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Initial assessment of the physical pressure from commercial fisheries on the seafloor in the Bulgarian Black Sea

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Introduction

- The present study was carried out in fulfillment of the obligations under the Marine Strategy Framework Directive (MSFD) to estimate the Sea-floor integrity (Descriptor 6) and the Physical damage (Descriptor 6.1), in particular from abrasion, as part of the Initial Assessment of the marine environmental status within the Bulgarian EEZ;

- The analysis represents the first quantitative evaluation of the trawling pressure on the seabed in the Bulgarian Black Sea;

- Trawling due to commercial fisheries is the main anthropogenic activity causing physical disturbance of the seabed substrates within the Bulgarian Exclusive Economic Zone (EEZ);

Data

- Trawling pressure within the Bulgarian Black Sea was assessed using statistical data from the vessel monitoring system (VMS):
position, time and speed of the fishing vessels provided by the National Agency for Fisheries and Aquacultures (NAFA);

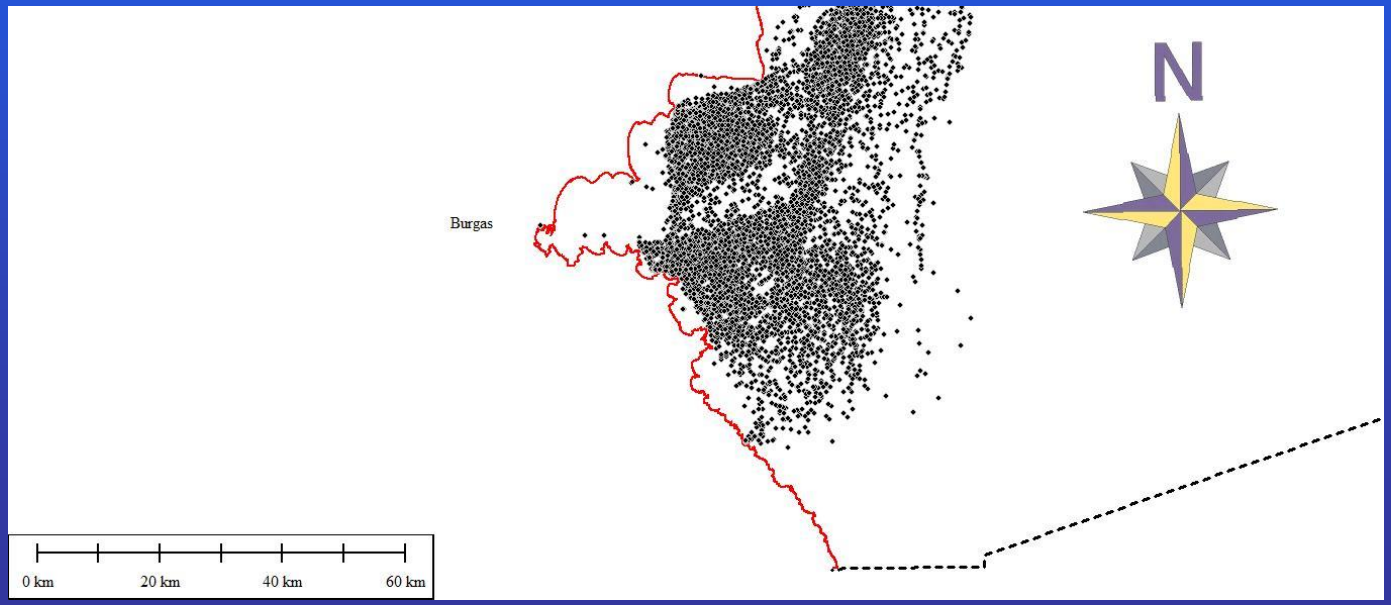
Date	Vehicle name	Position time	Reason name	Latitude	Longitude
1.7.2010 00:51	КАЛИАКРА	1.7.2010 00:51	Data report	042 39' 33"N	027 43' 55"E
1.7.2010 00:54	АФАЛИА 1	1.7.2010 00:54	Data report	043 24' 14"N	028 10' 02"E
1.7.2010 01:51	КАЛИАКРА	1.7.2010 01:51	Data report	042 39' 33"N	027 43' 55"E
1.7.2010 01:54	АФАЛИА 1	1.7.2010 01:54	Data report	043 24' 14"N	028 10' 02"E
1.7.2010 02:50	КАЛИАКРА	1.7.2010 02:50	Data report	042 39' 33"N	027 43' 55"E

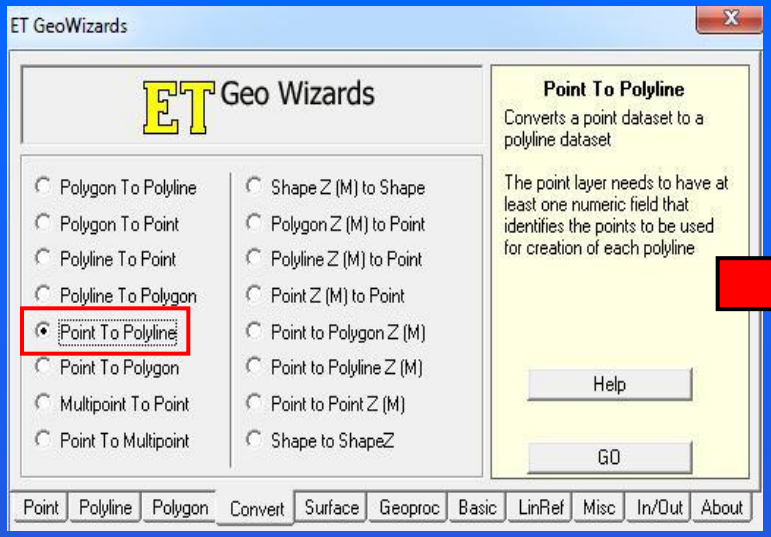
- Bathymetric contours (ESRI shape files) – digital archive of IO-BAS;
- Assessment zones (ESRI shape files) – digital archive of IO-BAS;
- Substrate types (ESRI shape files) – digital archive of IO-BAS.

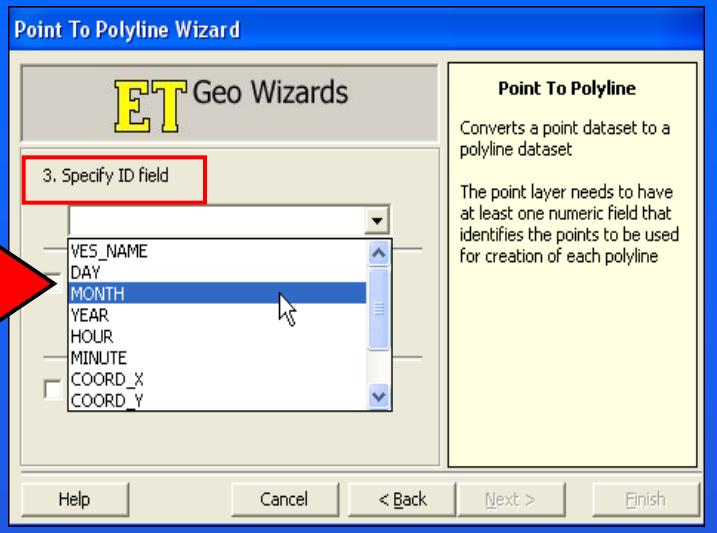
Methods

- The VMS coordinates data were transformed into WGS1984-based UTM Zone 35 N format , loaded and visualized as XY data into Arc Map, exported and saved as ESRI shape file point data feature classes;

- These rather large point feature classes were then sorted by vessel name and re-exported into separate smaller data sets.

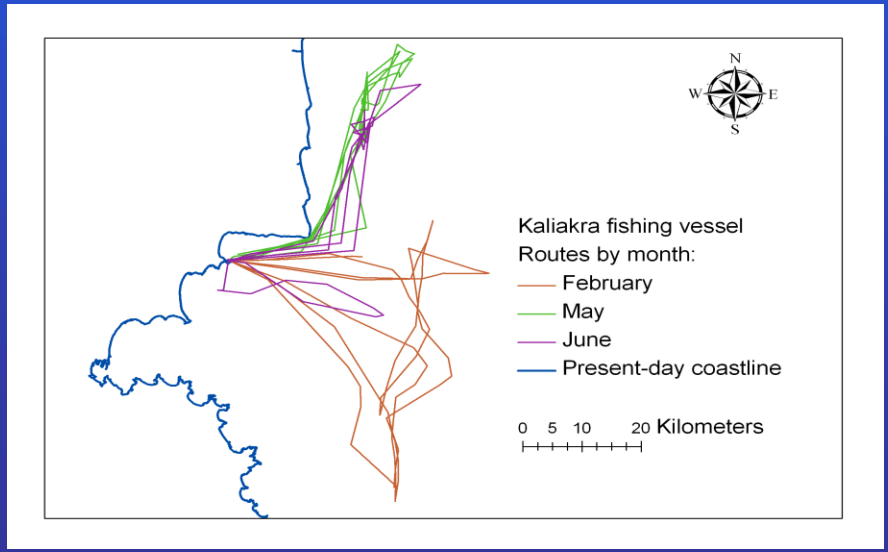






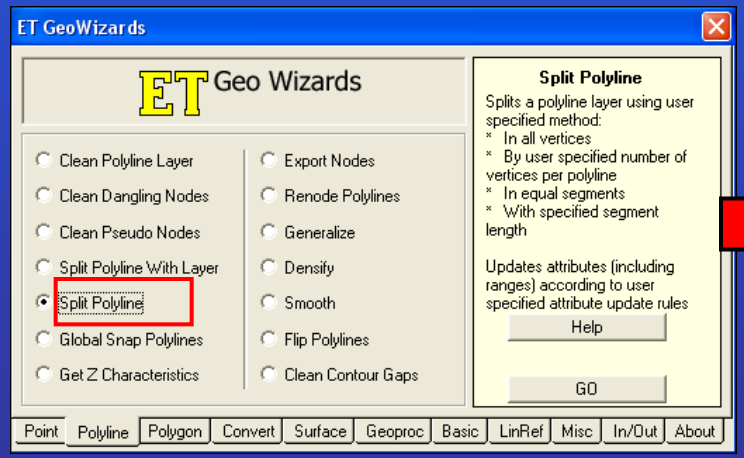
- The points were converted into polylines representing the routes of every fishing vessel during each month of the year in question.

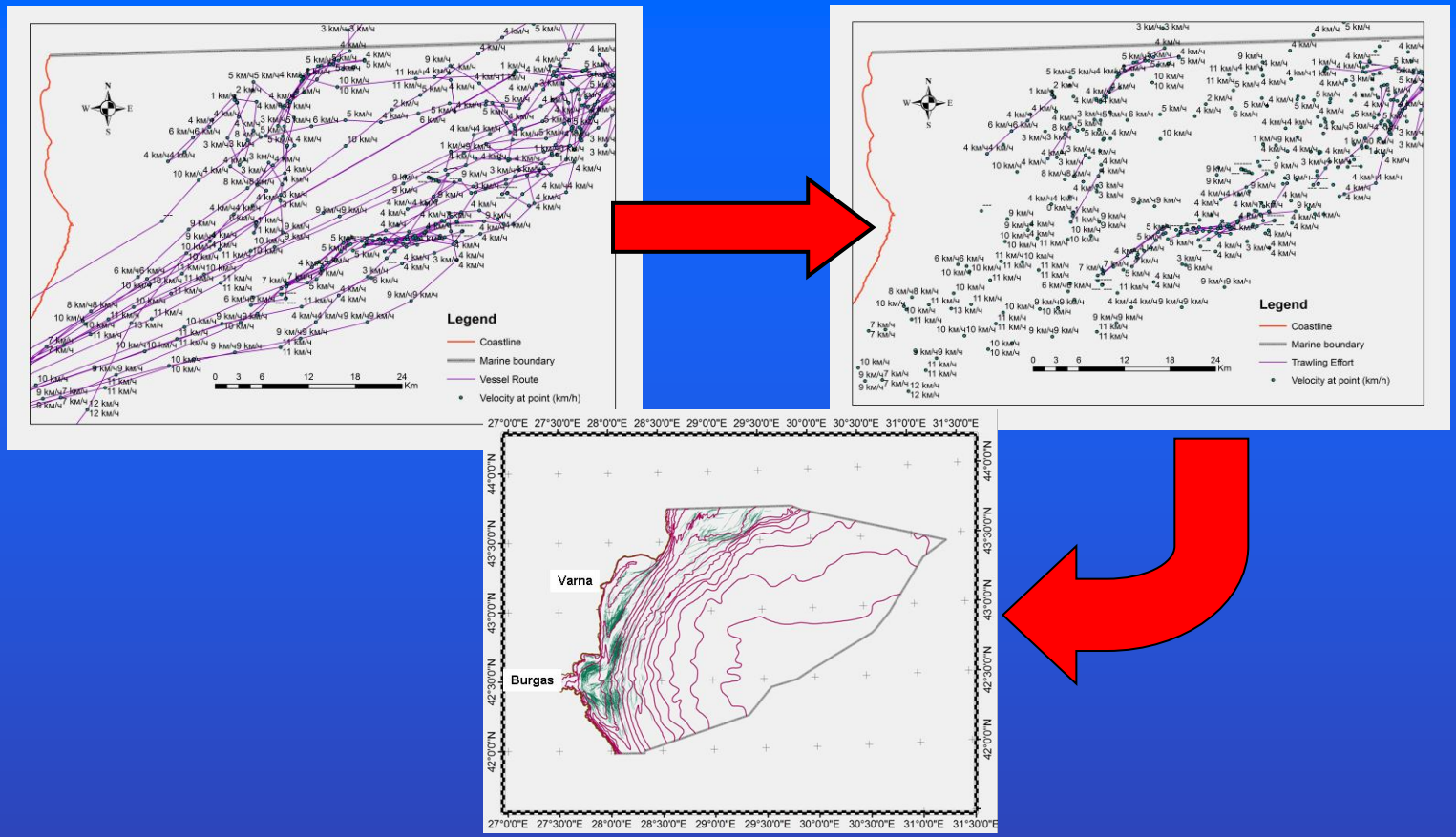
- The conversion procedures were performed using the ET GeoWizards extension developed for Arc GIS.



❑ The identification and subsequent extraction of the bottom trawling routes from all vessel routes was based on the following selection criteria:

- vessel speed characteristic of trawling – between 4 and 6 km/h;
- route trajectory and length – straight route, no longer than 10-12 km;
- route direction – parallel to the bathymetric contours, meaning that the variation of the trawling depth does not exceed ± 3 to 5 m.





- ET GeoWizards was used to split the polylines into segments and to subsequently extract only these route "fragments" that meet the above requirements with the help of the overlaid bathymetric contours and the point data for speed.

❑ For quantitative evaluation of the trawling pressure "trawling effort coefficient" *K* was introduced:

***K* = L / A**, where:

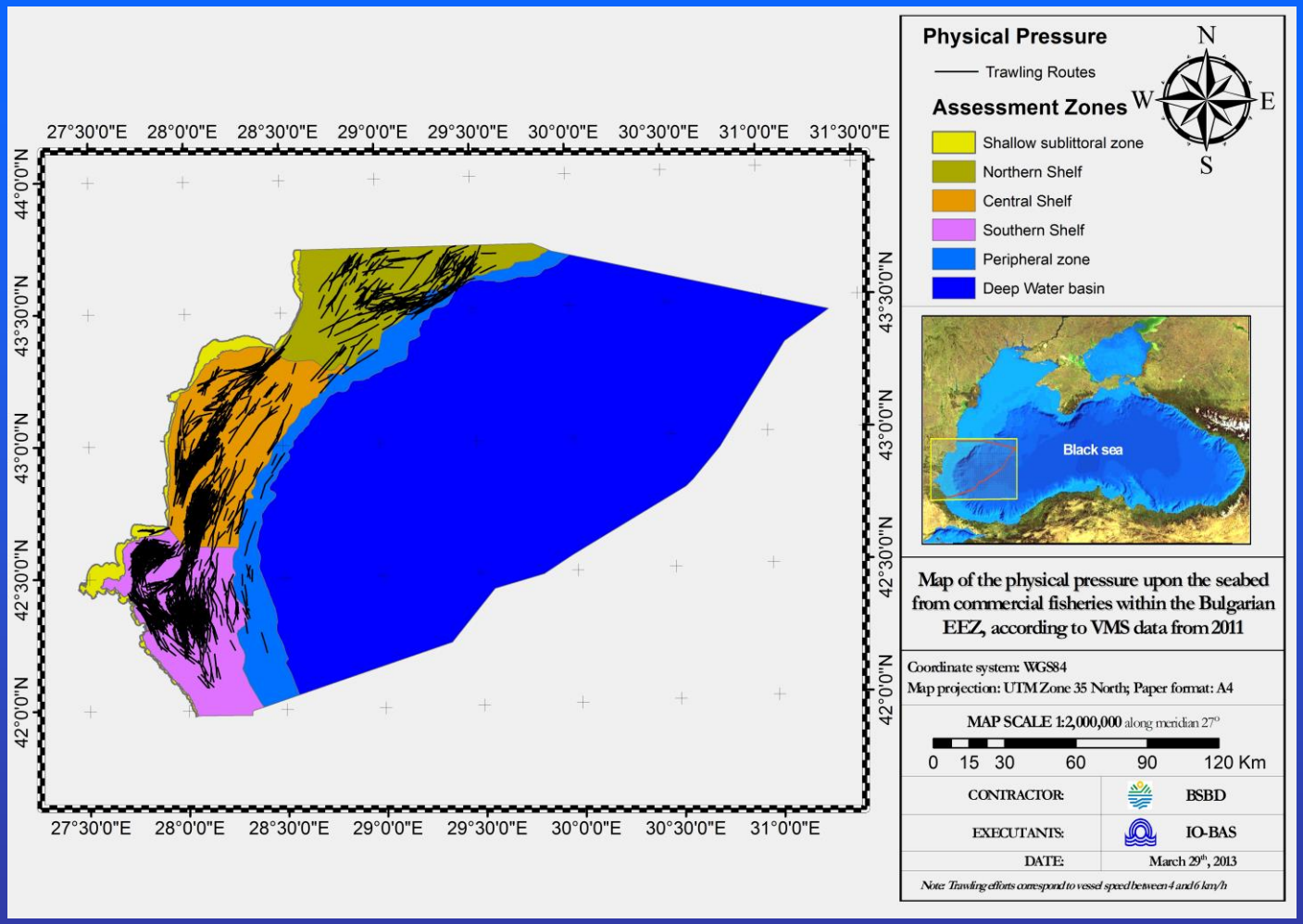
L – total annual length (in km) of all trawling routes within given area;

A – the total surface (in km²) of the assessed area;

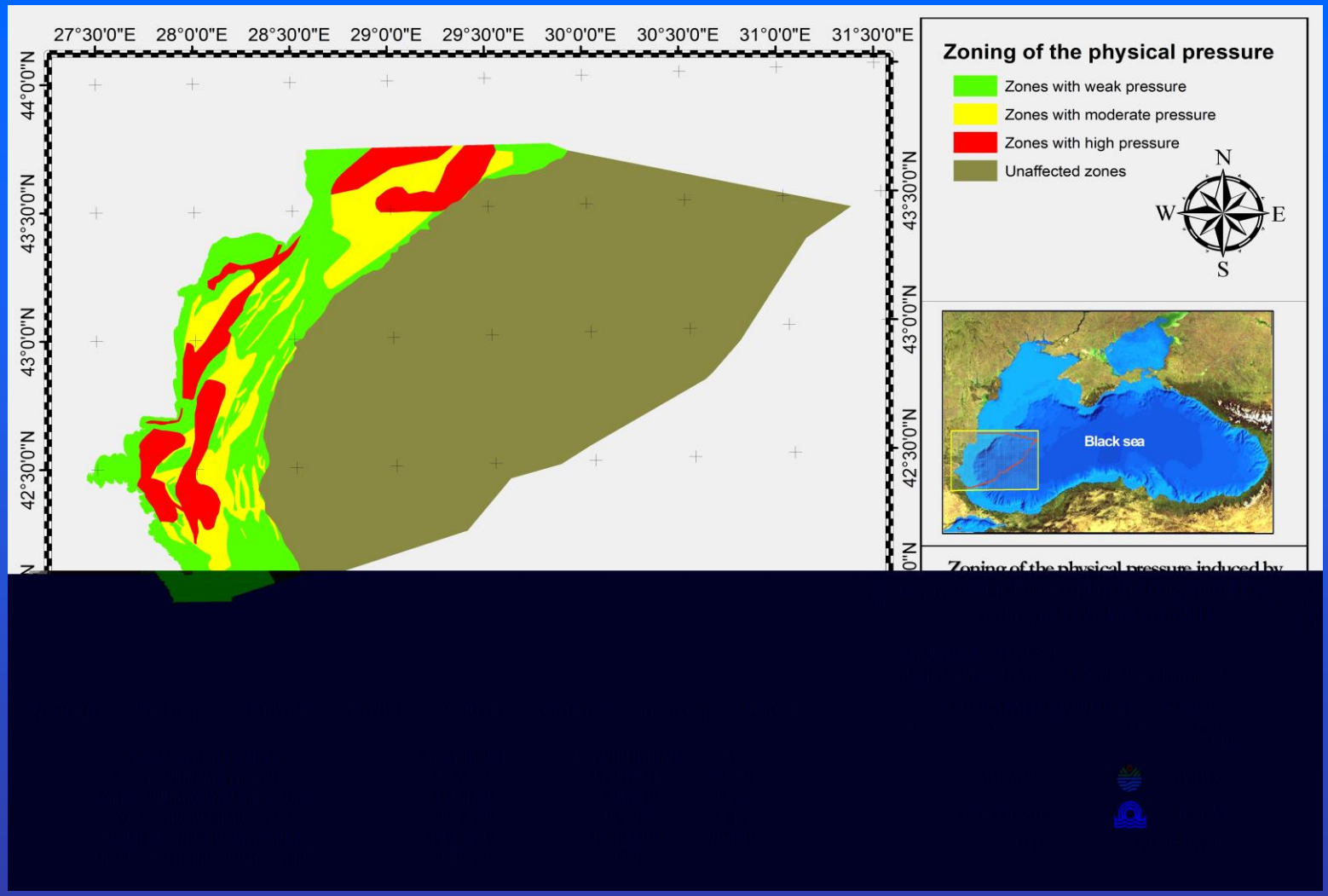
❑ Class boundary values for weak, moderate and strong trawling pressure were introduced as follows:

	Coefficient *K*		
Pressure	weak	moderate	strong
Boundary values	***K* ≤ 0.5**	**0.5 < *K* ≤ 1.5**	***K* > 1.5**

Results



- The trawling routes were superimposed over six previously defined assessment zones within the Bulgarian EEZ.
- For each zone the trawling effort coefficient *K* was calculated.



❑ The overall picture of the trawling pressure on the Bulgarian shelf was also acquired by visually differentiating areas of high, moderate and low pressure based on the trawling routes density. K was calculated respectively.

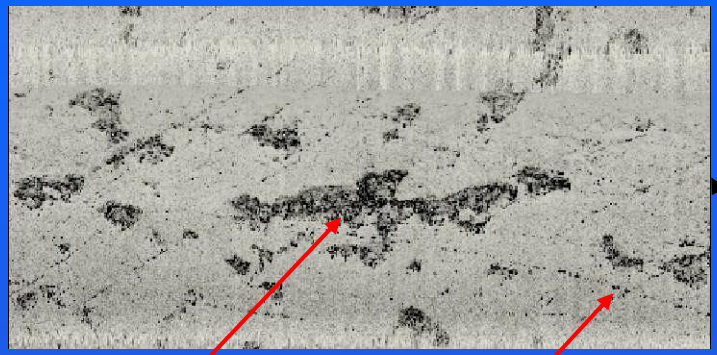
Assessment zones	Area (km²)	Trawling routes total length (km²)	*K*
Shallow sublittoral zone (0-20m depth)	690.54	52.90	0.08
Northern shelf	2851.26	1671.20	0.59
Central shelf	3471.88	6367.44	1.83
Southern shelf	2923.78	5919.02	2.02
Peripheral zone	2276.54	443.99	0.20
Deep-water basin	23392.64	1.29	0.00

Pressure zones	Area (km²)	Trawling routes total length (km²)	*K*	% of the total area 0-100m depth)
Zones under strong pressure	2680.0	11970.0	4.5	23.4
Zones under moderate pressure	3124.9	2430.0	0.8	27.3
Zones under weak pressure	5651.9	43.2	0.01	49.3
Total all areas (0-100m depth)	11456.8	14443.2	1.3	100.0

Physical pressure by substrate type

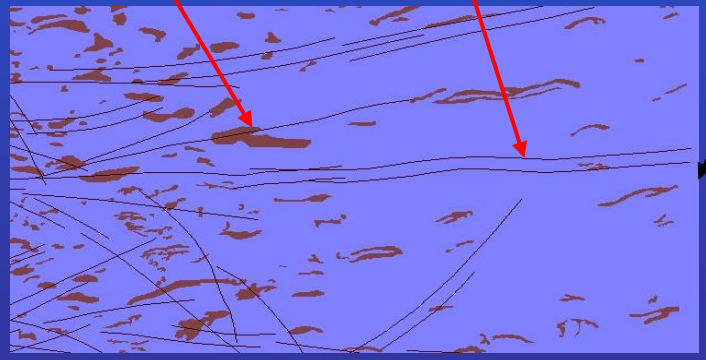
Substrate types (habitats)	Physical pressure	Area (km²)	% area under physical pressure
Sands		312.57	100.00
	Strong	10.52	3.4
	Weak	302.04	96.6
Shelf silts, upper circalittoral		302.04	100.0
	Strong	491.74	28.6
	Moderate	353.84	20.6
	Weak	873.13	50.8
Mussel beds		4053.71	100.0
	Strong	1034.42	25.5
	Moderate	892.50	22.0
	Weak	2126.78	52.5
Shelf silts, lower circalittoral		3559.84	100.0
	Strong	265.07	7.4
	Moderate	835.80	23.5
	Weak	1755.63	49.3
	Physical pressure absent	703.34	19.8
Shelf transformed substrates (phaseolinas)		2365.27	100.0
	Strong	878.04	37.1
	Moderate	1042.77	44.1
	Weak	389.60	16.5
	Physical pressure absent	54.41	2.3

Side-scan sonar backscatter image



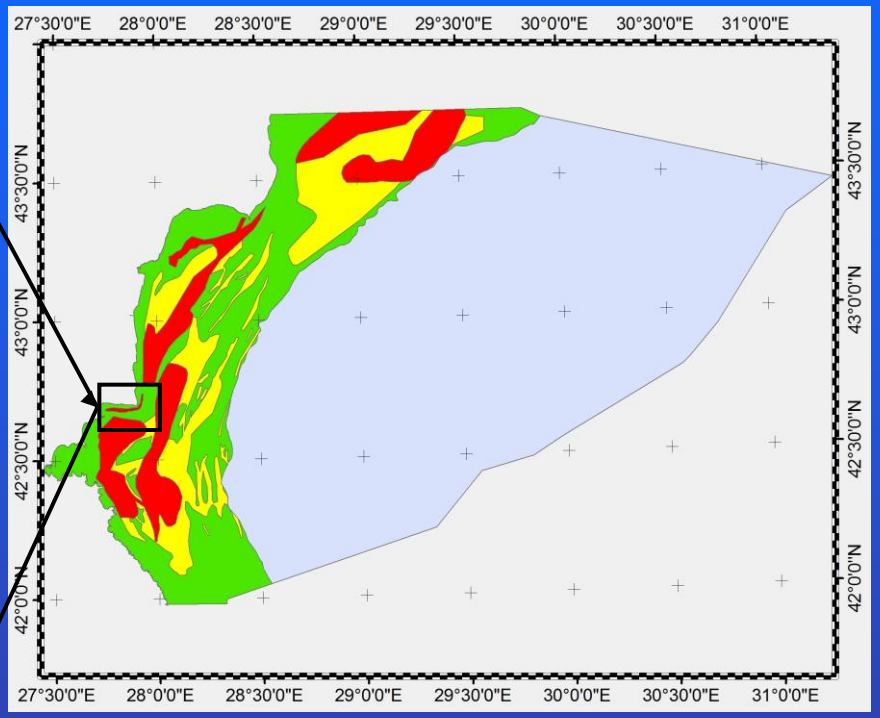
Mussel patch

Trawling trails



Post-processed image in Global mapper

AN EXAMPLE OF "COCKATRICE" MARINE PROTECTED AREA



Discussion

- The available VMS data does not allow fleet differentiation on the basis of fishing gear type used (benthic or pelagic trawls). Hence, the study assumed the use of pelagic trawls in the near-bottom layer (0.5-5 m above the sea bed) to also cause physical damage by abrasion;

- The physical pressure exerted by fishing boats < 15m was not taken into account due to absence of tracking devices installed. Meanwhile, these represent approximately 95% of the fishing fleet. Therefore, the physical pressure in the shallow sublittoral zone, where these small boats operate, may be significantly underestimated.

- The proposed class boundary values of the trawling pressure are conditional and have not been validated vs. the state of the benthic habitats and the associated biological communities. Further studies are needed to demonstrate the causality between the level of trawling pressure and the ecological impact, as well as to define acceptable pressure levels.

- Until 2011, bottom trawling was strictly prohibited, albeit illegally practiced. In 2012 the ban for the use of beam trawls was lifted (Fisheries and Aquacultures Act, 2012). Thus the study assessed the level of pressure **before** the legal permission. Increasing levels of trawling pressure are expected in the future as a result of the ban abolishment unless special management measures are introduced for restriction and control.

Conclusions

- In total, > 50% of the seabed down to 100 m depth within the Bulgarian EEZ is subject to abrasion by trawling;

- Highest values of the physical pressure were calculated for the southern (K = 2.02) and the central shelf zones (K = 1.83), while the northern shelf experiences moderate levels of anthropogenic disturbance of this kind (K = 0.59). The peripheral shelf area is subject to negligible disturbance (K = 0.20). Results obtained for the shallow sublittoral zone are of low confidence;

- Strongest abrasion impacts are registered for the phaseolina silts, upper circalittoral silts and the mussel beds;

- The mussel banks are the most susceptible to abrasion among all due to the epifaunal nature of *Mytilus galloprovincialis;*

- The initial assessment presented, despite being innovative, is of moderate confidence since it needs verification by further studies backed by more *in situ* data.

Acknowledgements

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