The effect of prescribed fire severity & burn patchiness on runoff & erosion

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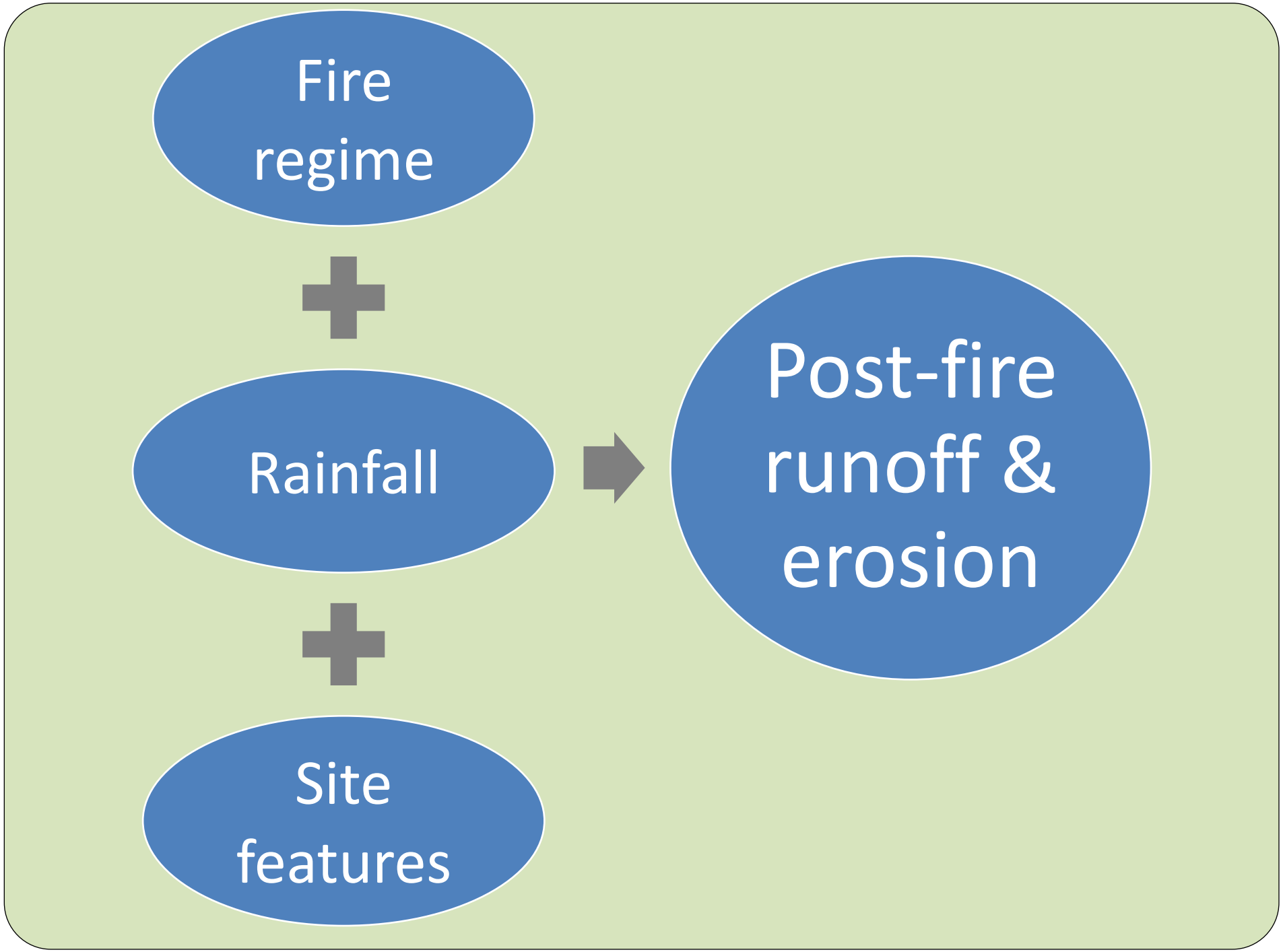
CRC for Forestry
Researching sustainable forest landscapes

Runoff & erosion after a wildfire can affect water quality

Debris flows are an example of extreme post-fire erosion

- Prescribed burning = deliberate use of fire to achieve objectives
- Little is known about its effects on water quality

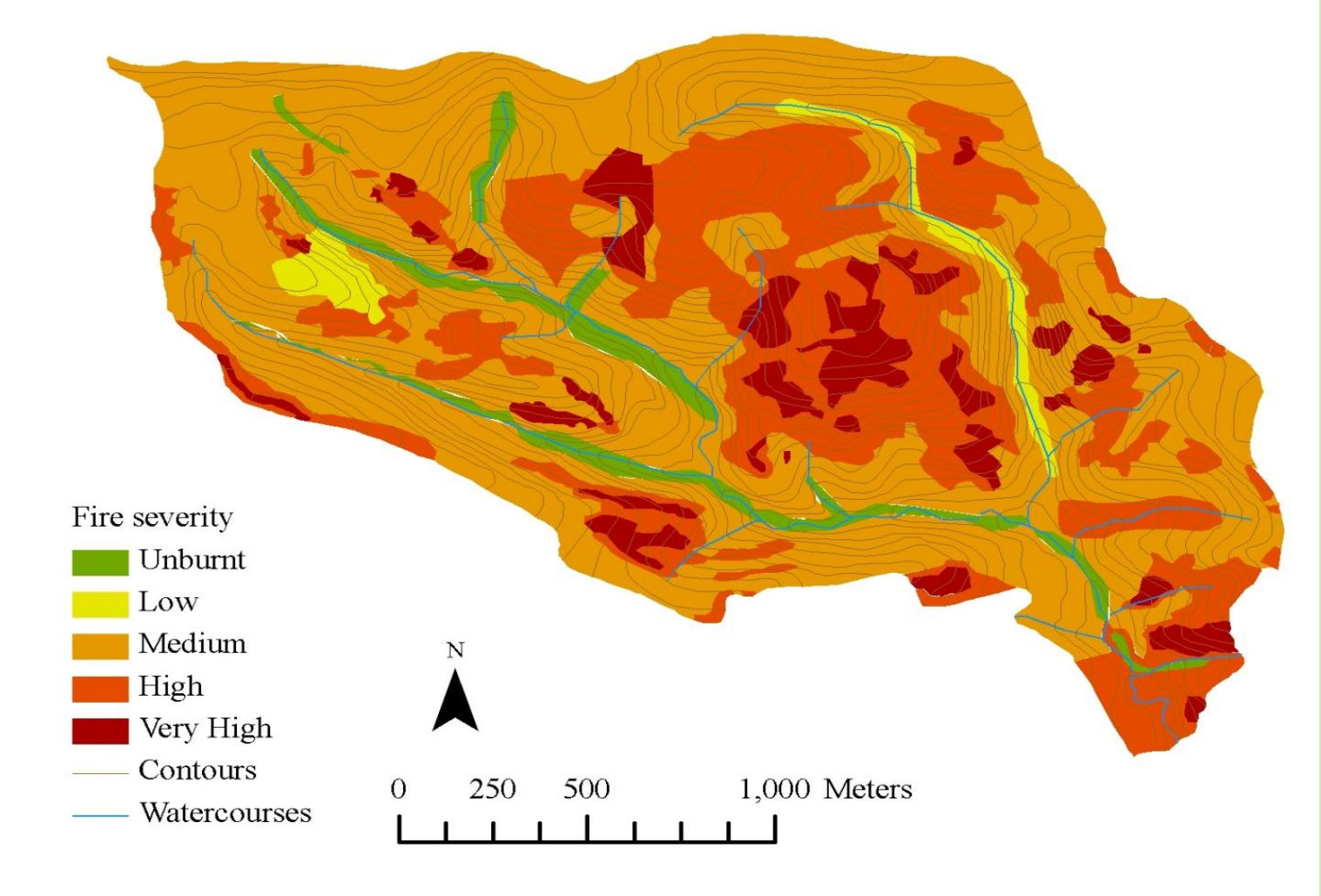

Fire regime
Rainfall
Site features
Post-fire runoff & erosion

Fire severity and burn patchiness can be manipulated in a prescribed burn

Fire severity

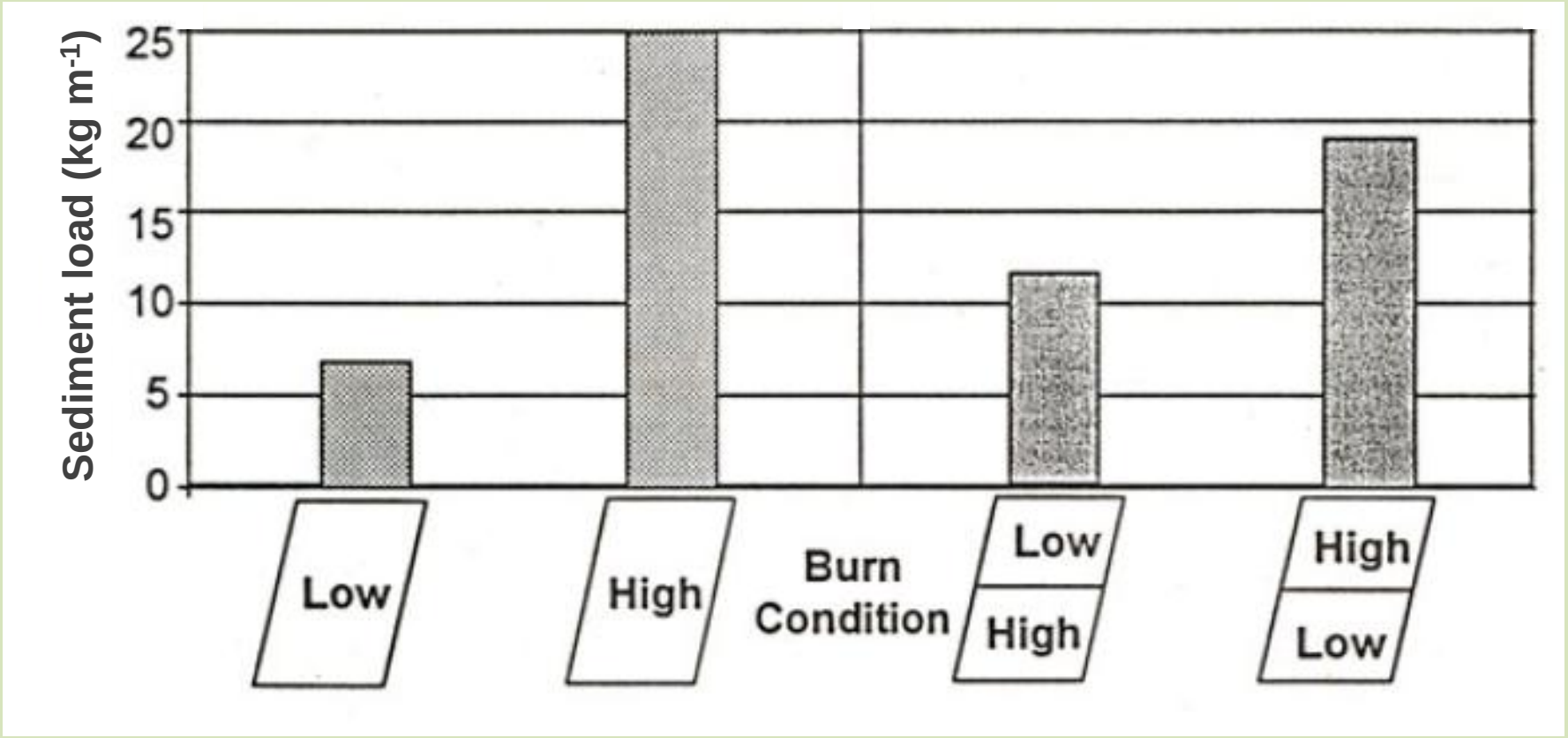
Considered an important factor, but few studies compare different fire severities

Burn Patchiness



Key factors: patch arrangement & density

Study by Robichaud & Monroe (1997) in a North American ponderosa pine forest

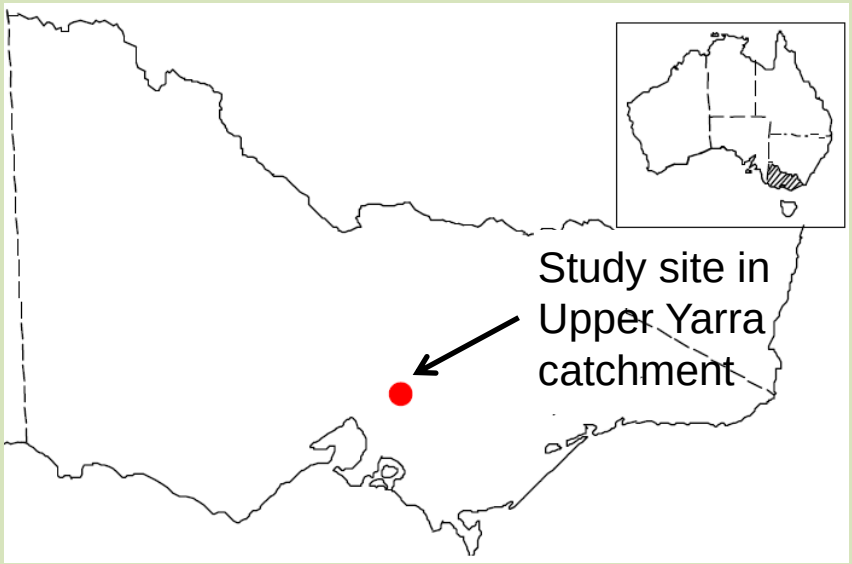


Aims of study were to quantify the:

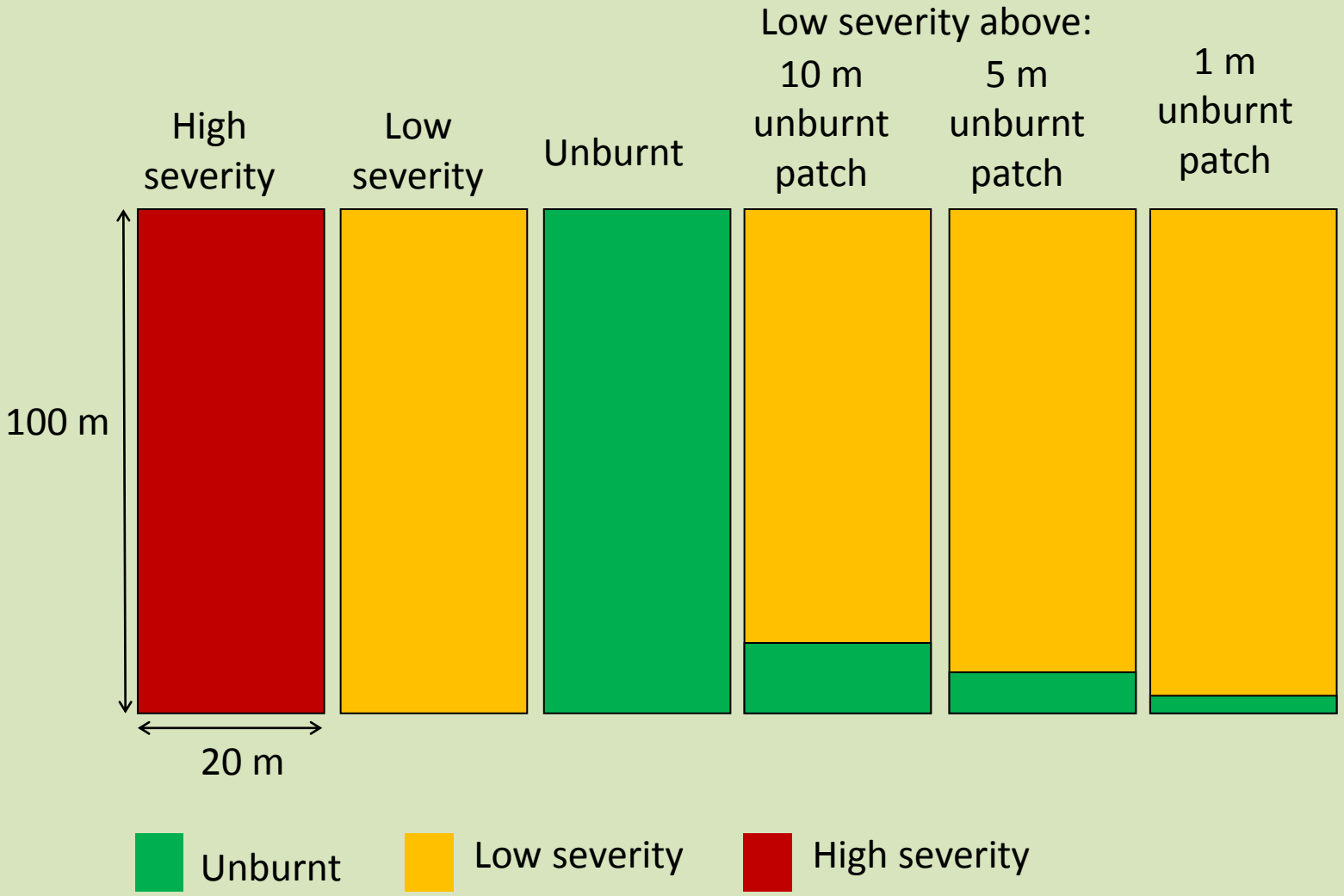
- effect of prescribed fire severities on runoff and erosion
- runoff and sediment trapping efficiency of unburnt patches

Site description

- North-facing slopes
- Shrubby foothill forest (EVC)
- Clay-loam soil
- Burnt April 2009



Methods

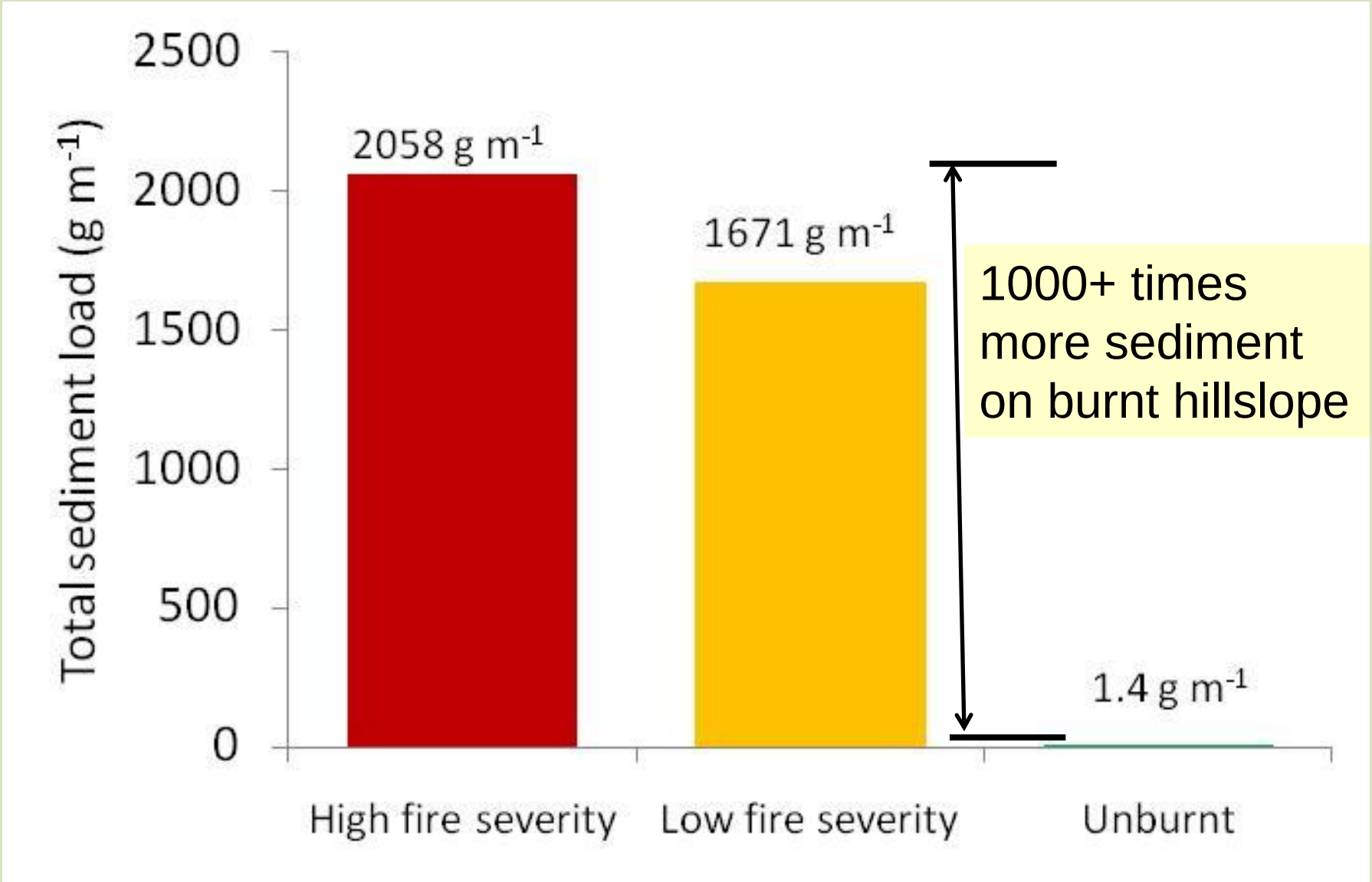

High severity
Low severity
Unburnt
Low severity above:
10 m unburnt patch
5 m unburnt patch
1 m unburnt patch
100 m
20 m
Unburnt
Low severity
High severity

Results

Results

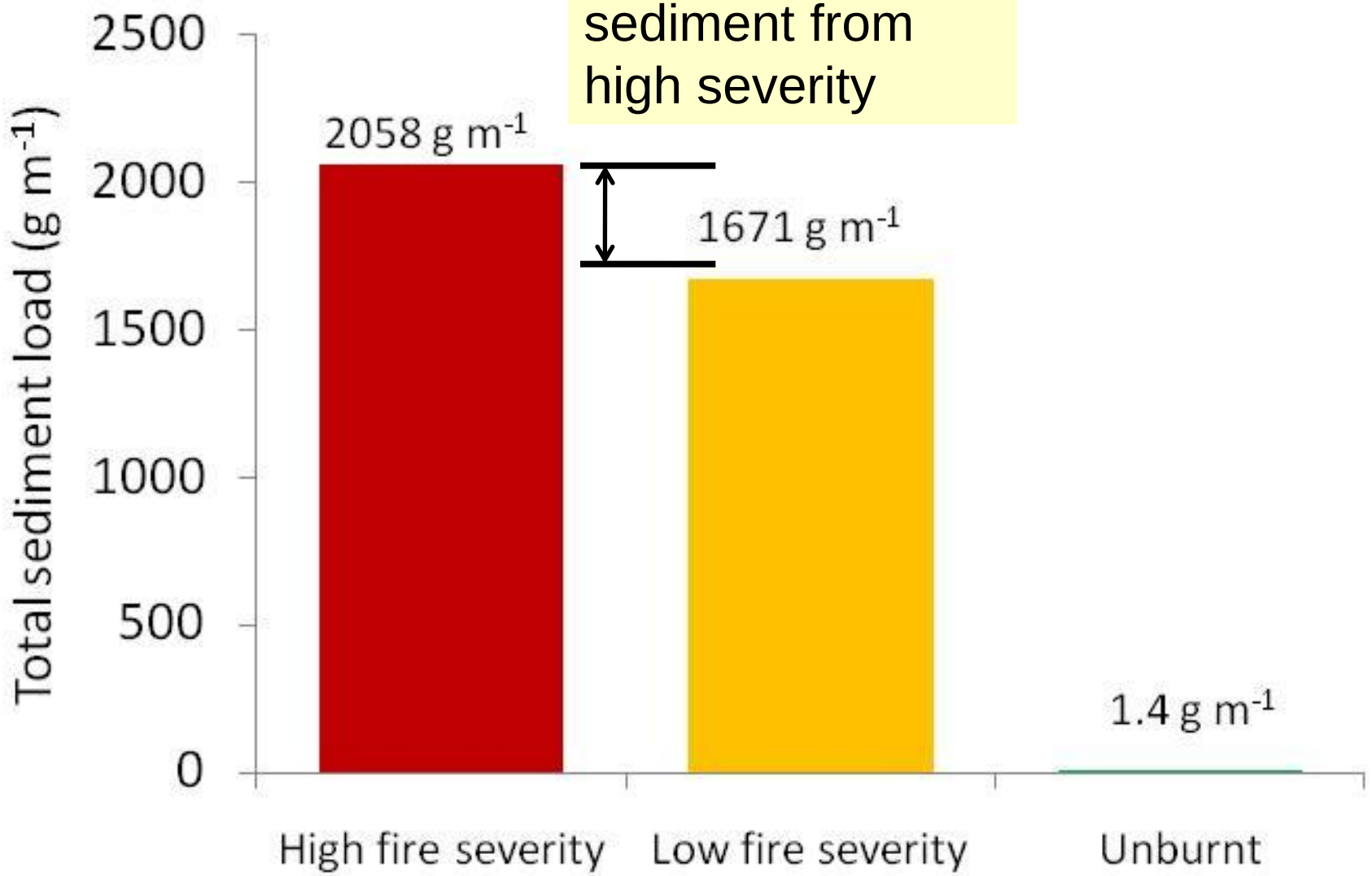

Total sediment load (g m-1)
2500
2000
1500
1000
500
0
2058 g m-1
1671 g m-1
1.4 g m-1
High fire severity
Low fire severity
Unburnt

Results

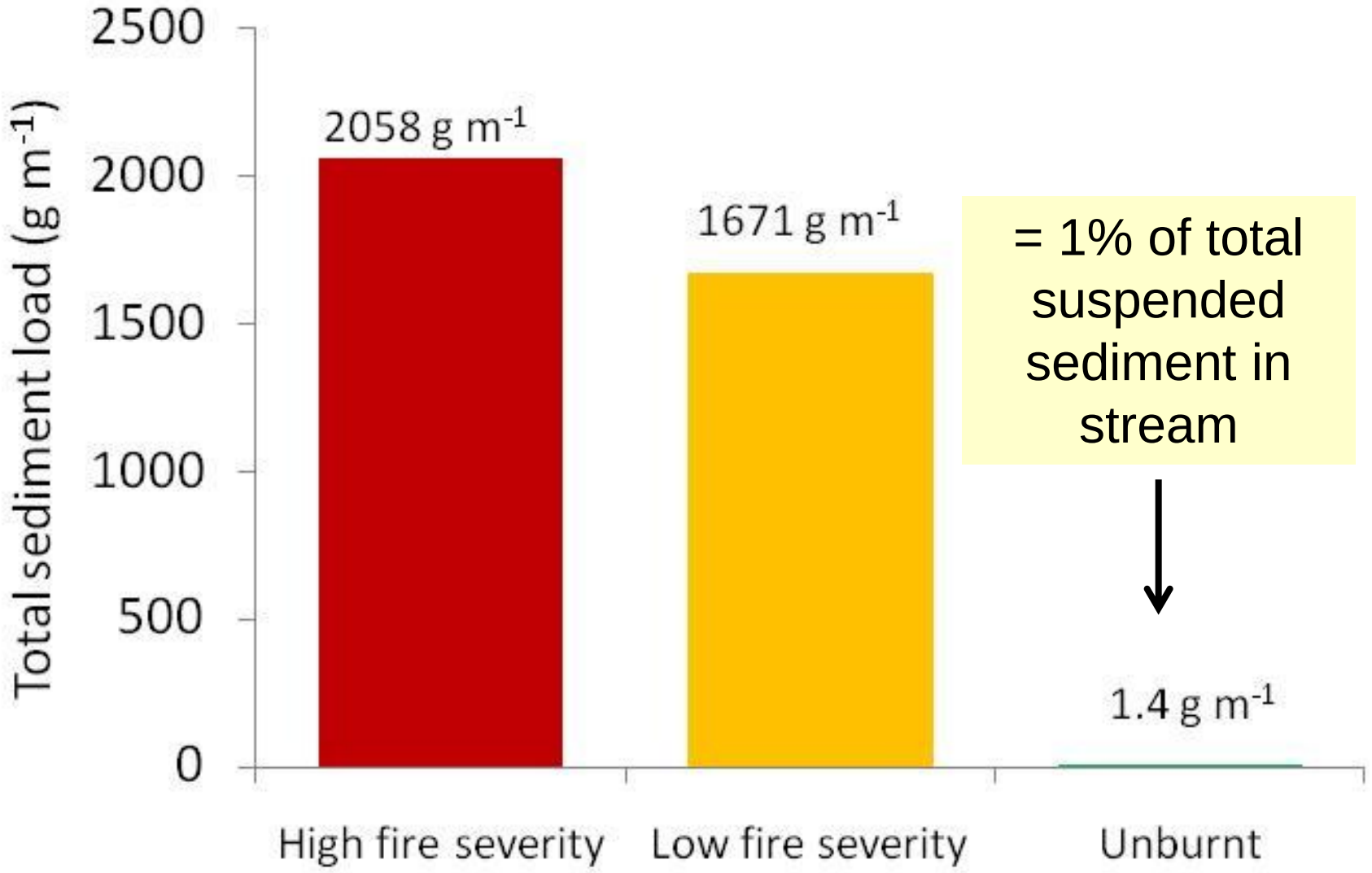

Total sediment load (g m-1)
2500
2000
1500
1000
500
0
2058 g m-1
1671 g m-1
1.4 g m-1
1000+ times more sediment on burnt hillslope
High fire severity
Low fire severity
Unburnt

Results

Only 13% more sediment from high severity



Results: compared to instream suspended sediment yields in a similar unburnt catchment (Bren & Turner, 2007)



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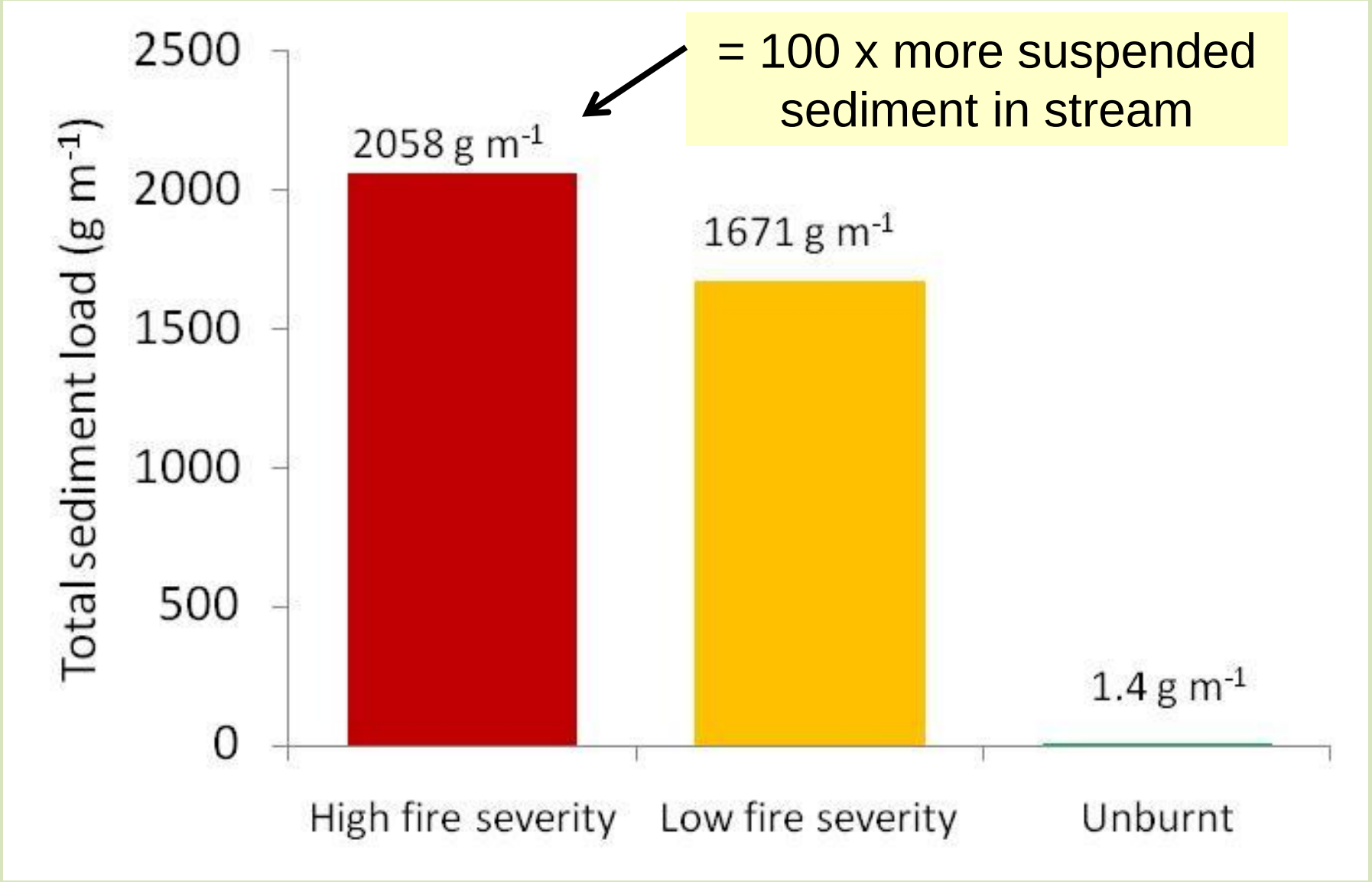
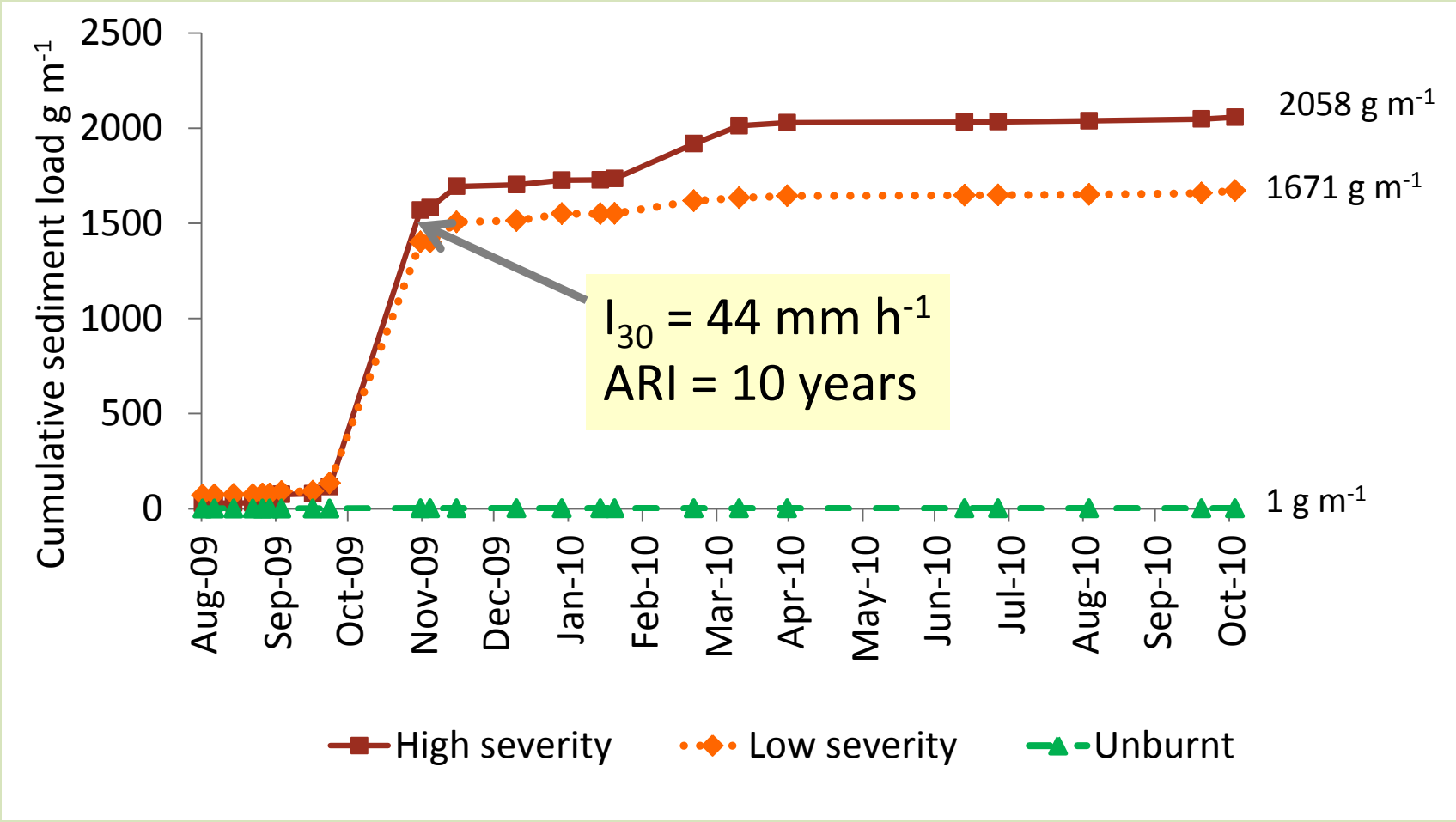


Results



Intense storms were very influential

Revisit objective 1

Effect of prescribed fire severities on runoff and erosion…

- burning substantially increases runoff & erosion

- fire severity is less important

(in the context of prescribed burning)

Low fire severity

=

High fire severity

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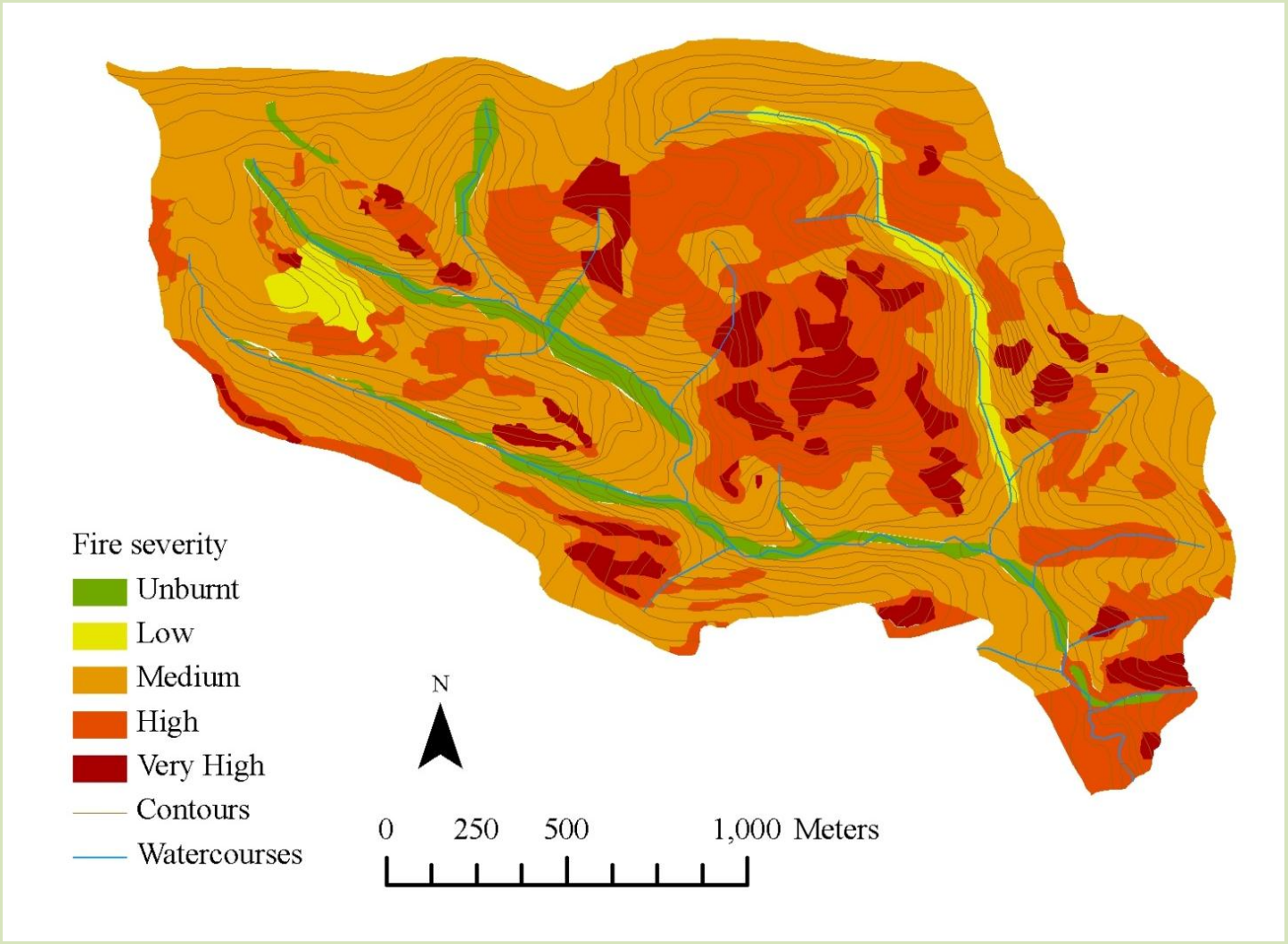
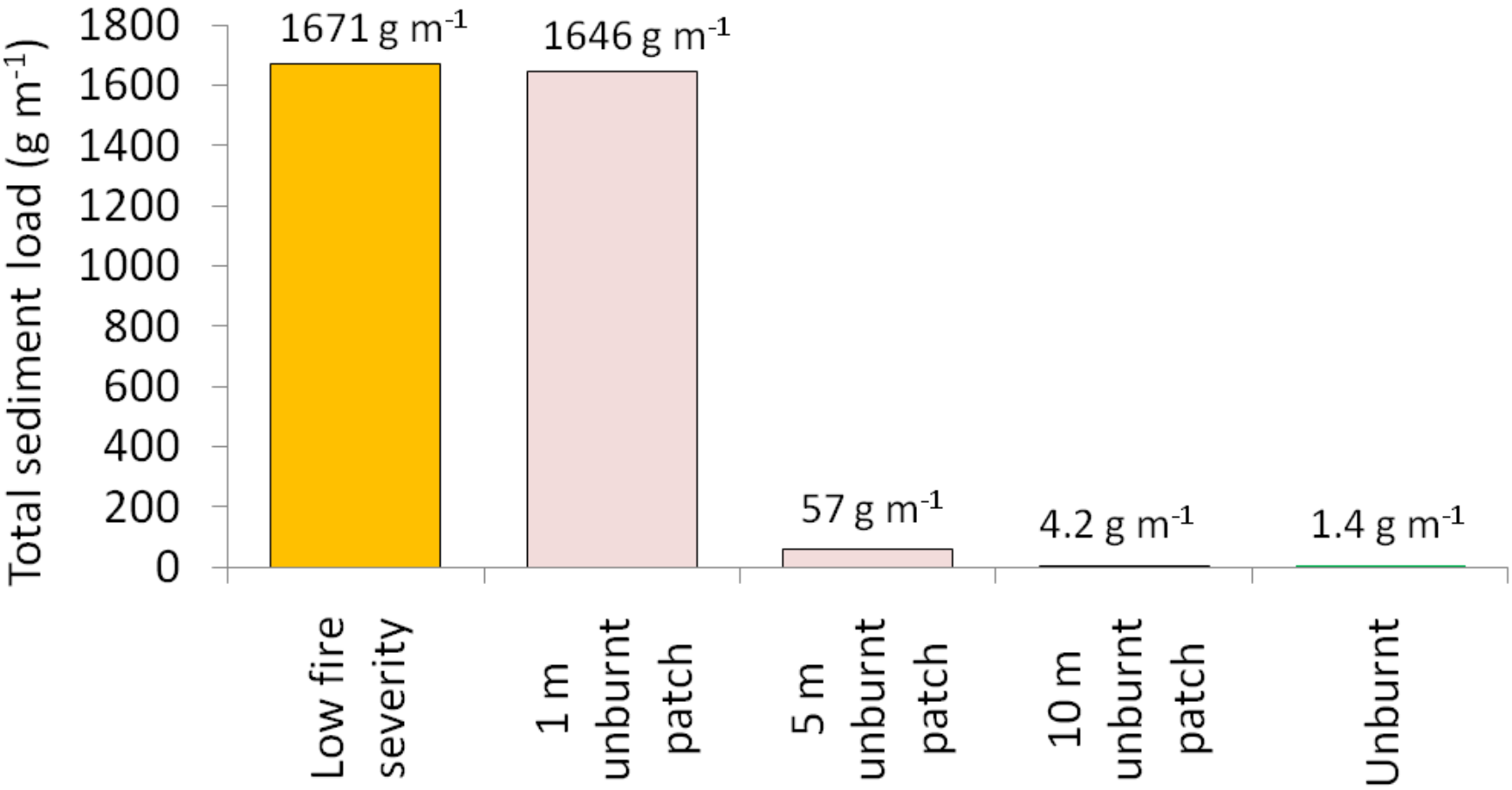


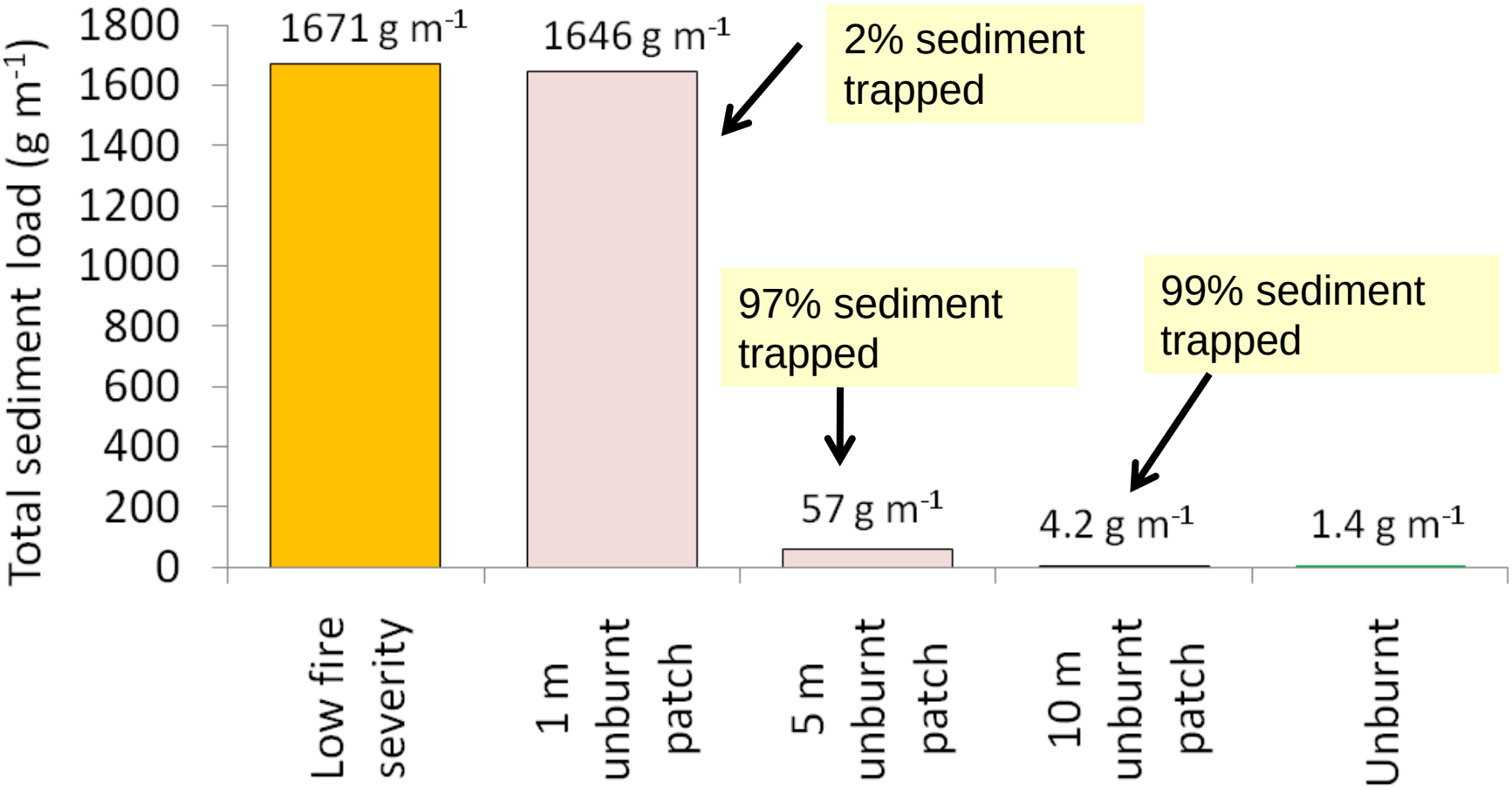
Does patchiness help prevent water quality impacts?

Results



Sediment trapping efficiency varied as a function of patch width

Results



Sediment trapping efficiency varied as a function of patch width

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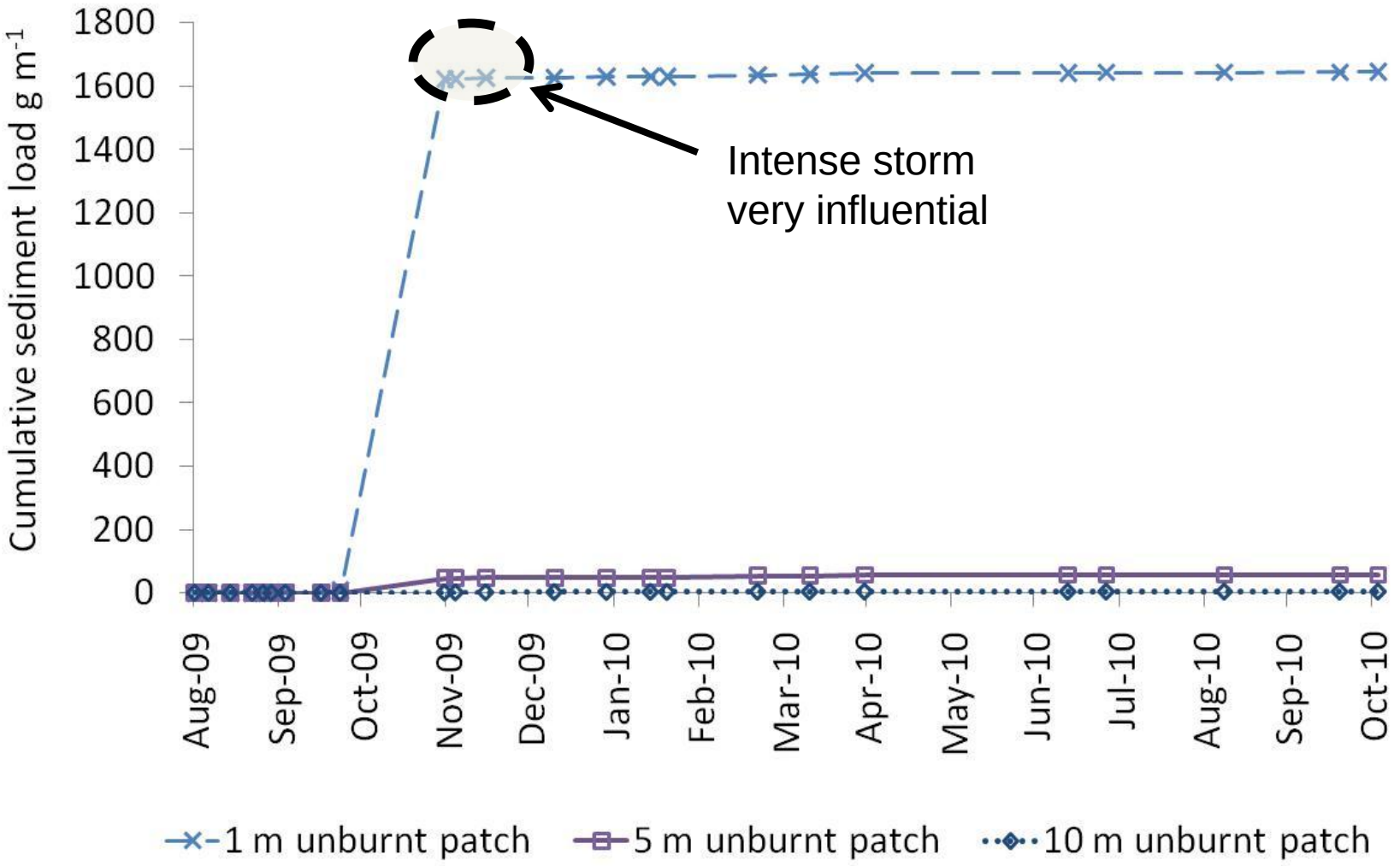
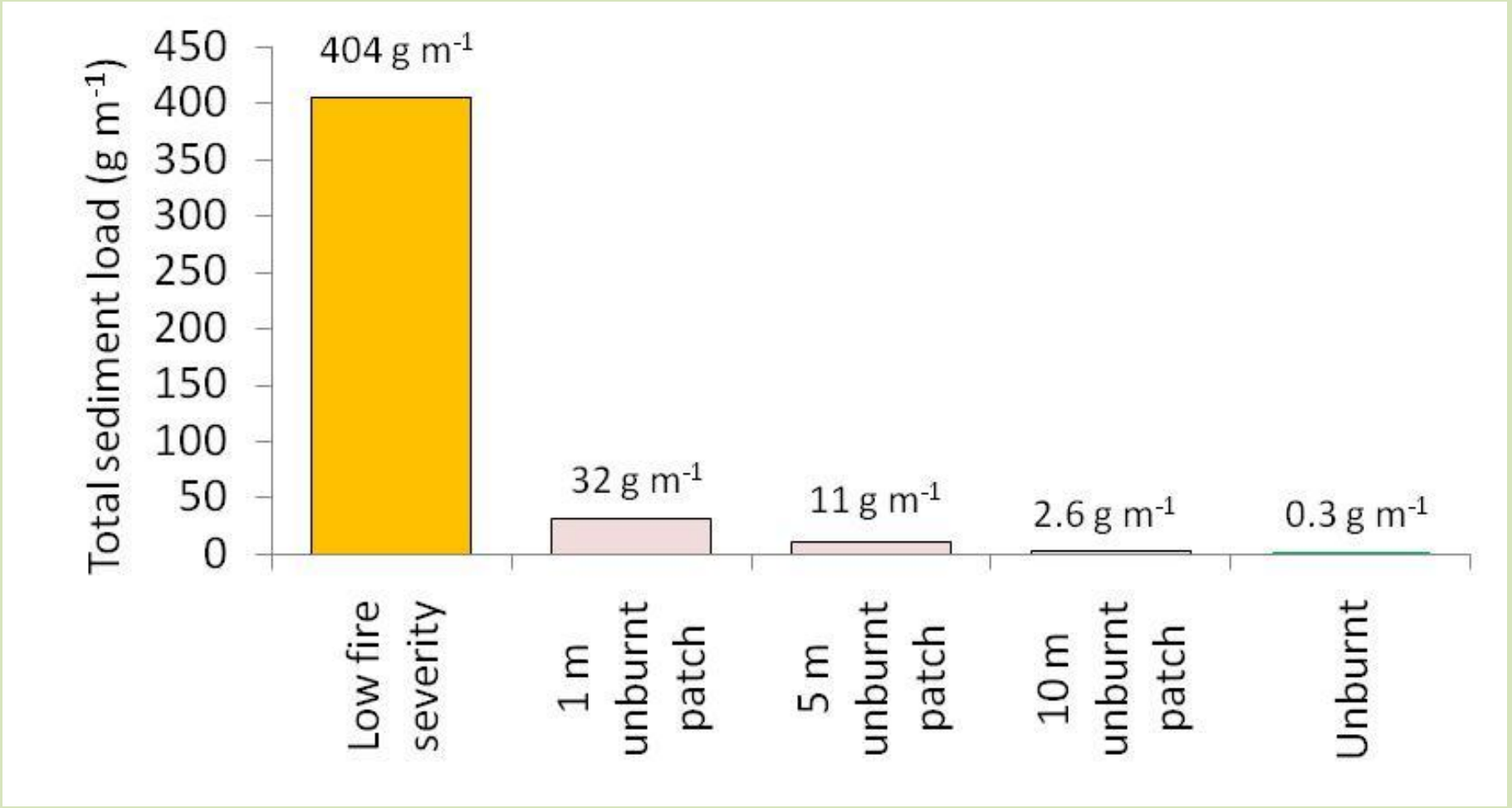

Cumulative sediment load g m-1
1800
1600
1400
1200
1000
800
600
400
200
0
Intense storm
very influential
Aug-09
Sep-09
Oct-09
Nov-09
Dec-09
Jan-10
Feb-10
Mar-10
Apr-10
May-10
Jun-10
Jul-10
Aug-10
Sep-10
Oct-10
1 m unburnt patch
5 m unburnt patch
10 m unburnt patch

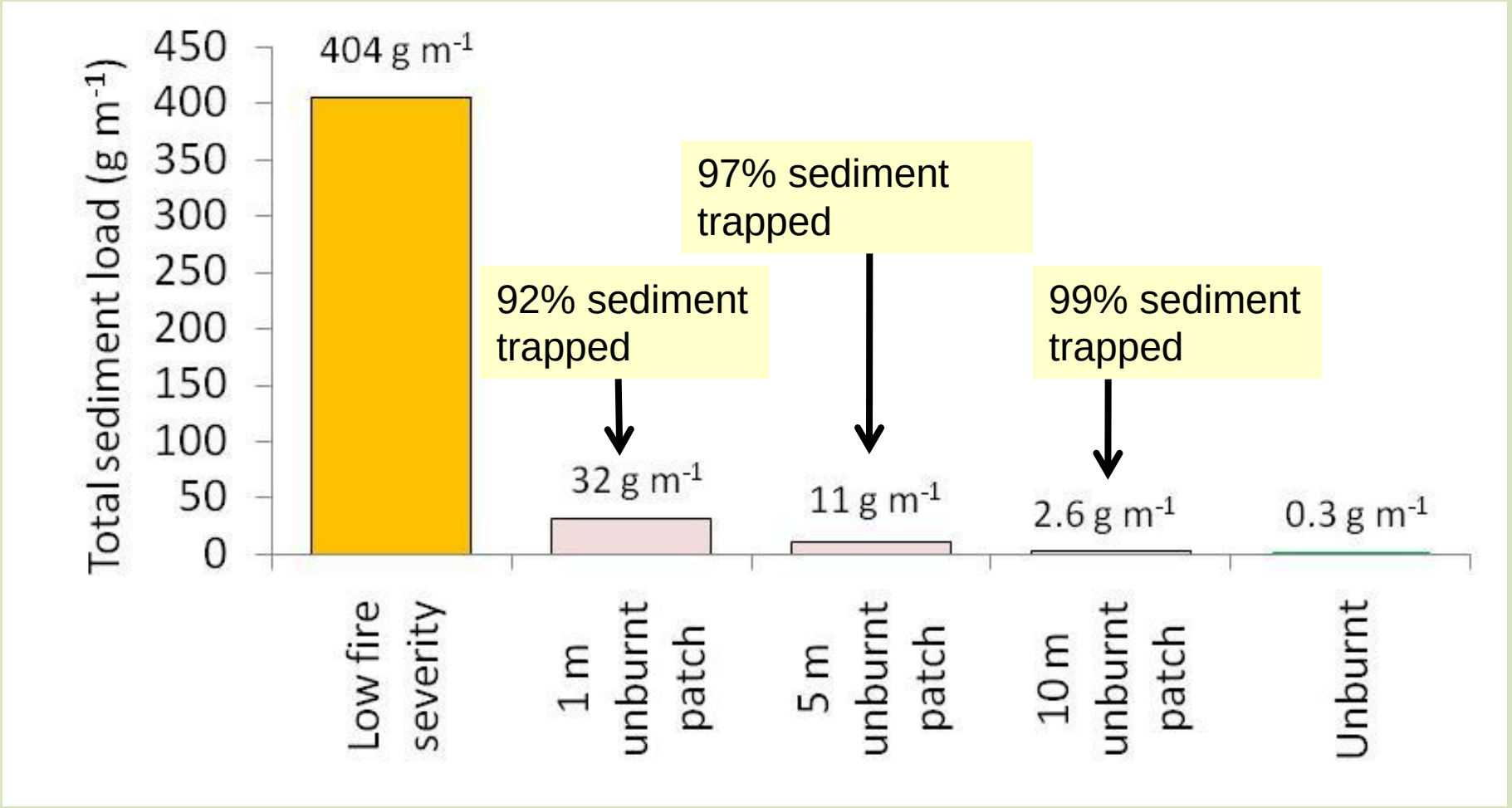
Results



Excluding 27-Nov-09 rainfall event

(all other events with ARI < 1 year)

Results



Excluding 27-Nov-09 rainfall

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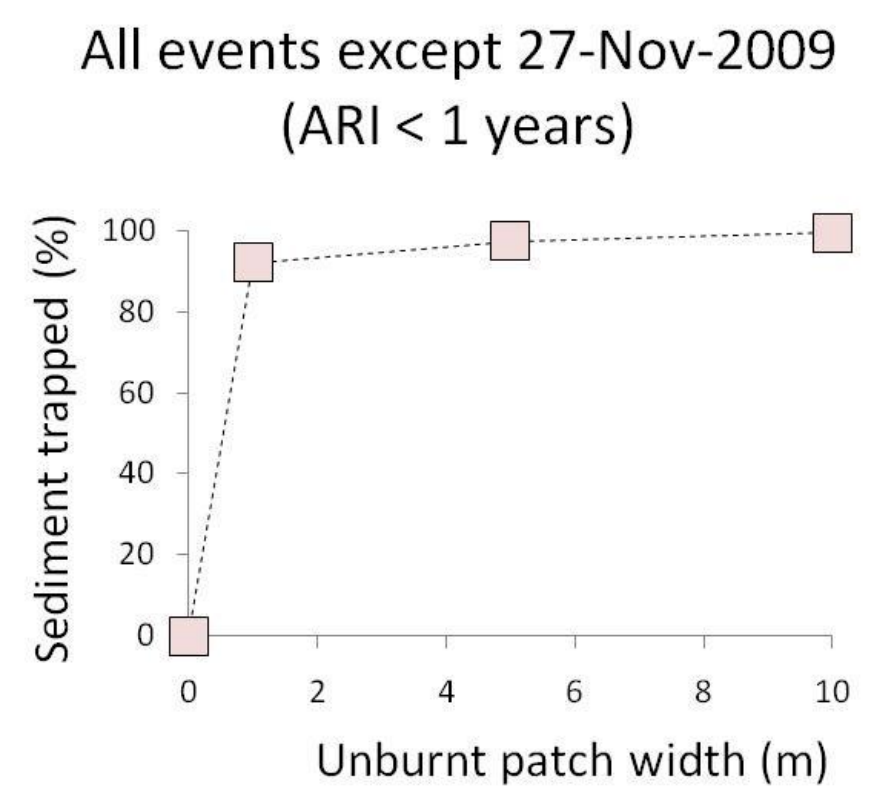
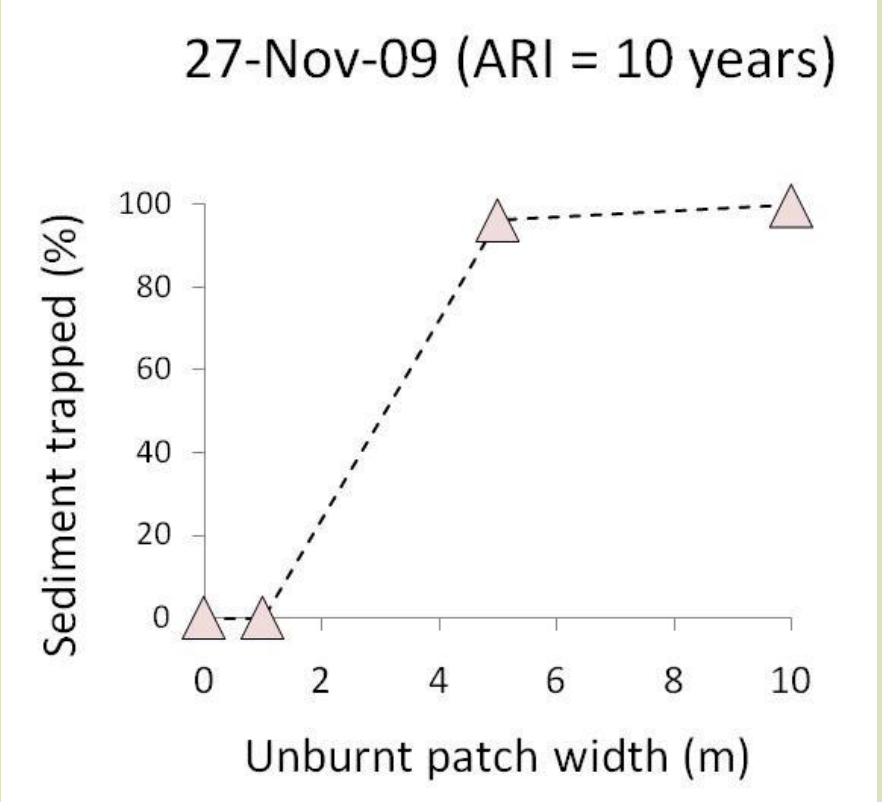
Results





Trapping efficiency varied as a function of patch width & rainfall intensity

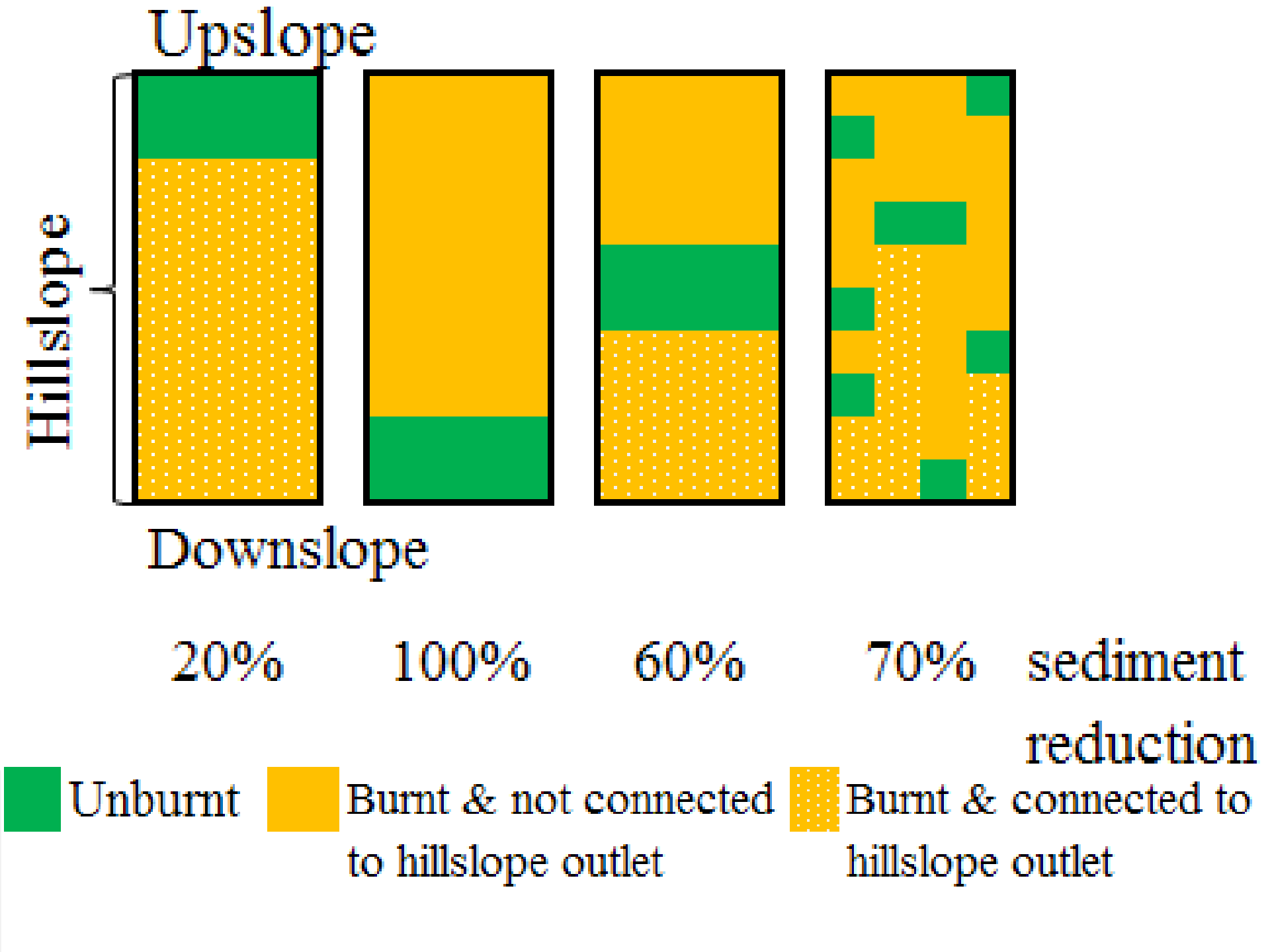
Revisit objective 2

Quantify the runoff & sediment trapping efficiency of unburnt patches…

- unburnt patches are effective sediment traps
- trapping efficiency depends on patch width & rainfall intensity

Management implications

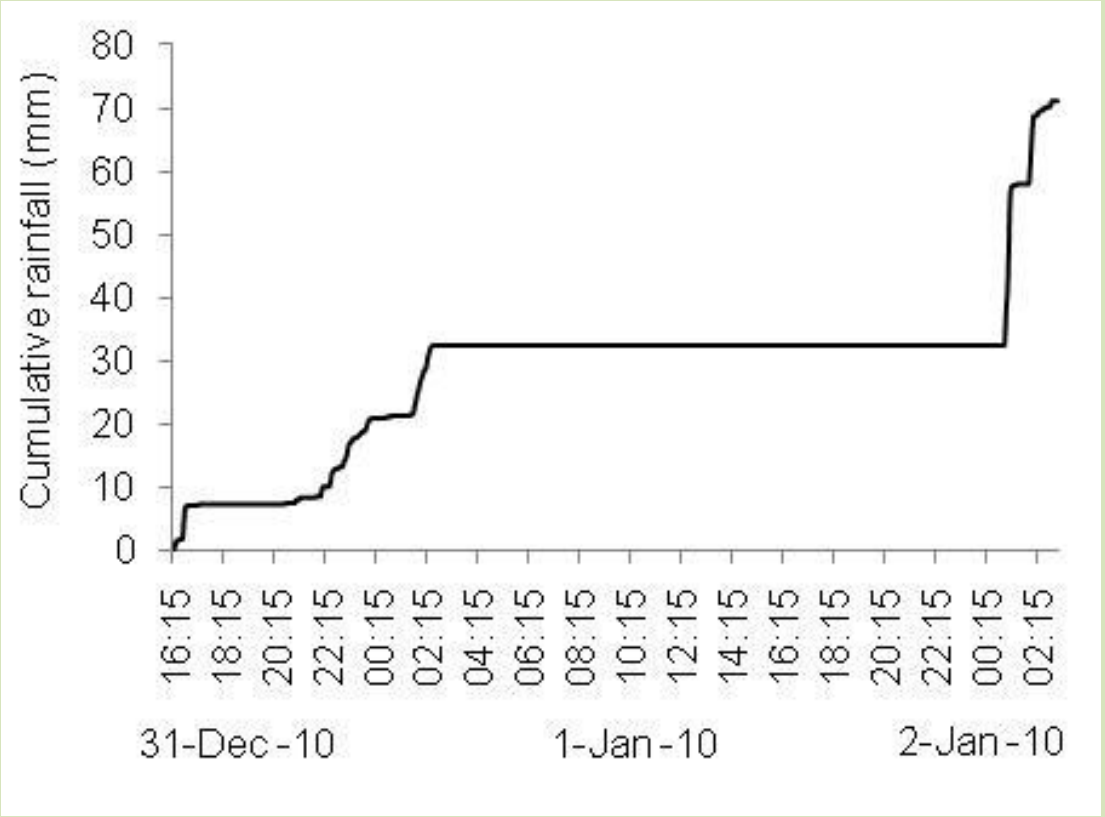
- Prescribed burning could affect water quality
- Those impacts may be reduced by maintaining unburnt patches
- Fire severity is less important


Upslope
Hillslope
Downslope
20%
100%
60%
70%
sediment reduction
Unburnt
Burnt & not connected to hillslope outlet
Burnt & connected to hillslope outlet

Patchiness reduces the impact of burning on water quality under moderate rainfall conditions

What about more intense rainfall?

- Patchy burn
- 9-months of recovery
- Steep terrain
- 39 mm in 2 h



- Debris flows are probably unavoidable
- But burn patchiness may reduce their magnitude
- More research is needed

Conclusions

- Burning increases the sediment yield >1000 x
- Only 13% more sediment generated for high severity compared with low severity
- Unburnt patches trap 92-99% sediment for rainfall events with an ARI < 1 year
- For more intense rainfall events (ARI = 10 years) the 1 m unburnt patch is ineffective

Acknowledgements

Thanks to:

- Chris Sherwin for designing & building the runoff samplers
- many people for helping with the fieldwork

Questions…