Supplemental Information

steppe

Table 1: Example of environmental variables and data sources commonly used in species distribution models that could be used during the spatial filtering step of our approach.

Variable	**Data Source**	**Geographic Extent**
Climate	WorldClim	Global
	CHELSA	Global
	Gridded Surface Meterological (GRIDMET)	CONUS
	PRISM	CONUS
Elevation	Multi-Error-Removed Improved-Terrain DEM	Global
	Global Multi-resolution Terrain Elevation Data (GMTED2010)	Global
	Aster Global Digital Elevation Model (ASTCTM)	Global
	United States National Elevation Dataset	CONUS
Land Uses / Land Covers	Dynamic World	Global
	Global Land Cover Characterization (GLCC)	Global
	Moderate Resolution Imaging Spectroradiometer (MODIS) Land Cover	Global
	National Land Cover Dataset (NLCD)	CONUS
Vegetation Cover	Remote Sensing Products (e.g. Landsat, MODIS)	Global
Soils & Geomorphology	SoilGrids	Global
	Harmonized World Soil Database	Global
	GeoMorpho90m	Global
	Web Soil Survey	CONUS

[a] CONUS; CONtinental United States

Figure 1 - Site Info

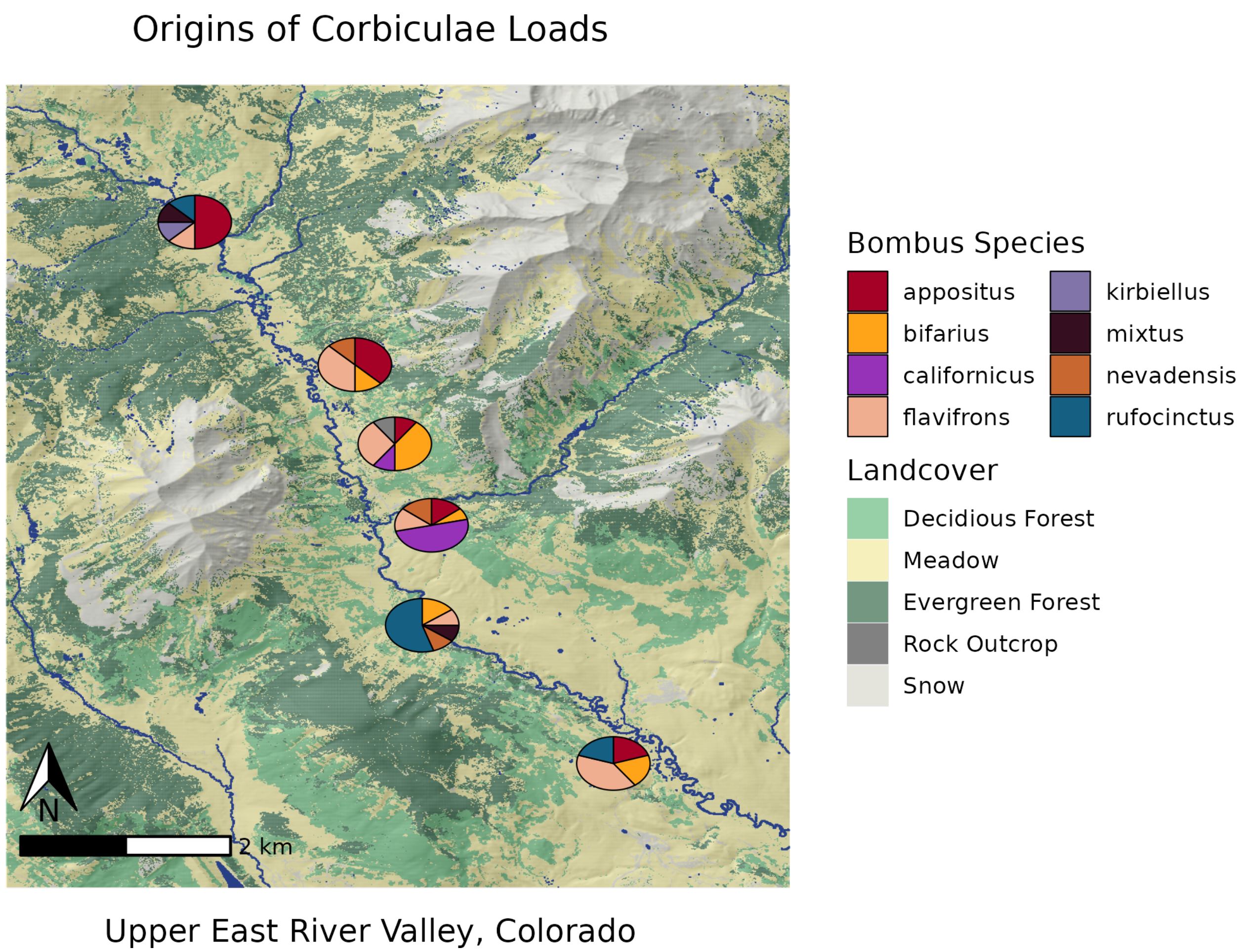

Origins of Corbiculae Loads
2 km
N
Bombus Species
appositus
bifarius
californicus
flavifrons
kirbiellus
mixtus
nevadensis
rufocinctus
Landcover
Decidious Forest
Meadow
Evergreen Forest
Rock Outcrop
Snow
Upper East River Valley, Colorado

Table 2 - Models used for Species Distribution Model Ensembles

The two machine learning models utilize Ensemble learning.

Ensemble learning utilizes many sets of trees, each tree being composed of many binary decisions, to create a single model. Each independent variable (- or *feature*) may become a node on the tree - i.e. a location on the tree where a binary decision will move towards a predicted outcome. Each of the decision tree models which ensemble learning utilizes is a weak model, each of which may suffer due to high variance or bias, but which produce better outcomes than would be expected via chance. When ensembled these models generate a strong model, a model which should have more appropriately balanced variance and bias and predicts outcomes which are more strongly correlated with the expected values than the individual weak models.

Random Forest (RF) the training data are continually bootstrap re-sampled, in combination with random subsets of features, to create nodes which attempt to optimally predict a known outcome. A large number of trees are then aggregated, via the most common predictions, to generate a final classification prediction tree. Each individual prediction tree is generated independently of the others.

Boosted Regression Tree (BRT) (or Gradient Boosted tree) An initial tree is grown, and all other trees are derived sequentially from it, as each new tree is grown the errors in responses from the last tree are weighed more heavily so that the model focuses on selecting dependent variables which refine predictions. All response data and predictor variables are kept available to all trees.

Bias predictions from an algorithm are systematically in error due to being prejudiced for or against certain results, due to assumptions during learning.

Variance errors in models due to an over-reliance and sensitivity of training to outliers in training data.

In general, Random Forest models have high bias and low variance, where boosted regressions trees have lower bias and higher variance. Theoretically, the weaknesses and strengths of bootstrap aggregation (bagging) as implemented by Random Forests are supplemented by the boosting.

Table 3 - Species Distribution Models Predictors

Layer	LM	Description	Name	Source
1.	N	Mean annual cloudiness - MODIS	Cloud Cover (EarthEnv)	Wilson et al. 2016
2.	Y	Cloudiness seasonality 1 - MODIS	Cloud Cover (EarthEnv)	Wilson et al. 2016
3.	N	Cloudiness seasonality 2 - MODIS	Cloud Cover (EarthEnv)	Wilson et al. 2016
4.	Y	Cloudiness seasonality 3 - MODIS	Cloud Cover (EarthEnv)	Wilson et al. 2016
5.	N	Beginning of the frost-free period	ClimateNA	Wang et al. 2016
6.	N	Climatic moisture deficit	ClimateNA	Wang et al. 2016
7.	N	Degree-days above 5C	ClimateNA	Wang et al. 2016
8.	N	Mean annual precipitation	ClimateNA	Wang et al. 2016
9.	Y	Mean annual precipitation as snow	ClimateNA	Wang et al. 2016
10.	Y	Temperature seasonality	ClimateNA	Wang et al. 2016
11.	Y	2015 Percent Grass/Herbaceous cover - MODIS	(MOD44B)	
12.	Y	2015 Percent Tree cover from Landsat 7/8	(GLCC)	
13.	Y	Soil probability of bedrock (R Horizon)	SoilGrids	Hengl et al. 2017
14.	N	Soil organic carbon (Tonnes / ha)	SoilGrids	Hengl et al. 2017
15.	N	Surface soil pH in H_2O	SoilGrids	Hengl et al. 2017
16.	Y	Surface soil percent sand	SoilGrids	Hengl et al. 2017
17.	Y	Soil USDA class	SoilGrids	Hengl et al. 2017
18.	N	Topographic elevation	Topography (EarthEnv)	Amatulli et al. 2018
19.	Y	Topographic elevation, moving window.	Topography (EarthEnv)	Amatulli et al. 2018
20.	Y	Topographic percent slope	Topography (EarthEnv)	Amatulli et al. 2018
21.	Y	Topographic wetness index	Topography (EarthEnv)	Amatulli et al. 2018
22.	Y	Topographic aspect	Topography (EarthEnv)	Amatulli et al. 2018
23.	Y	Annual potential solar radiation computed	r.sun	
24.	N	Estimated actual (w/-cloud) solar radiation	r.sun	Wilson et al. 2016
25.	Y	Log-transformed distance to surface water	Global Surface Water Explorer	Pekel et al. 2016
26.	Y	Percent surface water	Global Surface Water Explorer	Pekel et al. 2016

Amatulli, G., Domisch, S., Tuanmu, M.-N., Parmentier, B., Ranipeta, A., Malczyk, J., and Jetz, W. (2018) A suite of global, cross-scale topographic variables for environmental and biodiversity modeling. Scientific Data volume 5, Article number: 180040. DOI: doi:10.1038/sdata.2018.40.

Hengl T, Mendes de Jesus J, Heuvelink GBM, Ruiperez Gonzalez M, Kilibarda M, Blagotić A, et al. (2017) SoilGrids250m: Global gridded soil information based on machine learning. PLoS ONE 12(2): e0169748. https://doi.org/10.1371/journal.pone.0169748

Pekel, JF., Cottam, A., Gorelick, N. et al. High-resolution mapping of global surface water and its long-term changes. Nature 540, 418–422 (2016). https://doi.org/10.1038/nature20584

Wang T, Hamann A, Spittlehouse D, Carroll C (2016) Locally Downscaled and Spatially Customizable Climate Data for Historical and Future Periods for North America. PLoS ONE 11(6): e0156720. https://doi.org/10.1371/journal.pone.0156720

Wilson AM, Jetz W (2016) Remotely Sensed High-Resolution Global Cloud Dynamics for Predicting Ecosystem and Biodiversity Distributions. PLoS Biol 14(3): e1002415. https://doi.org/10.1371/journal.pbio.1002415

Table 4 - Molecular Reference Specimen Table

Table 1: Samples Used to Supplement the Sequence Reference Library

Taxon	Family	Herbarium	Accession	Preservation	Locality	Date	Collector
Cirsium parryi (A. Gray) Petr.	Asteraceae			silica-dried	USA, Colorado, Gunnison	20.IX.2020	Benkendorf, R.C. 2318
Cirsium parryi (A. Gray) Petr.	Asteraceae			silica-dried	USA, Colorado, Gunnison	20.IX.2020	Benkendorf, R.C. 2318
Ericameria parryi (A. Gray) G.L. Nesom & Baird	Asteraceae			silica-dried	USA, Colorado, Gunnison	20.IX.2020	Benkendorf, R.C. 2316
Erigeron speciosus (Lindley) De Candolle	Asteraceae	CHIC	23001	silica-dried	USA, Colorado, Gunnison	18.VII.2020	Benkendorf, R.C. 2217
Erigeron subtrinervis Rydb. Ex Porter & Britton	Asteraceae	CHIC	23000	silica-dried	USA, Colorado, Gunnison	20.VII.2020	Benkendorf, R.C. 2216
Helianthella quinquenervis (Hook.) A. Gray	Asteraceae			silica-dried	USA, Colorado, Gunnison	18.VII.2020	Benkendorf, R.C. 2200
Heliomeris multiflora Nutt.	Asteraceae	CHIC	22989	silica-dried	USA, Colorado, Gunnison	18.VII.2020	Benkendorf, R.C. 2201
Heterotheca villosa (Pursh) Shinners	Asteraceae	CHIC	22967	silica-dried	USA, Colorado, Gunnison	20.IX.2020	Benkendorf, R.C. 2314
Senecio serra Hook.	Asteraceae	CHIC	23008	silica-dried	USA, Colorado, Gunnison	20.IX.2020	Benkendorf, R.C. 2313
Symphyotrichum foliaceum (Lindl. Ex. D.C.) G.L. Nesom	Asteraceae	CHIC	22986	press-dried	USA, Idaho, Idaho	26.VII.2019	Benkendorf, R.C. 2192
Taraxacum officinale F.H. Wigg.	Asteraceae	CHIC	23011	silica-dried	USA, Illinois, McHenry	28.VII.2020	Benkendorf, R.C. 2326
Taraxacum officinale F.H. Wigg.	Asteraceae	CHIC	23011	silica-dried	USA, Illinois, McHenry	28.VII.2020	Benkendorf, R.C. 2326
Mertensia ciliata (James ex Torr.) G. Don	Boraginaceae	ID	175485	silica-dried	USA, Idaho, Valley	18.VI.2018	McCauley, S. 18-6
Mertensia ciliata (James ex Torr.) G. Don	Boraginaceae	ID	169837	press-dried	USA, Idaho, Adams	10.VII.2014	Gilman, I. 2014-73, Tank, D., Latvis, M., Jacobs, S.J.
Mertensia fusiformis Greene	Boraginaceae	RM	720522	press-dried	USA, Colorado, Gunnison	7.VI.1997	Taylor, K.J. 1070
Mertensia fusiformis Greene	Boraginaceae	RM	720600	press-dried	USA, Colorado, Gunnison	9.VI.1997	Taylor, K.J. 427
Campanula rotundifolia L.	Campanulaceae			silica-dried	USA, Colorado, Gunnison	18.VII.2020	Benkendorf, R.C. 2213
Lathyrus lanszwertii Kellogg var. leucanthus (Ryd.) Dorn	Fabaceae	CHIC	23002	silica-dried	USA, Colorado, Gunnison	18.VII.2020	Benkendorf, R.C. 2218
Lathyrus lanszwertii Kellogg var. leucanthus (Ryd.) Dorn	Fabaceae	CHIC	23002	silica-dried	USA, Colorado, Gunnison	18.VII.2020	Benkendorf, R.C. 2218
Lupinus argenteus Pursh	Fabaceae	CHIC	22997	silica-dried	USA, Colorado, Gunnison	18.VII.2020	Benkendorf, R.C. 2211
Lupinus argenteus Pursh	Fabaceae	CHIC	22918	press-dried	USA, Nevada, Pershing	29.V.2018	Benkendorf, R.C. 1287
Lupinus bakeri Greene	Fabaceae	IDS	10387	press-dried	USA, Colorado, Gunnison	29.VI.2010	Williams, C.F. 2010-96
Lupinus bakeri Greene	Fabaceae	IDS	10142	press-dried	USA, Colorado, Gunnison	15.VIII.2010	Williams, C.F. 2010-369.1
Vicia americana Muhl. ex Willd.	Fabaceae	CHIC	22996	silica-dried	USA, Colorado, Gunnison	18.VII.2020	Benkendorf, R.C. 2209
Vicia americana Muhl. ex Willd. var. minor Hook.	Fabaceae	CHIC	22956	silica-dried	USA, Montana, Carbon	4.VII.2019	Benkendorf, R.C. 2071
Frasera speciosa Douglas ex Griseb	Gentianaceae	RM	721930	press-dried	USA, Colorado, Gunnison	20.VI.1997	Taylor, K.J. 1783
Frasera speciosa Douglas ex Griseb	Gentianaceae	RM	719305	press-dried	USA, Colorado, Gunnison	7.VII.1997	Taylor, K.J. 2578
Hydrophyllum capitatum Douglas ex. Benth	Hydrophyllaceae	RM	tba	press-dried	USA, Colorado, Mesa	30.VI.2011	Kirkpatrick, M. K. 6836
Hydrophyllum capitatum Douglas ex. Benth	Hydrophyllaceae	RM	tba	press-dried	USA, Colorado, Delta	8.VI.2011	Brummer, L.E. 3693
Hydrophyllum fendleri (Gray) Heller	Hydrophyllaceae	ID	161100	press-dried	USA, Washington, Yakima	9.VI.2008	Knoke, D. 1576
Hydrophyllum fendleri (Gray) Heller	Hydrophyllaceae	ID	164040	press-dried	USA, Idaho, Idaho	27.V.2009	Davidson, C. 11359
Agastache pallidiflora (Heller) Rydberg	Lamiaceae	CHIC	23007	silica-dried	USA, Arizona, Coconino	17.VIII.2020	Benkendorf, R.C. 2310
Agastache pallidiflora (Heller) Rydberg	Lamiaceae	CHIC	23007	silica-dried	USA, Arizona, Coconino	17.VIII.2020	Benkendorf, R.C. 2310
Chamerion angustifolium (L.) Holub	Onagraceae	CHIC	22998	silica-dried	USA, Colorado, Gunnison	18.VII.2020	Benkendorf, R.C. 2212
Delphinium barbeyi (Huth) Huth	Ranunculaceae			silica-dried	USA, Colorado, Gunnison	18.VII.2020	Benkendorf, R.C. 2199
Delphinium nuttallianum Pritz.	Ranunculaceae	ID	166462	press-dried	USA, Idaho, Gem	15.VI.2011	Smith, J.F. 9594
Delphinium nuttallianum Pritz.	Ranunculaceae	ID	179376	press-dried	USA, Idaho, Gooding	29.IV.2017	Boyd, J. 14
Potentilla fruticosa Pursh	Rosaceae	CHIC	22999	silica-dried	USA, Colorado, Gunnison	18.VII.2020	Benkendorf, R.C. 2215
Potentilla fruticosa Pursh	Rosaceae	CHIC	22999	silica-dried	USA, Colorado, Gunnison	18.VII.2020	Benkendorf, R.C. 2215
Potentilla hippiana Lehman.	Rosaceae	CHIC	23005	silica-dried	USA, New Mexico, Catron	15.VIII.2020	Benkendorf, R.C. 2300
Potentilla pulcherrima Lehman.	Rosaceae	CHIC	22993	silica-dried	USA, Colorado, Gunnison	18.VII.2020	Benkendorf, R.C. 2205

Figure 2 - Pollen Key

1a: Pollen shed in clumps (tetrads/polyads); grains generally triangular, with an annulus subtending the porate apertures (go 34)

1b: Pollen generally dispersed as single units (monads); grains seldom if ever with annulus.

2a: Apertures porate, always lacking colpi

3a: grain outline from equatorial view circular

4a: Pores distributed along the equator.

5a: Pores > 5 (stephanoporate)

6a: Ornamentation homobrochate (~ *MENTZELIA*)

6b: Ornamentation otherwise (~ *POLYGALA*)

5b: Pores < 5 (CURRENTLY OPEN)

4b: Pores +/- distributed across grain (pantoporate)

7a: Ornamentation with striate ornamentation (~ *POLEMONIUM*)

7b: Ornamentation otherwise

8a: Ornamentation, slightly irregular - without regularly repeating features (scabrate) *(~ STELLARIA)*

8b: Ornamentation forming regularly repeating (reticulate) cells of varying shapes.

9a: spacing between the grid cells large (lophate), the walls of the cells with another set of projecting ornamentation (~ *OPUNTIA*)

9b: spacing between cells small, the wall of the cells without projecting features.

10a: Pores extending beyond the reticulate grids (~ *ARENARIA*)

10b: Pores extending beyond the reticulate grids *(~ PHLOX*)

3b: Outline from equatorial view otherwise (usually slightly triangular)

11a: Outline elliptic (CURRENTLY EMPTY)

11b: Outline not elliptic, grains often with acute, if rounded, angles along sides (e.g., triangular, polygonal) (EMPTY)

2b: Apertures with colpi, occasionally also with pores in addition (colporate)

12a: Grains with bristles tapering to points (echinate), and tri-colporate.

13a: Grains uniformly echinate, less the apertures. (Asteraceae 1)

13b: Grains with echinate bristles on ridges of lophae (Asteraceae 2)

12b: Grains without echinate ornamentation - this lead includes projections with ornamentation with round tips.

14a: Grains with either less than 3 apertures, or with two distinct ornamentation types (generally ½ psilate, ½ reticulate).

15a. Grains apparently lacking any apertures. (~ IRIS)

15b. Grains aperturate

16a. Ornamentation on one face of grain psilate, the other homobrochate (~ ZIGADENUS + ANTICLEA)

16b. Ornamentation psilate across both faces of grain (~ERYTHONIUM)

14b. Grains with either 3 or more apertures, or with an elongated spiral like aperture

17a. Grain with spiral like colpi

18a. Spiral with deep well-defined furrows (~ ERYTHRANTHE GUTTATA, syn. obsolete. MIMULUS)

18b. Spirals without well-defined grooves, ornamentation evidently perforate (~ RANUNCULUS ALISMIFOLIUS)

17b. Grains with colpi these not forming irregular spiral motifs.

19a. Grains elliptic, essentially perfectly cylindrical along longest axis, except for minor inundations along equatorial region. Apertures, of two types (heteroaperturate). (~ BORAGINACEAE)

19b Grains shaped similar or not, but never heteroaperturate.

20a. From a polar view, grains notably polygonal (hexagonal), also evident when seldom seen from a equatorial view. (~ PHACELIA/ maybe Hydrophyllaceae, *Hydrophyllum* not sampled)

20b. From a polar view, grains not with 6 convex apices

21a. Grains elliptic, with a short colporate aperture on each psilate face, the edges of each face and the apices with a distinct (homobrochate) textured ornamentation. (~ POLYGONUM)

21b. Grains otherwise, not featuring a mix of ornamentations independent of the apertures.

22a. Ornamentation perforate, the three colpi very short, their longest axis parallel to the equator rather than perpendicular. These colpi often times almost appearing to be slightly raised on an annulus like feature (~ LONICERA)

22b. Grains not as described in all aspects of the above.

23a. Apertures colporate

24a. Outline of grain in equatorial view circular, ornamentation smooth. (~MORPHOTYPE A).

24b. Grains otherwise

25a Grains distinctly triangular from polar view (go 26)

25b Grains elliptic (go 27)

26a Grains very large, clearly strongly triangular in cross section. (~ GERANIUM)

26b Grains smaller (SIZE), weakly triangular in cross section (~ POTENTILLA/DASIPHORA in part)

27a Grains elliptic to weakly circular (~MORPHOTYPE B)

27b Grains elliptic, much longer pole to pole than across equator.

28a Grains with evident protrusions of the pore, colpi short, scarcely noticeable (~ APIACEAE)

23b. Apertures colpate

30a Ornamentation psilate (~MORPHOTYPE C).

30b Ornamentation otherwise

31a Ornamentation homobrochate (~ MORPHOTYPE D)

31b Ornamentation otherwise

32a. Ornamentation bacculate, grains large, (~LINUM)

32b. Ornamentation otherwise

33a. Ornamentation of minor cross-corrugated grooves (fossulate) (~CORYDALIS)

33b. Ornamentation of scarcely perceptible irregular features (scabrate) (~RANUNCULUS IN PART)

34a: Annula subtending the apertures – making grains appear more or less triangular; Pollen often with viscin threads (ONAGRACEAE)

34b: Apertures not annulate – grains appear more or less circular (~ERICACEAE)

Morphotype A: Trifolium, Lupinus, Glyccrrhiza, Mitella, Geum

Morphotype B: Lupinus, Lathyrus, Potentilla, Androsace, Bistorta, Vicia

Morphotype C: Jeffersonia, Micranthes, Prunus, Delphinium, Androsace, Penstemon, Orthocarpus, Scuttelaria, Aquilegia, Castilleja, Draba)

Morphotype D: Salix, Boechera

Table 5 - All Species in the Sequence Databases

Table 1: All species present in the Reference Sequence Databases (Kraken and BLAST)

Order	Family	Taxon
Alismatales	Potamogetonaceae	Potamogeton wrightii
Apiales	Apiaceae	Osmorhiza aristata
Asparagales	Amaryllidaceae	Allium stamineum
	Asparagaceae	Streptopus amplexifolius
Asterales	Asteraceae	Anaphalis margaritacea
		Antennaria carpatica
		Antennaria dioica
		Artemisia sibirica
		Brickellia dentata
		Chrysothamnus greenei
		Cirsium pannonicum
		Cirsium parryi
		Cirsium vulgare
		Crepis pygmaea
		Ericameria parryi
		Erigeron ecuadoriensis
		Erigeron grandiflorus
		Erigeron rosulatus
		Erigeron uniflorus
		Helianthella quinquenervis
		Heterotheca villosa
		Hieracium avilae
		Hieracium jubatum
		Hymenoxys hoopesii
		Leucanthemum graminifolium
		Microseris lindleyi
		Omalotheca supina
		Packera quercetorum
		Pseudognaphalium attenuatum
		Pseudognaphalium frigidum
		Pseudognaphalium lacteum
		Pseudognaphalium oxyphyllum
		Rudbeckia hirta
		Scabrethia scabra
		Senecio adenophyllus
		Senecio algens
		Senecio apolobambensis
		Senecio candollei
		Senecio chionogeton
		Senecio formosus
		Senecio funckii
		Senecio gilliesii
		Senecio humillimus
		Senecio nutans
		Senecio puchei
		Senecio rufescens
		Senecio spinosus
		Senecio tephrosioides

(Continued on Next Page)

Table 1: All species present in the Reference Sequence Databases (Kraken and BLAST) *(continued)*

Order	Family	Taxon
		Solidago chilensis
		Stilpnolepis intricata
		Symphyotrichum foliaceum
		Taraxacum cucullatum
		Taraxacum officinale
		Tonestus lyallii
		Townsendia formosa
	Campanulaceae	Campanula argaea
		Campanula rotundifolia
Boraginales	Boraginaceae	Cynoglossum amplifolium
		Cynoglossum anchusoides
		Cynoglossum pringlei
		Mertensia ciliata
		Mertensia fusiformis
	Hydrophyllaceae	Hydrophyllum canadense
		Hydrophyllum capitatum
		Hydrophyllum fendleri
		Nemophila menziesii
Caryophyllales	Caryophyllaceae	Arenaria globiflora
		Arenaria serpyllifolia
		Cerastium arvense
		Cerastium lanceolatum
		Minuartia recurva
		Odontostemma leucasterium
		Pseudostellaria heterophylla
		Sagina procumbens
		Schizotechium monospermum
		Shivparvatia glanduligera
		Stellaria graminea
		Stellaria holostea
		Stellaria obtusa
	Polygonaceae	Rumex induratus
		Rumex spinosus
Celastrales	Celastraceae	Parnassia faberi
		Parnassia palustris
		Paxistima canbyi
Ericales	Ericaceae	Gaultheria prostrata
		Moneses uniflora
		Orthilia secunda
		Vaccinium vitis-idaea
	Polemoniaceae	Collomia grandiflora
		Ipomopsis aggregata
		Phlox douglasii
	Primulaceae	Androsace studiosorum
		Androsace vitaliana
Fabales	Fabaceae	Astragalus pelecinus
		Lupinus argenteus
		Lupinus sericeus

(Continued on Next Page)

2

Table 1: All species present in the Reference Sequence Databases (Kraken and BLAST) *(continued)*

Order	Family	Taxon
		Vicia americana
Gentianales	Gentianaceae	Frasera speciosa
		Gentiana cruciata
Hyphomicrobiales	Xanthobacteraceae	Azorhizobium caulinodans
Lamiales	Lamiaceae	Agastache pallidiflora
Liliales	Colchicaceae	Prosartes smithii
	Liliaceae	Erythronium dens-canis
	Melanthiaceae	Anticlea elegans
		Veratrum viride
Malpighiales	Hypericaceae	Hypericum perforatum
	Salicaceae	Populus alba
	Violaceae	Viola odorata
Myrtales	Onagraceae	Chamaenerion angustifolium
		Epilobium canum
		Epilobium parviflorum
Ranunculales	Berberidaceae	Berberis sibirica
	Papaveraceae	Corydalis aitchisonii
	Ranunculaceae	Actaea heracleifolia
		Anemone anemonoides
		Anemone obtusiloba
		Aquilegia ecalcarata
		Caltha palustris
		Delphinium barbeyi
		Delphinium gracile
		Delphinium nuttallianum
		Pulsatilla chinensis
		Thalictrum thalictroides
		Thalictrum tuberosum
		Trollius europaeus
Rosales	Elaeagnaceae	Shepherdia argentea
	Rosaceae	Crataegus bipinnatifida
		Dasiphora fruticosa
		Geum ternatum
		Hedlundia austriaca
		Holodiscus argenteus
		Karpatiosorbus devoniensis
		Micromeles japonica
		Potentilla anserina
		Potentilla pulcherrima
		Potentilla tetrandra
		Rubus chingii
Sapindales	Sapindaceae	Acer campestre
Saxifragales	Crassulaceae	Rhodiola rosea
		Sedum nudum
	Grossulariaceae	Ribes rubrum
	Saxifragaceae	Lithophragma parviflorum
		Saxifraga biflora
		Saxifraga fortunei

(Continued on Next Page)

Table 1: All species present in the Reference Sequence Databases (Kraken and BLAST) *(continued)*

Order	Family	Taxon
		Saxifraga maderensis
		Saxifraga oppositifolia
		Saxifraga portosanctana
		Saxifraga x geum

x geum* \end{longtable}

4

Figure 3 - Reads Per Loci

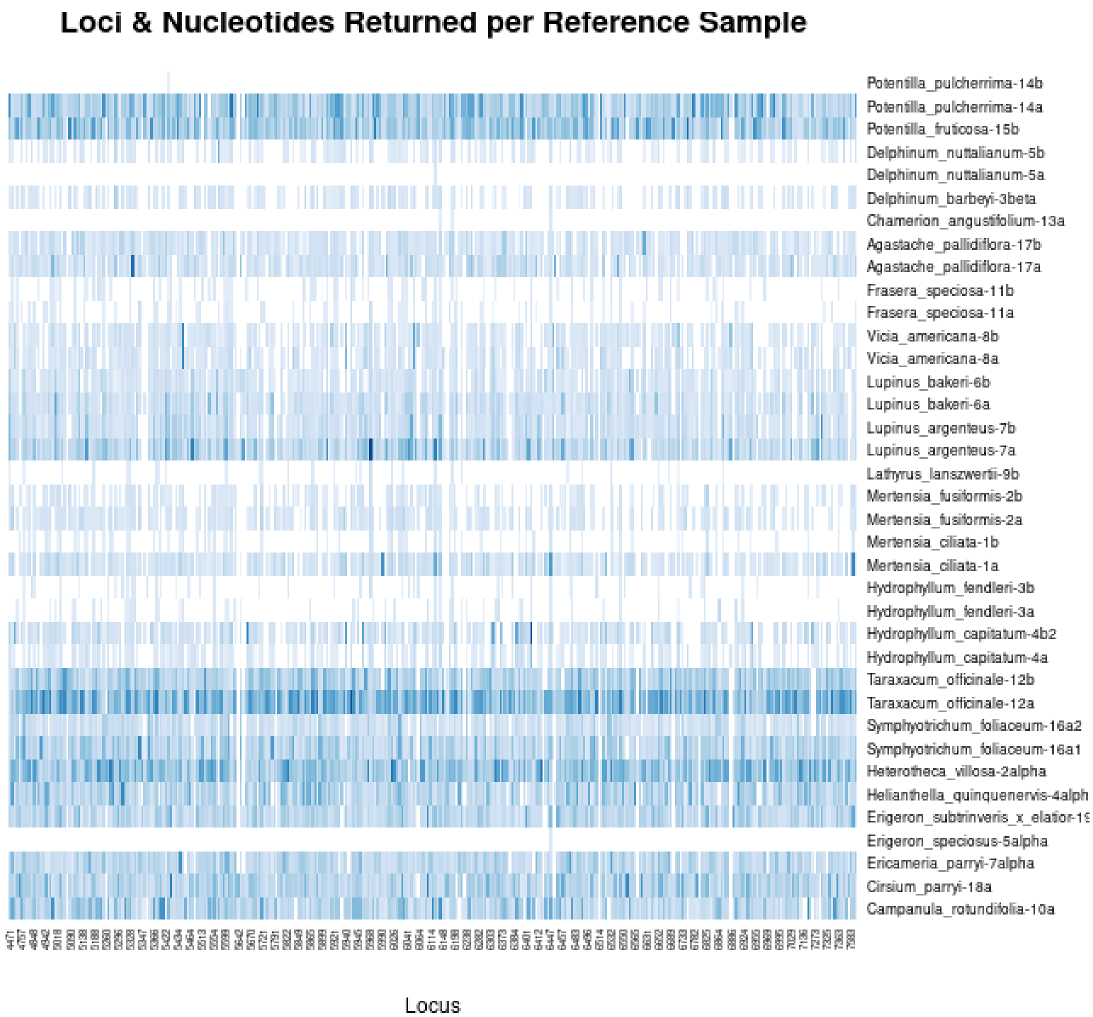


Figure 4 - Percent Loci Matched by Sample

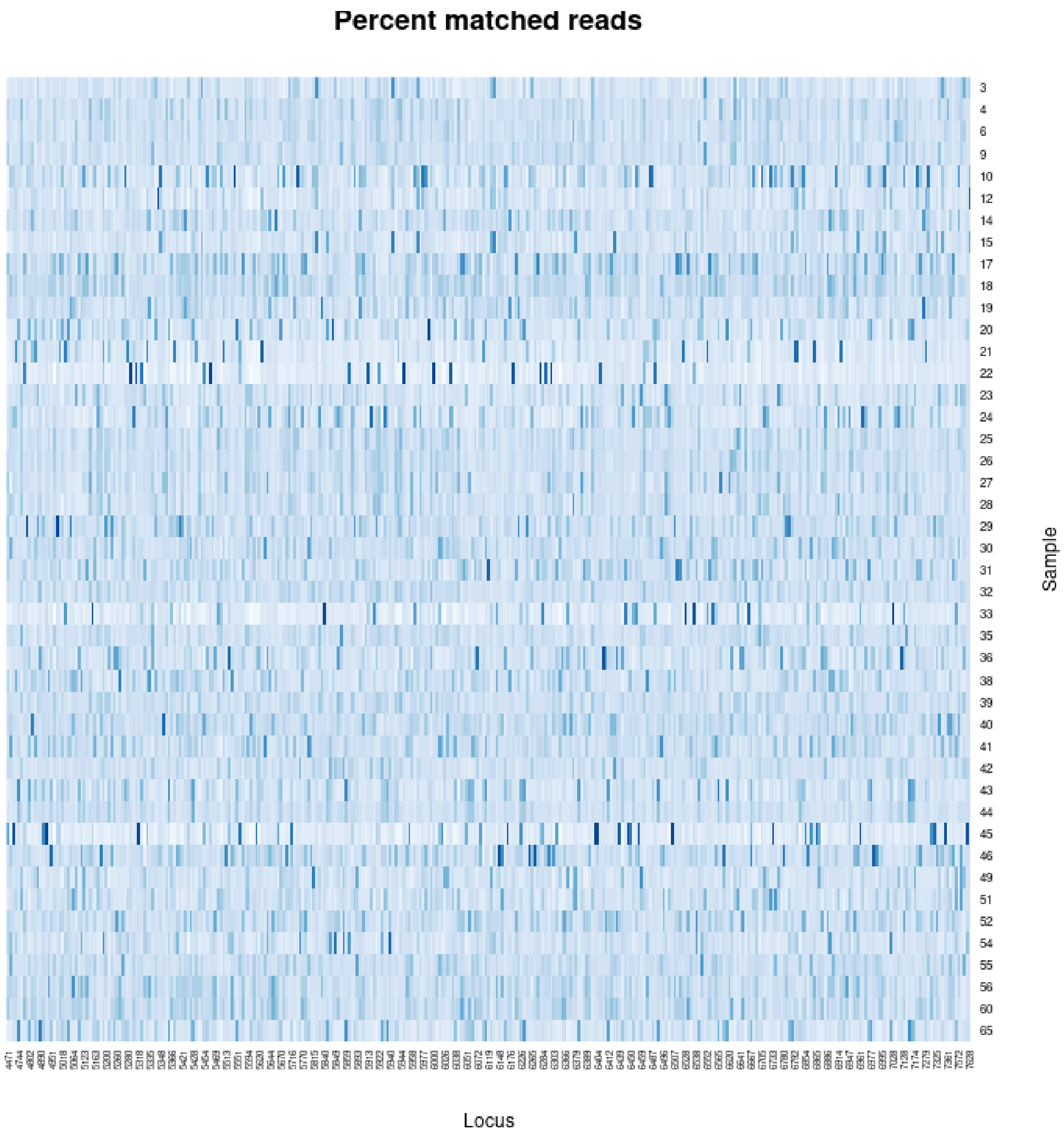


Figure 5 - Comparison of Kraken2, Bracken, and BLAST

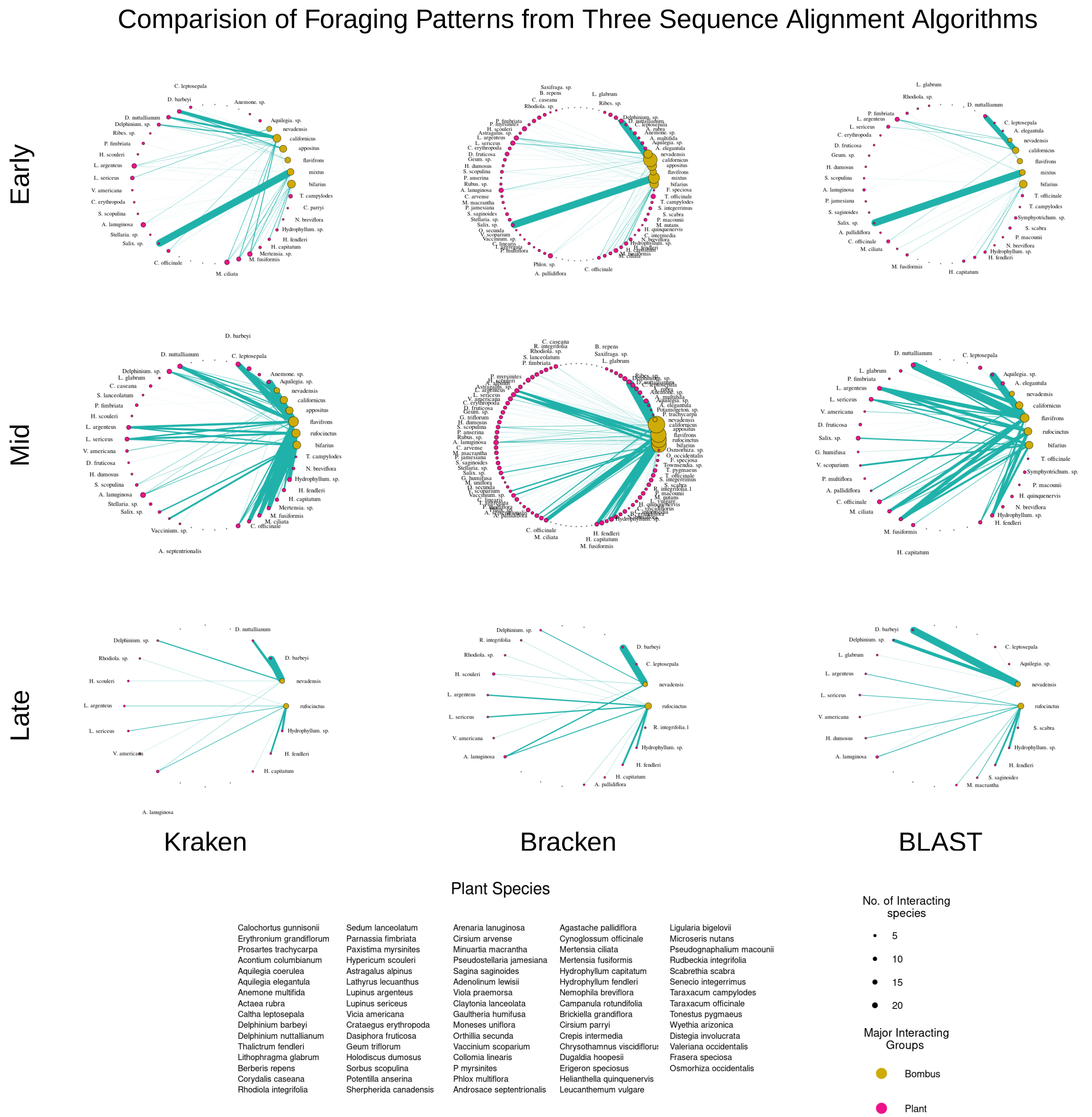


Figure 6 - Microscopy Rarefaction, Abundance

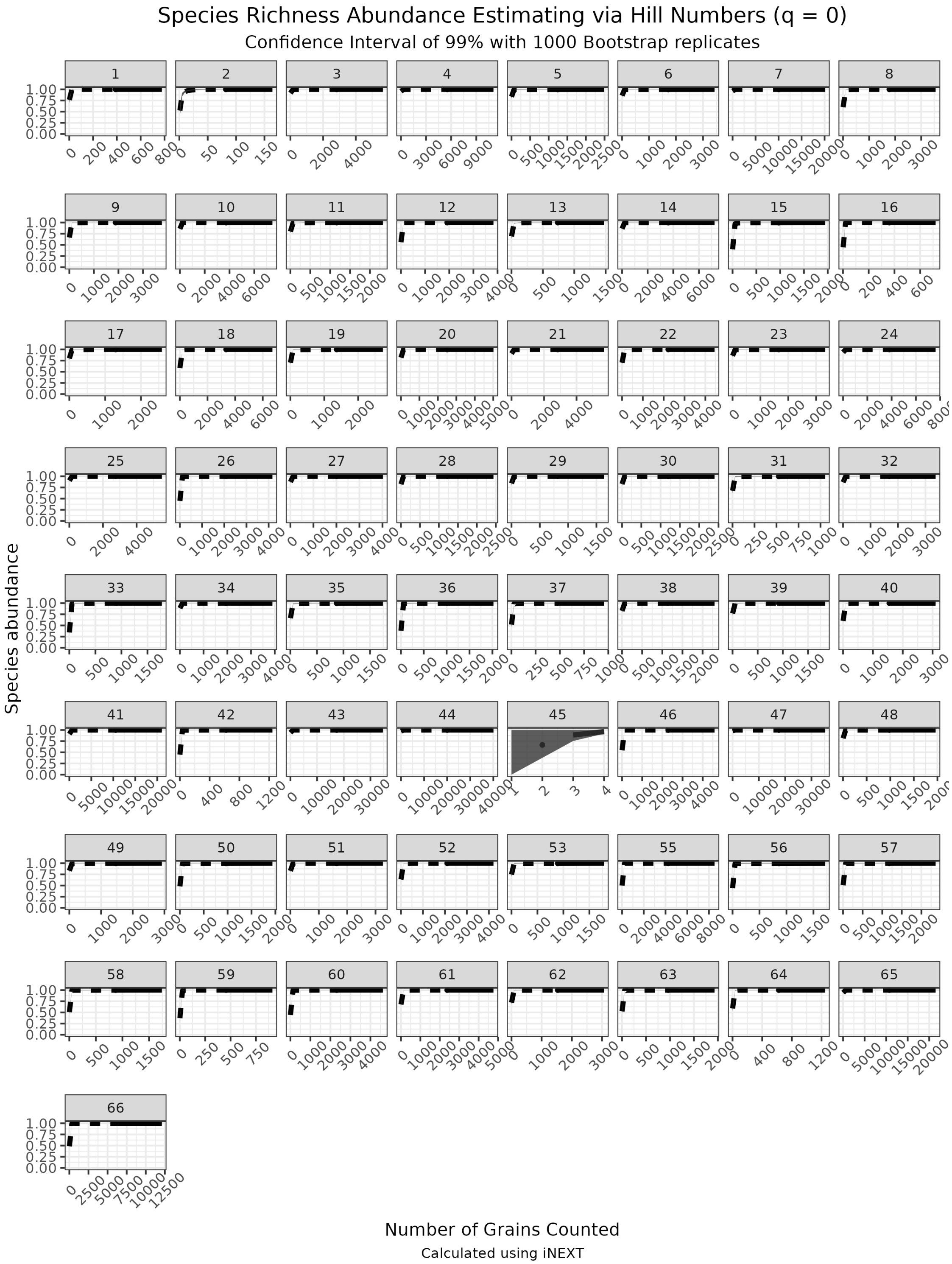
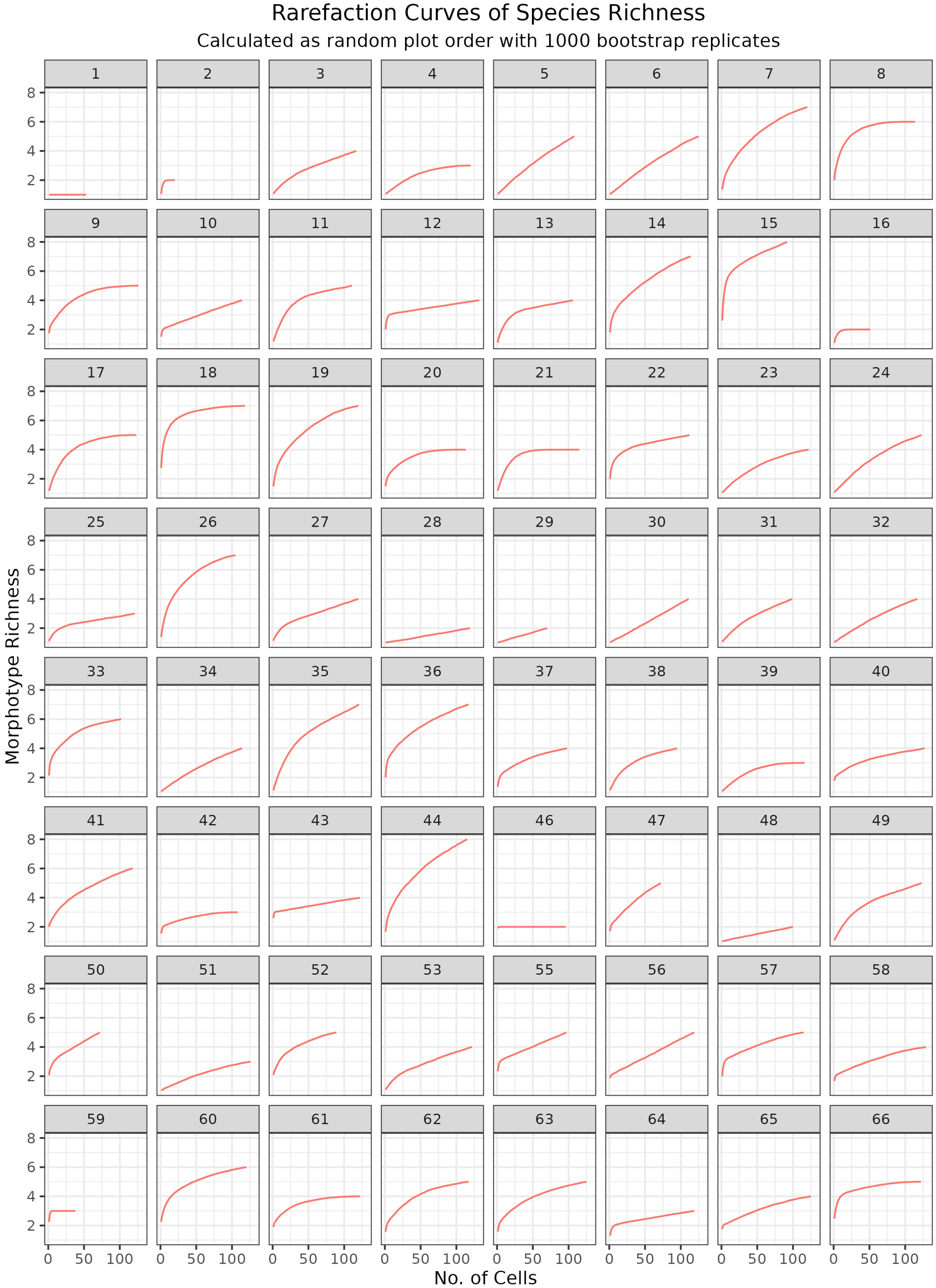


Figure 7 - Microscopy Rarefaction, Richness



Used to assess completeness of subsampling. VEGAN package 'specaccum' function used

Table 6 - Binary reclassification process

Table 1: Subset of Possible Combinations for re-classifying Sequences by Incorporating Ecological Factors

Spatial	Temporal	Congener	Confamilial	Congeners	Confamilials	Condition	Return	Rank
1	1	1	1	0	0	A.1	Input	Species
1	1	1	1	1	0	A.2	Input	Species
1	1	1	1	0	1	A.3	Input	Species
1	1	1	1	1	1	A.4	Input	Species
1	1	1	0	0	0	A.5	Input	Species
1	1	1	0	1	0	A.6	Input	Species
1	1	0	1	0	0	A.7	Input	Species
1	1	0	1	0	1	A.8	Input	Species
1	1	0	0	0	0	A.9	Input	Species
1	0	1	1	0	0	B.1	Congener	Species
1	0	1	1	0	1	B.2	Congener	Species
1	0	1	0	0	0	B.3	Congener	Species
1	0	1	1	1	0	C.1	Congener	Genus
1	0	1	1	1	1	C.2	Congener	Genus
1	0	1	0	1	0	C.3	Congener	Genus
1	0	0	1	0	0	D.1	Confamilial	Species
1	0	0	1	0	1	E.1	Confamilial	Family
1	0	0	0	0	0	F.1	Input	Species
0	0	1	1	0	0	G.1	Congener	Species
0	0	1	1	0	1	G.2	Congener	Species
0	0	1	0	0	0	G.3	Congener	Species
0	0	1	1	1	0	H.1	Congener	Genus
0	0	1	1	1	1	H.2	Congener	Genus
0	0	1	0	1	0	H.3	Congener	Genus
0	0	0	1	0	0	I.1	Confamilial	Species
0	0	0	1	0	1	J.1	Confamilial	Family

Note, for both 'Congener' and 'Confamilial' (*in the singular*) '1' denotes that a species is present; in a sense the genus is monotypic in space and time. For both 'Congener**s**' and 'Confamilial**s**' (*in the plural*), '1' denotes that two or more species are present; 'Confamilial' again representing a monotypic entity in space and time.

Spatial == 1 & Temporal == 1 ~ ***A***
Spatial == 1 & Temporal == 0 & Congener = 1 ~ ***B***

*The temporal dimension is now buffered and a form of **A** is employed*
Spatial == 1 & Temporal +/- Buffer == 1 ~ ***X***

Spatial == 1 & Temporal == 0 & Congener**s** >= 2 ~ ***C***
Spatial == 1 & Temporal == 0 & Congener**s** == 0 & Confamilial == 1 ~ ***D***
Spatial == 1 & Temporal == 0 & Congener**s** == 0 & Confamilial >= 2 ~ ***E***
Spatial == 1 & Temporal == 0 & Congener|**s** == 0 & Confamilial|**s** == 0 ~ ***F***

Spatial == 0 & Temporal == 0 & Congener == 1 ~ ***G***
Spatial == 0 & Temporal == 0 & Congener**s** == 1 ~ ***H***
Spatial == 0 & Temporal == 0 & Confamilial == 1 ~ ***I***
Spatial == 0 & Temporal == 0 & Confamilial**s** == 1 ~ ***J***

While the overall order matters, ***X*** in particular may significantly alter conclusions.