

# The role of life-history traits in explaining the ecological effects of temporal clustering of disturbance

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# Climate change

## BACKGROUND



Change in Indicator	Observed (since 1950)	Attributed (since 1950)	Projected at GWL (°C)		
			+1.5	+2	+4
Warm/hot extremes: Frequency or intensity	↑	✓ Main driver	↑	↑	↑
Cold extremes: Frequency or intensity	↓	✓ Main driver	↓	↓	↓
Heavy precipitation events: Frequency, intensity and/or amount	↑ Over majority of land regions with good observational coverage	✓ Main driver of the observed intensification of heavy precipitation in land regions	↑ in most land regions		↑ in most land regions
Agricultural and ecological droughts: Intensity and/or frequency	↑ in some regions	✓ in some regions	↑ in more regions compared to observed changes	↑ in more regions compared to 1.5°C of global warming	↑ in more regions compared to 2°C of global warming
Precipitation associated with tropical cyclones	↑	✓	↑ Rate +11%	↑ Rate +14%	↑ Rate +28%
Tropical cyclones: Proportion of intense cyclones	↑	✓	↑ +10%	↑ +13%	↑ +20%
Compound events: Co-occurrent heatwaves and droughts	↑ (Frequency)	✓ (Frequency)	↑ (Frequency and intensity increases with warming)		
Marine heatwaves: Intensity & frequency	↑ (since 1900)	✓ (since 2006)	↑ Strongest in tropical and Arctic Ocean		
Extreme sea levels: Frequency	↑ (since 1960)	✓	↑ (Scenario-based assessment for 21st century)		

medium confidence
likely/high confidence
very likely
extremely likely
virtually certain

World Meteorological Organization

<https://public.wmo.int/en/resources/bulletin/regional-trends-extreme-events-ipcc-2021-report>

# BACKGROUND



## Climate change



**DISTURBANCE  
REGIME**

Intensity

Spatial variability

Temporal variability



**ECOLOGICAL  
RESPONSES**



Life-history  
traits

# Experimental tests of effects of perturbations expected to become more intense and clustered

## BACKGROUND

Oecologia (2000) 124:270–279 © Springer-Verlag 2000

Declan J. McCabe · Nicholas J. Gotelli

**Effects of disturbance frequency, intensity, and area on assemblages of stream macroinvertebrates**

Ecology 86(3), 2005, pp. 2061–2067  
© 2005 by the Ecological Society of America

**CONTRASTING EFFECTS OF MEAN INTENSITY AND TEMPORAL VARIATION OF DISTURBANCE ON A ROCKY SEASHORE**

IACOPO BERTOCCI,<sup>1</sup> ELENA MAGGI, STEFANO VASELLI, AND LISANDRO BENEDETTI-CECCHI

Ecology, 87(10), 2006, pp. 2489–2499  
© 2006 by the Ecological Society of America

**TEMPORAL VARIANCE REVERSES THE IMPACT OF HIGH MEAN INTENSITY OF STRESS IN CLIMATE CHANGE EXPERIMENTS**

LISANDRO BENEDETTI-CECCHI,<sup>1</sup> IACOPO BERTOCCI, STEFANO VASELLI, AND ELENA MAGGI

Biological Applications, 20(7), 2010, pp. 1796–1800  
© 2010 by the Ecological Society of America

**Interactions among temporal patterns determine the effects of multiple stressors**

JORGE GARCÍA MOLINA<sup>1</sup> AND IAN DODDIER

Functional Ecology 2017, 31, 1122–1134 doi: 10.1111/1365-2435.12815

**Compounded perturbations in coastal areas: contrasting responses to nutrient enrichment and the regime of storm-related disturbance depend on life-history traits**


IACOPO BERTOCCI<sup>1,2</sup>, JORGE A. DOMÍNGUEZ GODINO<sup>1,2</sup>, CRISTIANO FREITAS<sup>1</sup>, MONICA INCERA<sup>1,4</sup>, ANA BIO<sup>1</sup> AND RULA DOMÍNGUEZ<sup>1,5</sup>

**Temporal clustering of tropical cyclones and its ecosystem impacts**

PETER J. MUMBY<sup>1,2</sup>, RENATO VITOLO<sup>1</sup>, AND DAVID B. STEPHANSON<sup>1</sup>

Global Change Biology (2017) 23, 3259–3268, doi:10.1111/gcb.13656

**Legacy effects and memory loss: how contingencies moderate the response of rocky intertidal biofilms to present and past extreme events**

MARTINA DAL BELLO , LUCA RINDI and LISANDRO BENEDETTI-CECCHI  
Department of Biology, University of Pisa, CoNISMa, Via Derna 1, Pisa, Italy

Journal of Ecology 2016, 104, 1453–1465 doi: 10.1111/1365-2745.12593

**Drought history affects grassland plant and microbial carbon turnover during and after a subsequent drought event**

LUCIA FUCHSLUEGER<sup>1,2,3</sup>, MICHAEL BAHN<sup>2</sup>, ROLAND HASIBEDER<sup>2</sup>, SANDRA KIENZL<sup>1</sup>, KARINA FRITZ<sup>2</sup>, MICHAEL SCHMITT<sup>2</sup>, MARGARETE WATZKA<sup>1</sup> AND ANDREAS RICHTER<sup>1</sup>

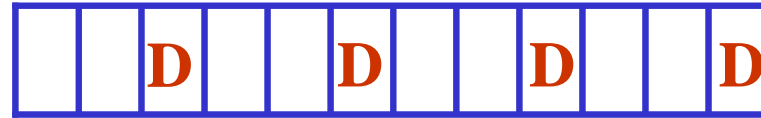


- Temporal variability as important as mean intensity to structure assemblages
- Time between disturbances is a key determinant

# BACKGROUND

➤ Time between disturbances is a key determinant

LOW FREQUENCY



Time

HIGH FREQUENCY



Time

LOW VARIANCE

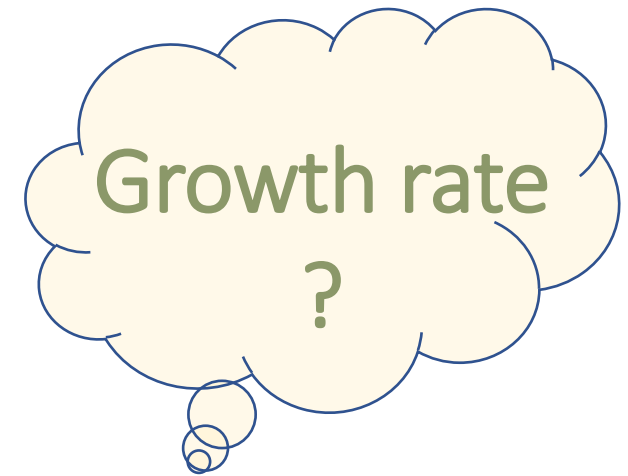
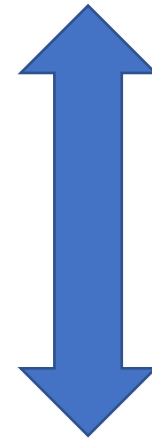


Time

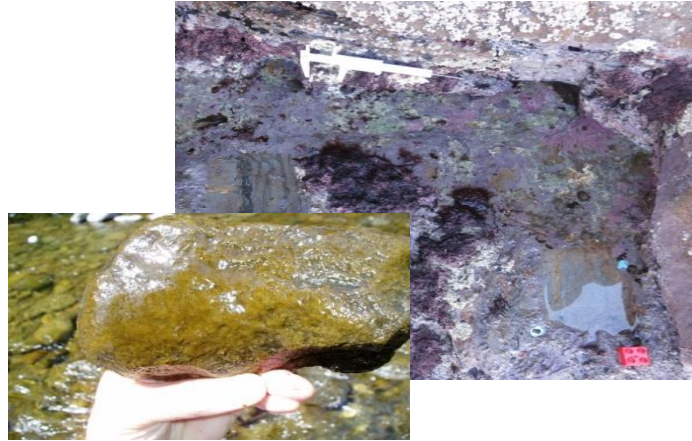
HIGH VARIANCE



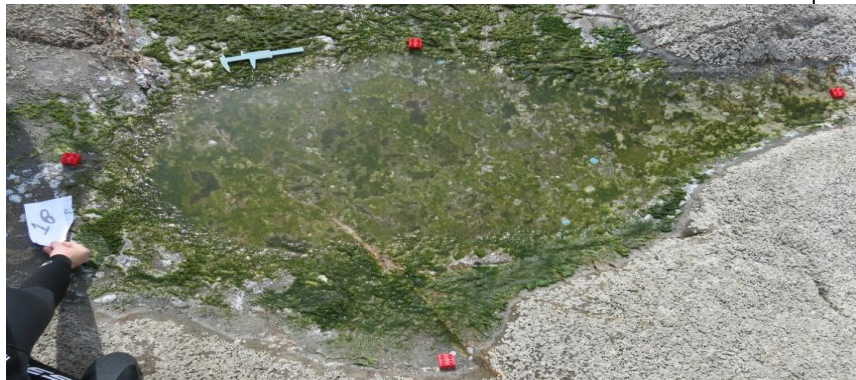
Time



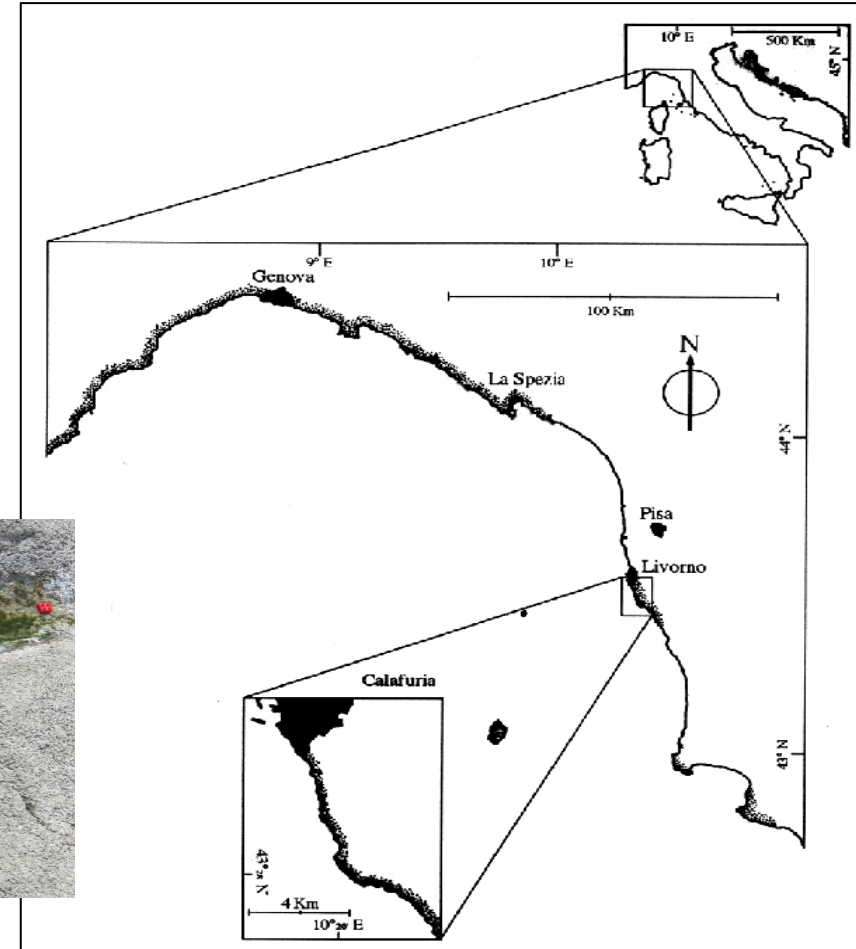
# STUDY ORGANISMS



**Epilithic microphytobenthos (EMPB)**  
Cyanobacteria, diatoms, spores, propagules



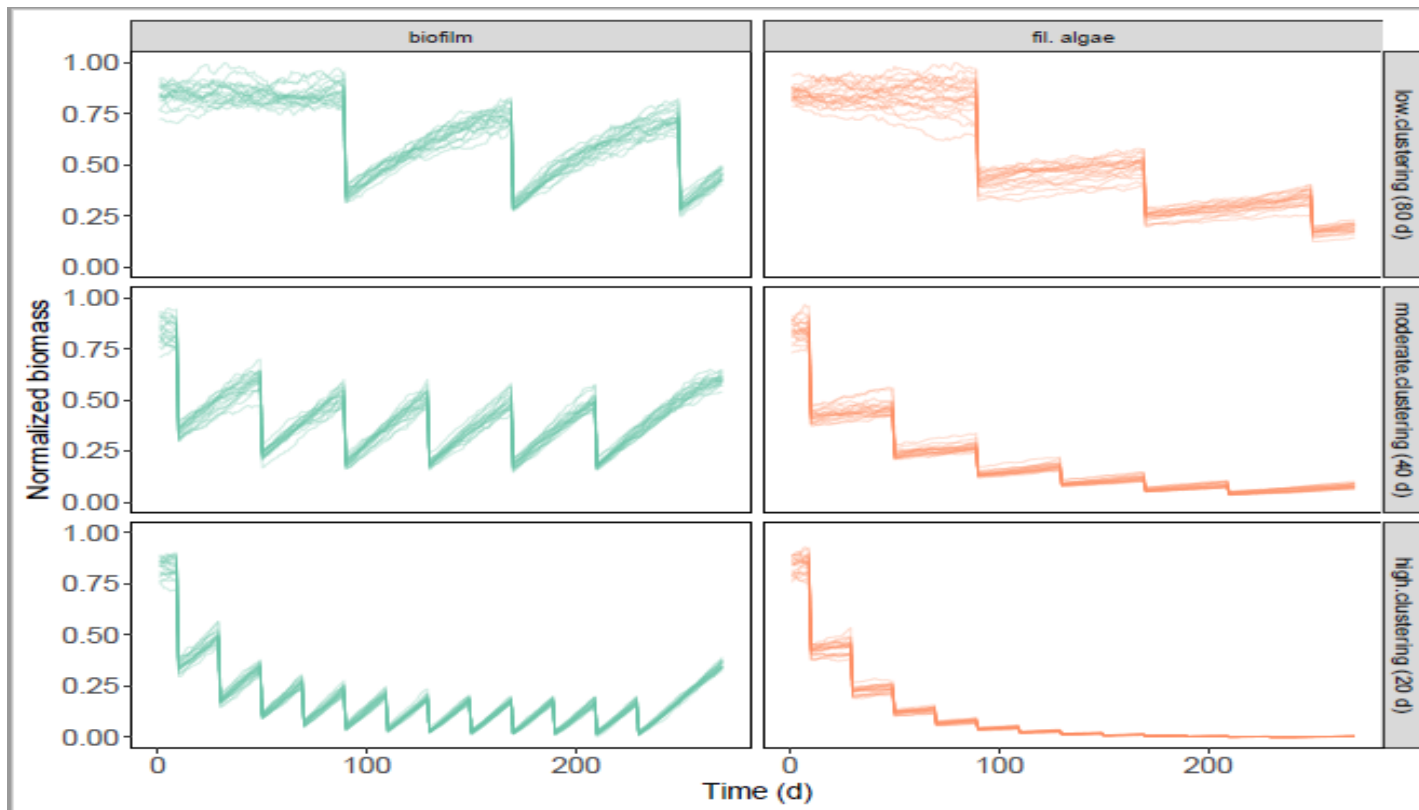
**Green filamentous algae**  
*Chaetomorpha aerea*, *Cladophora* spp.



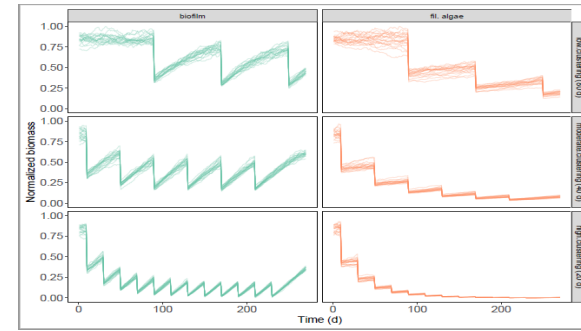
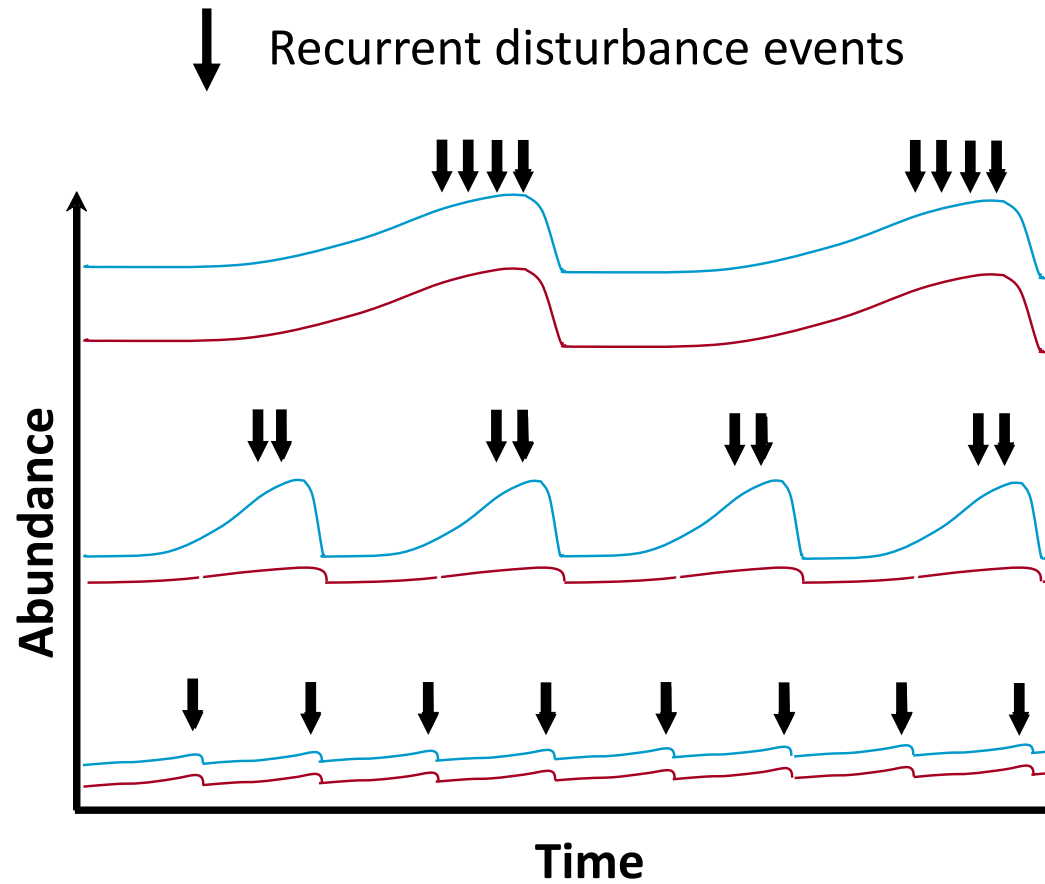
# PRELIMINARY MODELLING

Literature  
Past recovery exp.

Simple growth model



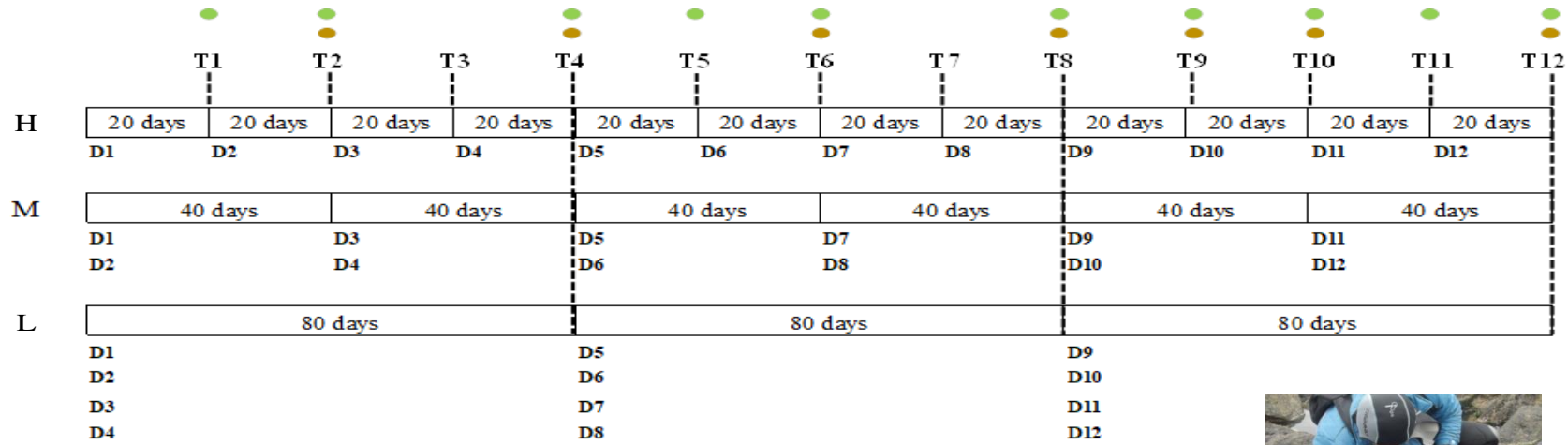
# HYPOTHESES



	Recovery	
Time interval	EMPB	Filam. algae
20 days	-	-
40 days	+	-
80 days	+	+



# METHODS

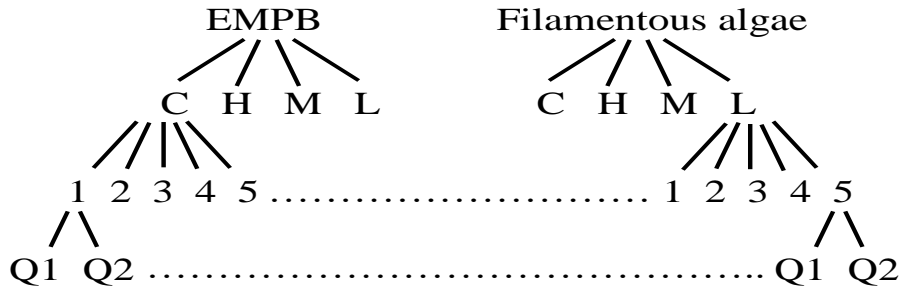


**Taxon**

**Disturbance pattern**

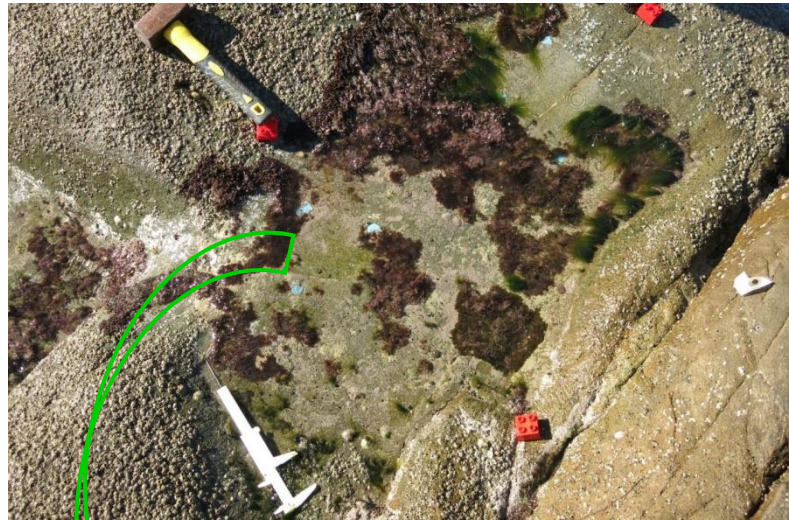
**Pool**

**Plot**



## Response variables

## METHODS



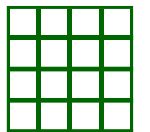
EMPB

$F_0$  (~biomass)



Filamentous algae

% cover (transf. into biomass by regression)

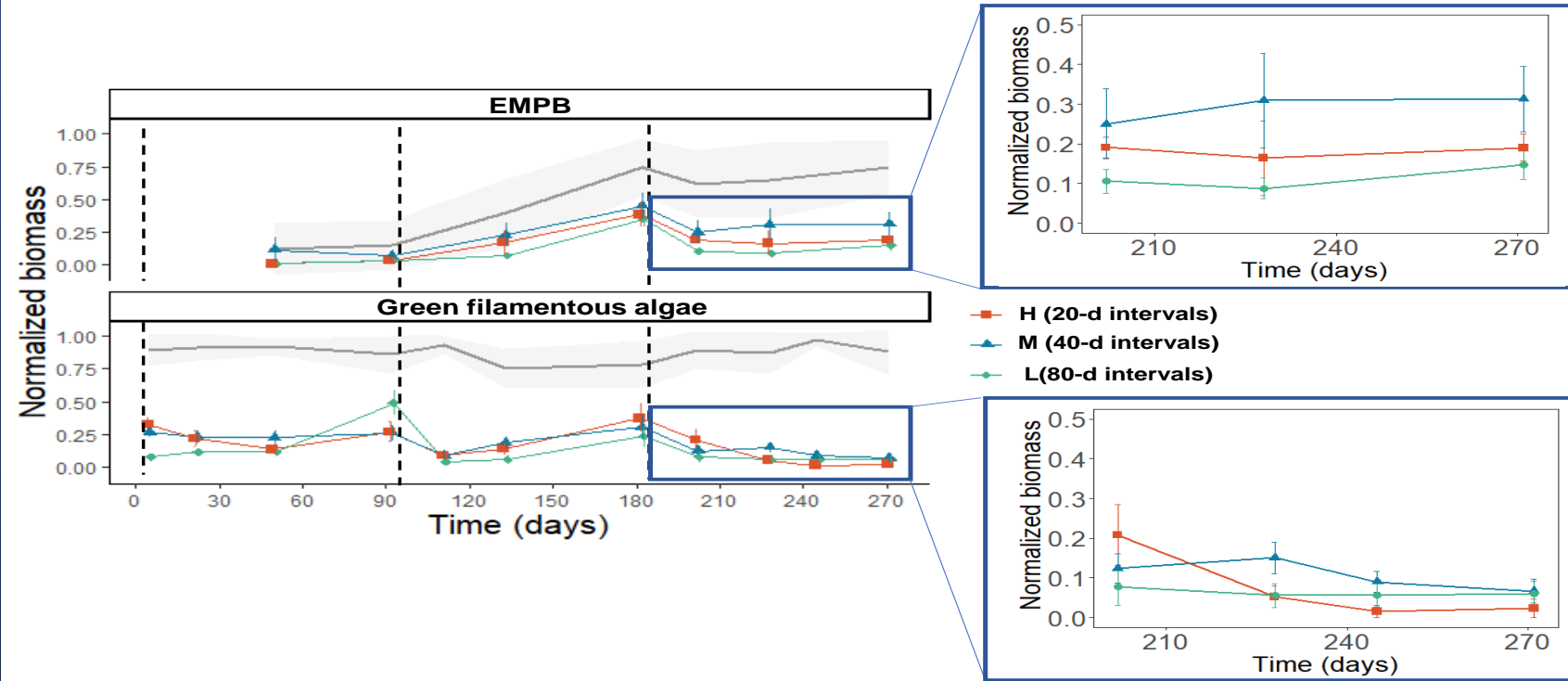


[0,1] Normalized biomass

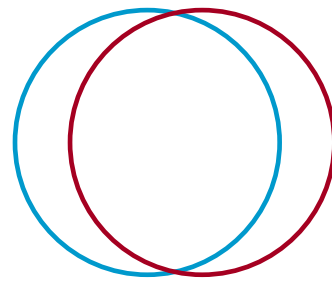
$$X' = (X - X_{\min}) / (X_{\max} - X_{\min})$$



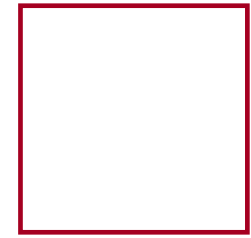
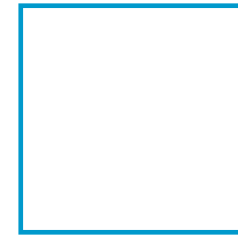
# RESULTS



# DISCUSSION AND CONCLUSIONS



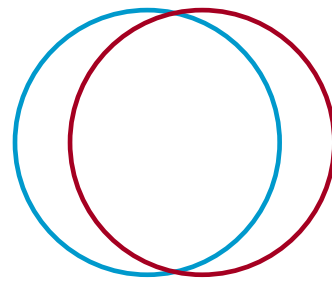
➤ Similar growth rates



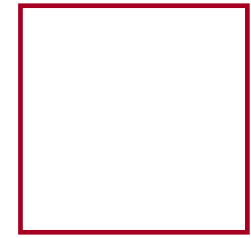
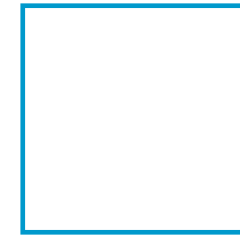
➤ Very different responses to disturbance



# DISCUSSION AND CONCLUSIONS



➤ Similar growth rates



➤ Very different responses to disturbance

➤ Temporal persistence



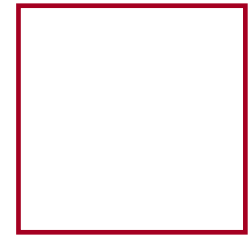
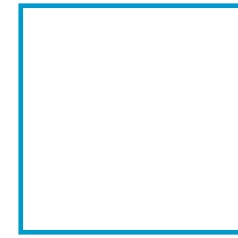
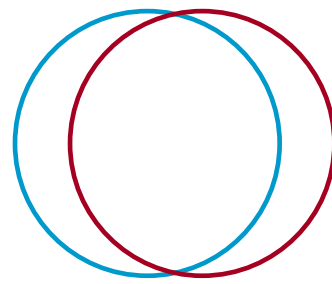
EMPB   
Filamentous  
algae



Under any  
clustering degree



# DISCUSSION AND CONCLUSIONS



➤ Similar growth rates ➤ Very different responses to disturbance

➤ Temporal persistence



EMPB   
Filamentous  
algae



Under any  
clustering degree



- Stronger responses expected from organisms with more contrasting life-history traits
- Implications for ecosystem functioning and management under climate change



THANK YOU FOR YOUR ATTENTION!

*...and, in case, for your compassion...*

PLEAS

