Wildfire & the stream-riparian web of life: observations & management implications

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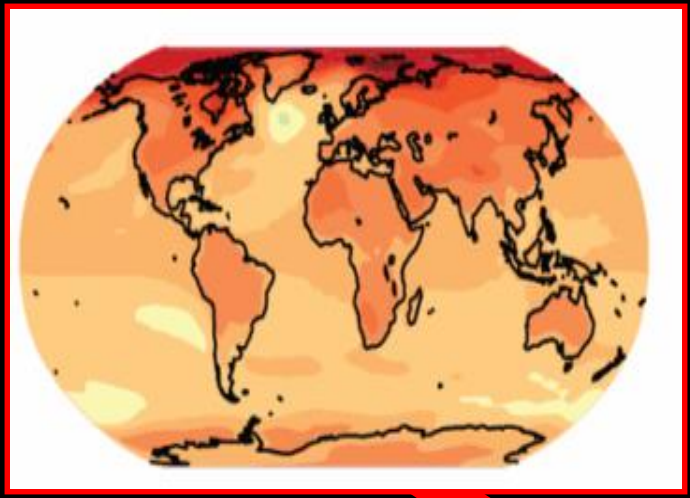
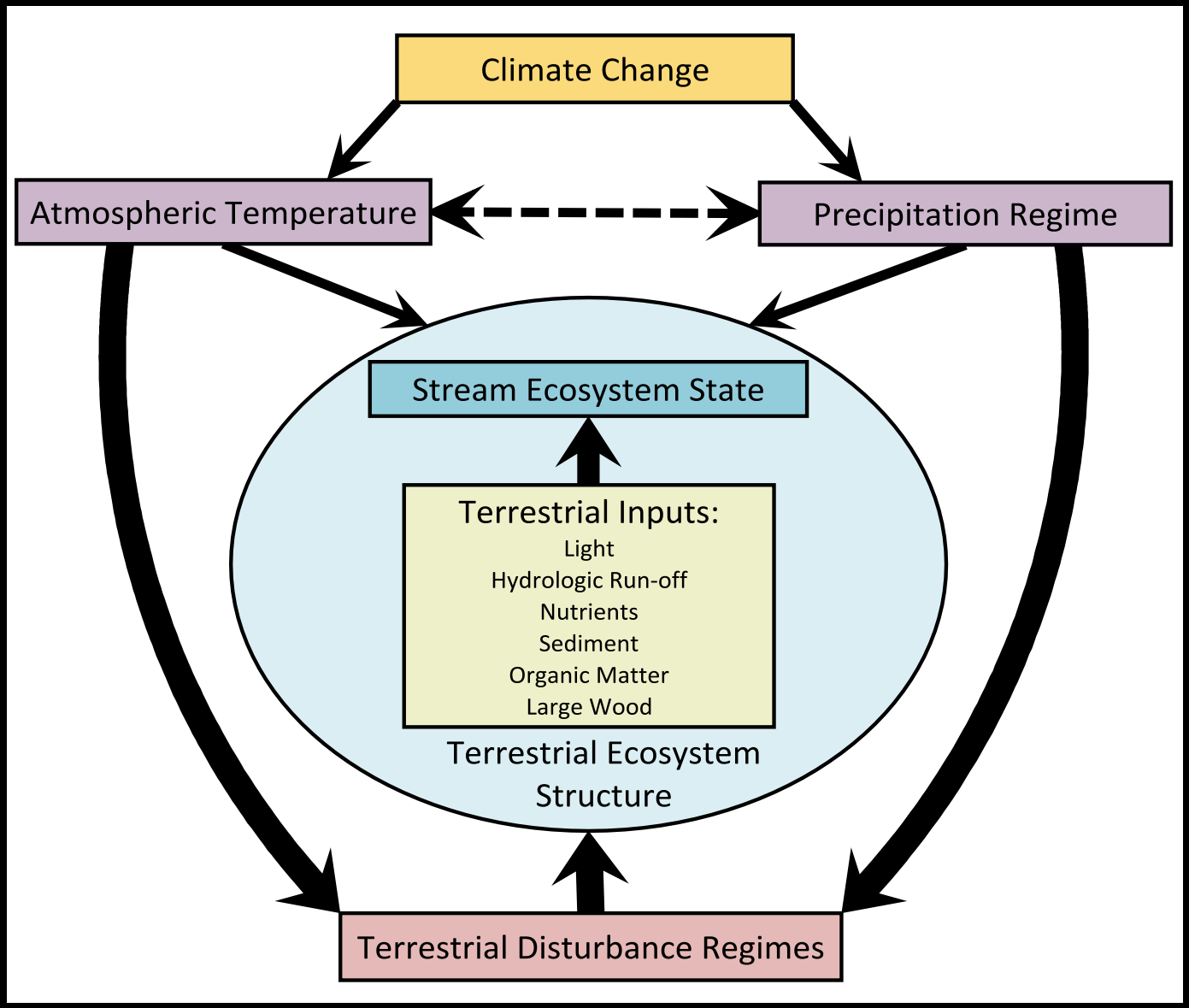
Stream Ecology Center, Department of Biological Sciences
Idaho State University



www.krisweb.com

www.hubpages.com



Davis, Baxter, Rosi-Marshall, Pierce, & Crosby Ecosystems 2013

The forest “feeds” the stream

ROLE OF ALLOCHTHONOUS DETRITUS IN THE TROPHIC STRUCTURE OF A WOODLAND SPRINGBROOK COMMUNITY[1]

G. Wayne Minshall[2]

Department of Biology and Potamological Institute, University of Louisville, Louisville, Kentucky

Ecology, 1967

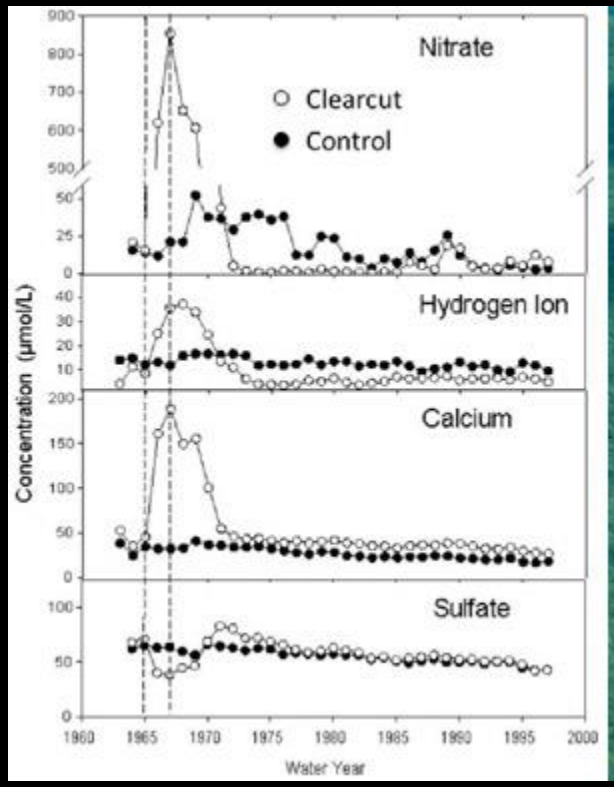
THE UTILIZATION OF LEAF LITTER BY STREAM DETRITIVORES[1]

Kenneth W. Cummins, Robert C. Petersen, Frederick O. Howard, John C. Wuycheck, and Virginia I. Holt

Kellogg Biological Station,[2] Michigan State University, East Lansing, Michigan 48823

1973

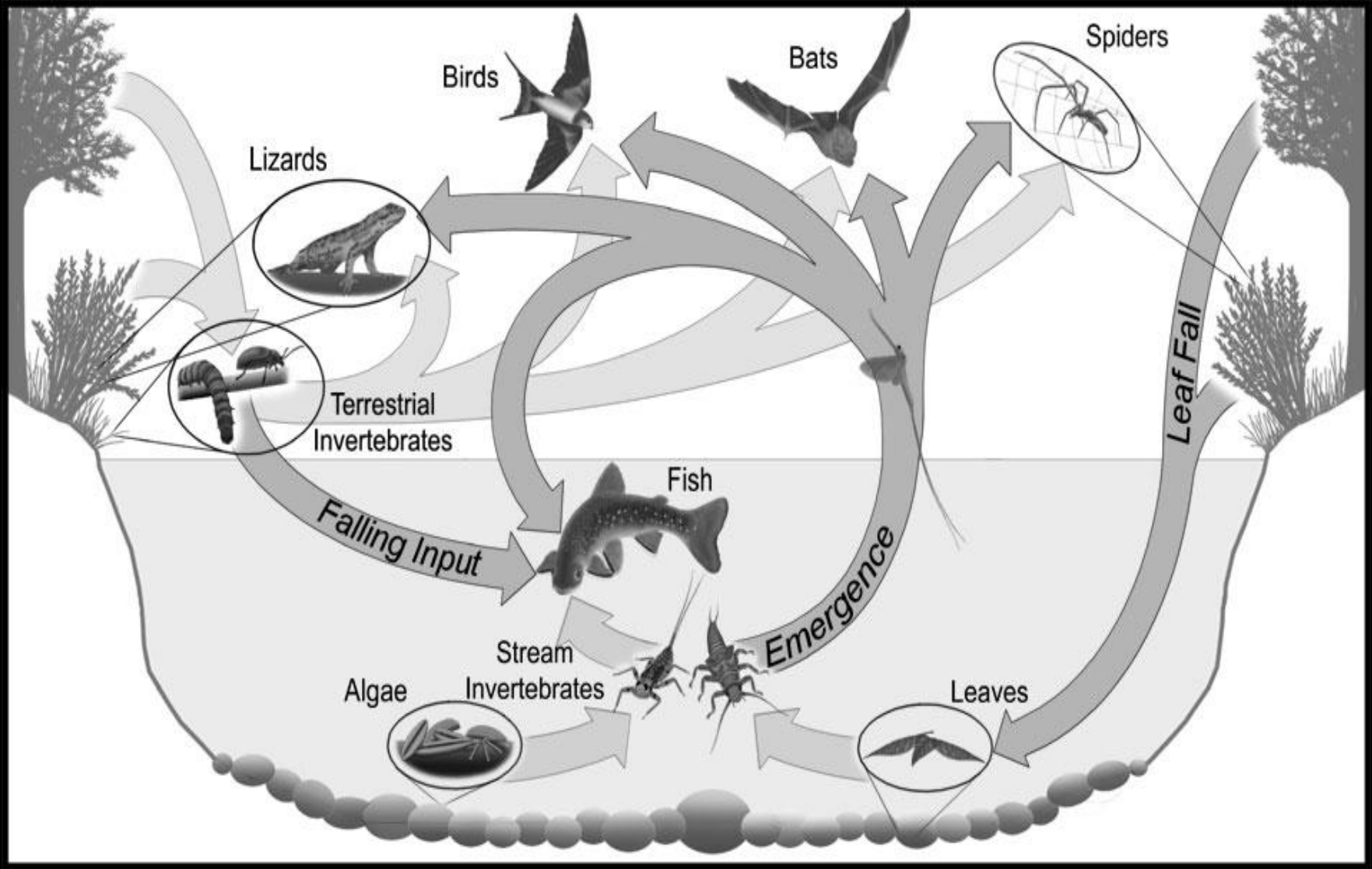
Change the forest, change the stream…



Hubbard Brook, New Hampshire

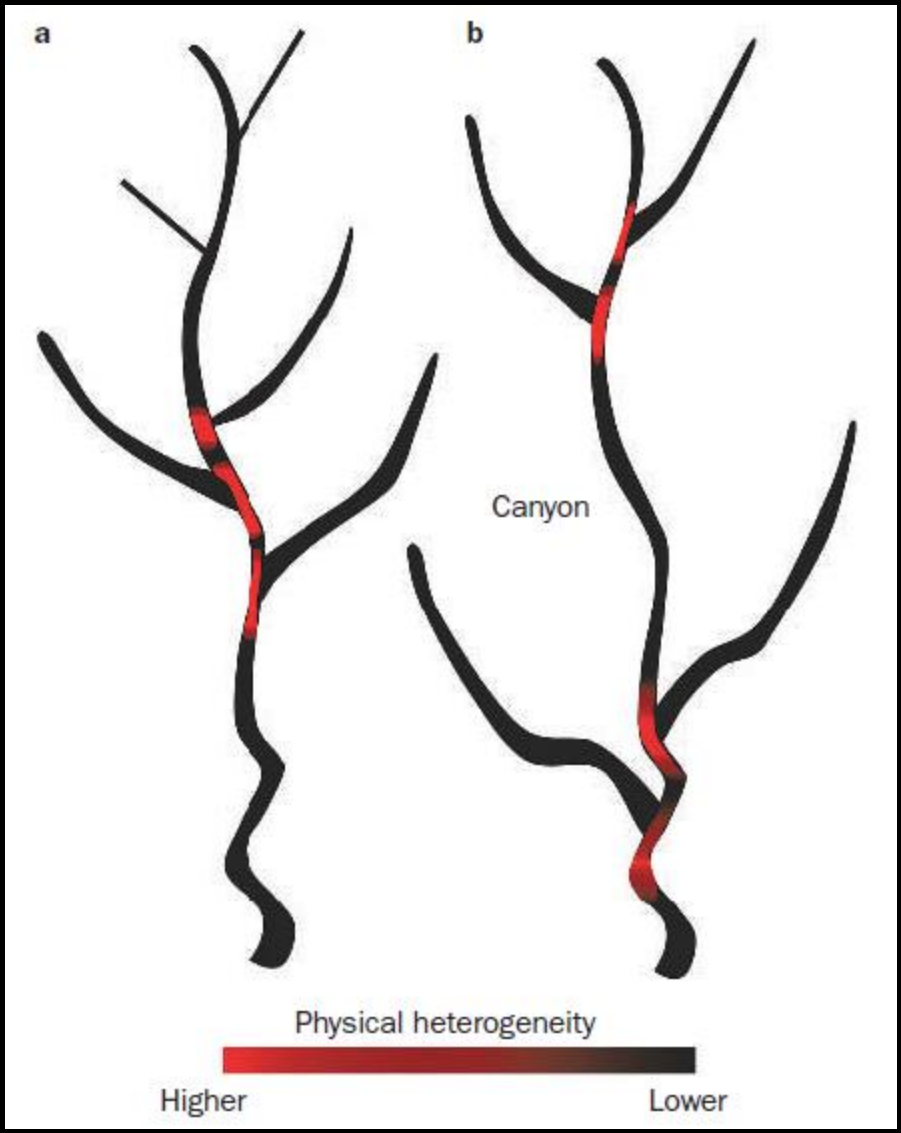
Likens et al. Eco Mon 1970, Likens & Bormann 1995

But…the stream "feeds" the forest too…



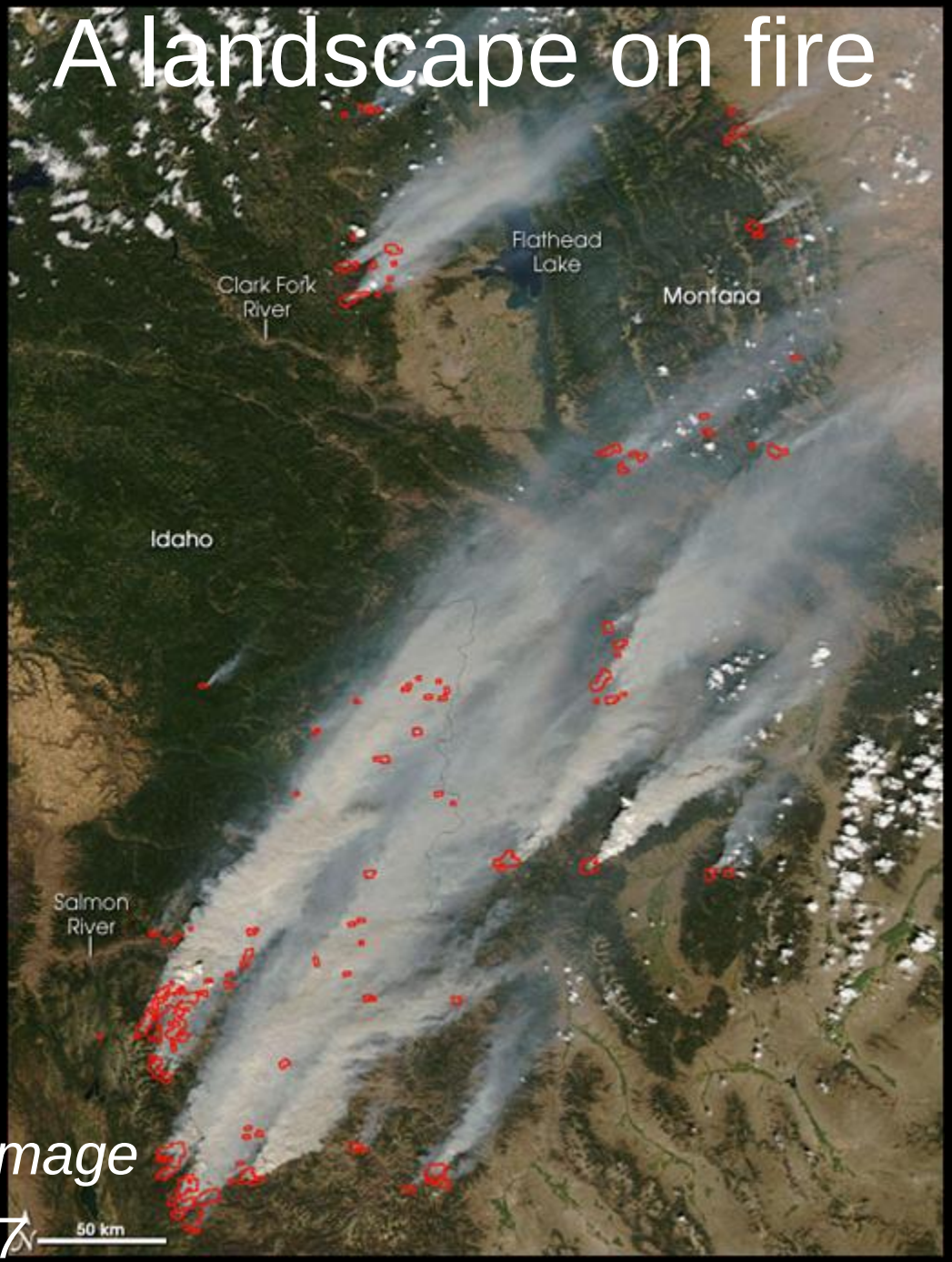
Baxter et al. Fresh. Biol. 2005

…and land-water interaction "signals" propagate throughout stream networks



Benda et al. BioScience 2004

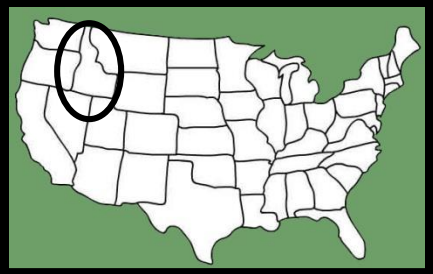
A landscape on fire

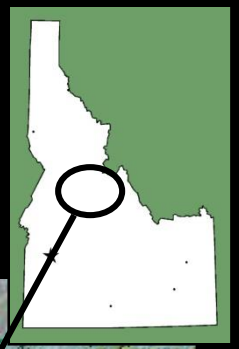


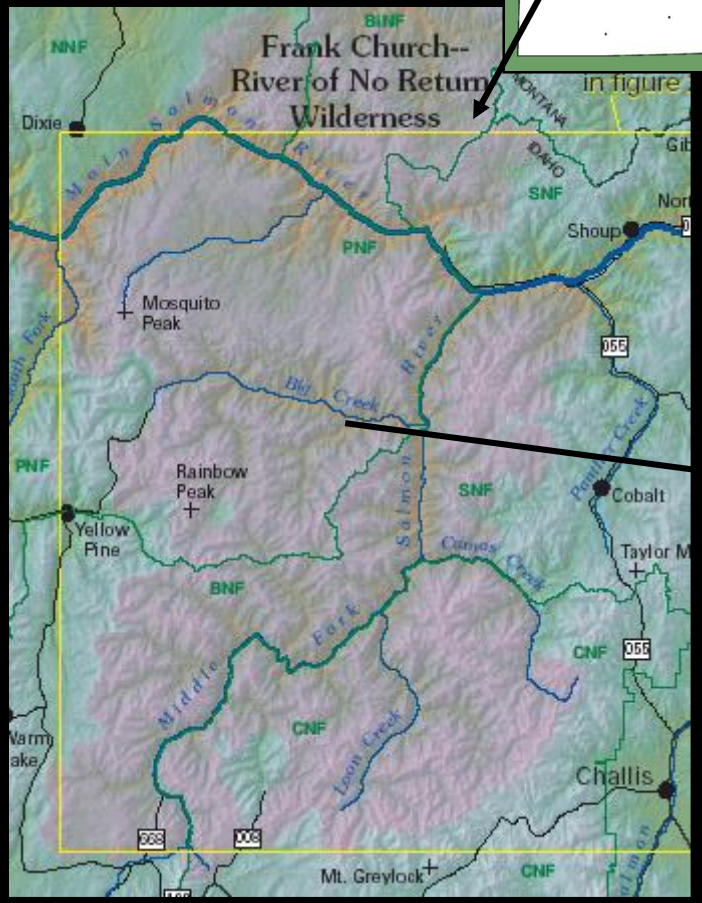
NASA MODIS image

August 12, 2007

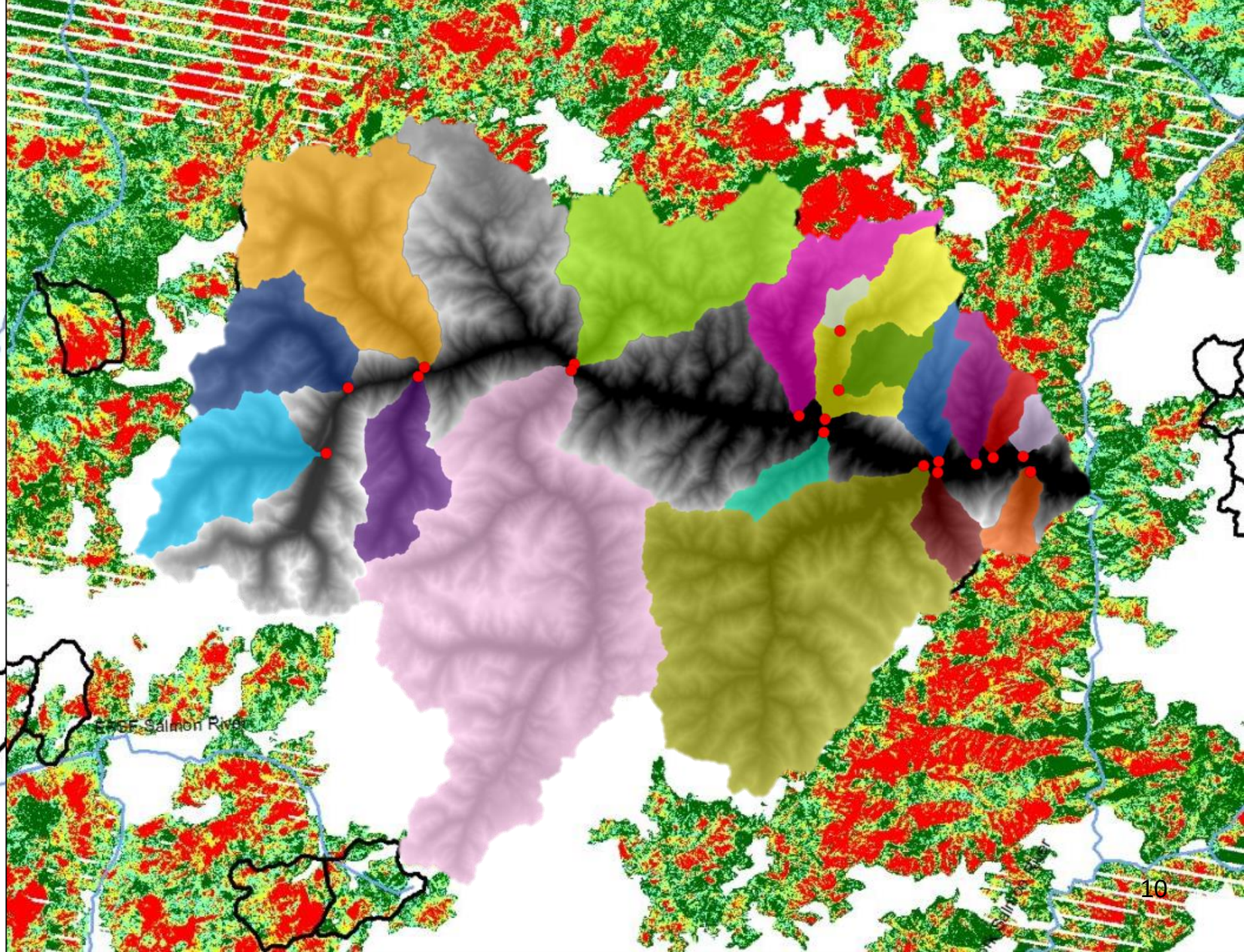
Study Location



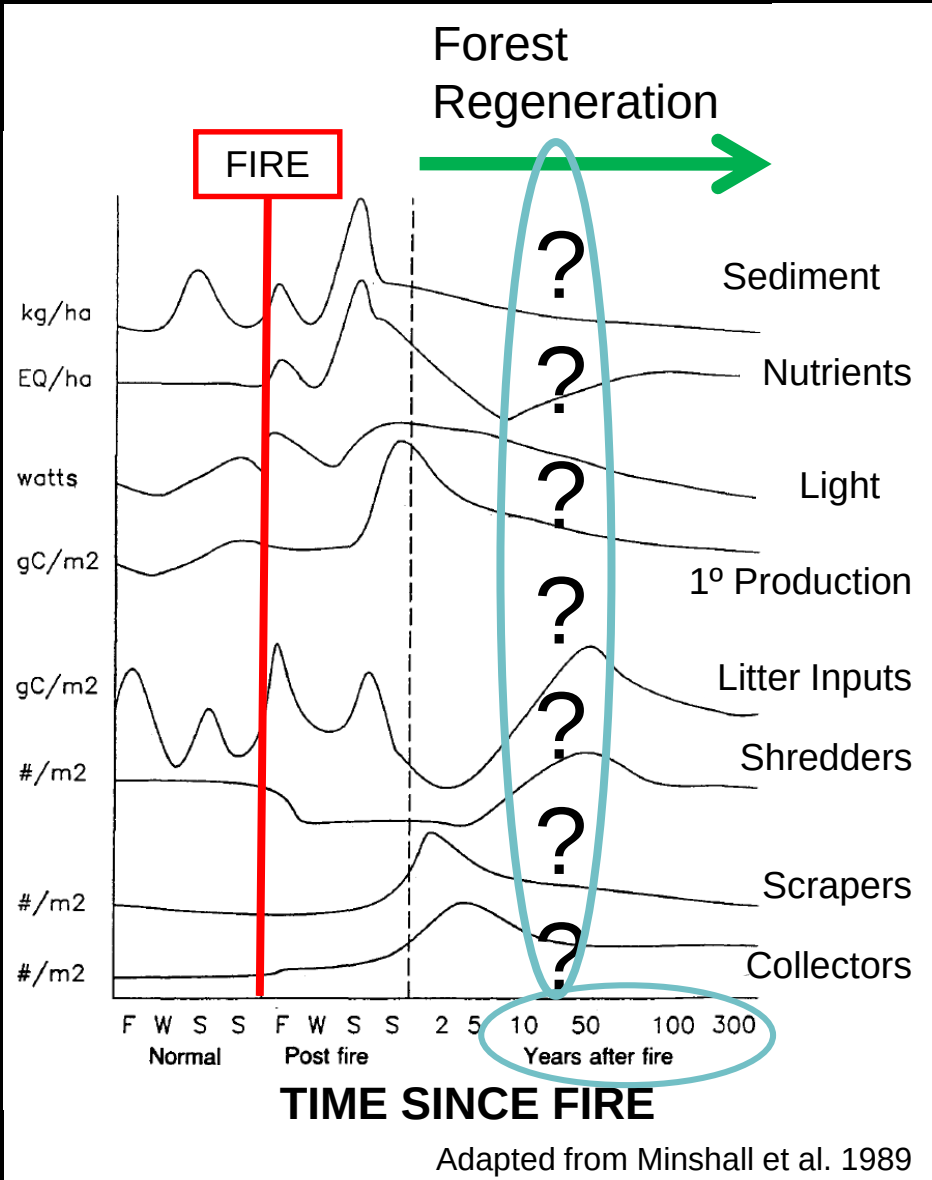




Salmon River Basin
Frank Church
'River of No Return'
Wilderness Area


Salmon River
EAGLE Salmon River
Salmon River

Post-fire trajectories…changing?



Adapted from Minshall et al. 1989

Post-fire: Limited conifer regrowth?

Mortar Creek Fire, Burned 1979, Photo 2012

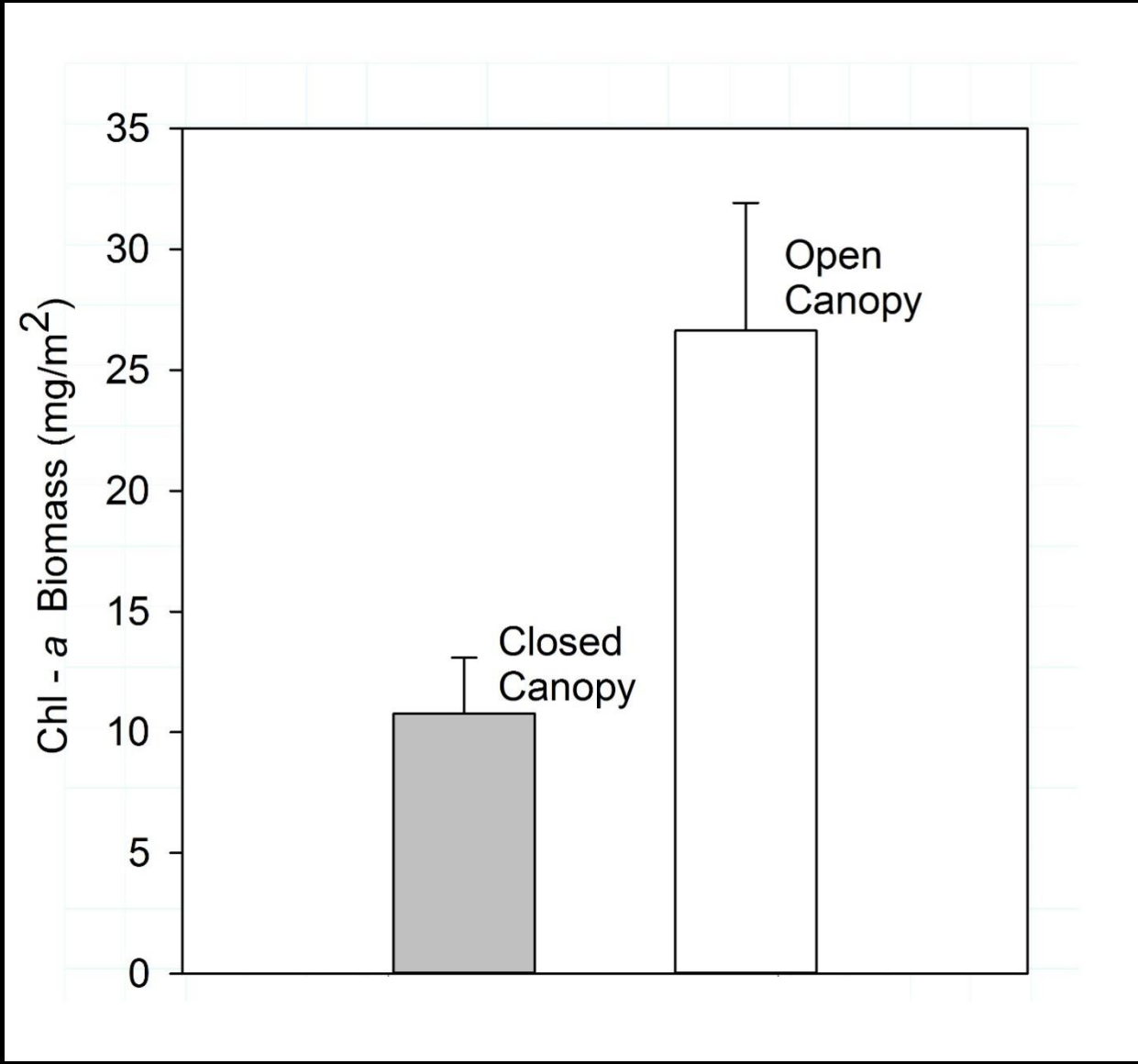
Divergent Riparian Regrowth…

Divergent Riparian Regrowth…

Need for decadal-scale studies…

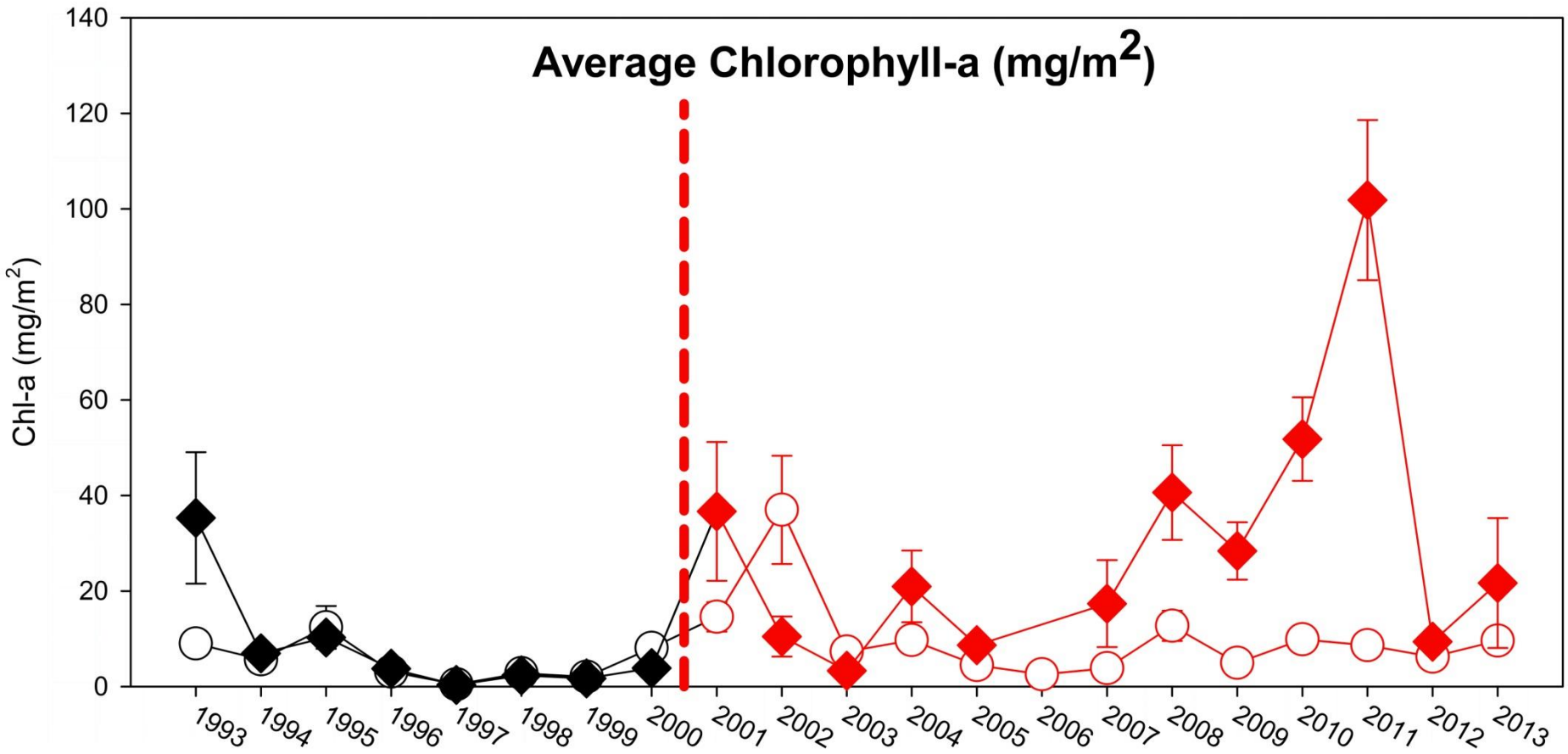
27-yr monitoring – started by G.W. Minshall

Post-fire stream algae– 13 yr averages



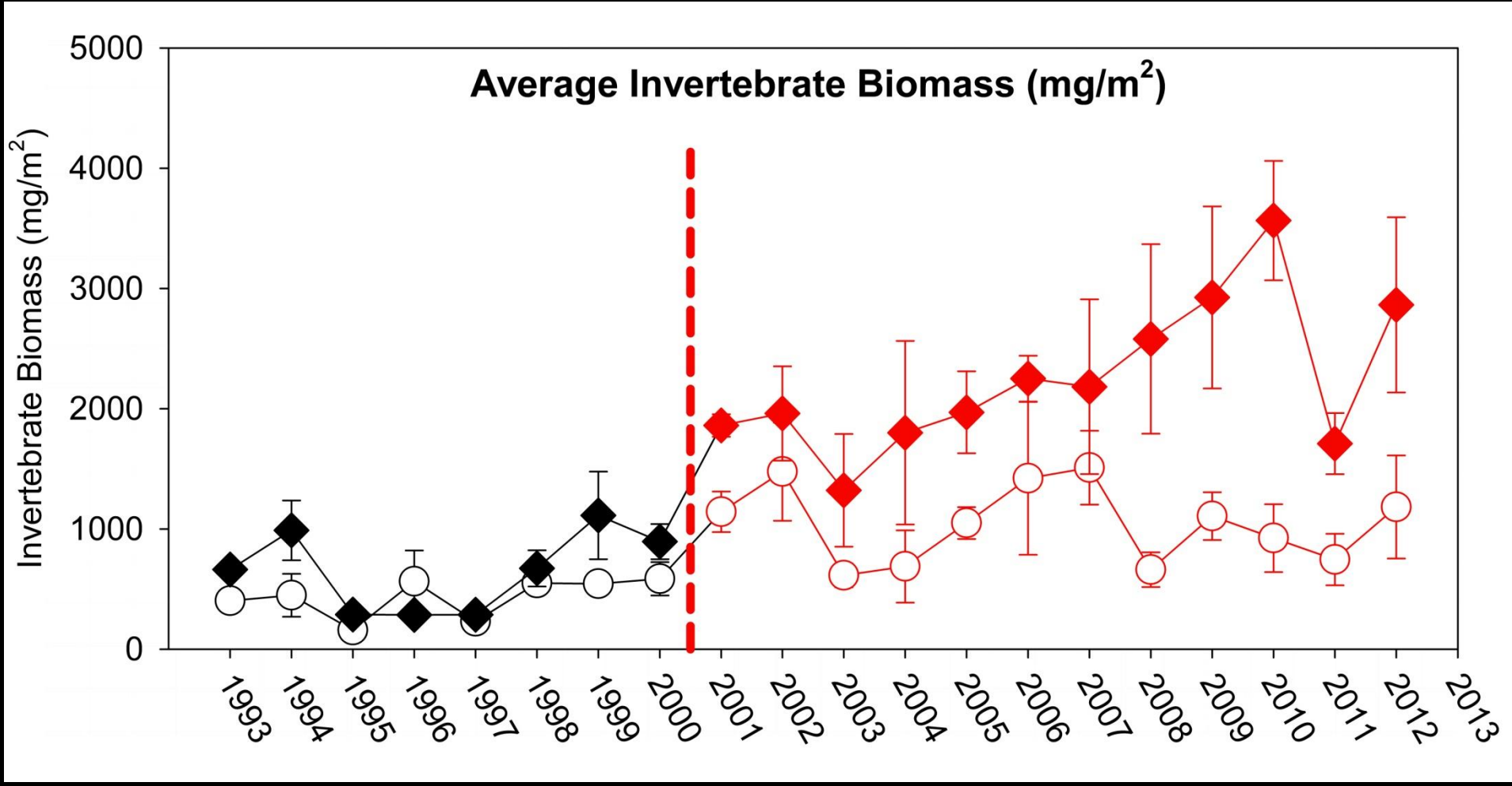
Davis et al. Fresh. Biol. 2013; Rugenski & Minshall Ecosphere 2014

Algae Time Series:
Open vs. Closed Canopy

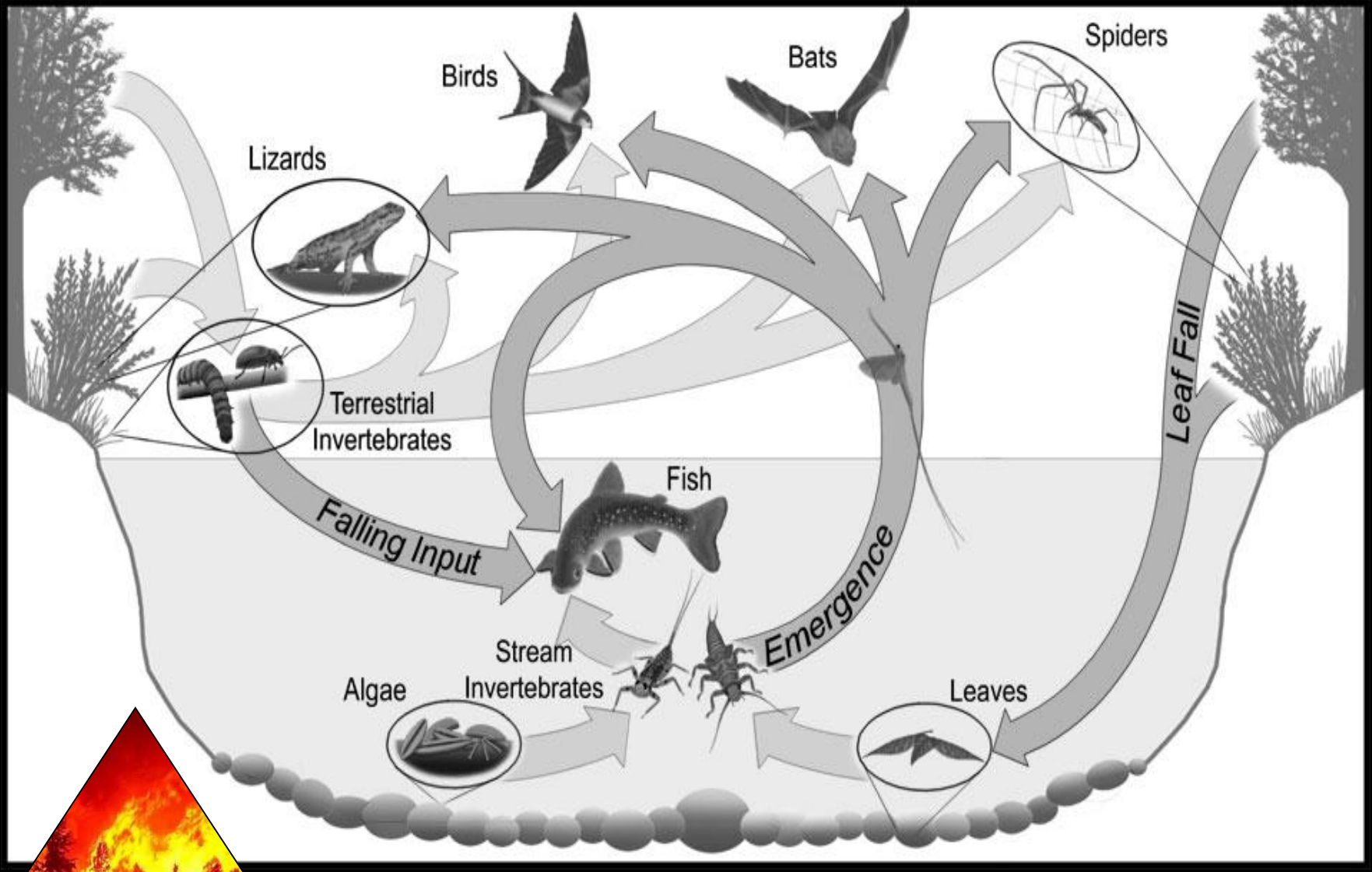


Davis, Baxter et al. Fresh. Biol. 2013; Rugenski & Minshall Ecosphere 2014

Stream Invertebrate Time Series: Open vs. Closed Canopy



Rugenski & Minshall Ecosphere 2014; Baxter & Minshall, unpublished



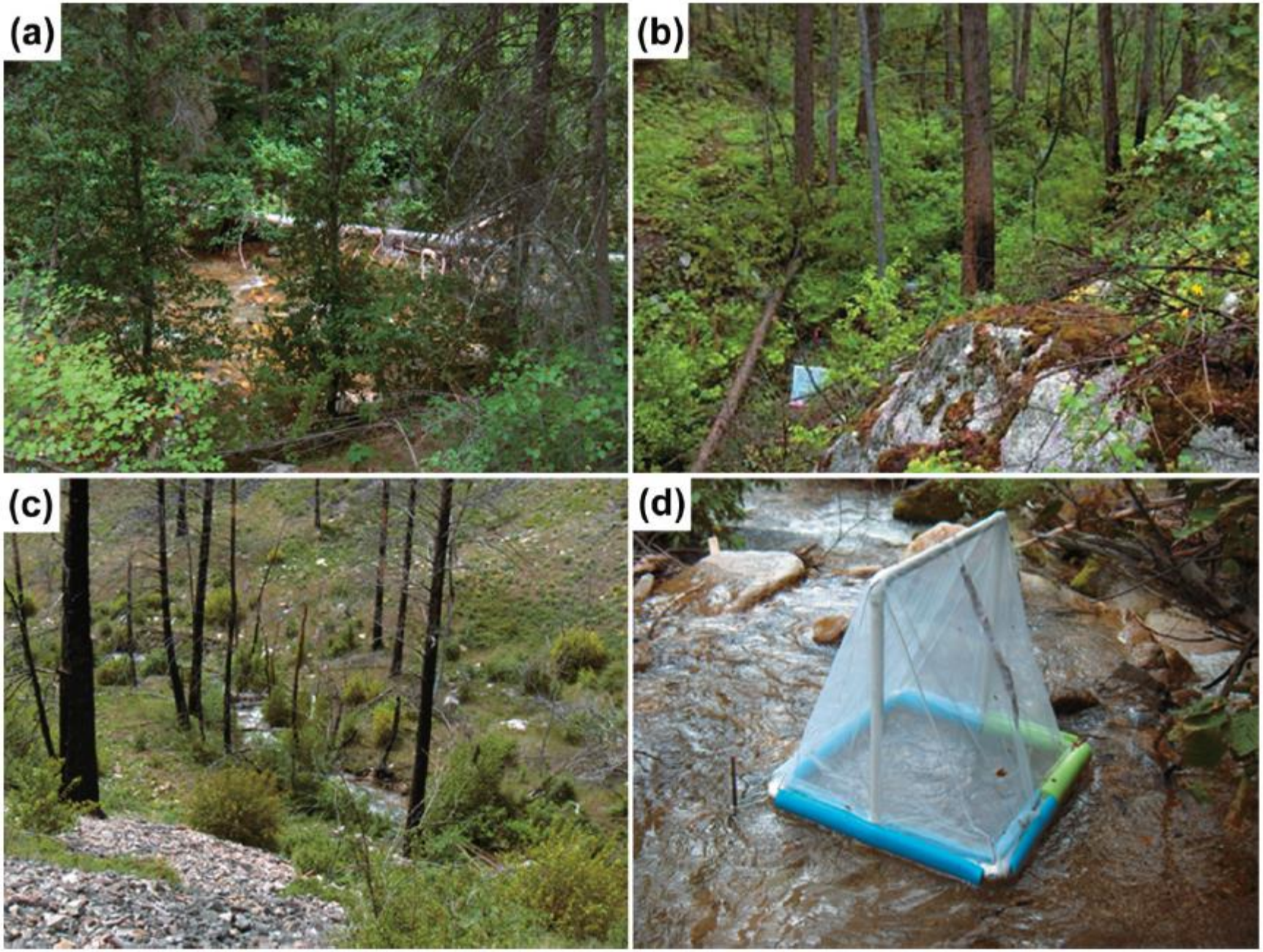
Baxter et al. Fresh. Biol. 2005

Responses via land-water linkages?
Vary by burn severity?

The fire pulse: wildfire stimulates flux of aquatic prey to terrestrial habitats driving increases in riparian consumers

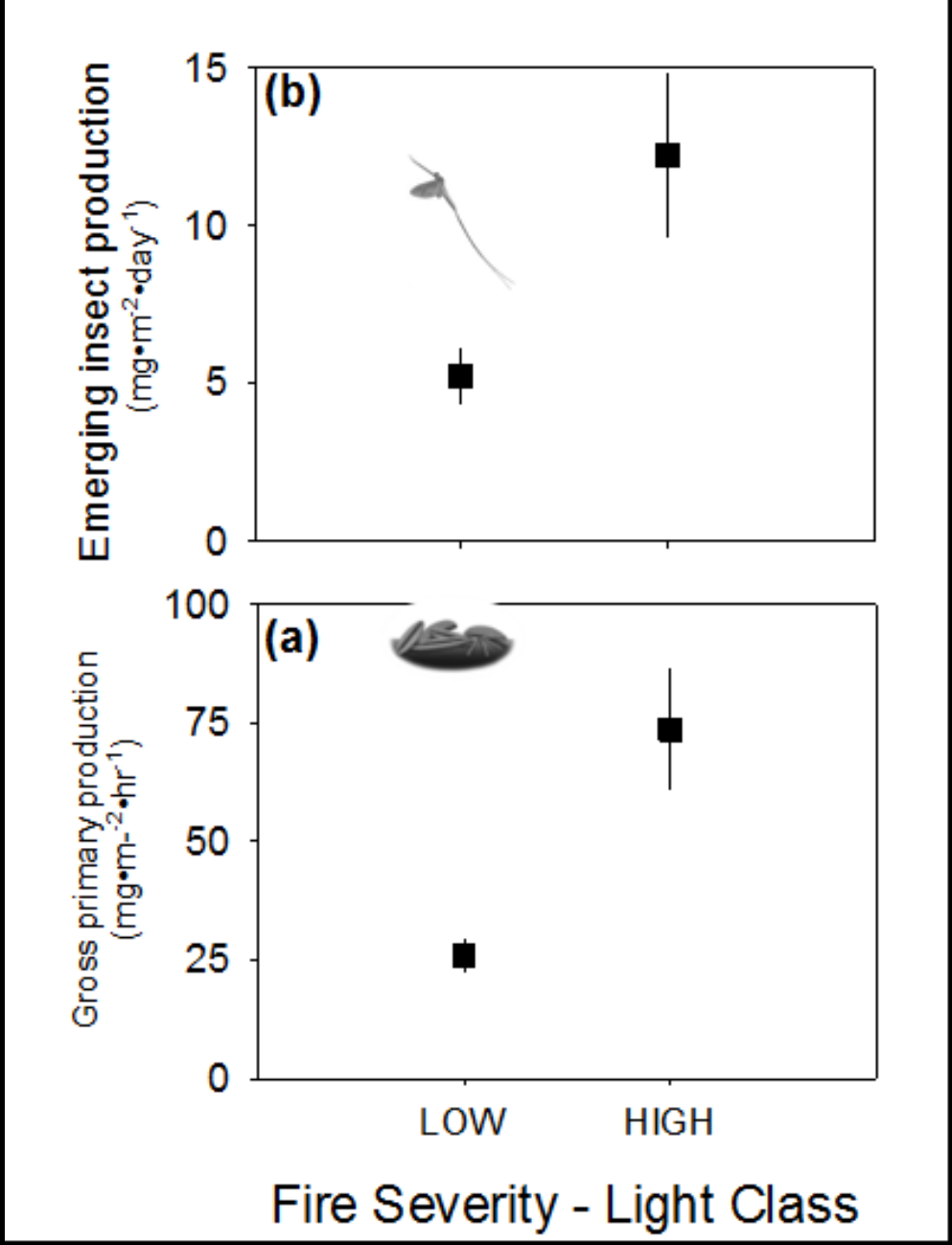
Rachel L. Malison and Colden V. Baxter

Rachel Malison, M.S. student



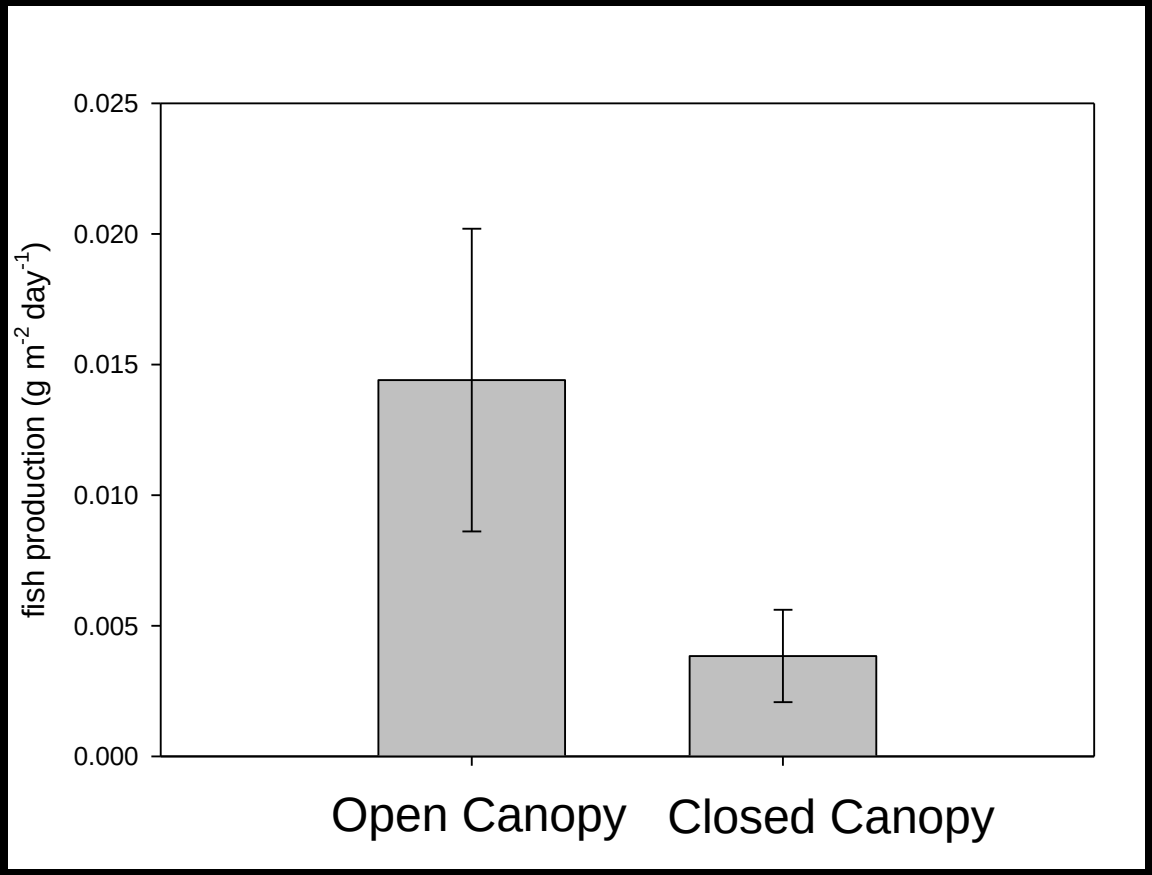
Malison & Baxter. 2010. Can. J. Fish. Aquat. Sci.

“Mid-term” productivity responses mediated by fire severity, riparian regrowth & light regime



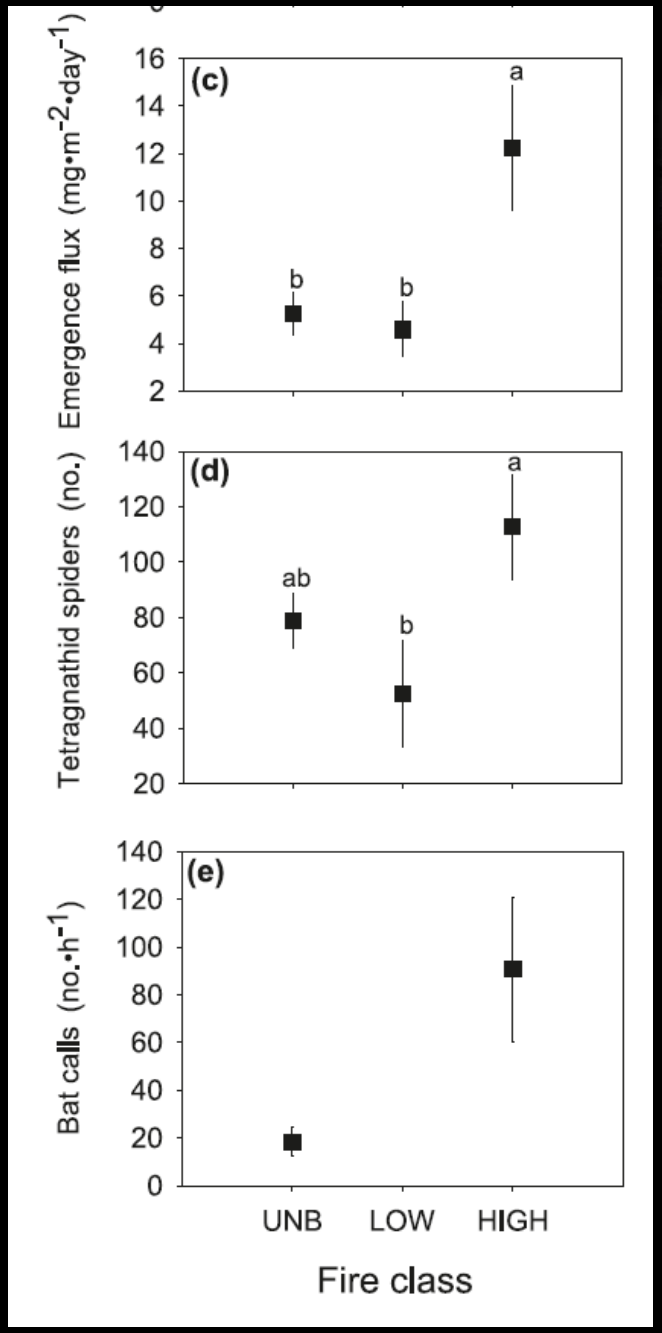
Malison & Baxter. 2010.
Can. J. Fish. Aquat. Sci. & 2010 Freshwater Science

High salmonid production in streams that burned severely 15 yrs ago, but retain high light



Schenk, Lyon & Baxter. In prep.

via emerging insects, responses extend to riparian wildlife



Malison & Baxter. 2010. Can. J. Fish. Aquat. Sci.

Bird responses

In high severity burn sites…
- Greater overall abundance & richness
- Greater incidence of riparian obligates (e.g., dippers) & fly-catchers

Low severity burn and unburned sites…
- Greater incidence of generalists (e.g., crows)

THE ECOLOGICAL IMPORTANCE OF SEVERE WILDFIRES: SOME LIKE IT HOT

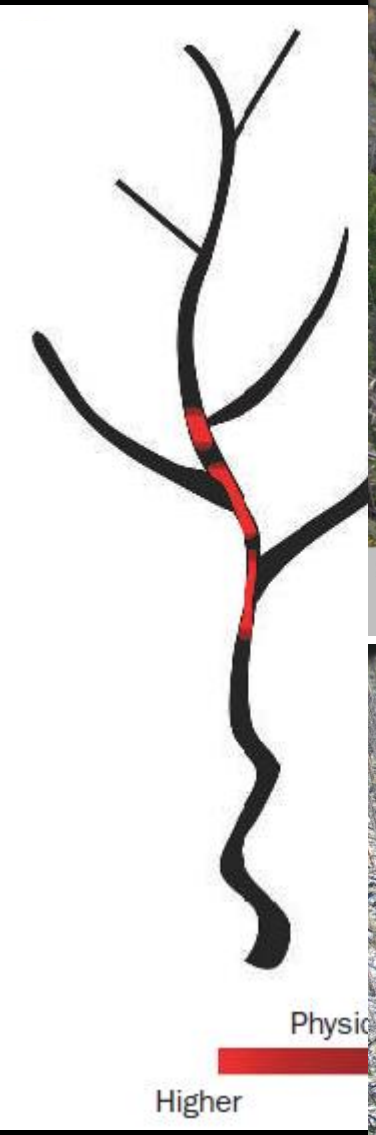
RICHARD L. HUTTO[1]

Hutto, Eco Apps 2008

www.birdsamore.com

Jackson, Malison, Sullivan & Baxter, 2015 (In press)

Network dynamics & the “fire pulse”



Export of habitat-forming sediment and wood

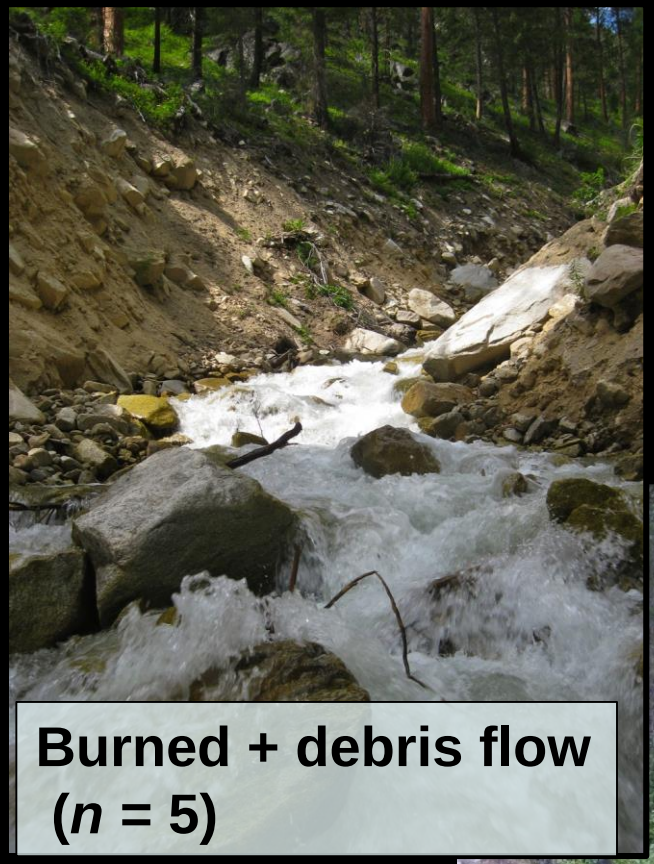
Benda et al. BioScience 2004, R. Thurow RMRS

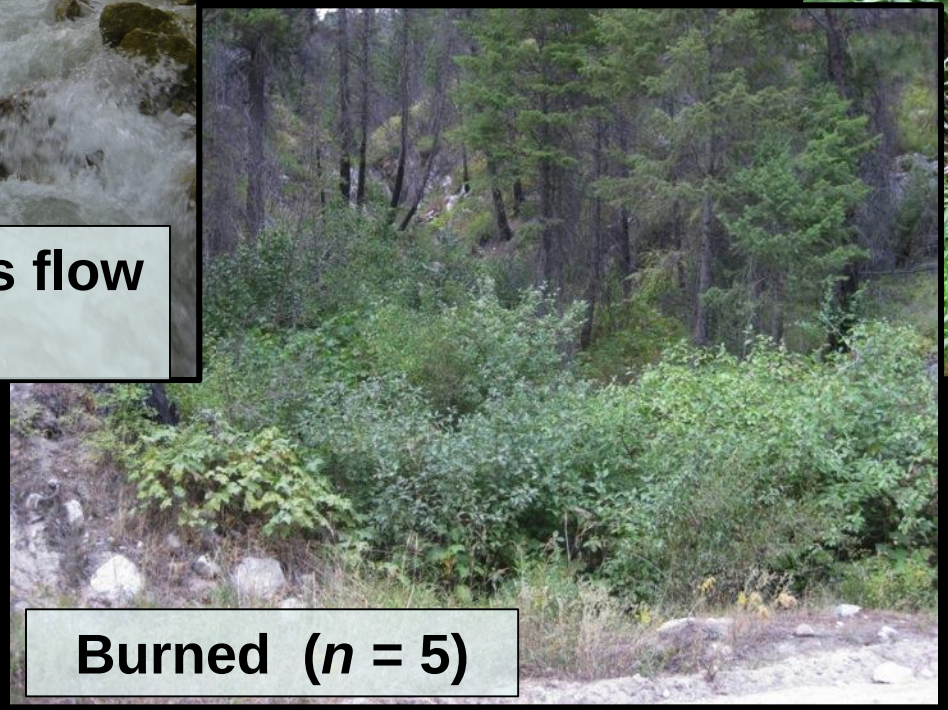
Network dynamics & the “fire pulse”

Export of insects from tributaries disturbed by fire & debris flows?

Network dynamics & the “fire pulse”

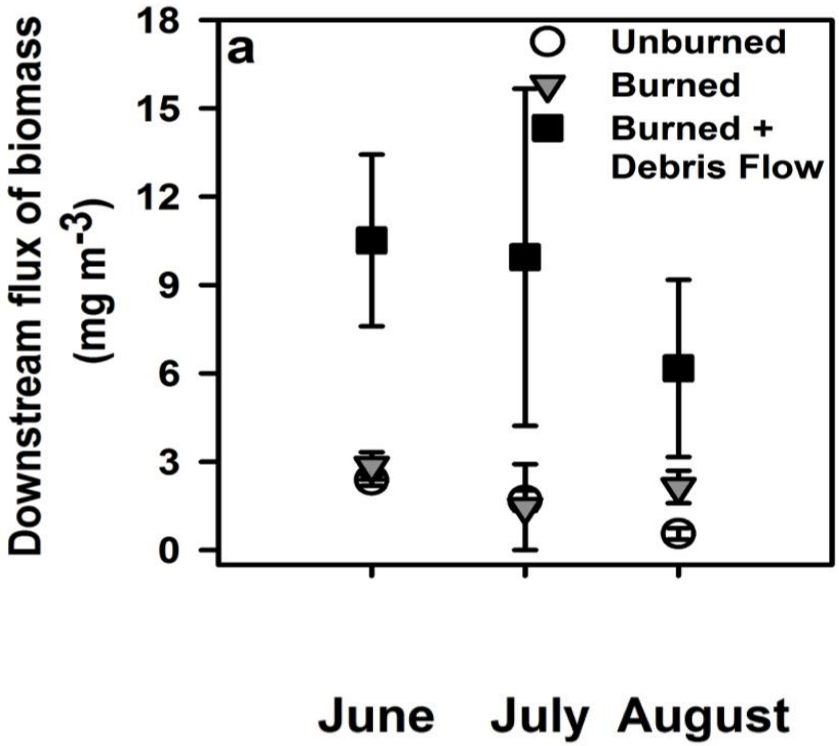
Hannah Harris, M.S. student

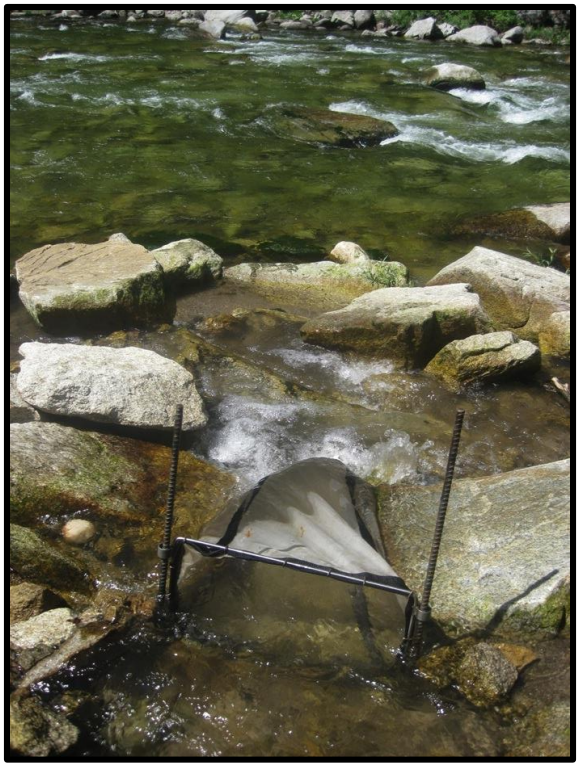

Burned + debris flow
(*n* = 5)


Burned (*n* = 5)

Unburned (*n* = 5)

More Drifting Invertebrates Exported from Disturbed Streams



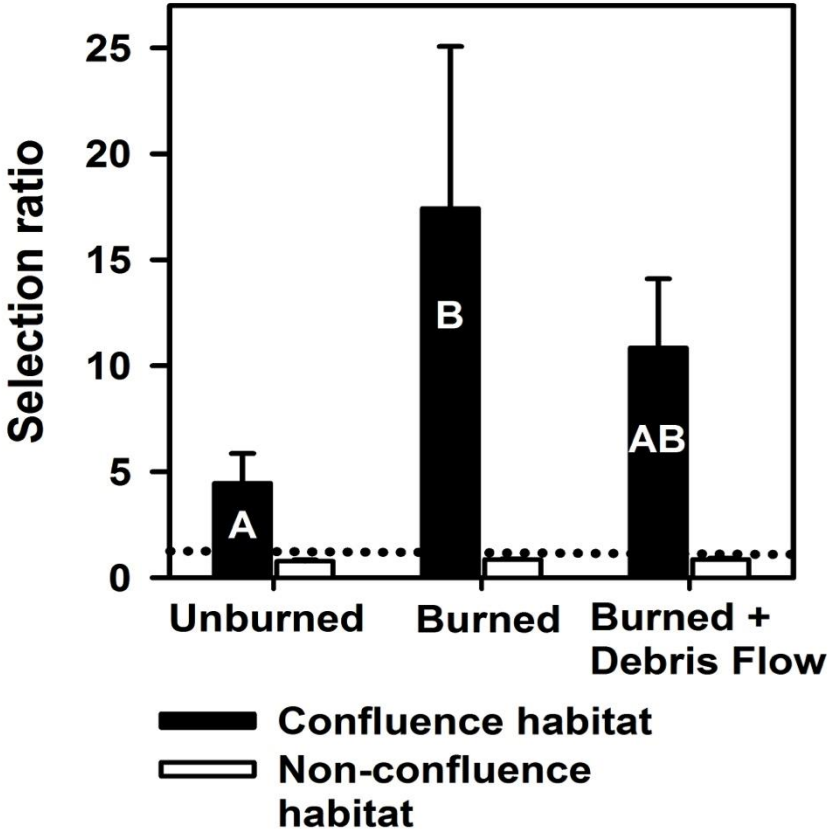


Harris, Baxter & Davis, *Freshwater Science In press.*

The “fire pulse” & consequences for fish in *downstream* habitats

Fish use of tributary confluences?

Abundance of Fish in Confluence Habitats



- Confluence habitat proportionally small
- Strong selection for confluences
- Strongest preference for confluences with *disturbed* tribs

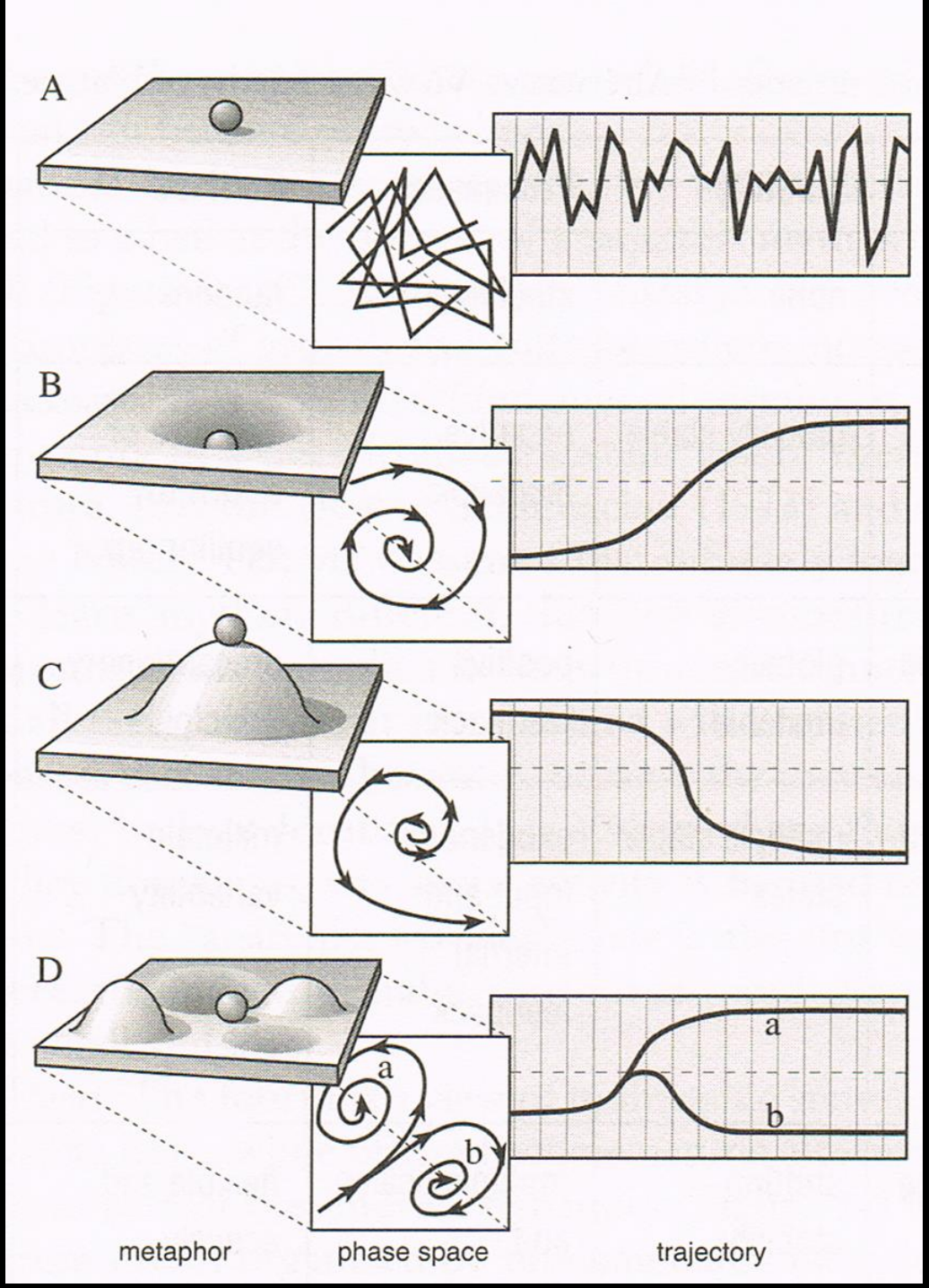
Harris, Baxter & Davis *in revision*

Summary

- Fires of varying severity have different effects
- Post- severe wildfire “pulse” of productivity may extend more than a decade
- Trajectory of riparian regrowth and light regime mediate longer term patterns in post-fire productivity
- Effects propagate reverberate between land & water and propagate through networks
- Debris flows mediate downstream fluxes
- Diverse linkages between land & water deserve focus in science & management of forested watersheds

Discussion

- Resistance & resilience
- Is the “mid-term” the new “long-term” state?
- Are forest changes reversible or no?
- We can’t tell without long term studies…

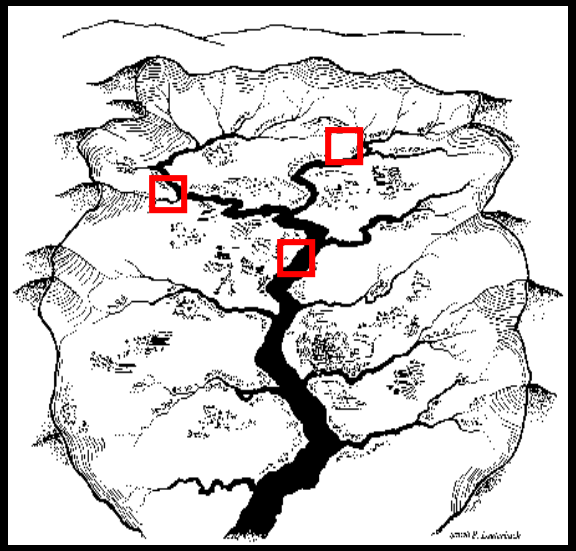


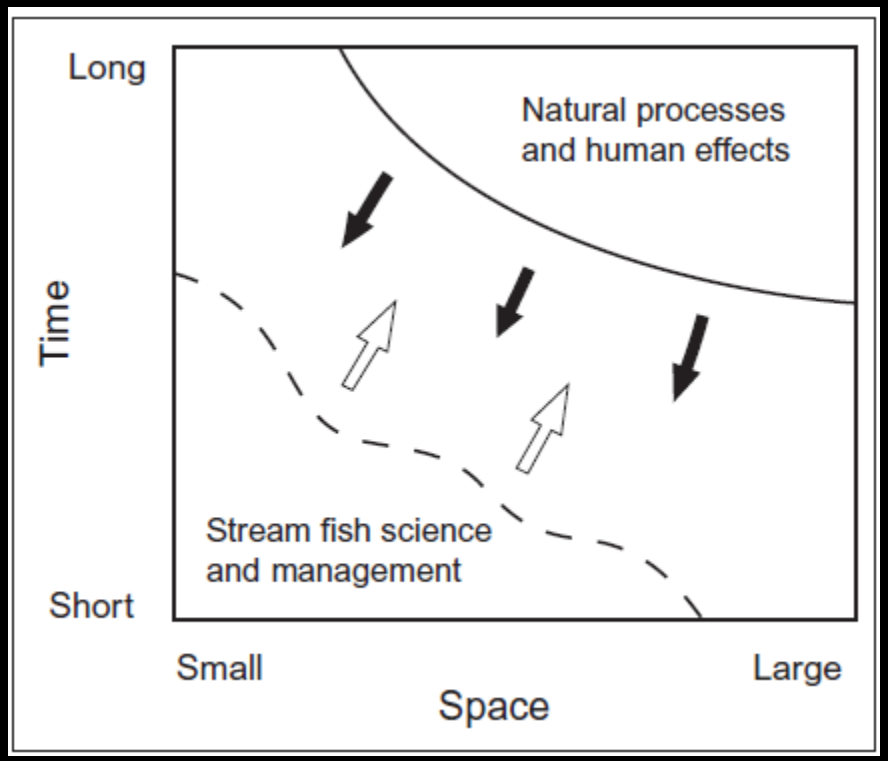
Gunderson & Holling 2001

Discussion

- Positive responses to severe fire evident at reach-scales, but…what about larger scales & under prolonged climate, fire regime change, vegetation change?

- Need for intermediate-scale investigations of food web responses to changing fire





Fausch et al. BioScience 2002

Management Implications

- no need to “fortify” against natural effects of wildfire — especially in wilderness
- such actions may be misplaced and erroneously credited as restoration or mitigation
- could be diversions from addressing actual problems
- may have unforeseen, undesired effects

Management Discussion

- “manage for the mess” – *J. Sedell*
- preserve processes that create and maintain complexity in nature (habitat and organisms)
- these are keys to resilience and adaptive capacity

Acknowledgments

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- Jim & Holly Akenson
- Drs. Ben Crosby, Sarah Godsey (ISU Geosciences)