How does mountain bike trail construction and use affect diversity in a desert ecosystem?

By Matthew Burke

Mountain bike enthusiasts are always looking for new places to ride and places to ride that are close to where they live. Estrella Mountain Ranch is a master planned community within the Sonoran Desert in the Southwest Phoenix metropolitan area that is bordered by a State park and Bureau of Land Management land. A series of mountain bike trails were carved into a portion of the desert bordering the development over a 2 year period from 2005 to 2007. There are three possible affects of trail construction and use on species diversity that this study attempts to evaluate: 1) trails have an insignificant affect 2) trails have a detrimental affect, or 3) trails have a positive affect. The variation in age of the trails and the variation of levels of disturbance required to construct different trails make this site a good candidate for studying how species diversity is maintained in a desert ecosystem.

Hypotheses

1) The intermediate disturbance hypothesis

Species diversity is maintained by intermediate levels of disturbance in intensity and frequency resulting in a continually changing environment.

2) The niche diversification hypothesis

Species diversity is maintained by a stable environment resulting in species specialization for niches.

Assumptions

1) Arthropod diversity is an indicator of overall diversity in an ecosystem

2) The trail construction and use in the area of study is of intermediate intensity and frequency

3) No control plot was established, so the trap lines that are 10 meters off of the trails are assumed to reflect undisturbed desert.

4) Trail use has an insignificant affect on disturbance level

Predictions

1) If the intermediate disturbance hypothesis is correct, than diversity should decrease with distance from the trail

2) If the niche diversification hypothesis is correct, than diversity should increase with distance from the trail

3) If there was a control plot, the intermediate disturbance hypothesis predicts less diversity at the control plot than near trails

4) If there was a control plot, the niche diversification hypothesis predicts more diversity at the control plot than near trails

Limitations

The level of disturbance caused by trail construction was not measured, nor was the disturbance caused by riding trails. It is possible, therefore, this study was not a valid test of the intermediate disturbance hypothesis. Without a control it is difficult to make any conclusions from the data collected. Moreover, without any evidence for or attempt to measure the reach of disturbance off of the trail into the desert caused by trail construction, this study probably doesn't provide data that can be interpreted in a way that supports either hypothesis.

Procedure

•A trap line of 5 pit fall traps was set very close to two different trails 5 meters apart within the trail system.

•2 additional lines, one 5 and one 10 meters into the desert parallel to the first were set at each trail

•The traps were set in the evening and picked up one the 3rd evening (72 hours) after being set

•Organisms were identified to the functional group which required the identification of the Class in most cases and the Order of a few such as Araneae and Scorpiones

•A single collection was made due to time restraints

•No control trap lines were set due to time restraints

Results

The shannon and simpson diversity indices of the trap lines at Chris's Kaos show the least amount of diversity next to the trail and the most 5 meters away from the trail. The diversity indices show the least amount of diversity 5 meters away from the trail and the most diversity 10 meters away from the trail at Rusty Rake.

Diversity analysis of trap lines on Chris's Kaos			
	richness	shannon	simpson
CK	6	1.3	0.63
CK...5	7	1.8	0.81
CK...10	8	1.5	0.7

Diversity analysis of trap lines on Rusty Rake			
	richness	shannon	simpson
RR	7	1.2	0.58
RR...5	7	0.8	0.35
RR...10	6	1.6	0.78

A comparison of the means of the simpson indices of the trap lines at Chris's Kaos and Rusty Rake shows no significant difference (P=0.65) in diversity of the two sites.

t-Test: Two-Sample Assuming Equal Variances		
	Rusty Rake	*Chris's Chaos*
Mean	0.57	0.63
Variance	0.046	0
Observations	3	3
Pooled Variance	0.023	
t Stat	0.48	
P(T<=t) one-tail	0.33	
t Critical one-tail	2.1	
P(T<=t) two-tail	**0.65**	
t Critical two-tail	2.8	

Below is the raw data used in the analysis above.

Order	Family	Functional Group	CK	CK + 5	CK + 10	RR	RR + 5	RR + 10
Acari		Omnivore	0	13	0	1	1	6
Araneae		Carnivore	5	4	5	2	1	0
Blattodea	Blattidae	Omnivore	0	0	0	0	0	1
Coleoptera	Carabidae	Carnivore	0	0	0	0	0	0
Coleoptera	Polyphagidae	Omnivore	1	0	0	1	0	0
Coleoptera	Tenebrionidae	Herbivore	7	5	11	11	12	7
Hymenoptera	Formicidae	Omnivore	4	7	27	39	96	6
Hymenoptera	Mutillidae	Herbivore	1	6	1	2	0	1
Hemiptera	Reduviidae	Carnivore	0	0	1	0	0	0
Isopoda		Detrivore	0	0	0	0	0	0
Myriocrypta	Meinertellidae	Detrivore	0	0	1	0	0	0
Scorpiones		Carnivore	0	2	0	0	1	0
Solpugidae		Carnivore	0	0	1	0	0	0
Thysanura		Detrivore	33	4	11	8	4	6

Conclusions

The limitations set by the experimental design, which was limited by time restraints and labor made the results of this study less than enlightening. Chris's Kaos was constructed in May 2007 and Rusty Rake was constructed in 2005. Rusty Rake is also a trail that is ridden significantly more than Chris's Kaos. There was no difference in species diversity between the two sites sampled (p=0.65). One possible meaning of this is trail use and age have no affect on diversity. The impact on arthropod diversity from trail construction appears to be a one time impact upon construction, and use appears to have no impact. Given this result one of the limitations of this study cited (not knowing the impact of trail use) is not relevant to understanding how mountain bike trail construction affects a desert ecosystem.

There was no control group to compare trail sites to so it is possible that trail construction has no impact on arthropod diversity. The trap lines farthest away from the trail were not the most diverse at both sites. It is possible that these trap lines were not far enough away and were still showing a trail effect. There were not enough sites in this study to establish how far from a trail the trail has an affect or if it has an affect on diversity at all. Further study with additional trail sites and a control site could answer the reach of the trail question.

The intermediate disturbance hypothesis predicts that the trap lines farthest away from the trail would have the least amount of diversity and trap lines closest to the trail would have the most given the assumptions previously stated. At Chris's Kaos, the diversity is lowest near the trail and highest at the intermediate distance. At Rusty Rake, the diversity was greatest at the farthest distance and least at the intermediate distance.

The intermediate disturbance hypothesis did not predict the results of this study any better. If the trap line near the trail and the one 5 meters off the trail at Rusty Rake were combined and then compared to the trap line 10 meters off the trail, the results are consistent with the niche diversification hypothesis. Without knowing the reach of the trail effect or if there is a trail effect, this is all just speculation.

All of the trails constructed at the study site are single tract trails, meaning they are just wide enough for one bicyclist to ride on. It is possible that the method of trail construction and use in the area studied has no impact on species diversity. Additional samples of the two sites compared to one or more control sites will provide an answer to this question.