

¿Cómo hemos llegado hasta aquí?

Experiencias en la gestión de ríos temporales en regiones de clima mediterráneo

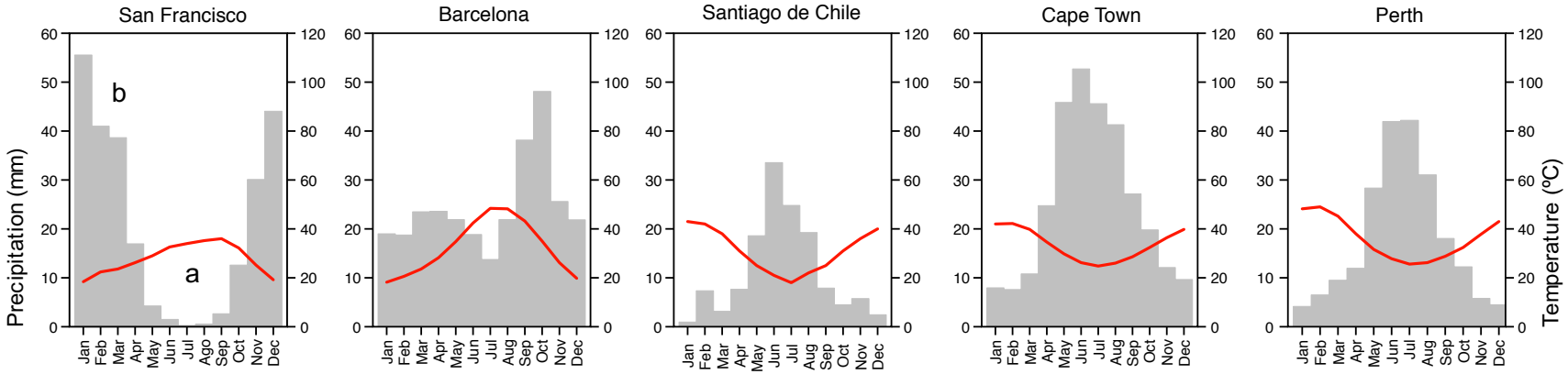
Núria BONADA
Universitat de Barcelona

FEHM lab RESEARCH GROUP
Freshwater Ecology, Hydrology & Management

Mediterranean regions



- 32° and 40°N and S
- 300 to 900 mm/year
- Mild winters (7-13ºC)
- Hot summers (14-25ºC)



Unique river ecosystems

Annu. Rev. Ecol. Syst. 1999. 30:51–81
Copyright © 1999 by Annual Reviews. All rights reserved

STREAMS IN MEDITERRANEAN CLIMATE REGIONS: Abiotic Influences and Biotic Responses to Predictable Seasonal Events

Avital Gasith[1] and Vincent H. Resh[2]
[1]*Institute for Nature Conservation Research, Tel Aviv University, Tel Aviv 69978, Israel; e-mail: avigas@post.tau.ac.il* [2]*Department of Environmental Science, Policy & Management, University of California, Berkeley, California 94720; e-mail: vresh@nature.berkeley.edu*



2013
Streams in Mediterranean climate regions: lessons learned from the last decade
Guest Editors:
Núria BONADA & Vince H. RESH

21 review papers

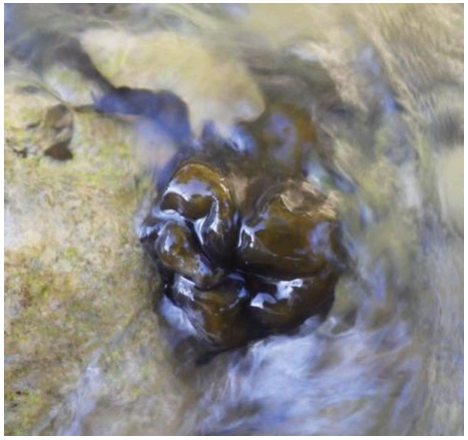
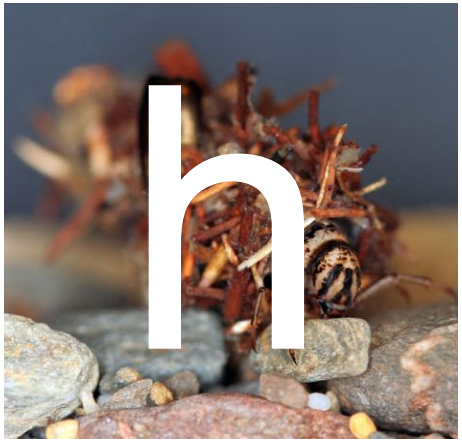
Hotspots of biodiversity



Myers et al., 2000

34 global hotspots for plants and vertebrates
(criteria: species endemisms and threat)






h

o

t


s

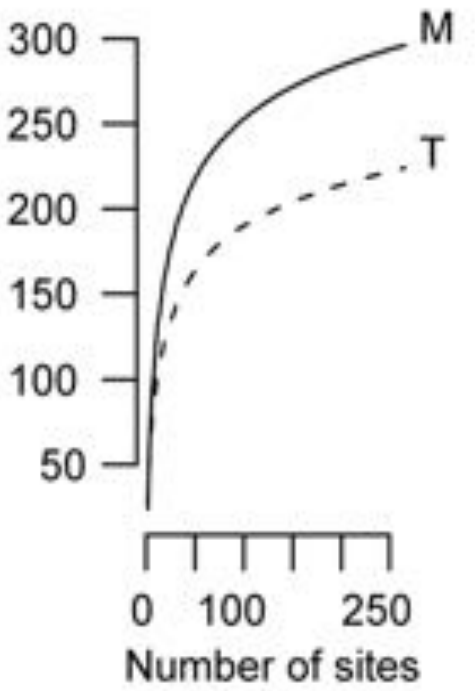
p

o

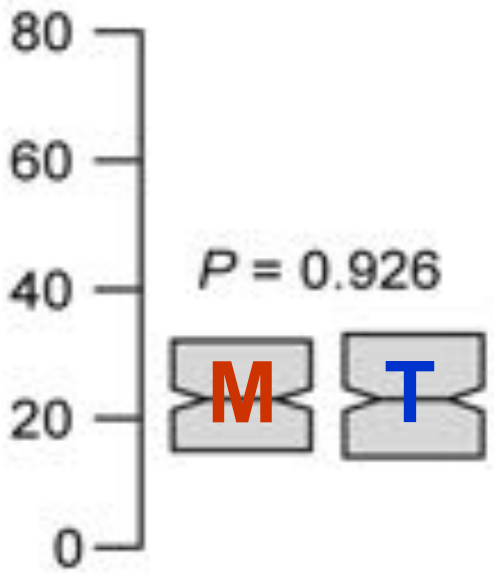
t

High diversity

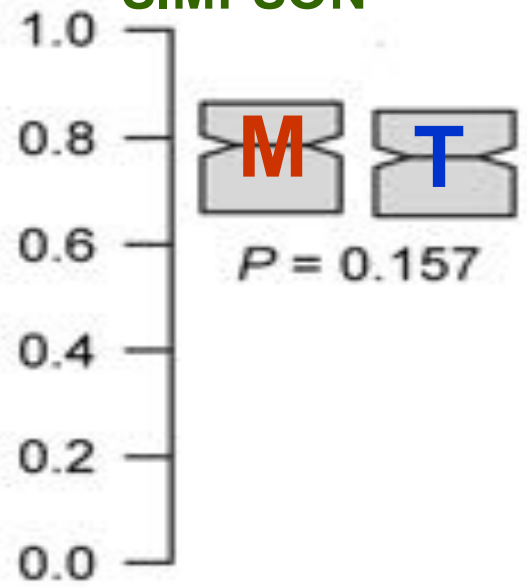
REGIONAL RICHNESS



LOCAL RICHNESS



SIMPSON



296 genera in M (**100 exclusive**)

224 genera in T (**28 exclusive**)

Bonada et al., 2007

Endemicity

HIGH LEVELS OF ENDEMISM

CALIFORNIA

63% Fish

MED-BASIN

55% Crustacea
57% Hydraenidae
51% Simuliidae
60% Amphibians
63% Fish

CHILE

80% Aquatic plants
61% Amphibians
70% Trichoptera

SOUTH AFRICA

86% Aquatic plants
72% Crustaceans
52% Water mites
92% Plecoptera
71% Trichoptera
69% Frogs
52% Fish

SW AUSTRALIA

59% Oligochaeta
56% Water mites
58% Ephemeroptera
82% Trichoptera
75% Plecoptera
81% Amphibians

Ball et al., 2013; Davis & Stewart, 2013; De Moor & Day, 2013; Tierno de Figueroa et al., 2013; Figueroa et al., 2013

Unknown diversity



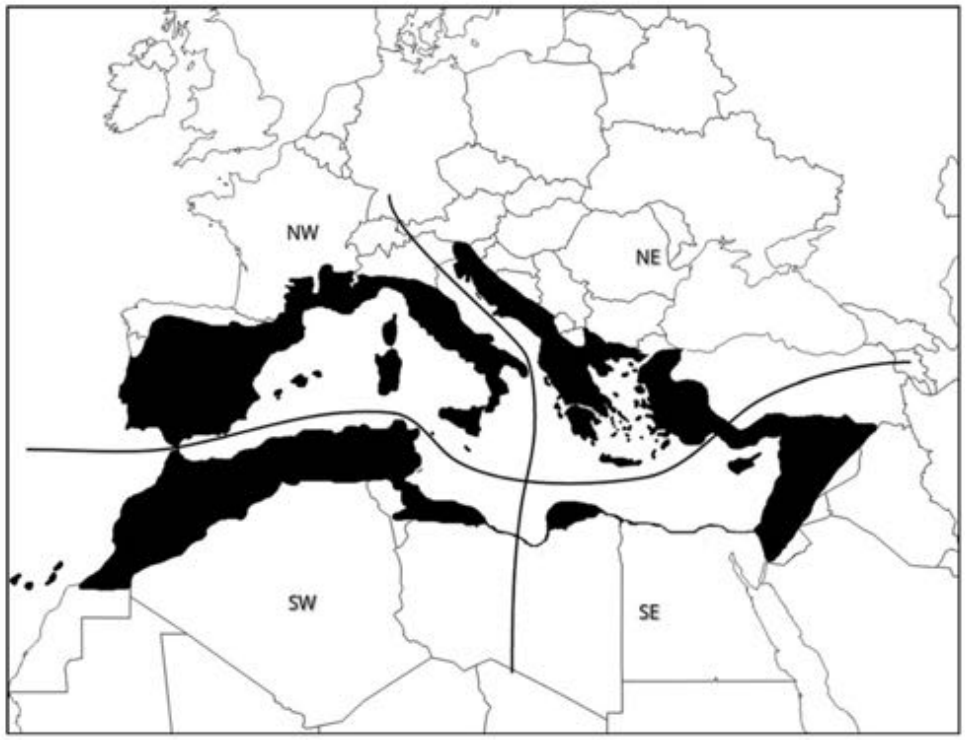


Zamora-Muñoz et al., in prep
Gavira et al., in prep.

Biodiversity patterns

HISTORICAL PROCESSES

Tyrrhenoleuctra antoninoi



Gasterosteus aculeatus

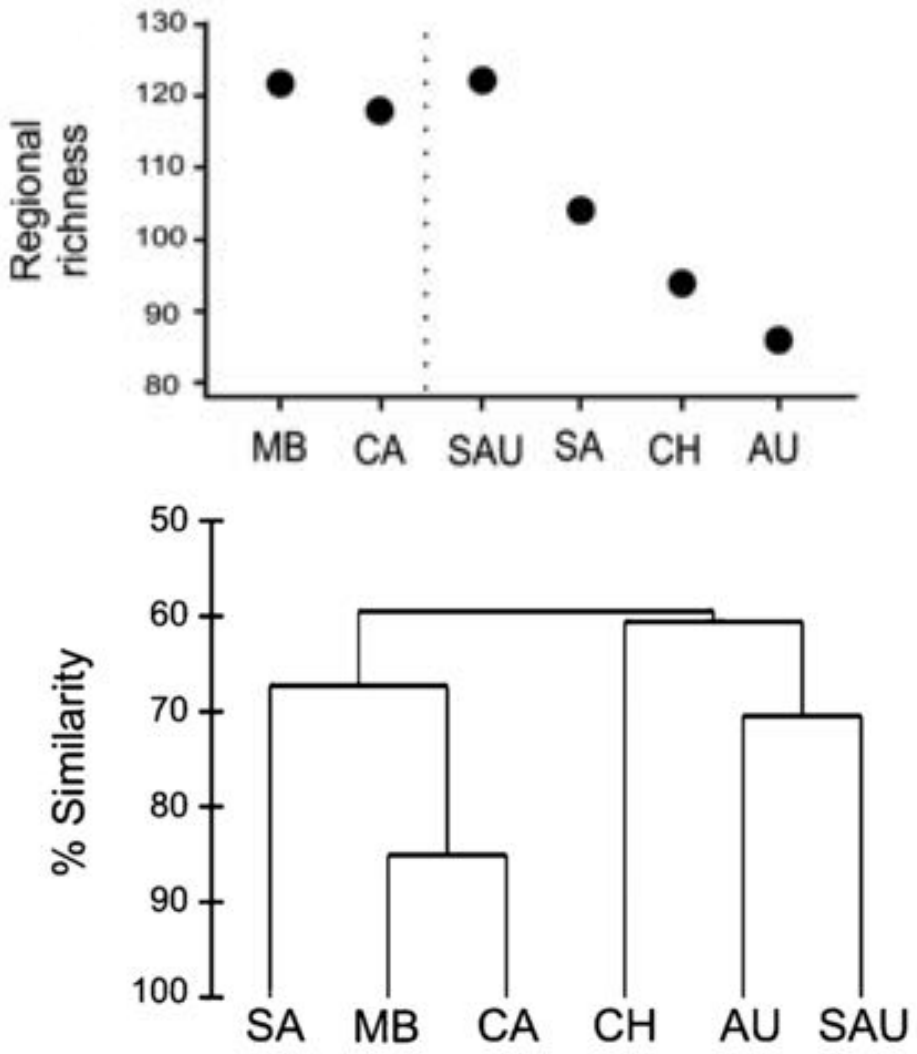
Tectonic activity
African connections
Glaciations

Archaic species
Pre-glacial relicts
Vicariant species
Post-Messinian colonization
Glacial relicts

Tierno de Figueroa et al., 2013

Biodiversity patterns

HISTORICAL PROCESSES



Bonada et al., 2008

Unique river ecosystems

Annu. Rev. Ecol. Syst. 1999. 30:51–81
Copyright © 1999 by Annual Reviews. All rights reserved

STREAMS IN MEDITERRANEAN CLIMATE REGIONS: Abiotic Influences and Biotic Responses to Predictable Seasonal Events

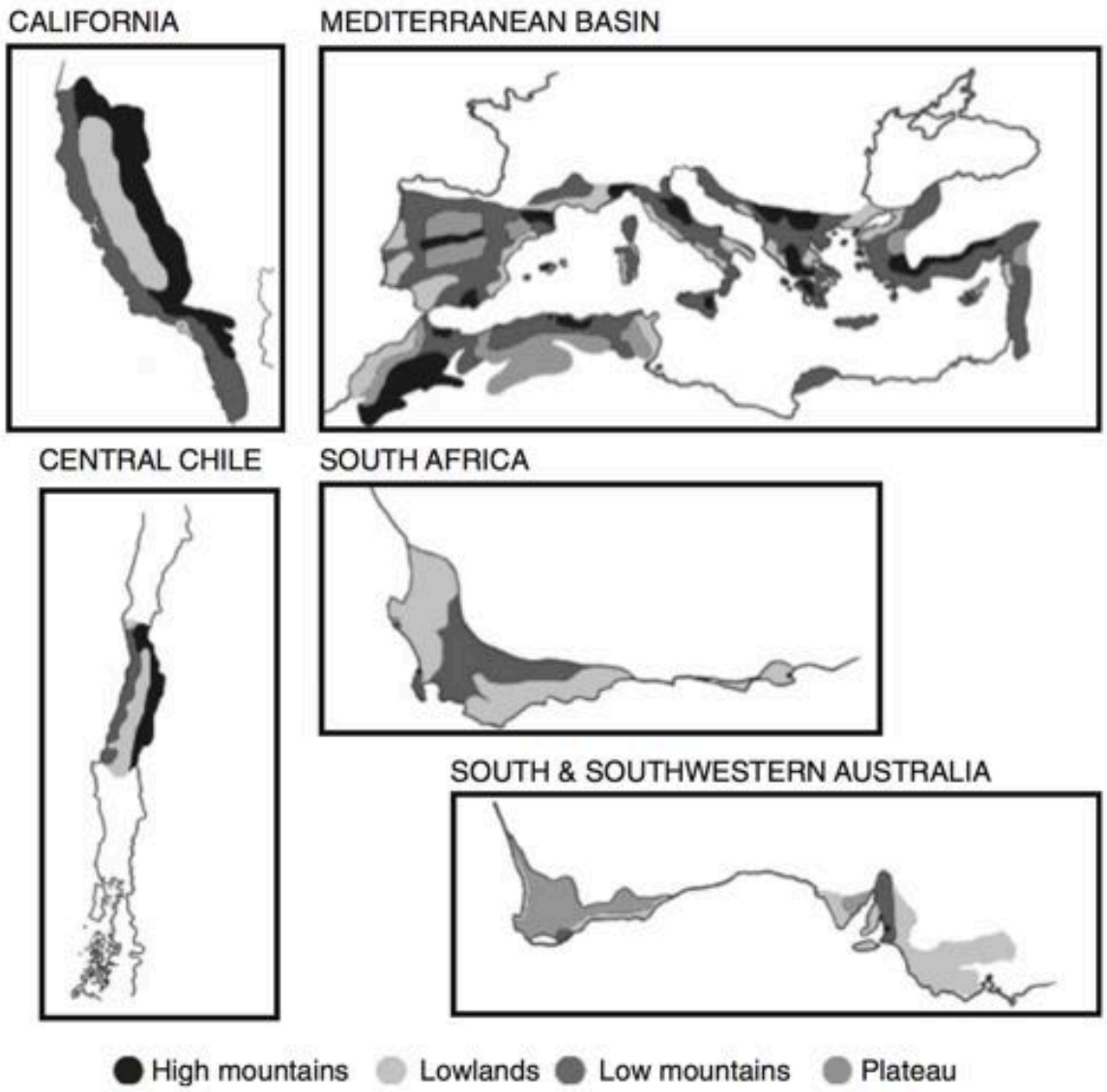
Avital Gasith[1] and Vincent H. Resh[2]
[1]*Institute for Nature Conservation Research, Tel Aviv University, Tel Aviv 69978, Israel; e-mail: avigas@post.tau.ac.il* [2]*Department of Environmental Science, Policy & Management, University of California, Berkeley, California 94720; e-mail: vresh@nature.berkeley.edu*



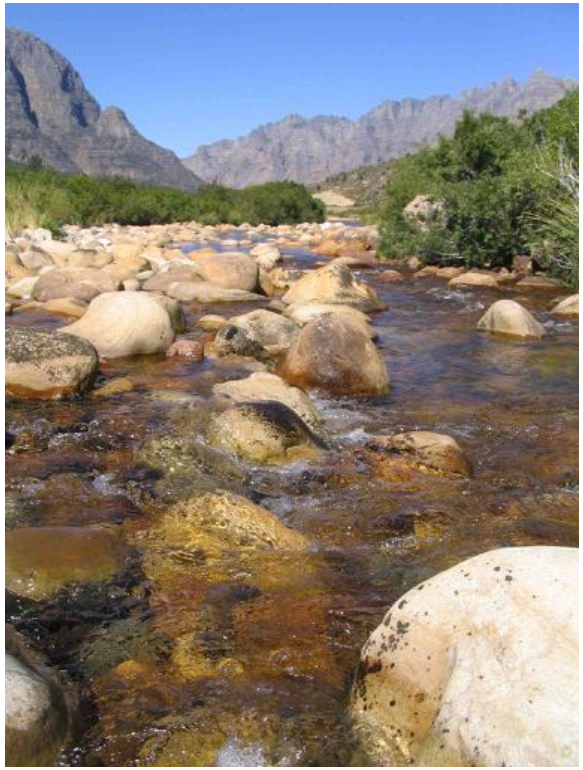
2013
Streams in Mediterranean climate regions: lessons learned from the last decade
Guest Editors:
Núria BONADA & Vince H. RESH

21 review papers

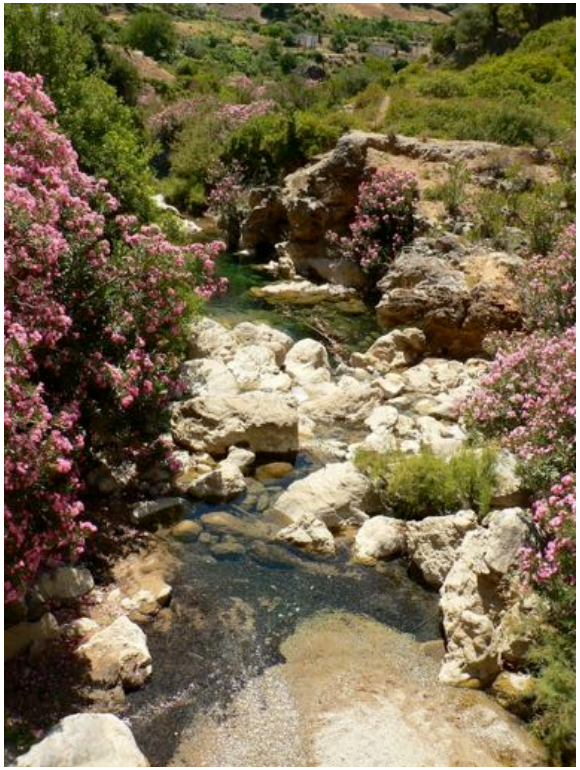
Spatial variability



Spatial variability



Helen Dallas



Núria Bonada

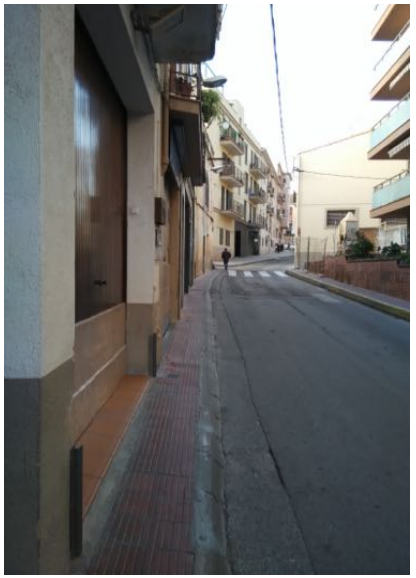


Maria Soria

Spatial variability



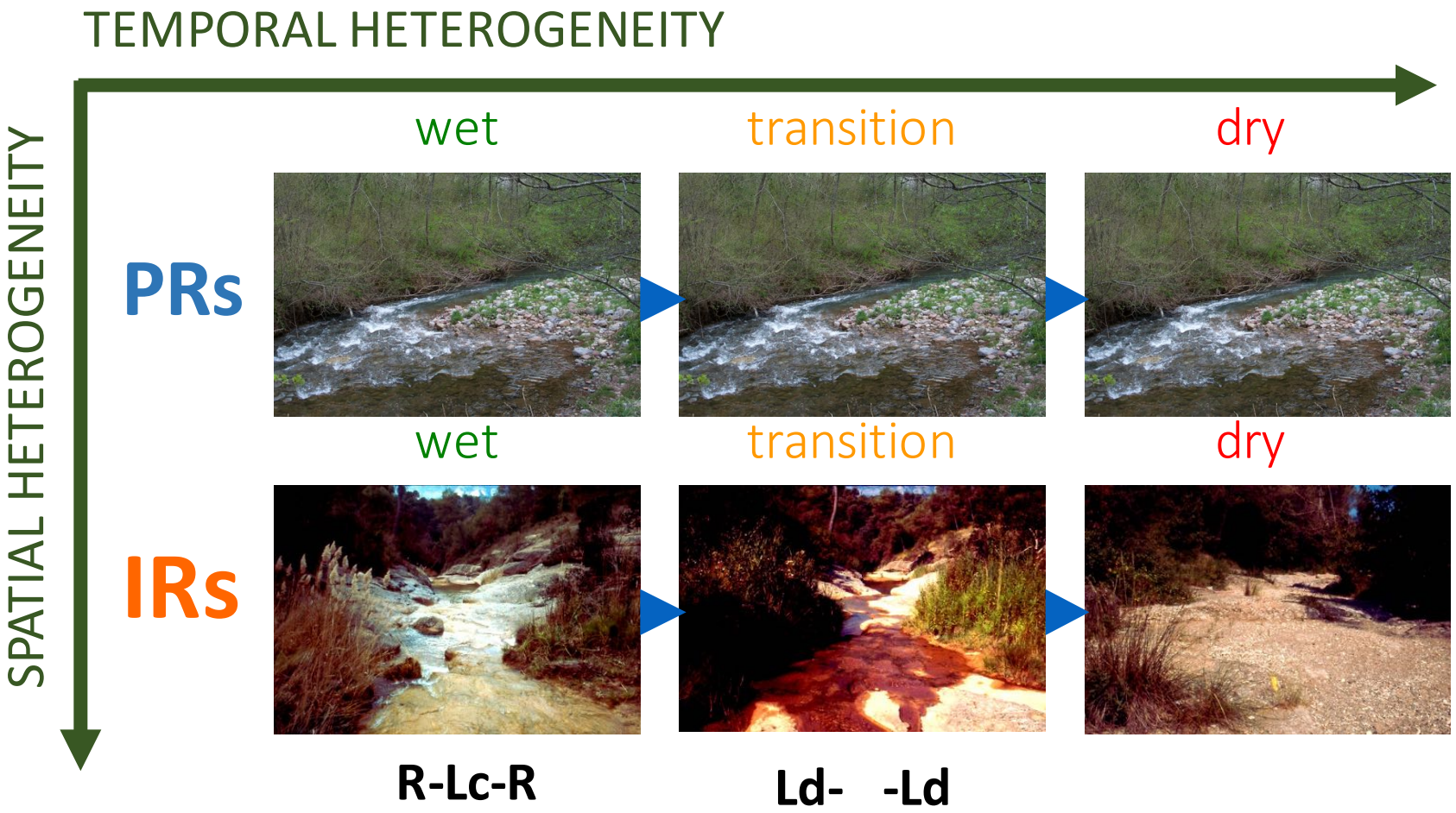

Núria Cid

Evelyn Garcia

INTERMITTENT RIVERS ARE FREQUENT

Temporal variability



Intermittent rivers

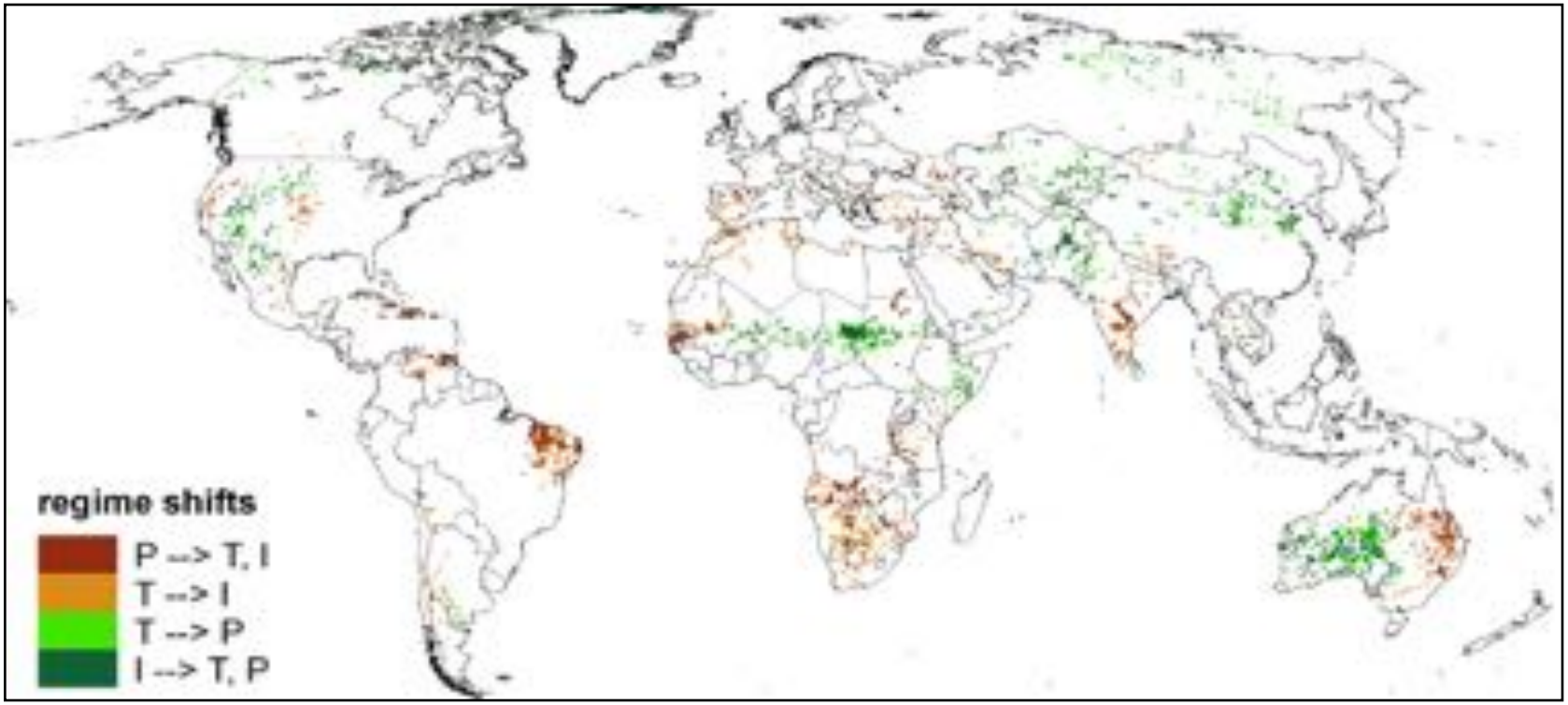


69% of the global low-order river network
30-40% of the global large river basins
70% of the river network in Australia
54% of the river network in the US
94% of the river network in the southwestern US

….is intermittent

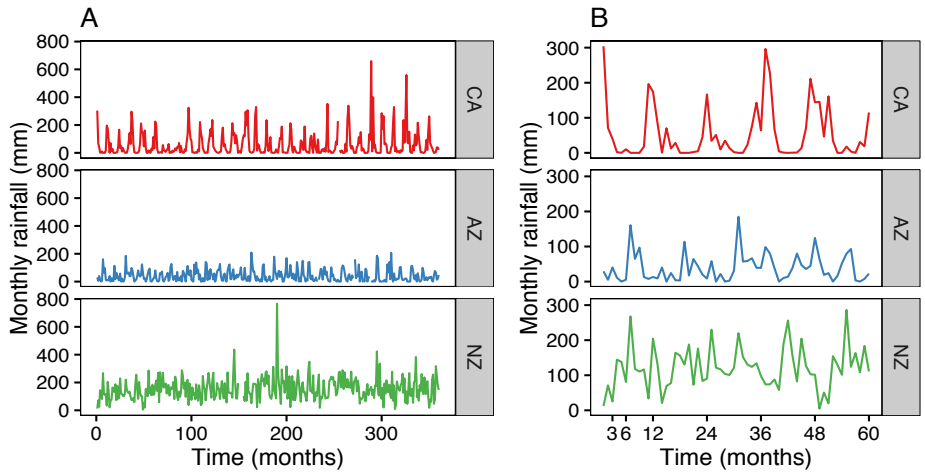
Intermittent rivers

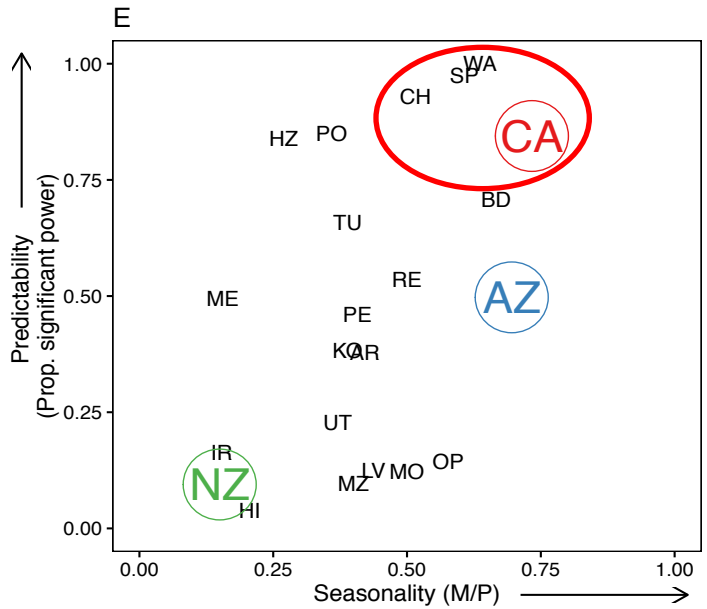
Döll & Schmied, 2012



Regime shifts among perennial (P), transitional (T) and intermittent (I) river flow regimes occurring between 1961–90 and 2041–70 due to climate change (as computed with WaterGAP, climate scenario HadCM3 A2).

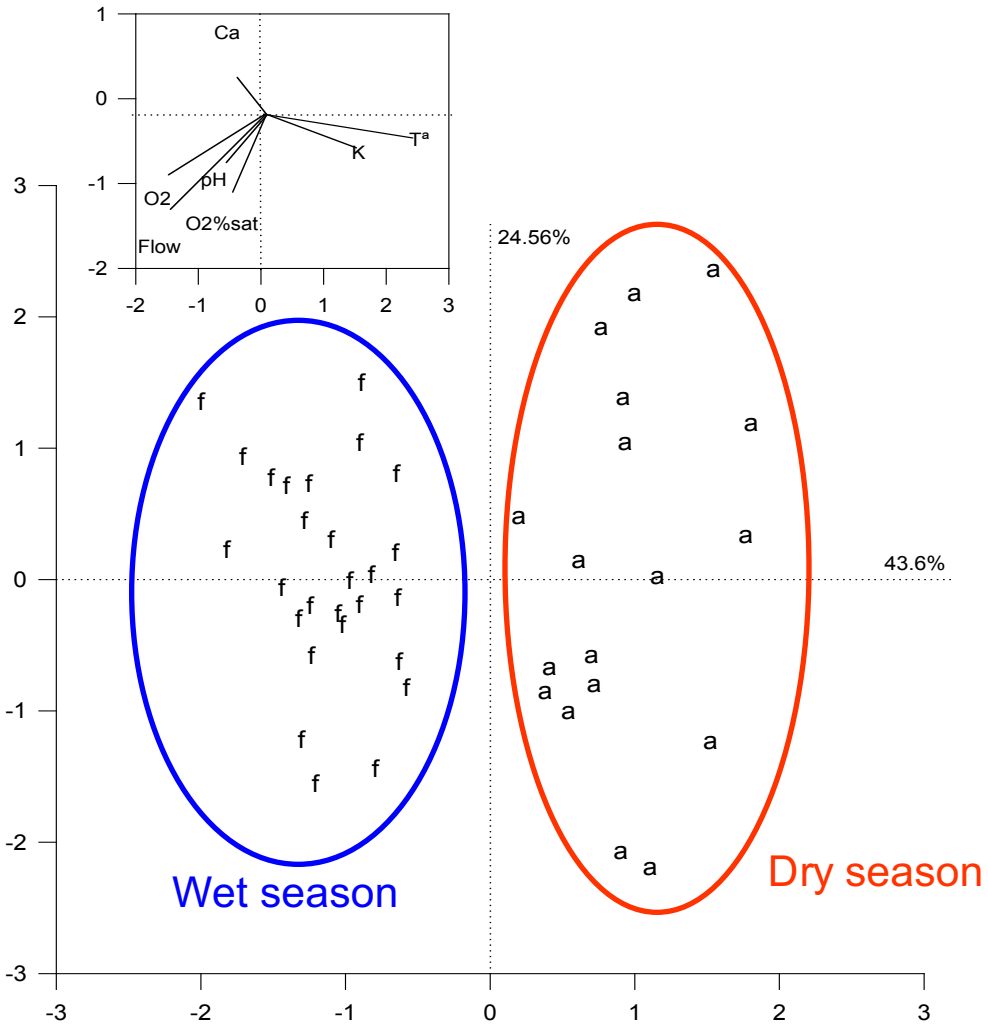
Seasonal and predictable

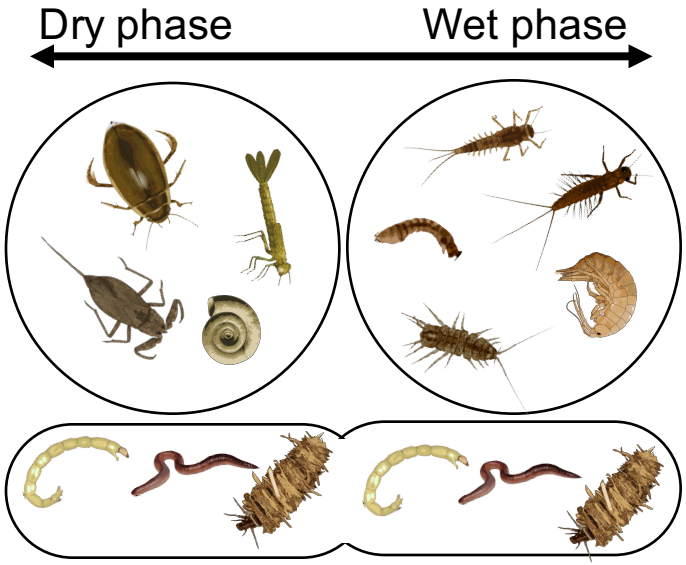




Tonkin et al. 2017

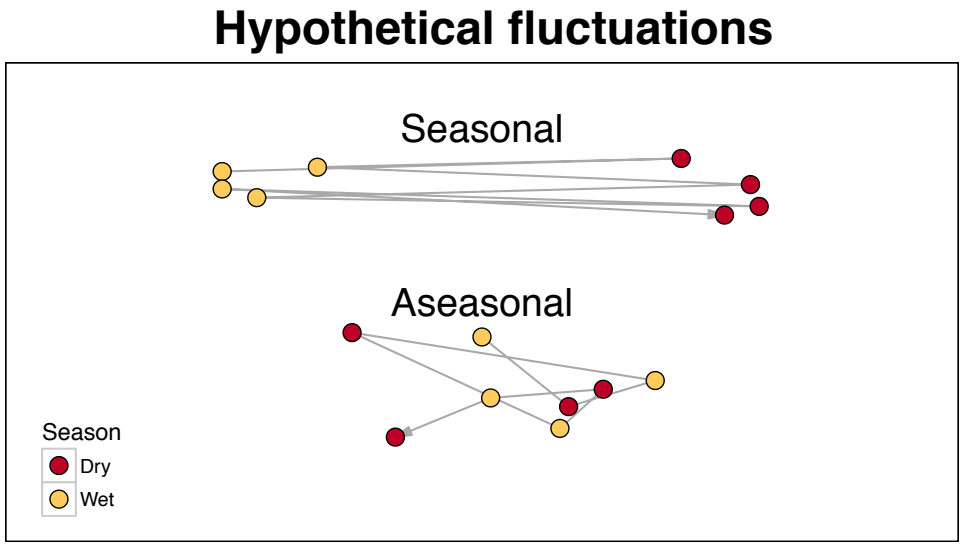
Seasonal and predictable

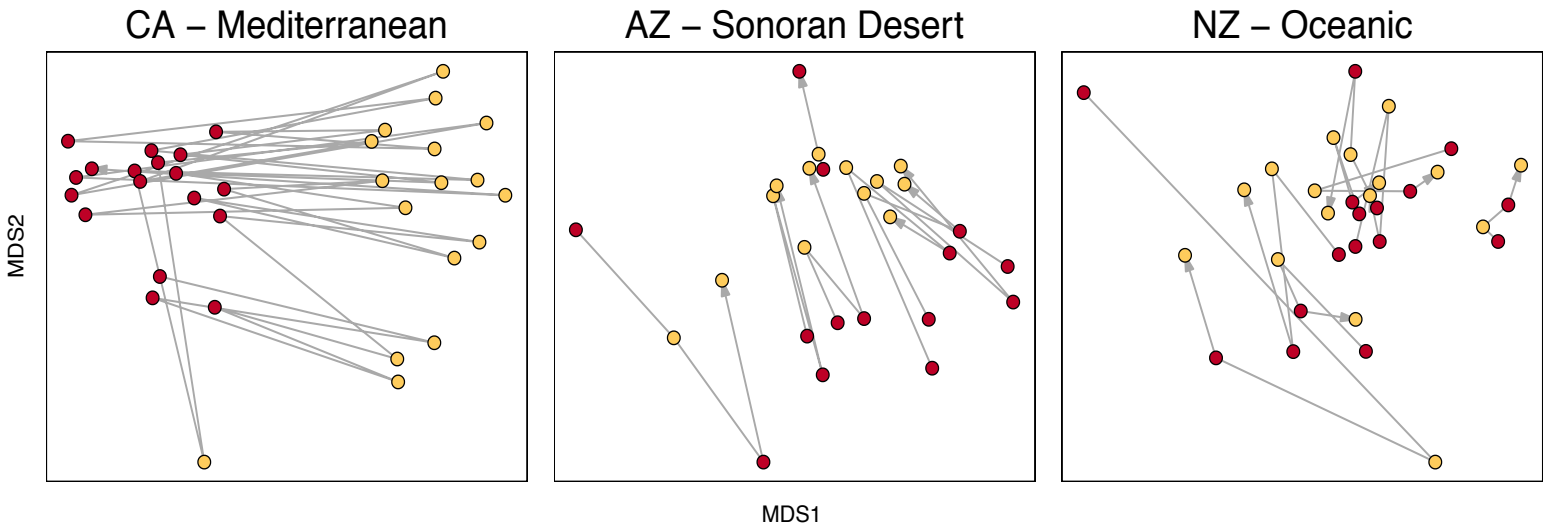




Rieradevall et al., 1999

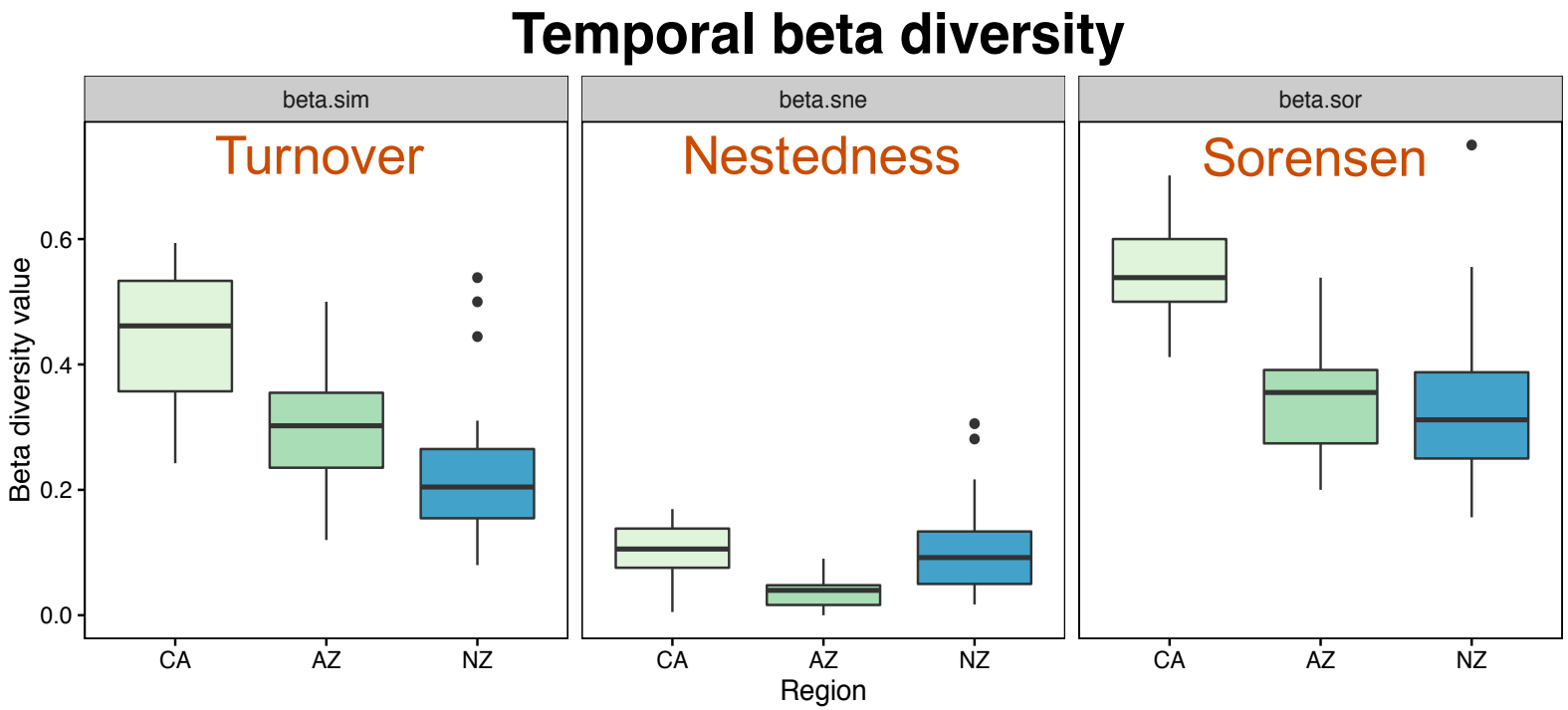
Seasonal and predictable





Tonkin et al., 2017

Seasonal and predictable



Tonkin et al., 2017

Are intermittent rivers poorer?



Overall design

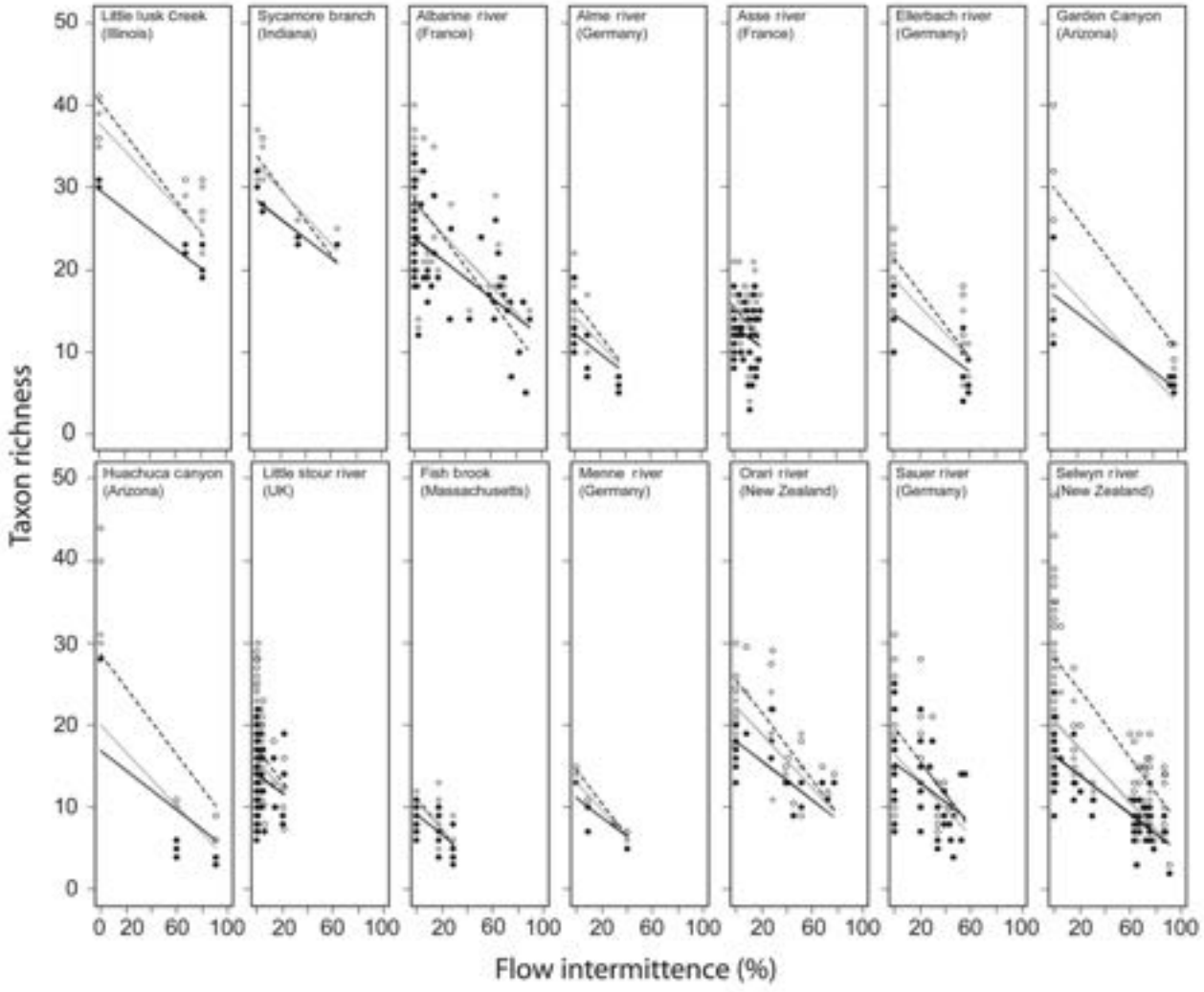
Model results

n	wES	SE	p-value	ci.lb	ci.ub
44	0.879	0.169	**<0.0001**	0.549	1.209

PERENNIAL RIVERS >> INTERMITTENT RIVERS

Soria et al., 2017

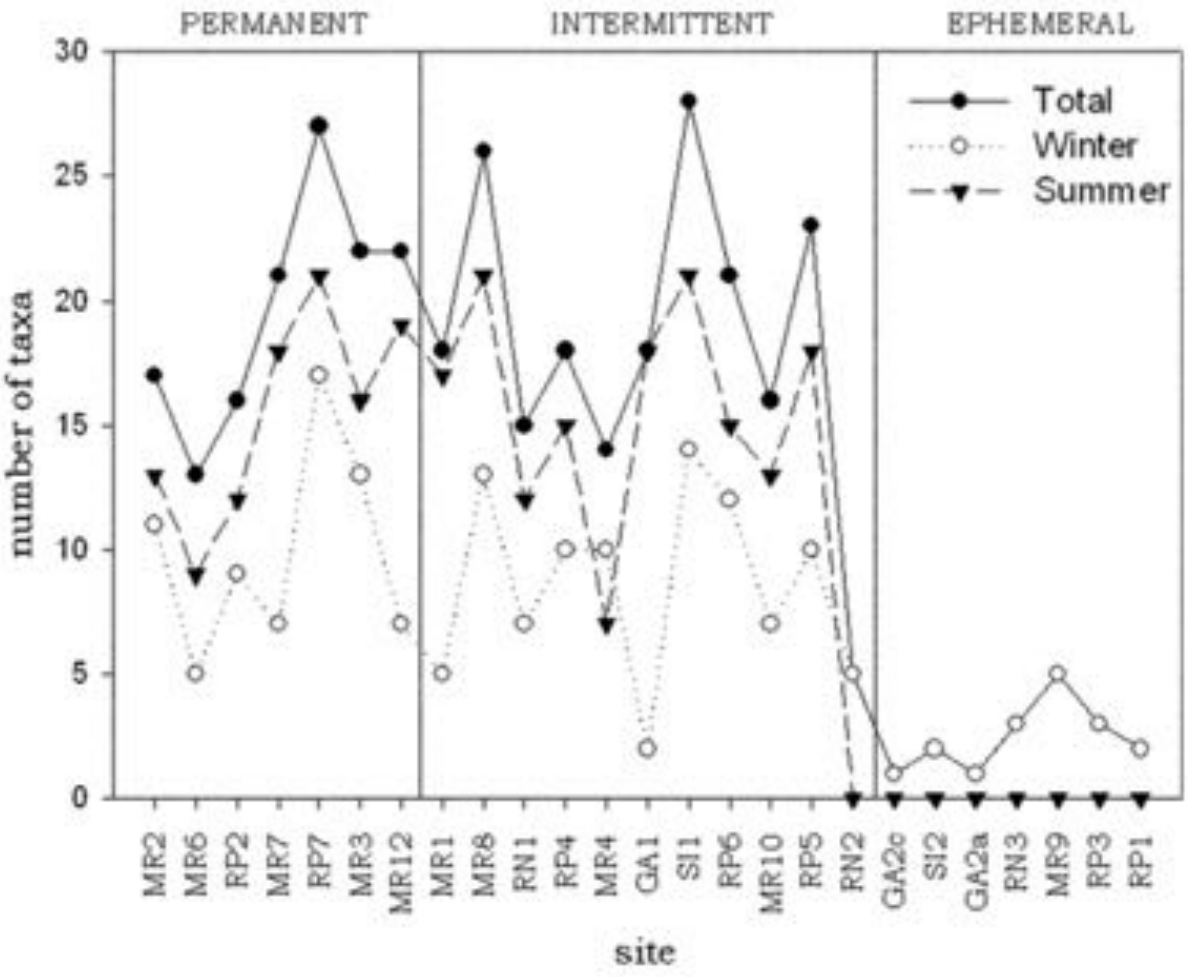
Are intermittent rivers poorer?



RICHNESS DECREASE WITH FLOW INTERMITTENCE

Datry et al., 2013

Are intermittent rivers poorer?



RICHNESS DECREASE WITH FLOW INTERMITTENCE

Bonada et al., 2007

Are intermittent rivers poorer?

Richness and EPT-OCH among
California/MedBasin/SouthAfrica/SWAustralia
(during the flow phase)

Nested ANOVA			d.f.	SS	MS	*F*-value	*P*-value
Richness	Region	MCRs	3	2239.82	746.61	28.53	<0.001
	Reach	PT(MCRs)	4	139.70	34.93	1.33	0.268
	Macrohabitat	RL[PT(MCRs)]	8	200.10	25.01	0.95	0.479
		Residuals	56	1465.04	26.16	4.03	
EPT/(EPTOCH)	Region	MCRs	3	0.17	0.05	4.03	0.011
	Reach	PT(MCRs)	4	0.26	0.06	4.47	0.003
	Macrohabitat	RL[PT(MCRs)]	8	0.42	0.05	3.59	0.002
		Residuals	56	0.81	0.01		

Richness → PERENNIAL RIVERS = INTERMITTENT RIVERS
EPT/EPTOCH → PERENNIAL RIVERS >> INTERMITTENT RIVERS

Bonada et al., 2008

Are intermittent rivers poorer?

COMPOSITION among
California/MedBasin/SouthAfrica/SWAustralia
(during the flow phase)

Nested ANOSIM			Global-R	*P*-value
Composition	Region	MCRs	0.89	0.010
	Reach	PT(MCRs)	0.32	0.001
	Macrohabitat	RL(MCRs)	0.39	0.001
		RL(PT)	0.18	0.001

One-way ANOSIM			Global-R	*P*
	Reach	MB	0.33	0.034
		CA	0.92	0.026
		SA	0.32	0.082
		AU	0.18	0.229
	Macrohabitat	MB	0.32	0.002
		CA	0.52	<0.001
		SA	0.33	<0.001
		AU	0.39	<0.001

Composition → PERENNIAL RIVERS ≠ INTERMITTENT RIVERS

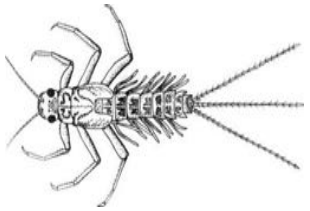
Bonada et al., 2008

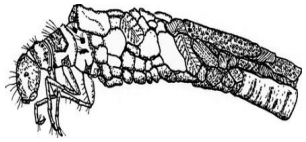
Are intermittent rivers poorer?

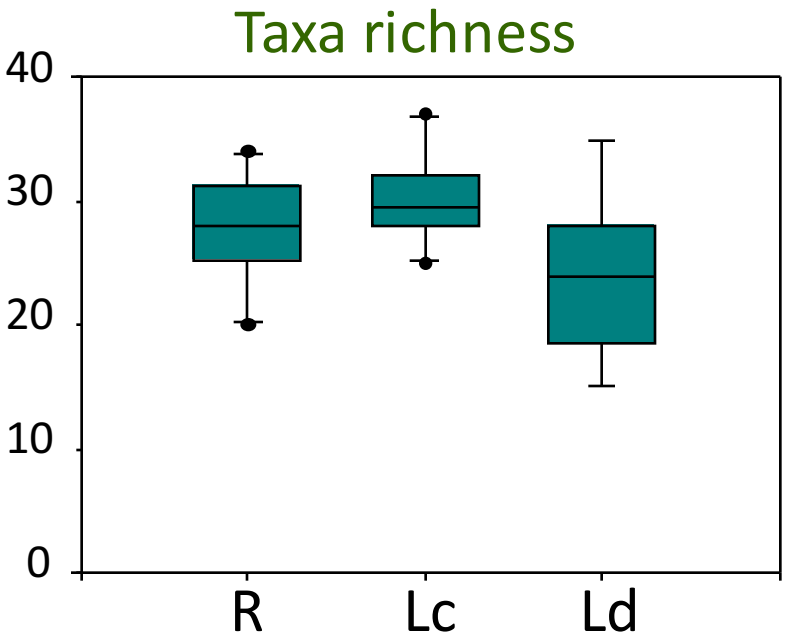
Temporal changes

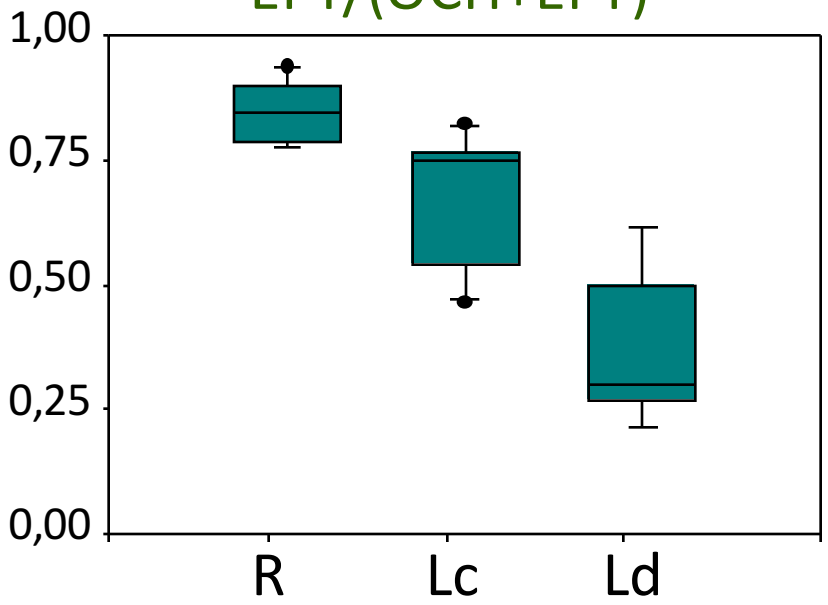


R-Lc-R **Lc-R-Lc** **Ld- -Ld**



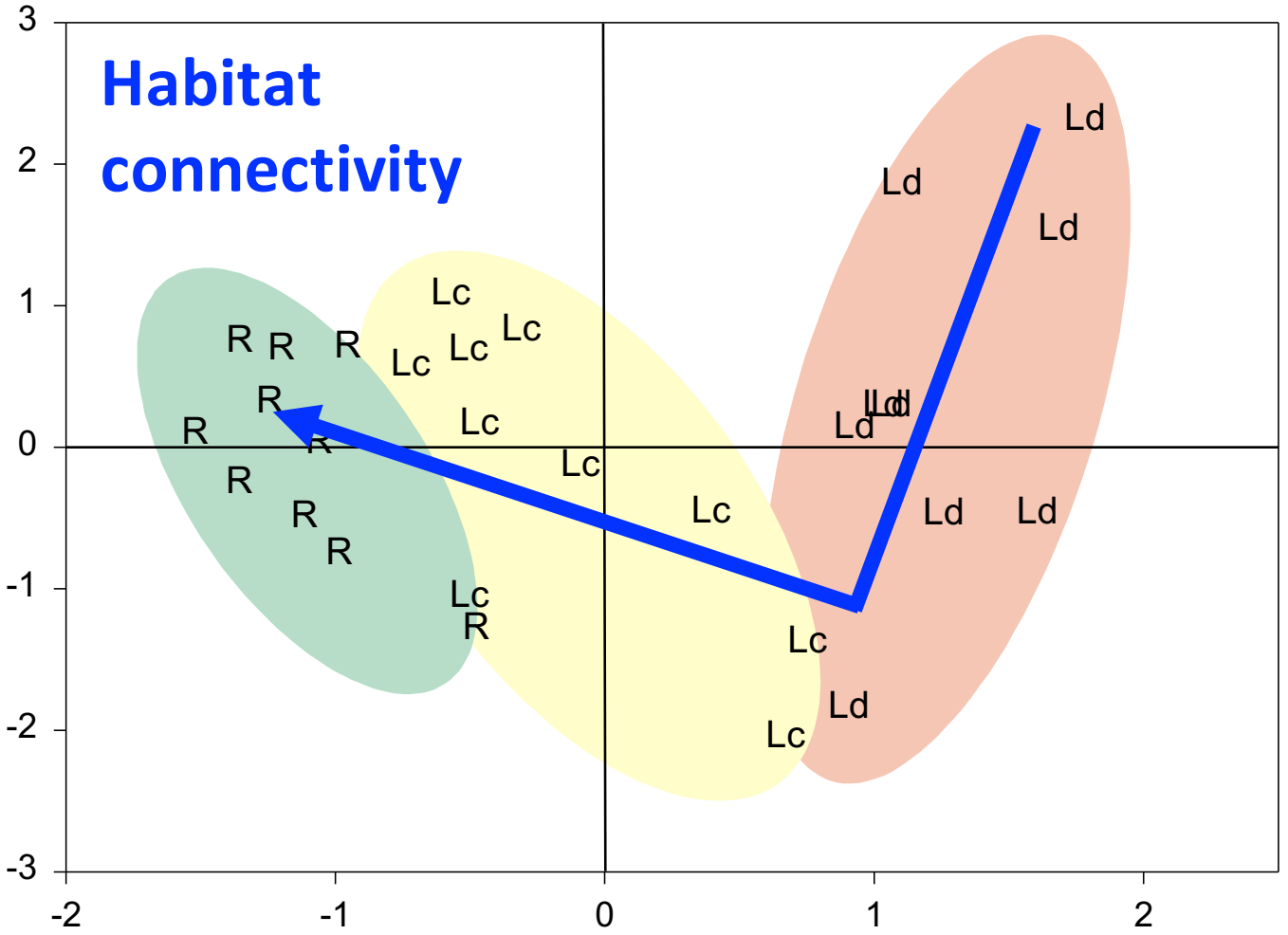






Bonada et al., 2006

Are intermittent rivers poorer?



Correspondence Analysis

Bonada et al., 2006

Biological adaptations

Jesús Arribas









Toni Hernández

Terrestrial plants
(Dallman, 1998)

Terrestrial arthropods
(Stamou, 1998)

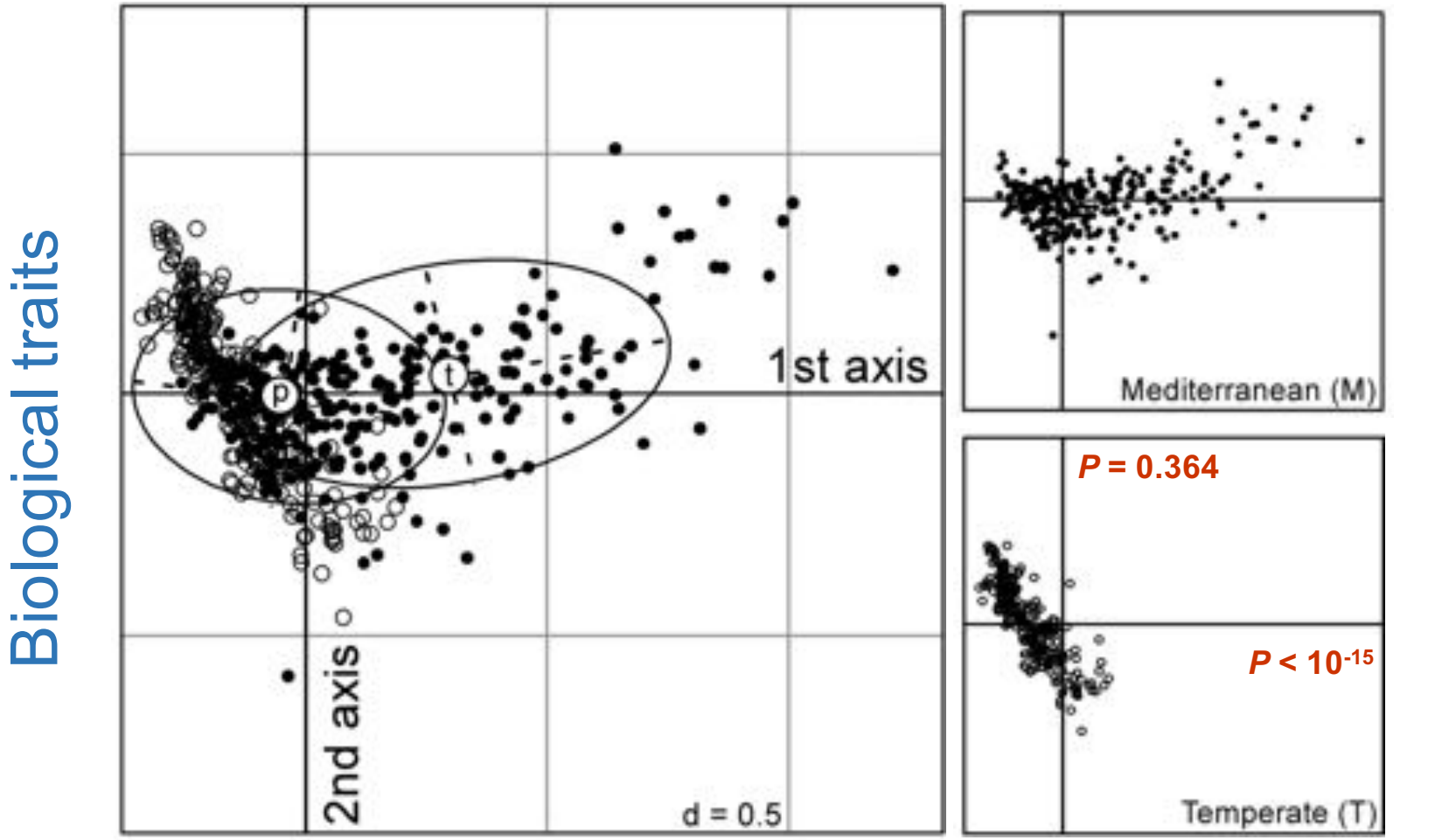
Algae
(Romaní et al., 2013)

Riparian plants
(Stella et al., 2013)

Aquatic invertebrates
(Bonada et al., 2007)

Biological adaptations

Fuzzy Correspondence Analysis



between-class variance = 0.021, *P* < 0.001

Bonada et al., 2007

Biological adaptations

PERMANENT



INTERMITTENT





With isolated pools

Highly ephemeral

Biological adaptations

PERMANENT

No significant traits in this analysis

INTERMITTENT

Lentic species

- Life cycles > 1 year
- Several repro-ductive cycles/ year
- Adults dominant
- Active dispersal (winged forms)
- Aerial respiration
- Locomotion: flying, swimmer or surface swimmer

Pioner species

- Life cycles < 1 year
- Few reproductive cyles/year
- Larvae important
- Passive dipersal (non-winged forms)
- Respiration by gills or tegument
- Locomotion: substrate attatchment

HUMAN PRESSURES IN MED-RIVERS









Núria Bonada


http://ichn.iec.cat


Tony Herrera


Fam. Sobregrau



Climate change

OBSERVED AND FORECASTED ECOLOGICAL RESPONSES

LIFE HISTORY

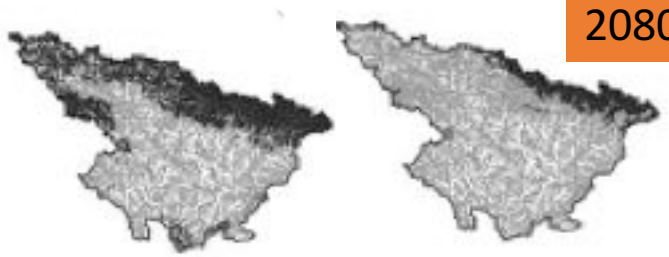
Cid et al., 2008

DISTRIBUTION



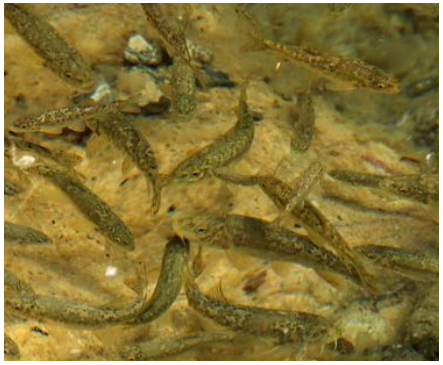
Romero et al., 1981

Salmo trutta (Ebro Basin)



Filipe et al., 2013

COMMUNITY

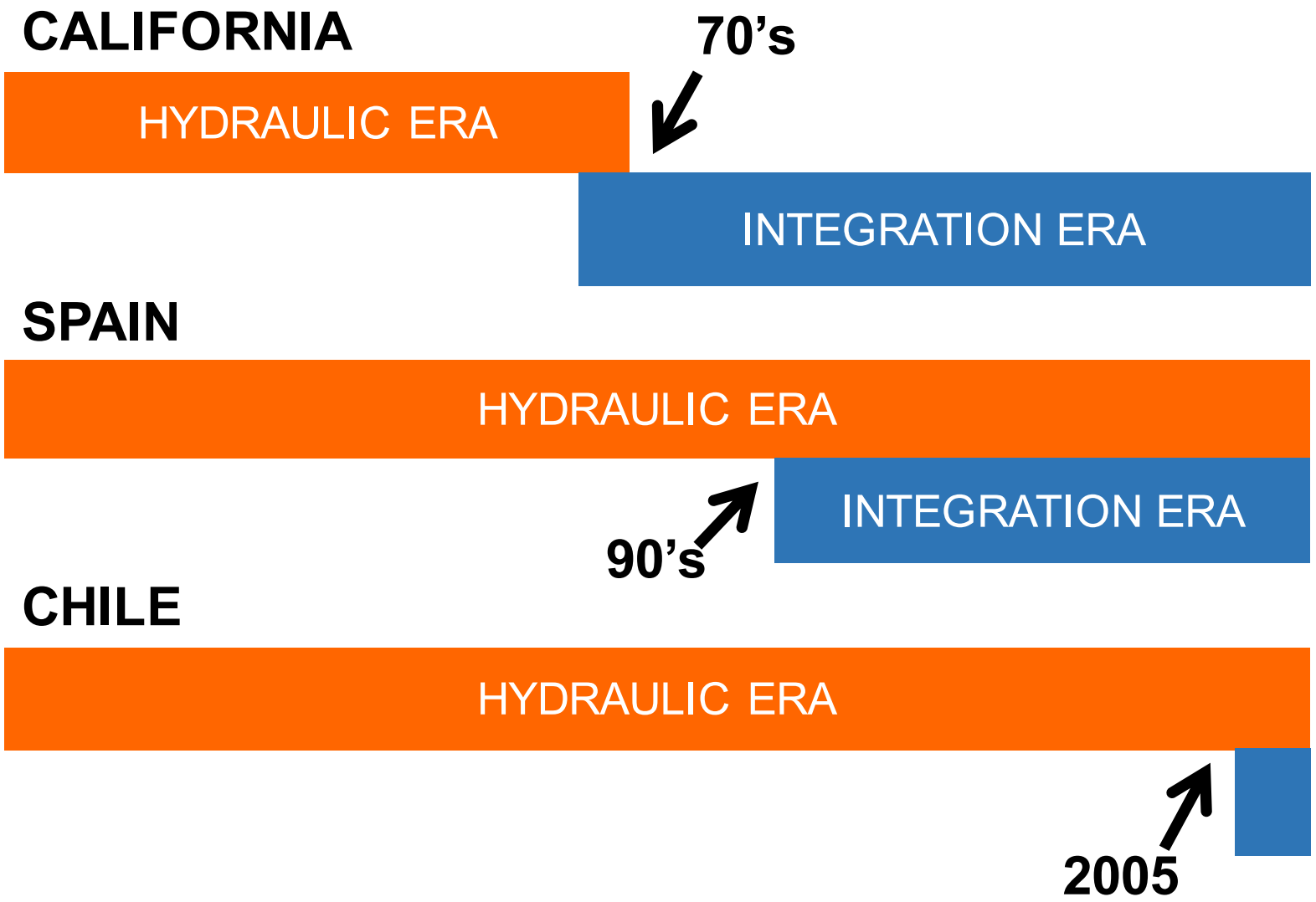


Buisson & Grenouillet, 2009



MANAGEMENT IN MED-RIVERS

Water management



Grantham et al., 2013

Bioassessment

Hydrobiologia (2013) 719:483–507
DOI 10.1007/s10750-012-1305-8

MEDITERRANEAN CLIMATE STREAMS

Review Paper

Ecological status assessment in mediterranean rivers: complexities and challenges in developing tools for assessing ecological status and defining reference conditions

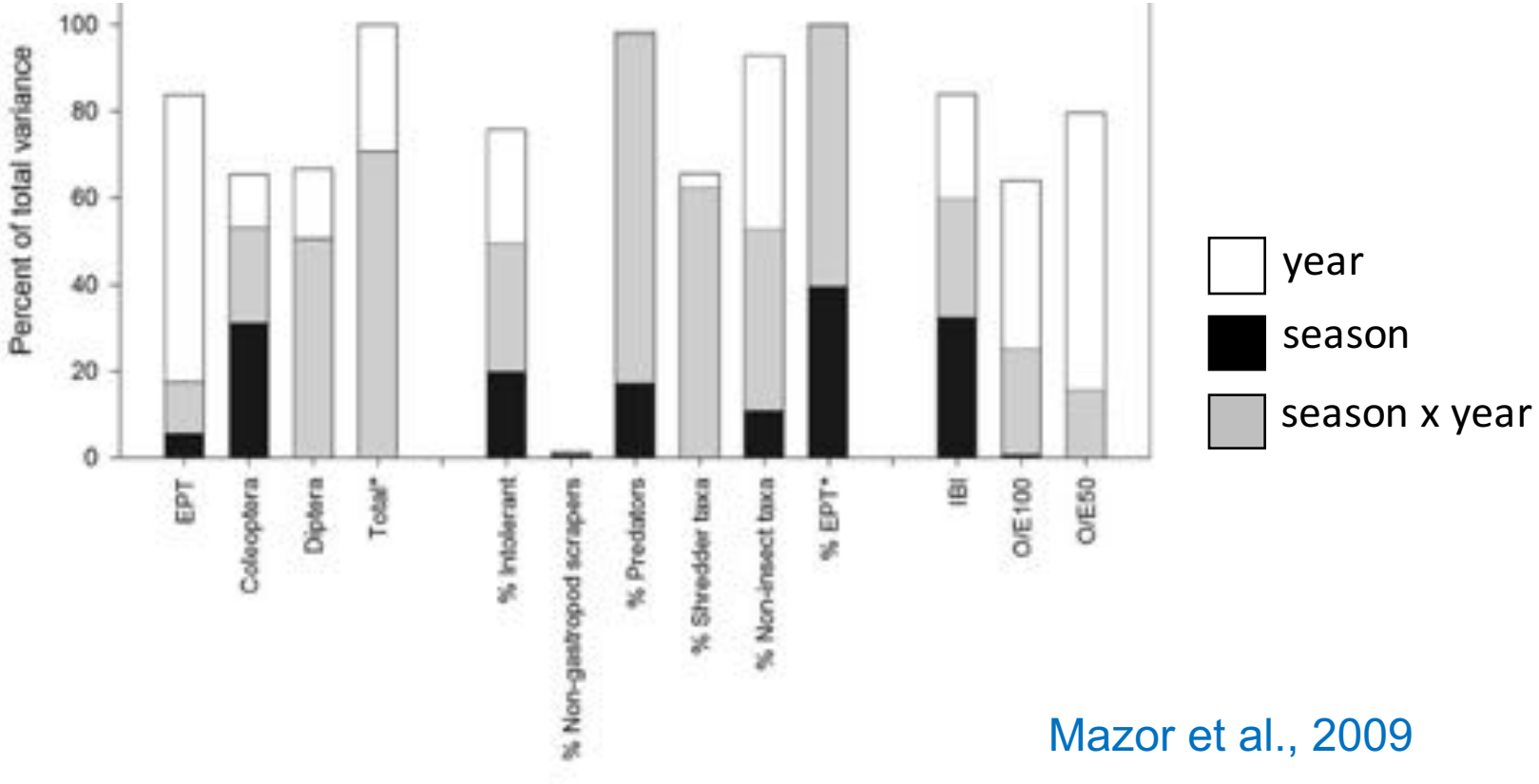
Helen F. Dallas

What biotic indices are used in routine monitoring?
How are reference sites identified?
How are reference conditions defined?
How is bioassessment data interpreted?
How is spatial variability incorporated?
How is temporal variability incorporated?
Are non-perennial streams included?
Has science been translated to legislation?

Bioassessment

SEASONAL VARIABILITY

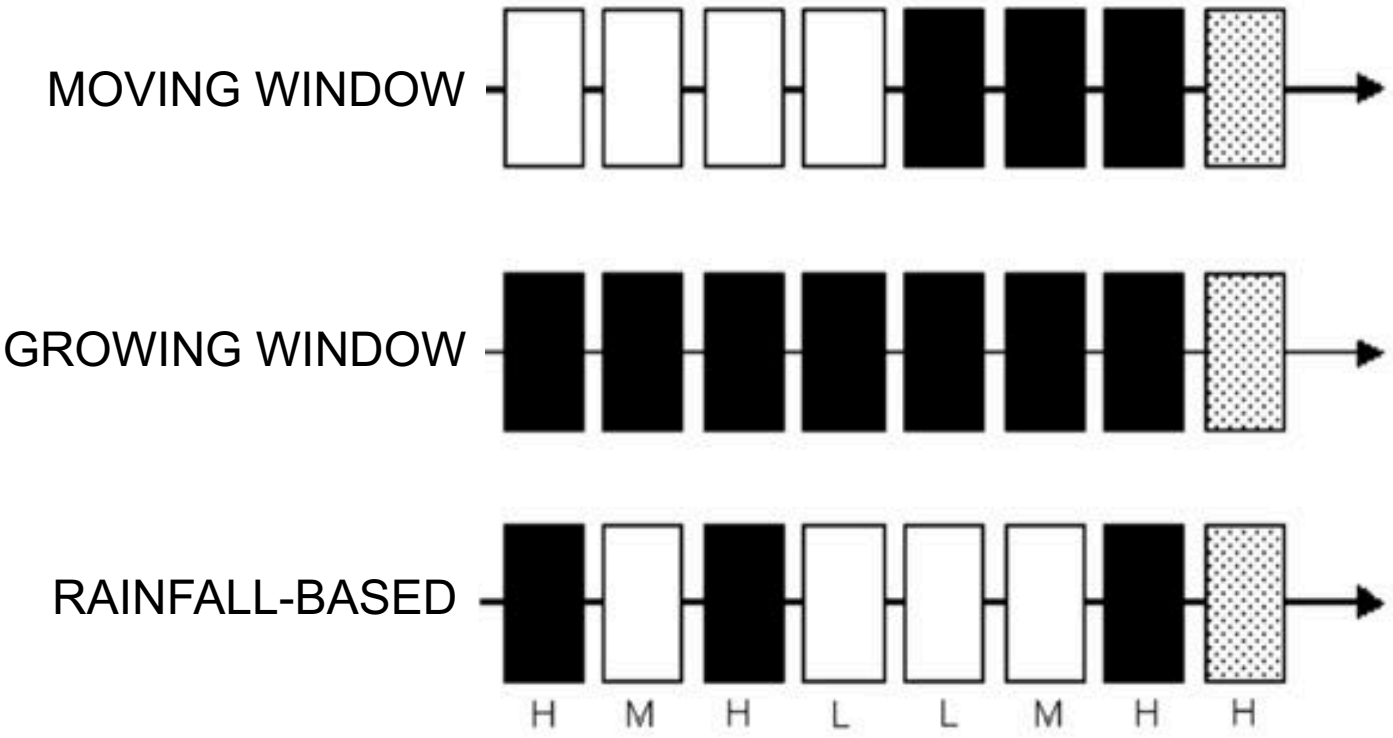
INTERANNUAL VARIABILITY



Mazor et al., 2009

Bioassessment

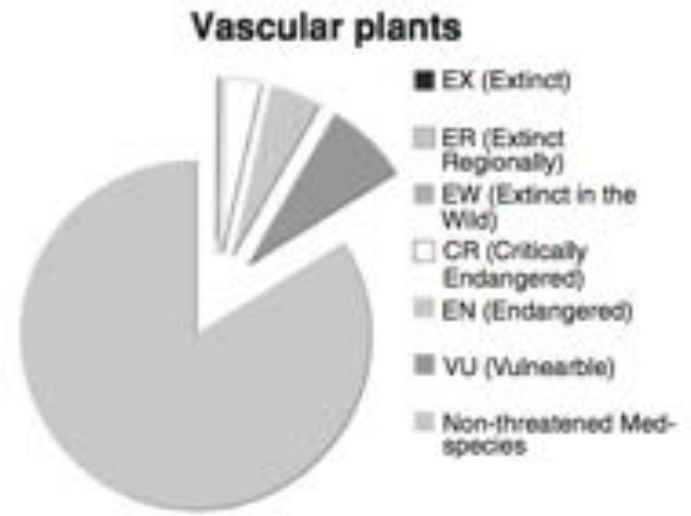
ESTABLISHMENT OF RC WITH LONG-TERM DATA



Resh et al., 2013

Conservation

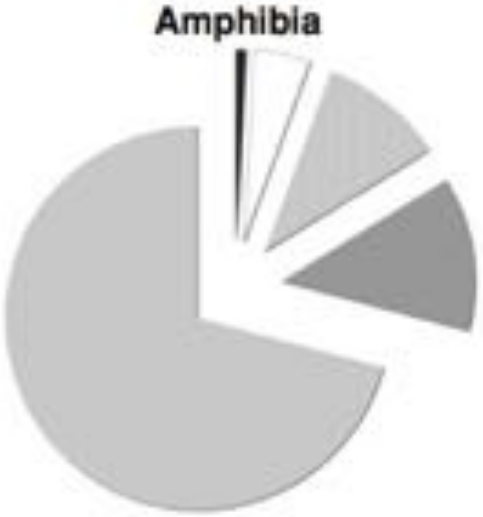












Tierno de Figueroa et al., 2013

Conservation





SCIENTIFIC AND SOCIAL CONSERVATION OBJECTIVES TO DESIGN FLUVIAL RESERVES

Conservation

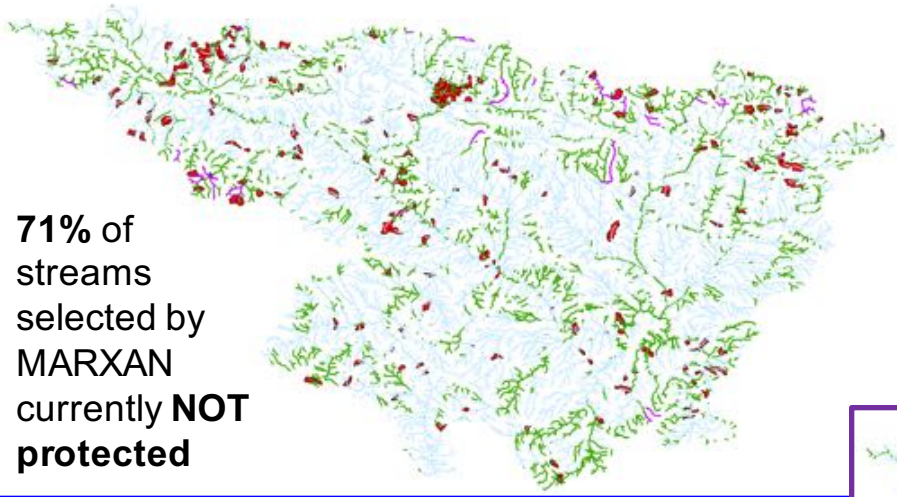


Natura 2000 = 8742 Km of streams

Current network of River Protected Areas = 349 Km of streams

Conservation

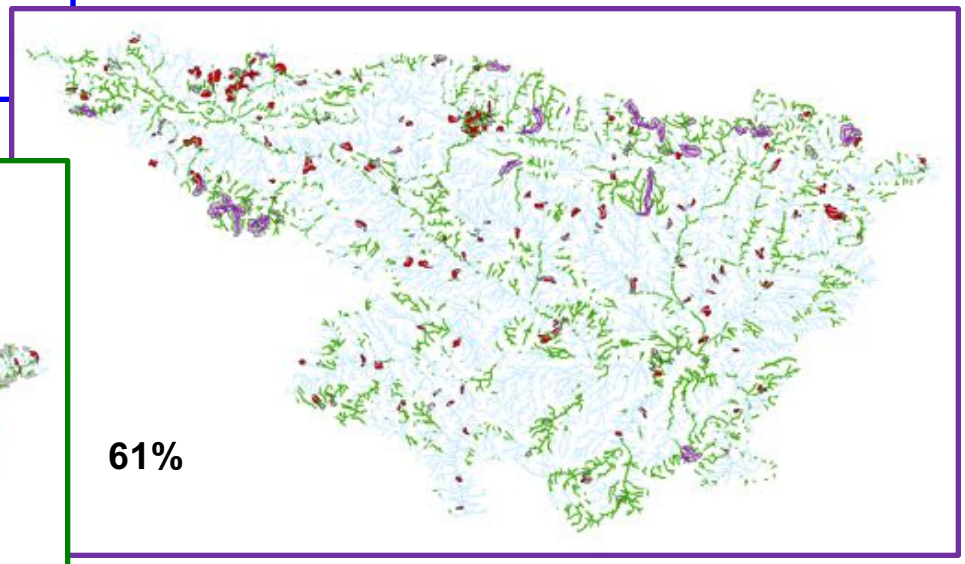
SOME PROSOSED REACHES ARE INTERMITTENT!



71% of streams selected by MARXAN currently **NOT protected**

Scenario 1: no streams blocked (854 km: none of the current River Protected Areas)

Scenario 2: current network of River Protected Areas blocked (1251km)



61%



12%

Scenario 3: current network of River Protected Areas and Natura 2000 blocked

Restoration

Cuneo Creek (California)



Kondolf et al., 2013

La Rambla de Barcelona

FEHM lab RESEARCH GROUP
Freshwater Ecology, Hydrology & Management

Thanks so much

www.ub.edu/fem

