Species richness in space and time: Follow-up activity to the ASM workshop

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I. Introduction

Estimating the number of species in a community or ecosystem is a fundamental problem in basic and conservation ecology. Basic researchers use biodiversity estimates to study latitudinal diversity gradients, to determine relationships between local and regional diversity, and as a response variable in manipulative experiments. Conservation ecologists use such estimates to prioritize conservation efforts (Myers et al. 2000) and predict species losses due to fragmentation (Pimm and Askins 1995, Brooks et al. 1997). Much of this work relies on the species-area relationship (SAR) to scale up field measurements of diversity to broader spatial scales. However, these estimates ignore the possibility that species number may be as sensitive to the temporal scale of observation as they are to the spatial scale.

Preston (1960) proposed that the relationship between species number and the period of observation, the species-time relationship (STR), should be equivalent to that between species number and area sampled, the species-area relationship (SAR). Recent work on vascular plant (Adler and Lauenroth 2003) and bird communities (White In Review) shows power-law relationships between the species richness and the time scale of observation, supporting Preston's conjecture and suggesting that similar mechanisms influence species distributions in space and time. The rapid accumulation of species observed in plant communities, even at relatively broad spatial scales (Adler and Lauenroth 2003), raises questions about the value of biodiversity assessments based on a single year of sampling. Although species accumulation is proportionally slower in the bird communities, increasing the time period of observation often leads to different conclusions about which sites have the highest richness (White unpublished data). The theoretical and applied significance of these results, combined with current paucity of STR studies in literature, makes a comparison of STRs across ecosystems and taxa a very timely activity.

LTER is uniquely situated to facilitate this synthesis effort. Investigators at a wide variety of sites have compiled long-term data on a range of taxa, and the LTER ASM meeting provided an opportunity for us to take an important first step towards producing a cross-site comparison. Our primary objective is to write a manuscript to be submitted for publication to *Ecology* that synthesizes what we know from available datasets about the STR, the SAR and the STR-SAR interaction. We will refer to this product as the cross-site comparison. A secondary objective is to write a manuscript, or perhaps several, that discuss the implications of the STR and STR-SAR interaction for particular disciplines such as conservation biologists, theoretical and empirical ecologists, and natural resource managers. A third objective is to discuss the possibility of LTER sites beginning a long-term data collection activity to address questions about the STR.

II. Progress to date

Our ASM workshop featured formal presentations about STRs using 4 datasets: plants in Kansas grasslands, plants in the arid Jornada ecosystem, birds communities across the U.S., and fish communities in northern temperate lakes. Collectively, these talks demonstrated similar functional forms of the STR across ecosystems but suggested interesting differences in the relative rates of species accumulation for different taxa and spatial scales. Much of the discussion that followed the formal presentations focused on the potential for using additional LTER datasets to evaluate these potential generalities and trends.

Since the workshop, we have made significant progress in defining our general objectives (see above) as well as specific questions for the cross-site comparison. We have identified a

group of committed participants, with expertise across the range of ecosystems and taxa we plan to analyze (Table 1). It is critical that we have sufficient funding to bring lake and small mammal ecologists to the meeting to complement our core group's strengths with plants and birds (Adler, Lauenroth and White). Finally, we have begun collecting datasets in a common format (Table 2).

III. Plan for the follow-up meeting

The objectives of the follow-up meeting will be three-fold. The primary objective will be to complete the analysis phase of the cross-site comparison. The second will be to begin work on subsequent manuscripts and the third will be to discuss ideas for long-term sampling of species richness that might be undertaken by sites in the LTER network.

By the time of the follow-up meeting, we expect that all of the quantitative analyses will be complete and will be in candidate graphical form. By candidate graphical form we mean figures that are candidates for inclusion in the cross-site comparison manuscript. The major activity of the follow-up workshop will be to discuss these figures, propose alternative figures, conduct analyses for alternative figures if necessary, and agree upon text to go with each figure. The three lead authors will take the text from the follow-up workshop and fashion Results and Discussion sections for the manuscript. Before the workshop we will have produced drafts of the Introduction and Methods sections, and will discuss these sections at the follow-up workshop. We plan to complete a draft of the synthesis manuscript within 2 months of the follow-up workshop. This will be sent to all of the participants in the ASM workshop who expressed an interest in being involved. We will ask for comments to be provided within 1 month and produce a final version within two more months. We are planning to hold the follow-up workshop in late January or early February. Provided we are able to keep this schedule, we are quite confident that we will have a cross-site comparison manuscript submitted to *Ecology* in July of 2004.

In addition to this cross-site cross-taxa comparison, we are interested in using the LTER data to write manuscripts about the specific implications of STRs for theoretical ecologists, conservationists, and natural resource managers. At the follow-up workshop, given sufficient interest in undertaking one or more of these topics, we will define objectives and produce outlines for these papers.

Our state-of-the-knowledge synthesis will identify critical gaps in our understanding of species-time and –area relationships. Patching these gaps will likely require initiation of new (and/or expansion of old), long-term data collection activities. The LTER network offers the ideal framework for promoting and supporting this effort. At the follow-up workshop we will discus whether we wish to propose such an activity and consider the details of what we would propose. We are veteran realists about the likelihood that LTER sites can take on an additional data collection activity so we will be approaching this with guarded enthusiasm and substantial caution.

IV. Budget

We are requesting the equivalent of 8 trips to Albuquerque. We assume that airfare will average $350 per person and lodging/meals/miscellaneous expenses will average $125 per day. We are planning a meeting that will take 3 days to complete. The first day will be a travel day, day 2 will be a full day of work and day 3 will be a half day of work and travel. Our total request is $6400.

References

Adler, P. B. & Lauenroth, W. K. (2003) The power of time: spatiotemporal scaling of species diversity. *Ecology Letters*, **6**, 749-756.

Brooks, T. M., Pimm, S. L., & Collar, N. J. (1997) Deforestation predicts the number of threatened birds in insular southeast Asia. *Conservation Biology*, **11**, 382-394.

Myers, N., Mittermeier, R. A., Mittermeier, C. G., da Fonseca, G. A. B., & Kent, J. (2000) Biodiversity hotspots for conservation priorities. *Nature*, **403**, 853-858.

Pimm, S. L. & Askins, R. A. (1995) Forest losses predict bird extinctions in eastern North America. *Proc. Natl. Acad. Sci*

Preston, F. W. (1960) Time and space and variation of species. *Ecology*, **41**, 611-627.

White, E. P. (In review) The species-time relationship in North American breeding birds: a two-phase approach. *Ecology*.

Table 1. List of participants based on e-mailed statements of interest following the ASM workshop. Names in bold are those that have currently expressed an interest in attending the follow-up workshop. We expect this list of potential attendees to increase.

Name	Role	Sending data	Analyzing own data	Attend next meeting
Adler, Peter	Author	x		yes
Arkama, Katie				
Colburn, Betsy				
Collins, Scott	Author	x		If appropriate
Cook, Bill				
Dalgleish, Harmony				
Dodson, Stanley	Author		x	If appropriate
Gill, Rick	Author	x		If appropriate
Homma, Kosake				
Kaufman, Dawn	Author	x		yes
Kaufman, Don				
Kratz, Tim	Author	x		If appropriate
Lauenroth, Bill	Author			yes
Lowe, Winsor				
Lynch, Michael				
Milkucki, Jill				
Muldavin, Esteban				
Rassweiler, Andrew				
Reed, Dan				
Riwa-Figura, Francisca				
Rusak, Jim	Author		x	If appropriate
Schloss, Pat				
Seastedt, Tim				
Shecky, Yehoshua				
Smith, Melinda				
Suding, Katie	Author	x		If appropriate
Vogt, Allison				
Waide, Bob				
White, Ethan	Author	x		yes
Yang, Xia				
Yao, Jin	Author	x		If appropriate

Table 2. Current list of data sources to be used in the data analysis paper. We expect to add more datasets to this list.

Site	**Contact**	**Taxa**	**Years**
Hays, KS	P. Adler	plants	35
Konza	P. Adler	plants	18
BBS	E. White	birds	20-35
Portal, AZ	E. White	mammals	25
Portal, AZ	E. White	plants	14
NTL	D. Balsiger	fish	22
NTL	D. Balsiger	phytoplankton	22
Jornada	J. Yao	plants	30+
KBS	K. Gross	plants	15
SEV	S. Collins	plants	14
SEV	S. Collins	mammals	14
GBER, UT	R. Gill	plants	30-50