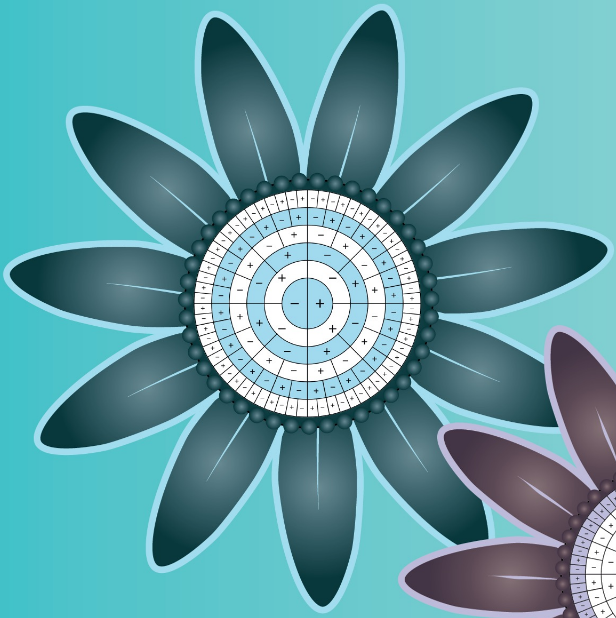
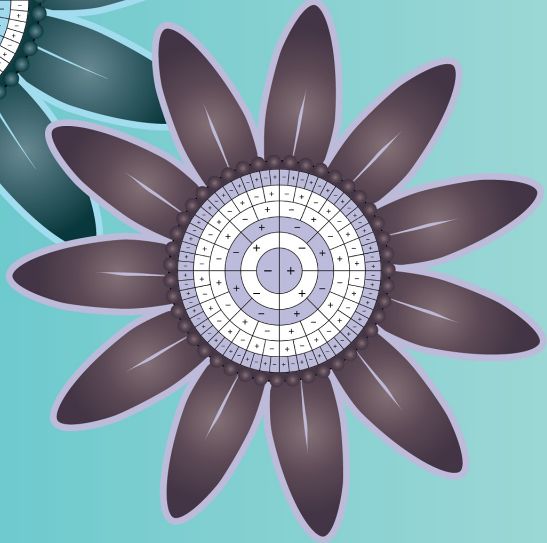
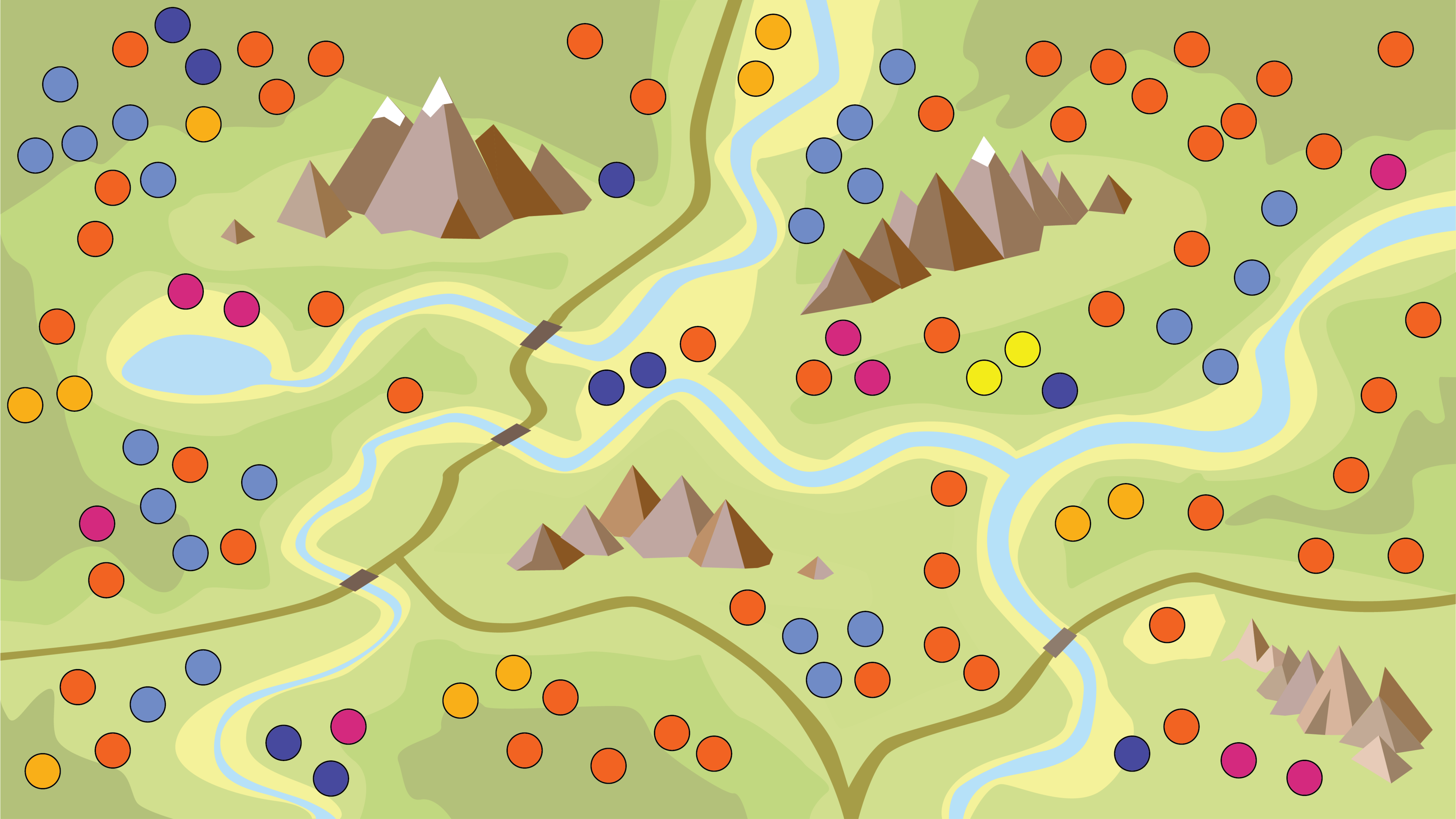
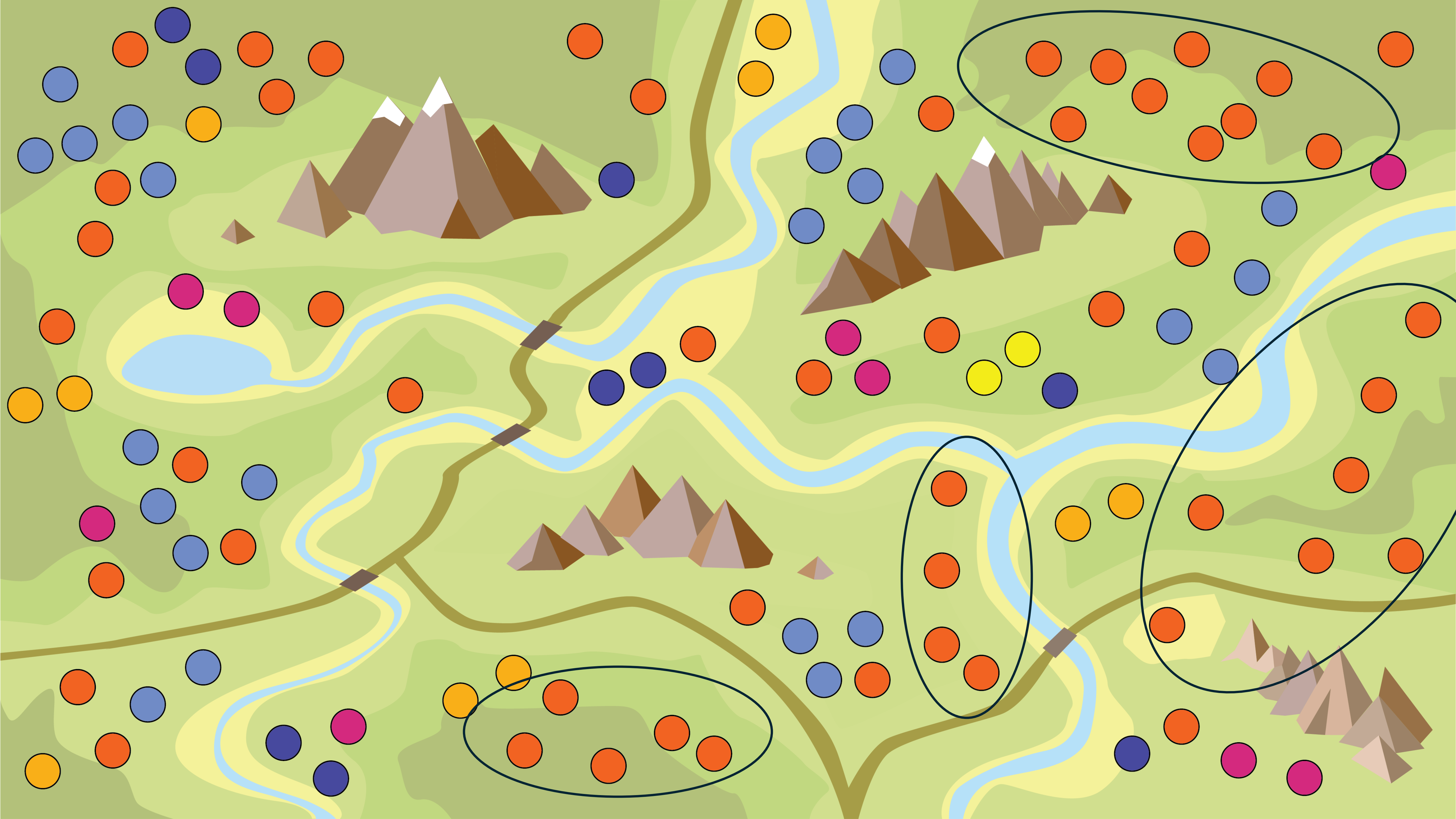
A Global Model of Discretized Rarity

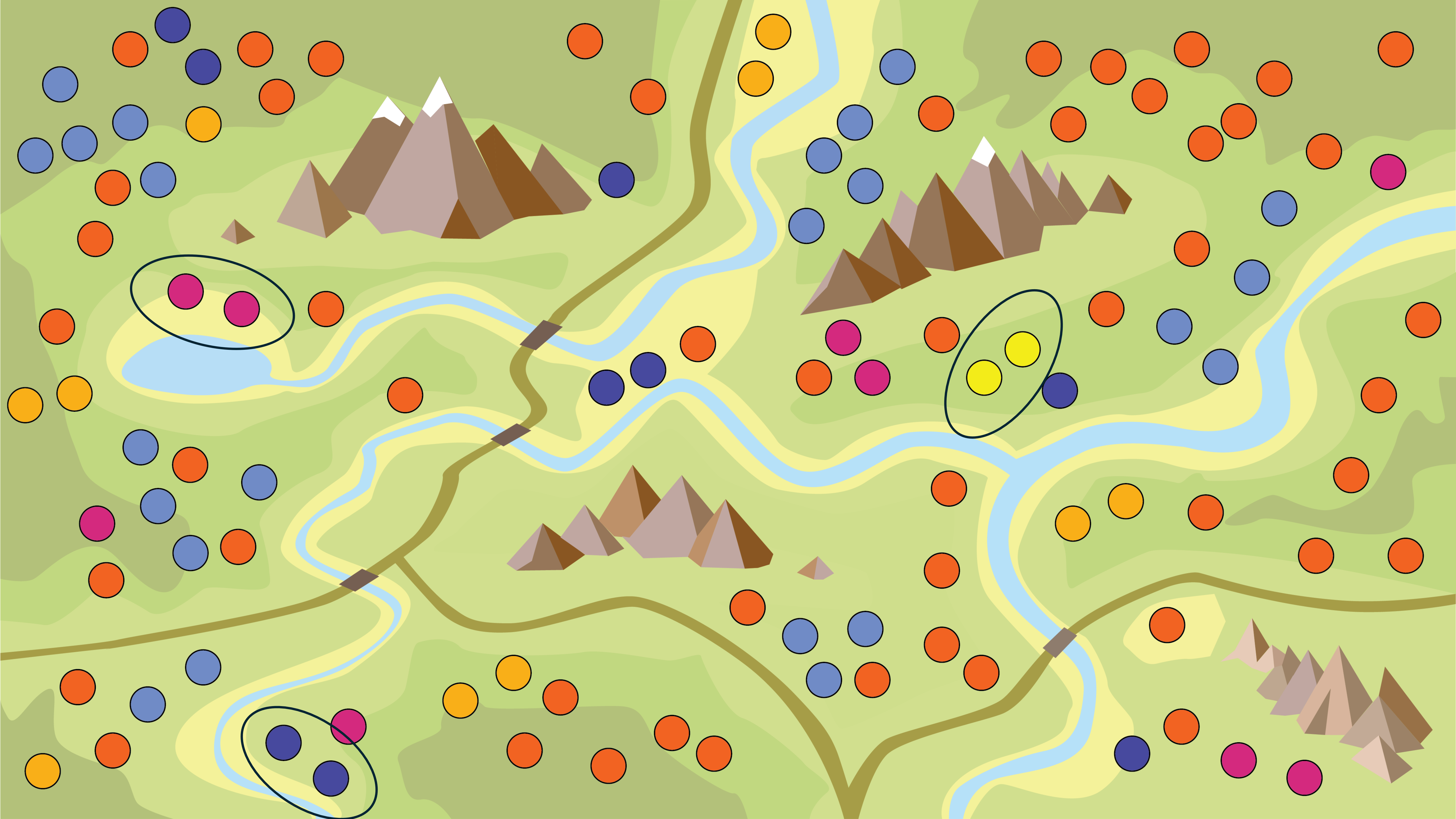




Alivia G. Nytko, Brian C. O'Meara,
Joe K. Bailey







Geographic Range		Large		Small	
Habitat Specificity		Wide	Narrow	Wide	Narrow
Local Population Size	Large				
	Small				

Rabinowitz 1981. *The Biological Aspects of Rare Plant Conservation*

Geographic Range		Large		Small	
Habitat Specificity		Wide	Narrow	Wide	Narrow
Local Population Size	Large				Endemic
	Small				

Rabinowitz 1981. *The Biological Aspects of Rare Plant Conservation*

Geographic Range		Large		Small	
Habitat Specificity		Wide	Narrow	Wide	Narrow
Local Population Size	Large				
	Small	Sparse			

Rabinowitz 1981. *The Biological Aspects of Rare Plant Conservation*

Geographic Range		Large		Small	
Habitat Specificity		Wide	Narrow	Wide	Narrow
Local Population Size	Large				
	Small				

Rabinowitz 1981. *The Biological Aspects of Rare Plant Conservation*

Functional Rarity: Trait Distinctiveness

Phylogenetic Rarity: Evolutionary Distinctiveness

Geographic Range		Large		Small	
Habitat Specificity		Wide	Narrow	Wide	Narrow
Local Population Size	Large				
	Small				

Rabinowitz 1981. *The Biological Aspects of Rare Plant Conservation*

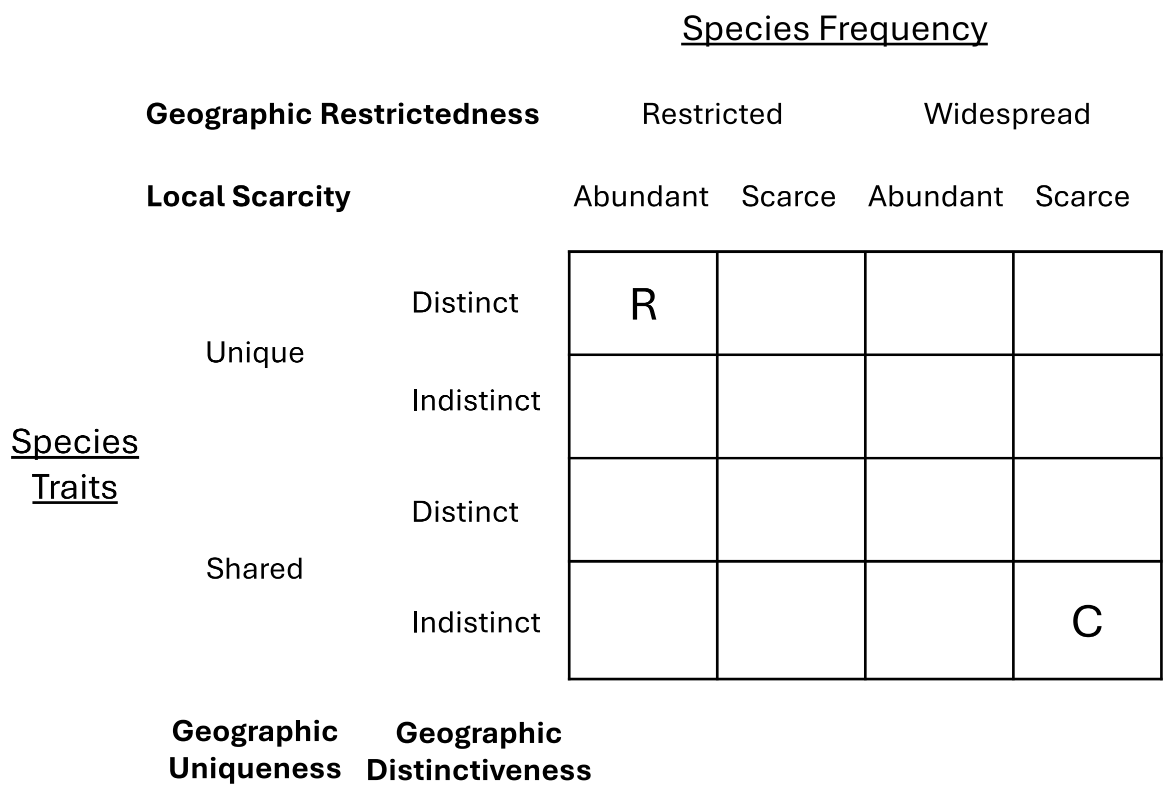
Functional Rarity: Trait Distinctiveness

Phylogenetic Rarity: Evolutionary Distinctiveness

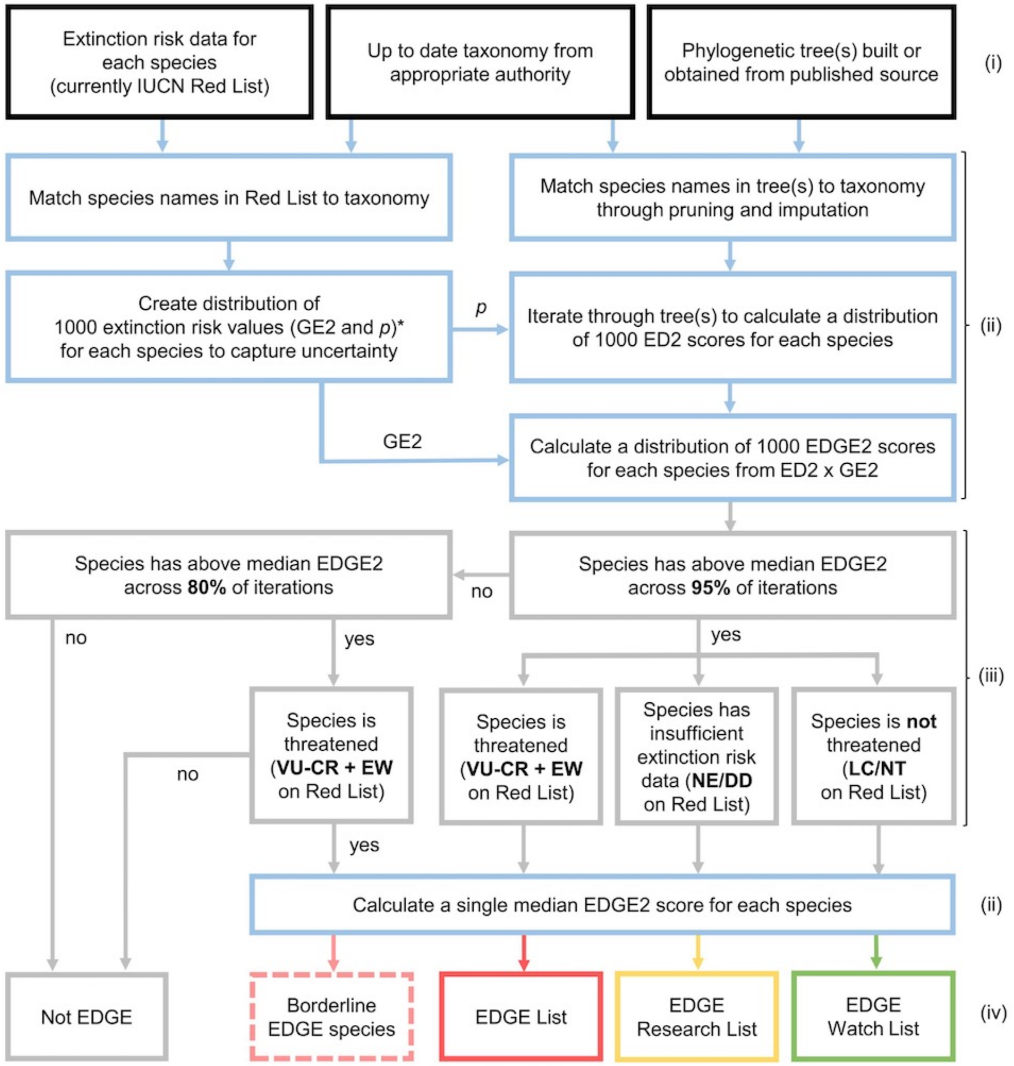
Geographic Range		Large		Small	
Habitat Specificity		Wide	Narrow	Wide	Narrow
Local Population Size	Large				
	Small				

Rabinowitz 1981. *The Biological Aspects of Rare Plant Conservation*

Functional Rarity Framework



EDGE Protocol



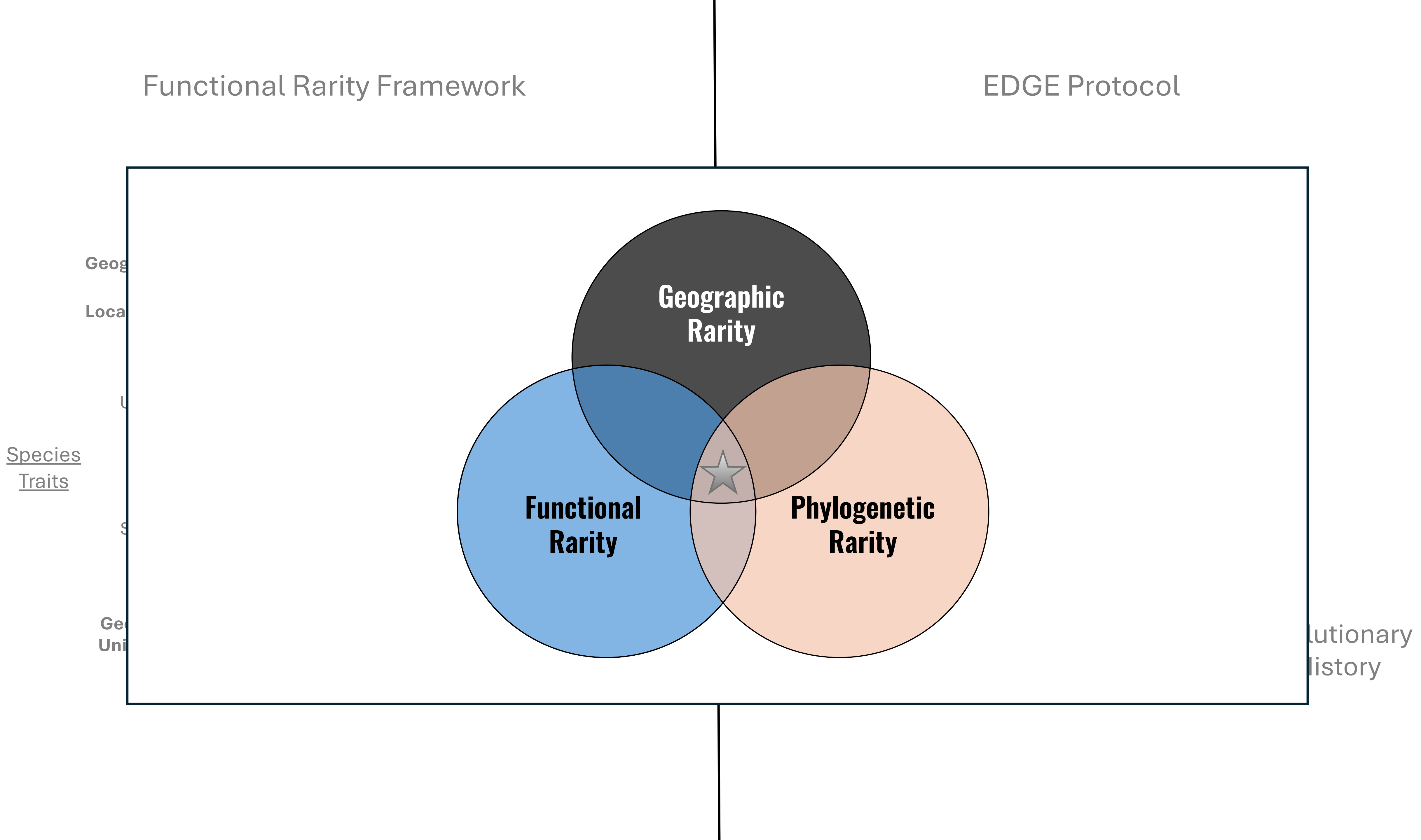

Functional Rarity Framework
EDGE Protocol
Geographic Rarity
Functional Rarity
Phylogenetic Rarity
Species Traits
lutionary
listory

Table 1
Summary of the links between rarity, distinctiveness, originality, and diversity developed in the main text with diversity indices Q, ${}^{\alpha}K$ and ${}^{\alpha}K^{*}$.

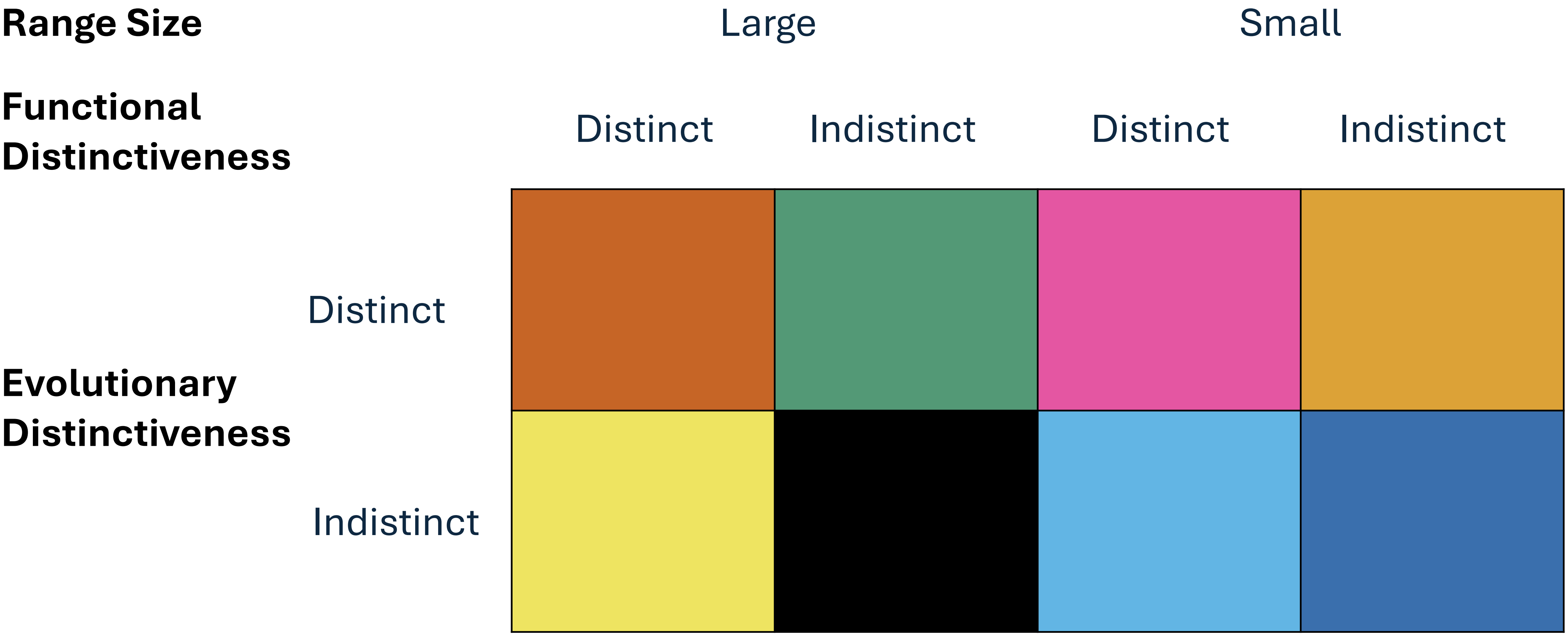
	Quadratic diversity[a]	First parametric extension[a]	Second parametric extension[a]
Species-level			
FP-distinctiveness	$D_j = \sum_{i \neq j}^{N} \frac{p_i}{1-p_j} d_{ij}$	${}^{\alpha}D_j = \frac{1-\left(\sum_{i=1}^{N} p_i s_{ij}\right)^{\alpha-1}}{1-p_j^{\alpha-1}}$	${}^{\alpha}D_j^{*} = \frac{\sum_{c=1}^{N-1} u_{c\vert j}\left(1-p_{c\vert j}^{\alpha-1}\right)}{\left(1-p_j^{\alpha-1}\right)}$
Abundance-based rarity	$\rho_j = (1-p_j)$	${}^{\alpha}\rho_j = \frac{1-p_j^{\alpha-1}}{\alpha-1}$	${}^{\alpha}\rho_j = \frac{1-p_j^{\alpha-1}}{\alpha-1}$
Effective originality	$O_j = U_j \times \rho_j$	${}^{\alpha}O_j = {}^{\alpha}D_j \times {}^{\alpha}\rho_j$	${}^{\alpha}O_j^{*} = {}^{\alpha}D_j^{*} \times {}^{\alpha}\rho_j$
Community-level			
Species diversity[b]	$S = \sum_{j=1}^{N} p_j \rho_j = 1-\sum_{i=1}^{N} p_i^2$	${}^{\alpha}S = \sum_{j=1}^{N} p_j\left({}^{\alpha}\rho_j\right) = \frac{1-\sum_{j=1}^{N} p_j^{\alpha}}{\alpha-1}$	${}^{\alpha}S = \sum_{j=1}^{N} p_j\left({}^{\alpha}\rho_j\right) = \frac{1-\sum_{j=1}^{N} p_j^{\alpha}}{\alpha-1}$
FP-diversity	$Q = \sum_{j=1}^{N} p_j O_j = \sum_{i=1}^{N}\sum_{j=1}^{N} p_i p_j d_{ij}$	${}^{\alpha}K = \sum_{j=1}^{N} p_j\left({}^{\alpha}O_j\right) = \sum_{j=1}^{N} p_j \times \frac{1-\left(\sum_{i=1}^{N} p_i s_{ij}\right)^{\alpha-1}}{\alpha-1}$	${}^{\alpha}K^{*} = \sum_{j=1}^{N} p_j\left({}^{\alpha}O_j^{*}\right) = \sum_{j=1}^{N} p_j \times \frac{\sum_{c=1}^{N-1} u_{c\vert j}\left(1-p_{c\vert j}^{\alpha-1}\right)}{\alpha-1}$
Species equivalents[c]	$E = 1/\sum_{i=1}^{N}\sum_{j=1}^{N} p_i p_j s_{ij}$	${}^{\alpha}E = \left(\sum_{j=1}^{N} p_j\left(\sum_{i=1}^{N} p_i s_{ij}\right)^{\alpha-1}\right)^{\frac{1}{(1-\alpha)}}$	${}^{\alpha}E^{*} = \left(\sum_{j=1}^{N} p_j\left(1-\frac{max_i(d_{ij})}{d_{\max}}+\sum_{c=1}^{N-1}\frac{u_{c\vert j}}{d_{\max}} p_{c\vert j}^{\alpha-1}\right)\right)^{\frac{1}{(1-\alpha)}}$

Pavoine & Ricotta 2021, *Biol. Conserv.*

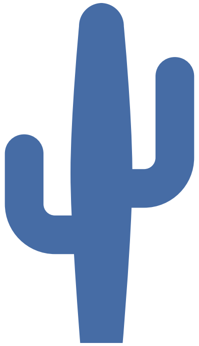

2.18
2.38

Range Size	Large	Small

Range Size	Large		Small	
Functional Distinctiveness	Distinct	Indistinct	Distinct	Indistinct

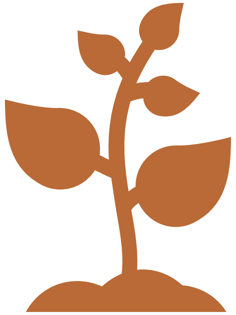

Range Size
Large
Small
Functional Distinctiveness
Distinct
Indistinct
Distinct
Indistinct
Evolutionary Distinctiveness
Distinct
Indistinct

Range Size		Large		Small	
Functional Distinctiveness		Distinct	Indistinct	Distinct	Indistinct
Evolutionary Distinctiveness	Distinct	Indicator	Adaptable Survivor	Classically Rare	Relict
	Indistinct	High Invasive Potential	Common	Endemic	Environmentally Rare



Environmentally Rare

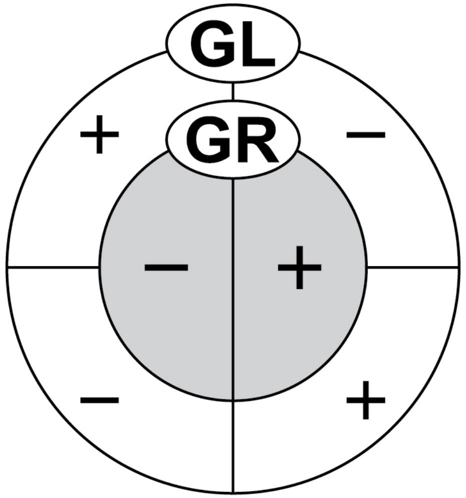
- High stress tolerance
- General mutualisms
- Recent speciation

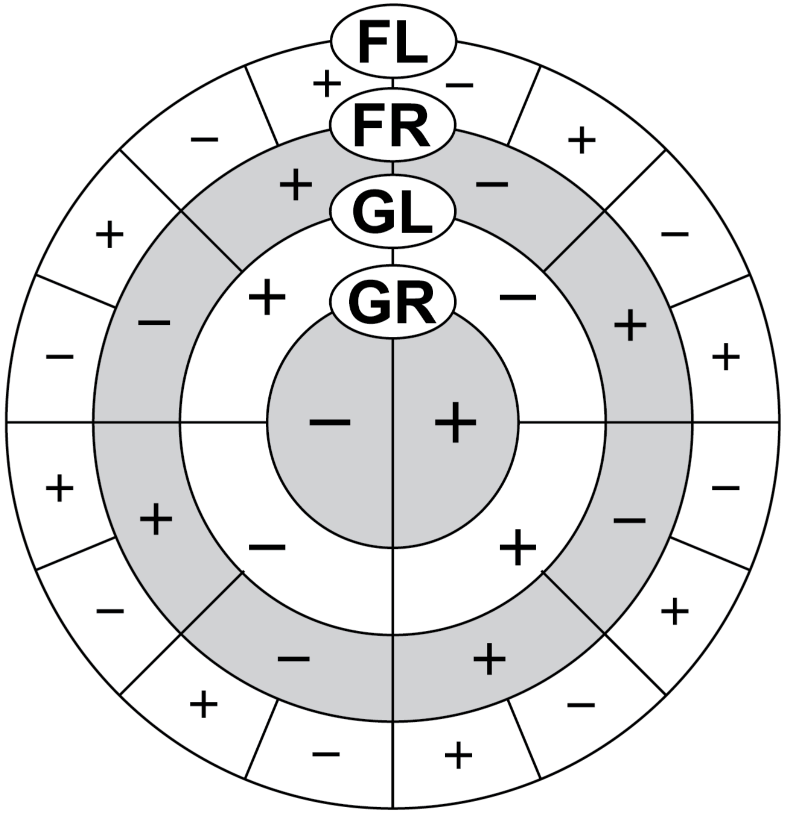


Indicator

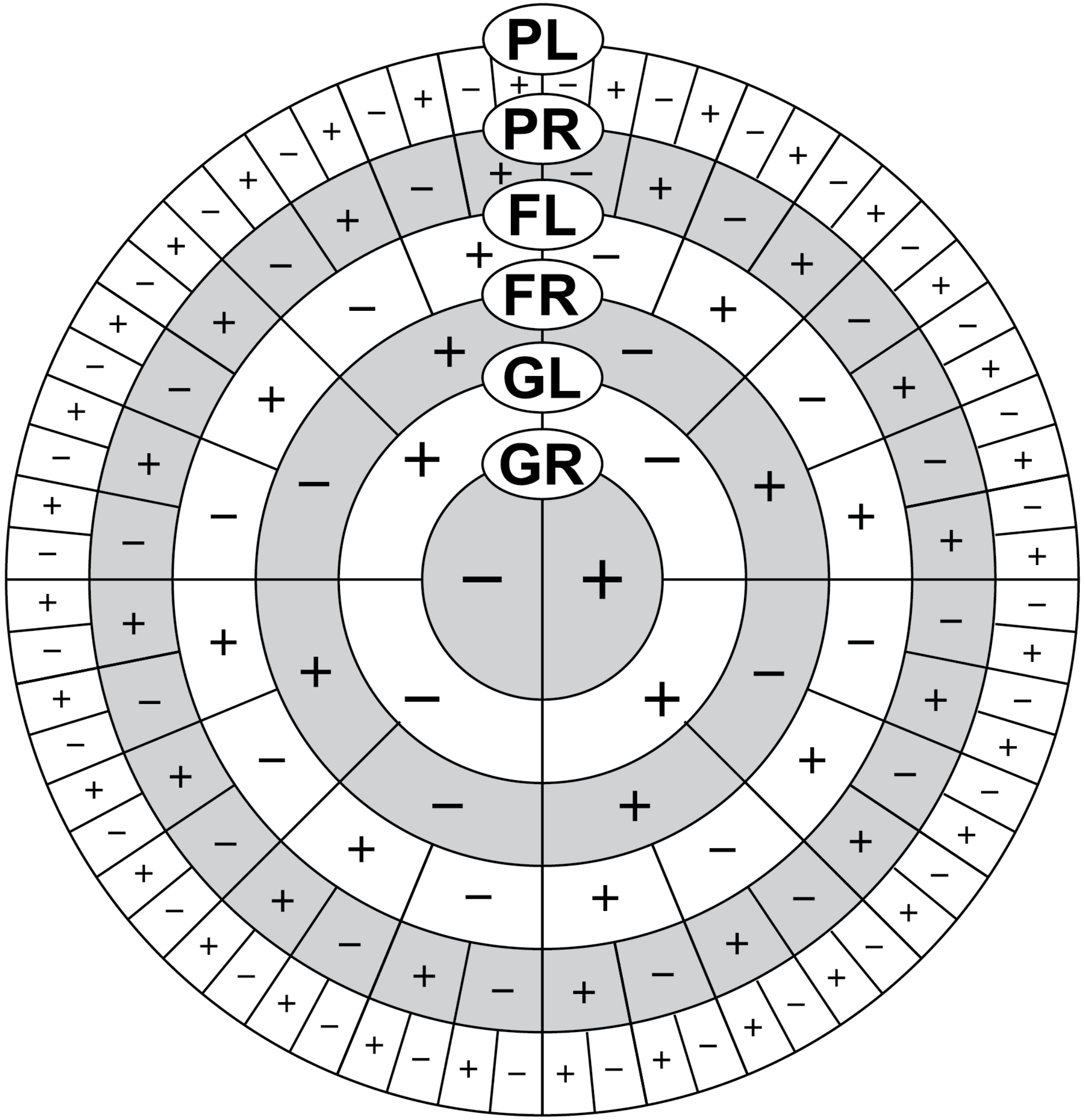
- Indicative of ecosystem health
- Disruptive outside of native range

What is the best definition of discrete rarity?

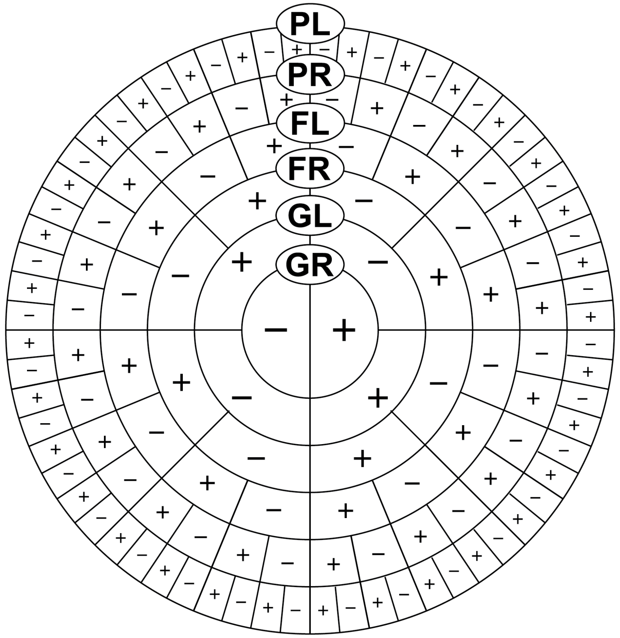

GL
GR
+
−
−
+
−
+


FL
FR
GL
GR

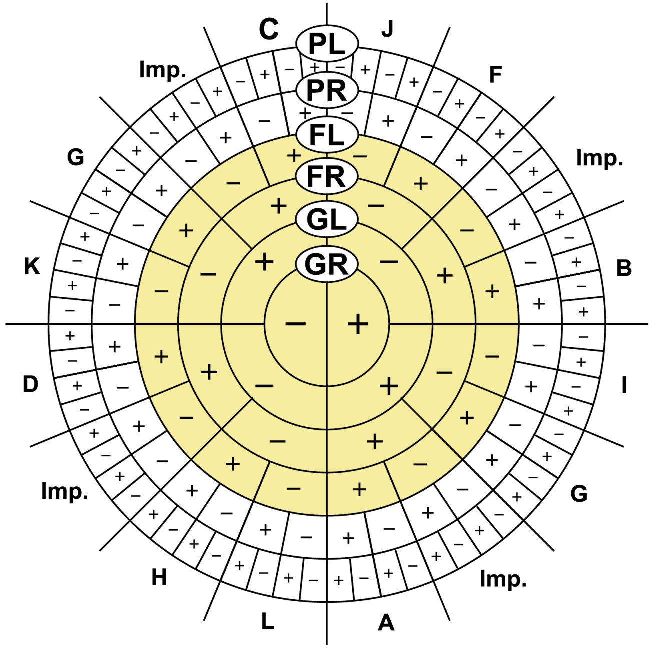
The Global Model of Discretized Rarity (GDR)



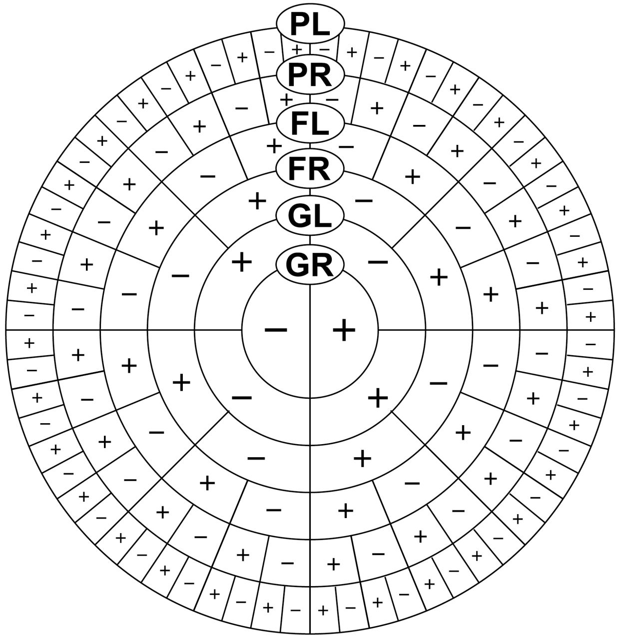
Global Model of Discretized Rarity



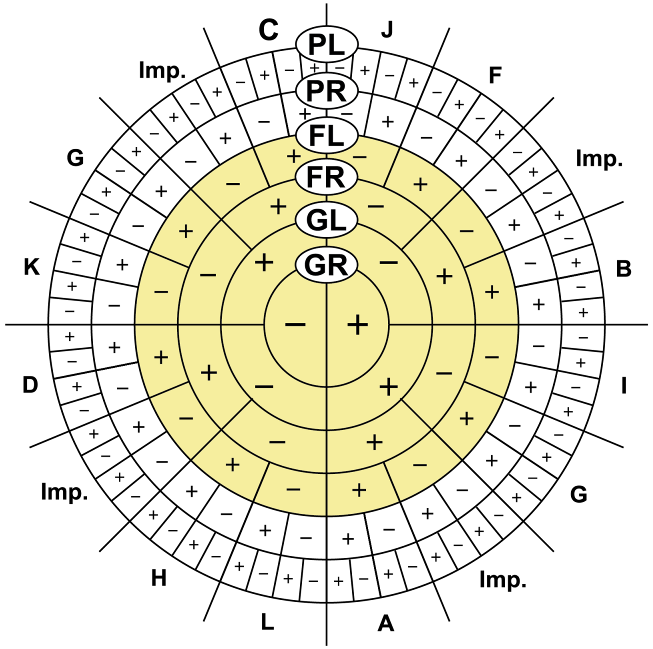
Functional Rarity Framework

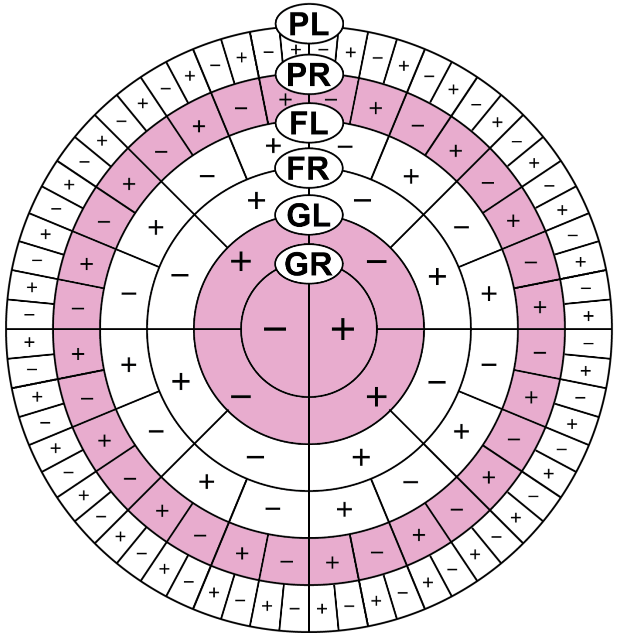


Global Model of Discretized Rarity



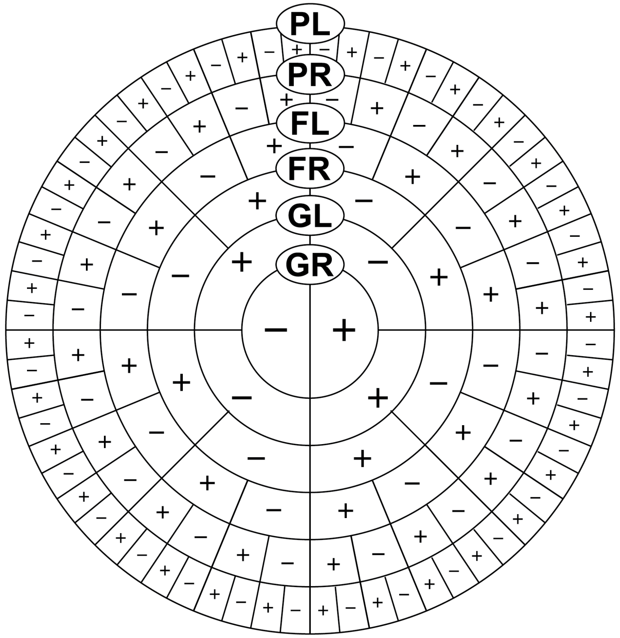
Functional Rarity Framework



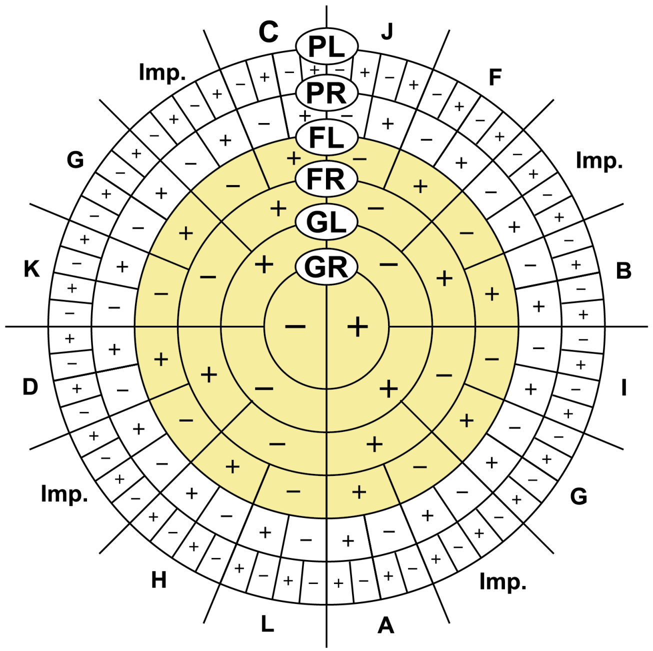


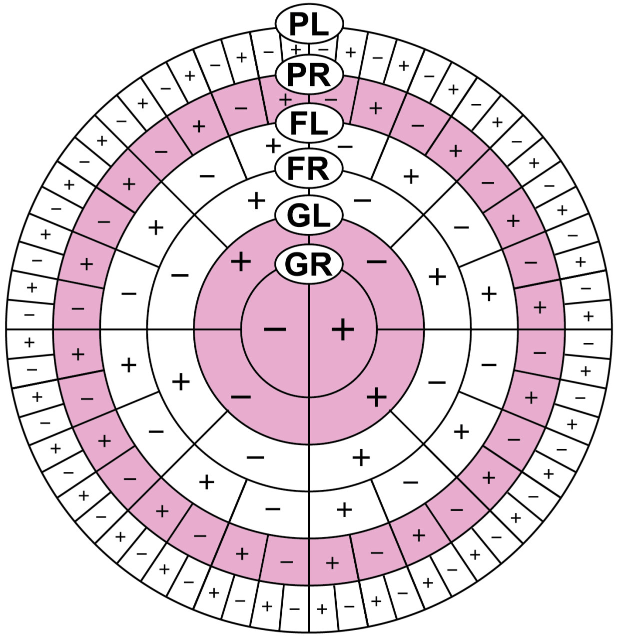
EDGE Protocol

Global Model of Discretized Rarity



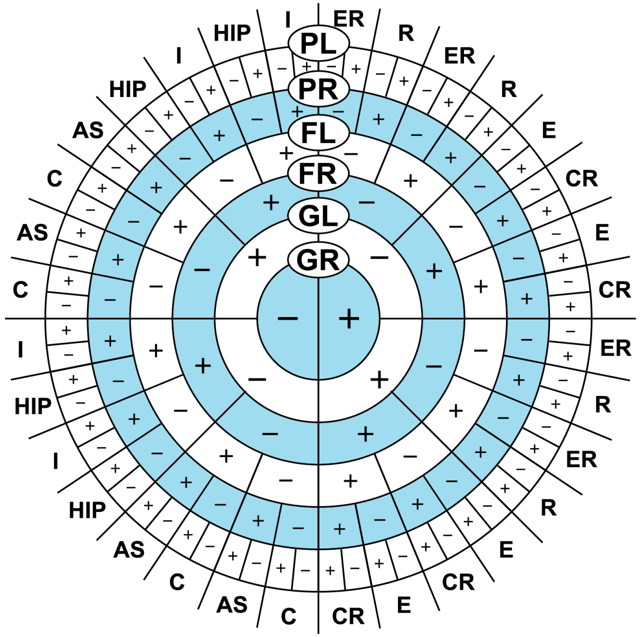
Functional Rarity Framework





EDGE Protocol

Eco-Evolutionary Rarity



Exploring the restrictions of GDR

1

Can we use rarity as a tool to understand ecological processes? How?

2

Are rarity types robust and ecologically relevant?

Guide the selection and application of GDR restrictions

- Data availability
- Research/Management Objectives
- Methods & ability to explain biological processes

Building a *working* global model

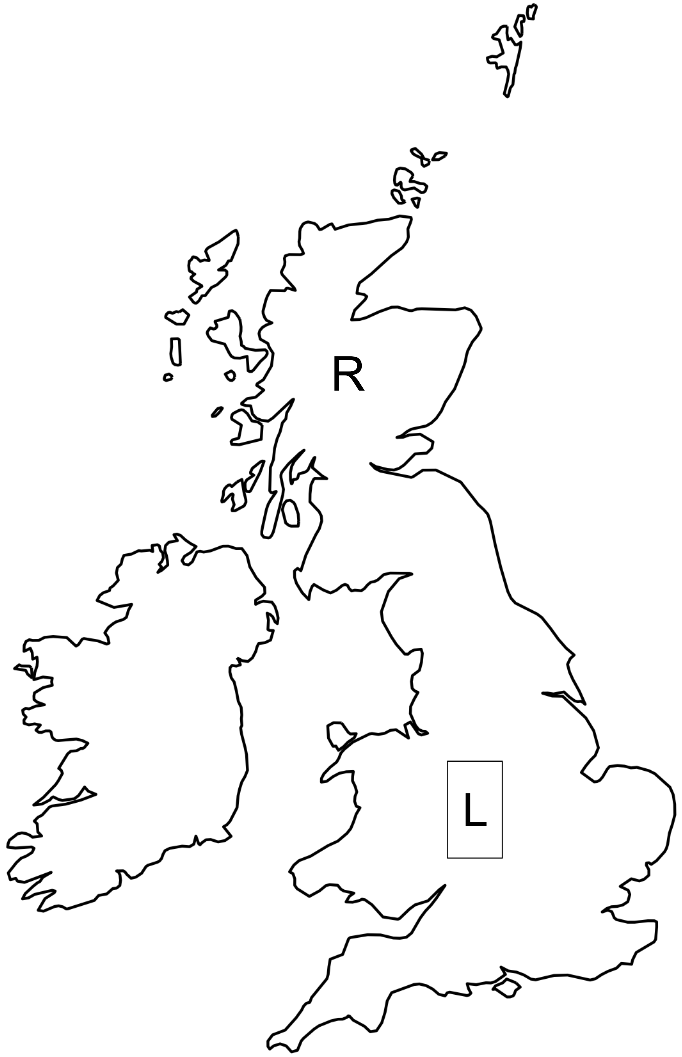
Building a *working* global model

Regional

GR = Extent of occurrence or taxonomic frequency

FR = Minimum or mean Euclidean distance

PR = Evolutionary Distinctiveness



Local

GL = Abundance

FL = Mean abundance weighted distance

PL = Phylogenetic abundance weighted or unweighted mean pair-wise distance

British Plant Species

- Rabinowitz rarity was classified for 177 British flora in 1986.

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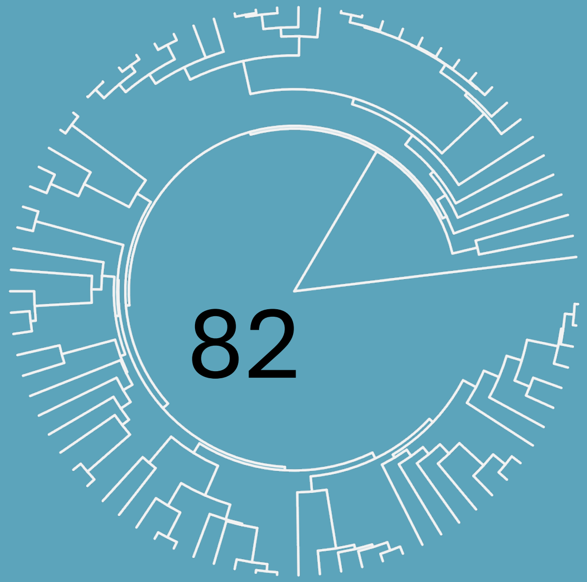

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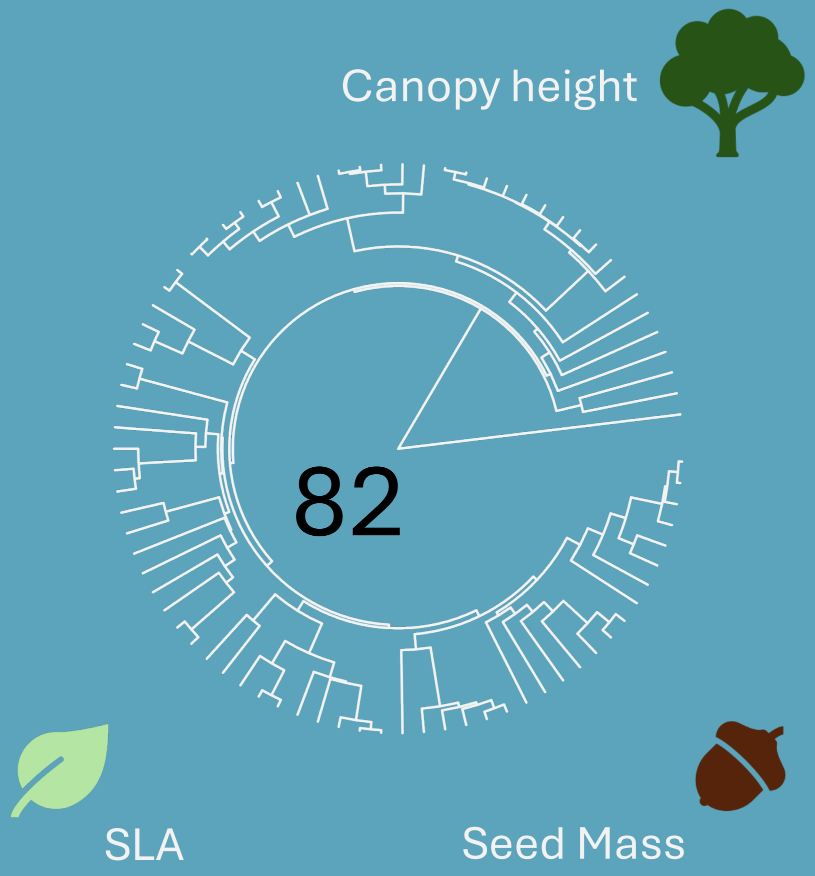

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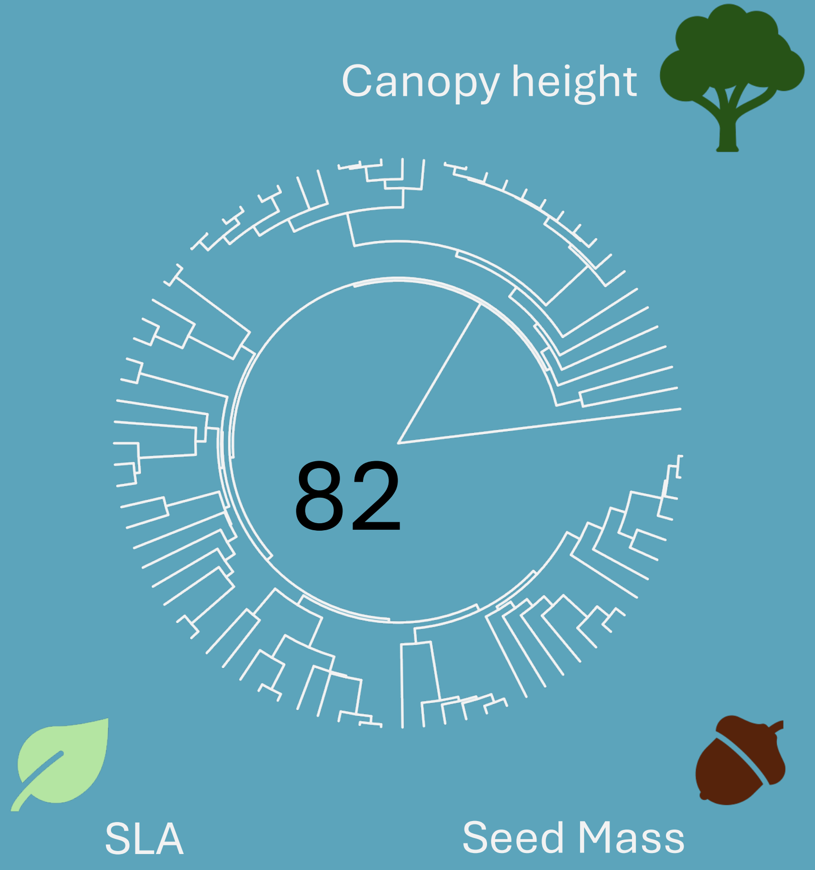
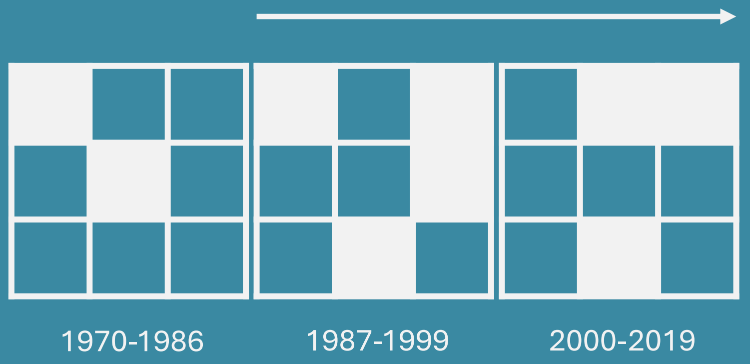


Plant Atlas 2020



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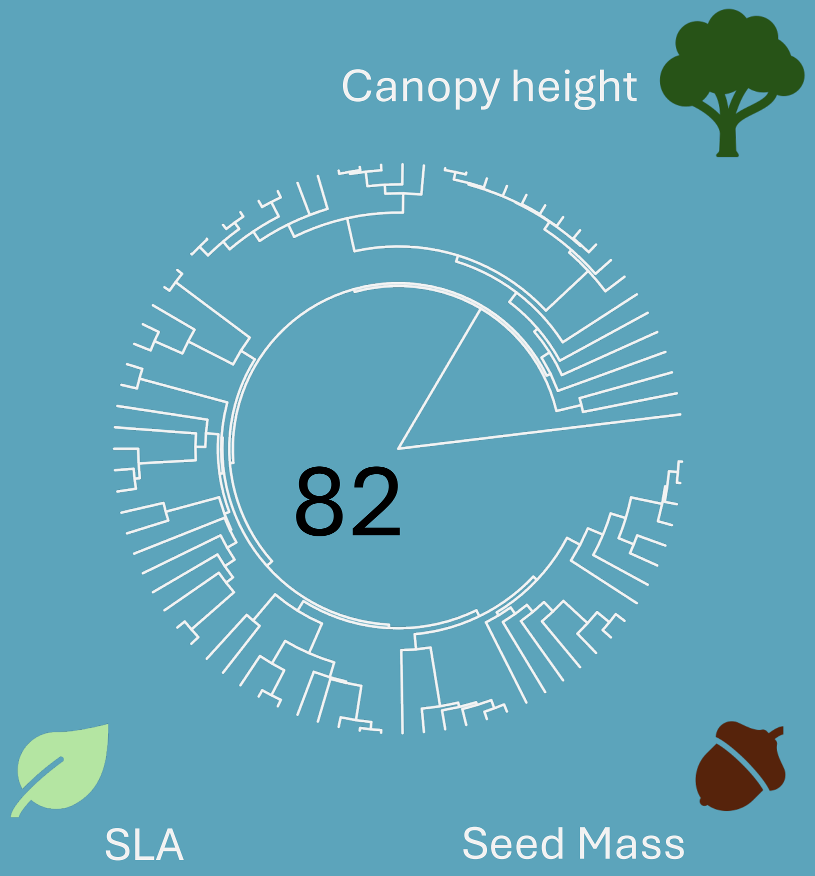
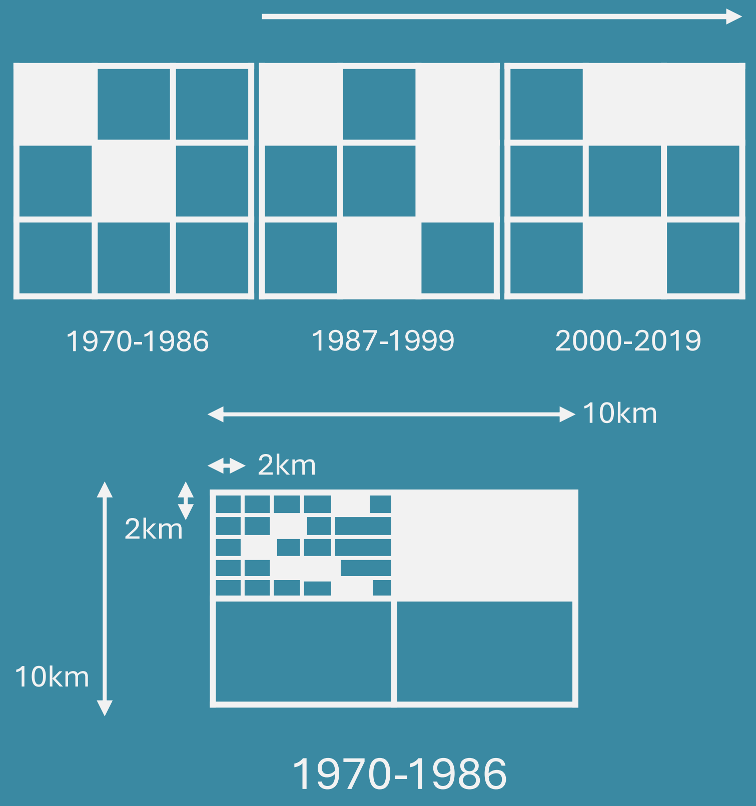


Plant Atlas 2020



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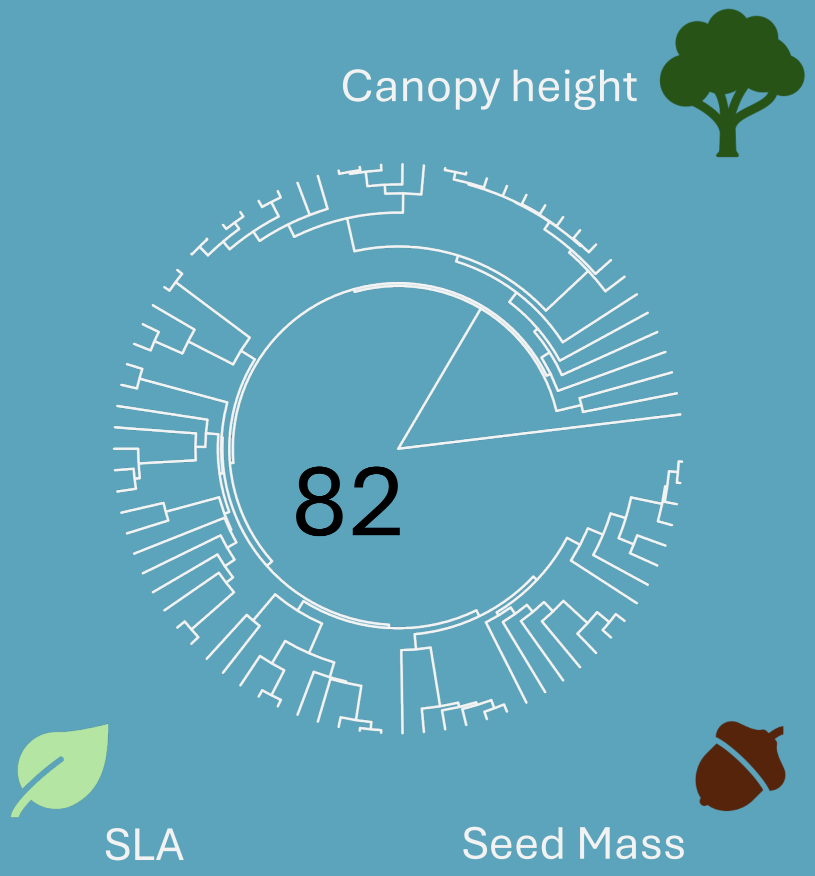
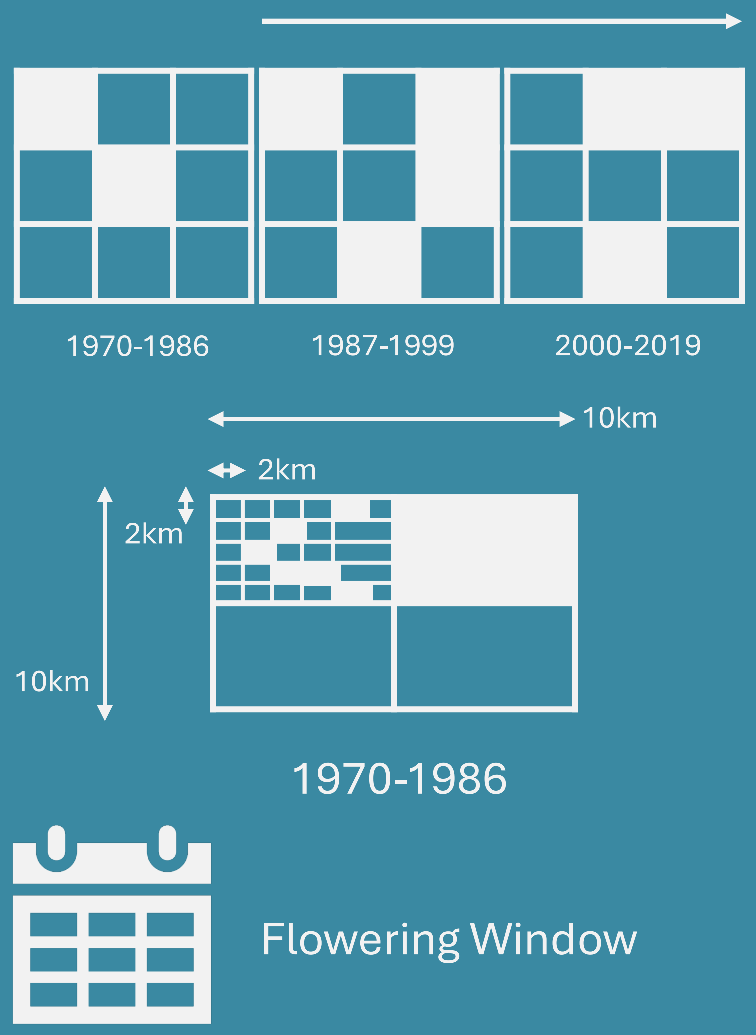
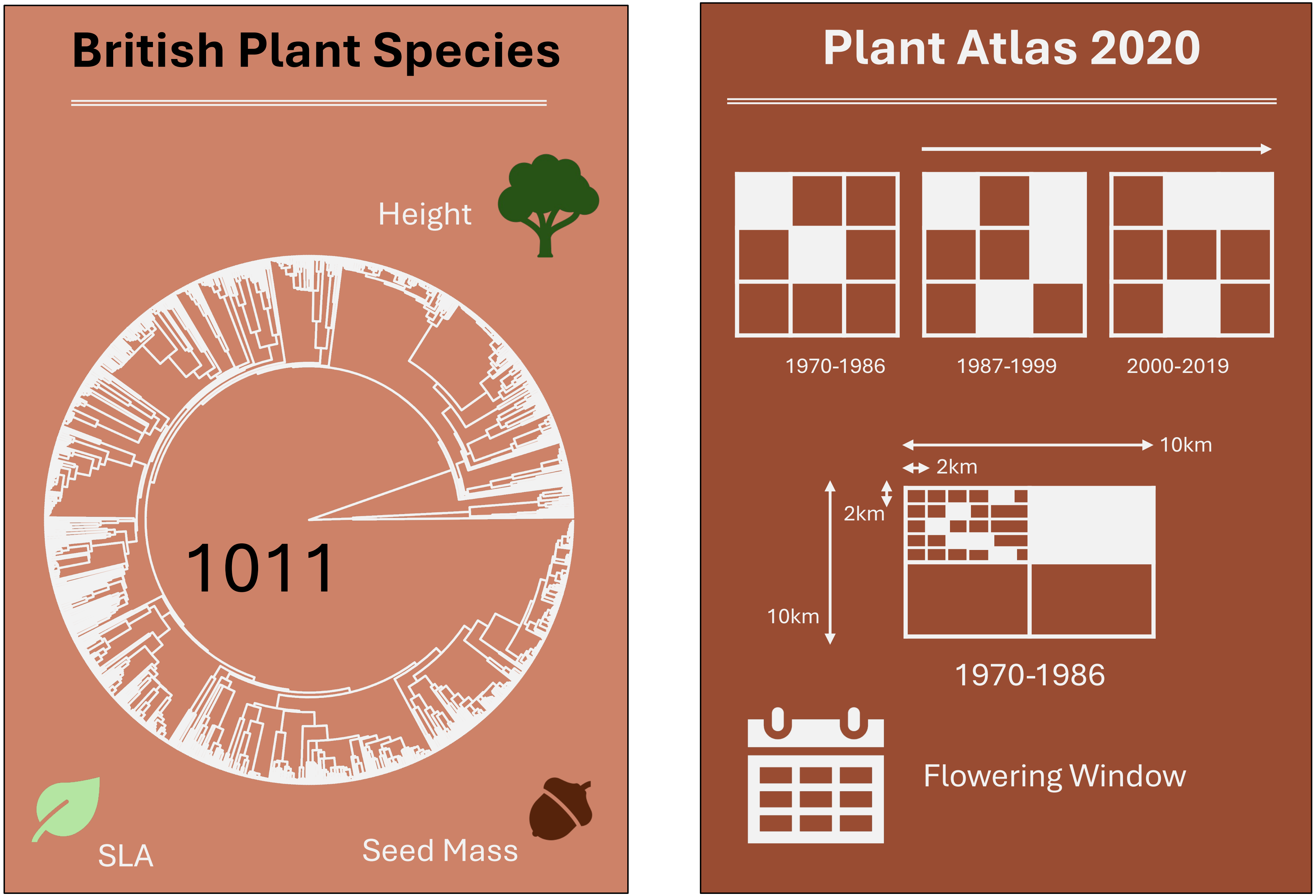


Plant Atlas 2020



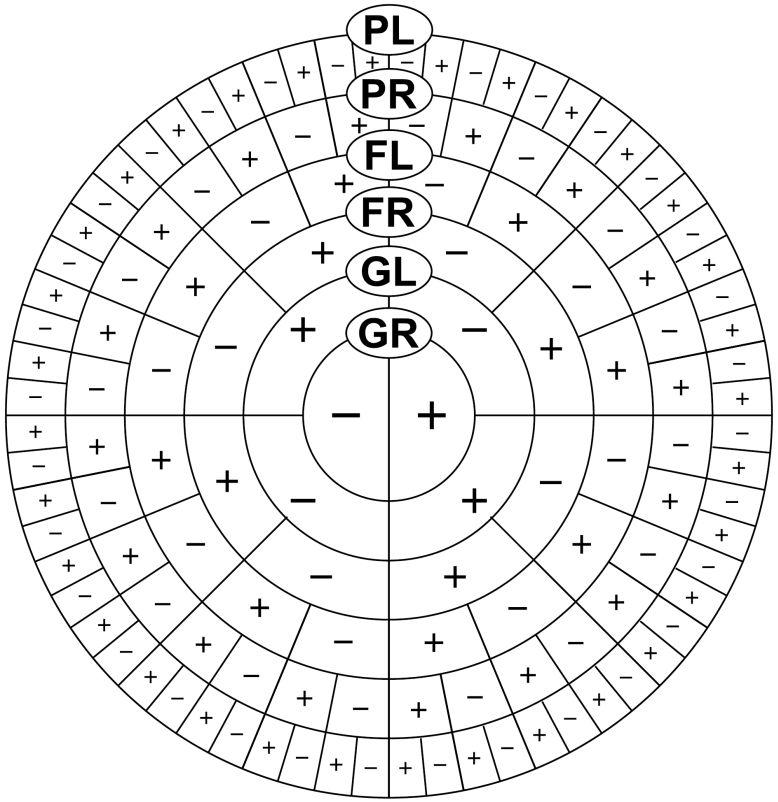

British Plant Species
Height
1011
SLA
Seed Mass
Plant Atlas 2020
1970-1986
1987-1999
2000-2019
10km
2km
2km
10km
1970-1986
Flowering Window

82 Species

1011 Species

4 Thresholds X 2 GR X 2 FR X 2 PL = 32 Methods

63 Restrictions



82 Species

1011 Species

4 Thresholds X 2 GR X 2 FR X 2 PL = 32 Methods

63 Restrictions

For each method:

Distribution Change ~ Restriction

82 Species

1011 Species

4 Thresholds X 2 GR X 2 FR X 2 PL = 32 Methods

63 Restrictions

For each method:

Distribution Change ~ Restriction

Flowering Phenology ~ Restriction

82 Species

1011 Species

4 Thresholds X 2 GR X 2 FR X 2 PL = 32 Methods

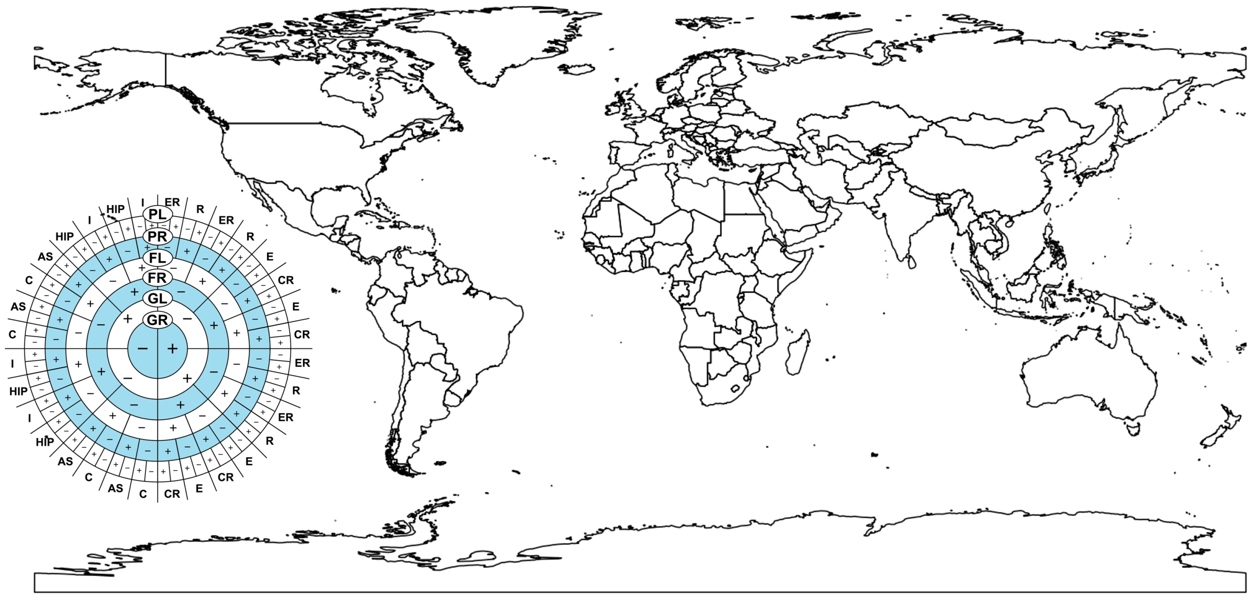
63 Restrictions

For each method:

Distribution Change ~ Restriction

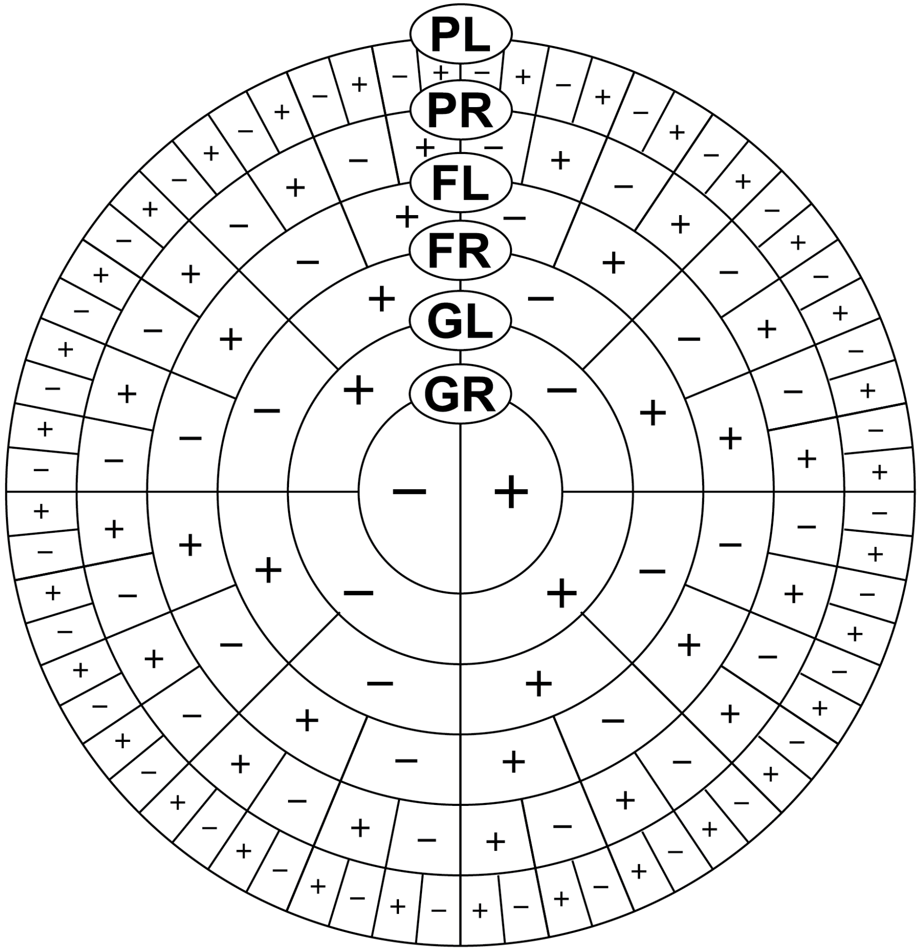
Flowering Phenology ~ Restriction

Best Method per Restriction & Best Restriction per Ecological Process



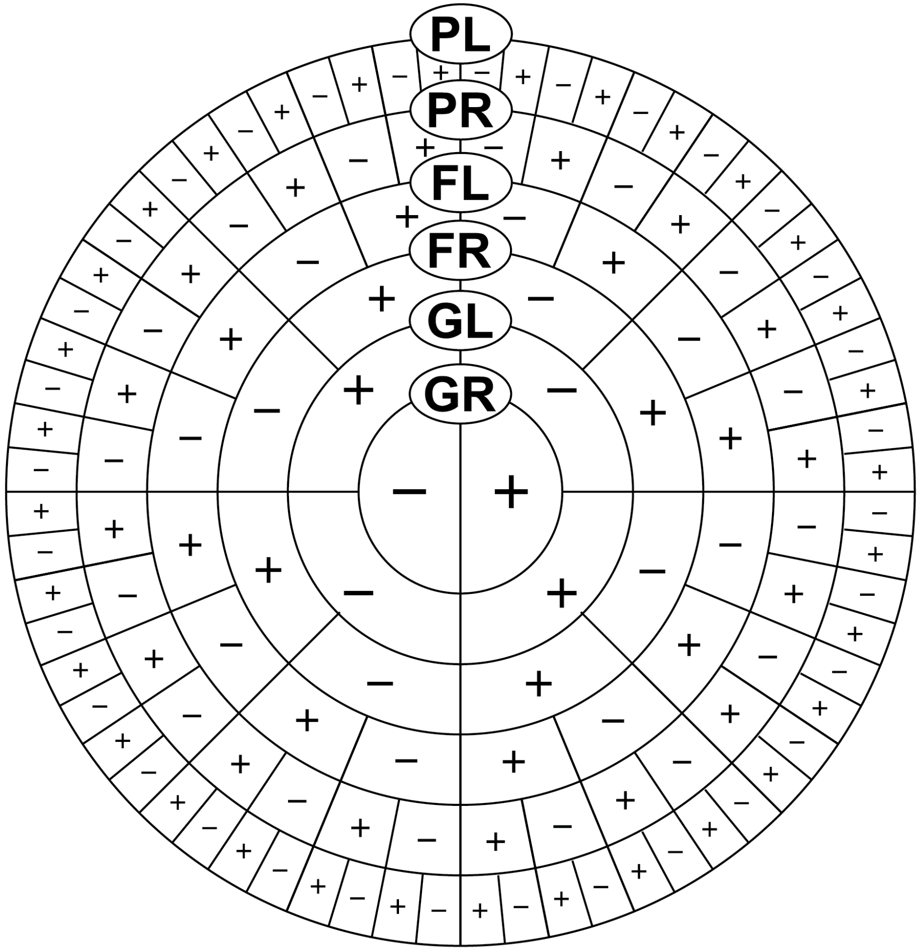
GRIIS
GLOBAL REGISTER OF INTRODUCED AND INVASIVE SPECIES

Eco-Evolutionary Rarity of 5,611 Global Angiosperms



The Global Model of Discretized Rarity performed well across sample sizes…

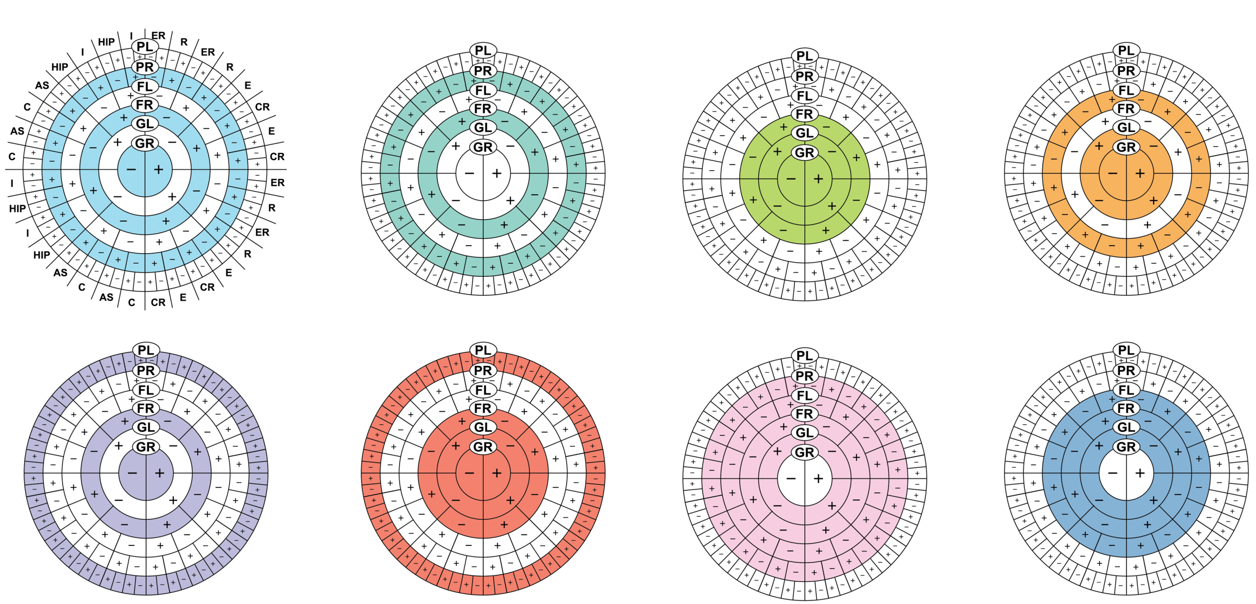
- 12.5% - 39% of variation in distribution change
- 13% - 49.1% of variation in flowering phenology



The Global Model of Discretized Rarity performed well across sample sizes…

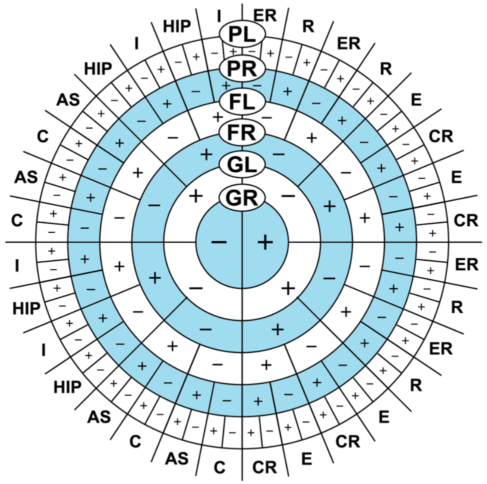
- 12.5% - 39% of variation in distribution change
- 13% - 49.1% of variation in flowering phenology

…but many restrictions outperformed the GDR

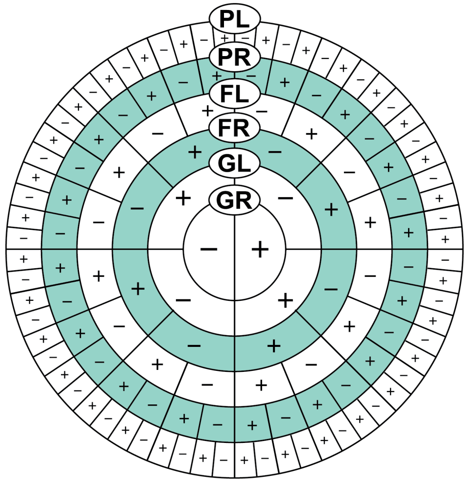


Small Sample Size

Large Sample Size



EER



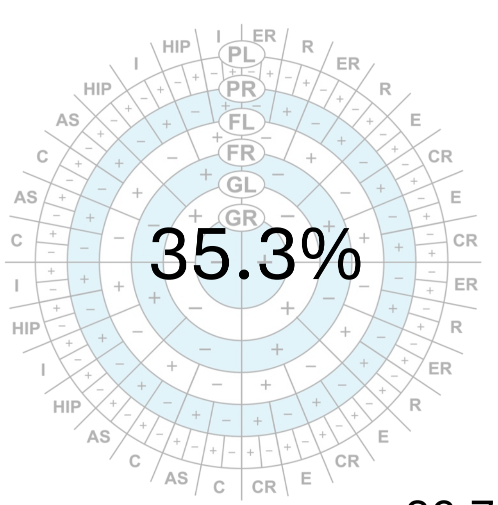
$F_R P_R$

Distribution Change

Flowering Phenology

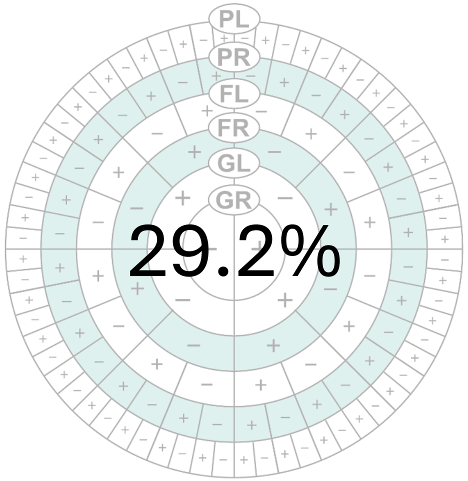
Small Sample Size

Large Sample Size



EER

36.7% AIC Weight



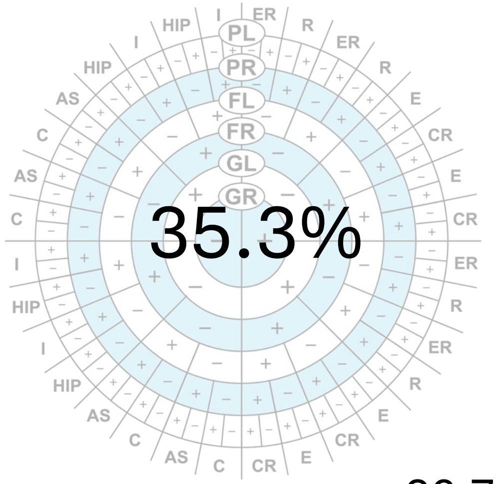
$F_R P_R$

Distribution Change

Flowering Phenology

Small Sample Size

Large Sample Size



EER

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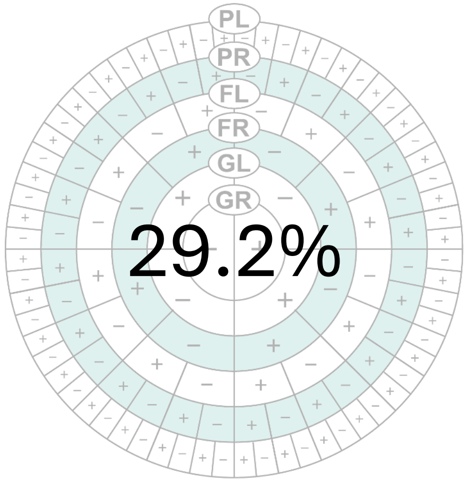
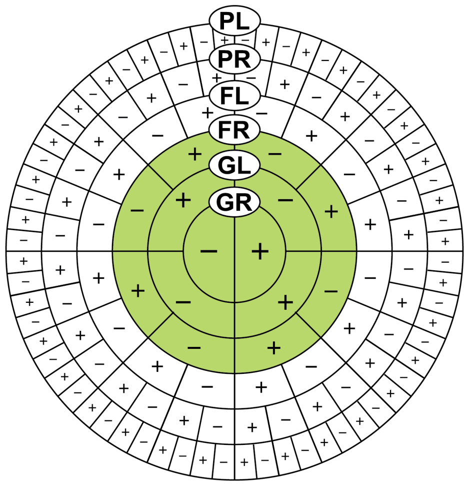
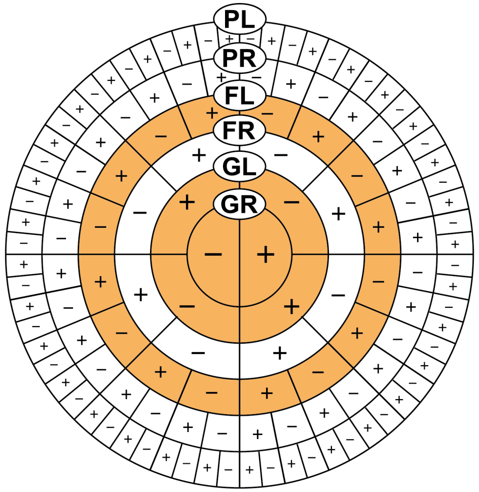


$F_R P_R$

Distribution Change



$G_{RL} F_R$

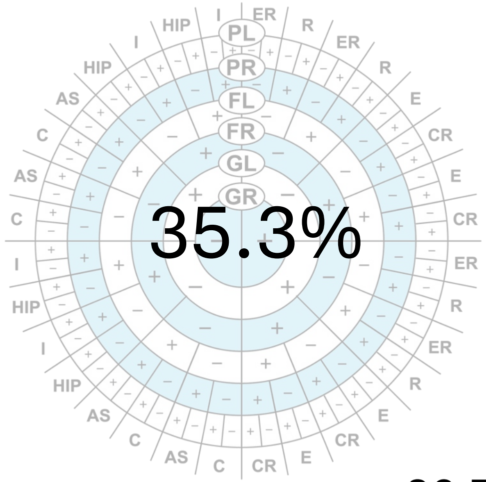


$G_{RL} F_L$

Flowering Phenology

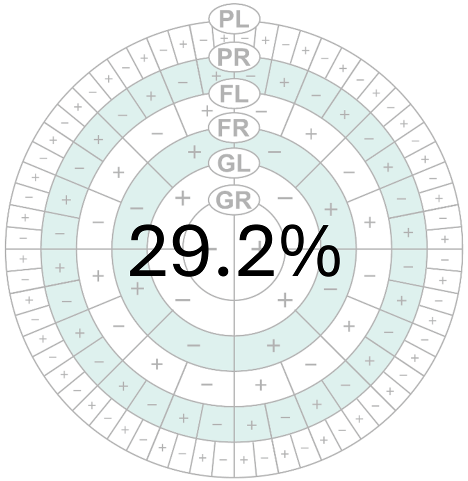
Small Sample Size

Large Sample Size



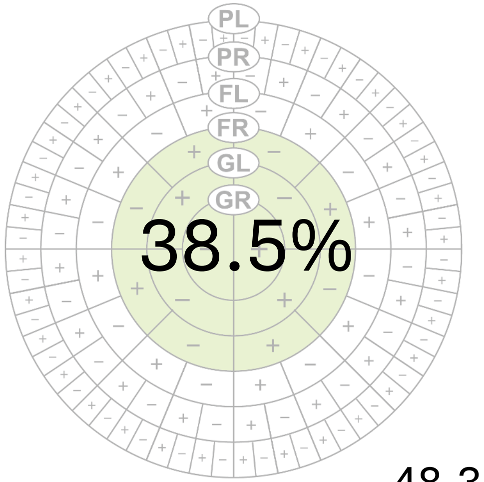
EER

36.7% AIC Weight



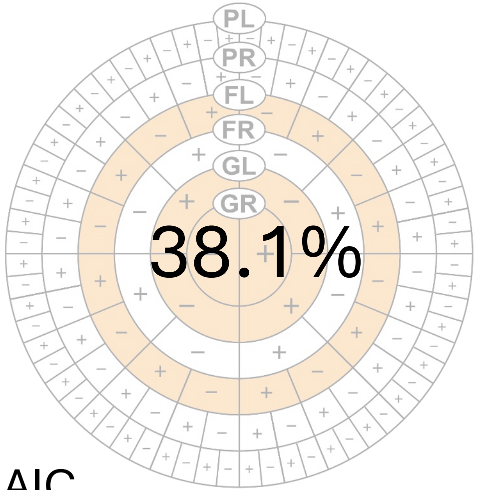
$F_R P_R$

Distribution Change



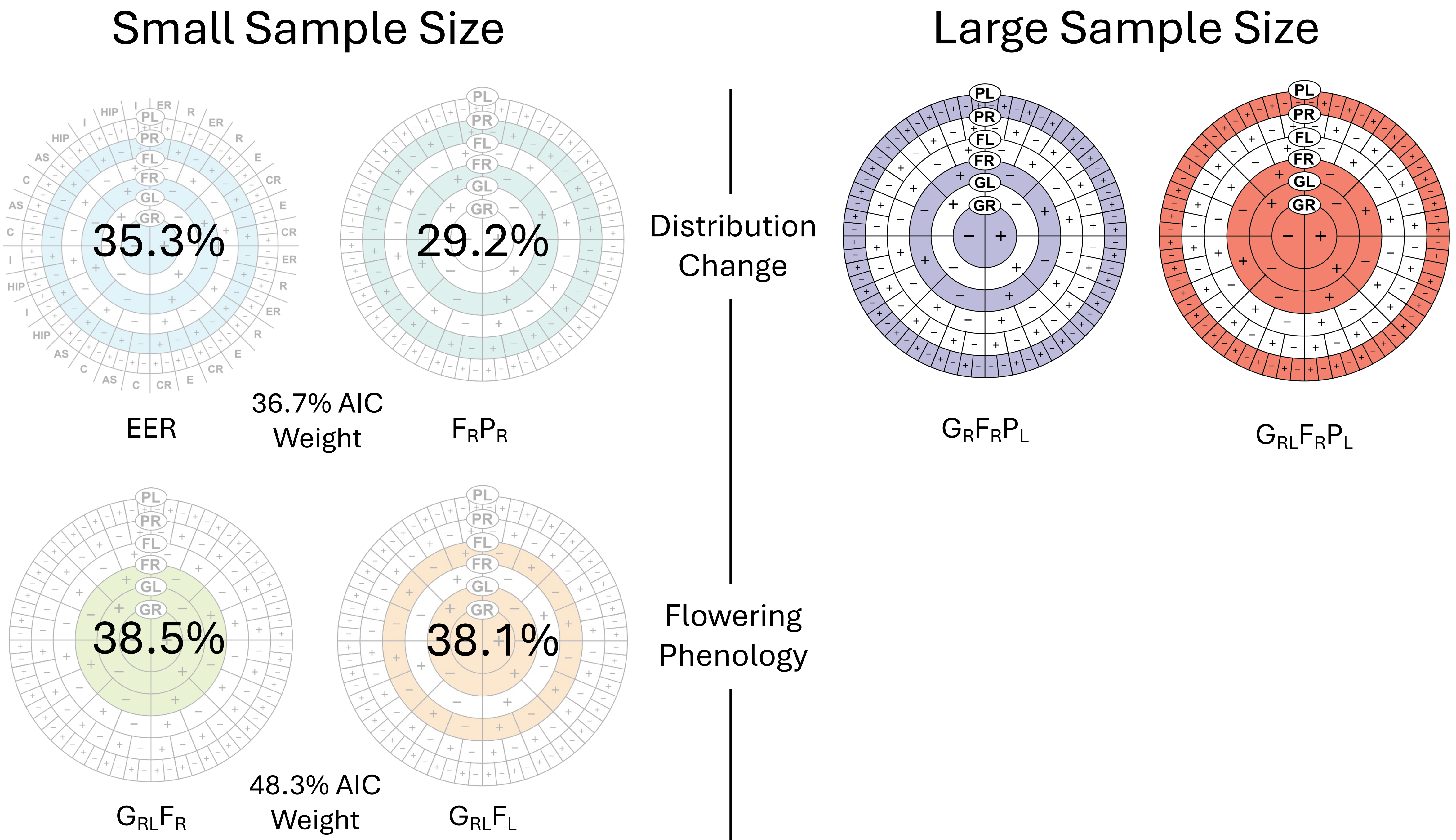
$G_{RL} F_R$

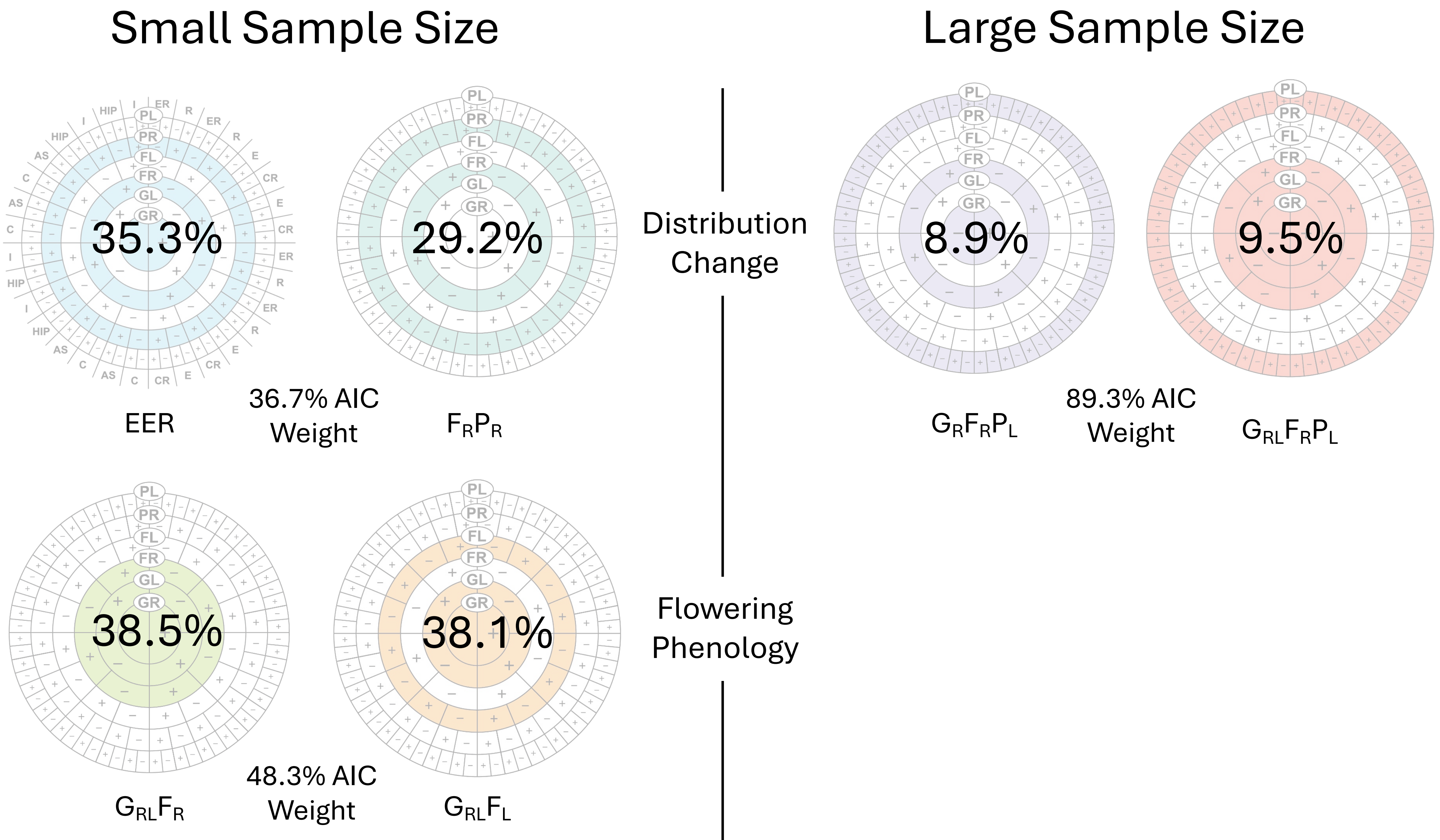
48.3% AIC Weight



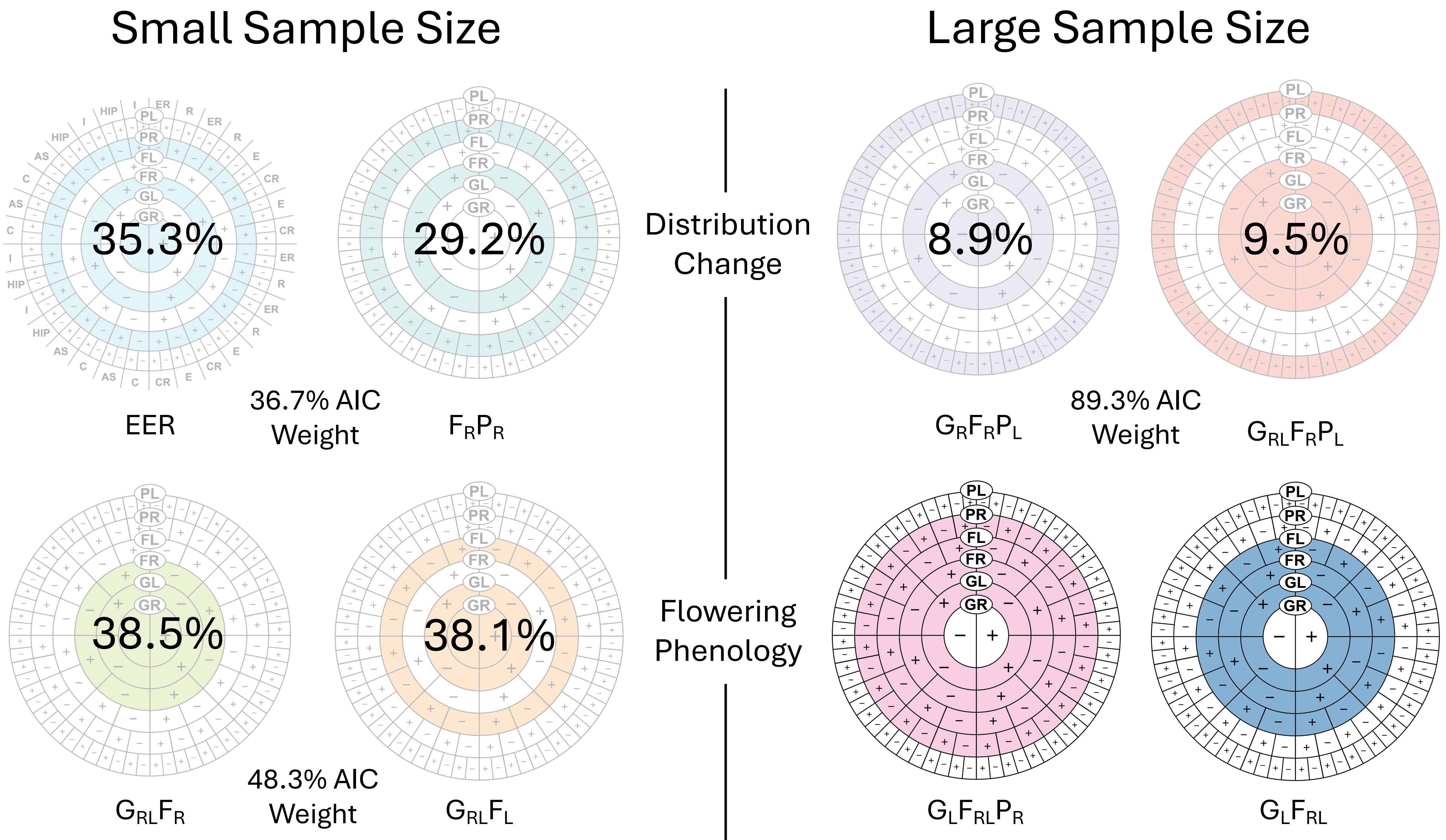
$G_{RL} F_L$

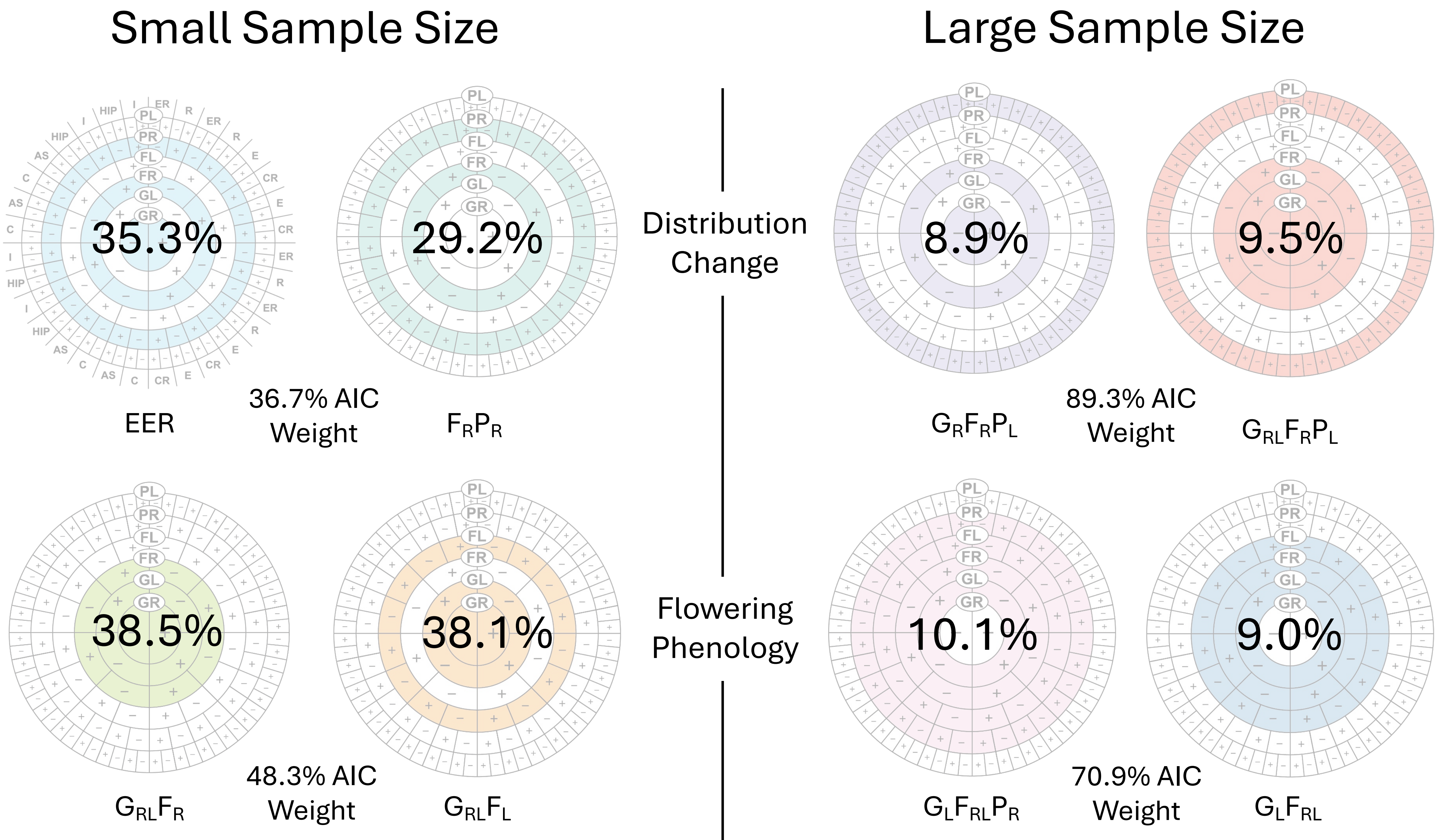
Flowering Phenology


Small Sample Size
Large Sample Size
35.3%
29.2%
EER
36.7% AIC Weight
$F_{R}P_{R}$
Distribution Change
$G_{R}F_{R}P_{L}$
$G_{RL}F_{R}P_{L}$
38.5%
38.1%
48.3% AIC Weight
Flowering Phenology
$G_{RL}F_{R}$
$G_{RL}F_{L}$
PL
PR
FL
FR
GL
GR



Small Sample Size
Large Sample Size
35.3%
29.2%
EER
36.7% AIC Weight
F_RP_R
Distribution Change
8.9%
9.5%
$G_RF_RP_L$
89.3% AIC Weight
$G_{RL}F_RP_L$
38.5%
38.1%
$G_{RL}F_R$
48.3% AIC Weight
$G_{RL}F_L$
Flowering Phenology

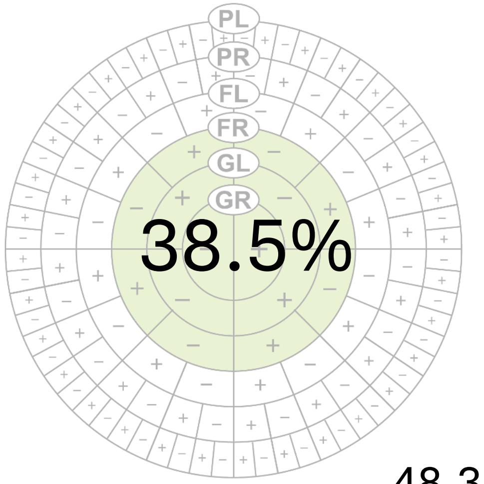

Small Sample Size
Large Sample Size
35.3%
29.2%
EER
36.7% AIC Weight
$F_R P_R$
Distribution Change
8.9%
9.5%
$G_R F_R P_L$
89.3% AIC Weight
$G_{RL} F_R P_L$
38.5%
38.1%
$G_{RL} F_R$
48.3% AIC Weight
$G_{RL} F_L$
Flowering Phenology
$G_L F_{RL} P_R$
$G_L F_{RL}$
PL
PR
FL
FR
GL
GR



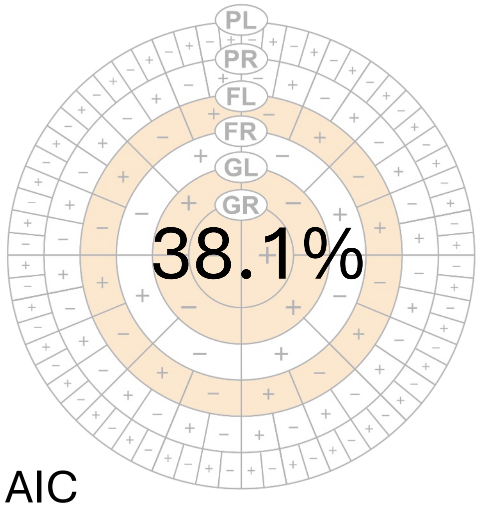
Small Sample Size
Large Sample Size
35.3%
EER
29.2%
$F_R P_R$
36.7% AIC Weight
Distribution Change
8.9%
$G_R F_R P_L$
9.5%
$G_{RL} F_R P_L$
89.3% AIC Weight
38.5%
$G_{RL} F_R$
38.1%
$G_{RL} F_L$
48.3% AIC Weight
Flowering Phenology
10.1%
$G_L F_{RL} P_R$
9.0%
$G_L F_{RL}$
70.9% AIC Weight

Small Sample Size

Dimension	AIC Importance
PR	96.7%
FR	91.6%
GR	73.1%
FL	23.8%
PL	15.7%
GL	15.6%



$G_{RL}F_R$



$G_{RL}F_L$

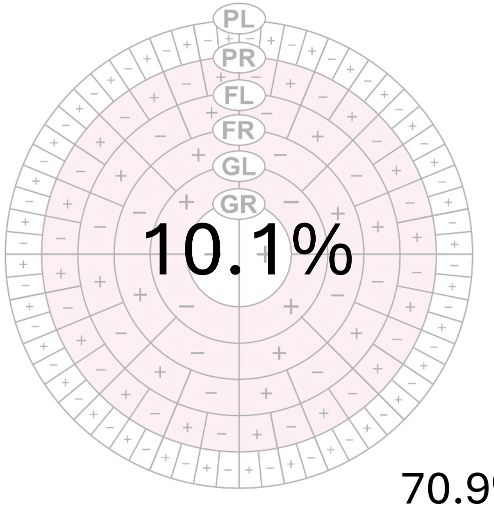
48.3% AIC Weight

Distribution Change

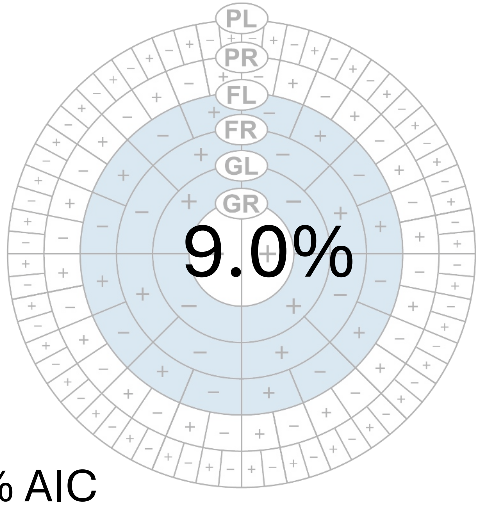
Flowering Phenology

Large Sample Size

Dimension	AIC Importance
GR	100%
FR	99.8%
PL	99.3%
GL	16.6%
PR	9.2%
FL	1.1%



$G_LF_{RL}P_R$



G_LF_{RL}

70.9% AIC Weight

Small Sample Size

Large Sample Size

Distribution Change

Small Sample Size:

Dimension	AIC Importance
PR	96.7%
FR	91.6%
GR	73.1%
FL	23.8%
PL	15.7%
GL	15.6%

Large Sample Size:

Dimension	AIC Importance
GR	100%
FR	99.8%
PL	99.3%
GL	16.6%
PR	9.2%
FL	1.1%

Flowering Phenology

Small Sample Size:

Dimension	AIC Importance
GR	100%
GL	100%
FR	69.8%
FL	45.1%
PR	28.7%
PL	18.5%

Large Sample Size:

Dimension	AIC Importance
GL	100%
FR	100%
FL	99.6%
PR	56.3%
PL	23.9%
GR	8.0%

Small Sample Size

Large Sample Size

Distribution Change

Small Sample Size

Dimension	AIC Importance
PR	96.7%
FR	91.6%
GR	73.1%
FL	23.8%
PL	15.7%
GL	15.6%

Large Sample Size

Dimension	AIC Importance
GR	100%
FR	99.8%
PL	99.3%
GL	16.6%
PR	9.2%
FL	1.1%

Flowering Phenology

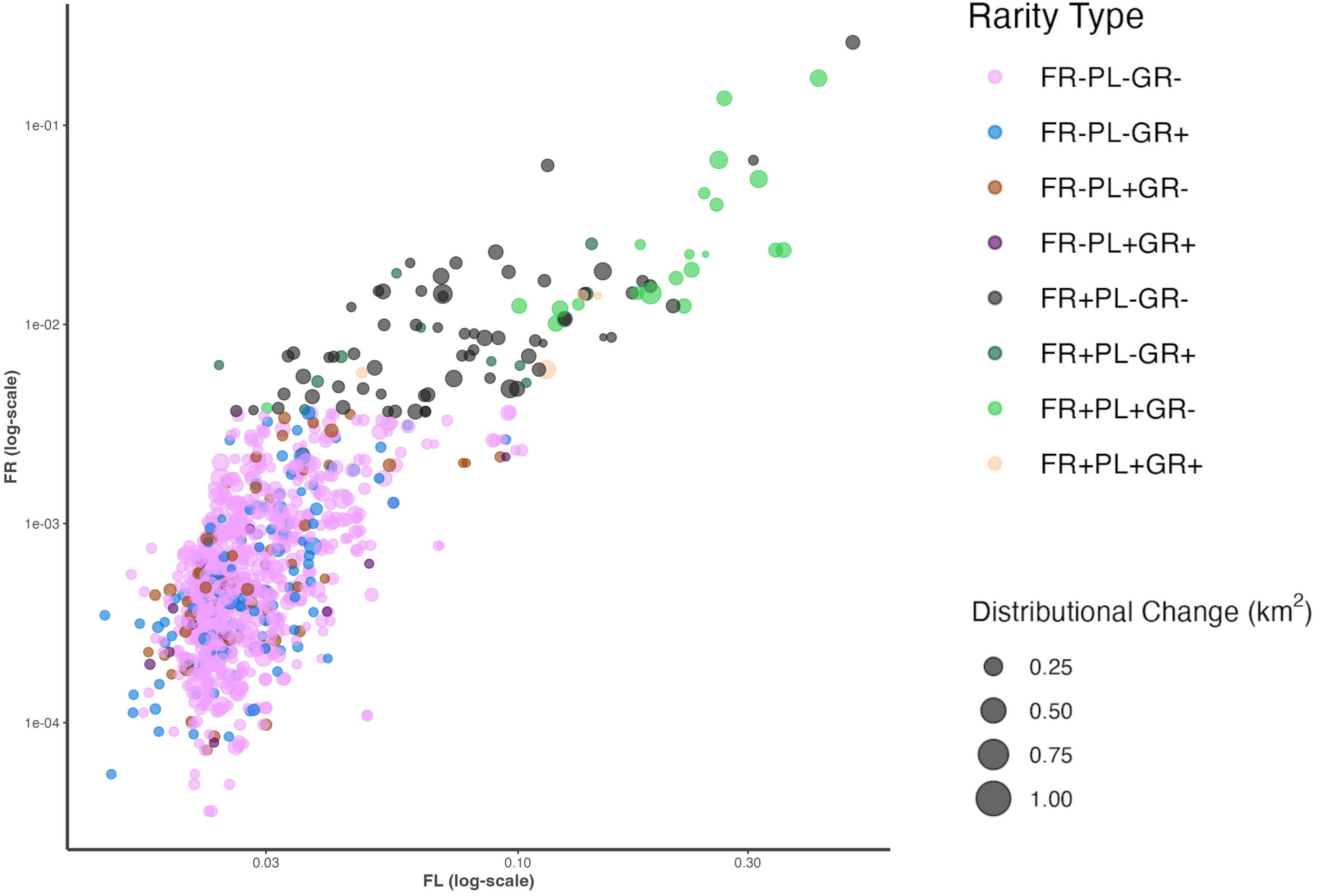
Small Sample Size

Dimension	AIC Importance
GR	100%
GL	100%
FR	69.8%
FL	45.1%
PR	28.7%
PL	18.5%

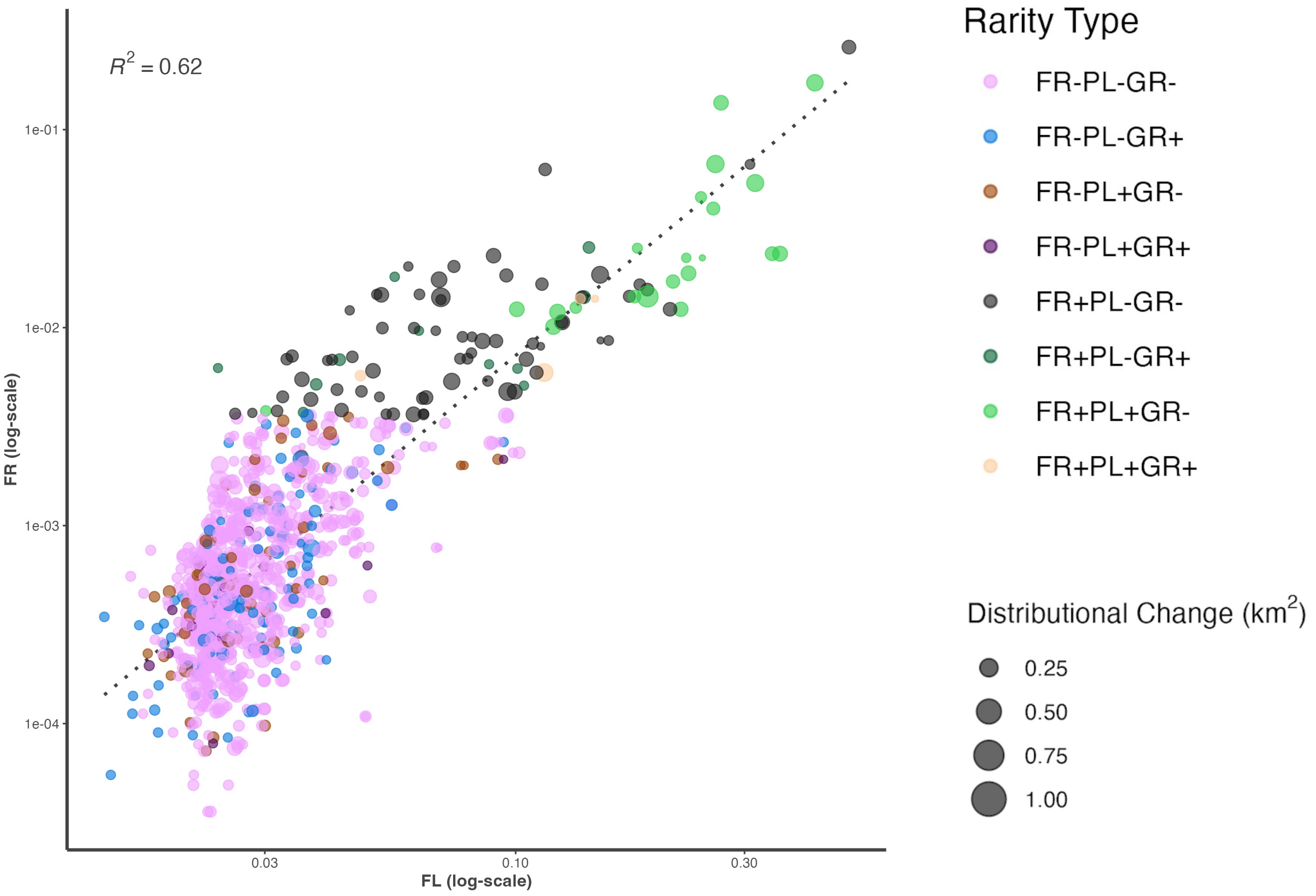
Large Sample Size

Dimension	AIC Importance
GL	100%
FR	100%
FL	99.6%
PR	56.3%
PL	23.9%
GR	8.0%

Distribution Change

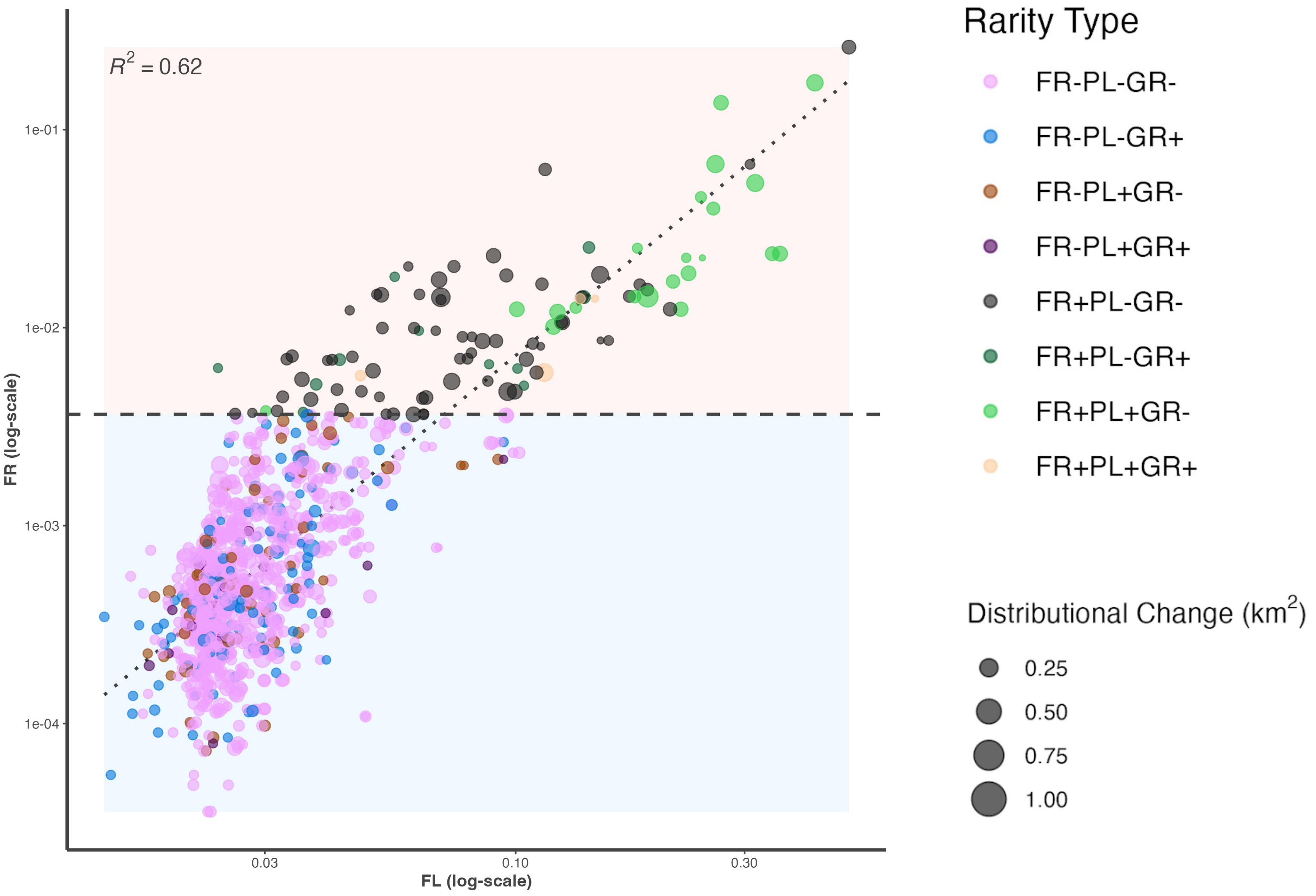


Distribution Change



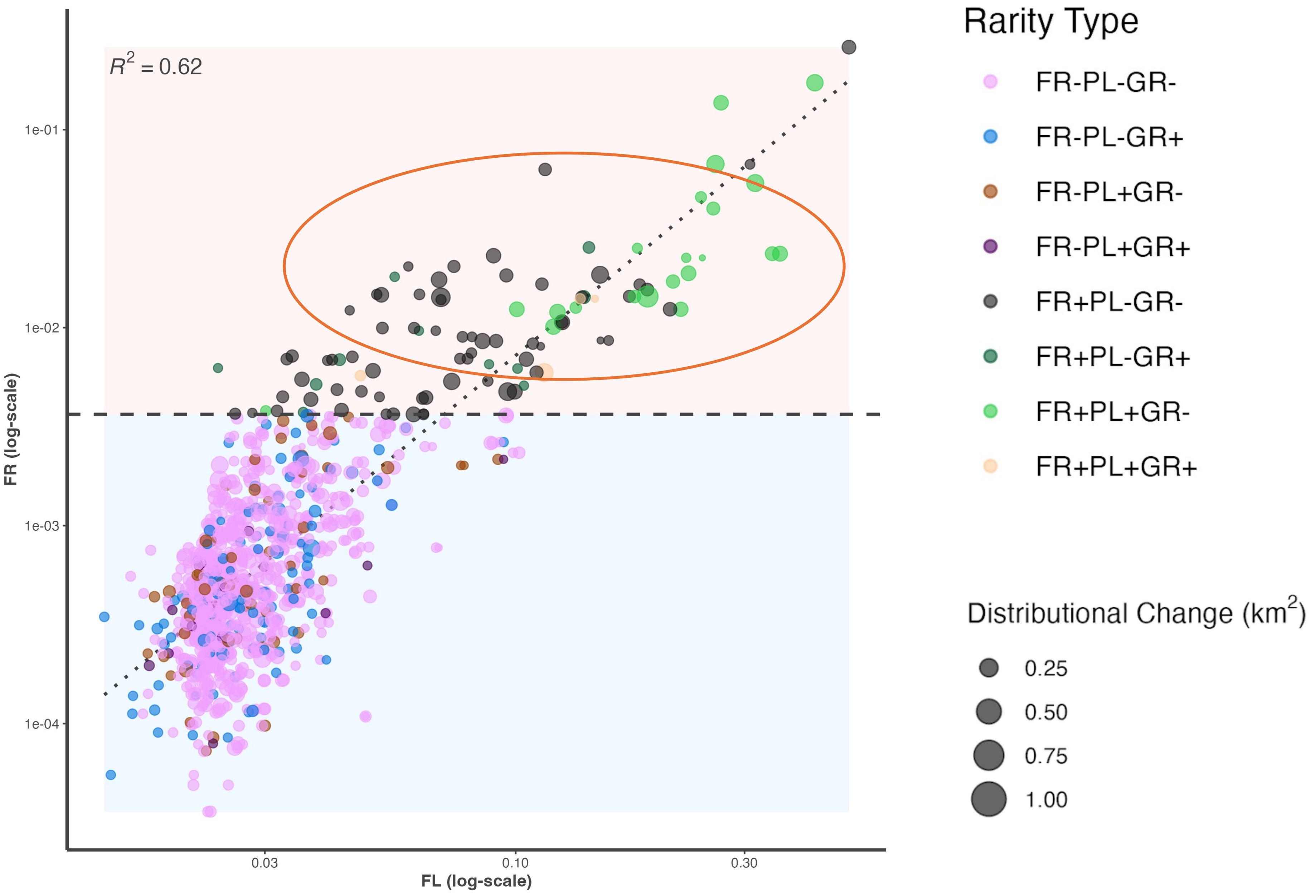
Distribution Change

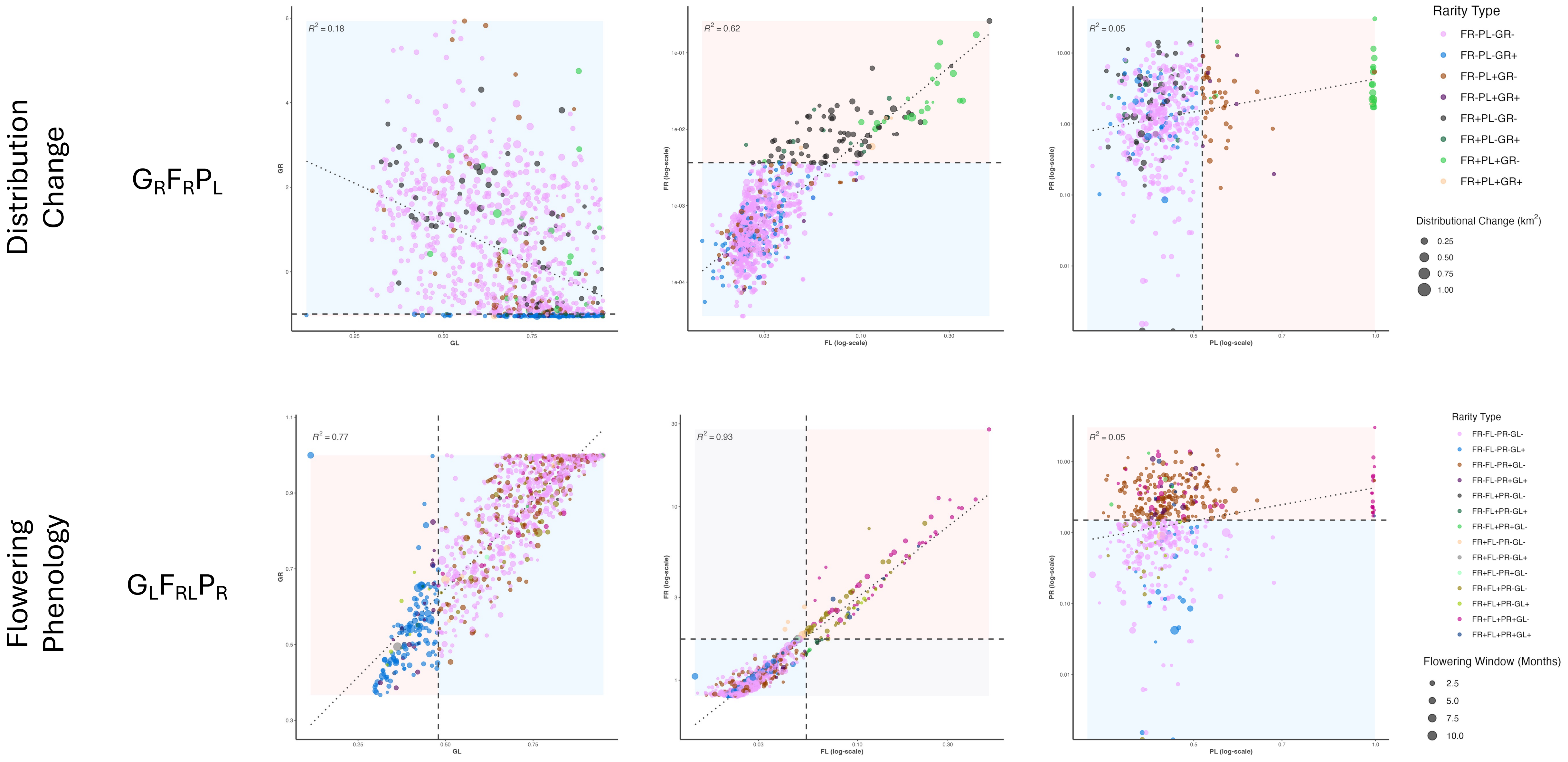
$G_R F_R P_L$



Distribution Change

$G_R F_R P_L$



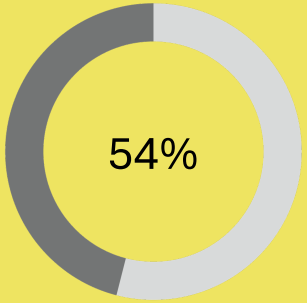


Distribution Change
$G_RF_RP_L$
Flowering Phenology
$G_LF_{RL}P_R$
$R^2 = 0.18$
$R^2 = 0.62$
$R^2 = 0.05$
$R^2 = 0.77$
$R^2 = 0.93$
$R^2 = 0.05$
GR
GL
FR (log-scale)
FL (log-scale)
PR (log-scale)
PL (log-scale)
Rarity Type
FR-PL-GR-
FR-PL-GR+
FR-PL+GR-
FR-PL+GR+
FR+PL-GR-
FR+PL-GR+
FR+PL+GR-
FR+PL+GR+
Distributional Change (km^2)
0.25
0.50
0.75
1.00
Rarity Type
FR-FL-PR-GL-
FR-FL-PR-GL+
FR-FL-PR+GL-
FR-FL-PR+GL+
FR-FL+PR-GL-
FR-FL+PR-GL+
FR-FL+PR+GL-
FR+FL-PR-GL-
FR+FL-PR-GL+
FR+FL-PR+GL-
FR+FL+PR-GL-
FR+FL+PR-GL+
FR+FL+PR+GL-
FR+FL+PR+GL+
Flowering Window (Months)
2.5
5.0
7.5
10.0

EER of Global Angiosperms

Range Size		Large		Small	
Functional Distinctiveness		Distinct	Indistinct	Distinct	Indistinct
Evolutionary Distinctiveness	Distinct	Indicator (0.9%)	Adaptable Survivor (7.4%)	Classically Rare (0.4%)	Relict (1.3%)
	Indistinct	High Invasive Potential (6.3%)	Common (70.4%)	Endemic (2.4%)	Environmentally Rare (10.9%)

Invasiveness of EER Types

Range Size		Large		Small	
Functional Distinctiveness		Distinct	Indistinct	Distinct	Indistinct
Evolutionary Distinctiveness	Distinct	Indicator	Adaptable Survivor	Classically Rare	Relict
	Indistinct		Common	Endemic	Environmentally Rare

Indicator
Eucalyptus exserta

Sun et al. 2016

Adaptable Survivor
Hibbertia riparia

Hammer et al. 2025

Classically Rare
Paulownia kawakamii

Relict
Gnetum gnemon

Ickert-Bond et al. 2016

High Invasive Potential
Pinus radiata

Williams & Wardle 2007

Common
Acer rubrum

Endemic
Flindersia brayleyana

Boland 2006

Environmentally Rare
Aporosa frutescens

1

Can we use rarity as a tool to understand ecological processes? How?

2

Are rarity types robust and ecologically relevant?

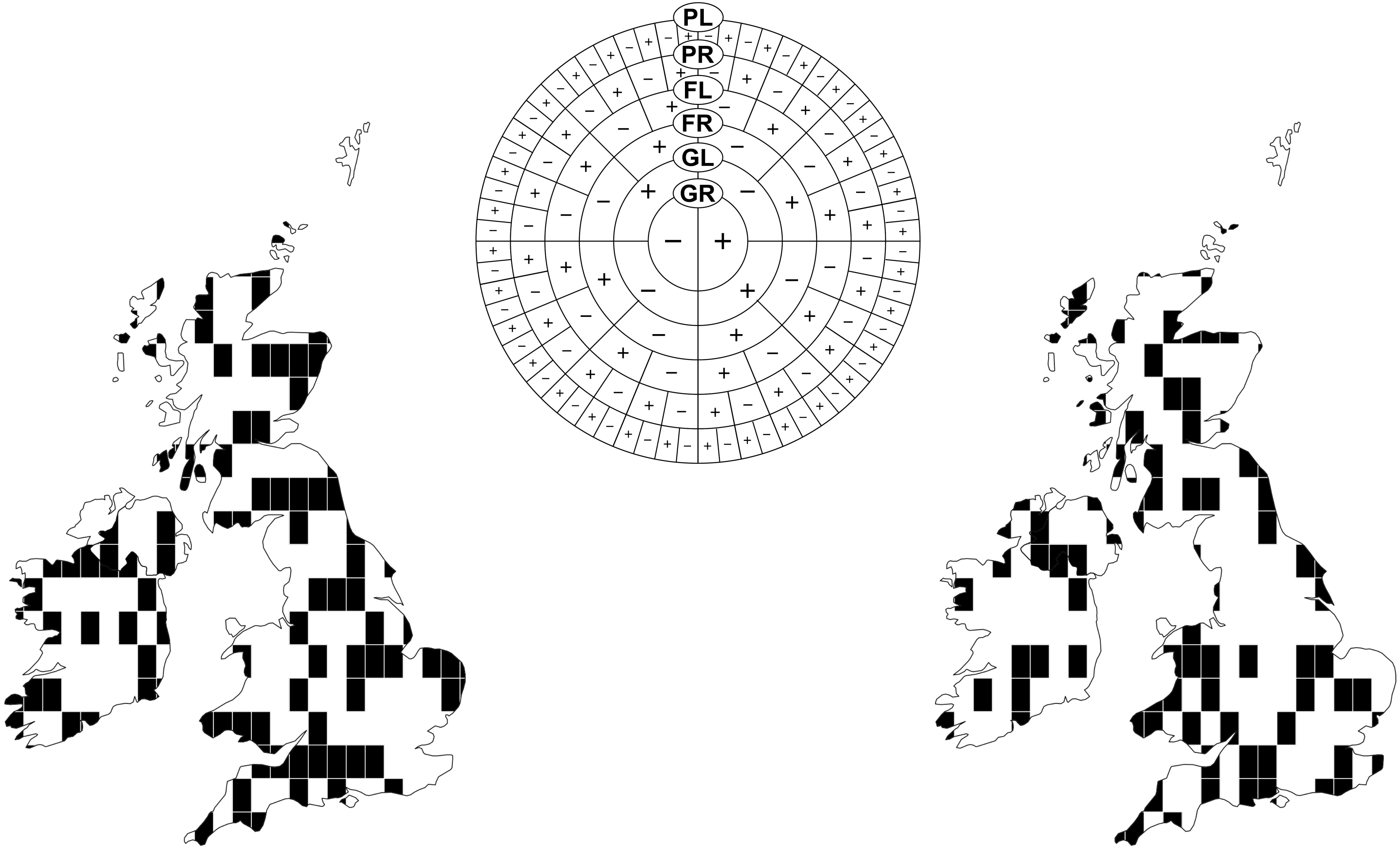
1

Can we use rarity as a tool to understand ecological processes? How?

Yes… with some caveats

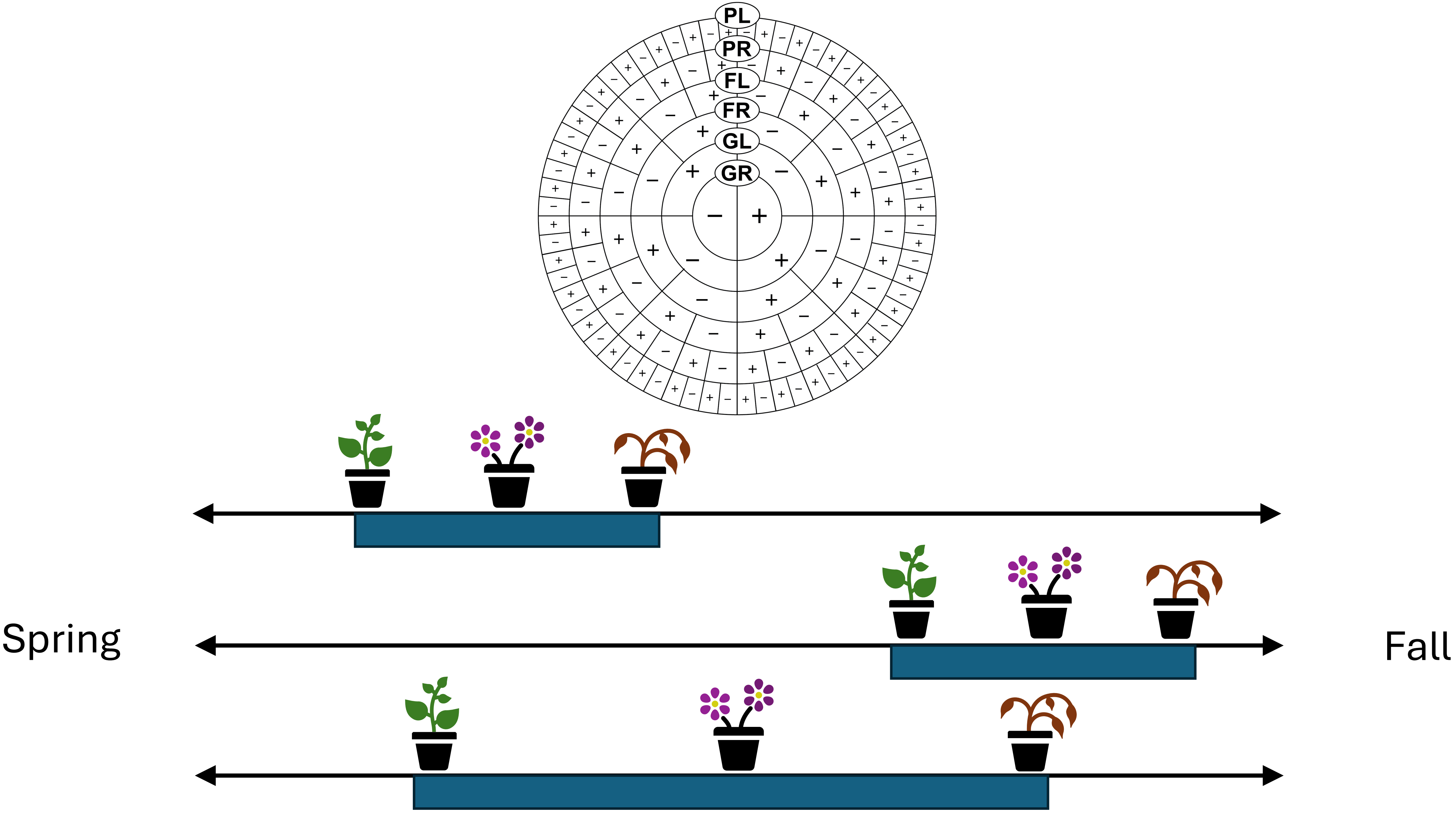
2

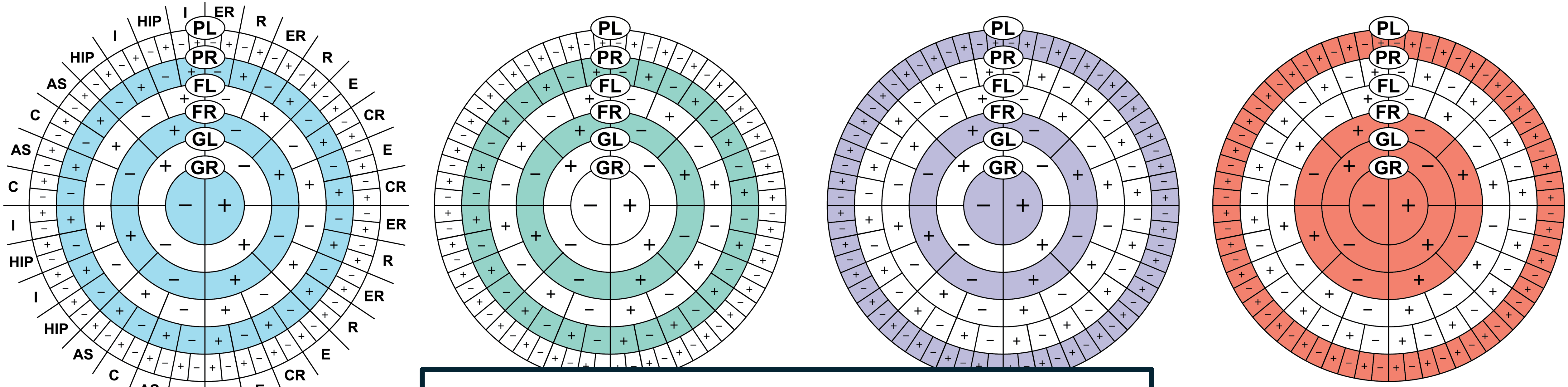
Are rarity types robust and ecologically relevant?



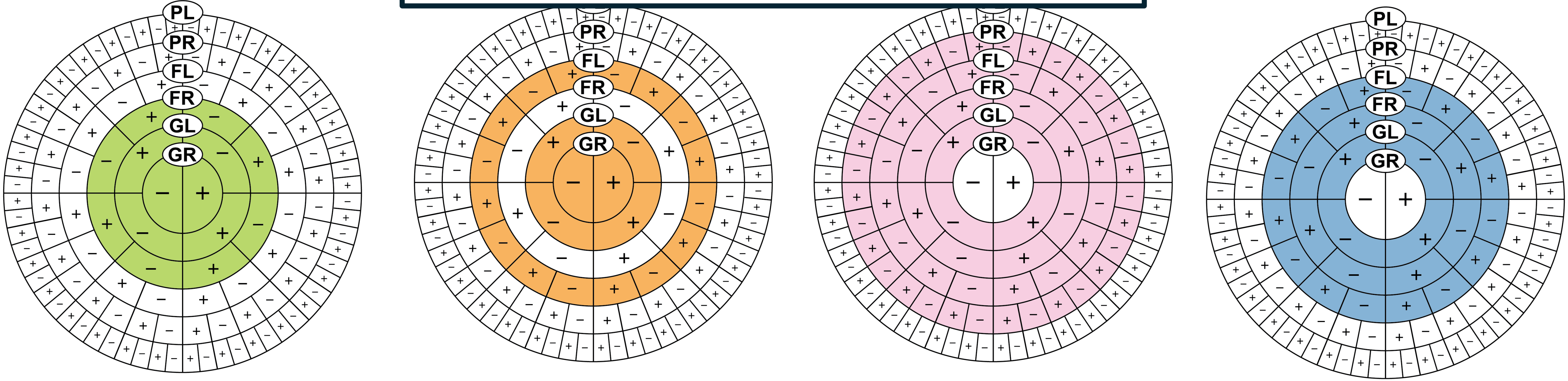
1987

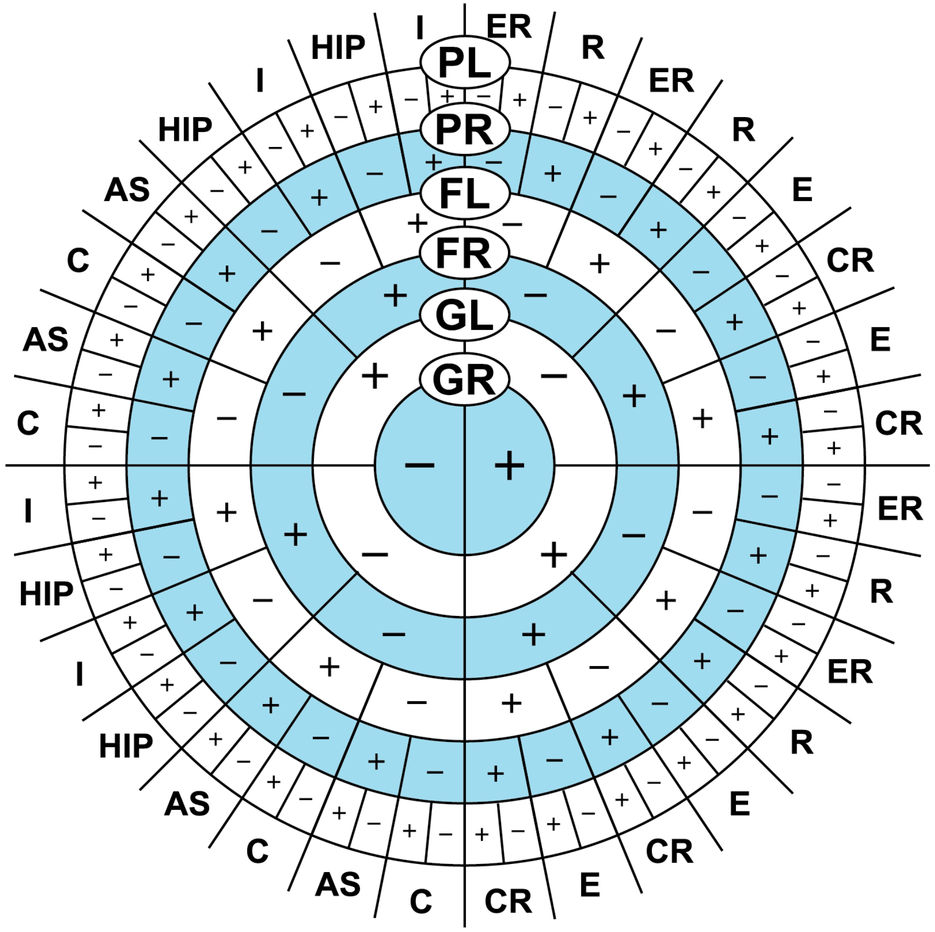
2019


PL
PR
FL
FR
GL
GR
Spring
Fall



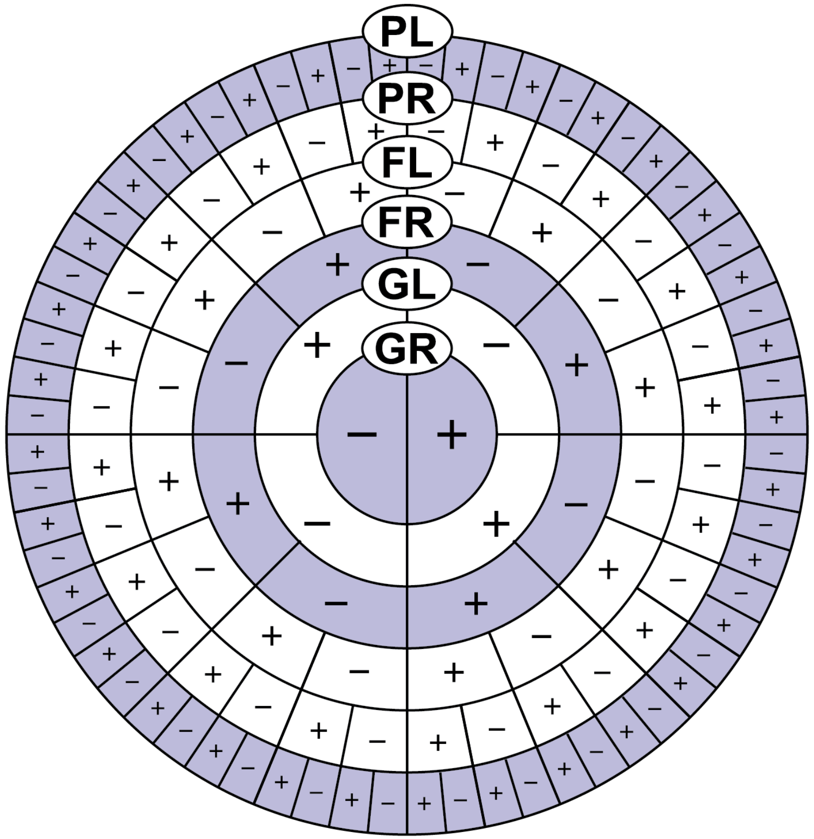
Novel Restrictions



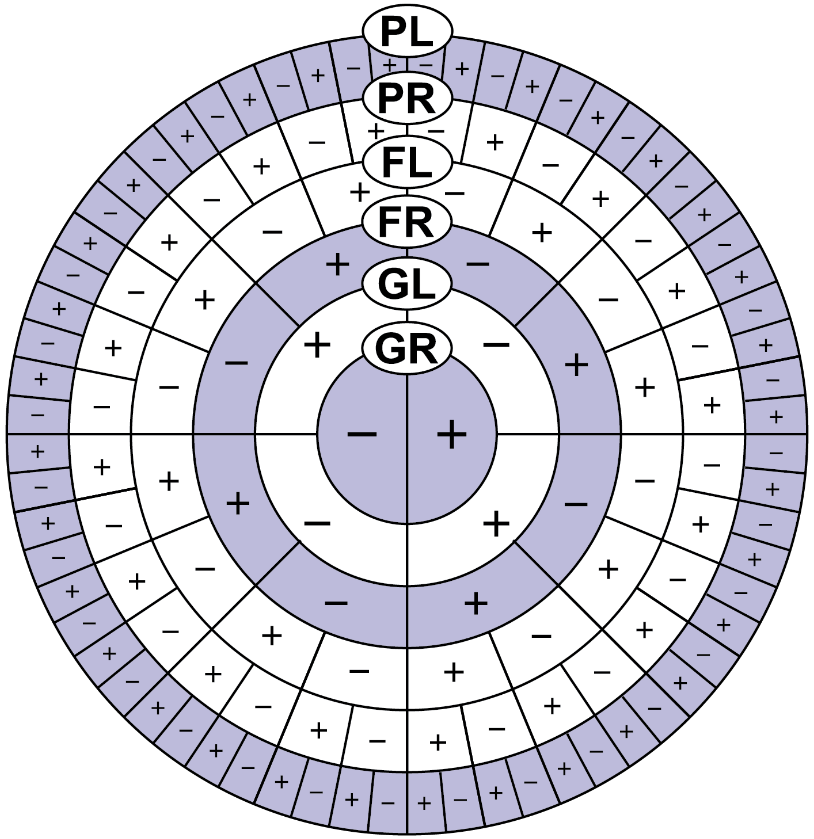


Eco-Evolutionary Rarity

VS

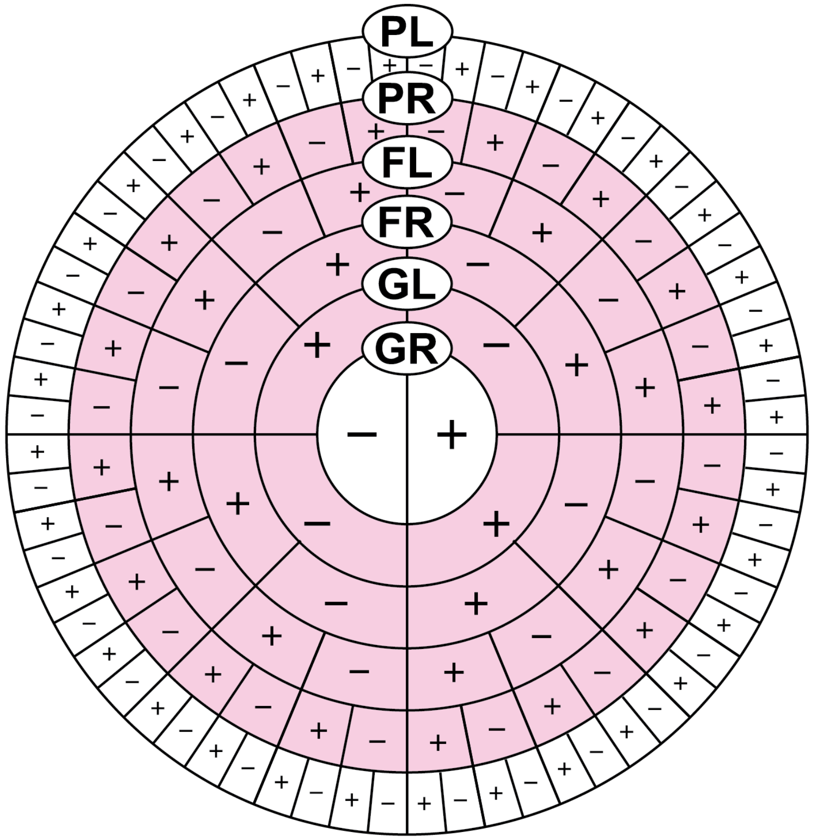


$G_RF_RP_L$

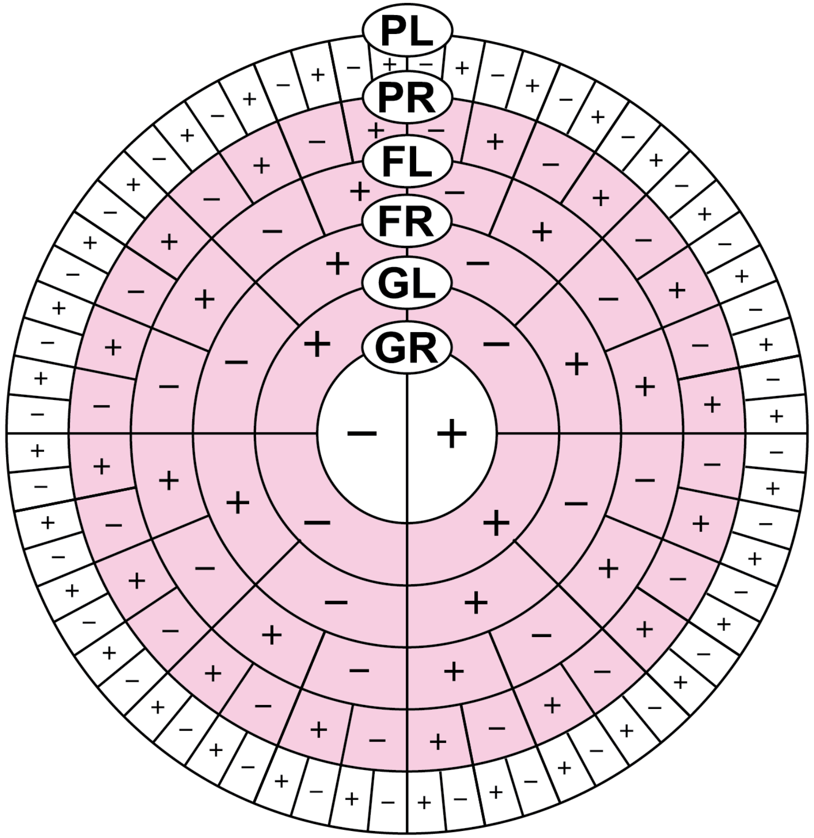


$G_R F_R P_L$

VS

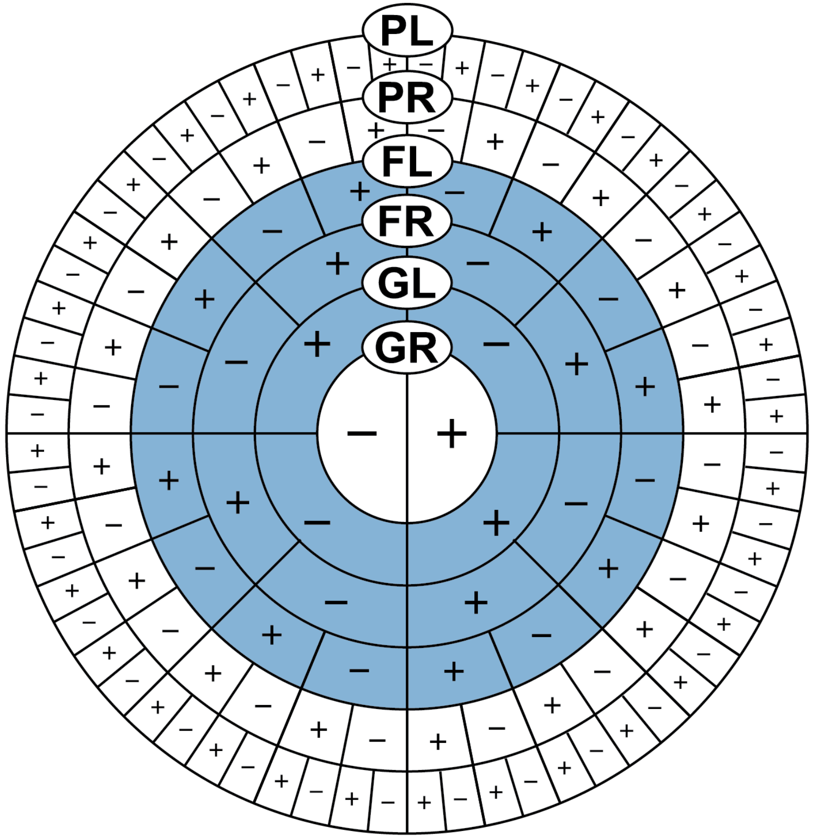


$G_{RL} F_{RL} P_R$

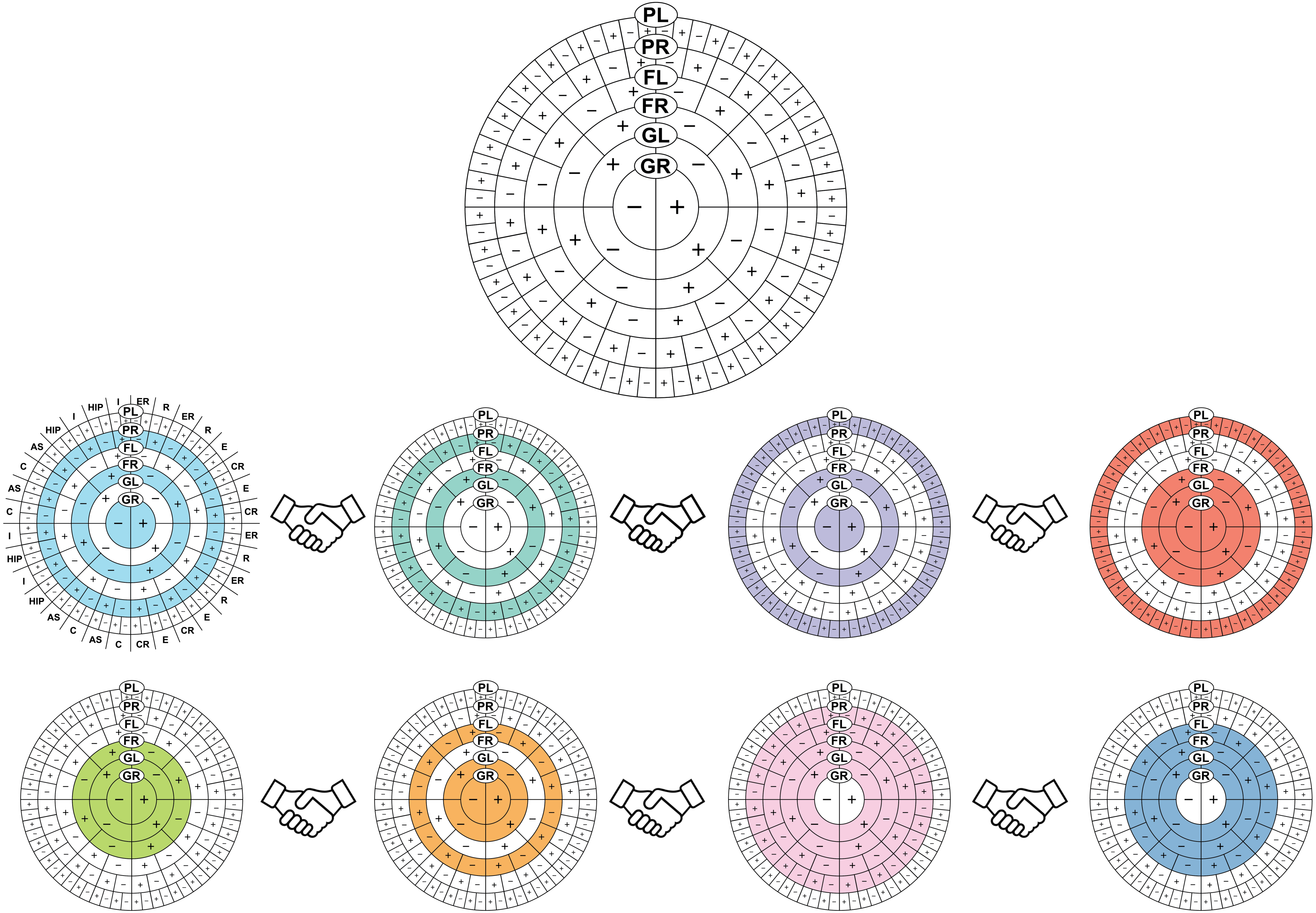


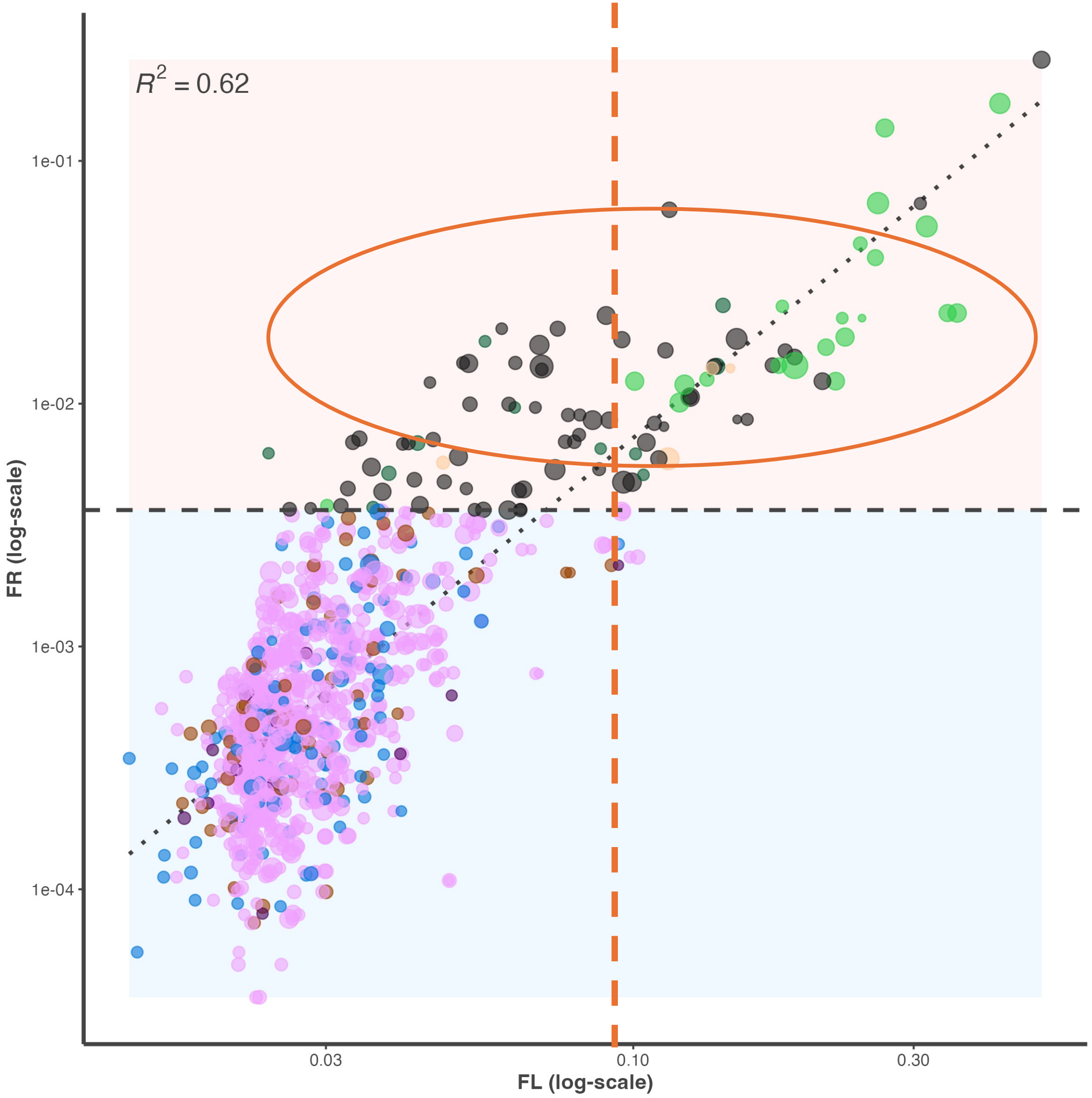
$G_{RL}F_{RL}P_{R}$

VS



$G_{L}F_{RL}$

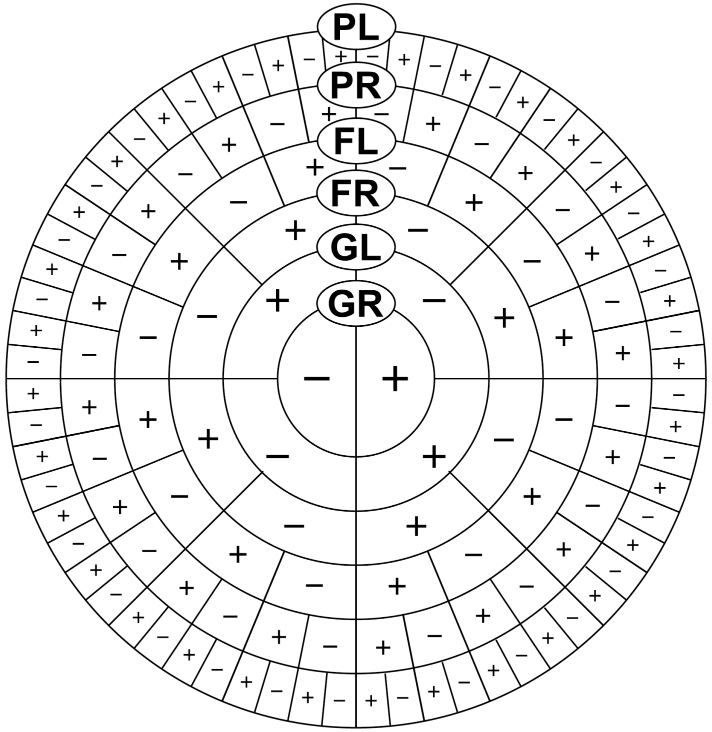

PL
PR
FL
FR
GL
GR
HIP
I
ER
R
E
CR
C
AS



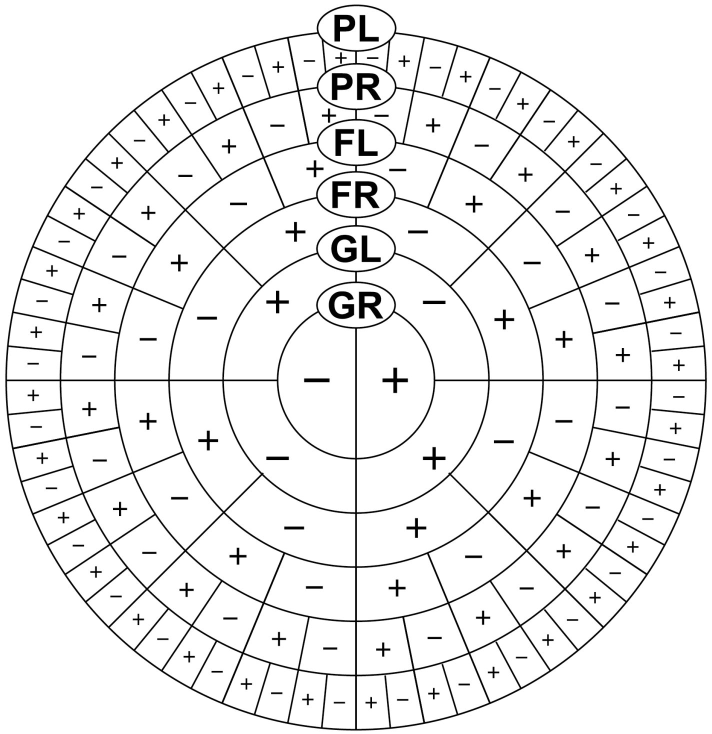
$R^2 = 0.62$
1e-01
1e-02
1e-03
1e-04
FR (log-scale)
0.03
0.10
0.30
FL (log-scale)

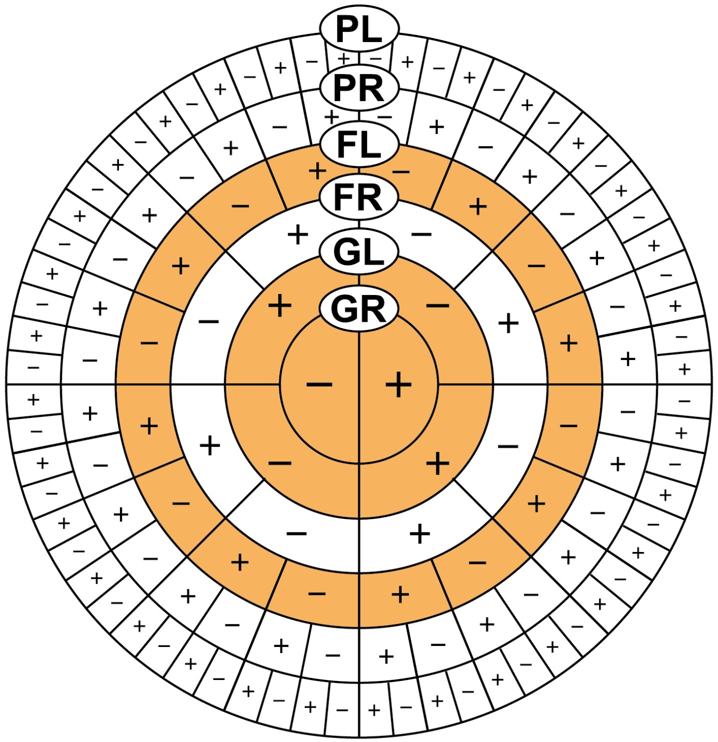
When and if rarity is best defined by its comprehensiveness or by its utility in explaining ecology?

When and if rarity is best defined by its comprehensiveness or by its utility in explaining ecology?



When and if rarity is best defined by its comprehensiveness or by its utility in explaining ecology?





63 Restrictions

GRFRLPR
GRFRLPRL
GRLPRL
EER
GRFRLPL
GRLFRLPR
GRLPL
GRFLPL
FRL
GRFRL
FLPL
GRLFL
GRLFLPRL
FRPR
GRFL
FRLPRL
GRLFRPRL
GLFRLPL
GRFRPL
GLFL
EDGE
GRLFR
PRL
GLFLPL
GRLFRLPL
GRLFLPL
GLFRPR
GLFLPR
GRFLPR
PR
GRPRL
GRL
FLPRL
GLPR
FL
GDR
GLFRL
FRLPR
FRLPL
GLFLPRL
GL
FLPR
GLFRLPRL
FRPRL
GLPL
GLPRL
GLFRLPR
Functional Rarity
GR
FR
FRPL
GRFRPRL
GRLFRPL
GRFR
GRLFRPR
PL
GRFLPRL
GLFRPRL
GRLFLPR

Limiting Abundance Data

GRFRLPR
GRFRLPRL
GRLPRL
EER
GRFRLPL
GRLPL
GRLFRLPR
GRFLPL
FRL
GRFRL
GRLFL
FLPL
GRLFLPRL
FRPR
GRFL
GLFRLPL
FRLPRL
GRLFRPRL
GLFL
EDGE
GRFRPL
PRL
GRLFR
GRLFRLPL
GLFLPL
GRLFLPL
GLFRPR
GLFLPR
GRFLPR
PR
GRPRL
GRL
GDR
FL
GLPR
FLPRL
FRLPR
GLFRL
FRLPL
GL
FLPR
GLFLPRL
GLFRLPRL
FRPRL
GLPRL
GLPL
GLFRLPR
Functional Rarity
FRPL
GR
FR
GRFRPRL
GRLFRPR
GRFR
GRLFRPL
PL
GRFLPRL
GLFRPRL
GRLFLPR

Defining Rarity

GRFRLPR
GRFRLPRL
GRLPRL
EER
GRFRLPL
GRLFRLPR
GRLPL
GRFLPL
FRL
GRFRL
FLPL
GRLFL
GRLFLPRL
FRPR
GRFL
FRLPRL
GRLFRPRL
GLFRLPL
GRFRPL
GLFL
EDGE
GRLFR
PRL
GLFLPL
GRLFRLPL
GRLFLPL
GLFRPR
GLFLPR
PR
GRFLPR
GRPRL
GRL
FLPRL
GLPR
FL
GDR
FRLPR
GLFRL
FRLPL
GLFLPRL
GL
FLPR
FRPRL
GLFRLPRL
GLPL
GLPRL
GLFRLPR
Functional Rarity
GR
FR
FRPL
GRFRPRL
GRLFRPL
GRFR
GRLFRPR
PL
GRFLPRL
GLFRPRL
GRLFLPR

Explaining Range Dynamics

GRFRLPR

GRFRLPRL

GRLPRL EER

GRFRLPL GRLFRLPR GRLPL

GRFLPL FRL

GRFRL FLPL GRLFL GRLFLPRL

FRPR

GRFL FRLPRL GRLFRPRL GLFRLPL

GLFL EDGE

GRFRPL

GRLFR PRL GRLFRLPL

GLFLPL

GRLFLPL GLFRPR GLFLPR

PR GRFLPR GRPRL

GRL

FLPRL GLPR FL GDR FRLPR

GLFRL FRLPL

GLFLPRL GL FLPR GLFRLPRL

FRPRL

GLPL GLPRL

GLFRLPR

Functional Rarity

GR FR FRPL

GRLFRPR GRFRPRL

GRLFRPL GRFR

PL GRFLPRL

GLFRPRL

GRLFLPR

Explaining Phenology

GRFRLPR

GRLPRL EER GRFRLPRL

GRFRLPL GRLFRLPR GRLPL

GRFLPL FRL

GRFRL FLPL GRLFL GRLFLPRL

FRPR

GRFL FRLPRL GRLFRPRL GLFRLPL

GRFRPL GLFL EDGE

GRLFR PRL GRLFRLPL

GLFLPL

GRLFLPL GLFRPR GLFLPR PR GRFLPR GRPRL

GRL

FLPRL GLPR FL GDR FRLPR GLFRL FRLPL

GL FLPR

GLFLPRL GLFRLPRL FRPRL

GLPL GLPRL GLFRLPR

Functional Rarity

GR FR FRPL

GRLFRPR GRFRPRL

GRLFRPL GRFR PL GRFLPRL

GLFRPRL

GRLFLPR

1

Can we use rarity as a tool to understand biological processes? How?

Yes… with some caveats

2

Are rarity types robust and ecologically relevant?

1

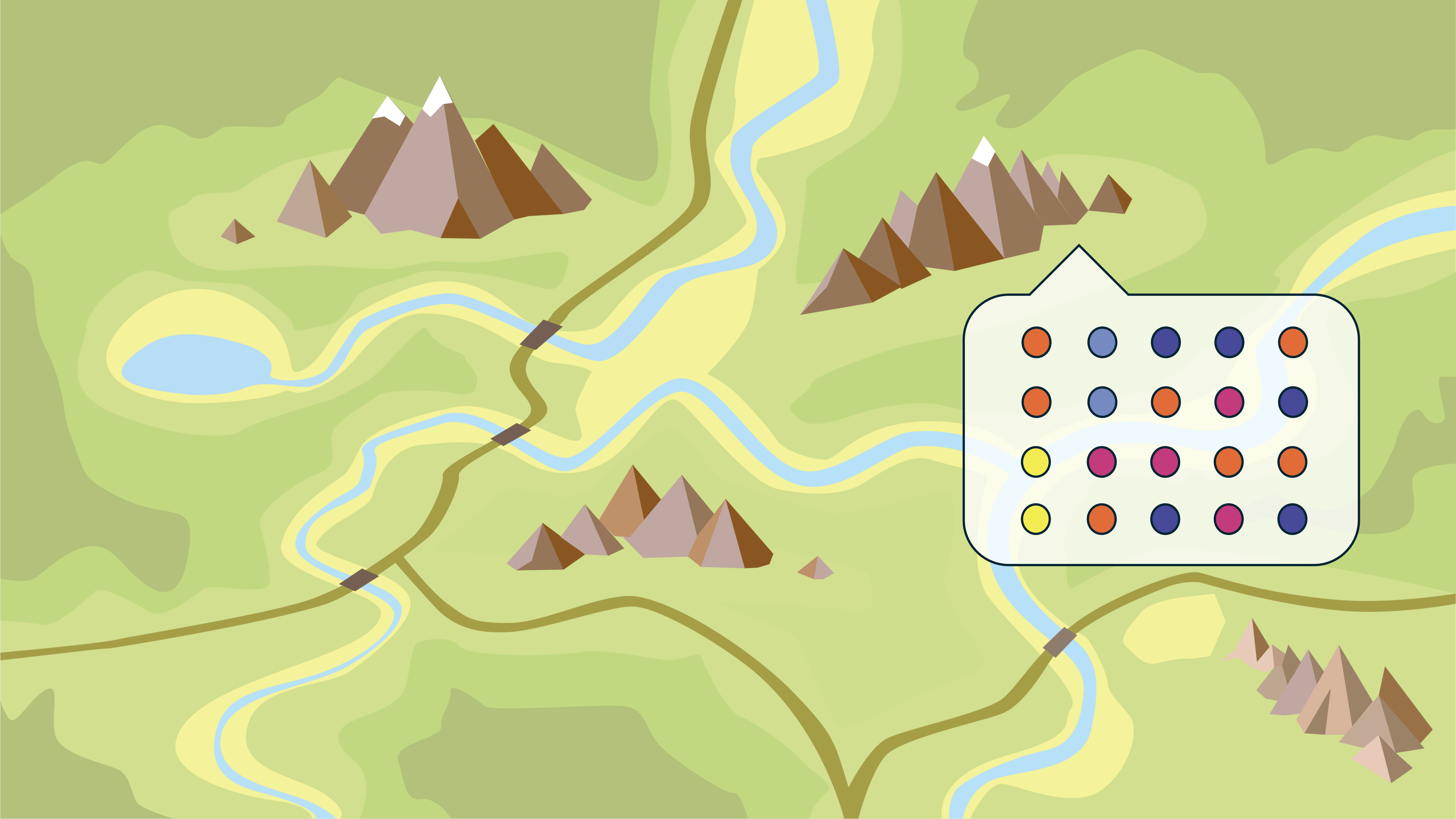
Can we use rarity as a tool to understand biological processes? How?

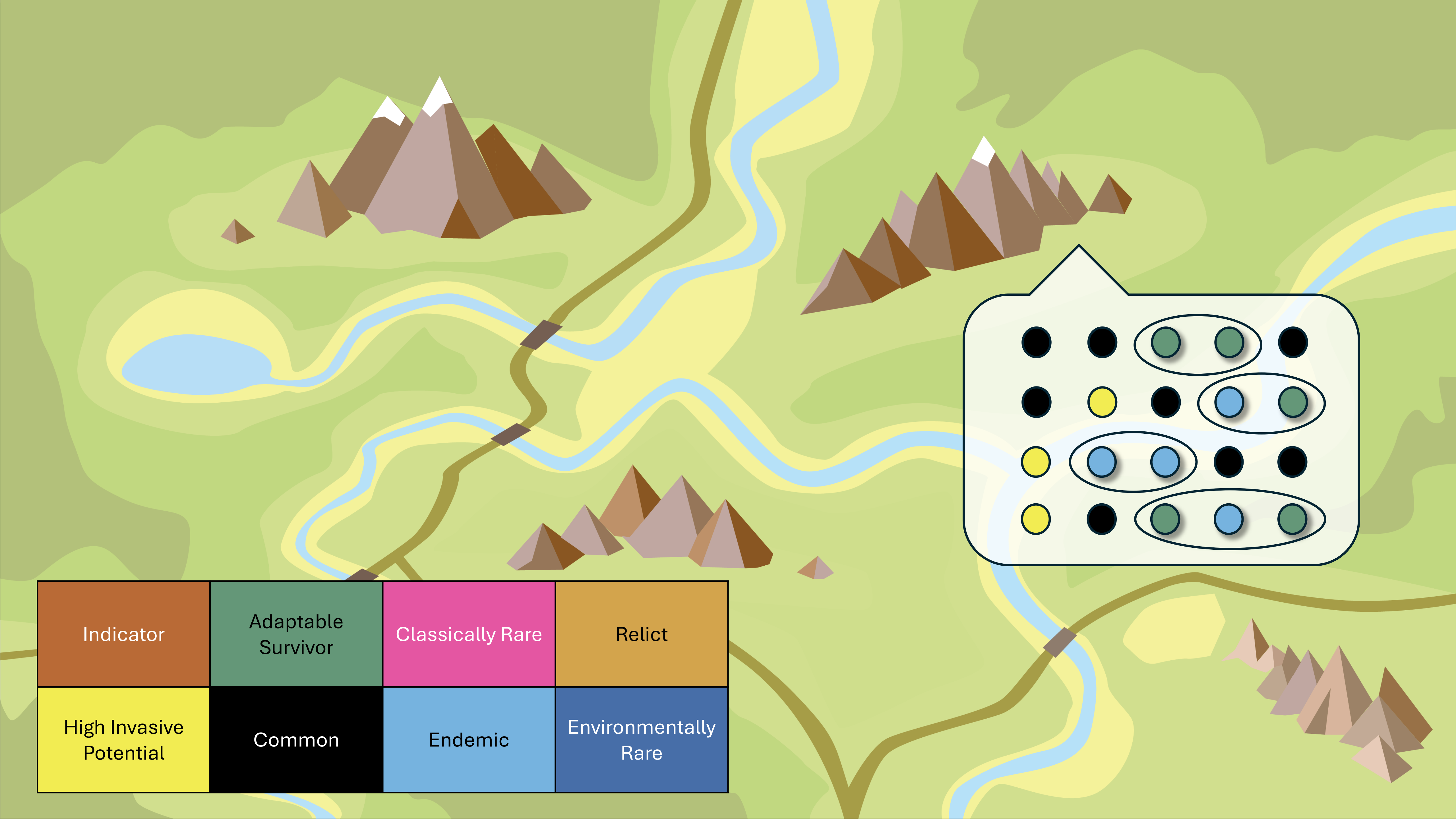
Yes… with some caveats

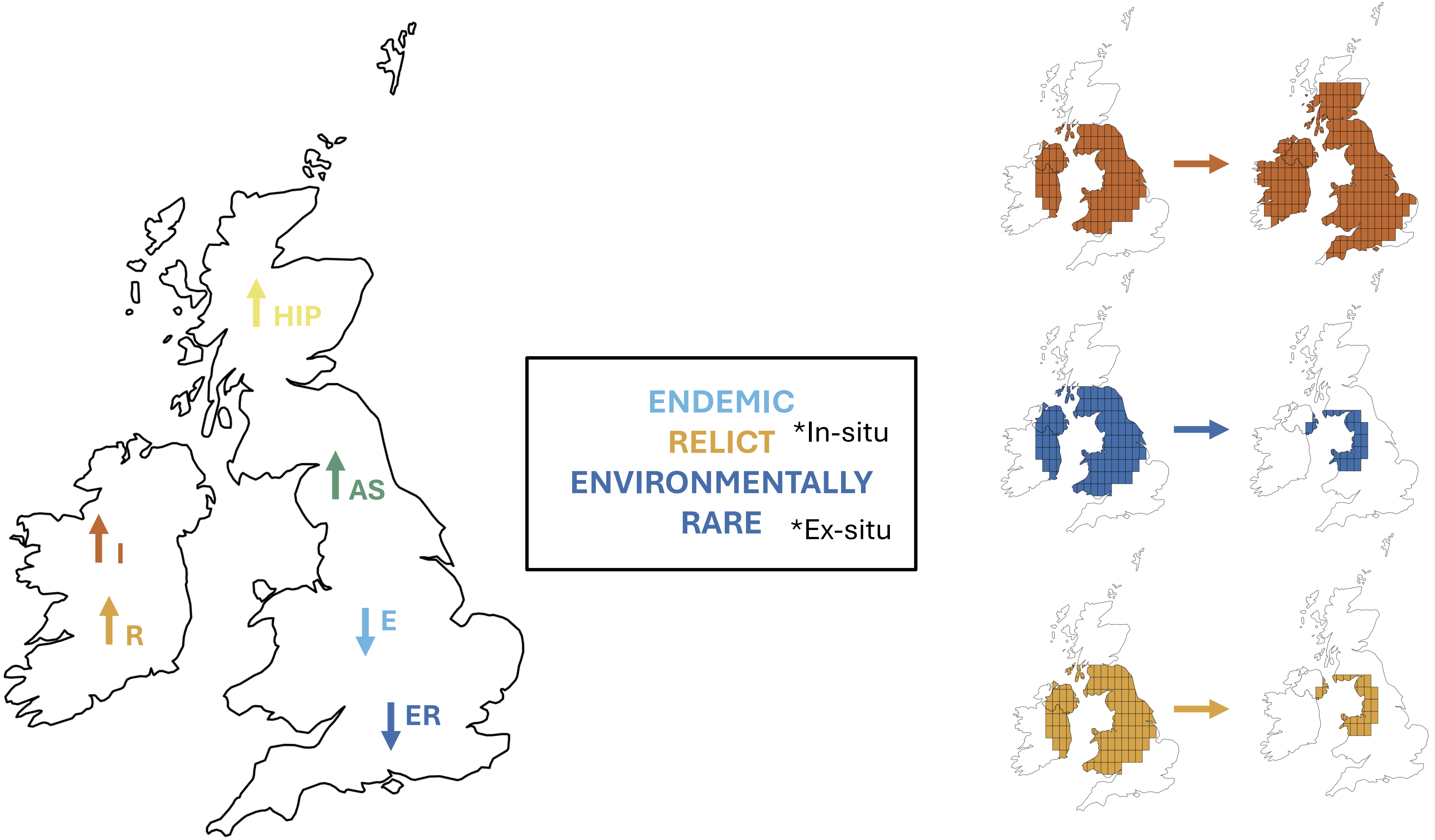
2

Are rarity types robust and ecologically relevant?

Probably... with large impacts for conservation




Indicator
Adaptable Survivor
Classically Rare
Relict
High Invasive Potential
Common
Endemic
Environmentally Rare



HIP
AS
I
R
E
ER
ENDEMIC
RELICT
*In-situ
ENVIRONMENTALLY
RARE
*Ex-situ

The **Global Model of Discretized Rarity** and its complementary restrictions overcome data limitations and provide more than 50 novel definitions of rarity and tools to understand ecological processes, grounded in a unified conceptual framework.

Future Directions

- Identify a suite of complementary restrictions that capture a wide range of ecological processes.
- Uncover the abiotic and biotic gradients that have shaped diversity in rarity within these restrictions through evolutionary time.
- Link rarity to ecosystem function.

Predict how species, communities, and ecosystems respond to climate change using **biodiversity-rarity-ecosystem function (BREF)** relationships.

Thank you!

Beaulieu Lab

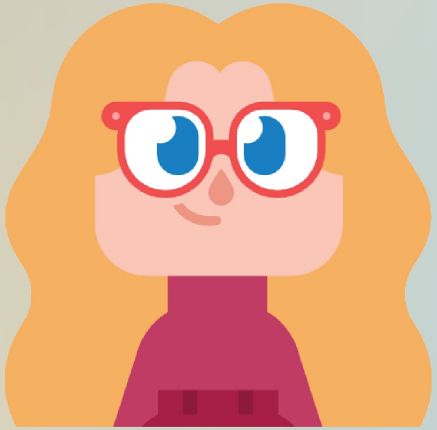
O'Meara Lab

Bailey Lab

NSF

ECOLOGICAL SOCIETY OF AMERICA
esa

THE UNIVERSITY OF TENNESSEE
KNOXVILLE



anytko@vols.utk.edu