

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 as in fisheries scientific analyses and management processes

The context

- VMS data are routinely processed within the **Data Collection Framework** (http://ec.europa.eu/fisheries/cfp/fishing_rule_s/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)

Métier classification in Mediterranean and Black Sea

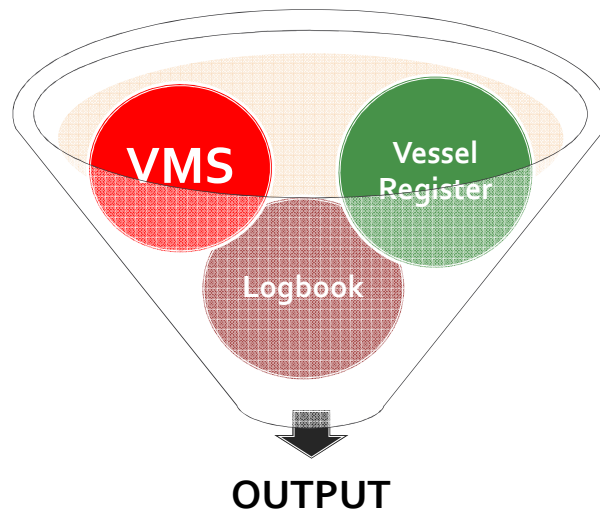
Level 1	Level 2	Level 3	Level 4	Level 5	Level 6	Level 7
Activity	Gear classes	Gear groups	Gear type	Target assemblage	Mesh size and other selective devices	
Fishing activity	Dredges	Dredges	Boat dredge (DRB)	Molluscs		shell slope mixed gulf and slope
			Bottom trawls	Demersal species	<=40	
	Trawls	Bottom trawls	Bottom otter trawl (OTB)	Deep water species*	<=40	
			Multi-ring otter trawl (OTT)	Mixed demersal species and deep water species*	<=40	
			Bottom pair trawl (PTB)	Demersal species	<=40	
			Beam trawl (TBB)	Demersal species	<=40	
			Midwater otter trawl (OTM)	Mixed demersal and pelagic species	<=40	
			Midwater otter trawl (OTM)	Mixed demersal and pelagic species	15-20**	
			Pelagic trawls	Pelagic pair trawl (PTM)	Small pelagic fish	<=20
	Rods and Lines	Rods and Lines	Hand and Pole lines (LHP) (LHW)	Fishes	(a)	
			Trotting lines (LTL)	Cephalopods	(a)	
			Drifting longlines (LLO)	Large pelagic fish	(a)	
	Hooks and Lines	Longlines	Drifting longlines (LLO)	Large pelagic fish	(a)	LLO_LPF_0_0_0 (BFT) LLO_LPF_0_0_0 (ALB) LLO_LPF_0_0_0 (DWG)
			Set longlines (LLO)	Demersal fish	(a)	
	Traps	Traps	Pole and Traps (PFC)	Demersal species	(a)	shell slope
			Flyke nets (FYN)	Californian species	(a)	
			Stationary uncovered pound nets (SPN)	Demersal species	(a)	
	Nets	Nets	Trammel net (ZTB)	Demersal species	<=16	
			Set gillnet (SNG)	Small and large pelagic fish	<=16	
			Demersal	Demersal species	16-40**	
			Driftnet (DNC)	Small pelagic fish	(a)	
	Seines	Gumounding nets	Purse seine (PS)	Small pelagic fish	<=14	
			Lampara nets (LAN)	Small and large pelagic fish	<=14	
			Fly shooting seine (SSC)	Demersal species	(a)	
		Seines	Anchored seine (CAN)	Demersal species	(a)	
			Poll seine (PSR)	Demersal species	(a)	
			Beach and boat seine (BS) (BV)	Demersal species	(a)	
	Other gear	Other gear	Crust. ect fishing	Glass eye	(a)	
	Miss. (specif.)	Miss. (specif.)			(a)	
		Other activity than fishing		Other activity than fishing		
		inactive		inactive		

(a) Not spelled out in DCFR but defined with reference to relevant EU Regulations
 (*) Including only the fish genus *Argocheilichthys* (Palaemonidae) and *Aketeus alternatus*, 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 sea 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

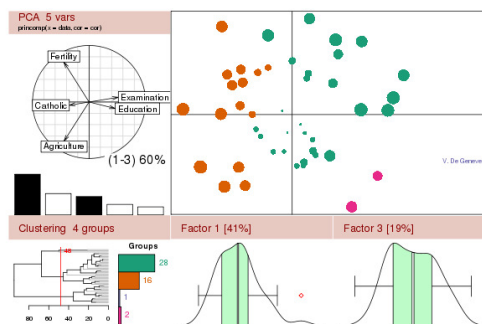
The data used



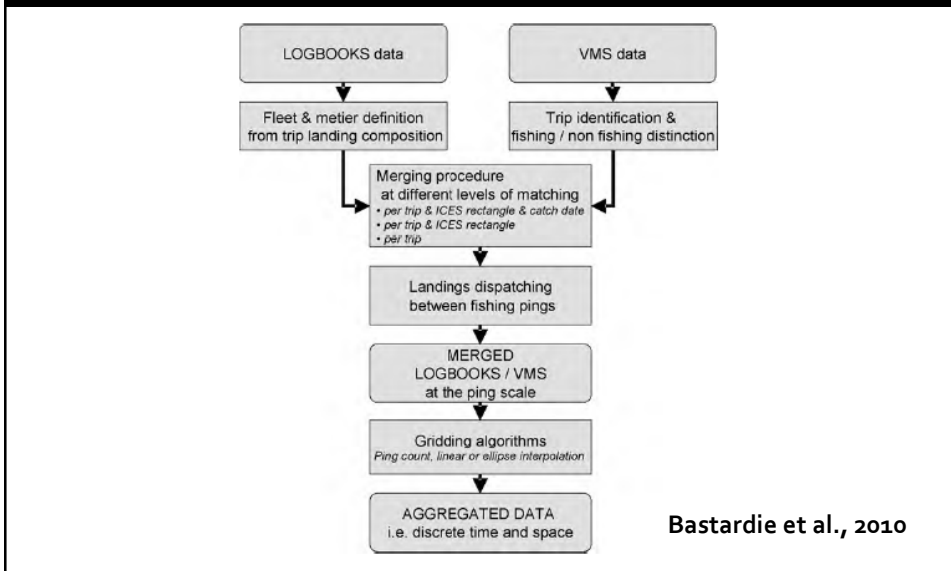
The way

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

The R Project for Statistical Computing



Matching with Logbooks



Interpolation

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New insights in interpolating fishing tracks from VMS data for different métiers
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ABSTRACT
The Vessel Monitoring by Satellite System (VMS) is a powerful tool in fishery management, since it allows for high resolution analysis of fishing activity and quantitative evaluation of fishing effort at both spatial and temporal scale. Given that the main VMS limit (as represented by the temporal resolution) is generally 2h of signals, a series of approaches has been developed to interpolate vessels positions. The newer and most powerful method in this framework is based on cubic Hermite splines (HS), which have been efficiently tested against the conventional straight line interpolation used in current representing fishing activity by beam trawl. However, this method has never been applied on other different gear and/or metiers. Here we propose a new approach (GTR), which is a modification of the Catmull-Rom algorithm (CR). This new method can be used for different gears or metiers in mixed fisheries, such as the combined activity of beam trawl and drift by sea current and wind of passive nets. The main component is not changed, but is contained within the method, using the VMS data. The method has been developed in order to model the behaviour of vessels that operate using different gear types. The CR method was compared to the CR method, using three reference datasets (each containing VMS signals at intervals of 2 hours) corresponding to three different metiers largely used in Mediterranean fisheries: bottom otter trawl for demersal species (OTB), trammel nets (GTR), and purse seine for small pelagic fish (PS), which differ each other for the dynamic aspects connected to the use of fishing gear, and represent an archetype of three groups actually used to classify fishing gears in landing vessels, active and passive. The comparison was carried out both modeling the error affecting interpolation of single tracks and converting the interpolated tracks into gridded data to be used in the computation of spatial and temporal fishing effort. The results clearly indicate that the CR algorithm performs better in interpolating beam trawl (OTB) and that, moreover, it is able to capture the complete behaviour concerning the trajectory of vessels performing the other two referenced metiers (GTR and PS). Finally, GTR allows a better estimation of fishing effort, as measured by ecological indicators. These findings support the idea that the conceptual foundation of CR method is appropriate to model whatever fishing tracks previously generated by fishery vessels and could be efficiently applied in order to obtain better estimations of fishing pressure and, if necessary, data are available, of fishing impact.

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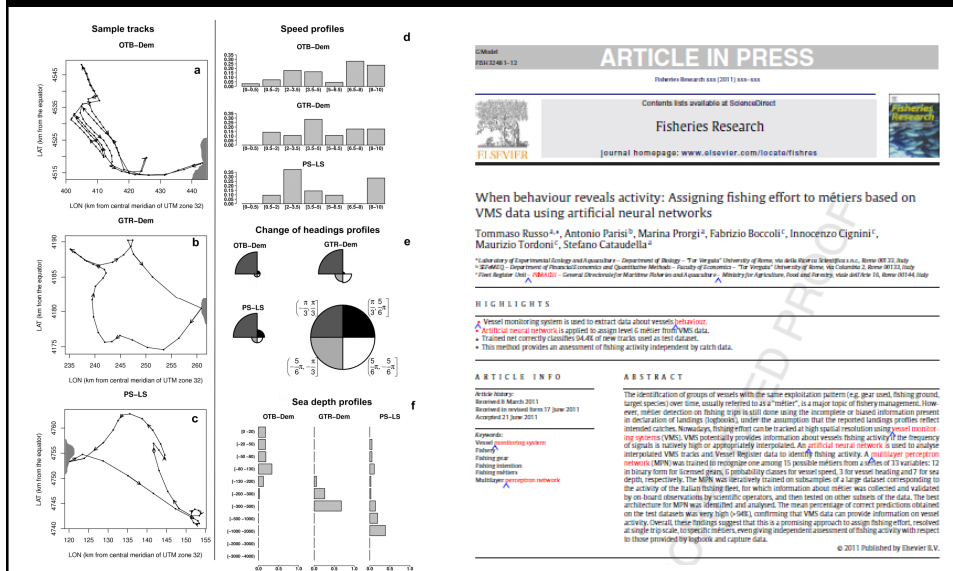
Towed gear: bottom otter trawl for demersal species (OTB)

Passive gear: trammel nets for demersal species (GTR)

Longitude (distance in km from the equator)

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



ARTICLE IN PRESS

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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 systems is used to extract data about vessels' behaviour.
- Artificial neural networks is applied to assign level of effort from VMS data.
- Trained net correctly classifies 54.4% of new tracks used as test dataset.
- This method provides an assessment of fishing activity independent by catch data.

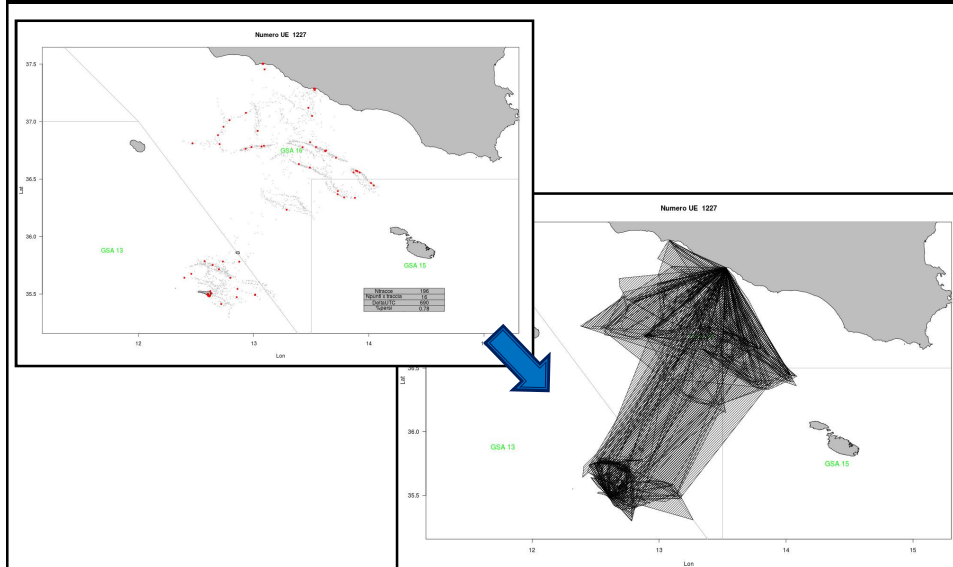
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ABSTRACT

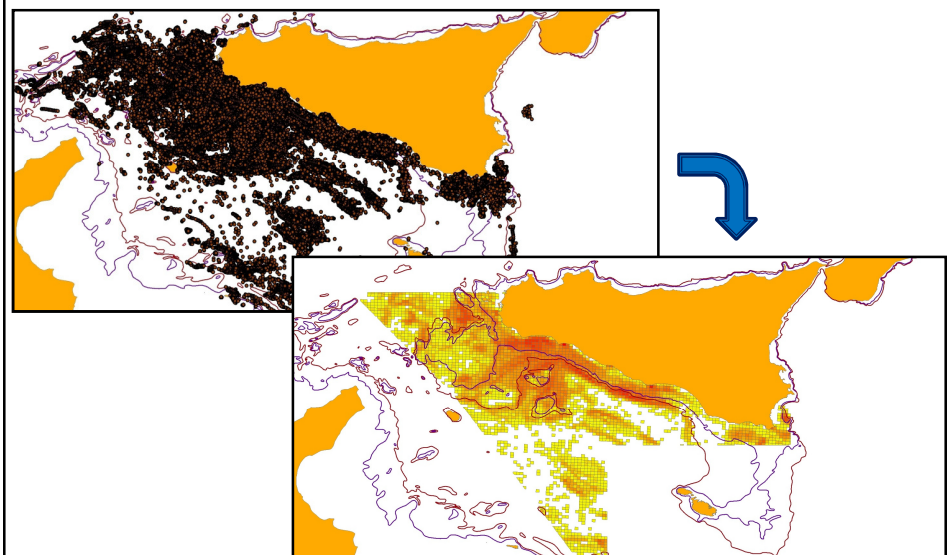
The identification of groups of vessels with the same exploitation pattern (e.g. gear used, fishing ground, target species) over time, usually referred to as a "métier", is a major topic of fishery management. However, métier detection on fishing logs is still done using the inspection of biased information present in declaration of landings (logbooks), under the assumption that the reported landings profiles reflect intended catches. Nowadays, logbook data can be tracked at high spatial resolutions using vessel monitoring systems (VMS). VMS potentially provides information about vessels' fishing activity if the frequency of signals is suitably high or appropriately interpreted. An artificial neural network is used to analyse interpreted VMS tracks and Vessel Register data to identify fishing activity. A multilayer perceptron neural network (MLP) was trained to recognize one among 15 possible métiers from a subset of 12 variables, 12 in binary form for forward gears, 5 probability classes for vessel speed, 3 for vessel heading and 7 for sea depth, respectively. The MLP was hierarchically located 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 MLP was identified and analyzed. The mean percentage of correct prediction 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, involved at single trawler to specific métiers, even giving independent assessment of fishing activity with respect to those provided by logbook and capture data.

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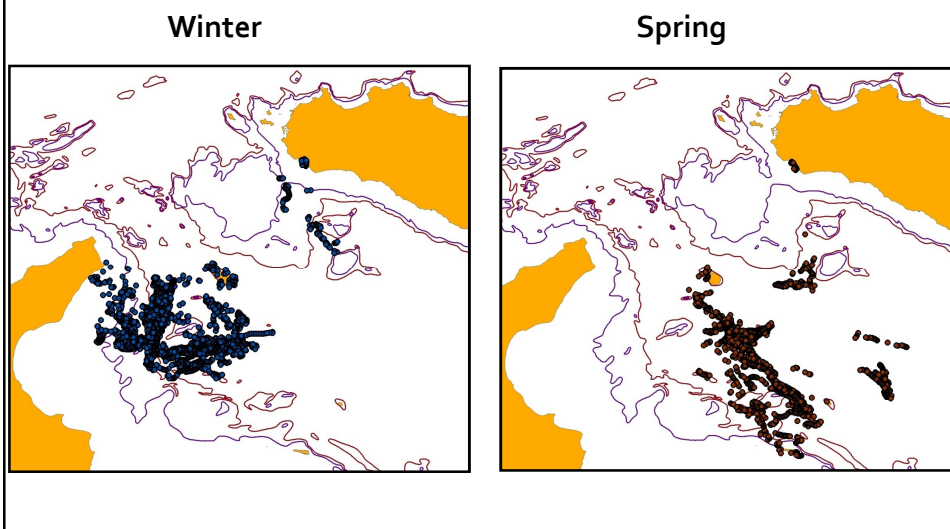
In summary: from points to tracks



From points to pattern

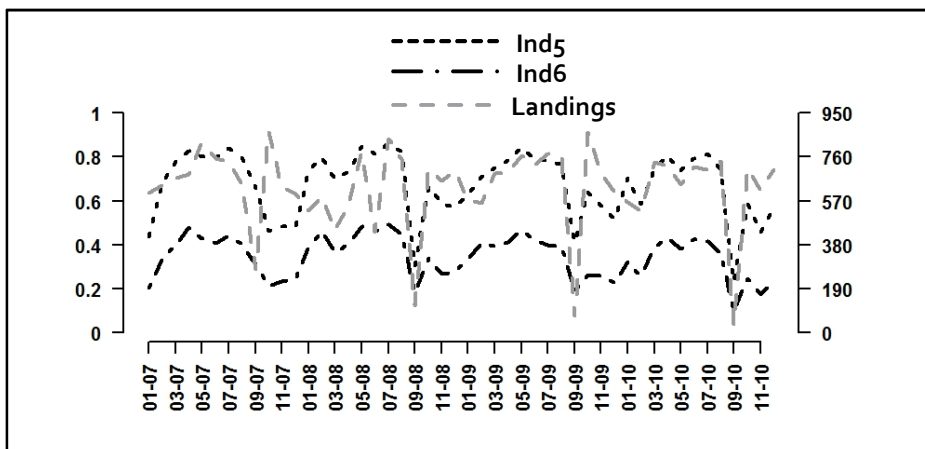


Possible analysis: seasonal patterns



Pressure indicators: temporal trends

Long-term monitoring of fishing activity (exploited area)

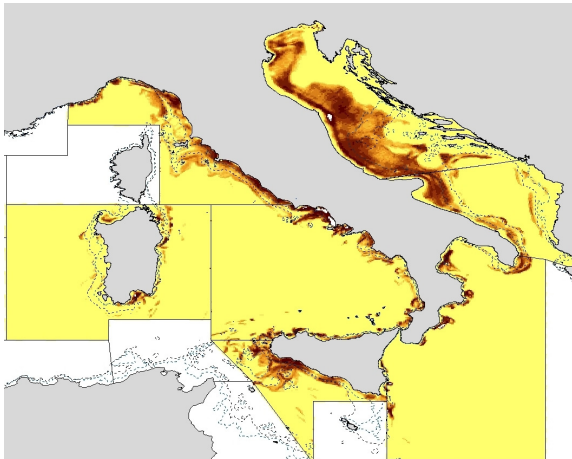


Fishing grounds

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

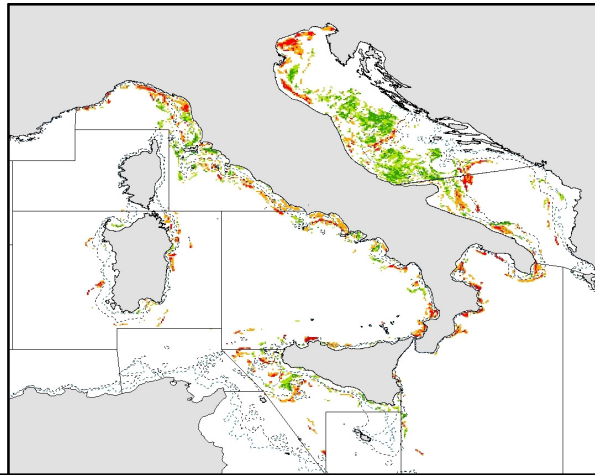


Tracking changes: Temporal trends within fishing grounds

“Dinamic” map of the fishing grounds

 Decreasing effort

 Increasing effort



Thank you for the attention

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