Marine Biological Association

13TH INTERNATIONAL TEMPERATE REEFS SYMPOSIUM
HOBART, UNIVERSITY OF TASMANIA

Revisiting historical kelp forests in a biogeographic transition zone

determining ocean warming winners and losers in the NE Atlantic

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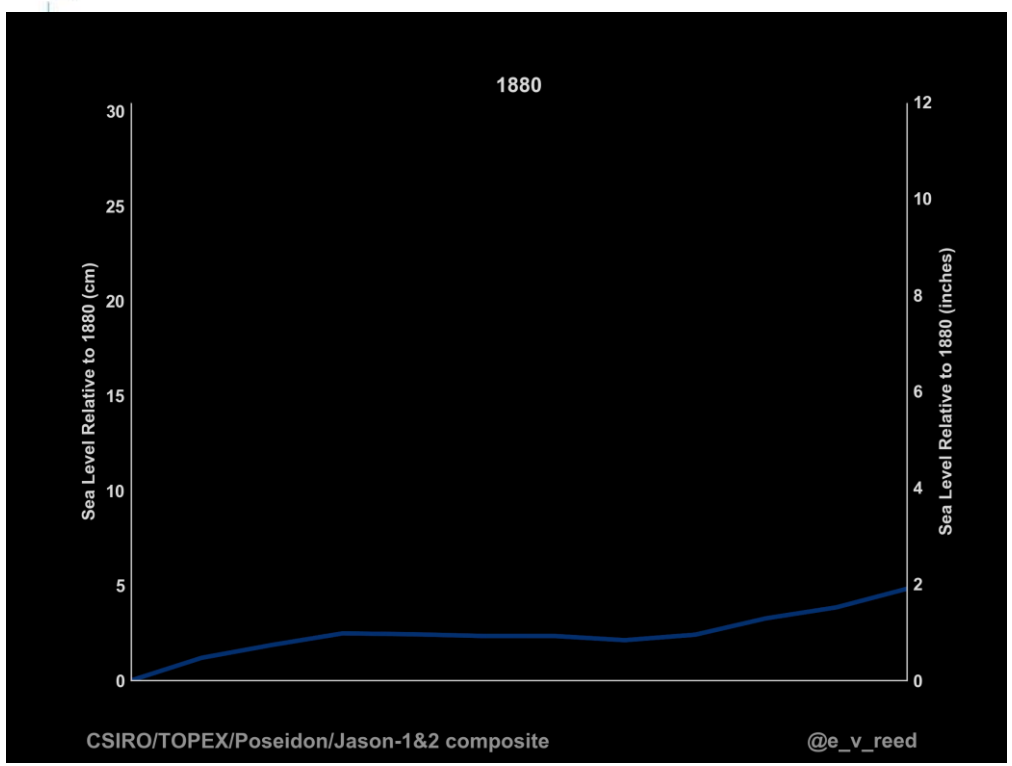
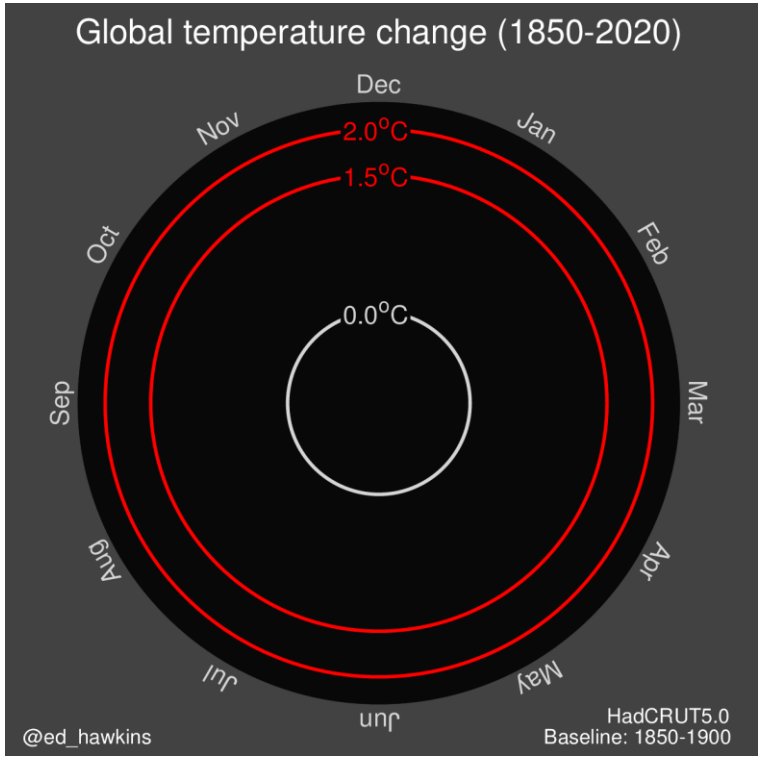
Benthic Ecosystems & Environmental Change
BEECH

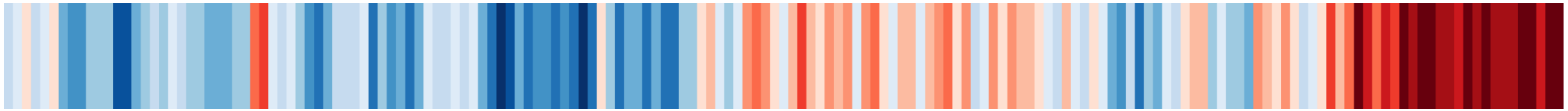
UNIVERSITY OF Southampton

INSPIRE

Anthropocene: time of global anthropogenic climate change



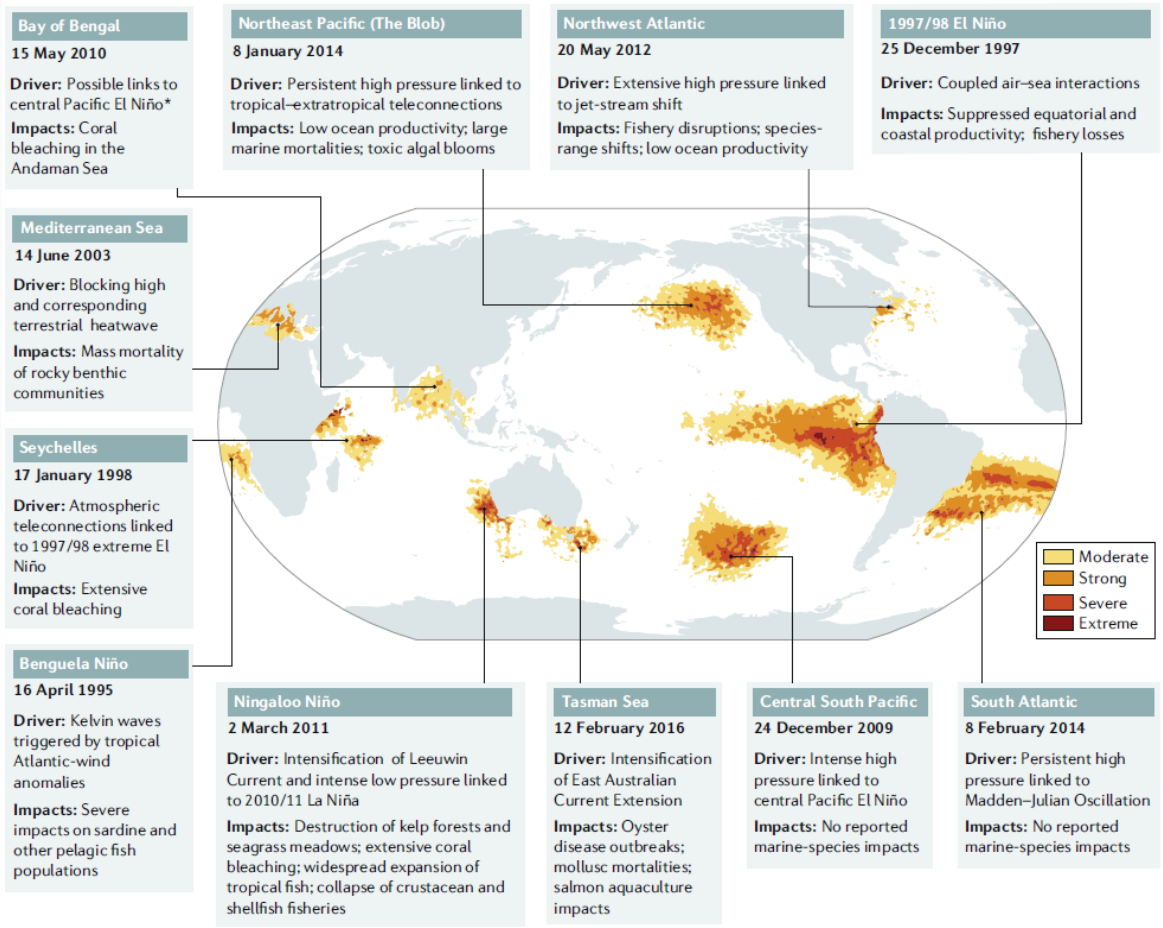




Warming Stripes for North Atlantic Ocean 1850-2020
@ed_hawkins #showyourstripes

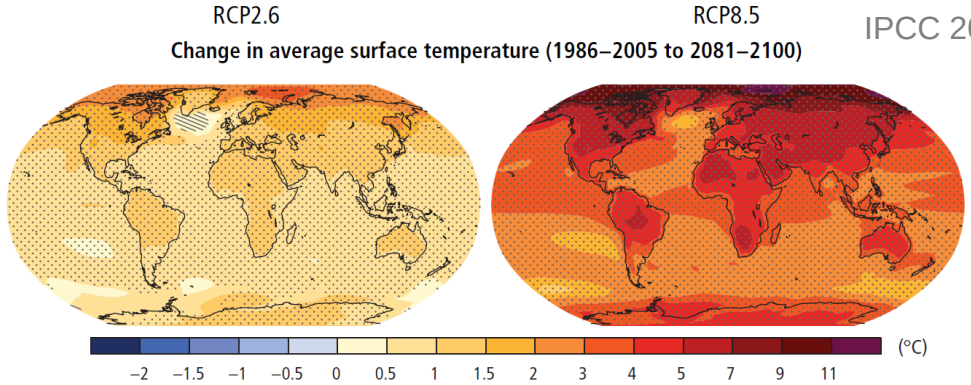
Climate change effects on coastal habitats

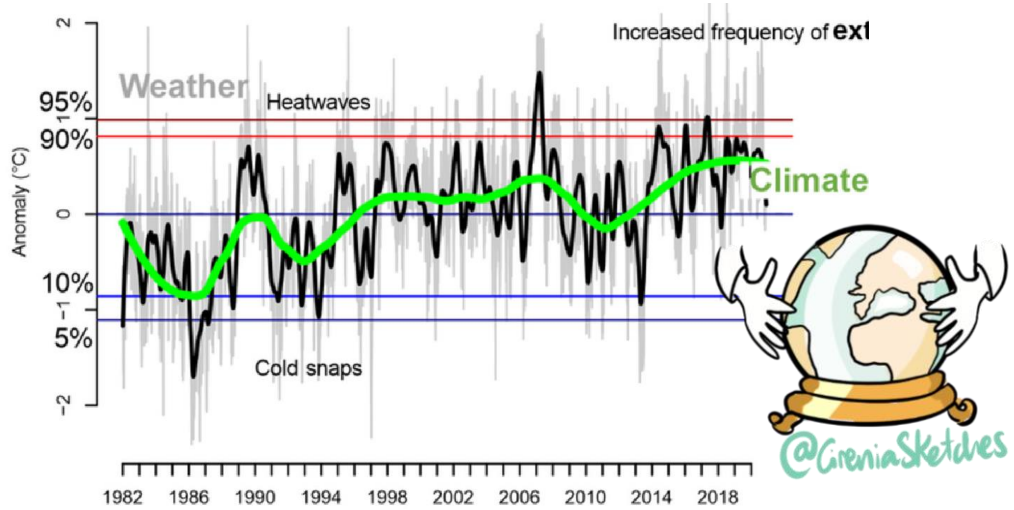
Major marine heat waves (MHW)



HOLBROOK ET AL 2020

IPCC 2014

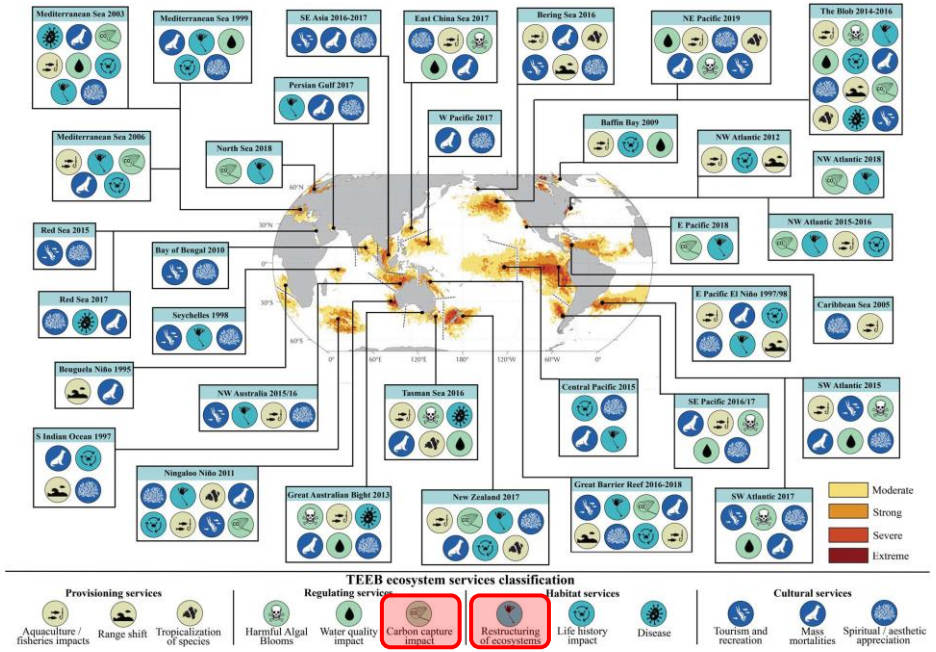




SST daily anomalies off Plymouth, UK (HAWKINS ET AL. 2022)

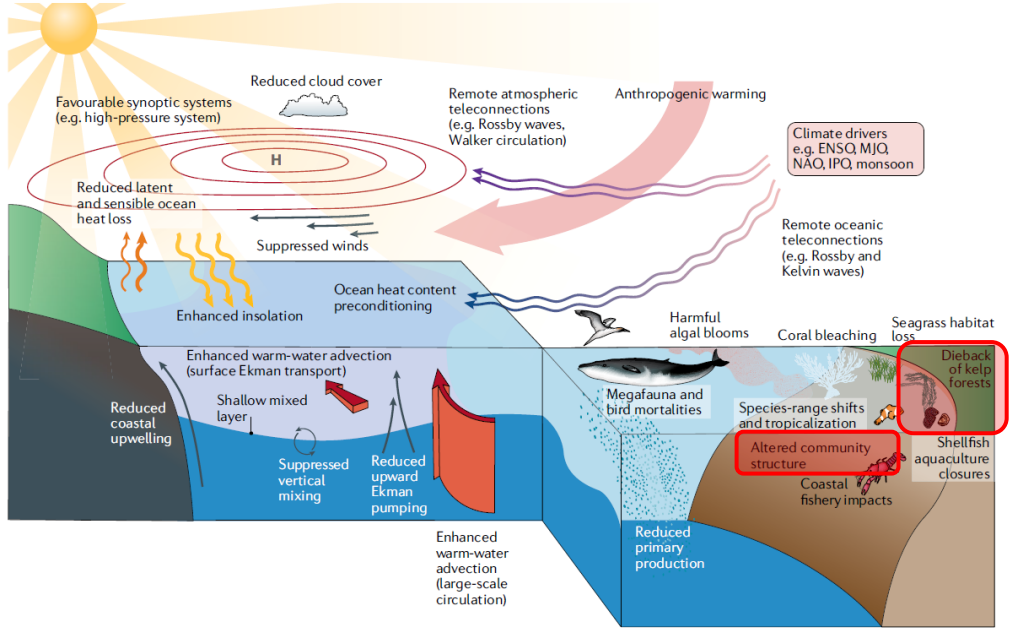
Temperature increase and MHWs impact seaweed communities and habitat provision

Socioeconomic impacts of MHWs



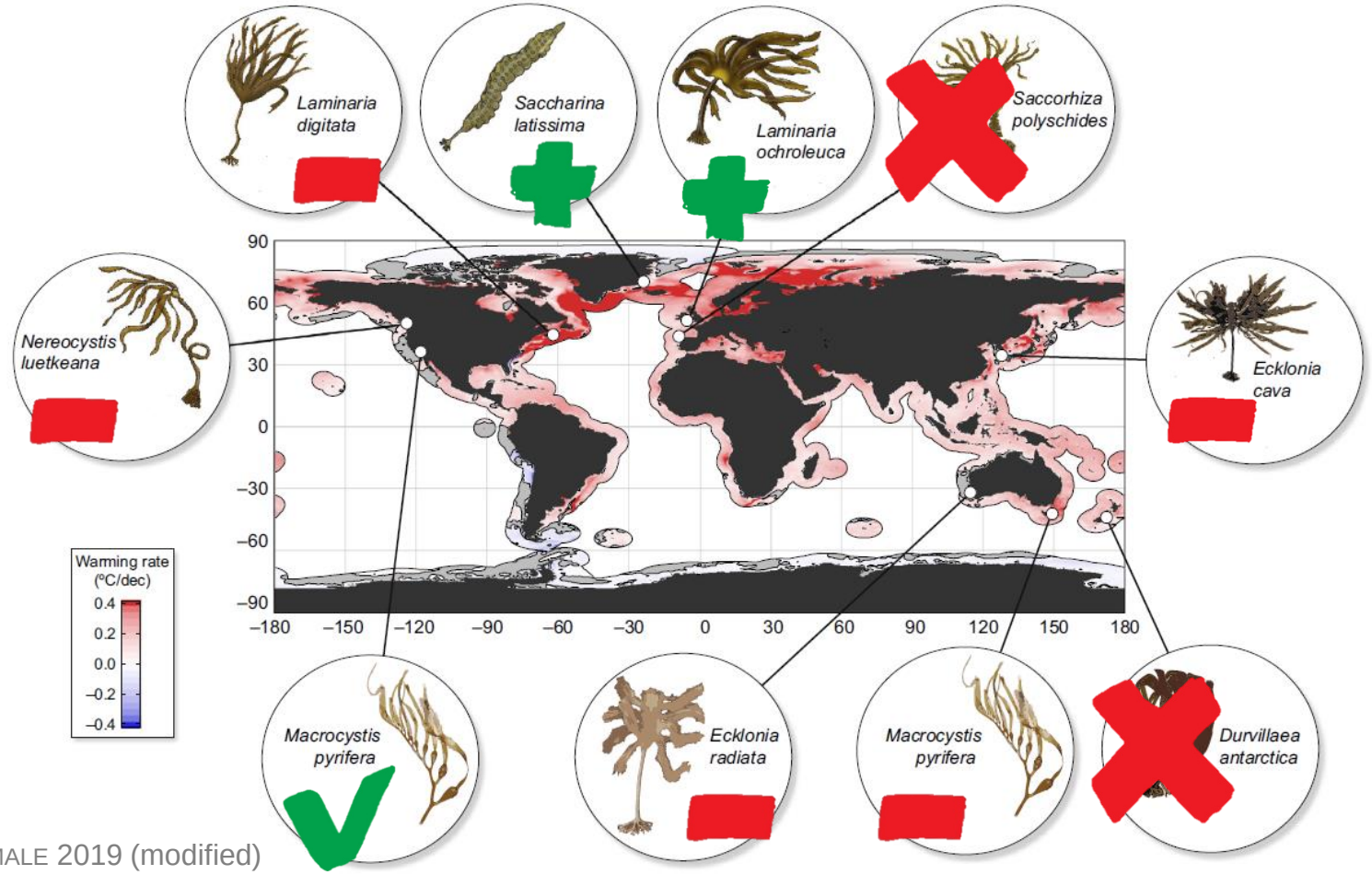
SMITH ET AL. 2021

Ecological impacts of MHW and ocean warming



HOLBROOK ET AL. 2020

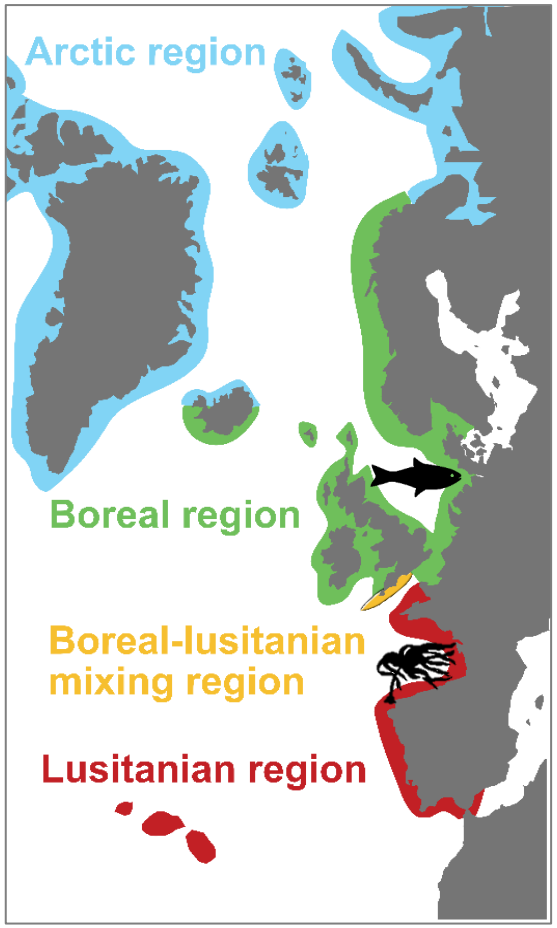
Temperature increase and MHWs impact seaweed community and habitat provision



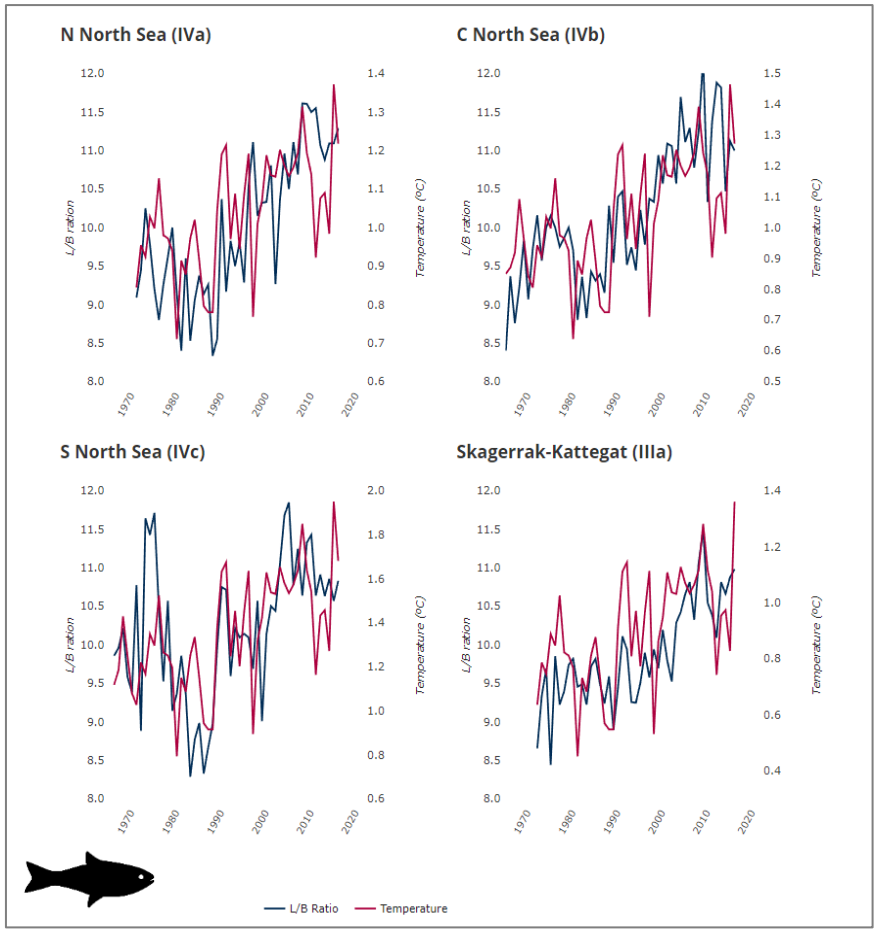
SMALE 2019 (modified)

- stable abundance
- range expansion, increased abundance
- range contraction, decreased abundance
- local extinction

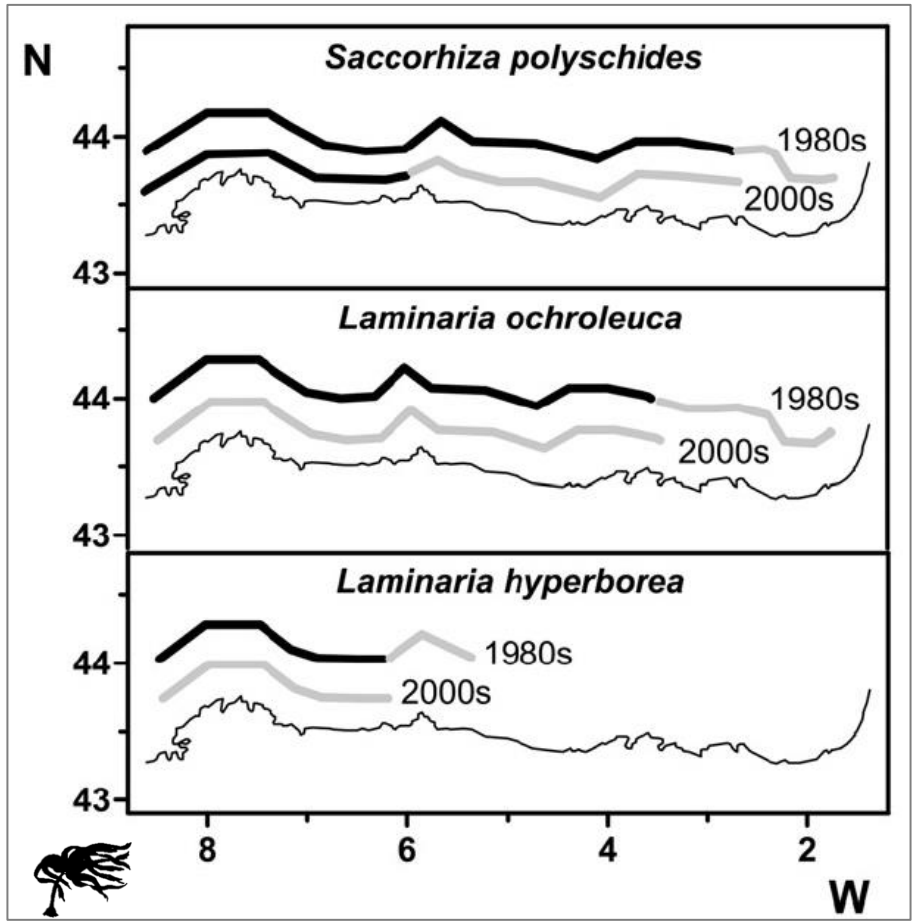
Species in the biogeographic transition zone in the NE Atlantic



modified according to DINTER 2001

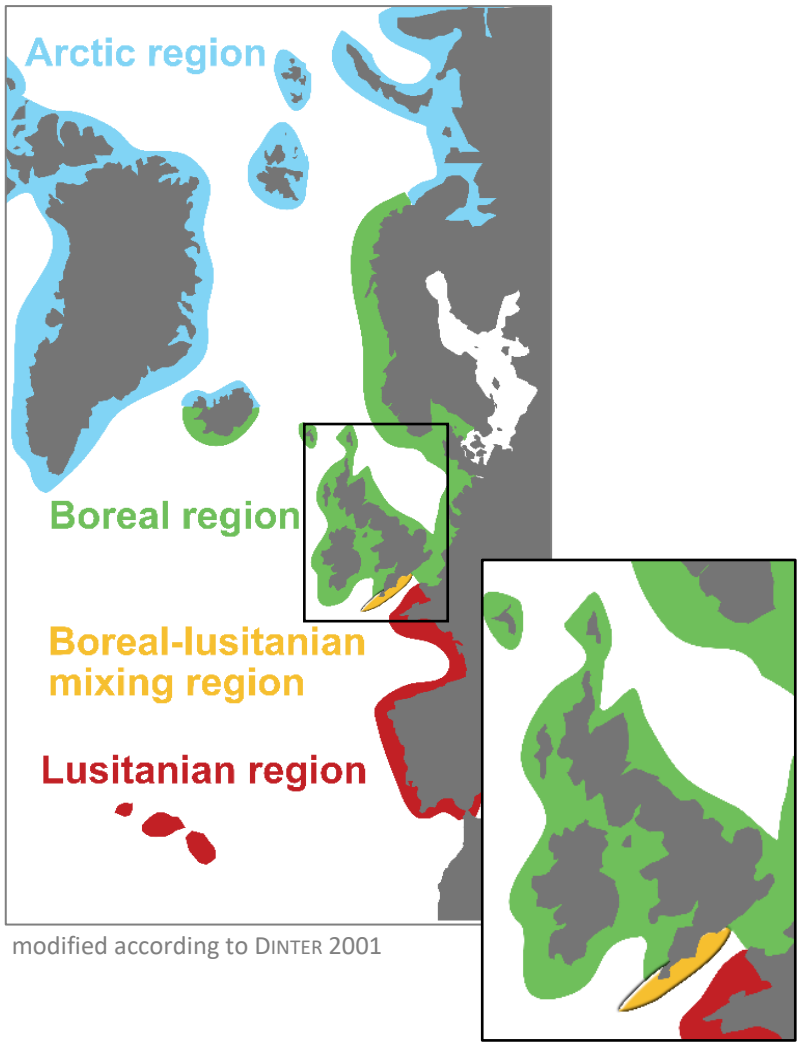


Ratio of Lusitanian and boreal fish species in trawls (blue) and SST (red) in the North Sea. EUROPEAN ENVIRONMENT AGENCY & ICES 2020



Dense (dark) and small patches (grey) of kelp populations on the north coast of Spain in 1980s and 2000s. FERNÁNDEZ 2011

Kelps in the Boreal-Lusitanian mixing region (BLMR)



modified according to DINTER 2001

Arctic/boreal kelps in SW England:

- *Alaria esculenta*
- *Laminaria hyperborea*
- *Laminaria digitata*
- *Saccharina latissima*

Lusitanian kelps in SW England:

- *Saccorhiza polyschides*
- *Laminaria ochroleuca*

Kelps with **other origin** (invasive, non-native) in SW England:

- *Undaria pinnatifida*

Survey motivation & hypothesis

Laminaria ochroleuca was first recorded in the far southwest of England in 1948 (Parke 1948) and has subsequently progressed eastwards as far as the Isle of Wight and northwards onto Lundy Island in the Bristol Channel (Blight & Thompson 2008; Brodie *et al.* 2009). It is thought that populations on the south coast of England are proliferating and that the species may be expanding its rang… is largely anecdotal…

…eover, anecdotal evidence suggests that, regionally, *S. polyschides* may have increased in density and extent over recent decades, perhaps due to increased sea temperatures or changes in canopy disturbance and structure (Birchenough and Bremner 2010, Smale et al. 2013). As such, any localized sup-

EPSTEIN ET AL. 2019

There has been some evidence to suggest that the relative abundance of *S. polyschides* has increased along the south coast of England (Birchenough and Bremmer 2010; S. J. Hawkins, pers. obs.), but reliable data are lacking.

There is some evidence to suggest that more southerly distributed …*polyschides*) have …dergone poleward …y, northern species …in abundance in …et al. 2005; Brodie …r 2010). However, anecdotal reports …detailed historical examinations of distribution patterns are lacking.

SMALE ET AL. 2013

Survey aim to gain **robust data,** and <u>eliminate ‘anecdotal evidence’</u> by revisiting historical kelp sites and comparing previous data with recent recordings

study, tempora… pa… caution, as historic… Even so, our ‘wei… *et al.* 2014 for bes… which incorporated …

surveys and resurveys of historical sites, would suggest with some confidence that *L. ochroleuca* has increased in abundance and expanded its distribution in the Western English Channel, most likely in response to recent seawater warming. Within the framework recently proposed by

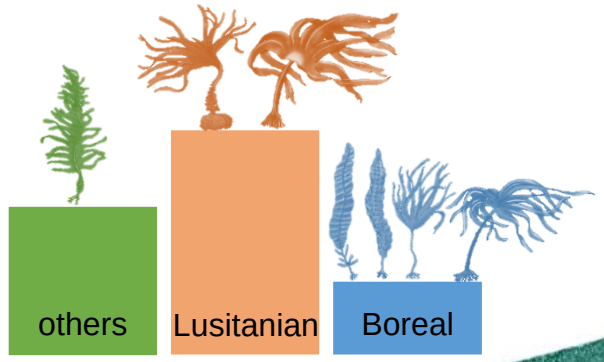
SMALE ET AL. 2015

The Lusitanian kelp *Saccorhiza polyschides* has rapidly increased in abundance in this region over the last few years and is displacing cold water Laminarians over large areas of the intertidal. There is currently insufficient evidence to ascertain whether *S. polyschides* is also displacing Laminarians below the low-water mark, but the

BIRCHENOUGH & BREMNER 2010

Anecdotal evidence suggests that *S. polyschides* populations have proliferated in recent decades in the south-west of the UK (Birchenough & Bremner, 2010; Smale *et al.*, 2013), which is the focal region of this study.

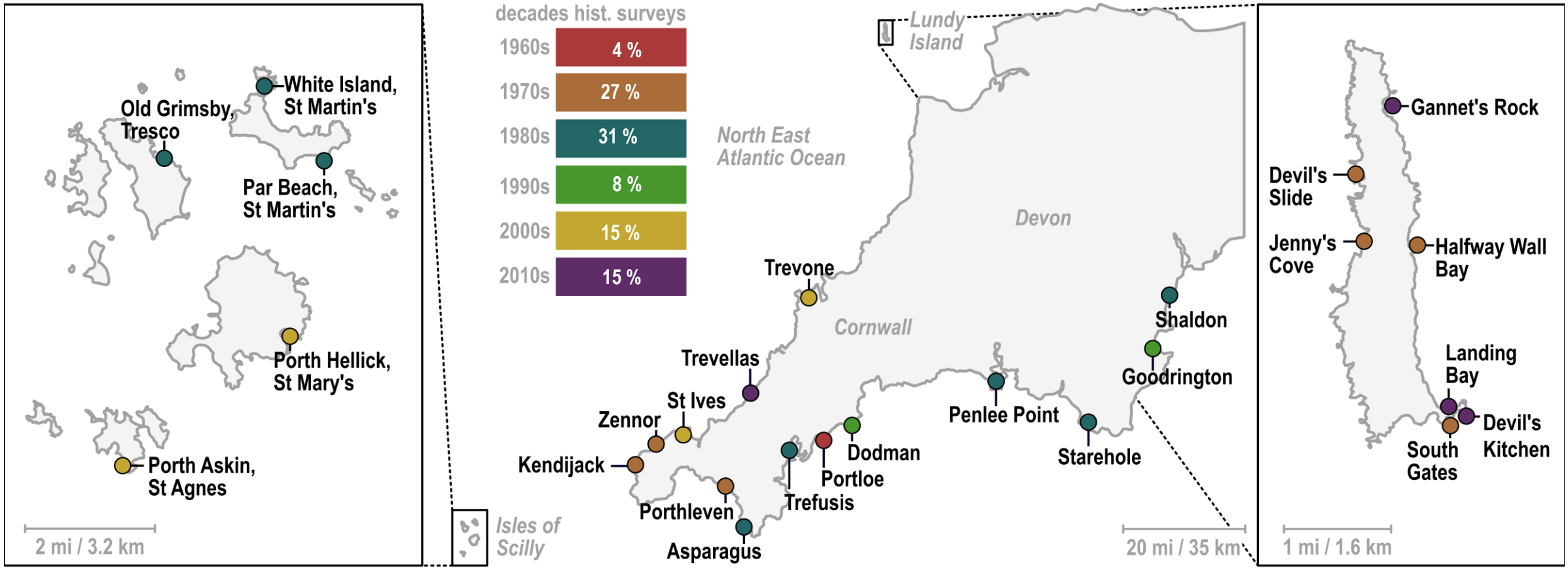
SALLAND & SMALE 2021



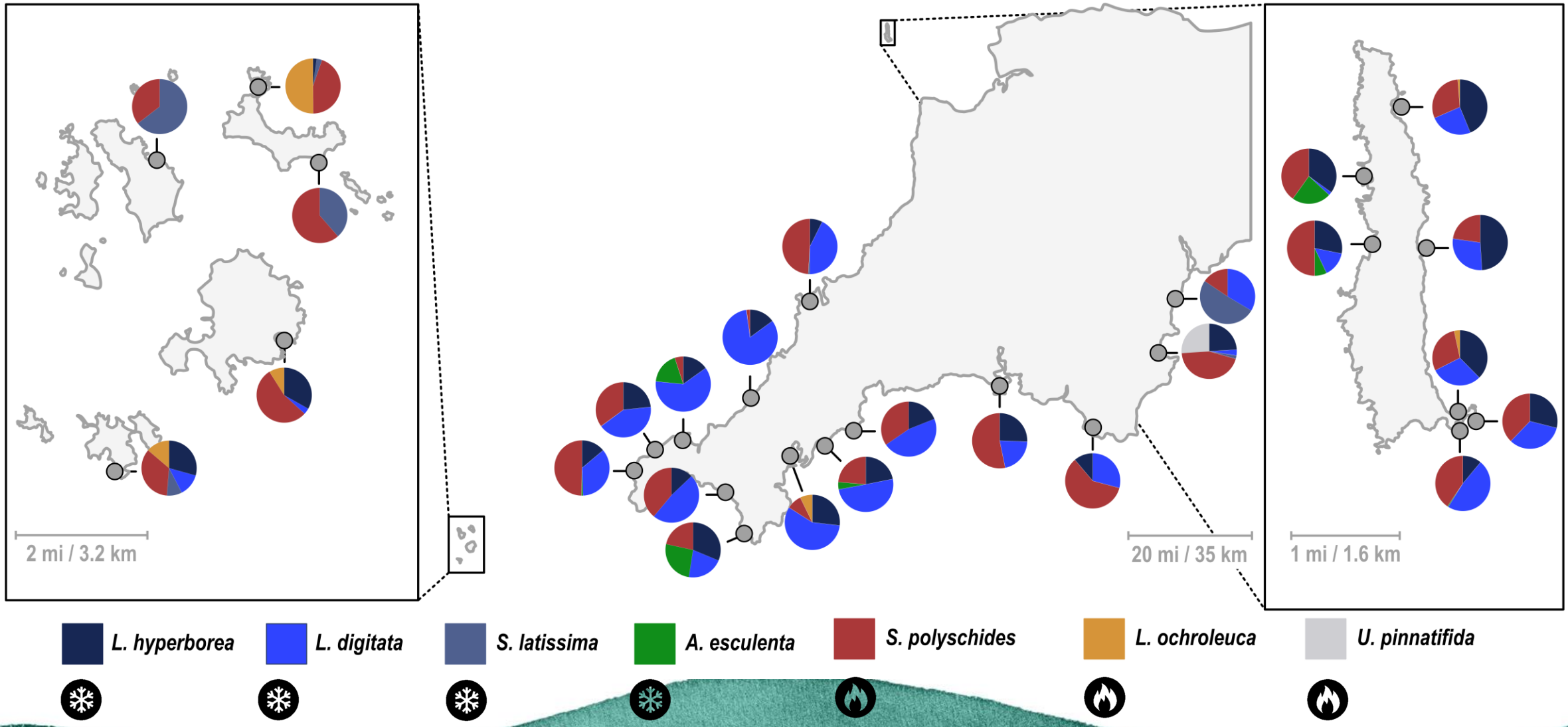
Survey methods

- historical kelp records (snapshots) between **1962 and 2016** from **several sources**
- priority of sites according to location, accessibility, depth, level of wave exposure, confidence in data quality, informal data value,…
- resurvey sites between **July-August 2021-2023** (ongoing survey!) via snorkelling (low intertidal, shallow subtidal ~4m depth)
- **SACFOR scale** of kelps and some large brown macroalgae
  - *L. hyperborea. L. digitata, L. ochroleuca, S. latissima, A. esculenta, S. polyschides, U. pinnatifida*
  - *Himanthalia elongata, Ascophyllum nodosum, Sargassum muticum, Halidrys siliquosa, Chorda filum, Desmarestia aculeata, D. ligulata, Cystoseira baccata*
- 10 quadrats: **density and cover**
- 10 individuals/species: **biometric measurements, tissue samples**

Survey sites 2021 & 2022 (N=26)

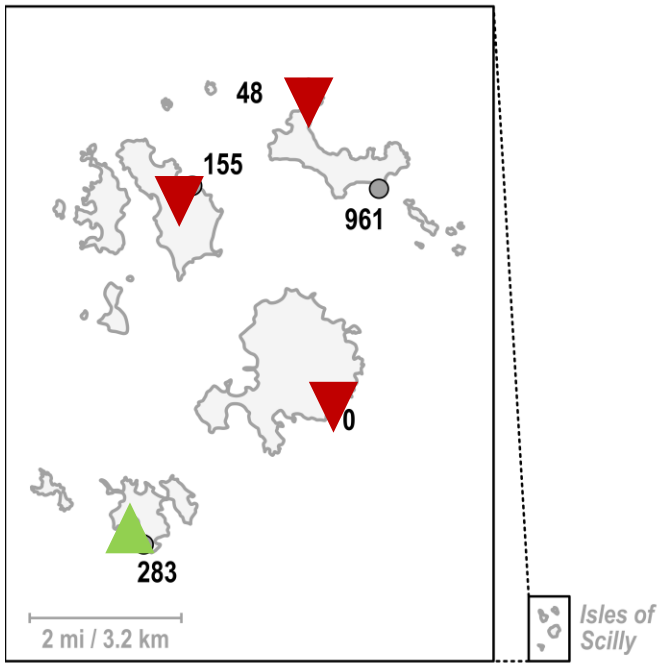


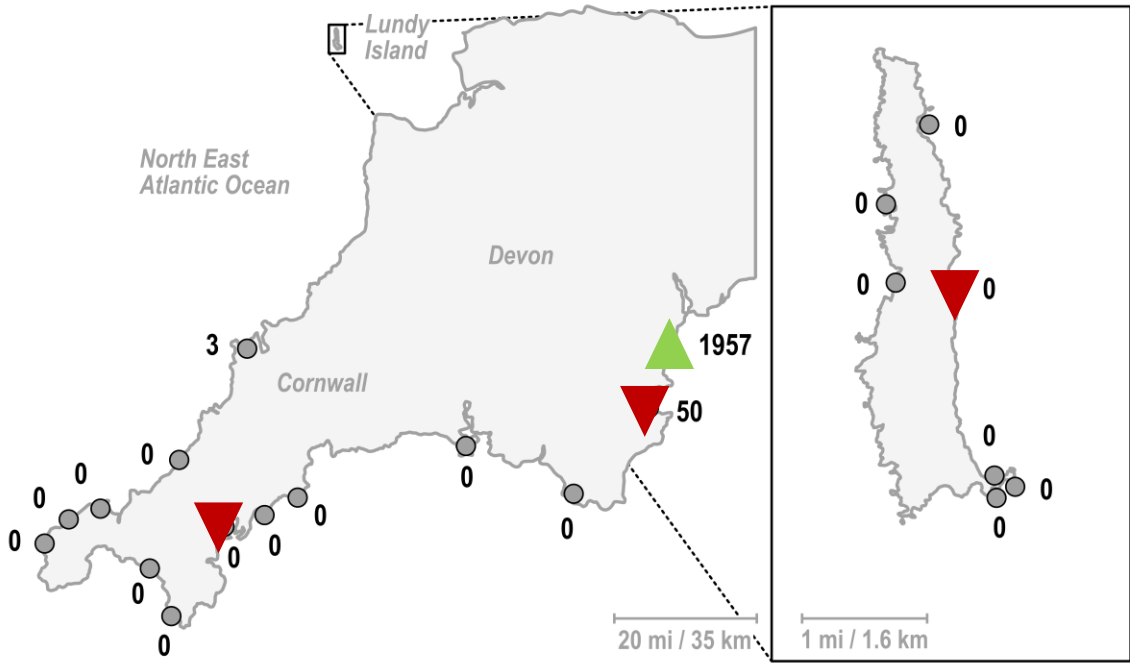
Kelp assemblage composition (% cover), recent data



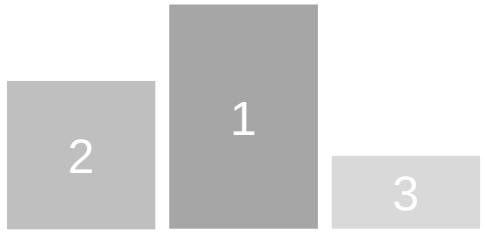
Standing stock & temporal population change

Saccharina latissima





standing stock in gFW m^2



frequent→rare

Isles of Scilly:
common→frequent

Mainland D&C:
common→rare

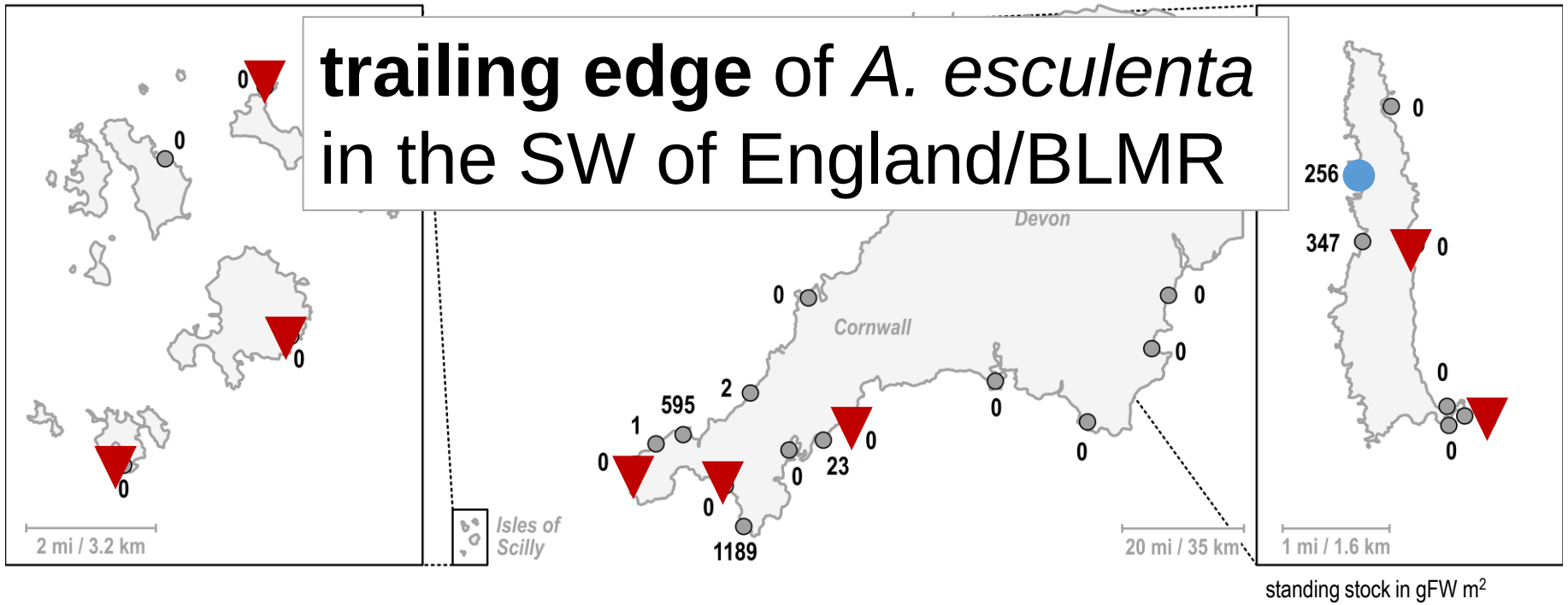
Lundy Island:
common→none

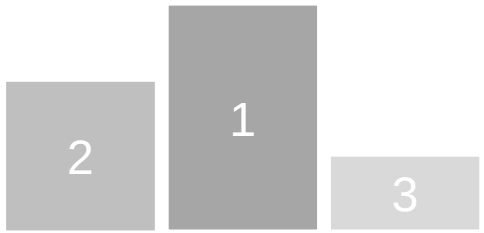
▼ pop. increase
▲ pop. decline
● pop. stable
S>A>C>F>O>R>N

Standing stock & temporal population change

Alaria esculenta

trailing edge of *A. esculenta* in the SW of England/BLMR





frequent→rare

Isles of Scilly:
superabundant→none

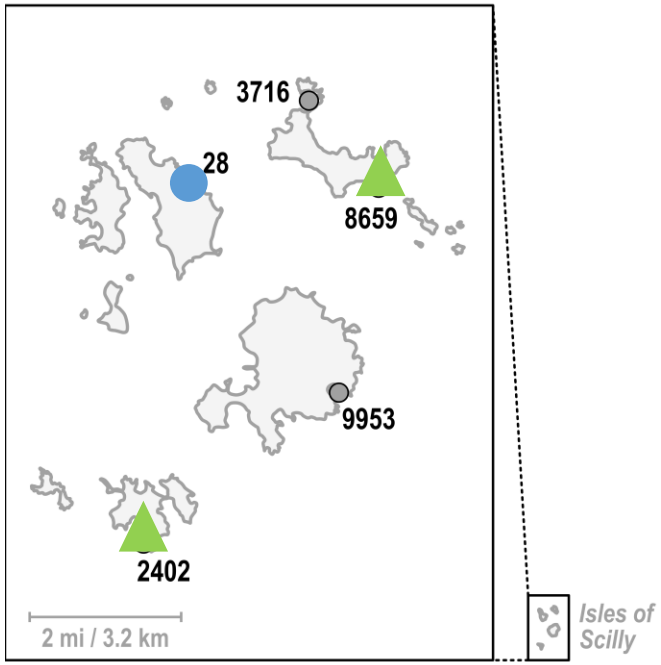
Mainland D&C:
occasional→rare

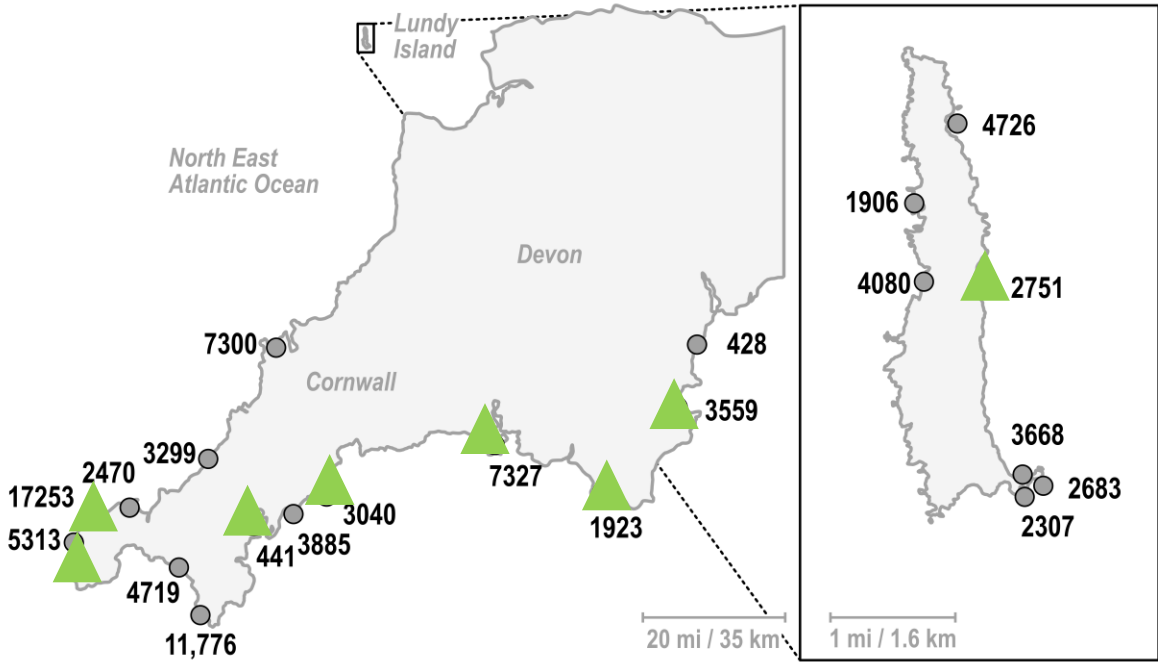
Lundy Island:
frequent→rare

▼ pop. increase
▲ pop. decline
● pop. stable
S>A>C>F>O>R>N

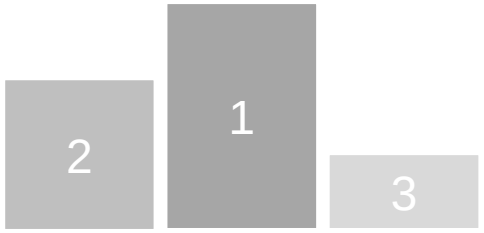
Standing stock & temporal population change

Saccorhiza polyschides





standing stock in gFW m^2



occasional→abundant

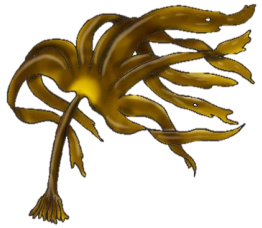
Isles of Scilly:
frequent→abudant

Mainland D&C:
occasional→abudant

Lundy Island:
occasional→ superabudant

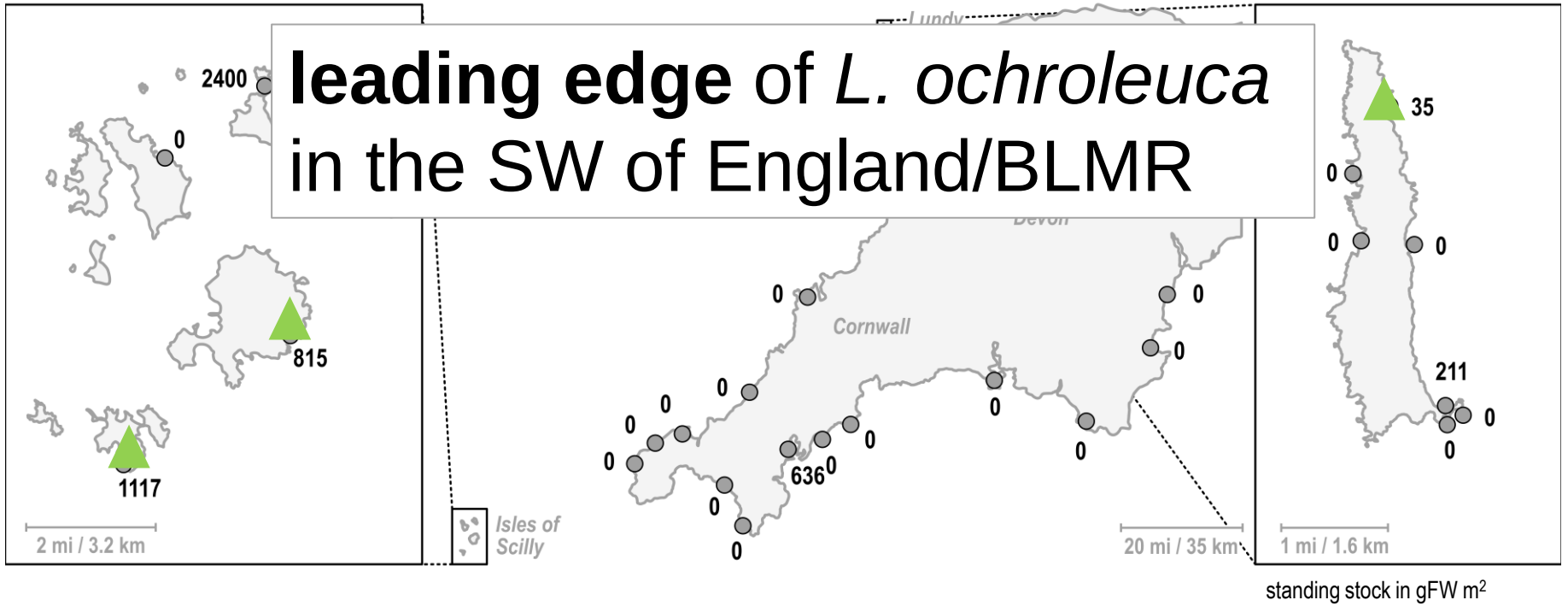
▼ pop. increase
▲ pop. decline
● pop. stable
S>A>C>F>O>R>N

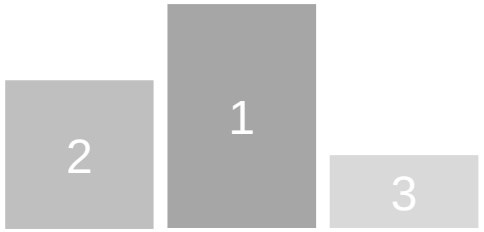
Standing stock & temporal population change



Laminaria ochroleuca

leading edge of *L. ochroleuca* in the SW of England/BLMR





none→rare

Isles of Scilly:
rare→occasional

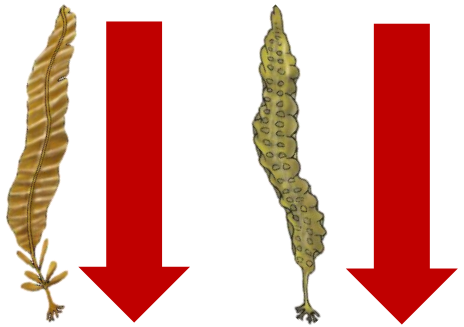
Mainland D&C:
none→rare

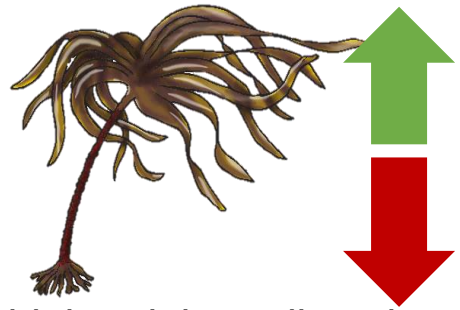
Lundy Island:
none→rare

▼ pop. increase
▲ pop. decline
● pop. stable
S>A>C>F>O>R>N

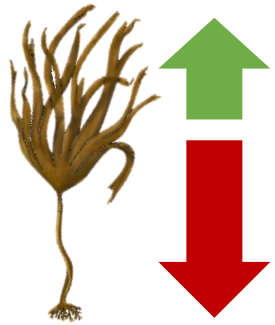
Preliminary summary of species trends

NE Atlantic kelp ecotype	species	historical SACFOR (average)	recent SACFOR (average)
Arctic / Boreal kelps	*Alaria esculenta*	frequent	rare
	Saccharina latissima	frequent	rare
	Laminaria hyperborea	abundant	abundant
	Laminaria digitata	super-abundant	common
Lusitanian kelps in the SW	*Saccorhiza polyschides*	occasional	abundant
	Laminaria oroleuca	none	rare
other kelps (invasive, non-native)	*Undaria pinnatifida*	none	





high epiphyte diversity, long lifespan



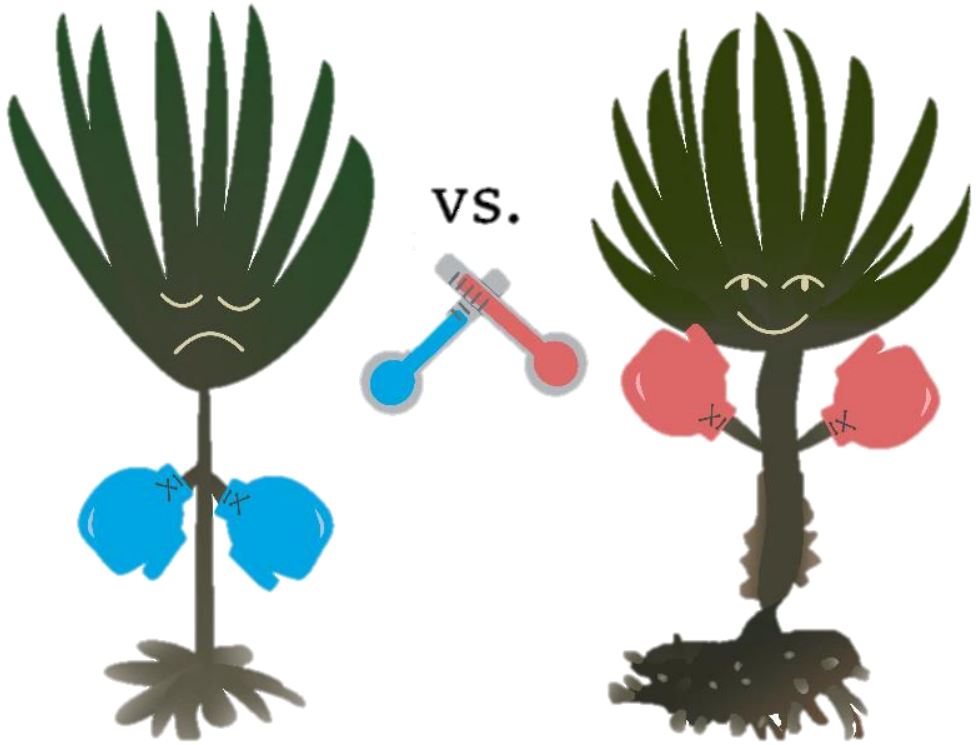
long lifespan

short lifespan

clean stipes, no epiphytes

shifts to less stable / persistant habitats

Winners vs losers: the battle continues…



- few more sites in **field season 2023** will fill spatial gaps in the survey area (possibly incl. a few proper subtidal sites), then final analysis for thesis chapter and publication…
- **Work in progress!** species distribution models… Ideas and chats welcome ☺

- **Who will be the winner, who will be the loser of future climate change in the SW?**
- **Kelp community of SW England as a model area for climate change effects in the NE Atlantic**

Acknowledgements

Thanks to my supervisors **Dr Dan Smale** and **Dr Antony Jensen** and to the **BEECH group & friends** for support during fieldwork, in particular **Dan Smale, Cat Wilding, Katie Smith, Cristina Galobart, Nathan King, Emma Stuart** for support and assistance during this survey! ☺
Thanks to **IPS (Paul C. Silva Student Grant) and P** for financial support to go Tasmania to this ITRS meeting.









Historical data set used for the survey: MNCR, SASSH, MarClim, Tom Vance master's thesis

References used in this talk: Birchenough & Bremner 2010 MCCIP Science Review; **Dinter 2001** Biogeography of the OSPAR Maritime Area; **Epstein et al. 2019** Ecosphere; **European Environment Agency & ICES 2020**; **Fernández 2011** European Journal of Phycology; **Holbrook et al. 2020** Nature Reviews Earth & Environment; **IPCC 2014** (International Panel for Climate Change); **Salland & Smale 2021** Journal of the Marine Biological Association of the UK; **Smale et al. 2013** Ecology and Evolution; **Smale et al. 2015** Marine Ecology; **Smale 2019** New Phytologist; **Smith et al. 2021** Science; **Yesson et al. 2015** Journal of the Marine Biological Association.

Thank you!

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HOBART, UNIVERSITY OF TASMANIA

Looking for post-docs starting 2024!

cold-adapted
(climate change loser)

Kelp-lover but potentially
happy to explore new horizons

team-player