

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

Thursday 2 March = presentations on single-species conservation and conservation above the level of single species. For non-presenters, remember to print out and bring “different group evaluation” handouts from website.

Thursday 9 March = evaluations due by 5pm as separate .pdfs emailed to Jake. If you are not a presenter, you will have 2 .pdfs to email (one for each group). Please name these “single-species_YOURLASTNAME” and “multi-species_YOURLASTNAME”. If you are a presenter, you will have a “same group evaluation” for each group member.

Changes to syllabus: guest lecture 1 week from today; lecture on source-sink dynamics 1 week from Thursday. Help session for Tutorial #2 1 week from Thursday. Tutorial #2 due 21 March.

Pre-reading: Tuesday 7 March = NA

Thursday 9 March = Stoner et al.

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

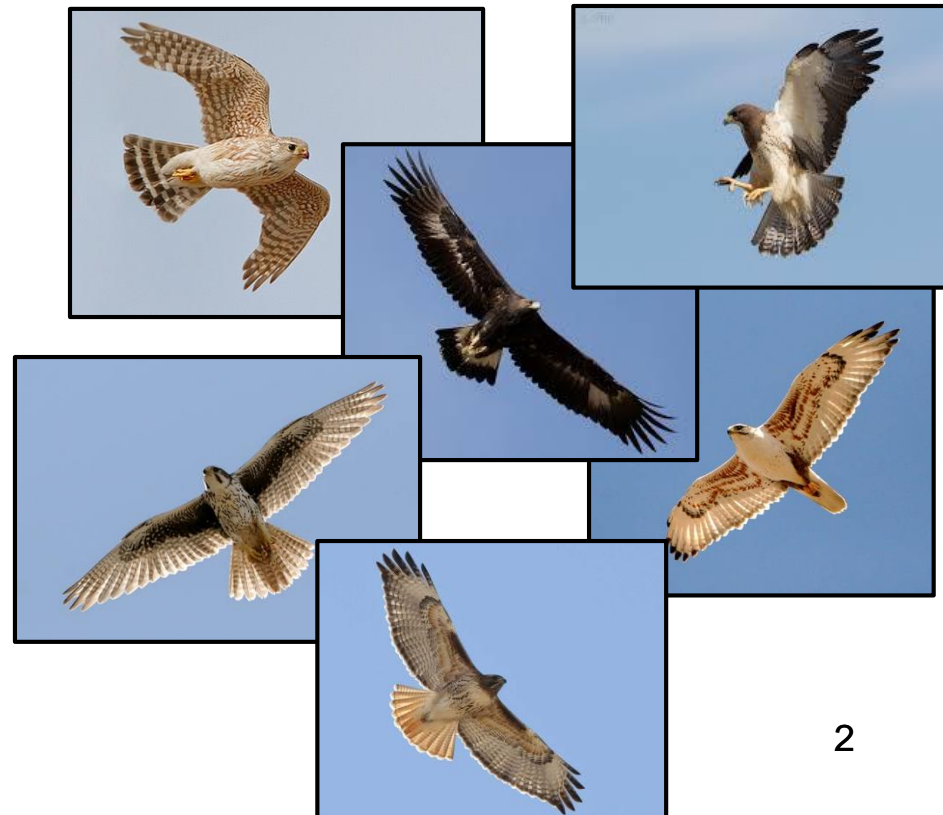
Estimating Properties of Communities

- species richness = the number of species in a region, site, or sample.

sagebrush-steppe
(richness = 2)



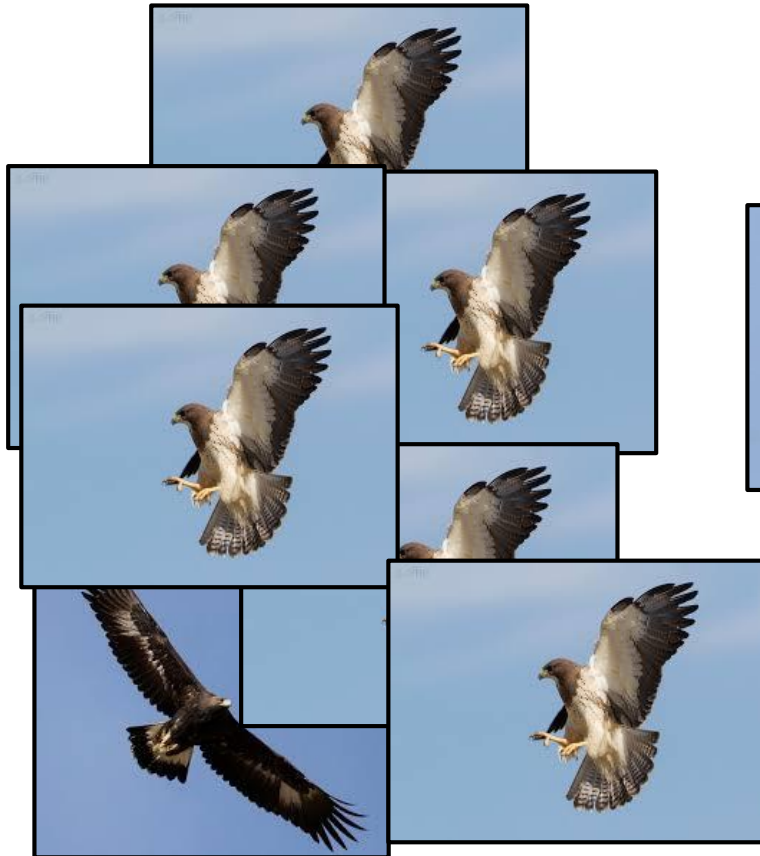
shortgrass prairie
(richness = 6)



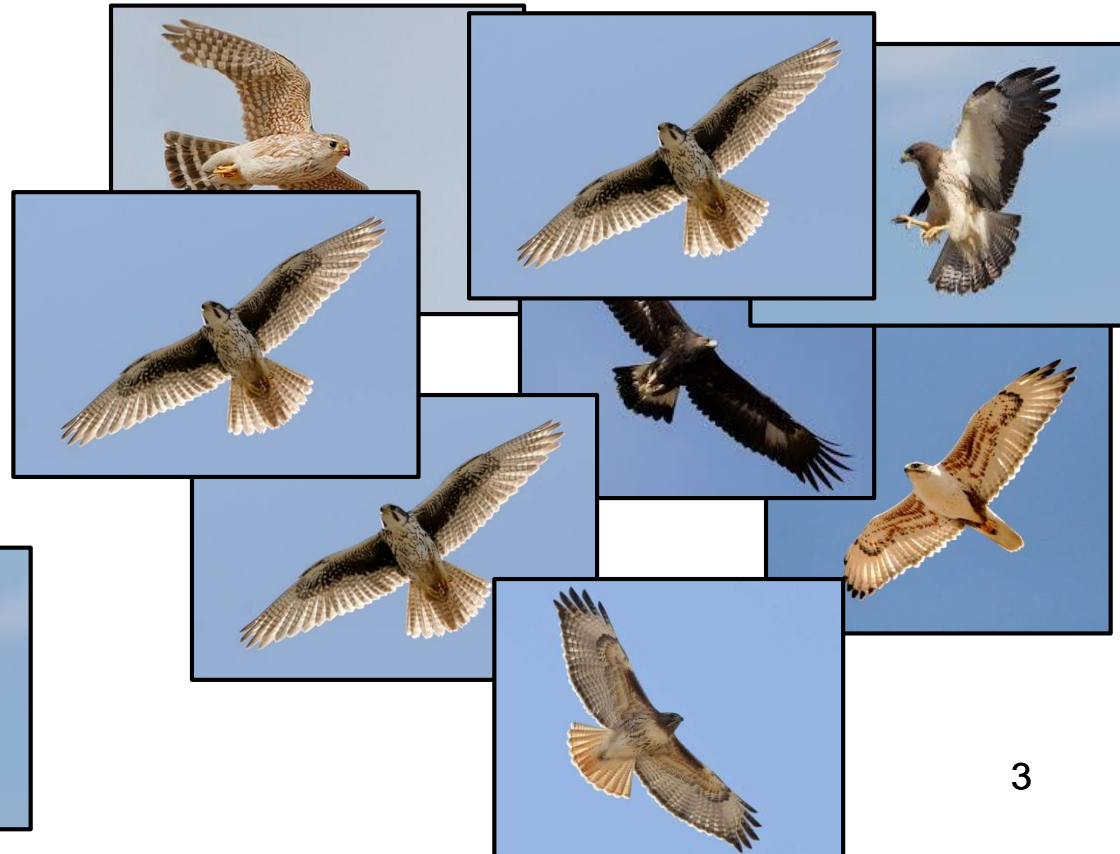
Estimating Properties of Communities

- species evenness = the degree to which individuals are divided equally among species.

sagebrush-steppe

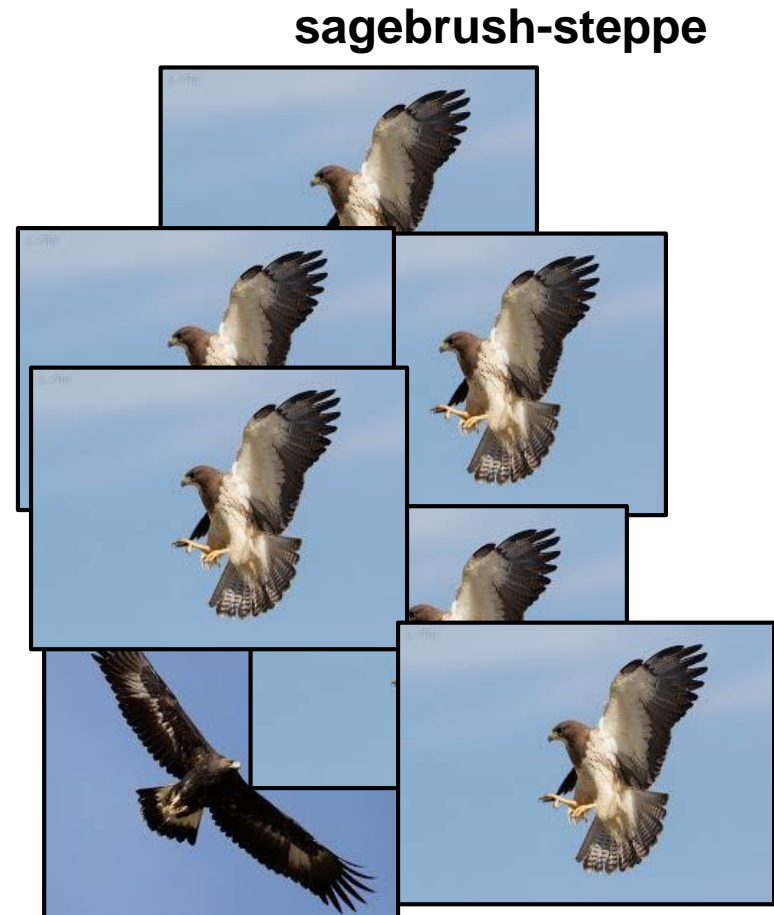


shortgrass prairie



Estimating Properties of Communities

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



Estimating Properties of Communities

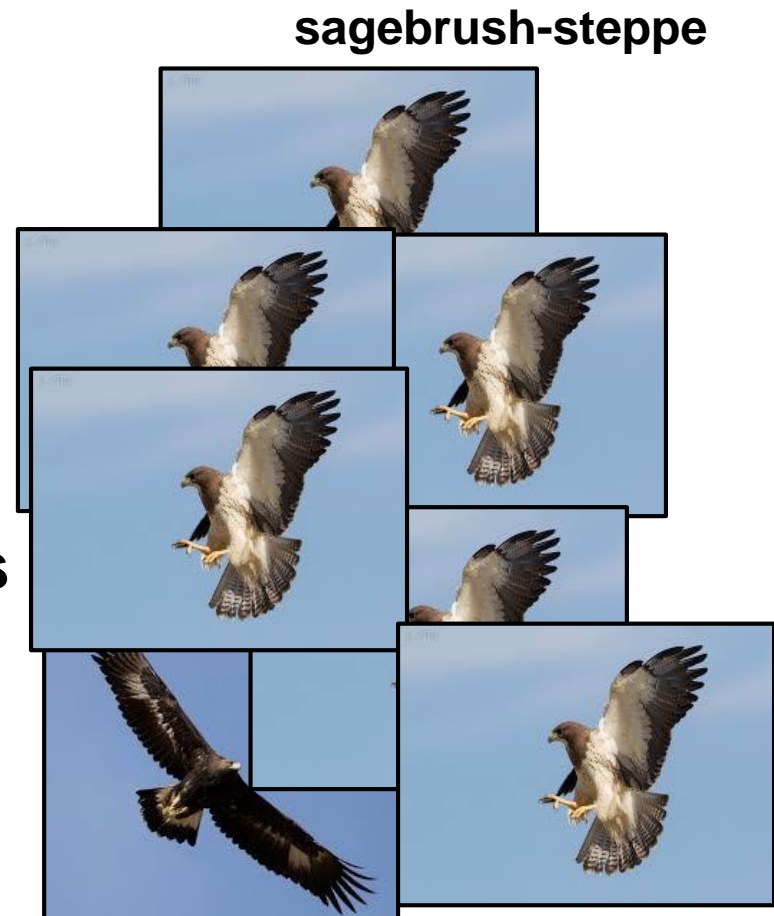
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$$H = - \sum_{i=1}^S (p_i * \ln (p_i))$$

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

S = total number of species sampled

p_i = relative abundance of species i



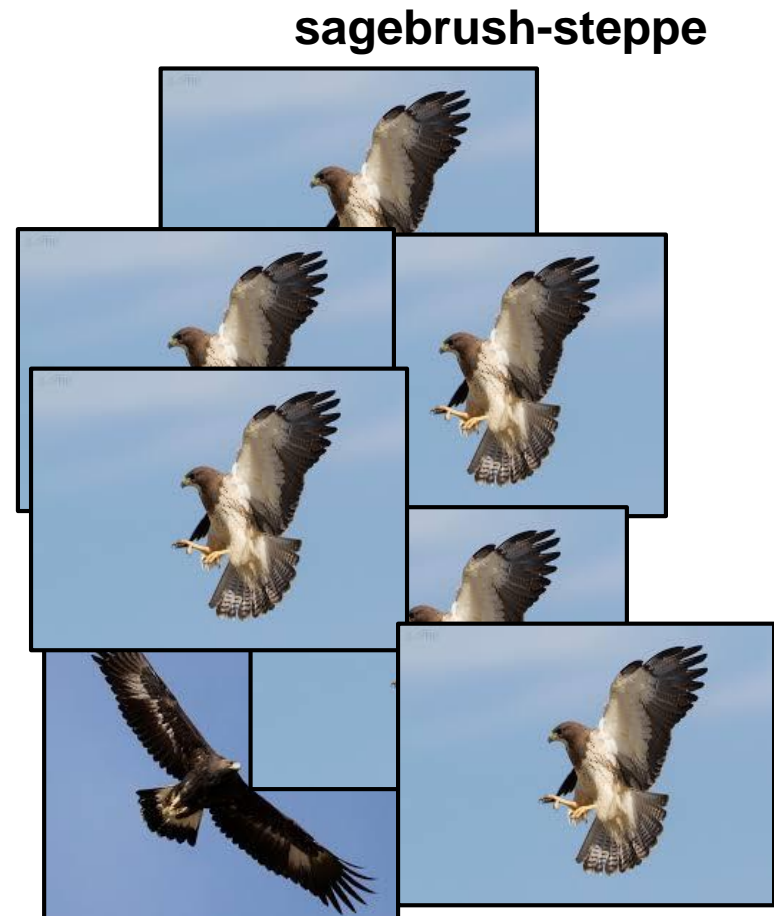
Estimating Properties of Communities

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Estimating Properties of Communities

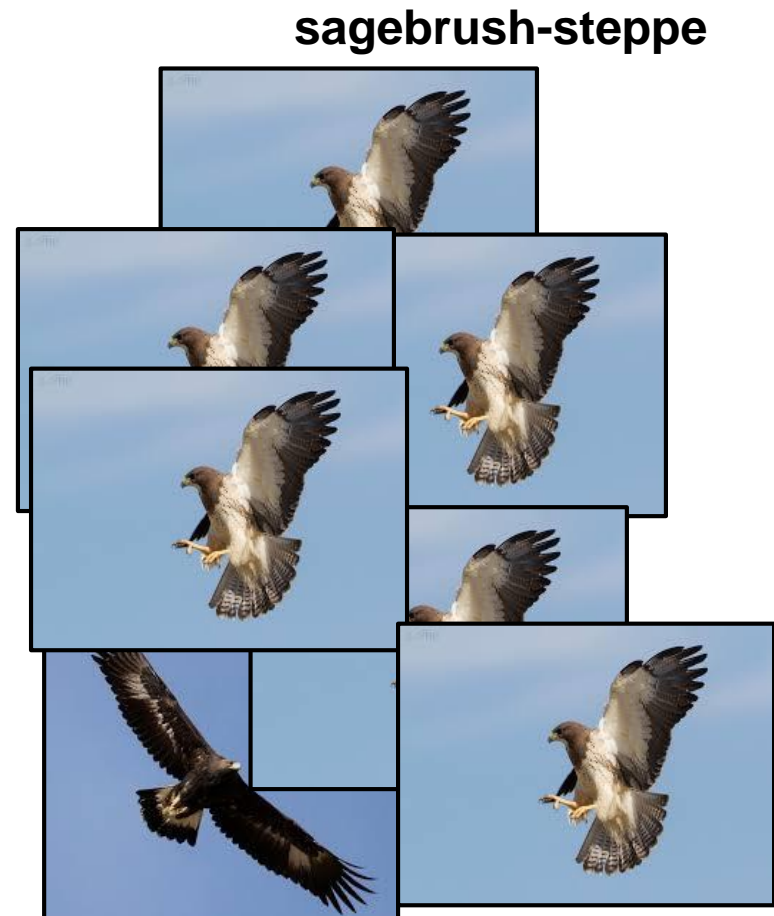
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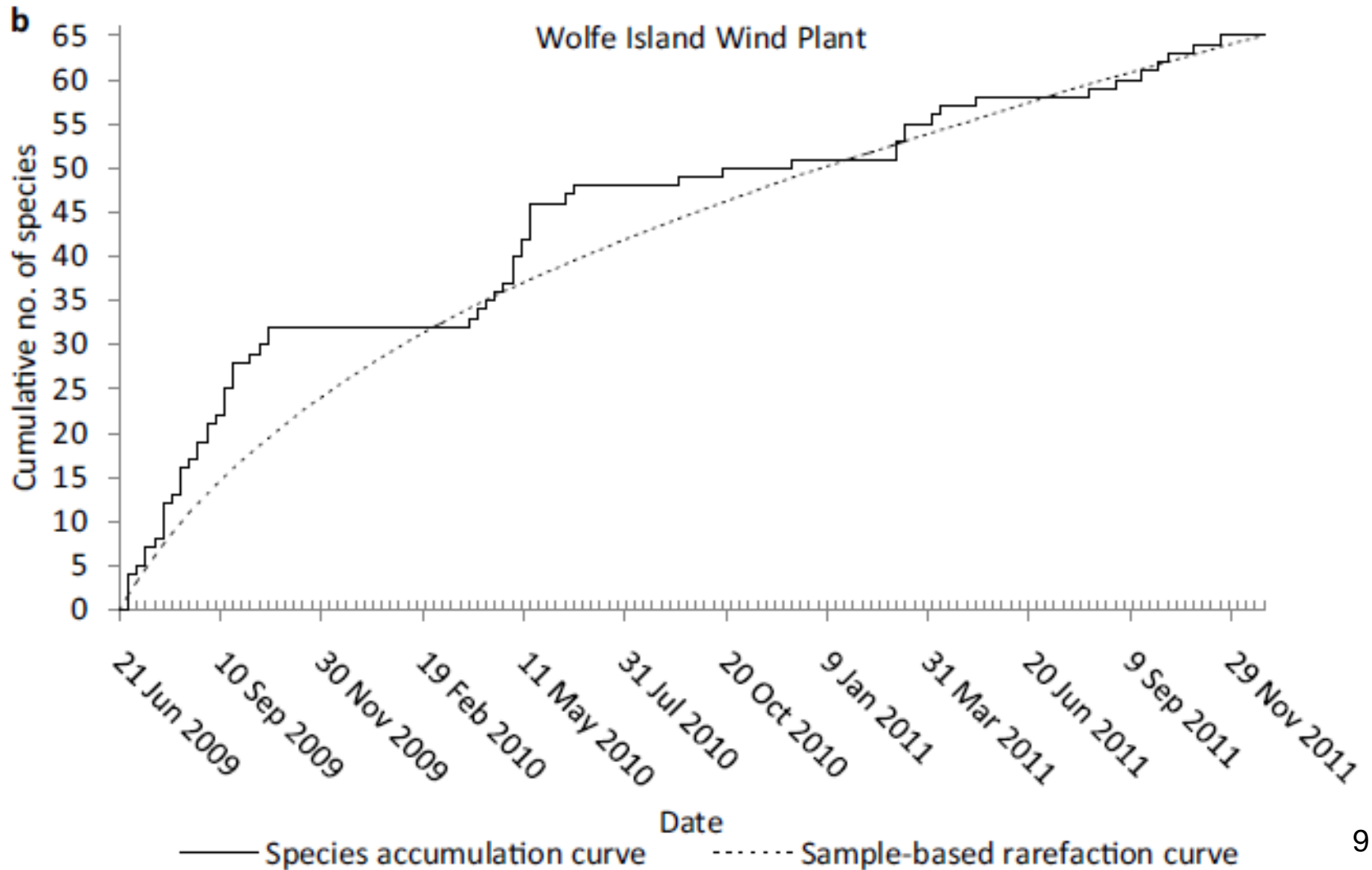
$$J = H/H_{\max} = 0.59$$



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

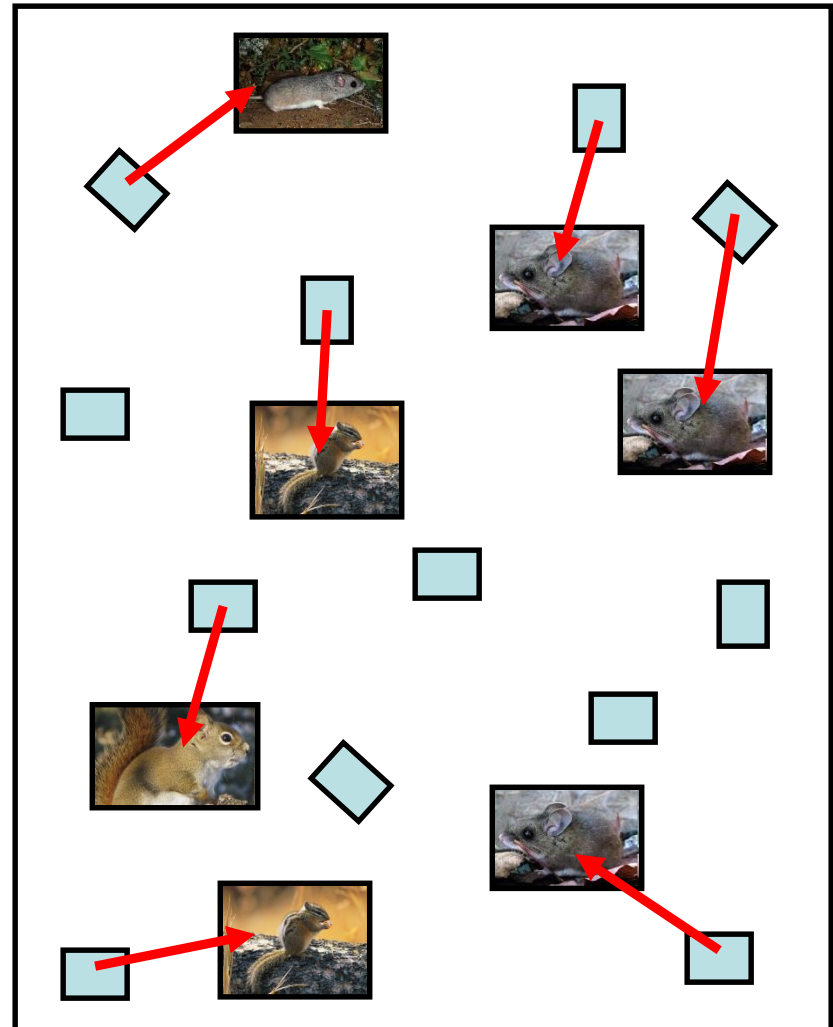
- **species accumulation curve = graph depicting the total number of species sampled during data collection as additional individuals/samples are added to the total of previously-sampled individuals/samples.**
- **used primarily to visualize how species are added (or accumulated) with increasing individuals/samples.**

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



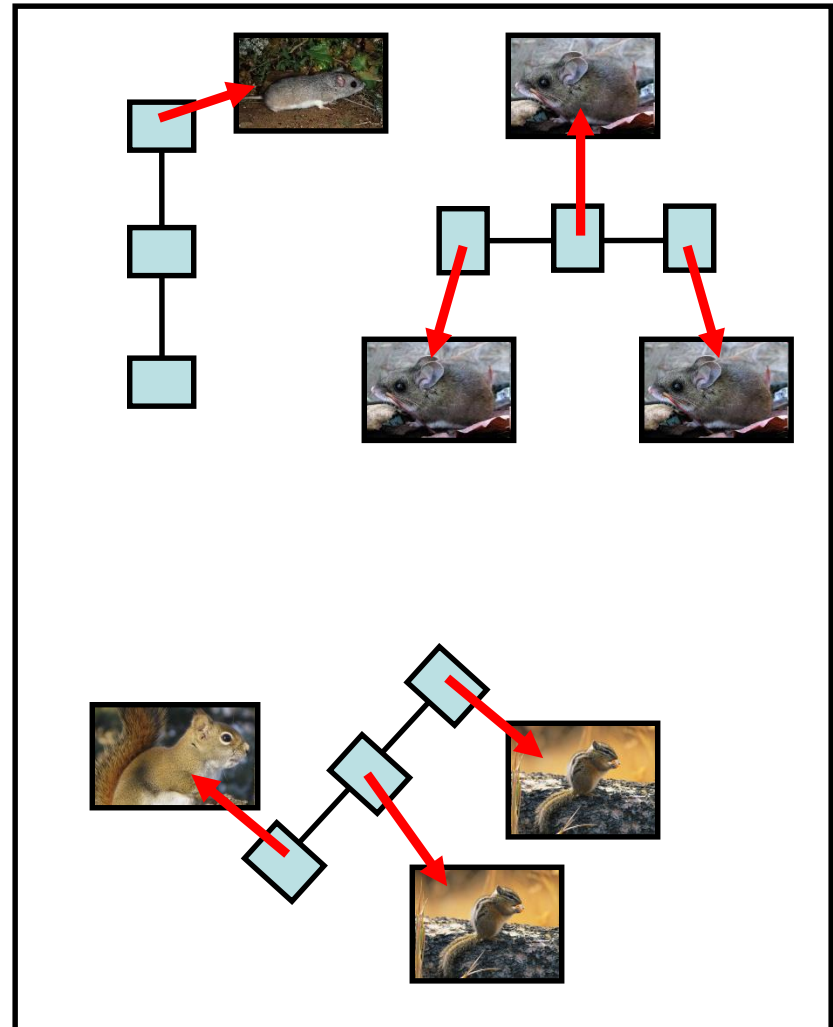
Sample- vs Individual-Based Curves

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

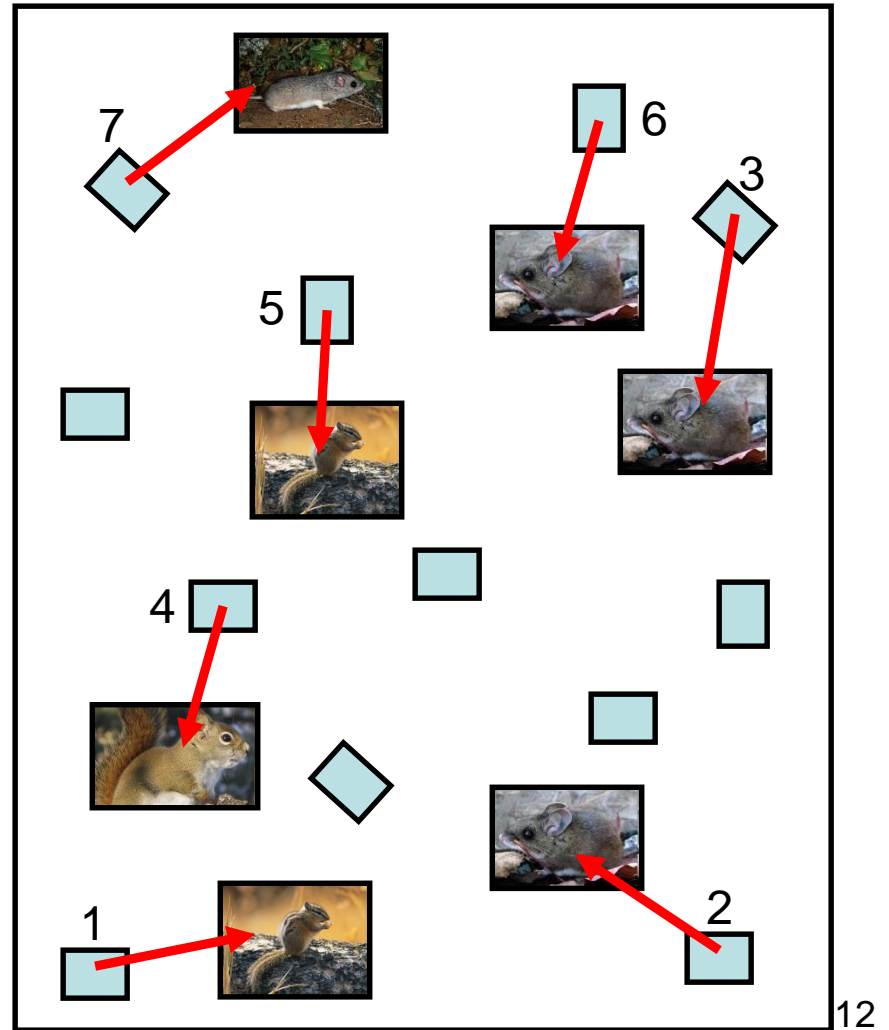
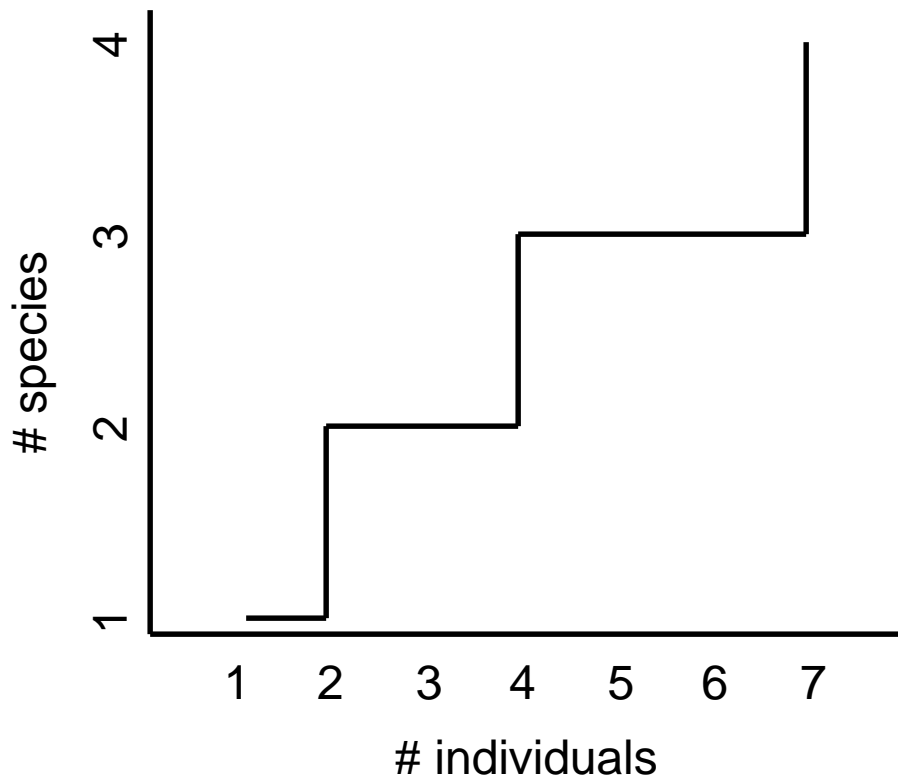


Sample- vs Individual-Based Curves

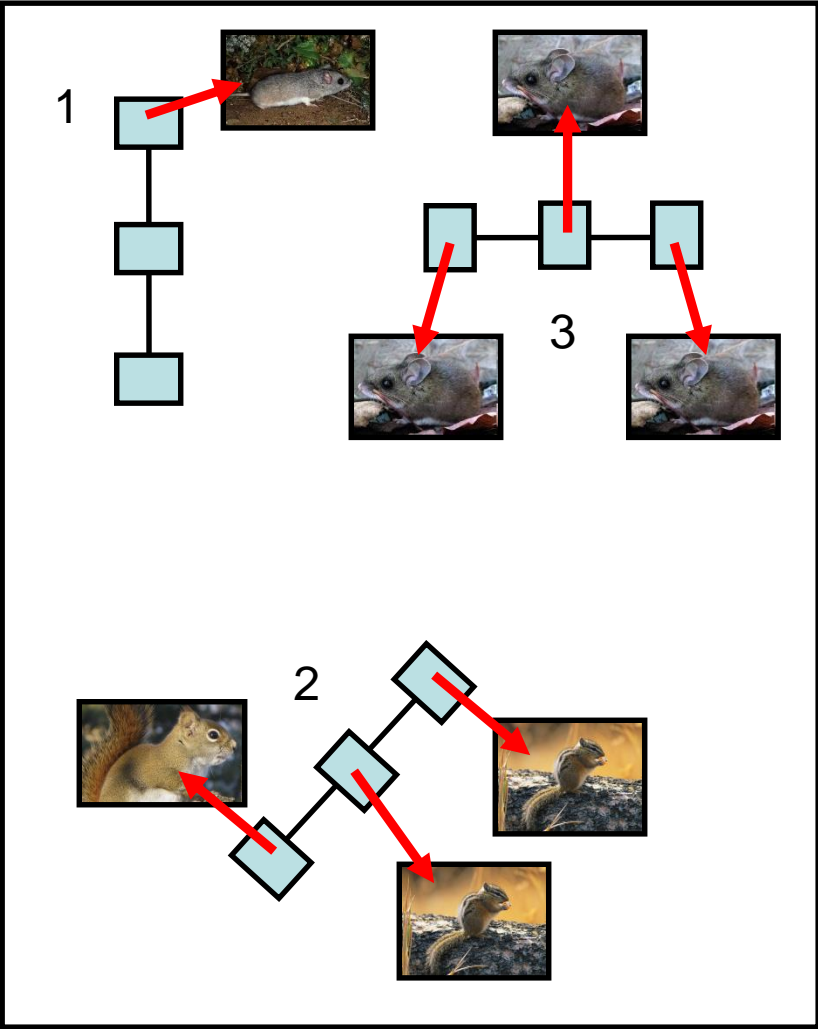
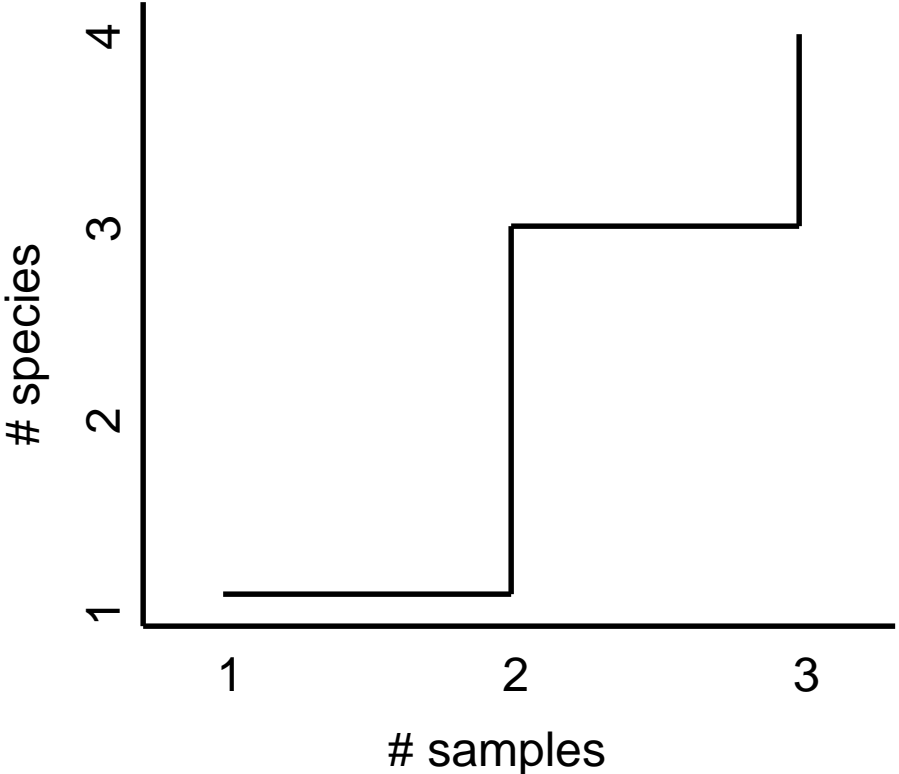
- Individual-based assessment examines a predetermined number of individuals (e.g., $n = 7$ small mammals) to assess richness
- Sample-based assessment uses replicate samples (e.g., $n = 3$ transects) to assess richness



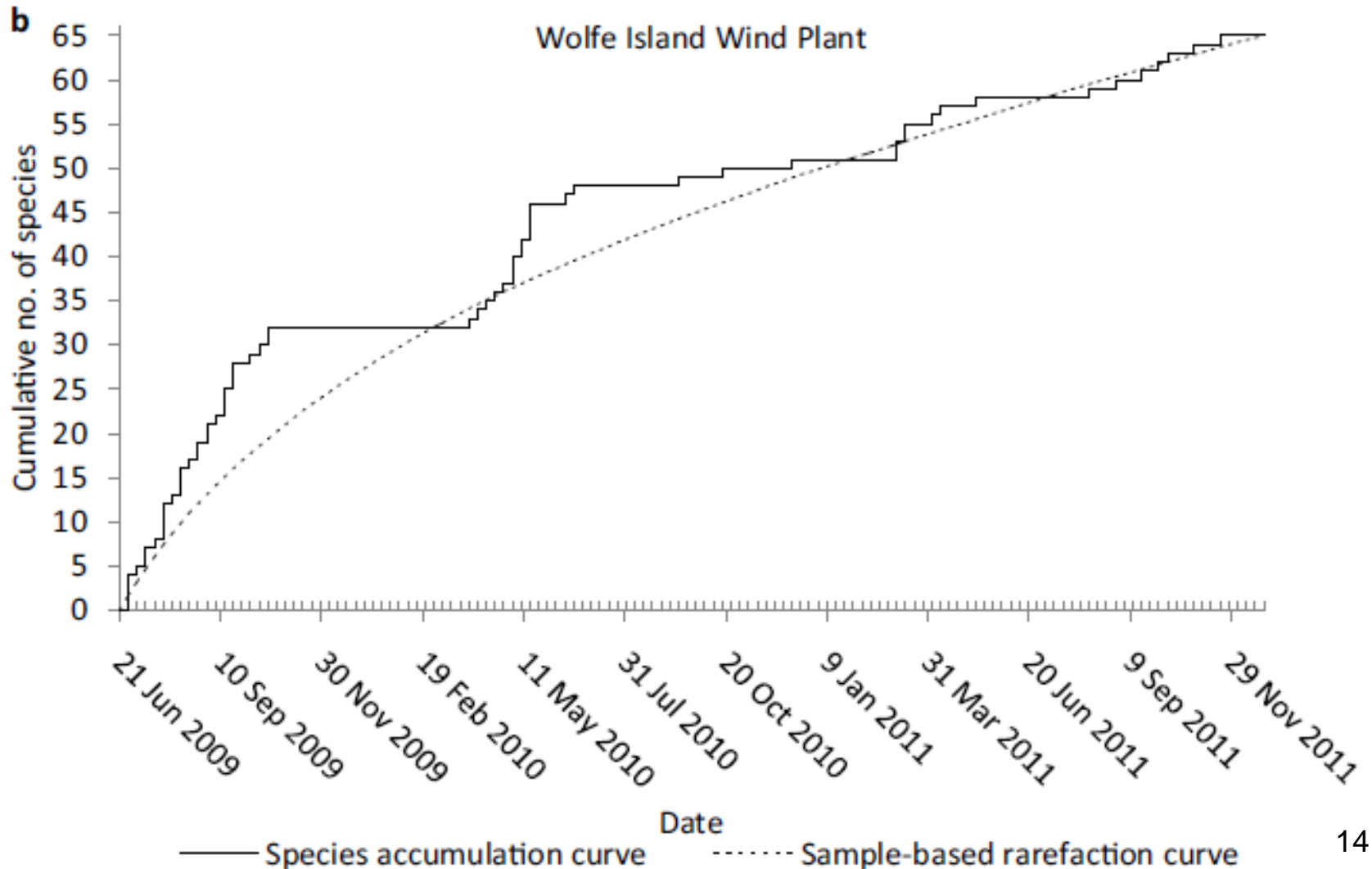
Individual-based Accumulation Curve



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

sagebrush-steppe

2 transects *

10 point counts/transect *

3 days = 60 total counts

= 19 individuals of 2 species



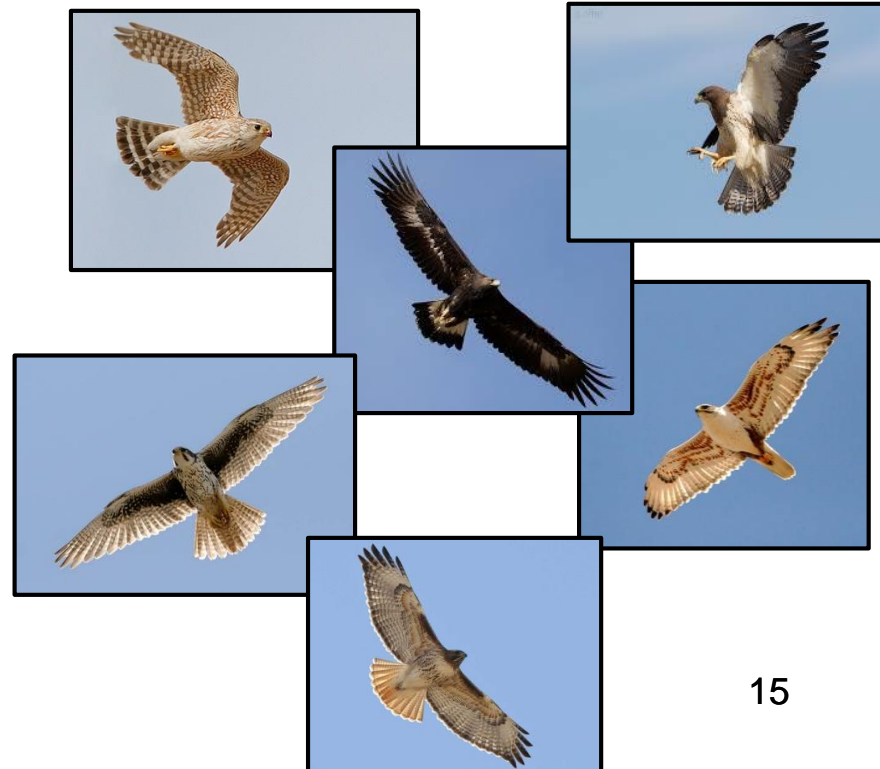
shortgrass prairie

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.

sagebrush-steppe

2 transects *

10 point counts/transect *

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shortgrass prairie

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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.

sagebrush-steppe

2 transects *

10 traps/transect *

3 nights = 60 trap-nights

= 19 individuals of 2 species

forest/woodland

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 rarefaction.

sagebrush-steppe

2 transects *

10 point counts/transect *

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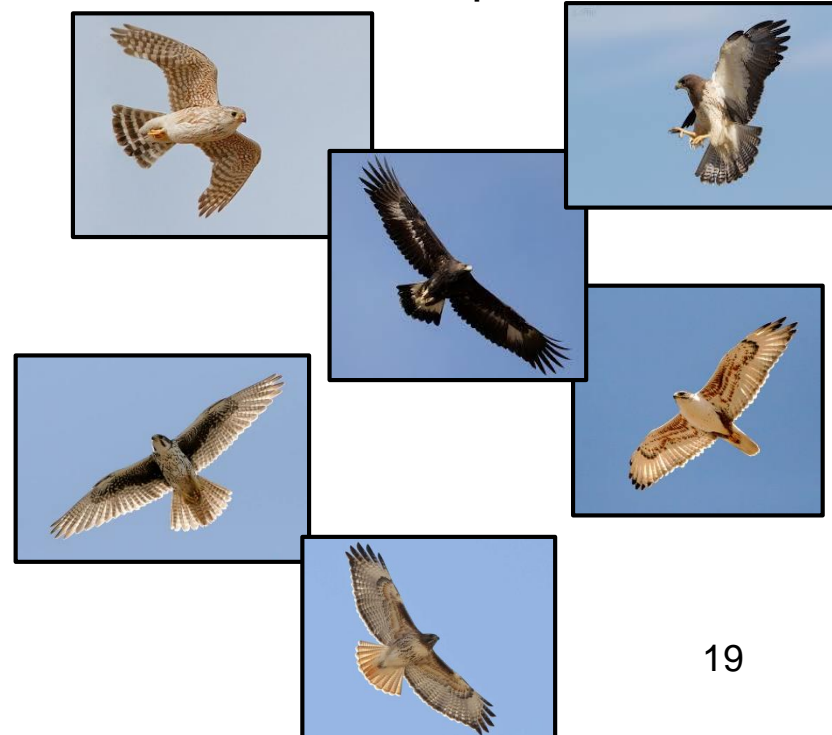
shortgrass prairie

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

- species rarefaction curve = 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.

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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

Community 1

7 individuals

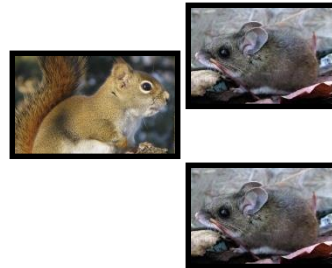
4 species



Community 2

3 individuals

2 species



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

Community 1
7 individuals
4 species



Community 2
3 individuals
2 species



Random Communities



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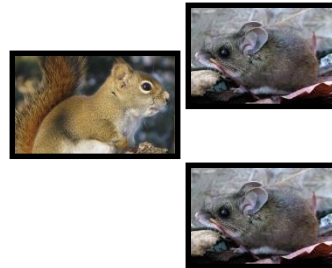
RC50 (or 100, or 1000, 24
or whatevs)

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

Community 1
7 individuals
4 species



Community 2
3 individuals
2 species



Random Communities

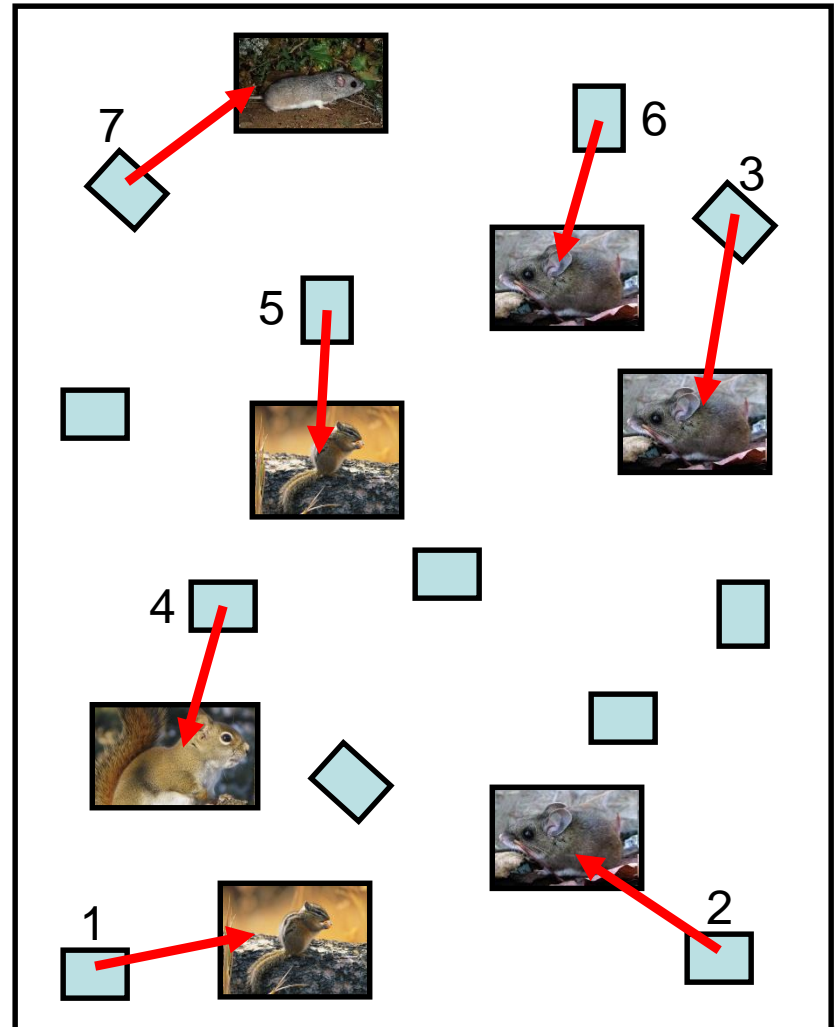
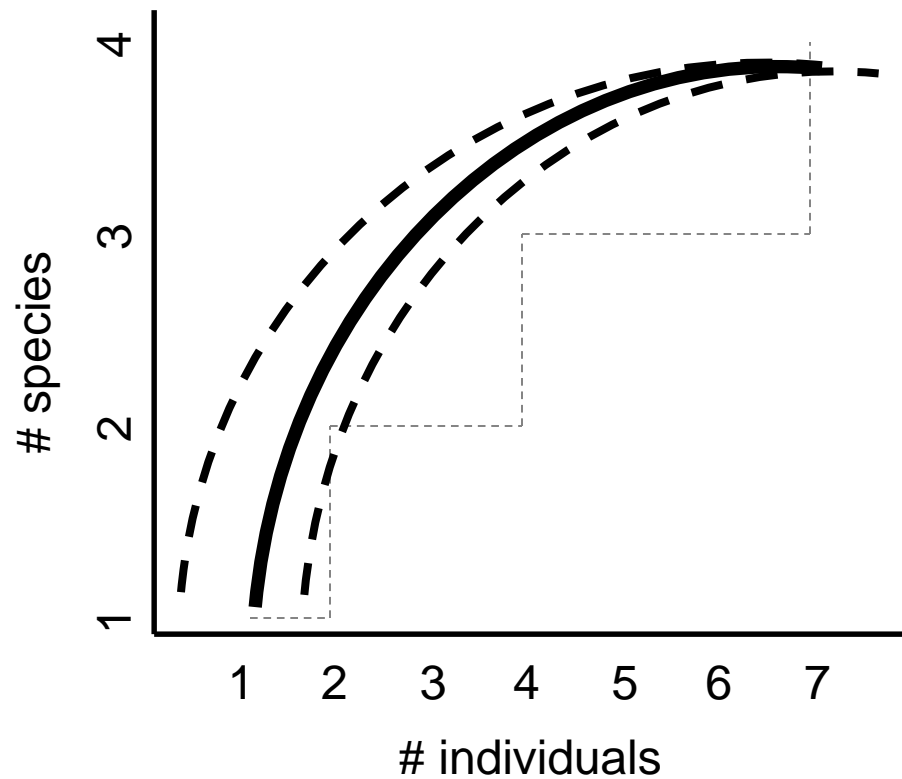


- we are randomly drawing n individuals from the total of N individuals many times, then calculate a diversity index (e.g., Shannon, Simpson).

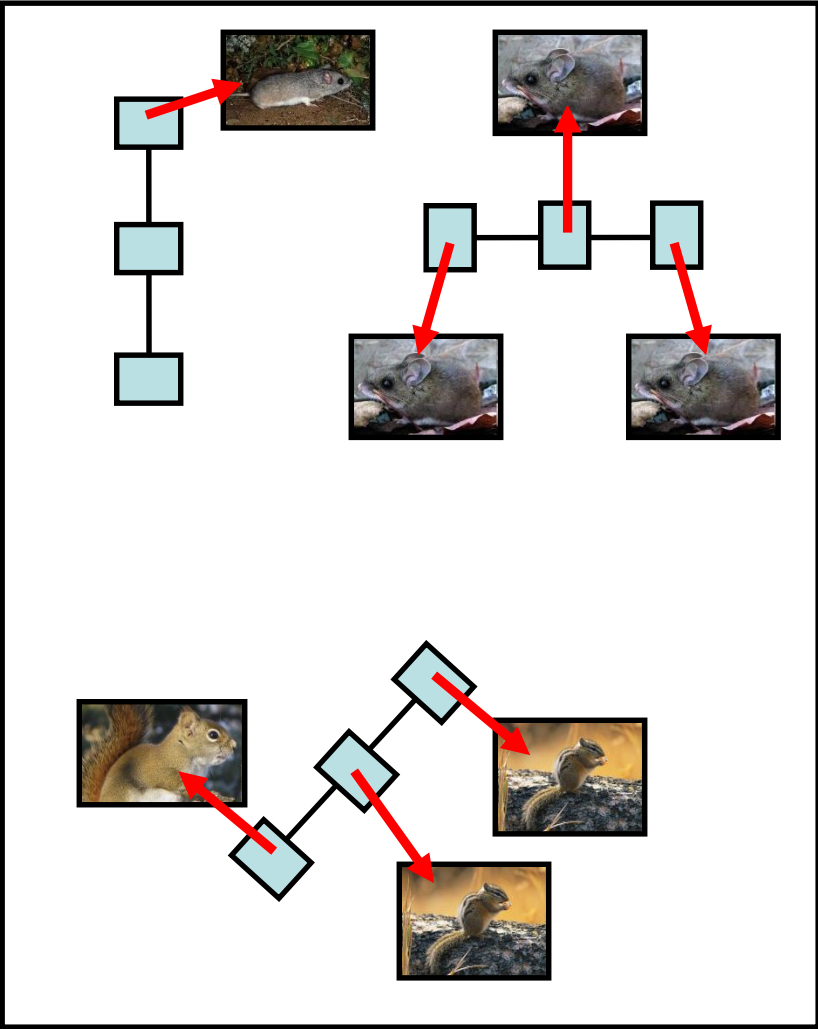
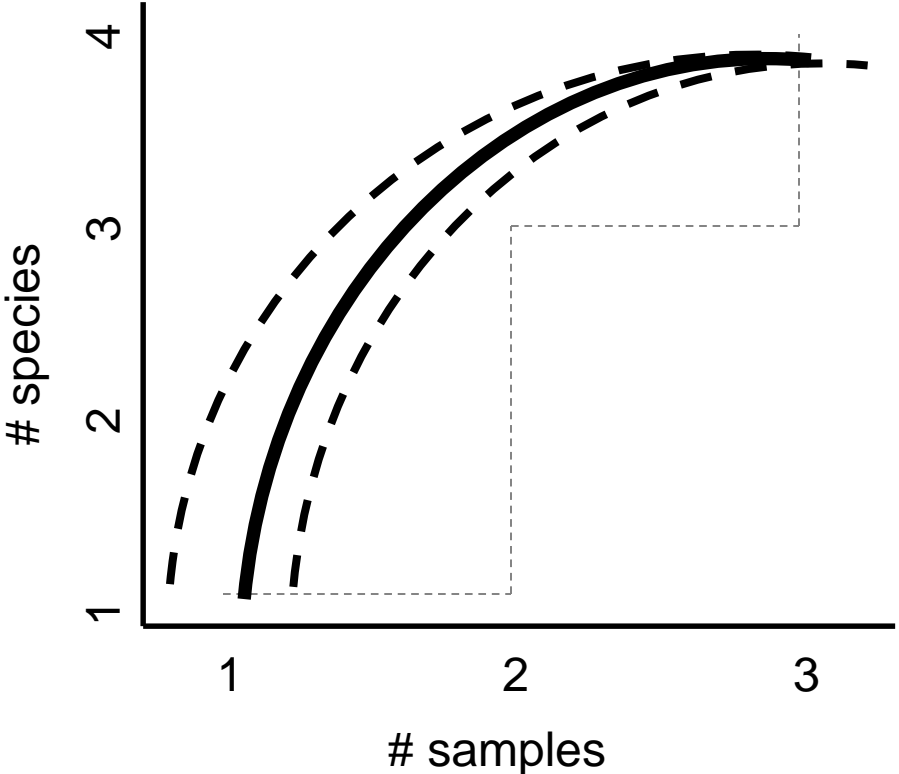
- because the diversity index is a mean calculated from the random communities, we also have a variance

RC50 (or 100, or 1000, 25 or whatevs)

Individual-Based Rarefaction Curve

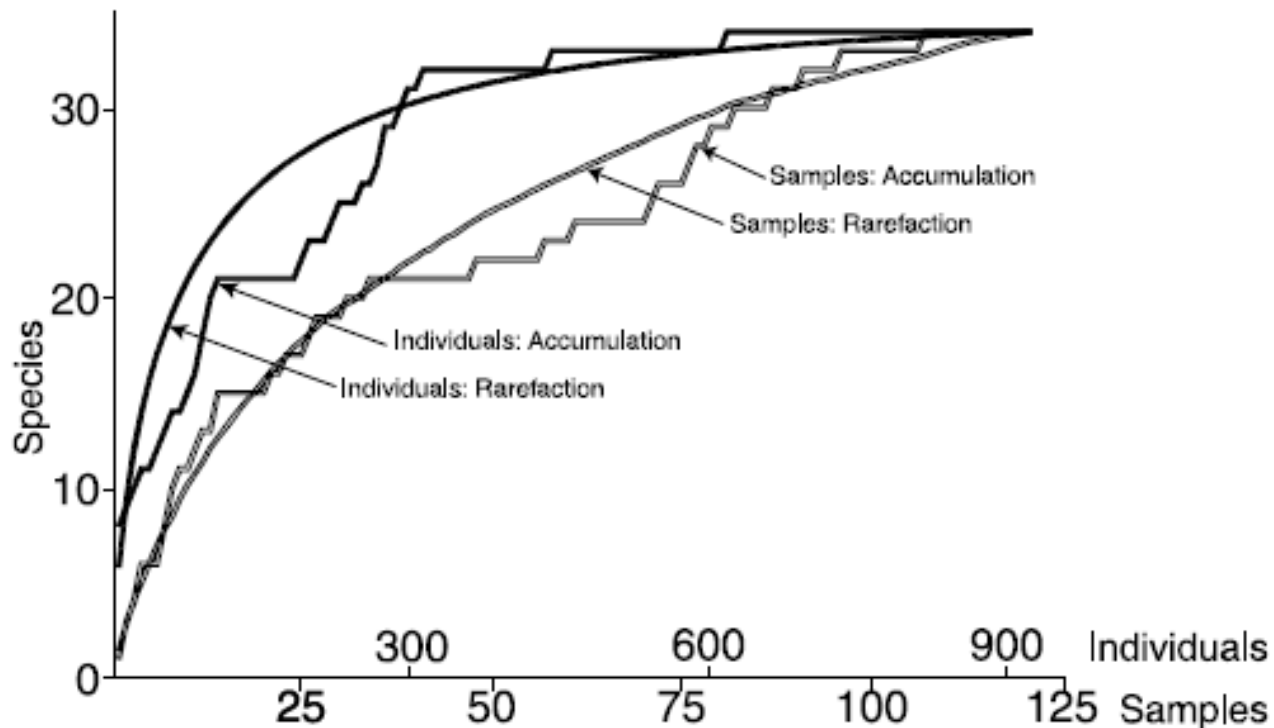


Sample-based Rarefaction Curve



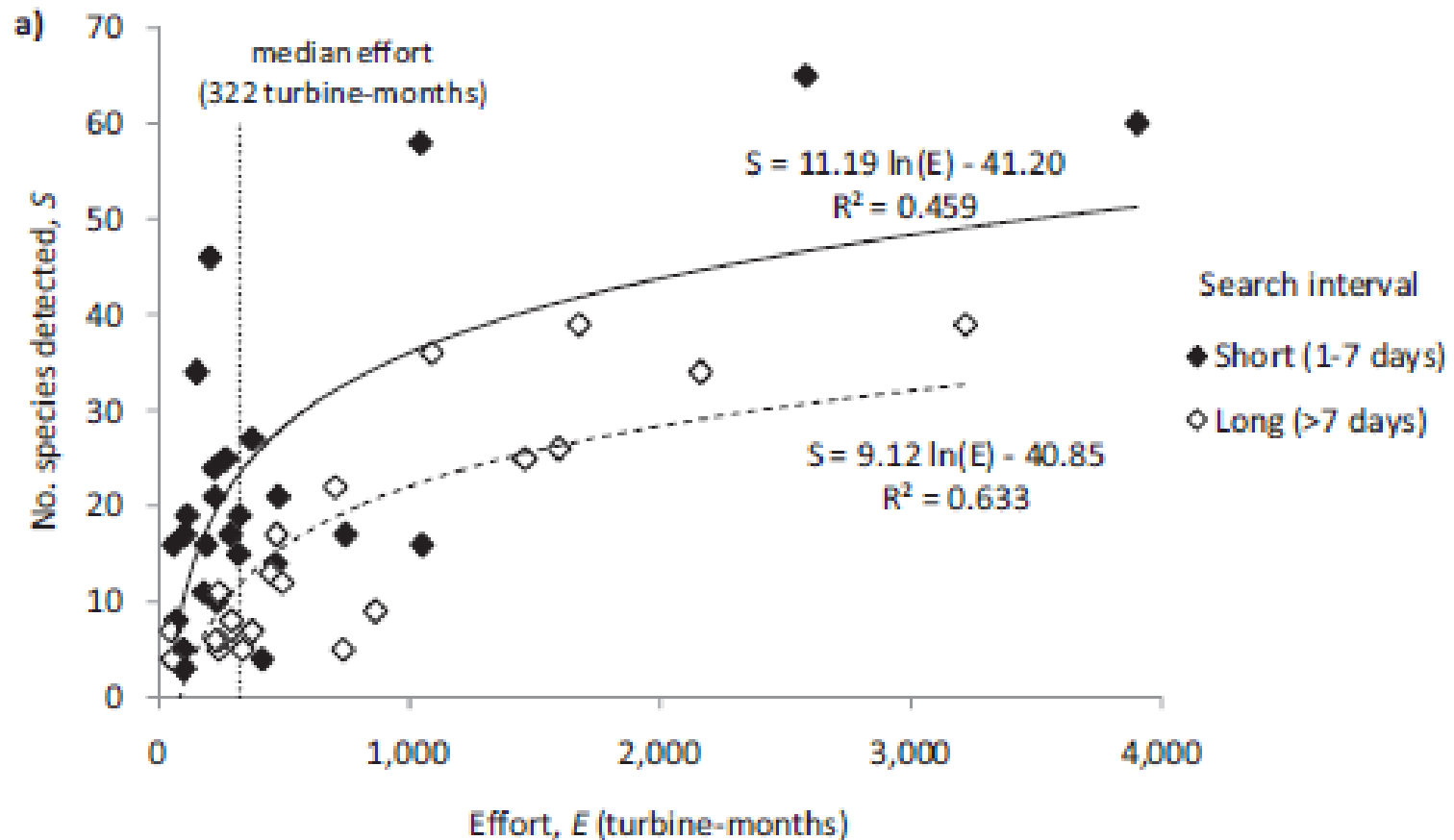
Discussion Q: If we plot individual-based accumulation and rarefaction curves, and sample-based accumulation and rarefaction curves, the sample-based curves are always “under” the individual-based curves. What does this mean? Why is this happening?

Hint: think to the mammal example, where certain species were only sampled on certain transects.



Sample-Based Rarefaction Curve

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



Sample-Based Rarefaction Curve

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

