State of the Bay 2023

Saldanha Bay and Langebaan Lagoon

Barry Clark

Cheruscha Swart, Ken Hutchings, Jess Dawson, Aiden Biccard, Adam Rees, Robyn Payne, Rushdi Ariefdien, Julian Conrad, Michael Holloway, Kirti Gihwala, Safiyya Sedick, Kady Ramjattan, Amoré Malan, Kevin Schmidt, Songeso Matsokoba & Amy Wright

State of the Bay Reporting

Annual assessment of **anthropogenic impacts** to and **ecological health** of Saldanha Bay and Langebaan lagoon

- Anthropogenic impacts:
  - **Activities and discharges** affecting health of the Bay
- Physical Health:
  - **Water quality (temperature, salinity, oxygen, nutrients), currents & waves, groundwater inflow**
  - Concentrations of **contaminants** (e.g. trace metals, bacteria) in **sea water**, **sediments** and **living organisms in the bay**
- Ecological health:
  - **Changes in** abundance and **community structure** of living organisms (macrophytes, invertebrates, fish, birds, mammals)

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Indicator response times

- Water… Hours/Days
- Sediments… Weeks/Months
- Living Organisms
  - Macrofauna… Weeks/Months/Years
  - Fish… Months/Years
  - Birds... Years/decades

Health category	Ecological perspective	Management perspective
Natural	**No or negligible modification** from the natural state	Relatively **little human impact**
Good	**Some alteration** to the physical environment. Small to moderate loss of biodiversity and ecosystem integrity.	**Some human-related disturbance**, but ecosystems essentially in a good state,, continued regular monitoring is strongly recommended
Fair	**Significant change** to the physical environment and associated biological communities; sensitive species may be lost, tolerant or opportunistic species beginning to dominate.	**Moderate human-related disturbance** with good ability to recover. **Management intervention required** to ensure no further deterioration takes place.
Poor	Extensive change to the physical environment and biological communities, majority of sensitive species lost, tolerant or opportunistic species dominate.	**High levels of human related disturbance. Urgent management intervention is required** to avoid permanent damage to the environment or human health.

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PPC STRENGTH GUARANTEED
PPC

CLUB MYKONOS
LANGEBAAN

SFF

TRONOX

AngloAmerican

ImproChem
Water, Energy & Air Solutions

TRANSNET
national ports authority

Sea Harvest

LANGEBAAN
COUNTRY ESTATE

METSEP
SALDANHA

Duferco
Duferco Steel Processing

vedanta
transforming elements

zinc international

Oiltankingmogs

KROPZ
ELANDSFONTEIN

ArcelorMittal

Premier Fishing
The First Choice

TRANSNET
port terminals

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sunrise energy
Subsidiary of MOGS oil & gas

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Thanks ….

CSIR
our future through science

ADU

South African Weather Service

South African National Parks

Percy FitzPatrick Institute

BSASA
BIVALVE SHELLFISH FARMERS' ASSOCIATION OF SOUTH AFRICA

WESKUS-DM-WEST COAST

TRANSNET
port terminals

Sea Harvest

SALDANHA BAAI BAY

forestry, fisheries & the environment
Department:
Forestry, Fisheries and the Environment
REPUBLIC OF SOUTH AFRICA

water & sanitation
Department:
Water and Sanitation
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Theme…..

Alien invasive species in the Saldanha Langebaan System

1. Activities & Discharges

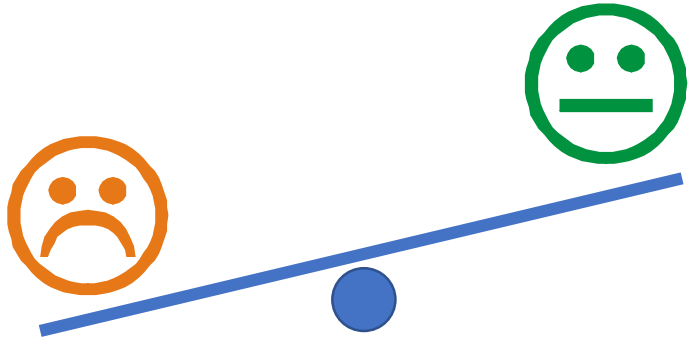
- Development pressure continues to ramp up in the Bay after having stalled for a short period (Global Financial Crisis, Covid)…

Up

- Ore exports (Manganese, Zinc)
- Zvrddrl traffic
- New projects (Green hydrogen, Powership, FSRU, RO Plants, LPG/LNG imports, ship repair, in-water hull cleaning)
- Residential development, storm water runoff
- Mariculture production (mussels & oysters)

Down

- Visitor numbers
- Effluent from WWTWs
- Ore exports (iron, lead)
- Ballast water discharges



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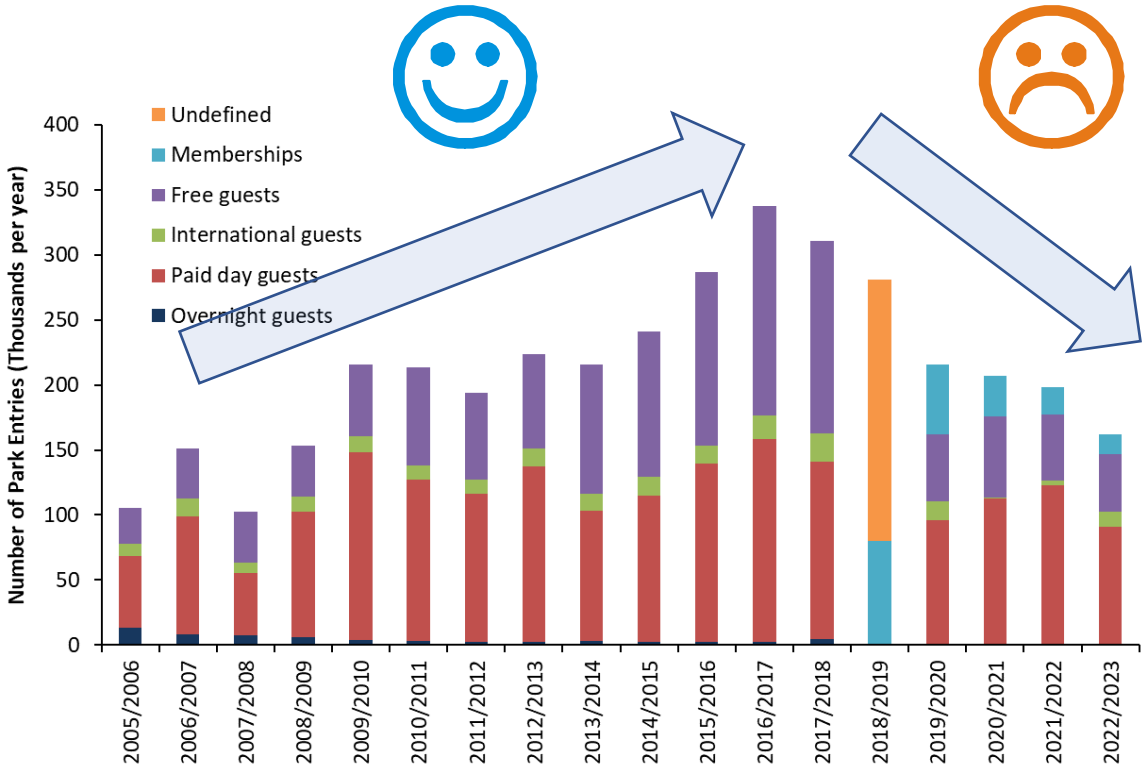
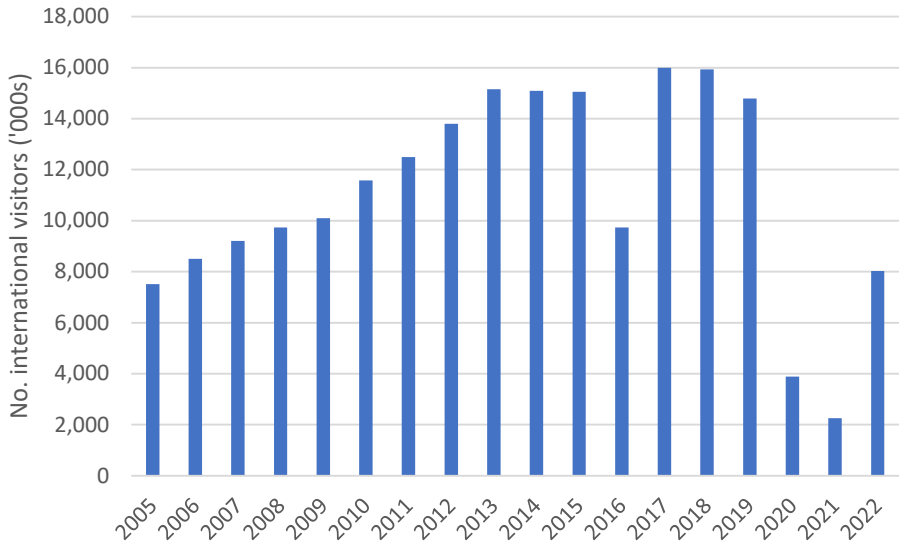
Visitor numbers….

Long term trend over time….



West Coast National Park…



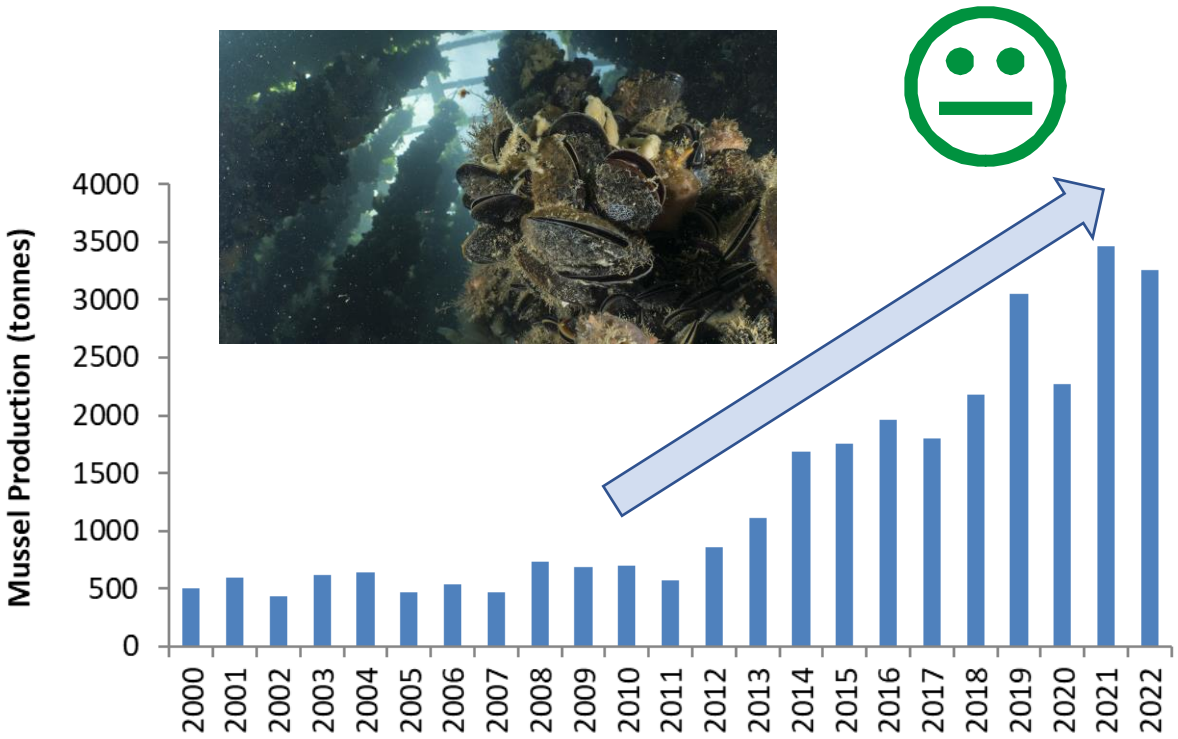
International visitors to South Africa…

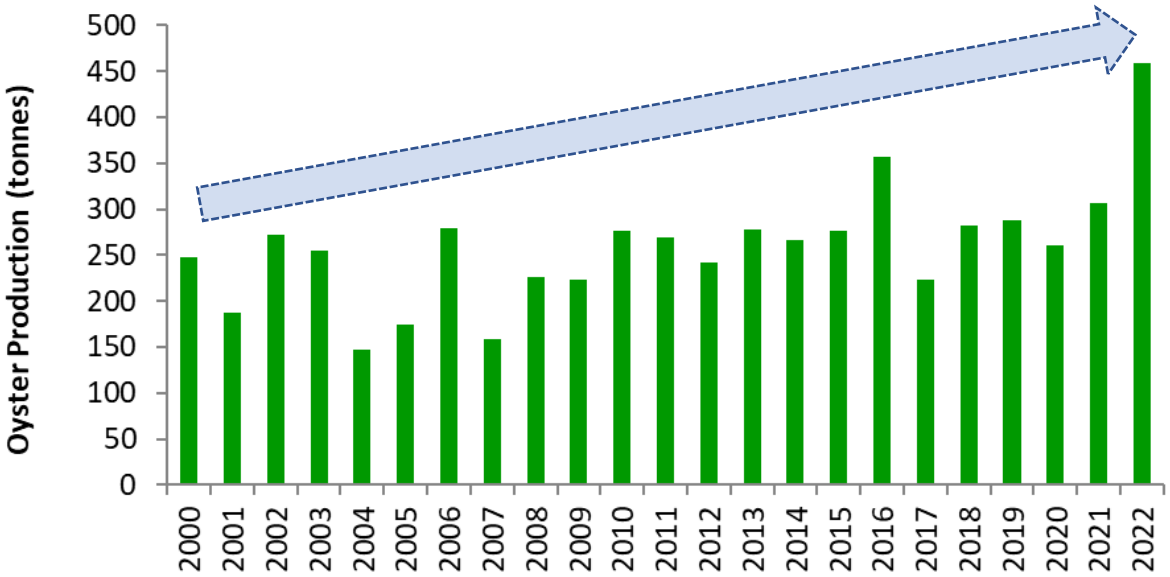
Tourism contributes 16-20% of the local GDP of Saldanha Bay

87% locals….

Mariculture production

- 2020: 28 rights holders, 15 operational
- 2021: 27 rights holders, 24 operational
- 2022: 30 rights holders, 25 operational





Stenton-Dozey *et al*. 1999: Impact of Mussel Culture on Macrobenthic Community Structure in Saldanha Bay, South Africa

Anchor Environmental 2022: Saldanha Bay sea-based Aquaculture Development Zone annual chemical survey. Report for WWF

Probyn *et al.* 2023: The effects of suspended bivalve culture on benthic community structure and sediment fluxes in Saldanha Bay, South Africa

Anchor Environmental 2023: Saldanha Bay sea-based aquaculture development zone environmental monitoring report. Report for DFFE

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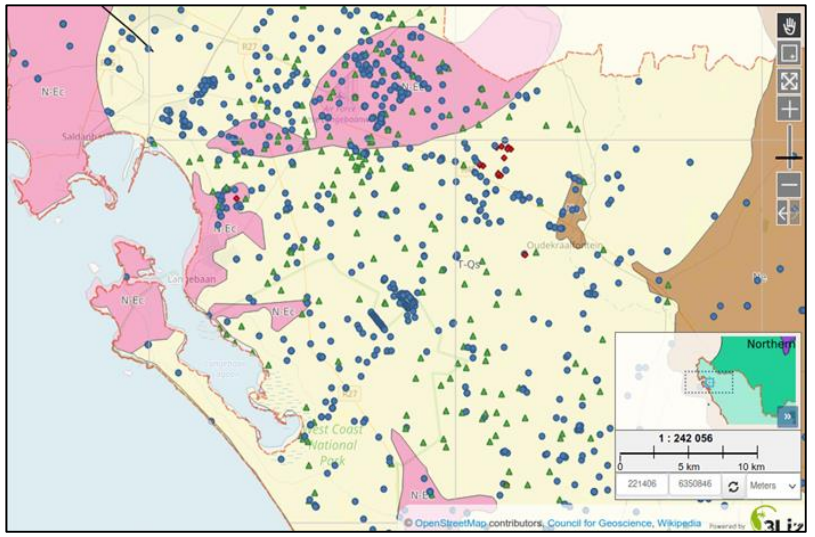
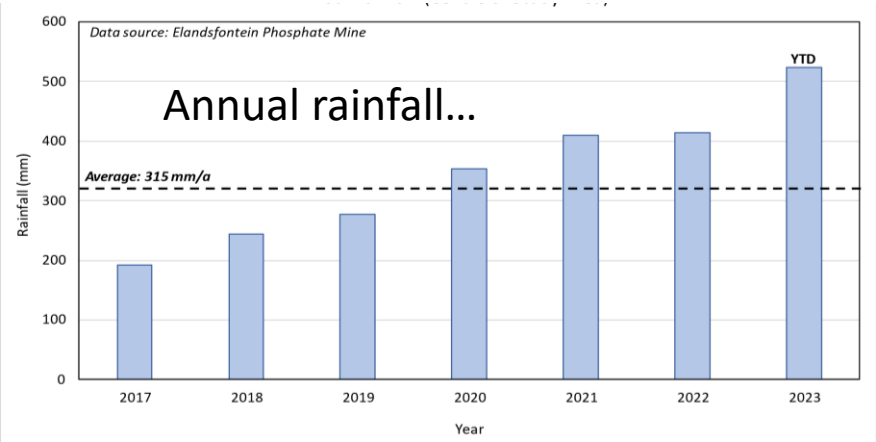
2. Groundwater

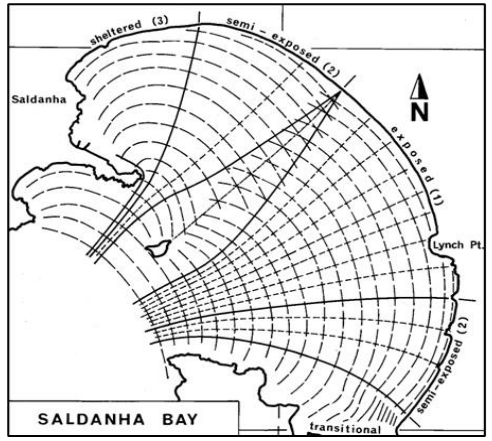
- Groundwater is very important water resource in Saldanha Bay (GW control area), few surface water resources
- Historically - uncertainly around GW flow patterns, recharge and environmentally sustainable yield but recent work has helped clarify the situation
- Main use of groundwater in the region remains the agricultural sector (1.5 Mm^3/a), other potential users include SBM with the Langebaan Road Aquifer Wellfield (5.1 Mm^3/a) and Hopefield Wellfield (1.6 Mm^3/a), and Elandsfontein Mine (reinjection only)
- Total “sustainable” useable groundwater exploitation potential: 15.2 Mm^3/a and
- Groundwater levels in the area are stable over the long term, no concerning trends in water level or water quality, GW levels have in fact recovered well over the past year due to above average rainfall….

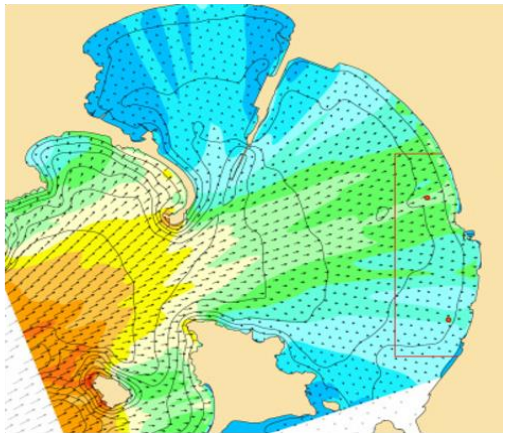


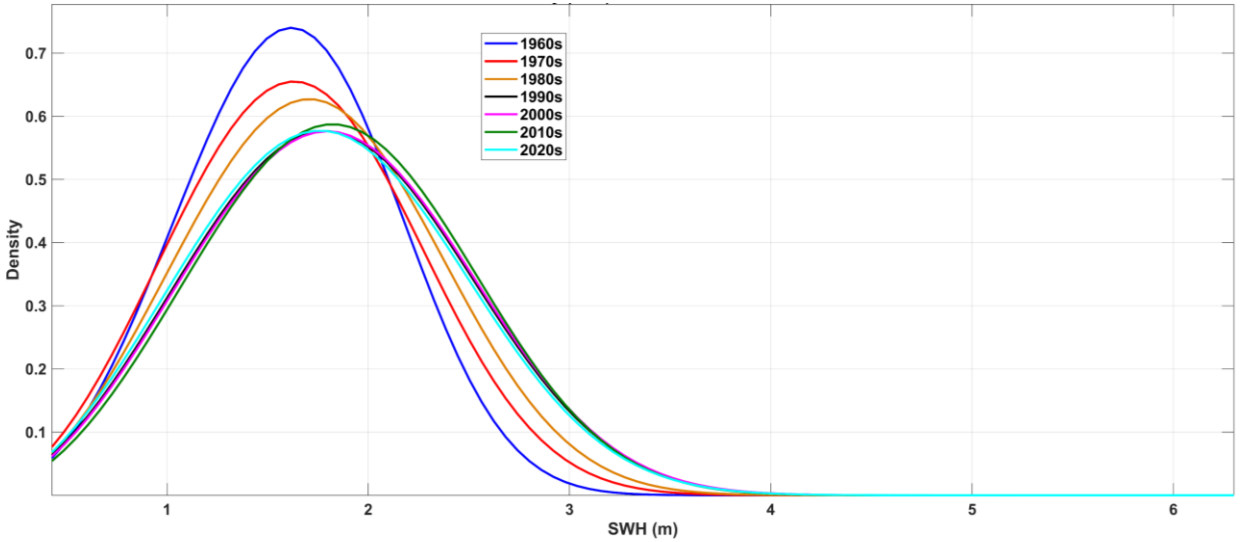


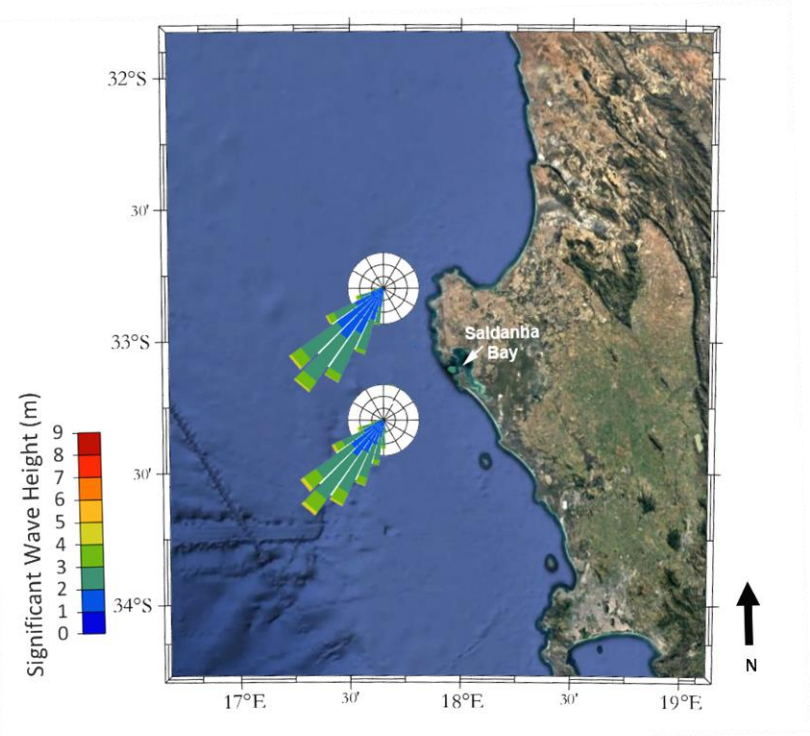
3. Wind, waves and currents

ERA5 global atmospheric reanalysis dataset (ECMWF)









Decade	Maximum SWH (m)*
1960s	4.18
1970s	5.02
1980s	5.96
1990s	5.43
2000s	5.85
2010s	6.10
2020 – 2022	6.24

* Significant wave height (SWH) = average height of the highest third of surface ocean/sea waves generated by wind and swell

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Hersbach et al. 2023: RA5 hourly data on single levels from 1940 to present. Copernicus Climate Change Service (C3S) Climate Data Store (CDS)

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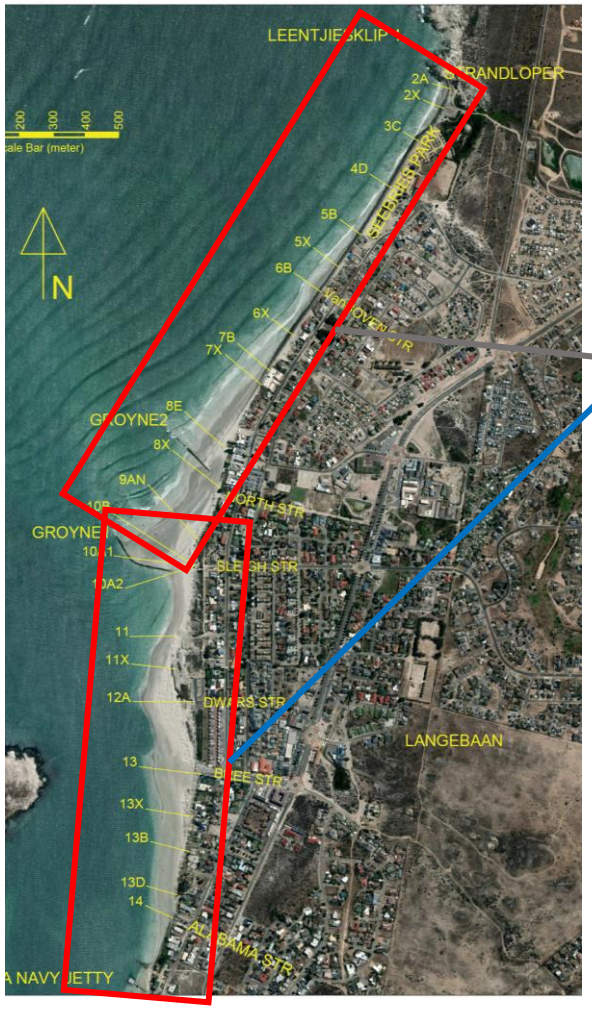
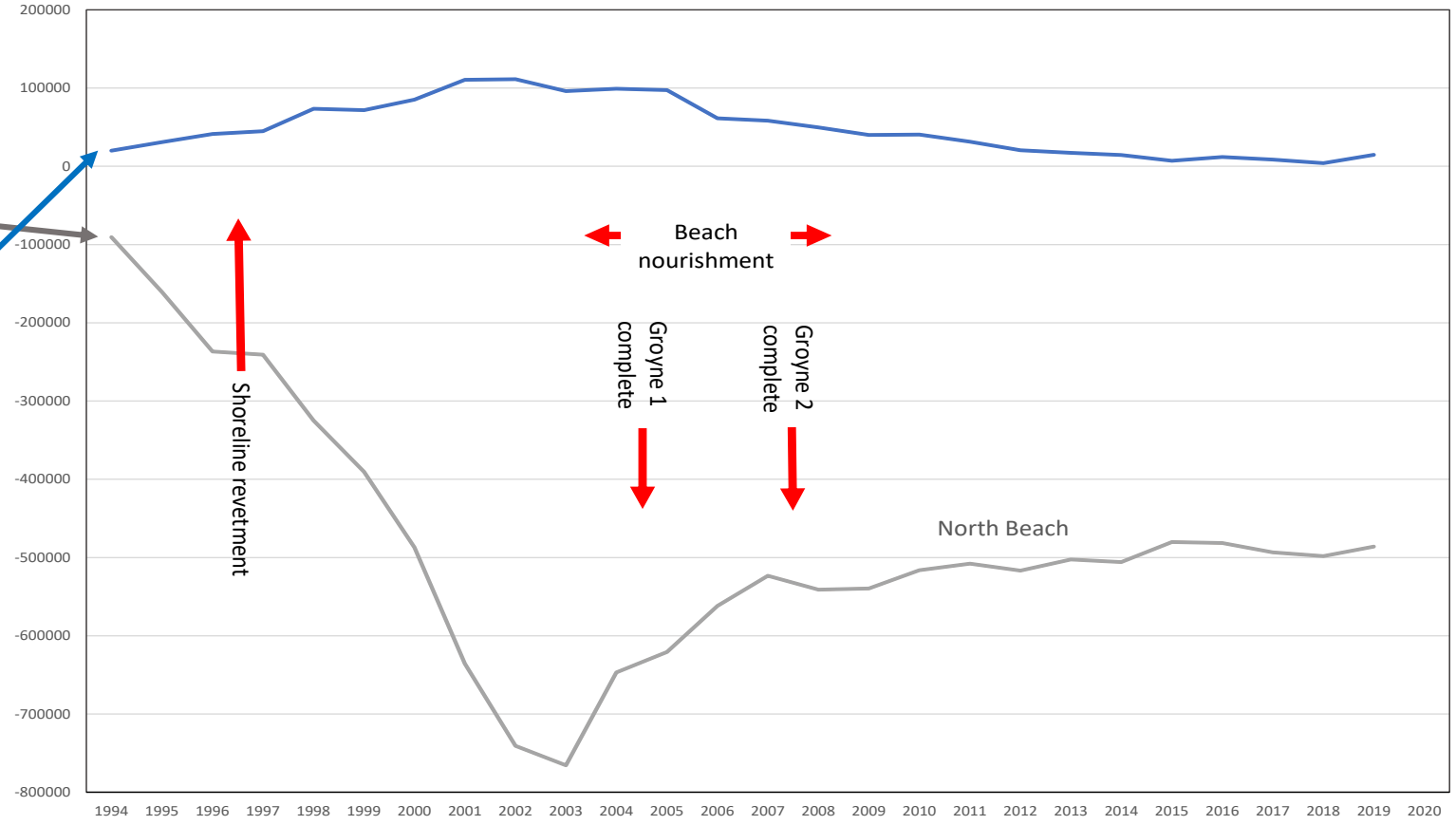
Shoreline erosion at Langebaan Beach





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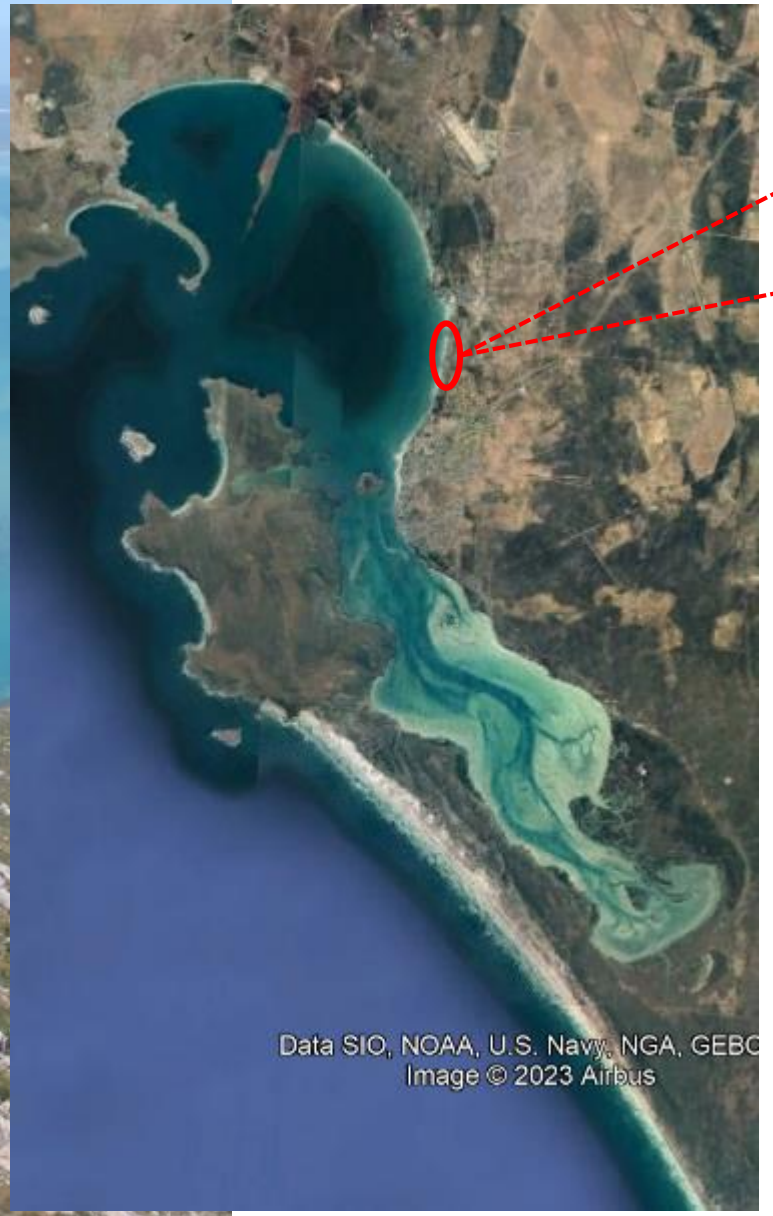
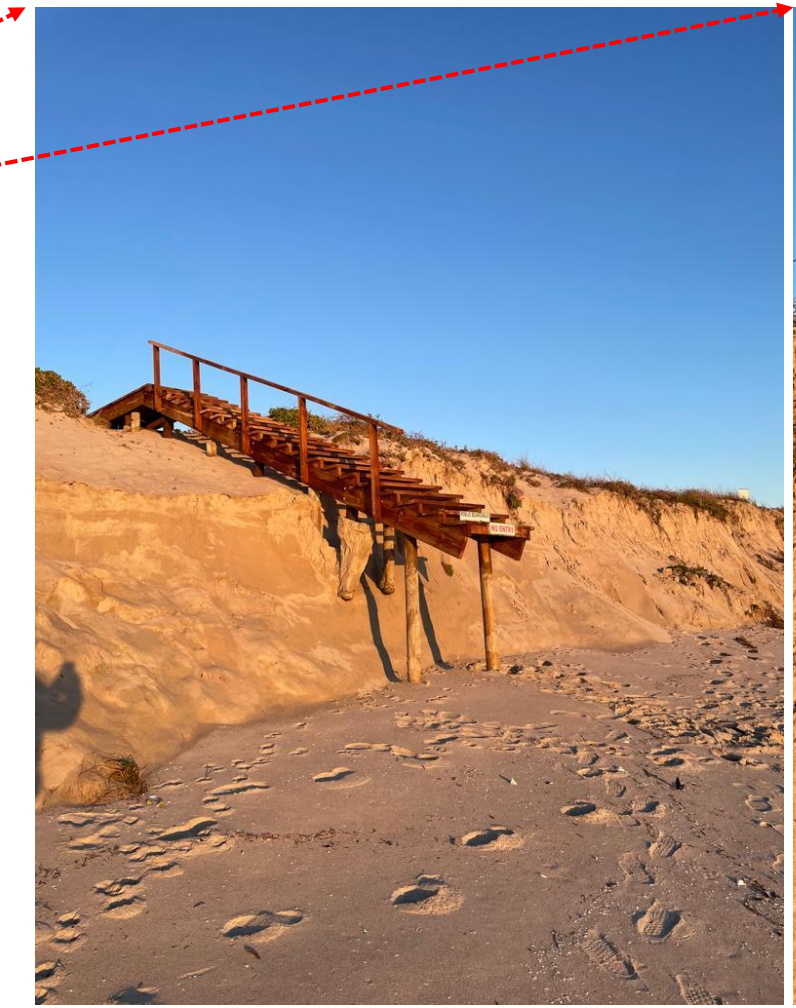
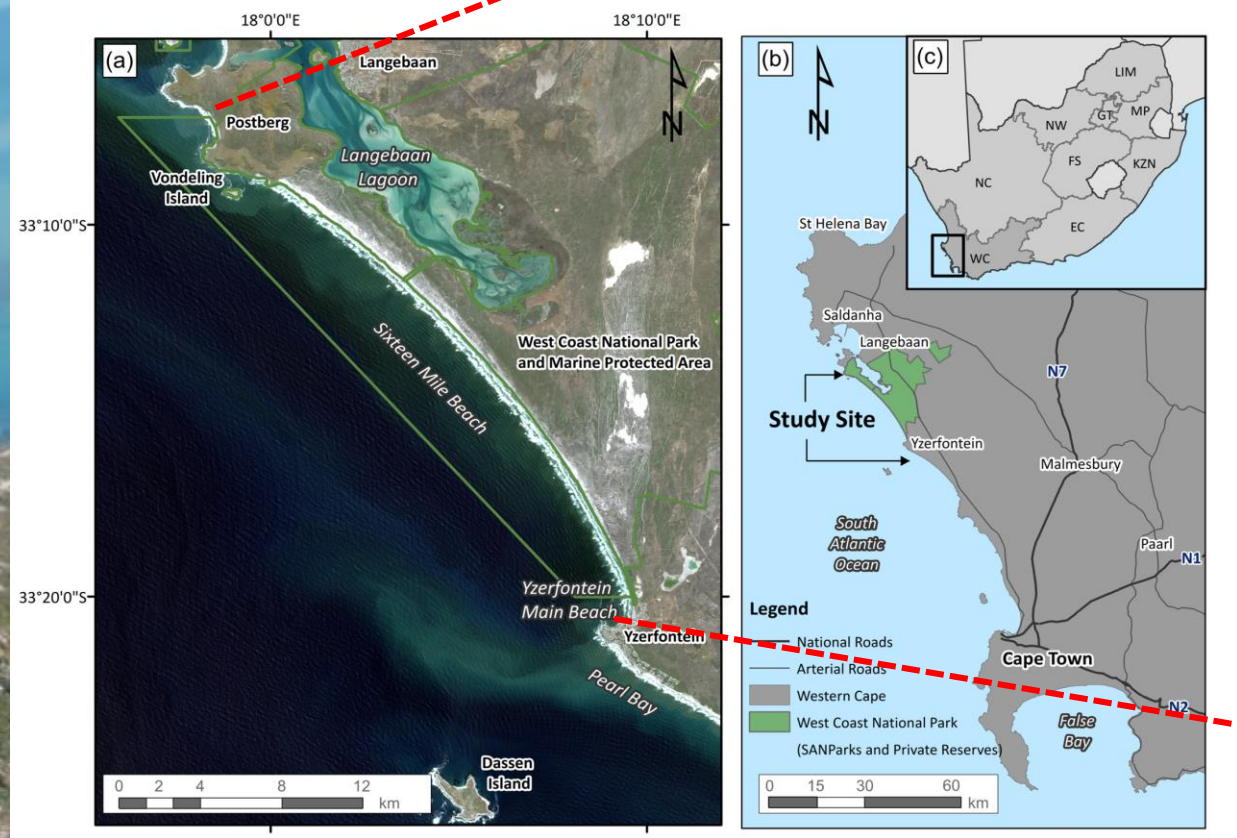
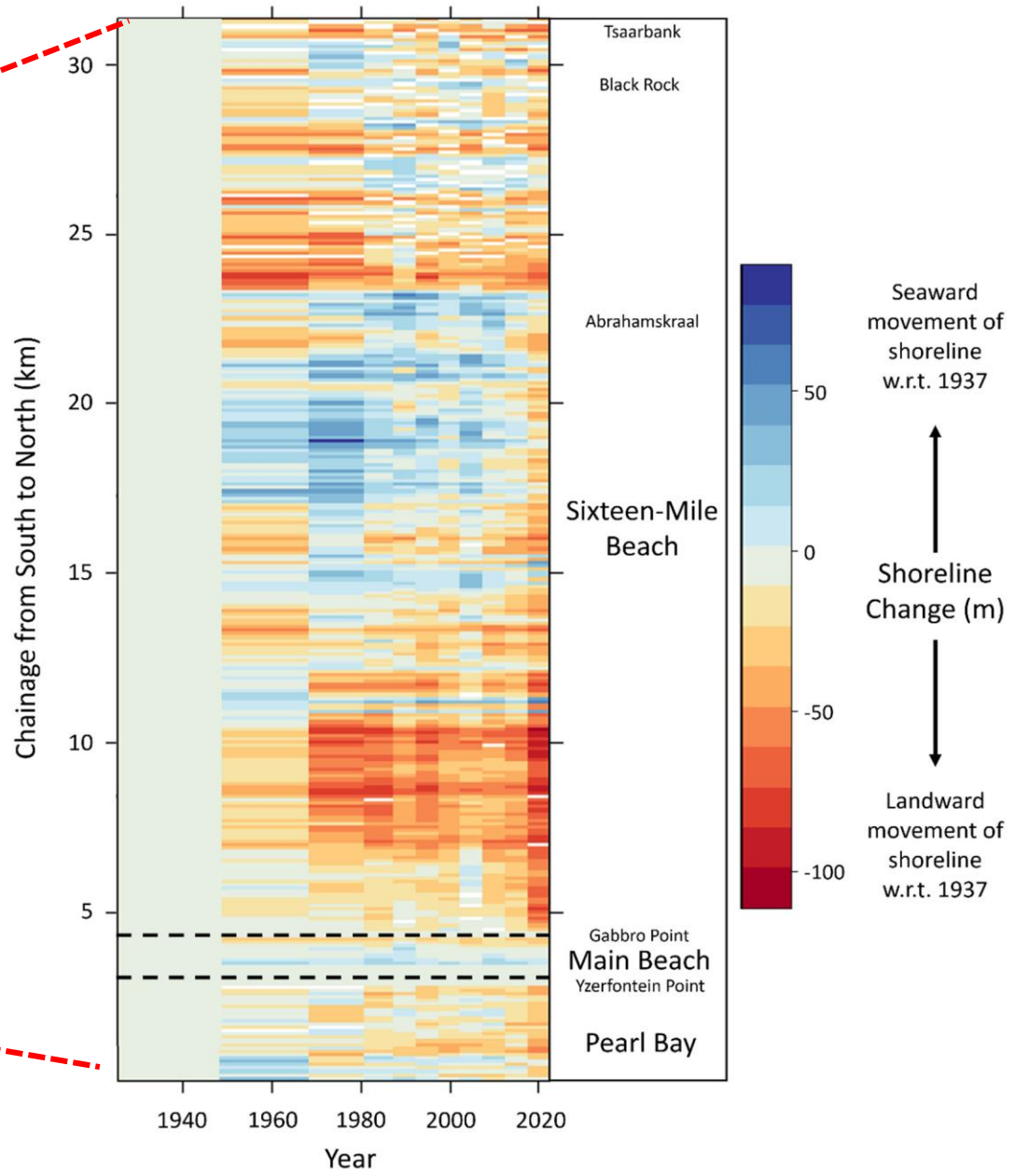
Shoreline erosion in Big Bay, Saldanha…





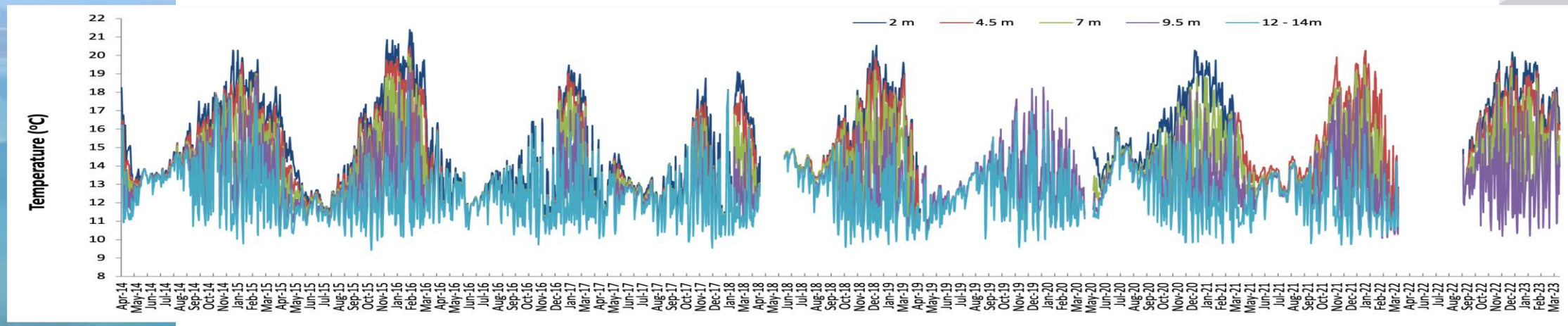
Shoreline erosion at 16 Mile Beach…

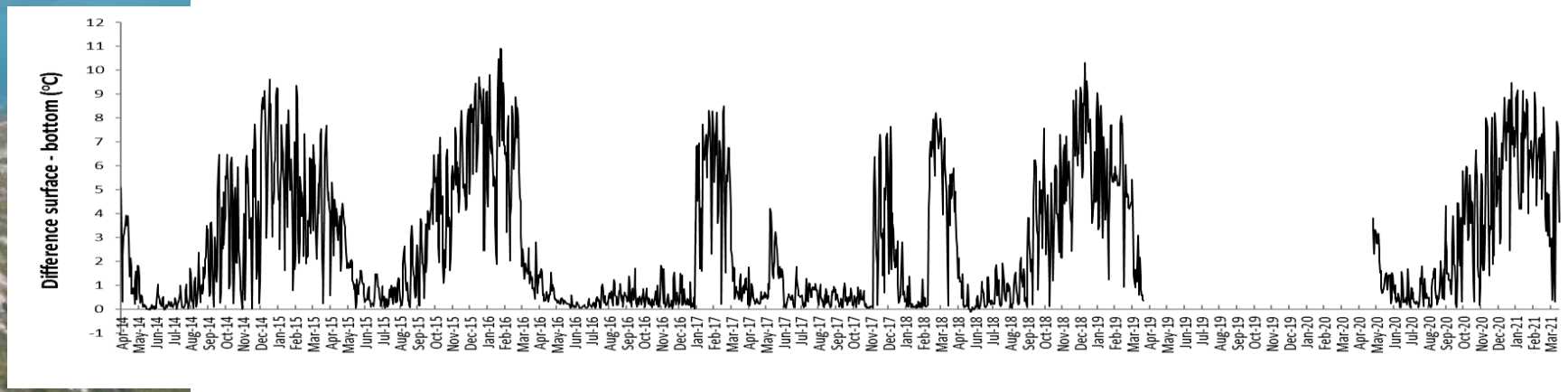


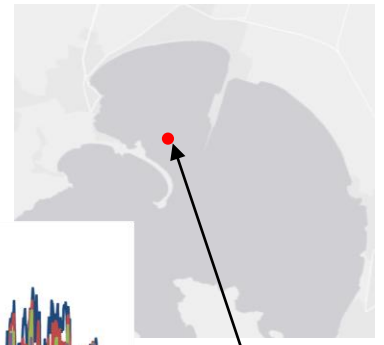


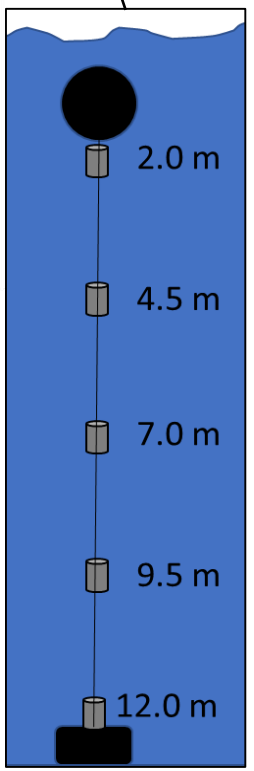
Murray et al. 2023. Monitoring Shoreline Changes along the Southwestern Coast of South Africa from 1937 to 2020 Using Varied Remote Sensing Data and Approaches. Remote Sens. 15: 317

3. Water Quality – SB Temperature









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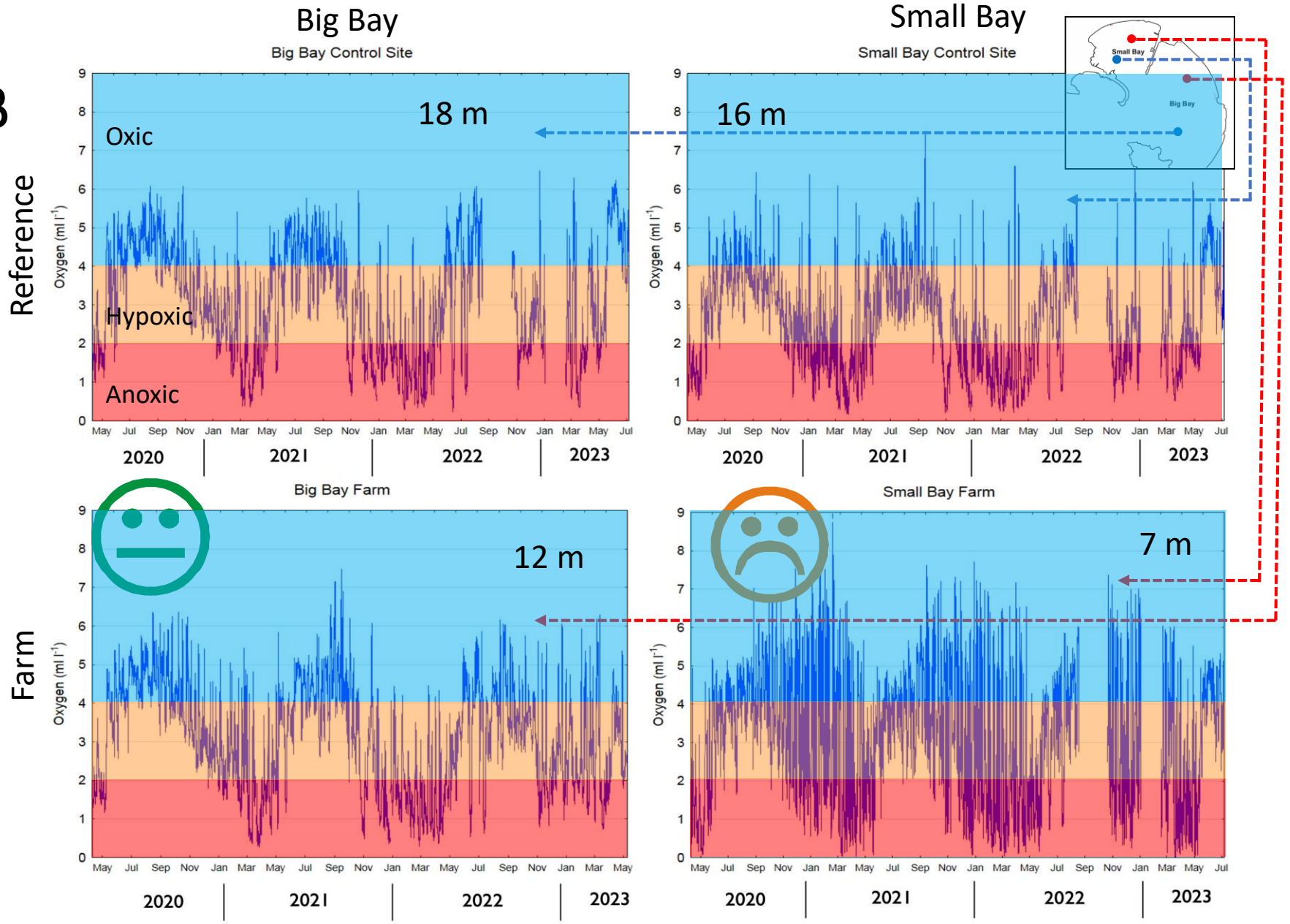
4. Dissolved oxygen (SB & BB)

Big Bay

- Very little difference between control and impact sites
- Hypoxic much of the time but seldom anoxic (2-3 months/y, late summer – Mar/Apr)
- Linked to upwelling & stratification, entirely/ largely natural

Small Bay

- Much higher variability in O_2 levels at farm sites vs. control (linked to depth)
- Hypoxic most of the time, frequently anoxic (5-6 months/y, summer + autumn – Dec-May)
- Linked to upwelling & stratification but greatly exacerbated by reduced circulation in Small Bay and organic loading from wastewater discharges and mariculture



Data from DFFE (ADZ monitoring)

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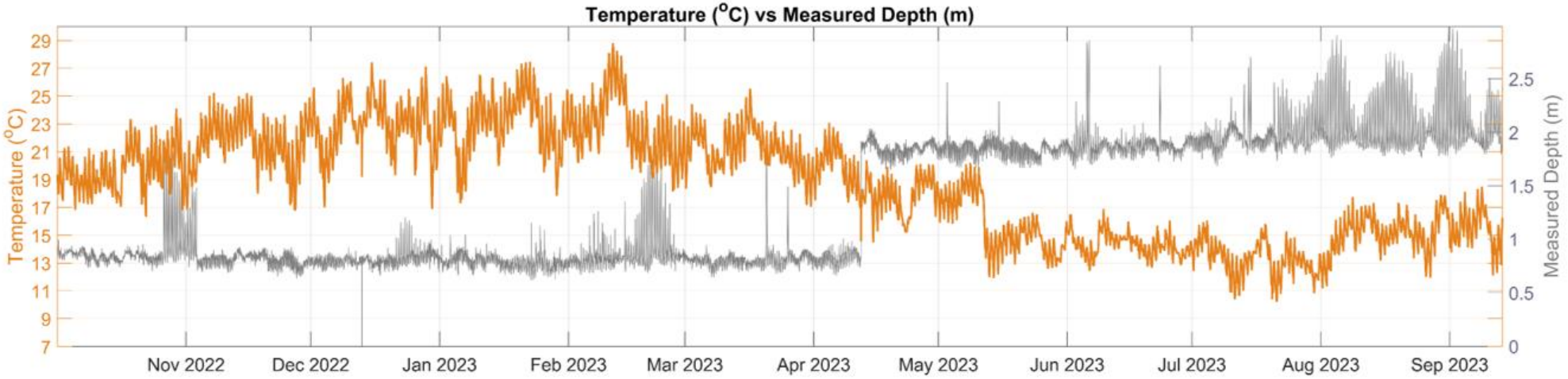
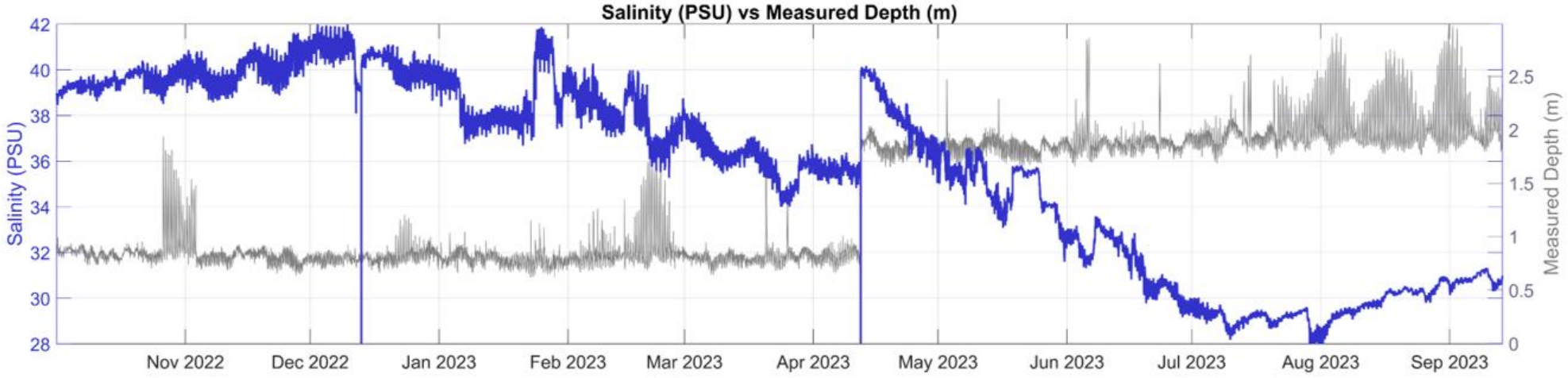
5. Temperature & Salinity (LL)





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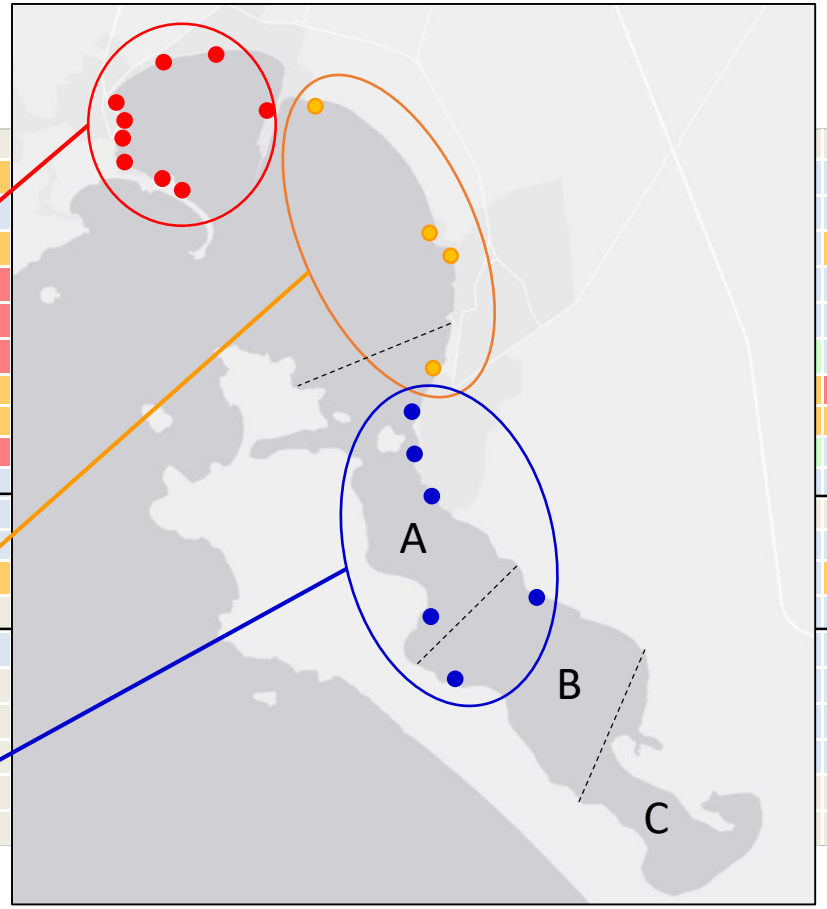
6 Faecal coliforms (recreational limits)

	Site	1999	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Small Bay	1. Beach at Mussel Rafts	Fair	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Fair	ND	Ex.	Ex.
	2. Small Craft Harbour	Ex.	Ex.	Good	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Fair	Ex.	Ex.
	3. Sea Harvest - Small Quay	Fair	Fair	Ex.	Ex.	Ex.	Ex.	Ex.	Fair	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.
	4. Saldanha Yacht Club	Poor	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Fair	Ex.	Ex.
	5. Pepper Bay - Big Quay	Poor	Ex.	Good	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Poor	Good	Ex.	Ex.
	6. Pepper Bay - Small Quay	Poor	Ex.	Good	Fair	Fair	Ex.	Ex.	Ex.	Ex.	ND	Ex.	Ex.	Ex.	Ex.
	7. Hoedjies Bay Hotel - Beach	Fair	Poor	Poor	Fair	Good	Fair	Good	Fair	Poor	Poor	Poor	Poor	Poor	Poor
	8. Beach at Caravan Park	Fair	Fair	Poor	Good	Fair	Ex.	Fair	Fair	Fair	Fair	Fair	Ex.	Good	Fair
	9. Bok River Mouth - Beach	Poor	Ex.	Poor	Fair	Good	Ex.	Poor	Poor	Fair	Fair	Good	Poor	Poor	Poor
	10. General Cargo Quay - TNPA	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Fair
Big Bay	11. Seafarm - TNPA	Ex.	ND	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Good	Ex.
	12. Mykonos - Paradise Beach	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Fair	Ex.	Ex.	Good
	13. Mykonos - Harbour	Fair	Fair	Ex.	Ex.	Good	Fair	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Fair
	14. Leentjiesklip	ND	Ex.	Fair	Ex.	Good	Ex.	Ex.	Ex.	ND	Ex.	Ex.	Ex.	Ex.	Fair
Langebaan Lagoon	15. Langebaan North - Leentjiesklip	Ex.	Ex.	Poor	Good	Ex.	Good	Ex.	Good	Ex.	Ex.	Fair	Ex.	Ex.	Fair
	16. Langebaan - Main Beach	ND	Ex.	Ex.	Ex.	Ex.	Fair	Ex.	Ex.	ND	Ex.	Good	Ex.	Ex.	Fair
	17. Langebaan Yacht Club	ND	Ex.	Ex.	Good	Ex.	Ex.	Fair	Good	ND	Ex.	Ex.	Ex.	Ex.	Fair
	18. Tooth Rock	ND	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	ND	Ex.	Ex.	Ex.	Ex.	Good
	19. Kraalbaai North	ND	ND	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	ND	Fair	Ex.	Ex.	Ex.	Ex.
	20. Kraalbaai South	ND	ND	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	ND	Ex.	Fair	Ex.	Ex.	Ex.



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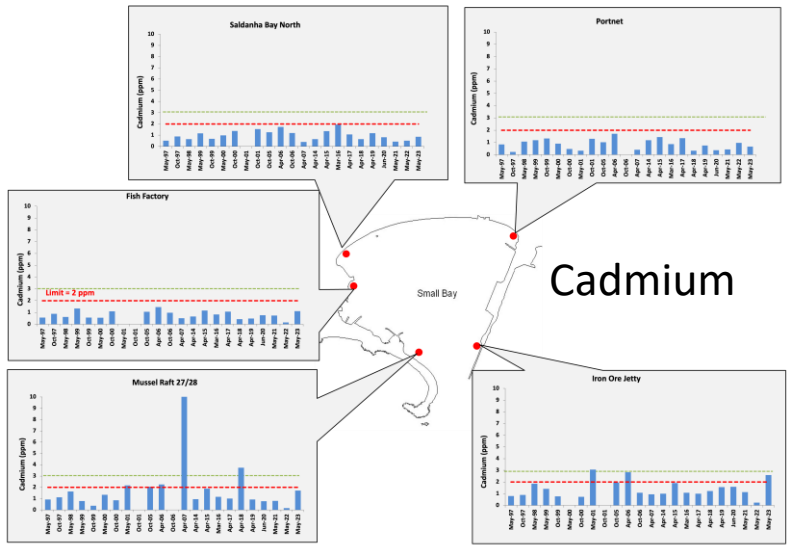
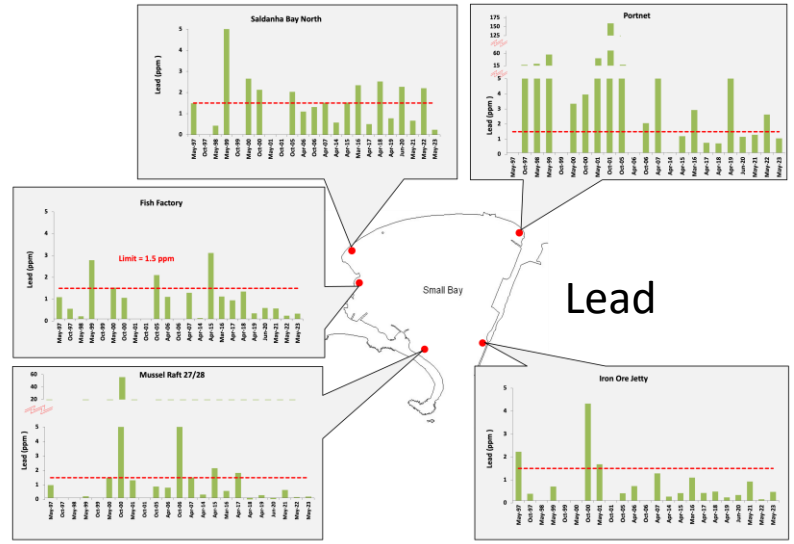
HAVE UPGRADES TO OOSTEWAL ROAD IN LANGEBAAN AFFECTED WATER QUALITY IN THE LAGOON?

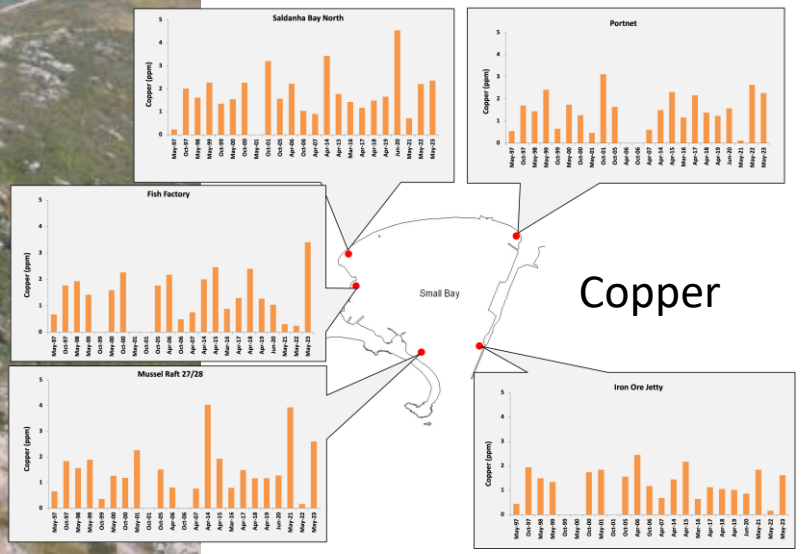
Increased erosion…

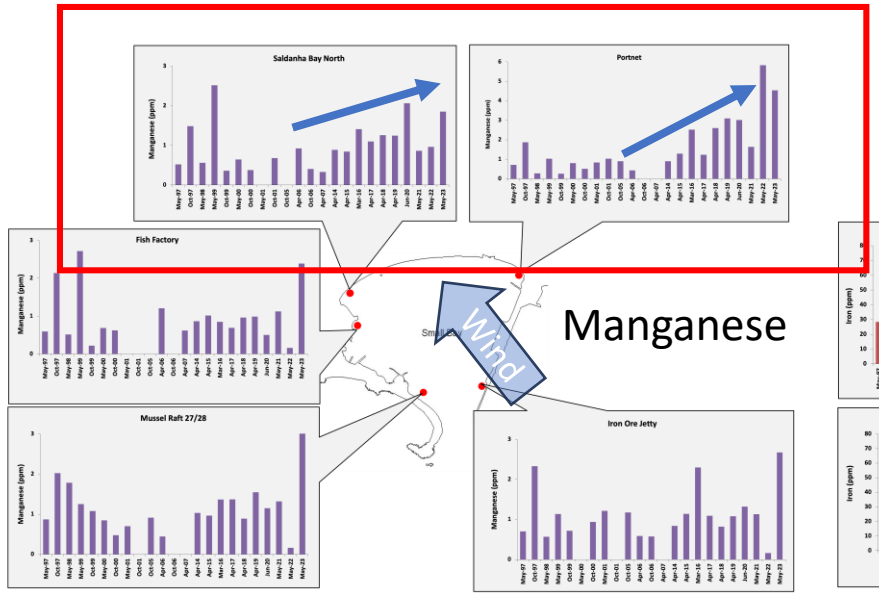
Litter…

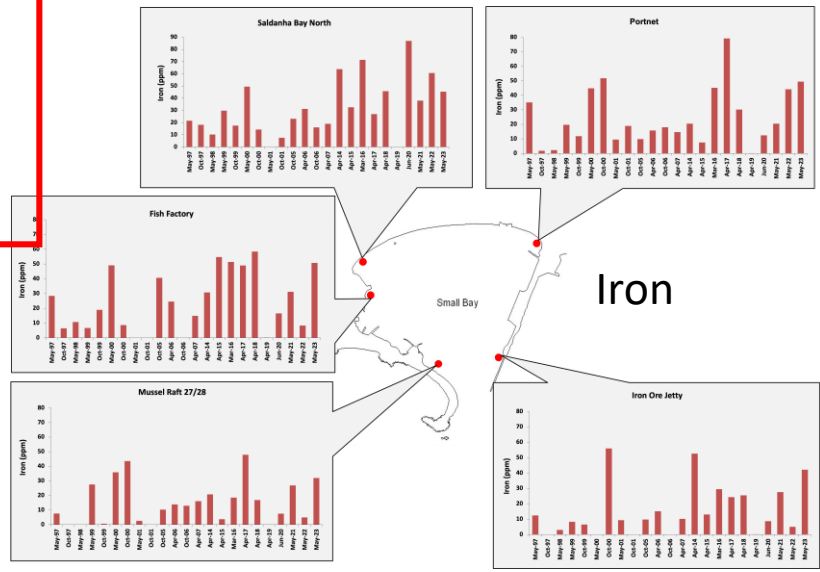
7. Trace metal in shoreline mussels



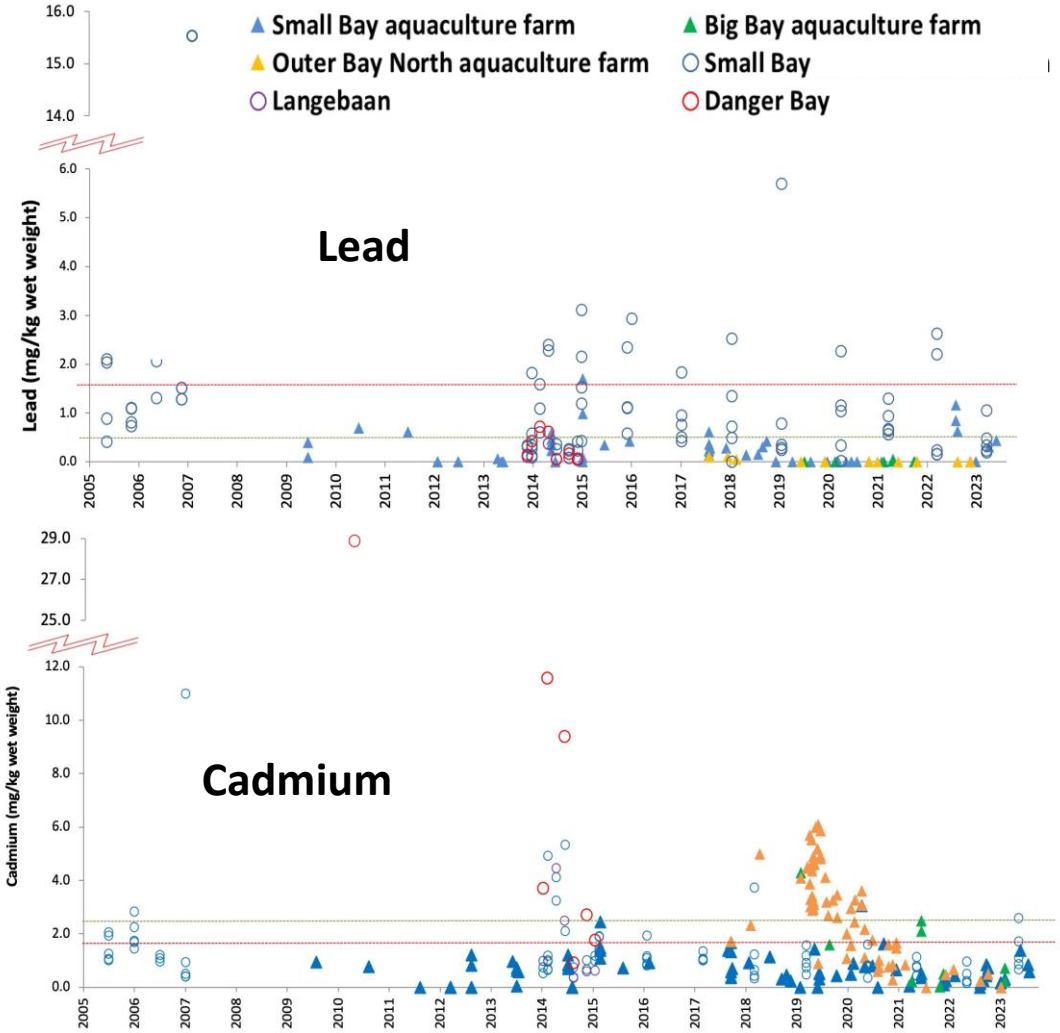


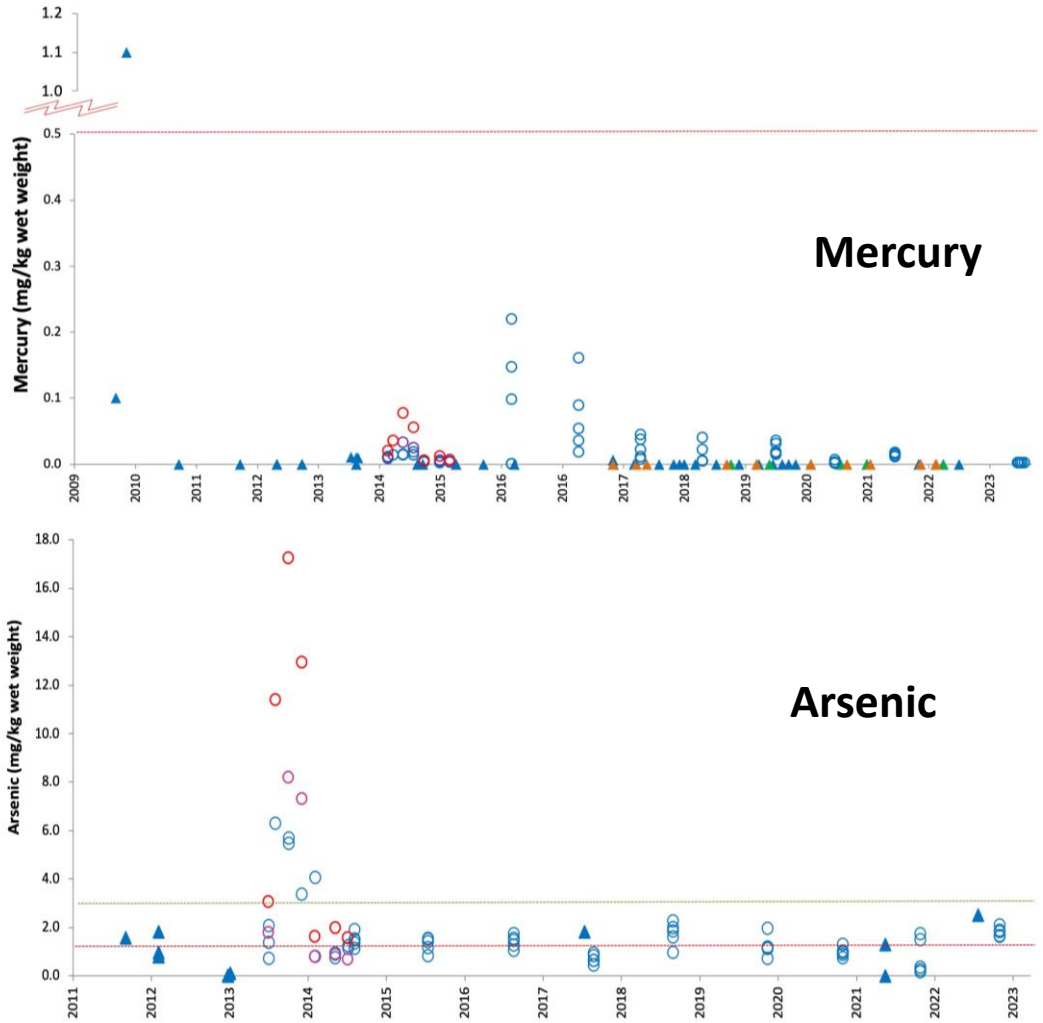






8. Trace metals in cultured mussels





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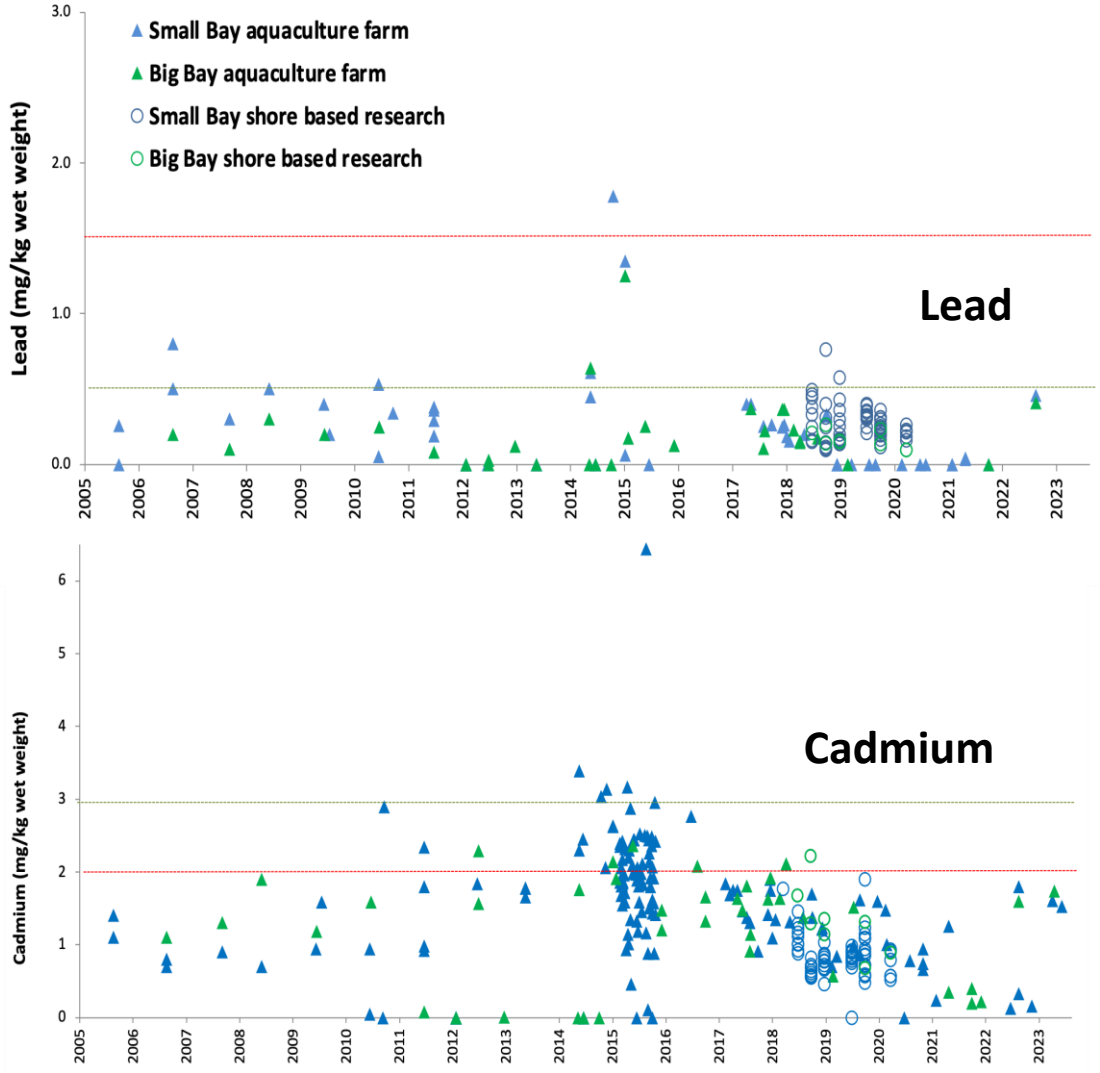
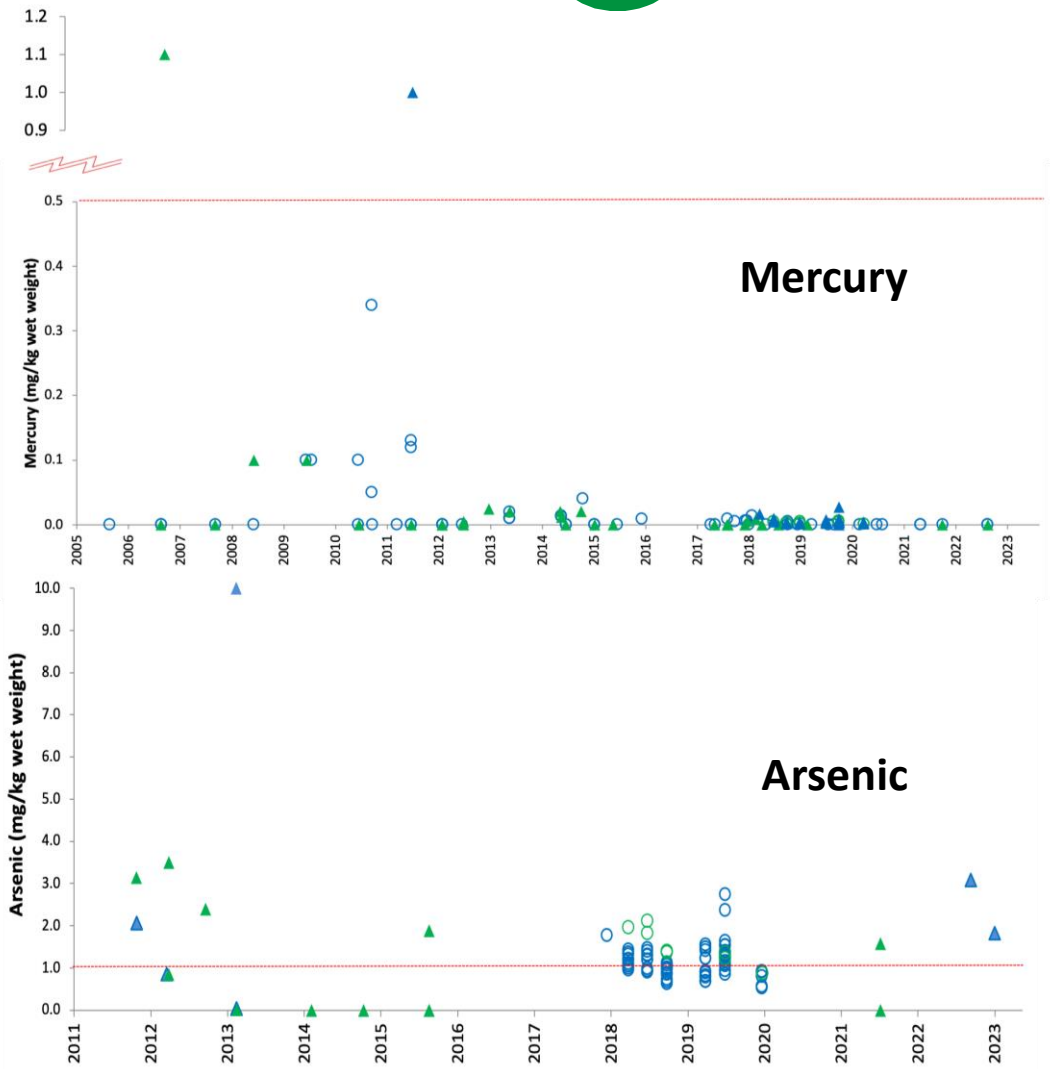
8. Trace metals in cultured mussels





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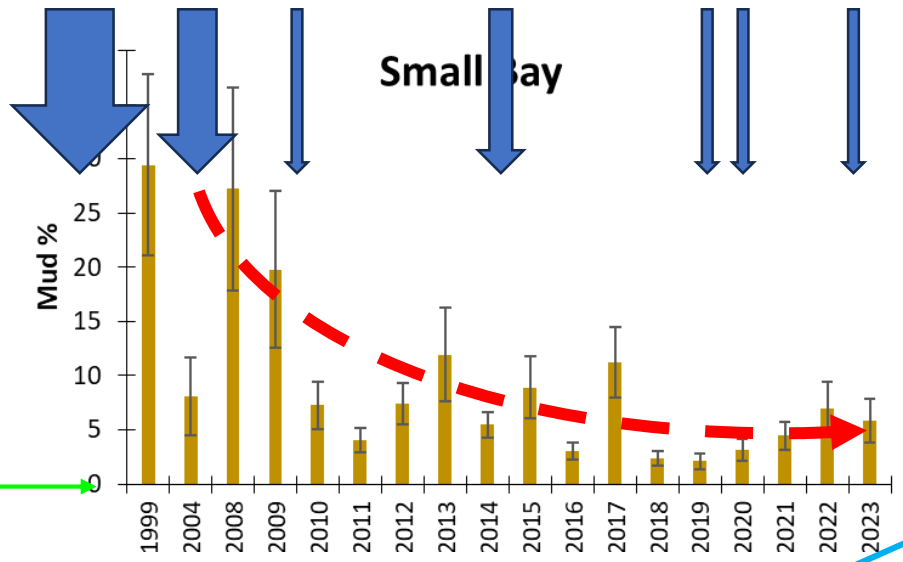
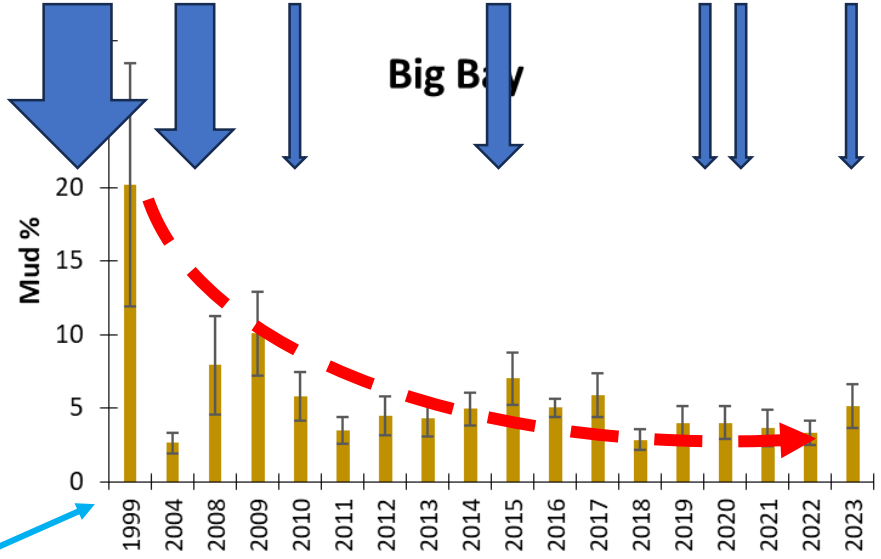
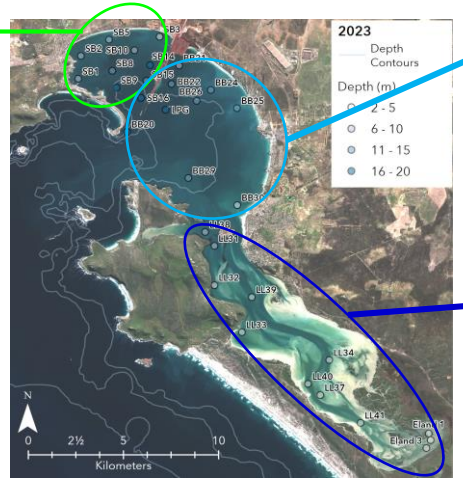
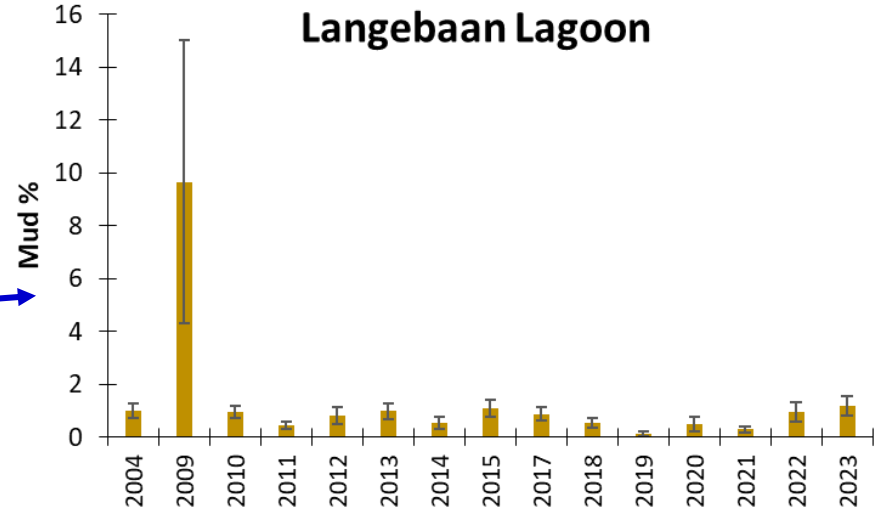
9. Sediment quality - particle size





Dredge events





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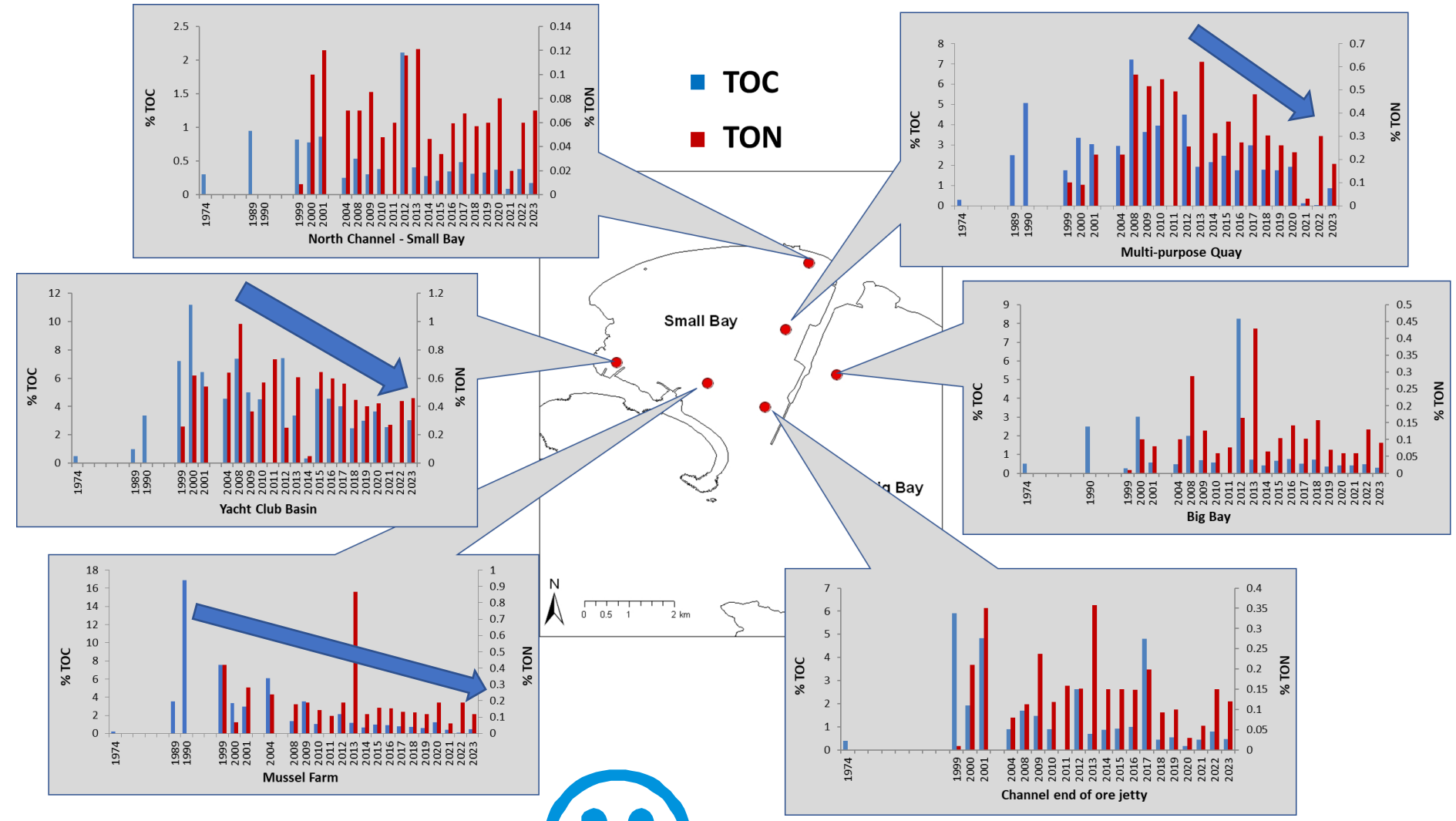
10. Sediment Organic Carbon & Nitrogen



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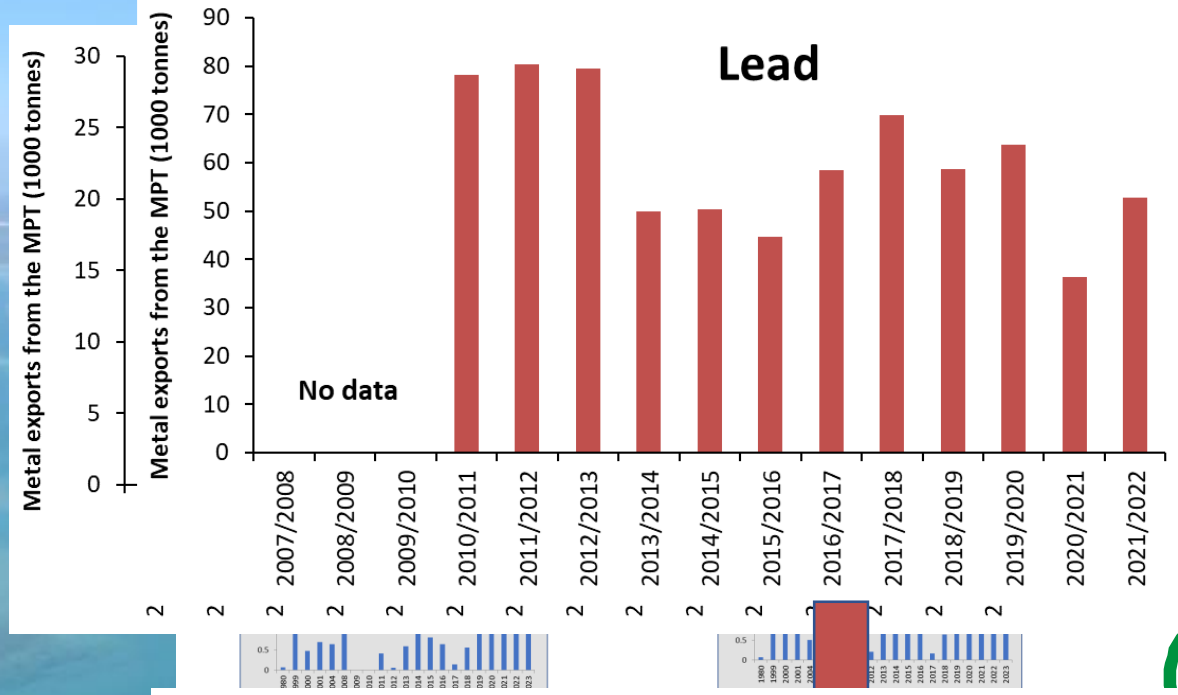

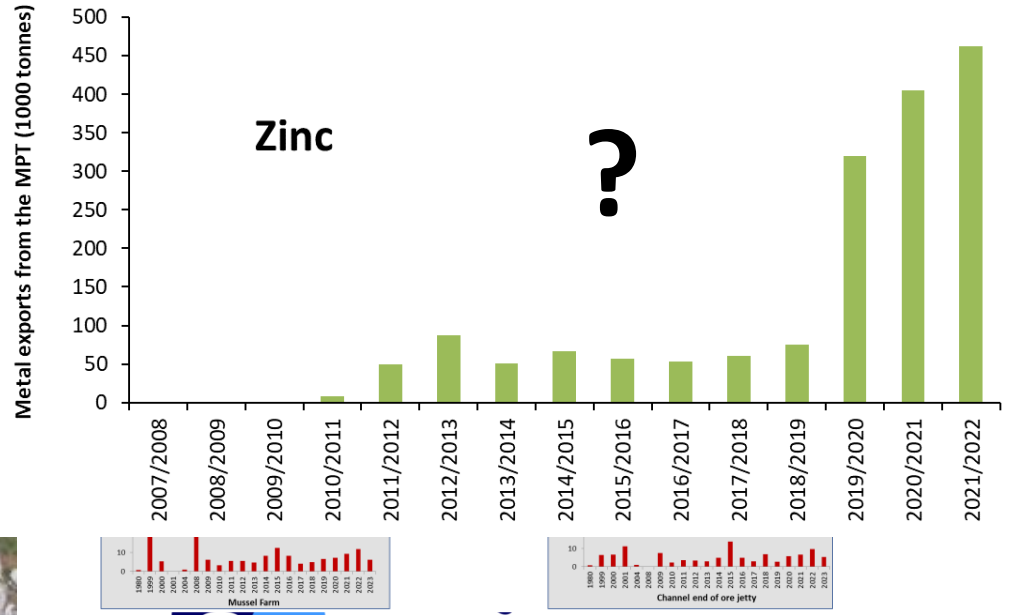

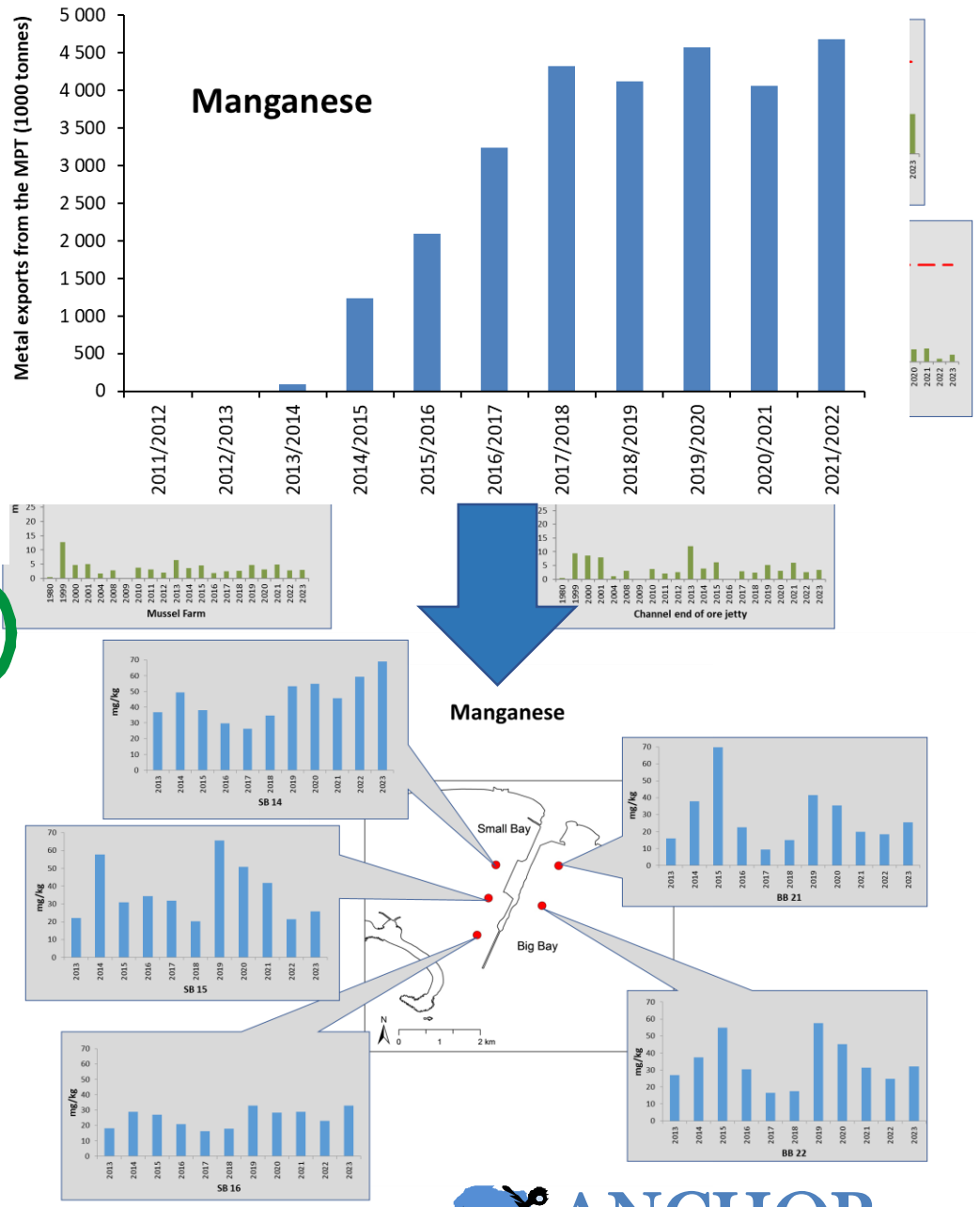

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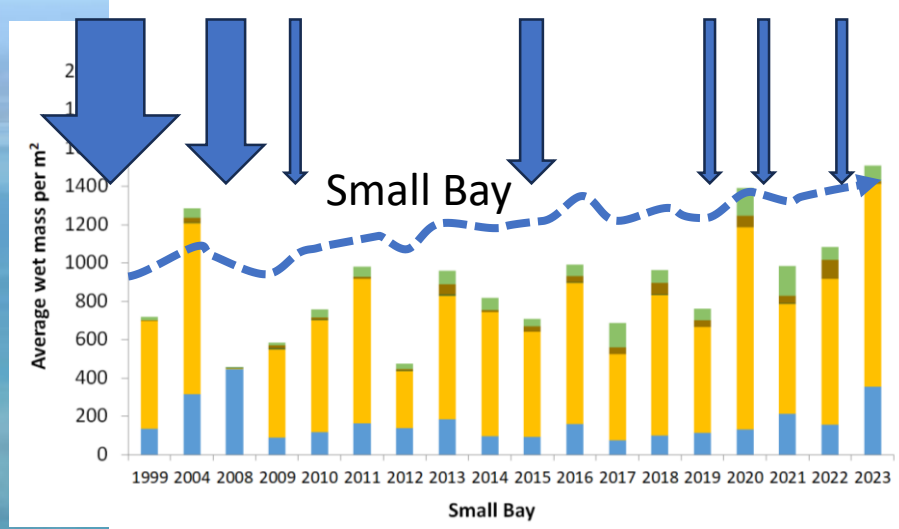
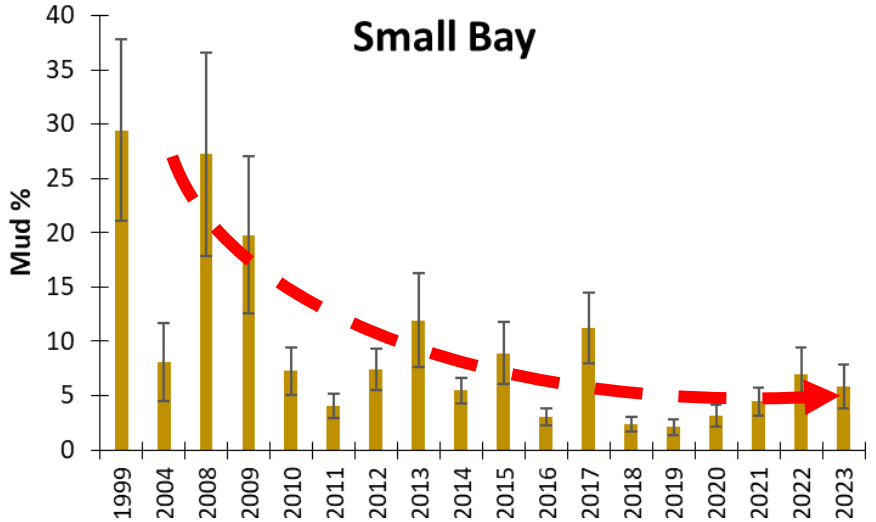
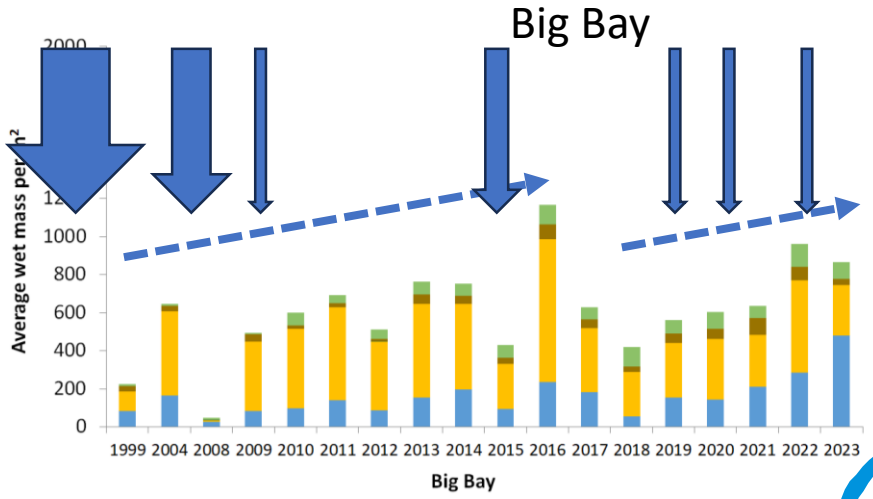
12. Soft bottom benthic macrofauna

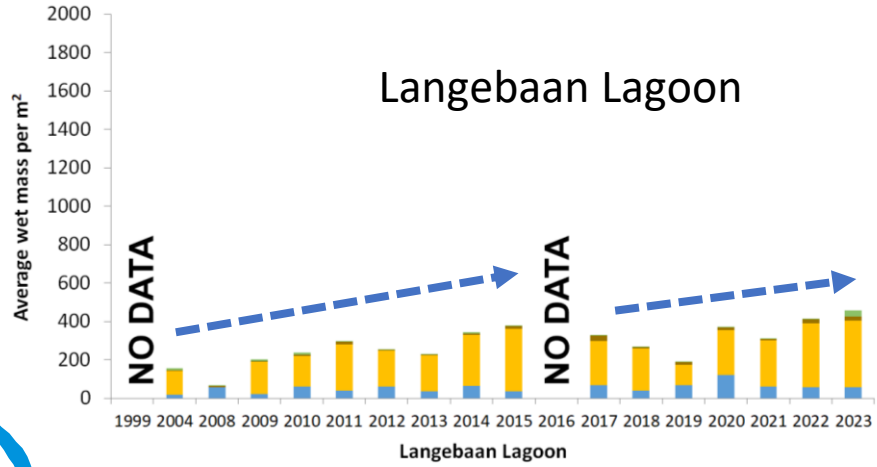


Dredge events



- Scavenger
- Predator
- Parasite
- Grazer
- Filter Feeder
- Detritivore
- Commensal





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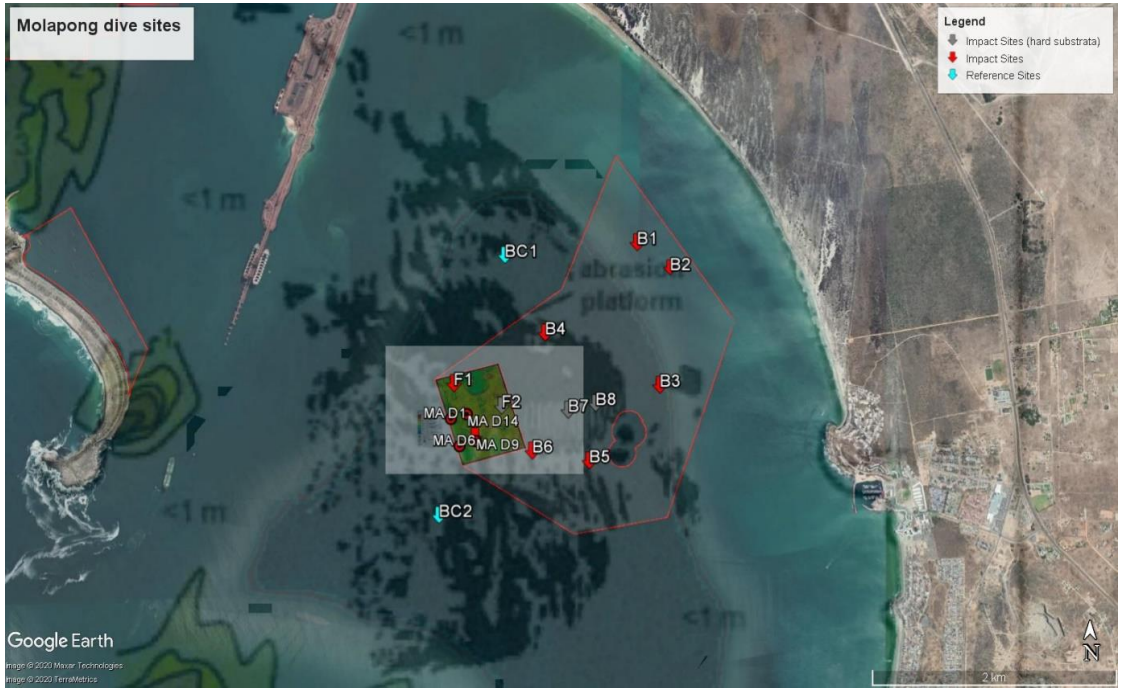
13. Hard bottom benthos

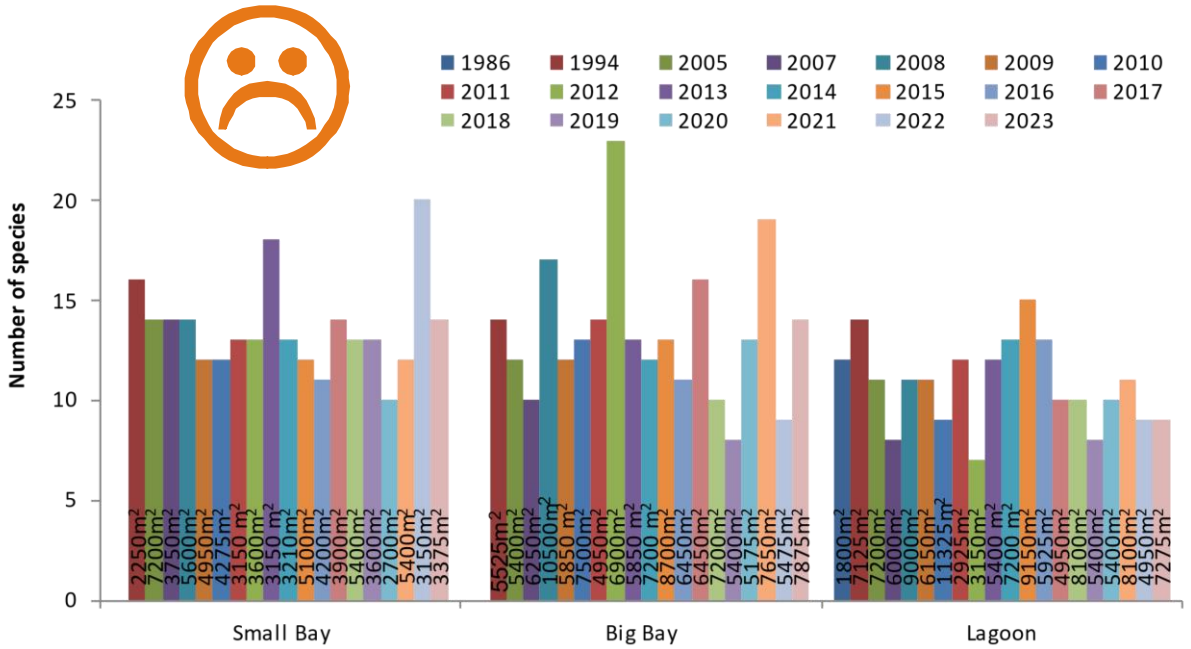
- Reef area in Big Bay is quite extensive (500 ha) and knowledge of this has been in place since the 1970s (Flemming 1977)
- Higher biodiversity and conservation importance than sediment but…
- ~50% of identified reef area falls within the (ADZ), LPG/LNG moorings area, proposed Karpowership site
- Soft sediment monitoring protocols (infauna, redox and H_2S) not really appropriate for this habitat type

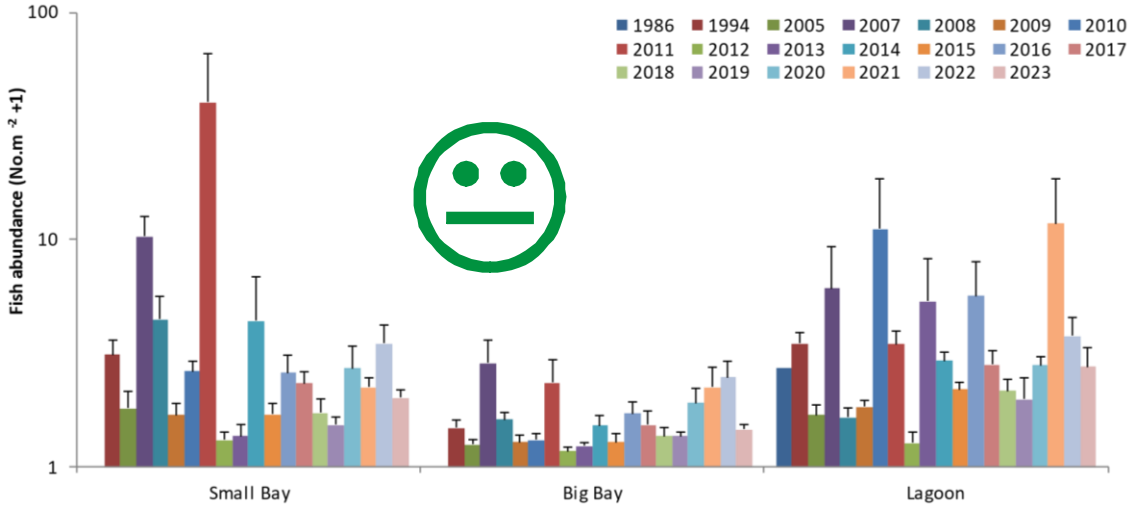
?
- Current extent of this reef is unknown
- Importance of this habitats to biota in the bay

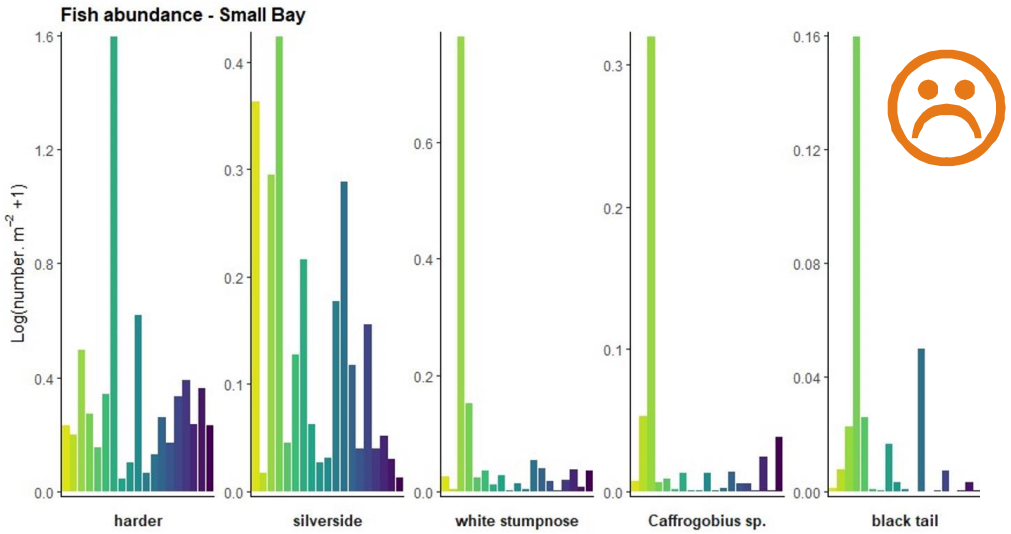


14. Fish

- Possible decline in numbers of species present in all areas of the Bay
- Overall abundance is very variable, but no clear change, except in Small Bay
- Stocks of some species (white stumpnose and elf) seem to have collapsed, presumably due to overfishing, but slight recovery evident during Covid but this was not sustained!







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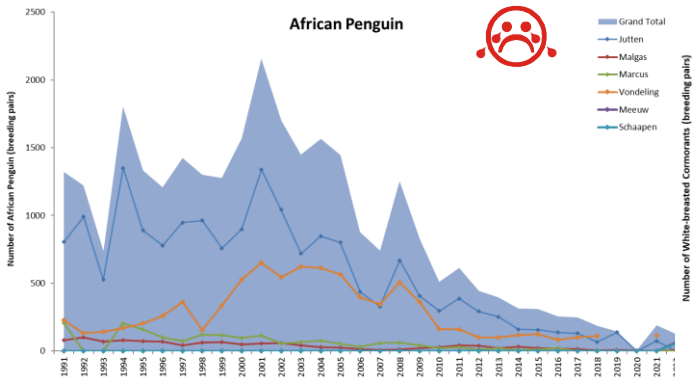
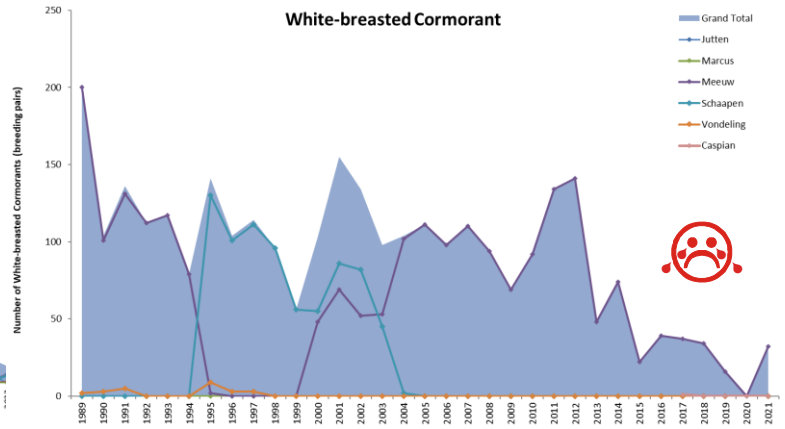
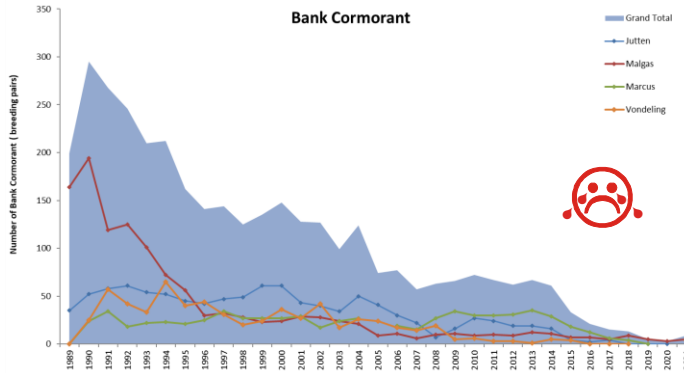
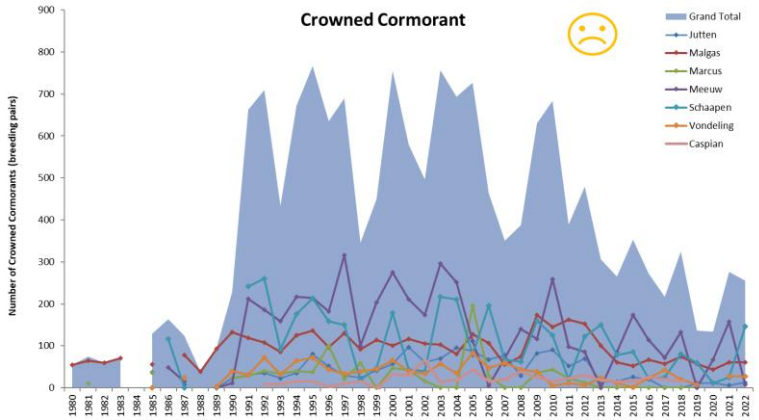
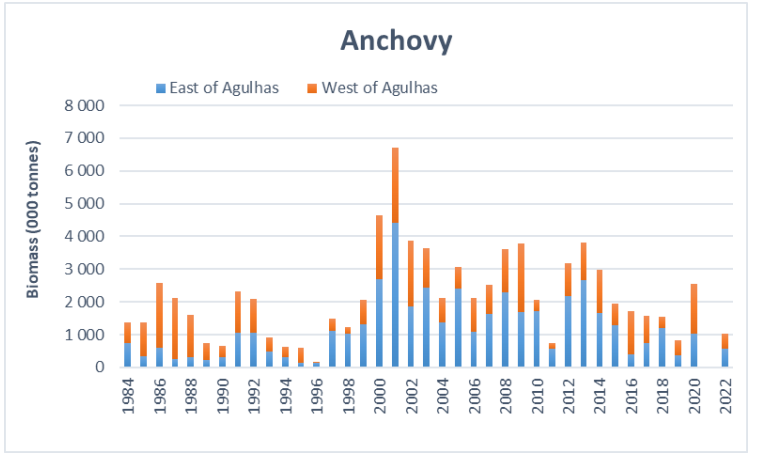
15. Birds – Islands breeding

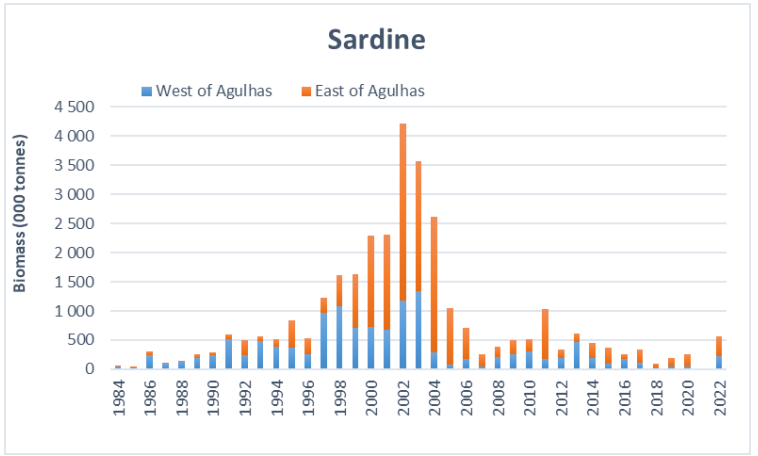












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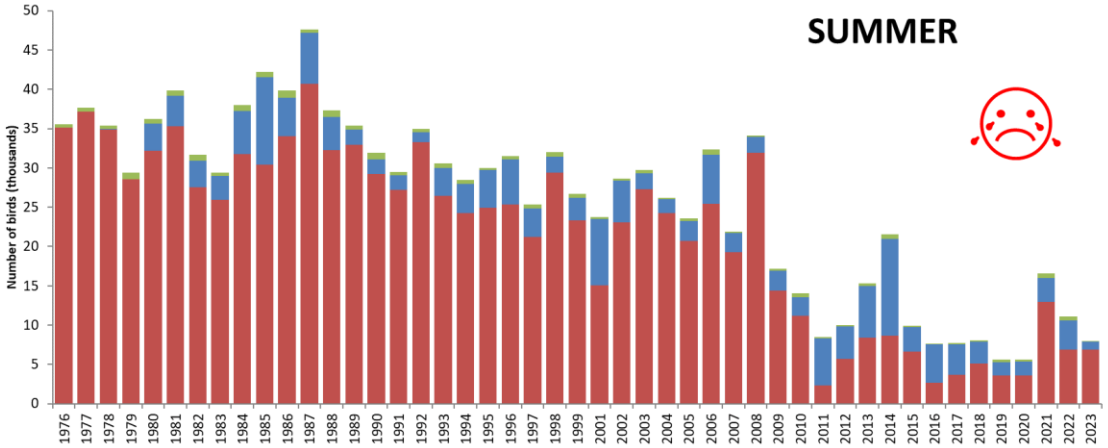
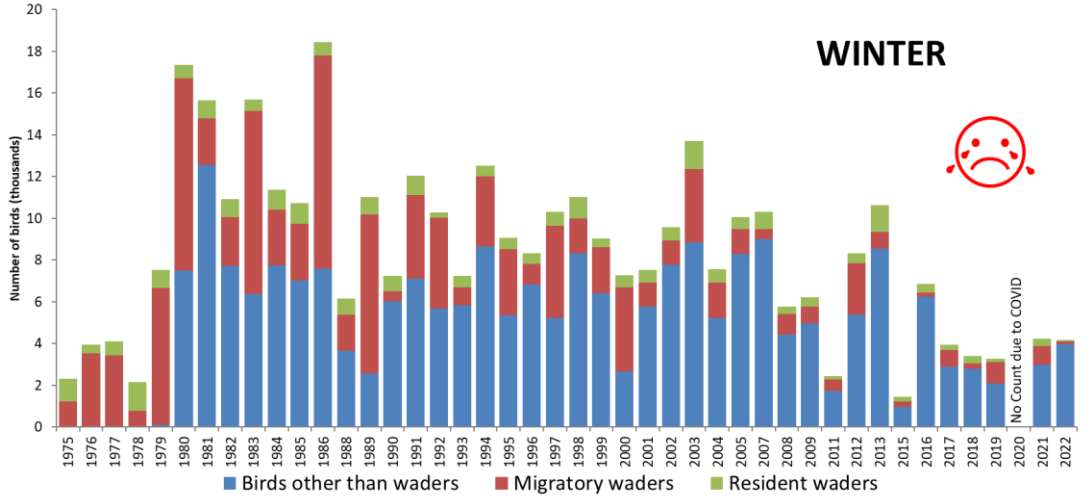
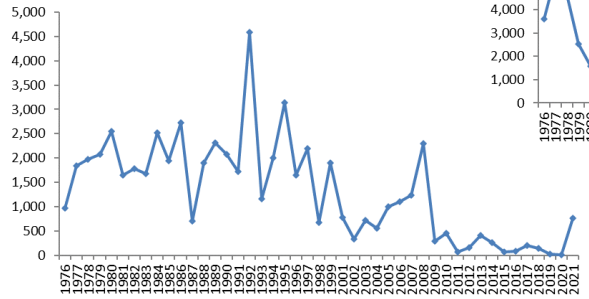
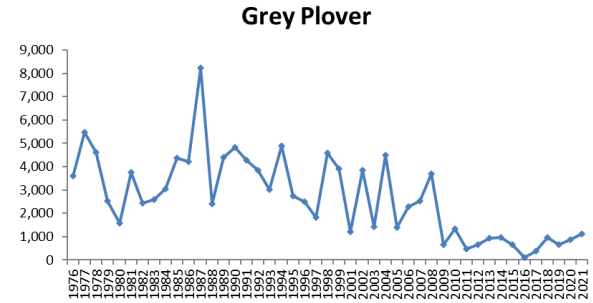
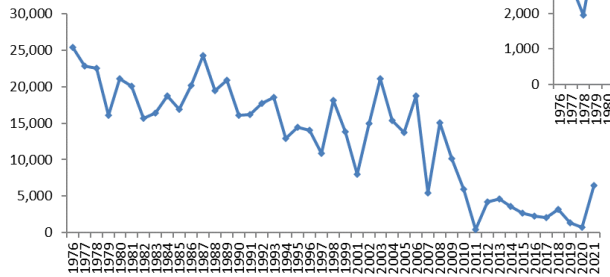
16. Birds: Langebaan Lagoon

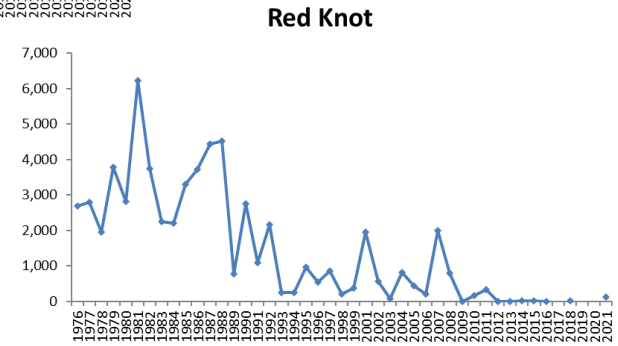












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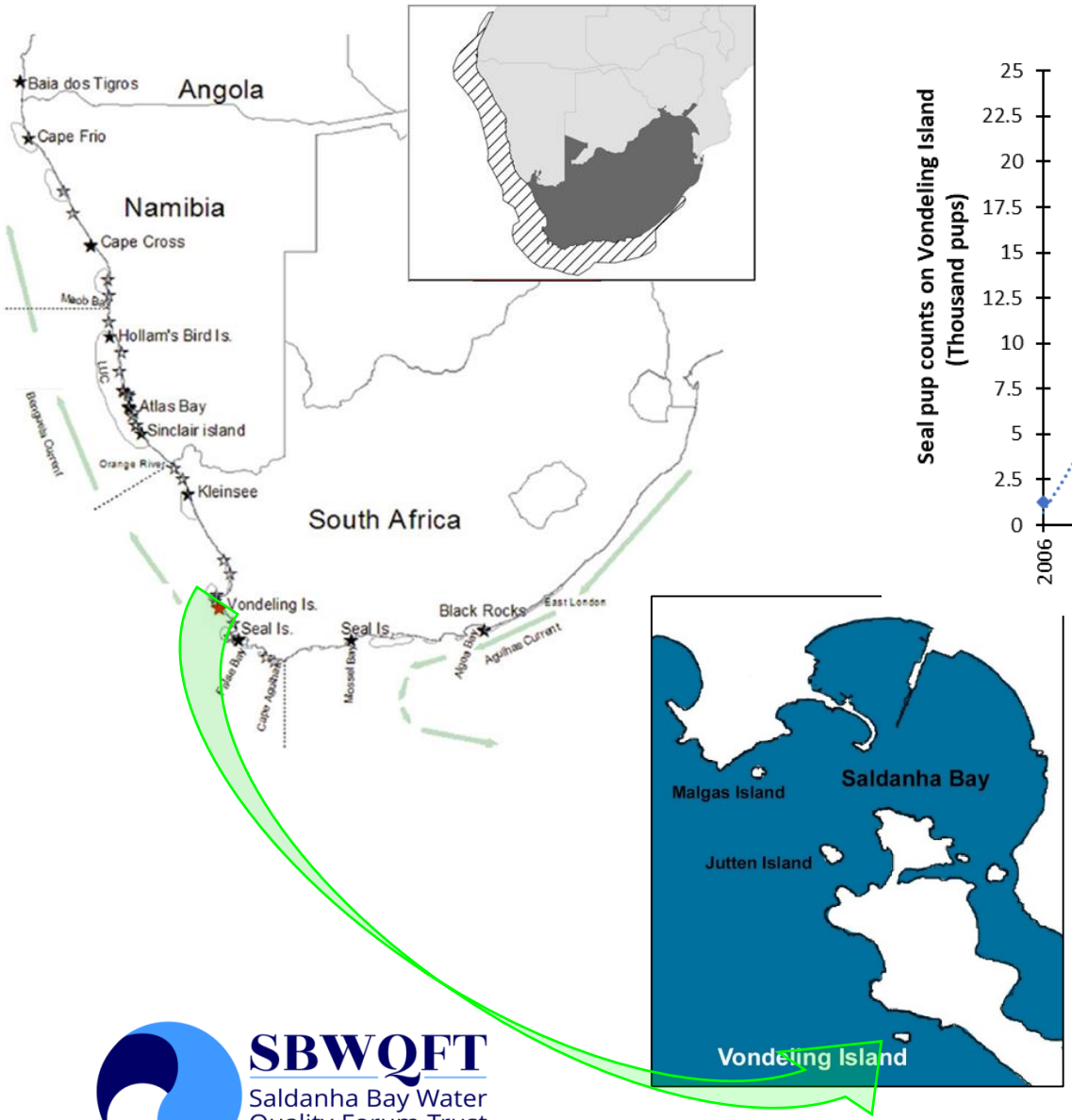
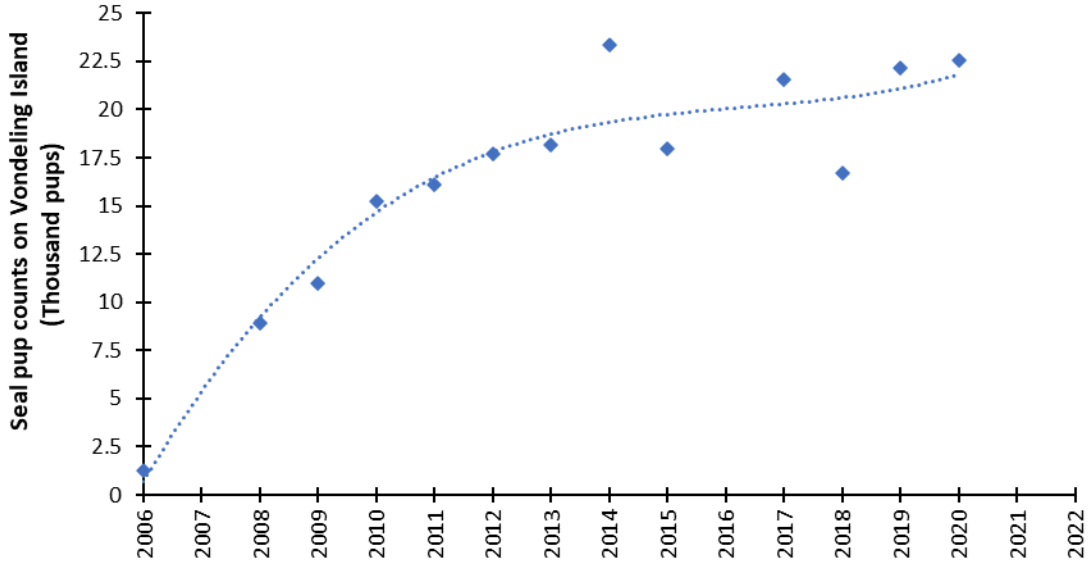
17. Cape Fur seals





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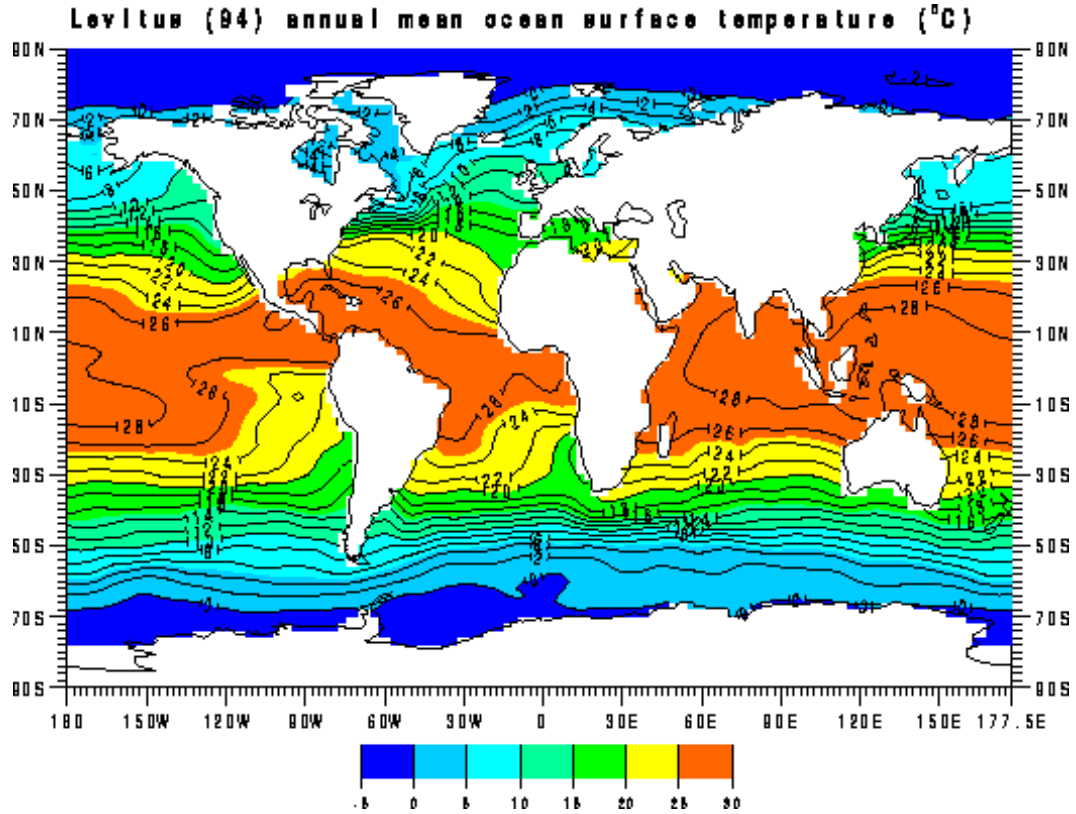
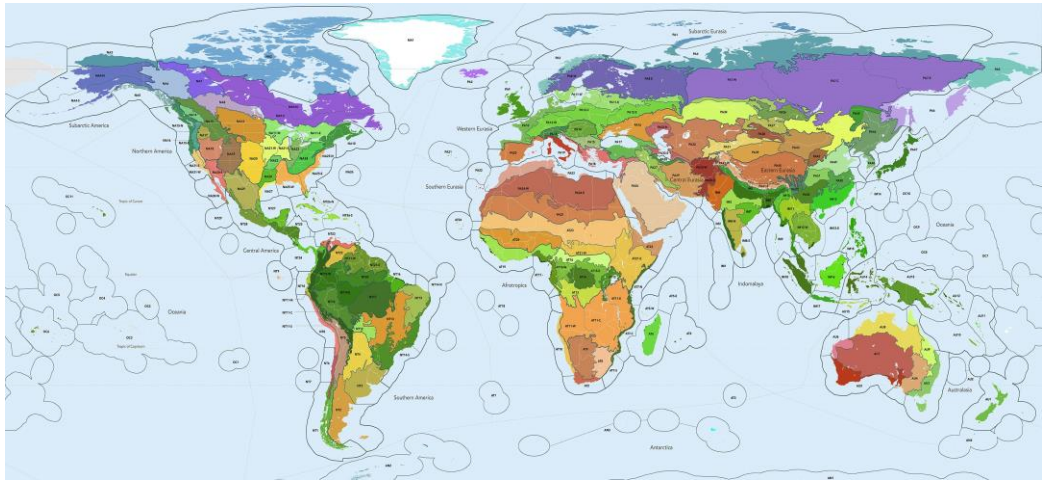
18. Alien & invasive species

- Natural movement of marine species around the world is restricted by thermal barriers and extensive areas of deep ocean





- A large number of different marine bioregions around the world each with their own largely unique species assemblages – just like we do on land

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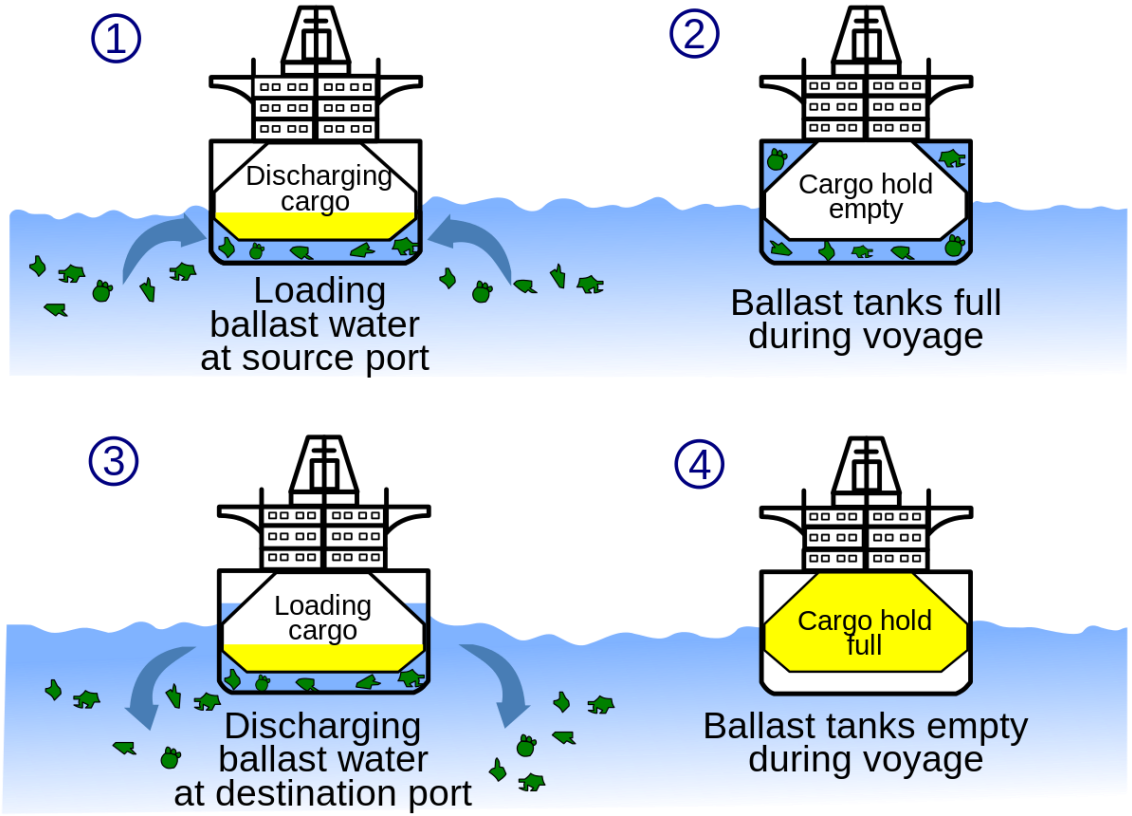
Shipping and its role in the transfer of alien species around the world

- Roughly 90% of the world's goods are transported by sea on ships
- Ships are very effective vectors for moving species from one part of the world to another either via hull fouling or ballast water



- Saldanha is a destination port and exports mostly metal ores to source ports in the far east (China Japan, Singapore) and Europe (Netherlands, Germany)
- Destination ports around the world tend to be major centers for invasion

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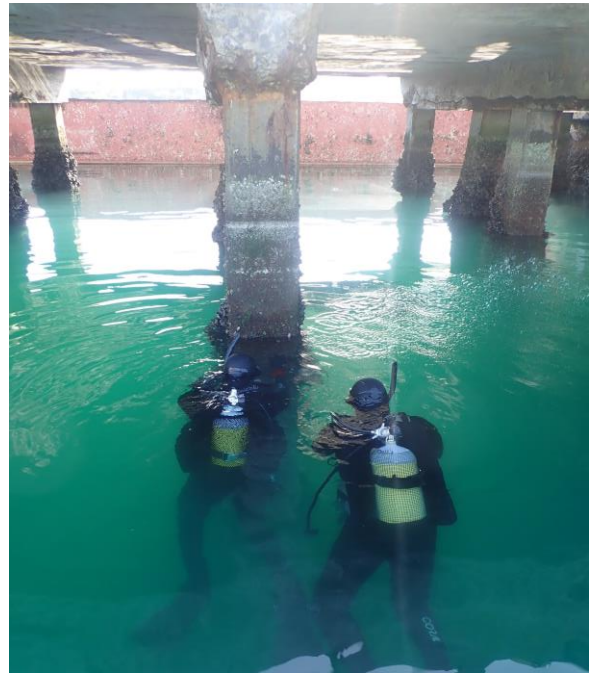
Alien species in Saldanha Bay

- To date, 95 alien marine species have been detected in South African waters , 67 of these are found along the West Coast, many of which occur or at least originate in Saldanha Bay
- Alien species are often problematic as they tend to proliferate after being introduced into a new environment due to the lack of natural predators and diseases
- Detection of new alien species and monitoring populations of alien species already introduced has to date been done largely on an ad hoc basis through the research programmes like the State of the Bay (benthic macrofauna, rocky intertidal, fish netting surveys) and the ADZ monitoring activities
- New alien species are arriving all the time (5 new species have been picked up through the SOB monitoring programme in the last 3 years!)
- Last year, Anglo American (Khumba Iron Ore) agreed to fund three years' worth of focusing alien species surveys in the bay using conventional sampling techniques as well as eDNA techniques



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What is eDNA?

- Environmental DNA (eDNA) is organismal DNA that can be found in the environment (water or sediment)
- eDNA originates from cellular material (skin, mucous, scales, faeces, etc.) shed by organisms into the environments that can be sampled and monitored using new molecular methods (water of sediment samples)
- SBWQFT in collaboration with Anglo American and a UK-based company Nature Metrics experimenting with eDNA to assist with this
- Aliens are often difficult to detect when they first arrive (cryptic, low numbers)
- But this is usually the best (and often the only) opportunity to eradicate them
- Early detection is critically important!

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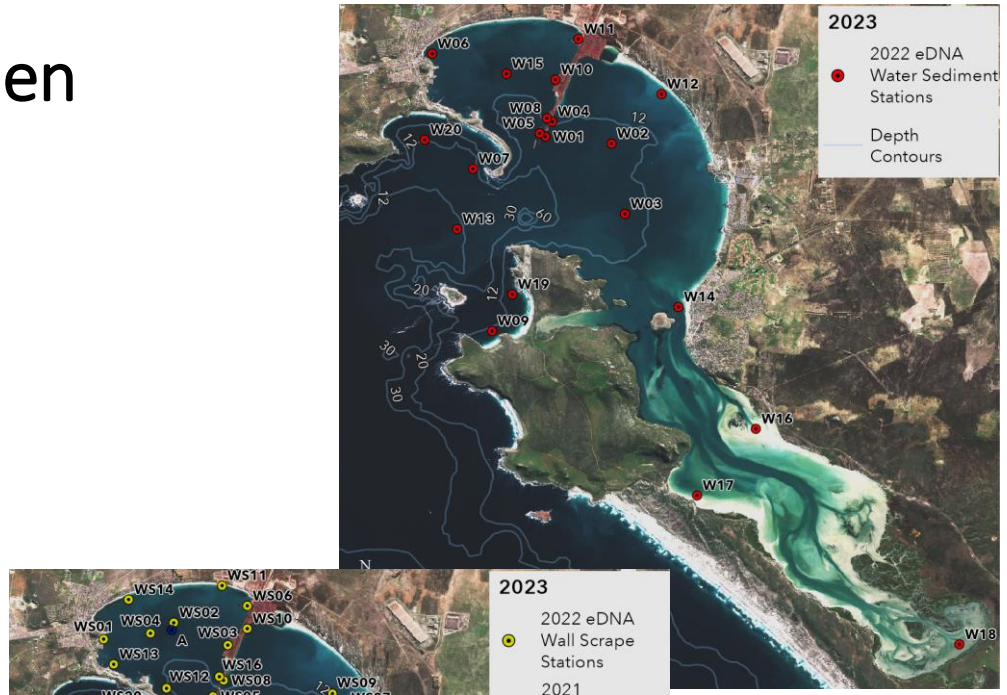
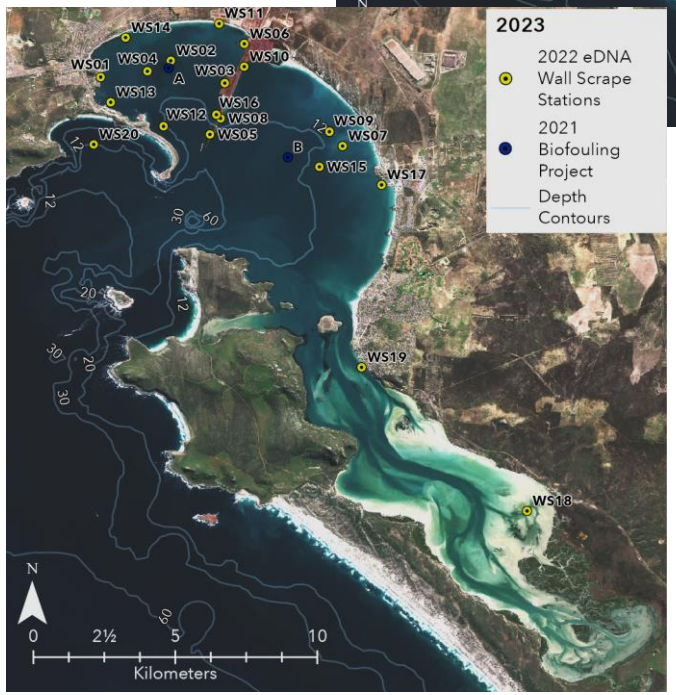
Anglo American-Nature Metrics-SOB Alien Species Monitoring Programme

- Sampling (commenced in 2023) of ballast water, seawater, sediment and fouling communities found on hard substrata (rocky reefs and artificial surfaces) in the Bay
  - 7 ballast water samples
  - 20 seawater samples
  - 20 sediment samples
  - 20 “wall” scrapes
- Samples have been processed using convention taxonomic techniques but were also homogenized, subject to DNA extraction, metabarcoding for all major groups (eukaryotes, bacteria, invertebrates and vertebrates)





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Results

- **Ballast water** – Taxa from all five Kingdoms (animal, plant, fungi, protist and monera) but no confirmed alien species; mostly bacteria and other unicellular organisms, no vertebrates species present,
- **Water samples** - Taxa from all five Kingdoms but no confirmed alien species; five bird species, 37 fish and two mammals
- **Sediment samples** - Taxa from all five Kingdoms including three confirmed or suspected alien species: an invasive mussel *Semimytilus patagonicus* (previously recorded) and two gastropods (*Nassarius megalocallus* and *Tritia ovoidea*) (not previously recorded)
- **Wall scrapes** – Taxa from all five kingdoms including six confirmed or suspected alien species: polychaete word *Polydora hoplura,* Bell ascidian *Clavelina lepadiformis,* pink mouth hydroid *Ectopleura crocea* (all recorded previously), Blue mussel *Mytilus edulis,* Bay mussel *Mytilus trossulus,* (not previously recorded).

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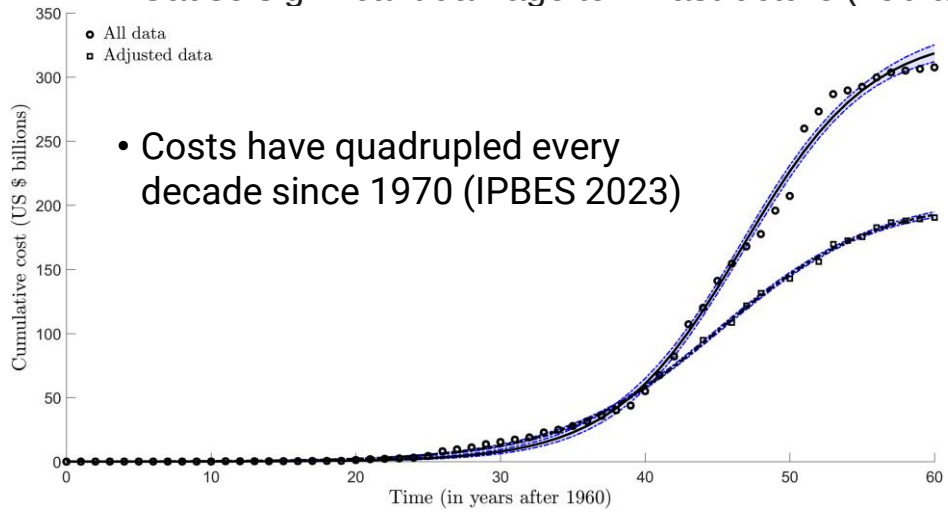
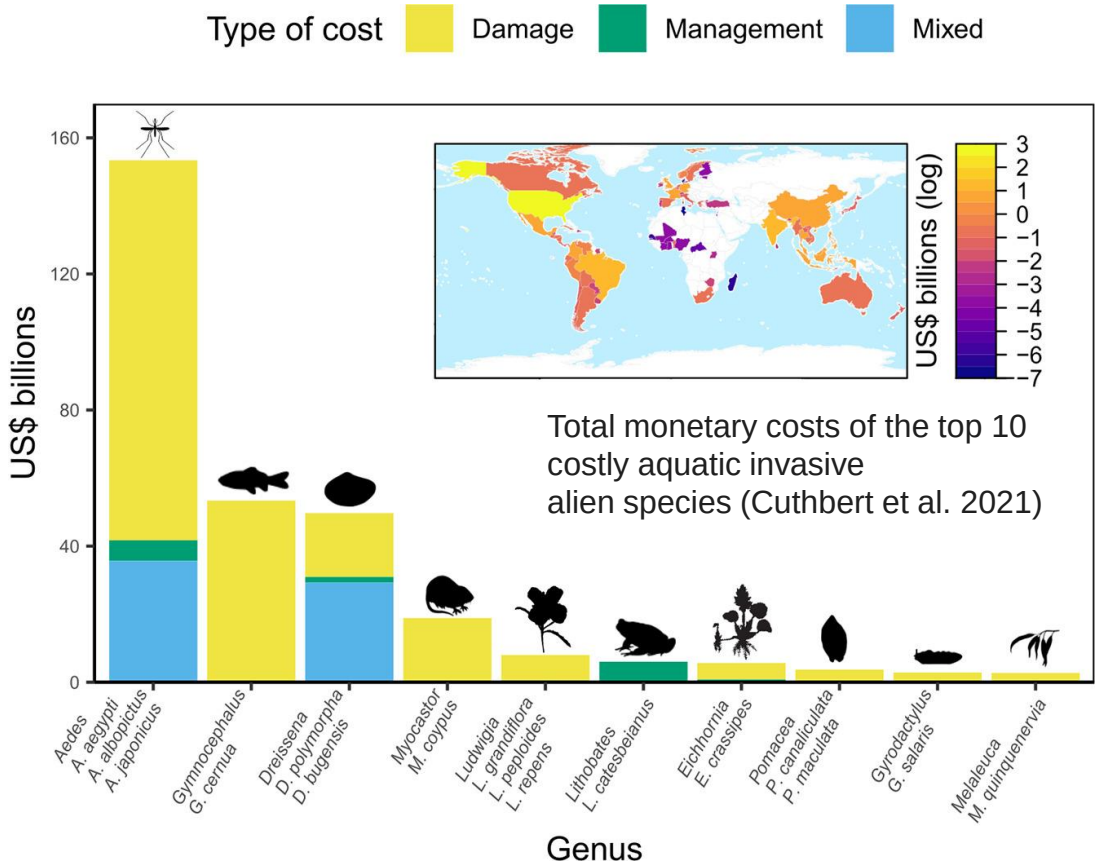
Why do we care about alien species….?

- Aquatic invasions have cost the global economy US$345 billion (Cuthbert *et al*. 2021)
  - Aquatic alien species make a major contribution to the burden of diseases,
  - Contribute to loss of income to tourism and recreation
  - Compete with economically important native species (wild capture fisheries and aquaculture)
  - Cause significant damage to infrastructure (zebra



- Costs have quadrupled every decade since 1970 (IPBES 2023)



Total monetary costs of the top 10 costly aquatic invasive alien species (Cuthbert et al. 2021)

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Summary

- Development pressure continues to ramp up in the Bay after having stalled for a short period (Global Financial Crisis, Covid) but visitor (tourist) numbers are down…
- Groundwater reserves have been stable over the long term and may even have increased in the last 12 month due to above average rainfall
- Wave energy intensity has increased significantly since 1960s (~50%)
- Water quality (faecal coliforms level) have increased dramatically opposite Langebaan in the last 12 months
- Sediment quality (mud fraction) has improved dramatically in the last two decades and still looking good
- Benthic macrofauna populations in soft sediments have responded positively to improvements in sediment quality...
- Remains a dearth of information on communities associated with hard bottom substrata in the bay, many of which are under increasing threat
- Fish populations overall are highly variable but do seem to be declining, throughout the Bay…
- Birds breeding on the islands in the Bay and those in the Lagoon continue to decline
- Marine aliens are increasing and we are getting better at finding them…

Overall: We are doing well but don't we don't want to take our eyes off the road…

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Thank You

Photo: Steve Benjamin