



Zeleni tehnologiji za ekološko čiščenje biološke
obrasti s trupa ladij v severnem Jadranu

Tecnologie verdi di pulizia ecologica dell'incrostazione
biologica sugli scafi nell'Alto Adriatico

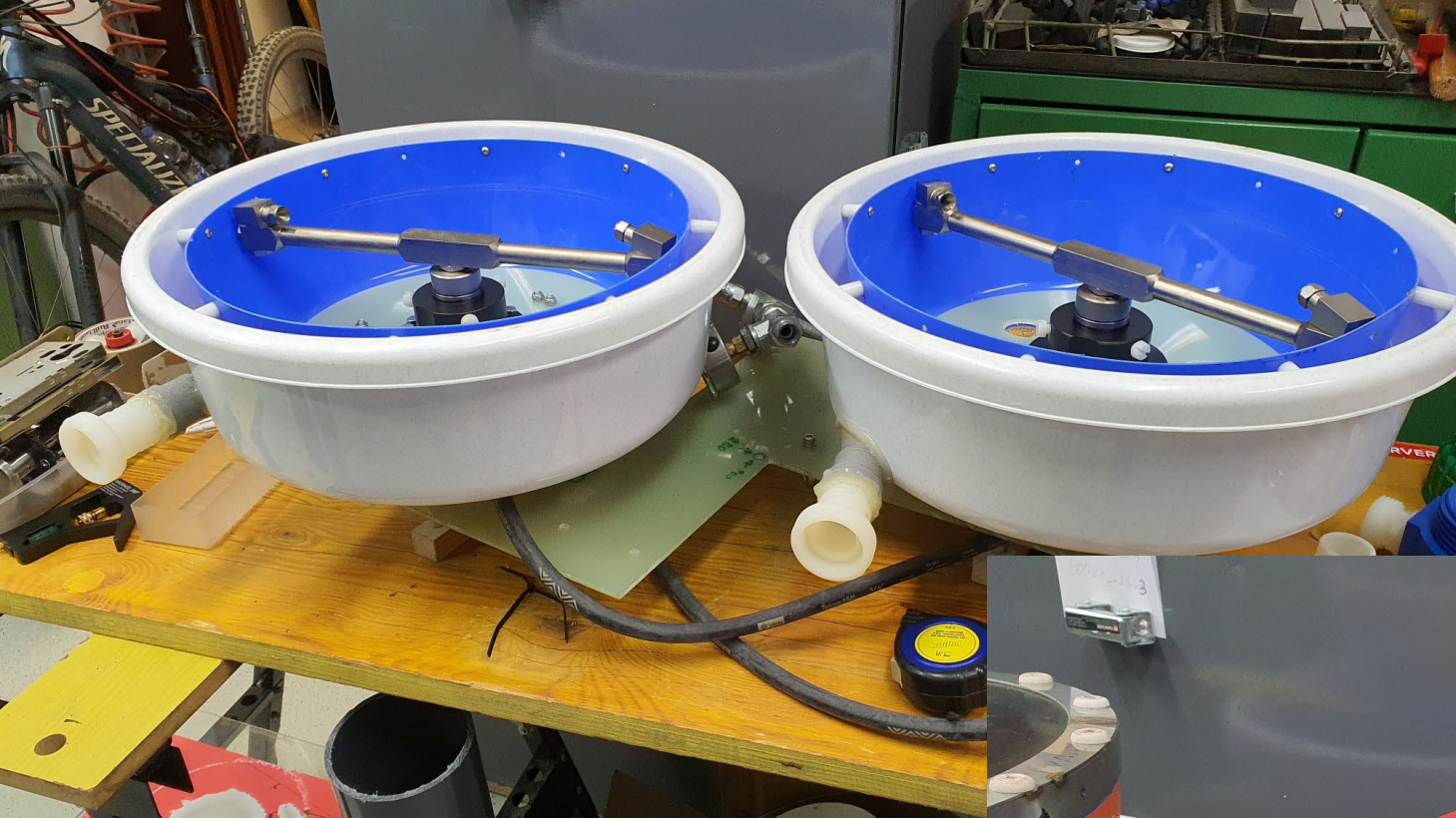
Monitoraggio ambientale e analisi biochimiche per la pulizia ecologica delle incrostazioni biologiche delle navi

**Okoljski monitoring in biološko-kemijske analize za zagotovitev ekološkega
čiščenja ladijske biološke obrasti**

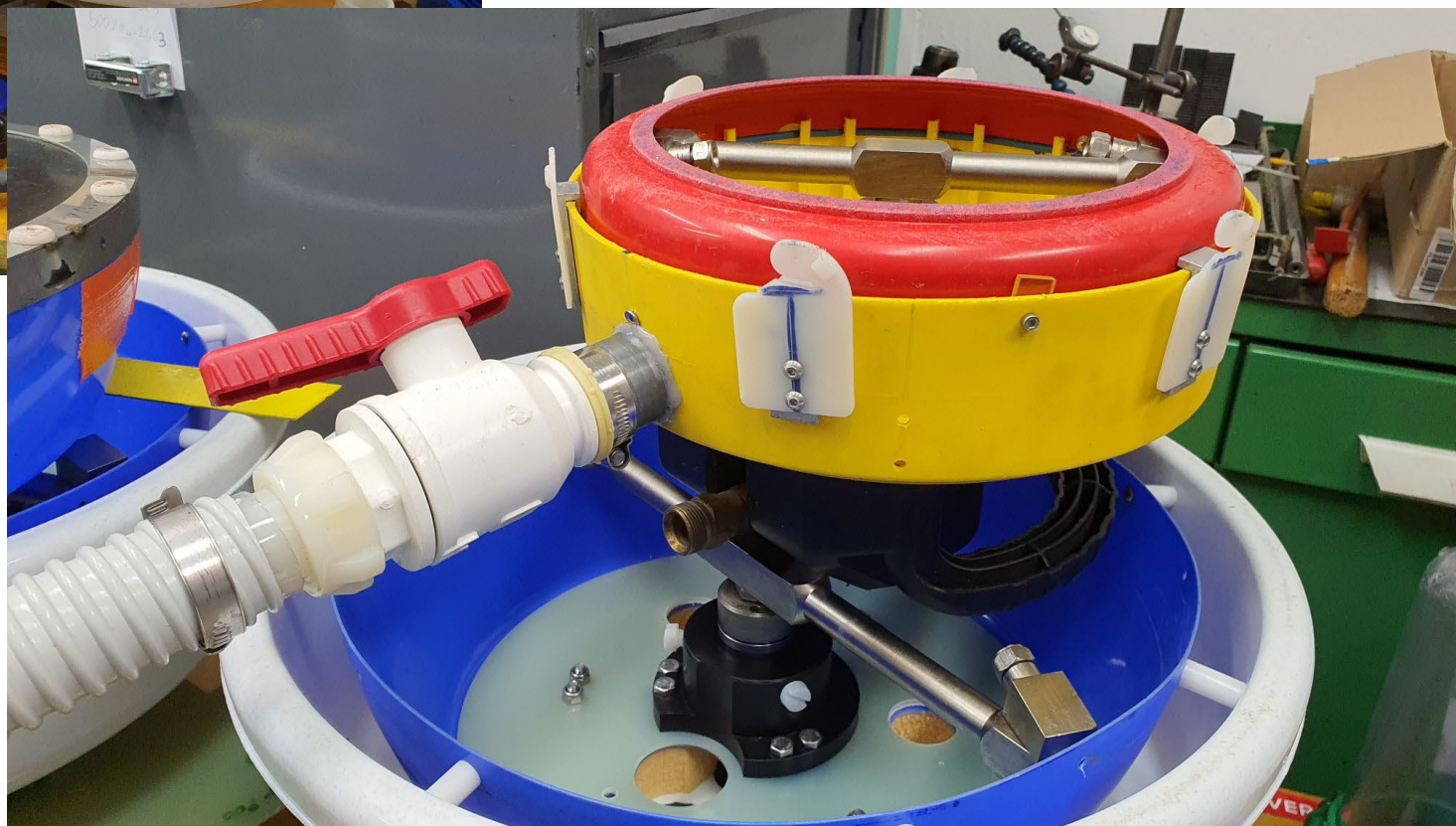
Vlado Malačič



Top side of ROV
with WiMO



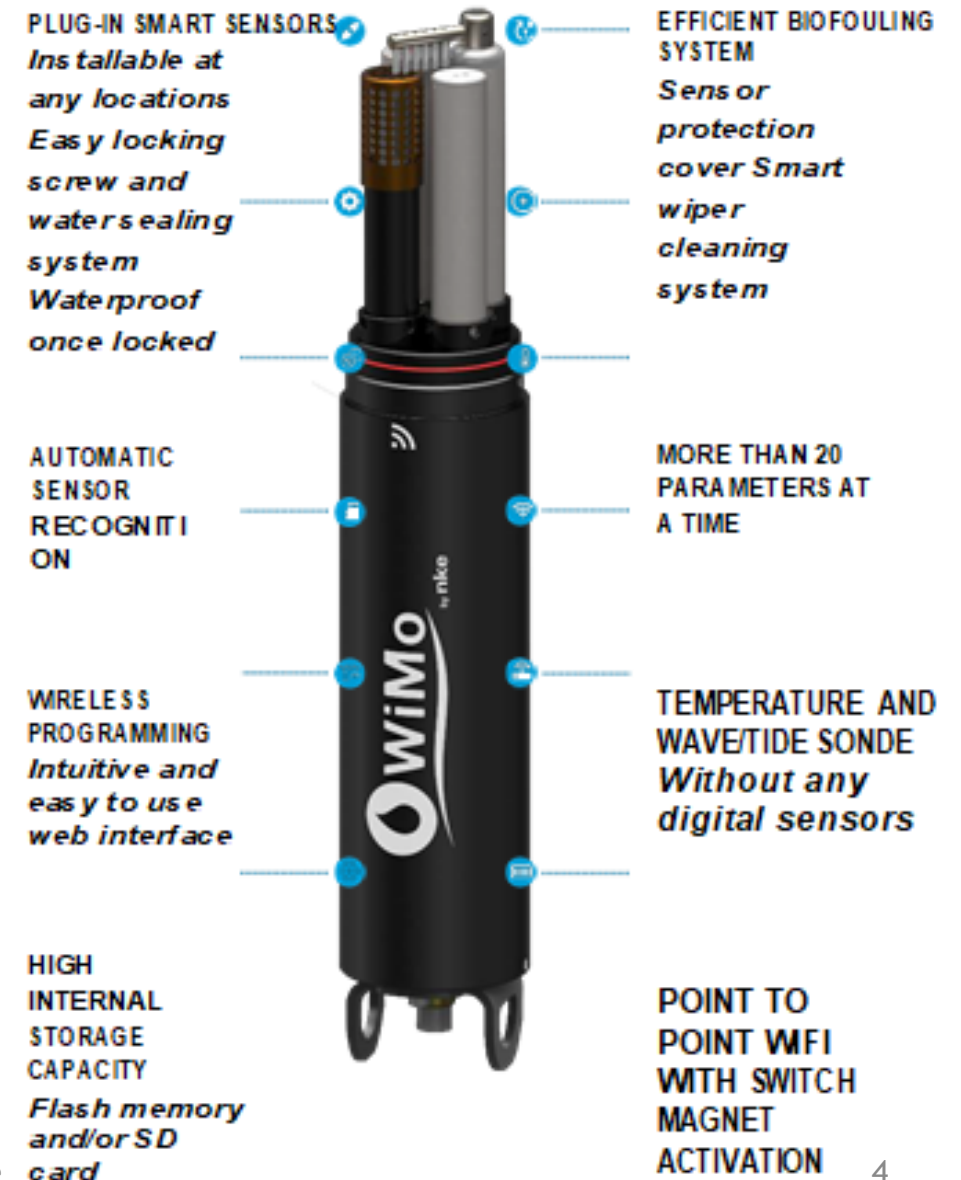
Scrabbing devices
at the bottom
side of ROV



WP 3.1 Development of Green Innovative Technology (NIB)

Online measurements of the ambient during cleaning of the vessel's hull

- Ambiental sensors for the monitoring of water quality will be installed on ROV
- Environmental monitoring & BI-CHE analyses of samples recovered during removal of biofouling of ship hull
 - Automatized in real time measurements of important parameters, e.g. oxygen concentration, temperature, salinity, visibility/turbidity and photosynthetic active radiance (PAR)
 - WiMO PLUS probe with integrated depth sensor, up to 7 locations: C&T sensor, FLUO Phycocyanin, FLUO Chl-a, FLUO CDOM, Turbidity, Dissolved Oxygen sensor, pH.
 - Modbus protocol for the communication of WiMO with the controlling board (on ROV)





- CT
- Turbidity
- CHl-a
- Wiper
- **CDOM**

indicator of
,bad' cleaning

- DO
- **Phycocyanin**

indicator of
,bad' cleaning

phycocyanin pigments: ⇒
cyanobacteria released
from fouling



Cleaning the hull

Online measurements **WiMO**

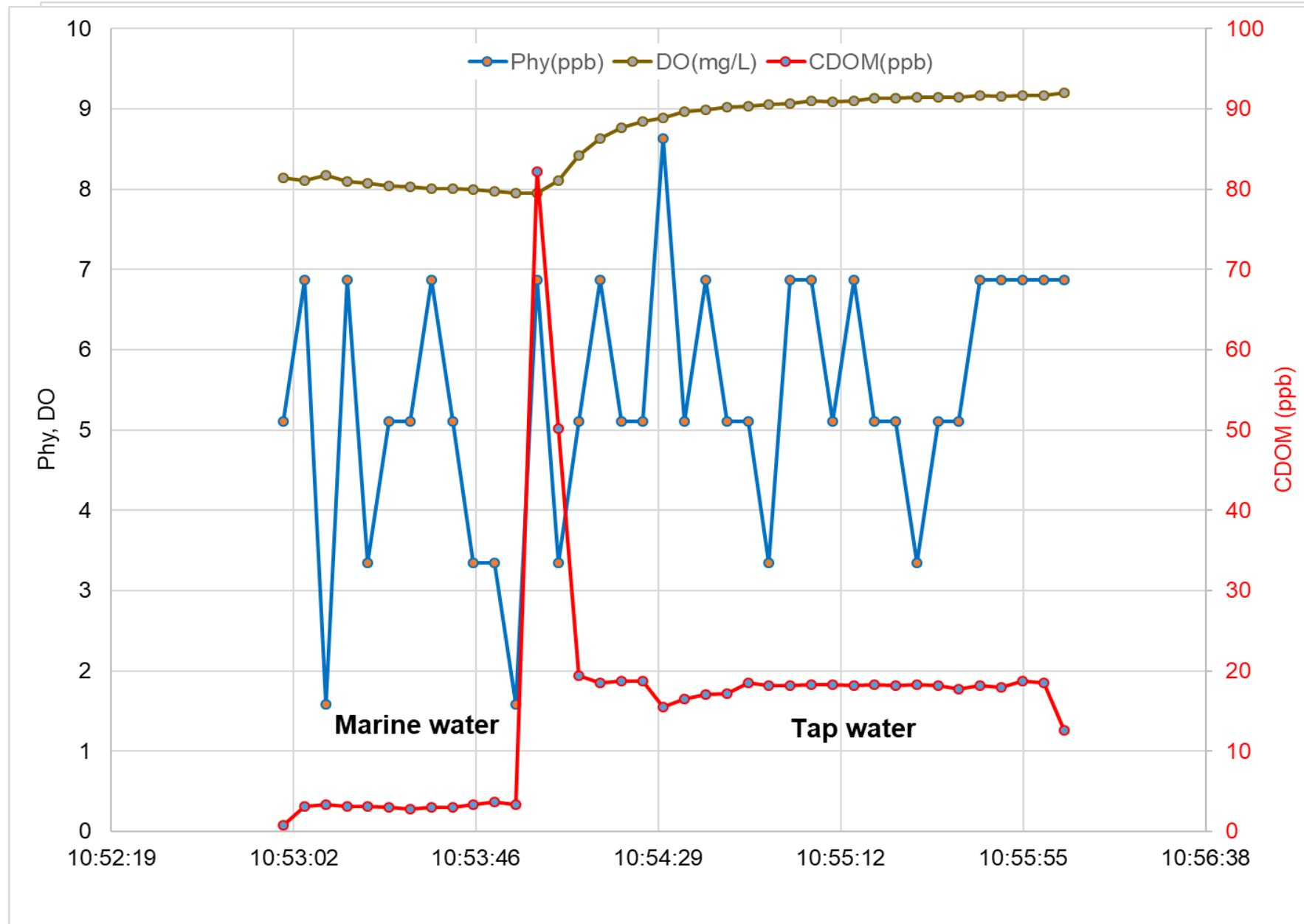
WiMo Sonde Specifications		
Number of locations	4	
Operating environment	Fresh and sea water	
Maximum Depth	250 m	
Communication	WiFi / Modbus RTU	
Power supply	External 9 - 16 VDC	
	Internal 6 alkaline batteries type D or 6 NiMh rechargeable batteries type D	
Temperature	Storage (no battery): -20°C à 70°C	
	Operating : - 2 à +50°C	
Size	Diameter :	85 mm
	Total length :	489 mm
Weight	2,65 kg	

WiMo Plus Sonde Specifications		
Number of locations	7	
Operating environment	Fresh and sea water	
Maximum Depth	250 m	
Communication	WiFi / Modbus RTU	
Power supply	External 9 - 16 VDC	
	Internal 6 alkaline batteries type D or 6 NiMh rechargeable batteries type D	
Temperature	Storage (no battery): -20°C à 70°C	
	Operating : - 2 à +50°C	
Size	Diameter :	110 mm
	Total length :	499 mm
Weight	3,05 kg	

Online measurements **WiMO**

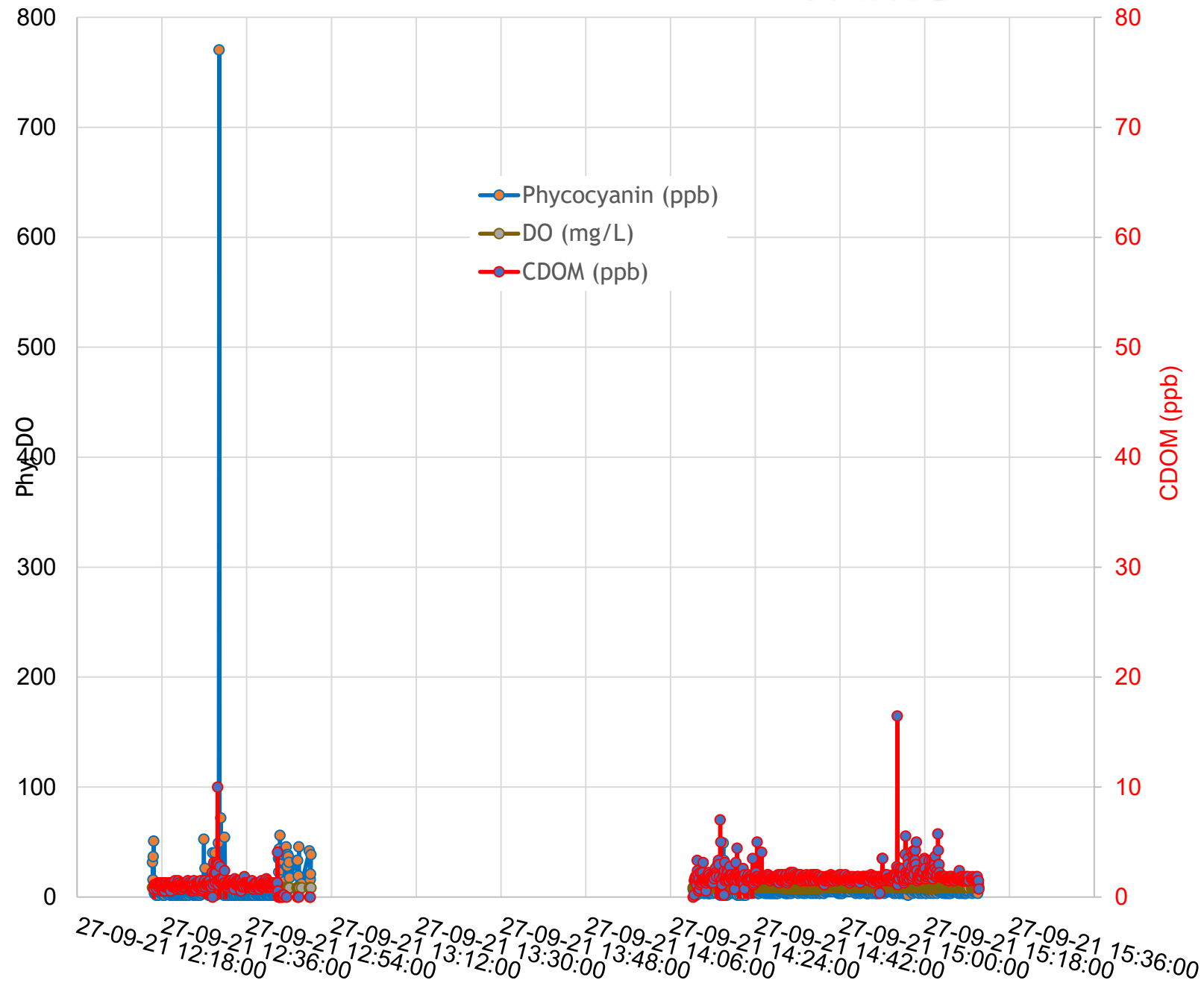
quantity	Range	Resolution	accuracy
Pressure	0-25 dbars	0.002 dbar	0.2 % of range
Temperature	-1 to 33 °C	0.005 °C	±0.07 °C
Conductivity	0-10 S/m	0.0001 S/m	±1 % of reading
Dissolved Oxygen	0-20 mg/L	0.03mg/L at 20 % O ₂	±0.1 mg/L at 20 % O ₂
pH	0-14	0.02	±0.1
Fluorescence (Chl- <i>a</i>)	0-500 µg/L	0.4 µg/L	Linearity at least 0.99 r ²
Fluorescence (<i>Phycocyanin</i>)	0-4500 ppb PC	2 ppb PC	Linearity at least 0.99 r ²
Turbidity	0-4000 FNU	0.01 FNU	0.5 FNU or 5 % reading
CDOM fDOM	0-1000 ppb 0-3000	0.1 Ppb 0.5 ppb	Linearity at least 0.99 r ²

Online measurements WiMO



Test
measurements
17 June 2021

Online measurements WiMO



measurements
27 Sep. 2021

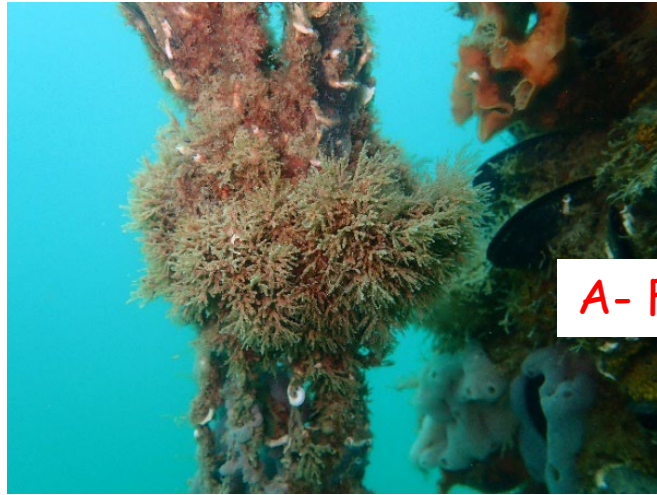
Sampling



Detection of non-indigenous species in the samples from the fouling community on boat hulls and buoys

- *Tricellaria inopinata* d'Hondt & Occhipinti Ambrogi, 1985

- Arborescent bryozoan



A- Fortič & B. Mavrič

- Origin: Pacific Ocean
- 1st record in the Med: **Venice lagoon, 1982**
- Introduction vector: hull fouling, mariculture

- *Paranthura japonica* Richardson, 1909

- Peracarid crustacean



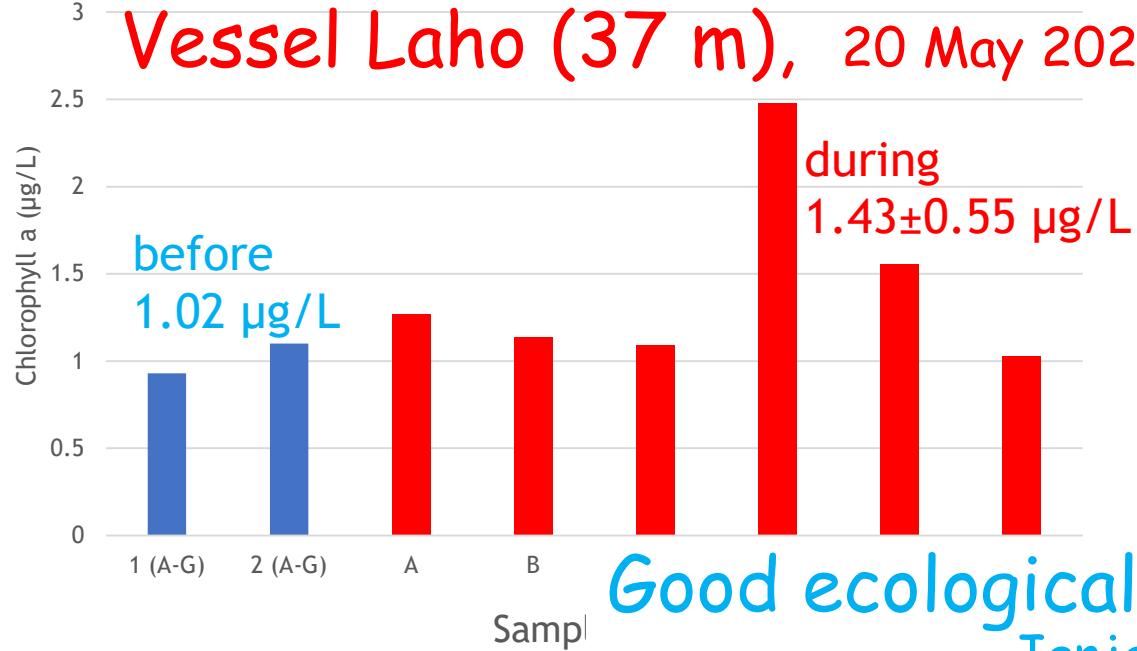
- Origin: Northwestern Pacific Ocean
- 1st record in Europe: atlantic coast of France, 2007
- Introduction vector: mariculture, hull fouling

Both species were found during the first two test samplings of the fouling community in bays of Piran and Koper!

Sampling: chl-a

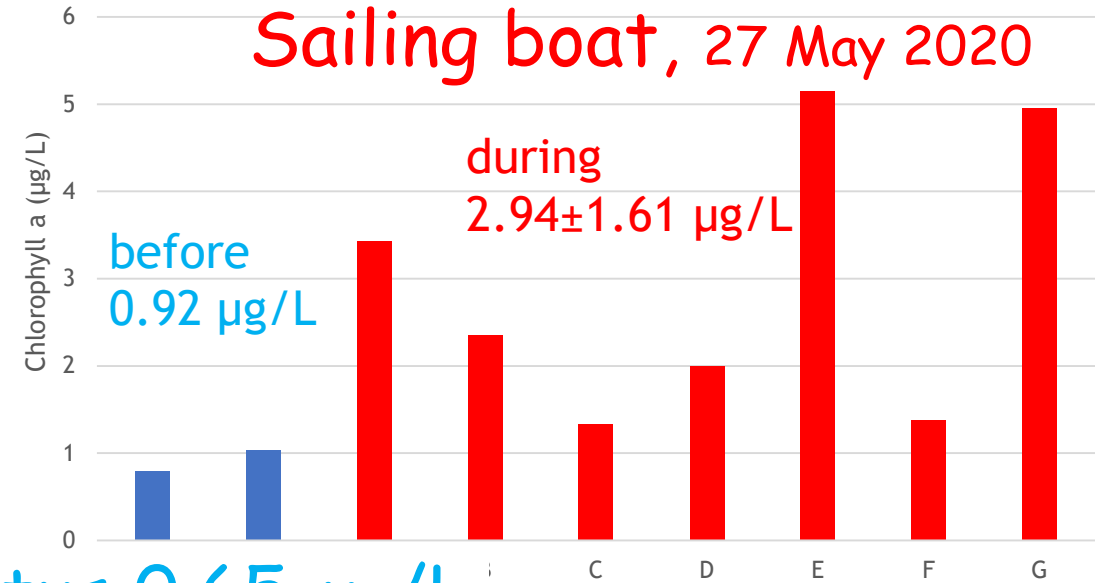
Sampling No. 1

Vessel Laho (37 m), 20 May 2020



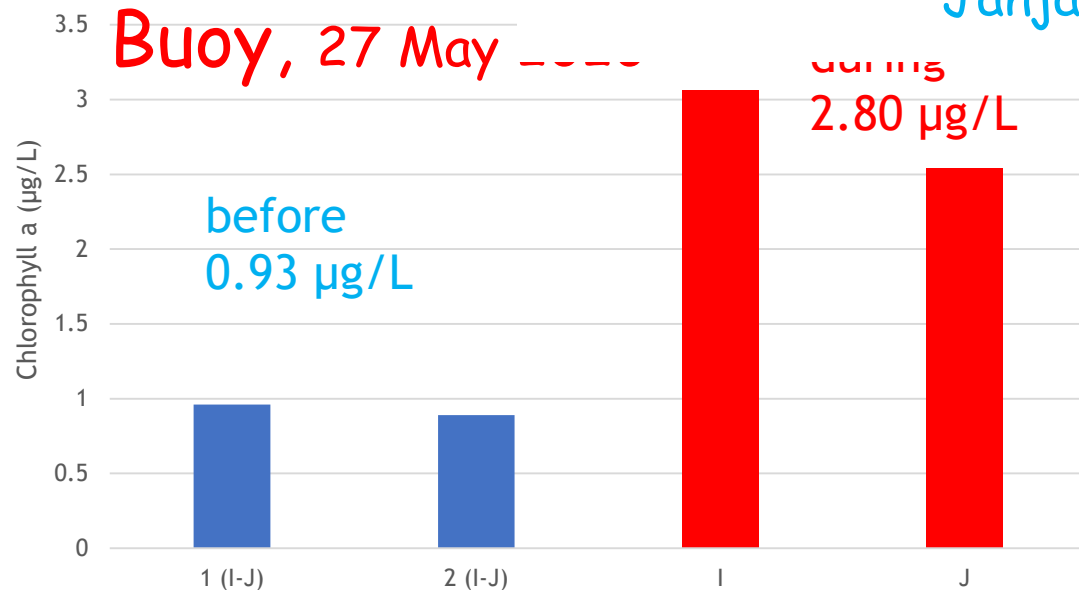
Sampling No. 2

Sailing boat, 27 May 2020



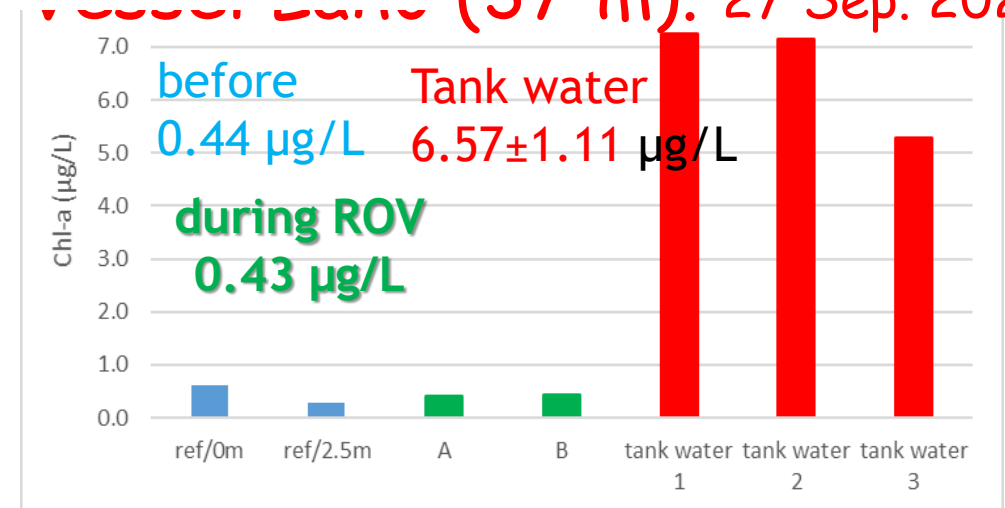
Sampling No. 3

Buoy, 27 May 2020



Sampling No. 4

(37 m). 27 Sep. 2021



Sampling: Cu & Zn

Laho, 27 Sep. 2021

Sample	Cu (ng/mL)	Zn (ng/mL)	
A background	1.33	9.44	Concentrations of Cu & Zn in samples taken at (A): beginning of the vessel, (B) in the middle of the hull (C): at the stern and (X), randomly taken sample near the vessel. Concentrations of Zn are around 5 ng/mL and Cu around 1 ng/mL.
B background	1.20	5.68	
C background	1.06	5.67	
X background	0.922	4.48	
B background during cleaning	1.36	5.33	Concentrations of Cu and Zn have not changed in the background during cleaning , the ROV is well operating and does not leak Cu & Zn in the
C background during cleaning	1.11	5.09	
B background after cleaning	1.48	4.28	Concentrations of Cu and Zn have not changed in the background just after cleaning , the ROV is well operating and does not leak Cu & Zn in the
C background after cleaning	1.01	24.0	
Testing contaminated water 50L	269	143	After cleaning the water is heavily polluted with Cu and Zn.
Esotech canister 1	762	314	
Esotech canister 2	578	211	

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PRILOGA 1: Seznam onesnaževal

1. organohalogeneske spojine in snovi, ki lahko tvorijo take spojine v vodnem okolju,
2. organofosforne spojine,
3. organokositrne spojine,
4. snovi in pripravki ali njihovi razgradni produkti, za katere je bilo dokazano, da imajo karcinogene ali mutagene lastnosti ali lastnosti, ki v vodnem okolju ali prek njega lahko vplivajo na sintezo steroidov, delovanje ščitnice, razmnoževanje ali druge funkcije, povezane z notranjim izločanjem,
5. obstojni ogljikovodiki in obstojne organske strupene snovi, ki se kopičijo v organizmih,
6. cianidi,
7. kovine in njihove spojine,
8. arzen in njegove spojine,
9. biocidi in fitofarmacevtski proizvodi,
10. neraztopljene snovi,
11. snovi, ki prispevajo k eutrofikaciji (zlasti nitrati in fosfati),
12. snovi, ki neugodno vplivajo na kisikovo bilanco (in se lahko merijo s parametri, kakršni so BPK, KPK itn.),
13. snovi iz predpisa, ki ureja stanje površinskih voda.