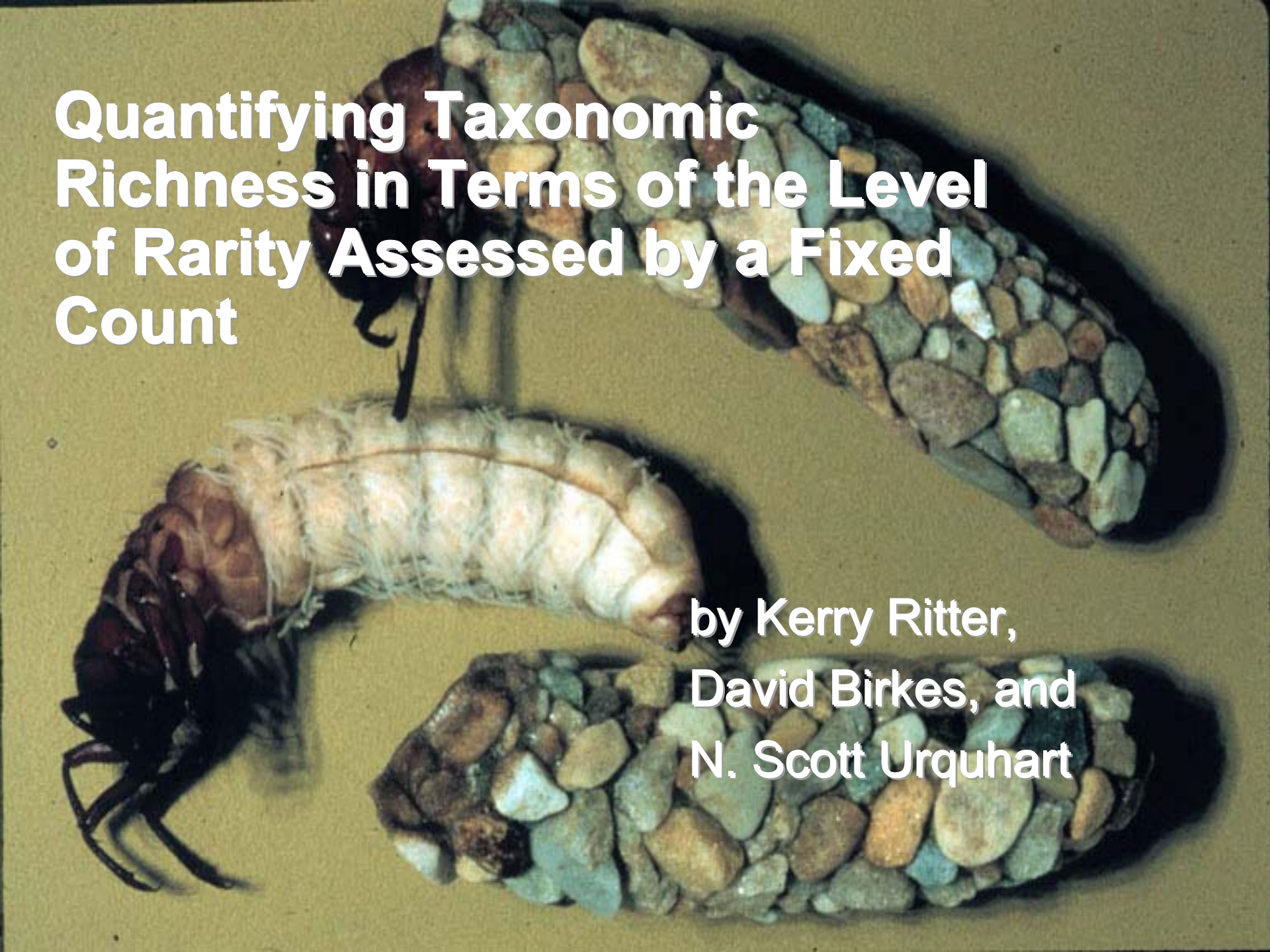

Quantifying Taxonomic Richness in Terms of the Level of Rarity Assessed by a Fixed Count

by Kerry Ritter,
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Overview

- Numerical Taxa Richness (NTR)
- Problem and Motivation
- Proposed Solution
- Jackknife Alternative
- Future Research

What is Numerical Taxonomic Richness (NTR)?

- NTR= number of taxa observed for a fixed (relatively small) number of individuals subsampled from a larger collection
- Saves time and money
- Provides fair comparisons among sites
- Effective measure of habitat quality

What is NTR “really” estimating?

- Population = Collection
- Underestimates total number of taxa in the collection.
- NTR effectively targets total number of “non-rare” taxa

Why do we care?

- A good idea to know what we're measuring
- Better understanding of how impacts affect benthic composition
- Weigh cost (ss) against resolution
- Develop alternatives
- Potential to correct for unequal sized subsamples

NTR Depends on Subsample Size

- As subsample size ↑
- Number of taxa ↑
- Likelihood of observing rare taxa ↑
- Sensitivity to disturbance ↑

Target Parameter, $C^*(\eta)$

- $C^*(\eta)$ = total # of taxa in the collection with relative frequency $\geq \eta$
- Goal: Determine η for a given subsample size, *n*

Zipf's Law for Relative Frequency of Taxa Sizes

- Let p_i = relative frequency of *i*th taxon
- Then the proportion of taxa having relative frequency $p_i \propto p_i^{-(1+\alpha)}$
  - Hill, 1974

Lemma

- Assume p_i's follow Zipf's Law, for $0 < \alpha < 1$
- Then the # of taxa observed in the subsample of size *n* is approximately unbiased for $C^*(\eta)$
  - where $\eta = 1/\ 2n * \gamma$
  - and $\gamma = ((1- \alpha)(5 - \alpha))^{1/2} - (1- \alpha)$

Data

- OSU/EPA 1992-1993 pilot study
- 7 composite samples of macroinvertebrates
- Reflect a variety of taxa distributions with regard to CV and proportion of “rare” taxa

Approximation for η

- Fit Pareto distribution to the data
  - (Pareto is continuous analogue of Zipf's law)
- From 7 composites: $\alpha \in [0.23, 0.43]$
  - => $\gamma \in [1.04, 1.15]$
- We chose $\gamma = 1$
- $\eta = 1/\ 2n$

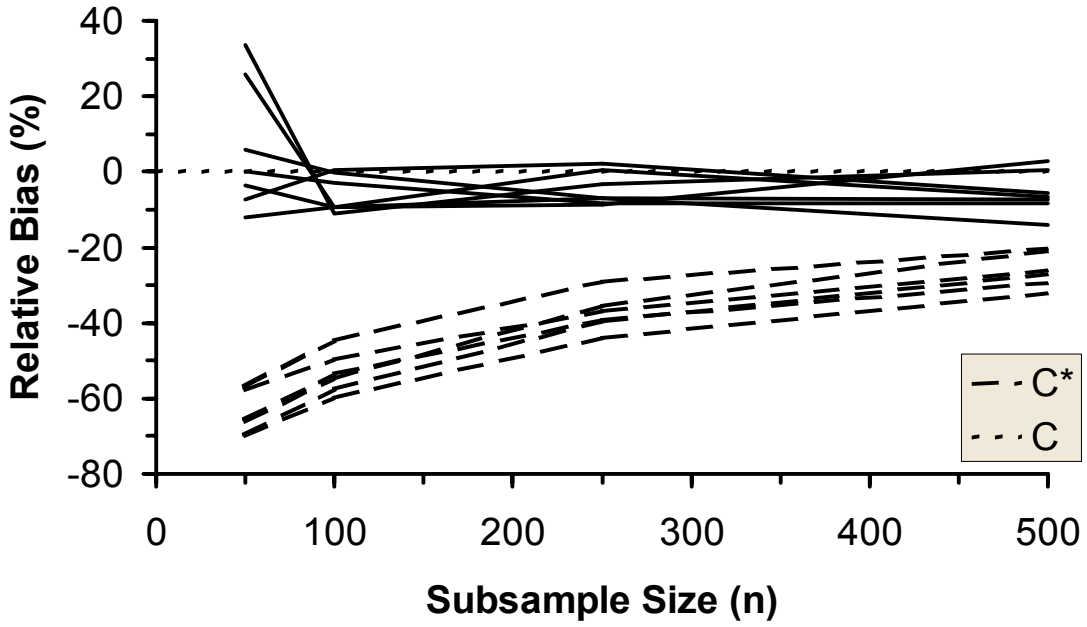
Simulation Study I

- 7 composites
- 10,000 random subsamples (with replacement)
- Individuals within each subsample randomly selected (without replacement)
- n = 50, 100, 250, 500
- Evaluated bias of NTR with respect to

  $C^*(1/2n)$ and C

NTR wrt C and C*(1/2n)

Figure 1



Finding 1

- NTR based on a subsample of size *n* is "nearly" unbiased for number of taxa which occur in the collection with relative frequency $\geq 1/2n$

Converse of Finding 1

- To estimate number of taxa which occur in the collection with relative frequency $\geq \eta$, use NTR based on a subsample size $1/2\,\eta$.

Jackknife Alternative

- Bias as a function of subsample size
- Finding 2: Jackknife based on a subsample of size n is nearly unbiased for $C^*(1/5n)$.
- Converse: Jackknife based on a subsample of size $1/5\eta$ is nearly unbiased for $C^*(\eta)$.

Jack(n = 1/ 5 η) vs. NTR(n = 1/ 2 η) for Estimating C*(η)

- Bias (Jack) $\cong$ Bias(NTR)
- SD(Jack) $\cong$ 2 $\times$ SD(NTR)
- RMSE(Jack) $\cong$ 3/2 $\times$ RMSE(NTR)

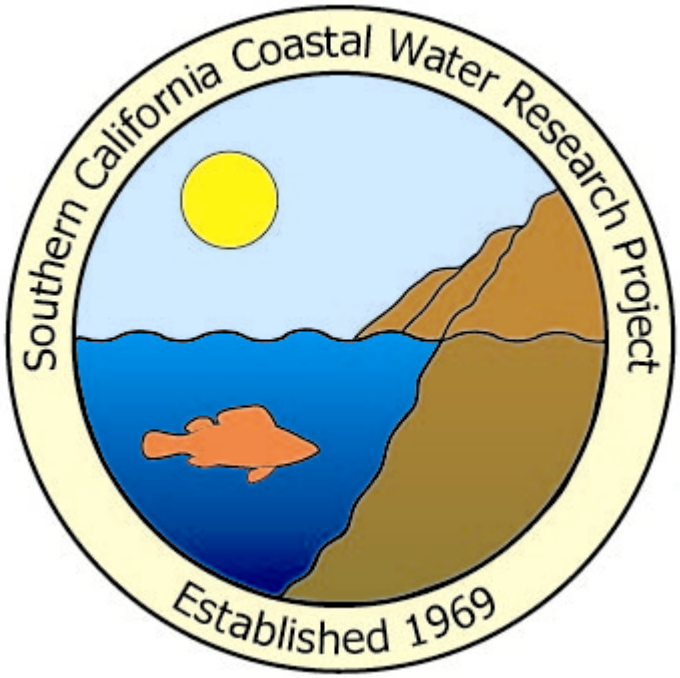
Summation

- NTR is “nearly unbiased” for # of taxa with relative frequency $\geq 1/2n$.
- Jackknife is “nearly unbiased” for # of taxa with relative frequency $\geq 1/5n$.
- Comparable bias with NTR can be achieved with Jackknife when subsample size is reduced by 60%.

Future Research

- Develop a correction factor that will allow for “fair” comparison with NTR for arbitrary subsample size

Contacts



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