

# Resilience metrics are robust across data qualities but sensitive to community size

Duncan O'Brien<sup>1</sup> &  
Christopher Clements<sup>1</sup>  
<sup>1</sup> University of Bristol

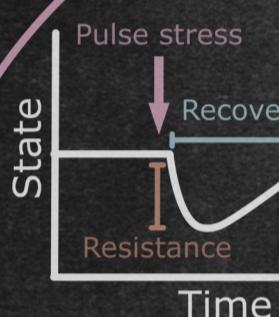
Ecosystem resilience is a key target for conservation monitoring but has been challenging to generically quantify.

Recently, generic tools have been suggested to estimate the system's **Jacobian** - which allows us to predict species interactions and future dynamics.

Here, we identify the behaviour of resilience metrics across **realistic data corruptions** such as short time series combined with systematic sampling error.

## Rationale

### What is resilience?

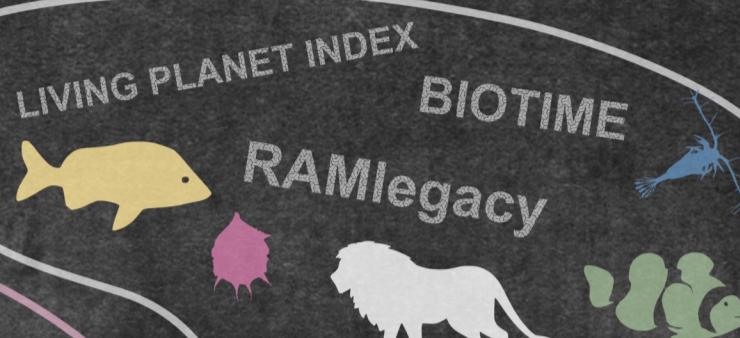


Resilience is 'the capacity to **persist** and **maintain** state and function in the face of **exogenous disturbance**' (Hodgson et al. 2015). Resilience/stability therefore should decrease when under stress.

The eigenvalues of the **Jacobian matrix** quantifies this stability. E.g. for a two species system (**x** & **y**), the Jacobian combines the species abundances, their **growth rates**, and **response to the other species**.

Jacobians have typically only been available to simulation/mathematical systems due to real-world **growth rates** and **species interactions** often being unknown.

**HOWEVER**, novel metrics have emerged (Grziwotz et al. 2023; Ushio et al. 2018) capable of estimating real-world Jacobian matrices, and their resilience dynamics.



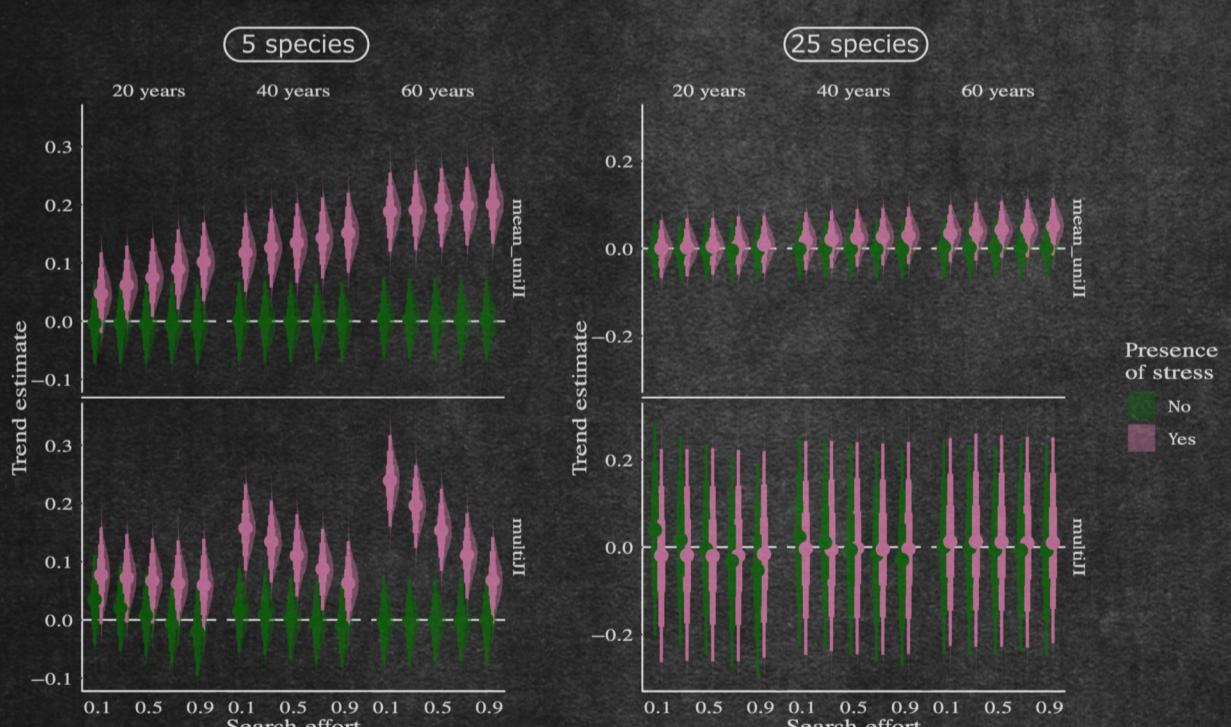
### Can resilience be estimated from global biodiversity time series?

90 unique multi-species reef communities were simulated 25 times each under stressful and stable conditions.

Data was 'corrupted' by trimming time series (10 → 70 time points) and introducing search effort error (0 → 100%).



## Results



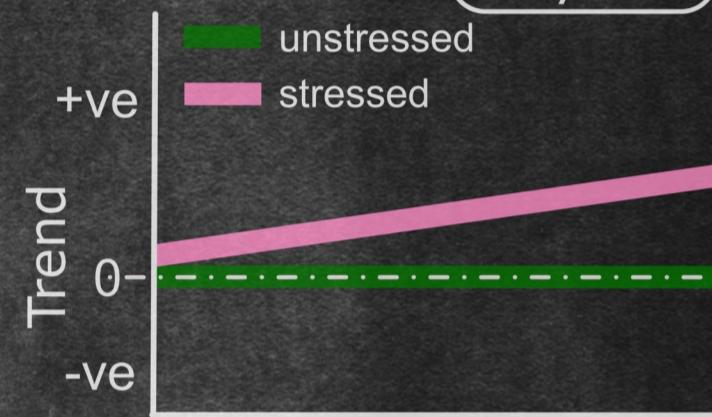
**The univariate Jacobian index performs as anticipated across time series length and search effort** - The multivariate index correctly identifies stressed or unstressed communities but weakens with search effort.

**Increasing the number of contributing species weakens metric capability** - Larger communities contain less influential species which mask the true resilience of the ecosystem.

## Expectation

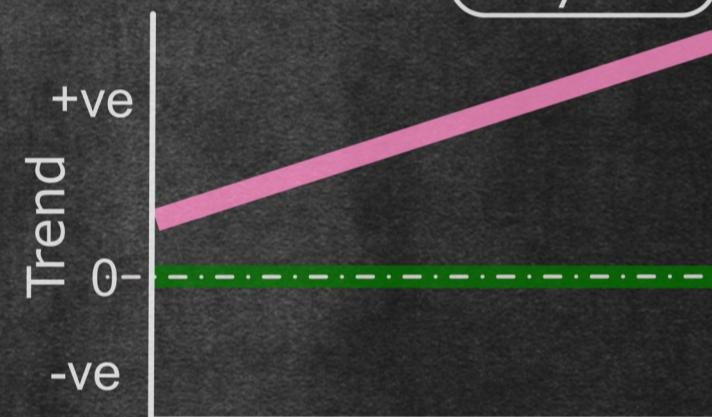
All metrics should display a **temporal trend in stressed simulations**, have **no trend in unstressed**, and a stronger trend in longer time series with high search efforts.

10 years



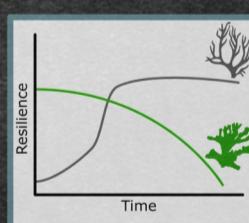
Search effort

40 years



Search effort

## Conclusion



**Generic resilience metrics behave predictably across data corruptions** - Such metrics are appropriate for real-time monitoring.

**Choice of species is critical to ensuring accurate resilience estimation** - Selecting ecologically important/keystone species is a suitable criterion.

## Info

If you want to calculate your own metrics, the R package **EWSmethods** can be found here:



@duncanobrienn  
duncan.obrien@bristol.ac.uk

University of BRISTOL GW4 FRESH