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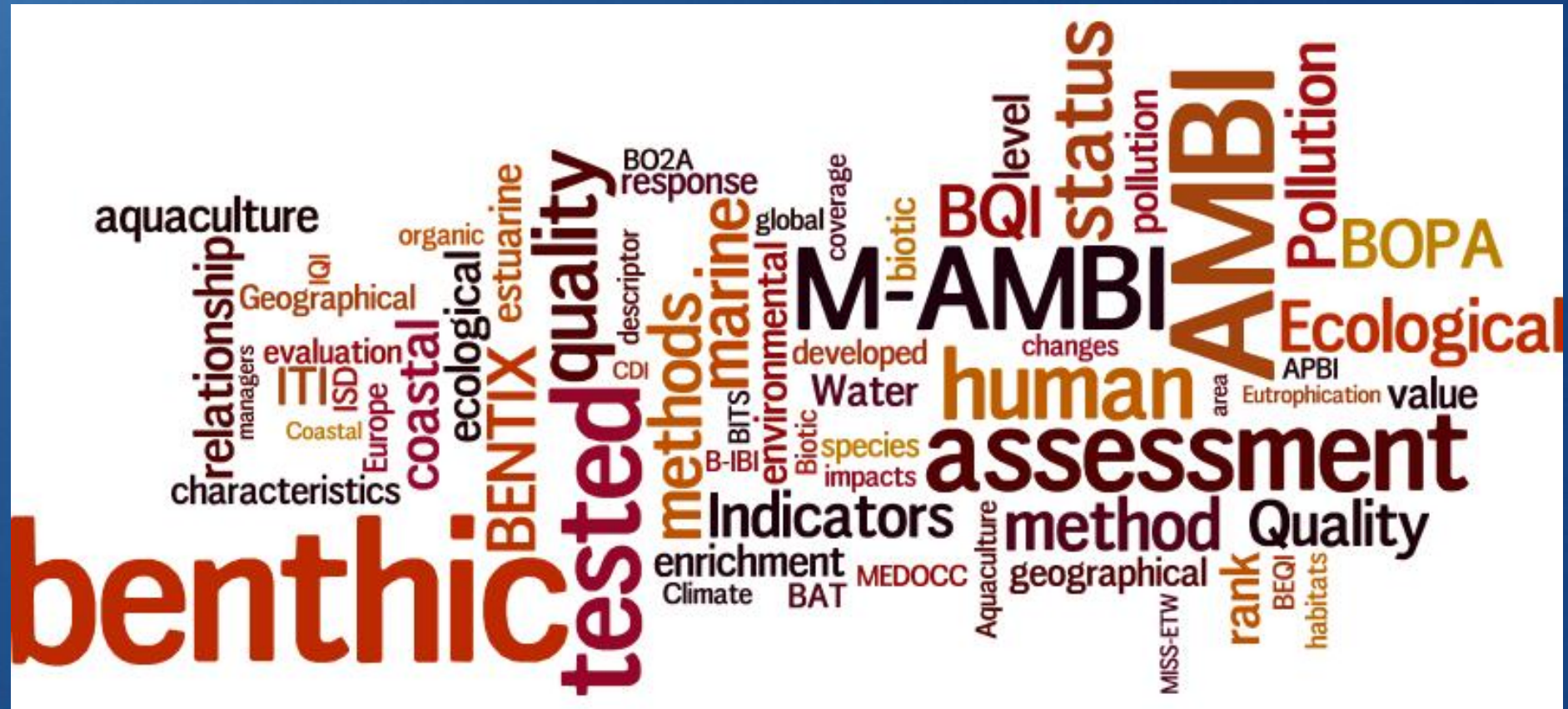
Is there a possibility of ranking benthic quality assessment indices to select the most responsive to different human pressures?

Ángel Borja, Sandra L. Marín, Iñigo Muxika,
Loreto Pino, José G. Rodríguez

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Introduction



Objective



To rank a series of benthic quality assessment indices used in different countries to evaluate the impacts produced by different pressures



For providing assistance to both managers and stakeholders in the choice of the most robust and useable

Methods (Step 1)



- **Identify the benthic indices** and assessment methodologies most commonly used in the world, interrogating SCOPUS and ISI Web of Knowledge, using the terms “index” AND “benth*” AND “marine” OR “estuar*”.

Descriptor	Details of the descriptors (attributes)
Name	Name of the method and acronym
Scientific Reference	Scientific reference in which the method or index is described
Description	<ul style="list-style-type: none"> • Short explanation of the method and calculation and Formula, if pertinent
Contact	<ul style="list-style-type: none"> • Web page to download the method (when exists) • Responsible institution
Original Geographical Area	Area where the method was developed
Application	<ul style="list-style-type: none"> • Quality Standards applicable • Boundary value which represents the good/not good threshold, when defined • Calculation guidelines, when exist • Required sampling design (locations/stations) • Devices required to take the sample • Number of replicates required • Sample processing and Taxonomic level required • Uncertainty of the calculation related to the ecological status assessment • Weaknesses and Strengthens

Methods (Step 2)



- Search for **peer-review references** on those indices in which correlations with various human pressures are established.

Type of pressures
Aquaculture: mollusc, crustacean or fish production
Sewage discharges: urban wastes, treated or not
Physical alteration: decrease or disappearance of habitats
Climate: environmental factors affecting benthic communities
Climate change: long-term changes in climatic conditions
Chemical pollution: industrial discharges or presence of metals and organic compounds
Dredging and sediment disposal: to maintain navigability in channels and harbours
Organic enrichment: discharge of organic matter, excluding aquaculture
Eutrophication: nutrient enrichment together with low oxygen concentrations and blooms
Aggregate extraction (other than harbours): sand and gravel extraction for construction
Oil and gas extraction: drilling, extraction and refining of petrol and gas
Hydrographic conditions modification: changes in hydrography, flow, residence time, etc.
Change in coastal line: morphological changes after dyke construction, land claiming, etc.
Multipressure: presence of two or more pressures, in some cases unidentified
Harbours: presence of ports and normal activity, excluding dredging

Methods (Step 3)



- **Identify the relationships between the indices and the pressures.**
 - Regression between the intensity of pressure and the impact assessed by the index
 - Mean comparisons
- When the relationship was statistically significant, but opposite to the expected (i.e. better status, as assessed by the index, with higher pressure, or vice-versa), the correlation was considered as not significant
- When not statistical test (i.e. 'p-value') exists, but the correlation is high (i.e. absolute value of Spearman's rho or Pearson's >0.30) or there is a spatial correlation with the pressure gradient (i.e. increasing quality, assessed by the index, with distance to the source) the relationship was assigned as 'significant relationship'.

Methods (Step 4)



- **(1) Global evaluation:** estimated for each index and related to a particular pressure, based upon three components:
 - **Coverage:**
 - Local (score 1): when an index has been used for that particular pressure in a single location;
 - Regional (score 2) is considered when the index has been used in several locations within the same continent;
 - Worldwide (score 3), when the index has been used at least in two continents.
 - **Number of citations:** number of references for which the index has been tested with a particular pressure.
 - **Number of citations with significant relationships:** number of references for which the index shows a statistically significant correlation with the pressure.

Methods (Step 5)



- Weighting each of the three components
 - Number of citations: 50%
 - Coverage degree: 30%
 - Number of citations: 20%
- **Global Evaluation (GE)** = $100 * [0.3 * (\text{coverage}/3) + 0.2 * \text{percentile rank (citations number)} + 0.5 * \text{percentile rank (citations number with significant correlation)}]$
 - The percentile rank interpolates the percentage hierarchy of a value within a group of values (E.g. if a particular pressure has been tested with 4 indices, with 2, 4, 5 and 10 citations, the percentile rank is, respectively, 0, 0.33, 0.67 and 1)
- GE ranks from: 0 (minimum value) to 100 (maximum value)

Methods (Step 5)



- (2) **Responsiveness to various pressures evaluation:** referred to the addition of the global evaluations of each of the reported pressures for a given index
 - so the maximum potential value is 1500 (15 pressures * 100 maximum scores obtained from the global evaluation for each pressure)
- Then a rank was established to determine the most extensively used and responsive indices.

Results: 35 indices



Name of the method	Acronym	Africa	North America	South America	Asia	Europe	Oceania
AZTI Marine Biotic Index	AMBI	x	x	x	x	x	x
Acadian Province Benthic Index	APBI		x				
Benthic Assessment Tool	BAT					x	
Benthic condition Index	BCI						
Bentix	BENTIX	x		x		x	x
Benthic Ecosystem Quality Index	BEQI					x	
Benthic Ecosystem Quality Index-2	BEQI-2					x	
Benthic Index of Biotic Integrity	B-IBI		x			x	
Biostress	BIOSTRESS					x	
Benthic Index based on Taxonomic Sufficiency	BITS					x	
Benthic Opportunistic Annelida Amphipods Index	BO2A	x				x	
Benthic Opportunistic Polychaetes Amphipods Index	BOPA	x			x	x	x
Benthic Quality Index	BQI	x	x			x	x
Benthic Response Index	BRI		x				
Community Disturbance Index	CDI					x	
Coefficient of Pollution	CoP						
Danish Quality Index	DKI					x	
Index of Biotic Integrity	IBI		x				
Infaunal Quality Index	IQI					x	
Index of Size Distribution	ISD					x	
Indicator Species Index	ISI					x	
Index of sSize Spectra Sensitivity	ISS					x	
Infaunal Trophic Index	ITI	x		x		x	x
Multivariate-AZTI Marine Biotic Index	M-AMBI	x	x	x	x	x	x
Marine Biotic Index Tool	MarBIT						
MEDiterranean OCCidental index	MEDOCC					x	x
Benthic indicator for the assessment of transitional estuarines	MISS-ETW					x	
Macrofauna Monitoring Index	MMI						
Norwegian Quality Index	NQI					x	
Norwegian Sensitivity Index	NSI					x	
Virginia Province Benthic Index	VPBI		x				
W-Statistic Index	W				x	x	
Macrozoobenthos Community Index	ZKI					x	

Results: GE (0 - 100)



Pressure / Impact	Indicator	GE - Value
Aquaculture	AMBI	100
	M-AMBI	90
	BENTIX	80
Sewage discharges	AMBI	40
Physical alteration	AMBI	40
	BOPA	35
Climate change	ZK	80
Climate	M-AMBI	76
	IQI	76
Chemical pollution	AMBI	70
	W	47
Dredging and disposal	AMBI	82
	M-AMBI	78
Organic enrichment	AMBI/M-AMBI	56
Eutrophication	AMBI	100
	M-AMBI	90
Aggregate extraction	AMBI	80
Oil and gas exploitation	AMBI	90
	BOPA/M-AMBI	52
Hydrography modifications	AMBI	60
Change in coastal line	M-AMBI	60
Multipressure	AMBI	100
	M-AMBI	96
	BENTIX	87
	BQI	85
	B-IBI	84
Harbours	AMBI/BENTIX	67
	M-AMBI	53

Results: Pressures



Index/pressure	Aquaculture	Sewage	Physical alteration	Climate	Chemical pollution	Dredging/disposal	Organic enrichment	Eutrophication	Aggregate extraction	Oil & Gas exploitation	Hydrography	Coastal line modification	Multipressure	Harbour	TOTAL
	8					7							20		
AMBI	100	50	40	10	70	82	56	100	80	90	60	10	100	67	914
APBI													20		20
BAT						27							57		84
BENTIX	80		10		10	27		67		10			87	67	358
BEQI													28		28
B-IBI							20						84	10	114
BIOSTRESS										30					30
BITS								46					28		74
BO2A						27							30		57
BOPA	60	10	35	10	33					52			70	43	314
BQI	37				43		20						85	10	196

Results: Pressures



- Indices for which **more references** exist: AMBI, M-AMBI, BENTIX, BOPA, BQI and ITI,
- Peer-review papers (%) with **significant correlation with pressures**: 93.2%, 93.7%, 80%, 63.6%, 88.9% and 37.5%, respectively
- Some indices with 100% of significant correlation (e.g. BAT, BITS, etc.) have very few papers (<4)
- APBI, CDI, ISD and MISS-ETW, with few papers, show no significant correlation

Results: Rank



Index/pressure	Aquaculture	Sewage	Physical alteration	Climate	Chemical pollution	Dredging/disposal	Organic enrichment	Eutrophication	Aggregate extraction	Oil & Gas exploitation	Hydrography	Coastal line modification	Multipressure	Harbour	TOTAL
AMBI	100	50	40	10	70	82	56	100	80	90	60	10	100	67	914
M-AMBI	90	93	10	76	10	78	56	90		52		60	96	53	765
BENTIX	80		10		10	27		67		10			87	67	358
BOPA	60	10	35	10	33					52			70	43	314
BQI	37				43		20						85	10	196
ITI	60					10		29			10		43	10	161

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Conclusions



- It is **possible to rank existing indices** to be selected by managers in taking decisions when they want to assess the status of a particular area under distinct human pressures.
- Rather than developing new indices, most effort should be placed in **obtaining** quantitative information and statistically supported **relationships between selected indices and pressure** to build greater consensus in the use of biotic indices.

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Dr Ángel Borja (aborja@azti.es)

Twitter: @AngelBorjaYerro

ResearchGate Profile: https://www.researchgate.net/profile/Angel_Borja/

LinkedIn: www.linkedin.com/profile/view?id=245091062&trk=tab_pro

