The major determinants for populations of culturable bacteria in coastal sediments of the eastern Gulf of Finland, Baltic Sea

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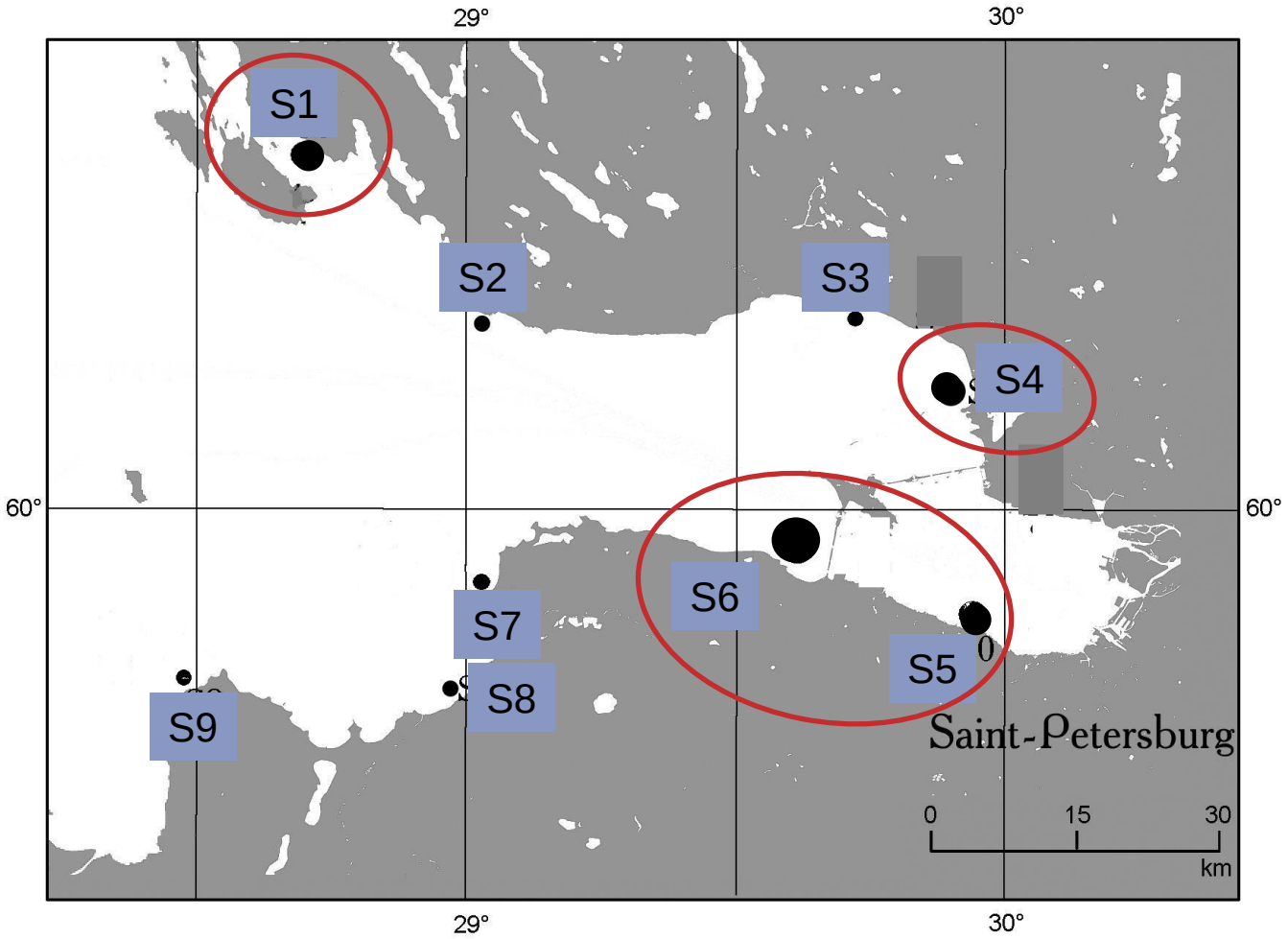
Benthic heterotrophic bacteria actively participate in biomineralization of sediment organic matter and biotransformation of hazardous substances accumulated in sediments.

The aim of the study

- To determine the spatial and temporal fluctuations of benthic heterotrophic bacteria;
- To explore their response to pollution;
- To validate their applicability as tools to assess the impact of human-induced pressure on the coastal ecosystem of the eastern Gulf of Finland.

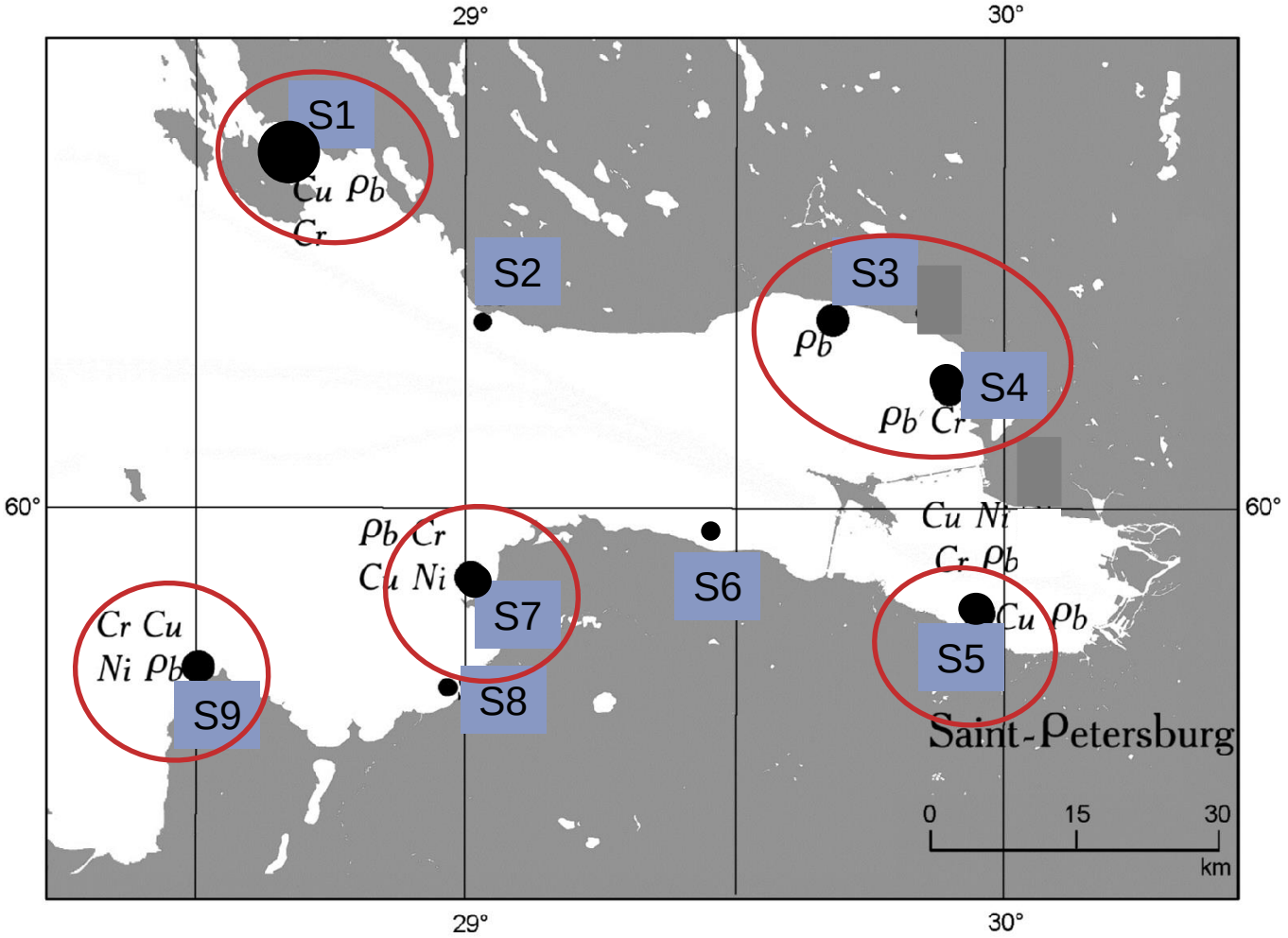
Total hydrocarbon concentration (THC) in sediments

- 1÷20 mg/kg; ● >30 mg/kg; ⬤ >100 mg/kg

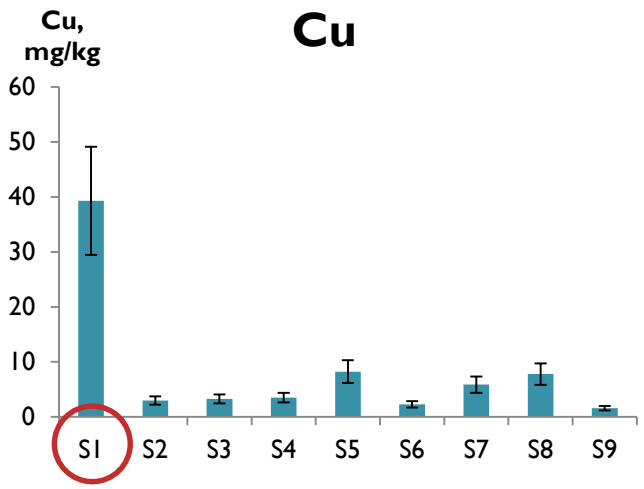


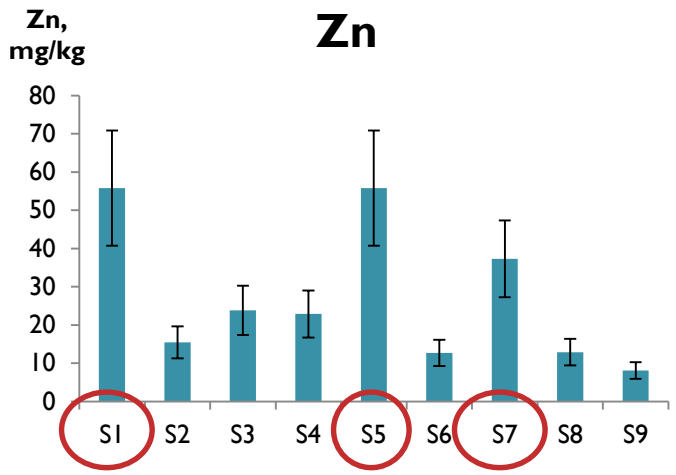
Metal distribution in coastal sediments

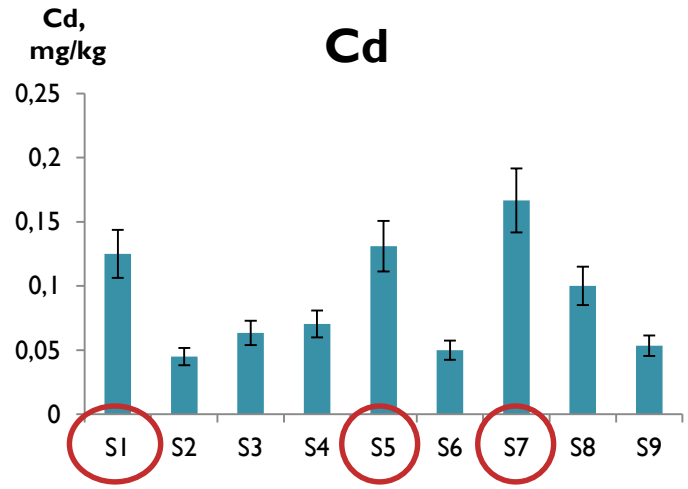
• < 5; ● 5÷20; ⬤ > 20 mg kg^{-1} dw

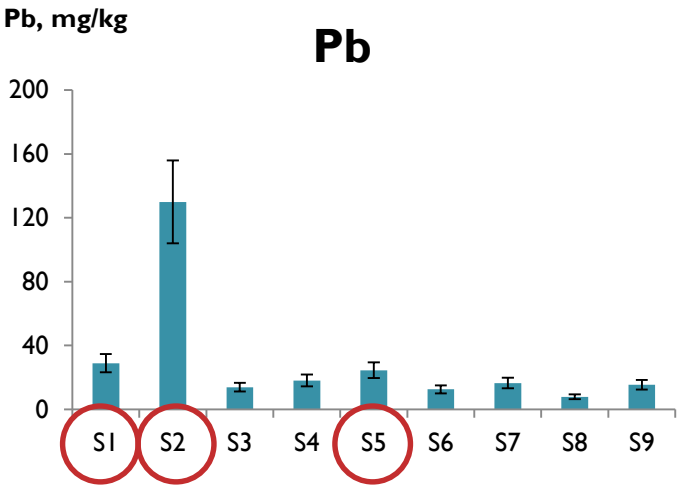


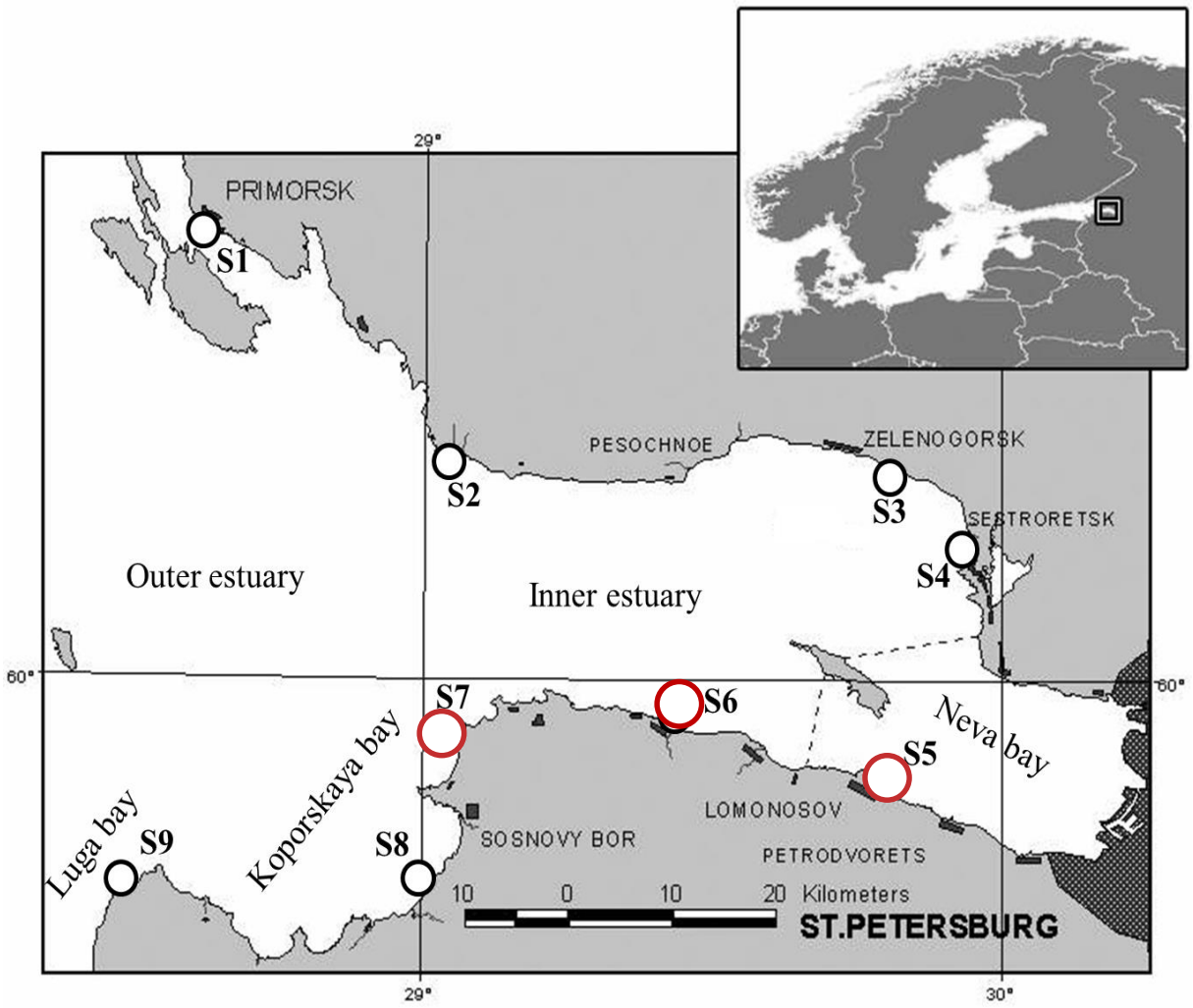
Metal content in the surface sediments at the sampling sites in the eastern Gulf of Finland









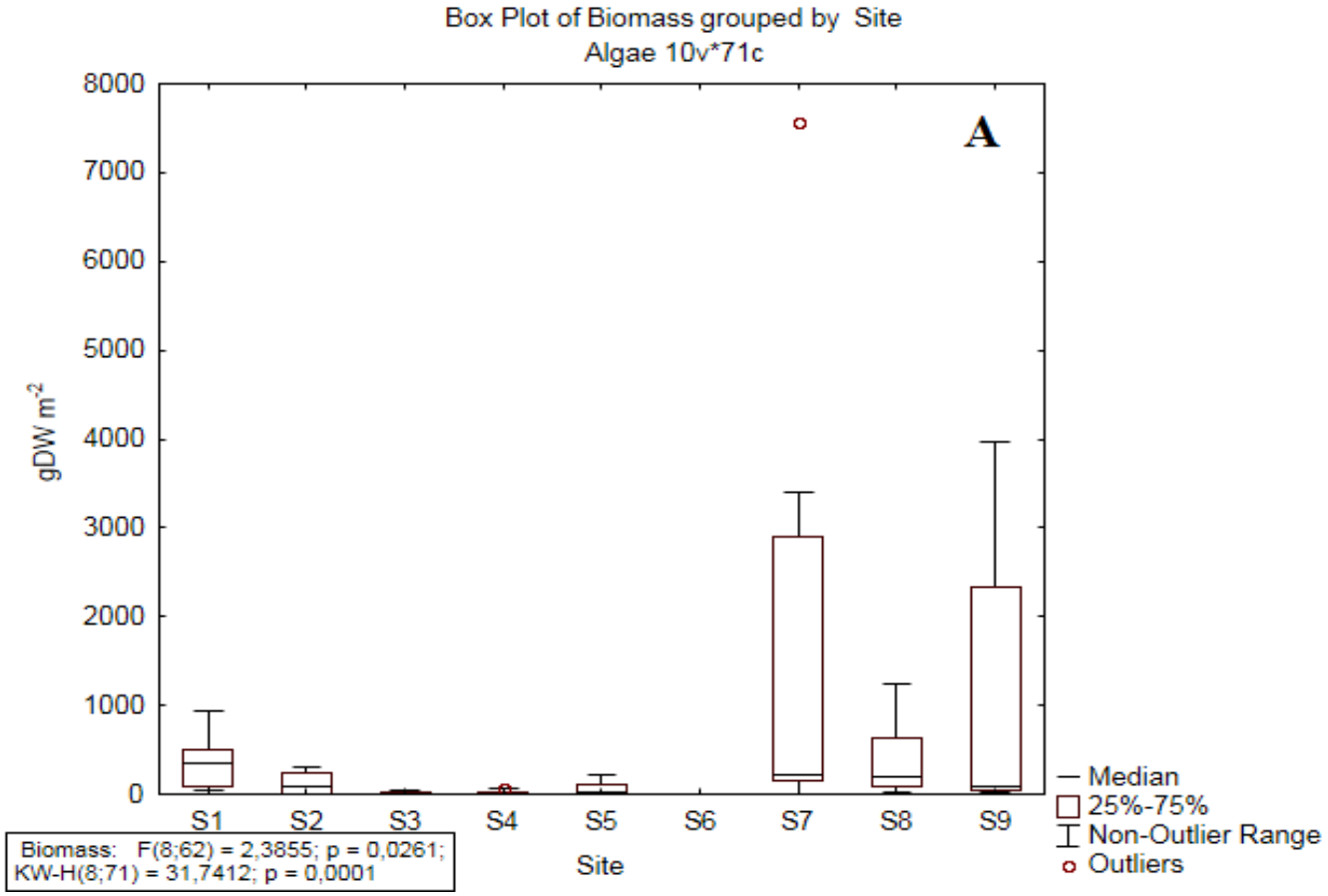


Location of the sampling stations in the eastern Gulf of Finland

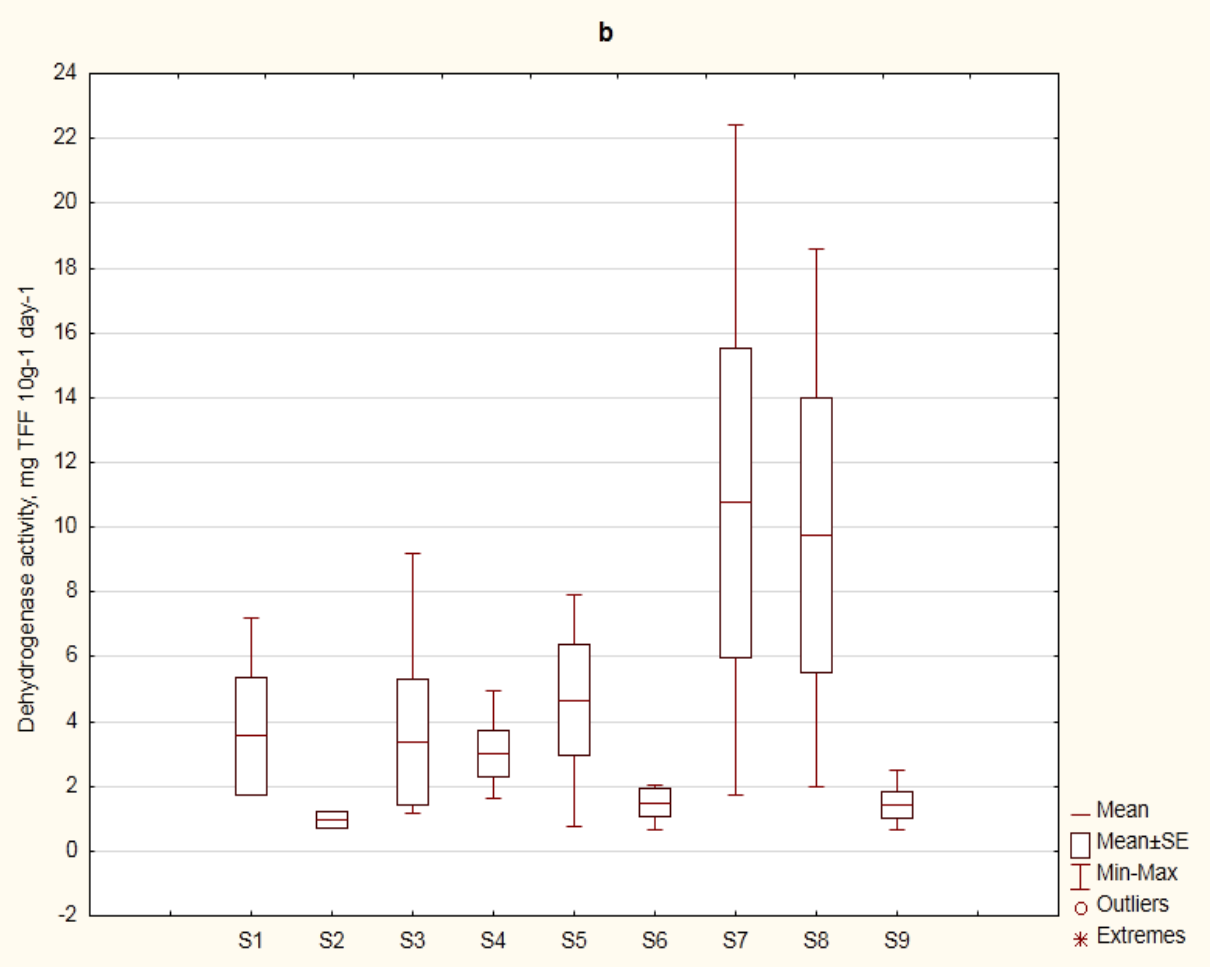
Mean values of sediment parameters at the sampling sites (±SD)

Parameter	S5	S6	S7
TOC, %	0.21±0.03	0.18±0.01	0.25±0.02
pH	7.1±0.1	6.7±0.1	6.6±0.1
Eh, mV	(-5)±31	30±12	(-152)±27
Salinity, g l^{-1}	0.30±0.05	1.32±0.16	3.21±0.27
P_2O_5, mg kg^{-1}	67,3±3,6	20,0±1,1	75,3±10,2
$N\text{-}NH_4$, mg kg^{-1}	8,2±0,4	10,0±0,5	23,6±3,0
THC, mg kg^{-1}	**31.3±11.6**	5.9±0.4	3.2±0.5
Cu, mg kg^{-1}	8.2±1.8	2.3±0.5	5.9±1.5
Zn, mg kg^{-1}	55.8±5.1	12.7±2.5	37.3±5.2
Cd, mg kg^{-1}	**0.29±0.12**	0.05±0.02	0.17±0.04
Pb, mg kg^{-1}	**24.5±3.9**	12.6±2.8	16.5±3.5
Mn, mg kg^{-1}	300±23	95±12	280±25
Fe, g kg^{-1}	8.1±0.3	10.2±1.0	9.7±0.8
Al, g kg^{-1}	33.6±0.9	26.4±1.5	39.6±1.3

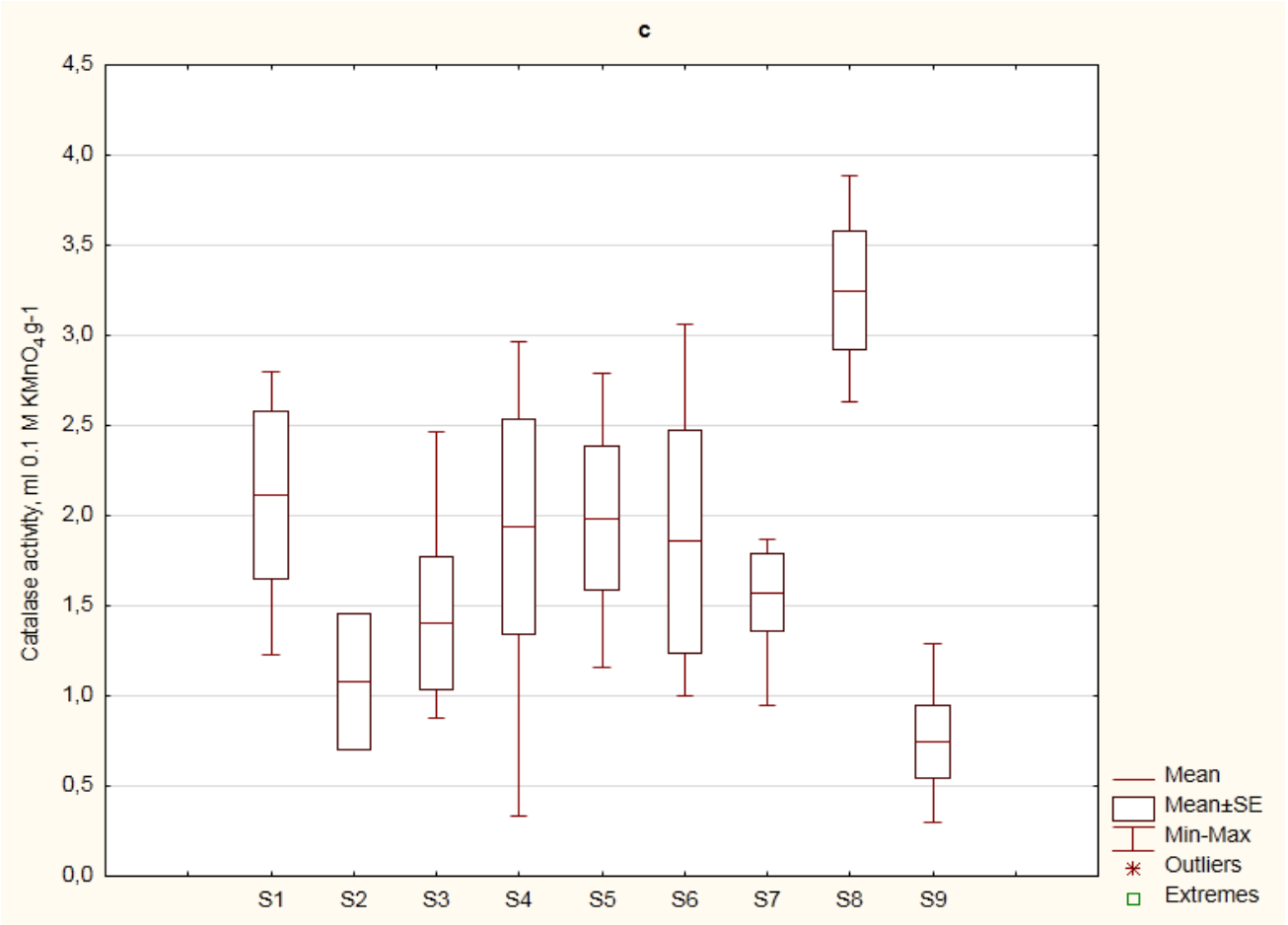
Biomass of macroalgae at the sampling sites



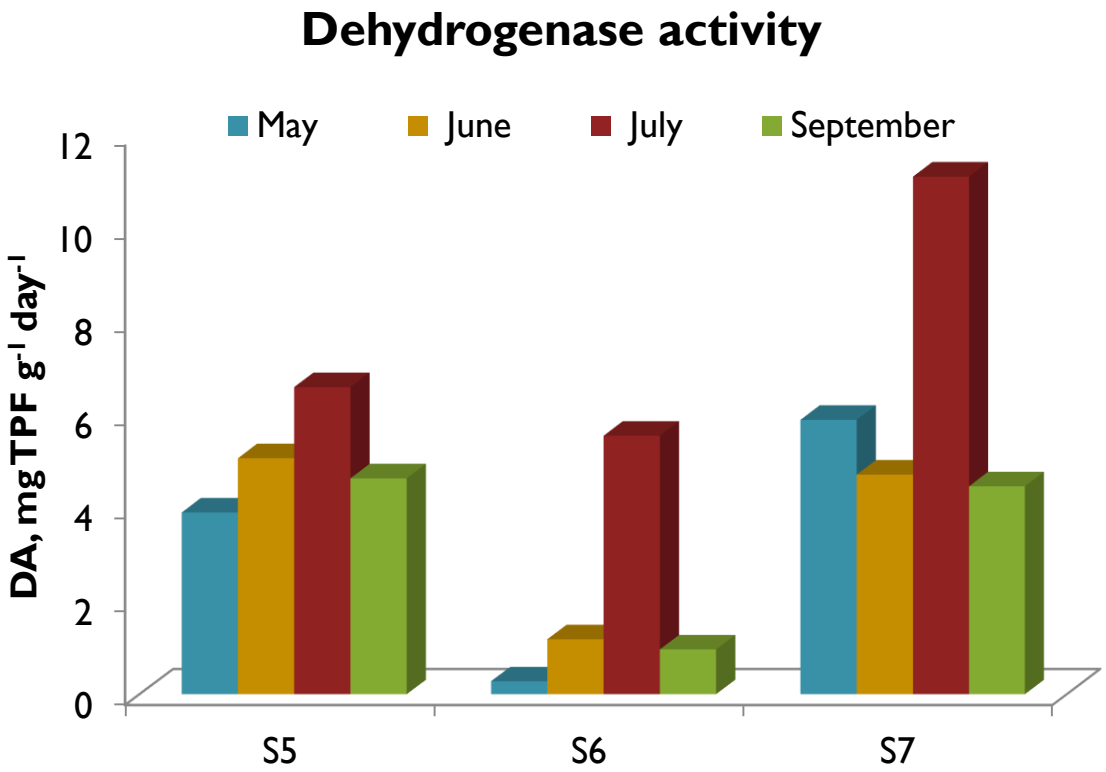
Dehydrogenase activity in coastal sediments of the eastern Gulf of Finland



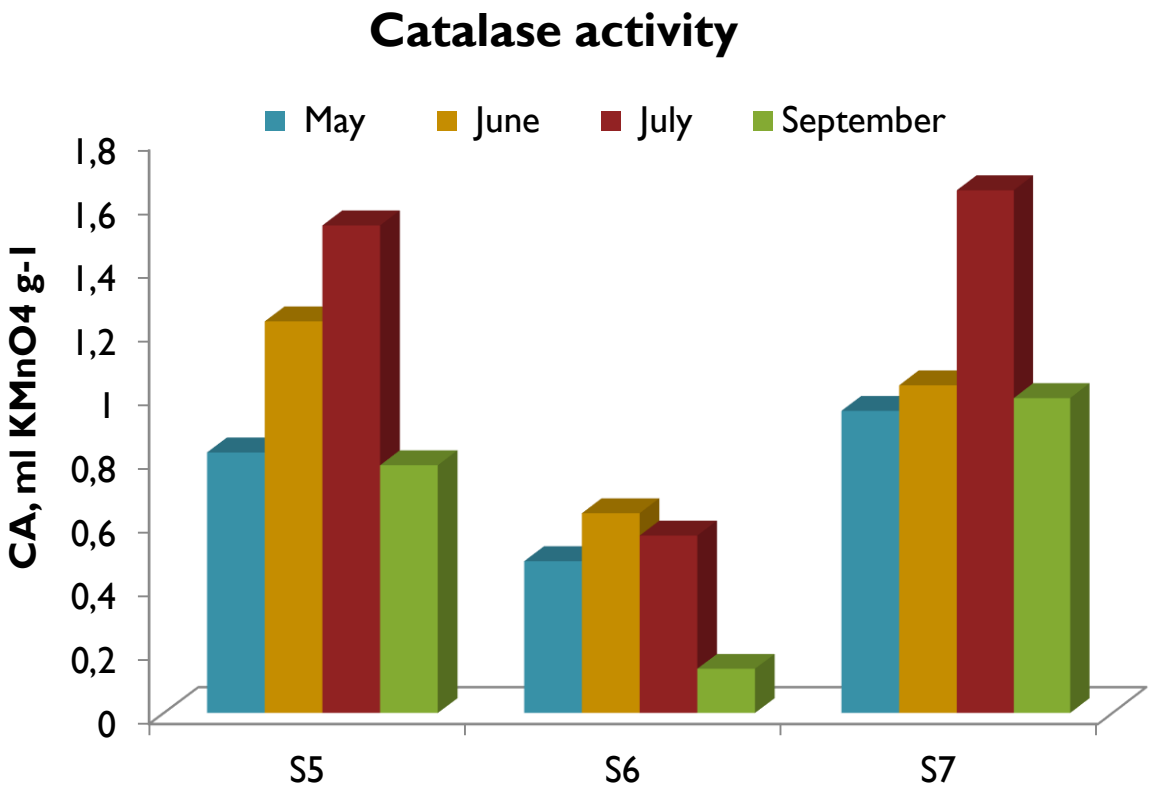
Catalase activity in coastal sediments of the eastern Gulf of Finland



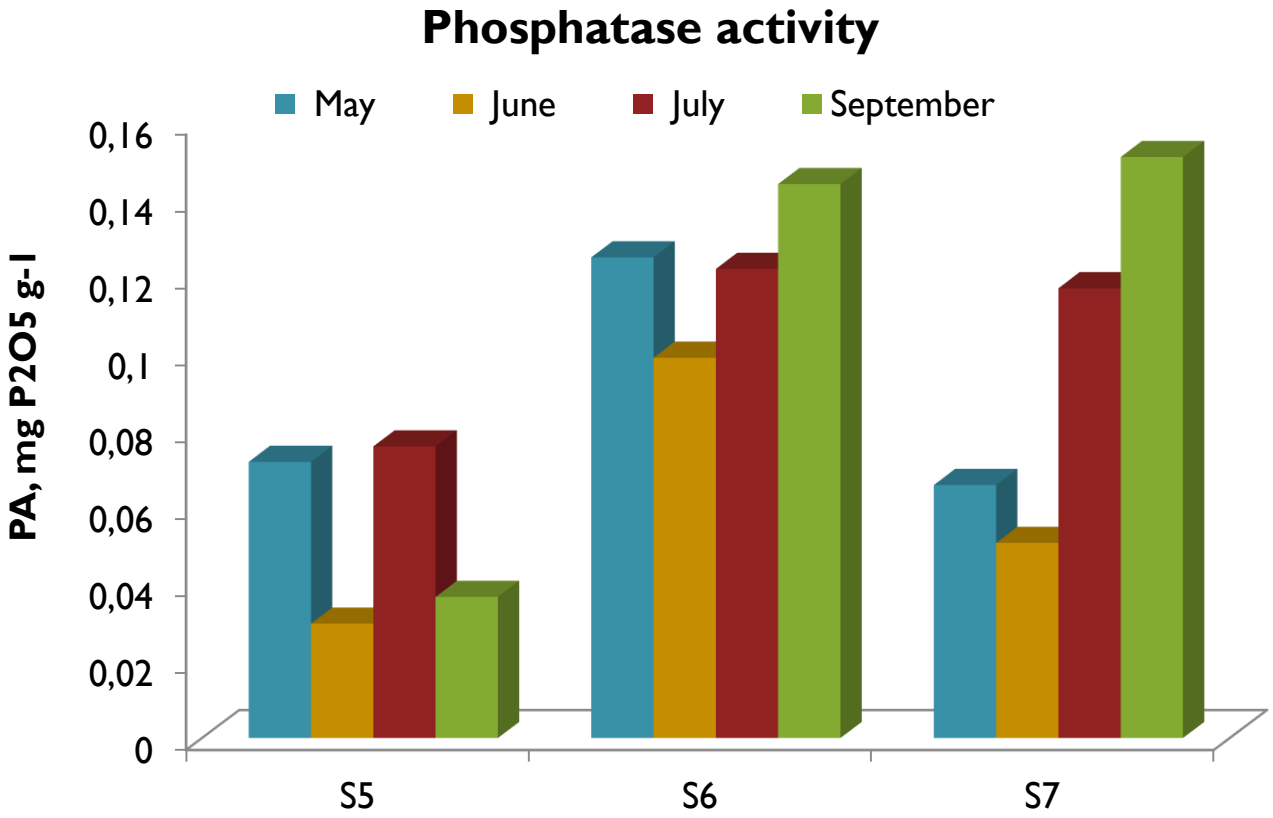
Dehydrogenase activity at sites S5-S7 during the period May-September 2018



Catalase activity at sites S5-S7 during the period May-September 2018

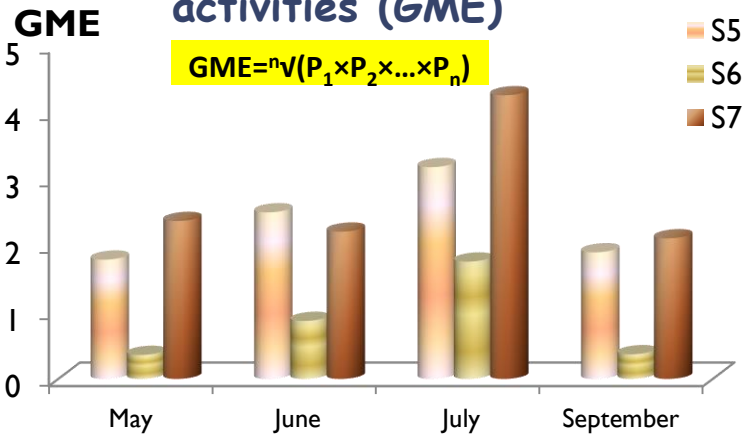


Phosphatase activity at sites S5-S7 during the period May-September 2018

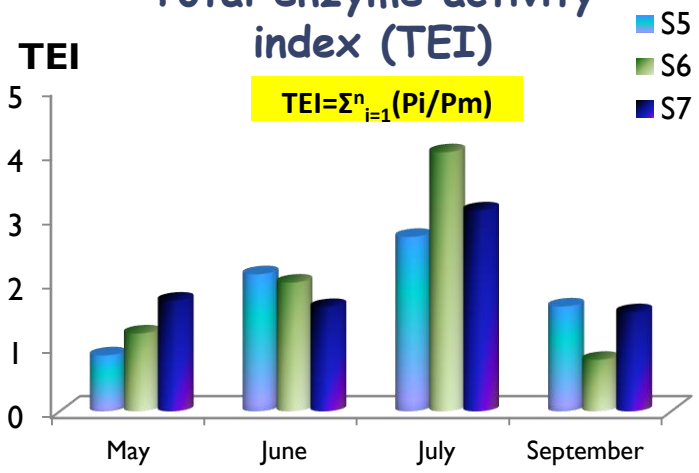


Temporal variability of enzyme activity indices in sediments of the eastern Gulf of Finland

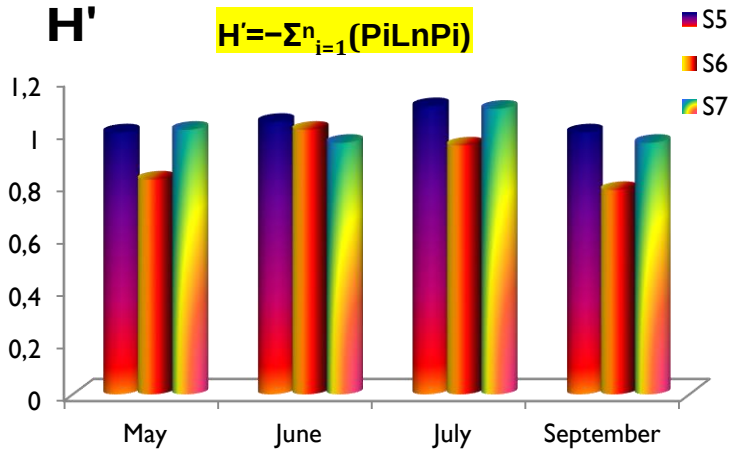
Geometric mean of enzyme activities (GME)



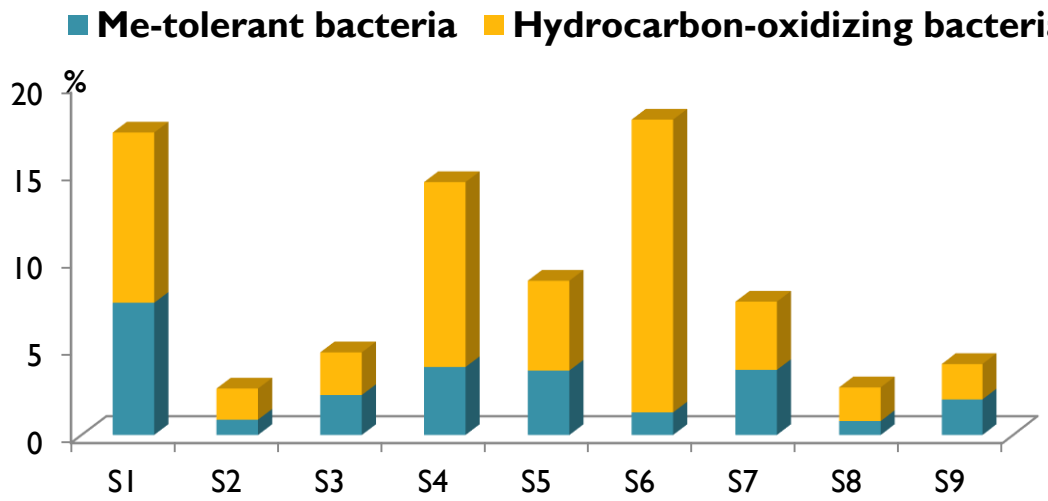
Total enzyme activity index (TEI)

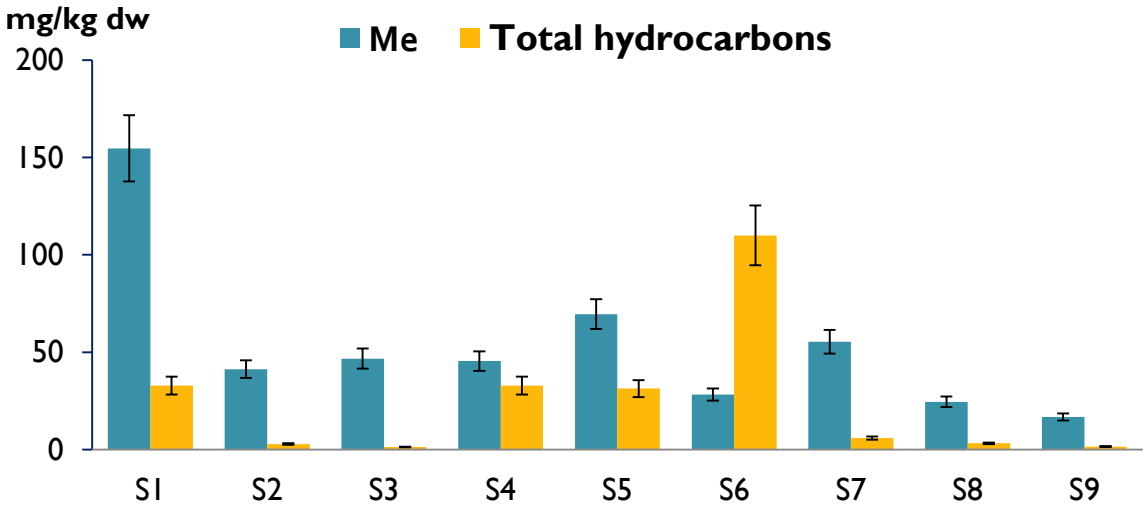


Shannon's diversity index (H')

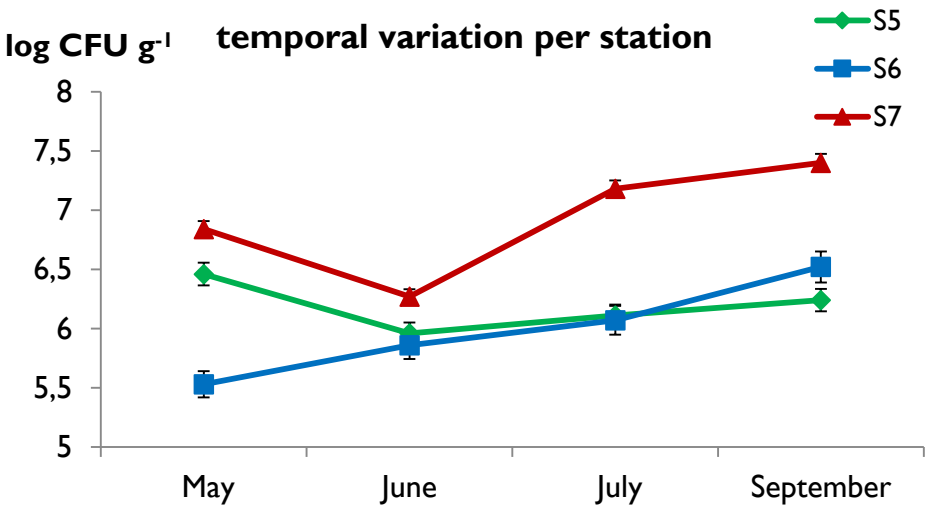


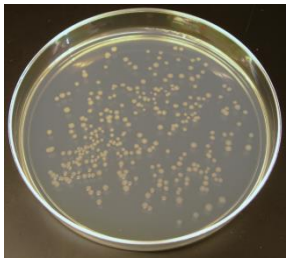
Abundance of metal-tolerant and hydrocarbon-oxidizing bacteria in coastal sediments of the eastern Gulf of Finland

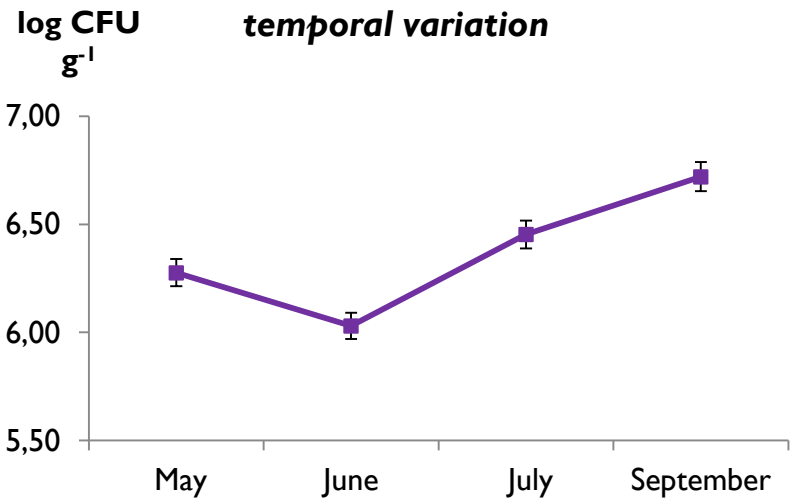


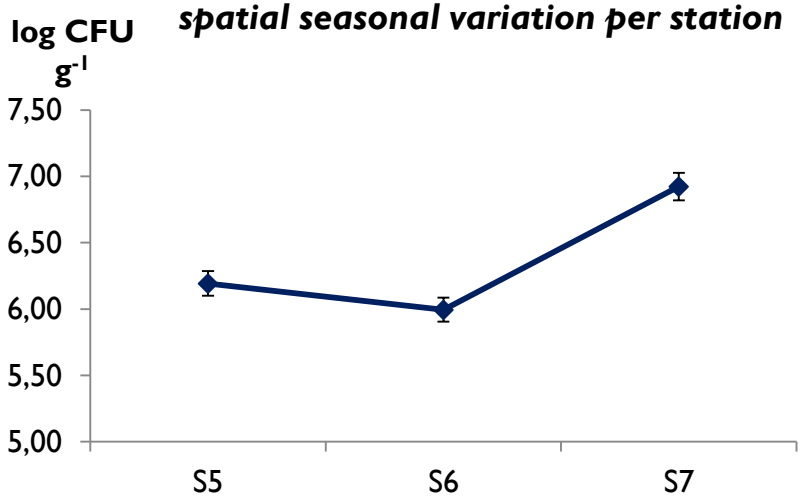


Abundance of heterotrophic bacteria at sites S5-S7 during the period May-September 2018

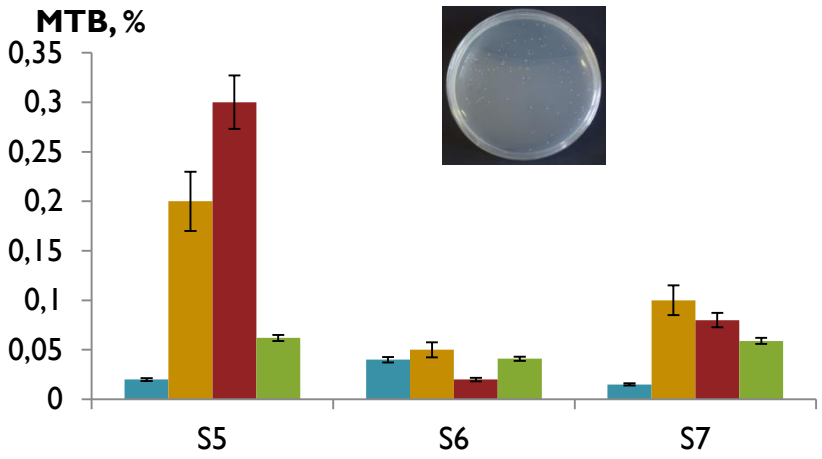


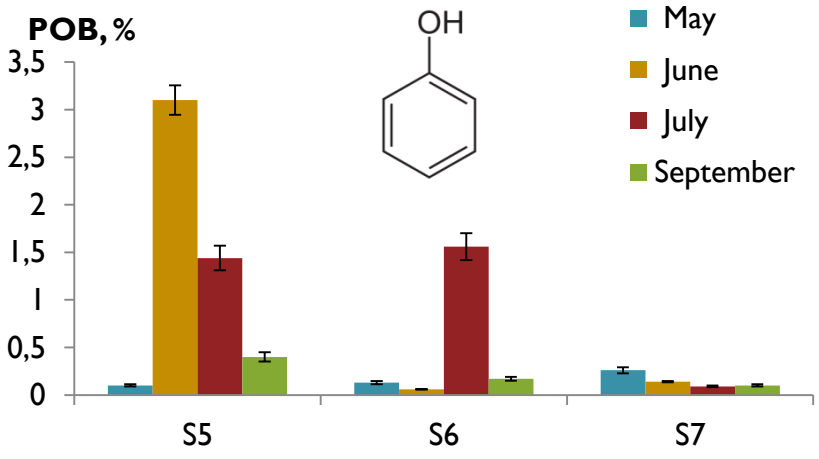


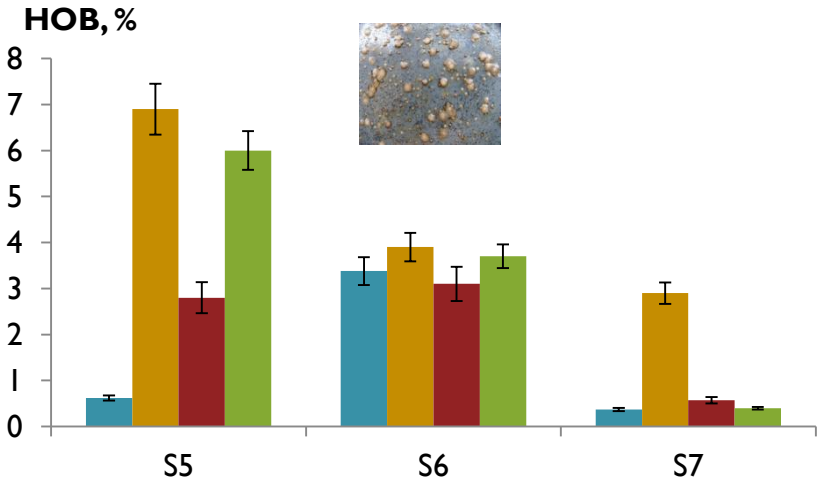




Abundance of metal-tolerant (MTB), phenol-oxidizing (POB) and hydrocarbon-oxidizing (HOB) bacteria at sites S5-S7 (May-September 2018)







Factor loadings of 23 variables in coastal sediments of the eastern Gulf of Finland

Variables	PC1	PC2	PC3
Dehydrogenase activity	0.031	**0.692**	0.222
Catalase activity	0.135	**0.755**	0.354
Heterotrophic bacteria	**0.663**	0.186	-0.259
Hydrocarbon-oxidizing bacteria	0.249	0.500	**-0.635**
Metal-tolerant bacteria	**0.615**	-0.319	0.177
Algal biomass	**0.750**	-0.032	0.261
Eh	-0.126	-0.352	**0.814**
pH	0.258	-0.503	**-0.536**
sand	0.057	**-0.870**	-0.137
clay	0.001	**0.781**	0.215
silt	-0.119	**0.857**	0.022
TOC	**0.902**	0.503	0.072
$N\text{-}NH_4$	**0.746**	0.225	0.046
Cu	**0.664**	-0.109	0.195
Zn	0.476	-0.080	-0.390
Cd	**0.931**	-0.052	0.187
Pb	**0.788**	-0.171	-0.115
Fe	**0.600**	0.509	-0.294
Labile Cu	**0.665**	-0.580	0.141
Labile Zn	**0.839**	0.038	-0.054
Labile Cd	-0.107	0.270	0.507
Labile Pb	**0.847**	-0.222	0.042
THC	0.196	0.520	**-0.682**

Conclusions

- Microbial abundance reflected changes occurring in environmental conditions, and adaptation of heterotrophic bacteria to sediment contamination.
- Anthropogenic activities leading to deposition of pollutants are harmful to sediment environment and disrupt the activities of sediment microorganisms.
- Observations on occurrence and activity of native microorganisms capable of toxicant tolerance are important not only to understand the extent of the pollution but also to realize the potential of benthic community to detoxify some of the toxic substances.
- Results emphasize the importance of using microbiological methods for the assessment of the impact of human-induced pressure on the Gulf of Finland ecosystem.


Thank you for your attention!