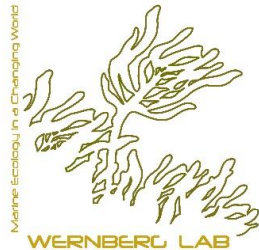
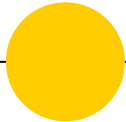


Turf algae as emergent drivers of ecological function in shallow reefs

Albert Pessarrodona, Karen Filbee-Dexter, Thomas Wernberg et multi al.

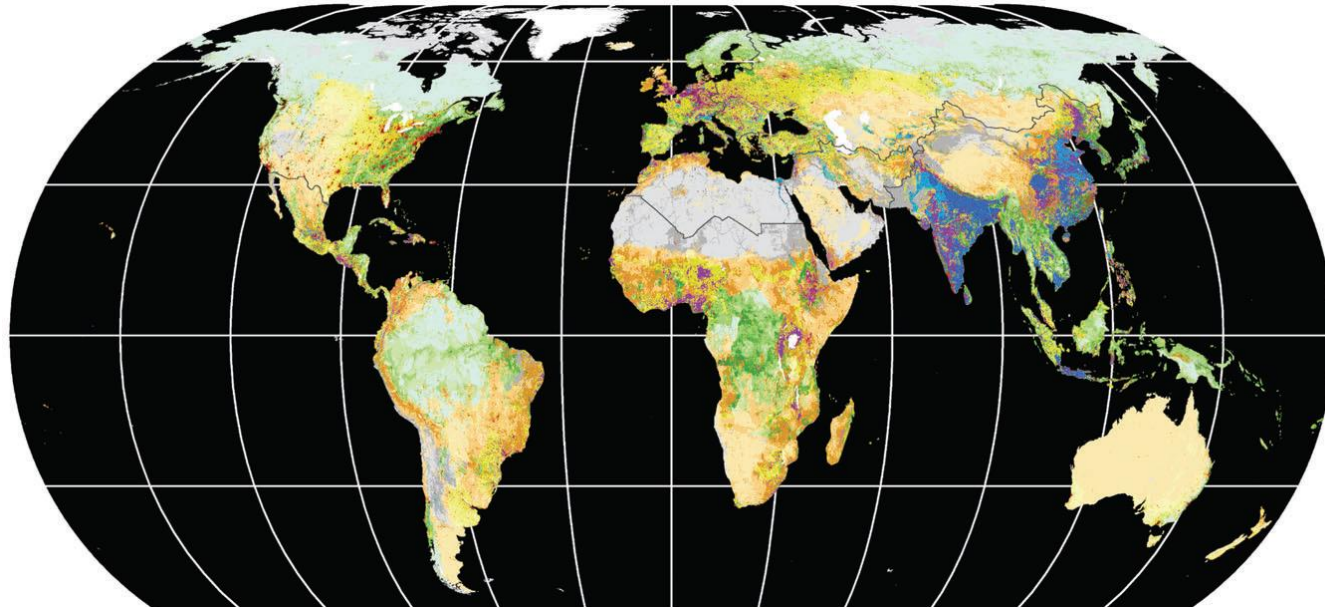


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Humans have transformed most Earth's biomes



Ellis et al. 2010 GEB

Used

- Dense Settlements**
- Urban
- Mixed settlements

Villages

- Rice villages
- Irrigated villages
- Rainfed villages
- Pastoral villages

Croplands

- Residential irrigated croplands
- Residential rainfed croplands
- Populated croplands
- Remote croplands

Rangelands

- Residential rangelands
- Populated rangelands
- Remote rangelands

Seminatural

Seminatural

- Residential woodlands
- Populated woodlands
- Remote woodlands
- Inhabited treeless & barren lands

Wild

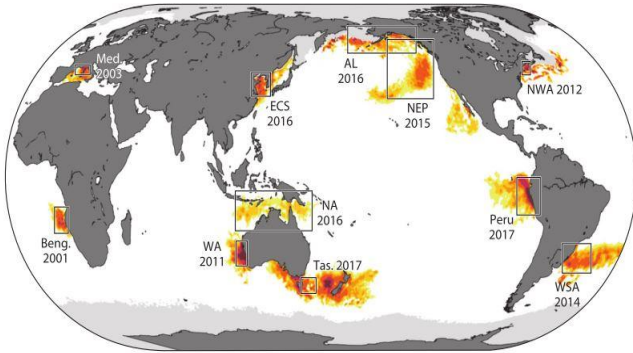
Wildlands

- Wild woodlands
- Wild treeless & barren lands



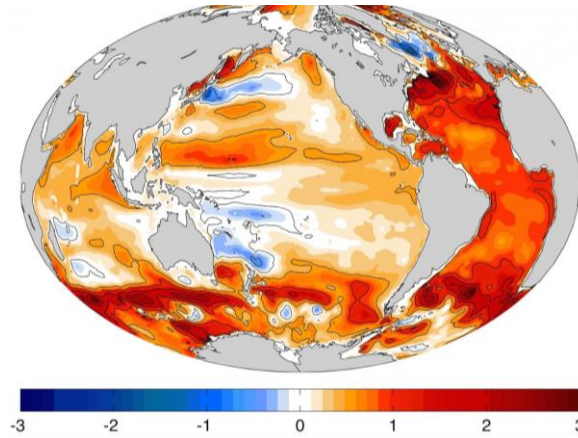
Pervasive changes in disturbance & stressors

Heatwaves



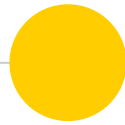
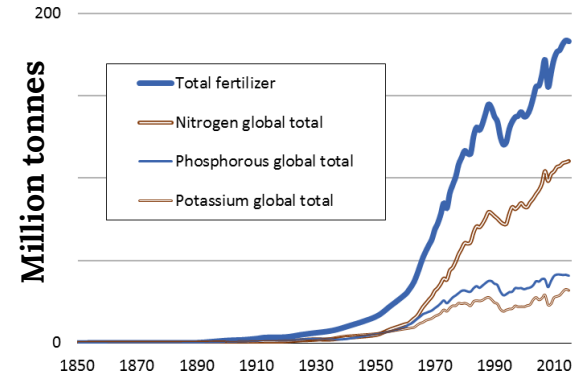
Frolicher & Laufkotter (2018) Nature Comms.

Warming



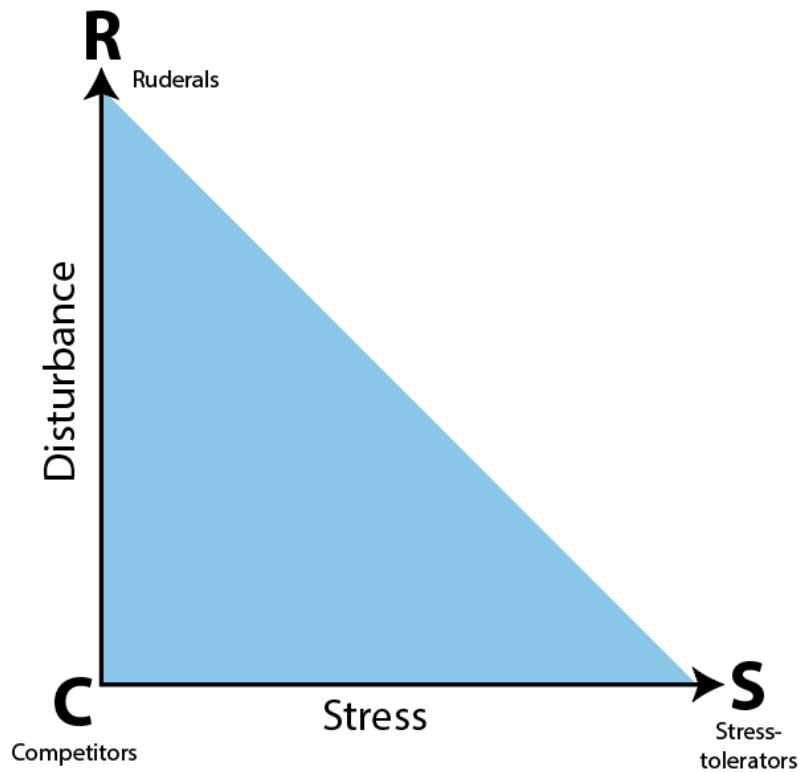
Ocean heat content trend (W/m²)

Eutrophication



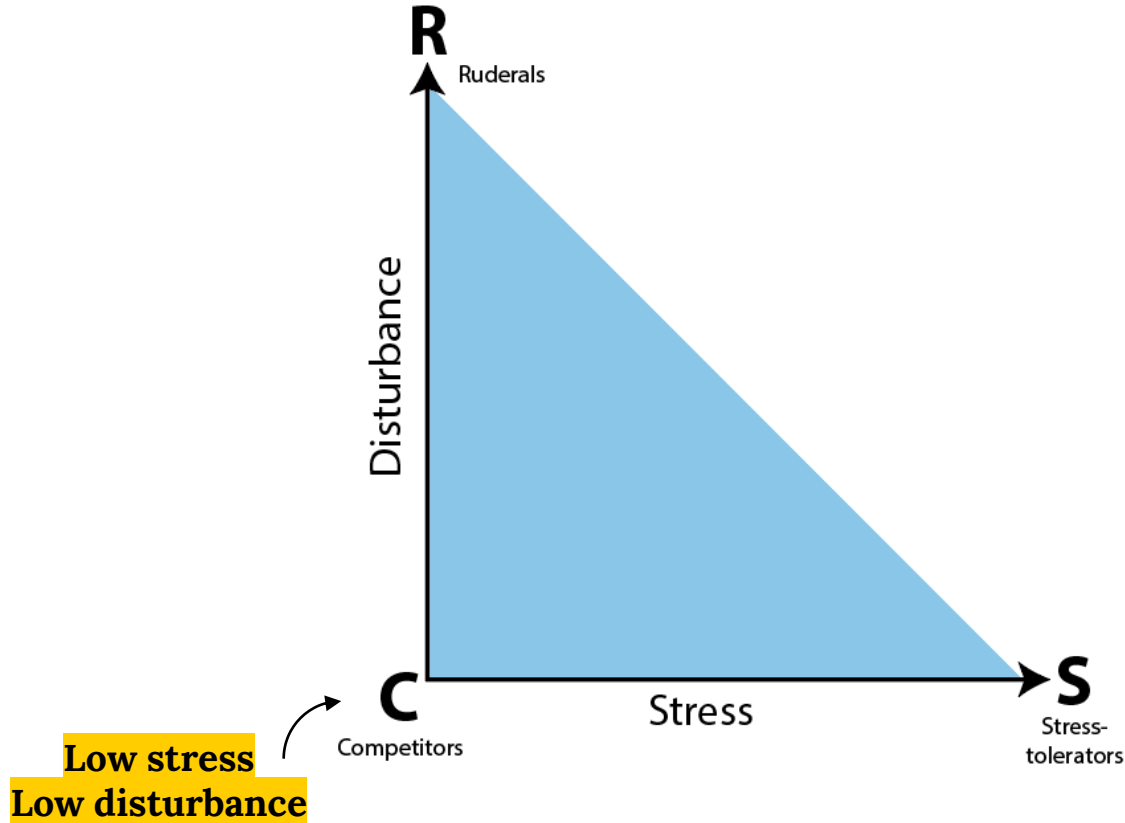


Grime's plant strategy triangle





Grime's plant strategy triangle





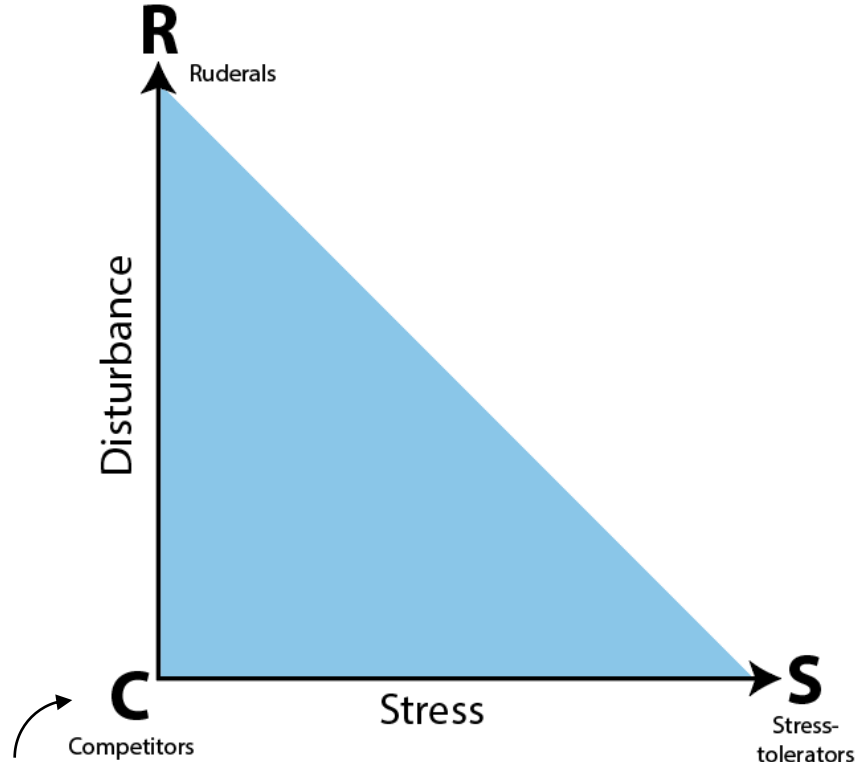
Grime's plant strategy triangle

Kelps



Dayton (1984)
Ecol. Mono.

Low stress
Low disturbance





Grime's plant strategy triangle

Low stress
High disturbance



R
Ruderals

Disturbance

Kelp



Dayton (1984)
Ecol. Mono.

Low stress
Low disturbance



C
Competitors

Stress

S
Stress-tolerators



Grime's plant strategy triangle

Low stress
High disturbance

R
Ruderals

Disturbance

Kelp



Dayton (1984)
Ecol. Mono.

Low stress
Low disturbance

C
Competitors

Stress

S
Stress-tolerators

High stress
Low disturbance

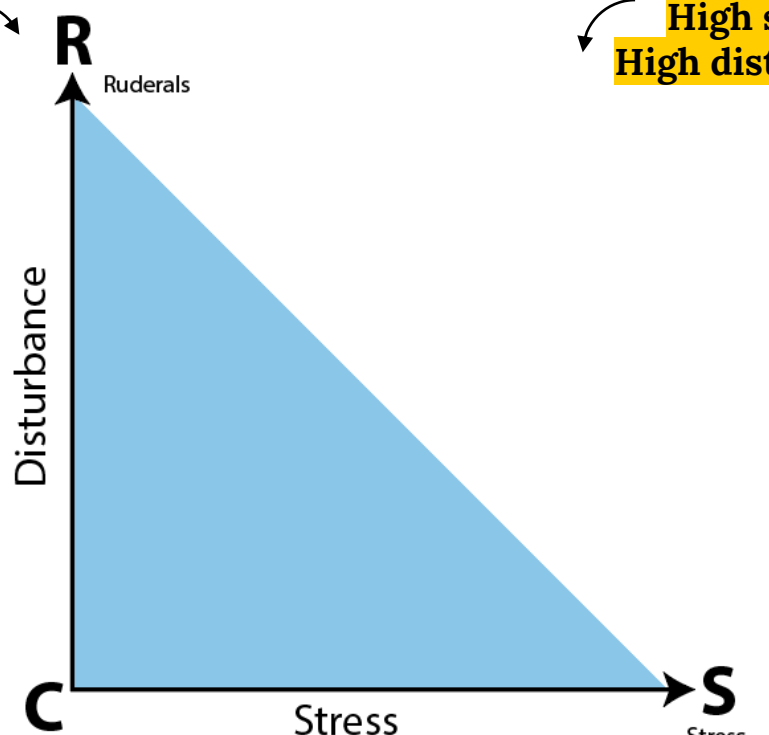




Grime's plant strategy triangle

Low stress
High disturbance

High stress
High disturbance



Kelps



Dayton (1984)
Ecol. Mono.

Low stress
Low disturbance

High stress
Low disturbance



Grime's plant strategy triangle

Turf



ruderals

Sousa (1980)
Oecologia

Kelps



Dayton (1984)
Ecol. Mono.

Disturbance

C
Competitors

Stress

Turf



Stress-
tolerators

Hay (1981) Ecology



Grime's plant strategy triangle

Turf



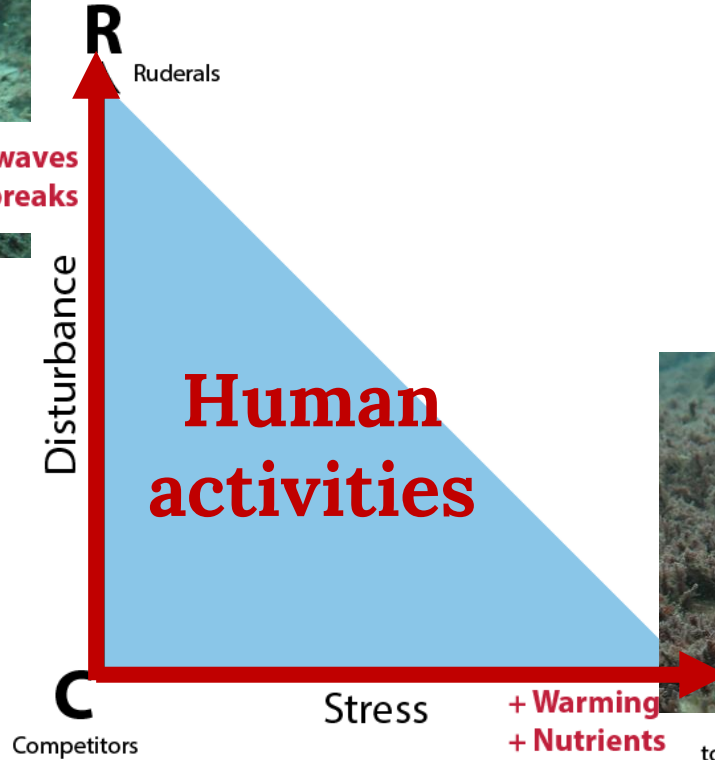
+ Marine heatwaves
+ Herbivore outbreaks

Sousa (1980)
Oecologia

Kelps



Dayton (1984)
Ecol. Mono.



Turf

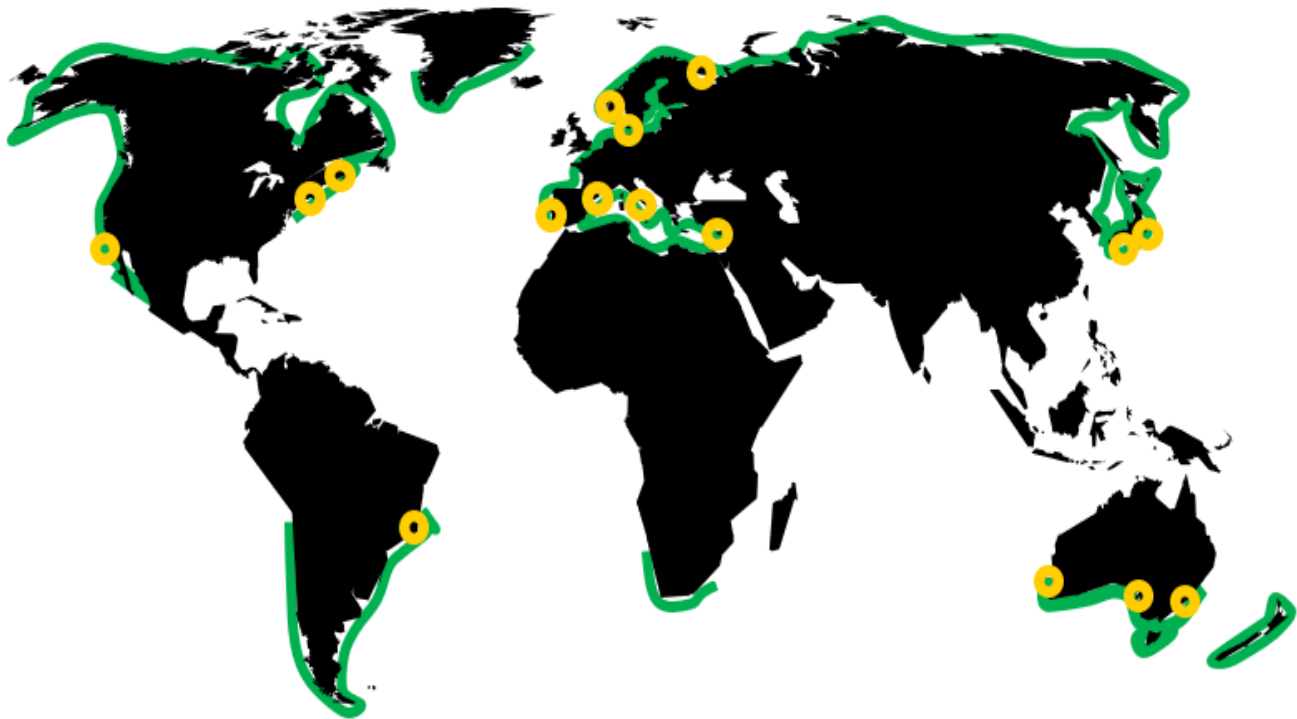




Stress-tolerators

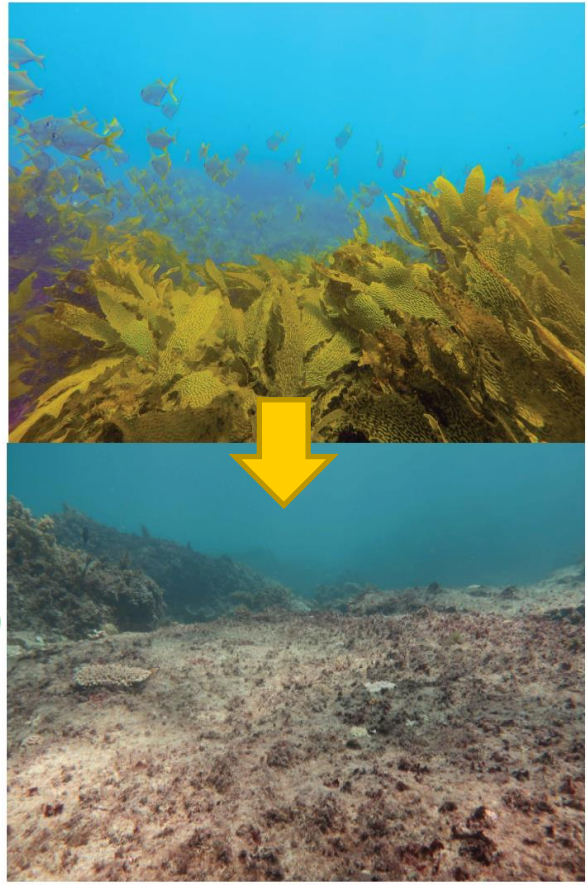
Hay (1981) Ecology



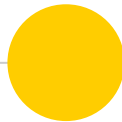
Anthropocene and the rise of turfs



 Temperate underwater forests
 Kelp → turf shift



**How is the rise of turfs in
subtidal temperate reefs
altering ecosystem function?**





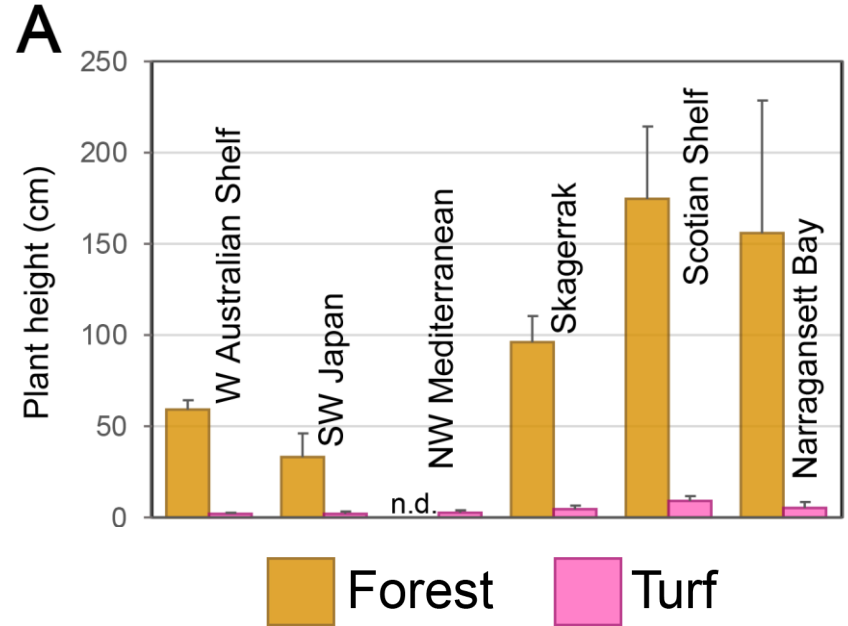
1

Habitat structure



Habitat flattening

**Smaller vegetation height
and surface area**

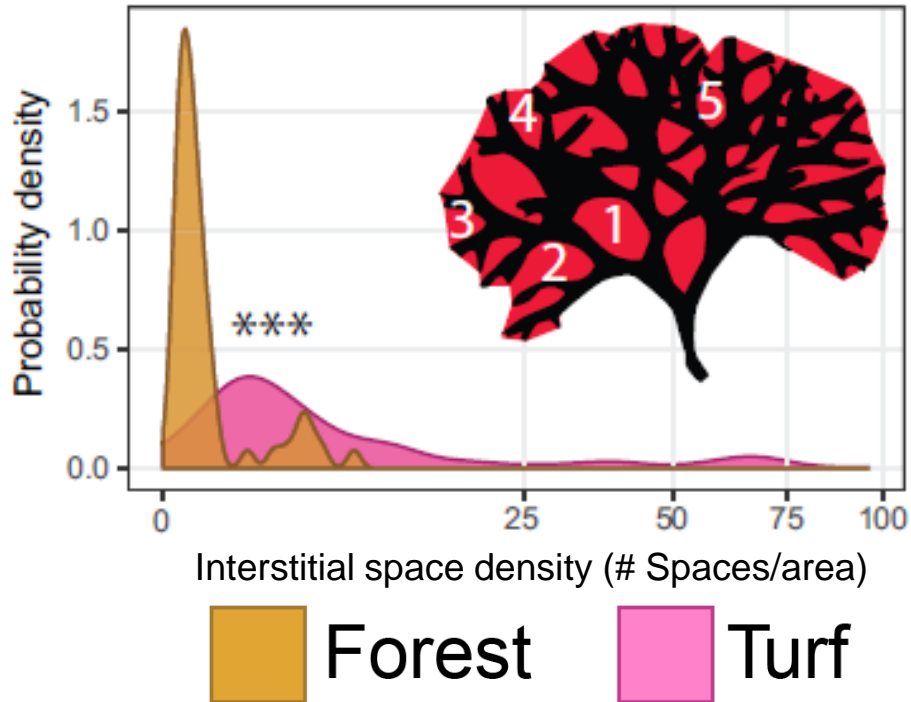


Pessarrodona et al. (2021) Glob. Chan. Bio.



Turfs have more interstitial spaces

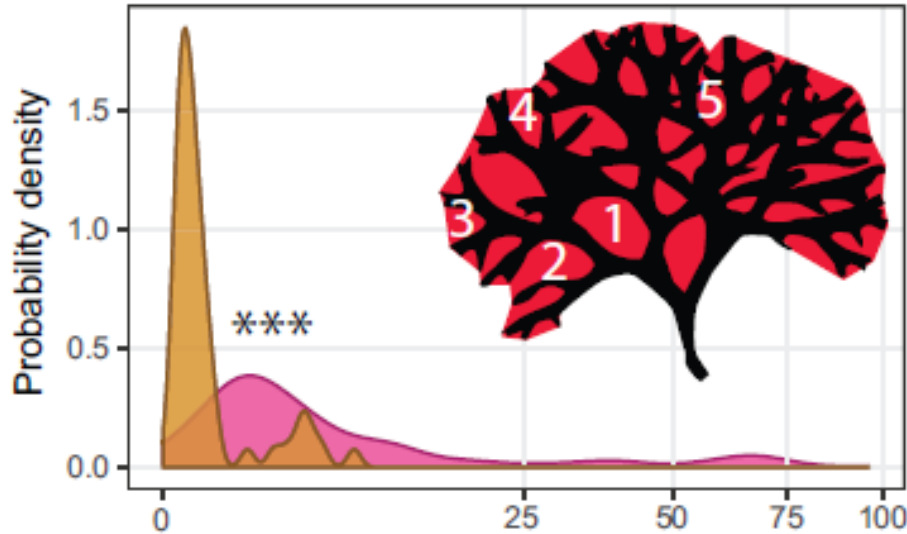
Interstitial Space Density





Turfs have more interstitial spaces

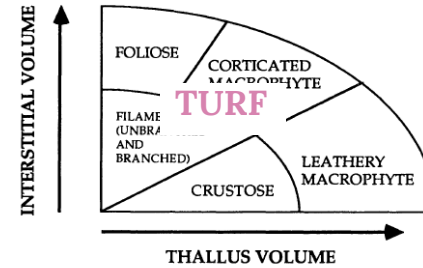
Interstitial Space Density



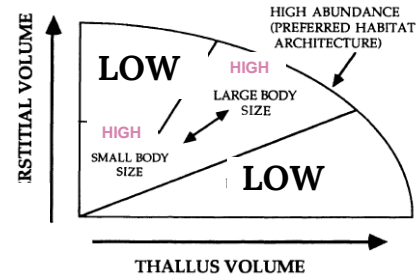
Interstitial space density (# Spaces/area)



A. ALGAL MORPHOLOGY



B. AMPHIPOD ABUNDANCE

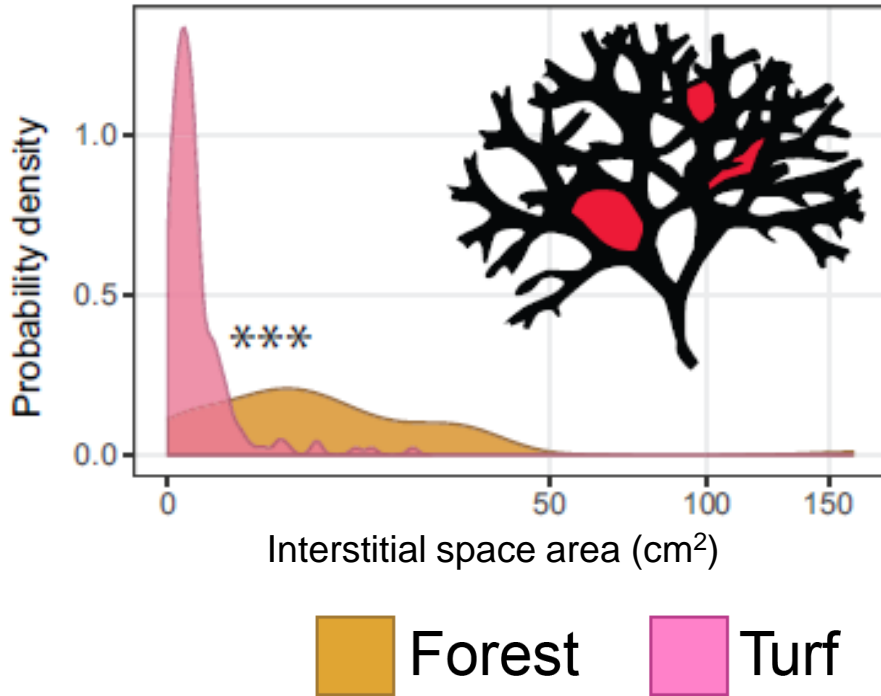


Hacker & Steneck (1990) Ecology



Turfs have smaller interstitial spaces

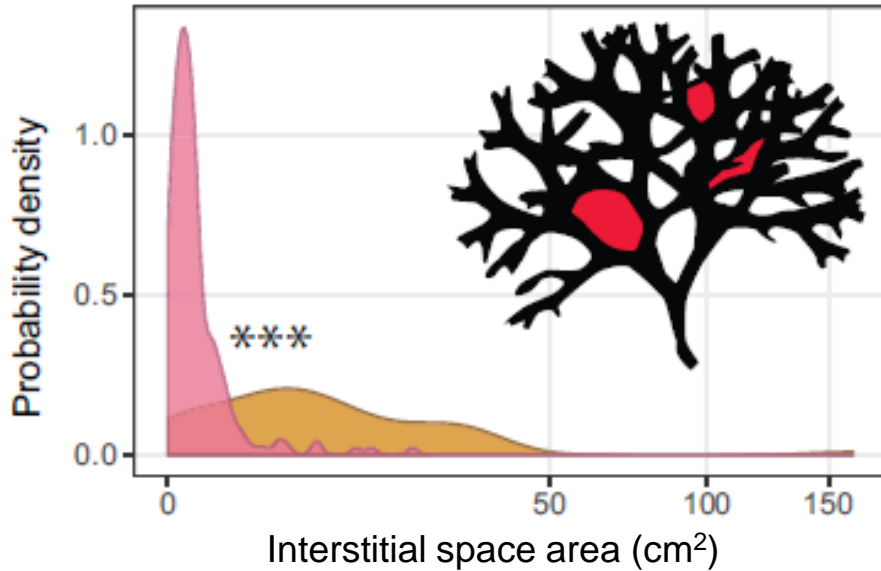
Interstitial Space Area



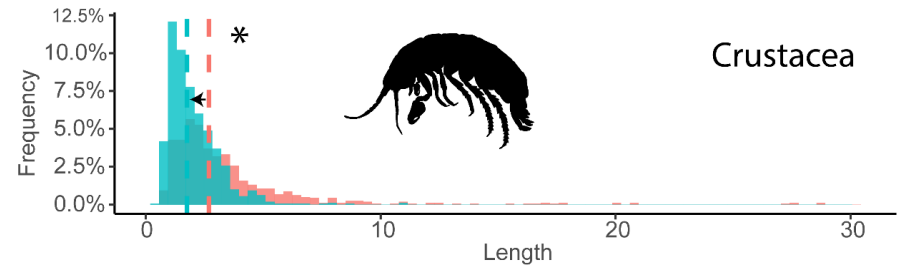


Turfs have smaller interstitial spaces

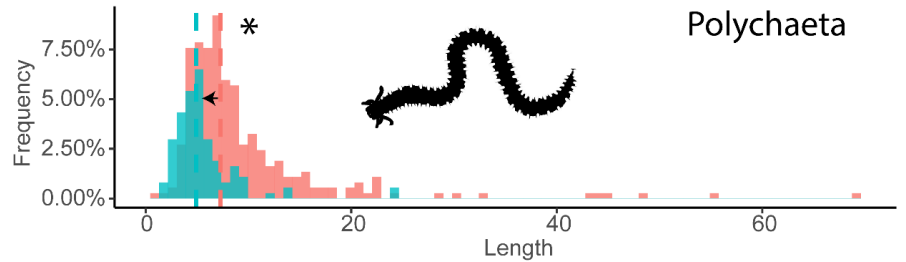
Interstitial Space Area



 Forest  Turf



Crustacea



Polychaeta

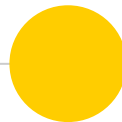
 Kelp  Turf

Pessarrodona (unpub.)



Miniaturization of habitat

Implications for fauna using seaweeds as habitat



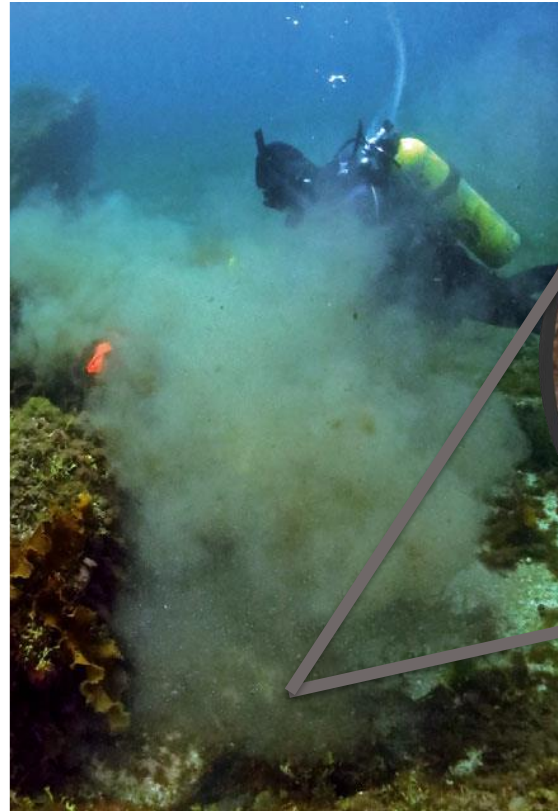
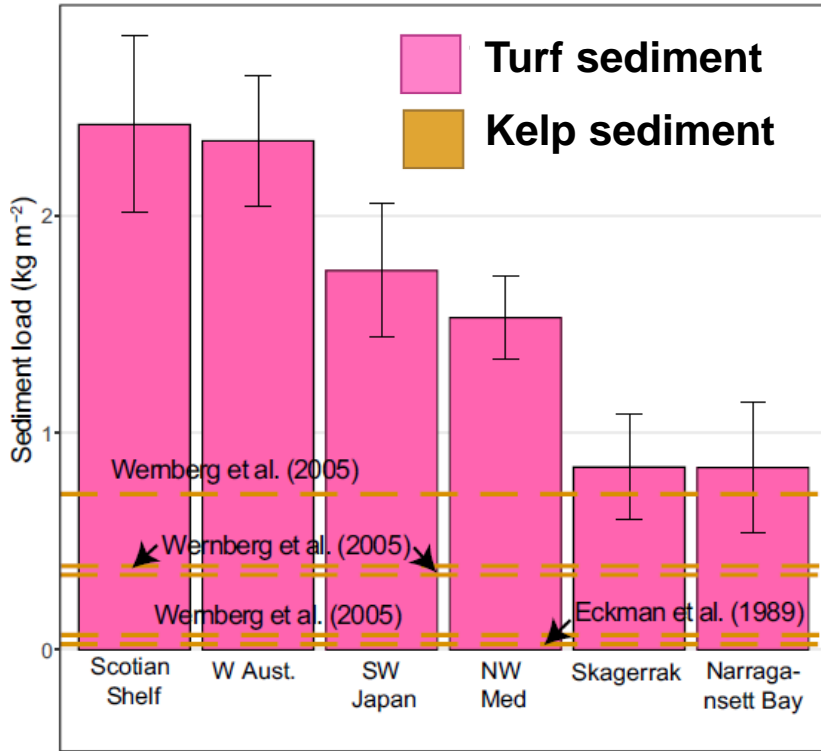


2

Sediment budget



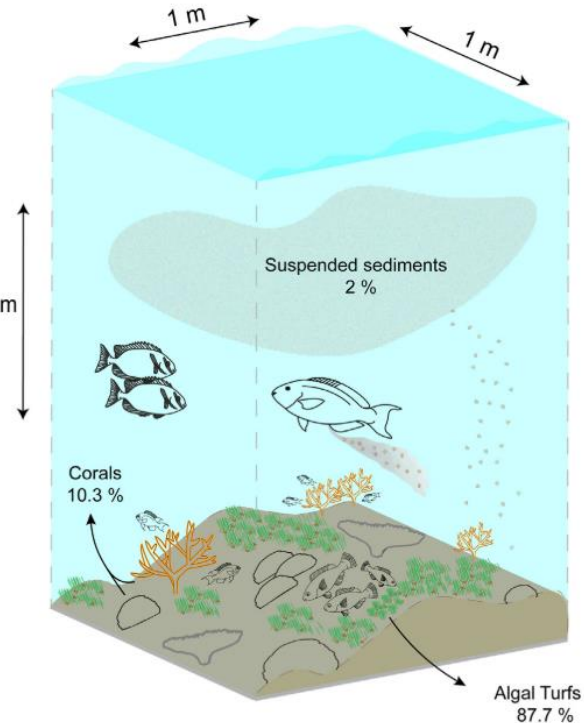
Turfs trap and accumulate sediment





Turfs become major reservoir of sediment

Sediment pools

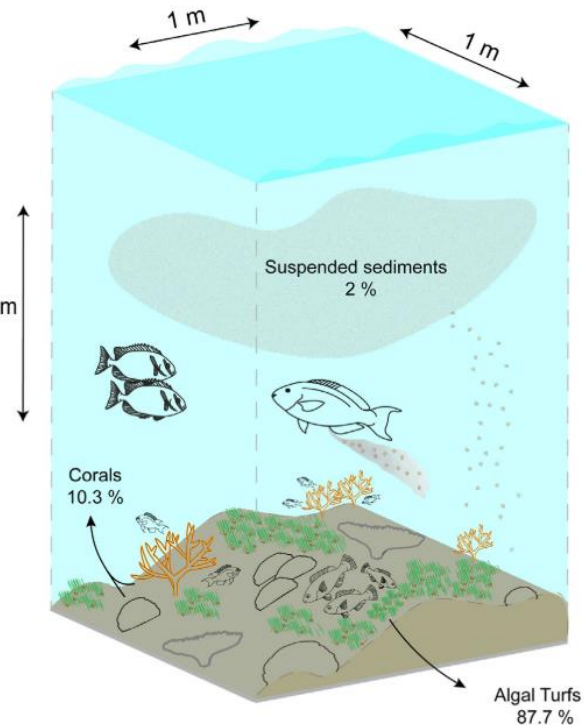


Latrille et al. (2019)
Mar. Pol. Bul.



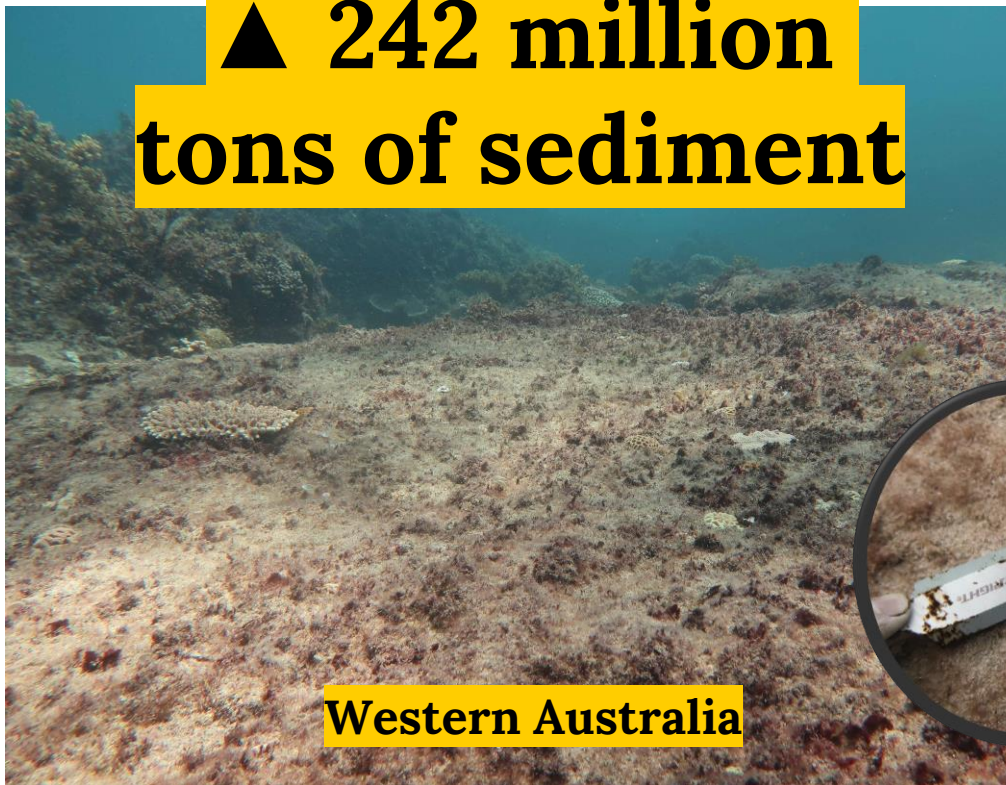
Turfs become major reservoir of sediment

Sediment pools



Latrille et al. (2019)
Mar. Pol. Bul.

▲ 242 million
tons of sediment



Western Australia

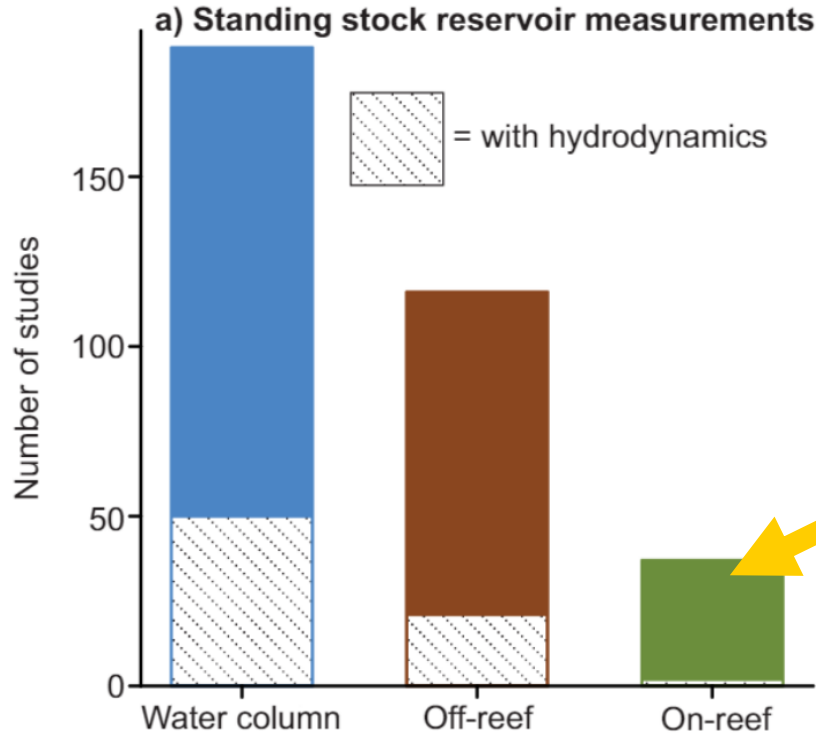


On-reef sediments remain poorly studied

 @pessa_3



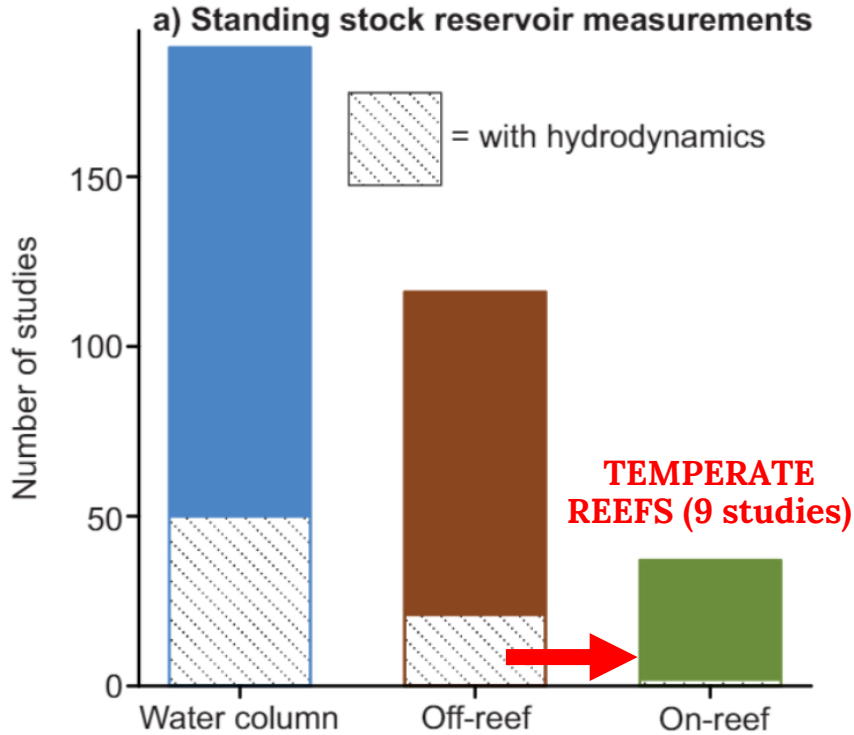
On-reef sediments remain poorly studied



On-reef (turf) sediment measurements under-represented



On-reef sediments remain poorly studied

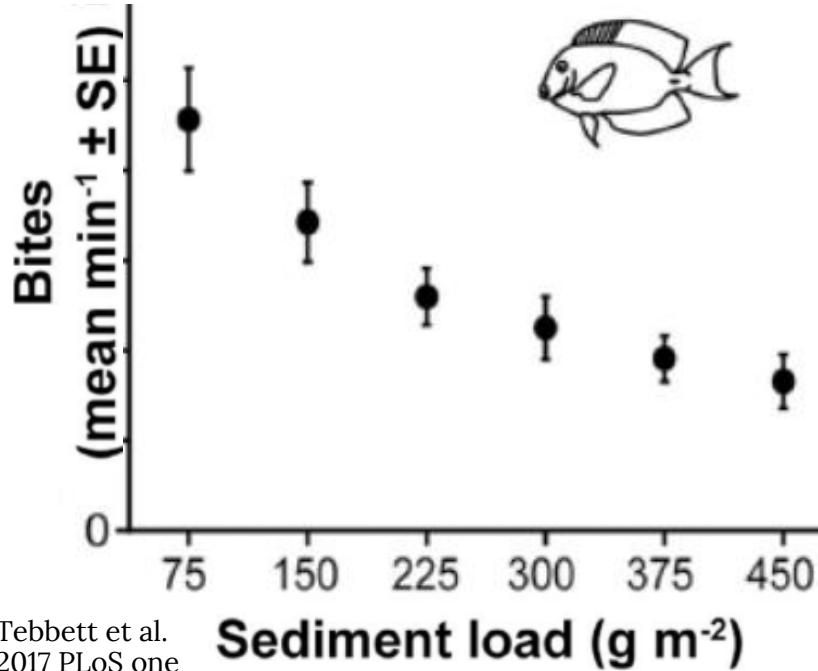


On-reef (turf) sediment measurements under-represented



Turf sediments impact ecosystem processes

Herbivory



Tebbett et al.
2017 PLoS one

Settlement



Birrell et al. 2005 Mar Pol Bull

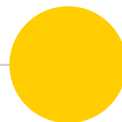


Turfs are a poorly studied, but major, reservoir of sediment on temperate reefs

Sediment may emerge as key driver of ecosystem function in temperate reefs



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3

Net primary productivity

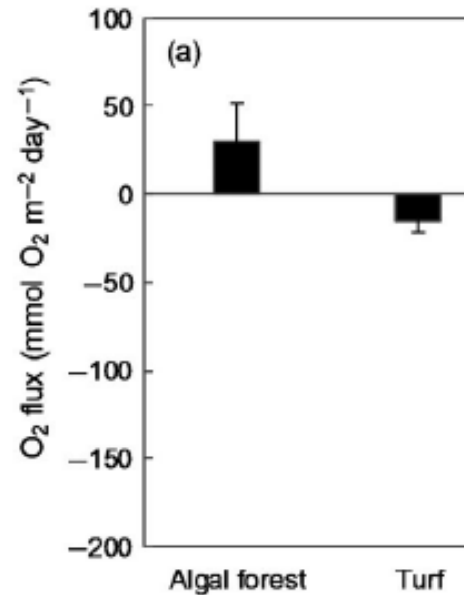


Turfs less productive than kelps & fucoids

	Depth (m)	Biomass	NPP	BeNPP	TNPP
Fucoids	4	225	2.6–6	0.9–3	1444
Kelp	3	410	14.8	2.7–4.4	5470
	10	241	2.5	0.09–0.36	921
Turfs	4	10–32	1.3–2.9	7–28	773
	10	13–28	0.1–0.6	0.8–6	171

Copertino et al. (2005). Phycologia

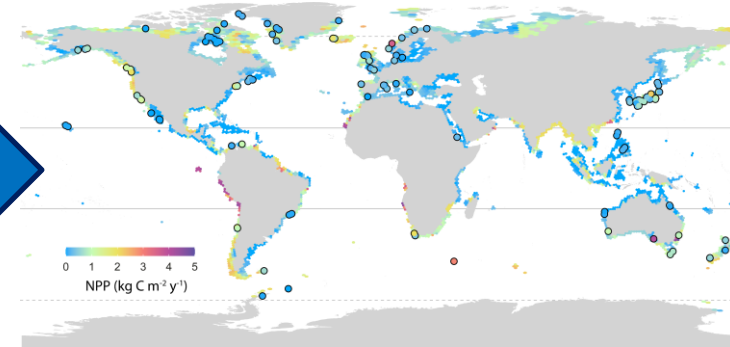
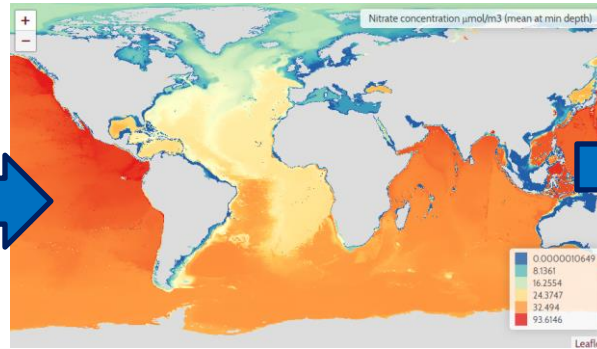
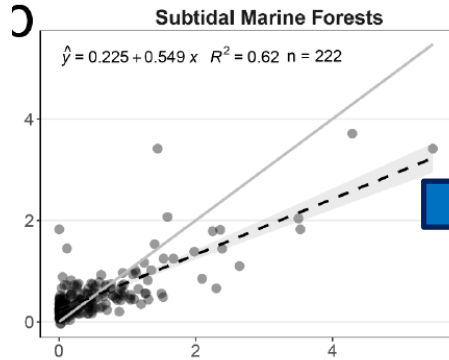
▼ 7x



Peleg et al. (2019) J. Ecol.



Environmental modelling approach



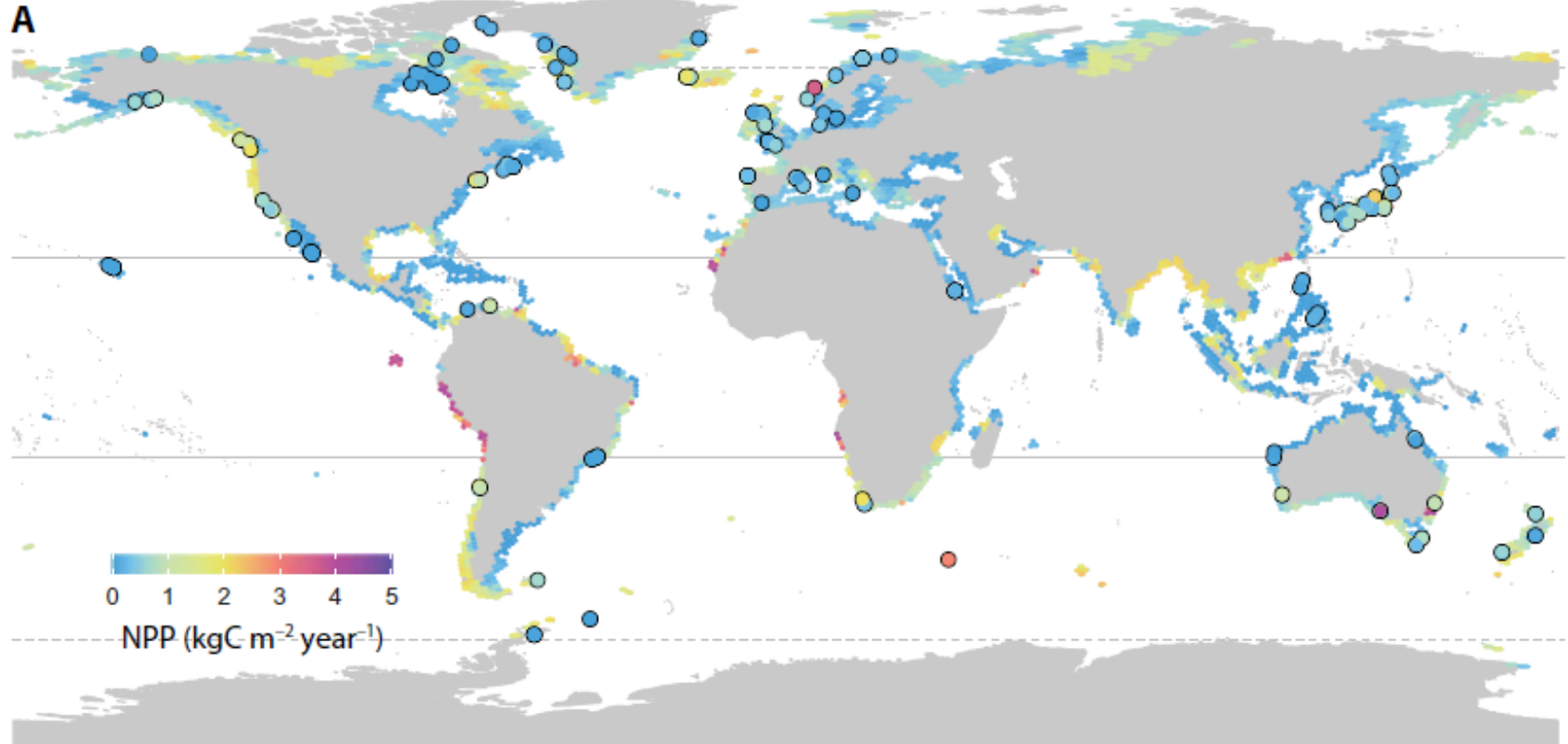
**Relate observations
to local envt.
conditions**

**Extrapolate NPP
based on climatic
forcing at sites you
don't have data**

**Global NPP
predictions**



NPP of subtidal marine forests



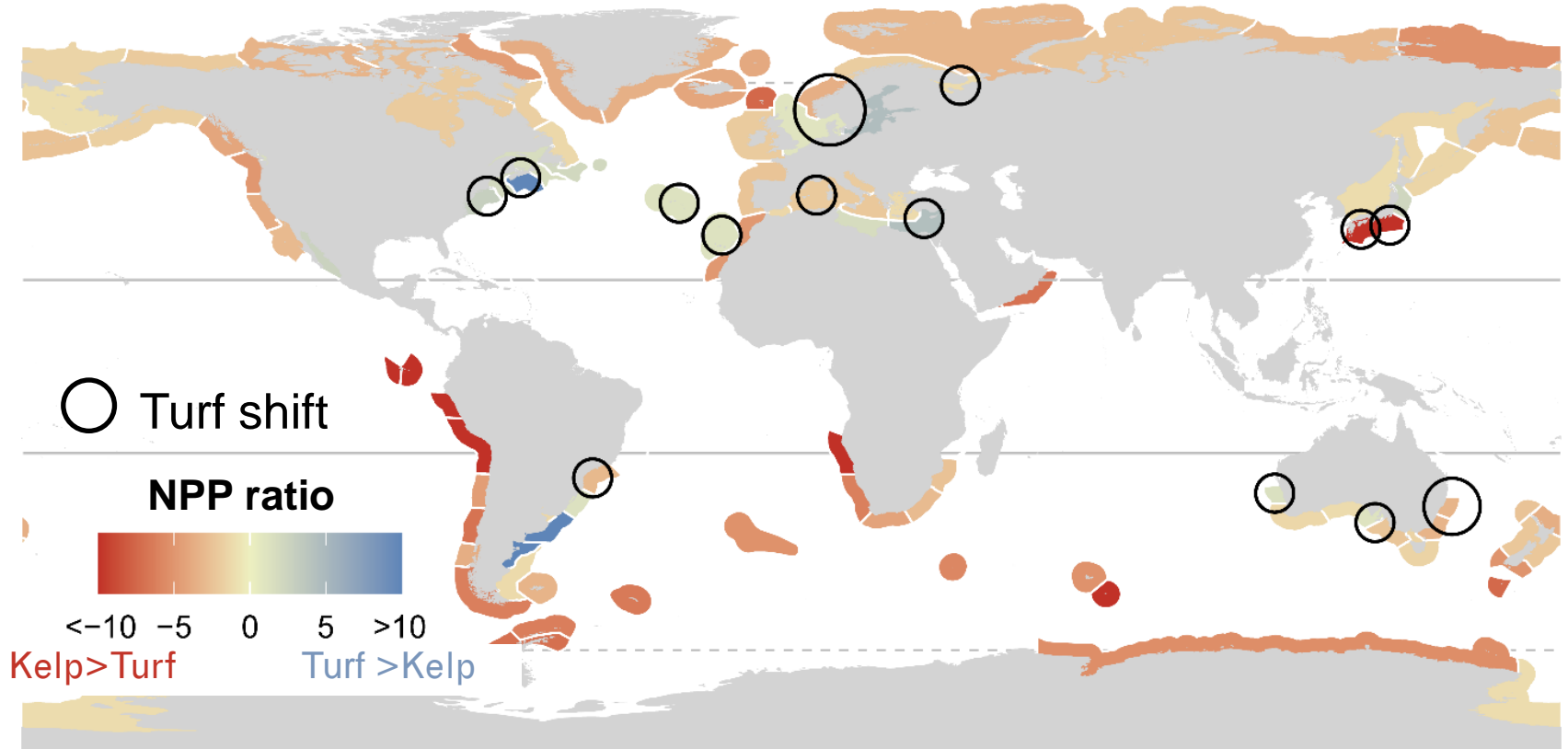


NPP of subtidal algal turfs





Loss of NPP with shift to turfs

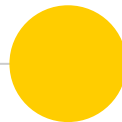




Turf shifts likely decrease reef NPP and overall carbon fixation

Potential impacts on the foodweb

Implications for role of seaweeds in global carbon cycle





Take home



Pessarrodona et al. (2021) Fun. Ecol.

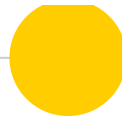
Photo: A. Vergés



Oceane Attlan
Poster Session

arbon

on

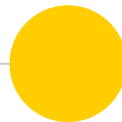




Turf shifts likely decrease reef NPP and overall carbon fixation

Potential impacts to the foodweb

Implications for role of seaweeds in global carbon cycle





Take home

Turf shifts likely decrease reef NPP and overall carbon fixation

Potential impacts to the foodw

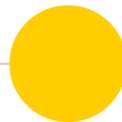
**Implications for role of seaweeds in glo
cycle**



Taylor Simpkins
Session 9 (212)



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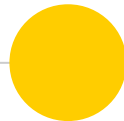




Final take home

Rise of turfs fundamentally alters the cycling of matter and energy on temperate reefs

Implications for ecosystem function across different spatial scales (local, regional, global)



An underwater photograph showing a vast, dense coral reef. The water is clear and blue, and the coral is a mix of brown and grey tones. A bright yellow rectangular box is superimposed over the center of the image, containing the text "Turfs are coming ...".

Turfs are coming ...