Fallen logs: creating patchiness in chenopod shrublands of South Australia

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Table of Contents

A Log Limerick

In arid lands my work does begin,
Rainfall so low it's a sin,
Soil nutrients are poor,
Plants wish there were more!
Survival each day is a win.

So what task do I have in my charge?
After all, arid lands really are large
Not beast- hoof or wing,
No, logs they're my thing,
and the plants that grow on their verge.

But before I go into detail,
Some background I must entail,
For lands that are arid,
Aren't nearly so horrid,
As a Saharan death-defying tale.

Soil nutrients and water are low,
But accumulation occurs, this we know.
In areas all bare,
It's hard to grow there,
But in patches these plants can now grow!

These patches, so varied they be,
Accumulations 'round shrub, grass and tree,
In holes and in pits,
And animal digs,
Resource islands within a bare sea.

These patches they have what plants need,
Lots of water, nutrients and even seed.
But ecosystem function,
Came to a junction,
For these patches have suffered from our greed.

We introduced grazing to the land,
Hard hooves this system must withstand,
And where grazers toil,
They churn up the soil!
And those patches they now barely stand.

Now this is where logs play their part,
I've made studying them into an art,
Soil samples and seeds,
Annual plants, even weeds,
Their effects I have teased them apart.

Logs are unique in this system,
Higher nutrients in soils around them,
Many seeds are there,
Much more than the bare,
And plant growth follows this pattern.

Soil temperature is favourable for seed,
Making establishment more likely to succeed.
Most important of all,
These affects are not small,
And occur at a very great speed.

For time is an important factor,
As restoration really does matter,
Plants grow so slow,
Restoration is low,
Thus fallen logs may just be the answer.

I introduced logs to the ground,
In degraded areas that I found,
Plant response so fast,
Only months had passed,
These logs did truly astound.

So my message to take home today,
If I only had one thing to say,
Is in lands that are arid,
And heavily degraded,
Logs may just save the day.

Abstract

Patchiness of resources strongly affects productivity and diversity of arid systems. Patchiness associated with trees, shrubs, grasses, and animal diggings are well documented but there is very little information on the effect of fallen logs. Fallen logs are one of few documented non-living structures in arid lands that contribute to resource heterogeneity. They can be particularly important in grazed systems, where most resource patches associated with living plants are reduced or destroyed. Further, logs provide a unique opportunity to study aspects of resource patchiness without them having biotic effects on annual plants. My Ph.D. thesis consists of four chapters:

Long term influence of fallen logs on patch formation and their effects under contrasting grazing regimes

Here I studied the long term dynamics of patch formation and the effect of fallen logs in heavily grazed areas. I studied soil nutrient content and soil seed banks associated with the presence of logs in the long ungrazed Koonamore Vegetation Reserve and in adjacent heavily grazed paddock in chenopod shrublands of South Australia. I studied patches associated with fallen logs of unknown age, and others known to have persisted for up to 78 years. Logs acted as traps for soil nutrients and seeds. Organic carbon and total nitrogen were higher in soils next to logs, and also higher inside the reserve than in the grazed paddock. Propagule number and species richness were higher next to logs than in open spaces and viable seeds were in much higher abundance next to logs in the grazed paddock than any other site. Increased time *in situ* of a log had some effect on soil organic carbon, total nitrogen and available potassium. Logs act as resource traps which may enhance the diversity of the system, and may be particularly important for maintaining patches of resources in areas of severe grazing damage.

Microclimate or accumulation of resources: which is the main driver of annual plant communities in a patchy system?

Here I decoupled microclimate and accumulation components of a patch to determine their relative importance for plant communities. I measured soil temperature and soil volumetric water content next to logs and in adjacent open spaces. I then conducted a soil core swapping experiment to separate these soil microclimate conditions from seed and resource accumulation to assess their importance in determining annual plant communities. Soils next

to logs had lower maximum and higher minimum temperatures than open space soils. Also, patches next to logs had lower soil volumetric water content and dried faster after a rainfall event than open spaces. The soil core swapping experiment showed complex interactions on the annual plant community suggesting that each factor has its own impact on annual plant communities.

Spatial and temporal heterogeneity of resources drive changes in community structure of arid annuals

Here I studied the effects of spatial and temporal heterogeneity on density dependence and community structure of annual plant communities. To achieve this I used fallen logs and open spaces coupled with high and low watering regimes in both the field and the glasshouse conducted over two consecutive years, encompassing two growing seasons. I found some evidence of competition among annual plant communities, but community structure of annual plants were strongly influenced by spatial heterogeneity of resources as well as watering regime. My results varied greatly across the two growing seasons, suggesting that both temporal and spatial heterogeneity of resources in arid lands are important determinants of annual plant communities.

Patch formation and patch dissipation associated with fallen logs

To study patch formation I introduced logs and fake logs (large PVC pipes) to open spaces at multiple orientations at two levels of grazing degradation. I assessed soil properties and any changes to annual plant communities over the three following years. I found that three years was not sufficient for creating changes to soil nutrients or annual plant communities when introducing logs, but the destocking which occurred during my experiment had a strong effect on soil nutrient contents. To look at patch dissipation I selected logs in pairs and one of each fallen log was removed. At each of log, open space and removed log I deployed soil temperature and moisture probes. I also collected soil samples to determine soil nutrient contents and soil seed bank across a one year period I found the removal of the log had immediate changes to the microclimate associated with the log, but that one year was not long enough to remove accumulated nutrients or seeds in the seed bank.

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