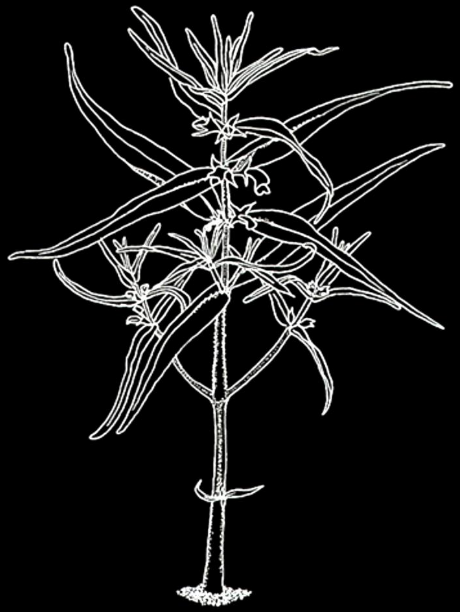
2ND INTERNATIONAL
WILDLIFE
REINTRODUCTION
CONFERENCE

Keynote, Session 3: Ecosystems

Everything is connected: ecosystem functioning as a rationale for, and to improve the effectiveness of, conservation translocations

Dr Sarah E. Dalrymple,
Liverpool John Moores University, UK

@SarahEDalrymple #IWRC2018
s.e.dalrymple@ljmu.ac.uk



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EVERYTHING
IS
CONNECTED
MAYFIELD
STATION
GRUB
food
FAIR
#MAYFIELD
IT'S
HOME
FOR
ALL
NOT
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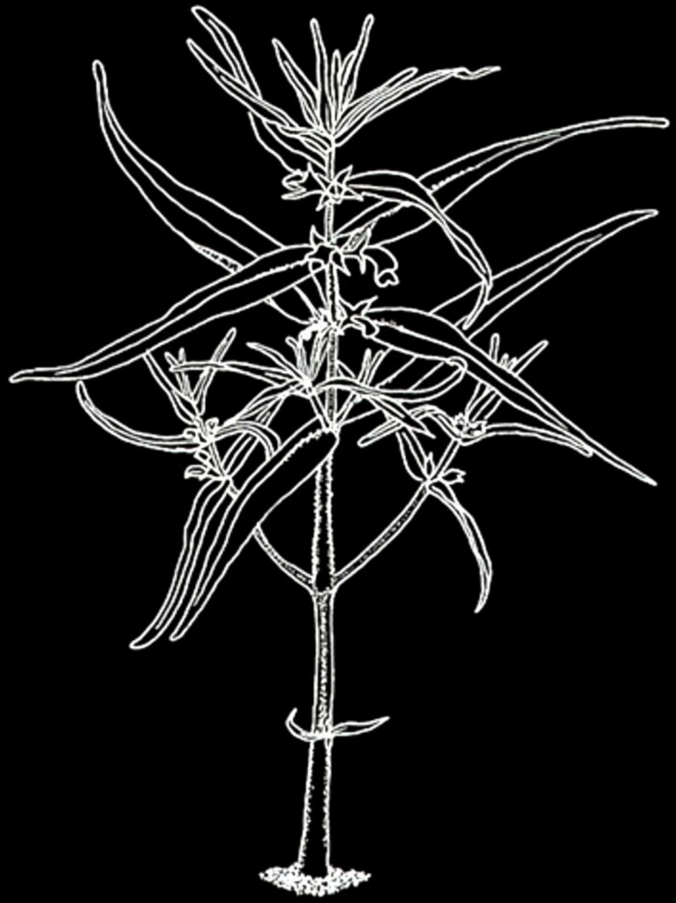
NOW
WARMER
TAXI

Every time we perform a conservation translocation, we test our understanding of the species' niche

…test?

…prediction?

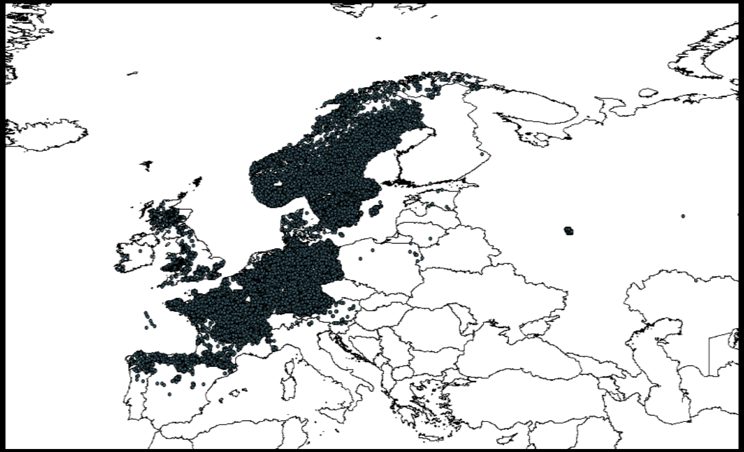
….or gamble?

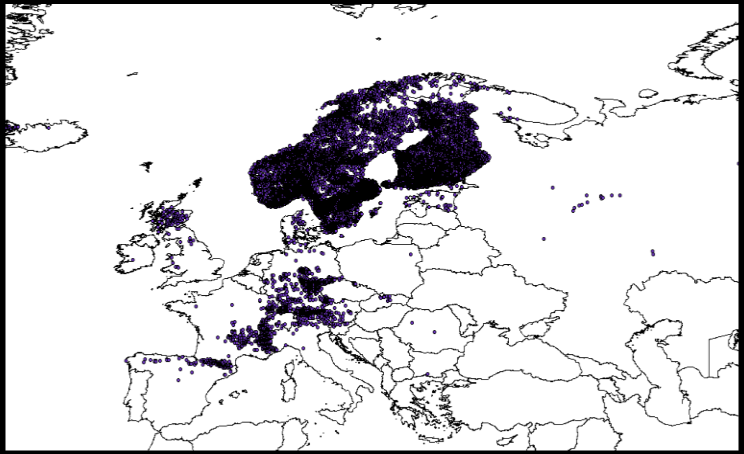


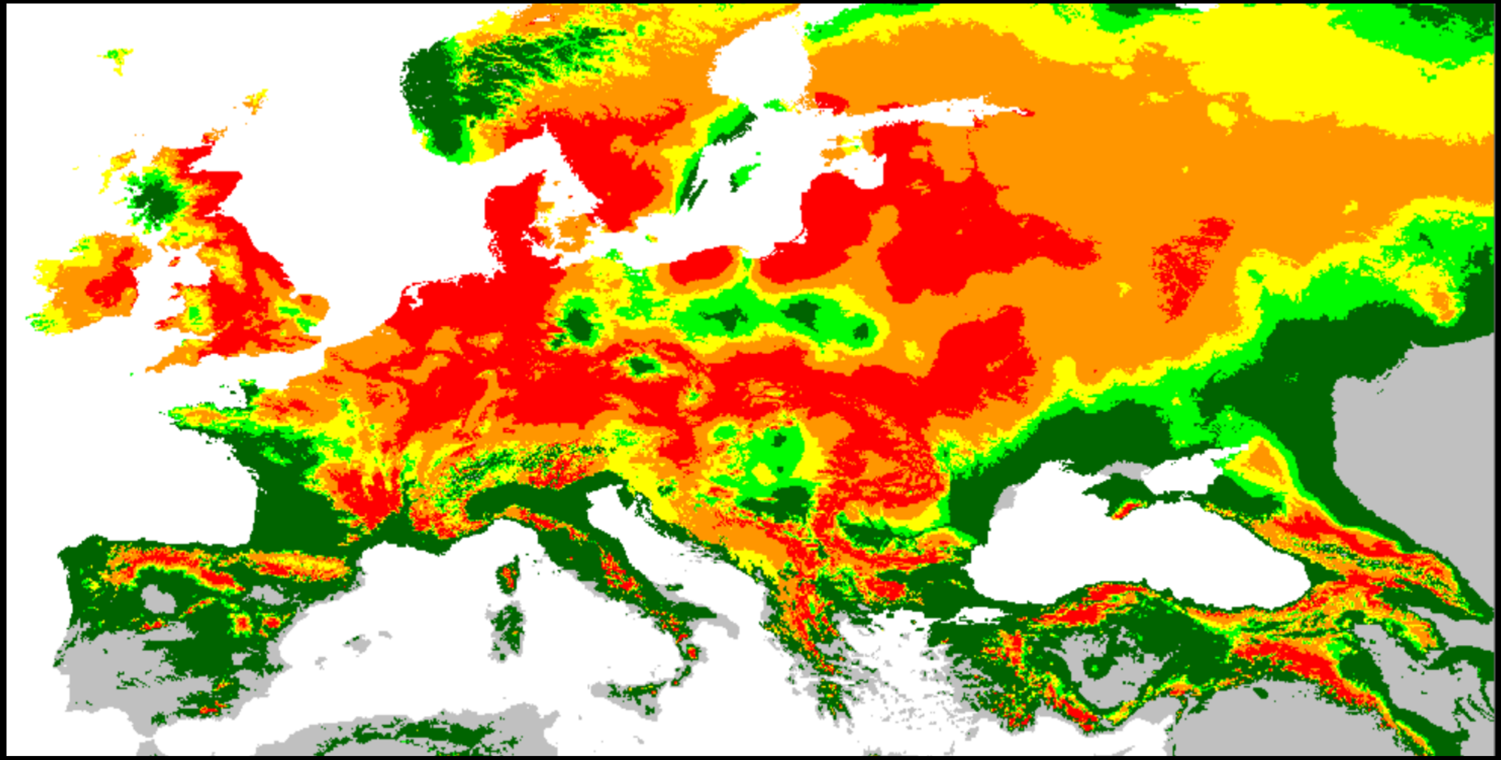
Melampyrum sylvaticum

Melampyrum pratense

Climatic niche of *Melampyrum*

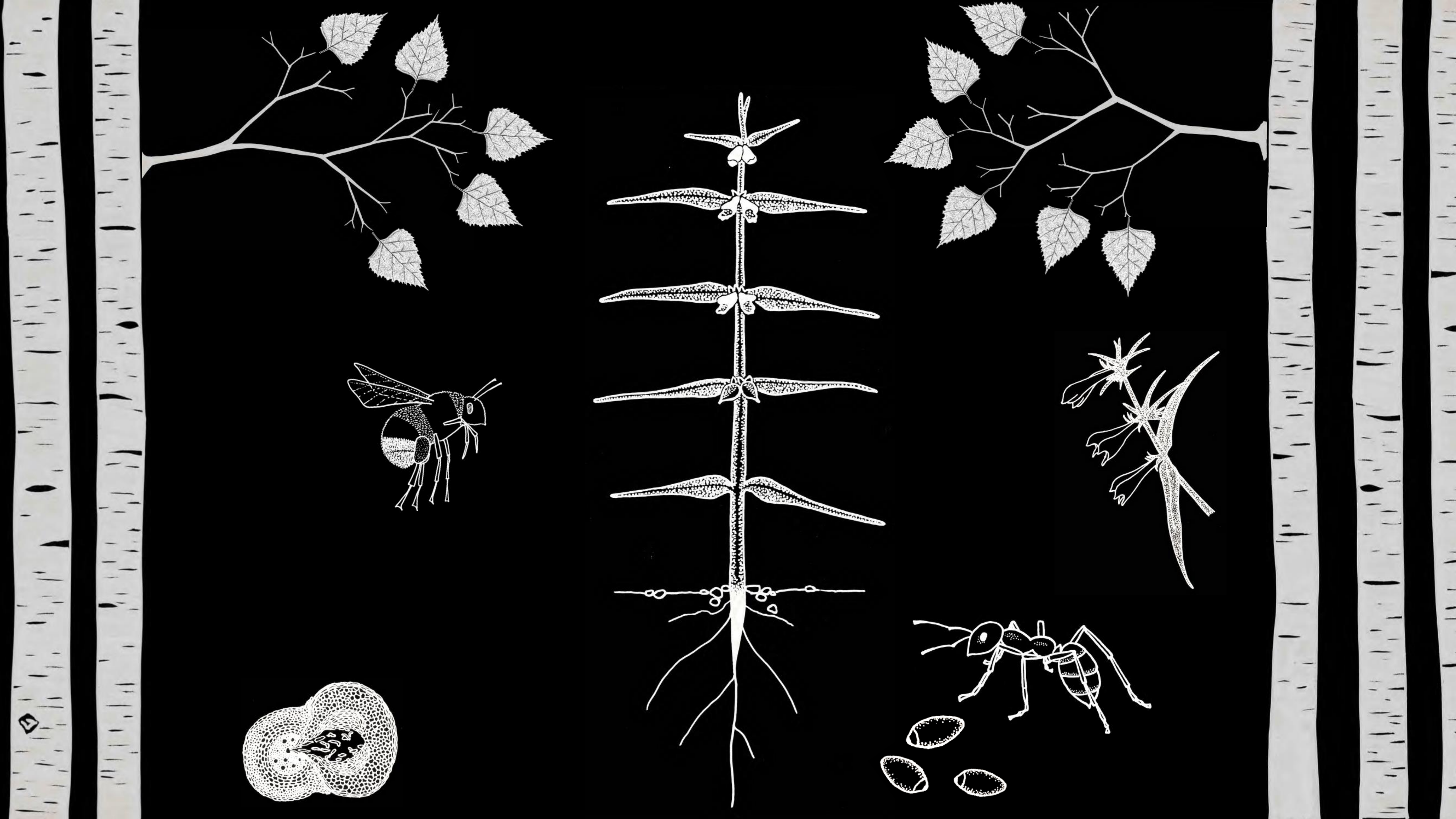






GBIF.org (8th February 2016) GBIF Occurrence Download http://doi.org/10.15468/dl.mprnn5
GBIF.org (3rd October 2018) GBIF Occurrence Download https://doi.org/10.15468/dl.rtts6c
DIVA-GIS *vers*. 7.5.0

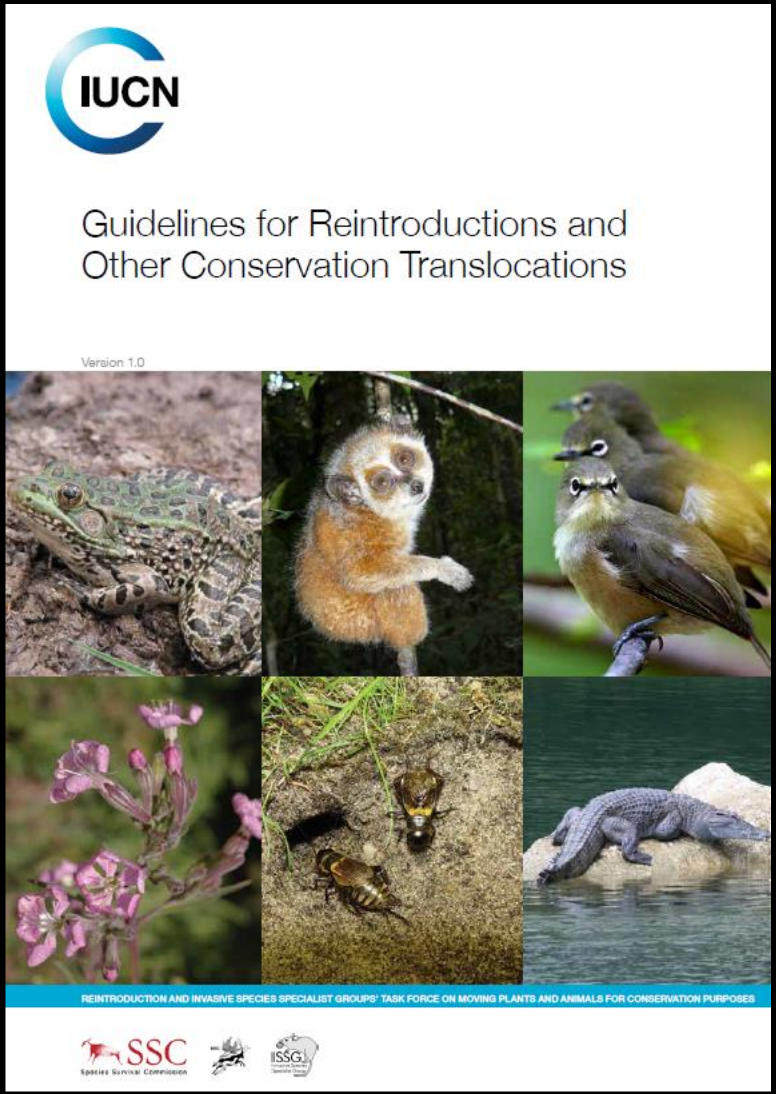
Indigenous range is not a proxy for the species' niche.

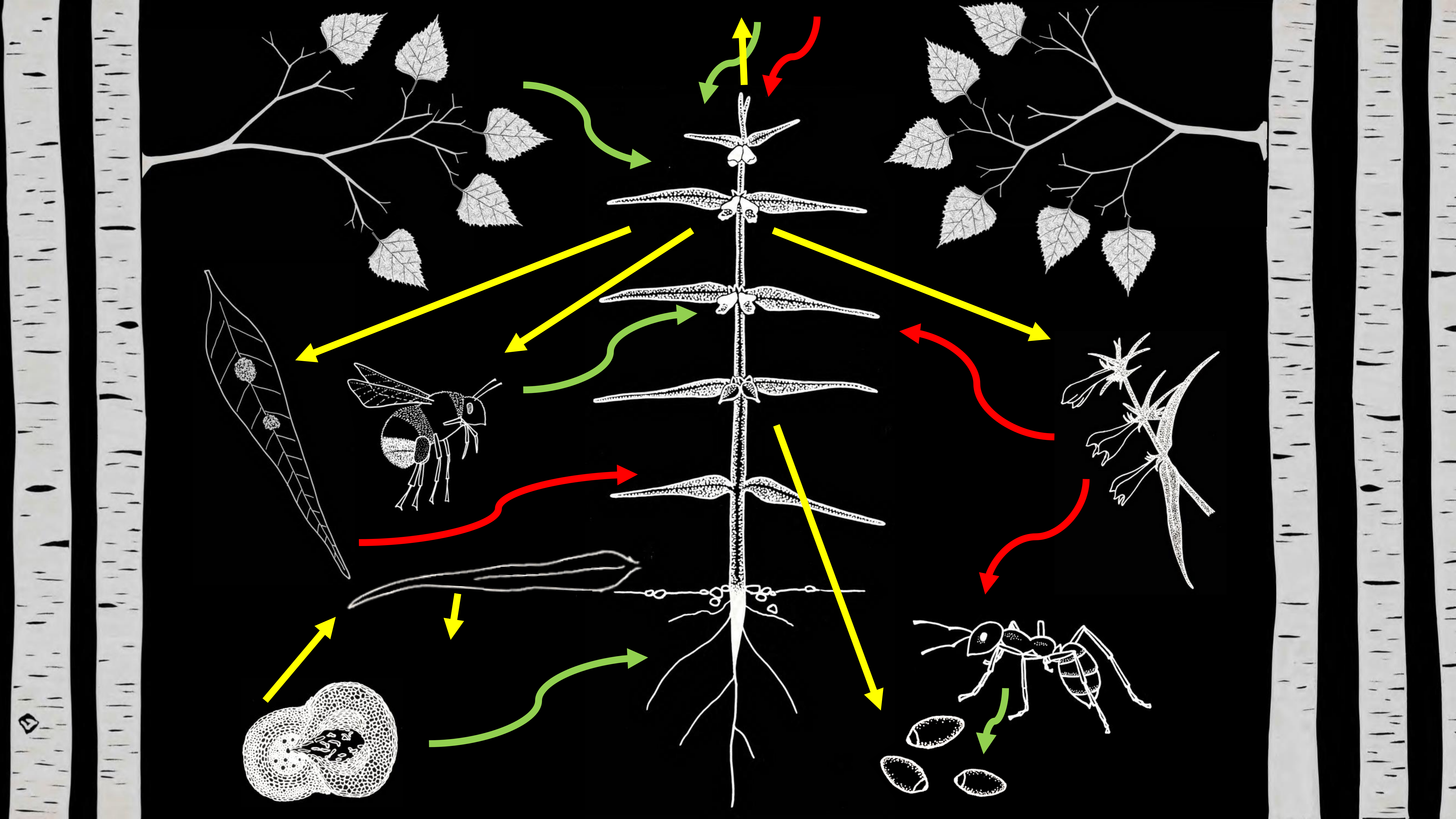


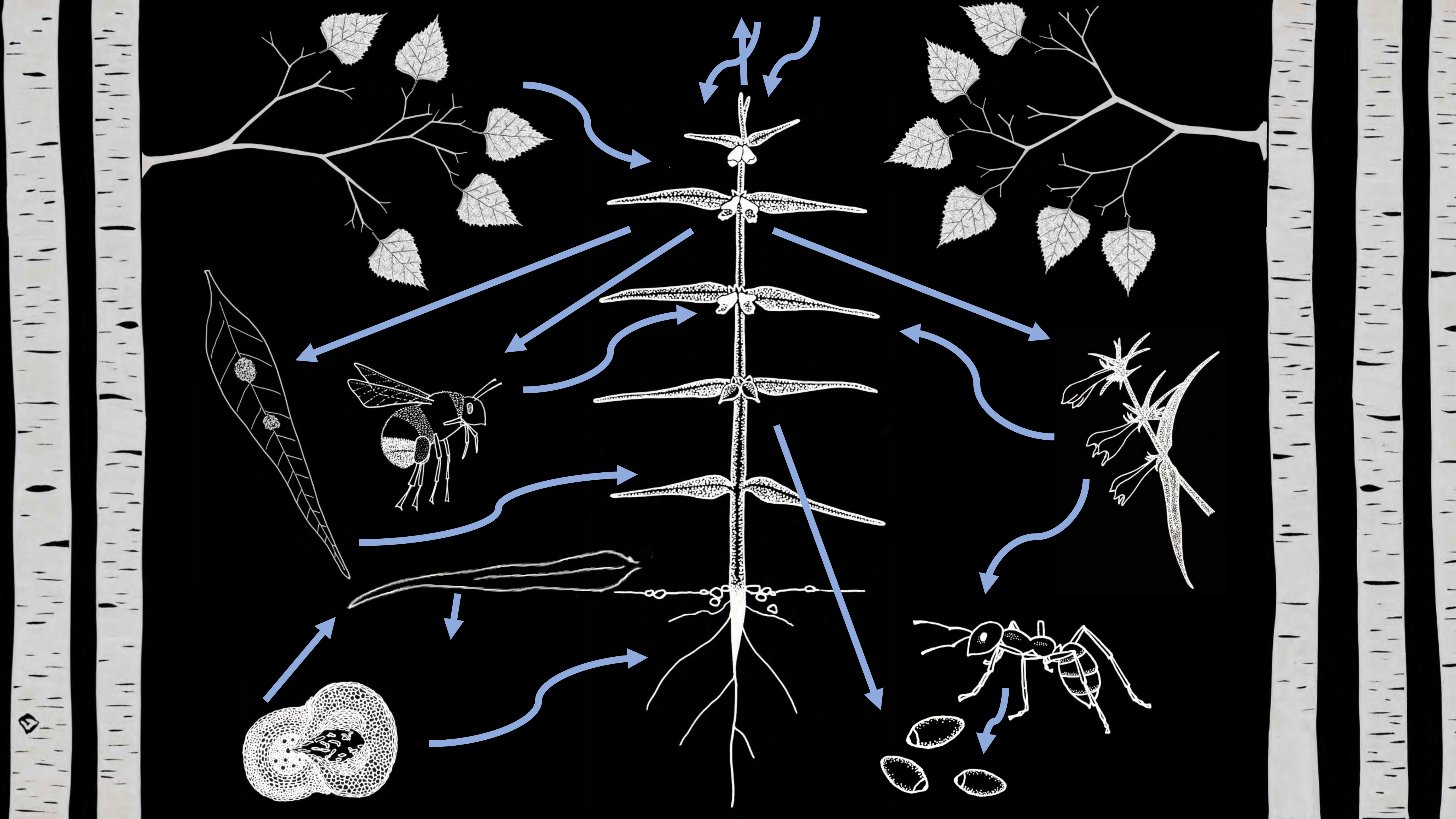
Ask not what your ecosystem can do for you,
but what you can do for your ecosystem.

“the primary objective [of CTs is to yield] conservation benefit:

…improving the conservation status of the focal species … **and/or restoring natural ecosystem functions or processes.**”

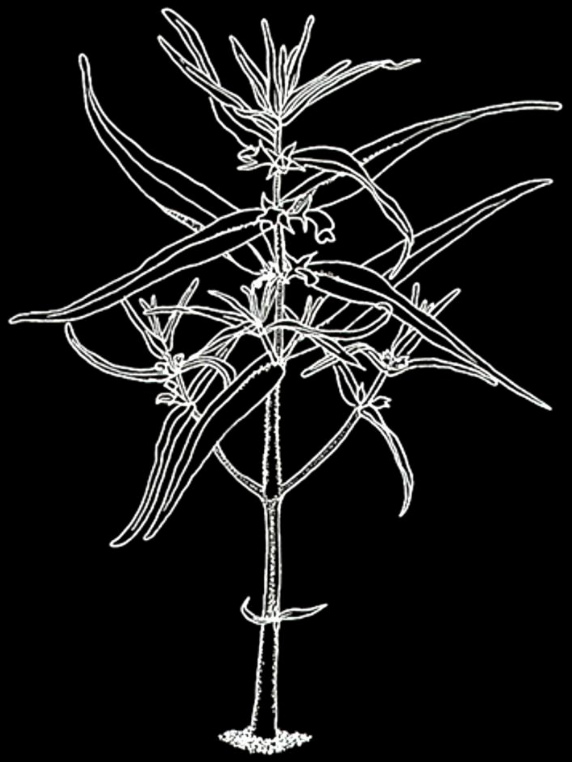






Ecosystem redundancy?

Would it really matter if *Melampyrum sylvaticum* went extinct?



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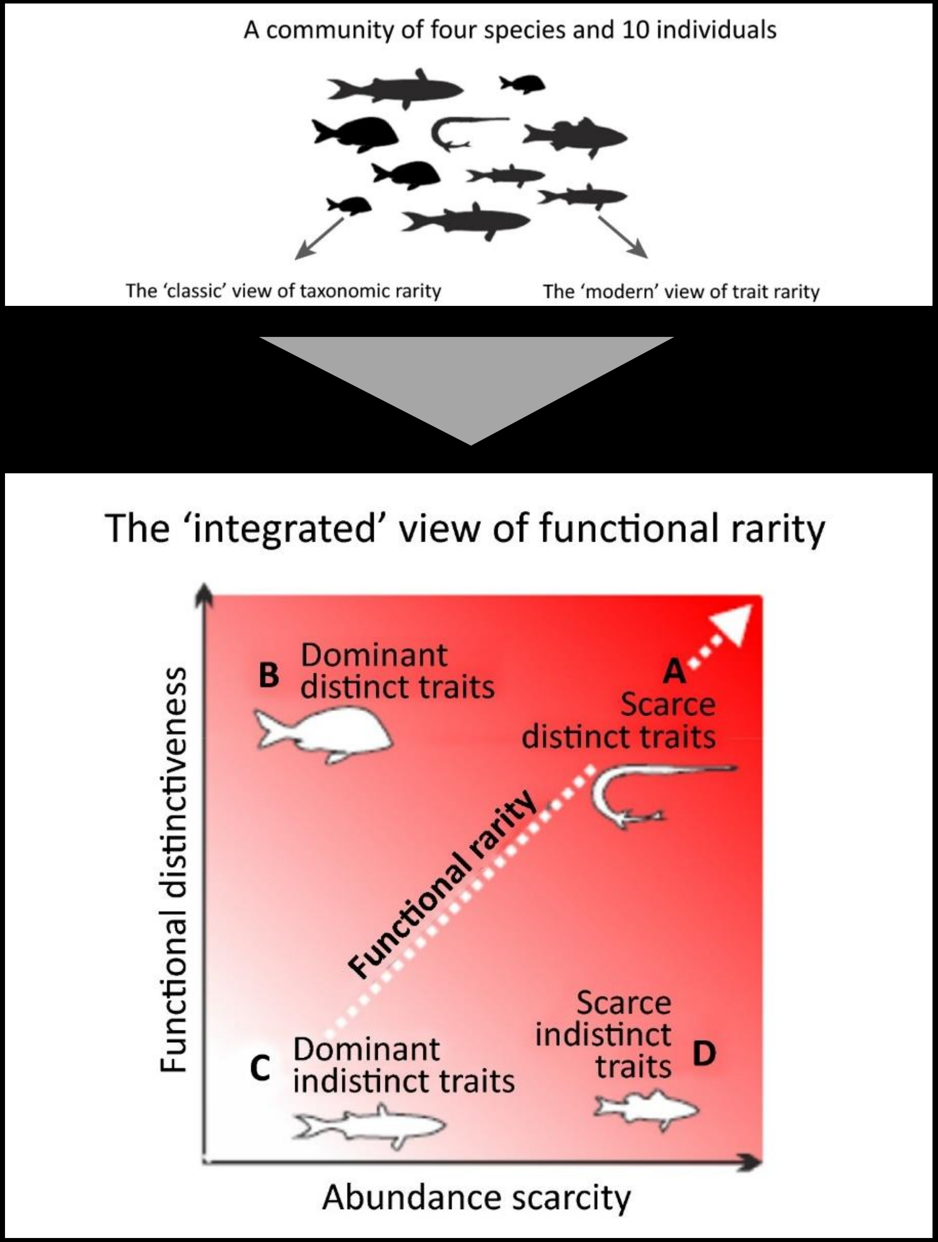
Functional rarity



Violle, C., Thuiller, W., Mouquet, N., Munoz, F., Kraft, N. J. B., Cadotte, M. W., … Mouillot, D. (2017). Functional Rarity: The Ecology of Outliers. *Trends in Ecology and Evolution*, *32*(5), 356–367.

Functional rarity

- 17 sites across England, Scotland and Wales
- 82 species including one or both *Melampyrum*
- 26 traits
  - environmental tolerance
  - growth form
  - reproductive traits
  - provisioning traits

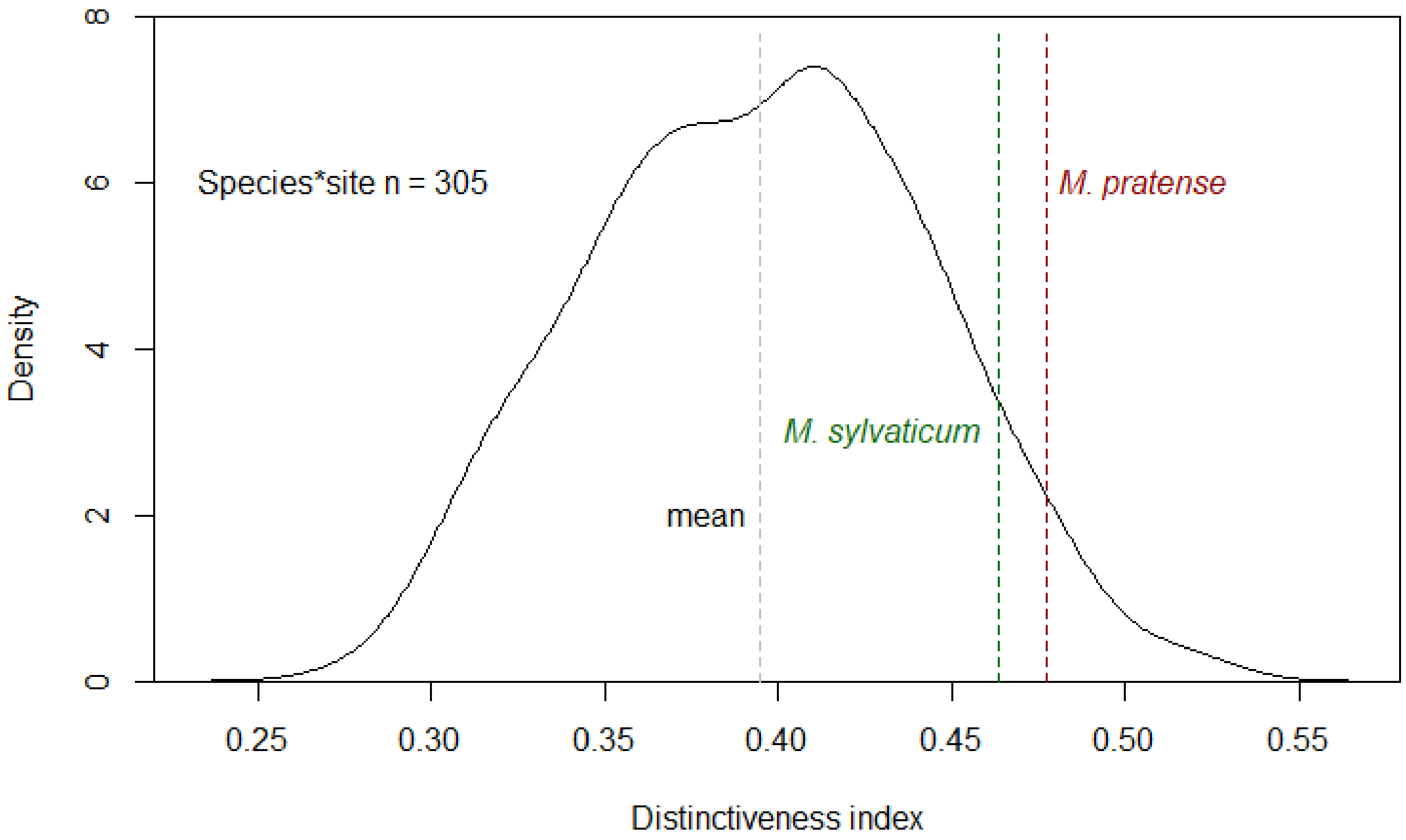
  Fitter, A. H. and Peat, H. J., 1994, The Ecological Flora Database, J. Ecol., 82, 415-425.
- R package "`funrar()`"

  Grenié *et al* (2017). funrar: An R package to characterize functional rarity. R package version 1.2.1, <URL: https://cran.r-project.org/package=funrar>.

Functional rarity

Every species given score based on distinctiveness in *each* community

Kernel density plot:

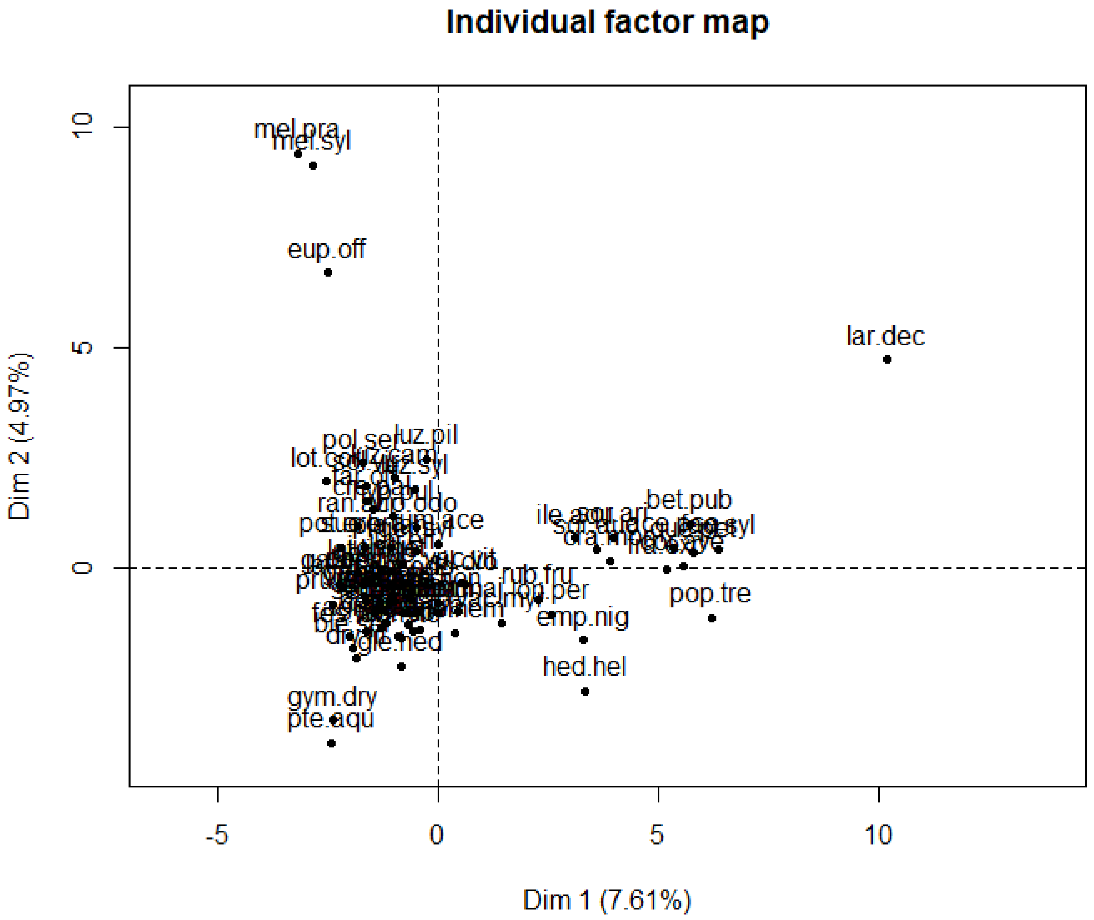


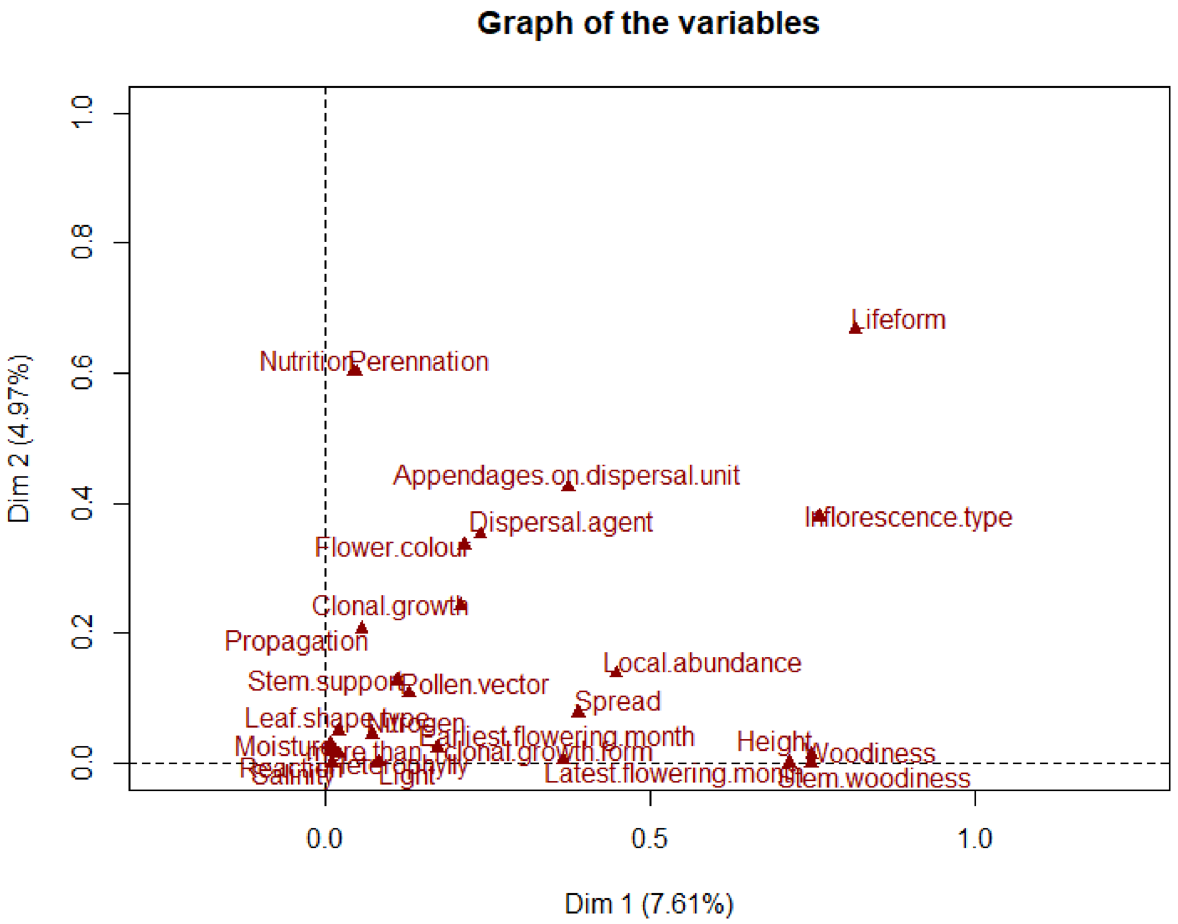
Distinctiveness

M. sylvaticum $\bar{x}$ = 0.463 ± 0.021 (SD)

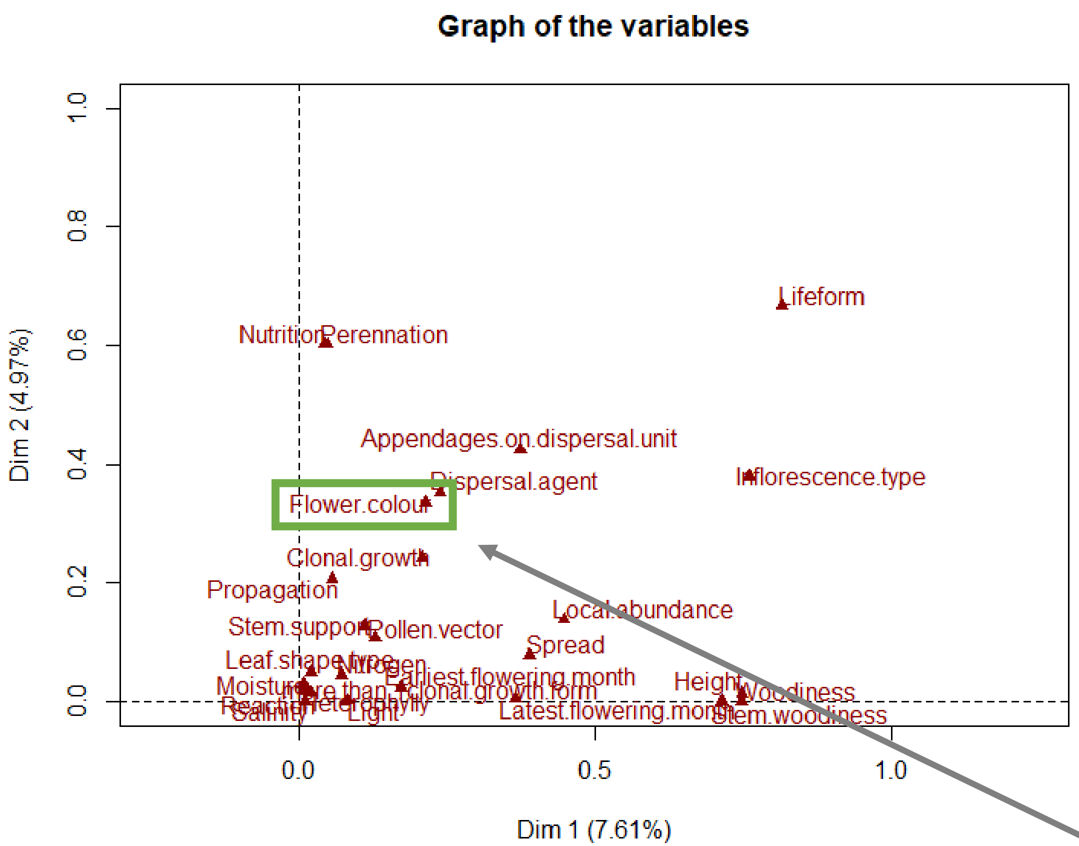
M. pratense $\bar{x}$ = 0.478 ± 0.022 (SD)

Which traits are most distinctive?





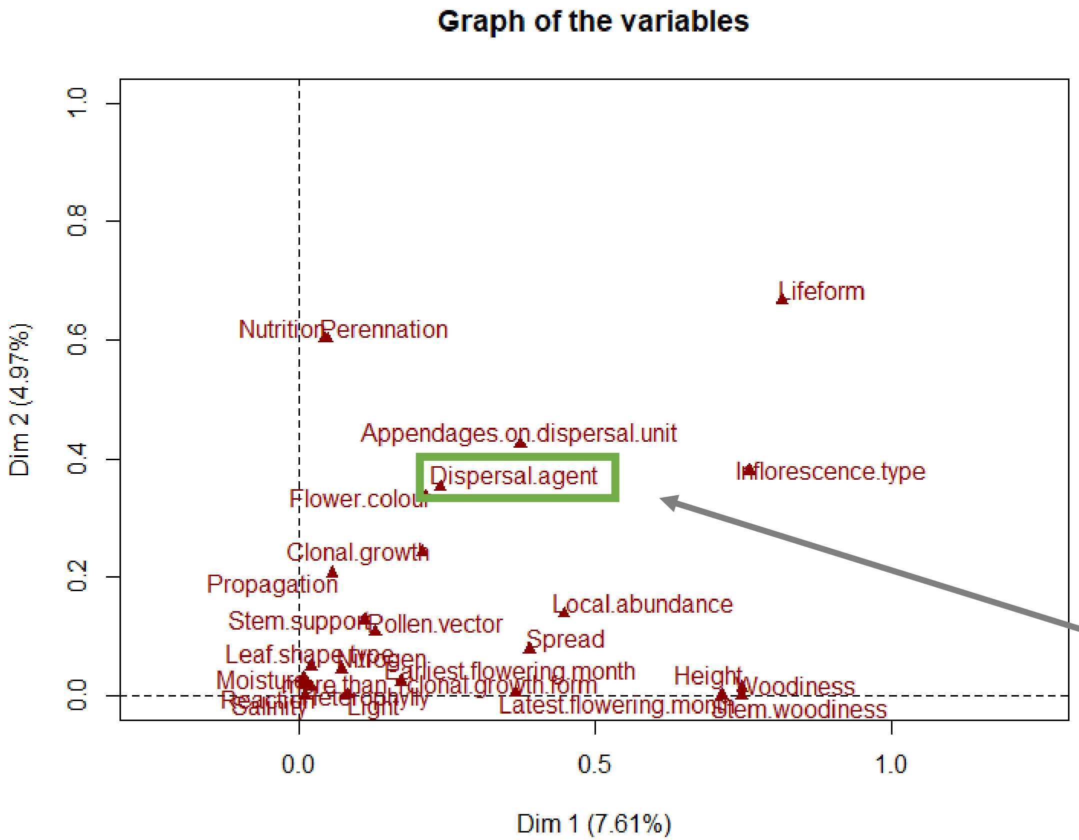
Le *et al.* (2008). FactoMineR: An R Package for Multivariate Analysis. Journal of Statistical Software, 25(1), 1-18.



Flower colour	n	cos²	v test
blue	4	0.003	-0.379
blue-violet	2	0	0.027
brown	8	0.094	2.203
cream	2	0.009	-0.612
green	21	0.078	-2.15
mauve	1	0.002	0.222
none	4	0.106	-2.7
pink	6	0.021	-0.945
purple	4	0.008	-0.521
red-purple	1	0	-0.054
violet	2	0	0.041
white	14	0.001	0.172
yellow	13	0.252	3.577

Flower colour = yellow

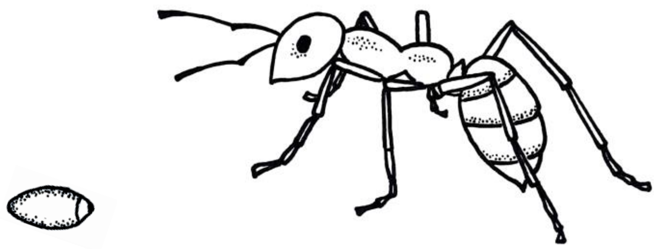
Critical mass of pollen and nectar provisioning flowers needed to sustain pollinators.



Dispersal agent	n	$\cos^2$	v test
abiotic	52	0.14	-2.678
ants	8	0.479	5.278
carried by birds	3	0.001	0.245
carried by mammals	3	0	-0.001
eaten by birds	15	0.015	-0.906
man	1	0.002	0.257

Seed dispersal = ants

Wood ants now lost from many forest ecosystems in UK. Undergoing reintroduction in many sites.



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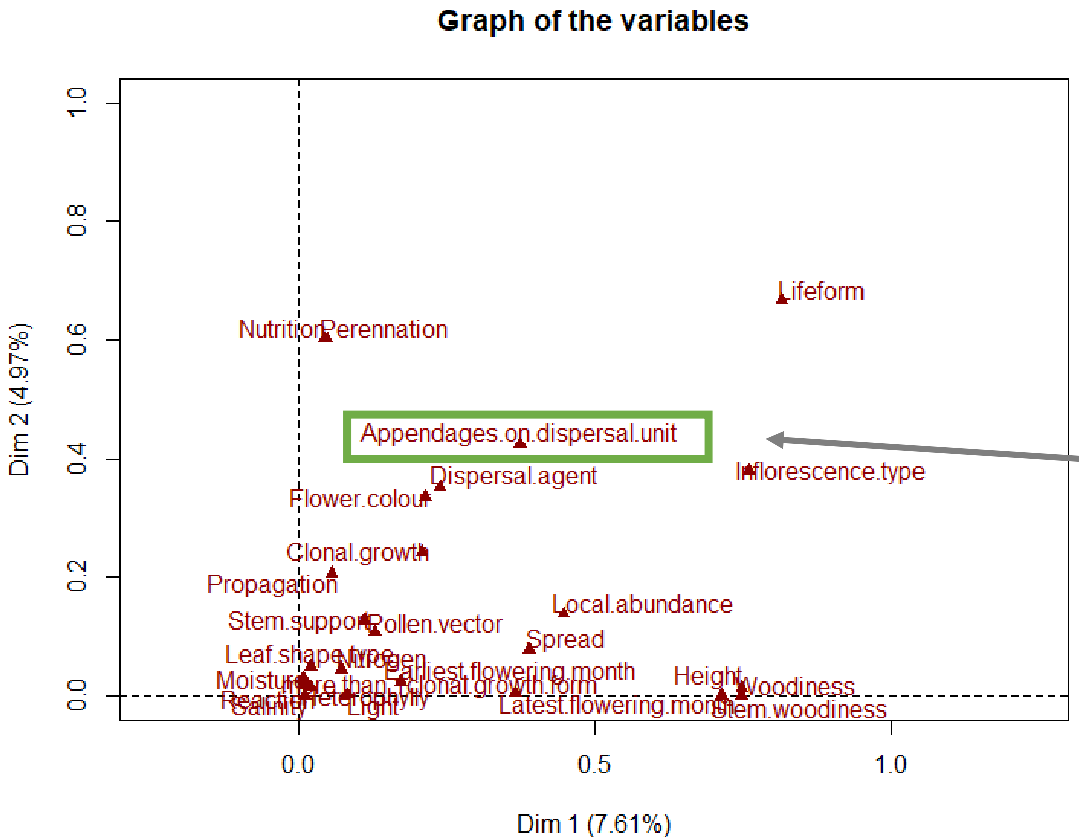


Appendage	n	$\cos^2$	v test
elaiosome	7	0.473	5.24
hooks	1	0.007	0.446
mucilage	7	0.01	-0.661
none	60	0.38	-4.277
pappus	3	0.037	1.306
wings	4	0.035	1.493

Seed appendages = elaiosome

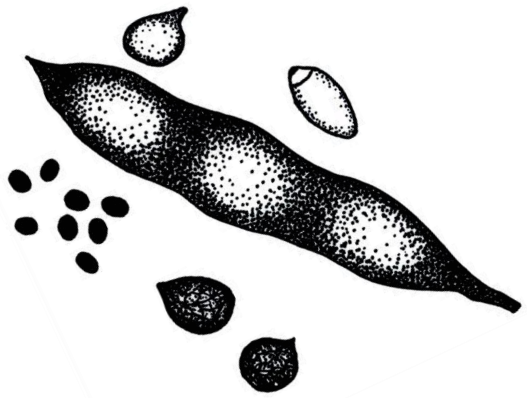
Important food resource for invertebrates, birds and small mammals.

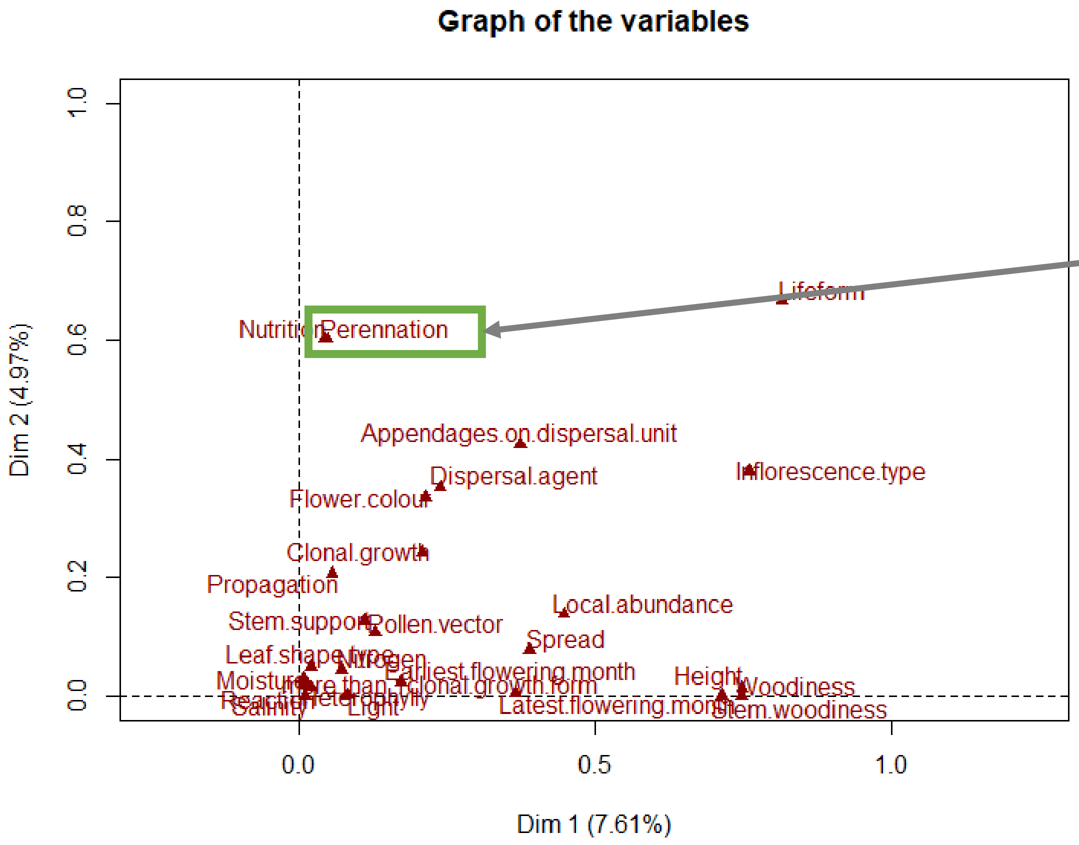
Seed dispersal = ants

Wood ants now lost from many forest ecosystems in UK. Undergoing reintroduction in many sites.

Flower colour = yellow

Critical mass of pollen and nectar provisioning flowers needed to sustain pollinators.





Life cycle	n	cos²	v test
annual	3	0.674	6.981
biennial	1	0.000	-0.087
perennial	78	0.588	-6.040

Perennation = annual

Annual turnover of biomass, annual inputs of seed and potential for high mobility within-site.

Appendages on seed = elaiosome

Important food resource for invertebrates, birds and small mammals.

Seed dispersal = ants

Wood ants now lost from many forest ecosystems in UK. Undergoing reintroduction in many sites.

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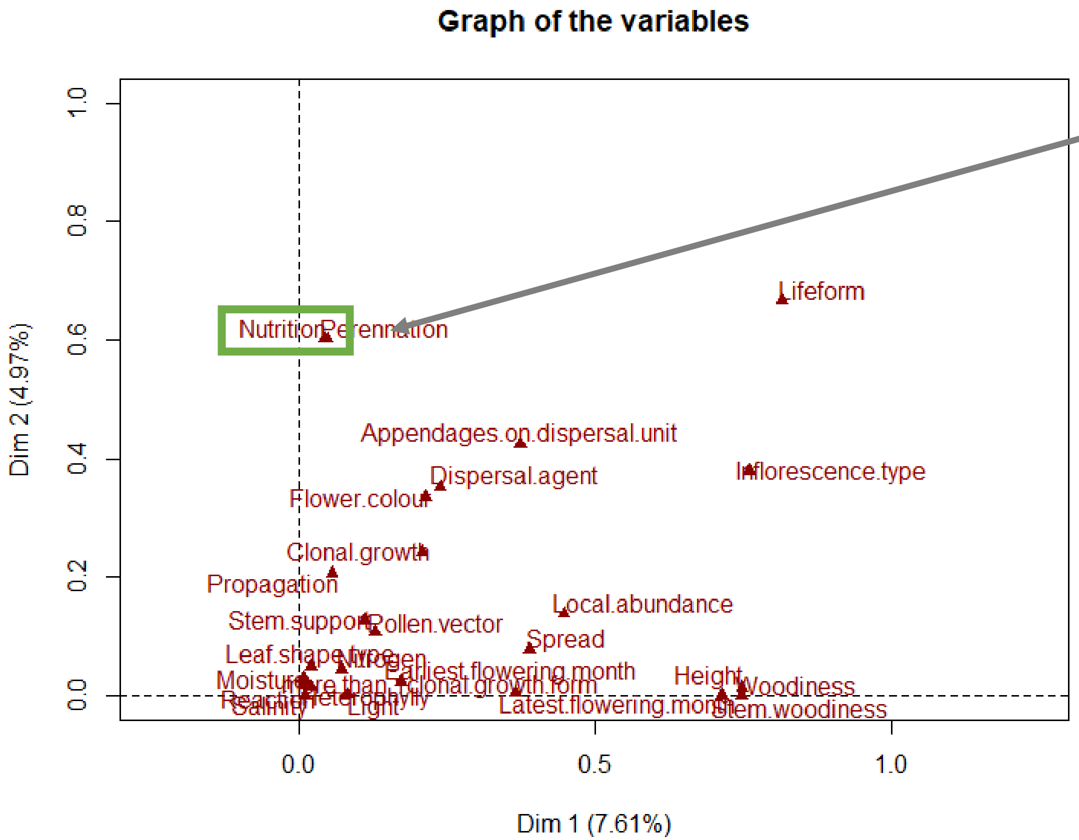
Critical mass of pollen and nectar provisioning flowers needed to sustain pollinators.



Nutrition = parasitic

Spatial redistribution of nutrients from hosts.

Perennation = annual

Annual turnover of biomass, annual inputs of seed and potential for high mobility within-site.

Appendages on seed = elaiosome

Important food resource for invertebrates, birds and small mammals.

Seed dispersal = ants

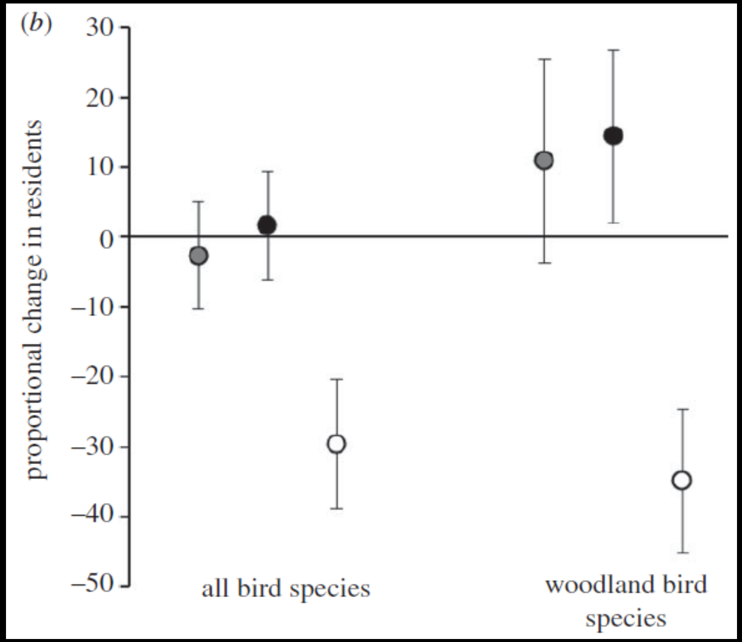
Wood ants now lost from many forest ecosystems in UK. Undergoing reintroduction in many sites.

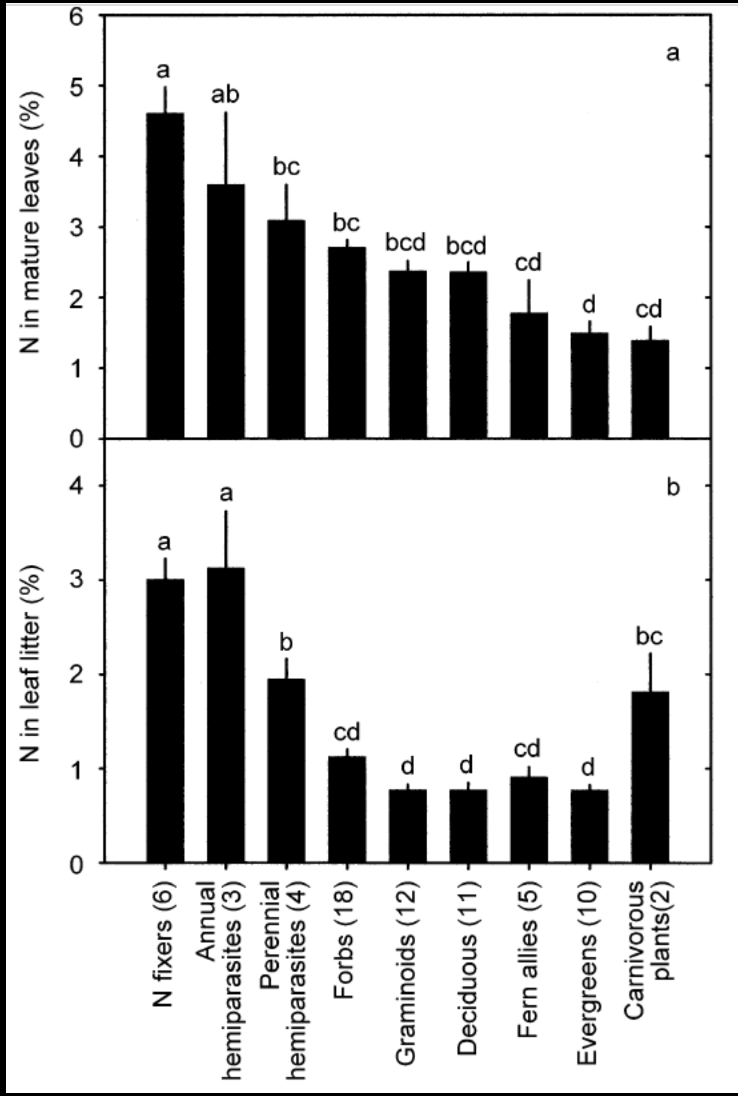
Flower colour = yellow

Critical mass of pollen and nectar provisioning flowers needed to sustain pollinators.

Nutrition	n	cos^2	v test
autotrophic	79	0.674	-6.981
hemi-parasitic	3	0.674	6.981

Hemiparasitism





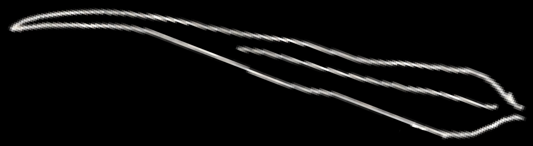
Watson & Herring (2012). Mistletoe as a keystone resource: an experimental test. *Proceedings of the Royal Society B: Biological Sciences*, *279*(July), 3853–3860.

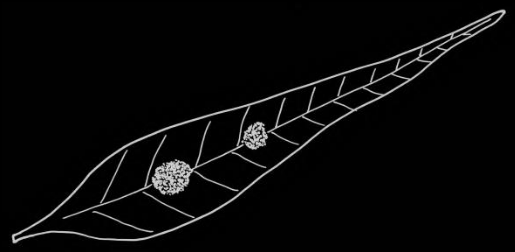
Quested *et al.* (2003). Decomposition of sub-arctic plants with differing nitrogen economies: A functional role for hemiparasites. *Ecology*, *84*(12), 3209–3221.

Implications for ecological replacement?

Missing traits

- seed mass
- leaf tissue N/P
- fungal associations





Implications for ecological replacement?

Rust fungi on *Melampyrum*:

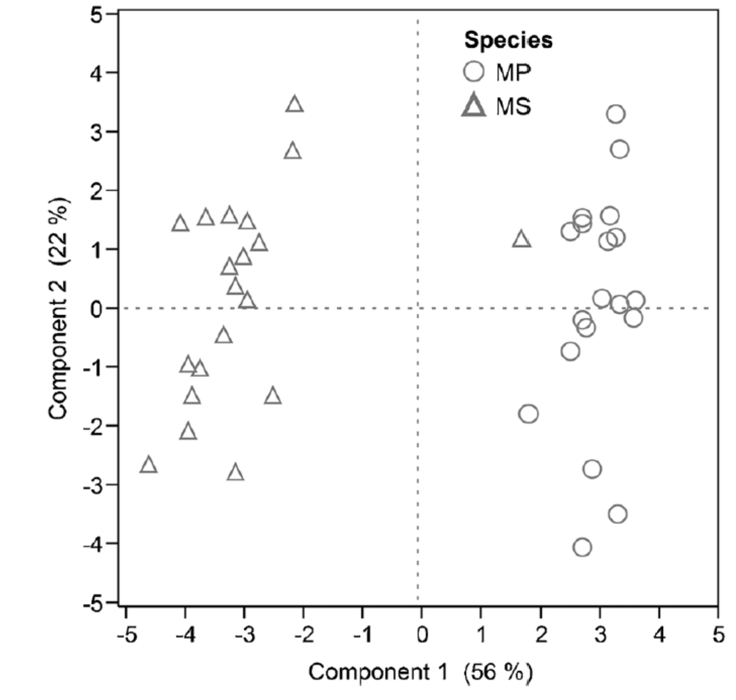
Puccinia nemoralis

(VU)

< 5 sites, all in Wales

Coleosporium tussilaginis

(LC, Wales)



PCA of phenolic profiles of *M. sylvaticum* and *M. pratense*.

Woods, R. G., Stringer, R. N., Evans, D. A., & Chater, A. O. (2015). Rust Fungus Red Data List and Census Catalogue for Wales. A.O. Chater, Aberystwyth.

Kaitera, J. & Witzell, J. (2016). Phenolic profiles of two Melampyrum species differing in susceptibility to Cronartium rust. *European Journal of Plant Pathology*, *144*(1), 133–140.

We cannot save everything, so functionally distinct species should be prioritised over those that are equally rare, but functionally redundant…

…this needs rigorous ecological understanding.

“We consider a species fully recovered if it is viable and ecologically functional in every part of its indigenous and projected range.”

Akçakaya et al. (2018). Quantifying species recovery and conservation success to develop an IUCN Green List of Species. *Conservation Biology*, 1–15.

LIVERPOOL JOHN MOORES UNIVERSITY

Many thanks to…

Dr David Bourke

Joe Bellis, MPhil, PhD candidate

Molly Frost (BSc, MSc, LJMU); 5208NATSCI **Conservation Practice** class of 2018, LJMU; **Susan Rodgers**, **Fiona Beaton & Yvonne McClean** (BSc, University of Aberdeen) and **Susie White** (MSc, University of Aberdeen).

Abstract

Our success in slowing the global decline of biodiversity will in part, depend on maintaining abiotic and biotic interactions that deliver niche requirements of threatened species. Being able to accurately describe the dimensions of an ecological niche is key to the effectiveness of interventions such as conservation translocations and every attempt to create a population of an endangered fungi, plant or animal is essentially a test of our understanding of the species' niche. However, organisms are not passive receptors of whatever their surroundings throw at them, and they in turn impact upon the environment and other organisms around them. This leads to the key message of this talk: while ecosystem-level processes are essential to maintain survival of the species we prioritise and conserve, they are also part of the rationale for undertaking a translocation and as conservation scientists, we have a responsibility to understand and facilitate these community-level roles. Growing evidence suggests that rare species deliver distinctive functions that can sustain biogeochemical processes and maintain ecosystem resilience to external perturbations. In a world where we cannot save everything, species that are functionally distinct should be prioritised more highly than those that might be equally rare, but functionally redundant. The evaluation of species contributions to ecosystem function in the context of past or proposed conservation translocations is likely to improve our understanding of the threatened systems we are trying to protect, the success of conservation translocations, and ultimately, will help maintain resilience in systems facing multiple threats and their cumulative impacts.

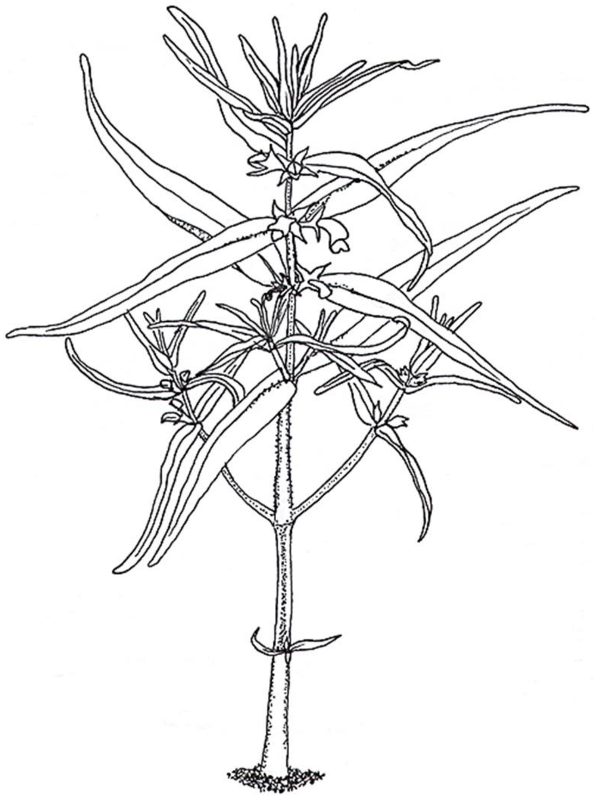
[word count: 250]

Session 3: Ecosystems

Keynote: Sarah Dalrymple	"Everything is connected: ecosystem functioning as a rationale for, and to improve the effectiveness of, conservation translocations"
Bryony Palmer	"A digger's gotta dig: assessing the impacts of reintroducing digging mammals in Australia"
John Bender	"Determining seed dispersal services by avian frugivores to guide rewilding efforts"
Blake Klocke	"Reintroduction efforts for two species of Panamanian Harlequin frogs *(Atelopus sp.)* threatened by amphibian chytrid fungus"
Colleen Crill	"Reintroducing flagship and keystone species to restore North Central Montana's mixed grass prairie ecosystem"
Marcelo Rheingantz	"Refaunating the Brazilian Atlantic Forest to restore lost ecological interactions"
Saul Cowen	"Returning to 1616 - the ecological restoration of Western Australia's largest island"

Table 1 N concentration of mature leaves and N concentration, C:N ratio and P concentration of leaf litter of hemiparasitic angiosperms and co-occurring species. SEs are given *in parentheses* after the mean (n=4)

	Mature leaf N (%)	Litter N (%)	Litter C:N ratio	Litter P (%)
Perennial hemiparasites				
Bartsia alpina	2.85 (0.05)	2.00 (0.04)	23.40 (1.73)	0.293 (0.067)
Pedicularis lapponica	4.18 (0.06)	1.81 (0.05)	23.20 (0.96)	
Pedicularis hirsuta	2.77 (0.04)	2.51 (0.06)	19.54 (0.48)	0.166 (0.010)
Pedicularis sceptrum-carolinum	1.55 (0.02)	1.48 (0.18)	32.72 (4.09)	0.231 (0.009)
Annual hemiparasites				
Euphrasia frigida	4.89 (0.20)	4.10 (0.11)	11.00 (0.28)	0.382 (0.017)
Rhinanthus minor	3.23 (0.02)	3.25 (0.14)	11.37 (0.46)	0.525 (0.031)
Melampyrum sylvaticum	1.69 (0.04)	2.04 (0.05)	21.90 (0.72)	0.536 (0.053)
Dwarf shrubs				
Vaccinium uliginosum	1.72 (0.10)	0.48 (0.03)	109.55 (7.17)	0.027 (0.005)
Vaccinium vitis-idaea	0.91 (0.01)	0.83 (0.09)	62.01 (6.57)	0.058 (0.027)
Betula nana	2.53 (0.03)	0.74 (0.02)	74.65 (1.73)	0.030 (0.022)
Empetrum hermaphroditum	1.00 (0.02)	0.69 (0.02)	85.14 (1.66)	0.094 (0.009)
Graminoids				
Calamagrostis lapponica	1.47 (0.04)	0.48 (0.03)	89.13 (6.16)	0.085 (0.009)
Carex vaginata	1.61 (0.02)	0.74 (0.04)	65.50 (1.79)	
Carex capitata	1.71 (0.02)	0.84 (0.02)	55.57 (0.43)	
Forbs				
Polygonum viviparum	2.79 (0.02)	0.77 (0.04)	63.41 (2.31)	0.191 (0.045)
Rubus chamaemorus	2.83 (0.09)	0.59 (0.03)	79.13 (2.80)	0.095 (0.009)



Quested, H. M., Press, M. C., Callaghan, T. V., & Cornelissen, J. H. C. (2002). The hemiparasitic angiosperm Bartsia alpina has the potential to accelerate decomposition in sub-arctic communities. *Oecologia*, *130*(1), 88–95. https://doi.org/10.1007/s004420100780

Types and examples of ecological functions of species

Akçakaya et al. (2018). *Conservation Biology*, 1–15.

Type of function of species	Example
Species interactions (including trophic functions)	pollination, seed dispersal, predation (including seed predation), host-parasite relationships, facilitation, providing resources (e.g., as prey)
Structural (landscape) functions	creation of habitat for other species, ecosystem engineering, substrate stabilization, peat formation, bushfire fuel accumulation, facilitation of landscape connectivity, maintenance of heterogeneity
Ecosystem-level functions	primary production, decomposition, nutrient cycling or redistribution, modification of fire and hydrological regimes
Within-species processes	migration, colony formation and other aggregations of individuals, adaptation (evolutionary potential)

First principles

"We are all connected; to each other, biologically. To the earth, chemically. To the rest of the universe atomically. We are not figuratively, but literally stardust."

Neil DeGrasse Tyson

Implications for ecological replacement?

Community diversity of ground flora in Scottish woodlands:

Species	Diversity index
Melampyrum sylvaticum	5.743
Melampyrum pratense	2.746

Frost, M. Unpublished thesis. Liverpool John Moores University, 2016.

Recommendations

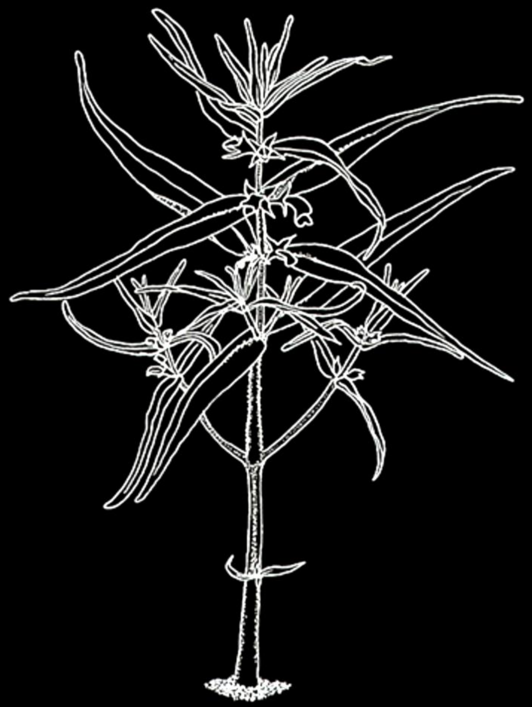
- If you undertake a translocation be aware of the place of your organism in the ecosystem;
- Quantify or at least, objectively describe, those ecosystem-level interactions;
- Identify those interactions that might impact upon the success of your translocation;
- Use these interactions to signal what contribution your focal organism might make to its recipient ecosystem post-translocation.

In the following session:

The realised niche

- typically a contraction of the fundamental niche
- in CTs we often feel that we need to make room for our focal species
- management required to e.g. subdue competitors

- but let’s adjust our thinking – we need to rehitch our species back into their ecosystems so that means explicitly acknowledging interactions that our species will cope with
- this is a good thing, it means that



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