Main Points

1) Introduction to estimating species richness
-- estimating species richness with the Shannon diversity index
-- the influence of abundance (sampling effort) on species richness

2) Species accumulation and species rarefaction
-- Example: estimating wind-turbine strikes of birds
-- sample- and individual-based assessment

Tuesday 10 October = presentations on single-species conservation and conservation above the level of single species. For presenters, it is optional to send me a ppt presentation >48hrs in advance for comments. For non-presenters, remember to print out and bring 2 copies of "different group evaluation" handouts from website.

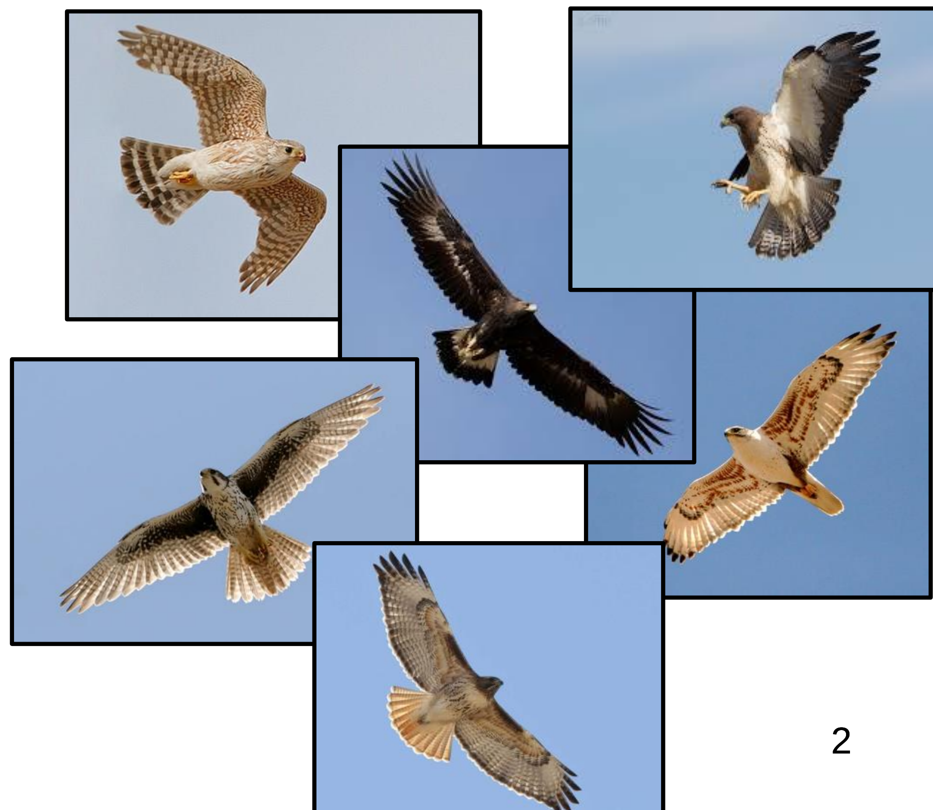
Pre-reading: Tuesday 10 October = NA
Thursday 12 October = Stoner et al.

Terms: species richness, species evenness, Shannon diversity index, accumulation curve, rarefaction curve, fixed mindset, growth mindset

Estimating Properties of Communities

- **<u>species richness</u> = the number of species in a region, site, or sample.**

shortgrass prairie (richness = 6)

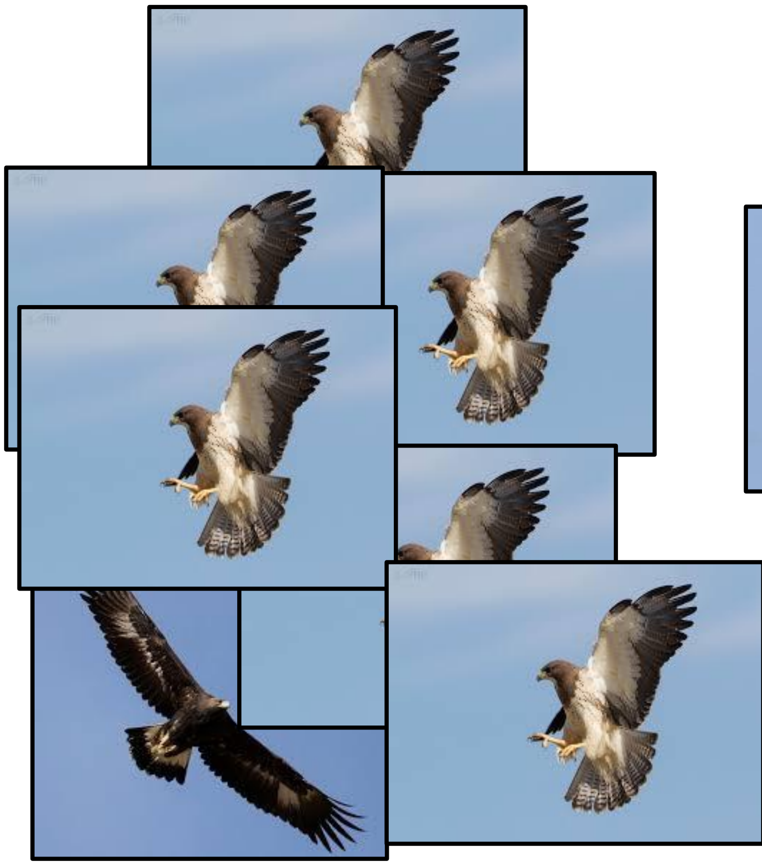


sagebrush-steppe (richness = 2)

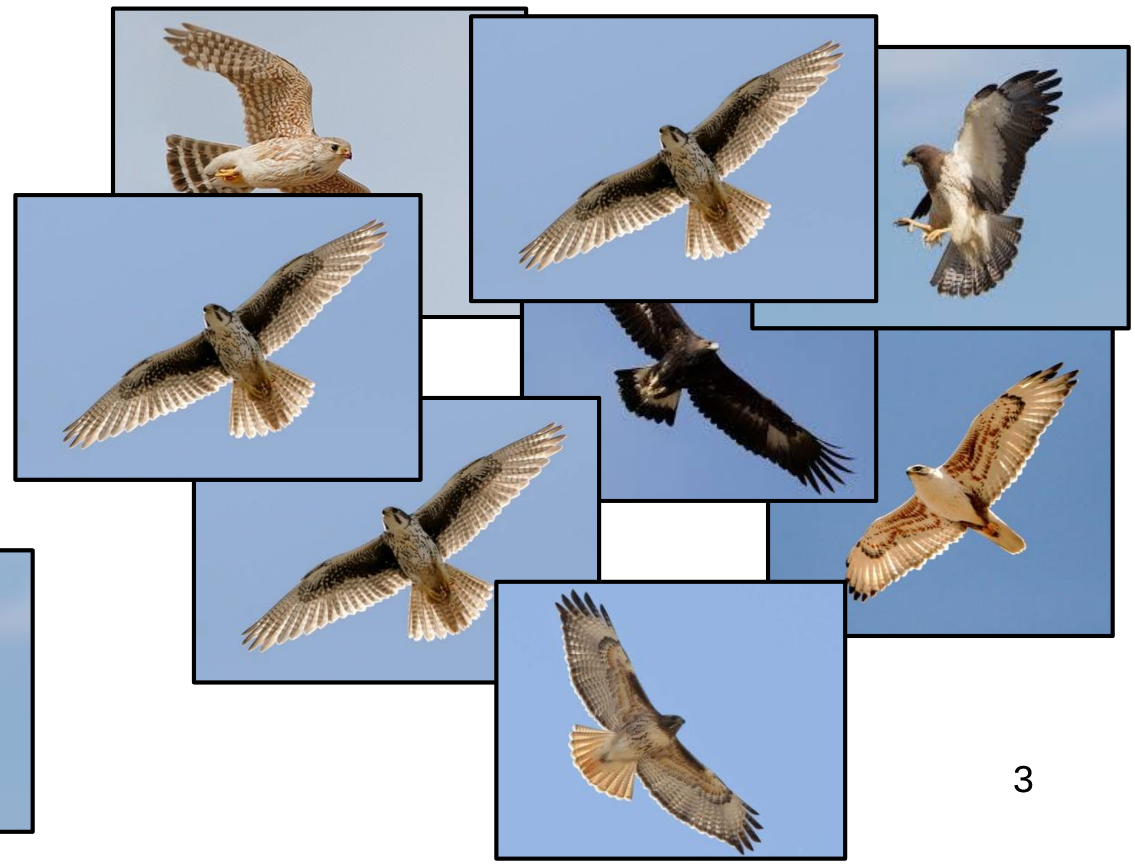
Estimating Properties of Communities

- **<u>species evenness</u> = the degree to which individuals are divided equally among species.**

sagebrush-steppe



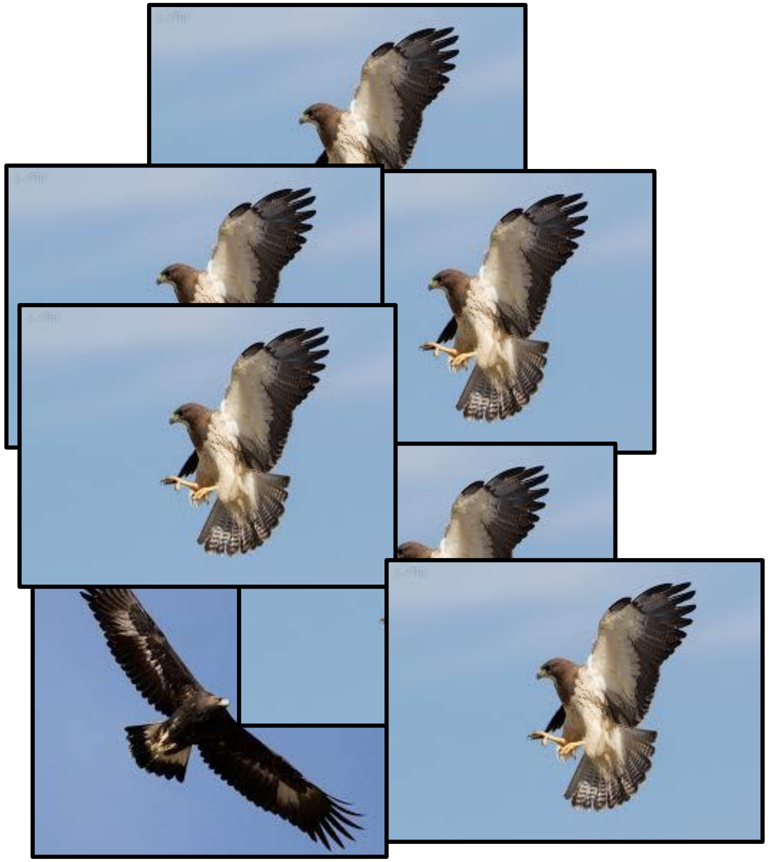
shortgrass prairie



Estimating Properties of Communities

- **species diversity (Shannon) = an index combining species richness and species evenness.**

sagebrush-steppe



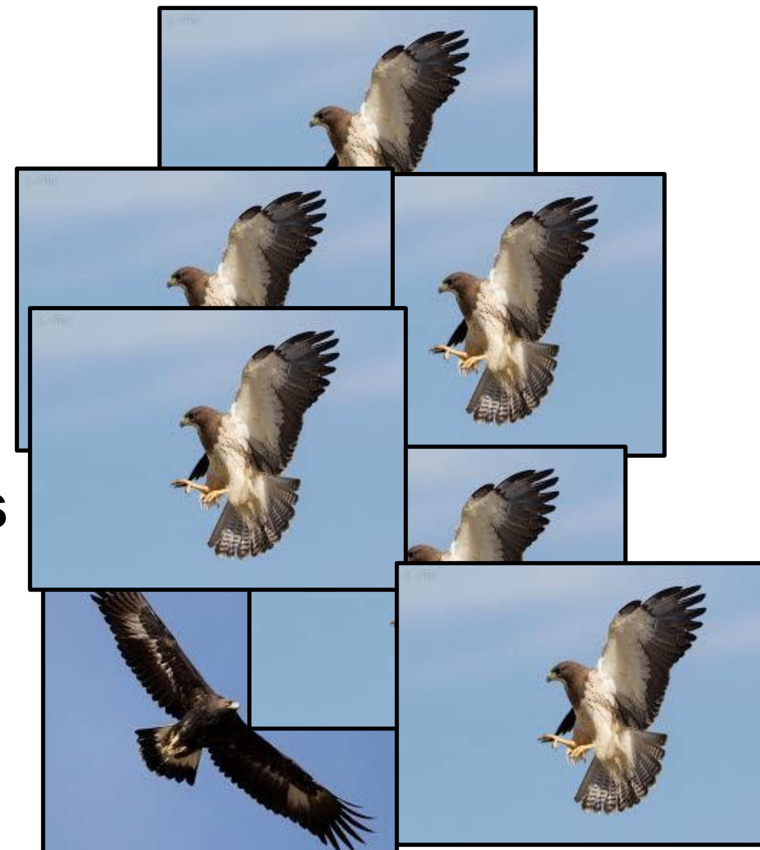
Estimating Properties of Communities

- **<u>species diversity (Shannon)</u> = an index combining species richness and species evenness.**

$$H = -\sum_{i=1}^{S} (p_i * \ln (p_i))$$

$$H_{max} = \ln (S)$$

sagebrush-steppe



S = total number of species sampled

p_i = relative abundance of species i

Estimating Properties of Communities

- **<u>species diversity (Shannon)</u> = an index combining species richness and species evenness.**

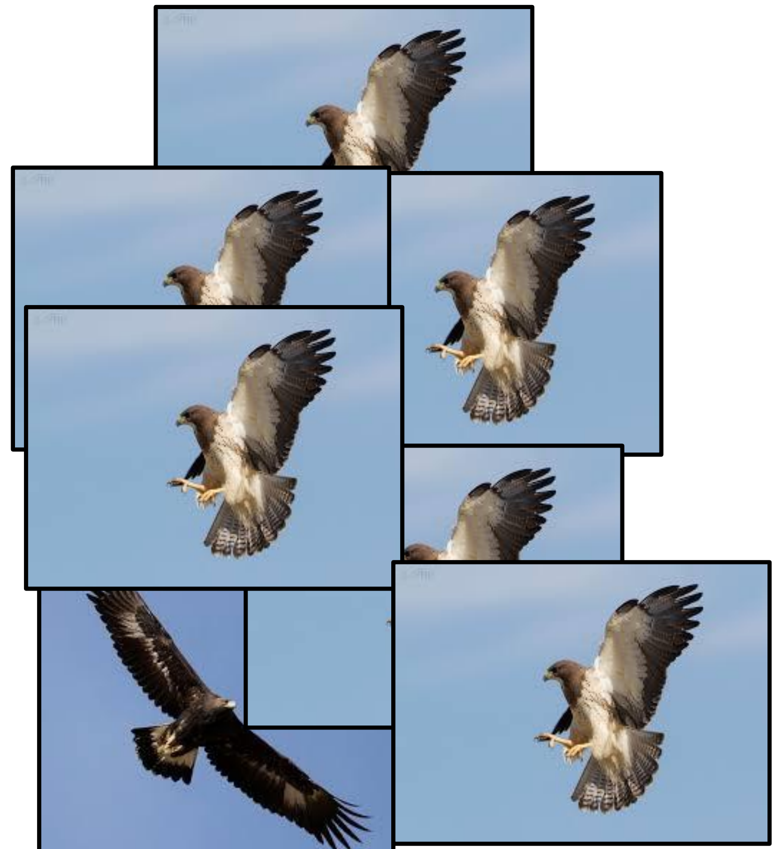
$$H = -\sum_{i=1}^{S} (p_i * \ln(p_i))$$

$$H_{max} = \ln(S)$$

$$H = -\Sigma\,(0.86 * -0.15) + (0.14 * -1.95)$$

$$= 0.41$$

sagebrush-steppe



Estimating Properties of Communities

- <u>species diversity (Shannon)</u> = an index combining species richness and species evenness.

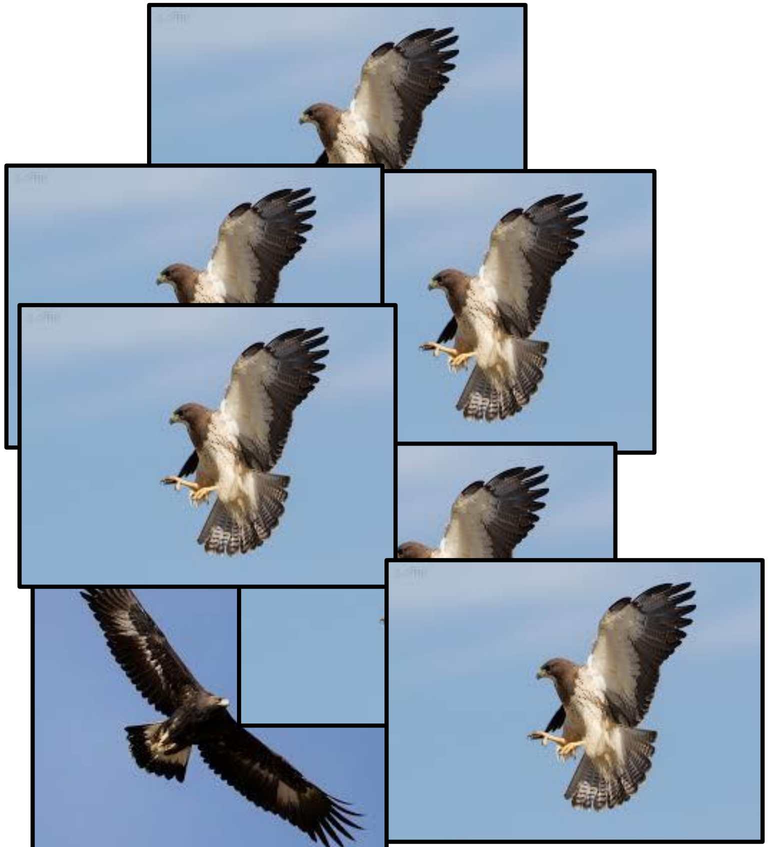
$$H = -\sum_{i=1}^{S} (p_i * \ln(p_i))$$

$$H_{max} = \ln(S)$$

$$H = -\sum (0.86 * -0.15) + (0.14 * -1.95) = 0.41$$

$$J = H/H_{max} = 0.59$$

sagebrush-steppe

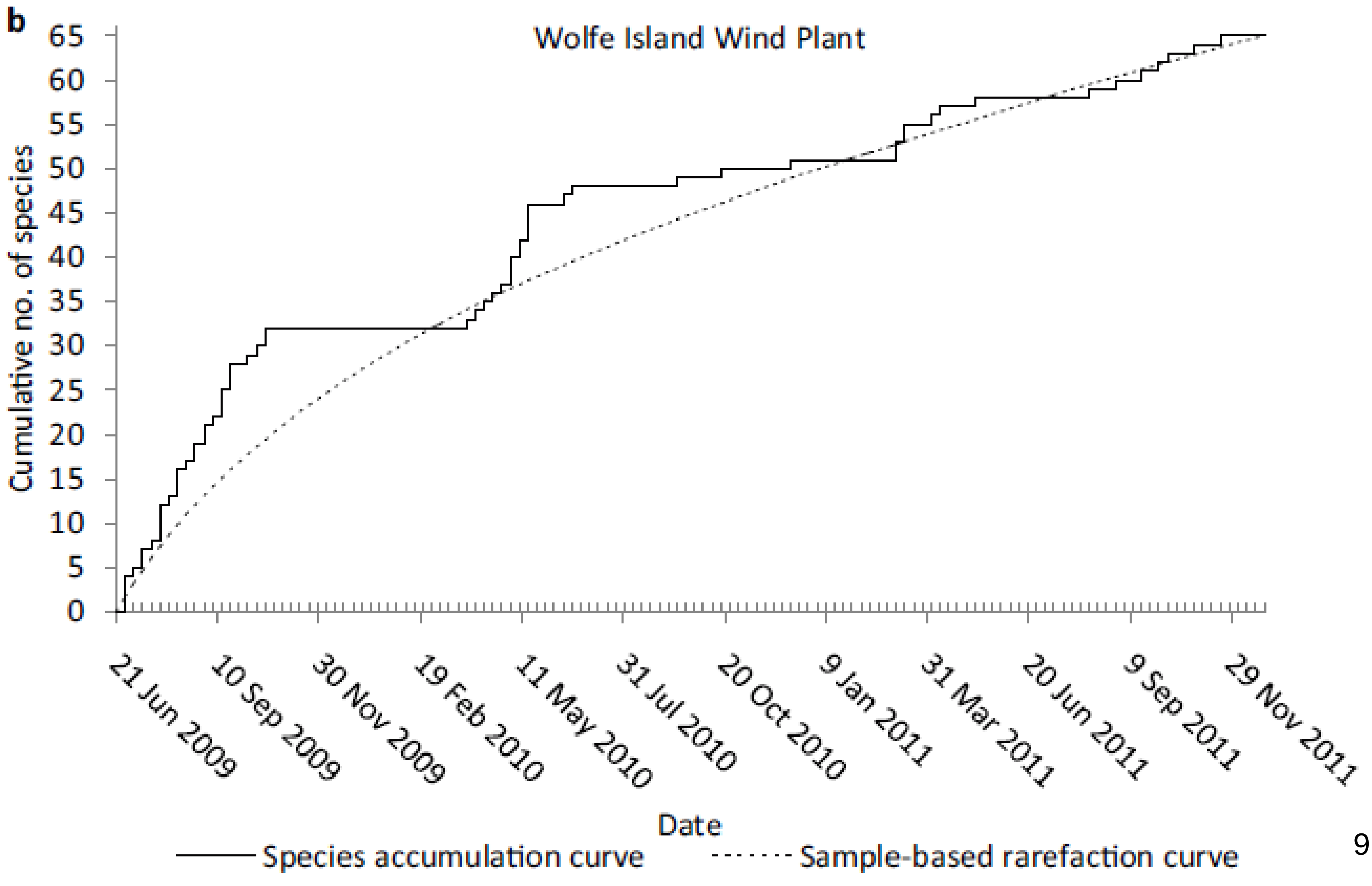


Accumulation Curves: What They Are, Why They're Used

- **species accumulation curve** = graph depicting the total number of species sampled during data collection as addition individuals/samples are added to the total of previously-sampled individuals/samples.

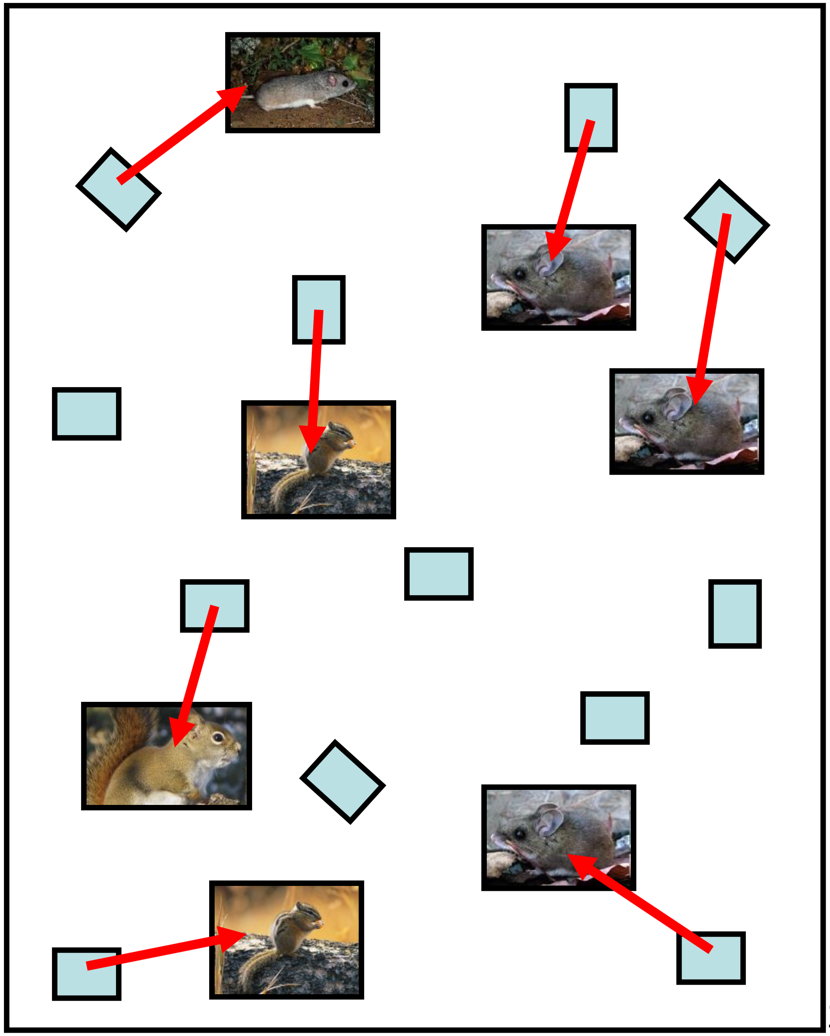
- **used primarily to visualize how species are added (or accumulated) with increasing individuals/samples.**

Accumulation Curves: What They Are, Why They're Used



Sample- vs Individual-Based Curves

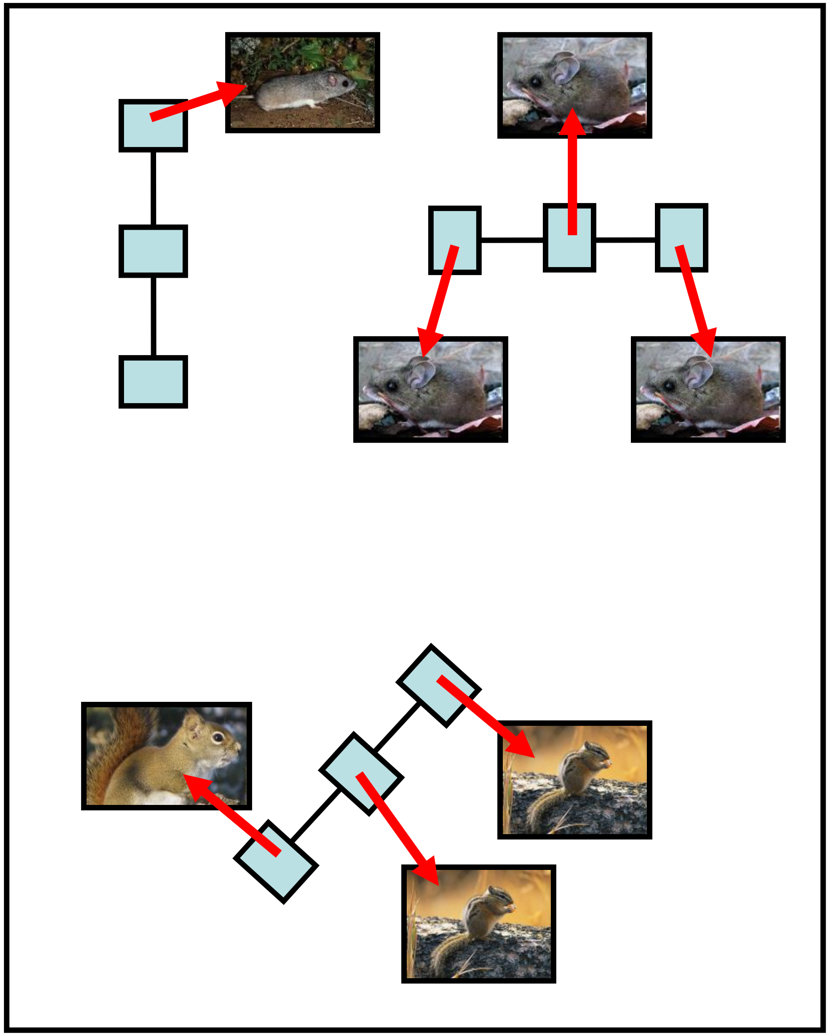
- **<u>Individual-based assessment</u> examines a predetermined number of individuals (e.g., n = 7 small mammals) to assess richness**



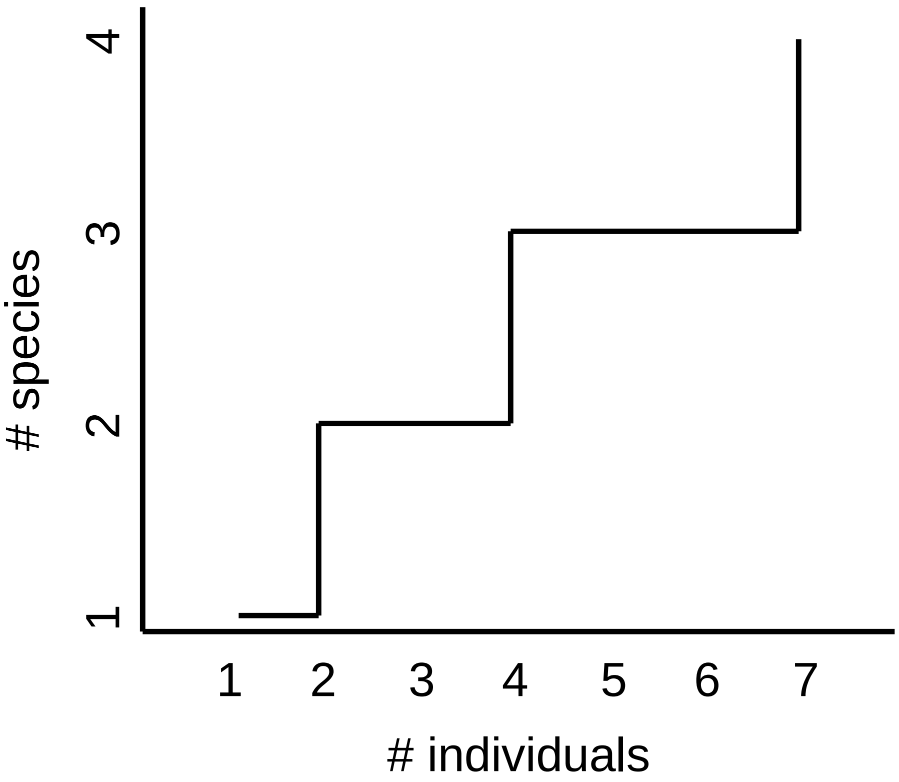
Sample- vs Individual-Based Curves

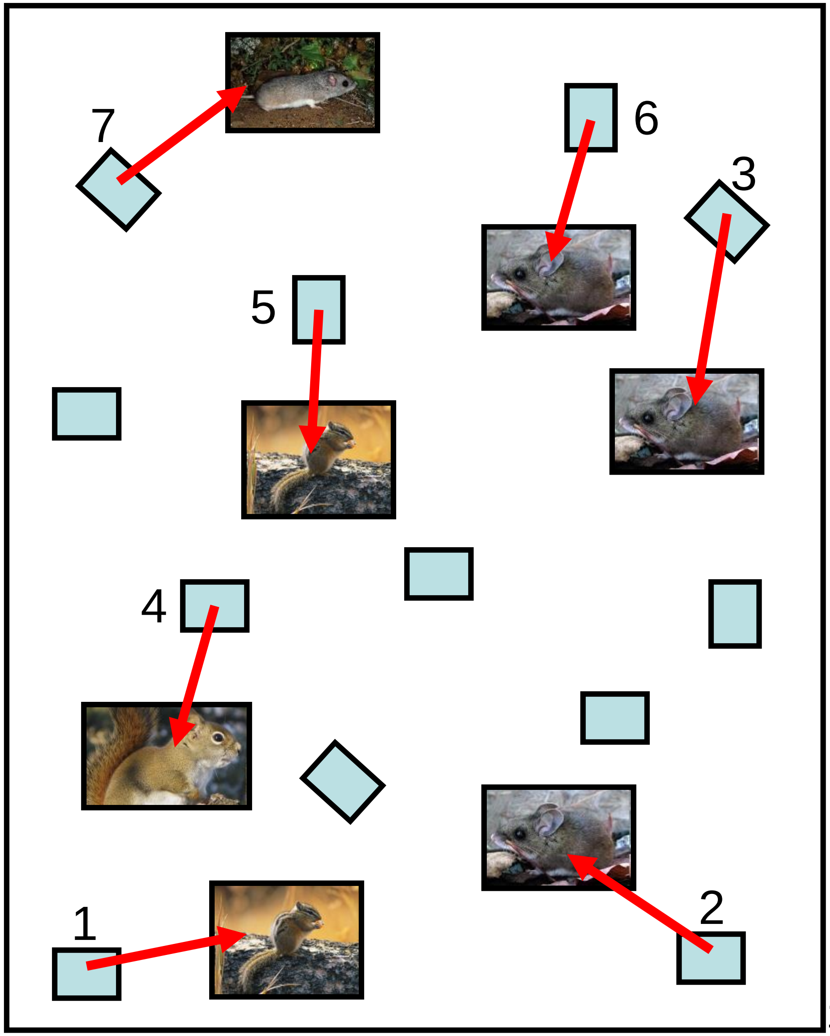
- **<u>Individual-based assessment</u> examines a predetermined number of individuals (e.g., n = 7 small mammals) to assess richness**

- **<u>Sample-based assessment</u> uses replicate samples (e.g., n = 3 transects) to assess richness**

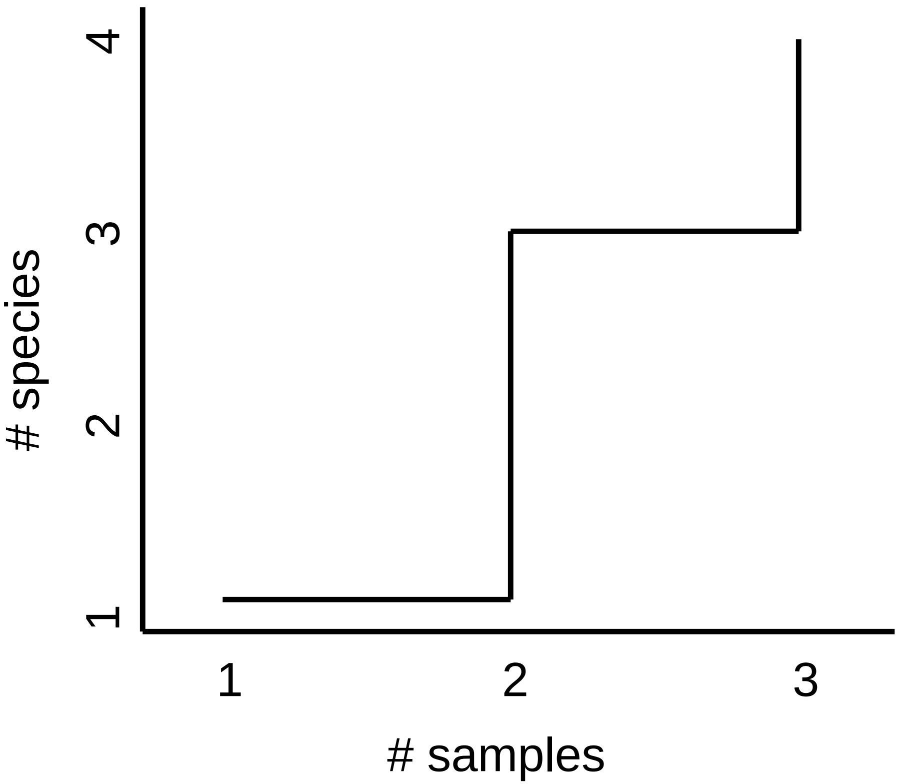


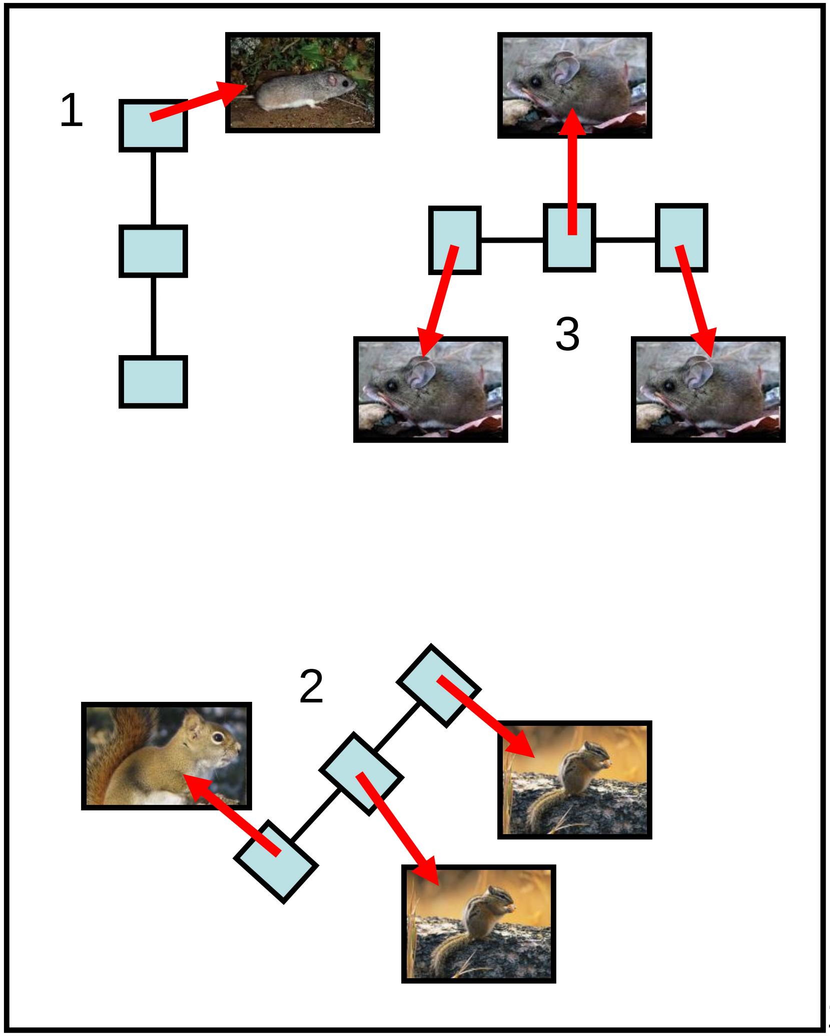
Individual-based Accumulation Curve



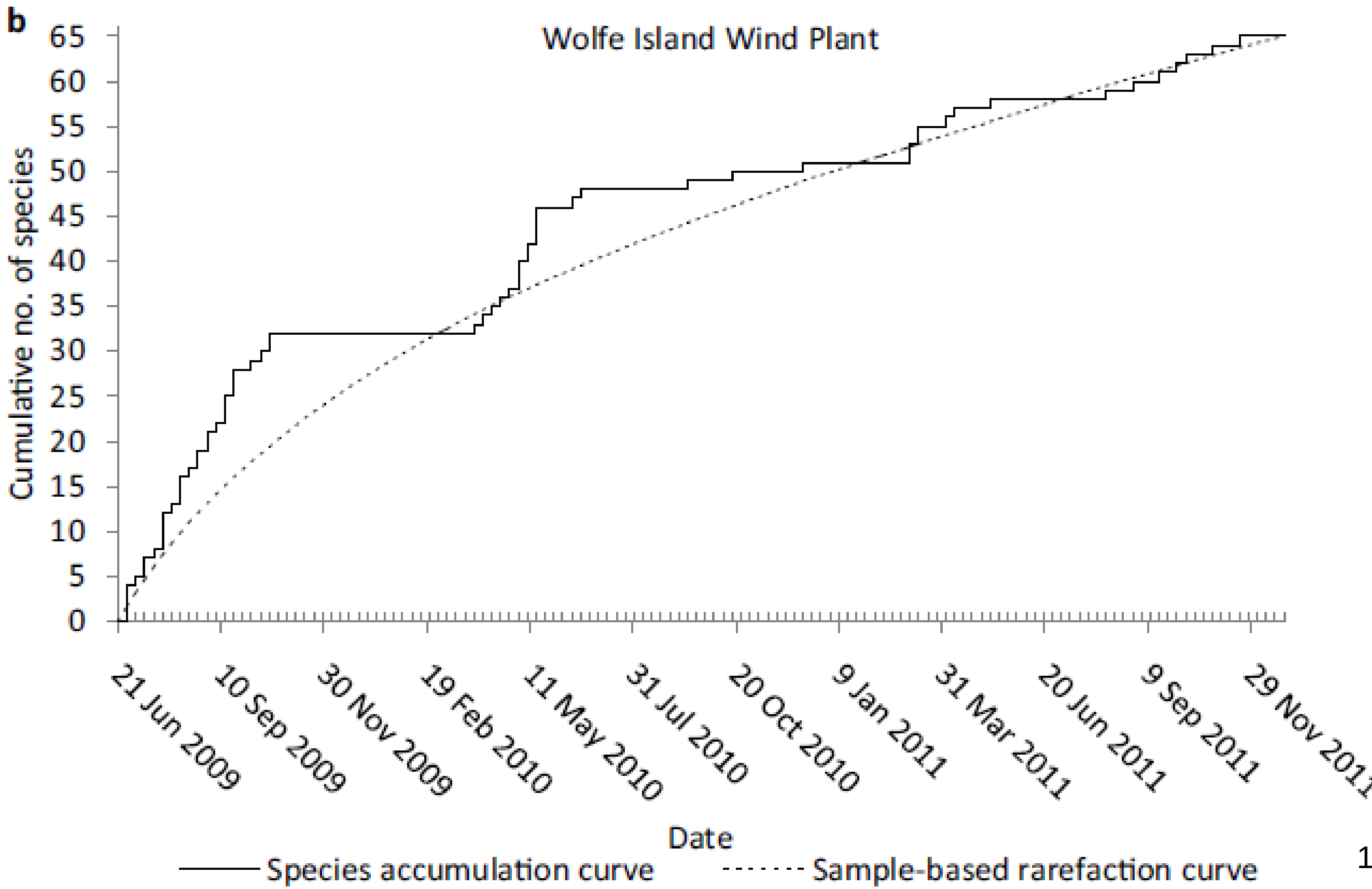


Sample-based Accumulation Curve





Discussion Q: Beston et al quantified the number of bird species killed at wind-power plants. What did they conclude about sampling effort and the number of species detected? How did they do this?



The Problem of Unequal Effort

<u>sagebrush-steppe</u>
2 transects *
10 point counts/transect *
3 days = 60 total counts

= 19 individuals of 2 species


<u>shortgrass prairie</u>
4 transects *
10 point counts/transect *
3 days = 120 total counts

= 36 individuals of 6 species






The Problem of Unequal Effort

- **generally, the number of individuals sampled (or samples taken) at a site is correlated positively with the number of species.**

<u>sagebrush-steppe</u>
2 transects *
10 point counts/transect *
3 days = 60 total counts

= 19 individuals of 2 species

<u>shortgrass prairie</u>
4 transects *
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3 days = 120 total counts

= 36 individuals of 6 species

The Problem of Unequal Effort

- **generally, the number of individuals sampled (or samples taken) at a site is correlated positively with the number of species.**

- **generally, the number of individuals sampled at a site also is correlated positively with sampling effort.**

<u>sagebrush-steppe</u>
2 transects *
10 traps/transect *
3 nights = 60 trap-nights

= 19 individuals of 2 species

<u>forest/woodland</u>
4 transects *
10 traps/transect *
3 nights = 120 trap-nights

= 36 individuals of 6 species

The Problem of Unequal Effort

- **so, the number of species we sample at a site should be partly determined by our sampling effort.**

The Problem of Unequal Effort

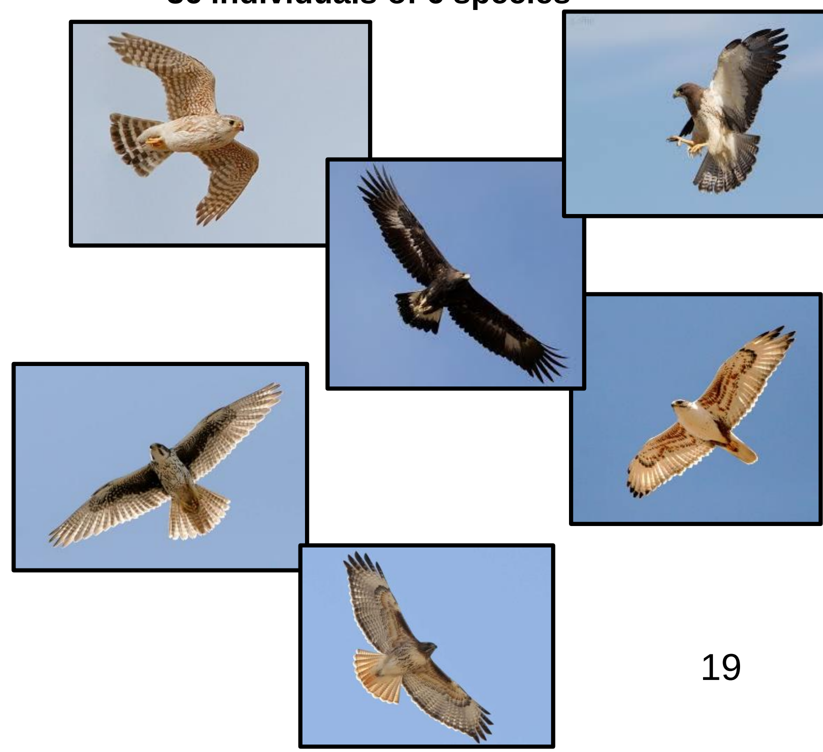
- we can account for the influence of unequal effort on the number of species through <u>rarefaction</u>.

<u>sagebrush-steppe</u>
2 transects *
10 point counts/transect *
3 days = 60 total counts

= 19 individuals of 2 species

<u>shortgrass prairie</u>
4 transects *
10 point counts/transect *
3 days = 120 total counts

= 36 individuals of 6 species



Rarefaction Curves: What They Are, Why They're Used

- **<u>species rarefaction curve</u> = graph produced by repeatedly resampling the total number of individuals/samples, and plotting the average number of species represented by 1, 2, … N individuals/samples.**

Rarefaction Curves:
What They Are, Why They're Used

- **<u>species rarefaction curve</u> = graph produced by repeatedly resampling the total number of individuals/samples, and plotting the average number of species represented by 1, 2, … N individuals/samples.**

- **this generates the expected number of species in a subset of n individuals/samples drawn at random from a larger total of N individuals/samples.**

Rarefaction Curves: What They Are, Why They're Used

- **species rarefaction curve = graph produced by repeatedly resampling the total number of individuals/sites, and plotting the average number of species represented by 1, 2, … N individuals/samples.**

- **this generates the expected number of species in a subset of n individuals/samples drawn at random from a larger total of N individuals/samples.**

- **used to compare species richness among communities where sampling effort differs, or to estimate variation within a community using bootstrapping.**

Rarefaction Curves:
What They Are, Why They're Used

<u>Community 1</u>
7 individuals
4 species

<u>Community 2</u>
3 individuals
2 species

Rarefaction Curves:
What They Are, Why They're Used

Community 1
7 individuals
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Community 2
3 individuals
2 species

Random Communities

RC1 = 

RC2 = 

RC3 = 

.

.

.

RC50 (or 100, or 1000, or whatevs)

Rarefaction Curves: What They Are, Why They're Used

Community 1
7 individuals
4 species

Community 2
3 individuals
2 species

Random Communities

RC1 =

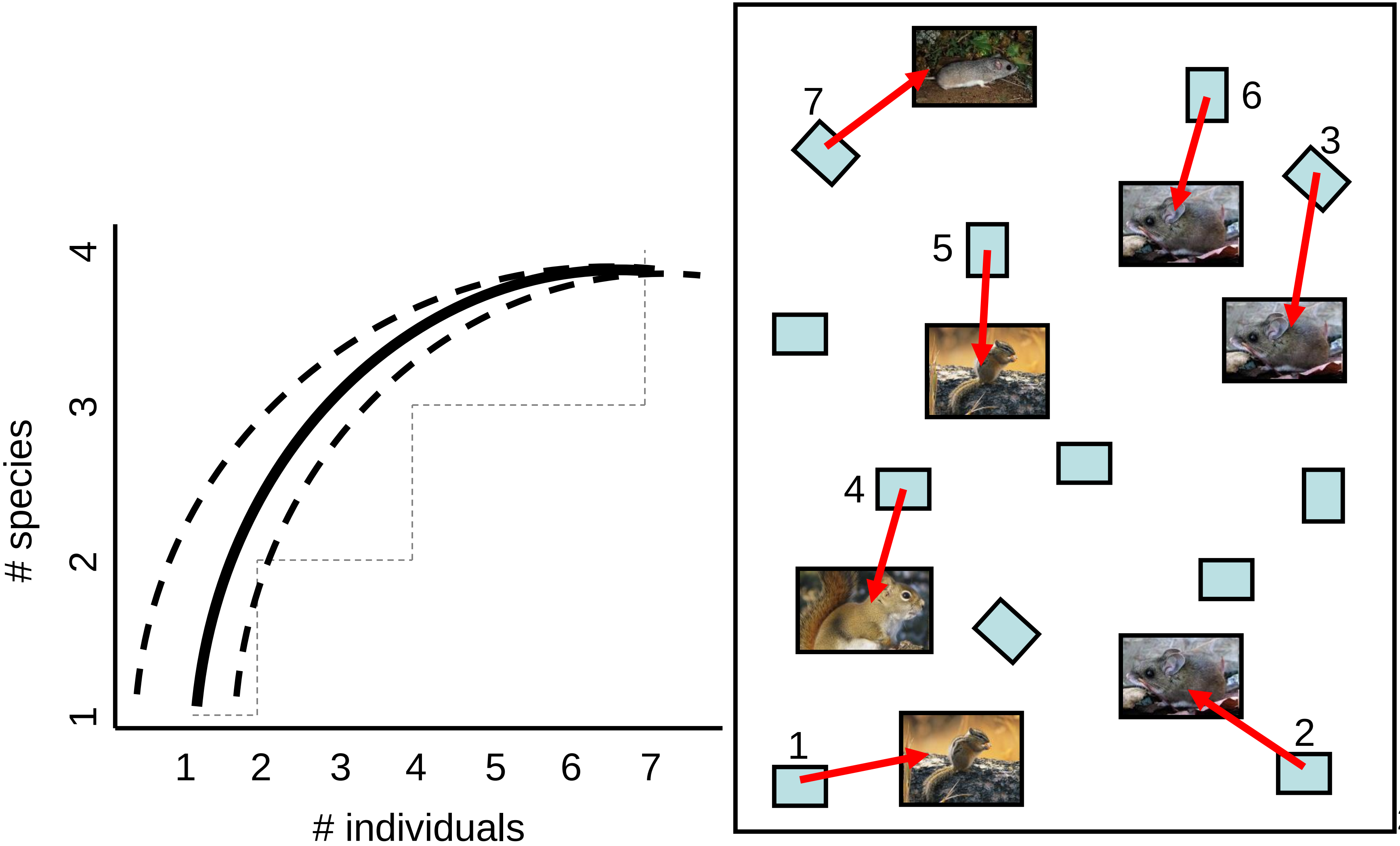
RC2 =

RC3 =

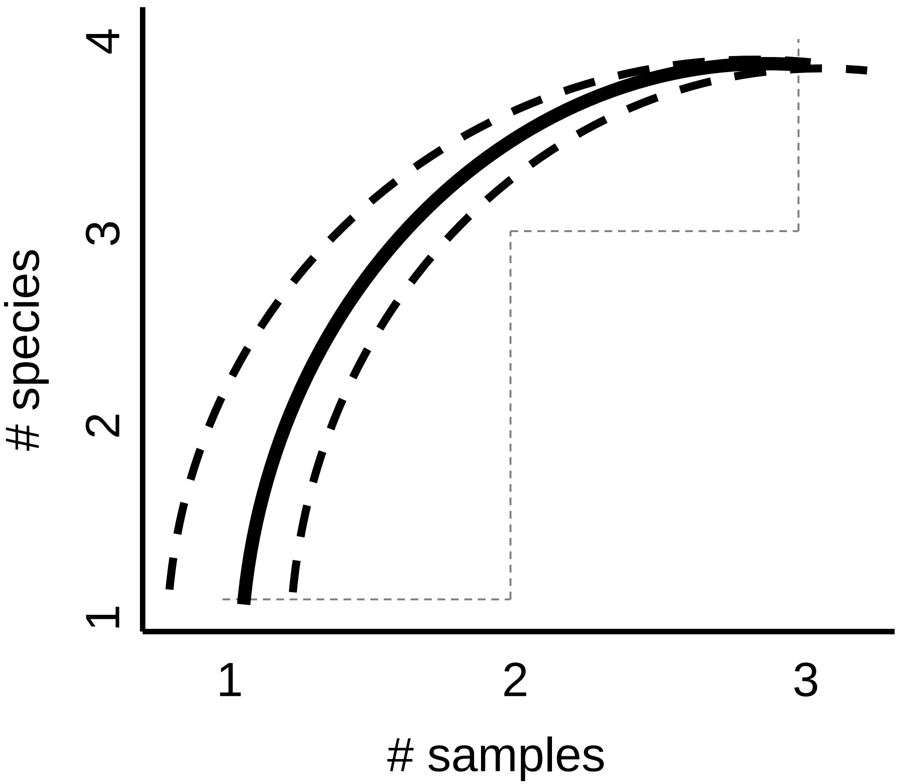
RC50 (or 100, or 1000, or whatevs)

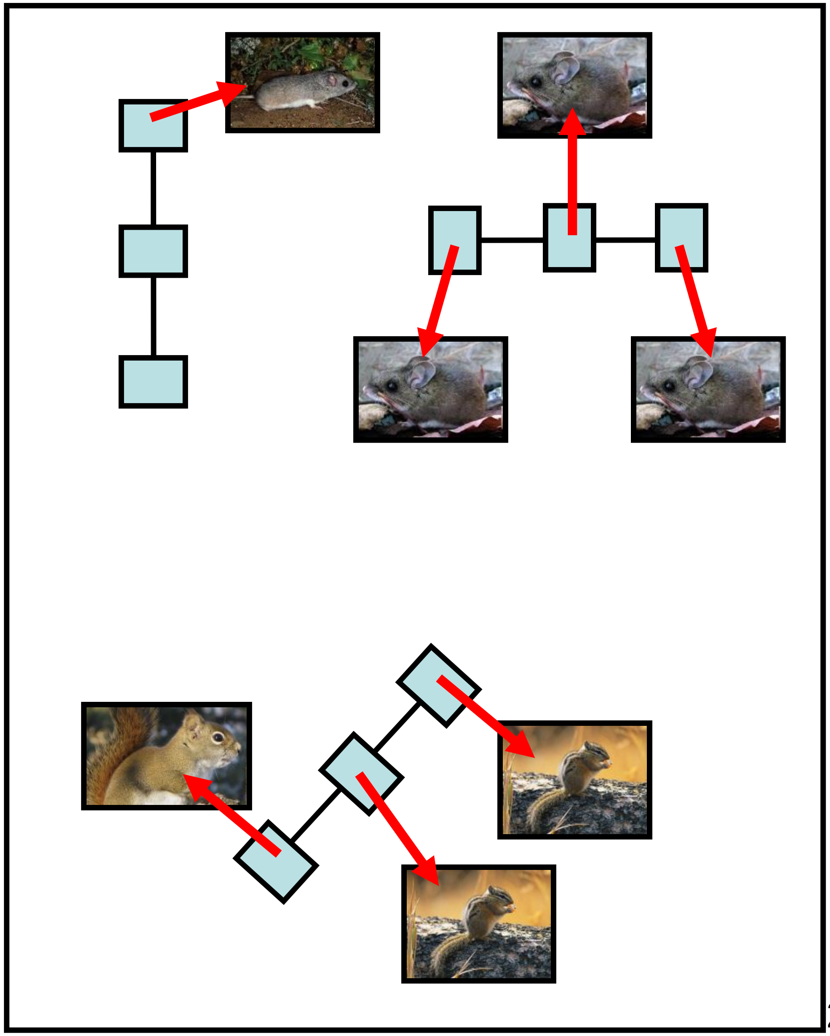
- we are randomly drawing n individuals from the total of N individuals many times, then calculate a diversity index (e.g., Shannon, Simpson).
- because the diversity index is a mean calculated from the random communities, we also have a variance

Individual-Based Rarefaction Curve



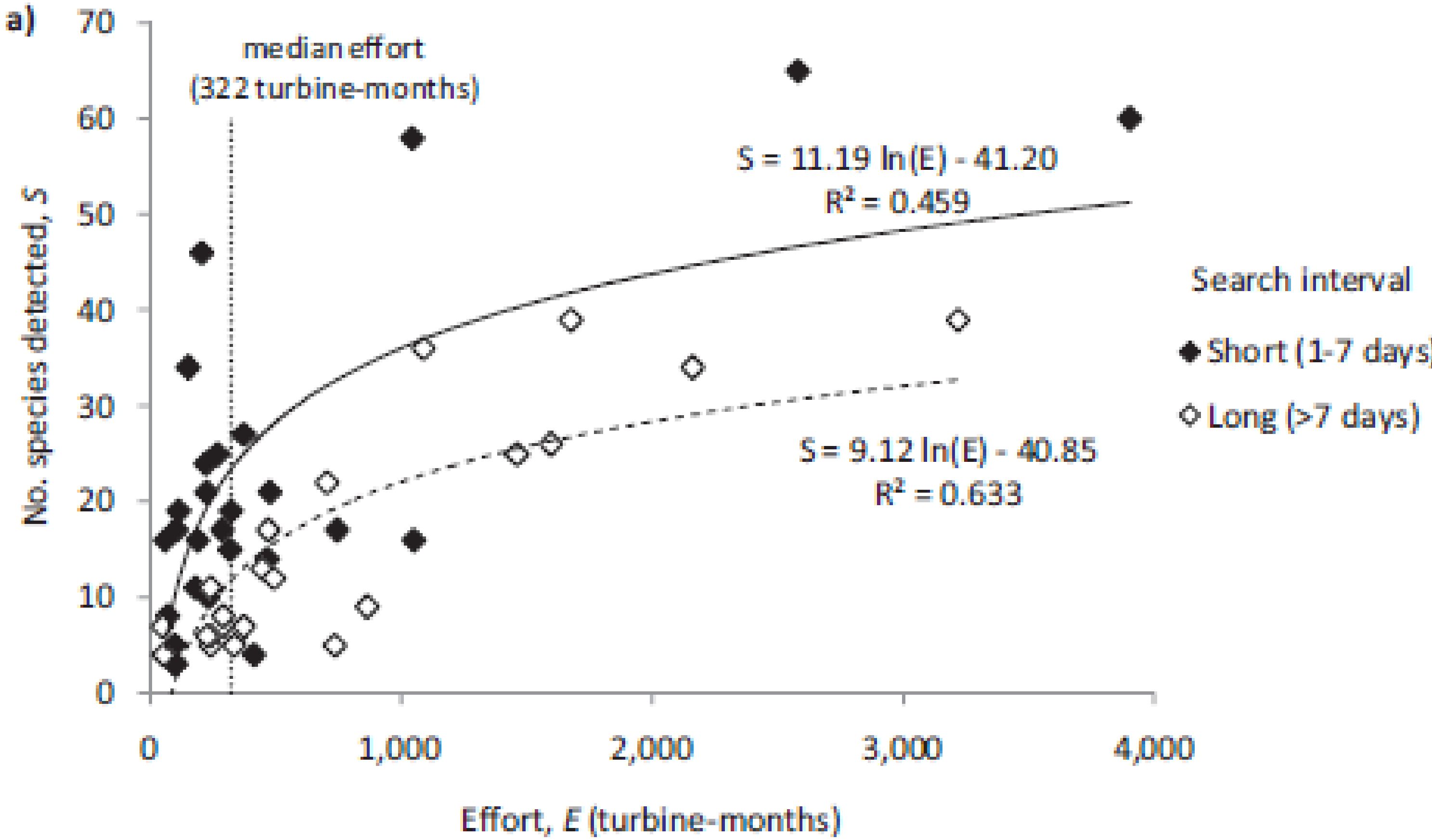
Sample-based Rarefaction Curve





Sample-Based Rarefaction Curve

-- compare between sites, treatments, methods, etc for a given sample size (or number of individuals)



Beston et al. 2007. J Wildl Manage.

Sample-Based Rarefaction Curve

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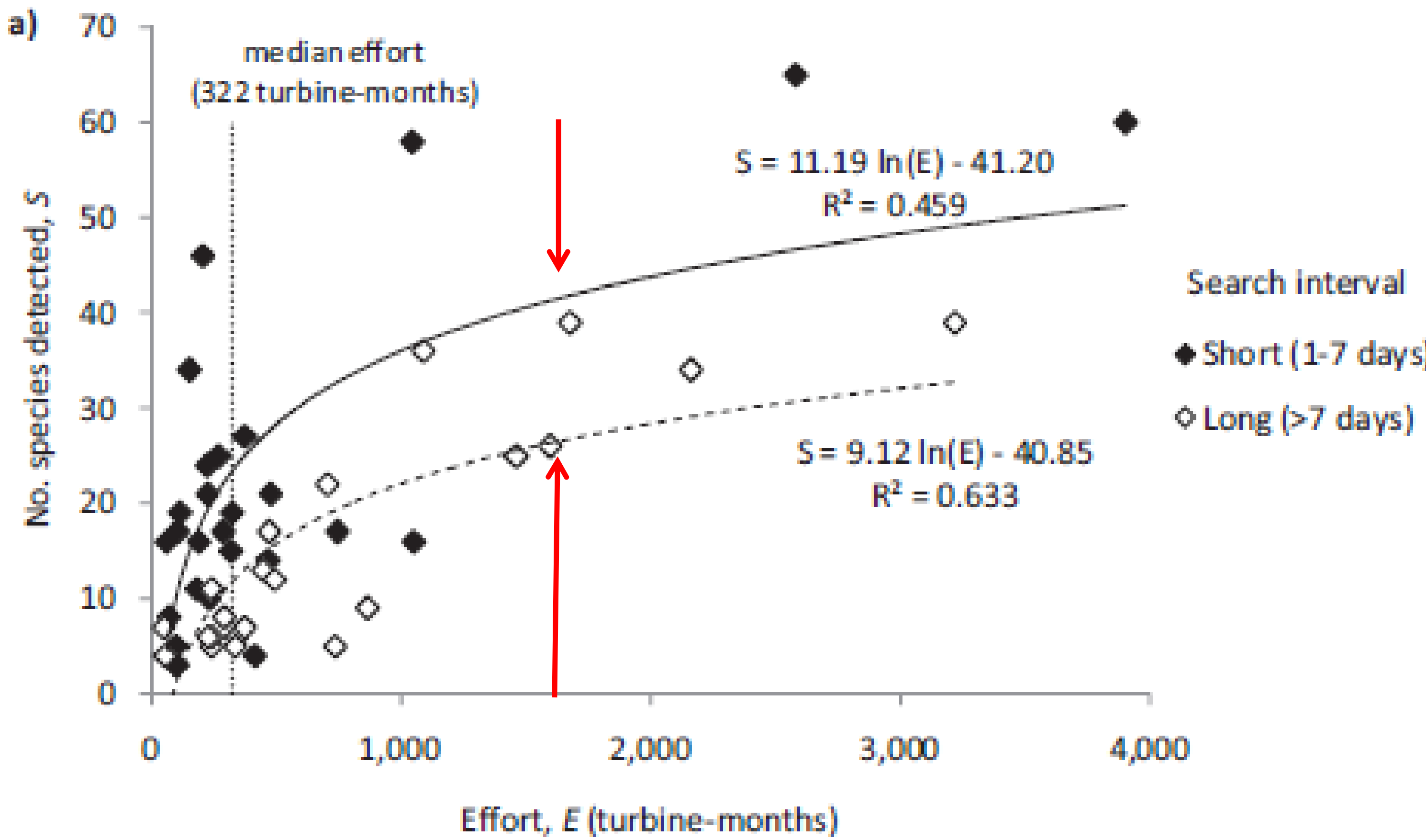

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