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(RESEARCH ARTICLE)

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Assessment of marine environment by ABC (abundance biomass comparison) analysis—A case study on western offshore area of Arabian Sea

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Abstract

Assessment of the variations in marine ecosystem can be effectively monitored using benthic fauna because pollutants from any source will ultimately end in the seabed. The benthic communities play an important role in the transfer of materials from primary production through detrital pool into higher tropic levels, including commercially exploitable fish. Majority of the benthic fauna are sedentary and sessile in nature and cannot avoid any environmental perturbation, hence are considered sensitive indicator of change in the environment caused by natural and anthropogenic disturbances. Based on the analysis of abundance and biomass of benthic communities, one very important and effective study in analyzing marine environment i.e. ABC (Abundance-Biomass Comparison) has been adopted in this paper.

Keywords: E&P activities; Mumbai High; ABC curve

1. Introduction

ABC curves have a theoretical background in classical evolutionary theory of r- and k-selection. In undisturbed states, the community is supposed to be dominated by k-selected species (slow-growing, large, late maturing), and the biomass curve lies above the abundance curve. With increasing disturbance, slow-growing species cannot cope, and the system is increasingly dominated by r-selected species (fast-growing, small, opportunistic), and the biomass curve will be below the abundance curve. The difference between the two curves is given by the W-statistic, which represents the area between them. The ABC method takes into account the number of species included in the analysis. [1] [2] An advantage of the method is that an appropriate data set for any area or time should allow the status of the community to be evaluated without the need for a spatial or a temporal control against which to compare the index obtained, because the biomass is compared with the abundance for the same time and place. [1] [2]

This paper aims to explore the validity and possibility of this method by considering the abundance and biomass data around the 21 ONGC offshore installations and drilling rigs (R-12A, HRA, NLM, BHS, NA, NQ, ICP, SHP, BLQ, B-193, B192, TPP-TCPP, WO-16, Sagar Gaurav B-155-B, B-127, Great drill Chaaru B-127N-C, B-48, GS-OSN-2004/1, GK-28/42, TPP-TCPP and reference points around Mumbai High, South Basin, Neelam Basin, Heera Basin during 2020-21.

2. Experimental procedure

2.1. Study area

The study area extends geographically from 18°16'20.32"N to 22°37'15.27"N, 71° 1'40.59"E to 72°30'0.00"E covering oil and gas fields of ONGC in the Western continental shelf. The cruise route (Fig: 1) and coordinates/water depth of the

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installations are given bellow.

Table 1(a) Details of sampling locations - platforms & rigs

Sr. No.	Platform	Latitude	Longitude
1	R-12A (Ratnagiri)	18°16'20.32"N	72°22'48.52"E
2	HRA (Heera)	18°34'37.20"N	72°14'27.00"E
3	NLM (Neelam)	18°42'16.80"N	72°20'17.40"E
4	B-193	18°55'35.68"N	72° 2'29.14"E
5	BLQ	19°12'16.80"N	72° 6'27.00"E
6	WO16	18°58'16.34"N	71° 37'18.03"E
7	NBP Field	18°36'9.93"N	71° 1'40.59"E
8	B-192-5	19°10'37.02"N	70°57'43.02"E
9	ICP	19°20'30.00"N	71°18'0.00"E
10	BHS	19°22'12.00"N	71°21'24.00"E
11	SHP	19°16'24.00"N	71°25'37.20"E
12	SCA	19°25'2.25"N	71°23'22.08"E
13	NA	19°34'15.00"N	71°21'32.40"E
14	NQ	19°34'15.00"N	71°21'32.40"E
15	Sagar Gaurav B-155-B	19°25'23.57"N	71° 30'55.42"E
16	B-127	19°28'41.99"N	71°46'39.99"E
17	Great drill Chaaru B-127N-C	19°36'23.07"N	71° 47'48.87"E
18	B-48	19°37'32.77"N	71° 2'23.97"E
19	GS-OSN-2004/1	21°37'23.26"N	68° 26'32.99"E
20	GK-28/42	22°37'15.27"N	68° 27'08.98"E
21	TPP-TCPP	20°36'3.20"N	72° 2'10.20"E

Table 1(b) Details of sampling locations - reference points

Reference Locations	Sampling Location Number	Latitude	Longitude
Mumbai High Reference Point	MHRF-1	19°48'55.00"N	71° 4'30.00"E
	MHRF-2	19°34'0.00"N	71° 4'30.00"E
	MHRF-3	19°18'0.00"N	71° 4'30.00"E
	MHRF-4	19° 4'20.00"N	71° 4'30.00"E
	MHRF-5	19°48'55.00"N	71°16'00.00"E
	MHRF-6	19°48'55.00"N	71°30'0.00"E
	MHRF-7	19°48'55.00"N	71°41'30.00"E
	MHRF-8	19°36'0.01"N	71°41'30.00"E
	MHRF-9	19°22'0.03"N	71°41'30.00"E
	MHRF-10	19° 4'20.01"N	71°41'30.00"E
	MHRF-11	19° 4'20.00"N	71°32'0.00"E
	MHRF-12	19° 4'20.00"N	71°18'0.03"E
South Basin Reference Point	S-Basin-1	19°26'0.00"N	71°54'30.00"E
	S-Basin-2	19°26'0.00"N	71°54'30.00"E
	S-Basin-3	18°49'0.00"N	71°54'30.00"E
	S-Basin-4	18°49'0.00"N	72°16'00.00"E

Reference Locations	Sampling Location Number	Latitude	Longitude
Neelam Basin Reference Point	Satellite N-1	18°56'50.00"N	72°11'20.00"E
	Satellite N-2	18°31'20.00"N	72°11'20.00"E
	Satellite N-3	18°31'20.00"N	72°30'0.00"E
	Satellite N-4	18°56'50.00"N	72°30'00.00"E
Heera Basin Reference Point	Satellite H-1	18°47'45.00"N	72° 5'20.04"E
	Satellite H-2	18°20'0.00"N	72° 5'20.00"E
	Satellite H-3	18°20'0.00"N	72°26'0.00"E
	Satellite H-4	18°47'45.00"N	72°26'0.00"E

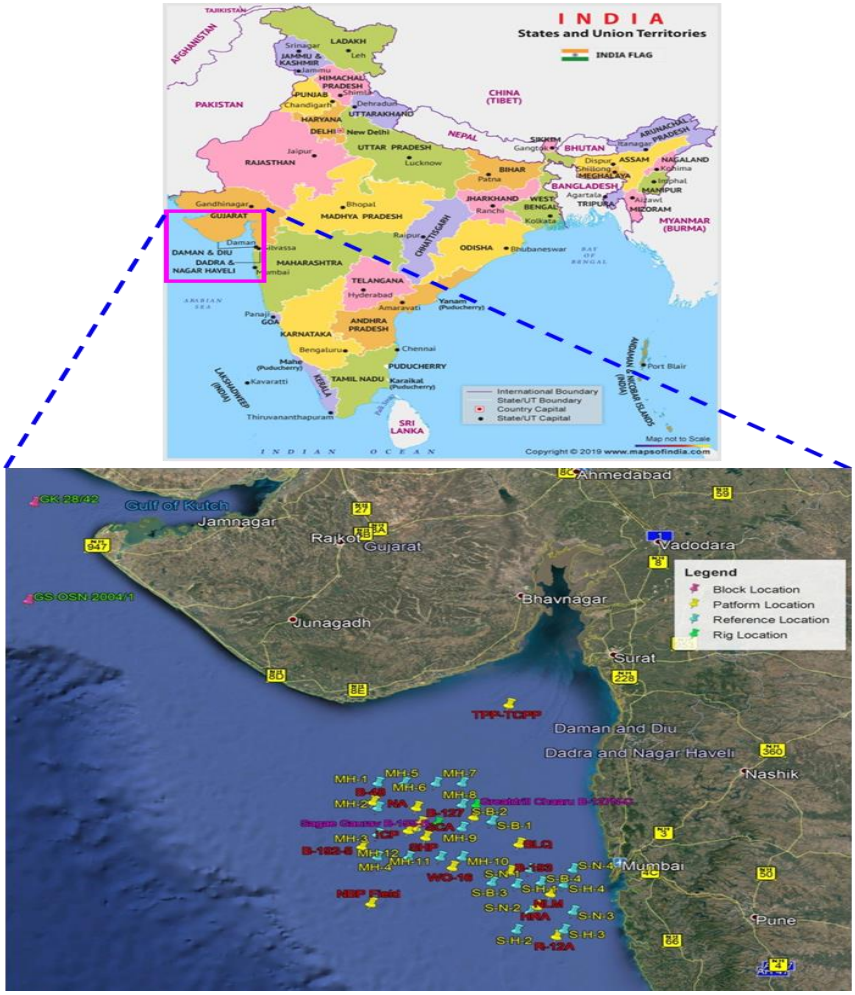


Figure 1 Index map

2.2. Field sampling

Based on OSPAR Guideline[3] (Fig: 2) and keeping in view the pipeline network in the vicinity of the platforms in addition to sea state and manoeuvrability of the vessel around the installations.

Samples are collected at stations scattered in circles of 250m, 500m, 1000m, 2000m and 4000m surrounding each installation. Reference samples were collected beyond 10 kms from the installations. Sea bottom dwelling organisms or benthos are collected at each stations by lowering a Van Veen Grab having penetration depth of 10 cms and variable surface coverage of 587.5 cm2 (small grab) and 1035 cm2 (large grab).

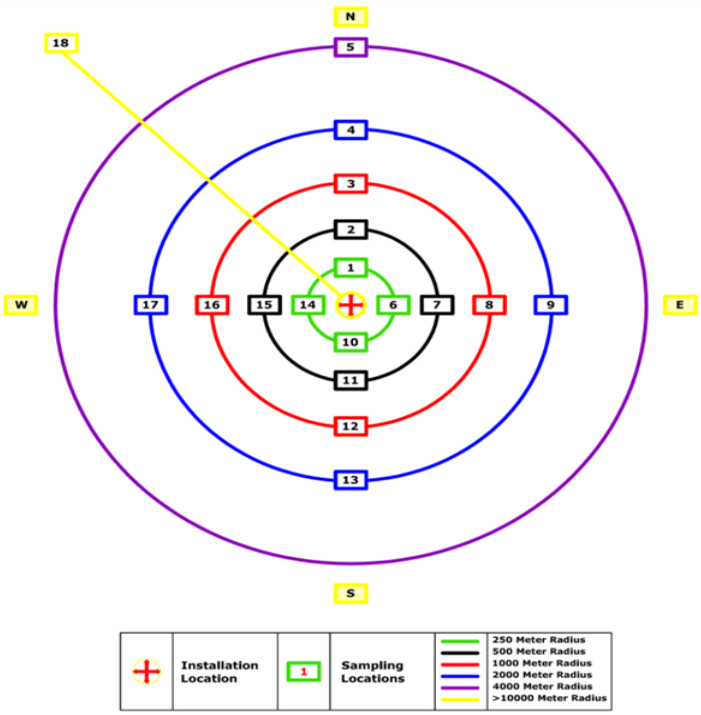


Figure 2 OSPAR Commission Sampling Strategy

2.3. Laboratory analysis

All the macro faunal samples were processed on board after 48 hrs. of collection using 500 micron stainless steel mesh screen in filtered seawater and material retained on sieve mesh were fixed in 5% formalin Rose Bengal. In biological laboratory, all the fauna was stored, identified up to the lower possible level under the Microscope. Biomass (wet weight) was measured by blotting the sample on a blotting paper and weight was taken by direct weighing on balance. The biomass was calculated in g/m2.

2.4. Data analysis

For construction of ABC curve, Primer (version 6), a software made for statistical analysis for ecological study, was used. Abundance i.e. mean density of different macro benthic species around each stations of an installation are counted as numbers/ meter2 and the total biomass of different stations are measured as gm. /m2 as listed tables (Table1 & Table 2). Now, the tables of abundance and biomass of different stations of a particular installation are incorporated in the software (primer V6). After running the software as “cumulative dominance curve” one ABC curve is formed where in y- axis we will get “cumulative dominance %” and in x-axis “species rank” will appear. The difference between the two curves is given by the W-statistic, which represents the area between them.

3. Results and discussion

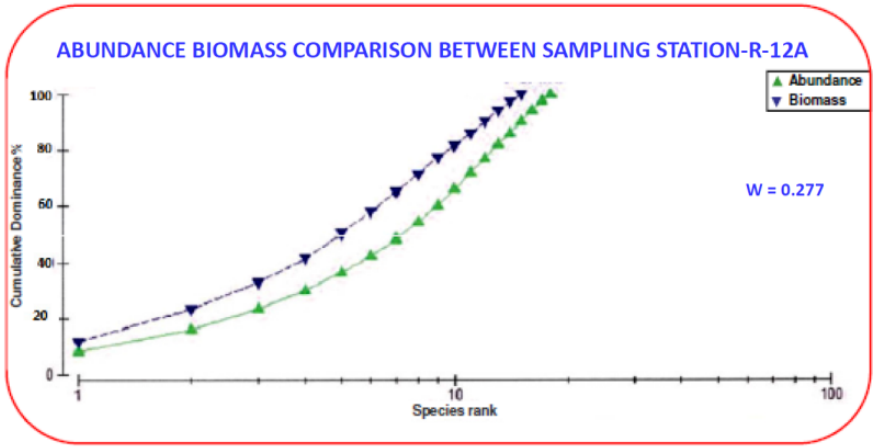
- In undisturbed communities the biomass is dominated by one or a few large organisms, leading to an elevated biomass curve, each of these groups are represented by rather few individuals so they do not dominate the abundance curve, which shows a typical diverse equitable distribution.
- Under moderate pollution or disturbances the large competitive dominants are eliminated and the inequality in size between the numerical and biomass and biomass dominates is reduced so that the biomass and abundance curves are closely coincident and may cross each other one or more time (Clarke and Warwick, 2001)
- As pollution become more severe , benthic communities become increasingly dominated by one or a few opportunistic group, which whilst they dominate the numbers do not dominate the biomass, because they are very small bodied, Hence the abundance curve lies above the biomass curve throughout its length(Clarke and Warwick, 2001).

Table 2 Abundance of Macro Fauna at various stations for different installations (in No/M2)

Installations	**STATIONS**																	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**
Heera	310	310	350	280	300	300	330	370	340	330	340	370	330	440	290	320	330	290
Neelam	320	310	250	290	400	300	430	310	300	380	360	420	340	410	380	410	390	430
BLQ	420	440	620	400	430	420	420	440	550	380	450	490	540	440	540	440	530	500
R-12A	250	240	260	280	270	220	240	280	360	290	330	250	190	270	240	270	260	330
B-193A	290	240	280	220	320	360	330	290	350	370	350	270	300	350	280	240	250	330
WO-16	330	310	300	240	280	300	300	280	350	270	290	310	330	290	280	320	270	320
NBP Field	360	360	350	340	400	330	290	270	390	340	300	180	290	280	310	320	320	390
NA	250	280	260	250	230	360	300	320	420	370	360	340	250	310	340	410	260	310
NQ	320	200	230	360	230	300	280	290	240	380	220	250	320	220	280	240	230	330
SCA	190	180	210	270	200	240	220	280	240	280	230	310	270	250	200	180	270	280
SHP	270	290	340	290	360	280	400	250	330	380	380	330	440	430	290	410	260	320
ICP	280	280	410	300	370	330	240	410	360	300	450	270	330	360	350	360	370	240
BHS	230	380	350	470	330	330	370	370	430	330	310	390	510	460	410	360	340	450
B-155-B	270	330	290	460	410	360	440	350	280	320	330	400	320	310	360	310	330	300
B-127	310	370	220	300	380	320	340	290	290	340	380	380	340	340	350	360	340	350
B-192-5	320	330	310	190	290	300	270	220	340	250	380	290	310	260	390	250	310	350
B-127N-C	310	310	280	400	470	350	430	320	350	390	360	360	290	310	360	340	340	360
B-48	140	270	160	160	170	240	250	210	420	280	230	250	290	240	200	230	250	300
GS-OSN-2004/1	280	310	210	310	280	430	270	290	260	200	200	310	190	420	220	190	200	390
GK-28/42	330	320	290	370	480	360	290	390	310	390	490	330	310	310	350	300	420	320
TPP-TCPP	180	250	260	260	170	220	160	170	260	180	170	380	200	250	230	280	230	280
MHRF	430	410	360	440	370	260	510	330	420	410	390	380						
S-BASIN	350	300	310	240														
SATELLITE	290	400	300	340	310	340	240	330	290									

Table 3 Biomass of Macro Fauna at various stations around different Installations (gm/M2)

Installations	**STATIONS**																	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**
Heera	4.52	3.95	3.47	2.89	3.21	3.19	3.58	3.89	4.1	3.14	3.29	3.78	3.19	6.21	4.22	3.44	3.56	4.12
Neelam	3.24	3.14	2.98	3.14	4.12	3.45	5.22	3.19	2.98	3.59	2.87	5.04	3.25	3.68	3.74	3.49	2.99	3.48
BLQ	3.58	4.12	6.77	4.66	3.98	3.47	3.45	3.68	5.34	3.19	4.15	5.62	5.11	4.1	4.87	3.66	6.23	4.77
R12A	3.01	3.65	2.84	4.12	3.84	3.14	3.12	3.58	3.78	4.1	5.12	3.14	2.98	3.74	3.59	2.84	2.95	5.22
B193A	3.45	2.88	3.86	2.96	3.02	4,11	3.22	2.48	3.56	3.15	4.55	2.78	3.14	3.24	3.41	2.91	2.86	2.78
WO-16	3.48	3.41	2.98	2.48	2.99	3.48	2.58	3.47	5.23	3.47	2.69	3.25	4.44	3.26	2.98	4.45	3.58	4.15
NBP Field	3.48	4.12	3.98	3.47	5.34	3.45	2.48	2.69	3.44	3.16	2.98	2.48	3.25	3.14	3.68	3.17	3.58	4.22
NA	3.57	3.96	3.61	3.48	3.42	4.12	4.01	3.65	5.12	4.24	4.35	4.22	3.59	4.15	4.36	5.01	3.74	3.15
NQ	4.21	2.56	2.84	4.69	2.89	2.99	2.48	4.01	3.69	4.65	2.84	2.96	3.1	2.84	3.69	2.81	3.71	3.24
SCA	2.69	2.54	3.14	3.57	3.26	3.47	3.47	3.68	3.48	3.69	3.54	3.15	3.56	3.64	3.29	2.48	3.48	3.89
SHP	3.15	3.48	4.15	3.14	4.12	3.58	5.24	3.56	4.26	4.35	4.44	4.36	4.36	4.32	3.58	4.68	4.12	4.36
ICP	3.12	3.47	5.33	2.85	3.14	3.19	3.11	4.98	3.45	3.12	5.64	3.1	3.14	3.26	3.54	3.68	3.49	2.98
BHS	3.24	3.47	3.26	5.1	3.47	3.26	3.48	3.69	4.02	3.95	3.17	3.69	6.33	4.36	3.59	3.47	3.24	5.13
B-155-B	2.85	4.35	3.15	5.14	3.96	4.12	5.01	4.26	3.14	4.23	4.12	4.26	4.21	4.11	4.29	4.36	4.16	4.1
B-127	4.32	4.58	3.14	2.96	3.41	3.12	3.25	3.56	4.12	4.21	4.26	4.23	4.1	4.06	3.48	3.51	3.11	3.19
B-192-5	3.68	3.48	3.25	2.87	3.14	3.45	2.96	2.47	3.89	3.47	4.1	3.11	2.58	2.47	3.14	2.96	3.15	3.17
B-127N-C	4.29	4.21	3.41	5.12	6.21	4.56	6.24	4.35	4.68	5.12	4.68	4.89	3.48	4.26	4.69	4.59	4.65	4.69
B-48	2.45	3.14	2.69	2.74	2.86	3.14	3.26	3.1	5.14	3.69	3.25	3.41	3.74	3.36	3.14	3.41	3.15	3.57
GS-OSN-2004/1	3.68	2.98	2.45	3.01	3.45	4.13	3.68	3.89	3.48	2.69	2.75	3.12	2.63	4.23	3.15	2.98	3.11	4.12
GK-28/42	3.31	3.12	2.81	3.69	4.12	3.15	3.96	4.12	3.58	4.16	5.03	3.26	3.65	3.16	3.75	3.45	4.33	3.42
TPP-TCPP	2.14	2.69	2.75	2.81	2.36	2.48	2.17	2.36	3.16	2.65	2.45	3.18	2.69	2.74	2.69	2.69	3.15	3.59
MHRF	5.12	5.01	4.25	4.36	3.48	3.16	4.69	3.54	4.02	3.69	3.48	3.49						
S-BASIN	3.19	2.98	3.14	2.98														
SATELLITE	3.15	3.89	3.48	3.59	3.11	3.69	2.48	3.62										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0
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10
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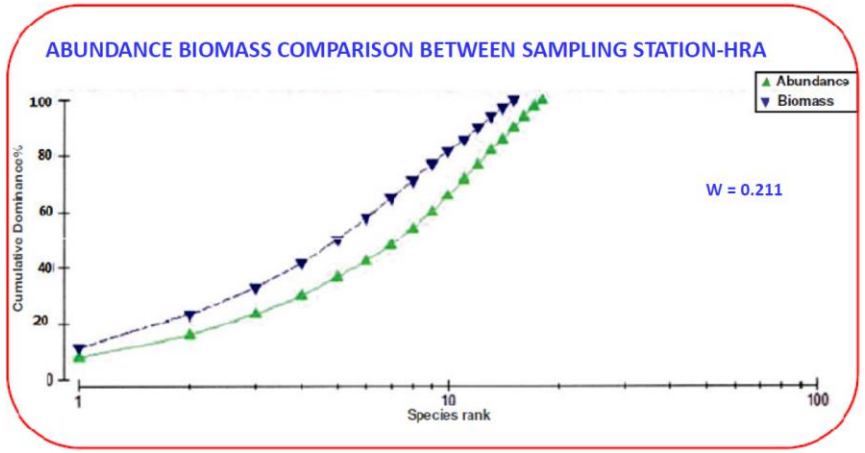
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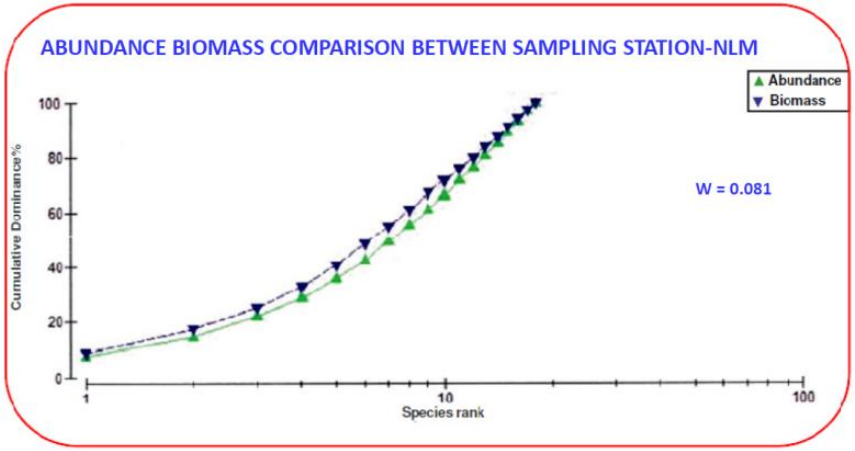
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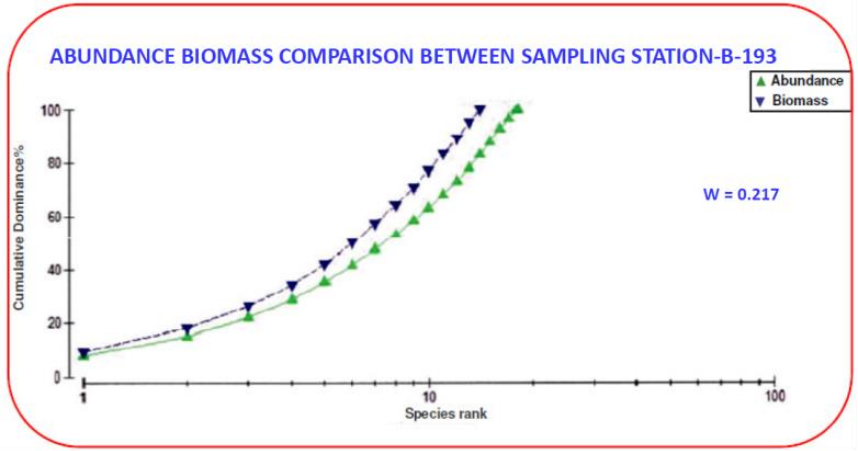
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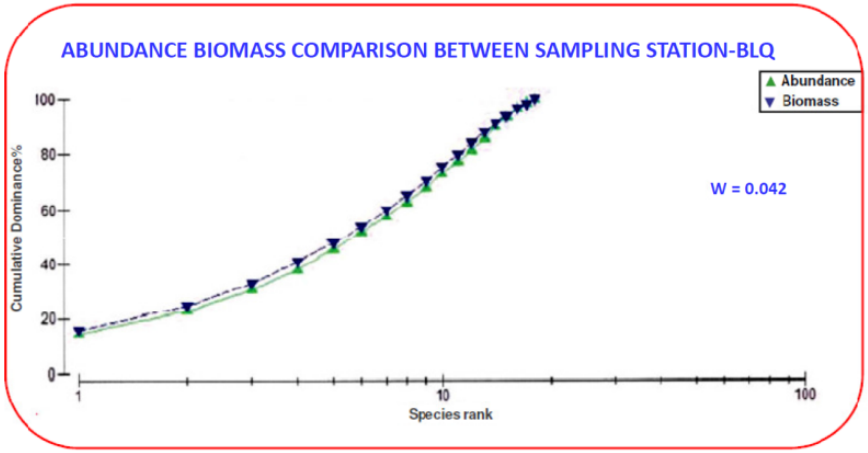
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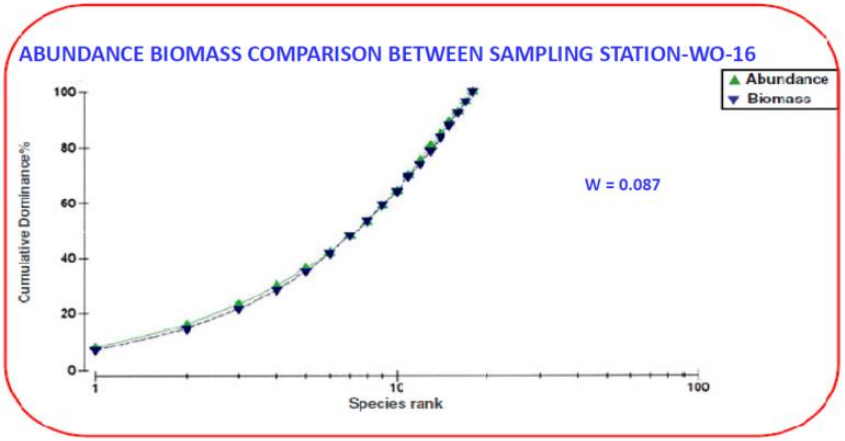
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Species rank
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60
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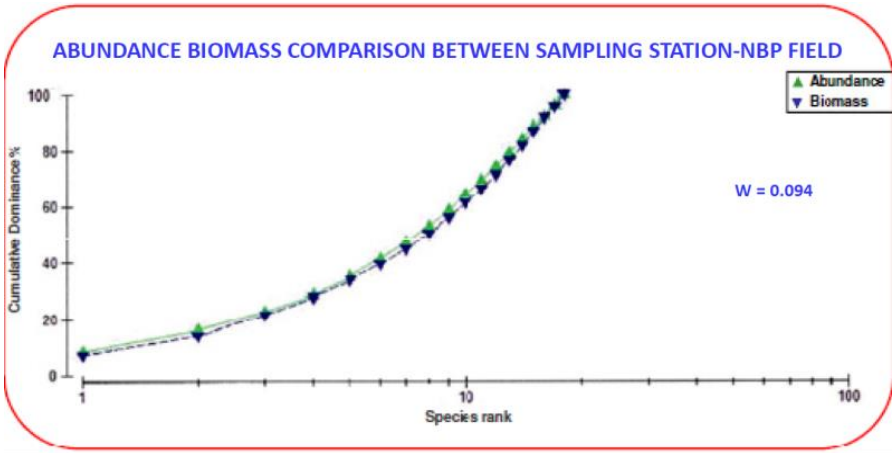
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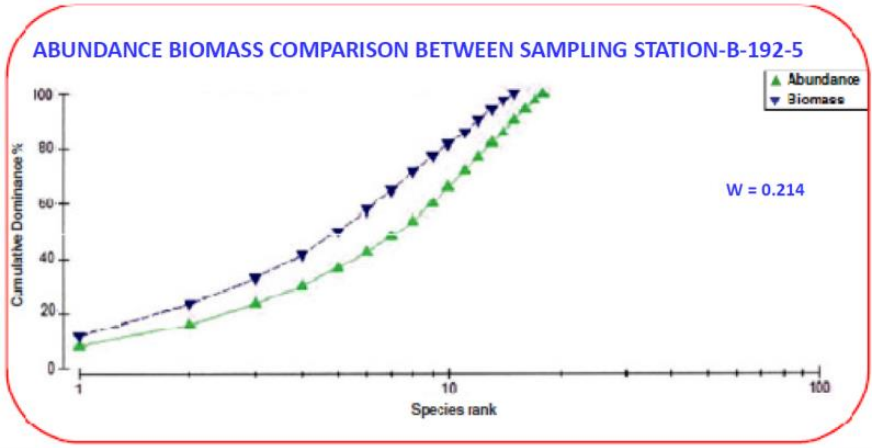
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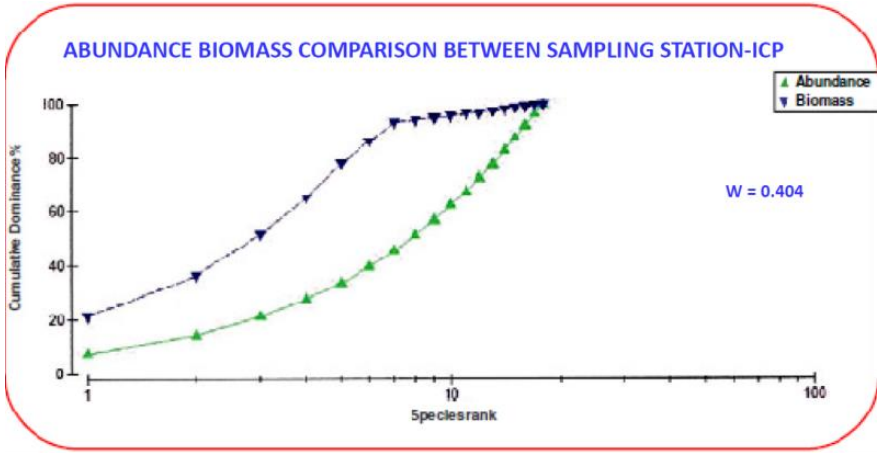
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Abundance
Biomass
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Cumulative Dominance %
Species rank
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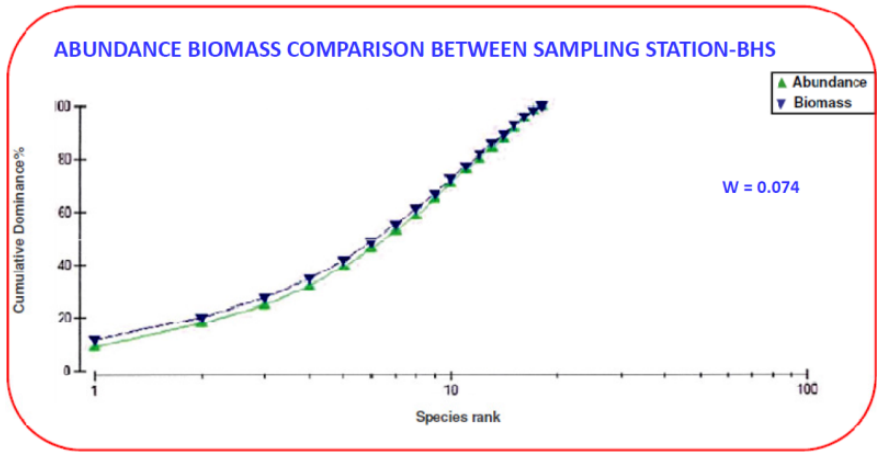
60
80
100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Abundance
Biomass
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Cumulative Dominance %
Species rank
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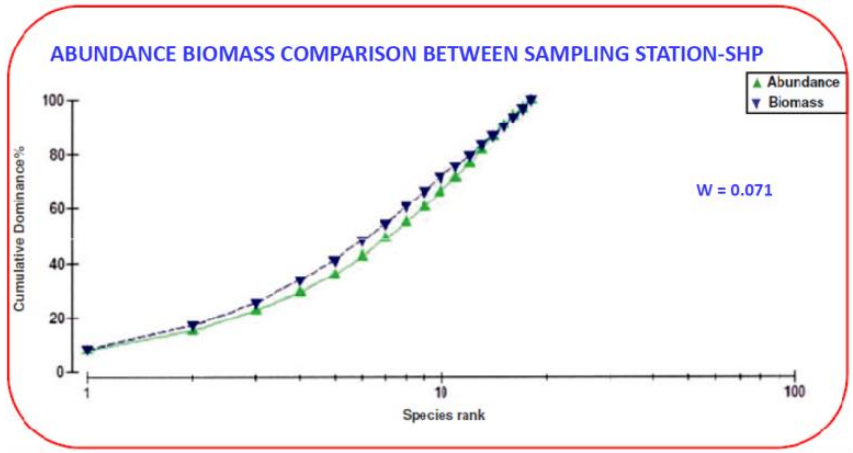
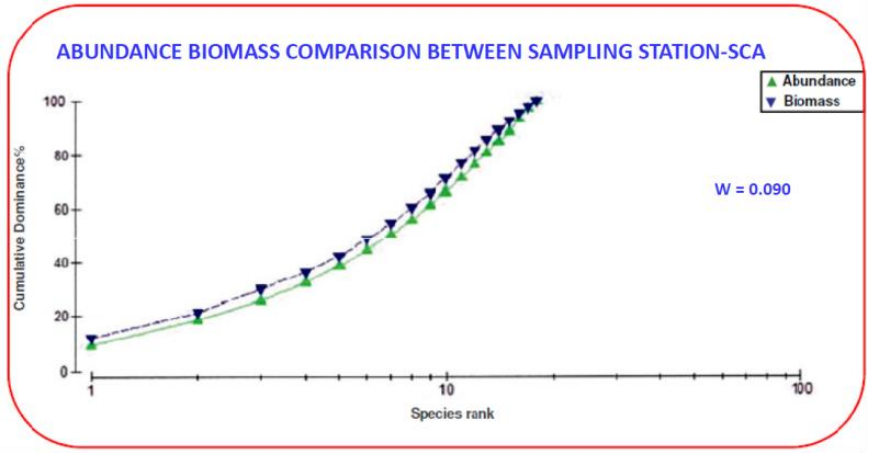
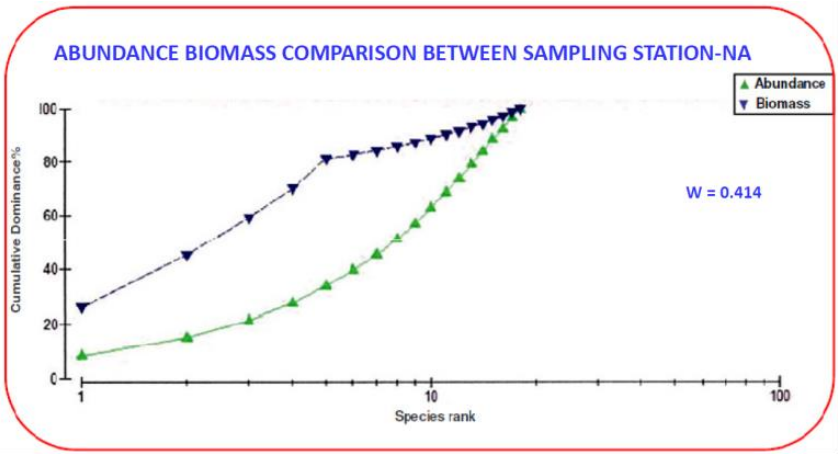
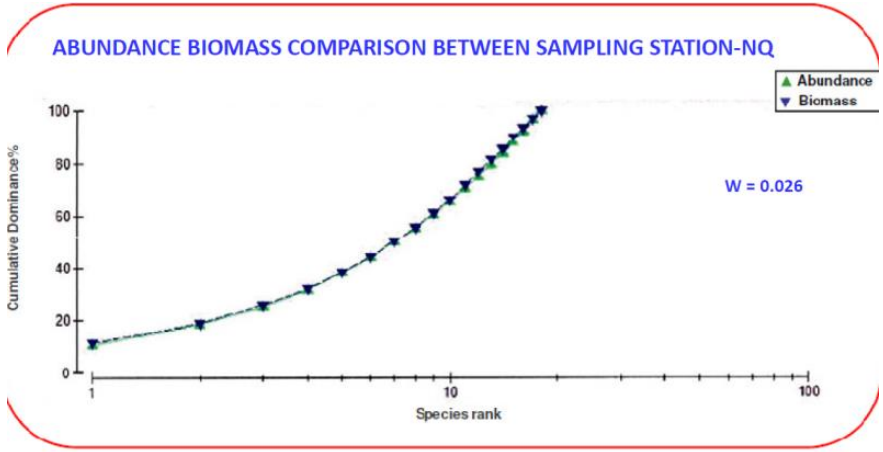
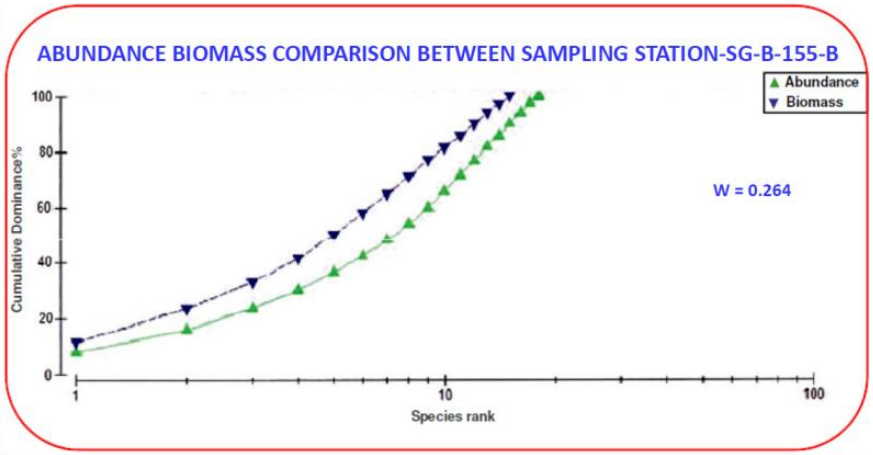
10
100
0
20
40
60
80
100

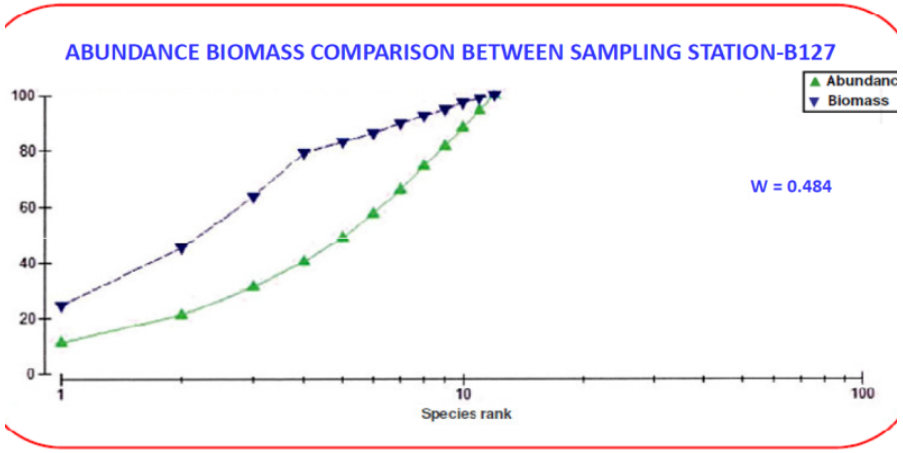

ABUNDANCE BIOMASS COMPARISON BETWEEN SAMPLING STATION-SHP
Abundance
Biomass
W = 0.071
Cumulative Dominance %
Species rank
1
10
100
0
20
40
60
80
100

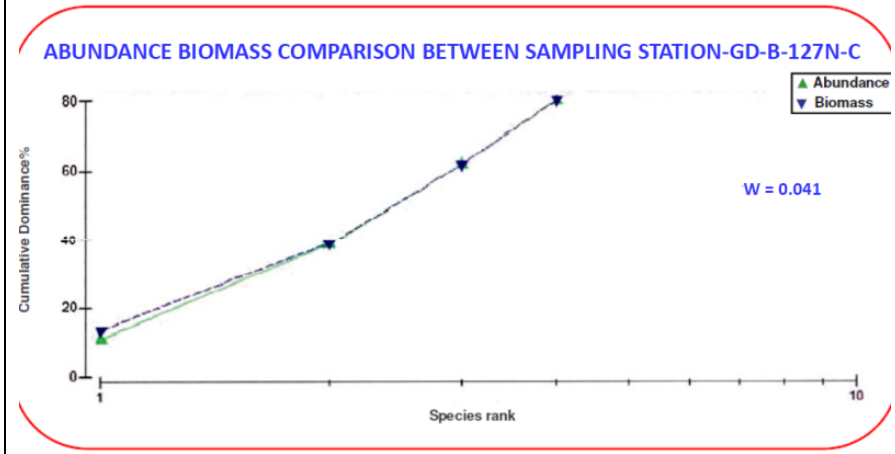

ABUNDANCE BIOMASS COMPARISON BETWEEN SAMPLING STATION-SCA
Abundance
Biomass
W = 0.090
Cumulative Dominance %
Species rank
1
10
100
0
20
40
60
80
100

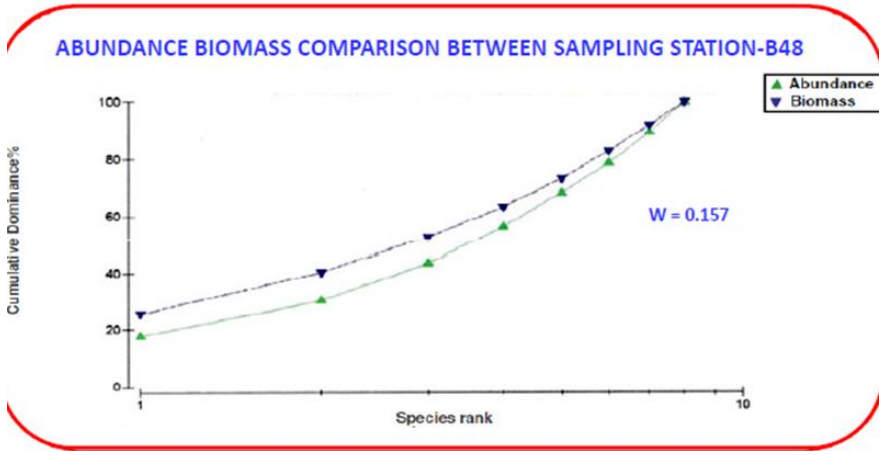

ABUNDANCE BIOMASS COMPARISON BETWEEN SAMPLING STATION-NA
Abundance
Biomass
W = 0.414
Cumulative Dominance%
Species rank
0
20
40
60
80
100
1
10
100

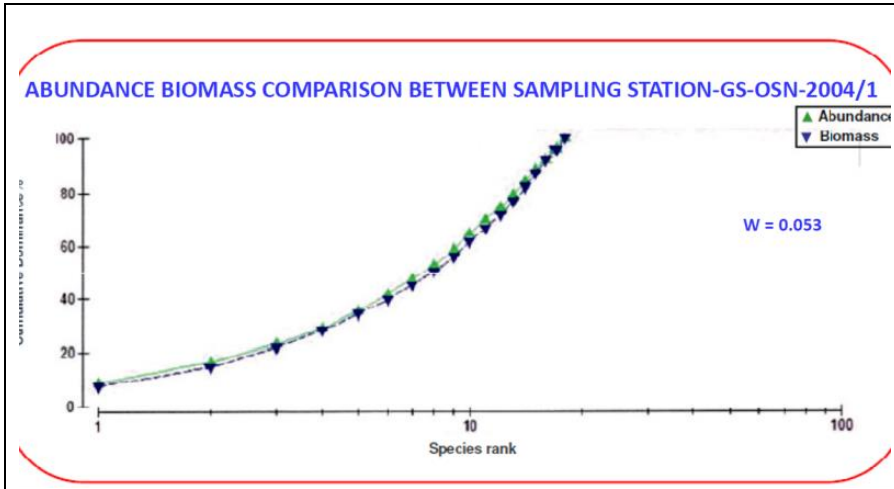

ABUNDANCE BIOMASS COMPARISON BETWEEN SAMPLING STATION-NQ
Abundance
Biomass
W = 0.026
Cumulative Dominance%
Species rank
0
20
40
60
80
100
1
10
100

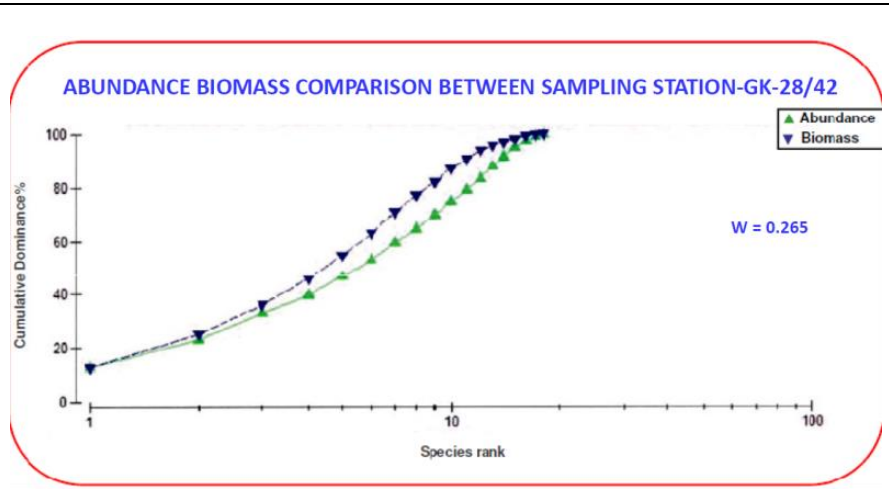

ABUNDANCE BIOMASS COMPARISON BETWEEN SAMPLING STATION-SG-B-155-B
Abundance
Biomass
W = 0.264
Cumulative Dominance%
Species rank
0
20
40
60
80
100
1
10
100

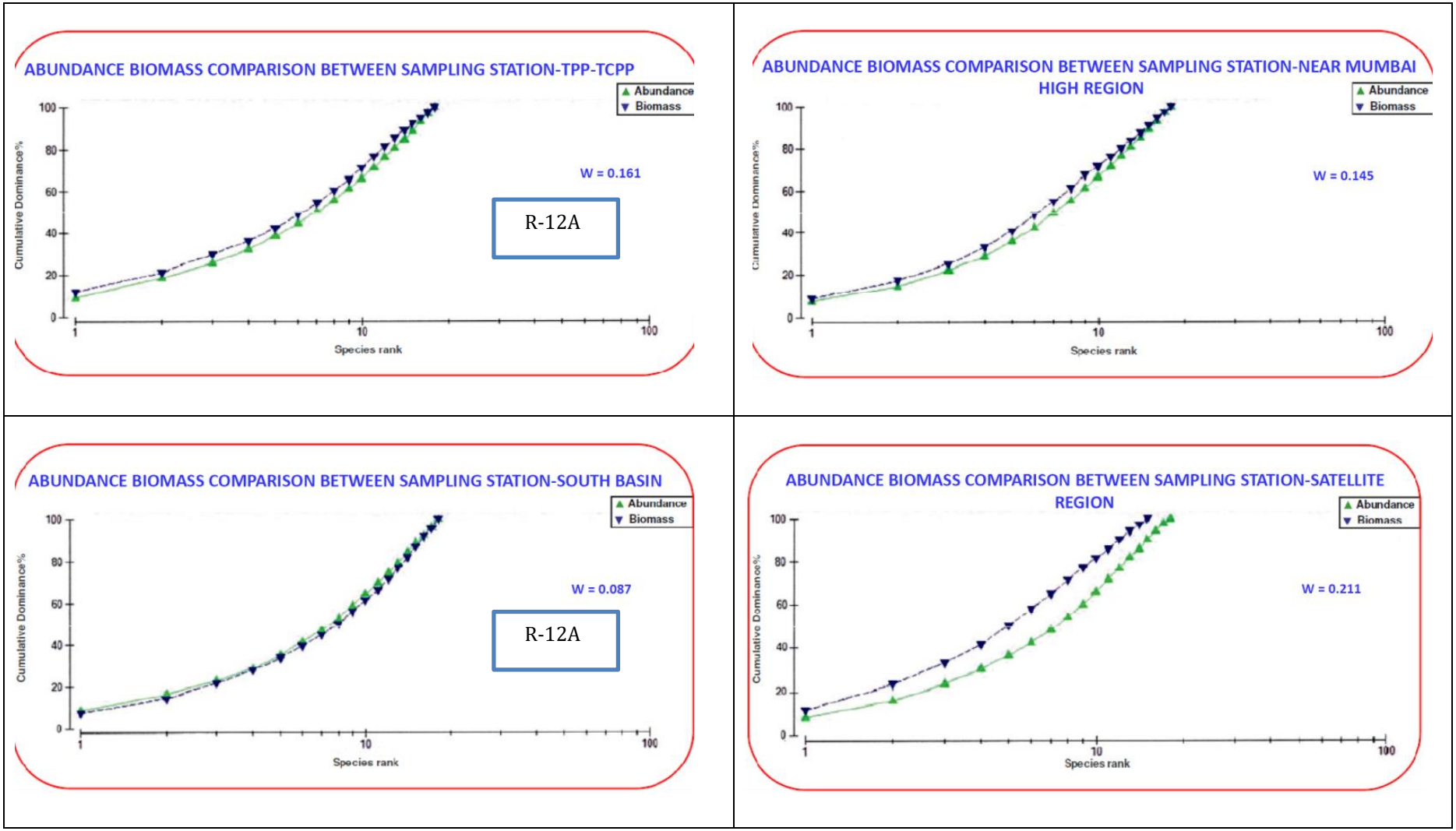

ABUNDANCE BIOMASS COMPARISON BETWEEN SAMPLING STATION-B127
Abundance
Biomass
W = 0.484
Species rank
0
20
40
60
80
100
1
10
100


ABUNDANCE BIOMASS COMPARISON BETWEEN SAMPLING STATION-GD-B-127N-C
Abundance
Biomass
W = 0.041
Cumulative Dominance%
Species rank


ABUNDANCE BIOMASS COMPARISON BETWEEN SAMPLING STATION-B48
Abundance
Biomass
W = 0.157
Cumulative Dominance%
Species rank


ABUNDANCE BIOMASS COMPARISON BETWEEN SAMPLING STATION-GS-OSN-2004/1
Abundance
Biomass
W = 0.053
Species rank


ABUNDANCE BIOMASS COMPARISON BETWEEN SAMPLING STATION-GK-28/42
Abundance
Biomass
W = 0.265
Cumulative Dominance%
Species rank



Biomass: ----------Blue line Abundance: ---------- Green line

The biomass curve of ICP, NA, B-127, R-12A, HRA, B-193, B-192-5, B-155-B, GK-28/42 and Satellite Reference point dominates the abundance curve which signifies the areas around the these installations undisturbed. The benthic stress around these installations are minimum. At the same time, the areas of Satellite reference, which are considered as no influenced areas from E&P activities, are found undisturbed.

Comparing the ABC curve around the installations NLM, BLQ, NQ, SCA, SHP, BHS, B 127N-C, GK-OSN-2204/1, WO-16, NBP filed, TPP-TCPP and Mumbai high & South basin Reference point, it has been observed that, both the biomass and abundance curves come closer to each other. It signifies that the areas around the installations are moderately disturbed. The benthic community around those areas are under moderate stress.

4. Conclusion

- From the abundance / Biomass comparison (ABC) method it can be concluded that few sampled installations (ICP, NA, B-127, R-12A, HRA, B-193, B-192-5, B-155-B, GK-28/42 and Satellite Reference point) are undisturbed. Other installations are moderately disturbed due to the ongoing activities, NLM, BLQ, NQ, SCA, SHP, BHS, B-127N-C, GK-OSN-2204/1, WO-16, NBP filed, TPP-TCPP and Mumbai high & South basin Reference point) like E&P activities, boat traffics and other fishing activities.
- Comparing the ABC analysis result of Mumbai High, South basin, & Satellite reference points with those around ONGC installations, minor influence of operational activities of ONGC on few installations are observed on benthic fauna.
- As the paper is aimed to generate a valuable data bank on the environmental status of marine sediments and bottom-dwelling biological communities, it will help in taking care of marine environment during E&P and other activities around western offshore areas. However, more modelling and comparative work is needed to establish these ABC analysis and their application in an ecosystem approach in these installations. The study will definitely open widows for further environment correlation studies

Compliance with ethical standards

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Disclosure of conflict of interest

The authors declare no conflict of interest.

References

[1] Warwick RM. A new method for detecting pollution effects on marine macro benthic communities. Marine Biology. 1986; 92: 557-562.

[2] WARWICK RM, CLARKE KR. Relearning the ABC: taxonomic changes and abundance/biomass relationships in disturbed benthic communities. Mar Biol. 1994; 118: 739-744.

[3] OSPAR Guideline. Guidelines for monitoring methods to be used in the vicinity of European Seas. 1998.

[4] OEM report around ONGC installations in Western Offshore Region during. 2020-21.

[5] Marine pollution bulletin.