Edith Cowan University

Geographe Bay seagrass meadows: stable, healthy and resilient to ocean warming

Dr Marlene Wesselmann and Ms Caitlyn O'Dea

Seagrasses provide awesome ecosystem services

- Seagrasses are not seaweed

- Flowering plants
- Live in shallow water in coastal zones

- **Protect our coastlines**
- **Clean our seawater**
- **Feed many animals**
- **Provide a home for many creatures**
- **Capture carbon**

Filter:
Nutrients
Pathogens
Viruses

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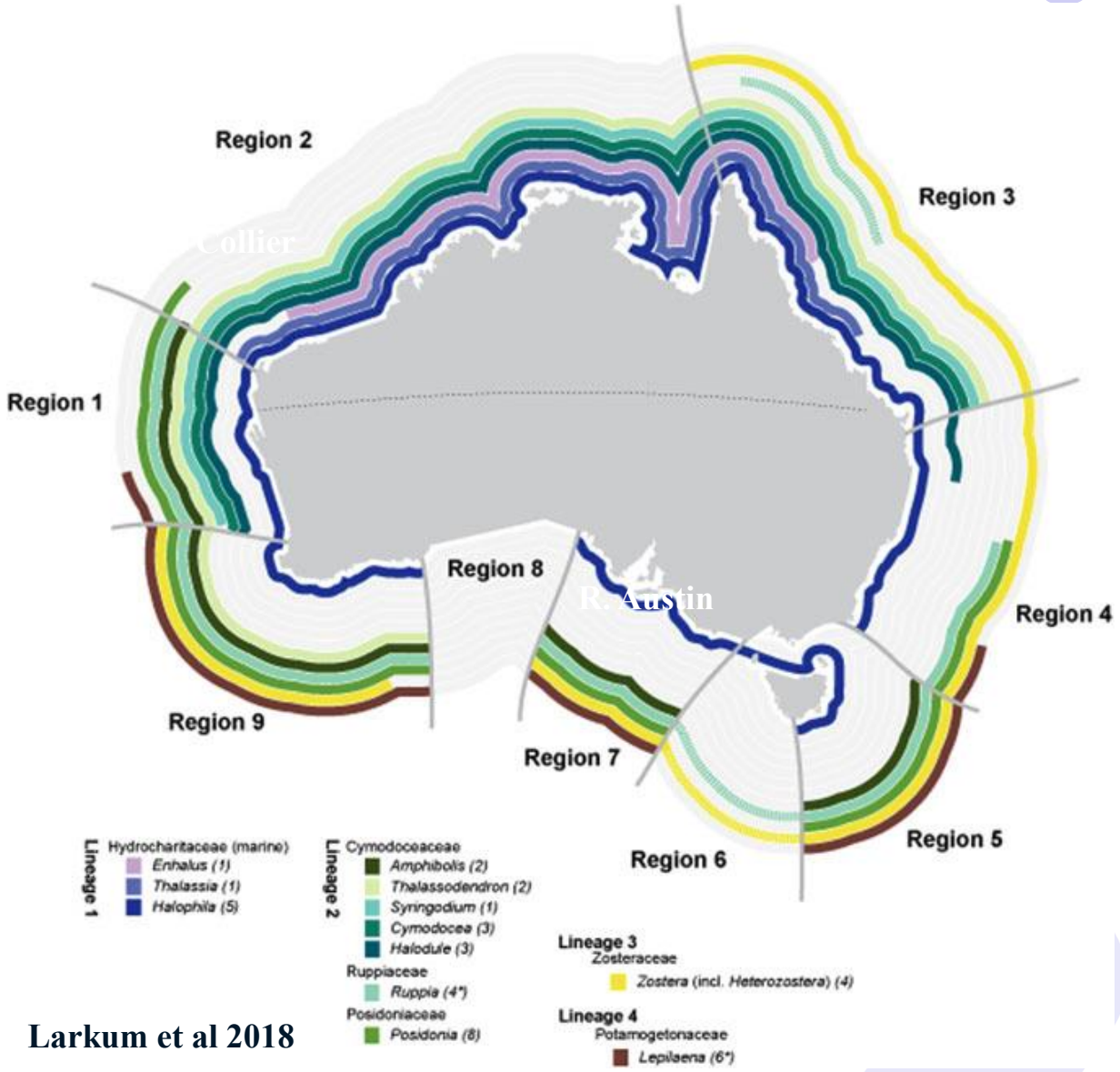
Posidonia sinuosa seagrass monitored across WA including Geographe Bay



Larkum et al 2018

- Dominant in temperate waters
- Historically significant losses
- Vulnerable on IUCN Redlist

Why monitor seagrass in Geographe Bay

- High nutrient loads from the catchment – threat to seagrass
- Ngari Capes Marine Park – seagrass is an important asset

- Keep Watch Program:
  - Seagrass is a marine indicator to link to threat from catchment nutrients
  - Clear objective: Is the amount of seagrass declining?
  - Repeatable and robust
  - Trigger values guide management decisions
  - Cost-effective

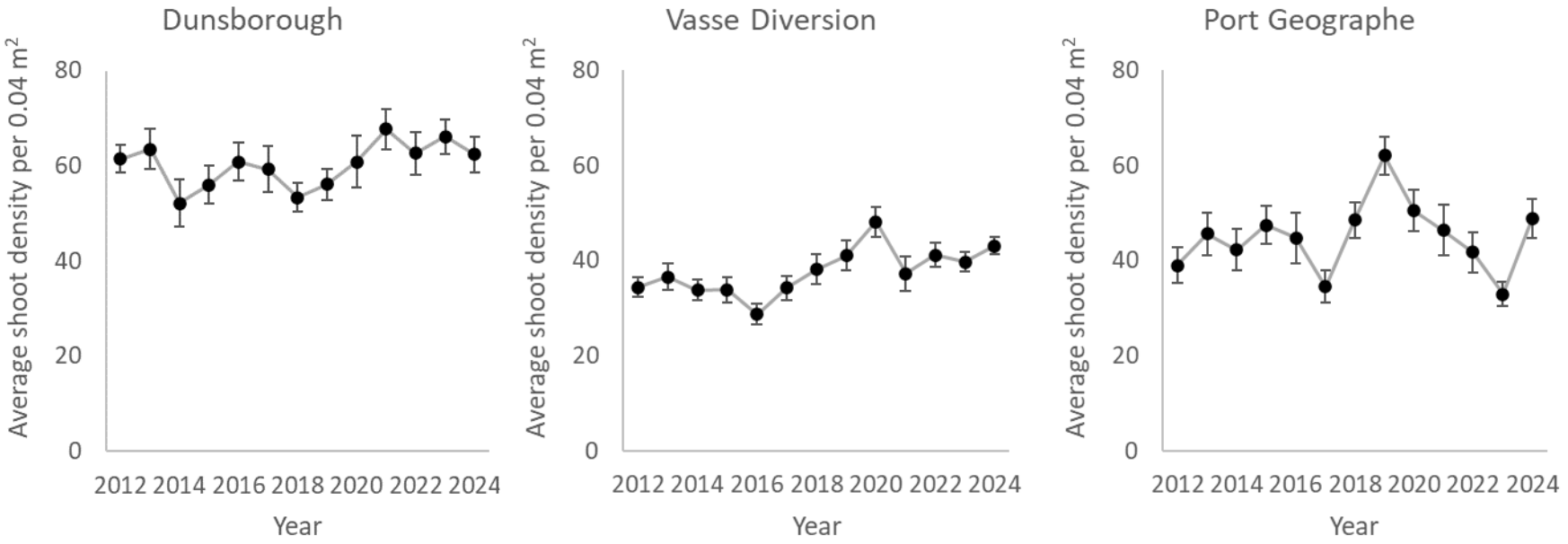

Keep Watch Sites
N+P
8. Capel
7.Forrest Beach
Ngari Capes Marine Park
1.Dunsborough
6.Vasse-Wonnerup
4.Busselton Jetty
5.Port Geographe
2.Buayanup
3.Vasse-Diversion
WHEN Every summer (Jan/Feb) from 2012
WHAT Count shoots of Posidonia seagrass, Nutrients, Algal epiphyte cover
ASSESSMENT Assess change over time with 3 triggers
Image © 2012 GeoEye
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Google earth
Imagery Date: 12/19/2010
lat -33.592450° lon 115.303961° elev -15 m
Eye alt 45.30 km

Monitoring approach – count shoots and leave

- Consistent indicator is seagrass shoot density

Seagrass meadows healthy: No indication of decline

Years	Trigger
2012-2013	✓
2013-2014	✓
2014-2015	✓
2015-2016	✓
2016-2017	✓
2017-2018	✓
2018-2019	✓
2019-2020	✓
2020-2021	✓
2021-2022	✓
2022-2023	✓
2023-2024	✓



- No indicators of decline based on triggers
- Differences in condition between sites
- Variations over time

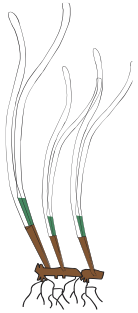
Higher epiphyte cover indicates more nutrient exposure

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
1. Dunsborough	3	2	3	3	2	2	3	3	3	2	3	3	3
2. Buayanup	3	2	3	3	4	4	3	1	4	4	4	4	4
3. Vasse Diversion Drain	2	3	4	4	4	4	4	2	4	4	4	3	4
4. Busselton Jetty	2	2	4	4	3	3	3	2	4	4	4	3	3
5. Port Geographe	2	1	2	2	3	3	3	2	3	3	3	3	4
6. Vasse-Wonnerup	2	1	2	3	2	2	2	1	2	3	2	3	2
7. Forrest Beach	2	1	2	2	2	1	2	1	2	2	1	2	3

- Differences in algal cover between sites
- Generally central sites have higher cover
- Variations over time but no negative impacts on seagrass condition

Nutrient content very low
Reduced concentrations over time at Capel

- Very low nitrogen in Posidonia seagrass tissues and no consistent changes over time indicating loads are not increasing



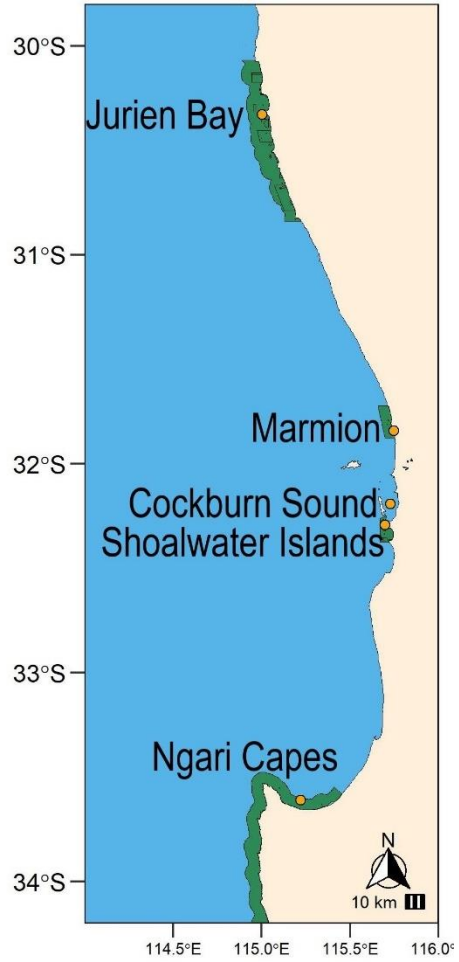
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
1. Dunsborough	0.68	0.51	0.95	0.43	0.46	0.45	0.64	0.59	0.59	0.41	0.49	0.45	0.72
2. Buayanup	0.92	0.45	1.06	0.55	0.70	0.59	0.60	0.67	0.82	0.70	0.66	0.63	0.62
3. Vasse Diversion Drain	0.58	0.39	0.95	0.47	0.73	0.65	0.54	0.63	0.72	0.56	0.71	0.45	0.89
4. Busselton Jetty	0.64	0.44	0.81	0.50	0.55	0.42	0.42	0.44	0.49	0.50	0.47	0.49	0.50
5. Port Geographe	0.74	0.60	1.12	0.49	0.92	0.65	0.72	0.69	1.05	0.63	0.87	0.72	0.81
6. Vasse-Wonnerup	0.60	0.39	0.93	0.43	0.52	0.51	0.47	0.38	0.63	0.44	0.48	0.44	0.63
7. Forrest Beach	0.64	0.47	0.92	0.39	0.51	0.43	0.66	0.53	0.71	0.66	0.68	0.52	0.52

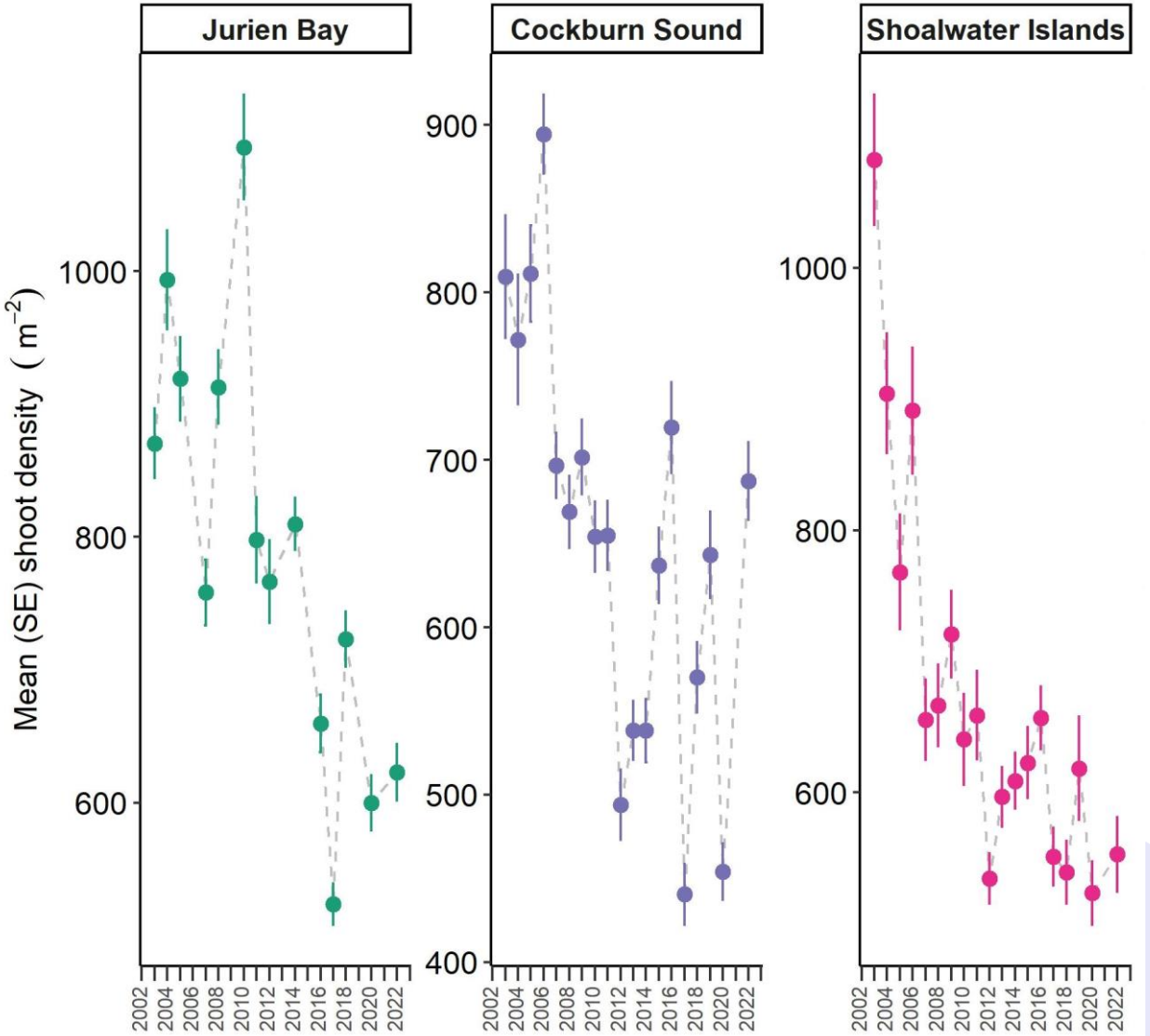
- Generally <1% N

- Reduced concentrations at Capel over time indicating reduction in nutrient loads entering the marine environment

		2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
4. Busselton Jetty / Vasse Diversion		0.44	1.07	0.86	0.52	0.70	0.75	0.75	0.86	0.95	0.61	0.53	0.83
7. Forrest Beach		0.64	0.87	0.51	0.63	0.35	0.59	0.58	0.64	0.73	0.54	0.46	0.32
8. Capel		1.88	1.79	1.07	1.12	1.37	1.26	1.13	1.78	1.30	1.22	1.23	0.59

Geographe Bay more resilient than other regions
Higher shoot density & no declines

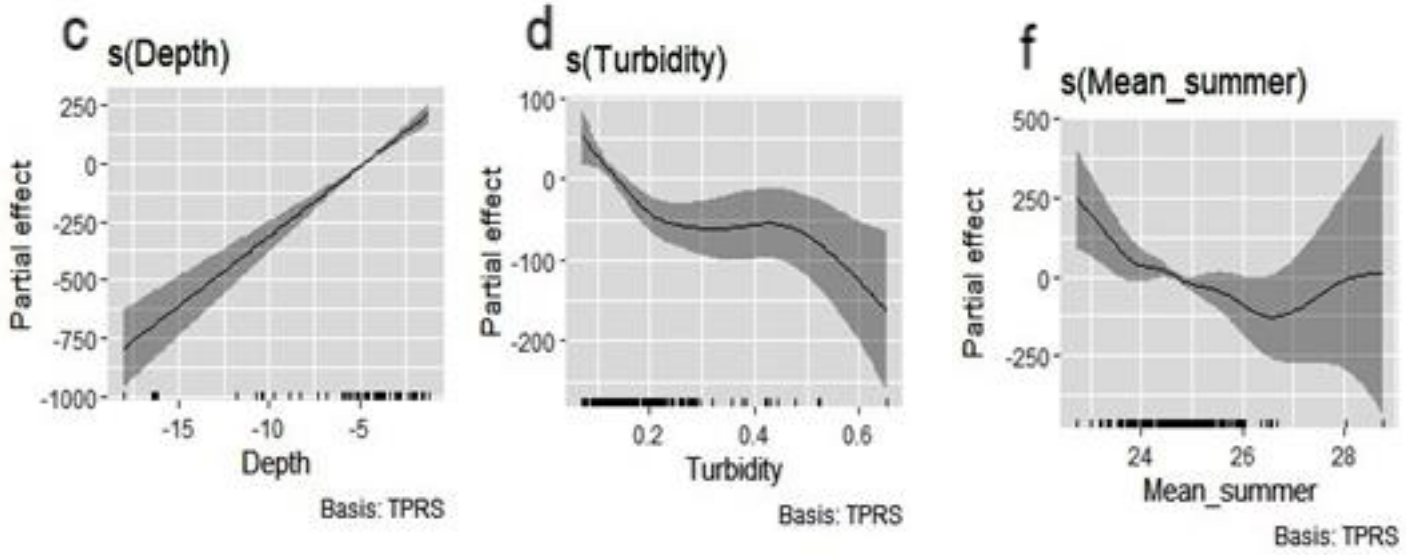




Webster et al 2024

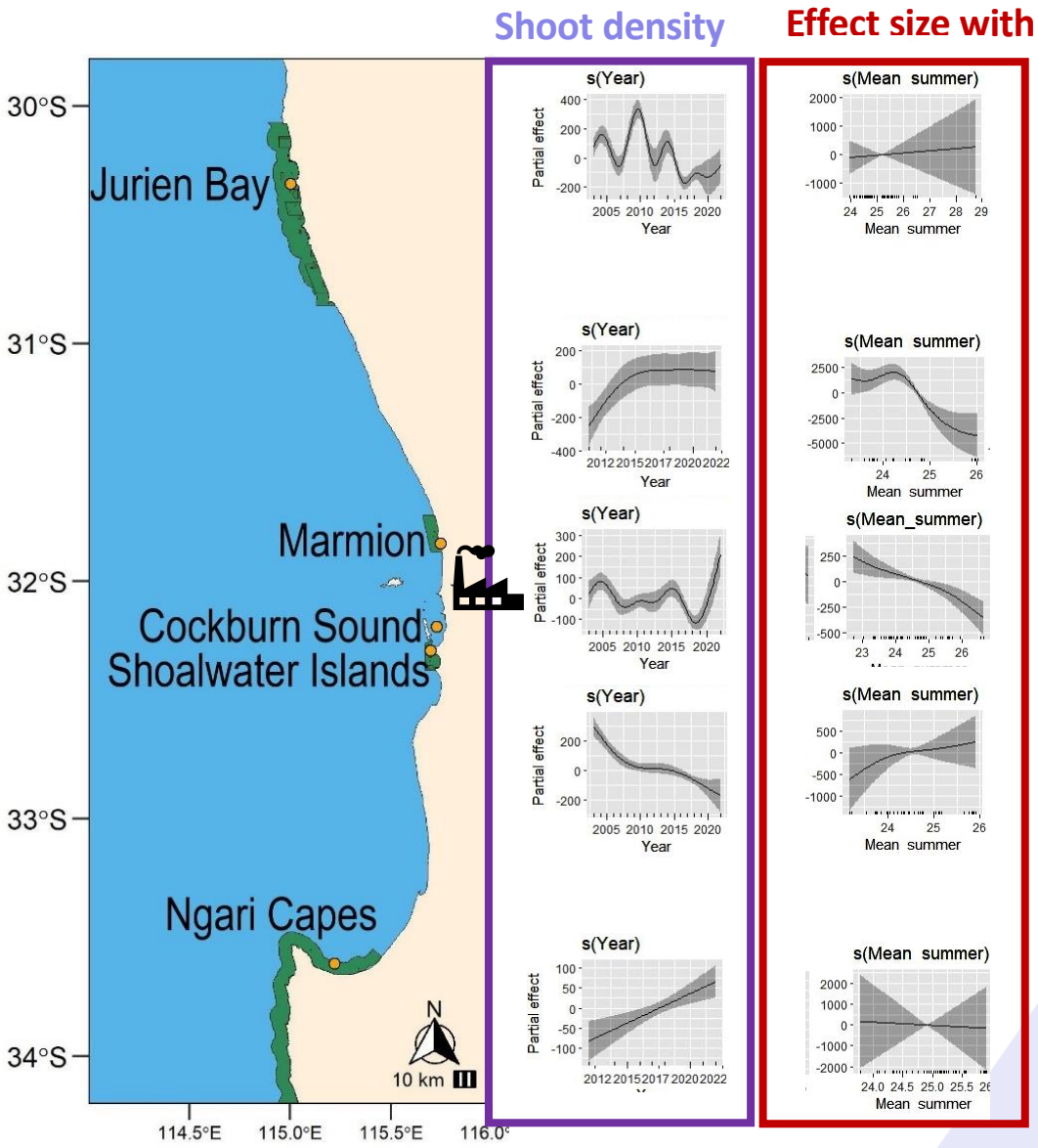
Analysis across all WA monitoring programs:
Water depth, turbidity & temperature strong predictors of seagrass condition

Predictor
Depth (m)
Turbidity (Kd490 attenuation)
Mean annual summer temperature (Dec-Mar)
Maximum difference (Annual max daily temp vs Global mean: 20 yrs)



- Shallow depths higher shoot density
- More turbid water lower shoot density
- Higher summer temperatures lower shoot density

But in Geographe Bay no negative effect of warming

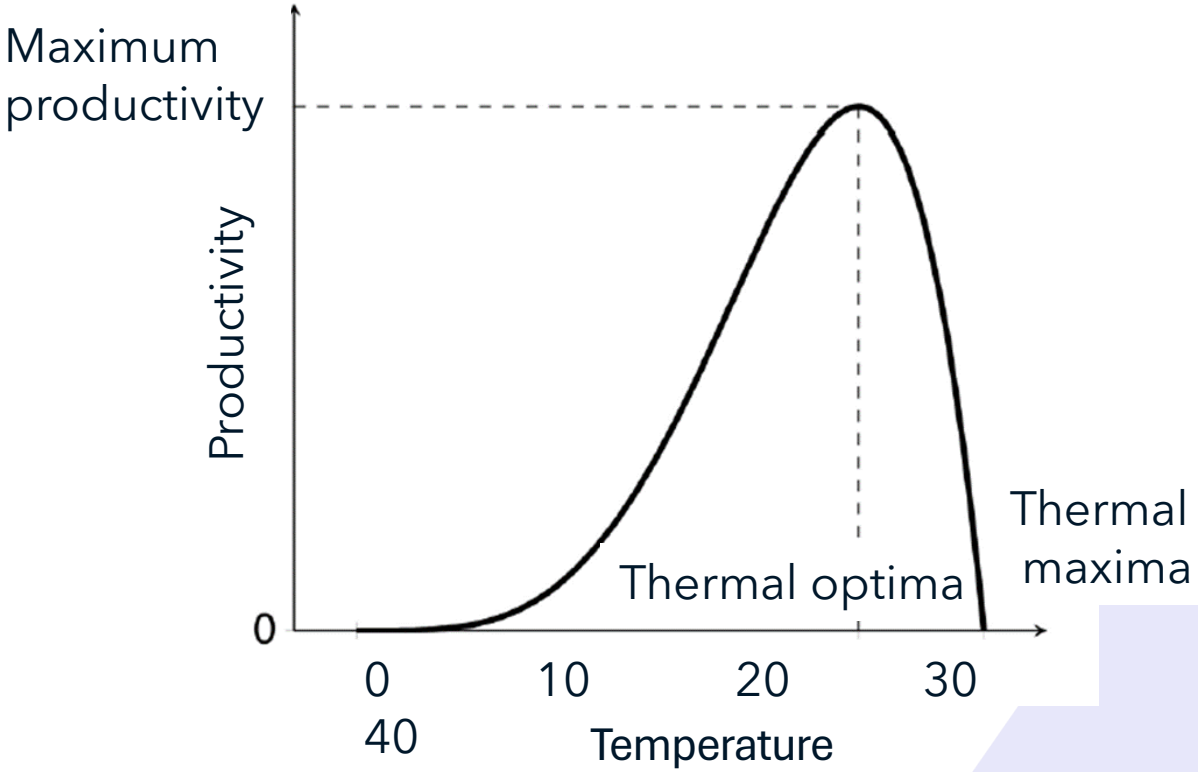


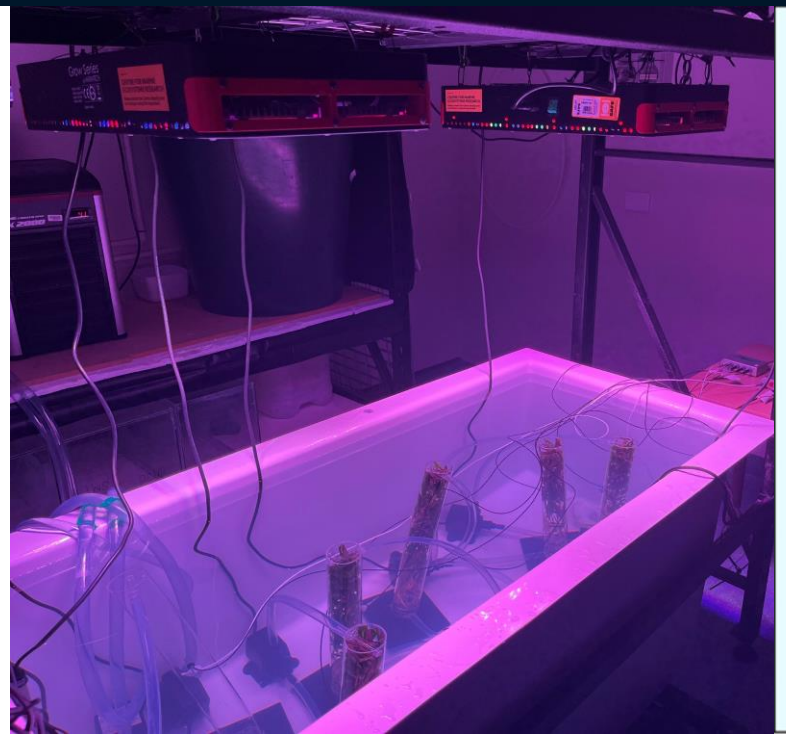
- Jurien Bay, Cockburn Sound and Shoalwater Bay seagrass condition declined over time
- Warming associated with lower shoot density in Marmion & Cockburn Sound but not in Geographe Bay
- Lower temperatures & no declines suggest Geographe Bay is currently a climate refuge

Webster et al 2024

Geographe Bay is resilient to ocean warming

- Seagrass thermal tolerance gives insights into resilience to warming
- Measures oxygen production over a range of temperatures (15-45°C)





- Can compare between regions to identify more climate resilient populations & use to predict when climate impacts may occur

Said et al 2024

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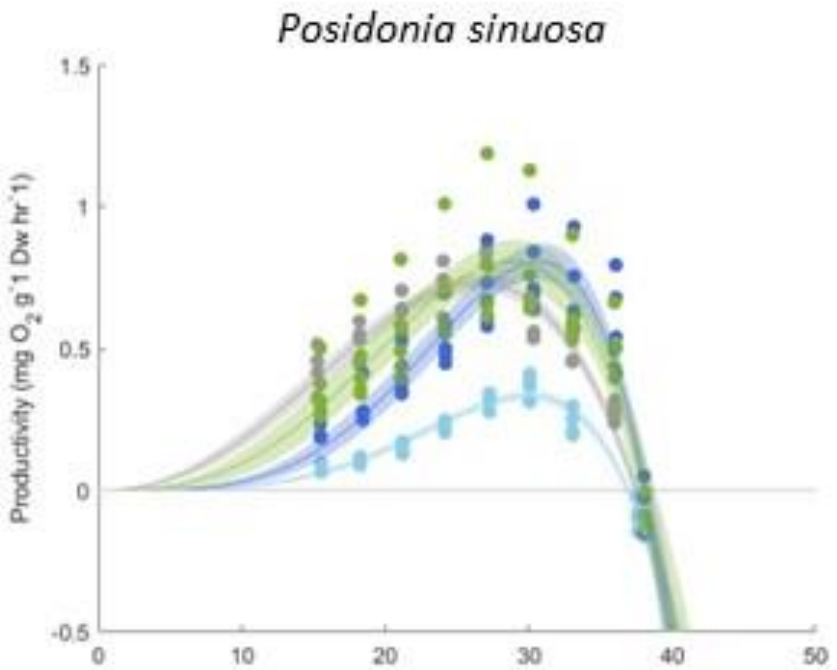
Geographe Bay is resilient to ocean warming



	Avg summer temp	Optimum temp
Geraldton	24	28.7 ± 0.5
Jurien Bay	24	30.7 ± 0.3
Perth	23	26.4 ± 0.3
Geographe Bay	23	29.9 ± 0.3

Geraldton	MC
Jurien Bay	MC
Perth	MC
Geographe Bay	LC

Key

- LC — Least concern
- MC — Moderate concern
- HC — High concern
- Warming
- heatwave
- Resilience building
- Refuge

Said et al 2024

Wrap-up

- Geographe Bay seagrass meadows are healthy, stable & resilient
- Important climate refuge site in temperate WA waters
- No evidence of impact from nutrient enrichment
- Nutrient reduction activities positive effect at Capel
- Keep Watch important program to assess seagrass condition supporting GeoCatch, WaterCorp, DBCA & DWER needs

Funding sources for the research presented

Keep Watch Seagrass Monitoring Program

https://www.geocatch.asn.au/keepwatch-seagrass-monitoring/

The KeepWatch seagrass monitoring project is coordinated by GeoCatch and funded by Water Corporation, with in-kind support from the Department of Biodiversity, Conservation and Attractions

GeoCatch The Environment - in Our Hands

WATER CORPORATION

AUSTRALIA ECU EDITH COWAN UNIVERSITY

Government of Western Australia Department of Biodiversity, Conservation and Attractions

WAMSI WESTPORT MARINE SCIENCE PROGRAM

WESTERN AUSTRALIAN MARINE SCIENCE INSTITUTION

WESTPORT

AUSTRALIA ECU EDITH COWAN UNIVERSITY

Government of Western Australia Department of Biodiversity, Conservation and Attractions

Government of Western Australia Department of Fisheries

THE UNIVERSITY OF WESTERN AUSTRALIA

Government of Western Australia Department of Water and Environmental Regulation

Regional drivers of change and Optimum temperature research

https://wamsi.org.au/research/programs/wamsi-westport-marine-science-program/

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Keep Watch Field Team 2024 (top) & Westport Team (bot)

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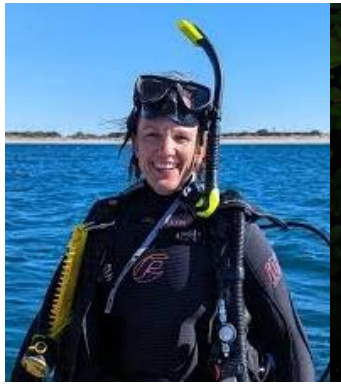
Eden Harris

Glenn Sutton

Josh Reagan



Dr Chanelle Webster

Dr Simone Strydom

Dr Claire Ross

Dr Eben Afrifa-Yamoah

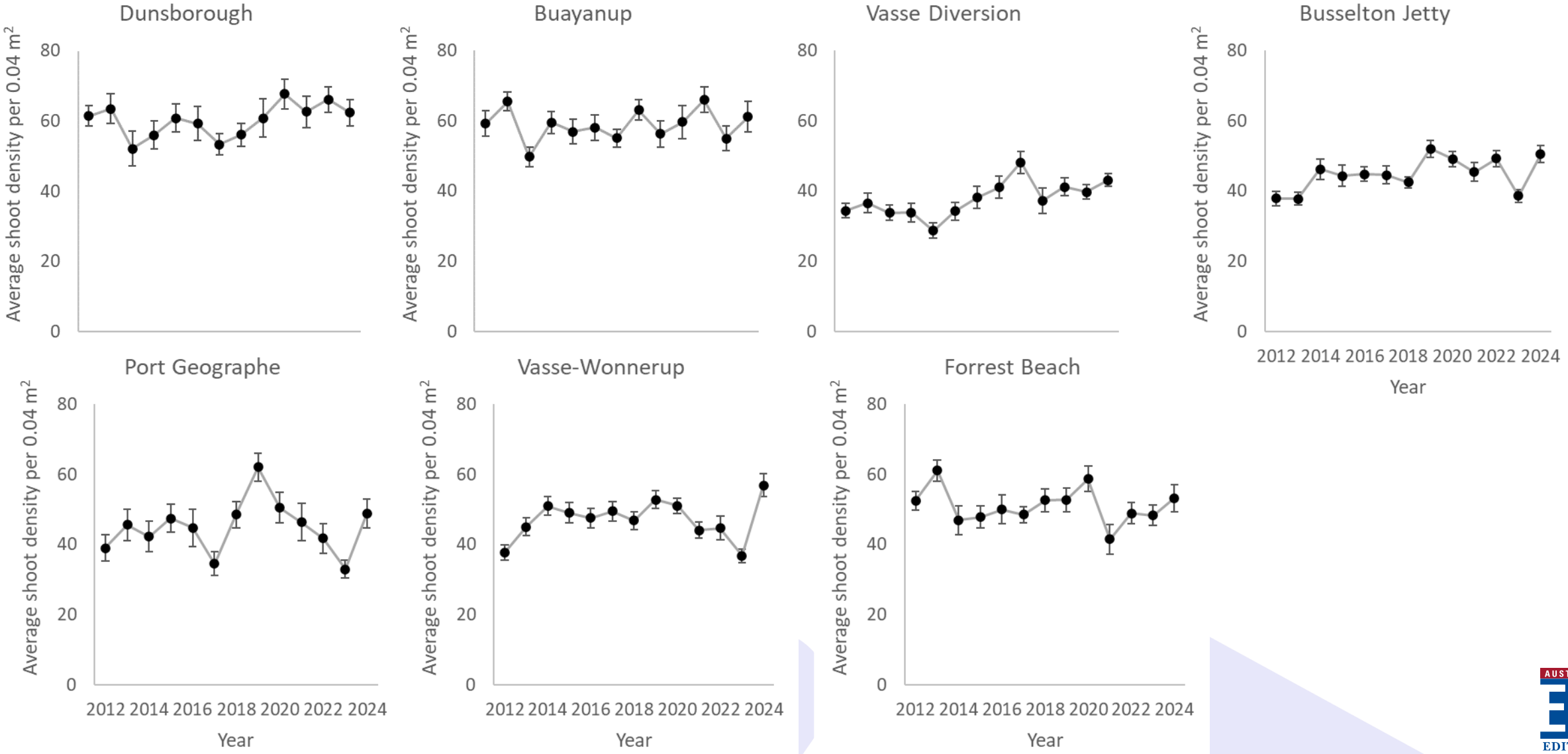
Nicole Said

Dr Renae Hovey

Dr Belinda Martin

Any questions

Time-series of all sites



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Reduced concentrations over time at Capel

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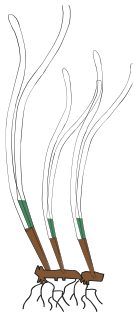

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8. Capel		1.88	1.79	1.07	1.12	1.37	1.26	1.13	1.78	1.30	1.22	1.23	0.59

- Nitrogen source at Capel still indicates different N source

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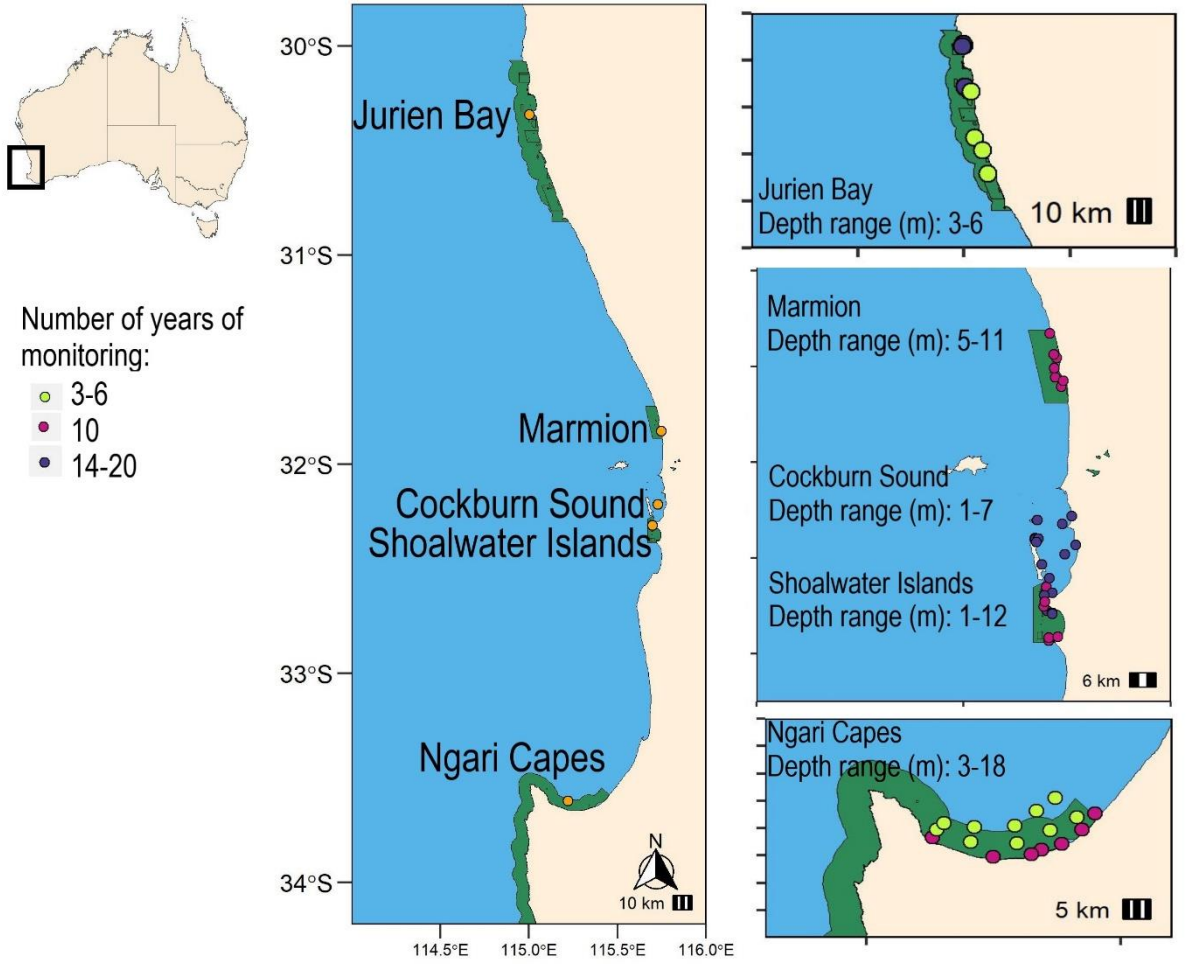
4. Busselton Jetty / Vasse Diversion		1.12	2.02	1.52	0.69	1.43	0.68	1.79	1.05	1.44	1.64	1.49	1.39
7. Forrest Beach		1.92	3.23	1.42	1.01	1.37	1.89	1.60	1.61	1.74	1.91	2.13	1.30
8. Capel		2.80	3.80	2.86	3.67	3.56	3.26	3.29	3.33	2.83	3.71	2.73	2.64

Nitrogen isotope ratio
0 = chemical fertiliser or nitrogen fixation
2-5 = native bushland
6-8 = animal waste or septic tanks
9 = treated waste water

Seagrass monitoring data sets collated & patterns over time assessed



Region	Marine Park (Year of designation)	Year monitoring started	Years (n) sampling*	n of sites	Depth range (m)	Data custodians
Jurien Bay	Yes (2003)	2003	14	10	3 - 5.6	DBCA
Marmion	Yes (1987)	2011	6	7	5.7 - 10.7	DBCA
Cockburn	No	2003	19	15	1.2 - 6.8	CSMC
Shoalwater Islands	Yes (1990)	2003	19	12	1.6 - 11.8	CSMC, DBCA
Ngari Capes	Yes (2012)	2012	10	17	3.6 -18	DBCA, ECU, GeoCatch

- 20 yrs data (2003-2022)
- over 3° latitude
- 61 sites
- Multiple pressures – heatwaves, dredging, industrialisation, eutrophication
- Range of management approaches

Predictor variables extracted & related to seagrass condition

Predictor
Depth (m)
Turbidity (Kd490 attenuation)
Mean annual summer temperature (Dec-Mar)
Maximum difference (Annual max daily temp vs Global mean: 20 yrs)

- Hierarchical Generalised Additive Models (HGAMs)
- Spatial (Region & site) & Temporal patterns & Environmental drivers

Prediction: regions with warmer temperatures and more industrialisation would have greater declines over time.