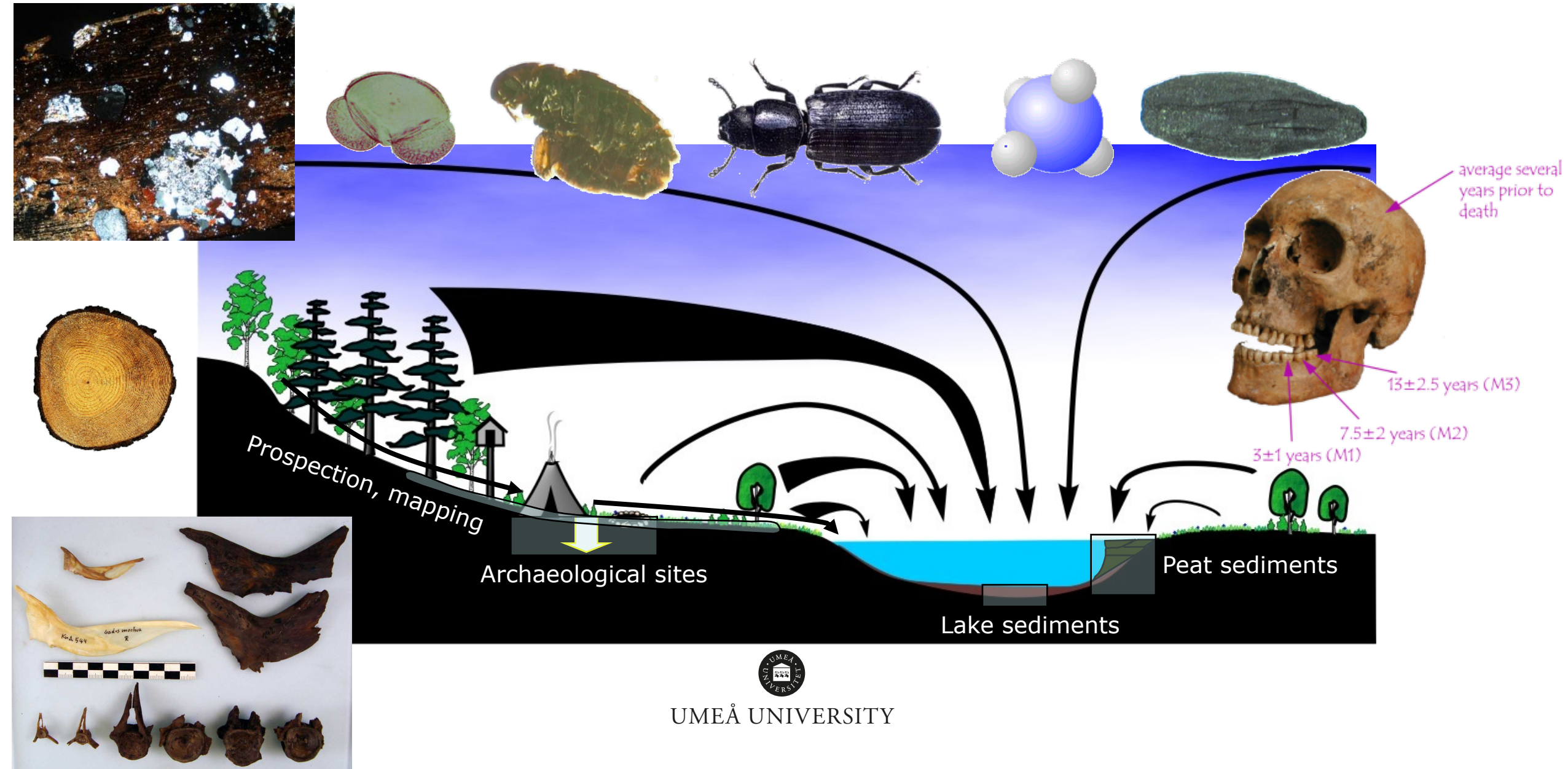


Data Analysis in Palaeoecology and Environmental Archaeology

Philip Buckland
Environmental Archaeology Lab.
Dept. Historical, Philosophical & Religious Studies
Umeå University, Sweden



Environmental change and human activity leave (proxy) evidence



Evidence preserved & sampled in many different ways



Environmental Archaeology

Analyses create lots of data and metadata...



gs	GL25	GL20	GL15	GL10	GL5	GL0	GL-0	GL-10
Philonthus_spp.							3	10
Ocypus_fuscatus Grav.							1	
Ocypus_fortunatum (Woll.)							2	
Quedius_spp.							2	4
Mycetoporus_sp.		1	1				3	2
Tachyporus_spp.		1	3			1	8	7
Tachinus_signatus Grav.								3
Tachinus_corticinus Grav.		1						
Tachinus_elongatus Gyll.							1	1
Gymnusa_brevicollis (Payk.)								1
Aleocharinae_gen. indet.	15	5	4	8	11	4	37	59
Biblopectus_sp.							1	
Tychus_niger (Payk.)						1	1	
Cantharis_sp.				1		1		
Agriotes_sp.						1	7	
Corymbetes (s.l.)_sp.							2	

Sample Title	Conc.	Std Err.	Mean	Date	Time	k -500	k	Resultat
Athous_haemorrhoida	Std 500 1	461.52	0	0.649	2008-04-24	10:32:34	463	499
Hypnoidus_riparius (F)	Std 500 2	462.24	0	0.65	2008-04-24	10:32:47	464	500
Hypnoidus_rivularius (F)	Ref UMD 1	32.064	0	0.048	2008-04-24	10:34:03	34	37
Cyphon_sp.	Ref BRA 1	143.03	0	0.203	2008-04-24	10:34:19	145	156
Dryops_spp.	07_0052 CitP 1	6.4995	0	0.012	2008-04-24	10:34:43	9	9
	07_0052 CitP 2	13.783	0	0.022	2008-04-24	10:34:58	16	17
Elmis_aenea (Müll.)	07_0052 CitP 3	17.639	0	0.027	2008-04-24	10:35:12	19	21
Esolus_parallelipiped	07_0052 CitP 4	27.137	0	0.041	2008-04-24	10:35:28	29	32
Oulimnius_tuberculatu	07_0052 CitP 5	23.424	0	0.036	2008-04-24	10:35:42	26	28
	07_0052 CitP 6	11.998	0	0.02	2008-04-24	10:35:58	14	15
Limnius_volckmari (Pe	07_0052 CitP 7	25.137	0	0.038	2008-04-24	10:36:13	27	29
Normandia_nitens (Mu	07_0052 CitP 8	40.919	0	0.06	2008-04-24	10:36:28	43	46
Georissus_crenulatus	07_0052 CitP 9	16.425	0	0.026	2008-04-24	10:36:42	19	20
	07_0052 CitP 10	26.209	0	0.039	2008-04-24	10:36:56	28	30
Heterocerus_sp.	07_0052 CitP 11	13.926	0	0.022	2008-04-24	10:37:11	16	17
Simplocaria_semistria	07_0052 CitP 12	31.136	0	0.046	2008-04-24	10:37:28	33	35
Simplocaria_metallica	07_0052 CitP 13	5.9282	0	0.011	2008-04-24	10:37:41	8	8
	07_0052 CitP 14	10.855	0	0.018	2008-04-24	10:37:52	13	14

Bessastadir, Reykjavik, Iceland

Medieval midden deposits.

Note: Diptera were not identified from all samples.

Note: House floors in medieval longhouse and kitchen - unpublished.

Lat: 64°5'60"N Long: 22°0'0"W Altitude: 10m

Identified by: Buckland, Sadler, Skidmore

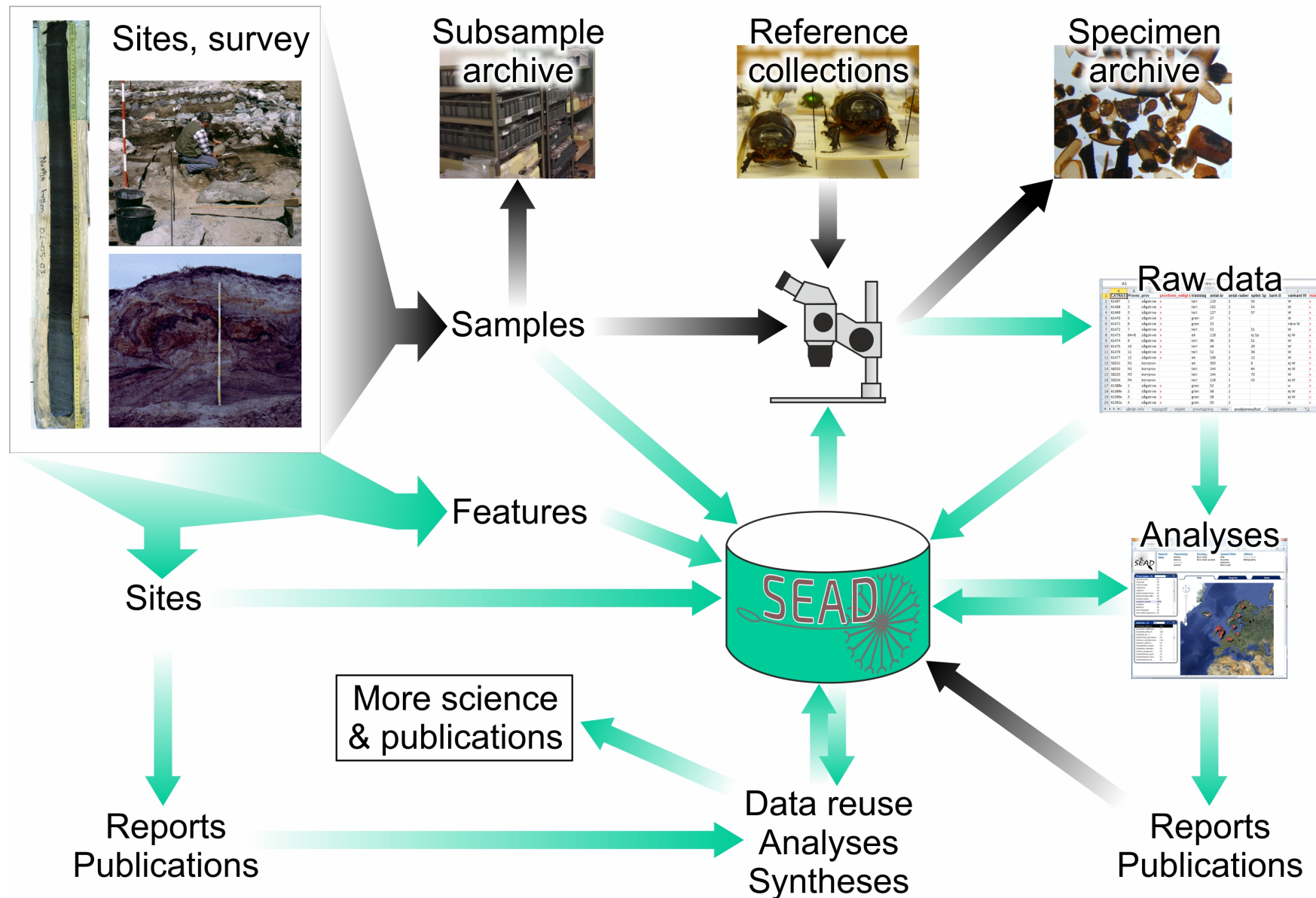
Specimens stored at Edinburgh University, UK

Search Result species found at site:

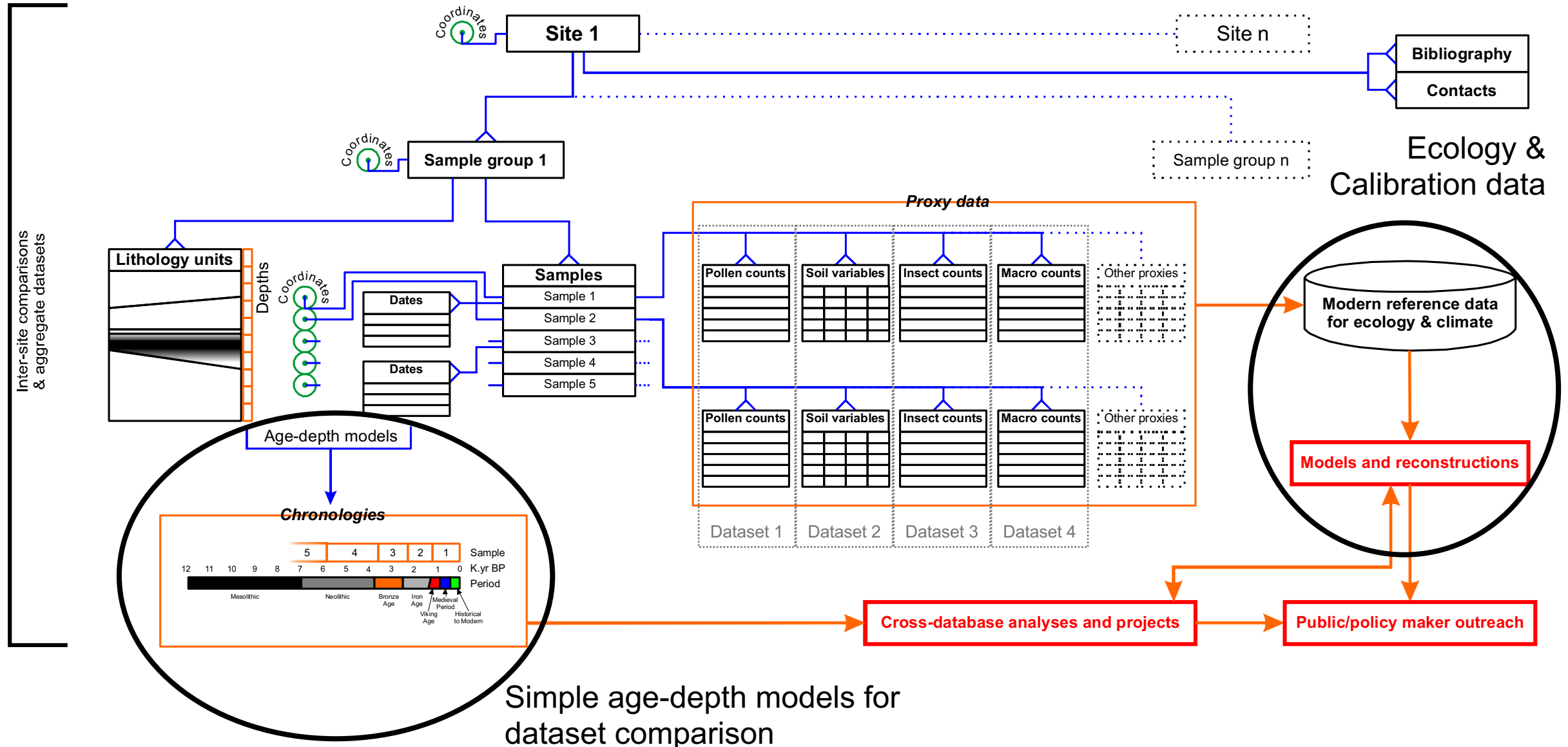
515.0010025	PEDICULIDAE	Pediculus humanus L.
1081.0080010	HIPPOBOSCIDAE	Melophagus ovinus (L.)
506.0010030	BOVICOLIIDAE	Bovicola ovis (L.)

3	12	13	12
4	31	33	31
6	10	11	10
7	29	31	29
8	36	39	36
9	117	126	117
1	76	82	76
2	79	85	79
3	48	52	48
5	29	32	29
1	31	33	31
2	42	45	42
3	31	34	31
4	43	46	43
4	39	42	39
6	41	45	41
7	46	50	46
9	64	68	64

Research Data Infrastructure: The Strategic Environmental Archaeology Database (SEAD)

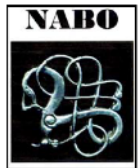
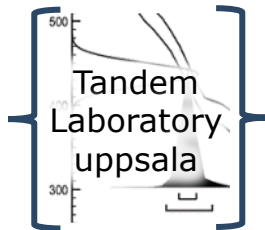
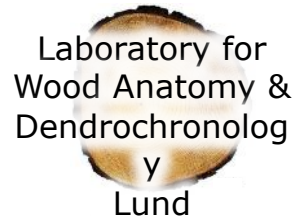


Research data model



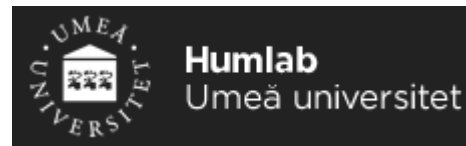
Open access database network

Data providers/partners, domain science expert

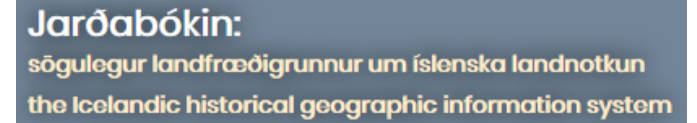


NABONE
ZOOARCHAEOLOGICAL DATABASE
9th Edition

Management, development hosting, maintenance



Data feeds, project links (API, GeoJSON, CIDOC-CRM...)

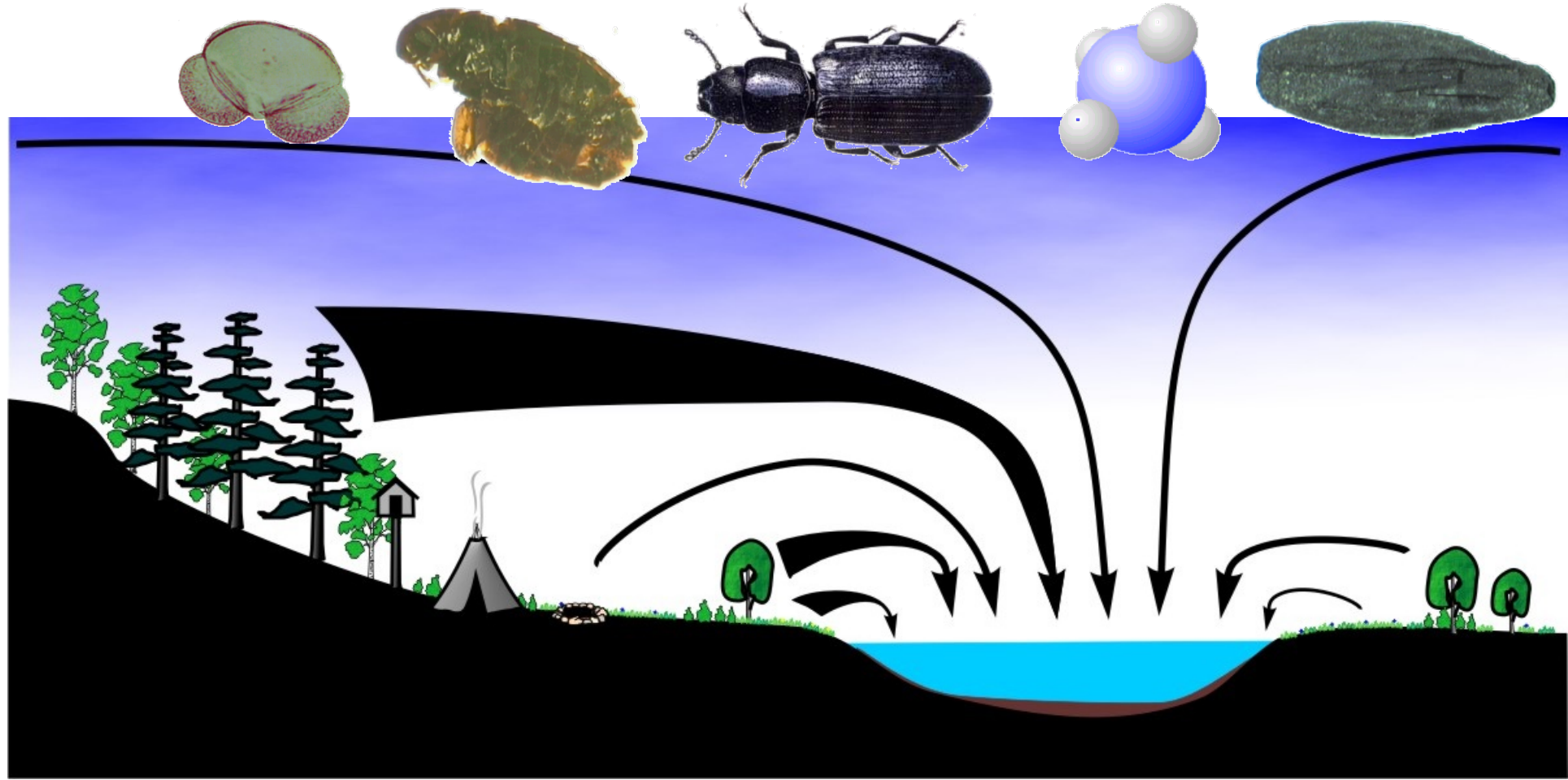


Digital Atlas of the Roman Empire



Environmental/climate reference/calibration data

Species traits, habitats, thermal tolerance, associations...



Summer

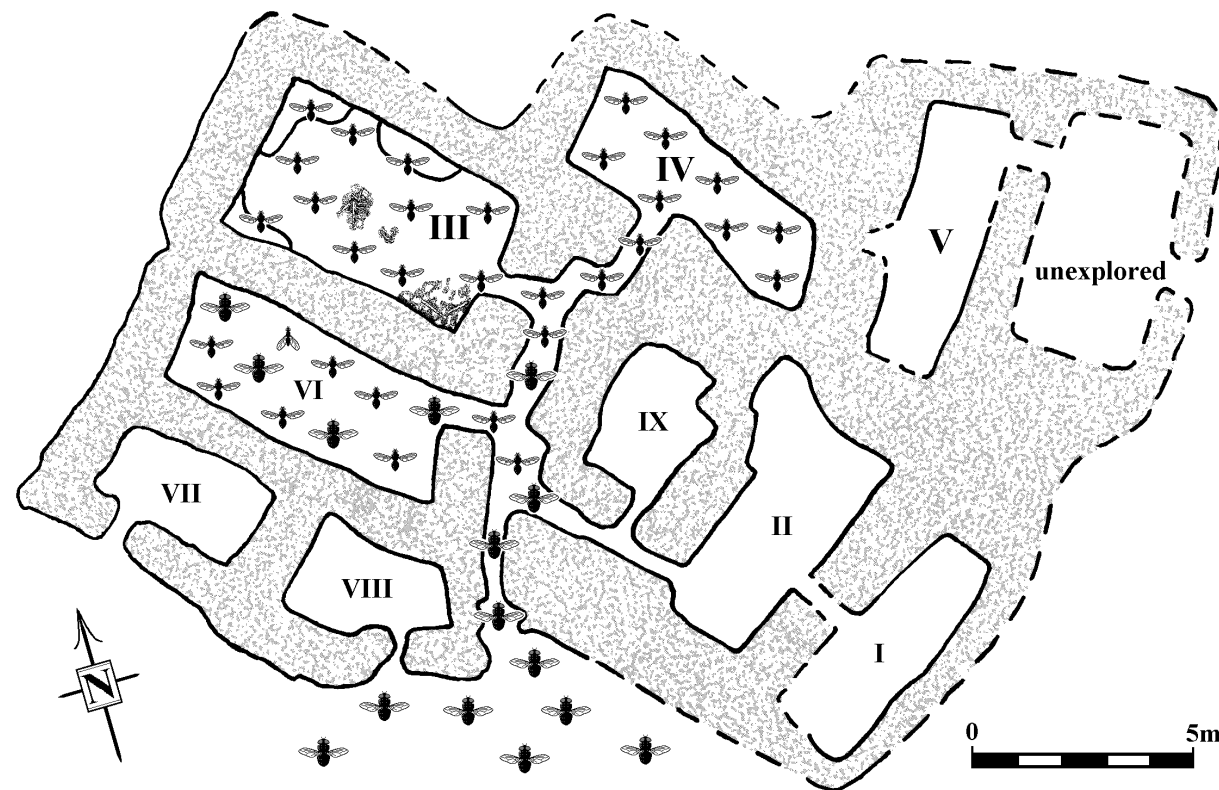
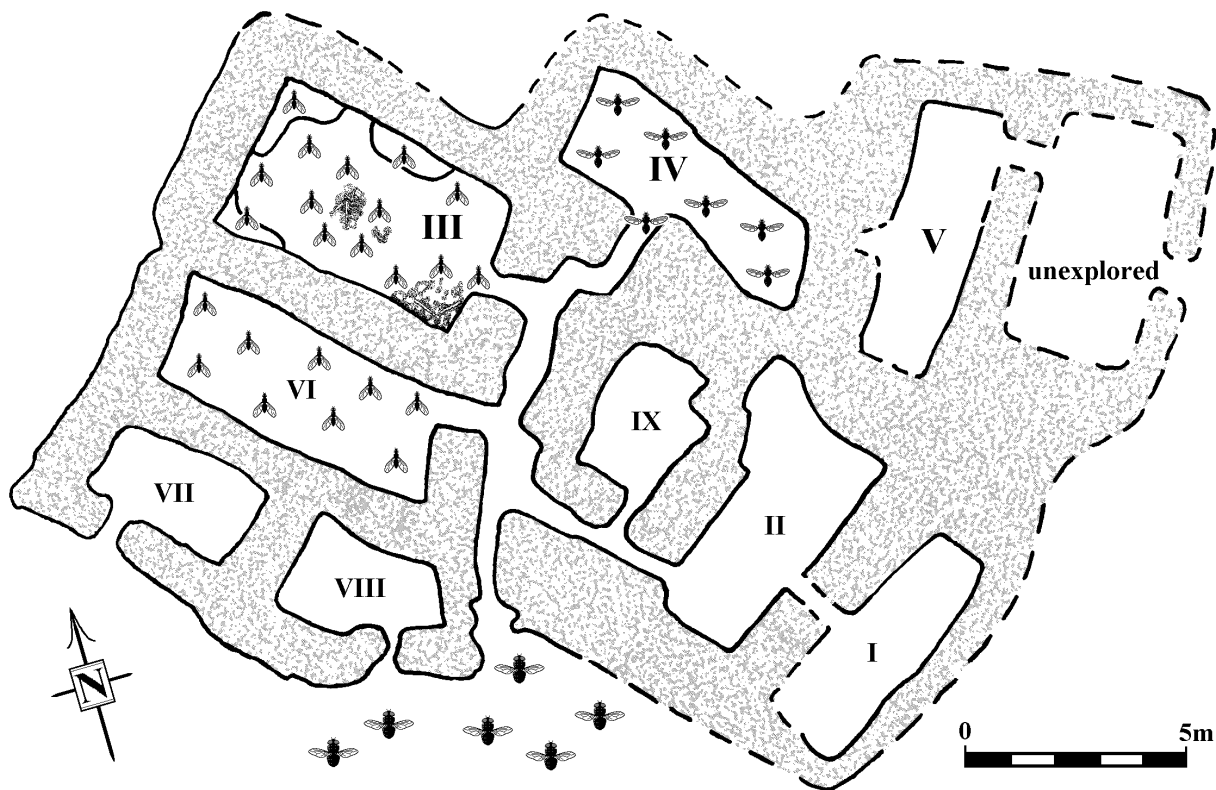


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Winter

Site based spatio-temporal, multivariate data, phases

Dead flies, Viking Age farm, Greenland



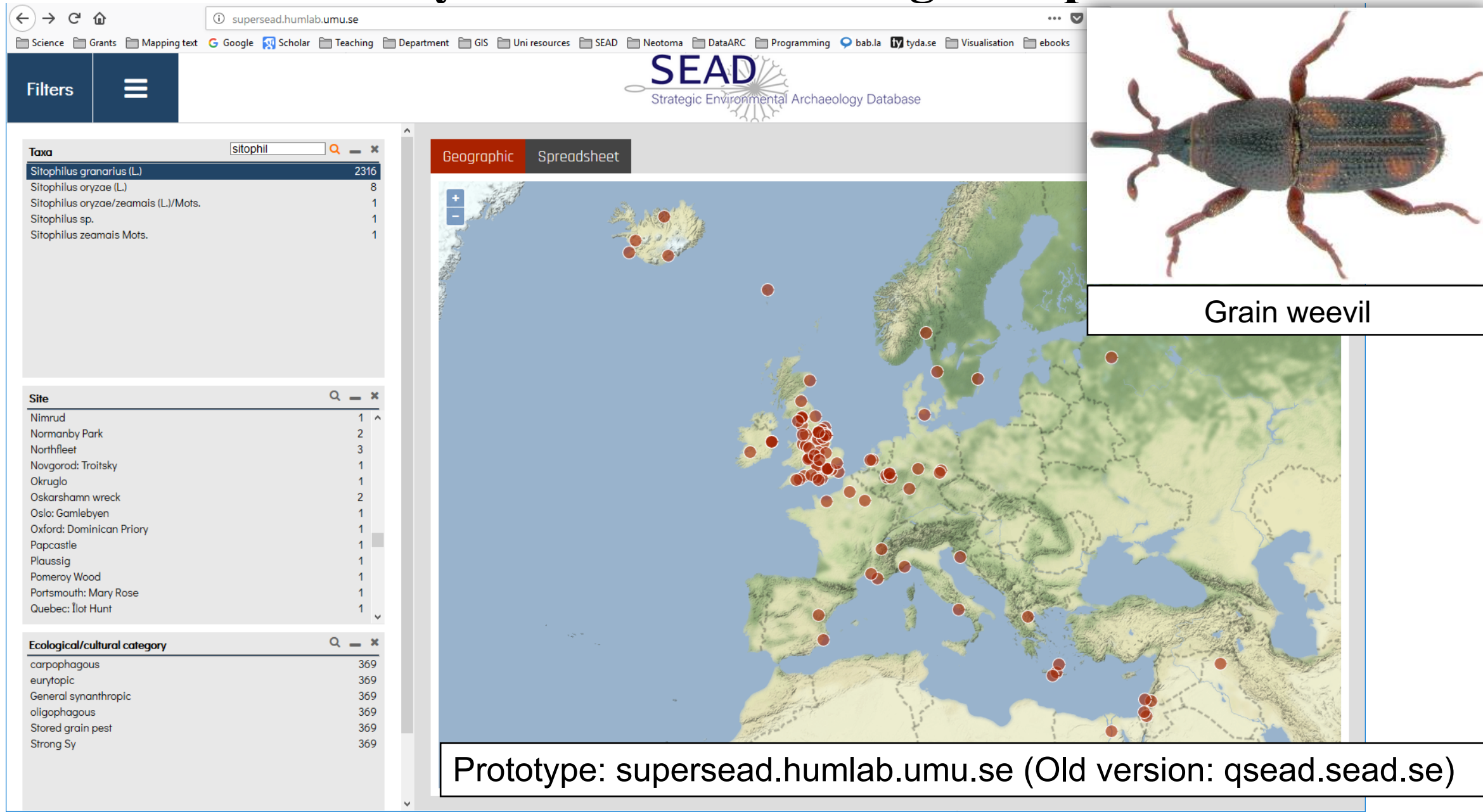
- Warm Temperature fauna (*Telmarina* dominated)
- Cold Tolerant fauna (*Heleomyzid* dominated)
- Exophilic (Outdoor) Necrophagic fauna
- Hearth
- Bench

Occupied - warm in some rooms, carrion outside

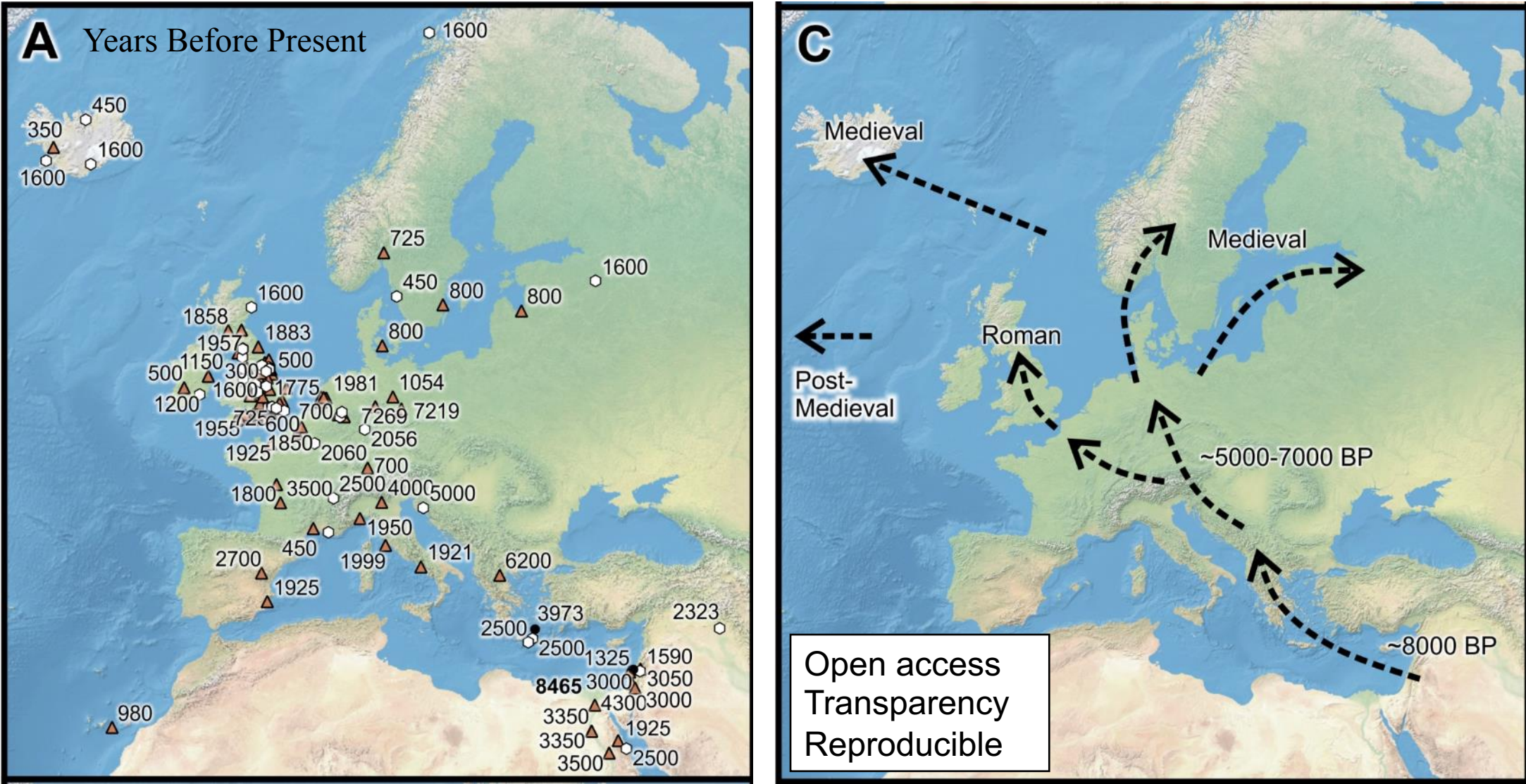
- Warm Temperature fauna (*Telmarina* dominated)
- Cold Tolerant fauna (*Heleomyzid* dominated)
- Exophilic (Outdoor) Necrophagic fauna
- Hearth
- Bench

Abandoned - cold in all rooms, carrion indoors

From many individual finds to global patterns



Dating the spread of agriculture and grain storage from fossil beetles

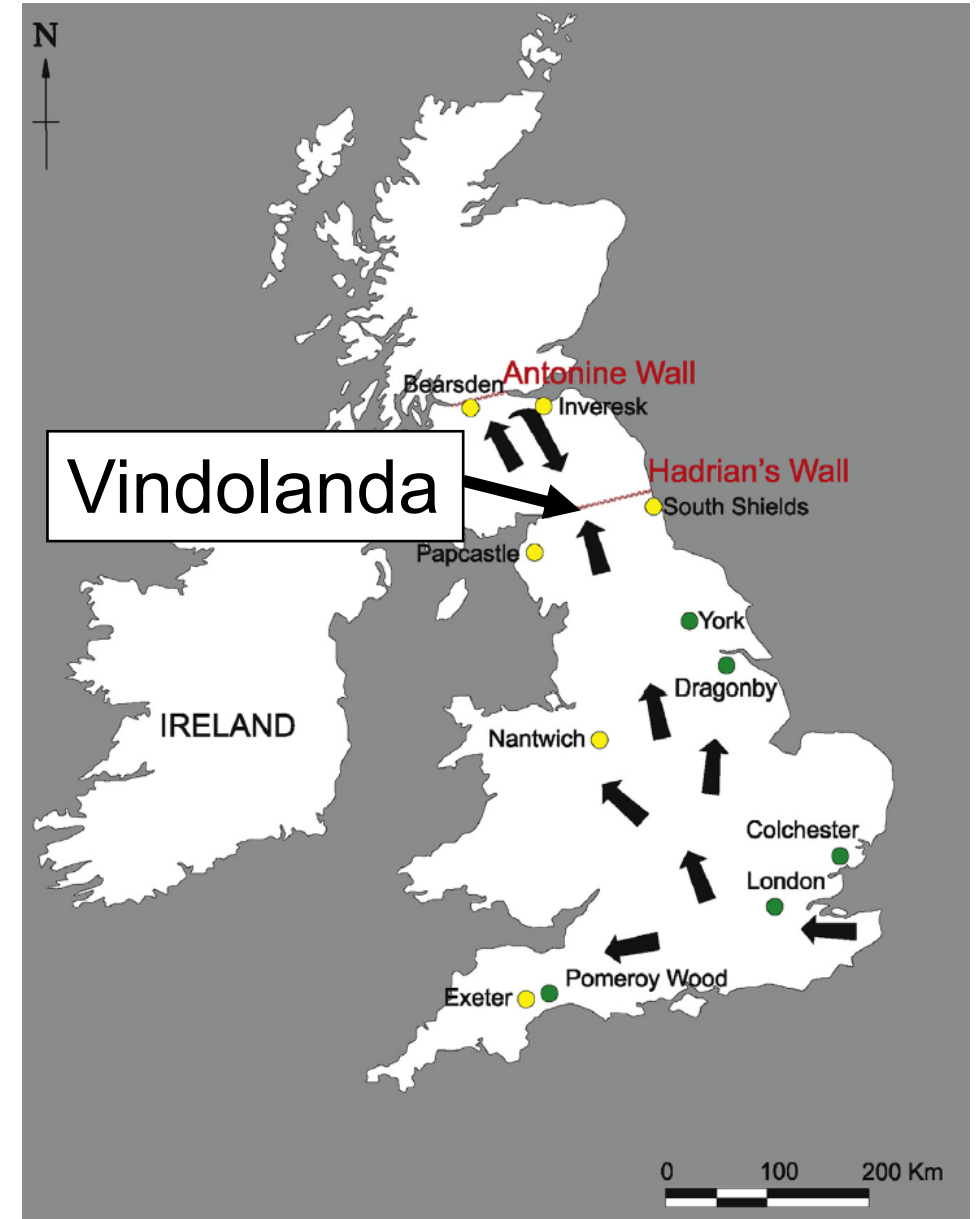
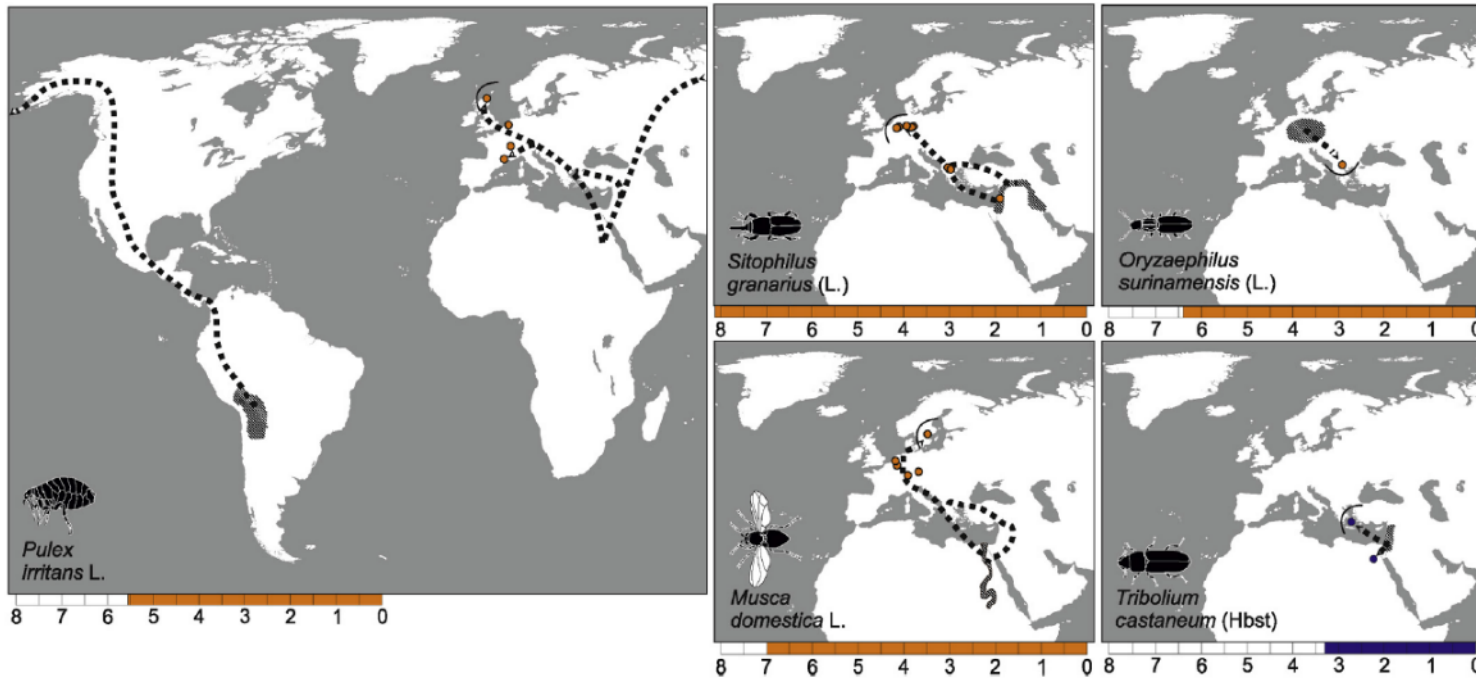


Panagiotakopulu & Buckland 2017 QSR, Buckland, *et al.* 2018 Encyclopedia of Global Archaeology

What have the Romans ever done for us?

“Roman sites with *Sitophilus granarius* L. [and other pests] in Britain indicating the spread of the species with the movement of the Roman army”

Panagiotakopulu, E. and Buckland, P.C., 2017.
QSR 156

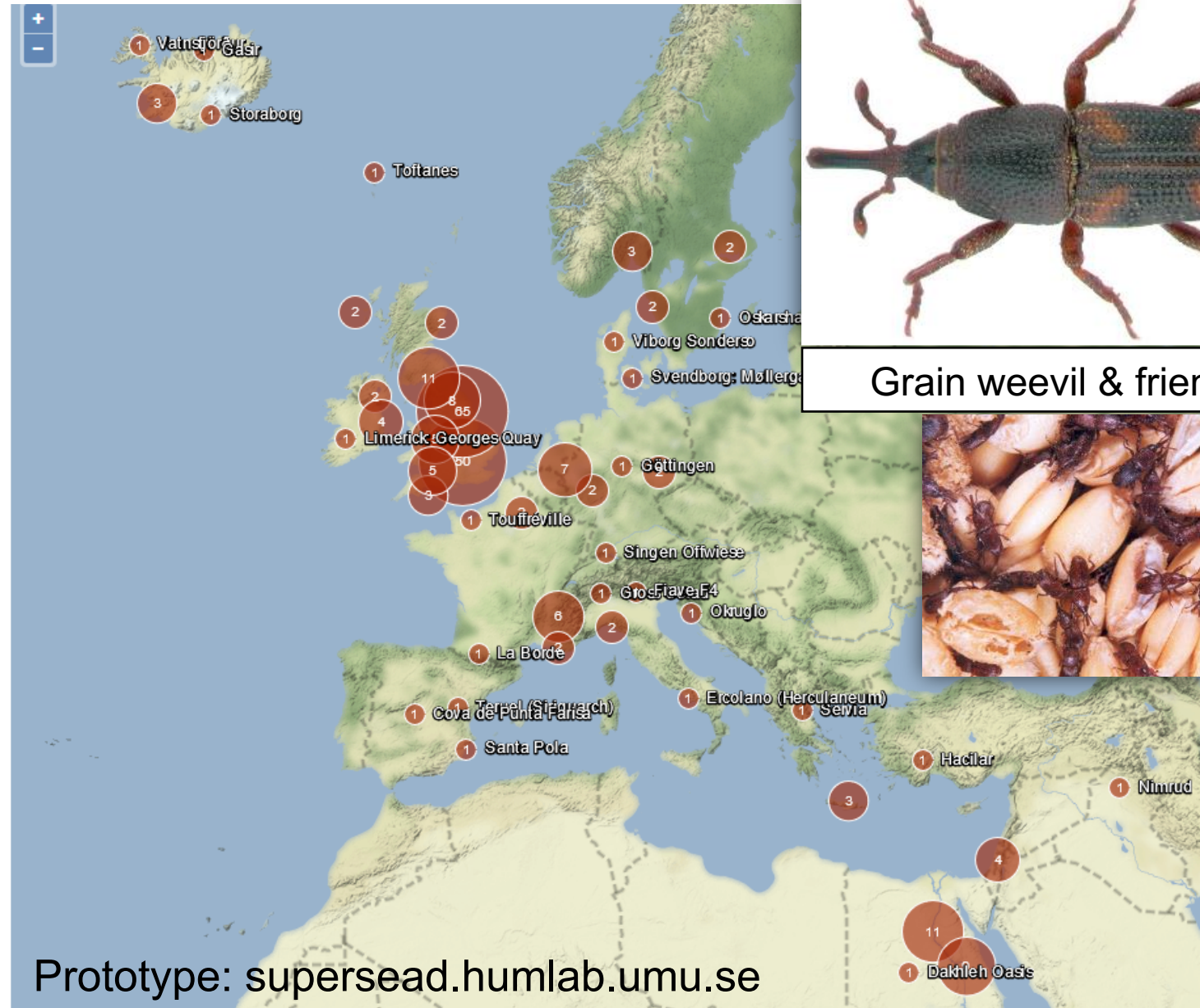


Reversing the questions – look for environments, not species

Ecological/cultural category	
Heathland & moorland	4991
Indicators: Coniferous	226
Indicators: Deciduous	1028
Indicators: Dung	1088
Indicators: Running water	776
Indicators: Standing water	2440
Meadowland	5268
Mould beetles	2417
Open wet habitats	4209
Pasture/Dung	4534
Sandy/dry disturbed/arable	4459
Stored grain pest	666
Wetlands/marshes	5512

Taxa	
Acanthoscelides obtectus (Say)	1
Anthrenus coloratus Reitter	1
Anthrenus sp.	1
Attagenus sp.	1
Callosobruchus maculatus (F.)	1
Cathartus quadricollis (Guérin)	1
Cryptolestes turcicus (Grouv.)	1
Dermestes frischii Kug.	1
Dermestes sp.	3
Dermestes spp.	1
Gibbium psyllodes (Czen.)	1
Gibbium sp.	11
Heterothops praevis Er.	1

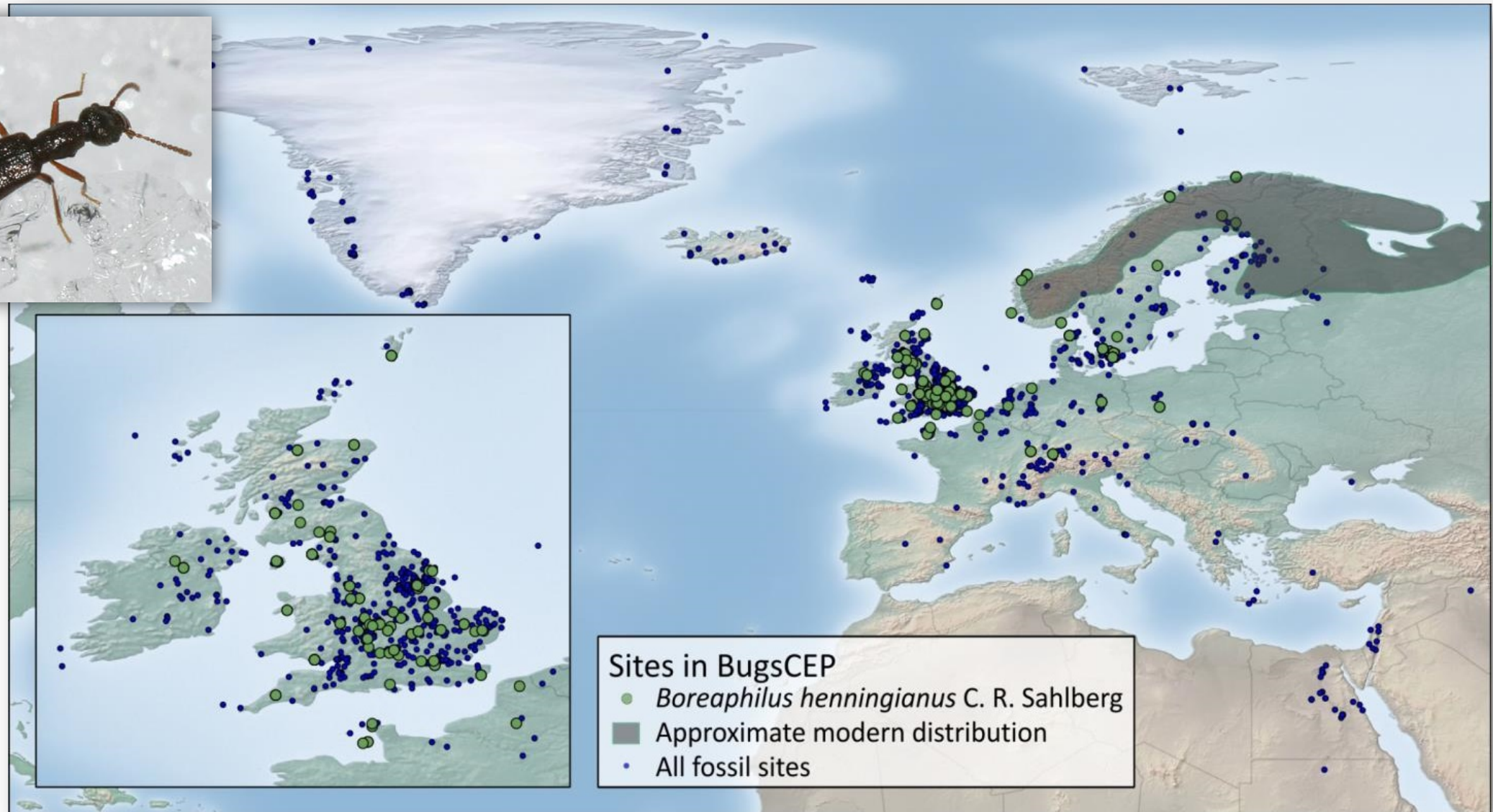
Site	
Aberdeen	7
Aberford: South Dyke	1
Abingdon	1
Akrotiri	13
Alcester: Roman Pit	1
Alcester: Defences	1



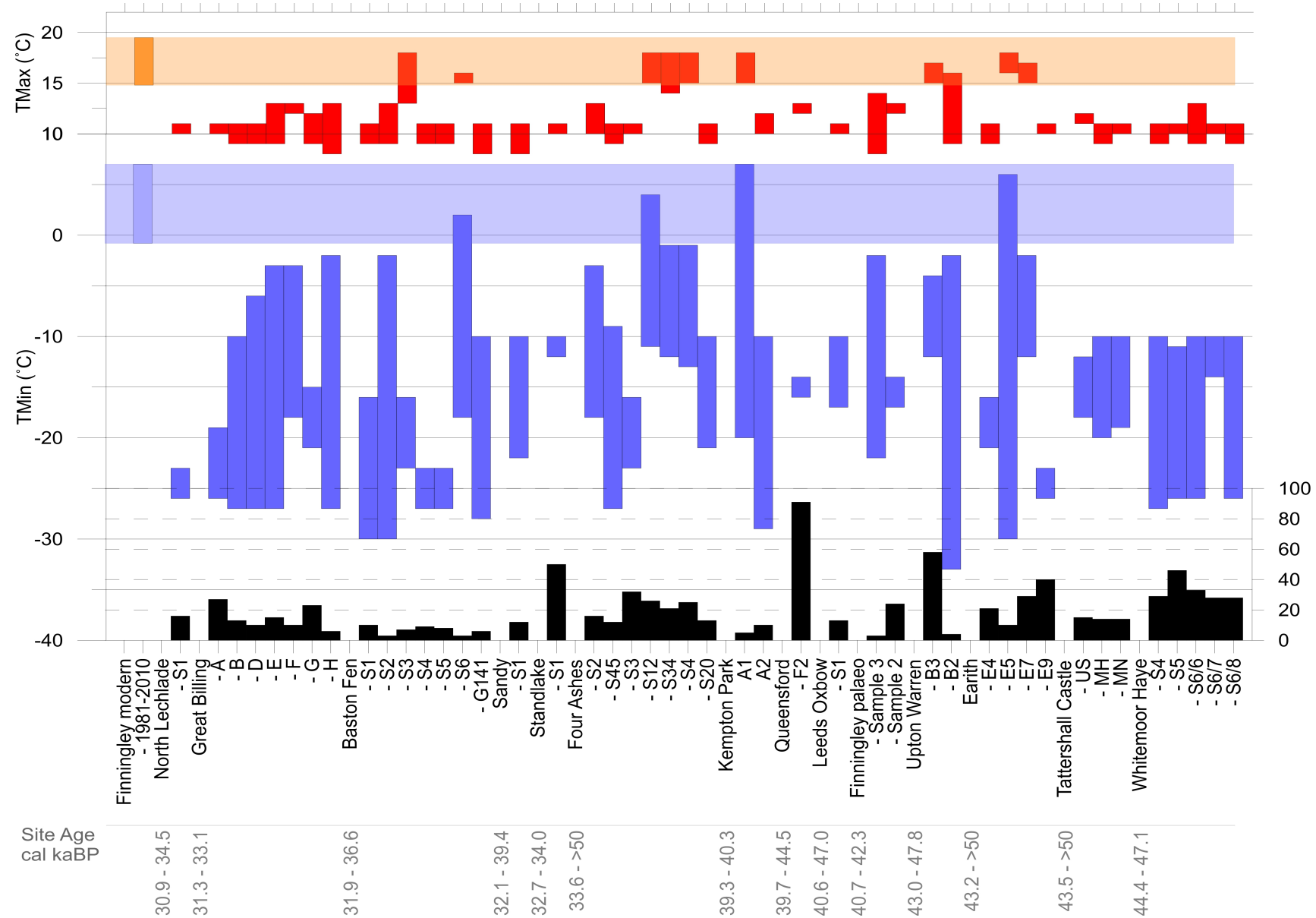
Grain weevil & friends



Simple questions with BIG implications – climate change



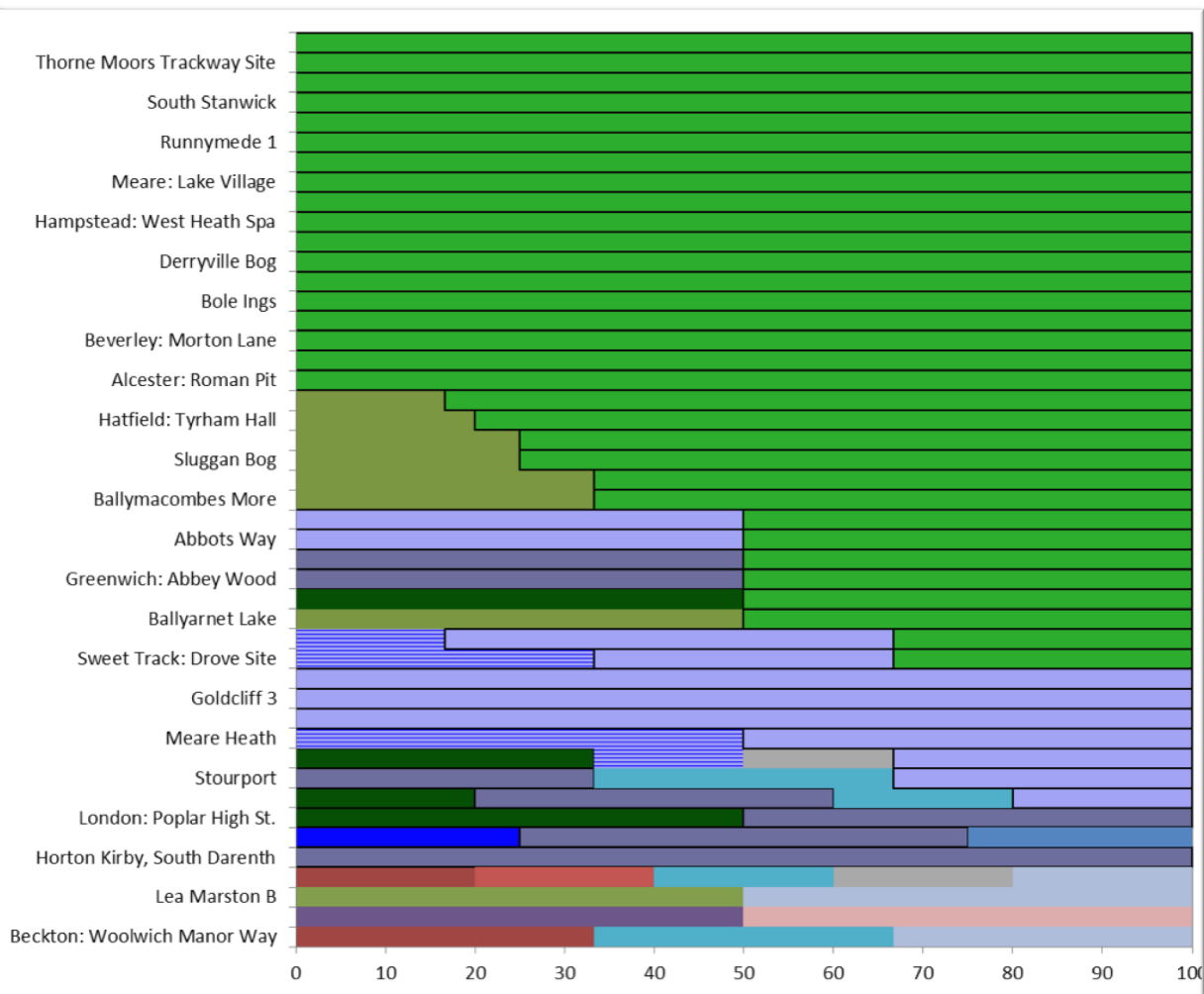
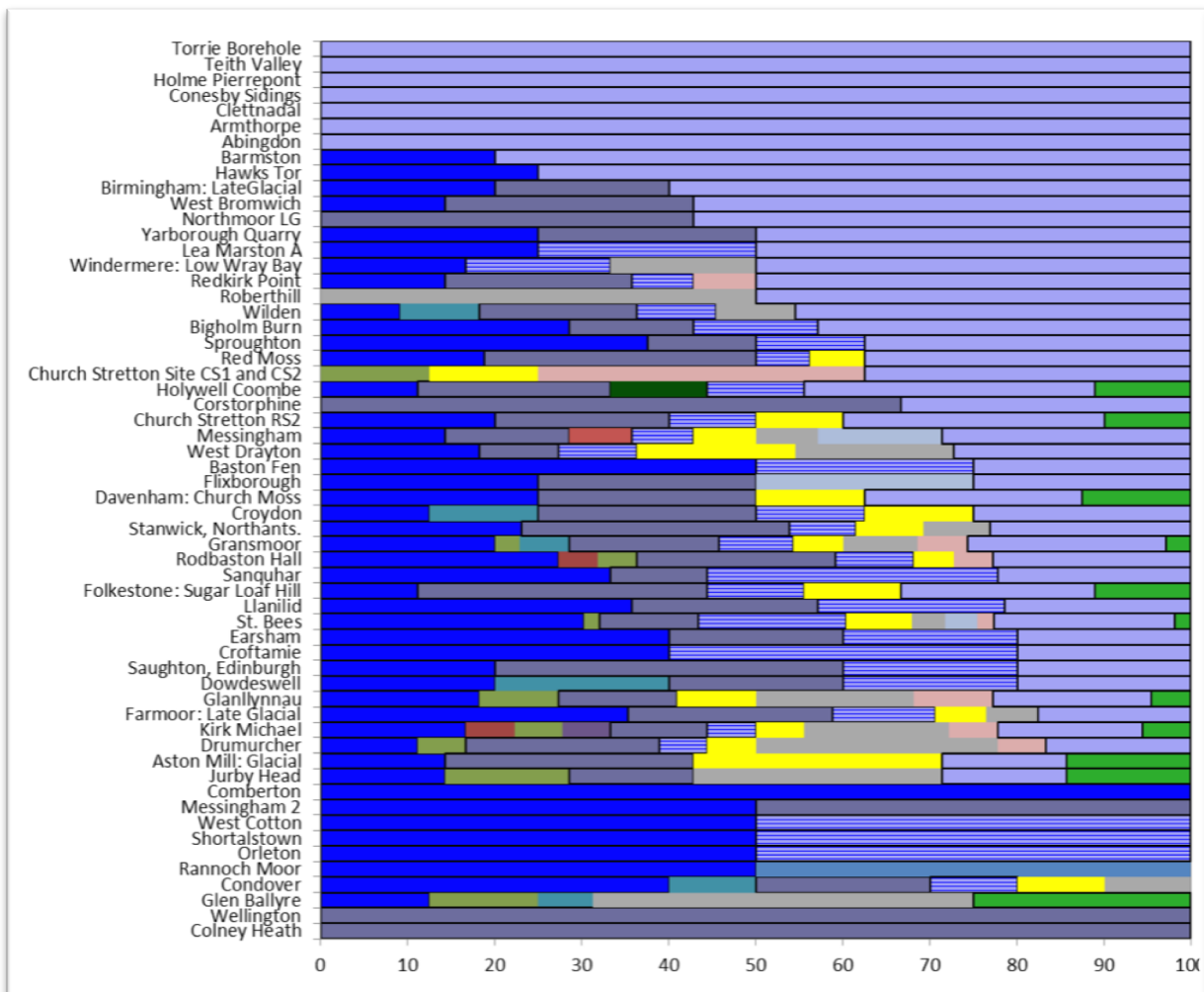
Simple questions with BIG implications – climate change



Environments derived from beetle UK *regional extinctions*

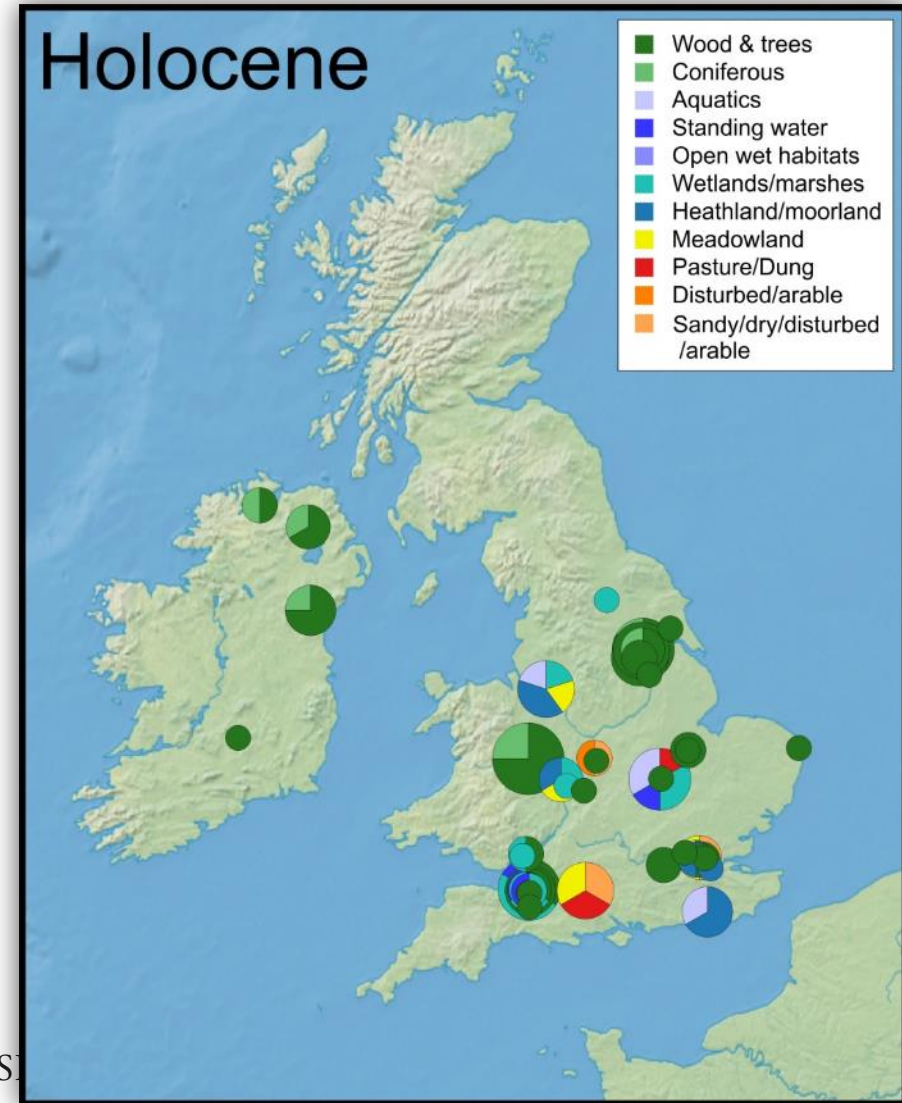
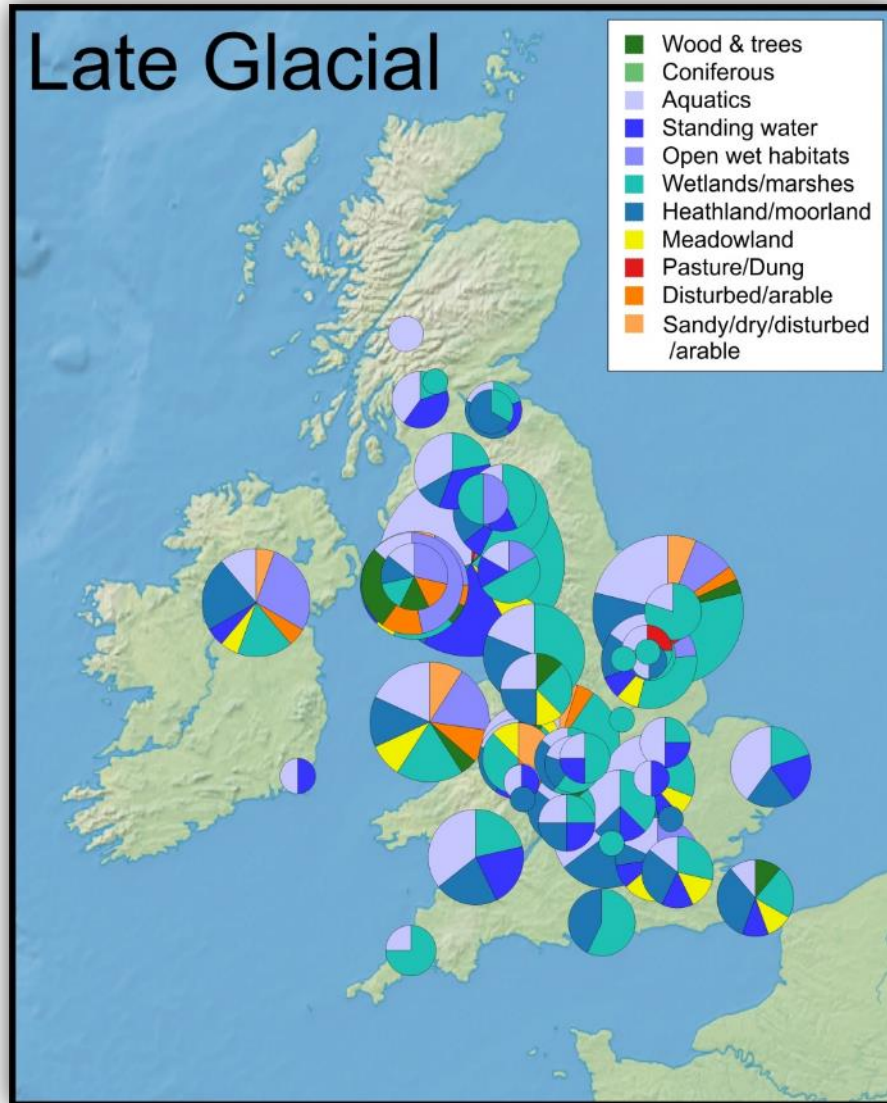
Lateglacial = wet (cold)

Holocene = woody

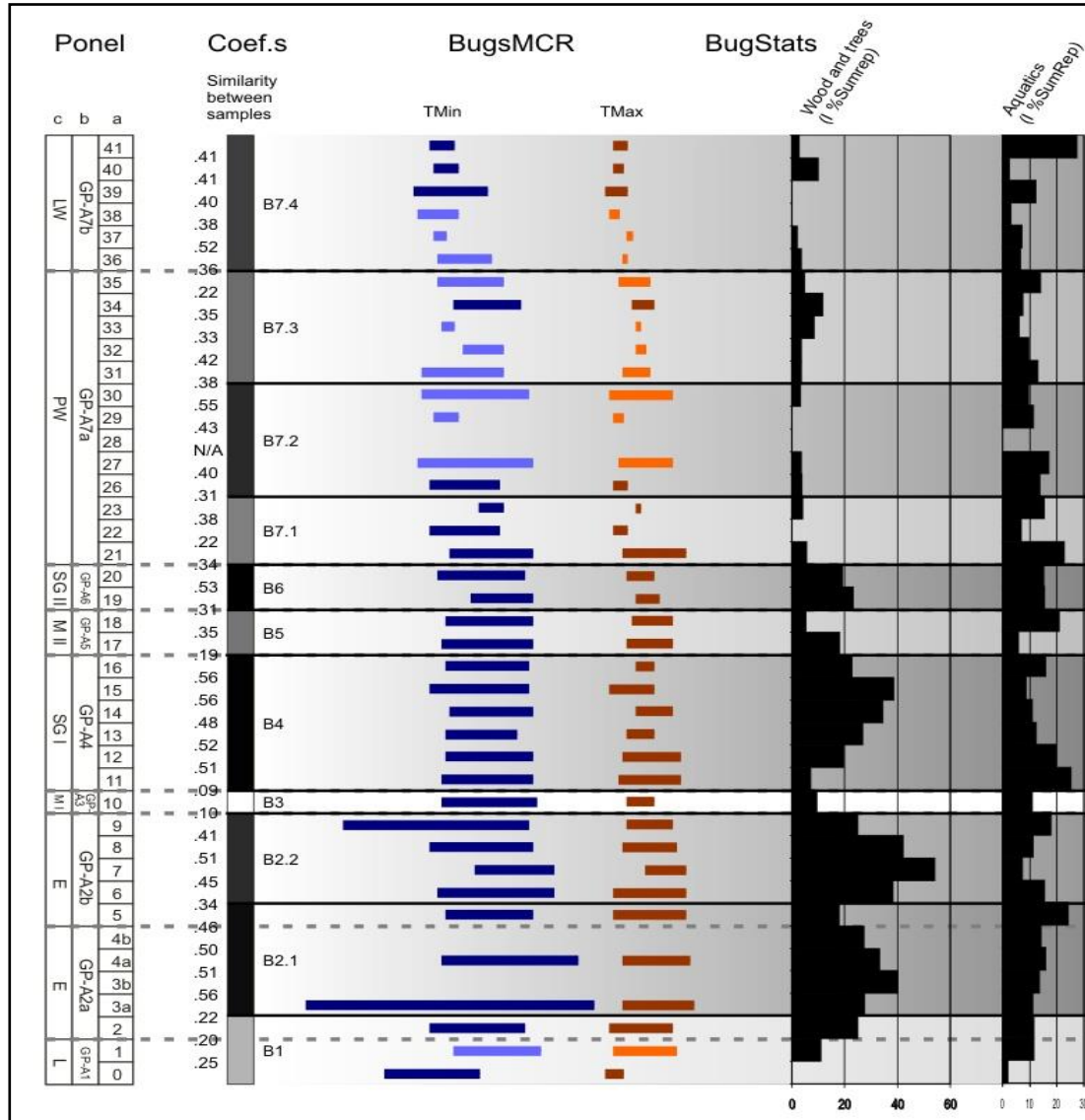


Interpretation & Visualization

Systematically to enable comparisons over multiple sites and time periods



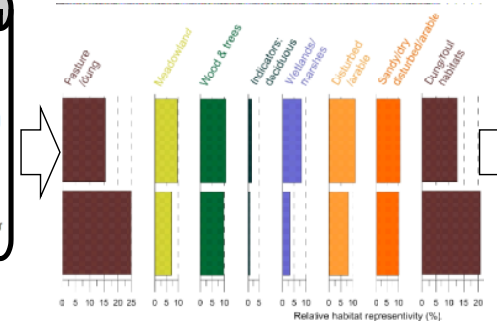
Complex research – integrating evidence



Narrative

A farmyard flora is indicated by several species. Nettles, the host of the pollen beetles of the genus *Brachyterus*, and the weevils, *Toenipion urticarium*, *Paretholus pollinarius* and *Iedys quadrimaculatus* (Davis 1983), would have benefitted from the nutrient-rich corners of the enclosure and docks and other weed species would also thrive in the environs of the farm. The small Roman period is remarkably similar to what could have been collected around a small farm before modern deep ploughing, widespread use of insecticides and herbicides and removal of hedgerows created the modern agri-industrial landscape. This is an aspect shared with several other rural Roman wells (e.g. Buckland 1980; 2000; Coope & Osborne 1968); it is radically different from similar

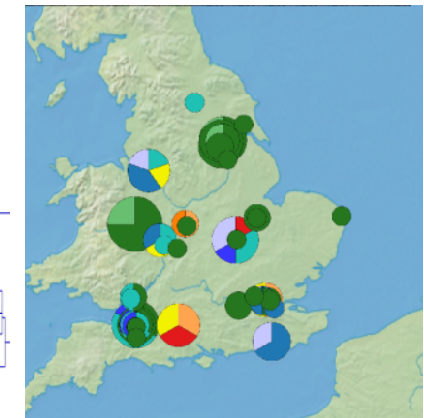
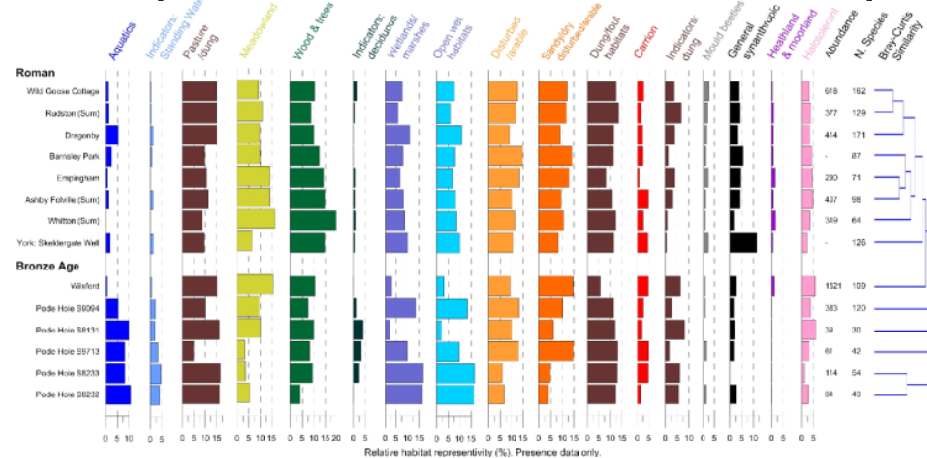
Quantitative



Visual

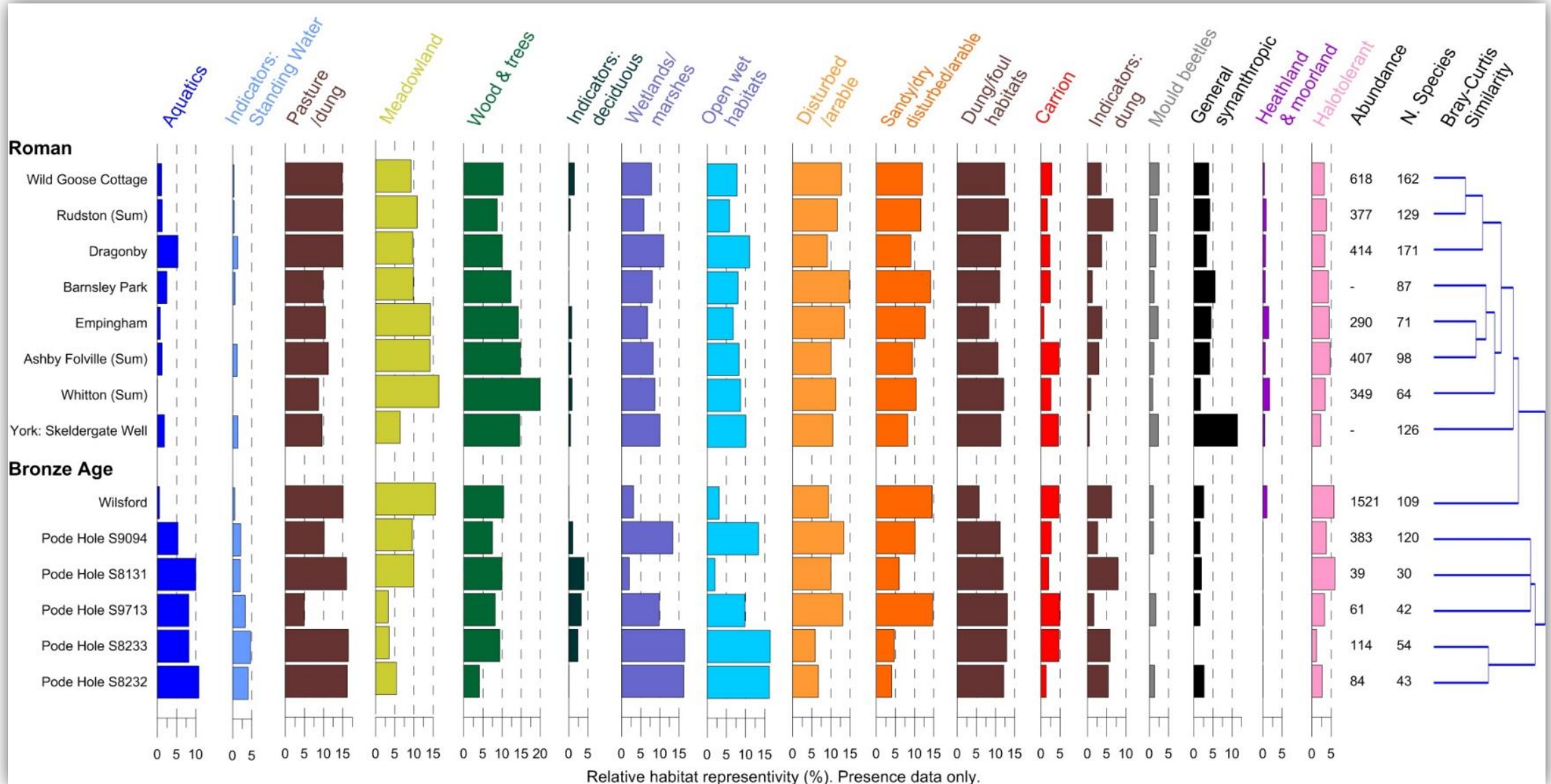


Comparisons, correlations & exploratory analysis



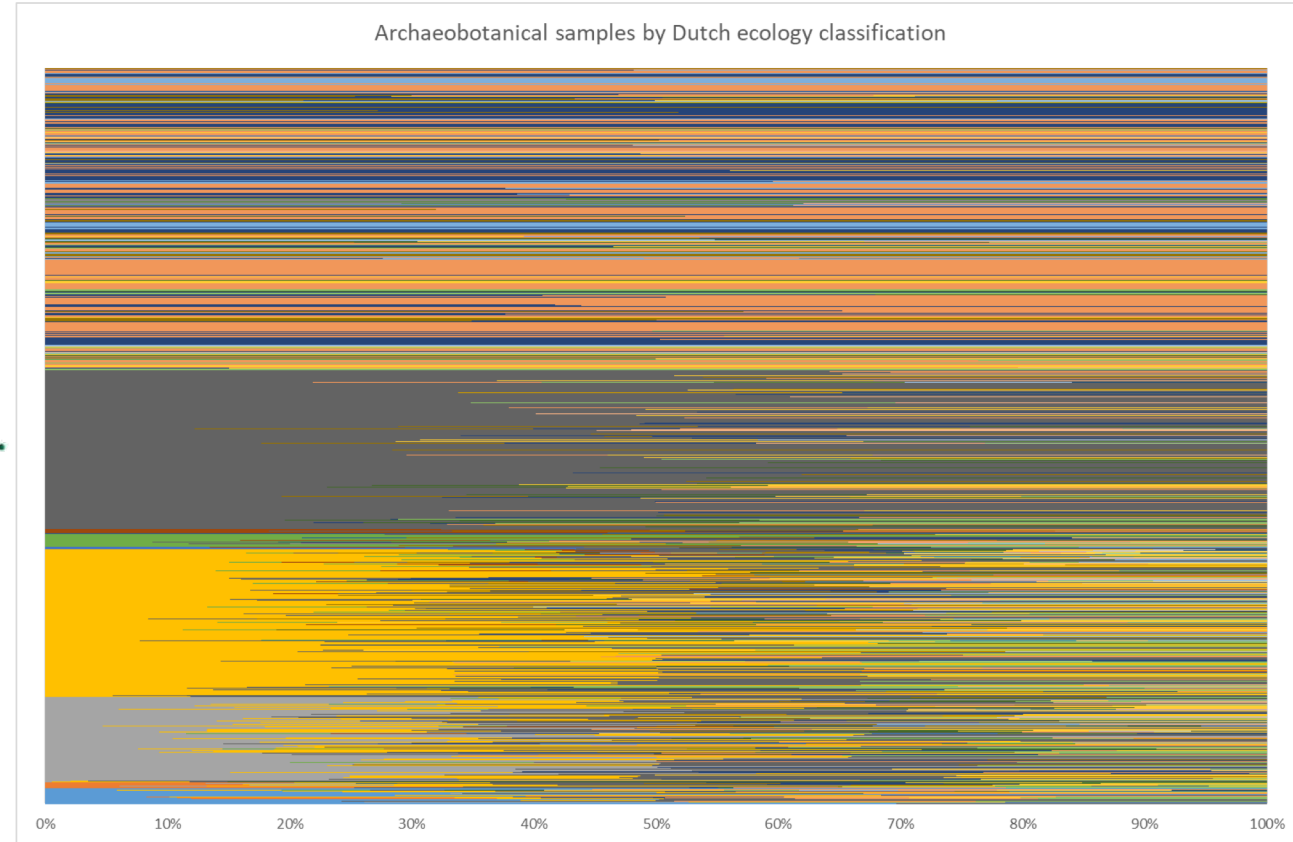
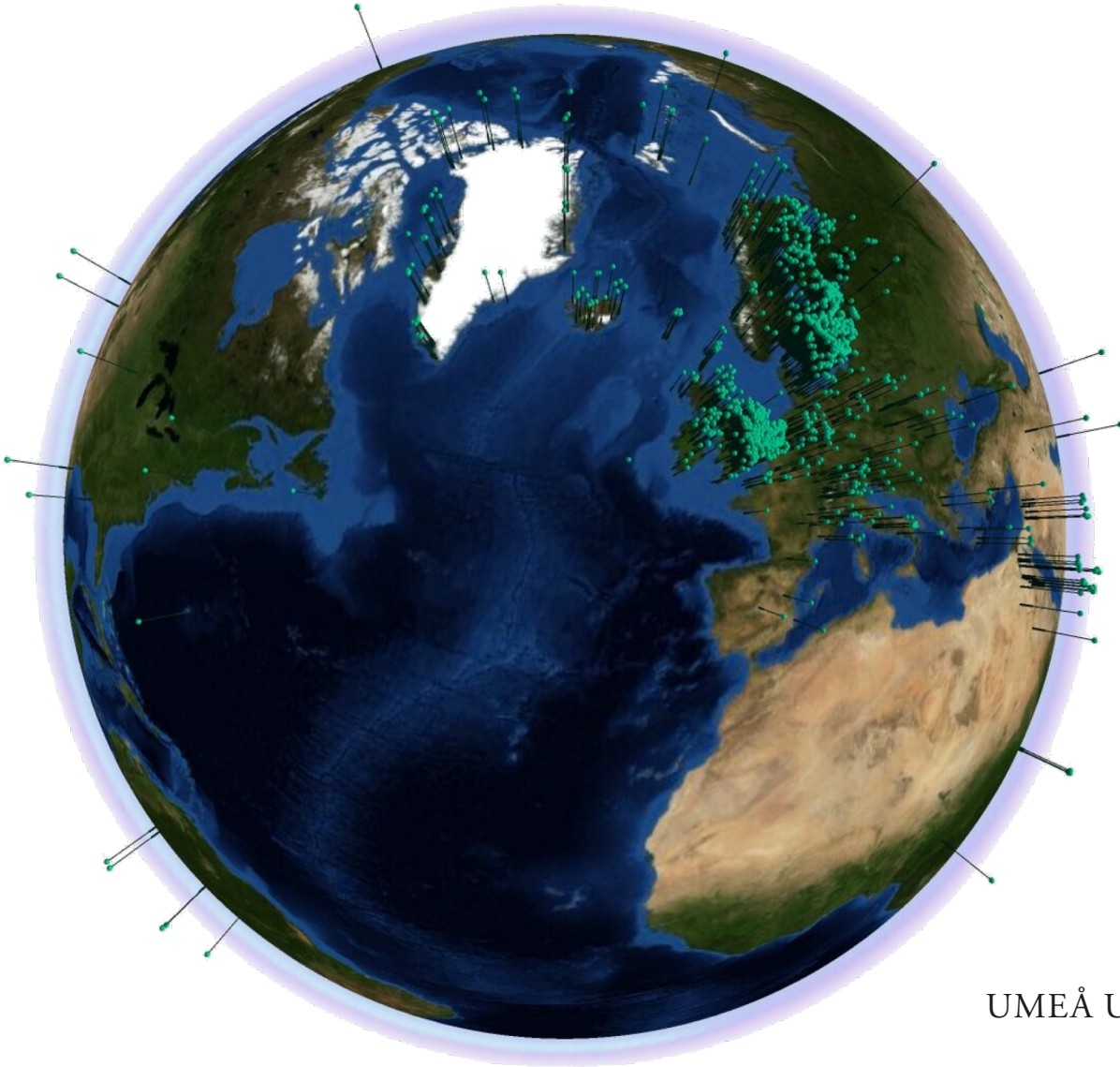
Interpretation & Visualization

Systematically to enable comparisons over multiple sites



Taking it further

Systematically to enable comparisons over ***all*** sites and time periods

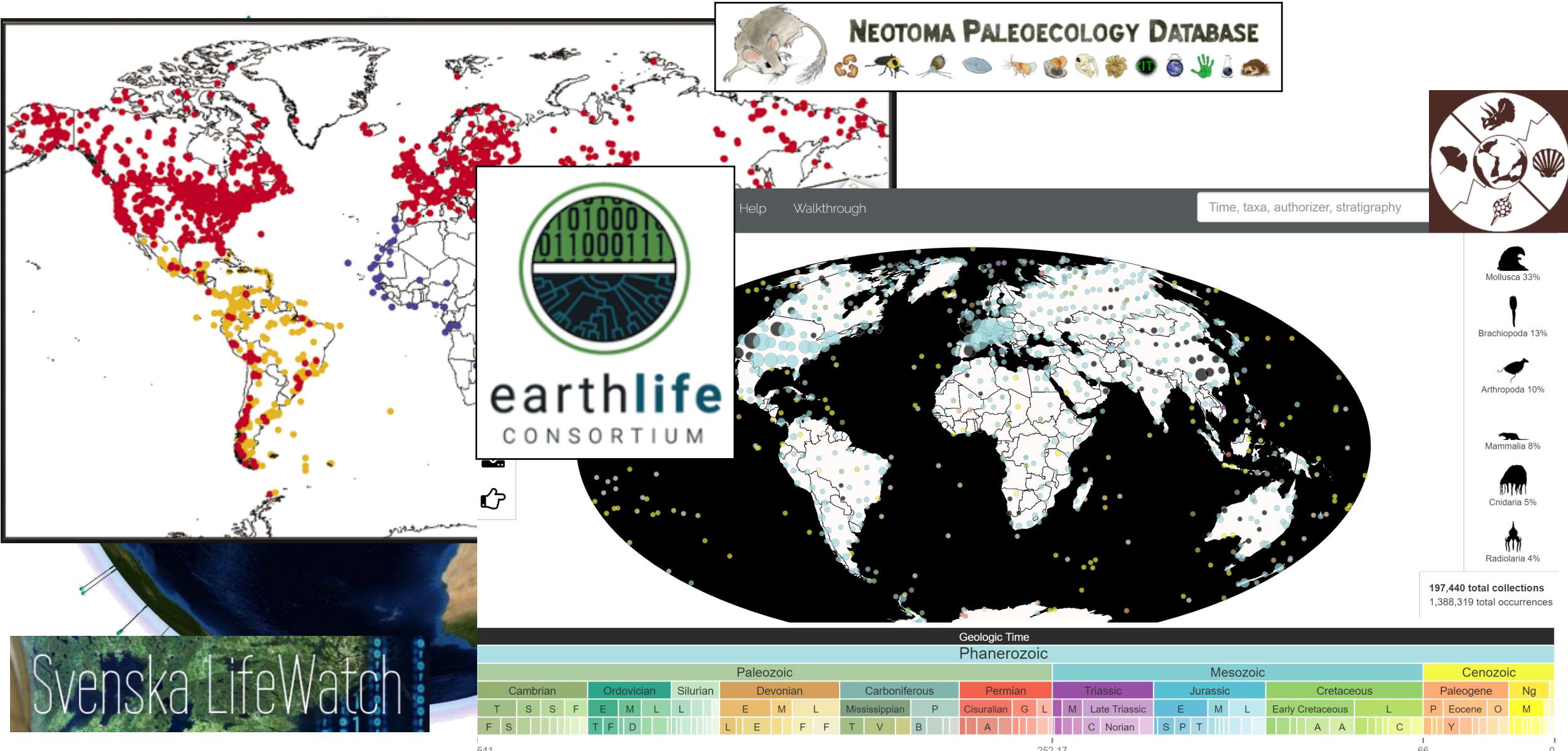


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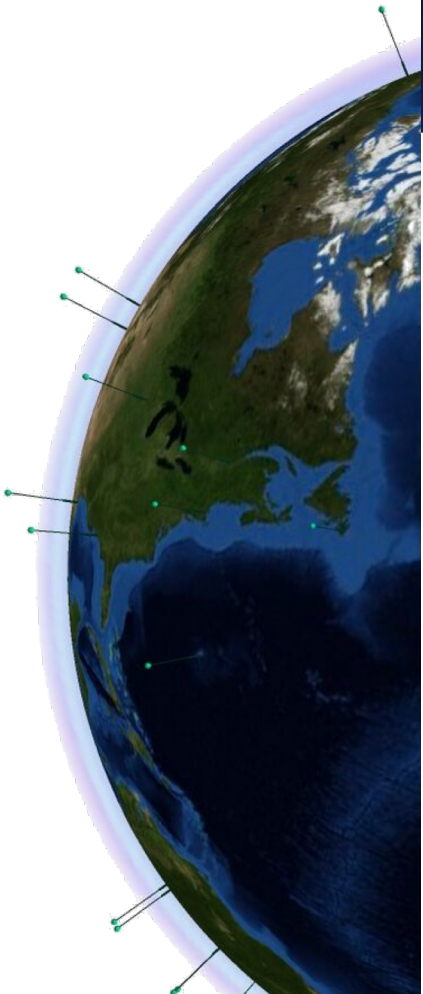
add key labels

Taking it further

Systematically to enable comparisons over ***all*** sites and time periods



Modern records, future predictions based on knowledge of past



The Analysis portal for biodiversity data

[Start](#) [Data](#) [Filter](#) [Settings](#) [Result](#) [Info](#) [My Pages](#)

[Data](#) > **Species observations (databases)**

[Save settings](#) [Download metadata](#)

<input checked="" type="checkbox"/>	Data provider	Number of observations	Number of public observations
<input checked="" type="checkbox"/>	Species Observations System (Artportalen) (Swedish Species Information Centre (ArtDatabanken)) i	65,909,426	65,503,396
<input checked="" type="checkbox"/>	Observation database of Redlisted species (Swedish Species Information Centre (ArtDatabanken)) i	725,929	0
<input checked="" type="checkbox"/>	MVM (Environmental data MVM, SLU) i	1,194,484	1,194,484
<input checked="" type="checkbox"/>	The National Register of Survey test-fishing (NORS) (Department of Aquatic Resources, SLU) i	2,693,173	2,693,173
<input checked="" type="checkbox"/>	The Database for electrofishing in streams (SERS) (Department of Aquatic Resources, SLU) i	407,425	407,425
<input checked="" type="checkbox"/>	Wireless Remote Animal Monitoring (WRAM) (Umeå Center for Wireless Remote Animal Monitoring (UC-WRAM), SLU) i	7,906	7,906
<input checked="" type="checkbox"/>	Shark SMHI (SMHI) i	620,834	620,834

My selections

[Data](#)
Data Providers (15 selected) [i](#)

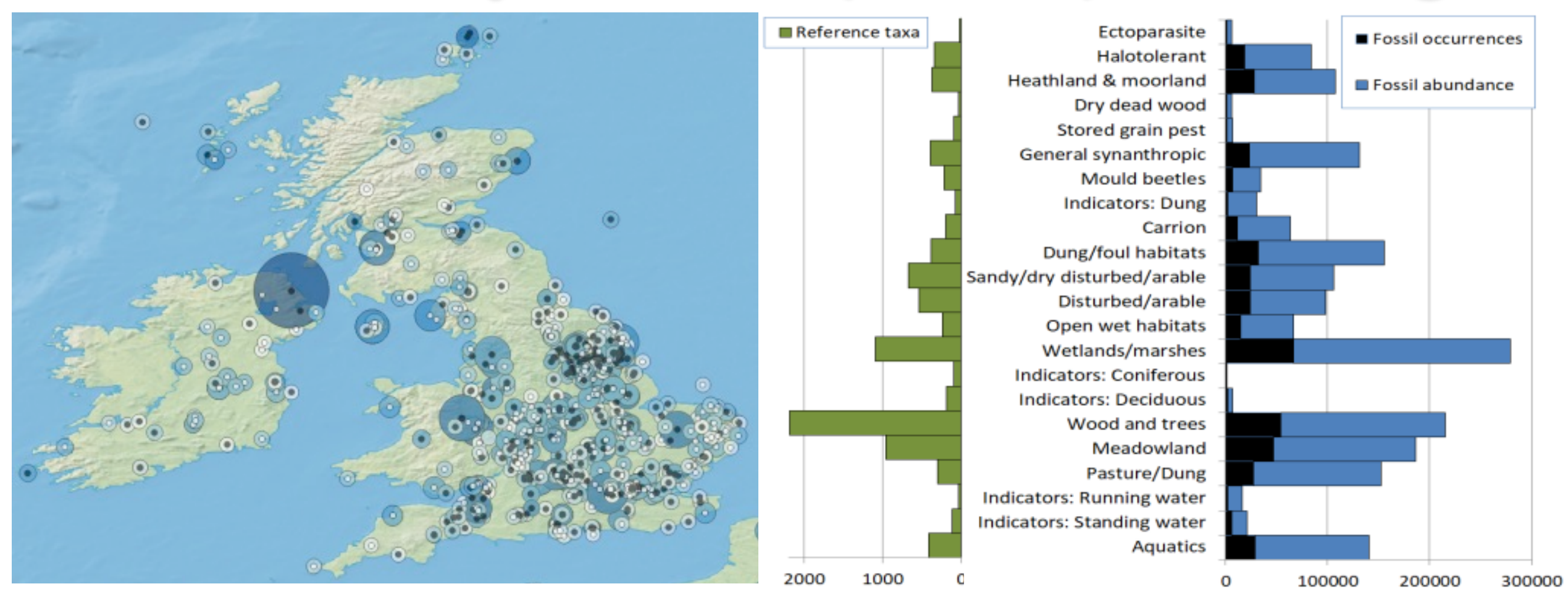
[Filter](#)
☒ Occurrence [i](#)

[Settings](#)
[Summary statistics](#) [i](#)
[Grid statistics](#) [i](#)
[Time series](#) [i](#)
[Coordinate system](#) [i](#)
[Table columns](#) [i](#)
[File format](#) [i](#)

[Reset](#)

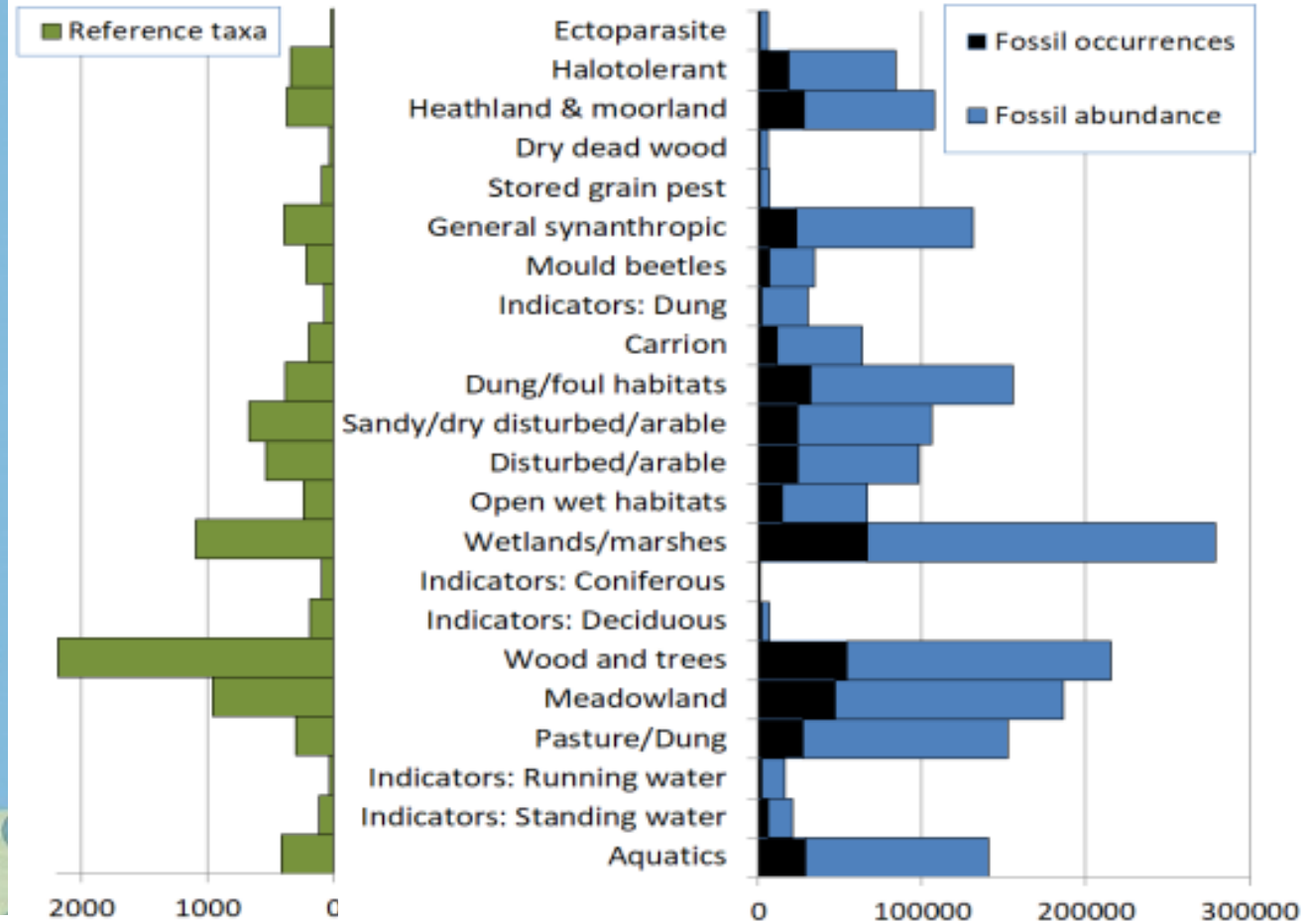
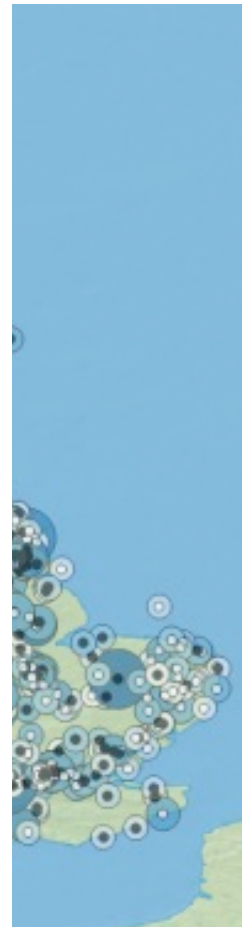
SBDI – Swedish Biodiversity Data Infrastructure

Insect biodiversity – fossil and (reference) data coverage



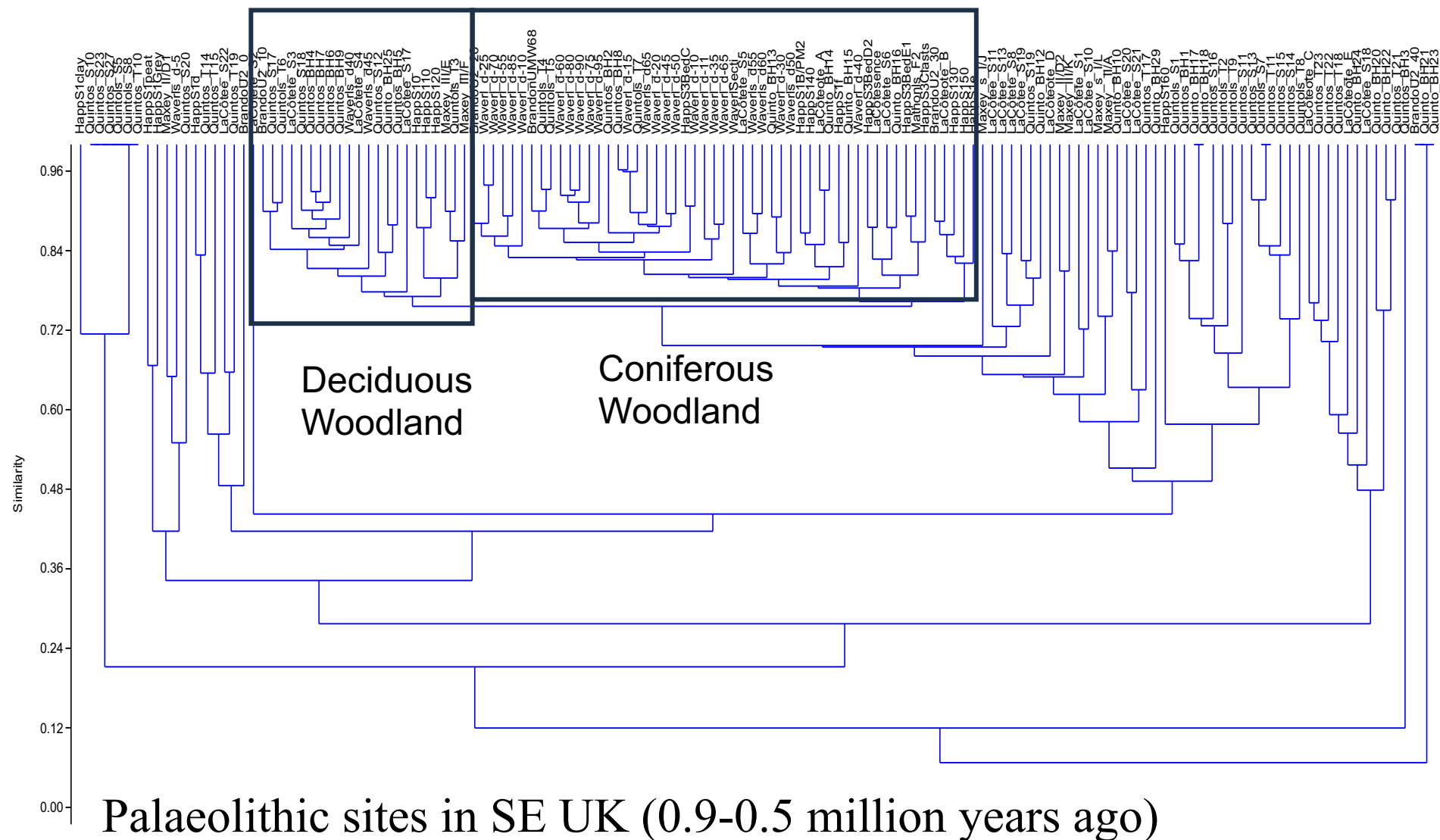
INSECTS ARE ALMOST EVERYWHERE

Ecological traits
=
Habitat categories
=
Concepts
=
Ontology
=
Linkable



...SO ARE HUMANS

Multi-site, multiproxy comparisons



Potentially similar samples, Cluster analysis, habitat proportions, Bray-Curtis



THANK YOU!

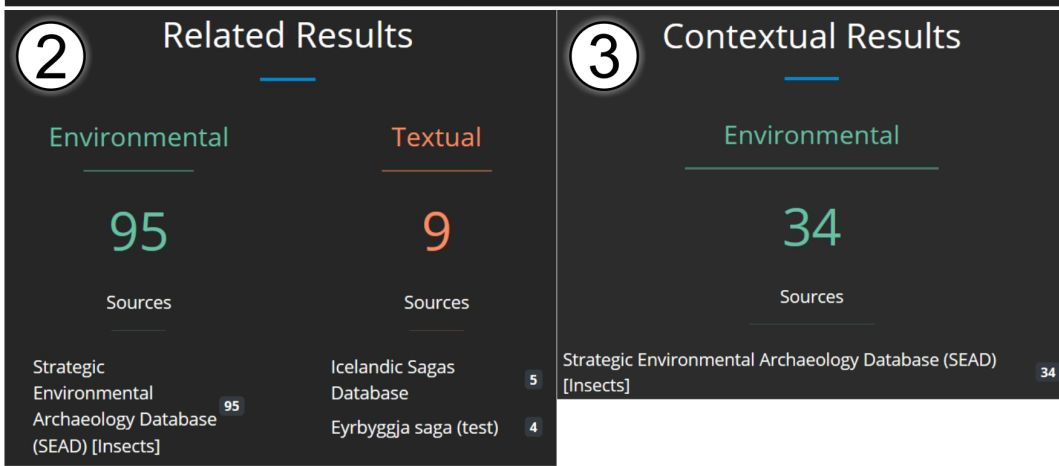
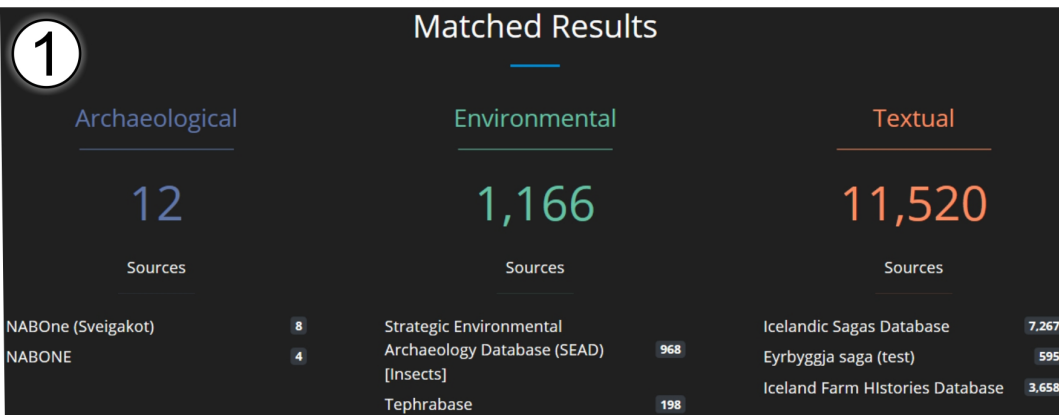
phil.buckland@umu.se
& many others

sead.se
visead.se
data-arc.org

VISEAD is supported by Riksbankens
Jubileumsfond

SEAD is supported by Umeå University with contributions from Lund and Stockholm Universities

DataARC is an NSF project



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