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

SALDANHA BAY SEA BASED AQUACULTURE DEVELOPMENT ZONE BASELINE BENTHIC SURVEY

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Saldanha Bay ADZ Specialist monitoring

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Background

- The Department of Environment, Forestry and Fisheries (DEFF), Branch Fisheries, as the holder of the Environmental Authorisation for the Saldanha Bay ADZ appointed an independent service provider Anchor Research and Monitoring (AR&M) to draft the baseline technical report for the Saldanha Bay ADZ. Shellfish aquaculture was operational in parts of the Big Bay and North Bay precincts at the time of the survey, but not at the Jutten Island precinct.

Introduction:

Sediment physico-chemical properties

- Organic matter is a universal pollutant affecting marine life, can lead to significant changes in community composition and abundance.
- High organic loading typically leads to eutrophication and hypoxia, which negatively affects biota (especially benthic macrofauna).
- Impacts can be increased by levels of other contaminants such as trace metals used in antifouling paints.
- Copper (Cu) and Zinc (Zn) are two metals that are commonly monitored in finfish growing areas (DAFF 2018).

Macrofauna:

- Important to monitor biological components of the ecosystem in addition to physico-chemical and eco-toxicological variables, as biological indicators provide a direct measure of the state of the ecosystem.
- Benthic macrofauna are the biotic component most frequently monitored to detect changes in the health of the marine environment.
- Used in the monitoring of health of an area by detecting effects of stress, as well as to monitor recovery after an environmental disturbances.

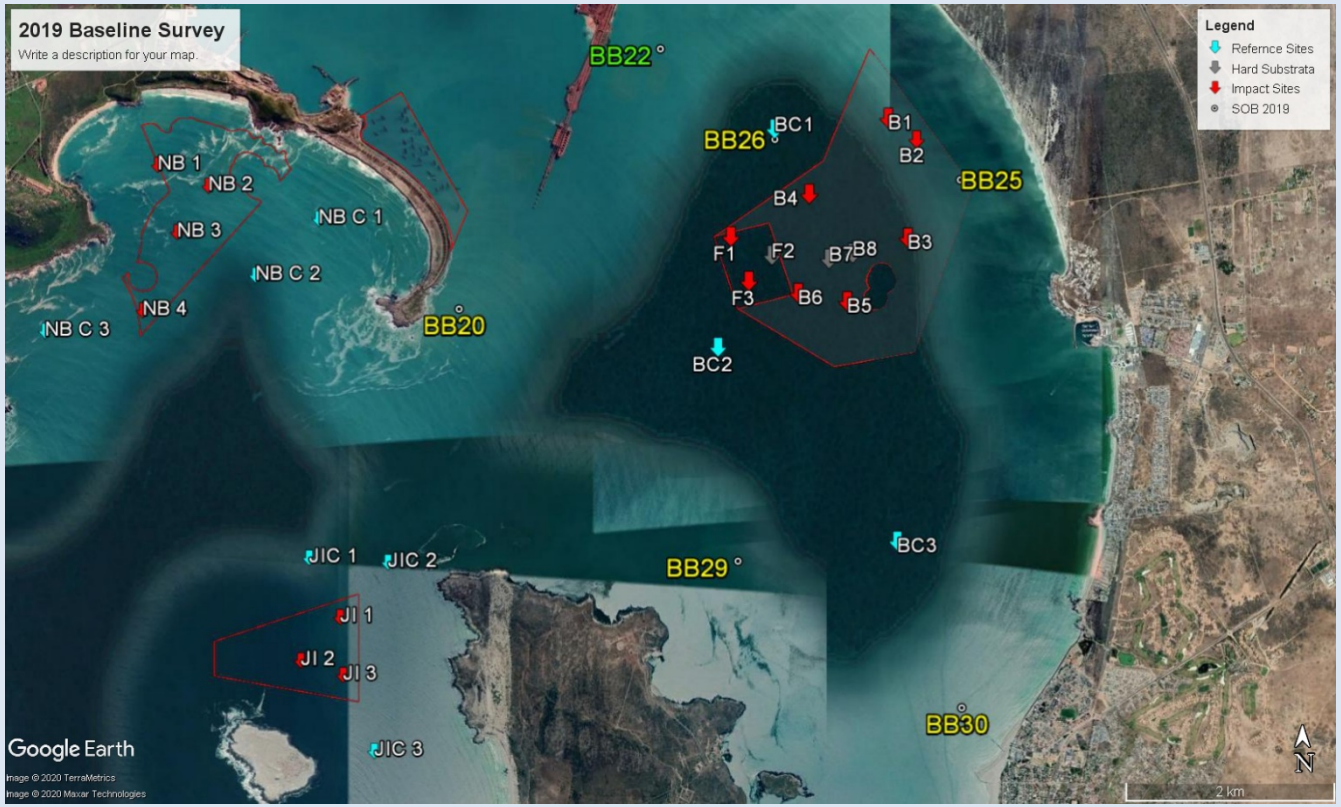
Sampling:

- Replicated Saldanha Bay Water Quality Trust (SBWQT) State of the Bay monitoring programme methods (hereafter referred to as SOB).
- An airlift was used to suck up sediment for macrofauna.
- Three replicates were taken in a single dive and pooled together.
- Sediment was sieved at the surface and macrofauna extracted.
- Macrofauna were sorted and identified.
- Three sediment samples were collected by scientific divers using PVC pipe cores – used for physio-chemical analysis of sediment.

- Relevant data collected during the during the 2019 SOB survey was included for further comparisons in the BB lease area.

Sampling:

- Sites in the Big Bay (BB), North Bay (NB) and Jutten island (JI) ADZ precincts were randomly selected and sampled by Capricorn Fisheries Monitoring between 17th January -11th April 2019. Yellow labels indicate sites sampled during SOB monitoring in 2019.
- Grey arrows indicate sites where **hard substrata was encountered and samples were not collected.**



Analysis:

Physio-chemical:

- Sediment characteristics were analysed by the CSIR.
- Trace metal content (Copper and Zinc) was statistically compared to sediment quality guidelines thresholds specified in the sample plan, highlighted below, as well as data from SOB 2019.

Table 1. Summary of Benguela Current Large Marine Ecosystem and National Oceanic and Atmospheric Administration metal concentrations in sediment quality guidelines

Metal (mg/kg dry wt.)	BCLME region (South Africa. Namibia. Angola)		NOAA	
	Special care	Prohibited	ERL	ERM
Cu	50 – 500	>500	34.0	270.0
Zn	150 – 750	> 750	150.0	410.0

- TOC and TON values from impact sites were statistically compared to those from reference station in the respective ADZ precincts, as well as data from SOB 2019.

Analysis

Macrofauna

- The statistical program, PRIMER 6 (Warwick and Clarke 1993), was used for multivariate analyses of benthic macrofauna abundance data.
- Multidimensional Scaling (MDS) plots were constructed in order to find 'natural groupings' of sites based on similarities in their macrofaunal communities.
- Biological indices were calculated for the three ADZ precincts and compared to thresholds stipulated in the sample plan (DAFF 2018).
- The thresholds which trigger management action are highlighted below:

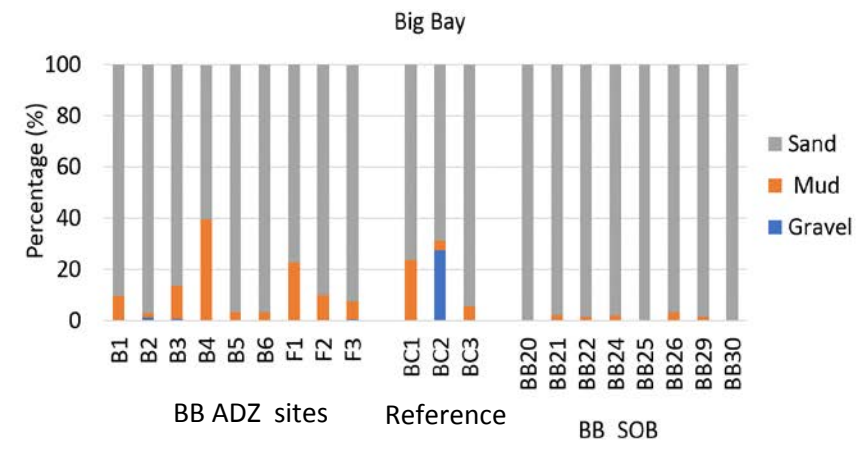
Table 2. Ranges of biological indices in five sediment organic enrichment categories (Borja et al. 2000).

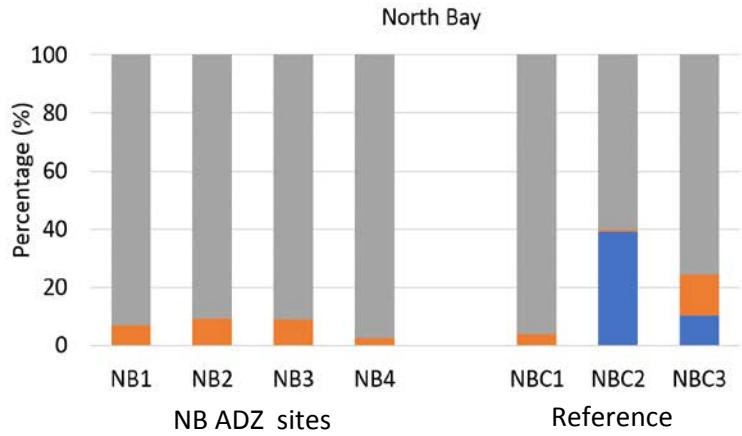
	Oxic A Well oxygenated	Oxic B Oxygen present	Hypoxic A Low oxygen	Hypoxic B Extremely low oxygen	Anoxic No oxygen
Biological:	Good				Bad
Shannon-Weiner diversity index (H')	>4	4 - 3	3 - 2	2 -1	<1
Infaunal Trophic Index (ITI)	>50	50 - 25	<25	<25	<5
AZTI Marine Biotic Index (AMBI)	<1.2	1.2 - 3.3	3.3 - 5	5 - 6	>6

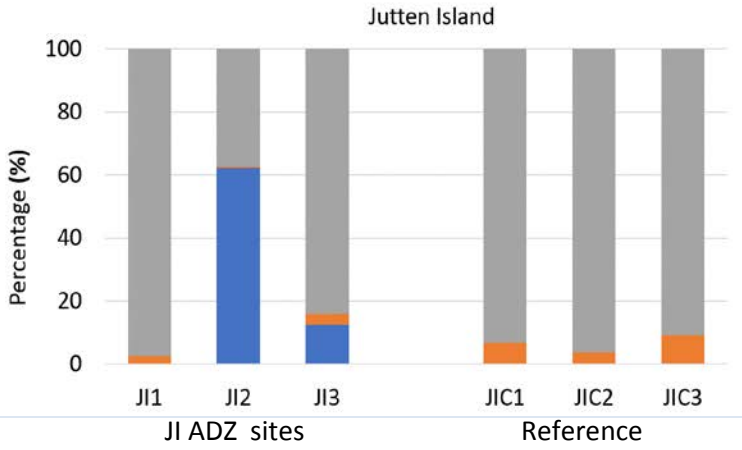
Results and Discussion:

<u>Sediment physico-chemical properties</u>
Sediment Characteristics

- Across all three ADZ precincts sand is the dominant component at both impact and reference sites.
- Big Bay – Differences noted in sediment composition between impact and reference sites and SOB 2019 data.
- Greater variability in sediment composition at Jutten Island (JI) impact sites and North Bay (NB) reference sites - situated in the deeper and more exposed outer Bay area.
- Sites B1, B3 and B4 are near mussel rafts and are likely affected by deposition of pseudo faeces from culture stock and biofouling organisms



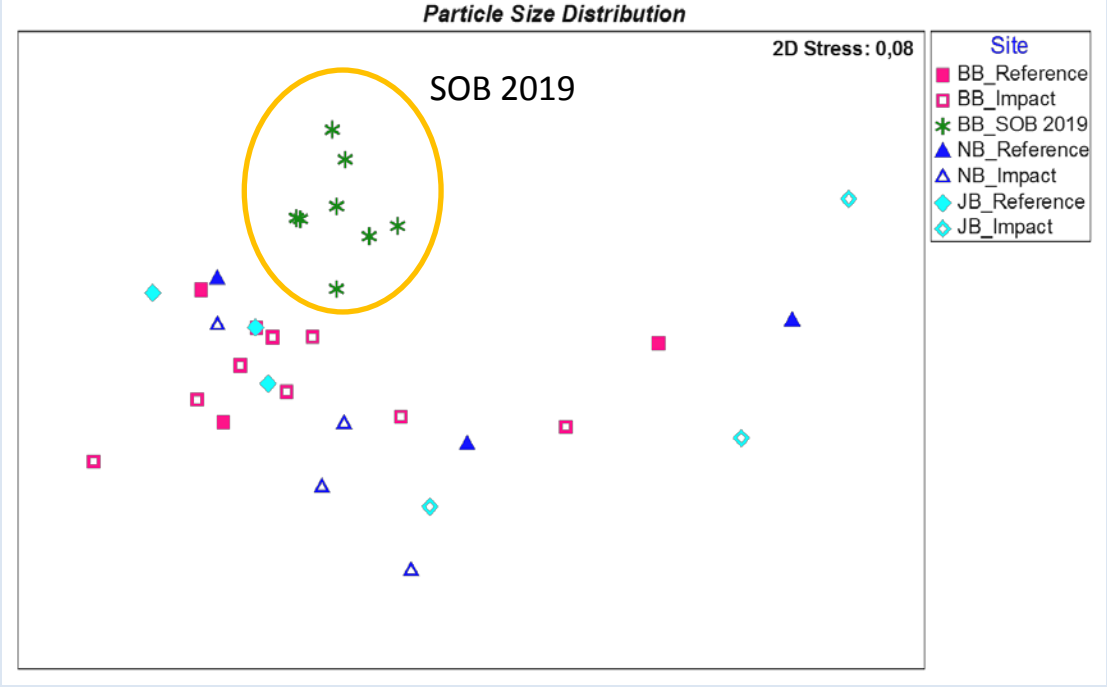




Results and Discussion:

Sediment Characteristics

- Sediment data collected from SOB 2019 forms its own cluster indicating different sediment composition compared to aquaculture lease areas.
- There is high variability in particle size distribution, effectively spacing out all the impact and reference sites for the three ADZ precincts.
- Differences between SOB 2019 and ADZ baseline is likely due to the presence of hard substrata in the BB ADZ, with fine (muddy) sediment potentially due to deposition of particulate matter from shell fish farms, or natural settling in deeper protected areas between hard patches.



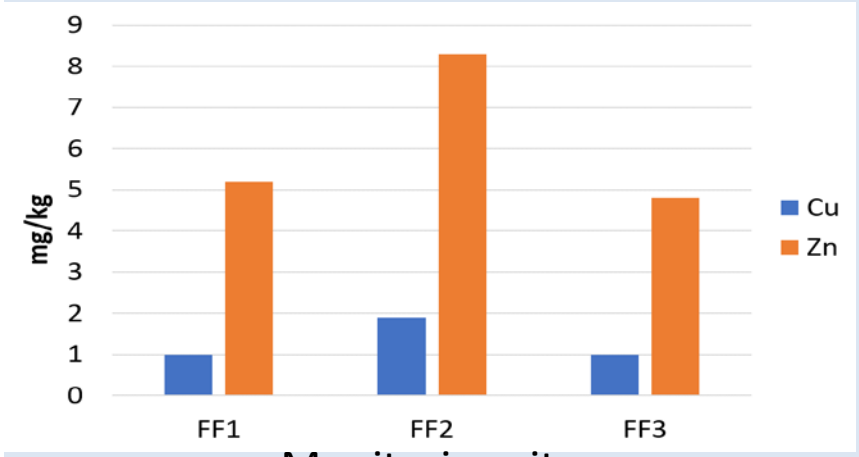
Results and Discussion:

Sediment physico-chemical properties

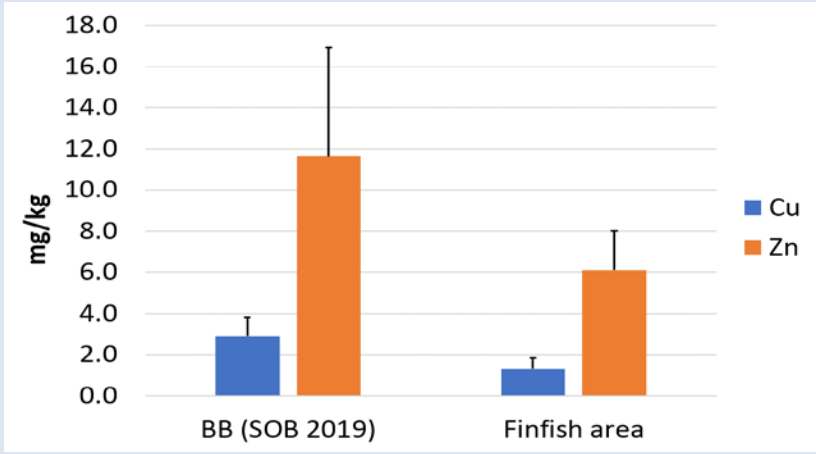
Trace Metals

- Cu and Zn baseline concentrations were significantly below their stipulated ERL threshold levels (DAFF 2018; Cu – 34 $mg.kg^{-1}$, Zn – 150 $mg.kg^{-1}$).
- Average sediment Cu and Zn concentrations in ADZ samples were less than those recorded in SOB 2019 samples.
- Currently there is no finfish aquaculture – and therefore no evidence of input of Cu (antifoulant) or Zn (health additive to feed).
- Molapong have indicated they do not intend to use antifoulant on cage infrastructure.

Metal concentrations at the finfish site



Average metal concentrations at the finfish site compared to SOB 2019 data

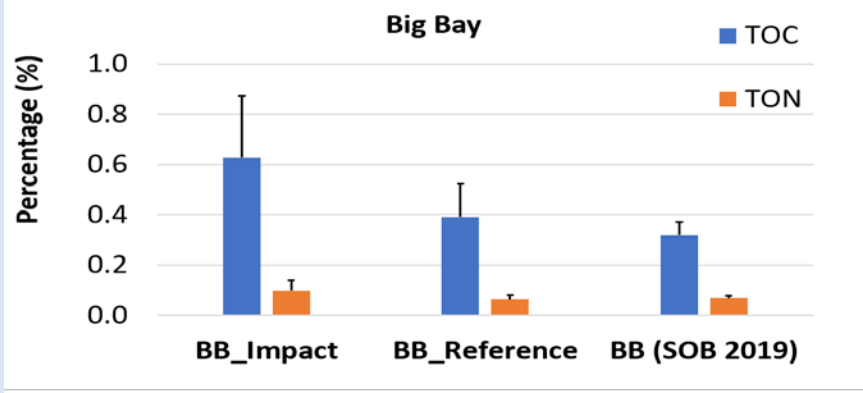


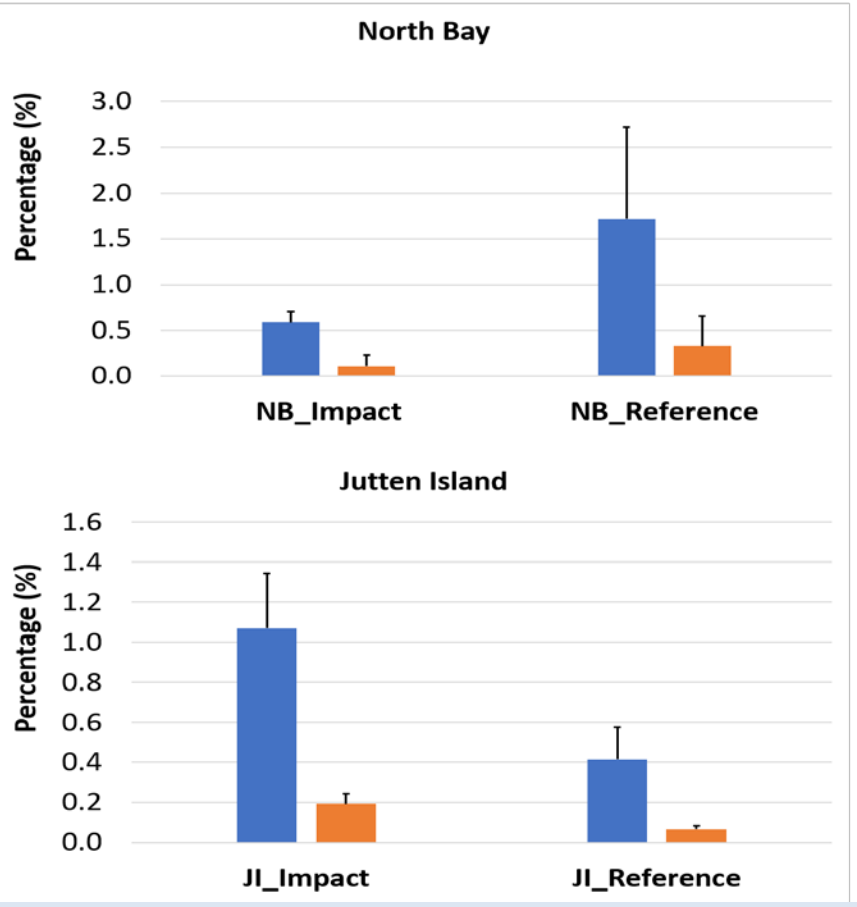
Results and Discussion:

<u>Sediment physico-chemical properties</u>

Total Organic Carbon (TOC) and Nitrogen (TON)

- TOC/TON levels for Big Bay and Jutten Island (no active mariculture) precincts were greater at the impact sites in comparison to reference sites, but these differences were not significant.
- No difference was found between the impact and reference sites in the North Bay.
- Data recorded in Big Bay at both the impact and reference sites are similar to levels recorded from SOB 2019.





Results and Discussion:

Baseline Macrofauna

Shannon-Wiener diversity index (H')

- In all cases the average H' for each ADZ precinct was significantly lower than the prescribed threshold of H' = 3, placing them in the Hypoxic B category or lower.
- No differences were detected between impact and reference sites in all three ADZ precincts.
- At Jutten Island (JI) there is currently no aquaculture, indicating the H' seen at the impact sites is typical of this area and not a reflection of aquaculture impacts.
- In addition, data from SOB 2019 indicates that no sites throughout Saldanha Bay or Langebaan exceeded a H' of 2.8.
- This suggests that Saldanha Bay naturally has a lower H' than the prescribed threshold.
- The threshold H' should be reduced to a value more reflective of the natural state in Saldanha Bay.

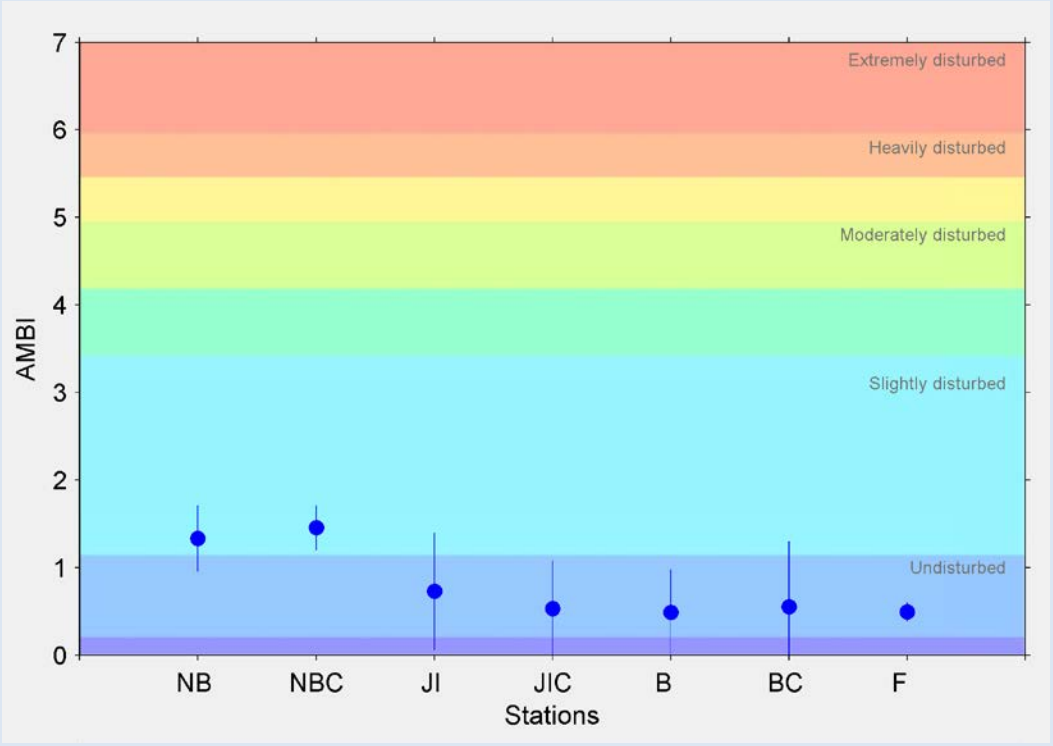
Area	Site	Shannon-Wiener diversity index (H')
Threshold		**≥ 3**
Big Bay	B 1	2.41
	B 2	2.02
	B 3	2.22
	B 4	1.51
	B 5	0.79
	B 6	0.83
	B 7	-
	B 8	-
	BC 1	1.64
	BC 2	2.52
	BC 3	1.40
	FF 1	2.05
	FF 2	-
	FF 3	2.00
North Bay	NB 1	2.12
	NB 2	2.21
	NB 3	2.69
	NB 4	2.64
	NB C 1	2.39
	NB C 2	1.85
	NB C 3	2.71
Jutten Island	JI 1	2.00
	JI 2	1.51
	JI 3	1.10
	JI C 1	2.53
	JI C 2	2.76
	JI C 3	0.67

Results and Discussion:

Macrofauna

AZTI organisation's Marine Biotic Index (AMBI)

- The AMBI score for each precinct was significantly lower than the prescribed threshold of AMBI = 3.3, placing them in the Oxic B category or higher.
- No differences between AMBI scores for impact sites and reference sites were detected in any of the ADZ precincts.
- The average AMBI scores indicate that Big Bay impact and reference, and Jutten Island impact and reference areas can be considered "Undisturbed" while both areas in North Bay are "Slightly disturbed".



Results and Discussion:

Macrofauna

Infaunal Trophic Index (ITI)

- In all cases the ITI for each ADZ precinct was above the prescribed threshold of >25, placing them in the Oxic B category or higher.
- No difference between the ITI at impact and reference sites within any of the three ADZ precincts.
- Based on the ITI the macrofaunal communities at the majority of sites were normal, or experiencing little anthropogenic impact.

- These biological indices provide a baseline condition for future monitoring to be compared to and indicate that the limited aquaculture operations at the time of sampling are having a negligible effect on benthic macrofauna present in these three ADZ precincts.

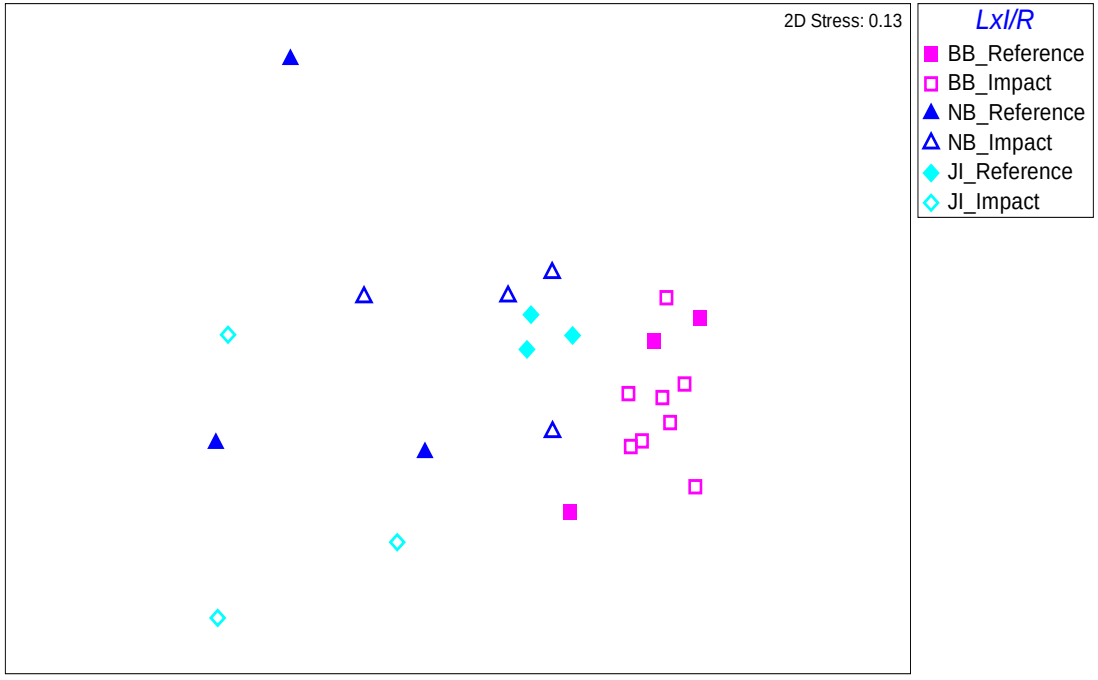
Area	Site	Infaunal Trophic Index (ITI)	ITI community description
Threshold		**≥ 25**	
Big Bay	B 1	67.3	Normal
	B 2	57.2	Normal
	B 3	66.1	Normal
	B 4	99.2	Normal
	B 5	99.7	Normal
	B 6	99.0	Normal
	B 7	-	
	B 8	-	
	BC 1	98.4	Normal
	BC 2	63.2	Normal
	BC 3	98.4	Normal
	FF 1	86.5	Normal
	FF 2	-	
	FF 3	90.3	Normal
North Bay	NB 1	65.5	Normal
	NB 2	78.9	Normal
	NB 3	46.9	Changed
	NB 4	74.5	Normal
	NB C 1	53.9	Changed
	NB C 2	87.5	Normal
	NB C 3	51.6	Changed
Jutten Island	JI 1	46.0	Changed
	JI 2	65.8	Normal
	JI 3	71.1	Normal
	JI C 1	87.7	Normal
	JI C 2	52.9	Changed
	JI C 3	97.7	Normal

Results and Discussion:

Macrofauna

Multivariate analysis

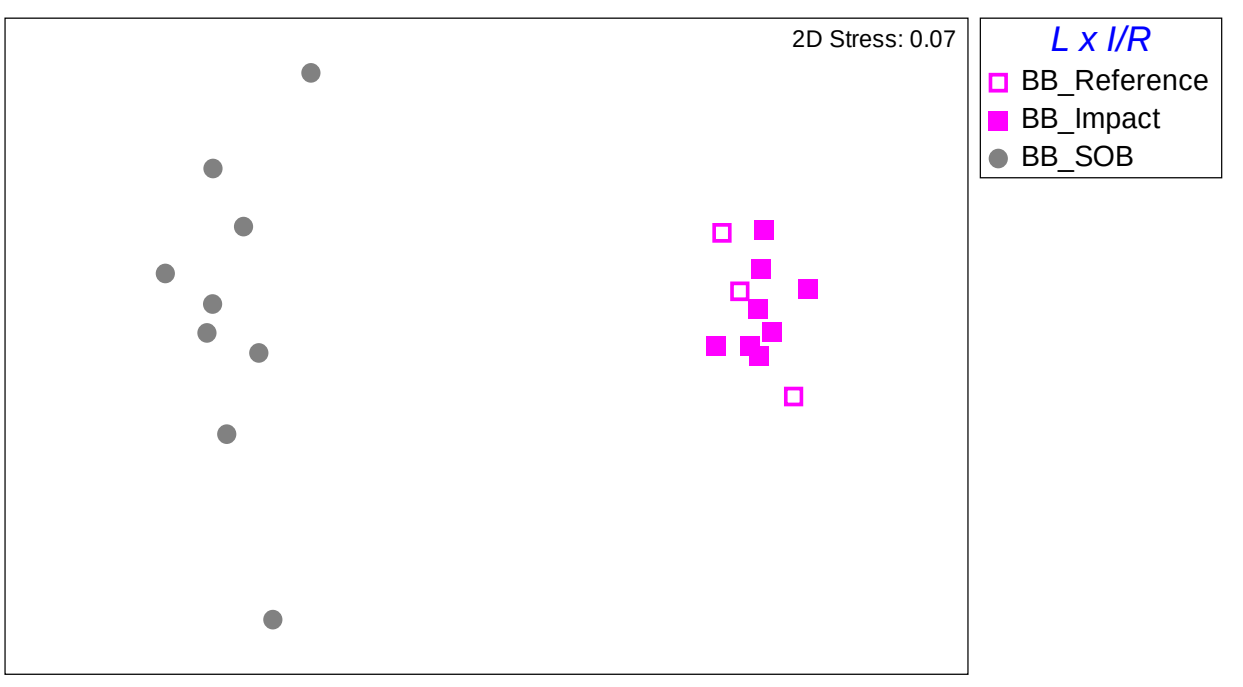
- MDS plot indicates macrofaunal communities present at the BB sites are clearly different to those at JI and NB.
- Both the reference and Impact sites in BB show a degree of similarity forming a distinct cluster with no obvious distinction between impact and reference sites.
- JI and NB share a degree of similarity with sites positioned in the same general area of the MDS.
- JI and NB - greater spacing between individual sites indicates a higher degree of within area variability.
- In the absence of aquaculture related impacts (e.g. JI), differences are likely to be linked to variability in physical and environmental parameters i.e. currents, wave exposure, water quality, sediment granulometry and depth.



Results and Discussion:

Macrofauna

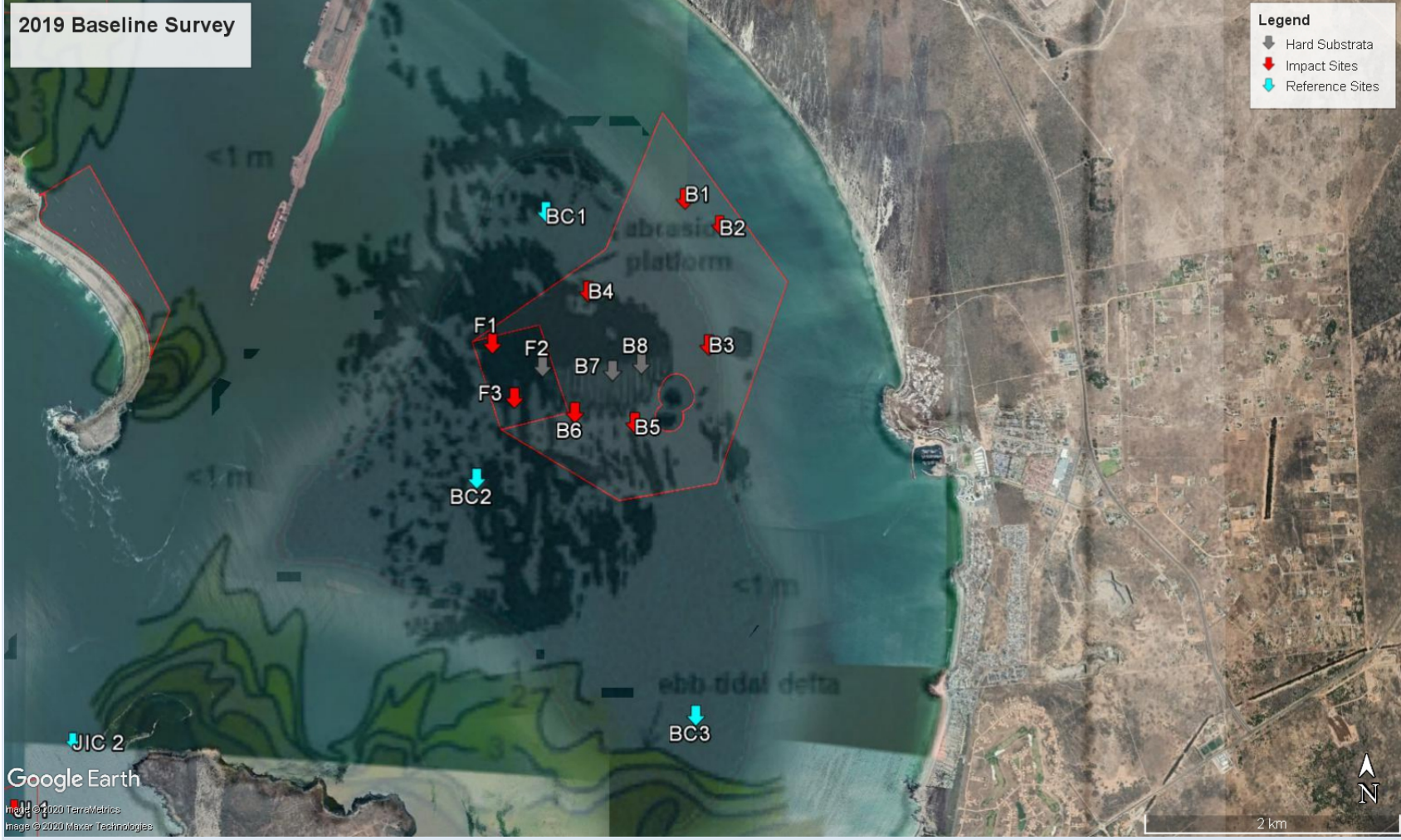
- Differences in macrofauna between the ADZ baseline study and SOB 2019 samples are attributed to sampling location with the SOB 2019 samples located on the perimeter of the Bay in sandy substrate, whilst ADZ Baseline samples are in the centre of the Bay in an area where an extensive abrasion platform with rock projecting above the soft sediment which may form reef.
- In summary, the univariate and multivariate analyses suggest that the aquaculture operations are currently having a negligible effect on **soft sediment** benthic macrofauna present in these ADZ lease areas.



Results and Discussion:

Presence of hard substrata/reef in Big Bay

- The marine specialist report for the Saldanha ADZ EIA considered subtidal reef habitat to be scarce in Saldanha Bay(Pulfrich 2018).
- Only identified Lynch blinder and North Bay blinder as important reef areas.
- Reports from divers during this assessment revealed the presence of calcrete rock at several sampling sites during the baseline survey (Capfish 2019).
- Difficulties in obtaining grab samples at several stations in Big Bay during 2020 (AR&M) sediment surveys also suggests that rock which may form reef is more widespread in Big Bay than originally suspected.
- Observations by ARM divers deploying water quality monitoring instruments during April 2020, also indicated reef in several areas of the Big Bay ADZ precinct.
- Subsequent literature review revealed the existence of an extensive abrasion platform (areas of exposed calcretre rock) throughout much of Big Bay (Flemming 2015).
- The distribution of the abrasion platform is overlaid on a map of Big Bay and the ADZ boundaries as well as the sampling sites on the following slide.

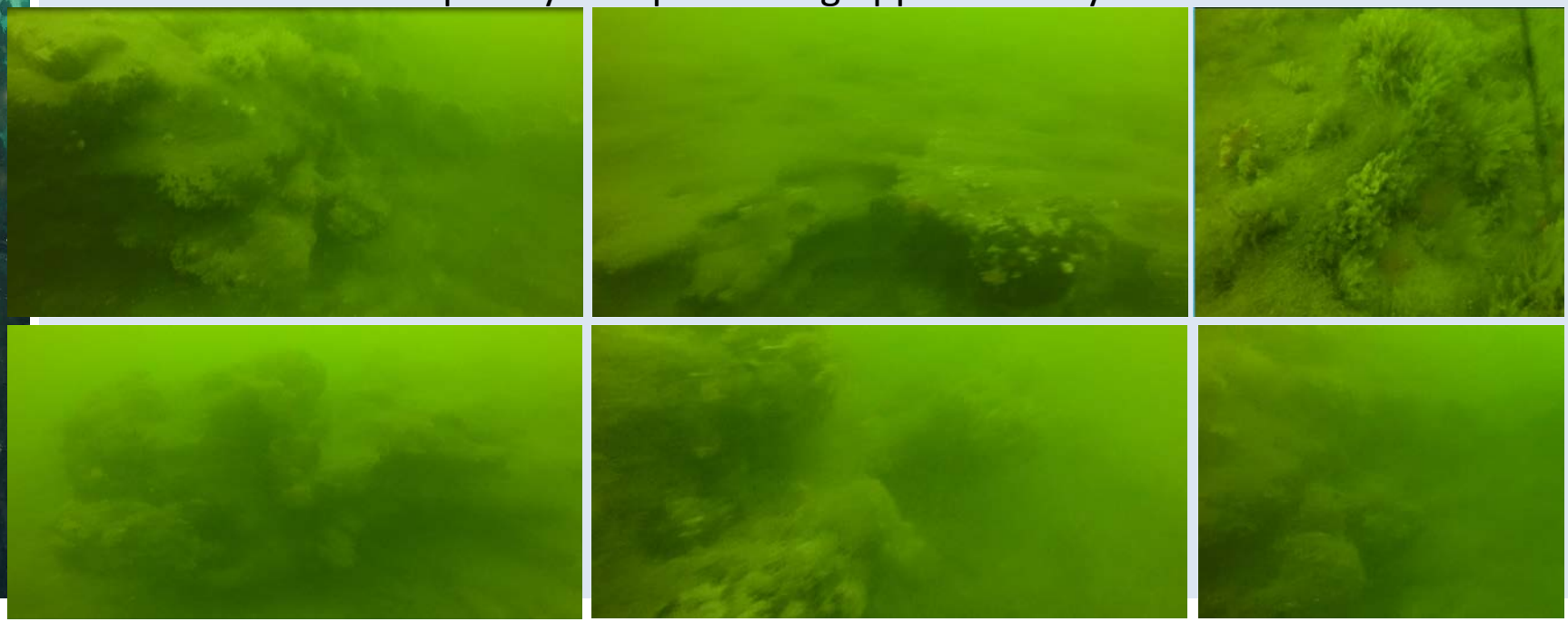


- It must be noted that Flemming's (2015) map is a rough overlay on a google earth image and the exact locations of the features depicted may not be accurate.
- The map indicating the extent of the abrasion platform dates from 1977, prior to the construction of the multipurpose terminal, which may have altered sediment deposition in BB, possibly altering the extent of the platform.

Results and Discussion:

Presence of hard substrata/reef in Big Bay

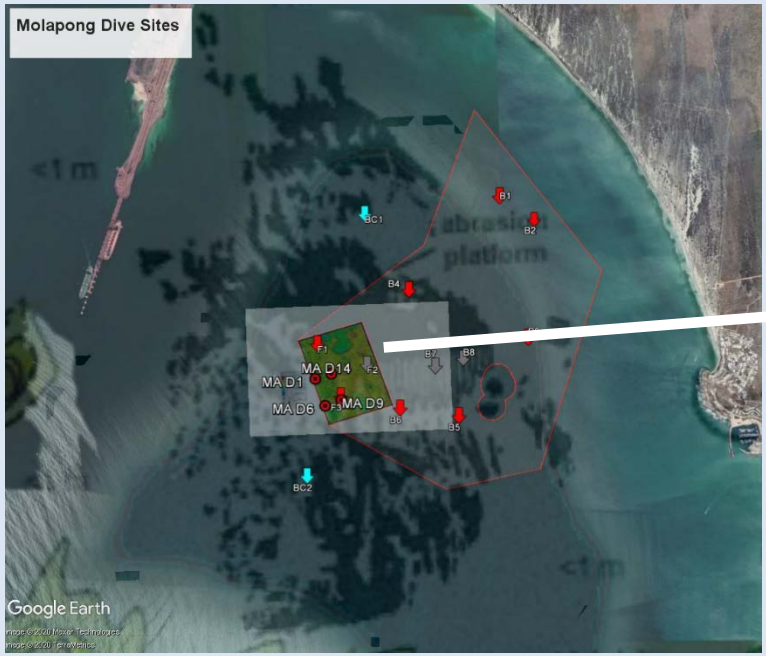
- The true extent of the abrasion platform is not known and nor are the biotic communities associated with it, as it is a largely unstudied habitat within Saldanha Bay.
- Underwater video footage obtained from one of the BB finfish lease holders (Molapong) revealed that the depth of sediment varied considerably within their lease area, and was frequently less than 50 cm.
- Videos of a small proportion of the lease area – dive sites 1 -15 (next slide).
- Visual evidence of patchy reef protruding approximately 1 m into water column.



Results and Discussion:

Presence of hard substrata/reef in Big Bay

- Molapong's bathymetry map of their lease area indicates extensive low-profile reef throughout the site (indicated by orange shading, approximately 13.2 – 14.8 m in depth).
- The green shading within the lease area (approximately 15.0 – 16.0 m in depth) indicates areas where soft sandy or muddy sediments would accumulate.
- The bathymetry shows a low-profile reef that is mostly < 1m in height from the sea floor; however, outcrops greater than 1 m may be present.



Results and Discussion:

Presence of hard substrata/reef in Big Bay

- Pictures of the rock/reef type habitat found in the finfish area were taken during instrument servicing in the finfish area on the 29th of June 2020.
- These images were taken in extremely poor visibility but indicate the presence of basket stars (Phylum Echinodermata), sponges (Phylum Porifera) and possibly Bryozoans. Before conclusions can drawn about the nature of the communities, specimens would need to be collected and identified.

Results and Discussion:

Presence of hard substrata/reef in Big Bay

- The Molapong diver video footage reveals that the visibility at the time (November 2019) was considerably better than that at the time of instrument servicing during (June 2020).
- West Coast Rock Lobster (*Jasus lalandi*) are evident in the video footage recorded from the Molapong dives was and were noted by AR&M divers deploying instruments.
- While Rock Lobster would benefit from increased organic matter originating from the aquaculture as a food source, their habitat may ultimately become smothered by fall off biofouling and culture animals.

Results and Discussion:

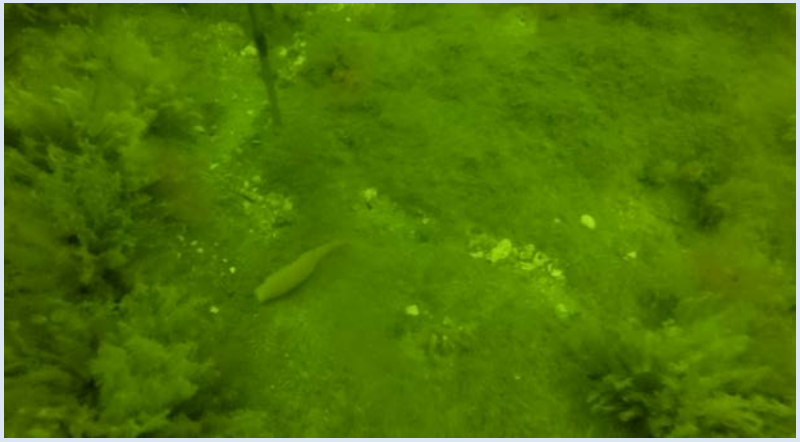
Presence of hard substrata/reef in Big Bay

- The initial marine ecology specialist study (SRK BAR 2017, appendix D2) and impact assessment (SRK BAR 2017, appendix F) of the Basic Assessment Report for the Saldanha Bay ADZ assessed impacts of the benthic environment assuming that soft sediment was present throughout the Big Bay ADZ precinct.
- The BAR identified Lynch Blinder in Big Bay as sensitive habitat and recommended a 100 m buffer zone.
- No further consideration was given to the presence of possible low-level reef being present in the ADZ.
- The marine ecology specialist study recommended a bathymetry survey should be undertaken and a bathymetric map should be submitted along with a sketch of the important habitats in the lease area as well as adjacent potentially sensitive and valuable habitats (conservation areas, biogenic habitats and reefs) (SRK BAR 2017, appendix D2, Pg. 82).

Results and Discussion:

<u>Presence of hard substrata/reef in Big Bay</u>
<u>Recommendations</u>

- Given the presence of low-lying reef detected during the baseline surveys and instrument deployments in the finfish area in Big Bay, it is recommended that a side scan sonar survey be undertaken across the whole of Big Bay to establish the actual extent of this reef and that reef biota be surveyed.
- Once the extent and nature of the reef and associated benthic communities have been assessed and quantified, the management measures, mitigation measures and monitoring measures should be reassessed.



Conclusions:

Sediment physico-chemical properties

- Aquaculture at current production levels in Big Bay and North Bay is having a negligible effect of sediment physico-chemical properties.
- Data collected at Jutten Island forms a good baseline for these properties prior to aquaculture development in this precinct.
- Trace metal levels for the finfish lease area in Big Bay also represent baseline data as no finfish aquaculture is currently operational on this site.

Macrofauna

Biological indices:

- The Shannon-Wiener diversity index (H') in Saldanha Bay is naturally lower than the prescribed threshold of H' = 3.
- This threshold should be adjusted to a more applicable value for future surveys.
- The ITI for each precinct was significantly above the prescribed threshold of >25.
- The AMBI score for each precinct was significantly lower than the prescribed threshold of AMBI = 3.3.
- Both the ITI and AMBI place all the stations in either the Oxic A or B categories.
- Generally, these data indicate that the aquaculture operations are having a negligible effect on benthic macrofauna present in these three ADZ precincts

Conclusions:

Macrofauna

Multivariate analyses

- Macrofaunal communities present at the BB sites are clearly different to those at JI and NB.
- Likely to be linked with differences in the physical and environmental parameters i.e. currents, wave exposure, water quality, sediment granulometry and depth.
- Both the reference and Impact sites in BB show a degree of similarity forming a distinct cluster with no obvious distinction between impact and reference sites.
- The Outer Bay precincts (NB and JI) exhibit greater macrofaunal assemblage variability.

Overall, the univariate and multivariate analyses presented here suggest that the aquaculture operations are currently having a negligible effect on soft sediment benthic macrofauna present in these lease areas. Ongoing monitoring will ascertain if this remains the case at future production levels.

These findings notwithstanding, it is important to note that change in sediment physico-chemical properties and benthic infauna are not appropriate indicators of impacts on rocky habitat (as sediment is absent), which seems to be widespread in Big Bay.

Conclusions:

<u>Presence of hard substrata and reef in the big bay precinct:</u>

- The presence of hard substrata and low lying reef (besides that identified at Lynch Blinder) within the Big Bay ADZ precinct has been highlighted for the first time.
- The reef appears to be low-profile that is mostly < 1m in height, although some outcrops greater than 1 m in height are present.
- The extent and nature of the reef needs to be quantified throughout Big Bay which is frequently impacted by scouring and sand deposition.
- The nature of the macrofaunal/epifaunal assemblages associated with the reef needs to be quantified.
- Once the above aspects are completed, the impacts of aquaculture in the Big Bay precinct in light of there being reef present should be re-assessed.

Thank you

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