Macroalgae Morphofunctional Indicators for Ecological Assessing of Coastal Ecosystems

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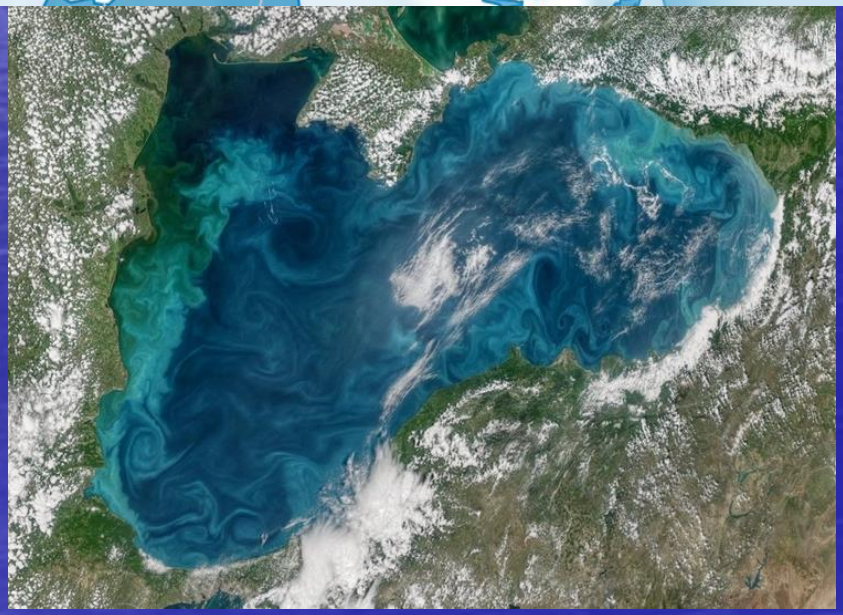
Implementation of the standards of European Water Directives in the Black Sea region

WFD,
2000/60/EC



MSFD,
2008/56/EC

Connection of the Phytobenthos with the MSFD Descriptors

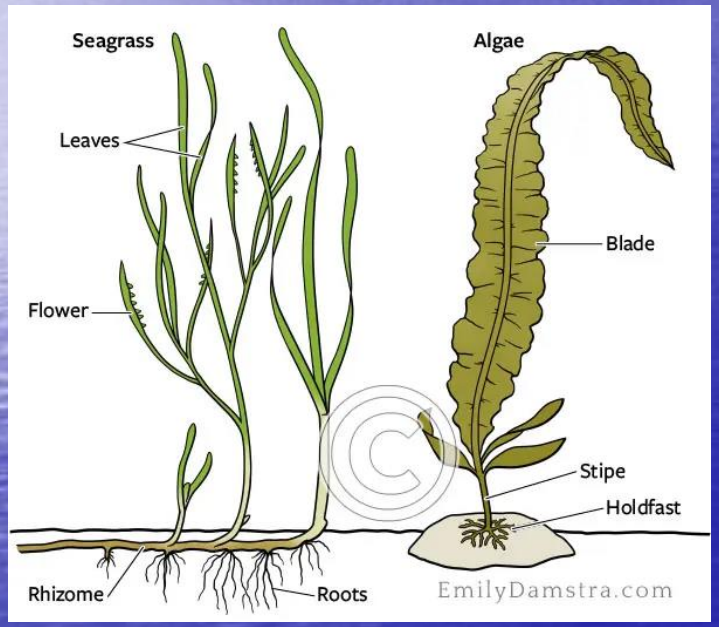
Biological Quality Elements

Biological diversity 1.	Non-indigenous species 2.	Population of commercial fish/shellfish 3.	Elements of marine food webs 4.
Eutrophication 5.	Sea floor integrity 6.	Alteration of hydrographical conditions 7.	Concentrations of contaminants 8.
	Contaminants in fish/seafood for human consumption 9.	Marine litter 10.	Introduction of energy including underwater noise 11.

Important Methodological Question

What should the macrophytes indicators reflect?

Structure or **Function**



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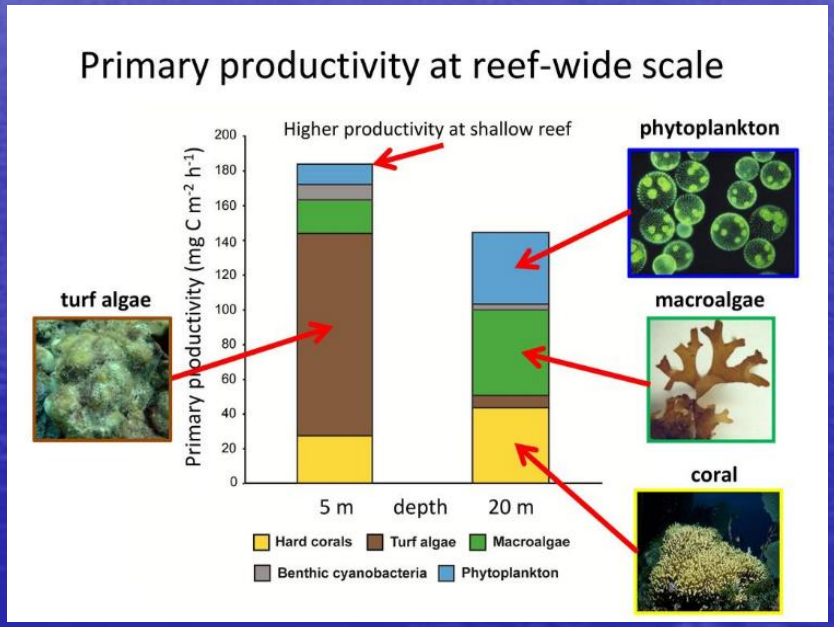


The success of assessing the Ecological Status Class of marine ecosystems strictly depends with properties and capabilities of biological indicators

Structure (Classical Approach)
Macroalgae Monitoring Indicators

- Floristic composition
- Percentage cover of macrophytes on the bottom
- Percentage ratio of species into phytocenouses
- Biomass
- Size structure of dominants species

Morphofunctional (Urgent Approach)
Macroalgae Monitoring Indicators

Surface Contour

Carbon Flow

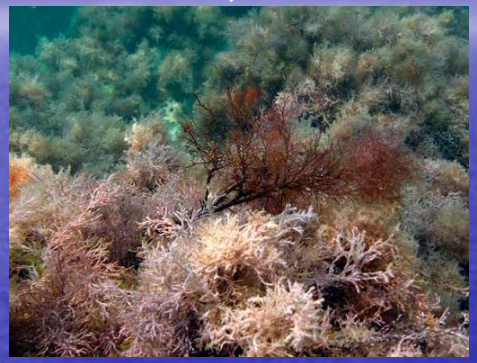
Primary Production

Morphological Parameters

Morphofunctional Indicators

Different approaches - Different results

Assessment



Classical Approach
Structure

Urgent Approach
Morphofunctional

Monitoring

Monitoring

State of Phytobenthos Community

Ecological Status Class Of Marine Ecosystems

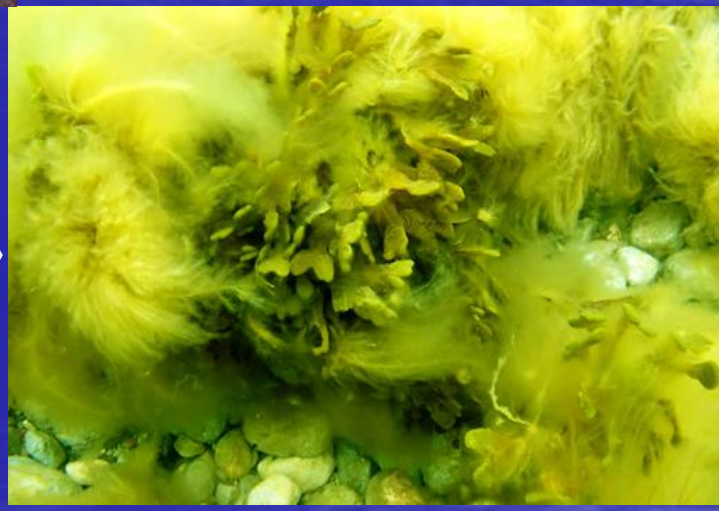
Morphofunctional Portrait of Macroalgae Communities = **Category of Ecological Status Class of Coastal Ecosystem**

The morphofunctional transformation of aquatic vegetation dependence from the substance and energy flow (Q)

Q1

Q2

Q3



Changes in the morphological portrait of macroalgae during eutrophication of the Baltic ecosystem

The specific surface of the populations S/W_p – tool for the quantitative ranking of the ecological activity of algae species

Maine advantage of morphofunctional approach - all vital and size forms of the autotrophies are estimating by the common universal index – **S/W_p (specific surface of the population, $m^2.kg^{-1}$)**

Monitoring in accordance with the requirements of the European Water Directives

ESC (Ecological Status Class)	EQR (Ecological Quality Ratio)	ES Environmental Status
High	1	GES
Good	0.75	
Moderate	0.5	Not GES
Poor	0.25	
Bad	0	

Ecological Evaluation Index (EEI) is the main parameter for assessment the **ESC** and **ES** on the basis macrophytes

EEI can be expressed with a **Classical** and **Morphofunctional** Indicators

Morphofunctional Indicators of Macrophytobentos to expresses the EEI

- ***Three Dominants Activity*** , S/W_{3Dp}

  Average value of the first Three Dominant Populations specific surface

- ***Community Activity (average),*** $S/W_{x\ com}$

  Average value of the all populations specific surface in the Community

- ***Phytosenouces Surface Index,*** Si_{ph}

  Total value of the phytosenouces algae surface

- **Sensitive species,** S_{sp}

  Percentage of sensitive species ($S/W_p \leq 25\ m^2.kg^{-1}$) in floristic composition

Guidelines for monitoring Macrophytobenthos of the Black Sea to standards of the WFD and MSFD

Minicheva G., Afanasyev D., Kurakin A. Black Sea monitoring guidelines. Macrophytobenthos // Secretariat of commission on protection of the Black Sea against pollution. – Istanbul. – 2015. – 76 pp.http://emblasproject.org/wp-ontent/uploads/2013/12/Manual_macrophytes_EMBLAS_ann.pdf

Application of the morphofunctional approach within the EMBLAS project

EMBLAS
Environmental monitoring in the Black sea

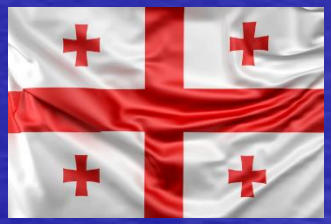
Black sea Nationals Classification schemes

ES	EEI range					
	$(S/W)_{3Dp}$, $m^2 \cdot kg^{-1}$	EQR	$(S/W)_x$, $m^2 \cdot kg^{-1}$	EQR	SI_{ph}, units	EQR
High	$(S/W)_{3Dp} < 15$	≥ 0.82	$(S/W)_x < 60$	≥ 0.98	$SI_{ph} < 25$	≥ 0.95
Good	$15 \le (S/W)_{3Dp} \le 30$	0.54	$60 \le (S/W)_x \le 80$	0.79	$25 \le SI_{ph} \le 40$	0.84
Moderate	$31 \le (S/W)_{3Dp} \le 45$	0.37	$81 \le (S/W)_x \le 120$	0.58	$41 \le SI_{ph} \le 55$	0.68
Poor	$46 \le (S/W)_{3Dp} \le 60$	0.25	$121 \le (S/W)_x \le 200$	0.17	$56 \le SI_{ph} \le 90$	0.15
Bad	$(S/W)_{3Dp} > 60$	≥ 0	$(S/W)_x > 200$	≥ 0	$SI_{ph} > 90$	≥ 0

Ukraine

Galyna Minicheva

ES	EEI range					
	$(S/W)_{3Dp}$, $m^2 \cdot kg^{-1}$	EQR	$(S/W)_x$, $m^2 \cdot kg^{-1}$	EQR	S_{sp}, %	EQR
High	$(S/W)_{3Dp} < 12$	≥ 0.92	$(S/W)_x < 50$	≥ 0.74	$S_{sp} \ge 40$	≥ 0.80
Good	$12 \le (S/W)_{3Dp} \le 30$	0.58	$50 \le (S/W)_x \le 70$	0.53	$39 \ge S_{sp} \ge 25$	0.50
Moderate	$31 \le (S/W)_{3Dp} \le 40$	0.39	$71 \le (S/W)_x \le 90$	0.32	$24 \ge S_{sp} \ge 15$	0.30
Poor	$41 \le (S/W)_{3Dp} \le 50$	0.19	$91 \le (S/W)_x \le 100$	0.21	$14 \ge S_{sp} \ge 10$	0.20
Bad	$(S/W)_{3Dp} > 50$	≤ 0.05	$(S/W)_x > 100$	≤ 0.06	$S_{sp} < 10$	≤ 0.01

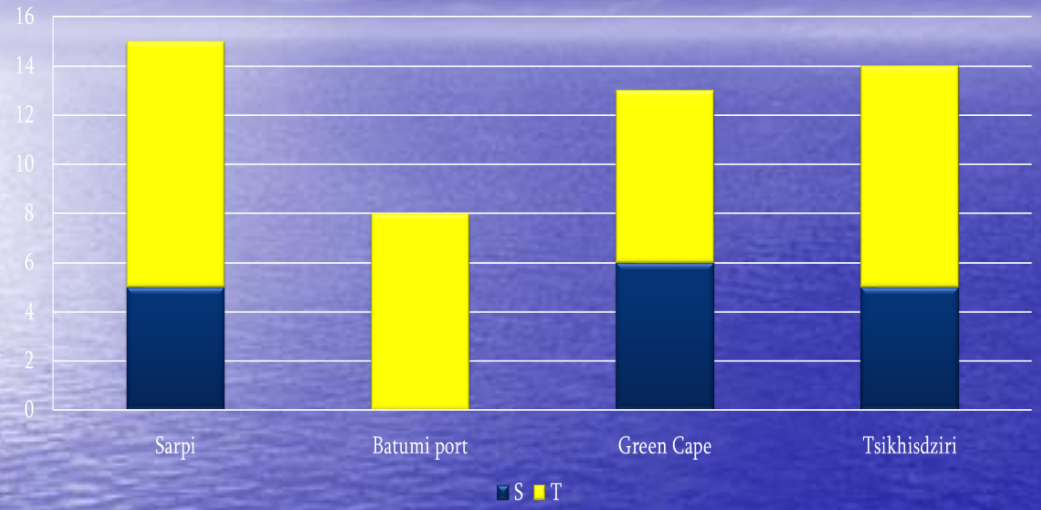


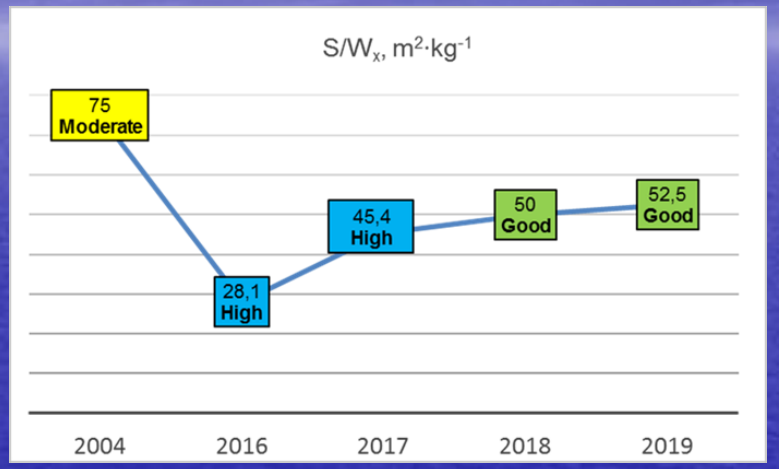
Georgia

Mariam Tsetskhladze

Assessment of current trends of the Ecological Status of nationals coasts: Georgia

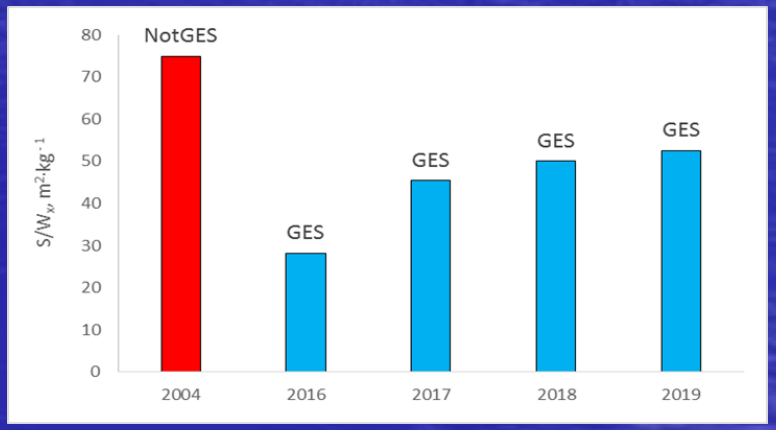
National Coast (by *Mariam Tsetskhladze*)





Sensitive species S/W ($S/W_p \leq 25\ m^2.kg^{-1}$)

Tolerant species S/W ($S/W_p > 25\ m^2.kg^{-1}$)

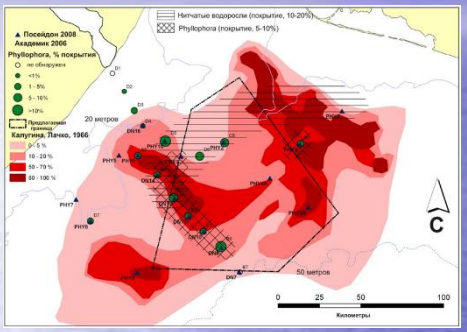


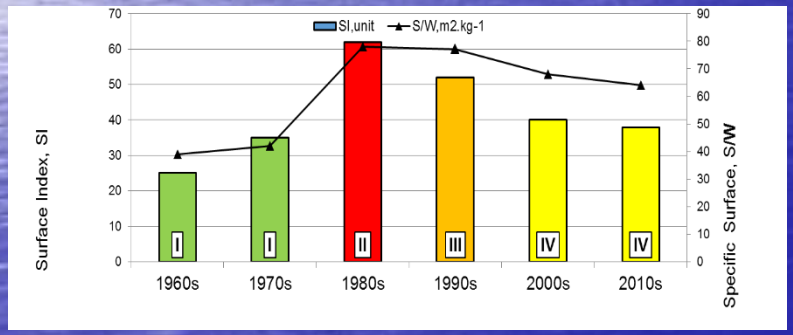
Long-term change of the ESC categories and GES/NotGES at the monitoring sites – Green Cape

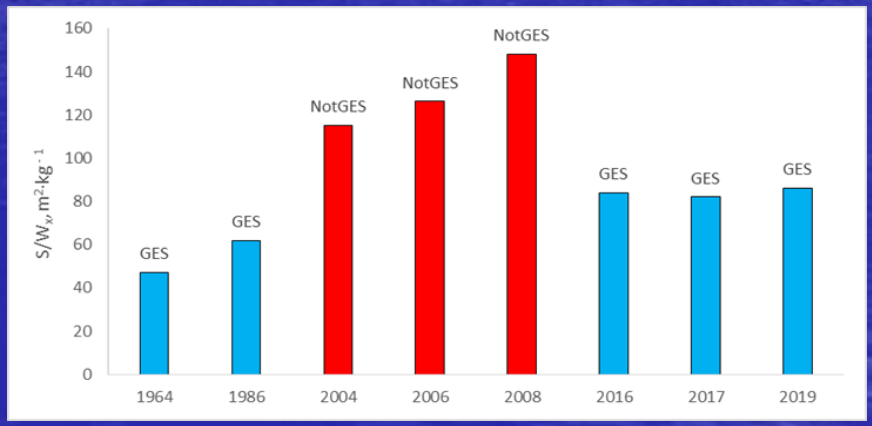
Assessment of current trends of the Ecological Status of nationals coasts: Ukraine

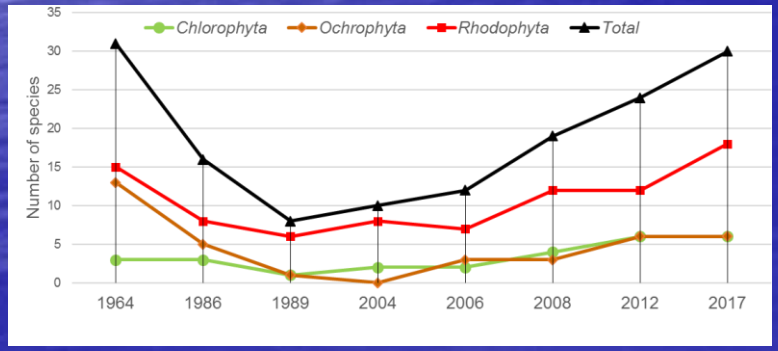
EMBLAS
Environmental monitoring in the Black sea

Northwester shelf - Zernov's Phyllophora Field (*Galyna Minicheva*)



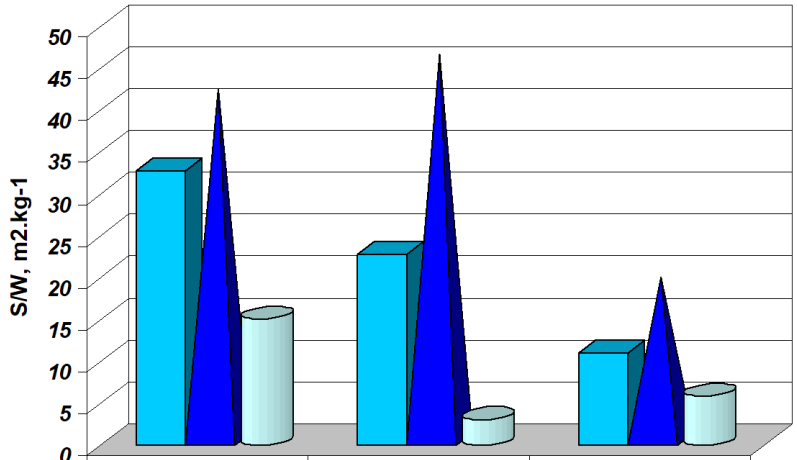






Long-term change of the ESC categories and the GES/NotGES for long monitoring St. 10

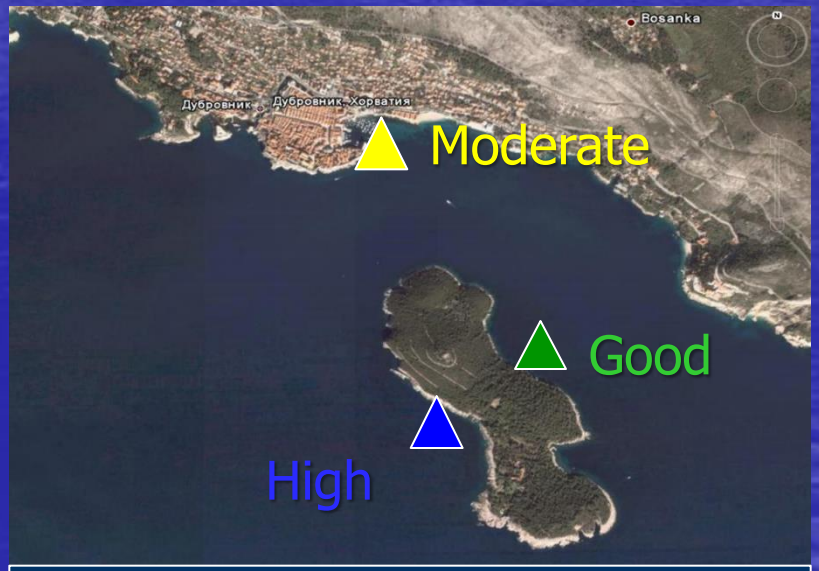
Experience the use of morphofunctional indicators of seaweed in the Mediterranean (Adriatic Sea, Dubrovnik)



	City beachs of Dubrovnik	Is. Lukrum (from the side of shore)	Is. Lukrum (opened part)
Average	32,9	22,9	11,1
Maximum	42	46	19,4
Minimum	15,2	3,16	5,95

Ecological Activity of seaweed communities in areas of the Adriatic Sea with different trophic conditions near Dubrovnik

Macrophyte samples taken along the Adriatic coast first allowed to analyze the empirical material of Mediterranean macrophytes using the morphofunctional approach. Macrophytes were sampled at 7 sites near Dubrovnik and Lukrum Island. According to 1200 measurements of morphological parameters, (S/W)p coefficients were estimated.



Lukrum Island

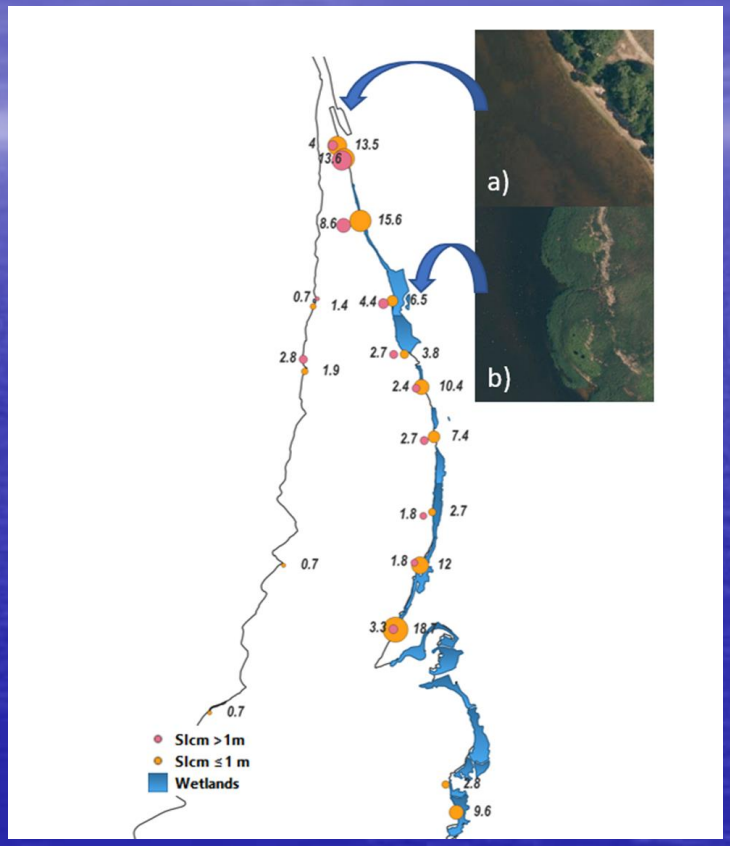
Experience the use of morphofunctional indicators of seaweed in the Mediterranean (Balear Sea, Palma de Majorca)

Site I (Island)		Site II (Beach)	
Floristic composition	$(S/W)_p$,m2. kg-1	Floristic composition	$(S/W)_p$,m2. kg-1
Corallina sp.	~ 21	*Corallina sp.*	~ 21
Padina sp.	~ 18	*Enteromorpha sp.*	~ 36
Laurencia sp.	~ 11	*Cladophora sp.*	~ 45
	16,7		34,2
ESC of island	Good	ESC of beach	Moderate

Experience the use of Morphofunctional indicators of macroalgae in the Baltic Sea (Curonian Lagoon, Klaipeda)

Species composition of submerged macrophytes in the littoral of the **Curonian Lagoon** and the (S/W)p of the macrophytes according to in situ measurements

Systematic goup	Species	Morphological growth form	S/W_p ($m^2.kg^{-1}$)
Angiosperms	*Potamogeton perfoliatus*	Stem – Cylindrical, leaves – lamellar	8,3
	Potamogeton rutilus	Stem – Cylindrical, leaves – lamellar	13.8
	Stuckenia pectinata	Stem – Cylindrical, leaves – lamellar	13.0
	Myriophyllum spicatum	Cylindrical	25
	Zannichellia palustris	Stem – Cylindrical, leaves – lamellar	11
		mean	14.2
Charophytes	*Chara contraria*	Cylindrical	16.1
	Chara aspera	Cylindrical	17.5
	Tolypella nidifica	Cylindrical	11
	Nitellopsis obtusa	Cylindrical	12.7
	Chara baltica	Cylindrical	15
		mean	14,5
Green algae	*Cladophora glomerata*	Cylindrical	116.9
	Ulva intestinalis	Lamellar	36,1
		mean	76.5



Distribution of Community Surface Index (SI_{cm}) in the northern part of the Curonian Lagoon. Values of SI_{cm} are represented as means for ≤1 m and >1 m depth group.

Conclusion:

The practice of using morphofunctional indicators of Macroalgae to assess the Ecological Status of the Black, Baltic and Mediterranean Seas has shown the advantages and widely possibility of their use for monitoring according to the standards of the EU Water Directives. Morphofunctional approach can be recommend for use in monitoring the Ecological Status of coastal ecosystem for all-European seas.

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Thanks for your attention
Ukraine will be Winner !