

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

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GENERAL FISHERIES COMMISSION FOR THE MEDITERRANEAN
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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

Fishing activity is classified with respect to used gear and targeted resources within the DCF

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	trawls	trawls	sole dredge (L26)	Mixed fish		
	Trawls	Bottom trawls	Bottom otter trawl (L18)	Demersal species	—>0	small otter trawl
			Deep water otter trawl*	Deep water species	—>0	mixed otter trawls
			Mixed demersal species and deep water species*	Mixed demersal species and deep water species*	—>0	
		Multispecies otter trawl (L27)	Demersal species	—>0		
		Bottom otter trawl (L15)	Demersal species	—>0		
		Beam trawl (L16)	Demersal species	—>0		
		Midwater otter trawl (L27b)	Mixed demersal and pelagic species	—>0		
	Pelagic trawls	Midwater otter trawl (L27a)	Mixed demersal and pelagic species	15-100m		
		Pelagic gear trawl (L27c)	Small pelagic fish	—>0		
	Hooks and Lines	Hooks and Lines	Hand and Pole lines (L40)(L41)	Flatfish	(2)	
			Trotting lines (L41)	Capelinidae	(2)	
			Large pelagic fish	(2)		
	Longlines	Longlines	Cutting longlines (L42)	Large pelagic fish	(2)	L10-L100 (BFT)
			Sail longlines (L43)	Demersal fish	(2)	L10-L100 (L100)
	Traps	Traps	Pots and Traps (L44)	Demersal species	(2)	small
			Fyke nets (L45)	Capelinidae species	(2)	side
			Stationary unweighted pound nets (L46)	Demersal species	(2)	
	Nets	Nets	Stationary unweighted pound nets (L46)	Large pelagic fish	(2)	
			Trawl net (L27a)	Demersal species	—>0	
			Small and large pelagic fish	Small and large pelagic fish	—>0	
			Demersal species	Demersal species	300-1000m	
	Nets	Nets	Drift net (L47)	Demersal species	—>0	
Demersal fish			Demersal fish	—>0		
Demersal species			Demersal species	—>0		
Small pelagic fish			Small pelagic fish	—>0		
Demersal fish			Demersal fish	—>0		
Nets	Outdrift nets	Purse seine (L48)	Large pelagic fish	—>0		
		Small and large pelagic fish	Small and large pelagic fish	—>0		
		Large pelagic fish	Large pelagic fish	—>0		
		Demersal species	Demersal species	—>0		
Nets	Nets	Artisanal seine (L49)	Demersal species	(2)		
		Artisanal seine (L50)	Demersal species	(2)		
		Pur seine (L51)	Demersal species	(2)		
Other gear	Other gear	Beam and otter trawl (L27)	Demersal species	(2)		
		Grass sea fishing	Grass sea	(2)		
Misc. (L52)(L53)	Misc. (L52)(L53)	Other activity than fishing	Other activity than fishing	(2)		
		Inactive	Inactive			

(*) Not spelled out in DCF but defined with reference to relevant EU Regulations
 (*) referring only to red shrimp, *Alpheonissus foliaceus* and *Alpheonissus antennatus*; species not included in the definition of deep sea species given by [Council Regulation \(EC\) No 1006/2006](#)
 (*) for black sea

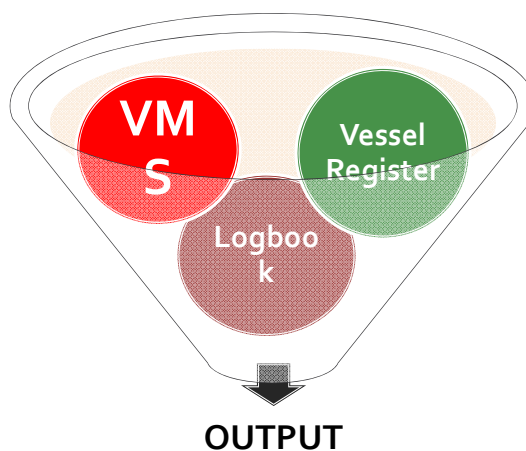
The challenge

Other steps:

- 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

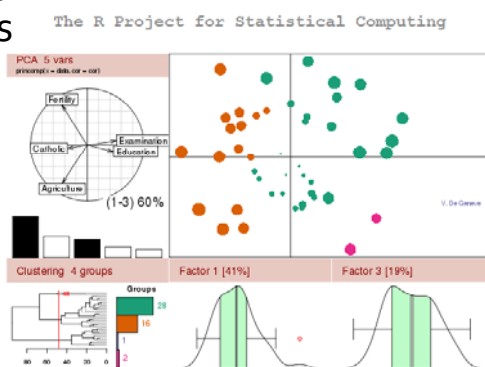
The data used

The main sources of data for these analyses are represented by:



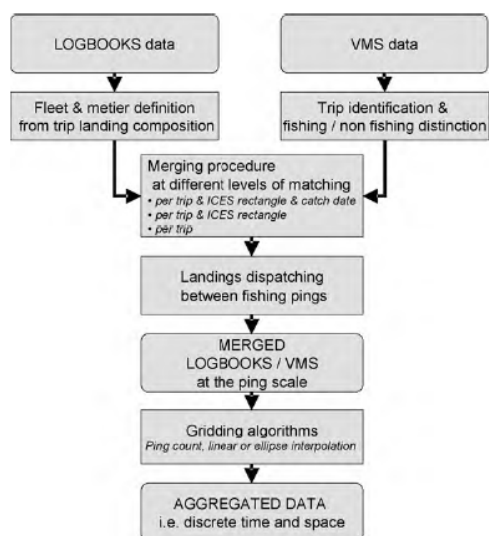
The way

- We developed a series of libraries and routines in R code in order to facilitate validation, sharing and enhancement of methodological skills



Matching with Logbooks

One of the main step of the analysis is represented by matching of VMS and Logbooks informations. This is performed using an approach developed by Bastardie et al., 2010



Interpolation

Marine Research 100 (2011) 106–114

Contents lists available at ScienceDirect

Fisheries Research

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

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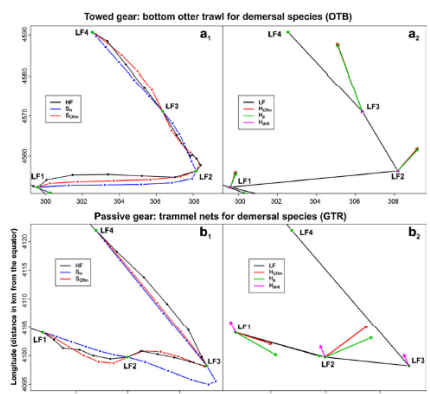
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ARTICLE INFO

ABSTRACT

The vessel monitoring 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 scales. Given that the more VMS data are represented by the temporal resolution (generally 2 h of signals), a series of approaches has been developed to interpolate vessel positions. The present and previous methods are based on the linear interpolation approach, which has been here efficiently tested against the conventional straight line interpolation over a dataset representing fishing activity by hook level. However, this method has never been applied on other different gear and/or species. Here we propose a new approach (CIN), which is a modification of the classic Run algorithm (CE). This new method takes account for the different gear and/or species configurations, both in the method of hook control and in the way control and vessel of position. The main component is not observed, but is measured within the method, using the VMS data. This method has been developed in order to avoid the behavior of vessels that operate using different gear types. The CIN method was compared to the CE method, using three different datasets (each containing VMS signals at intervals of 2 hours) corresponding to three different métiers largely used in Mediterranean fisheries: bottom otter trawl for demersal species (OTB), bottom otter trawl for demersal species (OTD), and gear only for small pelagic fish (OP), which differ each other for the fishing gear used (the use of fishing gear, and represent an advantage of the new approach used to classify fishing gear (Landing gear), active and passive). The comparison was carried out both analyzing the error affecting interpolation of single tracks and concerning the interpolated tracks into spatial data to be used for the comparison of results of area of fishing per unit time (miles² per unit time) between the two algorithms performed before and interpolating real tracks (OTB and OP), respectively. In order to capture the complex behavior characterizing the operations of vessels performing the other two respective métiers (OTD and OP), CIN allows a better evaluation of fishing effort as measured by ecological indicators. These findings support the idea that the conceptual framework of CIN may be applied to model all active fishing tracks previously generated by fishing vessels and could be effectively applied in order to obtain better estimates of fishing pressure and, if necessary, also in passive fishing.

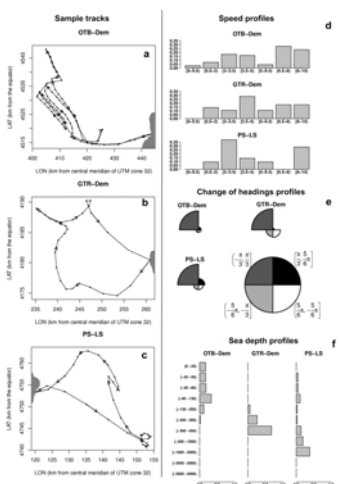
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We developed some specific tools for the interpolation of VMS data to obtain high frequency tracks from VMS signals natively characterized by low frequency (e.g. 2 hours, that is the default for Italian fleet)

Recognize fishing activity

We also developed a method, based on Artificial Neural Network, to classify the fishin activity associated to each VMS track



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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 are used to extract data about vessels' activities.
- Artificial neural networks is applied to assign level of métier from VMS data.
- Trained net correctly classifies 94.6% of new tracks used as test dataset.
- This method provides an assessment of fishing activity independent by catch data.

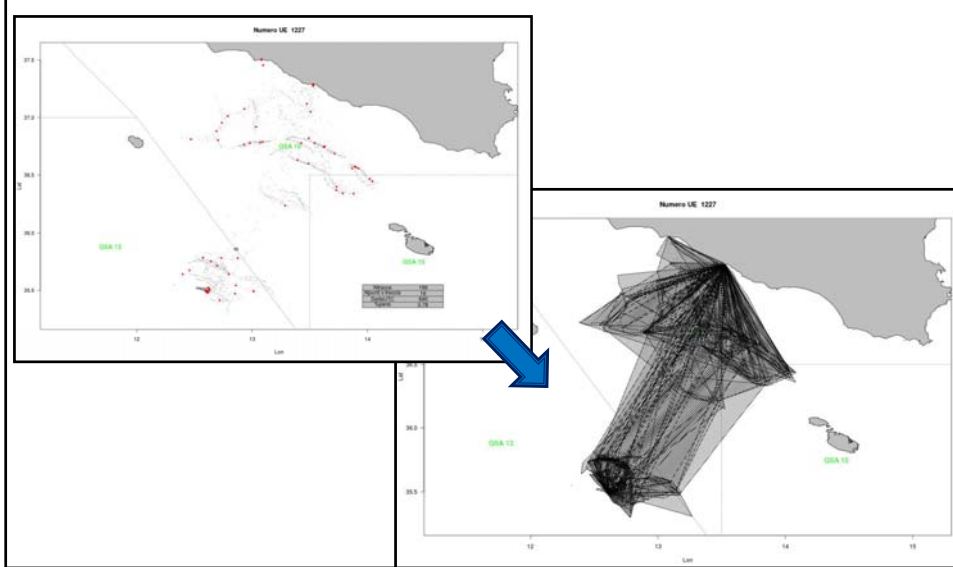
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ABSTRACT

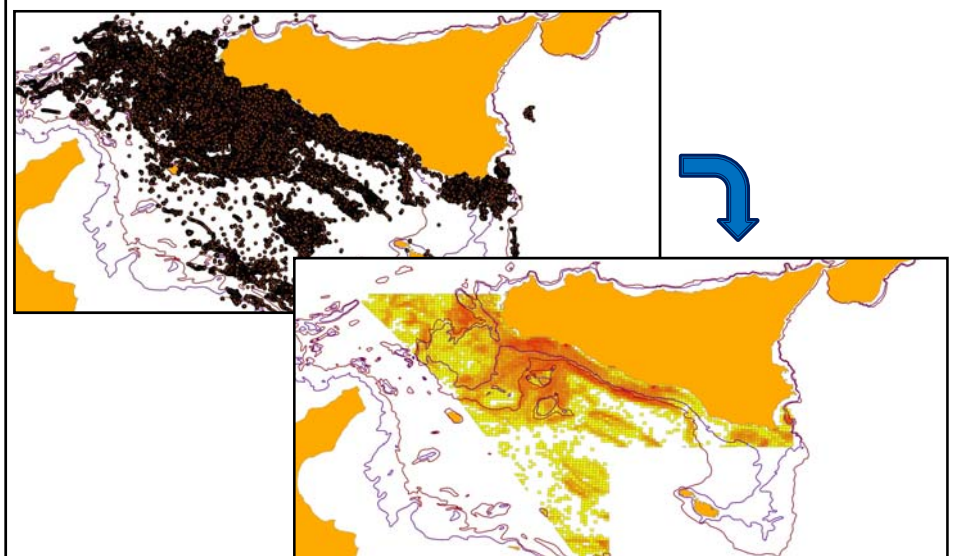
The identification of groups of vessels with different exploitation strategies (gear used, fishing ground, target species) over time, usually referred to as a "métier", is a major topic of fishery management. However, better decisions on fishing rights can be made using the information present in declaration of landings (logbooks), under the assumption that the reported landings profiles reflect landed catches. Knowledge, however, can be traced at high spatial or resolution using vessel monitoring systems (VMS). VMS potentially provides information about vessels fishing activity by the frequency of signals (a metric high or proportionally interpreted). An artificial neural network is used to interpolate VMS tracks and Venetian Region data to identify fishing activity. A multi-year (2000–2009) dataset (MPN) was trained to recognize one among 15 possible métiers from a subset of 23 variables: 12 as binary forms for (movement status), 6 probability classes for vessel speed, 1 for vessel heading and 7 for sea depth, respectively. The ANN was specifically trained on a sub-sample of a large dataset corresponding to the activity of the Italian fishing fleet, for which information about métier was collected and validated by the boat deckmaster by specific operators, and then used as other subset of the data. The best architecture for MPN was identified and analyzed. The mean percentage of correct predictions obtained on the test dataset was very high (>90%), confirming that VMS data can provide information on vessel activity. Overall, these findings suggest that this is a promising approach to assign fishing effort, instead of relying on logbook data, to obtain independent assessment of fishing activity with respect to those provided by logbook and capture data.

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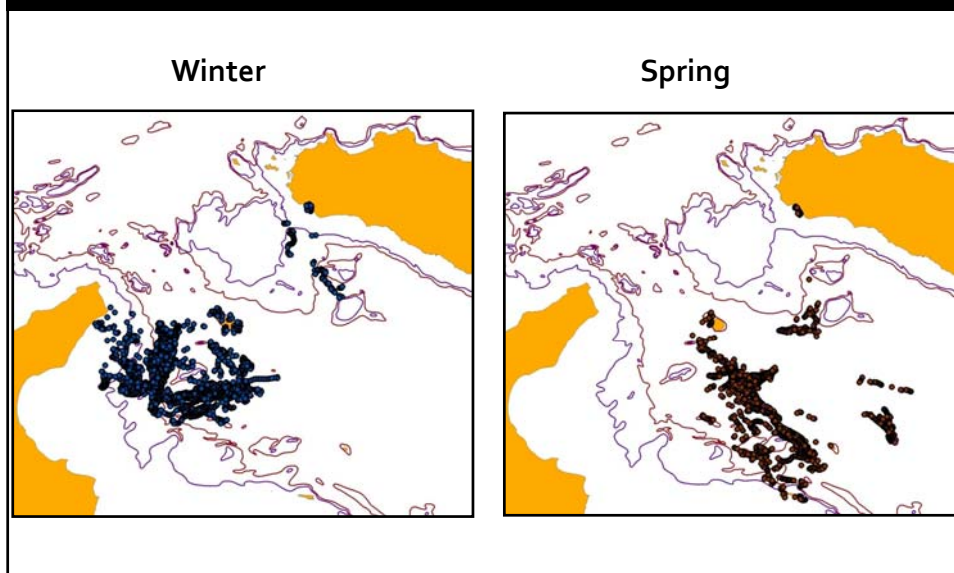
In summary: from points to tracks



From points to pattern

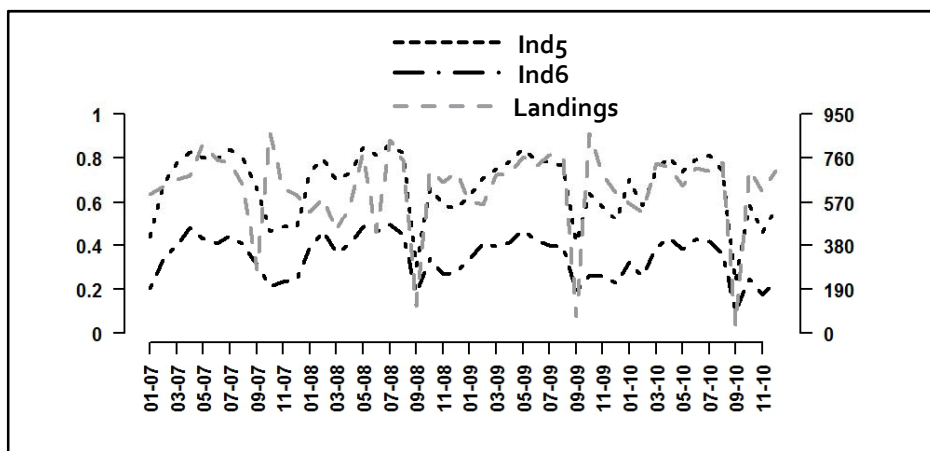


Possible analysis: seasonal patterns



Pressure indicators: temporal trends

Long-term monitoring of fishing activity (exploited area)

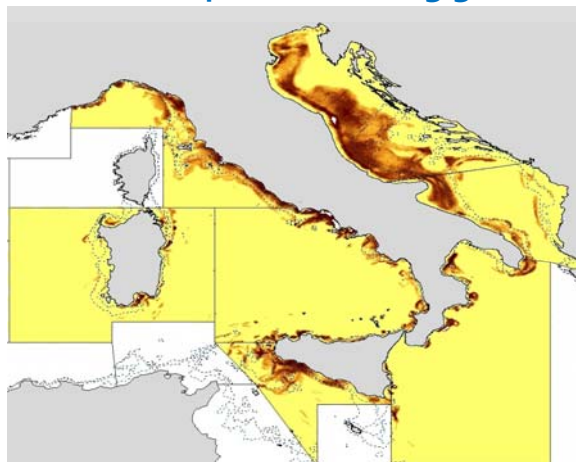


Fishing grounds

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



Thank you for the attention

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