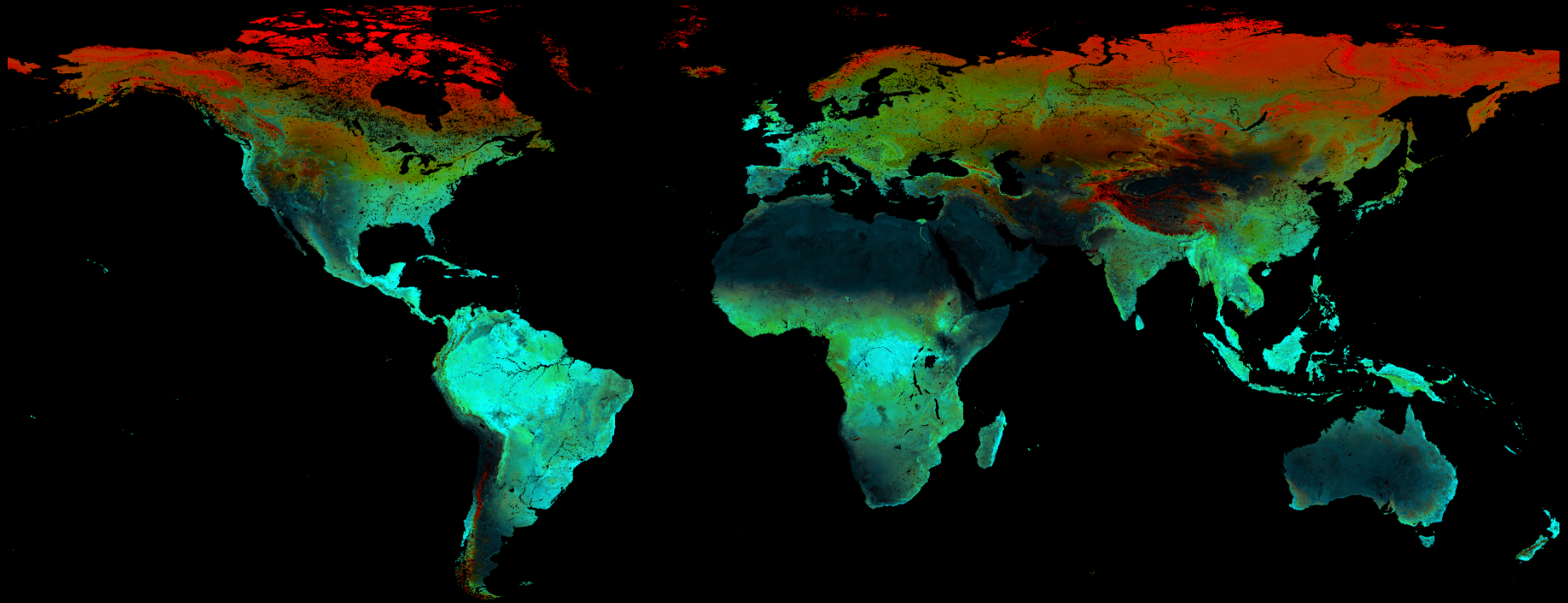
- I. Background: the Dynamic Habitat Indices
- II. Datasets: Composite and annual DHIs
- III. Proof of concept: DHIs and biodiversity



Datasets

- MODIS Composite DHIs for 2003-2014
 - Why: MODIS vegetation data have some noise and phenology varies among years
 - Why: Some biodiversity data, e.g., range maps, have no clear date
 - What it is: The median of all observations for a given date

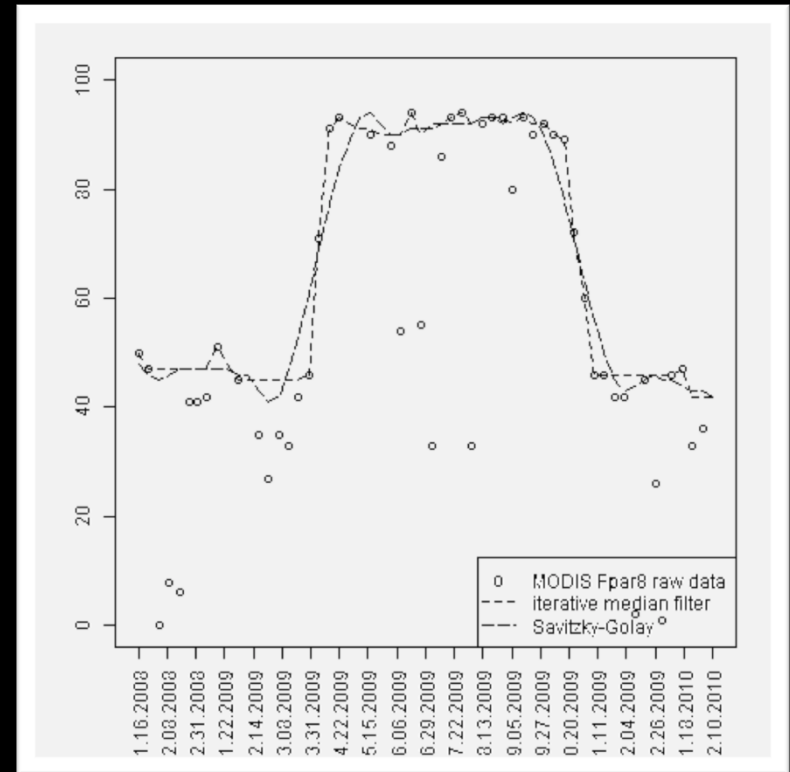
Datasets



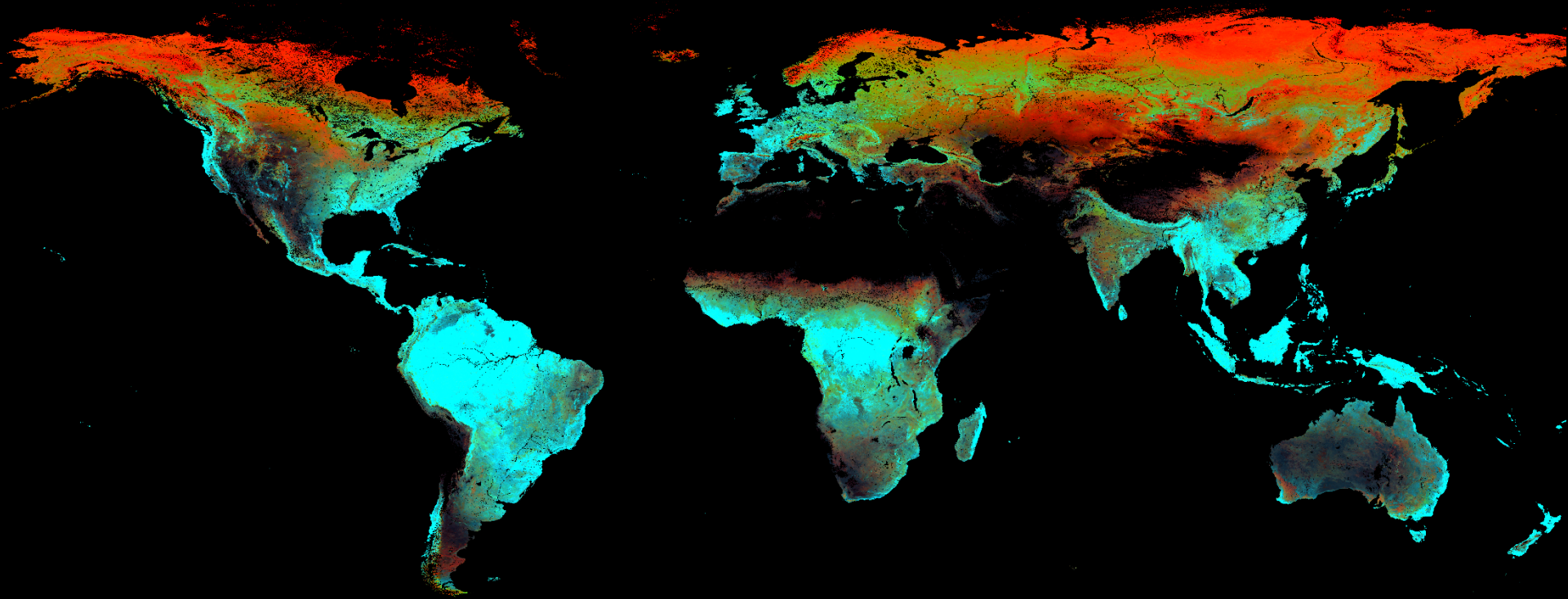
Composite 1-km EVI DHIs

Datasets

- Annual DHIs
 - Why: Interannual variability is important
 - Smoothing annual phenology
 - Iterative median
 - Savitzky-Golay



Datasets



FPAR DHIs 2012

Dynamic Habitat Indices

VARIABLE

- NDVI16
- EVI16
- FPAR8
- LAI8
- GPP8

Enhanced Vegetation Index

BANDS

- RGB composite (3-1-2)
- Band 1 (cumulative)
- Band 2 (minimum)
- Band 3 (secondary)

silvis.forest.wisc.edu/data/DHIs

DOWNLOADS

Vegetation Index	Composite DHIs from 2003 -2014 MODIS data	Smoothed annual DHIs													
NDVI16 Normalized Difference Vegetation Index	NDVI16 Composite DHIs	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	
EVI16 Enhanced Vegetation Index	EVI16 Composite DHIs	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	
FPAR8 Fraction absorbed Photosynthetically Active Radiation	FPAR8 Composite DHIs	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	
LAI8 Leaf Area Index	LAI8 Composite DHIs	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	
GPP8 Gross Primary Production	GPP8 Composite DHIs	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	

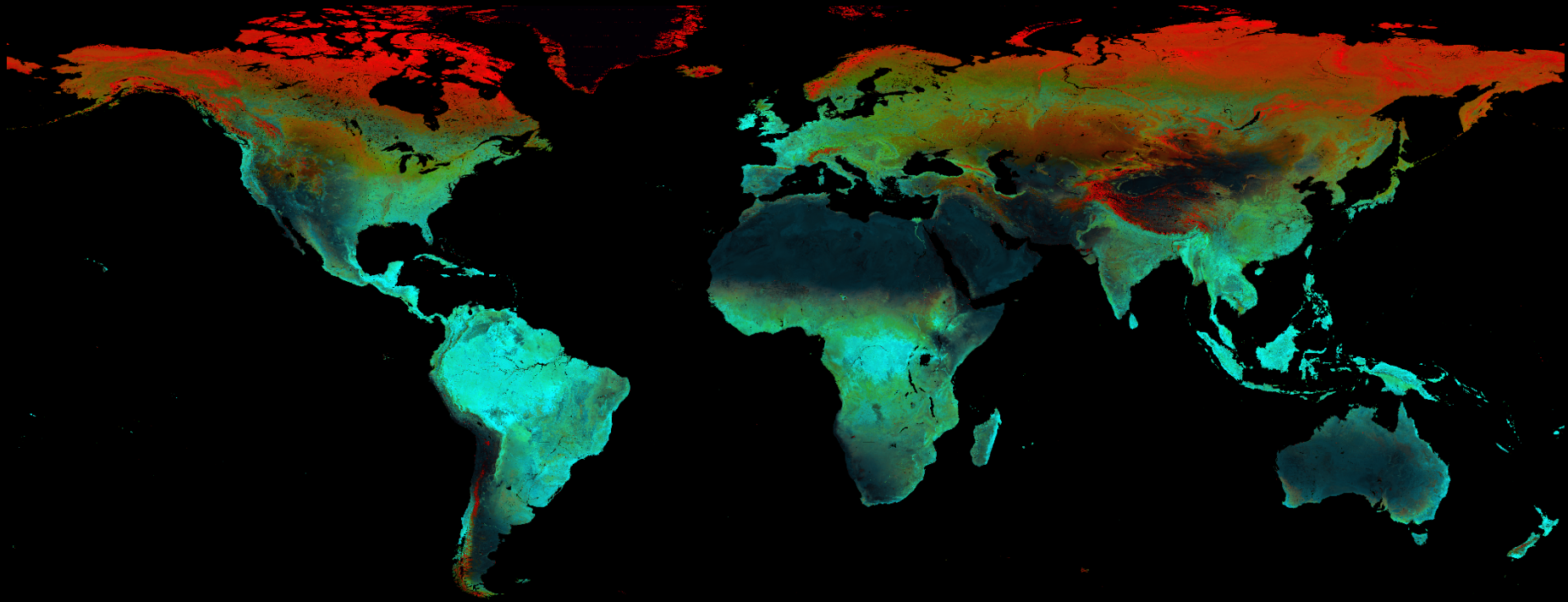
All DHIs datasets are single composite RGB images stored in GeoTIFF format at 1 kilometer spatial resolution. Map projection is WGS84 (EPSG:4326).

RELATED PUBLICATIONS

Hobi, M.L., Dubinin, M., Graham, C.H., Coops, N.C., Clayton, M.K., Pidgeon, A.M., & Radeloff, V.C. (2017). A comparison of Dynamic Habitat Indices derived from different MODIS products as predictors of avian species richness. *Remote Sensing of Environment*, 195, 142-152.

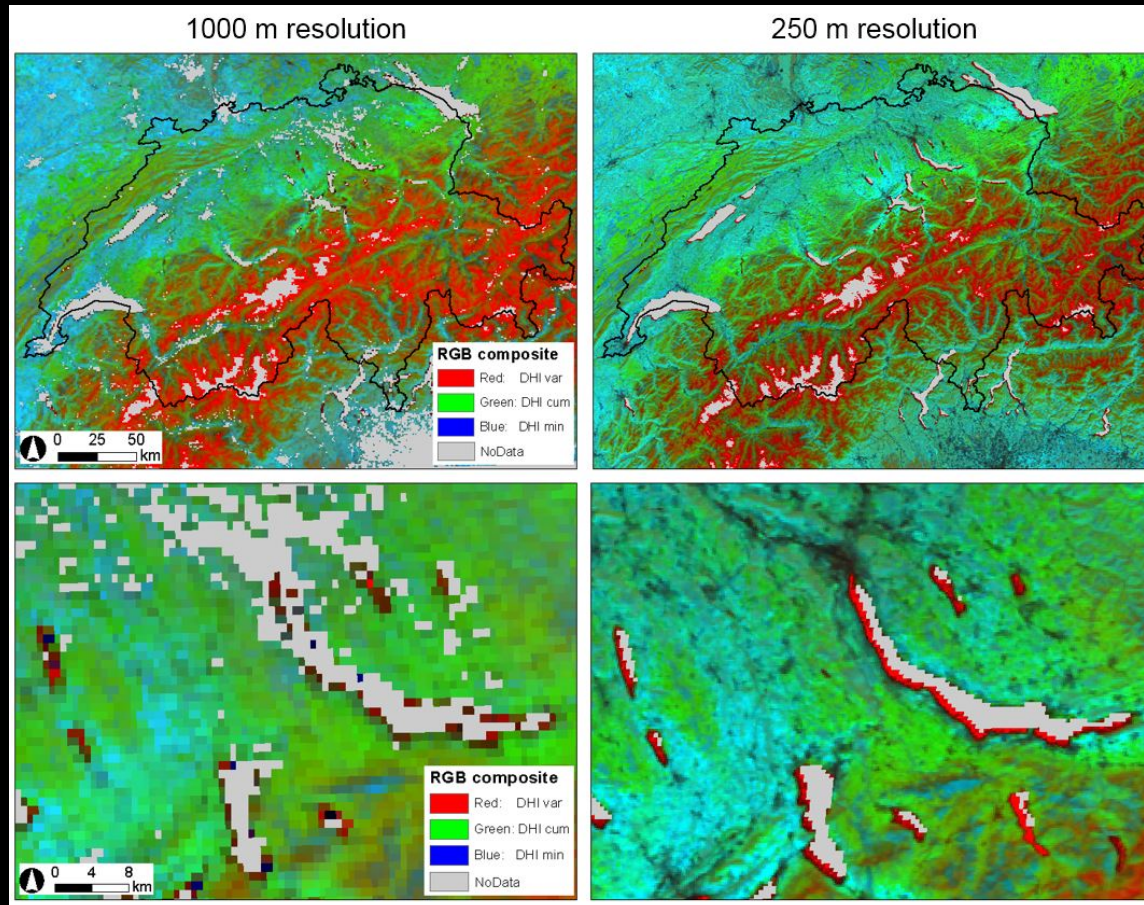
PDF

Datasets



Composite 250-m EVI DHIs

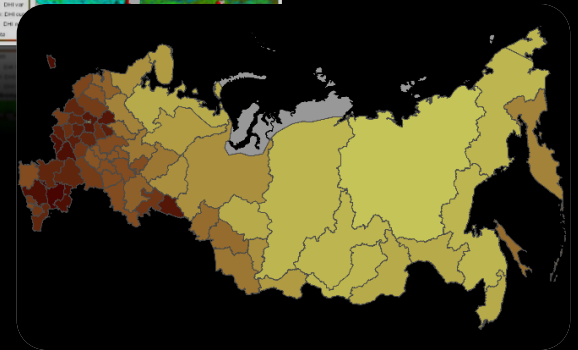
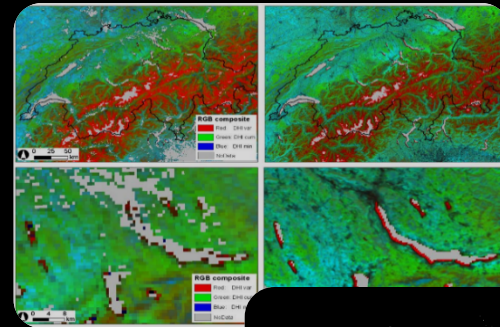
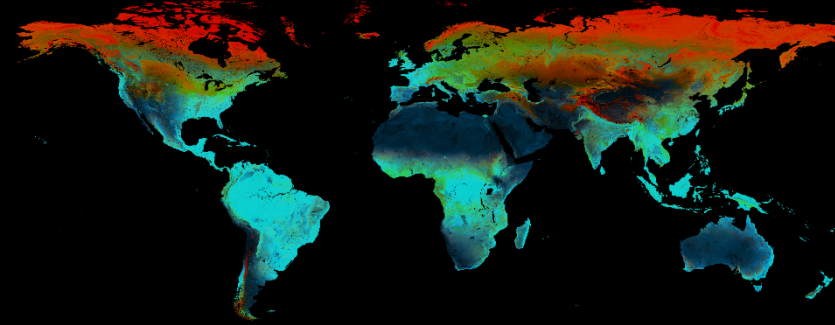
Datasets



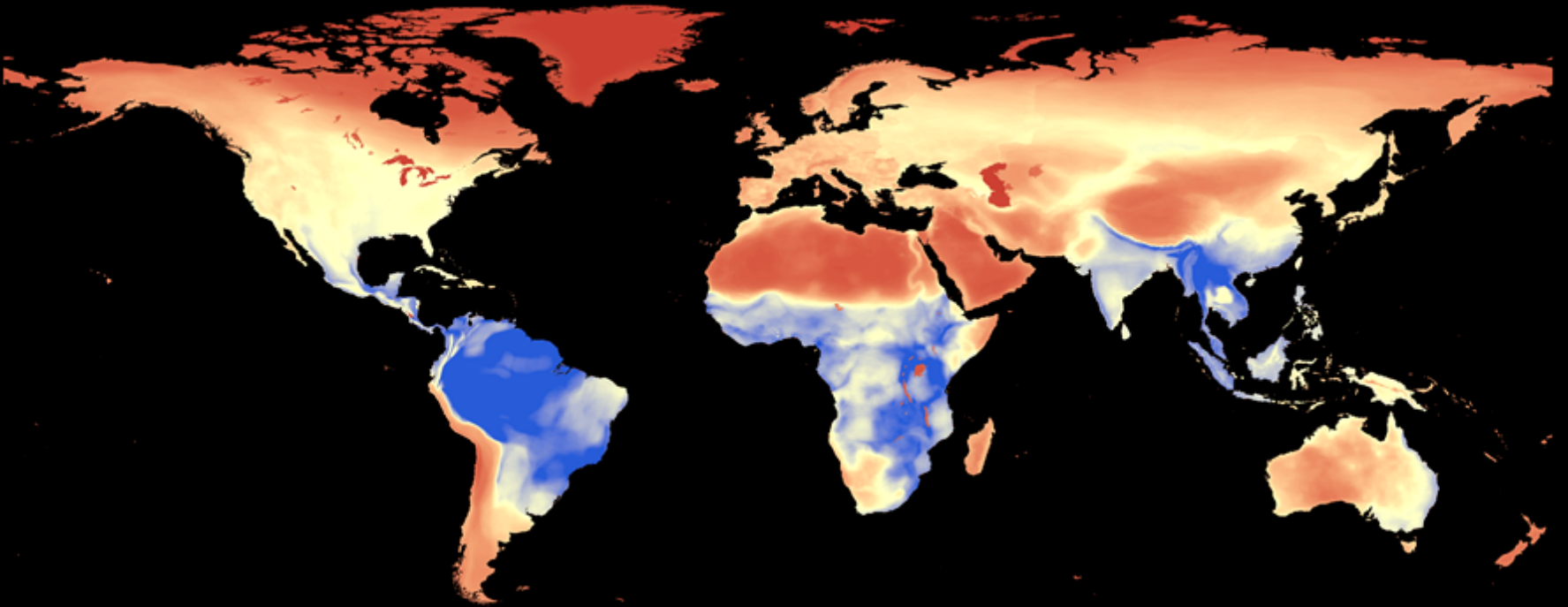
1-km vs. 250-m EVI DHIs

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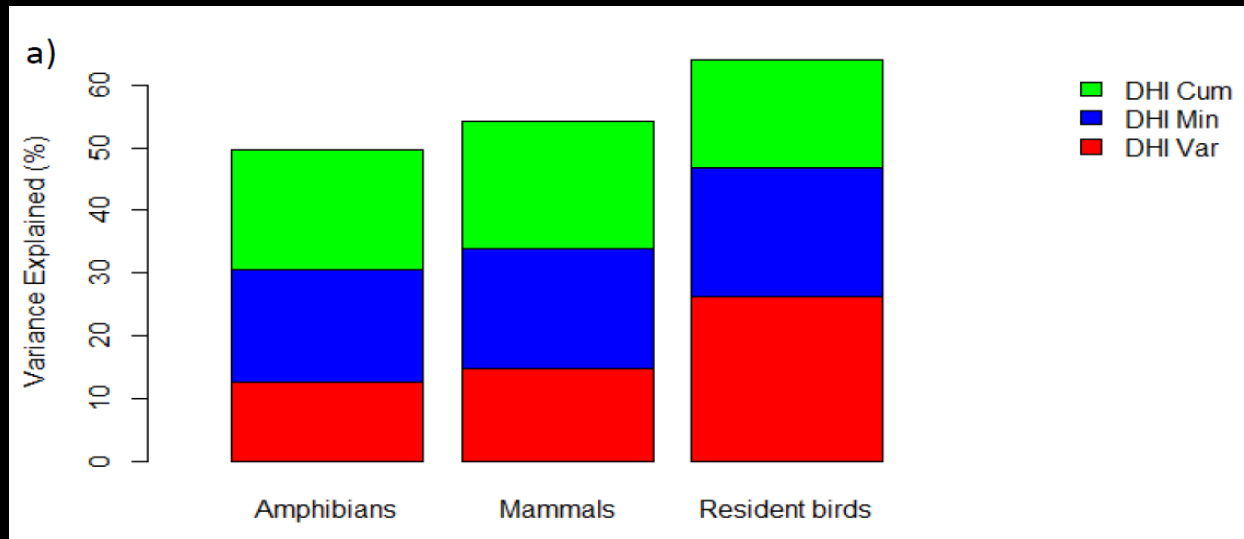


DHIs and global biodiversity

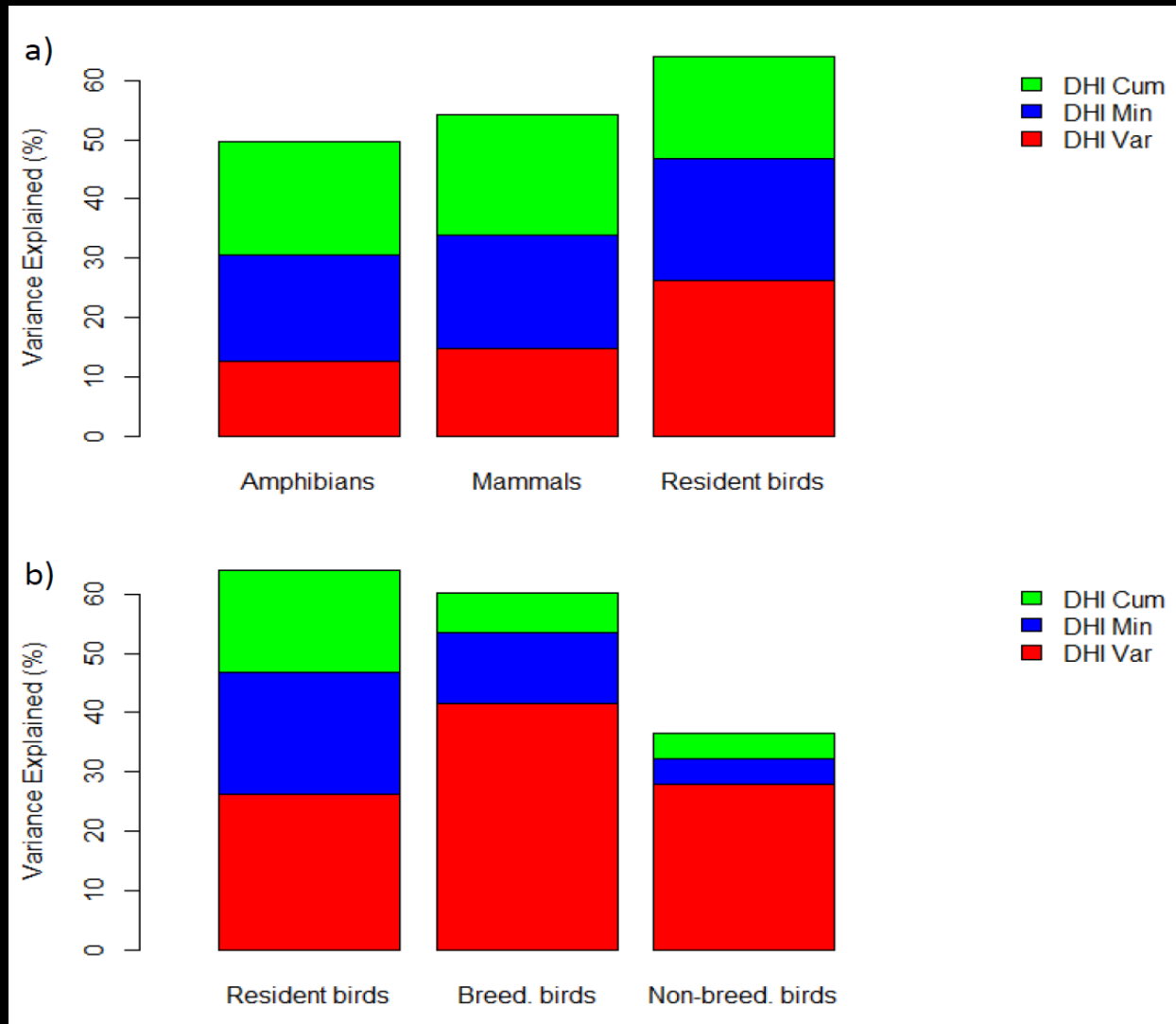


Birds

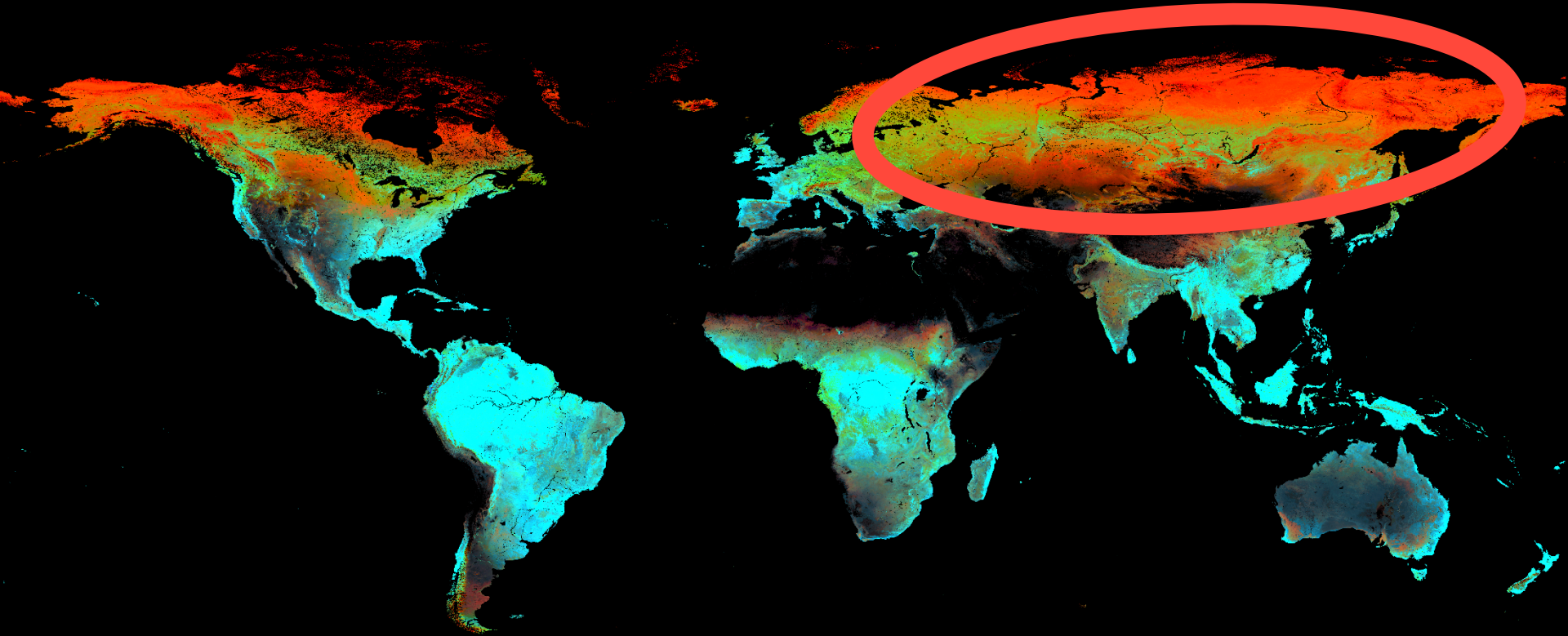
DHIs and global biodiversity



DHIs and global biodiversity



DHIs and abundances



Composite FPAR DHIs

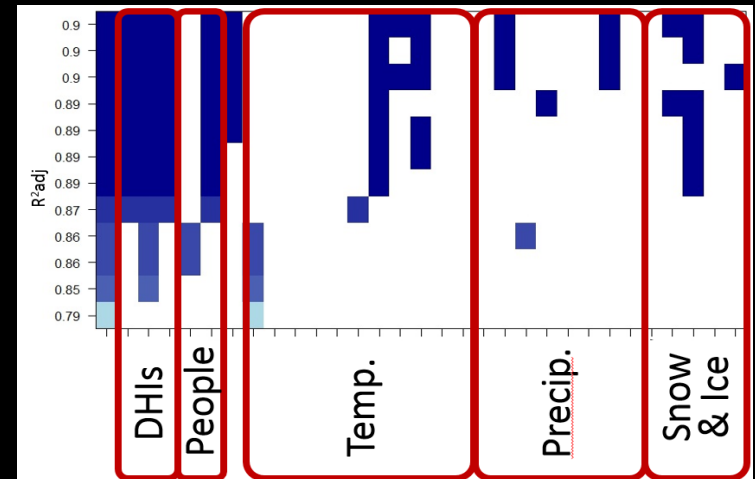
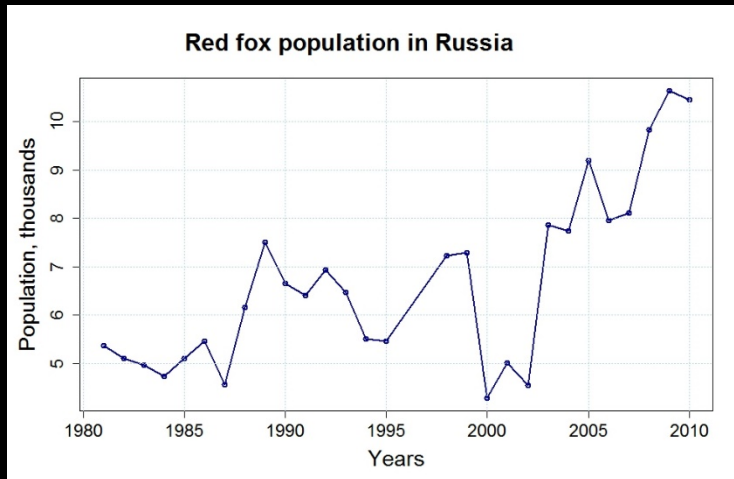
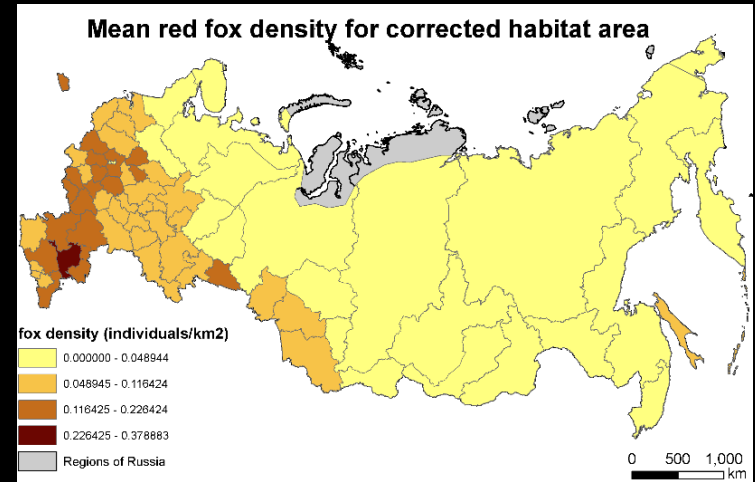
DHIs and abundances



- Russian Winter Track Counts
 - 50,000 transects
 - 10-km long
 - Start in 1966



DHIs and abundances



DHIs and abundances

Mean red fox density for corrected habitat area



Global response of the duration of frozen ground with and without snow cover to climate change

Likai Zhu¹, Volker C. Radeloff¹, and Anthony R. Ives²

¹SILVIS Lab, Department of Forest and Wildlife Ecology, University of Wisconsin-Madison, USA; ²Department of Zoology, University of Wisconsin-Madison, USA

Introduction

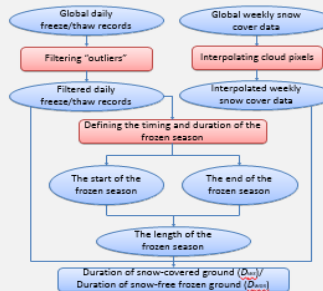
- The **subnivium** (the insulated and thermally stable area between snowpack and frozen ground) provides a refuge for organisms.
- There are excellent remote sensing datasets of frozen/thawed ground and snow cover globally.
- Global long-term datasets for the subnivium are lacking, and global trends of the subnivium and their relationships with climate change are still not well-understood.

Goal

- To characterize global changing patterns of the duration of frozen ground with or without snow
- To disentangle the relationships between **subnivium** and winter climate change

Data and methods

- NASA MEaSUREs Global Daily Landscape Freeze/Thaw Status data from SSM/I and SSMIS: 1982-2014 (25°x25 km)
- Weekly JASMES snow cover data from AVHRR and MODIS: 1982-2014 (5°x5 km)
- Climate Research Unit monthly gridded temperature (0.5°x0.5°)



Change in D_{ws} and D_{wos}

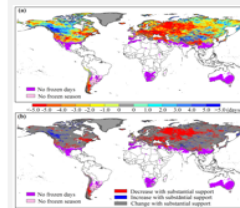


Fig. 1 Global changing pattern of the duration of snow-covered ground (D_{ws}) from 1982 to 2013. We used an autoregressive model of order 1 (AR(1)) to detect the trend. (a) changing slope, (b) changing pattern with statistical test.

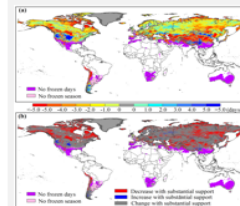


Fig. 2 Global changing pattern of the duration of snow-free frozen ground (D_{wos}) from 1982 to 2013. We used an autoregressive model of order 1 (AR(1)) to detect the trend. (a) changing slope, (b) changing pattern with statistical test.

Change in frozen season temperature

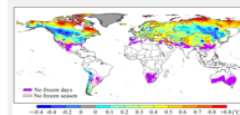


Fig. 3 Global changing pattern of frozen season temperature (FST) from 1982 to 2013. The frozen season temperature is defined as average temperature of the months within the mean range of frozen season for each pixel.

Correlation between D_{ws} , D_{wos} and FST

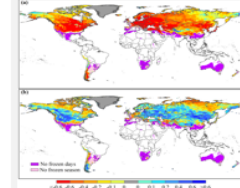


Fig. 4 Global patterns of the correlation coefficients (a) between D_{ws} and frozen season temperature, (b) between D_{wos} and frozen season temperature.

Sensitivity of correlation to mean FST

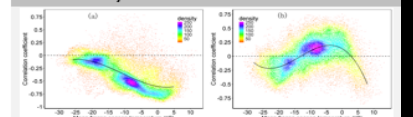


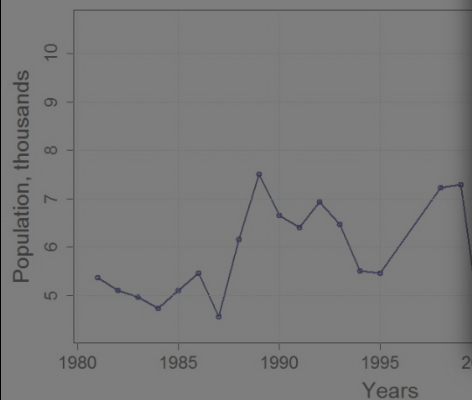
Fig. 5 Sensitivity of (a) the correlation between D_{ws} and frozen season temperature (FST) and (b) the correlation between D_{wos} and FST to mean FST (1982-2013)

Main conclusions

- We developed a 5-km spatial resolution dataset globally from 1982 to 2013 which enables assessing global changes of the **subnivium**.
- D_{ws} has a general negative correlation with frozen season temperature (FST), while D_{wos} has a positive correlation with FST mainly at mid-latitudes.
- With an increase in mean FST, the negative association between D_{ws} and FST becomes stronger, and the relationship between D_{wos} and FST changes from negative to positive correlation.
- Climate warming might cause an increase in D_{ws} at mid-latitudes, resulting in functionally cooling environment for organisms depending on **subnivium**.

References:
 Hori M. et al. (2017) A 38-year (1978-2015) Northern Hemisphere daily snow cover extent product derived using consistent objective criteria from satellite-borne optical sensors. *Remote Sensing of Environment*, 191, 402-418.
 Kim Y. et al. (2017) An extended global Earth system data record on daily landscape freeze/thaw status determined from satellite passive microwave remote sensing. *Earth System Science Data*, 9, 133-147.
 Zhu L. et al. (2017) Characterizing global patterns of frozen ground with and without snow cover using microwave and MODIS satellite data products. *Remote Sensing of Environment*, 191, 158-178.

Red fox population in Russia



Contact information
 Likai Zhu
 Department of Forest and Wildlife Ecology
 University of Wisconsin-Madison
 Madison, WI 53706

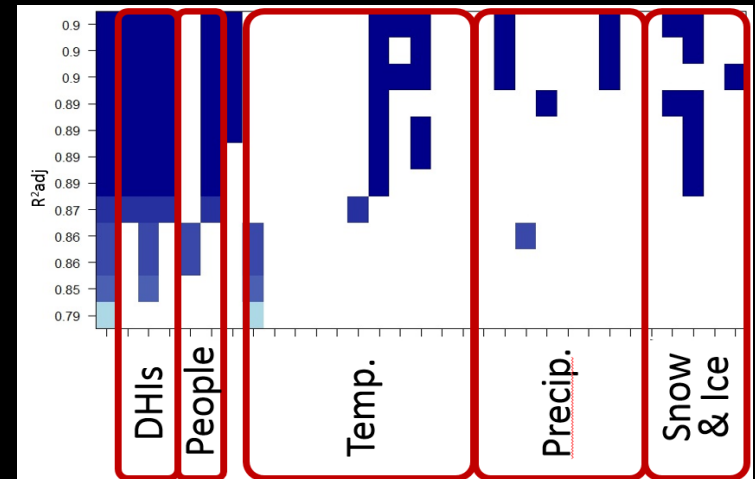
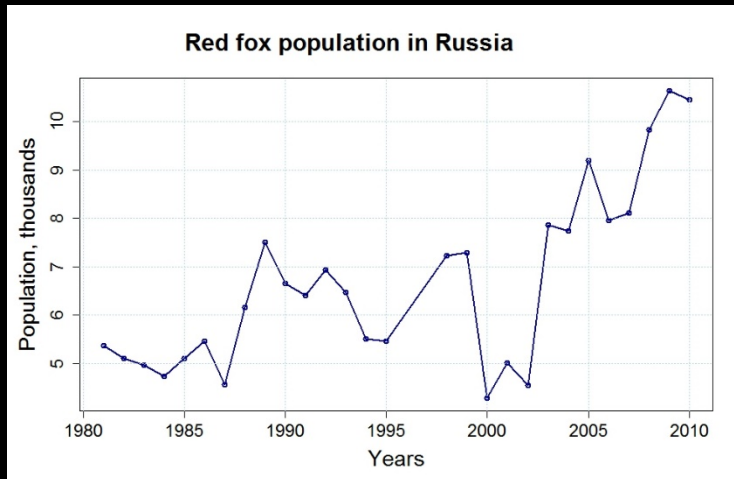
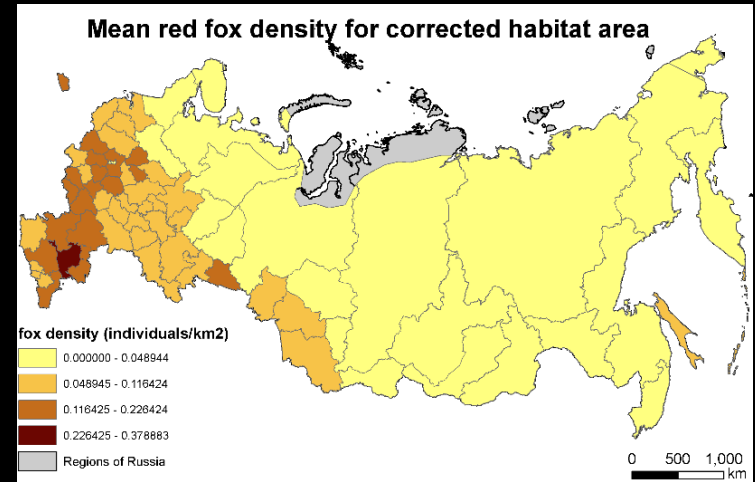
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 UNIVERSITY OF WISCONSIN-MADISON
 Tel: +1-608-263-4150
 E-mail: lzhu6@wisc.edu
 http://silvis.forest.wisc.edu

Acknowledgements

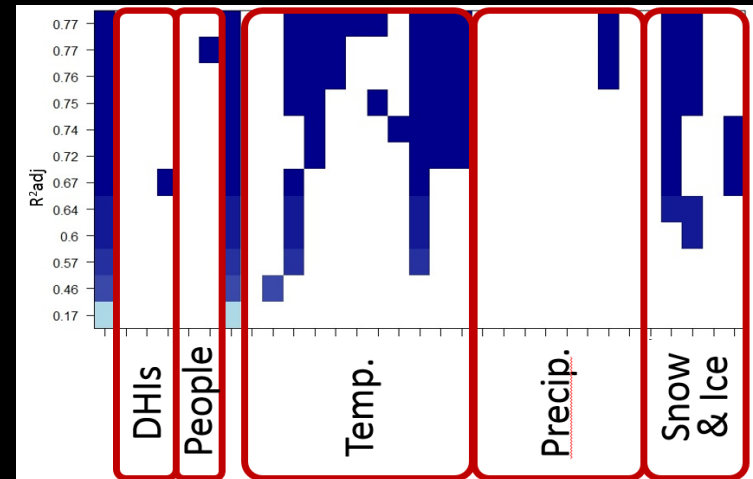
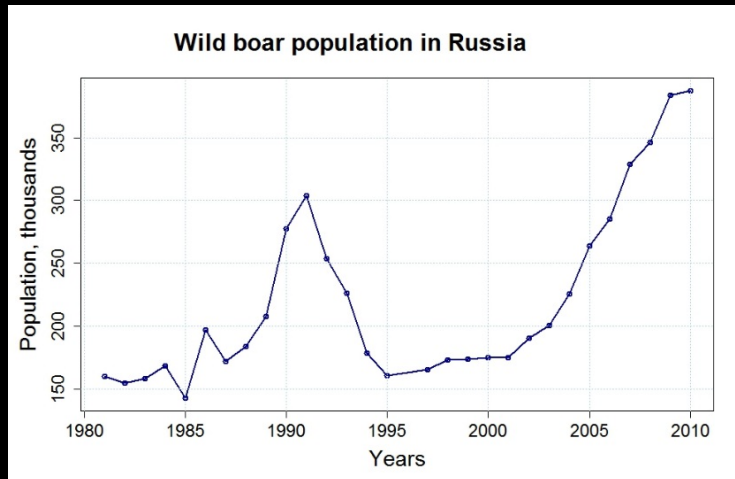
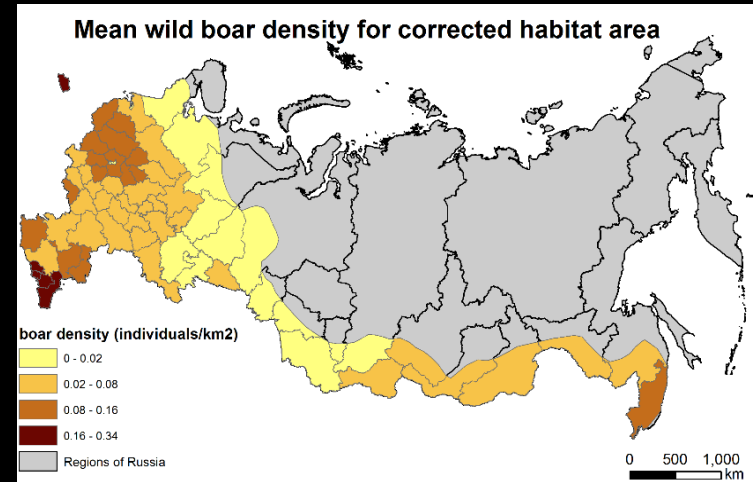
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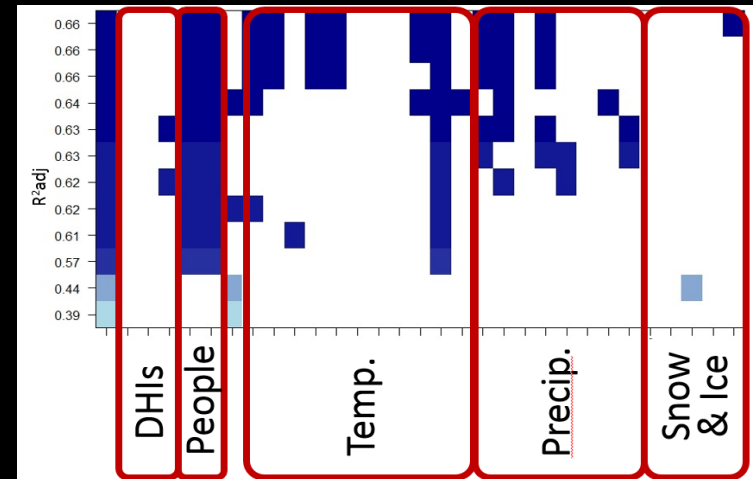
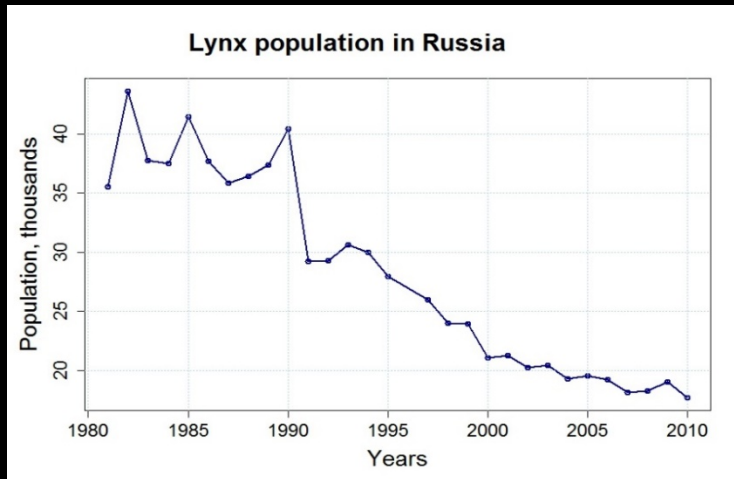
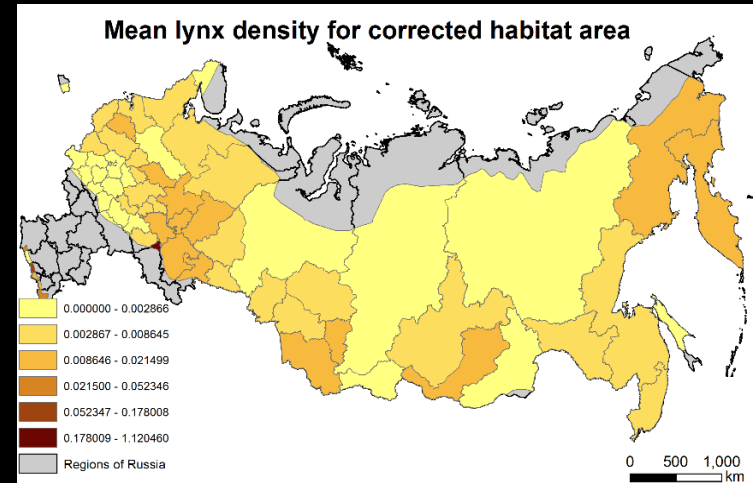
DHIs and abundances



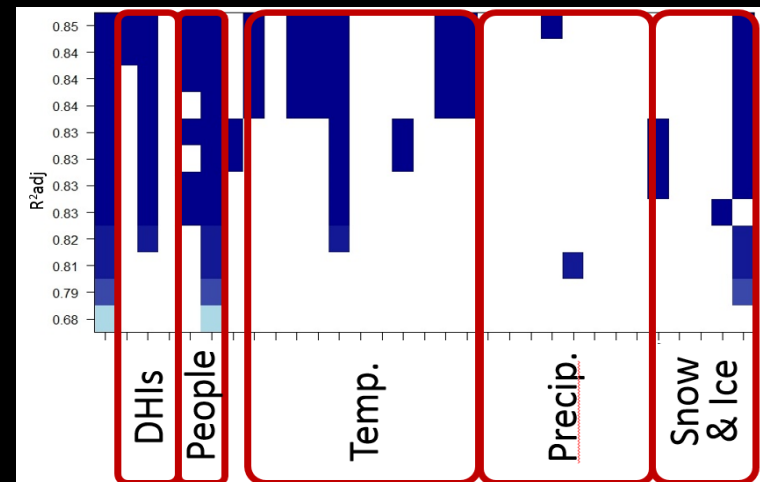
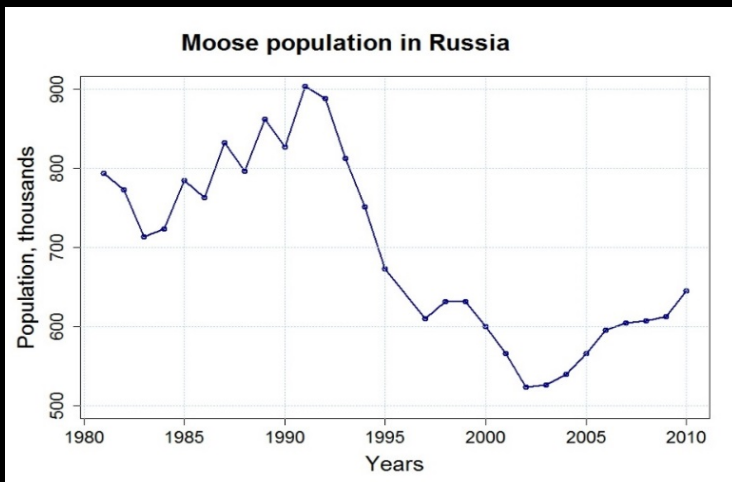
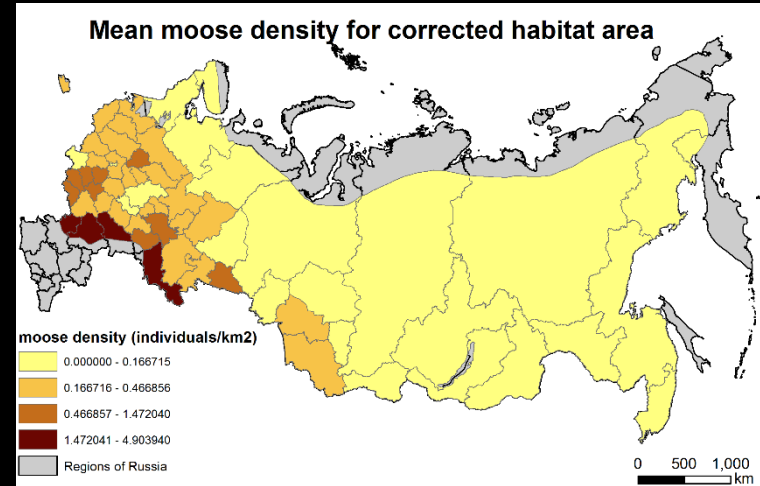
DHIs and abundances



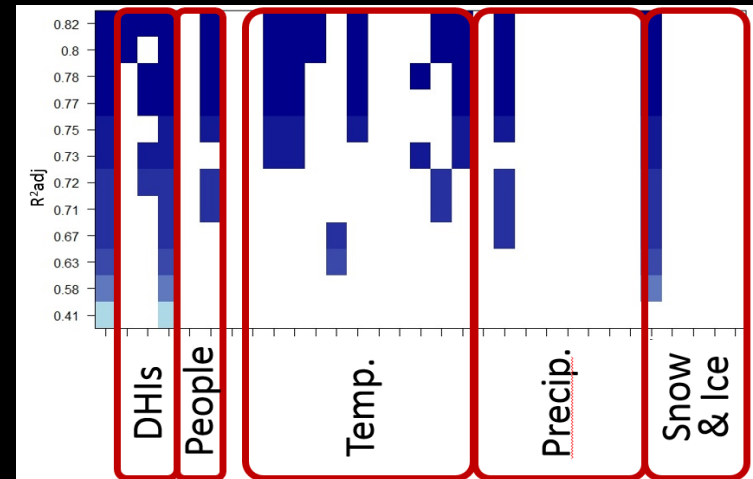
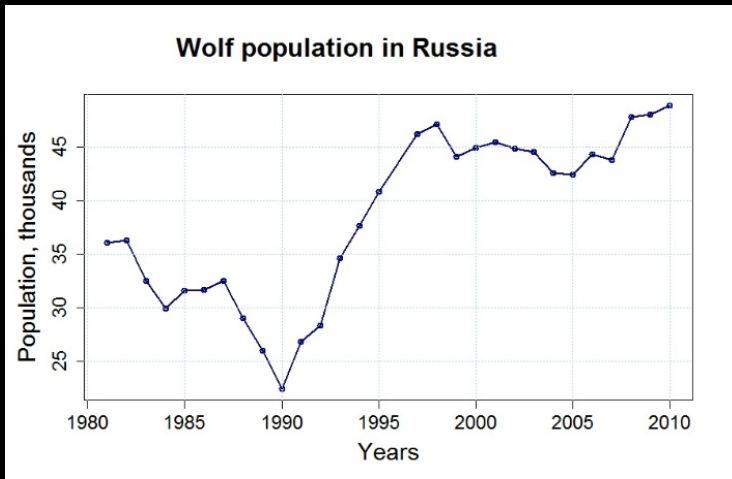
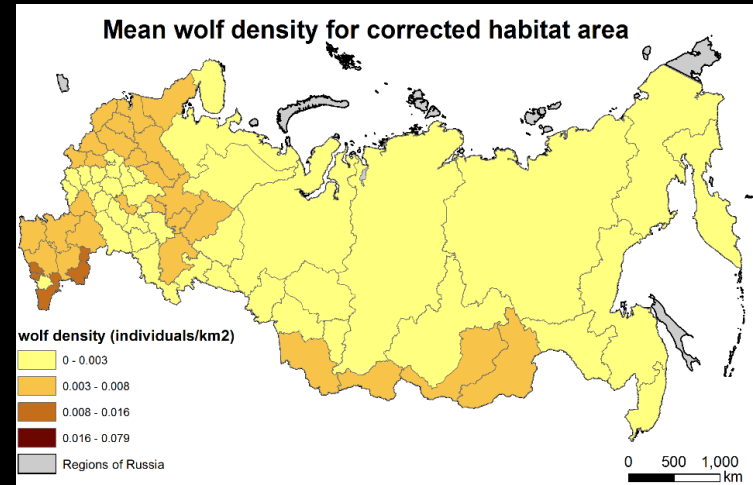
DHIs and abundances



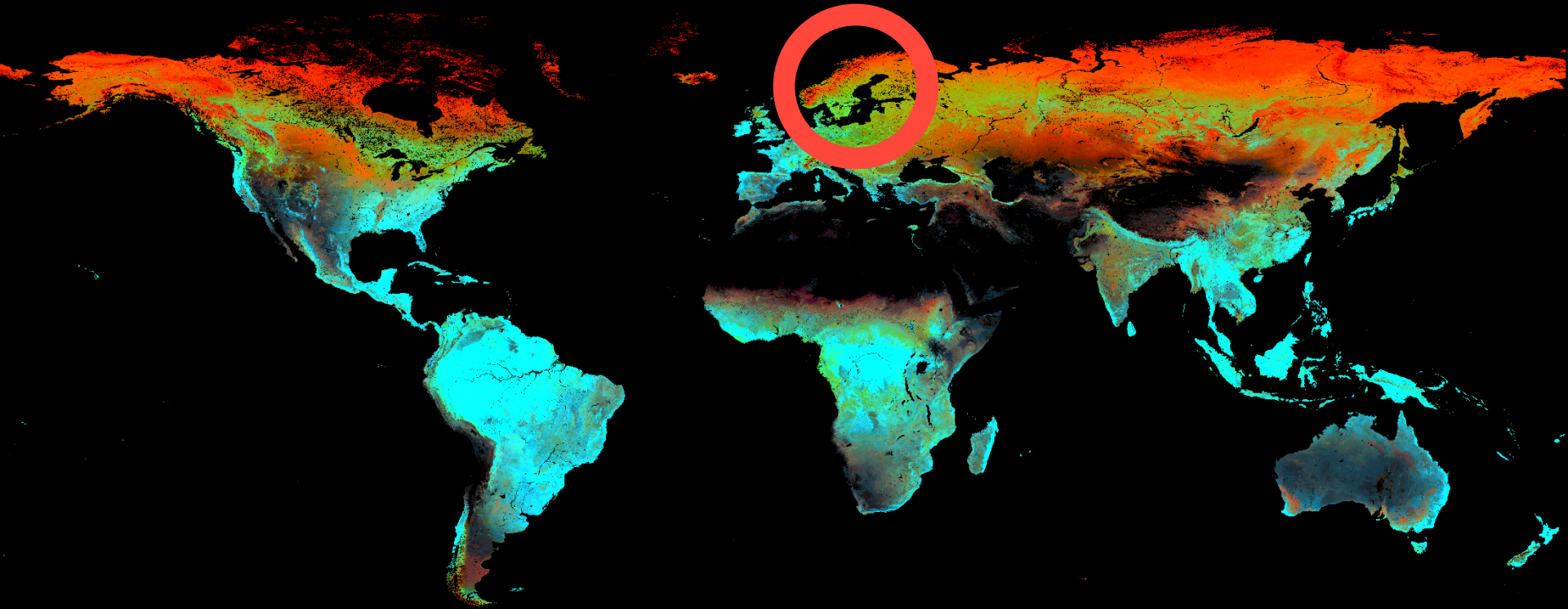
DHIs and abundances



DHIs and abundances



DHIs and abundances



Composite FPAR DHIs

DHIs and abundances



DHIs and abundances

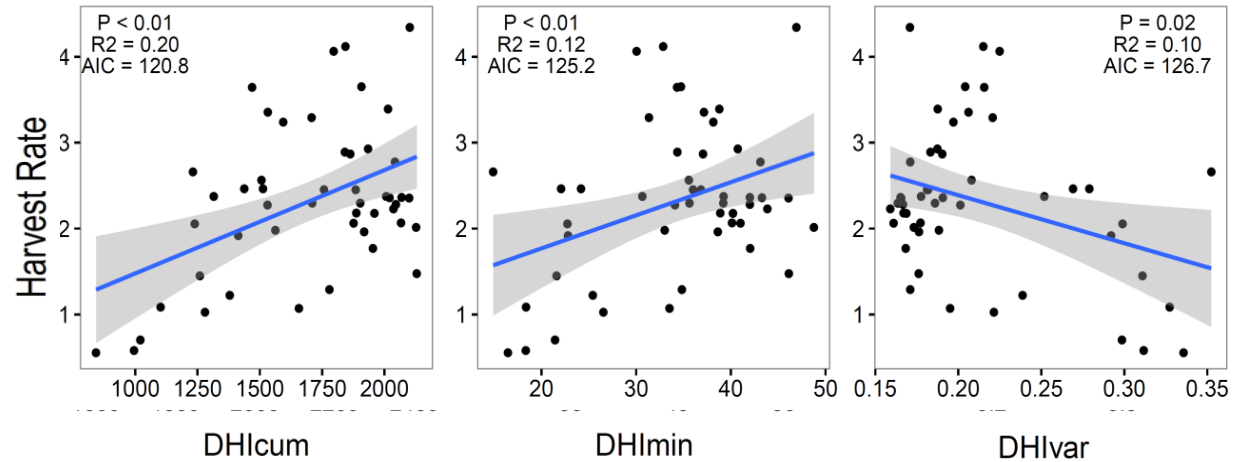


DHIs and abundances

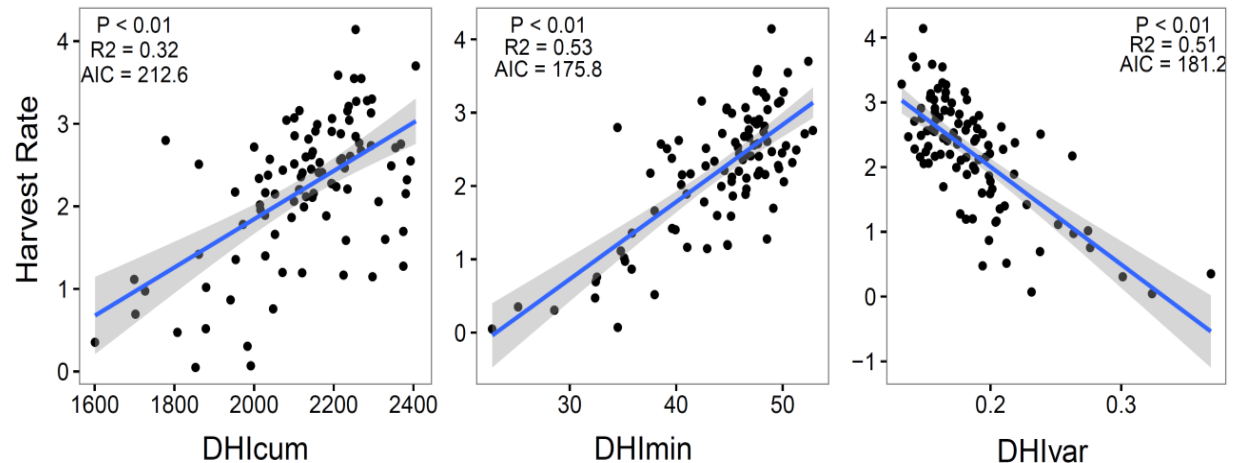


DHIs and abundances

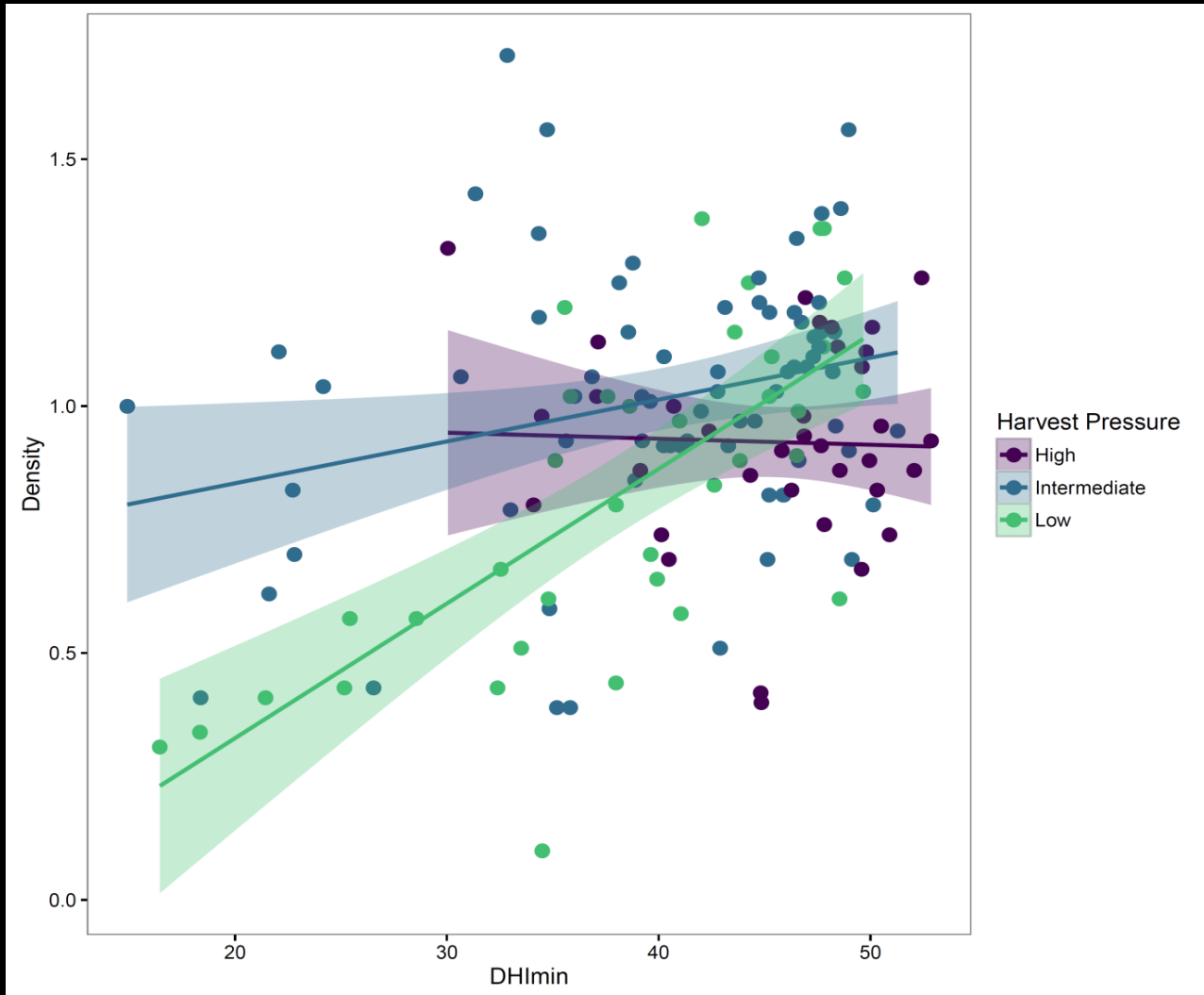
Northern
Sweden:
Low
productivity



Southern
Sweden:
High
productivity

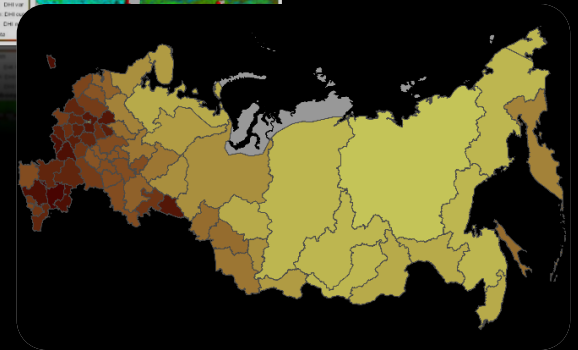
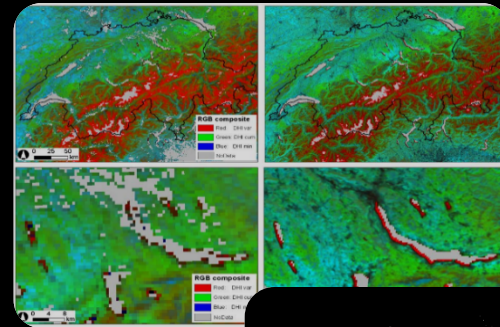
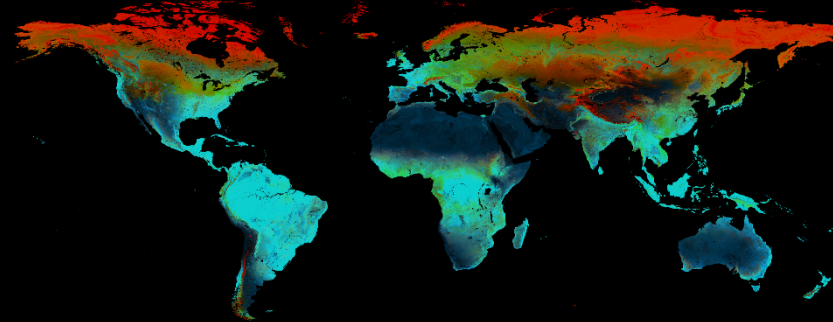


DHIs and abundances



Outline

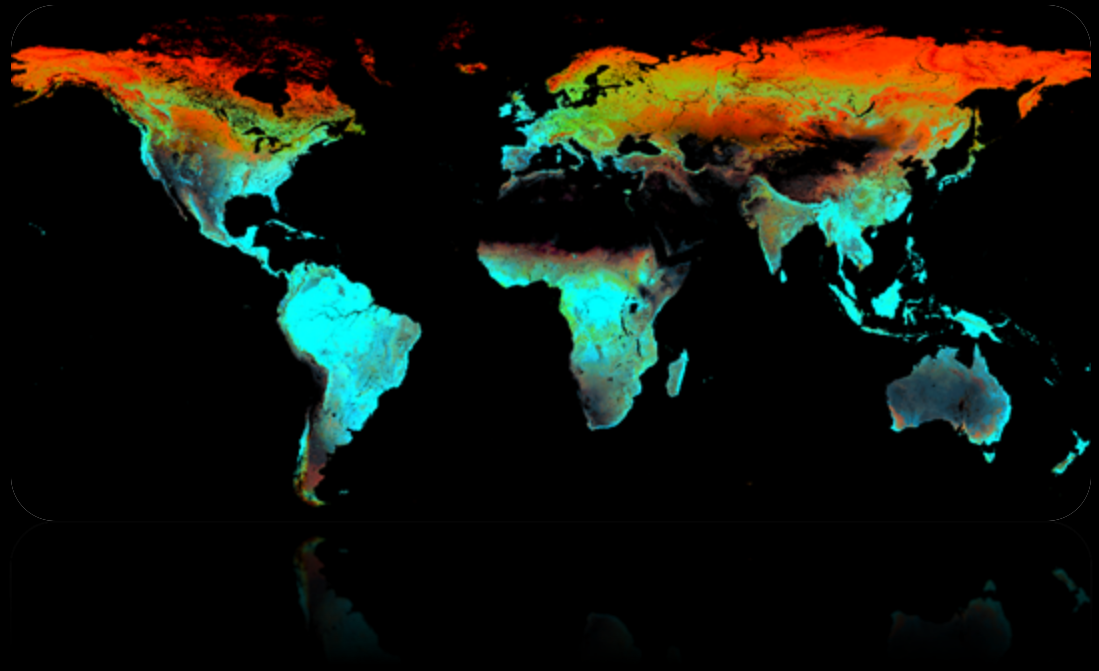
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Conclusions

I. Background

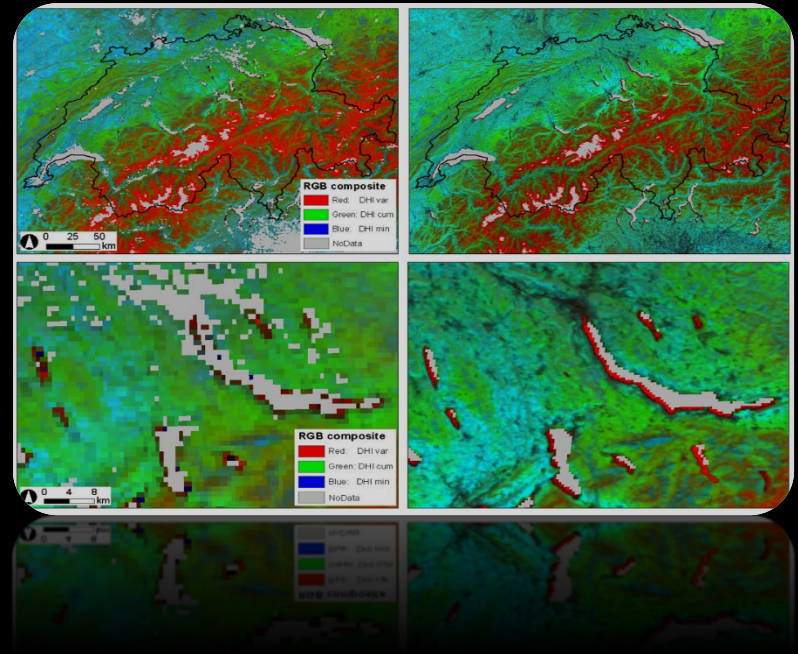
- The DHIs are based on biodiversity theory
- Three indices of productivity that are key for biodiversity



Conclusions

II. Datasets: completed

- Composite DHIs
- Annual DHIs
- Available for you!



Conclusions

III. DHIs and biodiversity

- Well correlated with global species richness
 - All three DHIs matter
- Well correlated with wildlife abundances
 - DHIs contribute to multivariate models
- Well correlated with predation rates
 - In highly productive areas, as they should

A world map with a color-coded overlay representing forest data. The overlay uses a color scale from blue (low) to red (high), with yellow and green in between. The highest concentrations (red) are visible in North America, Europe, and parts of Asia. The map is set against a black background.

silvis.forest.wisc.edu/data/DHIs
radeloff@wisc.edu

Thanks!

DHIs and abundances

	Cum DHI	Min DHI	Var DHI	Human	Elevation	Temp.	Precip.	Snow/ Ice	R ² _{adj}
Brown bear					+	+	+	+	0.77
Hare		+		+		+	+	+	0.94
Lynx				+	+	+	+		0.67
Red fox	+	+	+	+	+	+		+	0.90
Wild boar				+	+	+	+	+	0.79
Roe deer				+		+	+	+	0.66
Moose	+	+		+		+	+	+	0.85
Wolf	+	+	+	+		+	+	+	0.82