

*Studio e valutazione degli elasmobranchi delle acque italiane: sfruttamento e conservazione*  
*Università degli studi di Padova, Società Italiana di Biologia Marina (SIBM)*  
Palazzo Grassi, Chioggia, 10-11 Maggio 2016

*Stato di conservazione e di sfruttamento degli elasmobranchi, loro gestione*

Organizzatori: Carlotta Mazzoldi (Università di Padova), Fabrizio Serena (Arpat)

## Sharks bycatch and mitigation measures

- *Selective characteristics of a shark-excluding grid devices in Mediterranean trawls -*

Antonello Sala

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### Bycatch

Anything that a fisherman does not mean to catch

- fish turtles pieces of coral sponges other animals  
and non-living material –

### Response

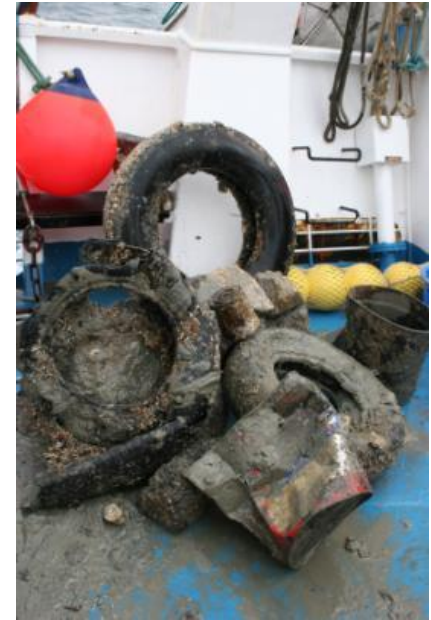
Trawl modifications bycatch reduction devices (BRD)



### Successful involvement of fishermen

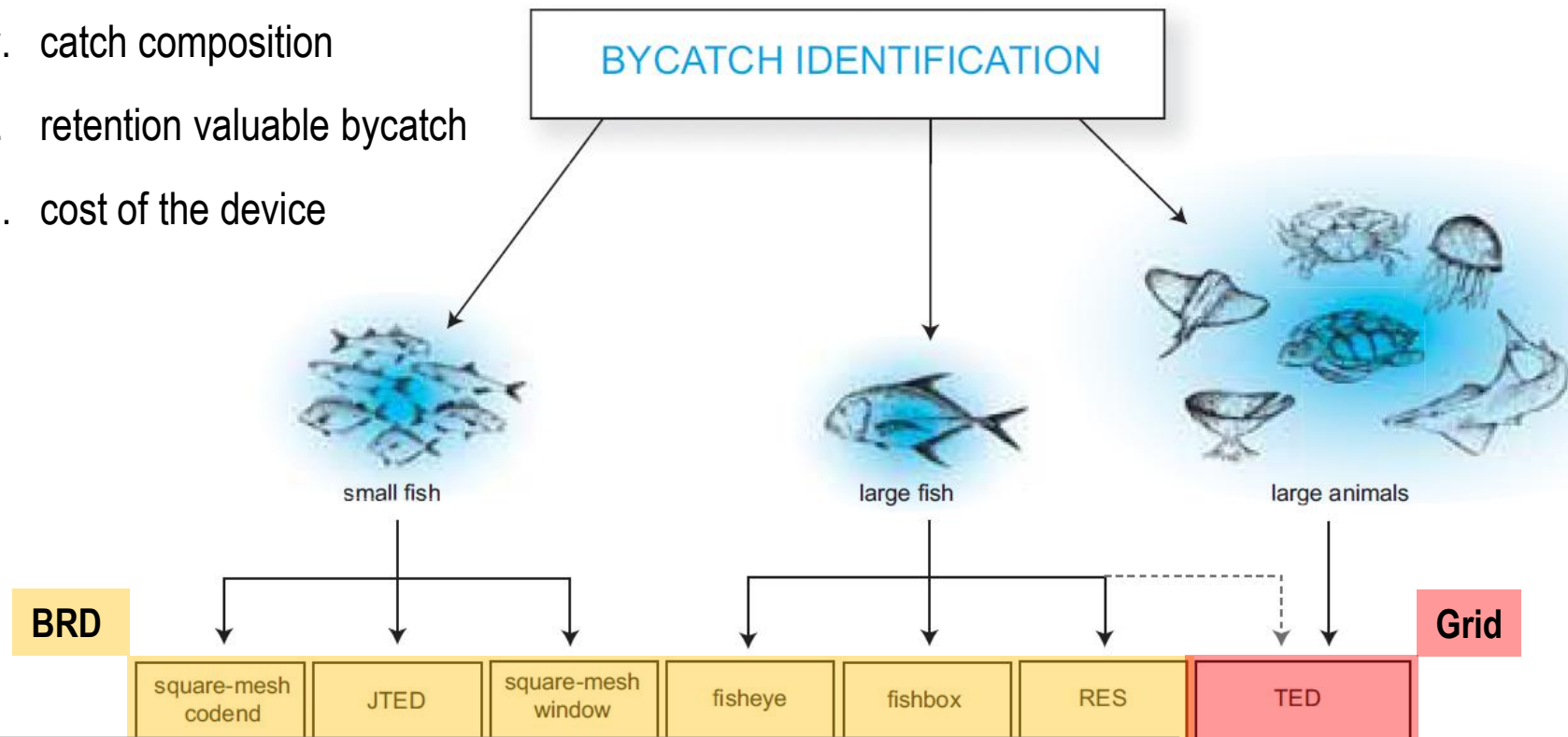
A **key to the successful involvement of fishermen** is to explore how they may benefit from reducing bycatch.

- i. Improved trawling and processing efficiency
- ii. Better product quality and marketing opportunities
- iii. Protecting the marine environment and extending the life of the fishery



### What type of bycatch is going to be excluded?

- i. the need to protect endangered or threatened species
- ii. the size and behaviour of fish
- iii. the size and behaviour of bycatch
- iv. catch composition
- v. retention valuable bycatch
- vi. cost of the device



### Two BRD categories based on excluding bycatch method

#### **BRDs that separate the catch by size**

- ✓ grid-style JTED
- ✓ square-mesh codend

#### **Exploitation of fish/bycatch behavioural differences**

- ✓ fisheye
- ✓ square-mesh window
- ✓ RES (*radial escape section*)



### Two BRD categories based on excluding bycatch method

#### BRDs that separate the catch by size

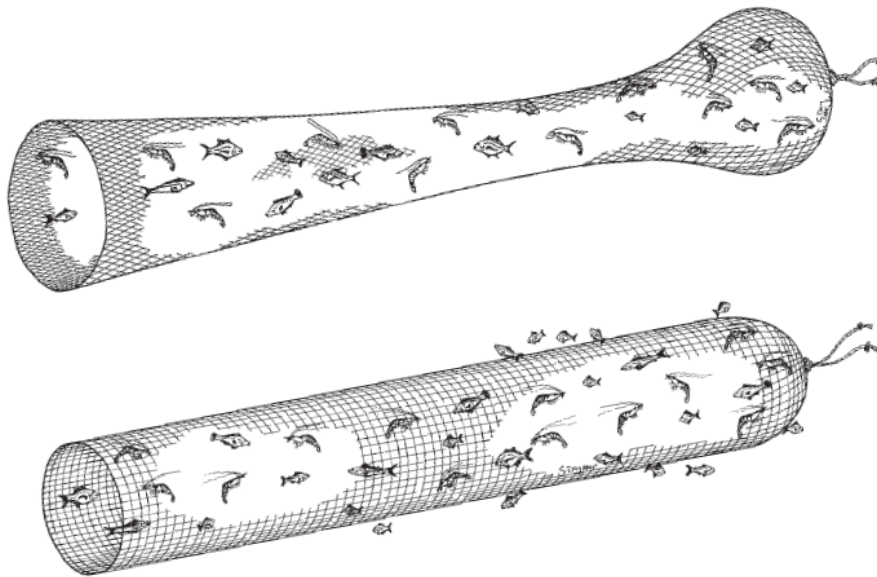
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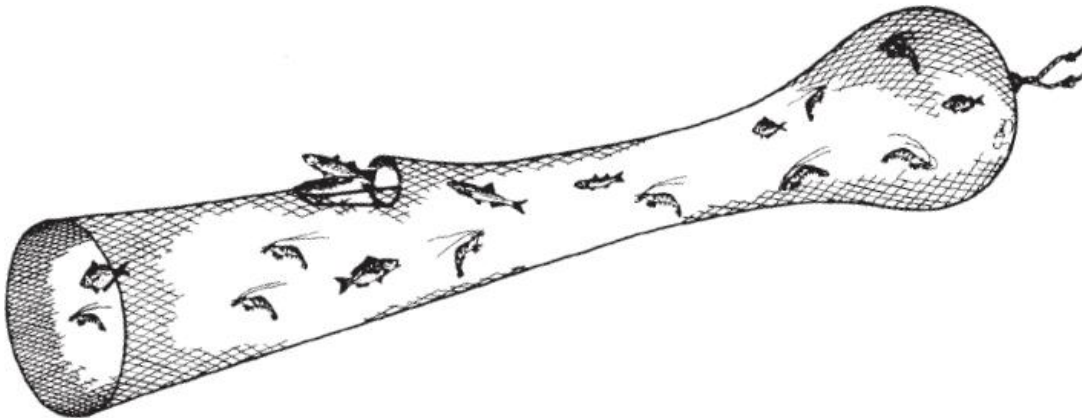
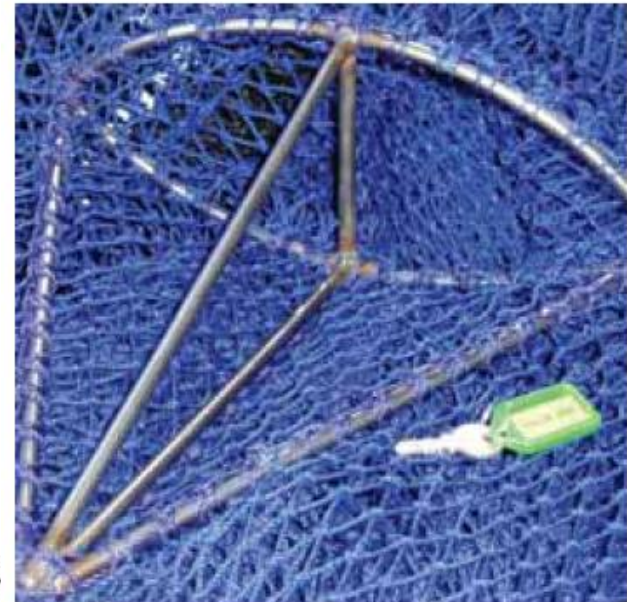
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- ✓ *square-mesh codend*

#### **Exploitation of fish/bycatch behavioural differences**

- ✓ *fisheye*
- ✓ *square-mesh window*
- ✓ *RES (radial escape section)*

*The fisheye is designed to allow strong swimming fish to escape from the trawl.*

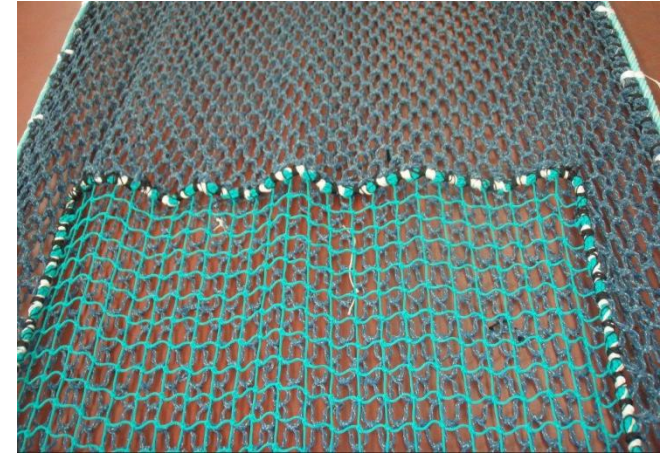




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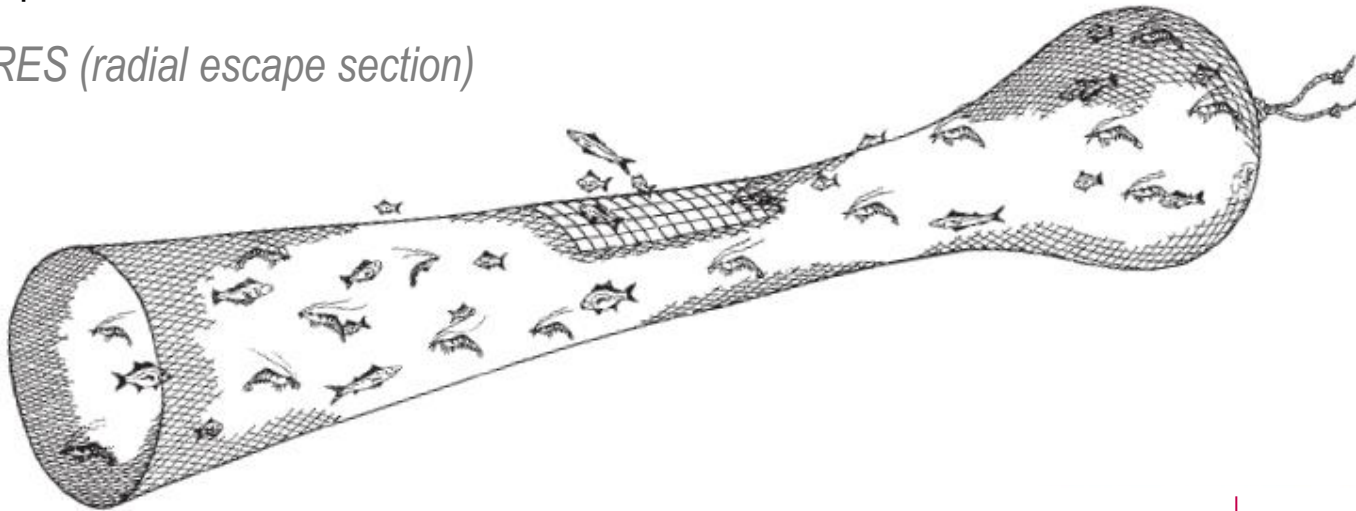
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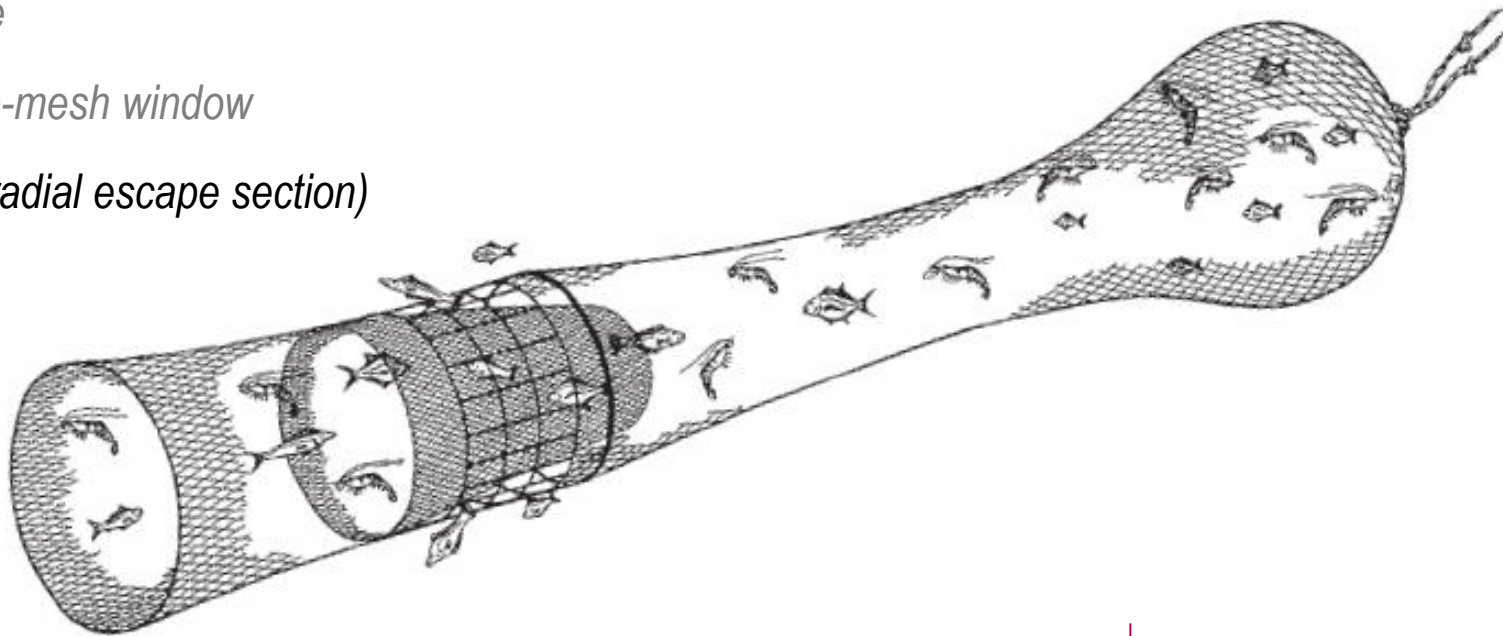
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- ✓ *square-mesh codend*

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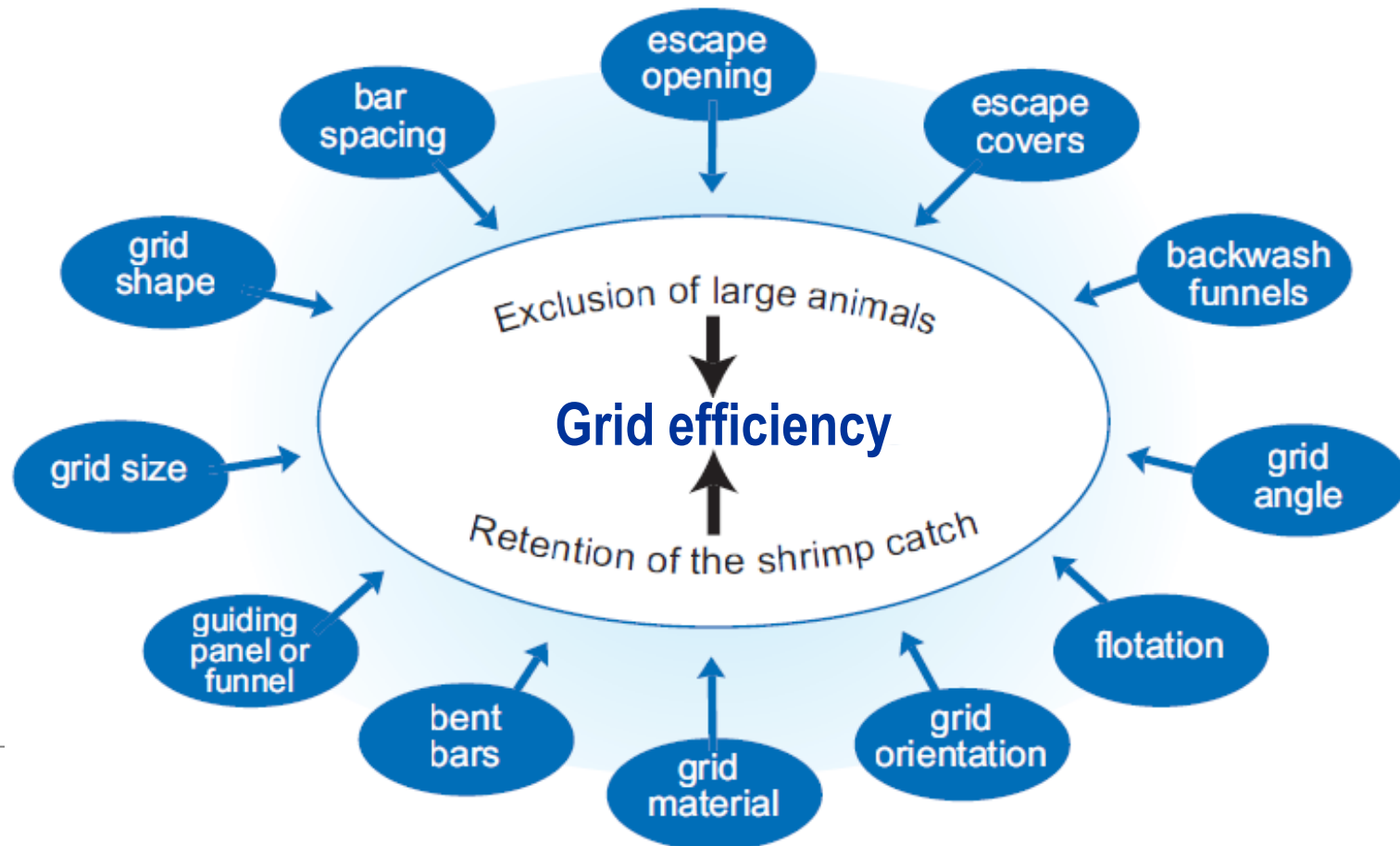
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- ✓ *square-mesh window*
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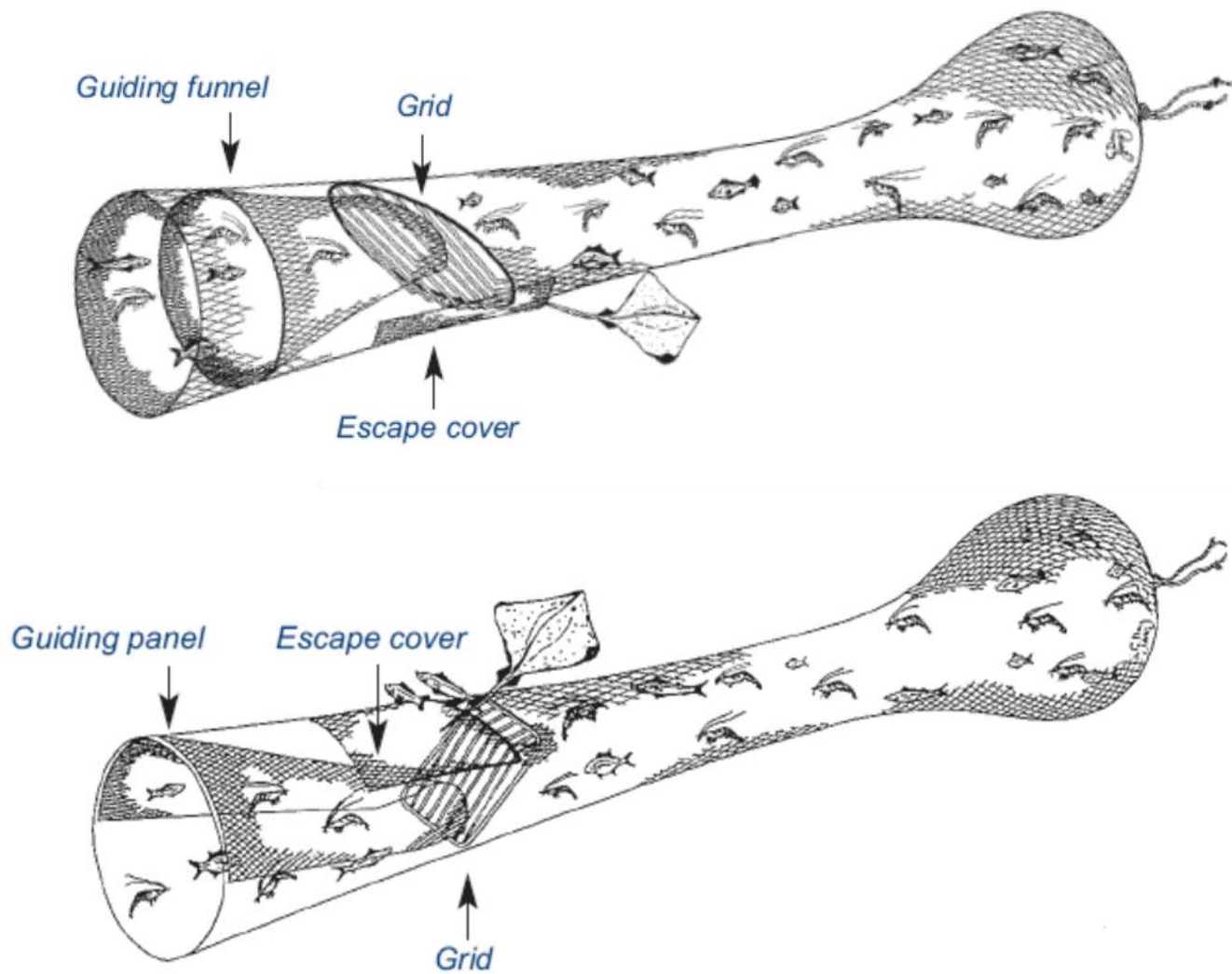


### Optimizing Grid Performance

A well-designed Grid should ensure that **large animals** and **objects** are rapidly excluded from the trawl and **fish loss** is minimal or nonexistent

This is influenced by the **design**, **construction** and **rigging** of the various TED components







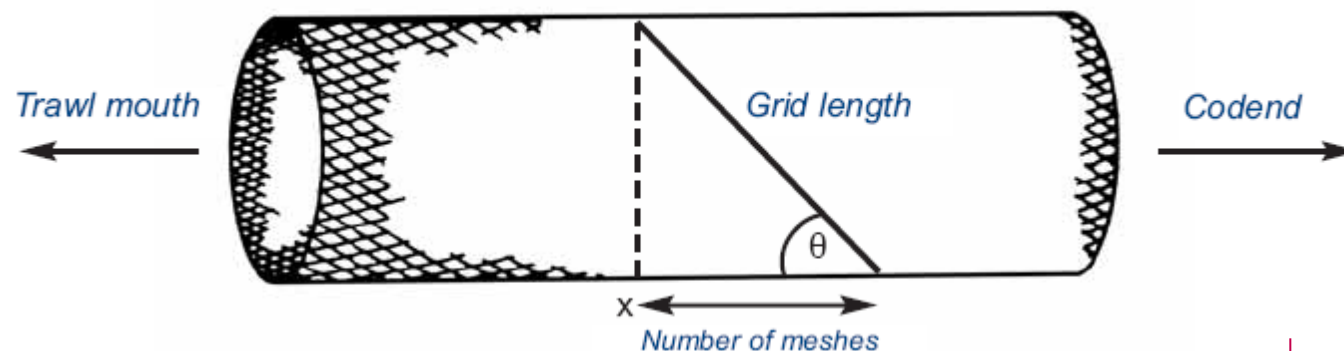
### How do I install a grid at the correct angle?

$$\text{No. of meshes} = \frac{\text{Grid length} \times \cos \text{angle } (\theta) \times 0.6}{\text{Mesh size}}$$

For example, if a grid measuring 100 cm was to be inserted at 55° into a codend with a mesh size of 35mm the number of meshes required would be:

$$\begin{aligned}\text{No. of meshes} &= \frac{100 \text{ cm} \times \cos 55 \times 0.6}{3.5 \text{ cm}} \\ &= \frac{100 \text{ cm} \times 0.573 \times 0.6}{3.5 \text{ cm}} \\ &= 10 \text{ meshes}\end{aligned}$$

*A protractor is a simple method of measuring grid angle during construction of the TED. It should also be frequently used at sea to check that grid angle has not changed.*



## Definitions and methods

### Selection of fish by a fishing gear

Process which causes the catch of the gear to have a **different composition** to that of the fish population in the geographical area in which the gear is being used

### Selectivity of a fishing gear

**Measurement of the selection process.** Relative likelihoods that different sizes and species of fish would have of being caught by the gear if there were equal numbers of each in the population

### Methods for measuring selectivity

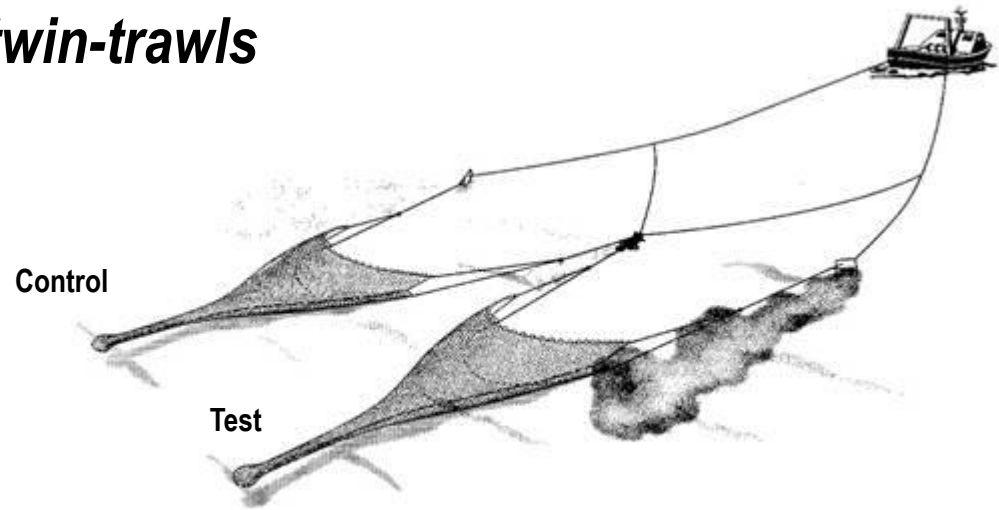
- Covered codend method (*codend selectivity*)
- Paired-gear method (*whole trawl selectivity*)

Republic of Venice (Doge period 17th century): wallboard in the fish market with the minimum commercial sizes of fish

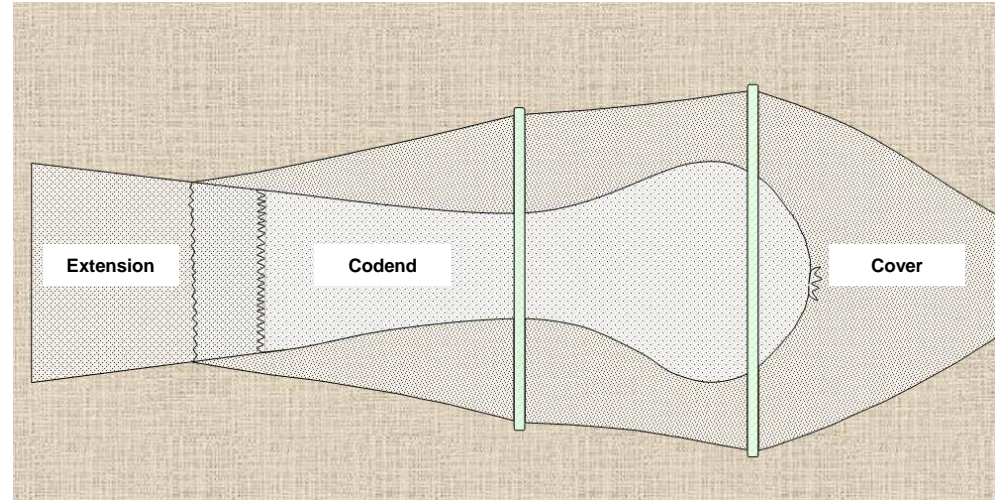


LUNGHEZZE MINIME PERMESSE PER LA VENDITA DEL PESCE DELLE SEGUENTI QUALITÀ		CENT.
BARBON. TRIA. SARDELLA. SARDON		7
BRANZIN. ORADA. DENTAL. CORBO	}	12
SPARO. BOTOLO. BOSEGNET. SOASO		
LOTREGAN. MECIATO. VERZELATA		
LOVO. SFOGIO. PASSARIN. ROMBO		
BISATO.		25
OSTREGA.		5
PECCIO.		3

### *Paired-gear method: twin-trawls*



### *Covered codend method*





### Covered codend method



ICES gauge

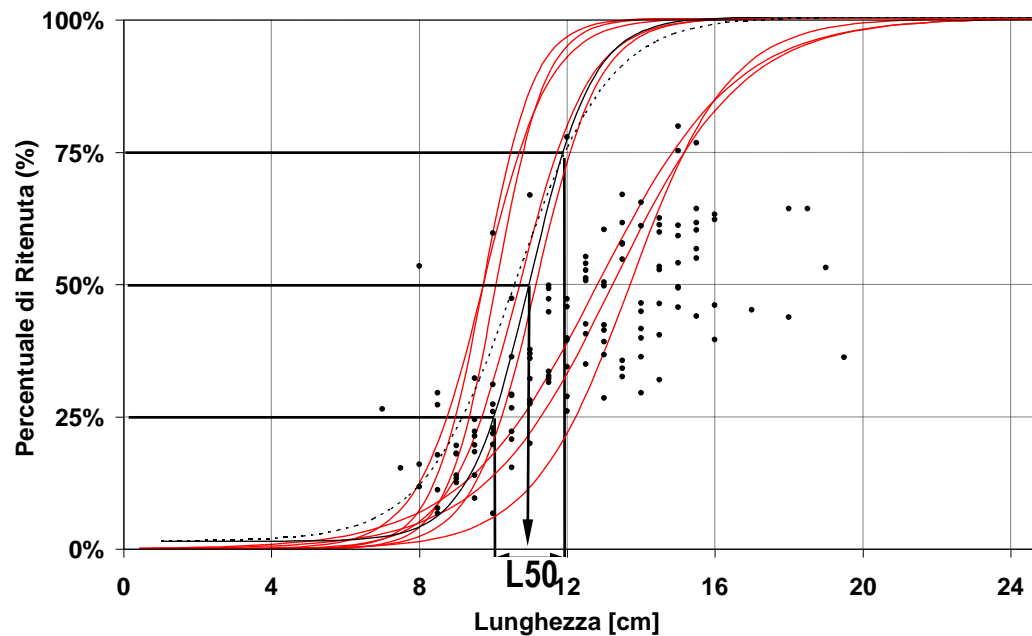


Omega gauge



### Statistical analysis

$$r(l) = \frac{e^{v_1 + v_2 l}}{1 + e^{v_1 + v_2 l}} \quad r(l): \text{probability that a fish of length } l \text{ is retained given that it entered the codend}$$



***L50***: the length at 50 % retention

***SR***: selection range:  $SR = L_{75\%} - L_{25\%}$



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Fisheries Research 83 (2007) 192–203



[www.elsevier.com/locate/fishres](http://www.elsevier.com/locate/fishres)

## The influence of twine thickness on the size selectivity of polyamide codends in a Mediterranean bottom trawl

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Received 22 March 2006; received in revised form

Fisheries Research 93 (2008) 8–21



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Fisheries Research

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## Size selection by diamond- and square-mesh codends in multi-species Mediterranean demersal trawl fisheries

Antonello Sala<sup>a,\*</sup>, Alessandro Lucchetti<sup>a</sup>, Corrado Piccinetti<sup>b</sup>, Mario Ferretti<sup>c</sup>

Fisheries Research 103 (2010) 63–72

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## The effect of mesh configuration and codend circumference on selectivity in the Mediterranean trawl *Nephrops* fishery

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Sede di Ancona, National Research Council (CNR) – Institute of Marine Sciences (ISMAR), Fisheries Section, Largo Fiera della Pesca, 60125 Ancona, Italy





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## Is square-mesh better selective than larger mesh? A perspective on the management for Mediterranean trawl fisheries



Antonello Sala<sup>a,\*</sup>, Alessandro Lucchetti<sup>a</sup>, Anna Perdichizzi<sup>b</sup>,  
Bent Herrmann<sup>c</sup>, Paola Rinelli<sup>b</sup>

Fisheries Research 110 (2011) 252–258

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## Effect of mesh size and codend circumference on selectivity in the Mediterranean demersal trawl fisheries

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Consiglio Nazionale delle Ricerche (CNR), Istituto di Scienze Marine (ISMAR), Sede di Ancona. National Research Council (CNR), Institute of Marine Sciences (ISMAR), Fisheries Section, Largo Fiera della Pesca, 60125 Ancona, Italy

## Experimental method for quantifying resistance to the opening of netting panels

A. Sala, F. G. O'Neill, G. Buglioni, A. Lucchetti, V. Palumbo, and R. J. Fryer

Sala, A., O'Neill, F. G., Buglioni, G., Lucchetti, A., Palumbo, V., and Fryer, R. J. 2007. Experimental method for quantifying resistance to the opening of netting panels. – ICES Journal of Marine Science, 64: 1573–1578.



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## The influence of twine tenacity, thickness and bending stiffness on codend selectivity



F.G. O'Neill<sup>a,\*</sup>, R.J. Kynoch<sup>a</sup>, L. Blackadder<sup>a</sup>, R.J. Fryer<sup>a</sup>, A.R. Eryaşar<sup>b</sup>, E. Notti<sup>c</sup>, A. Sala<sup>c</sup>

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Aquat. Living Resour. 19, 317–327 (2006)

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DOI: 10.1051/alr:2007002

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Aquatic  
Living  
Resources

## Experimental and theoretical study of red mullet (*Mullus barbatus*) selectivity in codends of Mediterranean bottom trawls

Antonello Sala<sup>1,a</sup>, Daniel Priour<sup>2</sup> and Bent Herrmann<sup>3</sup>

## Experimental design

*Galeus melastomus* (blackmouth catshark) is often caught as bycatch in demersal trawls in the Mediterranean

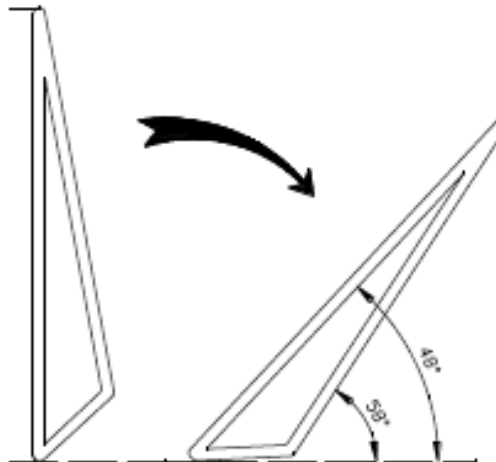
To reduce bycatches of shark we tested an excluder grid with 90 mm bar spacing in the Tyrrhenian Sea



- ✓ We used a **structural model** to estimate the contribution of the individual selective processes consisting of the excluder grid and the size selective codend
- ✓ Based on the results obtained from the experimental data, we were able to **predict the effect of changing grid bar spacing** on the selectivity

# Selective characteristics of a shark-excluding grid device in a Mediterranean trawl

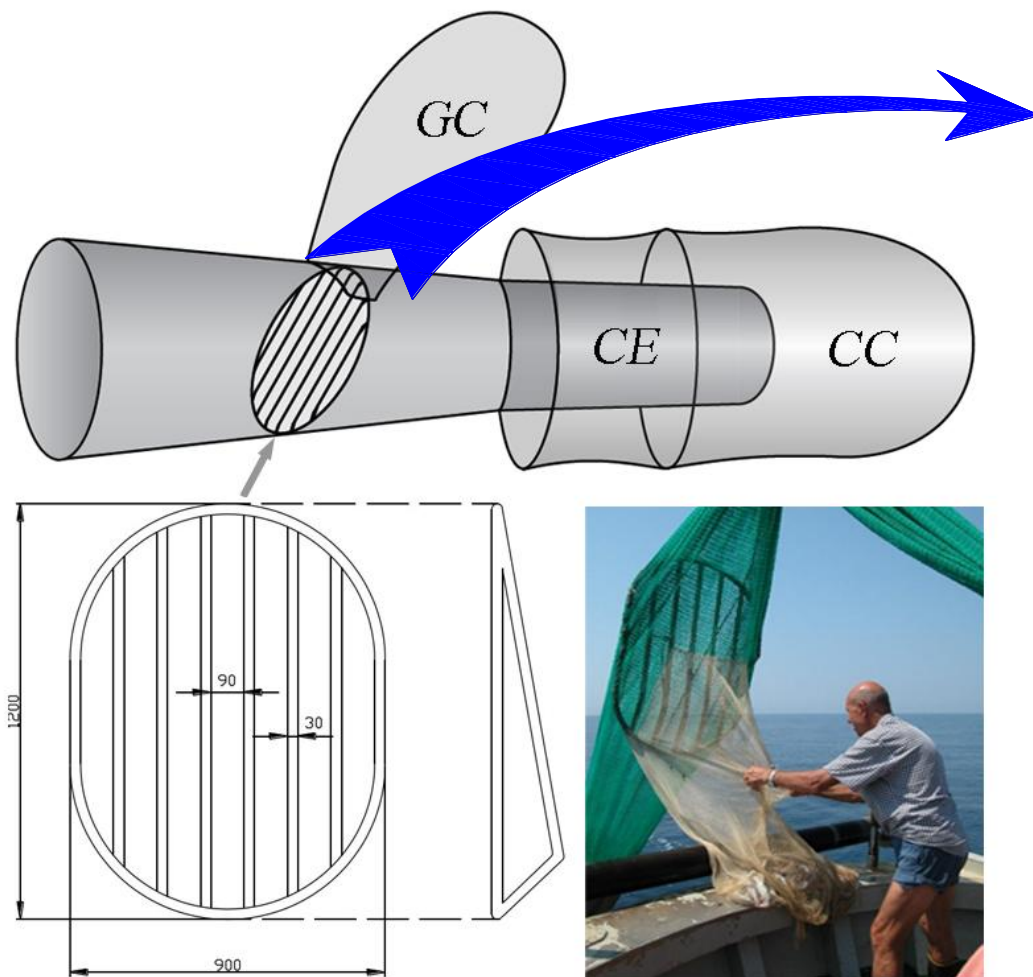
## Grid model: *Supershooter*





# Selective characteristics of a shark-excluding grid device in a Mediterranean trawl

## Conceptual drawing of a grid based dual selection system used in this study



### Selectivity analysis

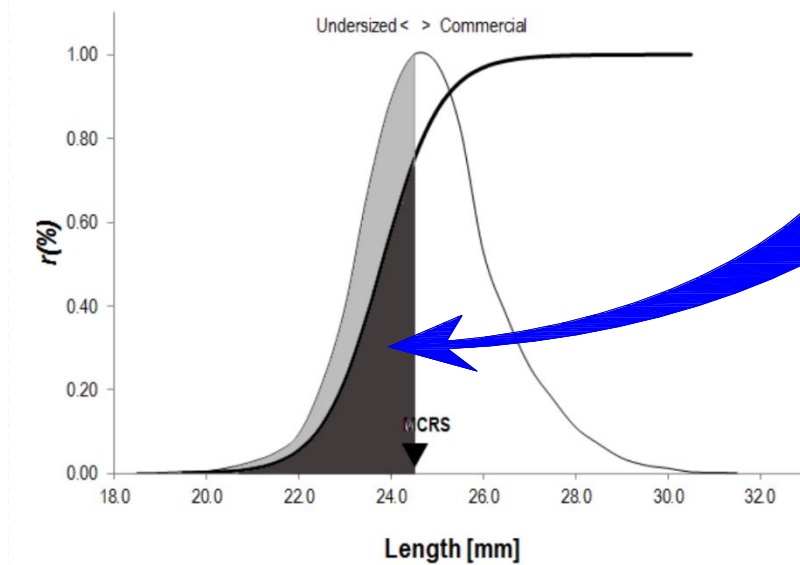
Size selection system: 90 mm grid and 50 mm diamond mesh codend

Grid bar spacing and codend mesh size can affect the overall selectivity

The first selection process starts when a fish encounters the grid zone. In order to pass through the grid, three conditions have to be fulfilled:

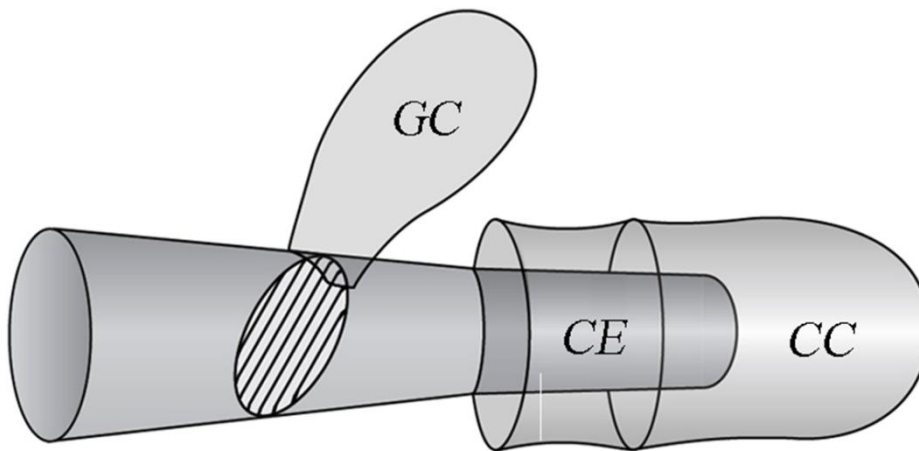
- 1) the fish must come into **contact** with the grid
- 2) it must be **morphologically** able to pass through the space between grid bars
- 3) it has to be properly **oriented** when it contacts the grid

## Statistical selectivity indicators



Percentage of retained individuals below ( $nP-$ ) and above ( $nP+$ ) Minimum Conservation Reference Size (MCRS)

Percentage of total individuals retained by the gear ( $nP_{Total}$ )



$$nP- = 100 \times \frac{\sum_j \left\{ \sum_{l < MLS} \frac{nCE_{jl}}{qCE_j} \right\}}{\sum_j \left\{ \sum_{l < MLS} \left\{ \frac{nCE_{jl}}{qCE_j} + \frac{nCC_{jl}}{qCC_j} + \frac{nGC_{jl}}{qGC_j} \right\} \right\}}$$

$$nP+ = 100 \times \frac{\sum_j \left\{ \sum_{l > MLS} \frac{nCE_{jl}}{qCE_j} \right\}}{\sum_j \left\{ \sum_{l > MLS} \left\{ \frac{nCE_{jl}}{qCE_j} + \frac{nCC_{jl}}{qCC_j} + \frac{nGC_{jl}}{qGC_j} \right\} \right\}}$$

$$nP_{Total} = 100 \times \frac{\sum_j \left\{ \sum \frac{nCE_{jl}}{qCE_j} \right\}}{\sum_j \left\{ \sum \left\{ \frac{nCE_{jl}}{qCE_j} + \frac{nCC_{jl}}{qCC_j} + \frac{nGC_{jl}}{qGC_j} \right\} \right\}}$$

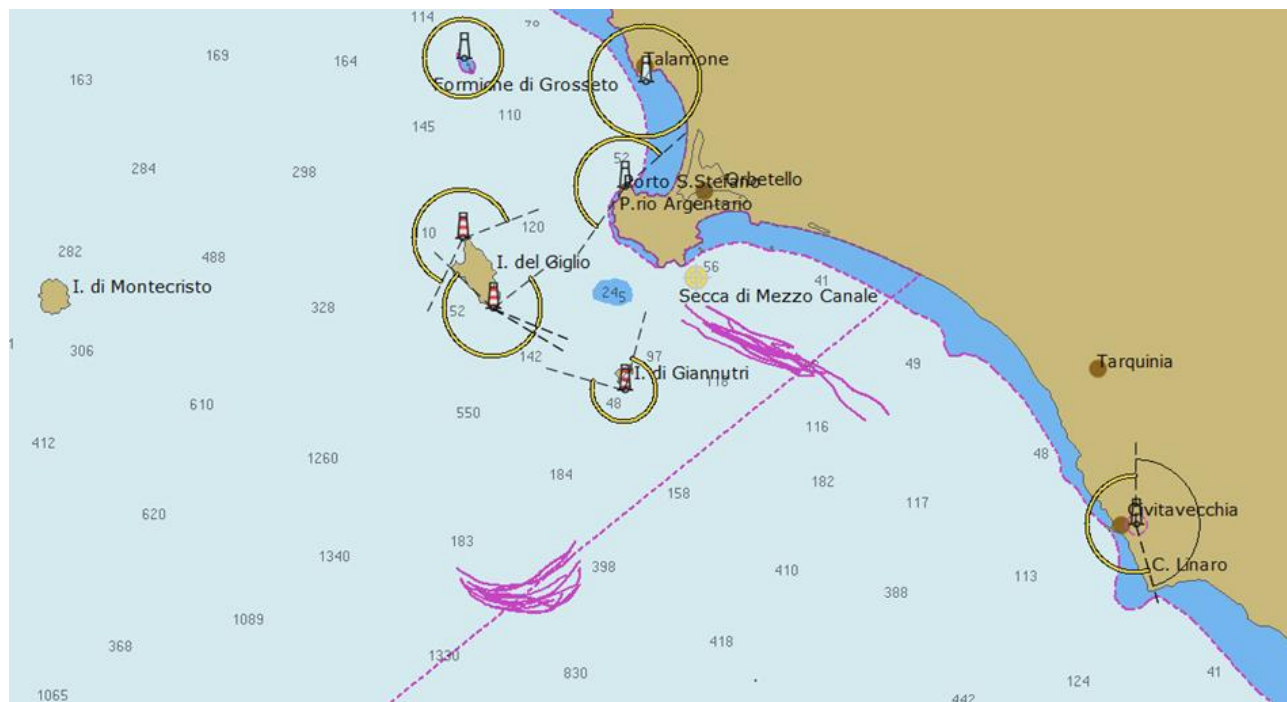
# Selective characteristics of a shark-excluding grid device in a Mediterranean trawl

## Results

Average water depth:  $421 \pm 21.1$  m

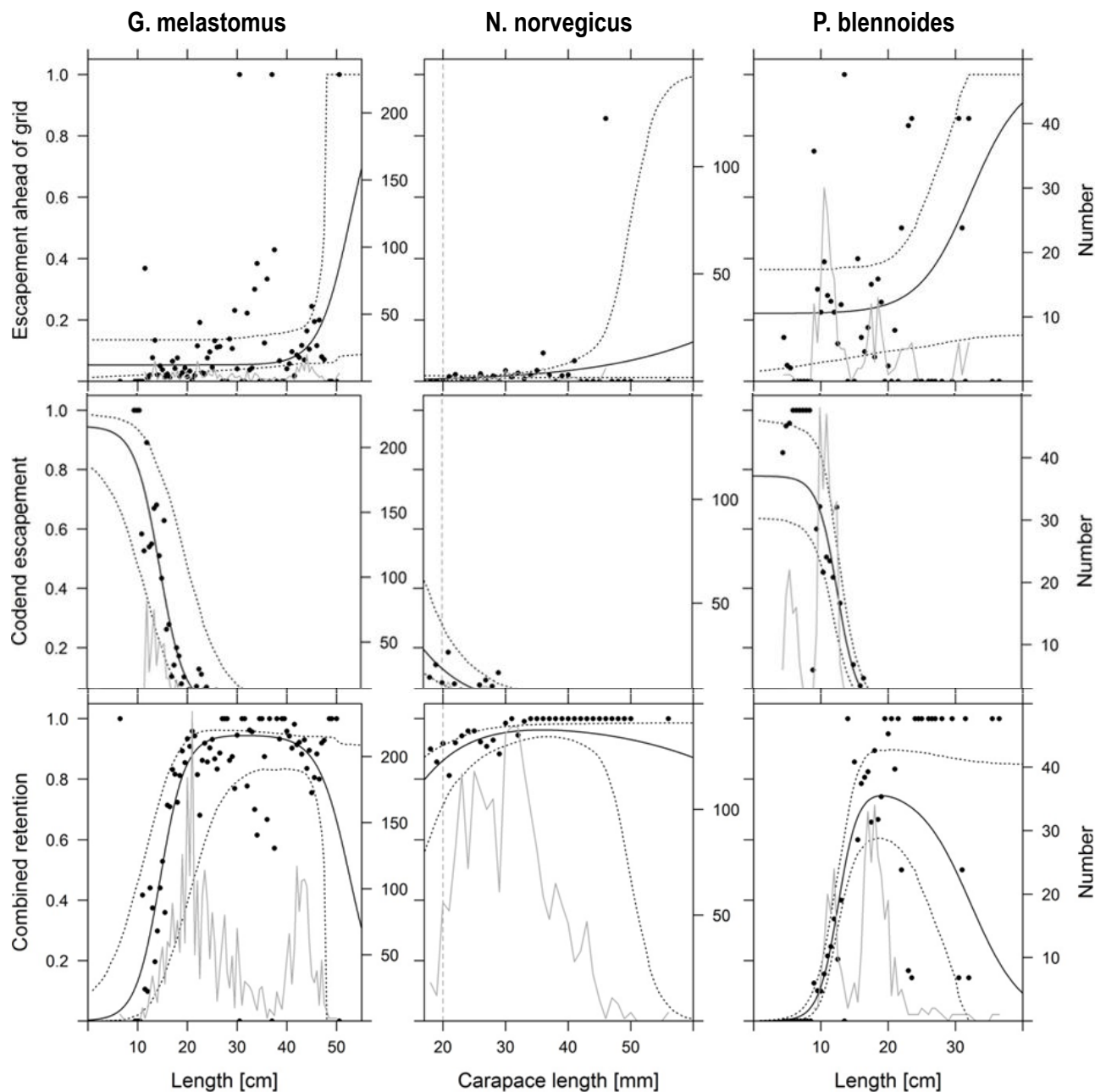
Towing speed:  $4.1 \pm 0.1$  knots

Tow duration:  $92.5 \pm 31$  minutes



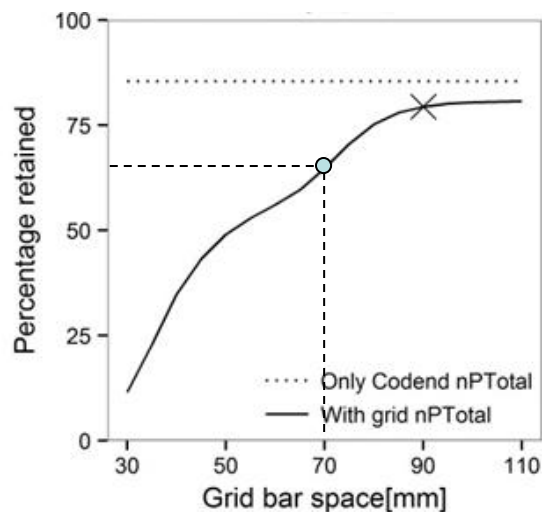
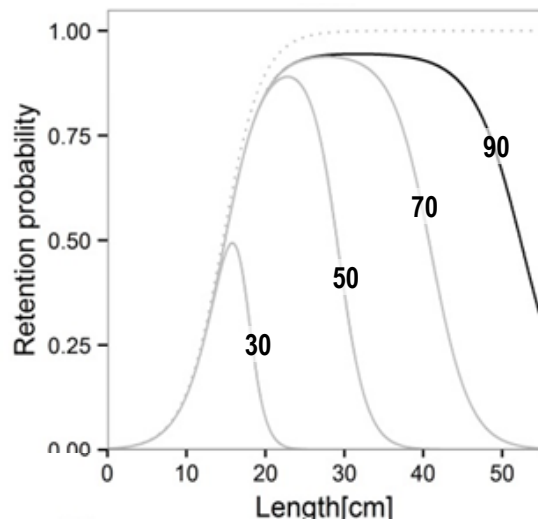


# Probability of escaping ahead of the grid, from the codend, and being retained in the codend

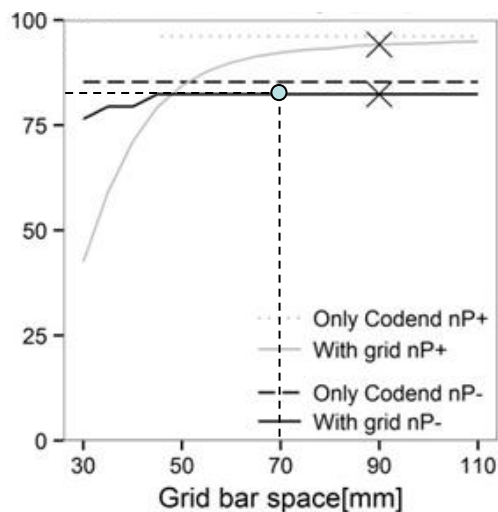
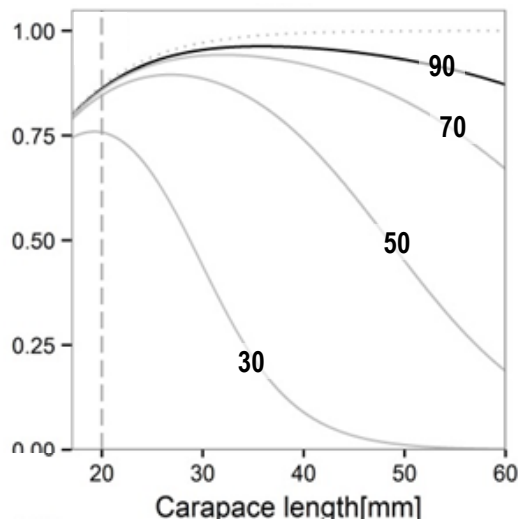


# Simulated retention curves for combined systems with grids 30, 50, 70 mm

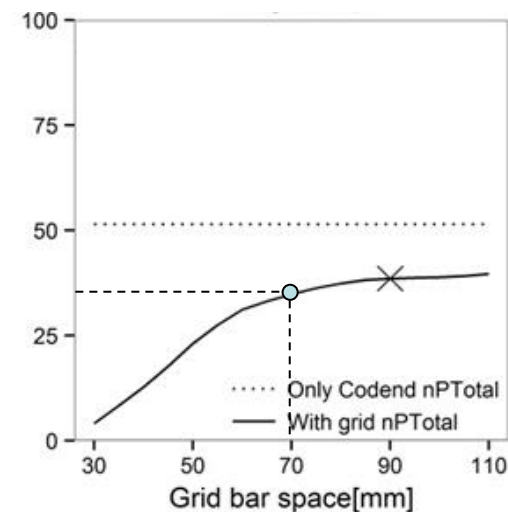
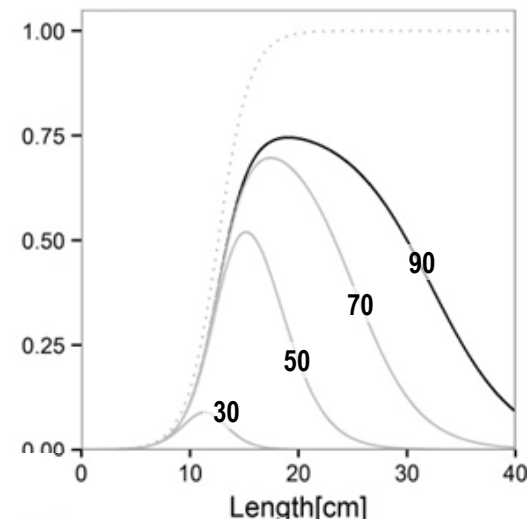
**G. melastomus**



**N. norvegicus**



**P. blennoides**



### Conclusions

- ✓ Grid did have an effect on *G. melastomus* catches: bigger individuals escaped ahead of the grid, but the chosen grid bar spacing (90 mm) may not be completely adequate for this species
- ✓ The majority of sharks that entered the gear were small enough to pass between the grid bars
- ✓ A large proportion of *P. blennoides* individuals was excluded by the grid
- ✓ Only small percentage of individuals of *N. norvegicus* above MLS were excluded by the grid
- ✓ **Reducing the grid bar spacing to 70-mm could provide a good trade-off between the reduction of *G. melastomus* catches while keeping a high catch rate of *P. blennoides* and *N. norvegicus***

### Discussion

Regulation (EC) No. 1380/2013 introduced an obligation for all Mediterranean EU countries to land all catches of species which are subjected to MCRS

Improvements of selective fishing techniques to avoid and reduce unwanted catches are highly encouraged

Due to the multispecies character of Mediterranean trawl catches, it is clear that no unique bycatch reduction solution can adequately improve selectivity of all species

Further studies on the effect of the **grid angle**, the presence and absence of the **funnel** in front of the grid, **underwater observation** on species behavior inside the net and its application in different areas should be tested in in order to draw final conclusion on the use of this type of grid in sustainable management of Mediterranean bottom trawl fisheries





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Interreg research project MARTE+, J. Brcic, B. Herrmann, F. De Carlo, P. Pelusi,  
S. Gambaccini, C. Musumeci, I. Rossetti, M. Sartini, A. Vannucci

*Grazie per l'attenzione*