



# Harmo(n)ization and Netwo(r)king for contaminant assessment in the Ionian and Adriatic Seas

## Status of MSFD Monitoring in Croatia



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**Institute of Oceanography and Fisheries**



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## Institute of Oceanography and Fisheries

- Since 1930, interdisciplinary institute
- 125 employees, 8 labs;  
Physics, Chemical oceanography and sedimentology, Plankton and shellfish toxicity, Microbiology, Ichthyology, Fisheries biology, Benthos and Aquaculture laboratory
- Involved in sequence of international and national scientific, technical and data management projects
- Involved in implementation of IMAP, WFD and MSFD through conduction of Croatian monitoring programs



## Marine Strategy Framework Directive (MSFD)

The main goal is to achieve Good Environmental Status of EU marine waters by 2020. The Directive defines GES as:

**“The environmental status of marine waters where these provide ecologically diverse and dynamic oceans and seas which are clean, healthy and productive”**





## Marine Strategy Framework Directive (MSFD)

- The **initial assessment** of the current environmental status of national marine waters and the environmental impact and socio-economic analysis of human activities in these waters
  - The determination of what **GES** means for national marine waters
  - The establishment of environmental **targets** and associated indicators to achieve GES by 2020
  - The establishment of a **monitoring programme** for the ongoing assessment and the regular update of targets
  - The development of a **programme of measures** designed to achieve or maintain GES by 2020
- The process is cyclical and the second cycle should start again in 2018.



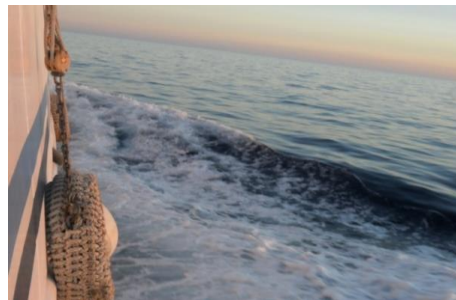
## Implementation of MSFD Monitoring

In December 2014 Government of the Republic of Croatia brought Decision of action program for the strategy of the management on marine environment and coastal area: “**Monitoring and observation system for assessment of the Adriatic Sea state according to MSFD**”

**(OG 153/2014)**

**“Monitoring system = MSFD Monitoring”**

### *Implementation of “Monitoring system” in Republic of Croatia*



## Implementation of MSFD Monitoring

Implementation of the monitoring according to MSFD includes state of 11 descriptors:

- D1 Biodiversity**
- D2 Non-indigenous species**
- D3 Populations of commercially exploited fish and shellfish**
- D4 Pelagic food webs**
- D5 Eutrophication**
- D6 Sea floor integrity**
- D7 Hydrographic conditions**
- D8 Contaminants**
- D9 Contaminants in food**
- D10 Marine litter**
- D11 Underwater noise**



## Implementation of MSFD Monitoring

Yearly costs of Monitoring according to MSFD for Croatia (**OG 153/2014**) were estimated to:

**12.028,362,00 kn** (no VAT)

- **For 2016** (~ 1 million kn was approved through specific Contracts for north, middle and south Adriatic)
- **For 2017 and 2018** (~ 3 million kn was approved through specific Contracts for north, middle and south Adriatic)

Contracts covered only part of descriptors D5, D1, D2, D4 and D7, and part of D10 and D11 (D3, D6, D8, D9 were not covered at all)

- **For 2019** process of Public procurement is in progress....



## D1: Biodiversity



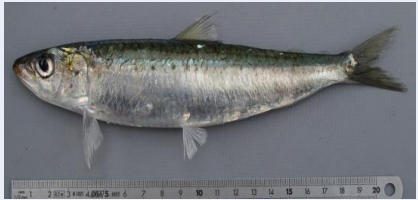

Biodiversity in the Adriatic Sea (Croatian part) is given by components that have to be covered by monitoring program


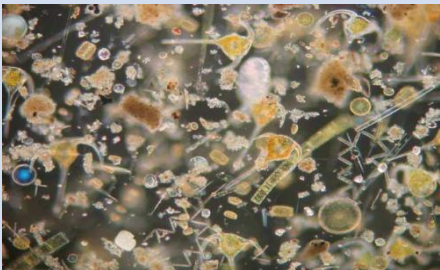

### Components:

- Sea mammals (Cetacea);
- Sea birds;
- Sea turtles;
- Fishes;
- Photophilic algae settlements and species *Cystoseira amentacea*;
- Posidonia settlements and species *Posidonia oceanica*
- Coraligen and species *Corallium rubrum*
- Pelagic plankton community



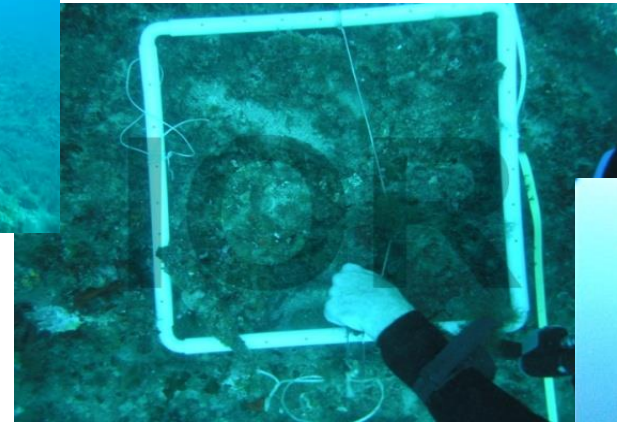


Descriptor	Components	Parameters	Sites/ areas	Sampling Frequency
<b>D1</b>    <b>Biodiversity</b>	<u>Mamals</u> : Cetacea: <i>Tursiops truncatus</i> , <i>Stenella coeruleoalba</i>	number, distribution of population	Whole Adriatic (cooperation with other countries)	each 3 year (air counting) Photo documentation: 1x year, every second year
	<u>Birds</u> : <i>Calonectris diomedea</i> , <i>Puffinus yelkouan</i> , <i>Phalacrocorax aristotelis desmarestii</i> , <i>Larus audouinii</i>	number, distribution, demographic characteristics of population	Nesting places	Through Birds Directive
	<u>Sea turtles</u> : <i>Caretta caretta</i>	Number, air counting, catch by chance, dead due to swallowing of litter- standard morphometric characteristics	Whole Adriatic divided on transects	each 3 year (air counting)
	<u>Fishes</u> : <u>Pelagic</u> : <i>Sardina pilchardus</i> , <i>Engraulis encrasicolus</i> <u>Demersal and coastal</u> <u>Osteichthyes</u> : <i>Mullus barbatus</i> , <i>Mullus surmuletus</i> , <i>Diplodus vulgaris</i> , <i>Diplodus sargus</i> , <i>Scorpaena porcus</i> , <i>Scorpaena scrofa</i> , <i>Symphodus tinca</i> , <i>Labrus mixtus</i> , <i>Pagellus erythrinus</i> , <i>Epinephelus marginatus</i> , <i>Chelidonichthys cuculus</i> , <i>Zosterisessor ophiocephalus</i> , <u>Demersal Chondrichthyes</u> : <i>Scyliorhinus canicula</i> , <i>Raja mireletus</i>	distribution, size, state and structure of population  	<u>Pelagic species</u> : Kvarner, Kvarnerić, middle Adriatic islands <u>Demersal and coastal</u> <u>Chondrichthyes</u> : open central Adriatic, Jabuka Pit <u>Coastal fishes</u> : Mali Lošinj, Senj archipelago, Pag, south side of Dugi Otok, Šibenik archipelago, around Split, Vis, Dubrovnik area	2 x year, summer, winter or for coastal fishes (summer, autumn)   

Descriptor	Components	Parameters	Sites/areas	Sampling Frequency
<b>D1</b>  <b>Biodiversity</b>	Coraligen and species <i>Corallium rubrum</i> 	<u>Coraligen</u> : Species, composition, indicators of coraligen functionality, qualitative and quantitative indicators of the impact on community <u>Red coral</u> : distribution and state of settlements (number, size); Environmental parameters: T	Mljet, Vis, Kornati island	<u>Coraligen</u> : through Habitat directive <u>Red coral</u> : each 3 year
	Plankton pelagic community: 	<u>Phytoplankton</u> : composition and number, geographic and seasonal variability, indexes of variability and ratios of the main functional groups <u>Zooplankton</u> : composition, distribution and seasonal variability of chosen groups	Marine and coastal waters of north, middle and south Adriatic	seasonal, at certain sites Up to <u>12 x per year</u>
	 Settlement of photophilic algae and species <i>Cystoseira amentacea</i> *	Distribution of <i>Cystoseira amentacea</i> and invasive species (D2) and areas damaged by sea urchins (D6)	Whole Croatian coast*; covered by WFD	<u>1 x in 3 years</u>


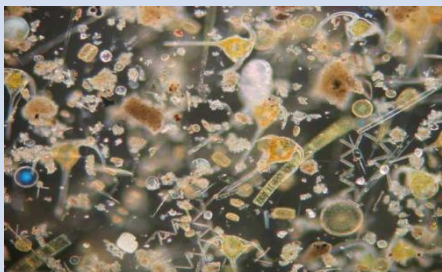

**\*applicable with additional measurements!**

## D1: Biodiversity



***\* additional investigations/measurements!***



Descriptor	Components	Parameters	Sites/areas	Sampling Frequency
<b>D1</b>  <b>Biodiversity</b>	Coraligen and species <i>Corallium rubrum</i> 	<u>Coraligen</u> : Species, composition, indicators of coraligen functionality, qualitative and quantitative indicators of the impact on community <u>Red coral</u> : distribution and state of settlements (number, size); Environmental parameters: T	Mljet, Vis, Kornati island	<u>Coraligen</u> : through Habitat directive <u>Red coral</u> : each 3 year
	Plankton pelagic community: 	<u>Phytoplankton</u> : composition and number, geographic and seasonal variability, indexes of variability and ratios of the main functional groups <u>Zooplankton</u> : composition, distribution and seasonal variability of chosen groups	Marine and coastal waters of north m A	seasonal, at certain sites Up to 12 x per year <div> <i>In 2016</i>  <i>Phytoplankton</i>  <i>1 X 22 sites in middle and south Adriatic</i> </div> <div> <i>In 2017, 2018</i>  <i>Phytoplankton</i>  <i>2 X 22 sites in middle and south Adriatic,</i> </div>
	Settlement of photophilic algae and species <i>Cystoseira amentacea</i> * 	Distribution of <i>Cystoseira amentacea</i> and invasive species (D2) and areas damaged by sea urchins (D6)	Wh co	<div> <i>In 2016. ZOOP.</i>  <i>1 X 5 sites in middle and south Adriatic</i> </div> <div> <i>IN 2017, 2018</i>  <i>ZOOP.</i>  <i>2 X 5 sites in the middle and south Adriatic</i> </div>

Monitoring sites for D1 during 2016, 2017 and 2018 (only component: plankton pelagic community)

No	Site	Depth (m)	$\phi$	$\lambda$
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No	Site	Depth (m)	$\phi$	$\lambda$
1	GR; 1; JA 01	12	18° 4.983′	42° 39.586′
2	A1; JA 02	107	18° 1.312′	42° 38.031′
3	3; A2; JA 04	332	17° 49.463′	42° 26.856′
4	5; A3; JA 06	1164	17° 40.615′	42° 16.637′
5	FP-O4; JA 07	78	17° 33.705′	42° 47.51′
6	*FP-O7; A6; JA 08	38	17° 19.706′	43° 2.007′
7	*FP-O15a; JA 09	12	16° 26.028′	43° 30.191′
8	*FP-O16b; ST103; JA 10	18	16° 27.2′	43° 31.8′
9	*FP-O16; JA 11	22	16° 24.111′	43° 32.502′
10	A8; 11; FP-O16a; ST101; JA 12	38	16° 22.9′	43° 31.1′
11	FP-O14; CJ007; JA 13	52	16° 23.611′	43° 25.603′
12	A9; CJ009; JA 16	103	16° 20.007′	43° 0′
13	A10; CJ010; JA 19	178	16° 16.408′	42° 36.251′
14	A11; CJ011; JA 21	108	16° 13.621′	42° 22.28′
15	*FP-O17a; JA 22	44	16° 12.498′	43° 30.205′
16	FP-O21; JA 23	60	15° 51.71′	43° 39′
17	A13; JA 24	169	15° 43.29′	43° 29.26′
18	A14; CJ003; JA 26	264	15° 7.62′	43° 5.22′
19	FP-O25; JA 27	54	15° 2.419′	44° 14.995′
20	FP-O27; JA 28	47	15° 24.416′	44° 16.946′
21	*FP-O28a; JA 29	49	15° .723′	44° 29.241′
22	*FP-O28b; JA 30	12	15° 2.9′	44° 26.82′

## D2: Non-indigenous species

Pečarević et al. (2013) listed species that were introduced by anthropogenic or natural way into the Adriatic Sea. 113 species is specified (15 phytoplankton, 16 zooplankton, 16 macroalgae, 44 zoobenthic species and 22 fish species)




### Components:

- **Determining of invasive species from the list**



*Ficopomatus enigmaticus*



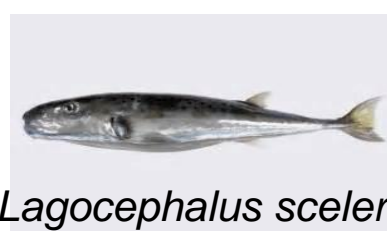
Descriptor	Components	Parameters	Sites/ areas	Sampling frequency
D2 Non indigenous species	Determining of non indigenous species	Taxonomic identification, impact assessment, impacted area, dynamics and mechanisms of distribution	Tuna farms Grška Bay (Brač), 2 sites in Zadar area	1 x year; spring, autumn
	Determining of non indigenous species (113 species list)		South Croatia: Dubrovnik – Molunat; Mljet area	Each two year; summer
	Determining of non indigenous species (113 species list)		shipyard: Trogir	Each two years; spring and autumn
	Determining of non indigenous species (113 species list)		harbours: Dubrovnik, Ploče, Šibenik. Zadar, Rijeka, Pula	Each two years; spring and autumn
	Determining of non indigenous species (113 species list)		harbours: Split, Kaštelanski zaljev	1 x year; seasonal
	<i>Caulerpa taxifolia</i>		Starigrad Bay	1 x year; autumn
	<i>Caulerpa racemosa</i> var. <i>cylindracea</i>		Certain sites in the north and middle Adriatic	1 x year; autumn
	<i>Codium fragile</i> subsp. <i>fragile</i>		Certain sites in the north and middle Adriatic	According to assessment
	<i>Ficopomatus enigmaticus</i>		Šibenik, Ploče	2x year, according to assessment
	<i>Callinectes sapidus</i>		North, middle and south Adriatic	2x year ; spring- summer, autumn
	<i>Fistularia commersonii</i>		North, middle and south Adriatic	2x year; spring- summer, autumn




Descriptor	Components		Parameters	Sites/ areas	Sampling frequency
<b>D2</b>	<i>Siganus luridus</i>		“	South, middle and north Adriatic	2x year; spring_summer, autumn
	<i>Lagocephalus sceleratus</i>		“	South, middle and north Adriatic	2x year; spring_summer, autumn
<b>Non indigenous species</b>	Research monitoring	<i>Lophocladia lallemandii</i>	“	Blitvenica and surrounding islands	autumn
		<i>Acrothamnion preissii</i>	“	Dubrovnik	
		<i>Womersleyella setacea</i>	“	South, middle and north Adriatic	
		<i>Hypnea spinella</i>	“	Dubrovnik	
		<i>Paraleucilla magna</i>	“	chosen areas	
		<i>Oculina patagonica</i>	“	Kaštela Bay	
		<i>Percnon gibbesi</i>	“	South Adriatic (Molunat)	
		New species	“	According to needs	According to needs

*In 2016 (fish, crabs)*  
*1 X 4 sites in middle and south Adriatic*

*In 2017, 2018 (fish, crabs)*  
*2 X 4 sites in middle and south Adriatic \**

**\* Different methods: trammel nets, visual census and LEK protocols**



Descript or	Components	Parameters	Sites/ areas	Sampling frequency
D2 Non indigenous species	Determining of non indigenous species	Taxonomic identification, impact assessment, impacted area, dynamics and mechanisms of distribution	Tuna farms Grška Bay (Brač), 2 sites in Zadar area	1 x year; spring, autumn
	Determining of non indigenous species (113 species list)		South Croatia: Dubrovnik – Molunat; Mljet area	Each two year; summer
	Determining of non indigenous species (113 species list)		shipyard: Trogir	Each two years; spring and autumn
	Determining of non indigenous species (113 species list)		harbours: Dubrovnik, Ploče, Šibenik. Zadar, Rijeka, Pula	Each two years; spring and autumn
	Determining of non indigenous species (113 species list)		harbours: Split, Kaštelanski zaljev	1 x year
	<i>Caulerpa taxifolia</i>		Starigrad Bay	1 x year
	<i>Caulerpa racemosa</i> var. <i>cylindracea</i>		Certain sites in the north and middle Adriatic	1 x year; autumn
	<i>Codium fragile</i> subsp. <i>fragile</i>		Certain sites in the north and middle Adriatic	According to the project
	<i>Ficopomatus enigmaticus</i>		Šibenik, Ploče	2x year; spring and autumn
	<i>Callinectes sapidus</i>		North, middle and south Adriatic	2x year; spring and autumn
	<i>Fistularia commersonii</i>		North, middle and south Adriatic	2x year; spring- summer, autumn

In 2017, 2018  
 (benthos)  
 2 X 2 sites in middle  
 and south Adriatic

In 2017, 2018  
 (benthos)  
 2 X 10 sites in  
 middle and south  
 Adriatic



## D2: Non-indigenous species

Monitoring sites of non-indigenous *benthic* and non-indigenous fishes and demersal crabs for D2 descriptor during 2017 and 2018



No	Location	$\phi$	$\lambda$
1	Komiža Bay	43,02046259	16,08622169
2	Vis Bay	43,06035969	16,19059181
3	<u>Trogir</u>	43,51027725	16,25139856
4	Kaštel Kambelovac	43,54836148	16,38449979
5	Harbour Split	43,50747599	16,43688834
6	North Split harbour	43,52863785	16,46535229
7	Grška Bay	43,28770251	16,48288393
8	Smrka Bay	43,28426613	16,49704599
9	Supetar	43,38490276	16,55438089
10	Stari Grad	43,18221103	16,58236169
11	Zavala, Hvar	43,12278792	16,69676220
12	<u>Mljet</u>	42,78280313	17,33179662
13	<u>Ploče</u>	43,03878334	17,42045688
14	<u>Dubrovnik</u>	42,63926270	18,11491583

## D3: Populations of commercially exploited fish and shellfish

In the fishing area of Republic of Croatia the state is monitored through monitoring of the commercial fishery and the state of resources by scientific expeditions (MEDITS and MEDIAS). After the entering into EU, Croatia set the monitoring of fishery state according to methodology through (DCF–Data Collection Framework)

- additionally data collection for repopulation areas to protect nurseries and hatcheries for juveniles recruitment in levels sufficient for sustainable fishery.


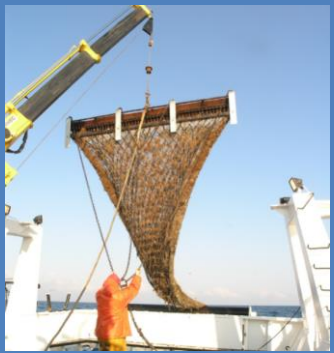



### Components:

- Demersal stocks
- Pelagic stocks
- Coastal stocks
- Shellfish stocks
- Hatcheries of sardines and anchovies
- Seagrass meadows
- Shellfish fishing by rampon





## D3: Populations of commercially exploited fish and shellfish

Descriptor	Components	Parameters	Sites/ areas	Sampling frequency
<b>D3</b> <b>Populations of commercially exploited fish and shellfish</b>  	<b>Demersal stocks</b> <i>Merluccius merluccius</i> , <i>Mullus barbatus</i> , <i>Nephrops norvegicus</i> , <i>Solea solea</i> <b>Pelagic stocks:</b> <i>Sardina pilchardus</i> , <i>Engraulis encrasicolus</i> <b>Priobalni stokovi:</b> <i>Spicara smaris</i> , <i>Mullus surmuletus</i> <b>Štokovi školjkaša:</b> <i>Venus verrucosa</i> , <i>Pecten jacobaeus</i> 	Frequency of appearance, indexes: biomass, abundancy, juveniles, adults, average mass, average length, ratio of average length and length of the first maturity, index of total biomass, index of total abundancy, total biomass without bluefish, biomass of commercially targeted species, biomass index of cephalopods, biomass index of pelagic fishes, biomass index of chondrichthyes, BOI (bottom dwelling fish index)	Open middle Adriatic, Jabuka Pit area, 20 randomly distributed sites in Croatian fishery sea 	2x year, (June-July)-srpanj) (December-January) 
	Hatcheries of sardines and anchovies	Appearance frequency of eggs and larvae, length structure, sex ratio, and values of batch fecundity of adults	Warm part of the year: Kvarneri; cold period of year: middle Adriatic islands with transect towards the sea	
	Seagrass meadows (critical areas for recovering of coastal fish populations - hatcheries	composition, length structure and biomass of fish populations	Mali Lošinj, Senj archipelago, Pag, Dugi Otok, Šibenik archipelago, around Split, Vis, Dubrovnik area	2x year, summer and autumn,
	Shellfish fishery by rampon	Catch and by catch composition, by rampon and species identification	West Istrian coast (fishery zone A)	seasonal

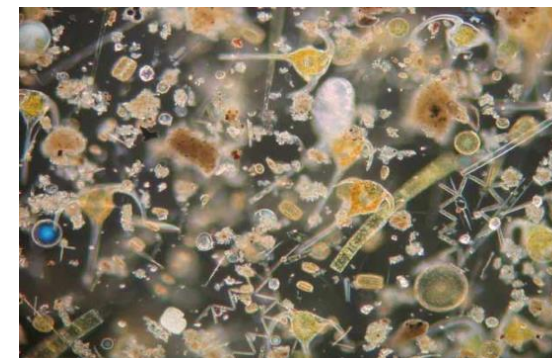
In 2016 -  
 In 2017, 2018 -  
 Data from DCF,  
 MEDITS and MEDIAS



## D4: Pelagic food web

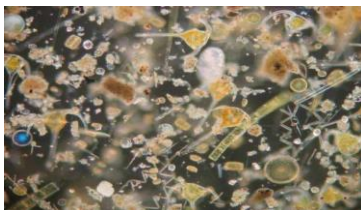
Pelagic food web characteristics in the Adriatic (Croatian side) are oligotrophic conditions that favors prokaryotic heterotrophs in relation to phagotrophs. So, chosen **components** include:

- **Microbe food web** – (heterotrophic bacteria; bacterial production; autotrophic picoplankton: cyanobacteria (*Synechococcus*, *Prochlorococcus*), picoeucaryots; heterotrophic nanoplankton, microzooplankton (ciliates)
- **Phytoplankton** – (species composition, number, biomass – chlorophyll *a*, primary production)
- **Mesozooplankton** – (composition, number )
- **Small bluefish**: sardines – (number, condition, food)
- **Top predator**: tuna – (number, condition)



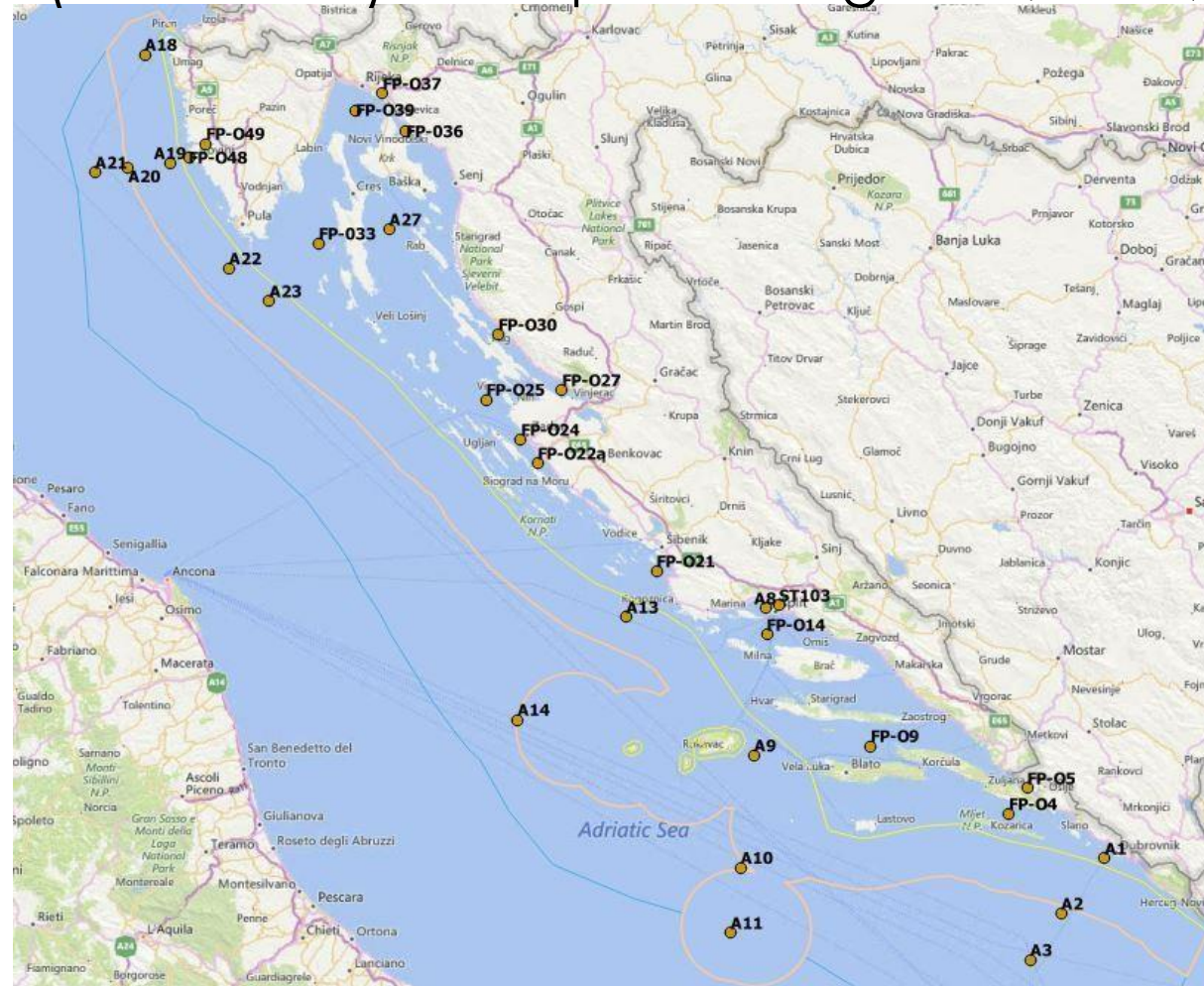
## D4: Pelagic food web

Descriptor	Components	Parameters	Sites/ areas	Sampling frequency
<b>D4</b> <b>Pelagic food webs</b>	Microbe food web	heterotrophic bacteria; bacterial production; autotrophic picoplankton, cyanobacteria; picoeucariots; heterotrophic nanoplankton, microzooplankton	<u>South Adriatic</u> : Dubrovnik – Bari <u>Middle Adriatic</u> : Split–Gargano, Šibenik – Ortona <u>North Adriatic</u> : river Po delta–Rovinj	North and middle Adriatic – 12 x year Lim, Bakar, west Istrian coast – 7 x year ; rest: - 4 x year
	Phytoplankton	Species composition, number, biomass, chl a, primary production		
	Mesozooplankton (target group: copepods)	Composition, number	Coastal areas: mouth of river Neretva, Kaštela Bay, Rijeka i Bakar Bay, west Istrian coast (total 33 sites)	<b>In 2016</b> 1 X 22 sites in middle and south Adriatic
	Small pelagic blue fish (target species: <i>Sardina pilchardus</i> )	number, condition, diet		
	Top predators (target species: tuna – <i>Thunnus thynnus</i> , <i>Thunnus albacore</i> , <i>Xipias gladius</i> )	Number, condition		<b>In 2017, 2018</b> 2 X 22 sites in middle and south Adriatic



## D4: Pelagic food web

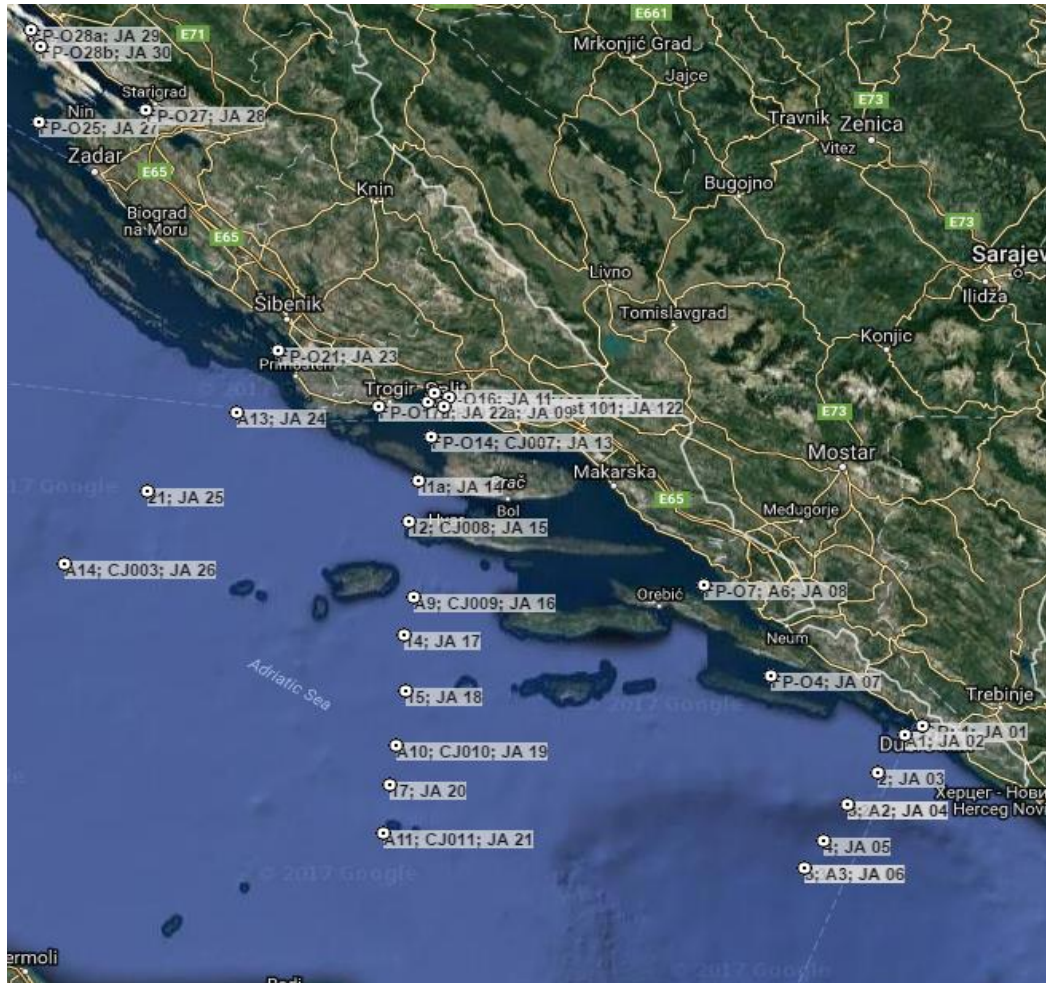
Monitoring sites for D4 (D5 and D7) descriptor during 2016, 2017, 2018 (north, middle, south Adriatic)





## D4: Pelagic food web

Monitoring sites for D4 (and D5) descriptor during 2016, 2017 and 2018



**Middle and south Adriatic measuring sites**

No	Site	Depth (m)	Φ	λ
1	GR; 1; JA 01	12	18° 4.983′	42° 39.586′
2	A1; JA 02	107	18° 1.312′	42° 38.031′
3	3; A2; JA 04	332	17° 49.463′	42° 26.856′
4	5; A3; JA 06	1164	17° 40.615′	42° 16.637′
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## D5: Eutrophication

Eutrophication is process caused by enriching the water body with nutrients, especially N and P compounds, that brings to increase of growth, primary production and algae biomass and consequently hypoxic (anoxic) events and changes in benthic community.

Components:

- Nutrient loadings
- Concentration of chlorophyll a
- Concentration of dissolved oxygen
- Toxic blooms events (frequency ...)
- Concentration of nutrients \*
- Submerged vegetation (changes)
- Benthic communities (changes)
- Benthic organisms / fishes (mortality)



Negative consequences of eutrophication

**\* Concentrations of  $\text{NO}_3^-$ ,  $\text{NO}_2^-$ ,  $\text{NH}_4^+$ ,  $\text{SiO}_4^{4-}$ , TIN,  $\text{HPO}_4^{2-}$ , TN, NORG, TP, PORG) + pH**

## D5: Eutrophication

Descriptor	Components	Parameters	Sites/ areas	Sampling frequency
<b>D5</b> <b>Eutrophication</b>	Nutrient loadings	t/g calculated from river loadings and urban and industrial input	<u>South Adriatic:</u> Dubrovnik – Bari	1x year
	Increase in primary production	Chl a concentration Satellite observations and modelling	<u>Middle Adriatic:</u> Split– Gargano, Šibenik – Ortona	1x year
	Chl a concentration	Annual average values (geometric average or 90 th percentill)	<u>North Adriatic:</u> river Po delta– Rovinj	Monthly or more frequent
	Concentration of dissolved oxygen	Annual average values (10th percentill)		Monthly or more frequent
	Toxic bloom	Bloom that cause damage for living resources (frequency, duration, area covered)	Coastal areas: mouth of river Neretva, Kaštela Bay, Rijeka, Bakar Bay, west Istrian coast	Yearly
	Nutrient concentrations	Average annual values (geometric average)		Monthly or more frequent
	Submerged vegetation	Changes in covered area and density	(total 33 sites)	
	Benthic community	Changes in biodiversity and ratios between sensitive and non sensitive species (multimetric indexes)		
	Benthic organisms/fish	Massive mortality events (documentation of the events)		

*In 2016*

*1 X 23 sites in  
middle and south  
Adriatic / 1 x 20  
in north Adriatic*

*In 2017, 2018  
2 X 23 sites in  
middle and south  
Adriatic*

docum  
mortal



## D6: Seafloor Integrity



According to National habitats classification in Croatian waters exist: 31 habitats, 60 biocenosis, 134 facies, associations, ecomorphosis and other specific habitats (fish farms, harbours, communities with non indigenous species ...) (Bakran-Petricioli, 2011)

### Components;

- Epifauna on soft bottoms and bottoms with fishery activities
- Macro i meiofauna on soft bottoms
- Mediolittorall on hard bottoms and rocks / Biocenosis of infralittoral algae (D1 component: Settlement of photophilic algae and species *Cystoseira amentacea*)
- *Posidonia oceanica* meadows (mapping)



## D6: Seafloor Integrity

Descriptor	Components		Parameters	Sites/ areas	Sampling frequency
<b>D6</b>  <b>Seafloor integrity</b>	Epifauna on soft bottoms and bottoms of fishery activity		Abundancy, biomass of each species	30 chosen sites in island area, open sea, whole coast of east Adriatic	1x year summer (June/ July)
	Macro and meiofauna on soft bottoms		Number of species, number, taxonomic and functional composition	North Adriatic	1x in 3 years
	 Mediolittoral; hard bottom and rocks / Biocenosis of infralittoral algae (D1-component: settlement of photophilic algae and <i>Cystoseira amentacea</i> )		Distribution of <i>Cystoseira amentacea</i> and invasive species (D2) and areas damaged by sea urchins (D6)	30 chosen sites in island area, open sea, whole coast of east Adriatic, 10 chosen sites in north Adriatic	1 x in 3 years
	 <i>Posidonia oceanica</i> meadows *	Mapping   Ecological state	Density of shoots, covering of meadows, leaf area, saccharose, ratio of nitrogen isotopes, ratio of sulphur isotopes, Pb in rhizome, N in epiphytes	38 sites covered by WFD + 17 annexed sites across the Adriatic *	After the mapping, till  <div> <p> <i>In 2016 -</i>  <i>In 2017, 2018 -</i>  <i>WFD data for</i>  <i>Posidonia oceanica*</i> </p> </div>

## D7: Hydrographic conditions

Characteristics of **hydrographic conditions** in Adriatic Sea waters (Croatia)

Permanent change of hydrographic conditions in the Adriatic can be caused by: two main impacts: 1) climate changes combined with natural variability and 2) human activities (building of dams, inputs of industrial waters, waste waters, outlets, fish farms, power plants, energy...),



Monitoring parameters:

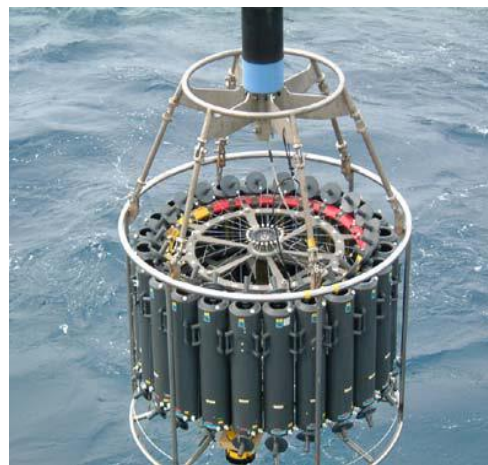
- **temperature**
- **salinity**
- **turbidity**
- **waves**
- **currents**
- **bathymetry**

- Connected to (D1) (D2), (D3), (D5) i (D11).



## D7: Hydrographic conditions

Descriptor	Components	Parameters	Sites/ areas	Sampling frequency
<b>D7</b> <b>Hydrographic conditions</b>	-	Temperature, salinity, sea currents, transparency, fluorescence (from chl a and colored dissolved organic matter), concentration of suspended matter , sea level	<u>South Adriatic:</u> Dubrovnik – Bari <u>Middle Adriatic:</u> Split–Gargano, Šibenik – Ortona <u>North Adriatic:</u> river Po delta–Rovinj Coastal areas: mouth of river Neretva, Kaštela Bay, Rijeka, Bakar Bay, west Istrian coast (total 33 sites)	North and middle Adriatic– 12 x year Lim, Bakar, west Istrian coast – 7 x year; rest: - 4 x year



*In 2016*  
*(T, S, transparency)*  
*1 X 31 sites in middle and south Adriatic / 1x 27 north Adriatic*

*In 2017, 2018*  
*(T, S, transparency)*  
*2 X 31 sites in middle and south Adriatic*



## D8: Contaminants

Components:

**-Concentrations of contaminants in:**

seawater (priority list\*);

sediment (Cd, Pb, Cu, Zn, HgT, Cr, organotins, hexachlorbenzene, aldrine, dieldrine, endrine, heptachlor, p,p'-DDE, DDD, DDT, PCB-7 congeners, PAH-s )

organisms (in shellfish: organotins; in fishes and shellfish – as in sediments)

**- Effects of contaminants** (toxicity and genotoxicity)





**\*Annex X (WFD 2013/39/EU)**



## D8: Contaminants

Contaminants

Descriptor	Components	Parameters		Sites/ areas	Sampling frequency
D8	Concentrations of contaminants	Seawater	Concentrations of priority and priority dangerous compounds	16 sites in coastal and marine Adriatic waters	4 X year; seasonal (monitoring conducting Croatian waters)
		Sediment	Cd, Pb, Cu, Zn, HgT, Cr, organotin compounds, hexsachlorbenzen, aldrine, dieldrine, endrine, heptachlor, p,p'-DDE, DDD, DDT, PCB-7 congeners, PAH-s	16 sites in coastal and marine Adriatic waters	1x year
		Biota	<u>Shellfish</u> : organokositreni spojevi <u>Shellfish and fishes</u> : Cd, Pb, Cu, Zn, HgT, Cr, heksaklorbenzen, aldrin, dieldrin, endrin, heptachlor, p,p'-DDE, DDD, DDT, PCB-7 congeners, PAH-si	16 sites in coastal and marine Adriatic waters	1x year
	Effects of contaminants	Seawater	tokxicity, genotoxicity	16 sites in coastal and marine Adriatic waters	4x year; seasonal
		Sediment	toxicity	16 sites in coastal and marine Adriatic waters	1x year
		Biota	<u>Shellfish</u> : effect of organic matters/ content of neutral lipids Effect of metals/ metalothionine content, effect of pesticides and carbamates / activity of AChE, effect of genotoxic compounds / induction of DNA damaging, index of cell stress / stability of lysosomal membrans, total stress index / survival on air <u>Fishes</u> : effects PAHs / metabolite ; PAH-s in liver, activity EROD	16 sites in coastal and marine Adriatic waters	1x year

In 2016 –

In 2017, 2018 (Effects of contaminants CIM Rovinj)



*In 2016 –*  
*In 2017, 2018 (Effects of contaminants CIM Rovinj)*



## D9: Contaminants in seafood

### Components:

- **Shellfish *Mytilus galloprovincialis***; (Cd and Pb; marine biotoxins - ASP, DSP, PSP; PAH-s: benzo(a)pyrene, chrysene, benzo(b)flurantene i benzo(a)anthracene)
- **Commercially important fishes** (Cd, Pb and Hg; dioxines, PCB-s like dioxines) (according to EC 1881/2006)





## D9: Contaminants in seafood

Descriptor	Components	Parameters	Sites/ areas	Sampling frequency
D9 Contaminants in seafood	Shellfish: <i>Mytilus galloprovincialis</i> .	Heavy metals: Cd and Pb	16 sites in coastal and marine Adriatic waters	1x year
		Marine biotoxins: ASP, DSP i PSP		
		polycyclic aromatic hydrocarbons (PAH): benzo(a)pyrene, chrysene, benzo(b)flurantane i benzo(a)anthracen e		
	Commercially important fishes (in accordance with D3)	Heavy metals: Cd, Hg and Pb dioxins, PCBs like dioxine and indicators PCBs		

In 2016 -  
 In 2017, 2018 -




## D10: Marine litter

### Components:

- Litter washed ashore (quantity, composition)
- Litter on sea surface and seafloor (quantity, composition)
- Micro-plastics on beaches and sea surface (quantity, composition, distribution)
- Litter ingested by marine animals



## D10: Marine litter

Descriptor	Components	Parameters	Sites / areas	Sampling frequency
<b>D10</b> <b>Marine litter</b> 	Solid waste washed ashore	quantity, composition	Southern exposed coastal areas of islands and coast in north, middle and south Adriatic, river mouths sandy beaches	Seasonal 4x year
	Solid waste on sea surface and sea bottom	quantity, composition	Main trajectories of marine traffic, southern exposed coastal areas of islands and coast in north, main trawling areas	Seasonal 2x year (spring and autumn)
	Micro-plastics on beaches and sea surface	quantity, composition, distribution	Chosen sandy beaches in south, middle and north Adriatic, main trawling areas, around wastewater outlets	Seasonal 4x year
	Liter ingested by marine animals	quantity, composition	Main fishery areas	Seasonal 4x year

*In 2016 –  
 (DeFishGear proje  
 data)*

*In 2017, 2018  
 1 X on new locations!*



## D10: Marine litter

### Locations of monitoring sites for D10 during 2017, 2018

Izveštajni sustav monitoringa Jadrana

Korisnik: Matijević Slavica  
Laboratorij za kemijsku oceanografiju i sedimentologiju mora

Statistika
Analiza podataka
Ažuriranje podataka

Projekt JADMON teren otpad iz mora 2017

trenutno:

**Tablica postaja - Uređivanje postaja**

Ime	dubina	dan	vrijeme	širina	dužina
OMD-sjeverni Jadran	43	02.07.2017	13:55	44,82583330	13,52666667
OMD-srednji Jadran	217	08.07.2017	13:30	43,41888330	15,42253333
OMD-južni Jadran	140	12.07.2017	17:30	42,65055000	17,27318333
LMP-Nin	0	17.07.2017	10:00	44,24685142	15,19738111
LMP-Neretva	0	19.07.2017	09:00	43,01927780	17,44662500
LMP-Prapatna	0	19.07.2017	18:00	42,81711749	17,67631250
LMP-Zaglav	0	21.07.2017	17:00	43,03305674	16,22841944
Biota-Sjeverni Jadran	47	25.08.2017	22:00	44,40239183	14,00619500
PIO-Pelegrin	0	06.09.2017	07:45	43,27965000	16,38988333
MikroP-Hvarski kanal	0	06.09.2017	08:45	43,27965000	16,38988333
PIO-Mljet	0	06.09.2017	12:45	42,77680000	17,31670000
MikroP-Mljet	0	06.09.2017	13:15	42,77680000	17,31670000
PIO-Dugi otok	0	12.10.2017	10:30	43,84344164	15,18281667
MikroP-Dugi otok	0	12.10.2017	11:00	43,85450000	15,18281667
OP-Nin	0	16.10.2017	10:00	44,24690330	15,19704333

Karta
Satelit
Pokaži imena

## D11: Underwater noise

Characteristics and sources of underwater noise in the Adriatic waters (Croatia)

D11 describes the impact of anthropogenic underwater noise on marine organisms (without human impact there are natural sources of noise: seismic, meteorological and biological).



### Components:

- **Impulsive** noise
- **Ambient** (continuous) noise



## D11: Underwater noise

Descriptor	Components	Parameters	Sites/ areas	Sampling frequency
<b>D11 Underwater noise</b>	Ambient (continuous) noise	Levels of ambient noise of low and middle frequency inside 10- 20kHz frequency area  Trends of noise levels on belts inside whole frequency area	4 sites on west coast area (west istrian coast, Kornati islands, Žirje and Split harbour	2 x year : June-August; October -April
	Impulsive	Activity that causes impulse noise, duration, location, sound source level	Whole Croatian part of the Adriatic	Continued registration of anthropogenic activities that create noise

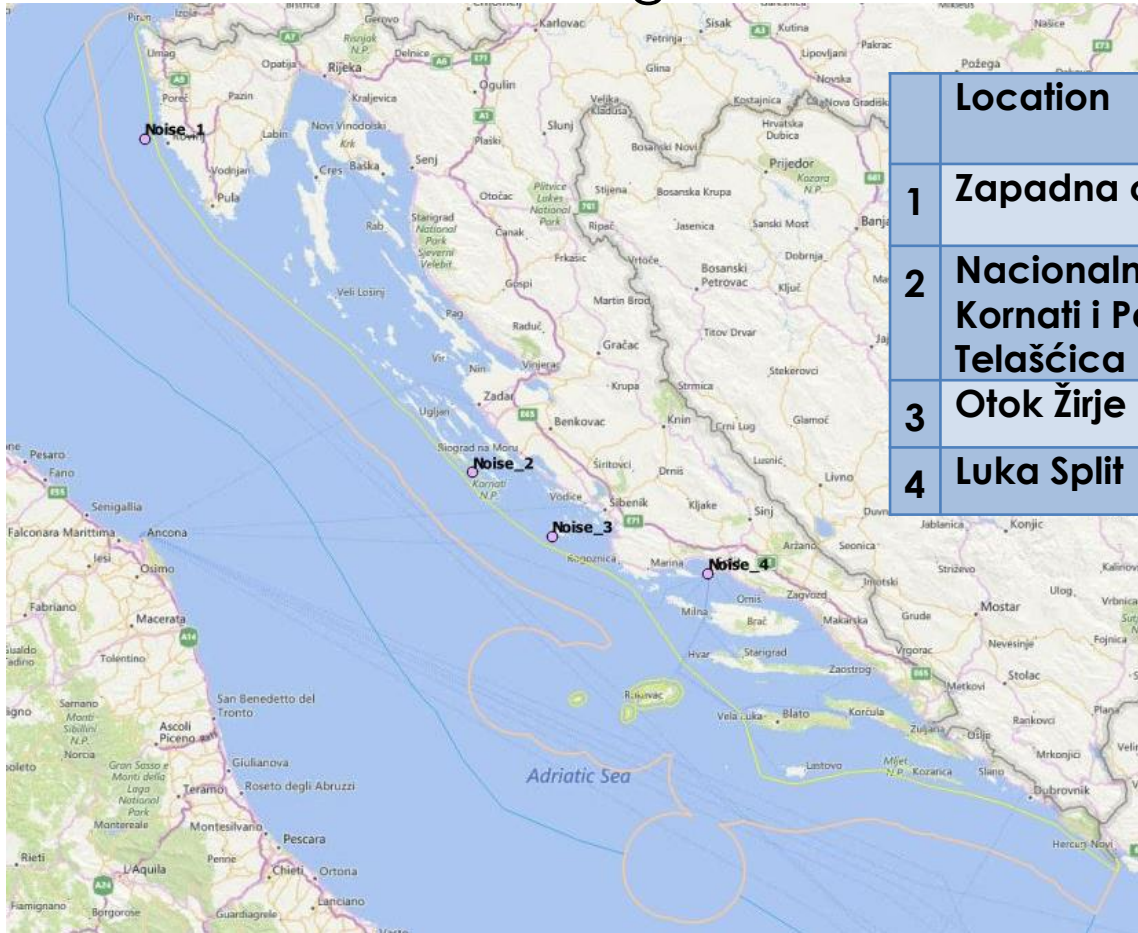
*In 2016 –*

*In 2017, 2018 (continuous  
noise inside 63 and 125  
Hz frequency levels)*



## D11: Underwater noise

Location of monitoring sites for D11 descriptor

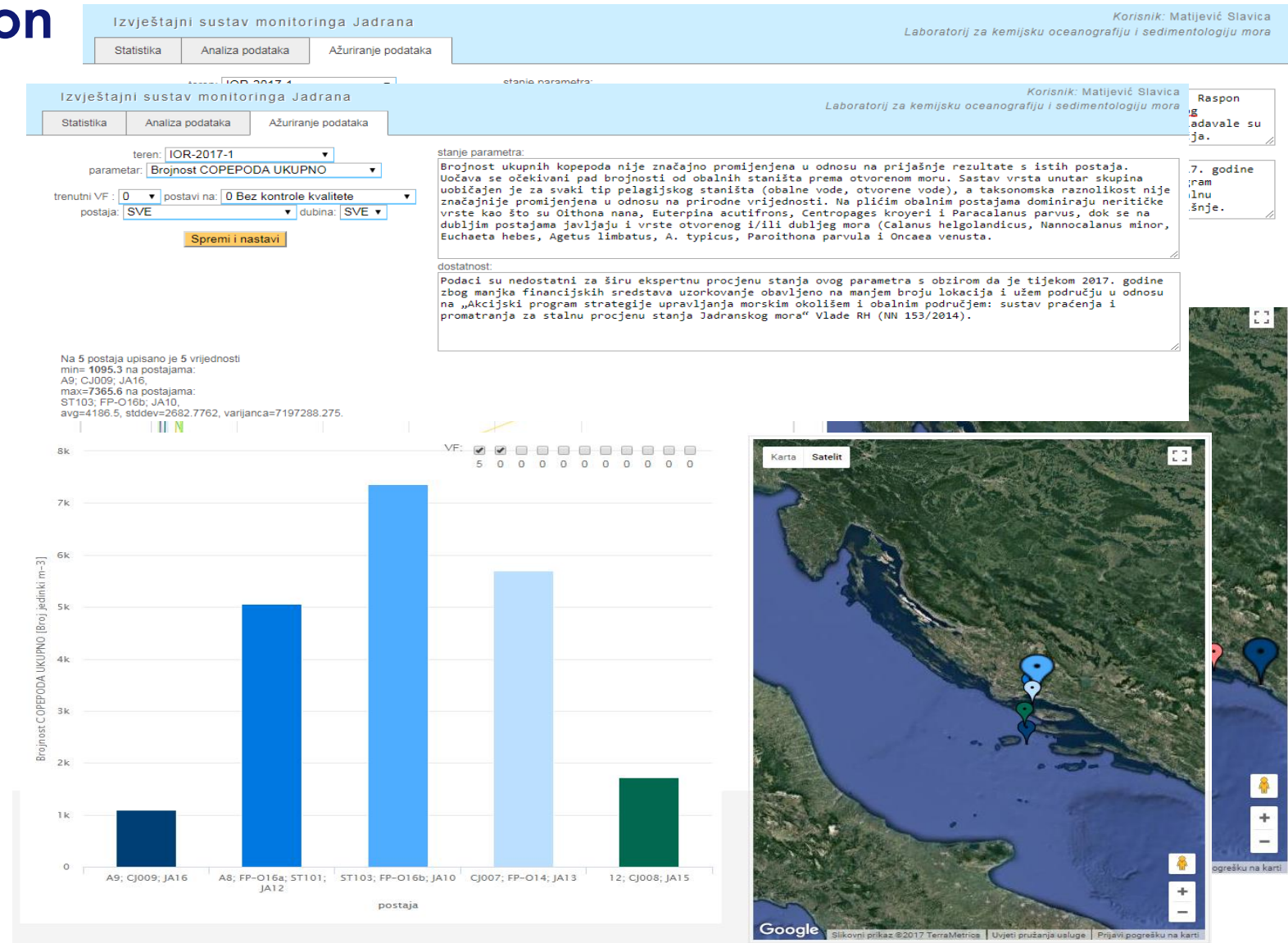


	Location	Water body	Name	$\varphi$	$\lambda$
1	Zapadna obala Istre		Noise 1	45.102778	13.515278
2	Nacionalni park Kornati i Park prirode Telašćica	O423-KOR	Noise 2	43.873889	15.207222
3	Otok Žirje	O423-KOR	Noise 3	43.636111	15.615278
4	Luka Split	O423-BSK	Noise 4	43.496111	16.420833

# Descriptor's Data Interpretation

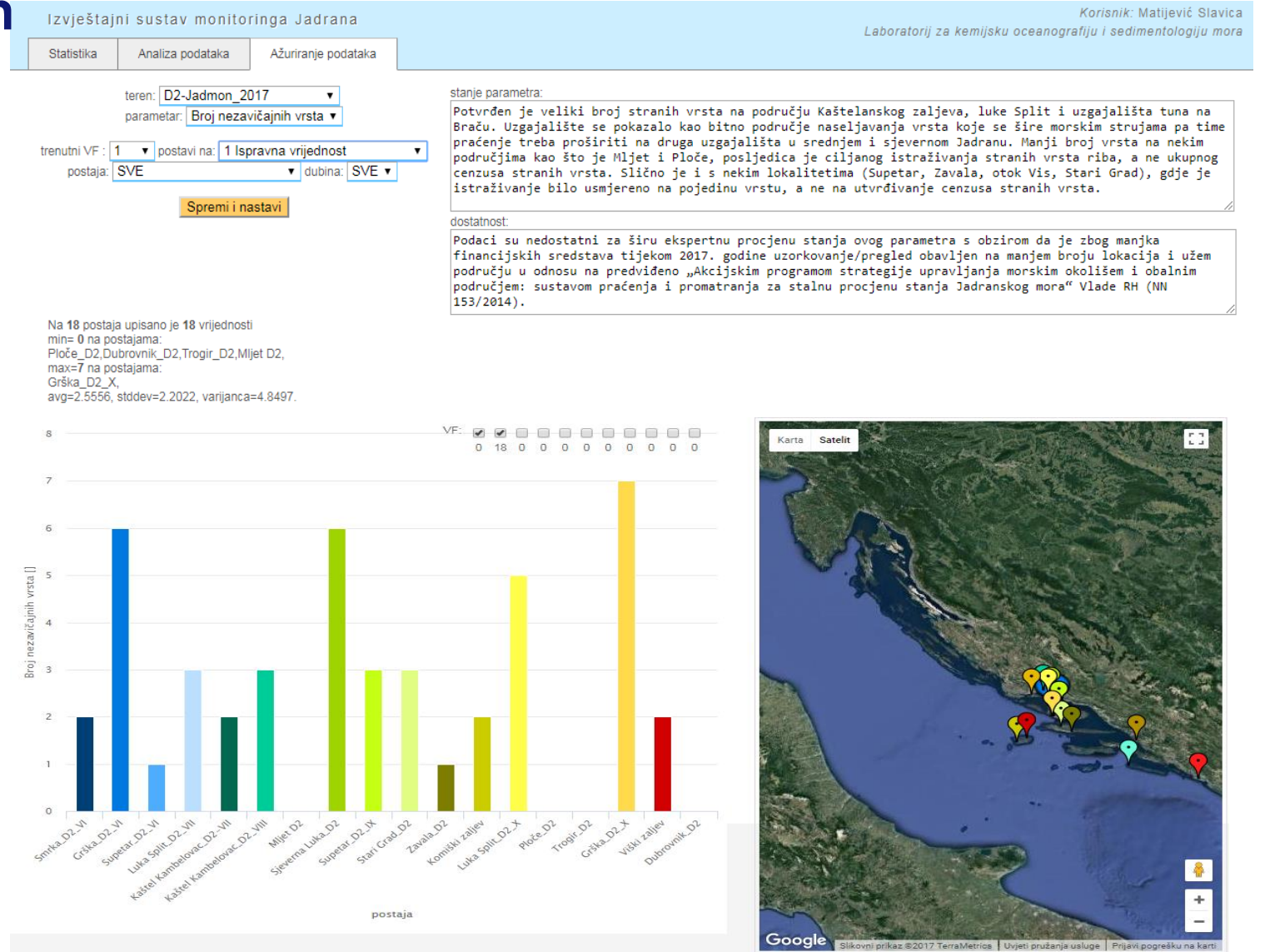
Example of results for D1 state in the **Reporting system of the Adriatic Sea Monitoring** (total abundancy of phytoplankton)

Example of results for D1 state in the **Reporting system of the Adriatic Sea Monitoring** (total number of copepods)



# Descriptor's Data Interpretation

Example of results for D2 state in the **Reporting system of the Adriatic Sea Monitoring** (number of non-indigenous species)





# Descriptor's Data Interpretation

Example of results for D5 state in the **Reporting system of the Adriatic Sea Monitoring** (concentration of total dissolved inorganic nitrogen)

teren: 
  
 parametar: 
  
 trenutni VF:  postavi na: 
  
 postaja:  dubina:

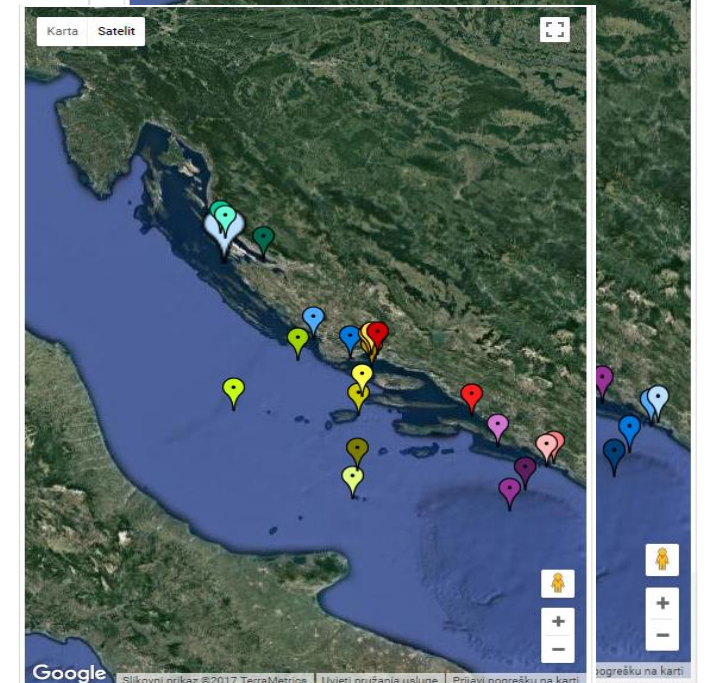
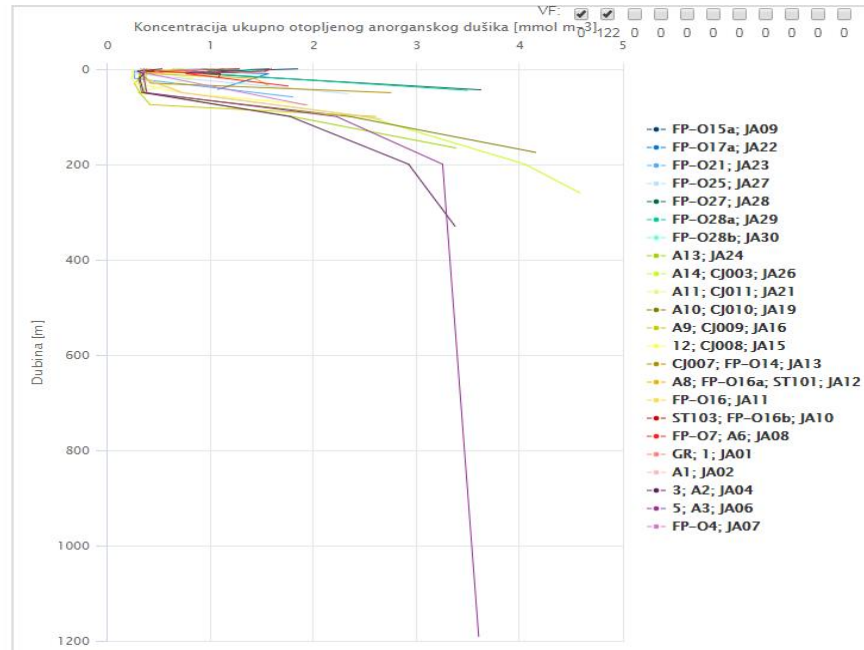
stanje parametra:

Koncentracija ukupnog anorganskog dušika (suma otopljenog nitrata, nitrita i amonijevih soli) u vodenom stupcu postaja srednjeg i južnog Jadrana u listopadu 2017. godine bila u rasponu od 0,23 do 4,58 mmol m<sup>-3</sup> sa srednjom vrijednošću od 1,05±1,01 mmol m<sup>-3</sup>. Ove su vrijednosti unutar raspona određenog „Početnom procjenom stanja i opterećenja morskog okoliša hrvatskog dijela Jadrana“ (IOR, 2012)“. Iz prikaza vertikalnih profila raspodjele koncentracije po dubini vodenog stupca na istraživanim postajama je vidljivo da su značajno više koncentracije u pridnom sloju većine postaja u odnosu na ostale slojeve što se pripisuje remineralizaciji iz sedimenta.

dostatnost:

Podaci su nedostatni za širu ekspertnu procjenu stanja ovog parametra s obzirom da je tijekom 2017. godine zbog manjka financijskih sredstava uzorkovanje obavljeno samo dva puta u odnosu na „Akcijski program strategije upravljanja morskim okolišem i obalnim područjem: sustav praćenja i promatranja za stalnu procjenu stanja Jadranskog mora“ Vlade RH (NN 153/2014) kojim je predviđeno 7-12 uzorkovanja godišnje.

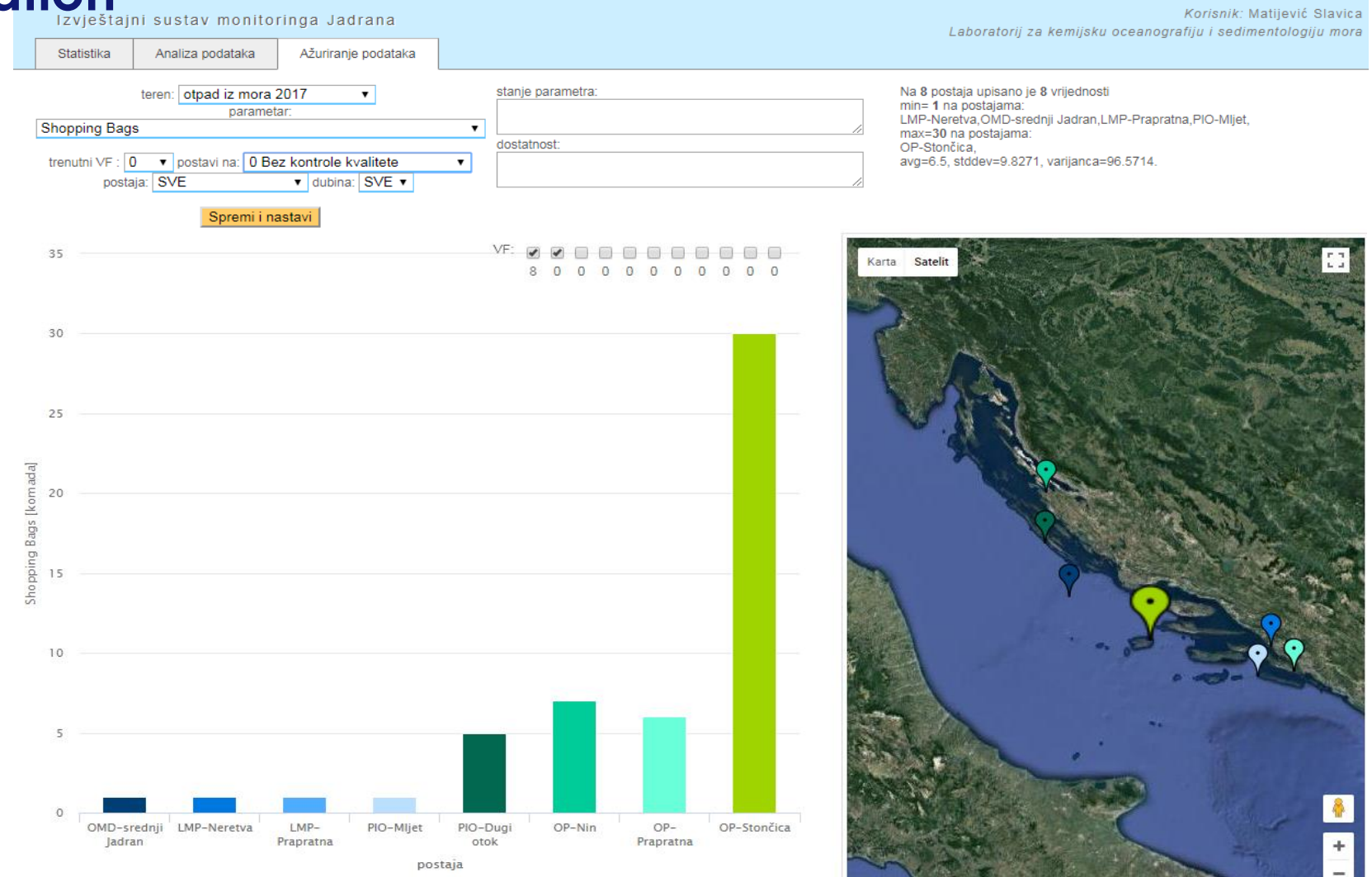
Na 23 postaja upisano je 122 vrijednosti  
 min= 0.23 na postajama:  
 12; CJ008; JA15,  
 max=4.58 na postajama:  
 A14; CJ003; JA26,  
 avg=1.0536, stddev=1.0096, varijanca=1.0192.





# Descriptor's Data Interpretation

Example of results for D10 state in the **Reporting system of the Adriatic Sea Monitoring** (number of plastic bags on the beaches)



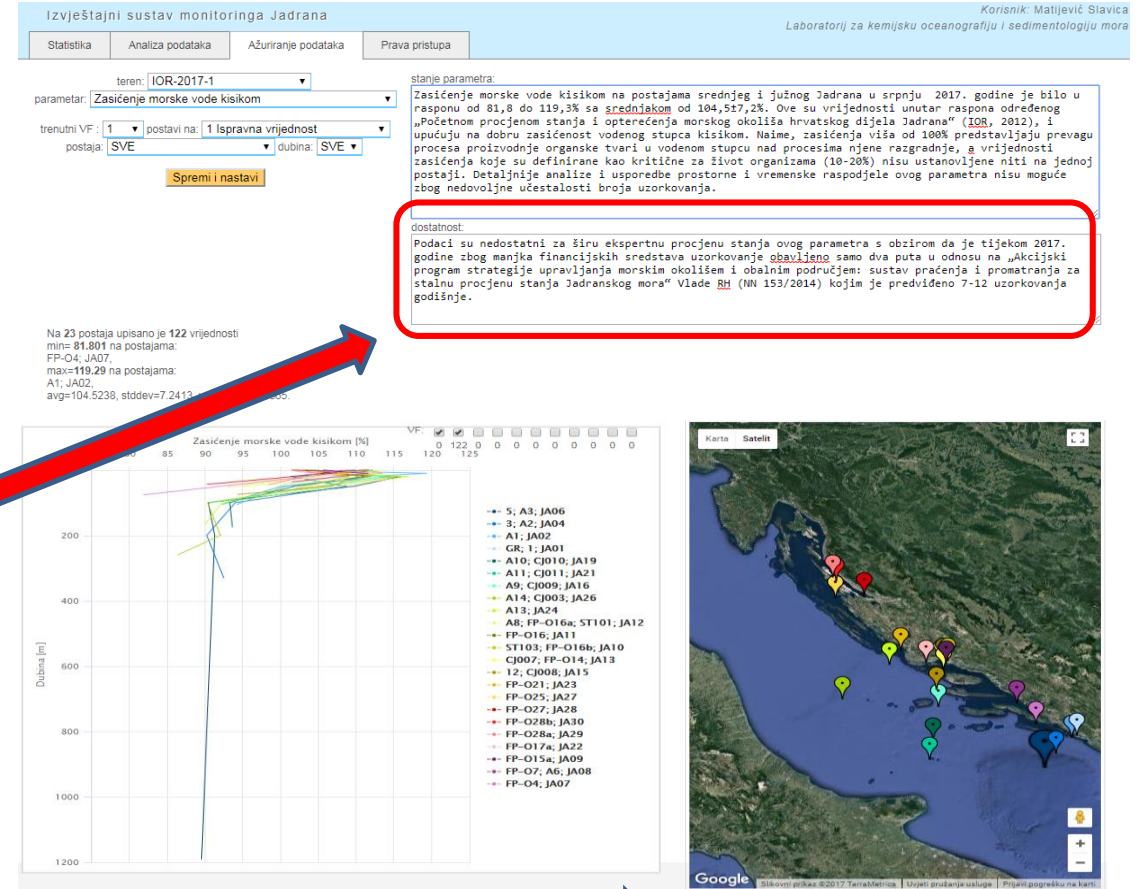


# Descriptor's Data Interpretation



Podaci su nedostadni za širu ekspertnu procjenu stanja ovog parametra s obzirom da je tijekom 2017. godine zbog manjka financijskih sredstava uzorkovanje obavljeno samo dva puta u odnosu na „Akcijski program strategije upravljanja morskim okolišem i obalnim područjem: sustav praćenja i promatranja za stalnu procjenu stanja Jadranskog mora“ Vlade RH (NN 153/2014) kojim je predviđeno 7-12 uzorkovanja godišnje.

**“Insufficiency of data”**



## Problems:

Insufficient financial resources for Monitoring data for certain descriptors

Lack of Reporting to EU?



# Thank You for Your attention!



**Interreg**  
**ADRION** **ADRIATIC-IONIAN**  
European Regional Development Fund - Instrument for Pre-Accession II Fund



**HarmonIA**



Thank you for your attention!

Hvala na pažnji !



<b>*Prioritetna tvar</b>
para-para-DDT
<b>Heksaklorocikloheksan (SUMA)</b>
Endosulfan
Pentaklorobenzen
Bromirani difenileter-kongener 28
Bromirani difenileter-kongener 47
Bromirani difenileter-kongener 99
Bromirani difenileter-kongener 100
Bromirani difenileter-kongener 153
Bromirani difenileter-kongener 154
<b>Pentabromodifenileter (SUMA)</b>
Tributilkositrovi spojevi (Tributilkositar-kation)
Cibutrin
Terbutrin
<b>Specifične onečišćujuće tvari</b>
Cu (i njegovi spojevi)
Zn (i njegovi spojev)

Postaja/imena razna	JADMON MSFD ime	φ	λ	Dubina	*
GR; 1	JA 01	42,65976	18,08305	12	
A1	JA 02	42,63385	18,02187	107	
2	JA 03	42,53332	17,92941	167	samo CTD
A2; 3	JA 04	42,44760	17,82438	332	
4	JA 05	42,35112	17,74323	807	samo CTD
A3; 5	JA 06	42,27728	17,67692	1164	
FP-O4	JA 07	42,79183	17,56175	78	
A6; FP-O7	JA 08	43,03346	17,32843	38	
FP-O15a	JA 09	43,50318	16,43380	12	
ST-103; FP-O16b	JA 10	43,53000	16,45333	18	
FP-O16	JA 11	43,54171	16,40184	22	
A8; 11; ST-101; FP-O16a	JA 12	43,51833	16,38167	38	
CJ 007; FP-O14	JA 13	43,42672	16,39352	52	
11a	JA 14	43,31000	16,39833		samo CTD
12; CJ 008	JA 15	43,19988	16,31713	78	samo CTD
A9; CJ 009	JA 16	43,00000	16,33345	103	
14	JA 17	42,90016	16,29980	124	samo CTD
15	JA 18	42,75000	16,30340	149	samo CTD
A10; CJ010	JA 19	42,60418	16,27347	178	
17	JA 20	42,50015	16,25004	172	samo CTD
A11; CJ011	JA 21	42,37133	16,22702	108	
FP-O17a	JA 22	43,50341	16,20829	44	
FP-O21	JA 23	43,65000	15,86183	60	
A13	JA 24	43,48767	15,72150	169	
21	JA 25	43,28177	15,41505	170	samo CTD
A14; CJ003	JA 26	43,08700	15,12700	264	
FP-O25	JA 27	44,24992	15,04031	54	
FP-O27	JA 28	44,28243	15,40693	47	
FP-O28a	JA 29	44,48736	15,01205	49	
FP-O28b	JA 30	44,44700	15,04833	12	