A comparison of two approaches for identifying key areas for biodiversity conservation

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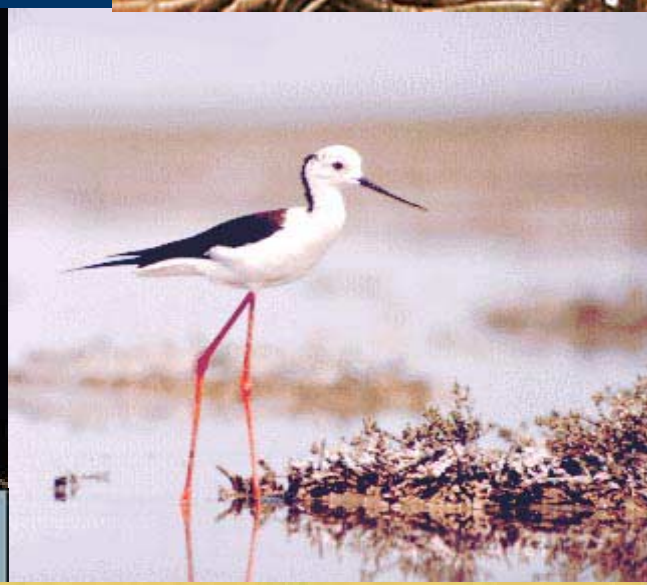
Biodiversity is rapidly Shrinking

128 of 450 vertebrate species in Israel are currently endangered

(Dolev and Perevolotzky 2003)



Given the current rate of land use change,
protection of biodiversity requires
optimal allocation of the land.
Mapping biodiversity is a crucial prerequisite.

Nowhere can the full range of species diversity be mapped -- let alone the full scope of biodiversity

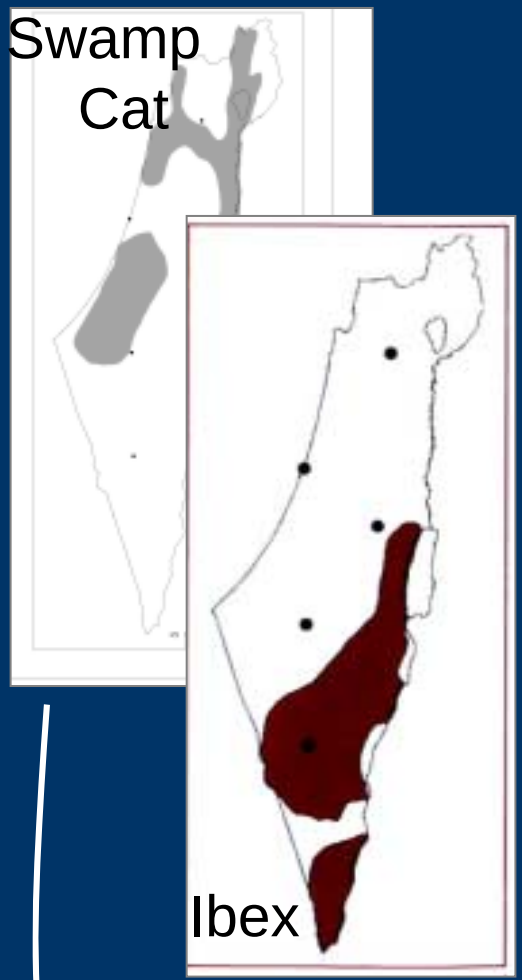
Surrogates are used.

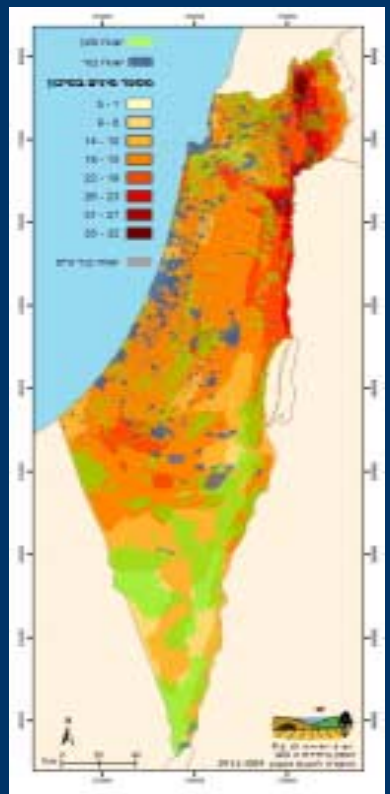
Biological surrogates:

diversity of a taxonomic group is taken to represent biodiversity as a whole

A popular example:
GAP ANALYSIS

Gap analysis





Dolev, Sapir & Carmel, in Prep.

Biological surrogates: shortcomings

Expensive in time and money

Uncertainty in each distribution map is accumulated over numerous such maps, thus the reliability of the product is unknown

Diversity patterns of a single taxonomic group may not refelct biodiversity patterns of the entire biota.

Bats
(27 species)

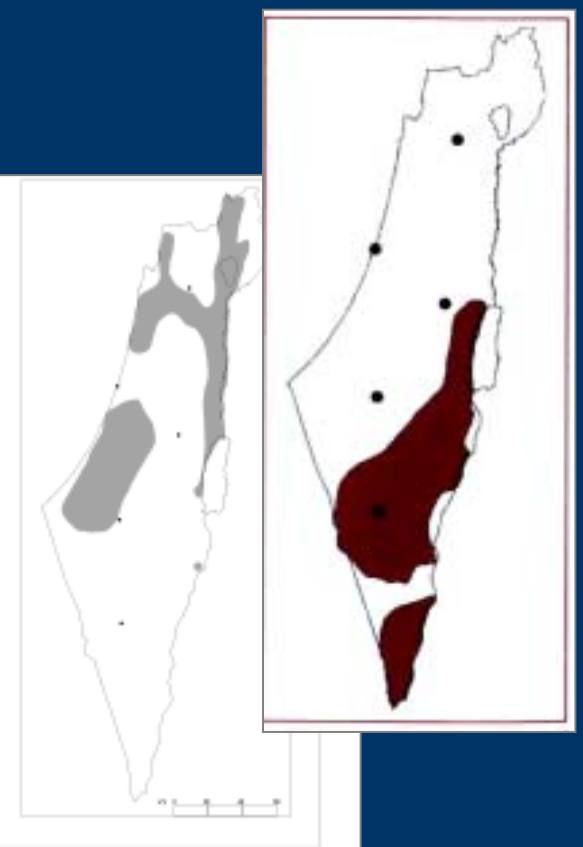
Birds
(48 species)

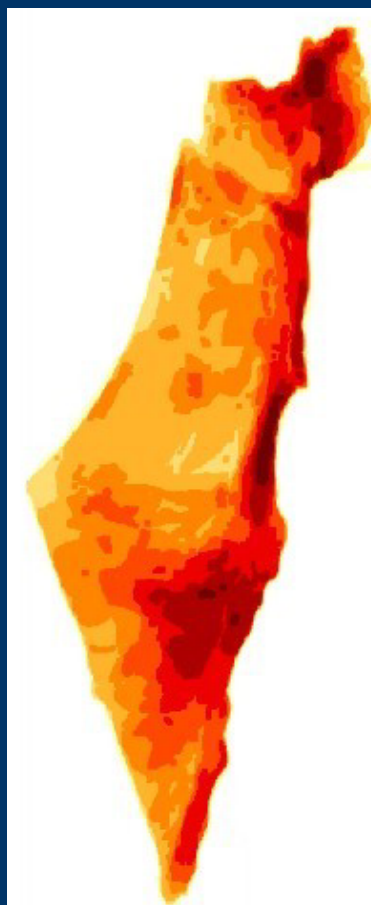
Hotspots of one taxon may be cold spots of another

Complementarity:

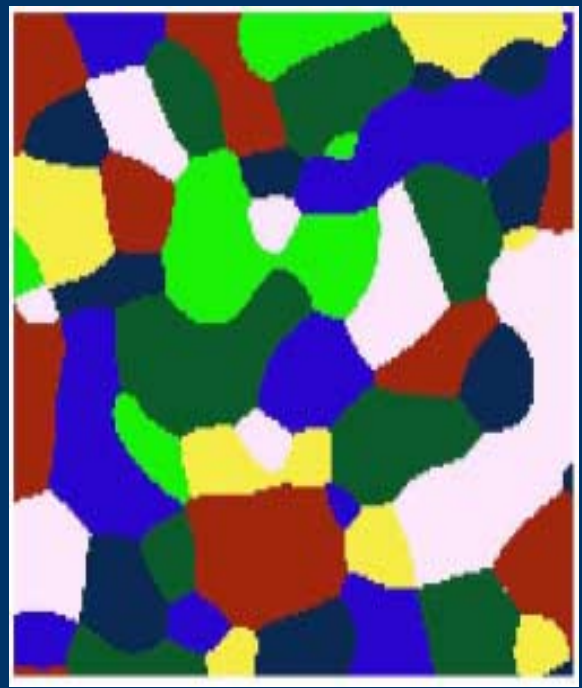
forget ‘hotspots’. Choose a set of sites that would

(1) minimize species overlap between selected areas
(2) maximize the total # of species ‘covered’ by the set





Environmental surrogates: diversity of unique environmental domains is taken to represent biodiversity as a whole



Belbin 1993; Faith and Walker 1996
Wessels et al 1999; Lenton et al 2000;
Fairbanks 2000; Araujo et al 2001;
Amarnath et al 2003

Environmental diversity for biodiversity **(ED/BD)**

Its rationale is the niche theory: species distribution is dependent on a set of environmental variables (soil, climate, topography)

Thus, a given set of environmental variables (= environmental units) would translate into a unique species assemblage. Areas that are similar environmentally would be similar biologically.

Protection of biodiversity (which is difficult to map) can be achieved via protection of environmental diversity (easier to map)

Environmental diversity for biodiversity

Advantages:

- Rapid, cost-effective
- General,
- May be applied in areas where no biological data is available

Shortcomings:

- Is it Representative ? ? ?

Current evidence is rare, and ambiguous

GOAL:

A direct comparison* of the two approaches for mapping of biodiversity

method:

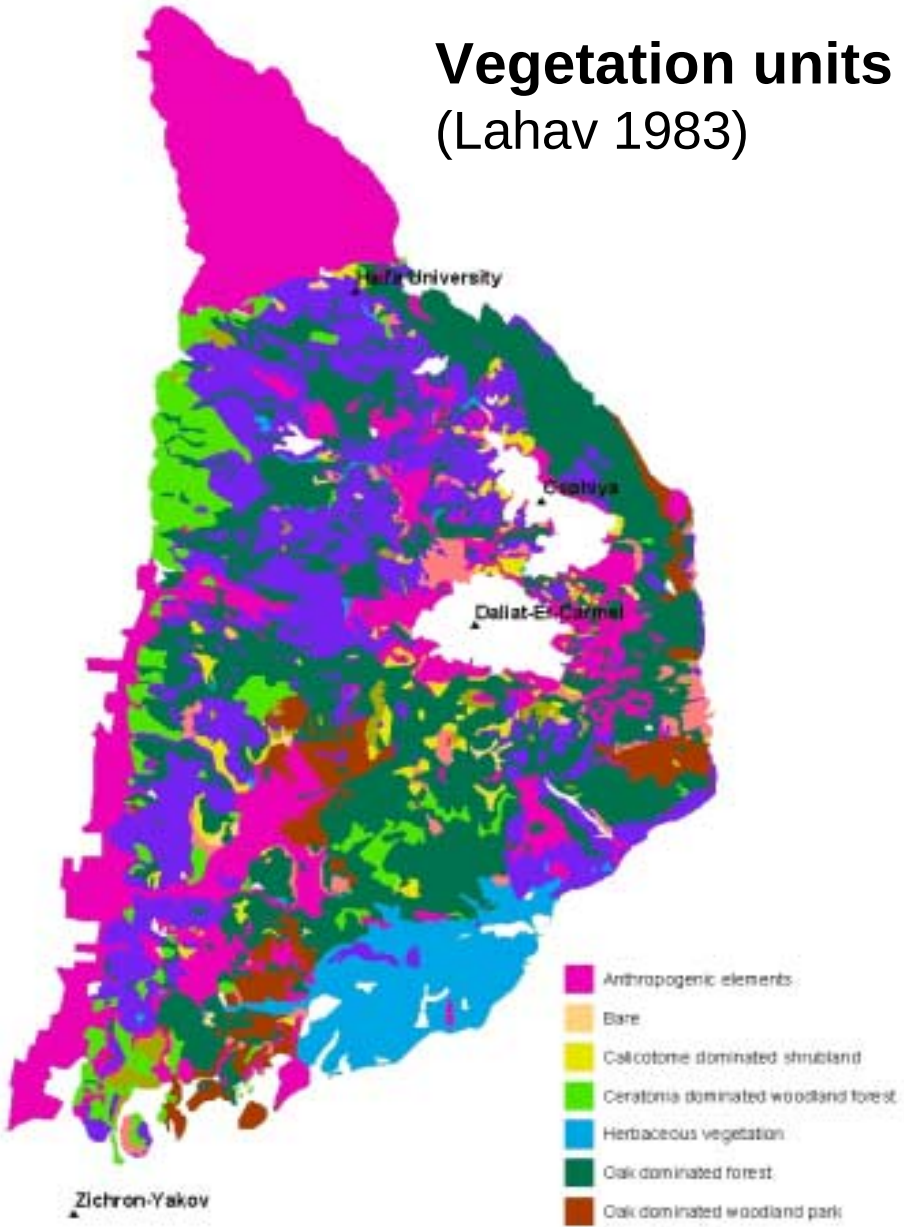
Construct several surrogates for each approach. Test their relative performance

Study area:

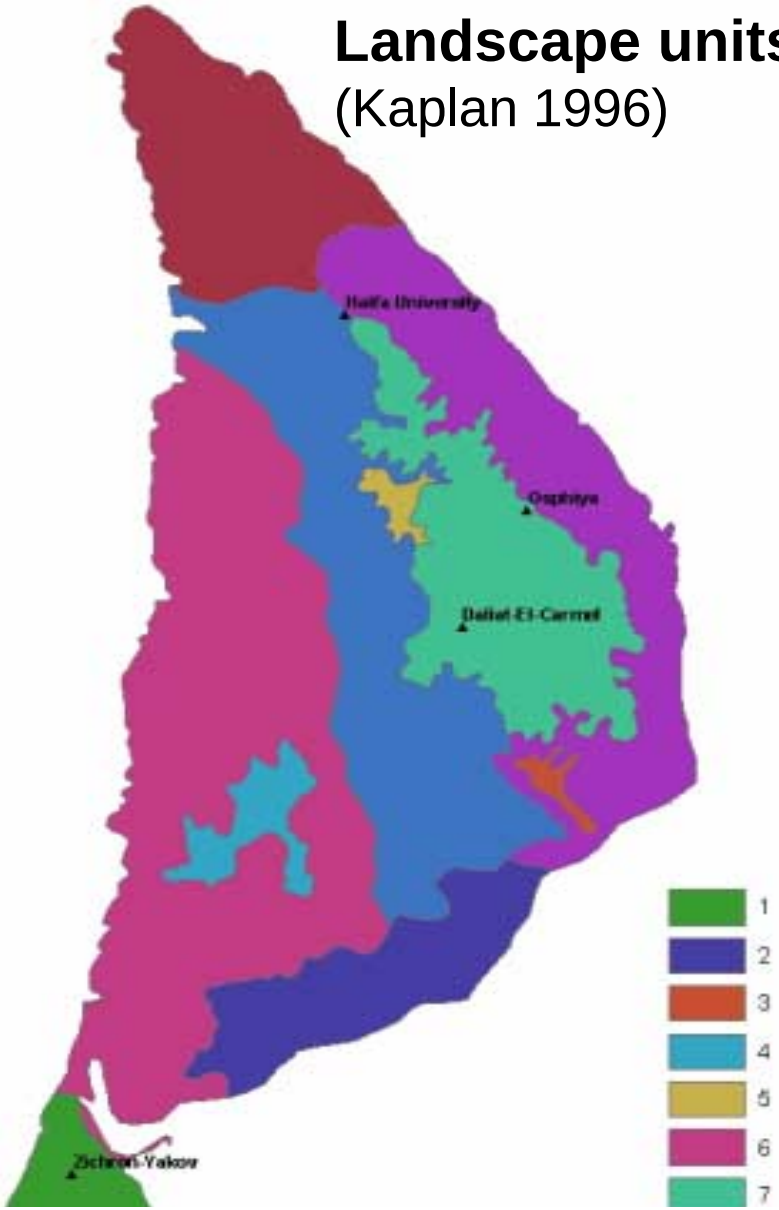
Mt. Carmel region (300 km2)

* At a local scale, relevant for planning and management

Vegetation units
(Lahav 1983)



Landscape units
(Kaplan 1996)



Manually delineated environmental surrogates

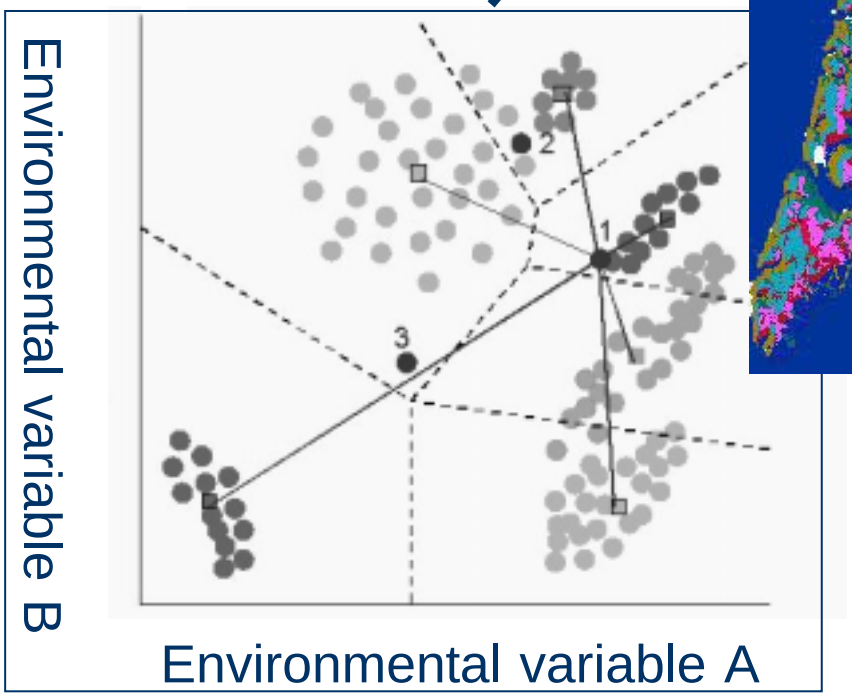
Veg. data

climate

Soil data

Topographic data

K-means classification



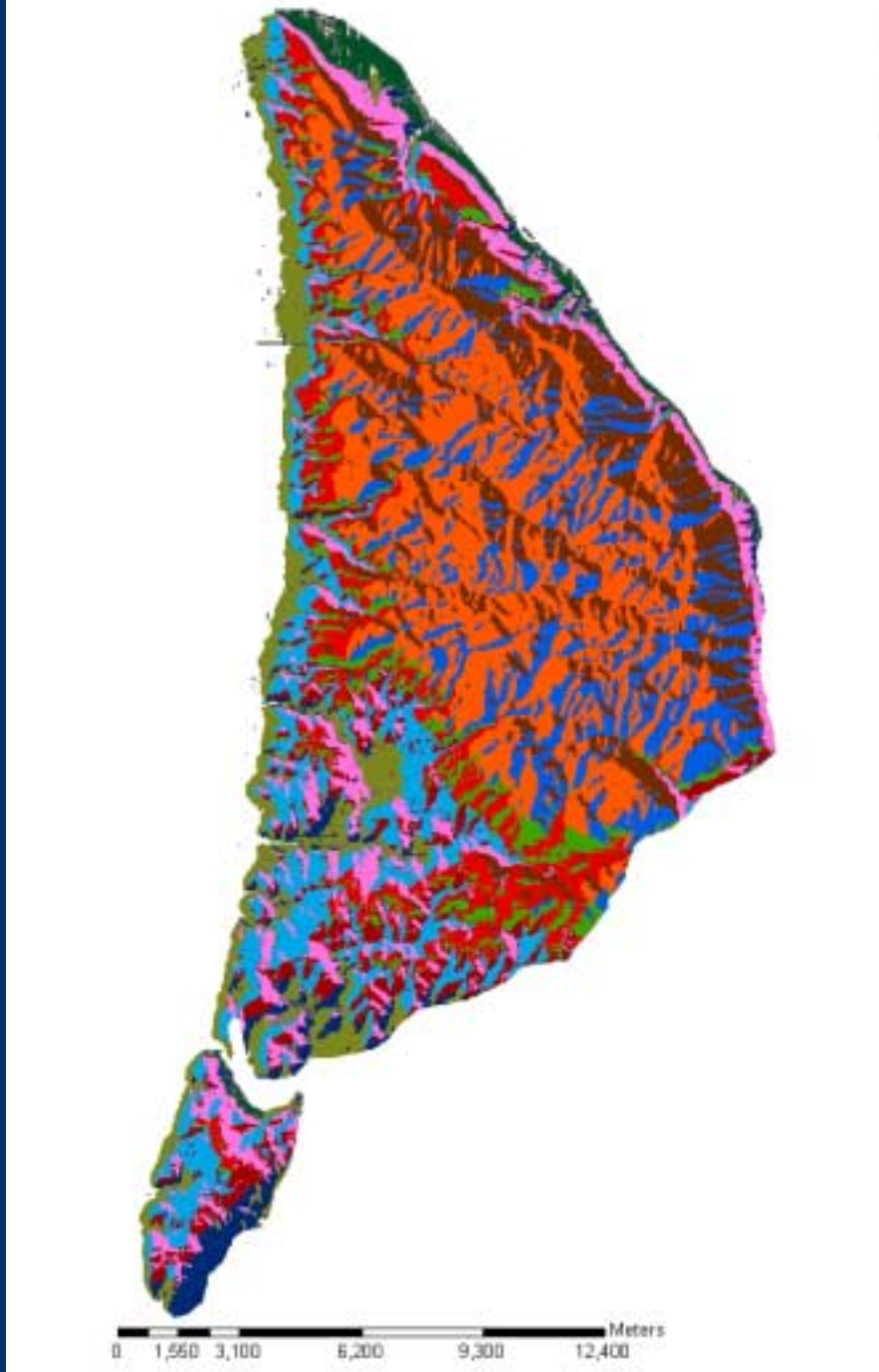
Digitally classified environmental surrogates

The product: a map of 11 environmental domains in Mt. Carmel

Each color represents a unique combination of environmental variables

For example, the orange consists of north western Terra Rosa slopes, with low to moderate woody vegetation cover

Note the obvious Hierarchic pattern, with 3 general regions corresponding to the north, south, and surrounding plains; each of which contains few domains



The super - surrogate

A good surrogate needs to be GENERAL and ROBUST

The k-means classifcation is almost fully automated.
The only user-inputs are # of classes (=domains) and – which env. variables drive the process.

In order to assess the generality of this surrogate, we constructed:

(a) Maps of varying # of env. Domains, ranging 6-29.

(b) Maps based on each possible combination of env. variables in the classification

Three bio-surrogates

110 sampling points were randomly selected across Mt. Carmel (Excluding Haifa, Druze villages, agriculture).
3 samples, 20 m apart were taken in each point
Presence/absence was recorded for species of 3 biological groups:

	land snails	geophytes	woody species
sampling unit	1 m^2	75 m^2	
total species #	17	52	56
mean species # in sample	4 ±1.9	11 ±4.2	14.7 ±5.9

Statistical analysis

Biological surrogates:

Biological similarity between sites (for each group):

Jaccard similarity index was recorded for each pair of sites

similarity matrix: sites in the rows, sites in the columns and similarity in the cells

} X3

Mantel test (with 1000 permutations) -- to test resemblance between 2 biological matrices

$$Jaccard(x_1, x_2) = \frac{a}{a+b+c}$$

Statistical analysis

Environmental surrogates:

Environmental similarity between sites (for each group):

two sites of the same environmental domain – 1

two sites of different environmental domains – 0

Gower Similarity index

similarity matrix for each environmental surrogate

Mantel test (with 1000 permutations) -- to test resemblance between an environmental similarity matrix and each of the 3 biological matrices

Results: biological surrogates

	Mantel statistic
Woody species----------geophytes	0.28***
Geophytes----------land snails	NS
Land snails----------woody species	NS

* p<0.05 ** p< 0.01 *** p< 0.001 NS – not significant

Results: Environmental surrogates

MANTEL test for comparing biological similarity in sites

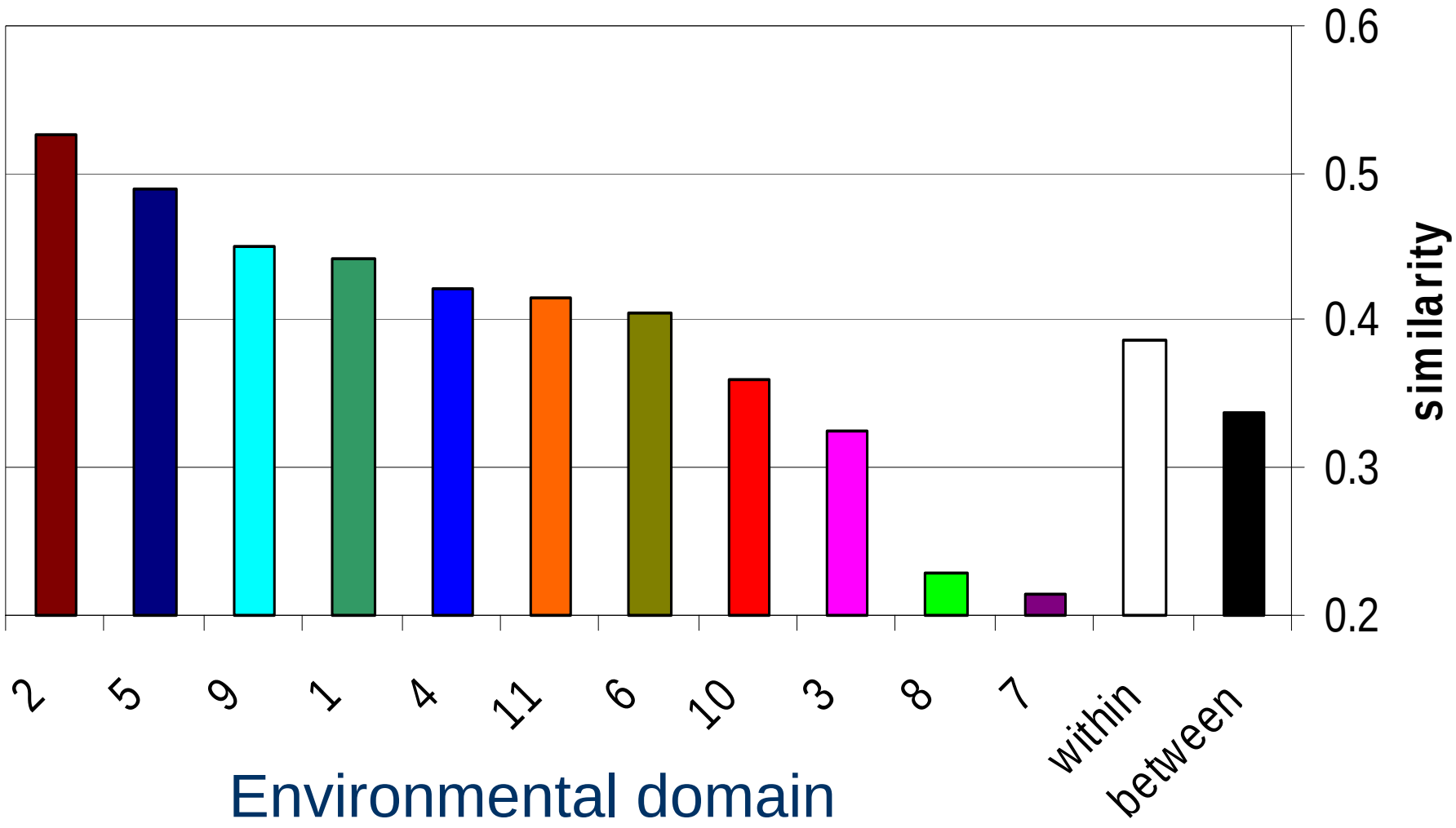
of the same environmental domain

of different environmental domains

	land snails	geophytes	woody species
land units	NS	NS	0.09*
vegetation units	NS	***0.074	0.226***
env. domains	0.034***	0.059***	0.103****

* p<0.05 ** p< 0.01 *** p< 0.001 **** p < 0.0001

Similarity in woody species between pairs of sites

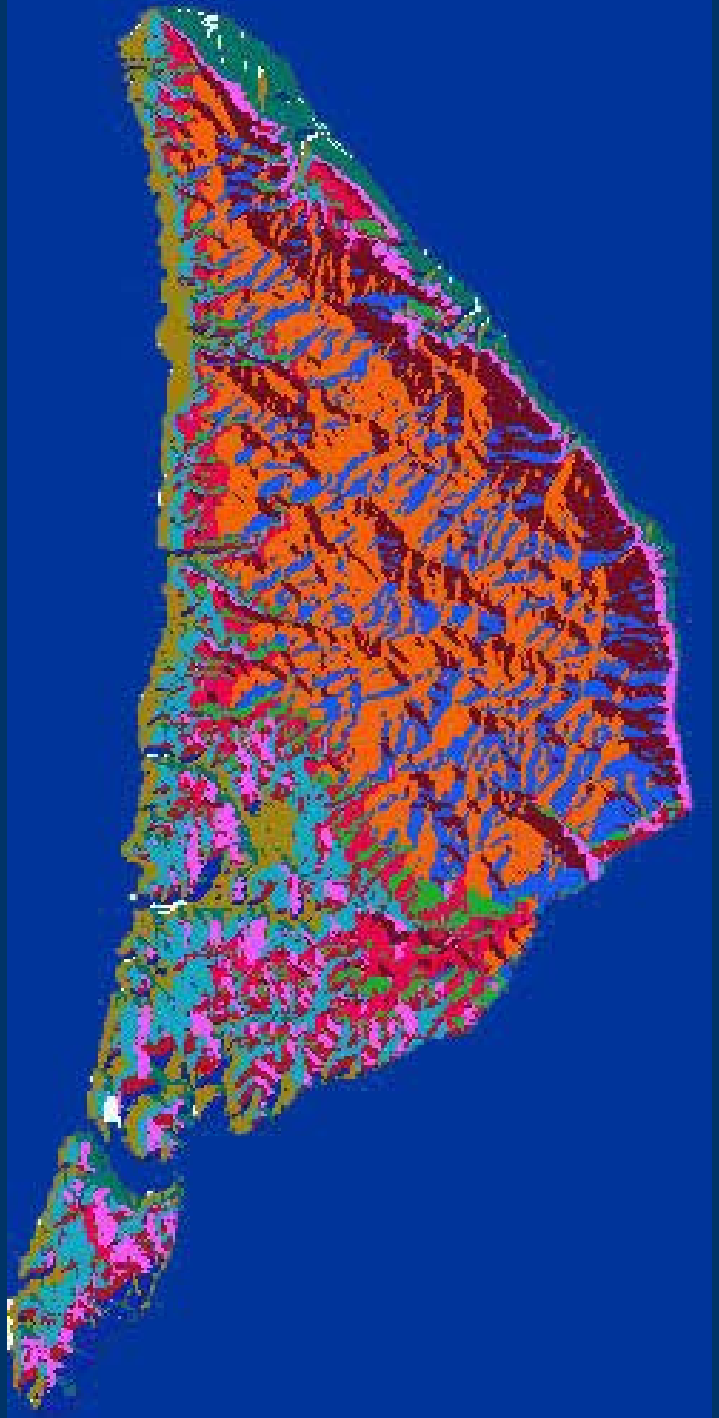


Results: Environmental domains

(digital classification)

For various combinations of variables

	woody species	geophytes	land snails
topography, veg-cover, soil	0.103****	0.041**	0.034***
climate, veg-cover, topography	0.079****	0.032*	0.045**
climate, soil, topography	0.079****	0.04**	NS
climate, soil, veg-cover	0.127**	0.044**	0.032*
climate, soil, veg-cover, topography	0.079****	0.045*	0.049*



conclusions

The digitally classified environmental surrogate outperformed biological, as well as other environmental surrogates for biodiversity.

This conclusion was found to be robust for various combinations of input variables and for different numbers of domains between 5 and 26.

Yair Or, Einav Namer, Amir Halachmi and Ran Lotan, and Avi Bar Massada helped us in the field

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TODA RABA