

# Decomposition and Carbon/Nitrogen Cycling



## Decomposition

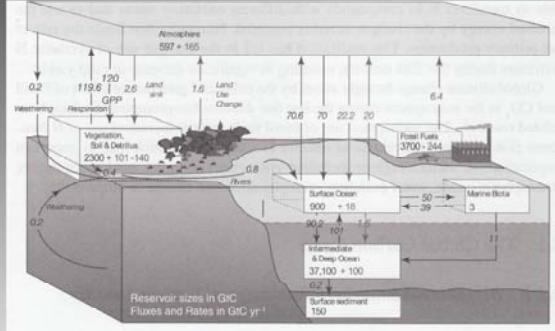
Key ecosystem process, integrating NPP to NEP

Processes near equivalent quantities of C per annum to that of photosynthesis

Pathway for development of soil organic matter and long-term C sequestration

Pathway for release of CO<sub>2</sub> into atmosphere...access to very large C pool

Pathway for nutrient turnover, provision and supply



Balance between production and decomposition is fuel load

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## Decomposition

Despite this importance...understanding of the decomposition process is poor

Lack mechanistic, process based model which can fully describe the decomposition process

We know that controlling factors vary with spatial scale

Climate is the more distal controller...latitudinal scale

e.g. Meentemeyer model includes evapotranspiration

On smaller spatial scales, litter chemistry is the proximal control

e.g. Aber and Mellilo model includes lignin:N ratio

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## Decomposition – In the (sub-) alpine

What about decomposition in alpine environments?

Alpine unique due to:

- High biodiversity in species
- High diversity of functional groups
- Steep micro-environmental gradients
- Plant distribution discrete and strongly linked to microclimate

Alpine represents the intersect between climate and litter

What is the inter-relationship climate and litter chemistry?

Alpine systems are unique in their ability to test these questions

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## Decomposition – Methodology

Study sites located on the Bogong High Plains, Victoria

Community structure follows an inverted tree-line

*Eucalyptus pauciflora* spp. *Niphophylla* (SW) on shallow soil, rocky exposed ridges

Open Heathland shrubs midslope (OH)

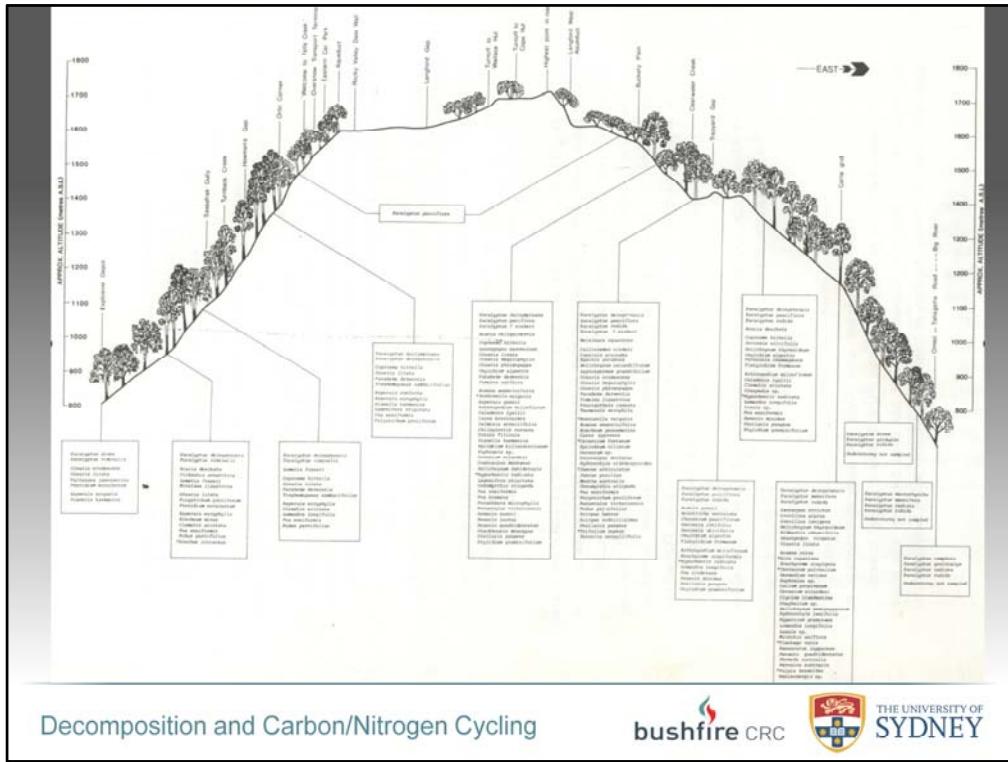
*Poa* spp. grassland/herbfield (GH)

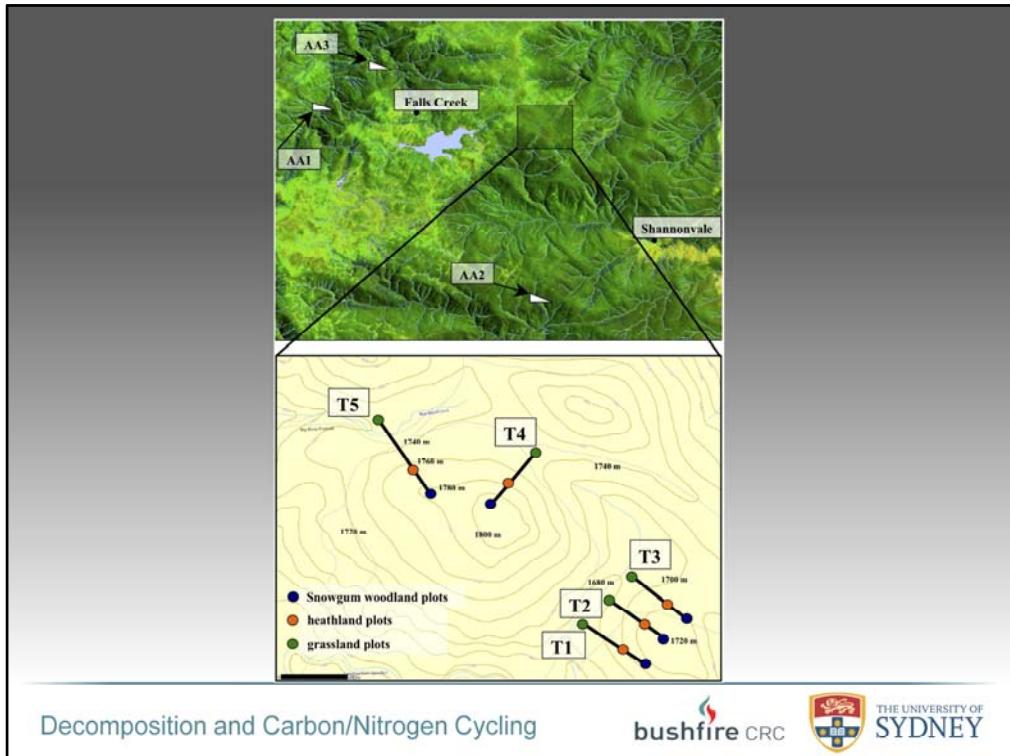
Established five replicate transects which included each of these three community types

Additional sites in surrounding *Eucalyptus delegatensis* montane forest (MF)

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## Decomposition – Climate Methodology

Logging stations established in each community type (n=3)

Additional sensors deployed in SW and MF sites

Logged

Air temperature (SW/MF only)  
Relative humidity (SW/MF only)  
Surface temperature  
Soil temperature (2cm)  
Soil temperature (5cm)

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## Decomposition – Buried Bag Methodology

Collected litter samples from the three major transect communities

Represent distinct functional growth forms

Included an agronomic legume (*Medicago sativa*) as an external standard

All litters:

Air dried

Placed (unprocessed) into nylon mesh bags (gap 1 - 1.5mm)

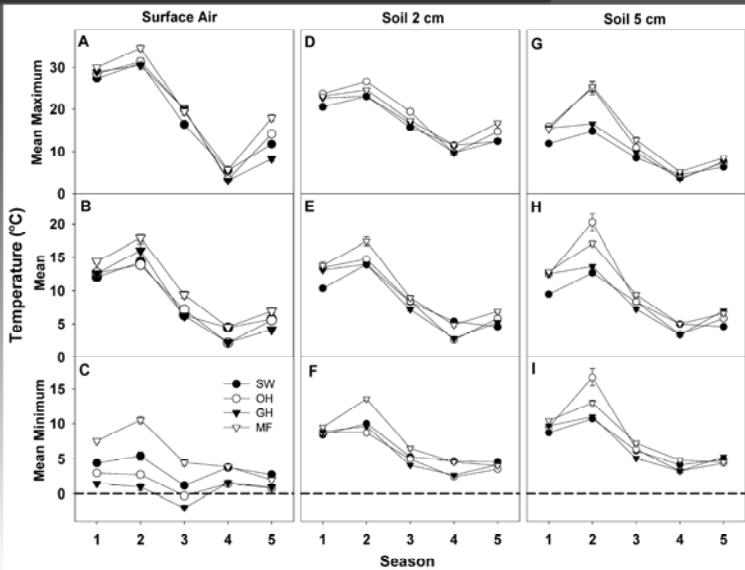
Buried in duplicate

Sub-sampled and analyzed for initial chemical makeup

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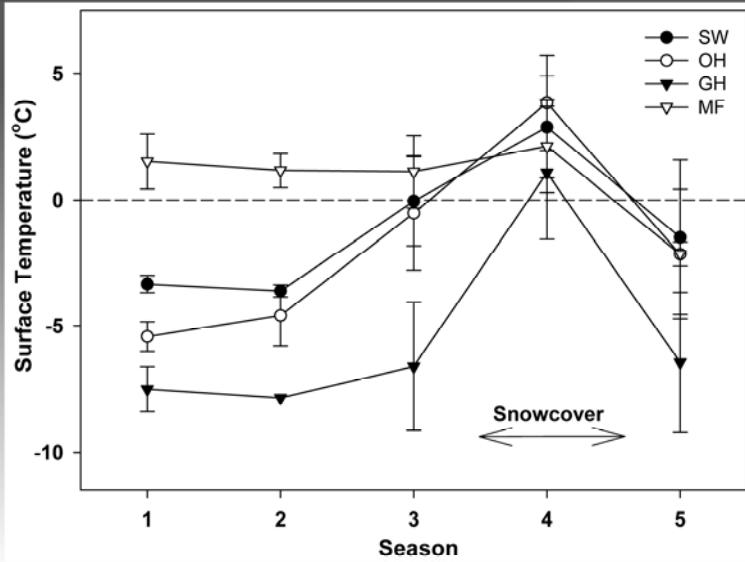
## Decomposition – Climate Results



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## Decomposition – Climate Results

Clear relationships between slope position and mean minimum/extreme minimum temperatures only

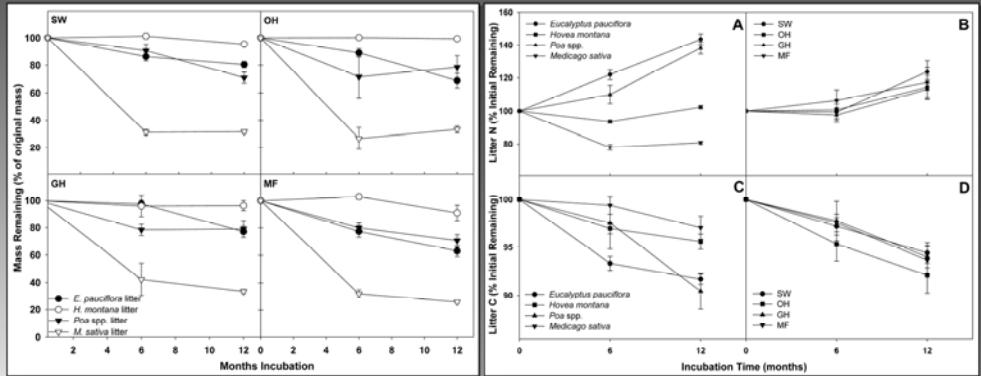
Supports the conclusions of Williams and Ashton (1987)

Points to cold-air drainage as an influential factor in determining plant functional group distribution

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## Decomposition – Decomposition Results



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## Decomposition – Litter Chemistry

	Total C (%)	Total N (%)	C:N	Crude Cellulose (%)	Lignin (%)	Lignin:N
<i>E. pauciflora</i> foliage	51.9	1.7	30.7	22.3	38.5	22.5
<i>H. montana</i> foliage	50.9	2.4	21.5	27.2	28.2	11.8
<i>Poa</i> spp. foliage	40.1	0.8	50.4	30.4	7.1	8.7
<i>M. sativa</i> foliage	41.8	3.4	12.4	25.1	6.5	2.1

As a collective, litter represent good ranges in most major indices of litter chemistry

One would suspect that these may explain variation in rates of mass loss...

No combination of litter chemistry or microclimatic condition significantly explained rates of mass loss

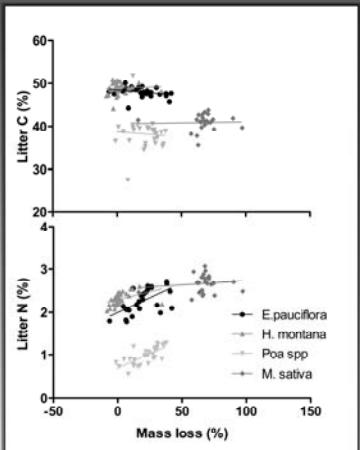
## Decomposition – Litter Chemistry

Variable	Fixed Factor	Six Month			Twelve Month			Total		
		F	df	P	F	df	P	F	df	P
Mass Loss (%)	Litter type	52.96	3	<0.001*	145.22	3	<0.001*	125.66	3	<0.001*
	Landscape position	0.83	3	0.483	2.73	3	0.056	1.54	3	0.209
	Litter type x Landscape position	0.92	9	0.517	1.01	9	0.449	0.54	9	0.841
Change C (%)	Litter type	2.58	3	0.064	8.92	3	<0.001*	7.05	3	<0.001*
	Landscape position	0.52	3	0.670	1.54	3	0.215	1.32	3	0.272
	Litter type x Landscape position	1.75	9	0.104	1.40	9	0.214	2.48	9	0.013
Change N (%)	Litter type	25.43	3	<0.001*	127.91	3	<0.001*	71.73	3	<0.001*
	Landscape position	0.31	3	0.819	1.20	3	0.319	0.48	3	0.695
	Litter type x Landscape position	0.42	9	0.921	1.44	9	0.198	0.30	9	0.974

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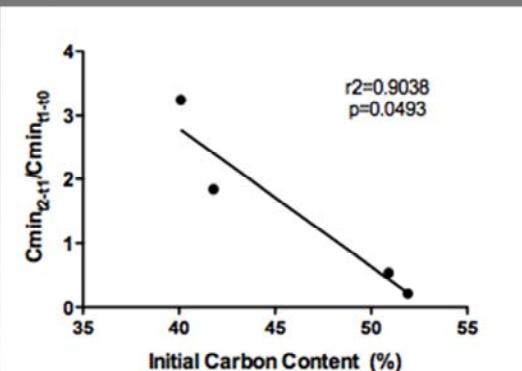


## Decomposition – Litter Chemistry



C is not lost in significant proportions with decomposition

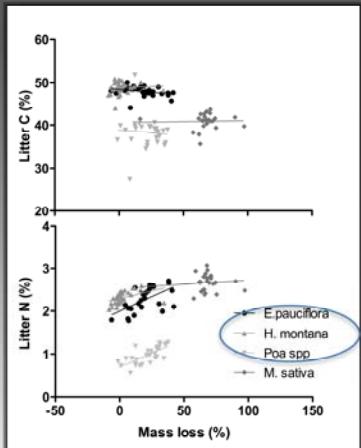
Timing of C release related to initial C content



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## Decomposition – Litter Chemistry



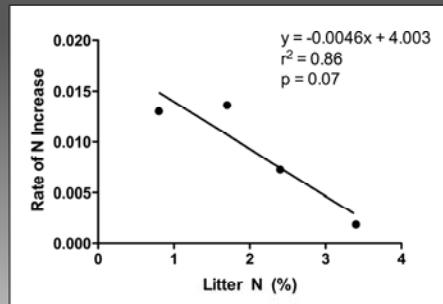
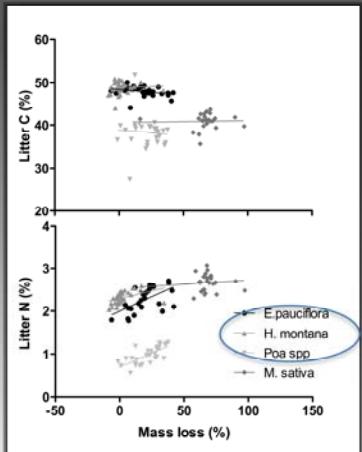
General trend of N immobilisation as decomposition proceeds

Significant relationships for all but *Medicago*

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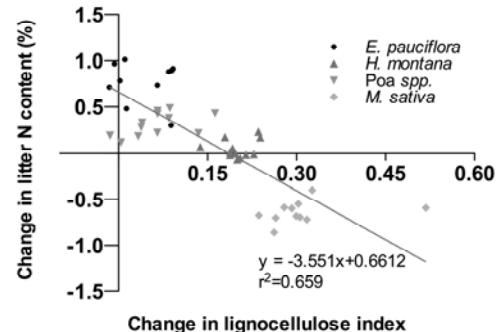
## Decomposition – Litter Chemistry



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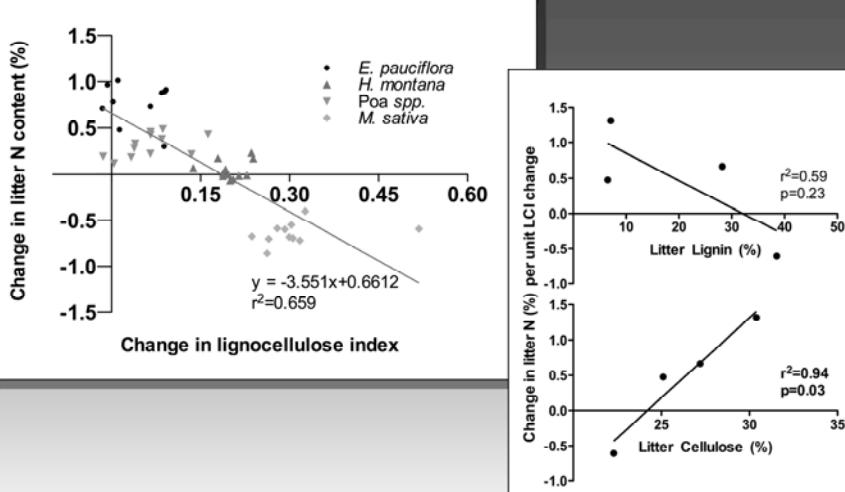
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Decomposition and Carbon/Nitrogen Cycling



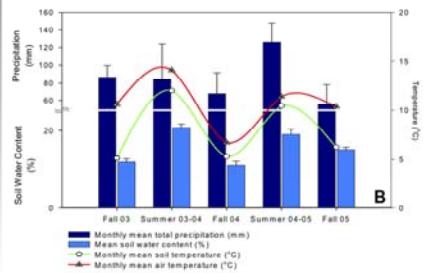
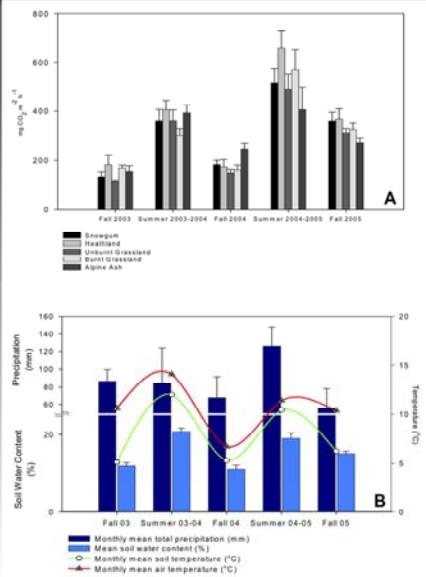
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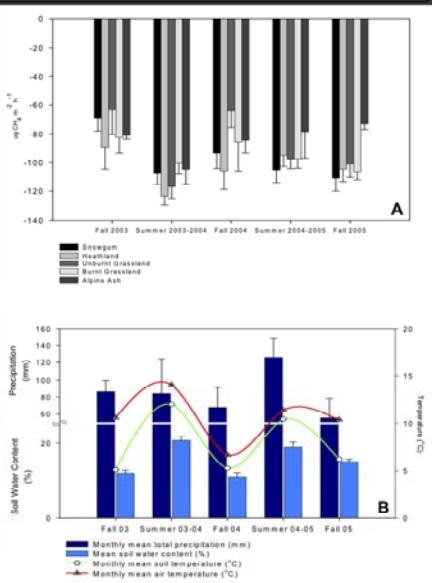
## Decomposition – Trace gas fluxes



Decomposition and Carbon/Nitrogen Cycling



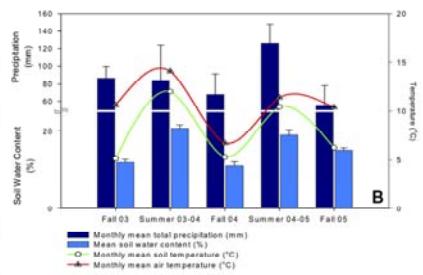
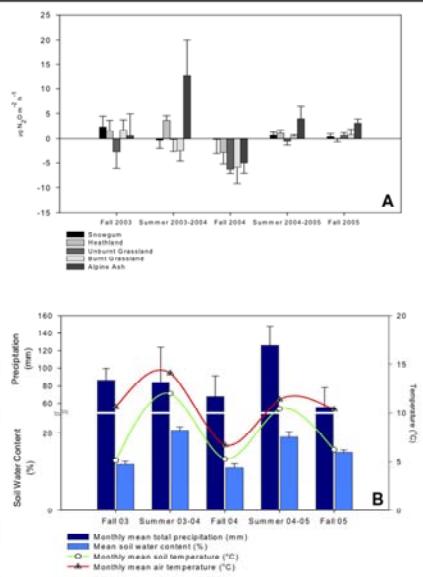
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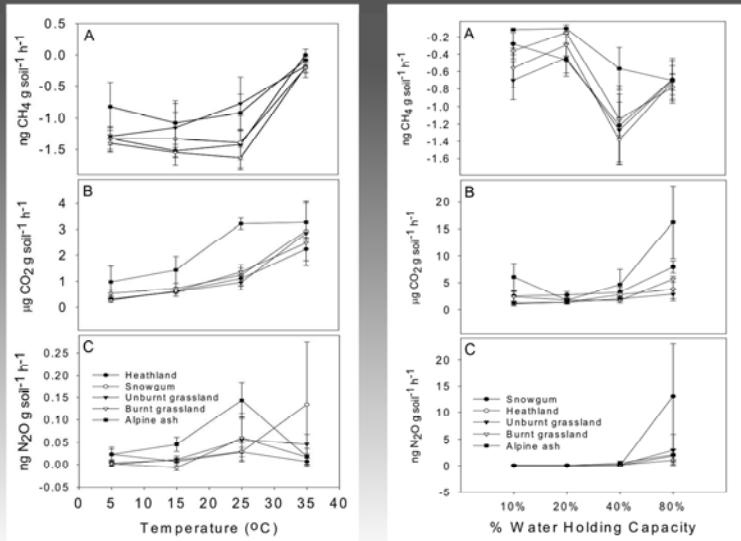
## Decomposition – Trace gas fluxes



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## Decomposition – Trace gas fluxes



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## Decomposition – Trace gas fluxes

Microclimate has no influence on rates of mass loss either between litter types or within litter types

Litter type the sole determining factor of mass loss

No single litter chemistry variable can predict observed rates of mass loss

No existing model of decomposition can resolve observed rates of mass loss

Initial carbon content explains the timing of C mineralisation from decomposing litter

N immobilisation/mineralisation dependent on initial N concentration

Soils from study communities did not differ in production of CO<sub>2</sub> and N<sub>2</sub>O or uptake of CH<sub>4</sub>

Soils from study communities show little variation during *in vivo* incubations and respond similarly to temperature and moisture

Data from grassland plots suggest no acute effect of fire on trace gas budgets

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## Decomposition – Trace gas fluxes

Climate change will affect sites more through alterations to plant/community distribution

Interaction between fire and plant/community distribution also significant

Disparate rates of mass loss combined with rates of litter production => assessing fuel loads

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