Progress in the analysis of VMS data: Scientific insights from Italian experience

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GENERAL FISHERIES COMMISSION FOR THE MEDITERRANEAN
Workshop on the implementation of a Vessel Monitoring System in the Mediterranean and Black Sea
Zagreb, Croatia, 28-30 November 2011

Main objectives of this workshop

- Discuss the utility of data originating from VMS and other tracking devices in the monitoring of the intensity and distribution of fishing effort, as well <u>as in fisheries scientific analyses</u> and management processes

The context

- VMS data are routinary processed within the **Data Collection Framework** (http://ec.europa.eu/fisheries/cfp/fishing_rules/data_collection/index_en.htm) in order to assess and analyze the spatial extension of fishing effort
- This requires a complex flow since VMS data must be processed and coupled with other data sources (i.e. Logbooks)

The challenge

Some key steps are:

- Disaggregation of VMS dataset into single "tracks", that are fishing trips starting by and ending to a given harbor;
- Interpolation at an adequate standard frequency (e.g. 10 minutes) in order to realistically represent fishing activity;
- Recognize fishing activity with respect to targeted resources (i.e. Métiers classification)

Mètier classification in Mediterranean and Black Sea

Level 1	Level 2	Level 3	Level 4	Level 5	Level 6	Level 7
Activity	Gear classes	Gear groups	Gear type	Target assemblage	Mesh size and other selective devices	
Fishing activity	Dredges	Dredges	Boat dredge [DRB]	Molluscs		
	Trawls	Bottom trawls	Bottom otter trawl [OTB]	Demersal species	>=40	shelf slope mixed shelf and slope
				Deep water species*	>=40	
				Mixed demersal species and deep water species*	>=40	
			Multi-rig otter trawl [OTT]	Demersal species	>=40	
			Bottom pair trawl [PTB]	Demersal species	>=40	
			Beam trawl [TBB]	Demersal species	>=40	
		Pelagic trawls	Midwater otter trawl [OTM]	Mixed demersal and pelagic species	>=20	
			Midwater otter trawl [OTM]	Mixed demersal and pelagic species	13-20**	
			Pelagic pair trawl [PTM]	Small pelagic fish	>=20	
	Hooks and Lines	Rods and Lines	Hand and Pole lines [LHP] [LHM]	Finfish	(a)	
				Cephalopods	(a)	
			Trolling lines [LTL]	Large pelagic fish	(a)	
		Longlines	Drifting longlines [LLD]	Large pelagic fish	(a)	LLD_LPF_0_0_0 (BFT) LLD_LPF_0_0_0 (ALB) LLD_LPF_0_0_0 (SWO)
			Set longlines [LLS]	Demersal fish	(a)	shelf slope
	Traps	Traps	Pots and Traps [FPO]	Demersal species	(a)	
			Fyke nets [FYK]	Catadromous species	(a)	
				Demersal species	(a)	
			Stationary uncovered pound nets [FPN]	Large pelagic fish	(a)	
	Nets	Nets	Trammel net [GTR]	Demersal species	>=16	
			Set gillnet [GNS]	Small and large pelagic fish	>=16	
				Demersal species	360-400**	
				Demersal species	>=16	
			Driftnet [GND]	Small pelagic fish	(a)	
				Demersal fish	(a)	
	Seines	Surrounding nets	Purse seine [PS]	Small pelagic fish	>=14	
				Large pelagic fish	>=14	
			Lampara nets [LA]	Small and large pelagic fish	>=14	
		Seines	Fly shooting seine [SSC]	Demersal species	(a)	
			Anchored seine [SDN]	Demersal species	(a)	
			Pair seine [SPR]	Demersal species	(a)	
			Beach and boat seine [SB] [SV]	Demersal species	(a)	
	Other gear	Other gear	Glass eel fishing	Glass eel	(a)	
	Misc. (Specify)	Misc. (Specify)			(a)	

Other activity than fishing	Other activity than fishing		
Inactive	Inactive		

(a) Not spelled out in DCR but defined with reference to relevant EU Regulation(s)

(*) refering only to red shrimps *Aristaeomorpha foliacea* and *Aristeus antennatus*, species not included in the definition of deep sea species given by Council Regulation (EC) 2347/2002.

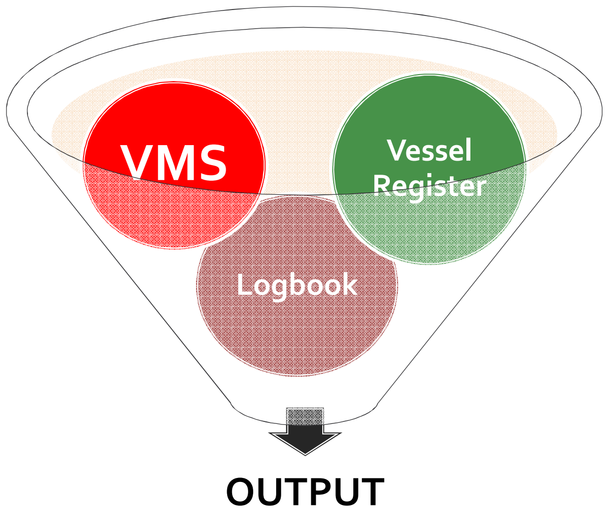
(**) for black sea

The challenge

- Distinguish between fishing and steaming points within each classified track;
- Aggregate fishing points per area, per activity and per time, on a spatial grid;
- Analyze the obtained pattern in order to:

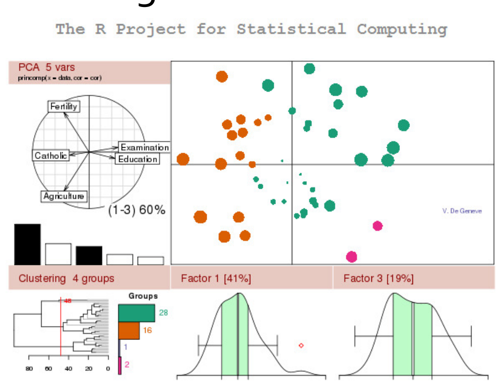
1. Compute pressure indicators (extension of exploited area)
2. Identify and monitoring fishing grounds through time

The data used

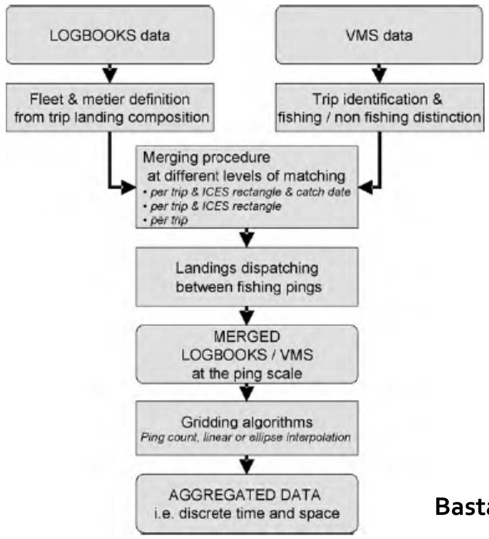


The way

- Development of R code (libraries, routines) in order to facilitate validation, sharing and enhancement of methological skills

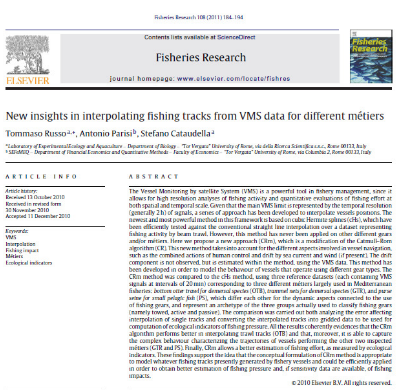


Matching with Logbooks



Bastardie et al., 2010

Interpolation



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New insights in interpolating fishing tracks from VMS data for different métiers

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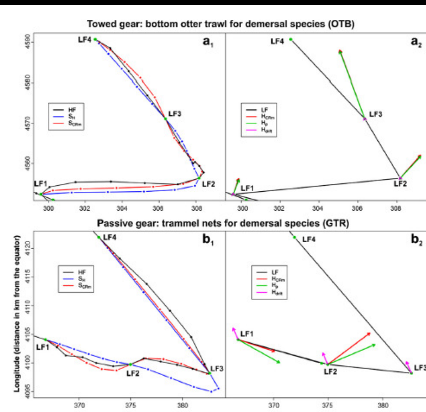
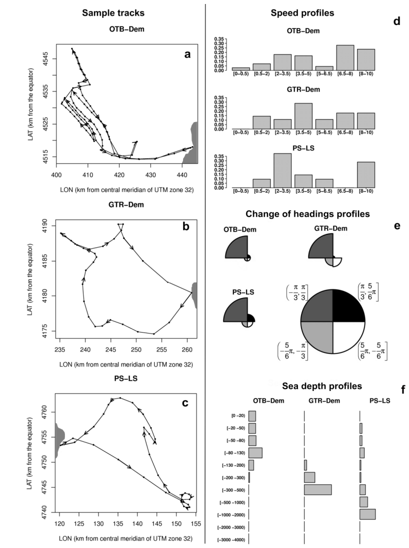
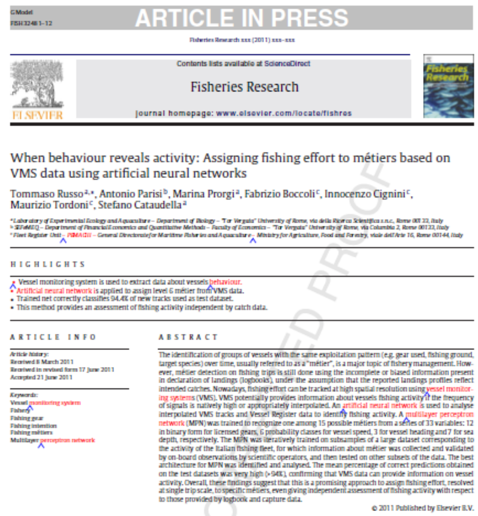


In this way it is possible to obtain high frequency tracks from VMS signals natively characterized by low frequency (e.g. 2 hours, that is the default for Italian fleet)

Recognize fishing activity





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When behaviour reveals activity: Assigning fishing effort to métiers based on VMS data using artificial neural networks

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HIGHLIGHTS

- Vessel monitoring system is used to extract data about vessels behaviour.
- Artificial neural network is applied to assign level 6 métier from VMS data.
- Trained net correctly classifies 94.4% of new tracks used as test dataset.
- This method provides an assessment of fishing activity independent by catch data.

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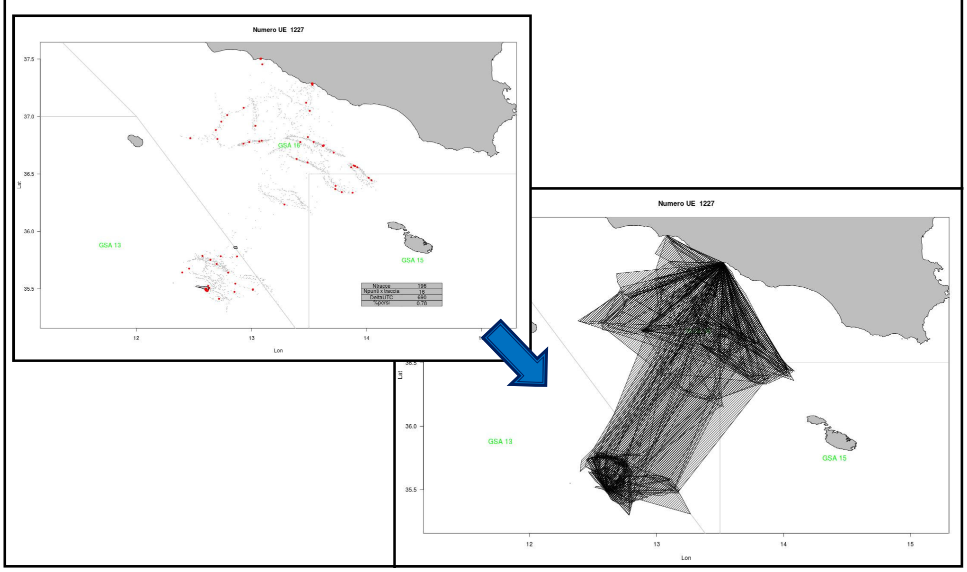
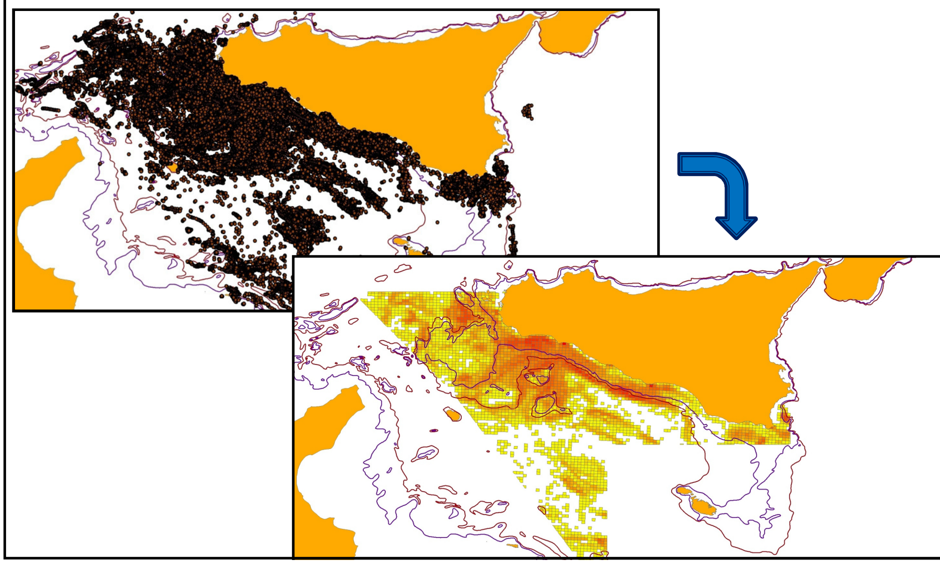
ABSTRACT

The identification of groups of vessels with the same exploitation pattern (e.g. gear used, fishing ground, target species) over time, usually referred to as a "métier", is a major topic of fishery management. However, métier detection on fishing trips is still done using the incomplete or biased information present in declaration of landings (logbooks), under the assumption that the reported landings profiles reflect intended catches. Nowadays, fishing effort can be tracked at high spatial resolution using vessel monitoring systems (VMS). VMS potentially provides information about vessels fishing activity if the frequency of signals is natively high or appropriately interpolated. An artificial neural network is used to analyse interpolated VMS tracks and Vessel Register data to identify fishing activity. A multilayer perceptron network (MPN) was trained to recognize one among 15 possible métiers from a series of 33 variables: 12 in binary form for licensed gears, 6 probability classes for vessel speed, 3 for vessel heading and 7 for sea depth, respectively. The MPN was iteratively trained on subsamples of a large dataset corresponding to the activity of the Italian fishing fleet, for which information about métier was collected and validated by on-board observations by scientific operators, and then tested on other subsets of the data. The best architecture for MPN was identified and analysed. The mean percentage of correct predictions obtained on the test datasets was very high (>94%), confirming that VMS data can provide information on vessel activity. Overall, these findings suggest that this is a promising approach to assign fishing effort, resolved at single trip scale, to specific métiers, even giving independent assessment of fishing activity with respect to those provided by logbook and capture data.

In summary: from points to tracks

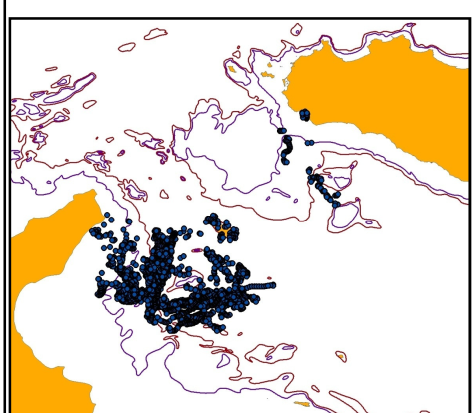


From points to pattern

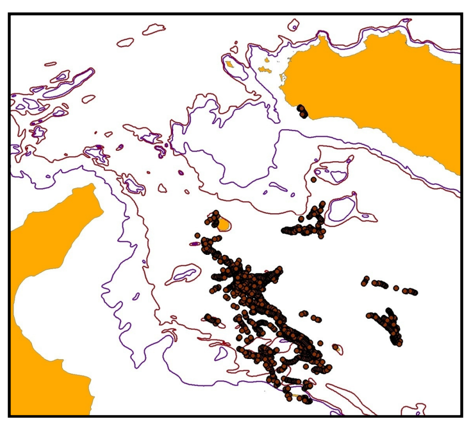


Possible analysis: seasonal patterns

Winter

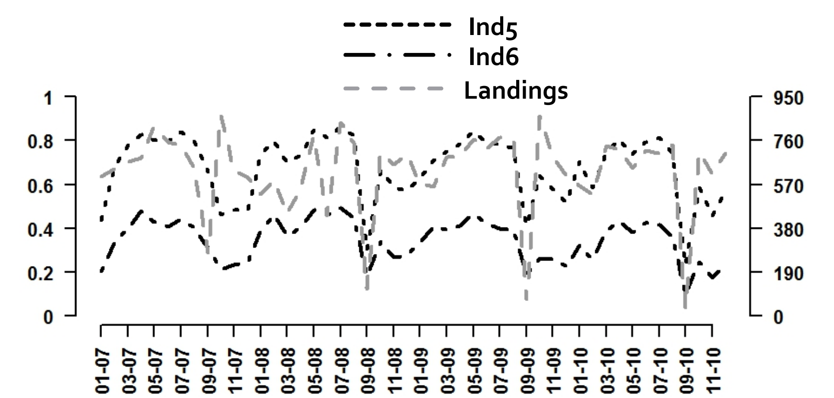


Spring



Pressure indicators: temporal trends

Long-term monitoring of fishing activity (exploited area)

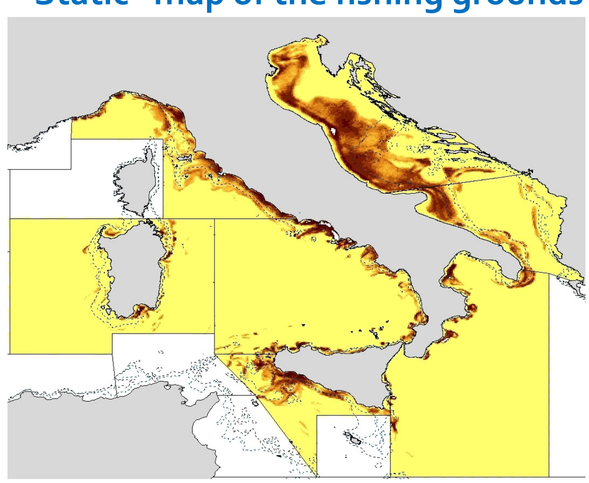


Fishing grounds

Use of VMS data to track spatio-temporal changes of fishing grounds.

We developed a statistical method to identify fishing grounds and to track temporal changes.

"Static" map of the fishing grounds

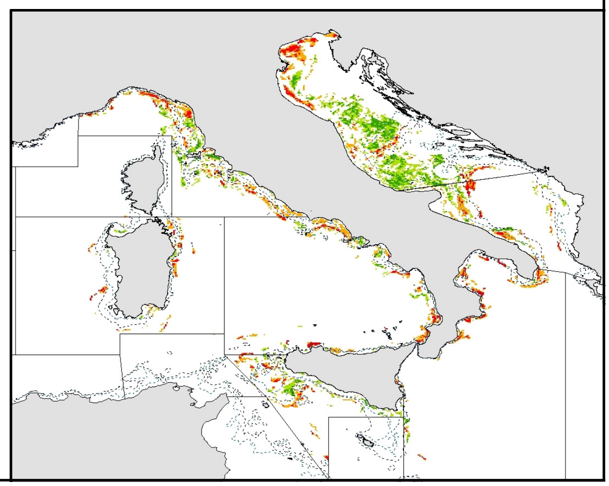


Tracking changes: Temporal trends within fishing grounds

"Dinamic" map of the fishing grounds

Decreasing effort

Increasing effort



Thank you for the attention

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