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Vulnerability to collapse of coral reef ecosystems in the Western Indian Ocean

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Norwegian Agency for Development Cooperation


Summary on contribution from fish data

Data

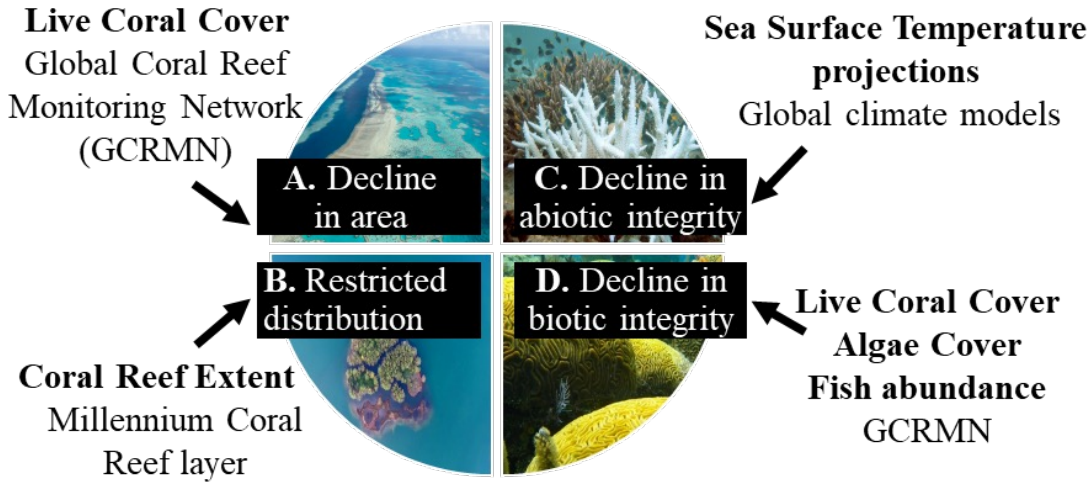

Photo credit: Keith Ellenbogen

Data contributors

Embedded in Western Indian Ocean GCRMN/ Coral Reef Task Force

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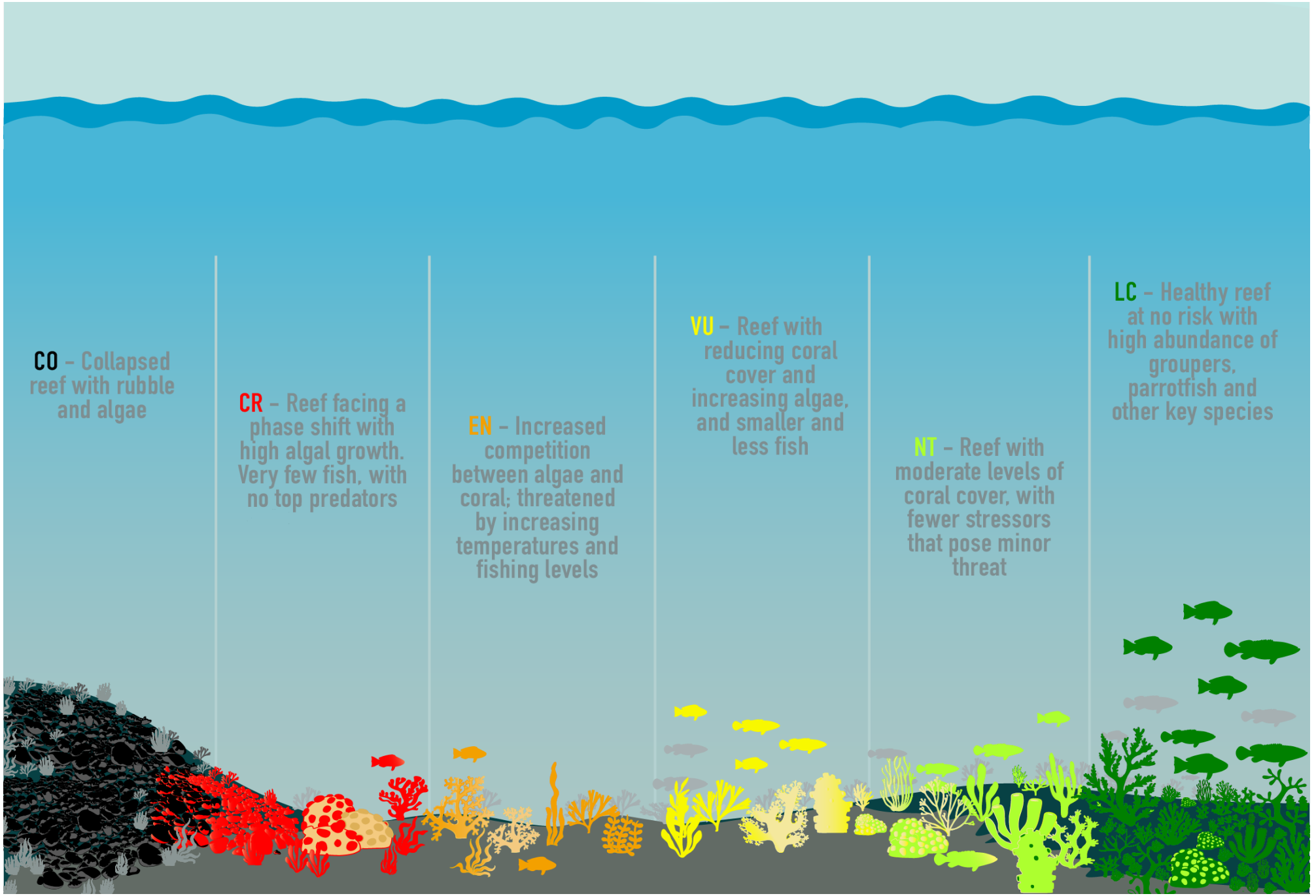
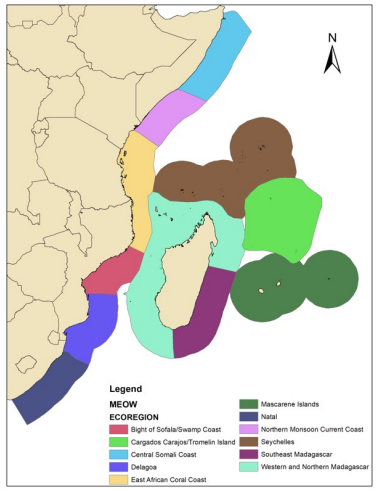
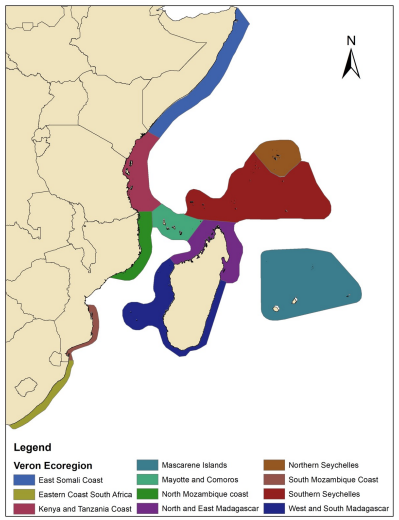

CO – Collapsed reef with rubble and algae
CR – Reef facing a phase shift with high algal growth. Very few fish, with no top predators
EN – Increased competition between algae and coral; threatened by increasing temperatures and fishing levels
VU – Reef with reducing coral cover and increasing algae, and smaller and less fish
NT – Reef with moderate levels of coral cover, with fewer stressors that pose minor threat
LC – Healthy reef at no risk with high abundance of groupers, parrotfish and other key species

Western Indian Ocean – geographic units of assessments

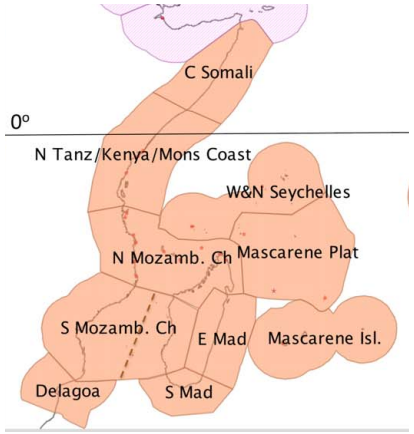
MEOW 2007



Veron COTW 2015



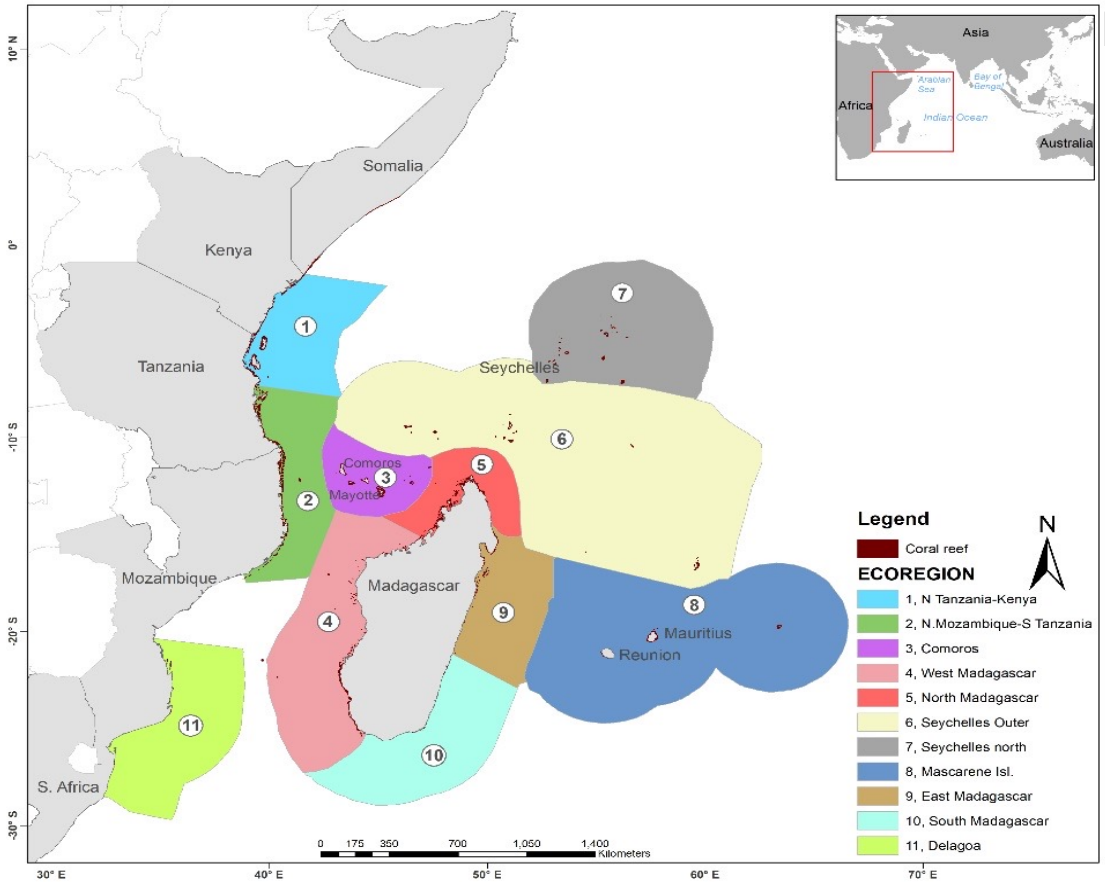
Obura 2012



Global typology – Keith et al. 2021

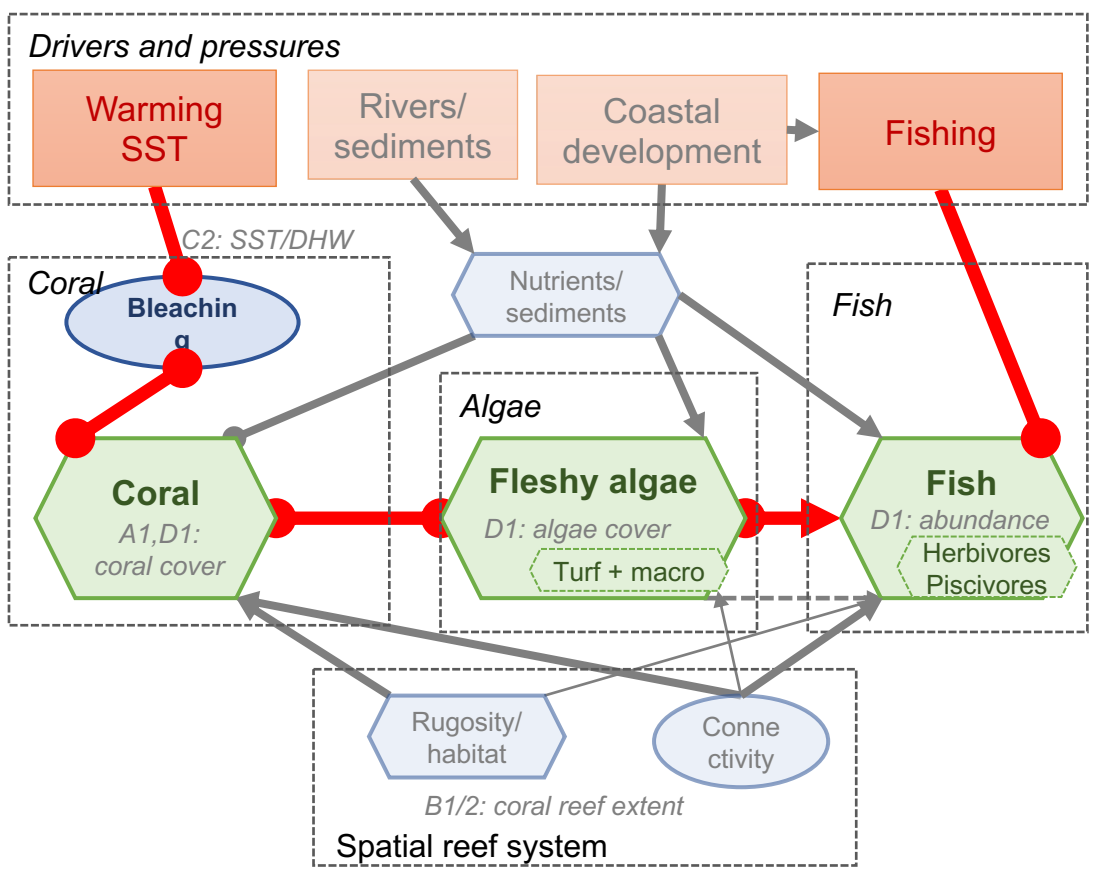
1. **Realm** – marine
2. **Biome** – shelf ecosystems
3. **Functional group** – coral reef
4. **Biogeographic ecotype** – province/ecoregion? (top-down)
5. **Global ecosystem type** – ecoregion? (bottom-up?)
6. **Local ecosystem type** – derived from bottom up

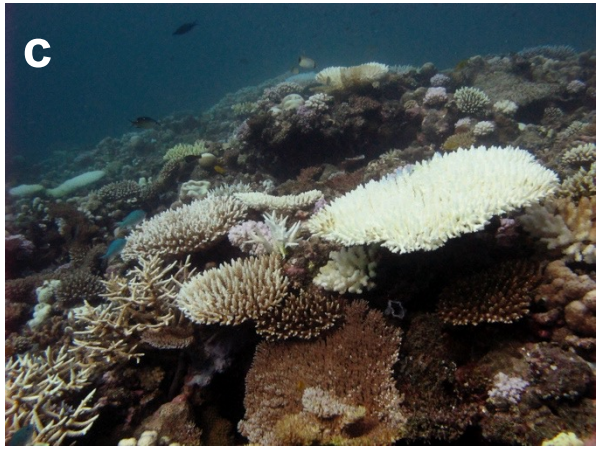
RLE 2019

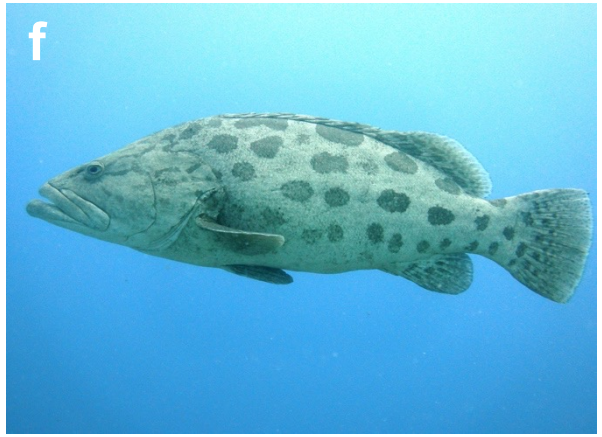


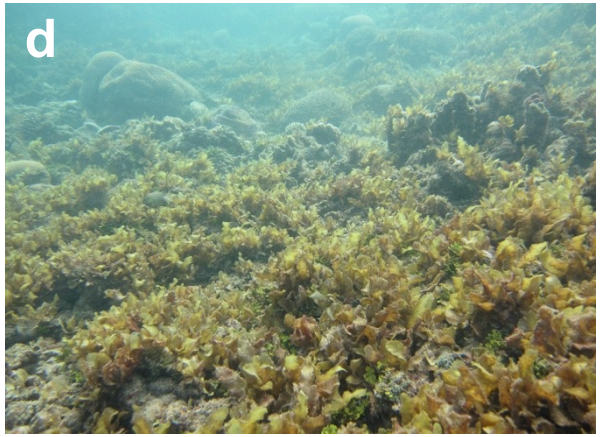
Ecosystem model

a









RLE Assessment Criteria

Five criteria for assessment:

Area

A – decline in ecosystem extent

B – small geographic distribution

Integrity

C – abiotic disruption

D – biotic disruption

~~E~~ – quantitative model

Ecosystem type

Ecosystem model

Data

Thresholds

Rules

Calculations

All ecosystems →

Adequate data

Evaluated

Collapse (CO)

Threatened categories

Critically Endangered (CR)

Endangered (EN)

Vulnerable (VU)

Near Threatened (NT)

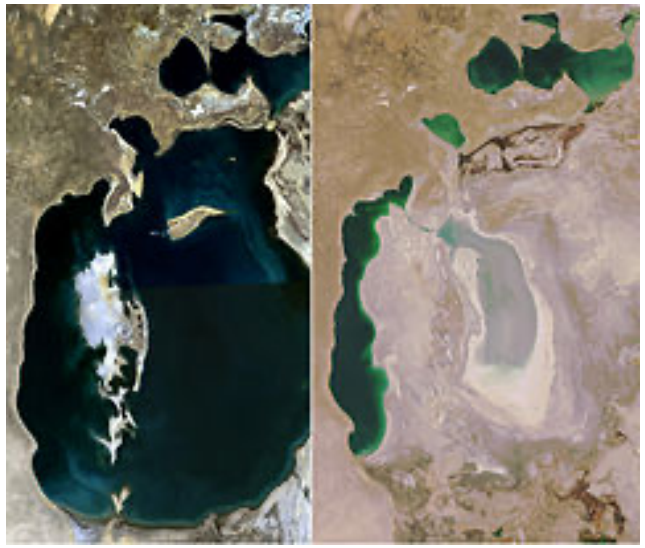
Least Concern (LC)

Data Deficient (DD)

Not Evaluated (NE)

Spatial Criteria

Criterion A – reduction in geographic distribution



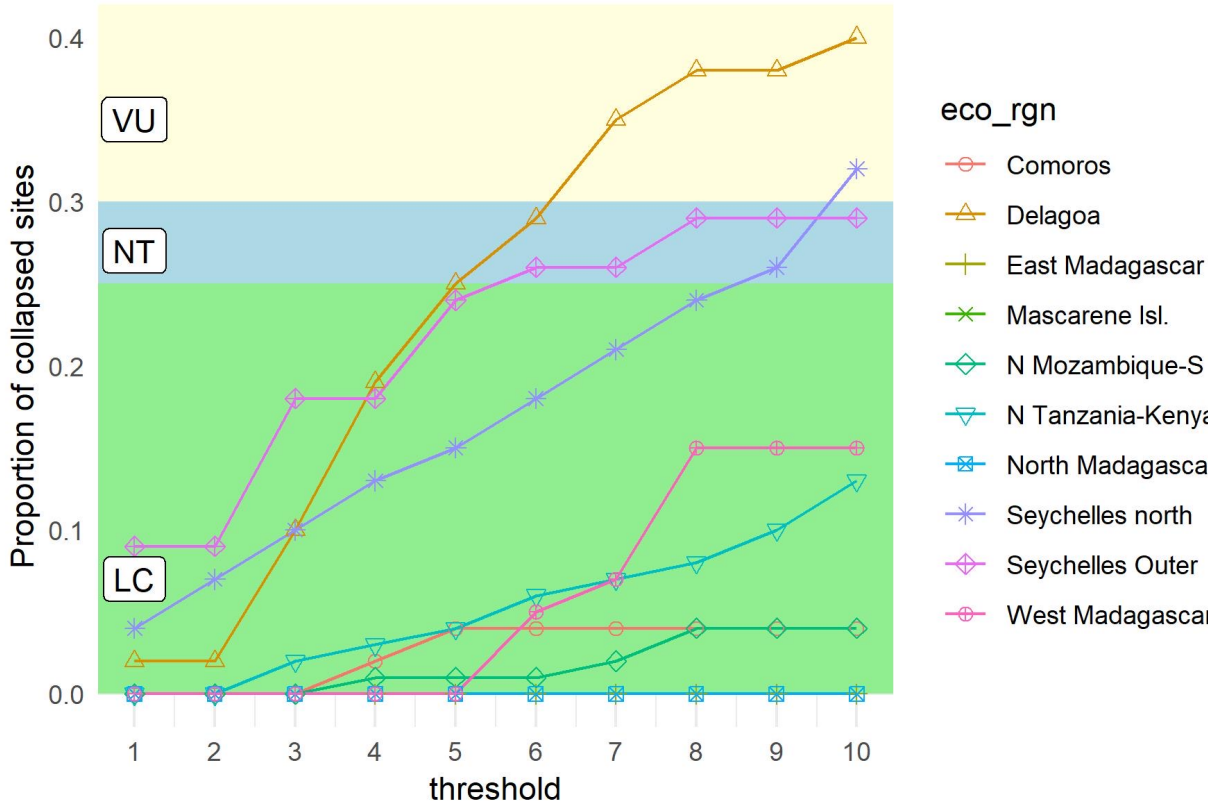
No map of reef extent over 50 years

Reef can transform without any detected change in reef structure by mapping

Data - used in-situ data of **hard coral cover** at survey sites

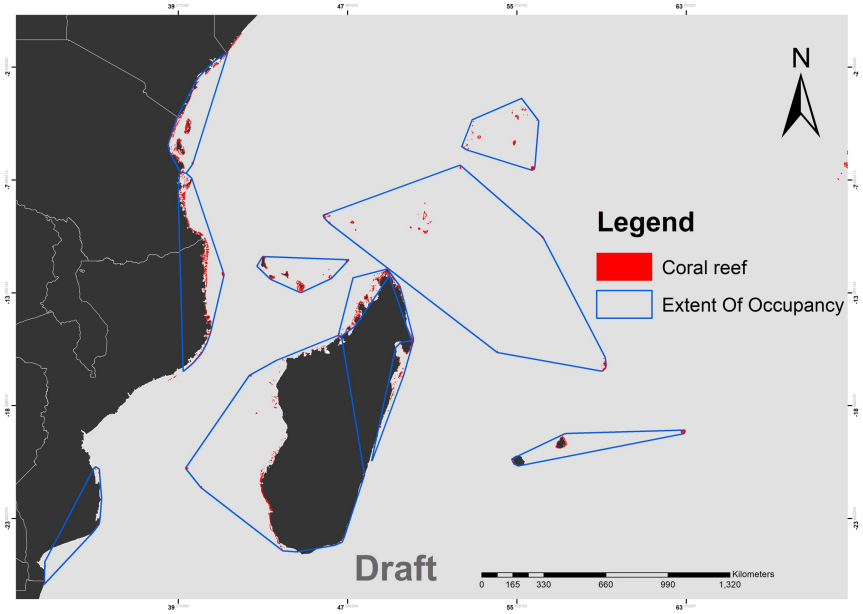
Indicator (proxy) - the proportion of sites with less than **10% hard coral cover***

*Perry et al. 2018



Spatial Criteria

Criterion B – Restricted geographic distribution



- **Criterion B:** identify ecosystems whose **distribution** is so restricted that they are at risk of collapse from the chance occurrence of single or few interacting **threatening** events
- **Two standardised metrics**: the extent of occurrence (**EOO**) and the area of occupancy (**AOO**)

Subcriterion	*Measure of geographic distribution*	CR	EN	VU
B1	Extent of a minimum convex polygon (km^2) enclosing all occurrences (extent of occurrence, EOO) is:	≤ 2,000	≤ 20,000	≤ 50,000

Data:

- **Millennium coral reef layer** curated by the World Conservation Monitoring Centre
- Localized correction for Delagoa provided by the Oceanographic Research Institute of South Africa

Criterion C - Environmental (abiotic) degradation

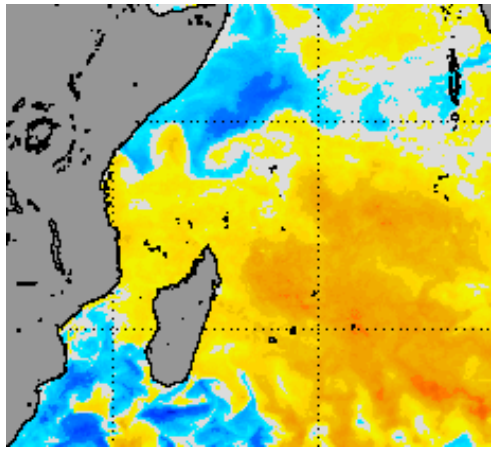
Thermal stress (coral bleaching)

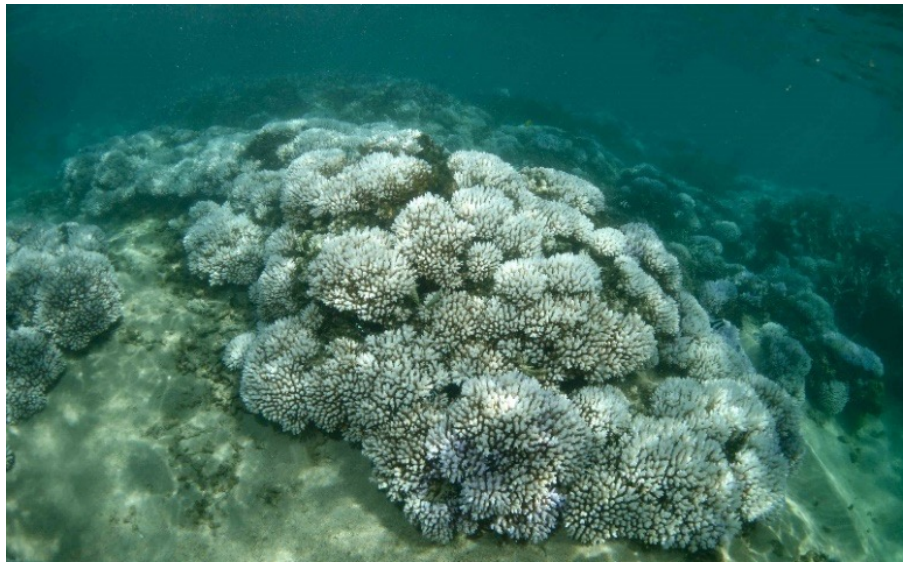
Timeframe - next 50 years (2015-2024 to 2065-2074)

Data – Degree-Heating-Weeks (DHW) projections (van Hooidonk et al. 2016).

Indicator – Per decade: number of years where max DHW ≥ 12

Collapse threshold – 2 i.e. 2 exceedances of 12 DHW in a decade



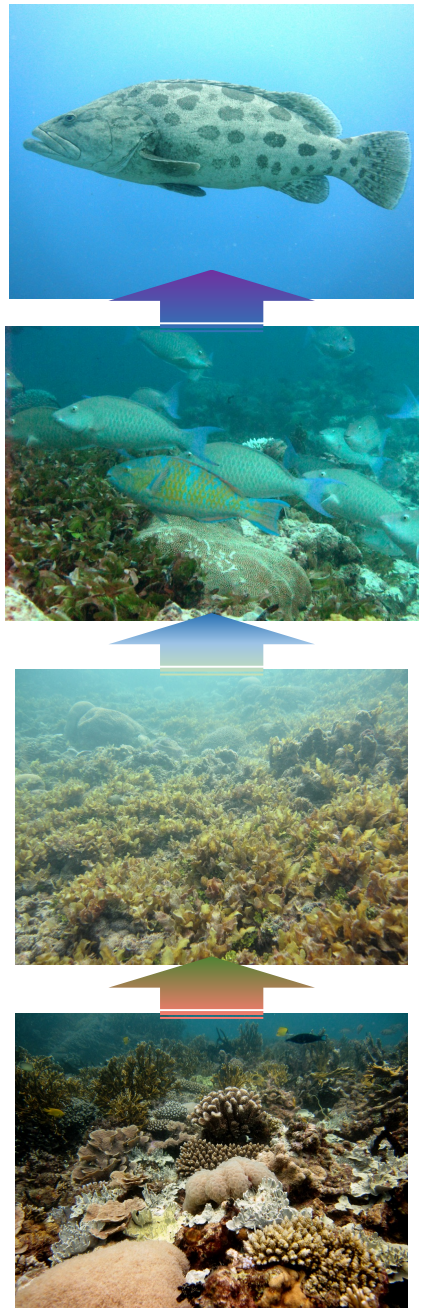


Coral bleaching @ St Leu, Reunion (2016)
Photo credits: Julien Wickel

Criterion D
Biotic degradation

- biotic degradation of reefs using **four** key indicators of ecosystem health

Photo credit: Keith Ellenbogen



Piscivory
(Grouper abundance)

Herbivory
(Parrotfish abundance)

Macroalgae
(ratio to coral cover)

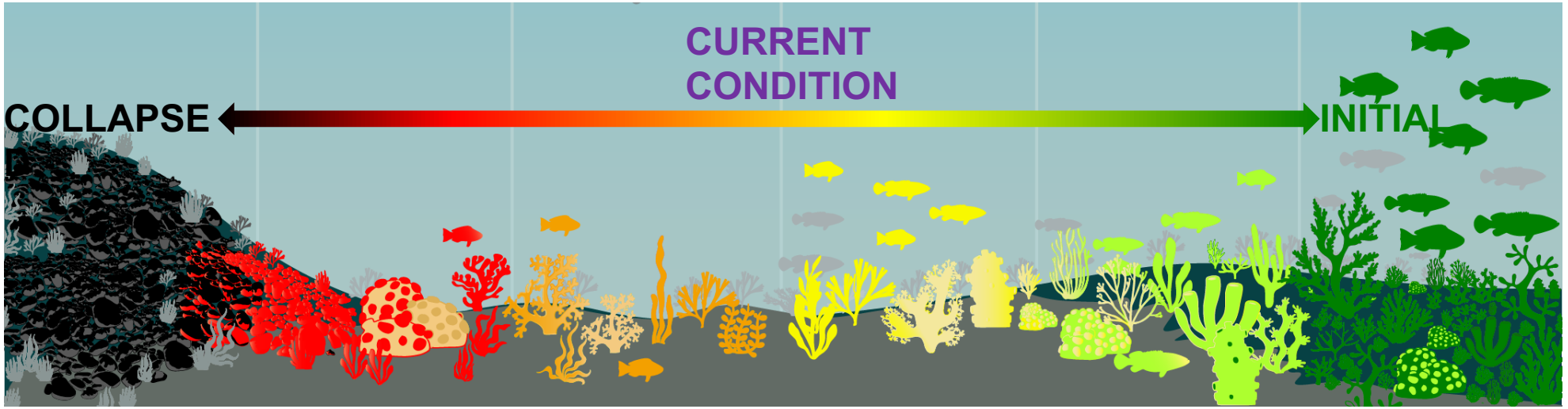
Hard coral
(% cover)

Biotic degradation

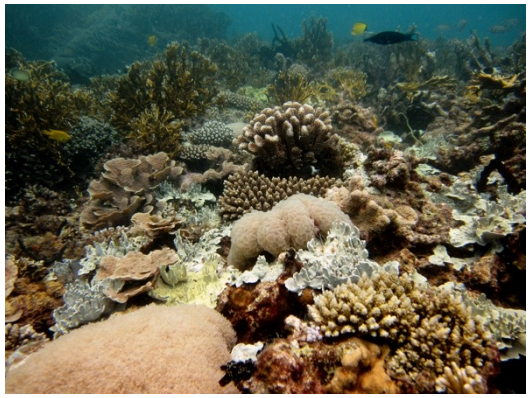
relative severity of decline

measure of the **current** condition relative to a **collapse** threshold and **initial** condition

how close ecosystem is to collapse (severe disruption)



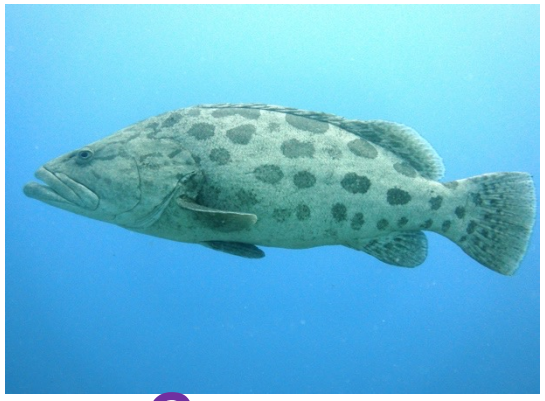
Structured model for coral reef collapse



Hard coral
(all hard corals, % cover)

Fleshy algae
(ratio of algae cover to coral cover)

Parrotfish abundance
(herbivory indicator)

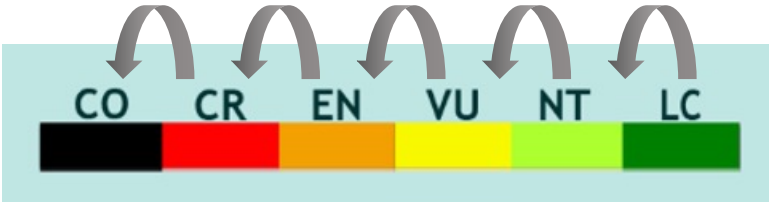


Grouper abundance
(piscivory indicator)

Question – is a reef Critically Endangered if only one component has that level of risk?

Structured sequential model

- Start with status of coral
- Increase risk status by ONE level if the next component is at greater risk.

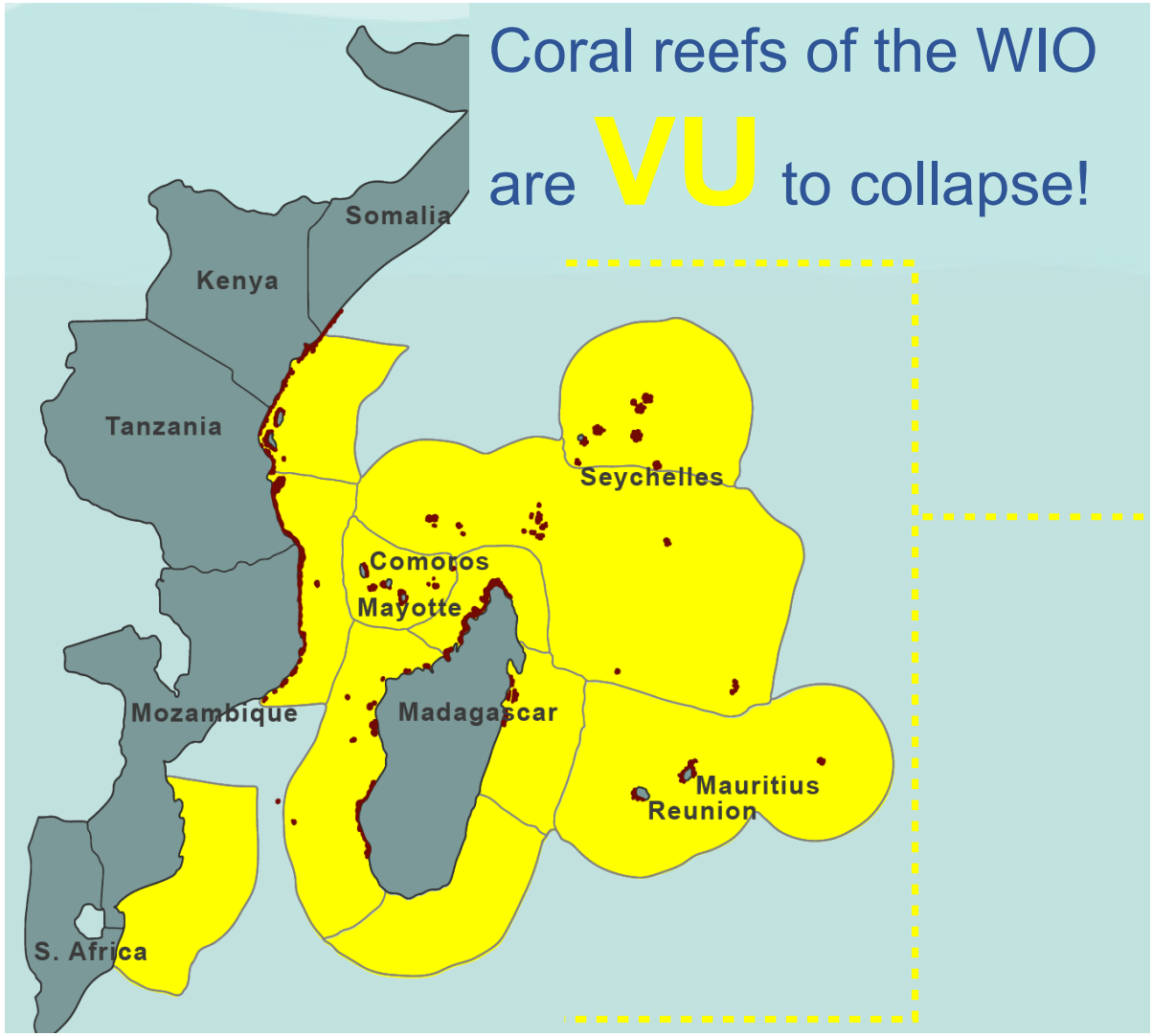


- Addresses role of corals as architects of reef ecosystem
- Acknowledges functional redundancy of reef compartments
- Reduces vulnerability to data availability
- Avoids inflation of risk level
- Applicable to other biogenic ecosystems

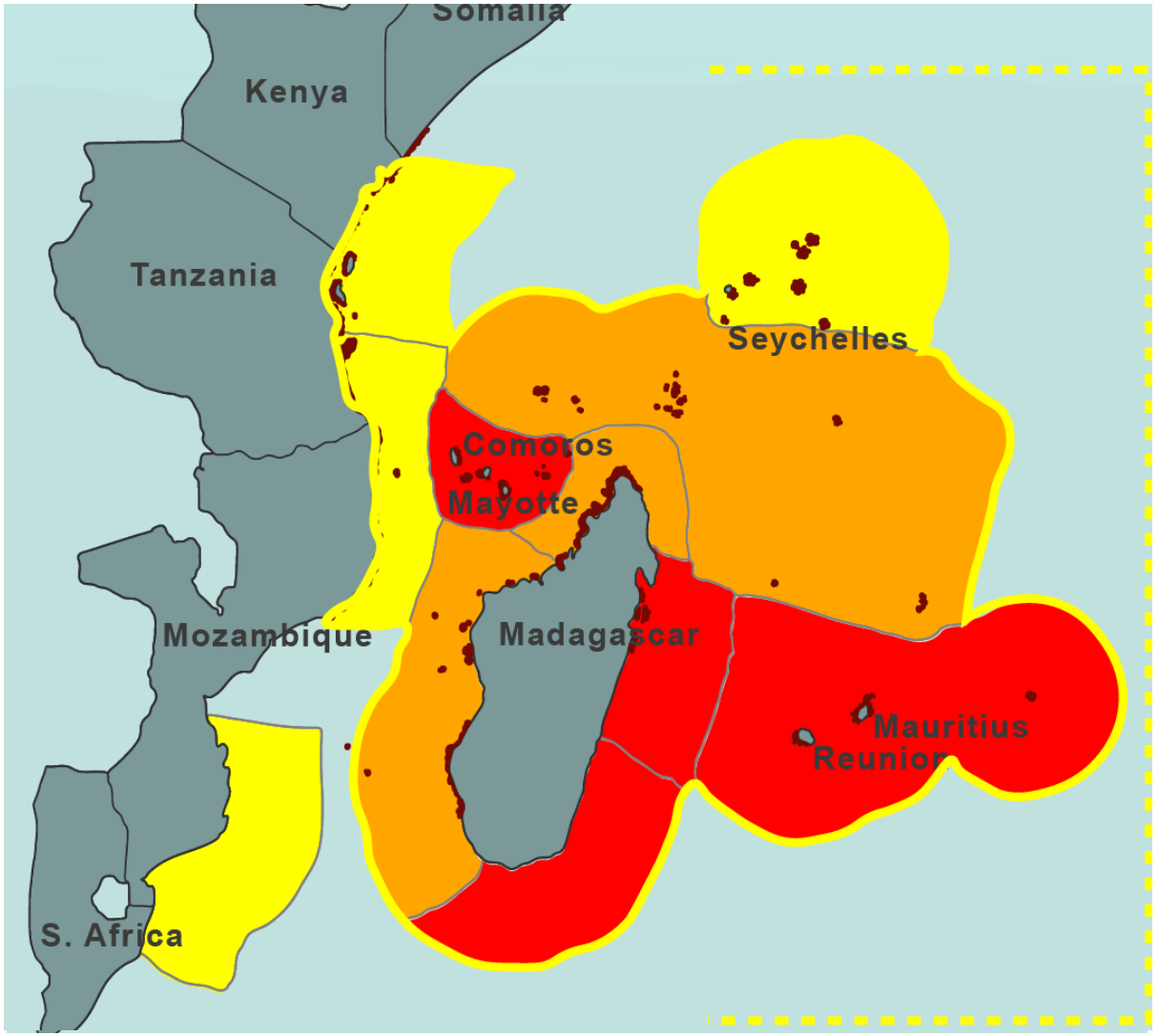
Structured model for coral reef collapse – worked examples

Ecoregion and steps	Coral	Algae	Parrotfish	Groupers	Status
N.Tanzania...Kenya	**LC**	**NT**	**NT**	**EN-CR**	**VU**
Comparison		>LC	=NT	>NT	
Rationale	Starting status	Increases one step	Remains the same	Increases one step	
Stepwise result:	**LC**	**NT**	**NT**	**VU**	

Region results



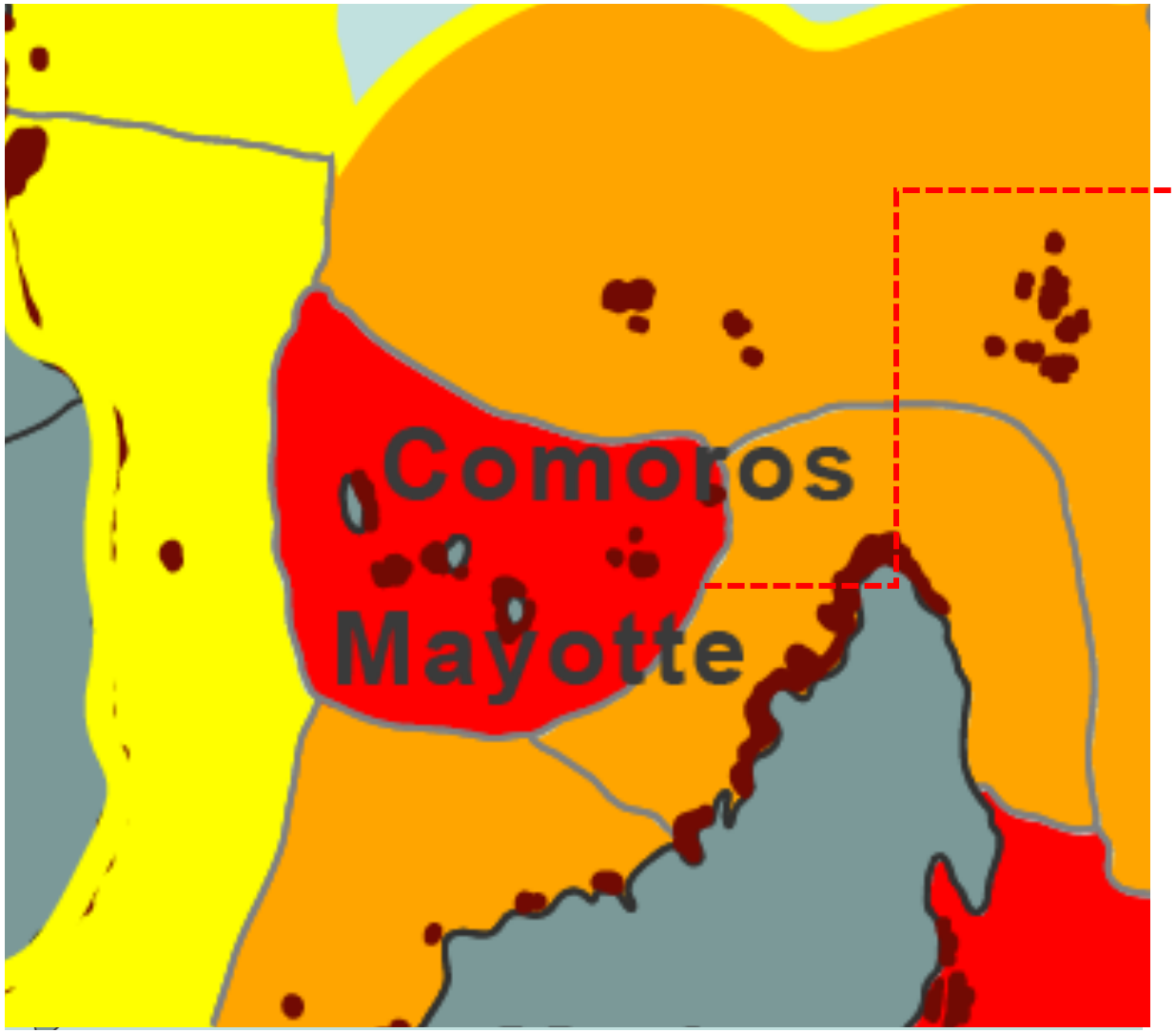
Eco-region results

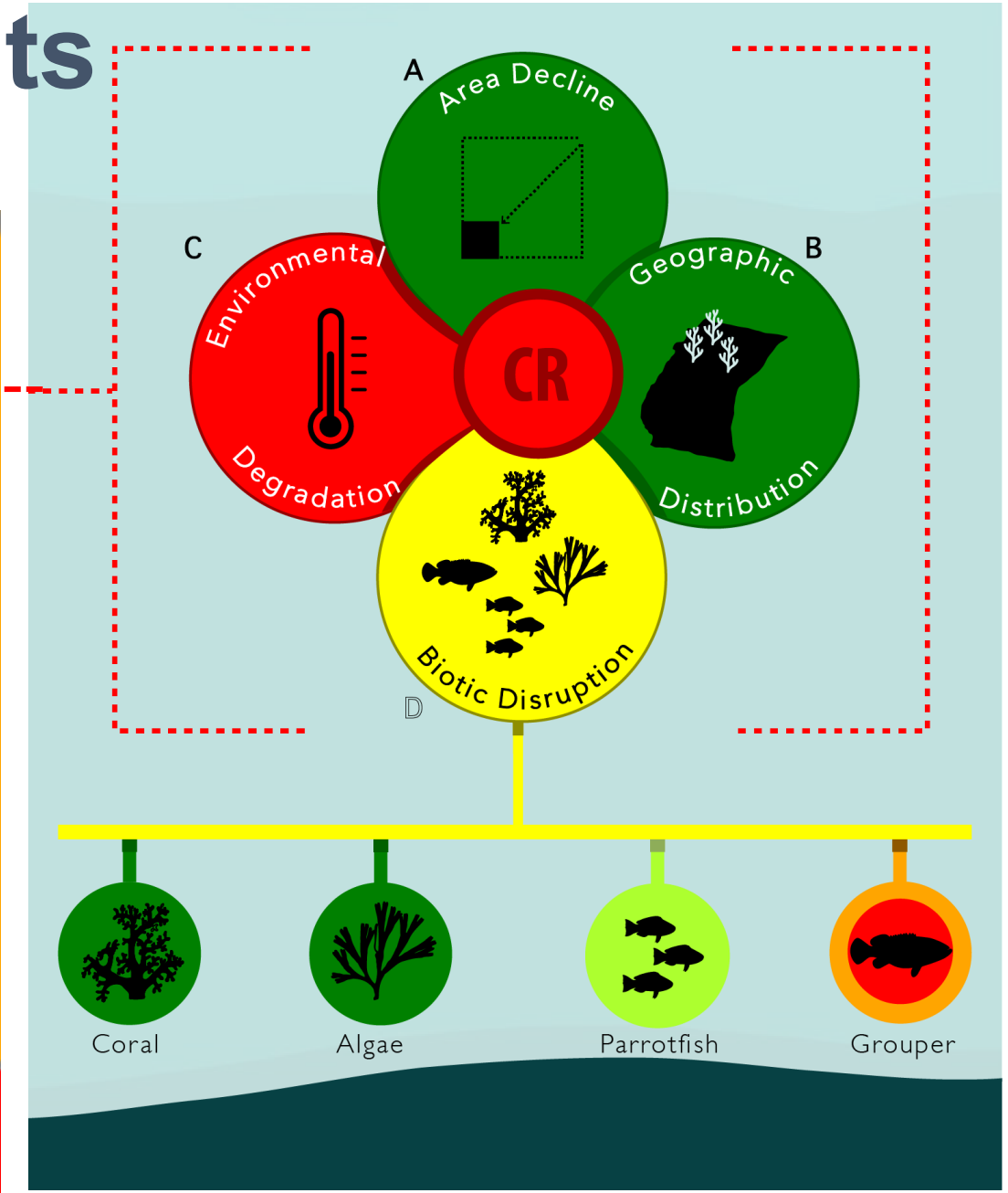


All ecoregions are in threatened categories

- **VU** – 4 eco-regions
- **EN** – 3 eco-regions
- **CR** – 4 eco-regions

Criteria results





Thank You!!

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