

# Bycatch reduction in towed fishing gears



# Flow



Definitions



Decision Tree



Examples



Literature



Conclusion



Catch

Target

Non-target Species

Bycatch

Commercial Species

Incidental Catch

Endangered

Vulnerable

Rare Species

Accidental Catch

By-product

Bycatch Reduction Devices

Grid

TED

FED

DEFINITIONS

JTED

FLEX

No-drift more Grid

Super

sloop

Tunnel

Escape Opening

Fisheyes

Escape Window

Ground Gear

Drop Chain

Raised Foot rope

Lead Line

Selectivity

Diminish

Exclude

Minimize

Mitigate

Reduce

Separate

Sieve

Sort

# Definitions

**Catch:** all living biological material retained or captured by the fishing gear, including corals, jellyfish, tunicates, sponges and other non-commercial organisms, whether brought on board the vessel or not. (Kelleher, 2005).

**Bycatch:** The part of the *catch* that is unintentionally captured during a fishing operation in addition to the *target species*. It may refer to the catch of other commercial species that are landed, commercial species that cannot be landed (e.g. undersized, damaged individuals), non-commercial species, as well as to the incidental catch of endangered, vulnerable or rare species (e.g. sea turtles, sharks, marine mammals) (Sacchi, 2021).

**Bycatch Reduction Devices (BRD)** are devices inserted in a trawl, close to the cod-end, to allow escapement of juveniles and unwanted species (including medusae) or individuals (juveniles) or endangered species (e.g. seals, turtles, dolphins) (FAO, 2021).



# Definitions

Selectivity is understood here as the capacity of any method or gear type to capture certain fractions or sections of the fish population whether grouped by species, age, size or behaviour, and to exclude others (FAO, 1984).

Target species those species that are primarily sought in a particular fishery and are the subject of directed fishing effort in a fishery. Target species may also be discarded due to landing size limits, over-quota, low quality as a result of depredation, scavenging or spoilage, or safety issues (Perez et al., 2019).

Non-target species species for which the gear and fishing effort is not specifically intended to catch, although they may have immediate commercial value and be a desirable component of the catch, but in many cases, they are discarded (Perez et al., 2019).

Mitigation measures the modification to fishing practices and/or equipment that reduces the likelihood of incidental non-fish catch (Brothers et al. 1999).

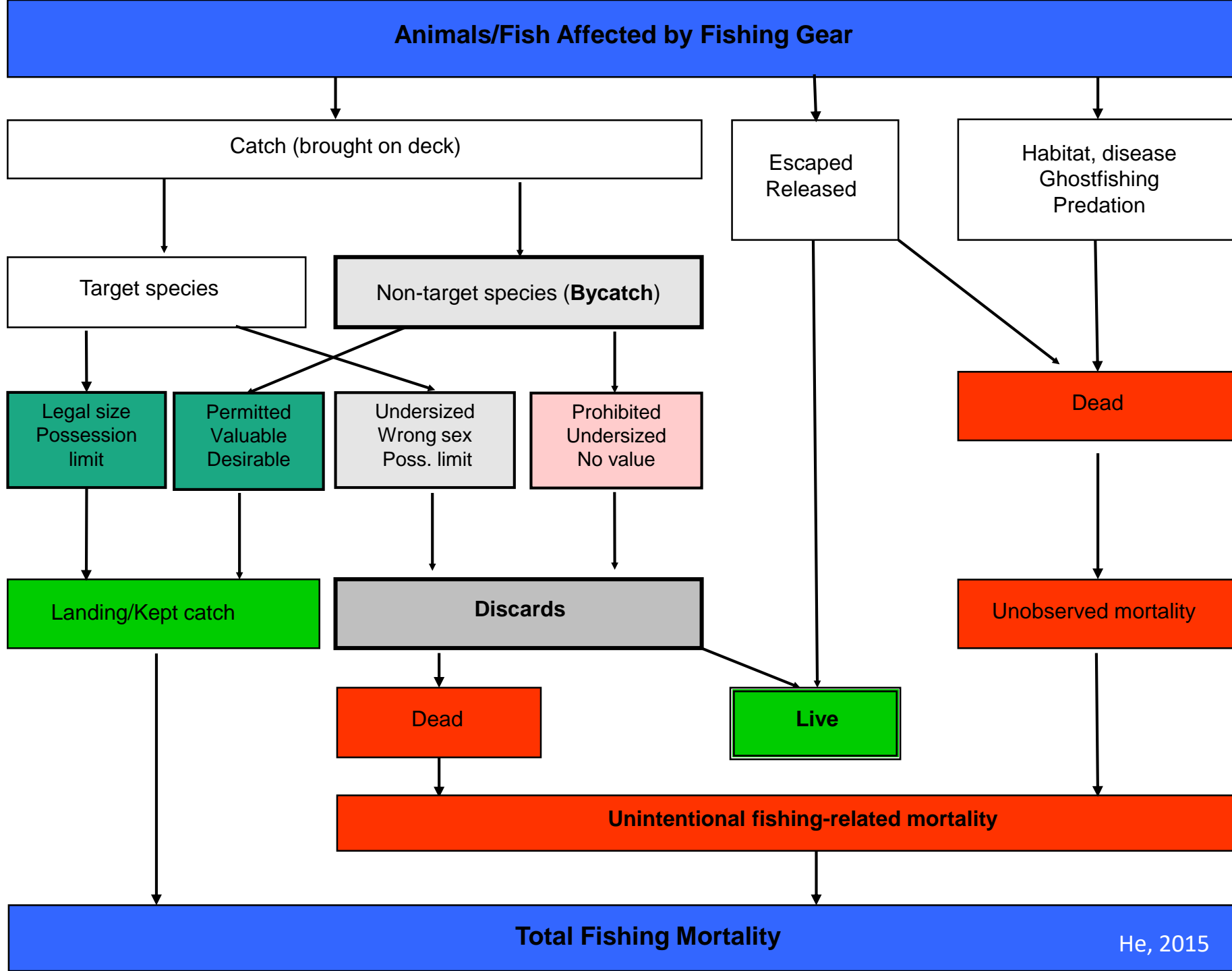
Turtle excluder device (TED) A grid of bars with an opening either at the top or the bottom of the trawl net. The grid is fitted into the neck of a shrimp trawl. Small animals such as shrimps pass through the bars and are caught in the bag end of the trawl. When larger animals, such as sea turtles and sharks, are captured in the trawl, they strike the grid bars and can leave through the opening (Sacchi, 2021).

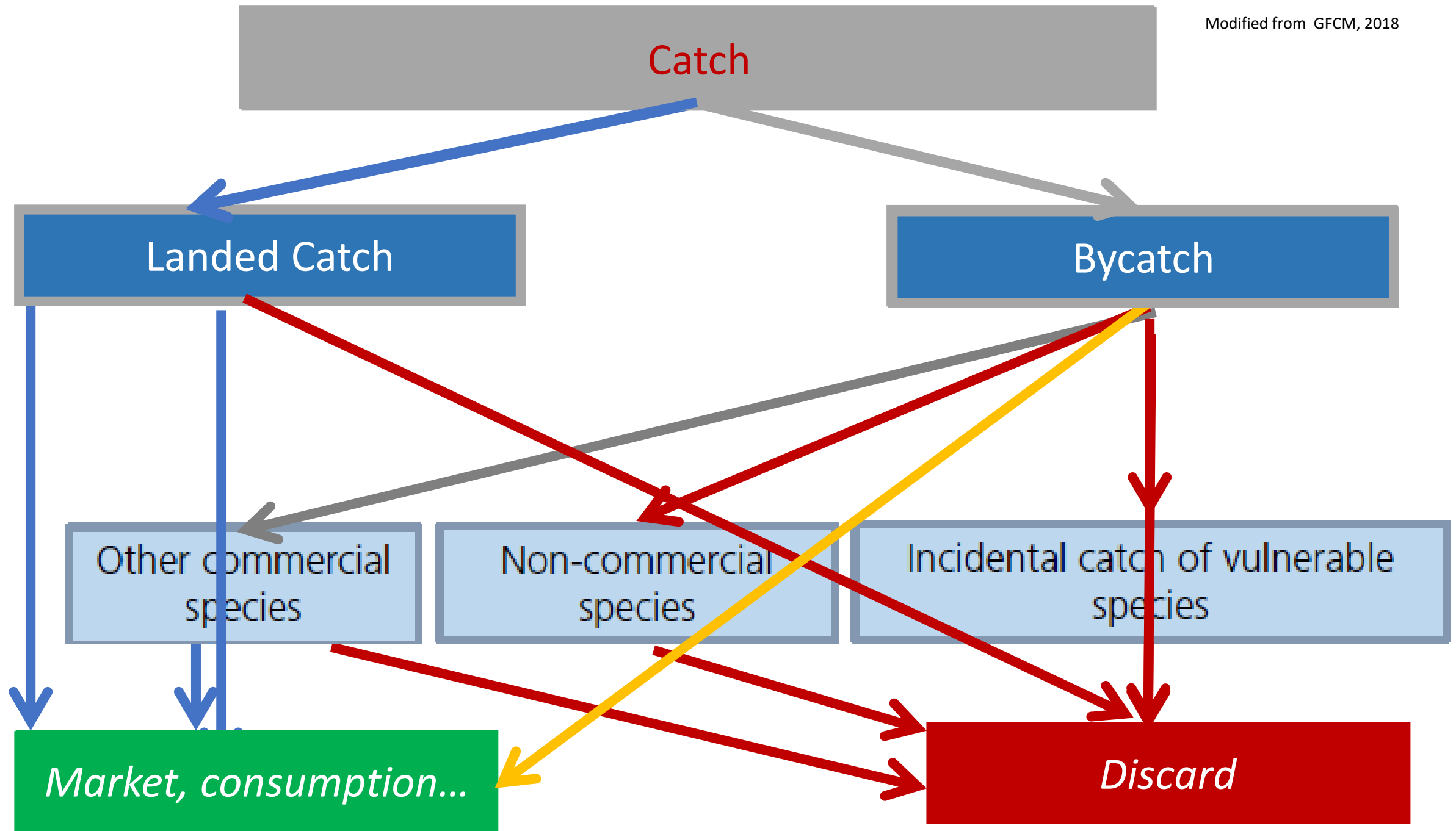
FAO, 1984 Papers presented at the Expert Consultation on the regulation of fishing effort (fishing mortality). Rome, 17–26 January 1983. A preparatory meeting for the FAO World Conference on fisheries management and development. [FAO Fish.Rep.](#), (289) Suppl.2: 214 p.

Pérez Roda, M.A. (ed.), Gilman, E., Huntington, T., Kennelly, S.J., Suuronen, P., Chaloupka, M. and Medley, P. 2019. A third assessment of global marine fisheries discards. FAO Fisheries and Aquaculture Technical Paper No. 633. Rome, FAO. 78 pp. Licence: CC BY-NC-SA 3.0 IGO.

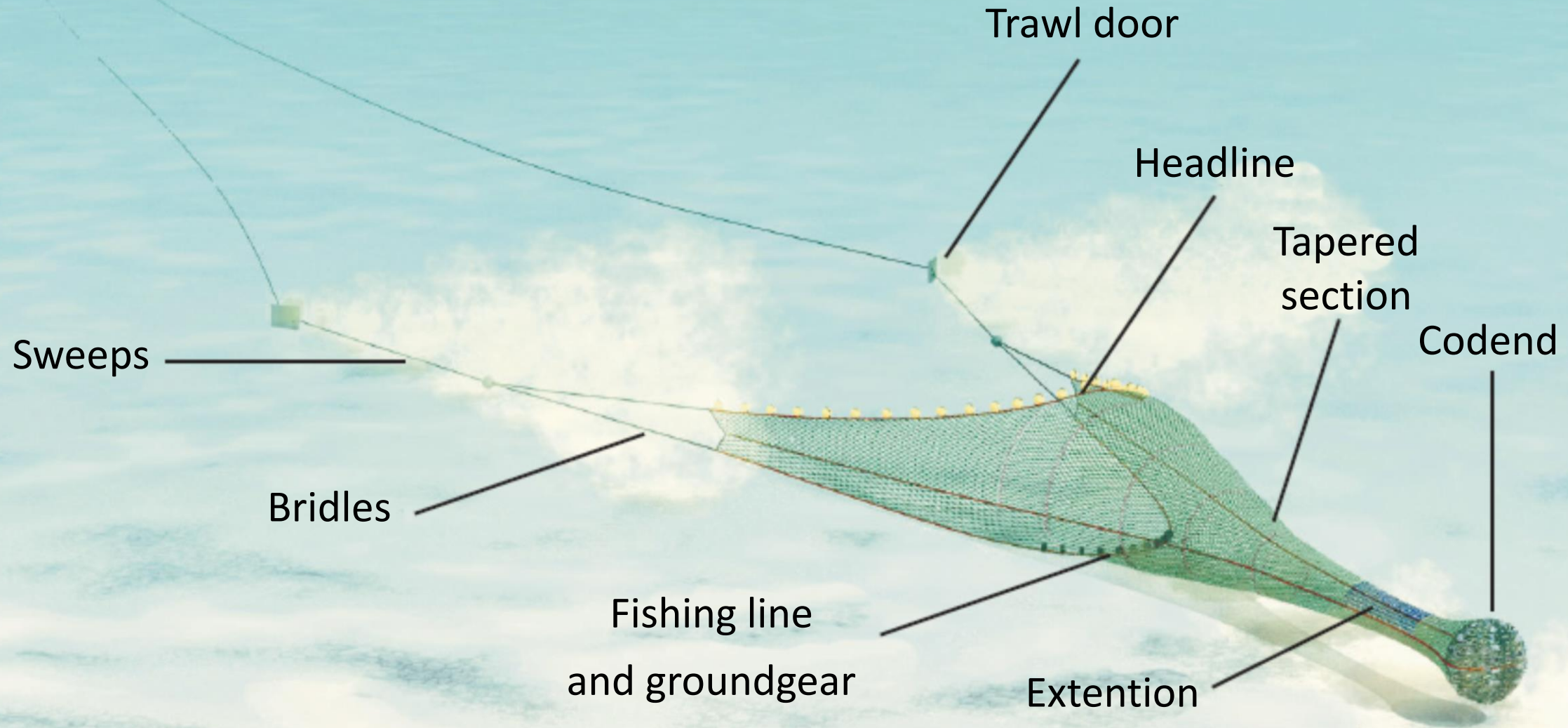
Brothers, N.P.; Cooper, J.; Løkkeborg, S. 1999: The incidental catch of seabirds by longline fisheries: worldwide review and technical guidelines for mitigation. Rome, Food and Agriculture Organisation of the United Nations. 101p.

Sacchi, J. 2021. *Overview of mitigation measures to reduce the incidental catch of vulnerable species in fisheries*. General Fisheries Commission for the Mediterranean. Studies and reviews No. 100. Rome, FAO. <https://doi.org/10.4060/cb5049en>



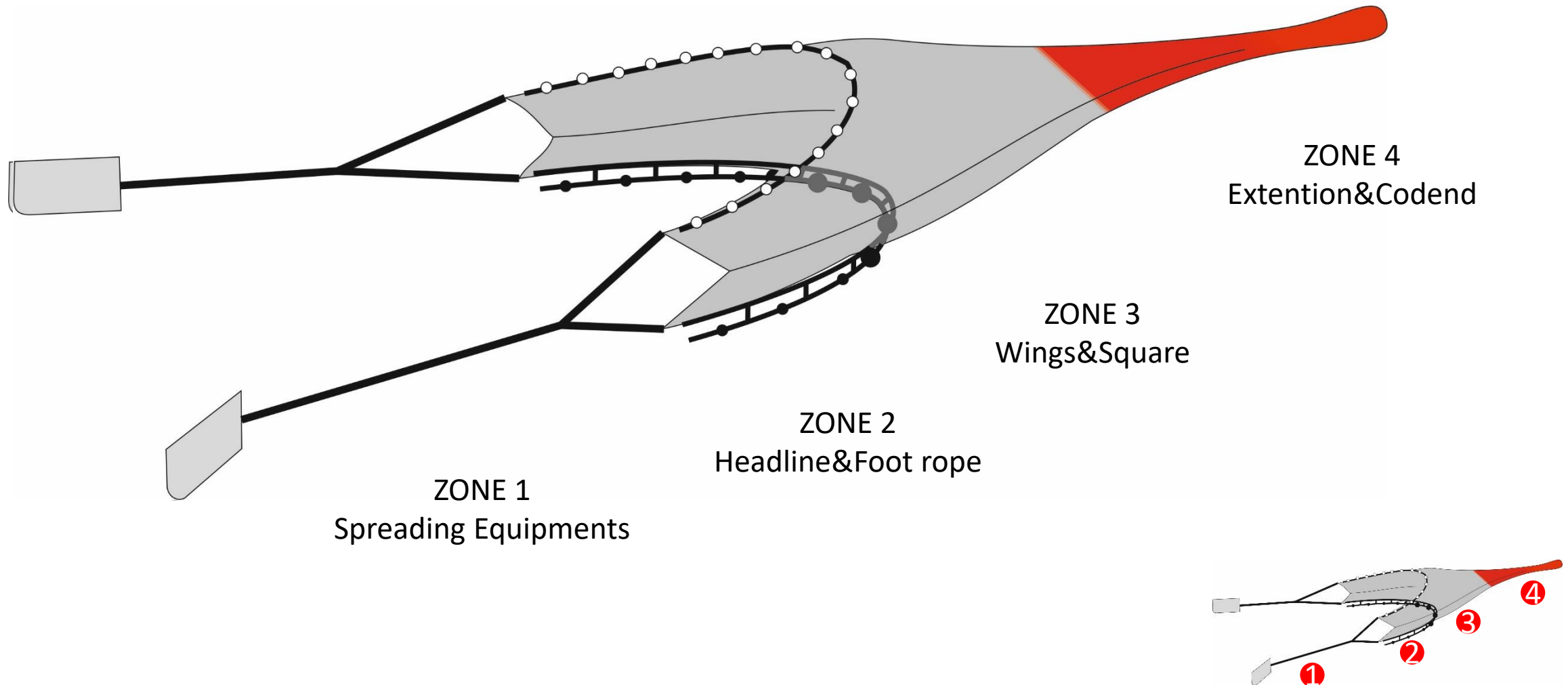


# Anatomy of a trawl gear

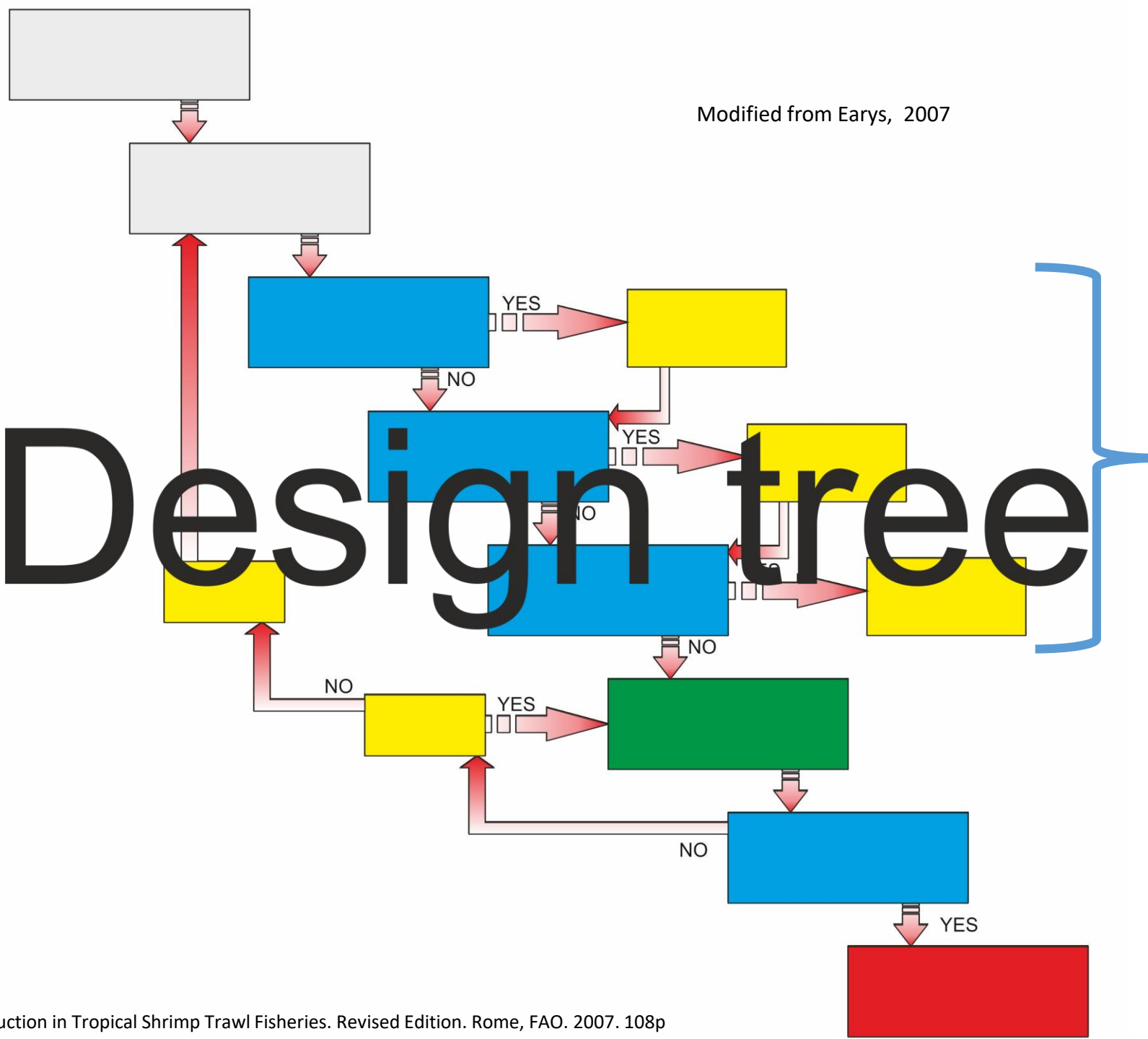


# Trawl zones assessed to improve mitigation

Modified from McHugh et al., 2017



1 2 3 4 5 6



Sep 1

Step 2

Step 3

Step 4

Step 5

Step 6

# Identify bycatch

Global

Monitoring programmes

Research Institutions

NGO's



# Identify bycatch



# When

DAY NIGHT



Bycatch similar or smaller in size

**SIZE**

**MATTERS**



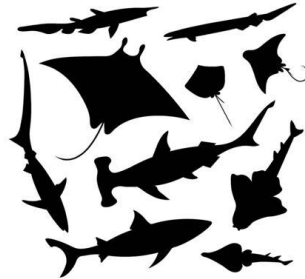
# Planning mitigation measures

## Morphological

*Small fish*

*Large fish*

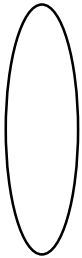
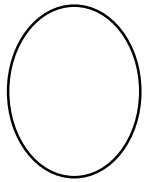
*Large animals*



*Round*

*Compressed*

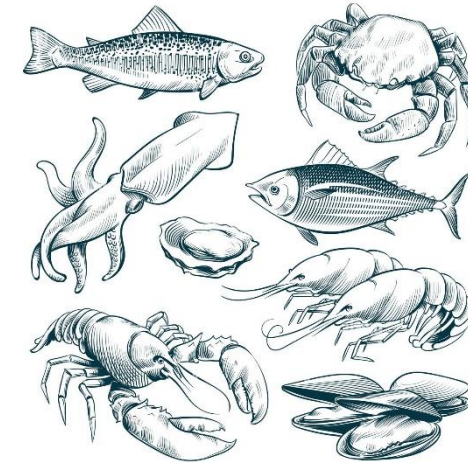
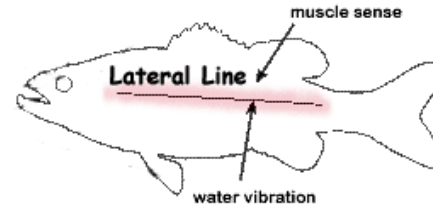
*Flat*



## Physiological and Behavioural

*Sense*

*Locomotion & Avoidance*



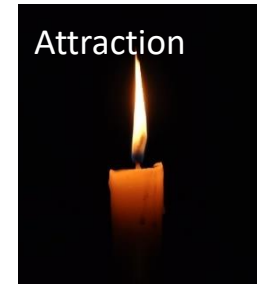
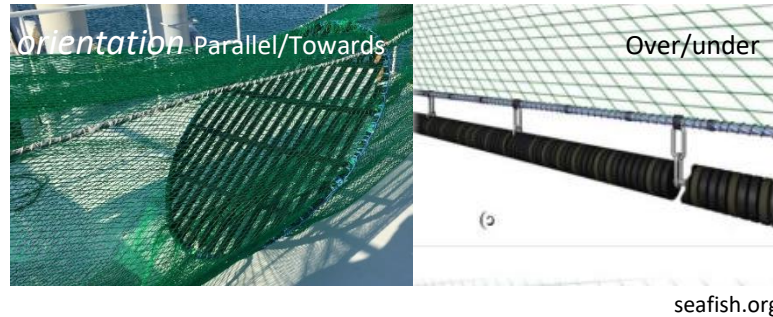
# Planning mitigation measures

## Behaviour

### *Locomotion*



### *Avoidance*



wikimedia.org/wiki/File:Candle.jpg



Guitar fish  
Common stingray

Spiny Butterfly ray









Octopus



# Identify type of bycatch to be excluded

## Define problem

- Which species size and behaviour?
- Where and When?
- Whose problem?

Managers! Researchers! NGOs! Fishermen!

## For successful adaptation

problem has to be recognised and aimed to be solved by fishermen in particular

<sup>1</sup> 'BRD' <sup>2</sup> 'TED' 'FED' 'BED' 'RES' 'Grid' 'JTED' 'Nordmore Grid' 'Super shooter' 'Separator Panel' 'BCF Sortin Grid' 'Vertical Separator Panel' 'American Type Separator Panel' 'V Type' 'X Type' 'Flex Grid' 'Flexible TED' 'FLEX' 'FRESHWIND' 'Vertical Separator Panel' 'NMFS TED' 'LA TED' 'GA TED' 'TX TED' 'HH Sorting Panel' 'Morrison Soft TED' 'Short Nets' 'Hard and Soft TEDS' 'Fisheyes' 'Parrish TED' 'Skylights' 'Georgia TED' 'Fish Shooter' 'Florida Fisheye' 'Kiffe BRD' 'AUS Ted' 'Ledet Excluder' 'Bannock Shooter' 'Lake Arthur Excluder' 'Eymard Accelerator' 'NAF TED' 'DISELA II' 'Bacoma' 'Square-mesh Codend' 'Square-mesh Panel' 'Large Mesh Codend' 'Large Mesh Wings' 'Lower Headline' 'Topless Trawl' 'Ground Gear' 'Drop Chain' 'Raised Foot Rope' 'LED Lights' 'Flip Flap Netting' 'FCAP Netting' 'Horizontal separator panel' 'Guiding Ropes' 'Jones-Davis BRD' 'Deflector' 'Danish panel' 'Horizondal seperator' 'Diamond Mesh Pannel' 'Hexagonal Mesh'

BRDS

# Classification of the BRDs

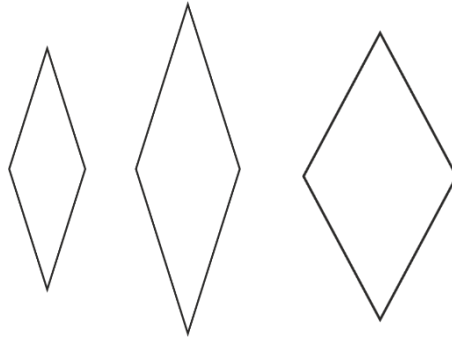
- Modified nettings
- Ground gear and Head rope modifications
- Attached Equipment
- Novel tools

# Classification of the BRDs

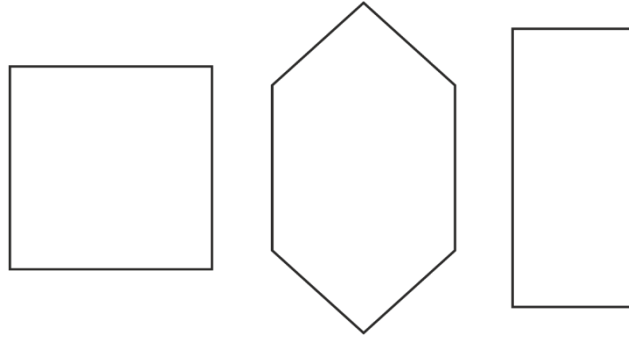
- Modified nettings

- Size
- Shape
- Diameter
- Orientation
- Number
- Opening

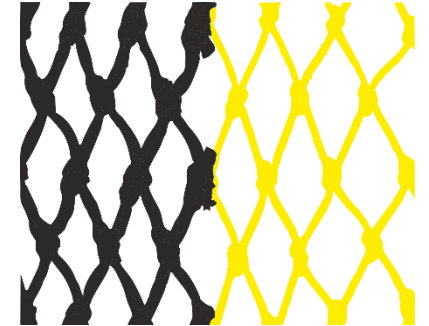
Size



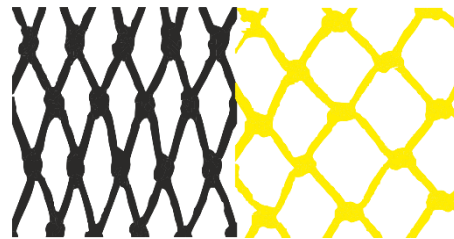
Shape



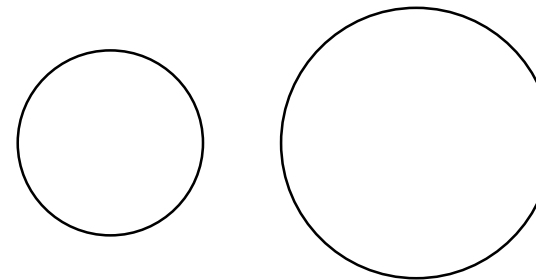
Twine thickness



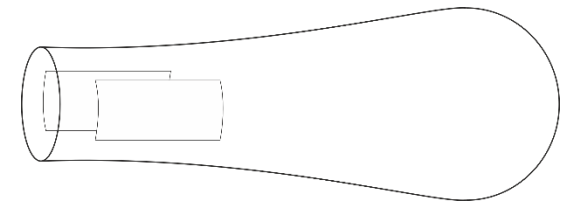
Mesh Orientation



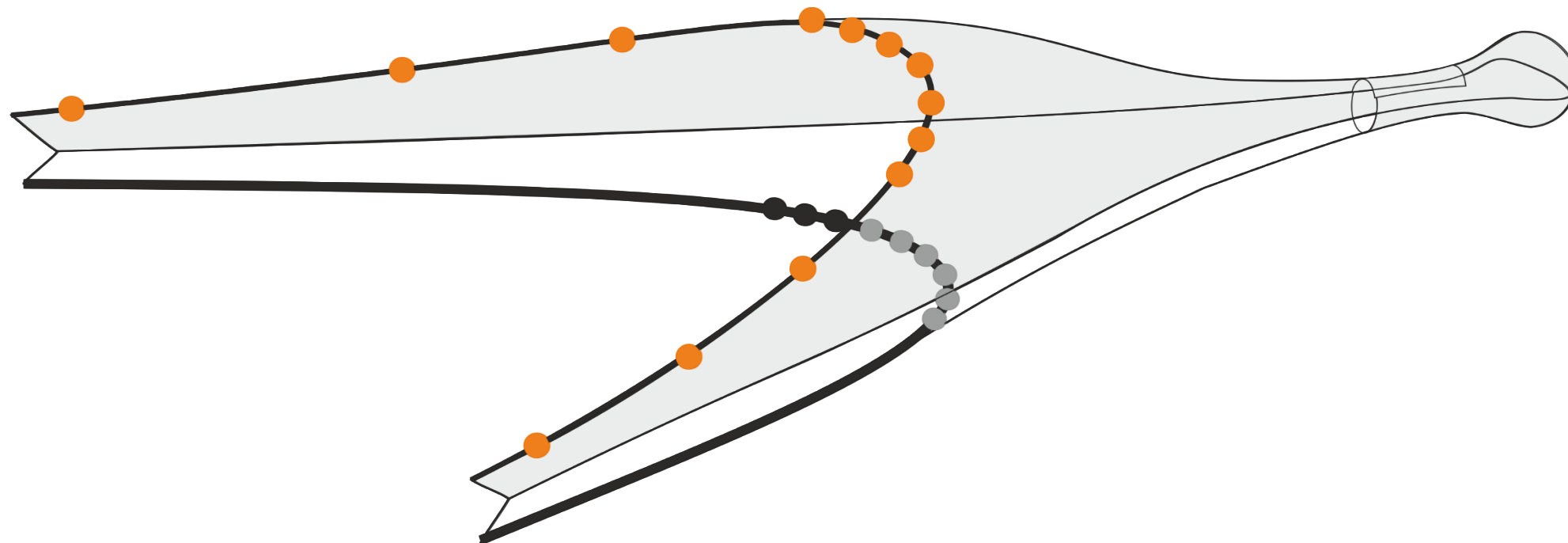
Number of meshes  
in codend circumference



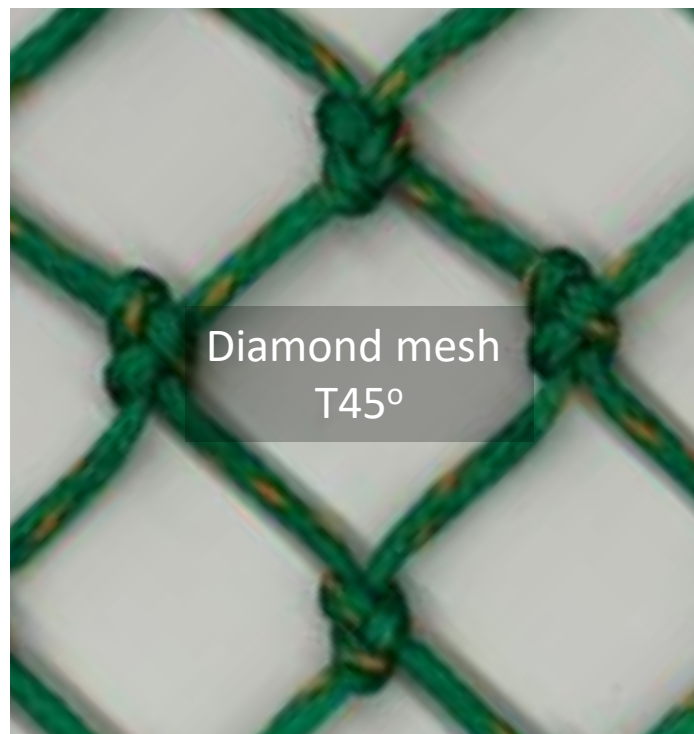
Escape Windows



# Modified Netting

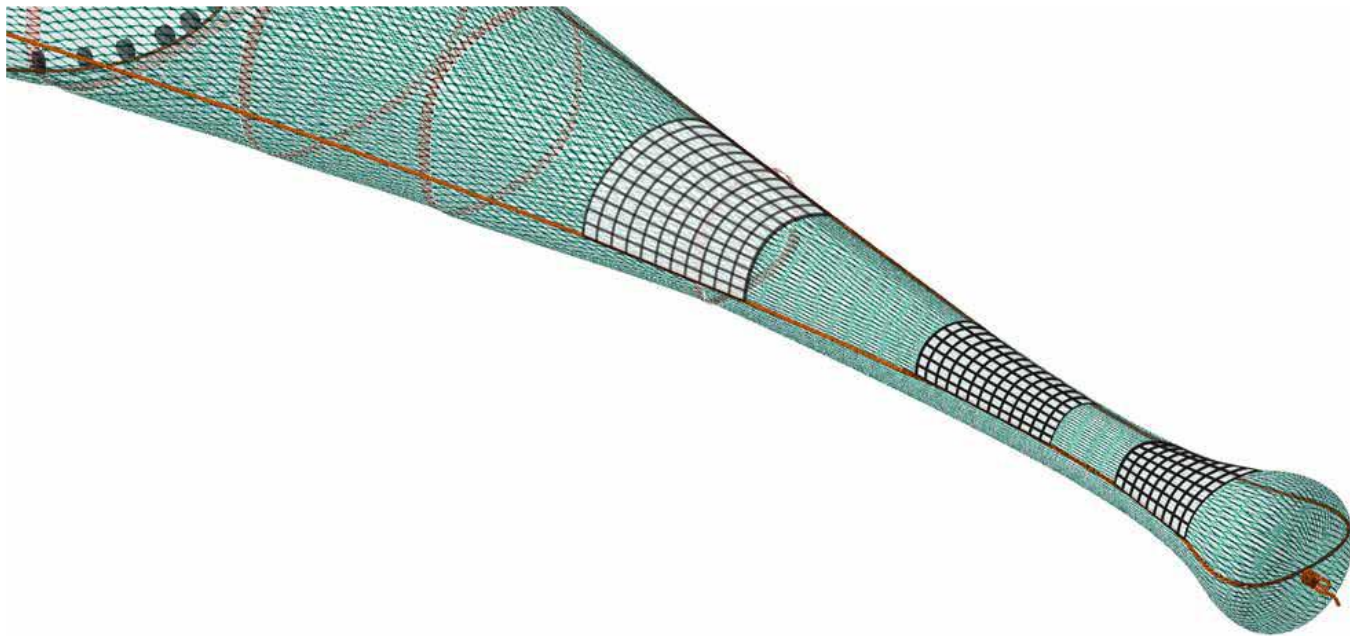


# Square Mesh Codend

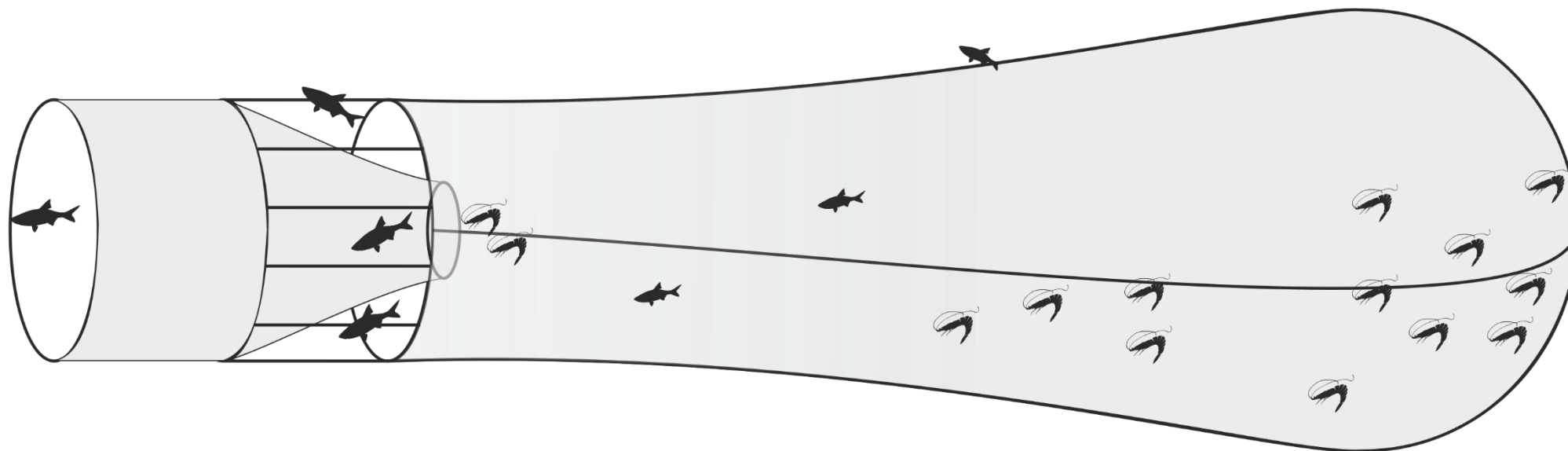




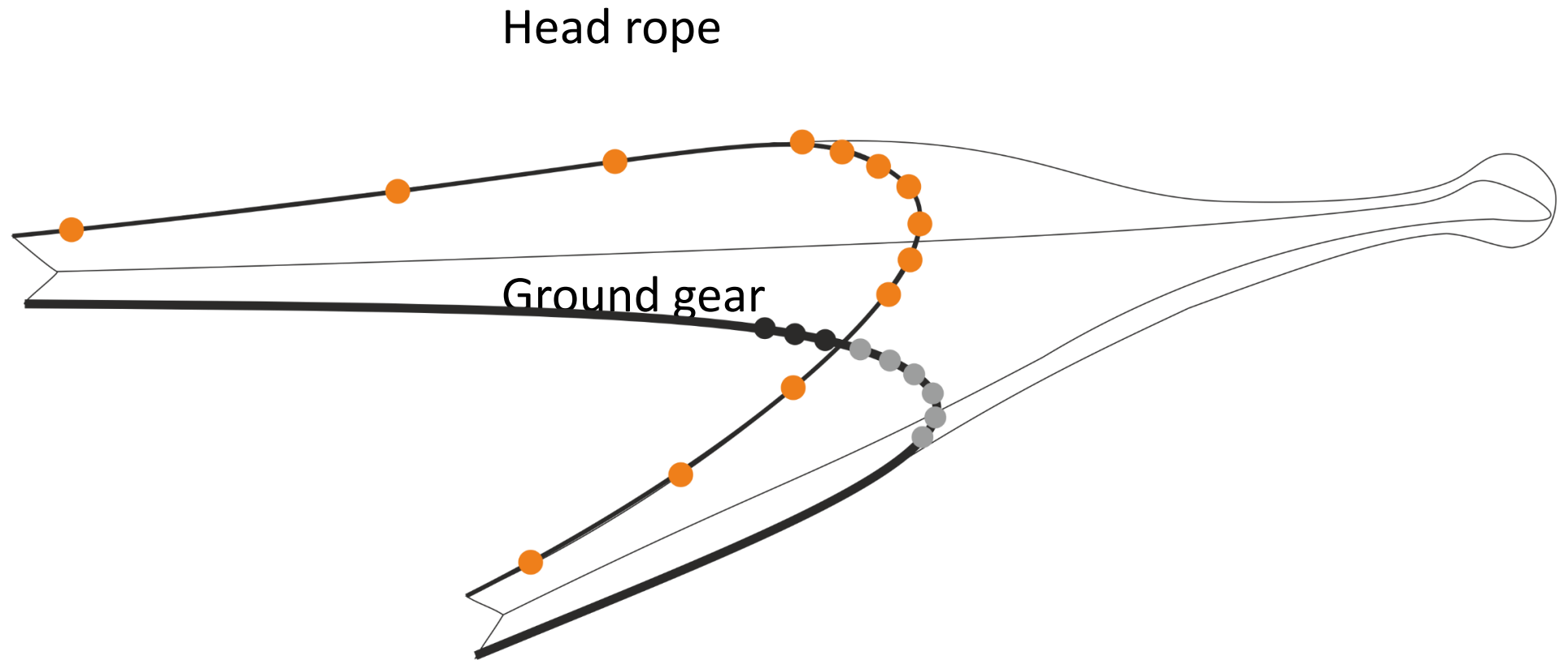
# Escape Windows



# Escape Gap

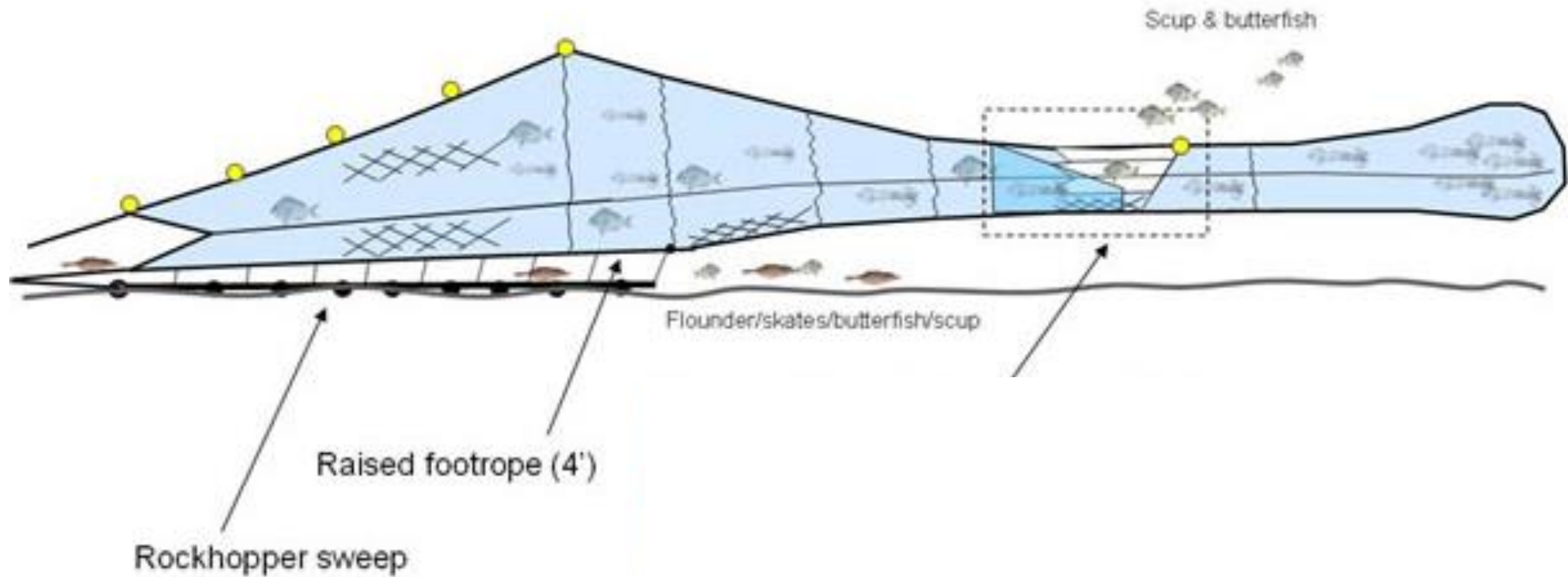


# Ground gear and Head rope modifications

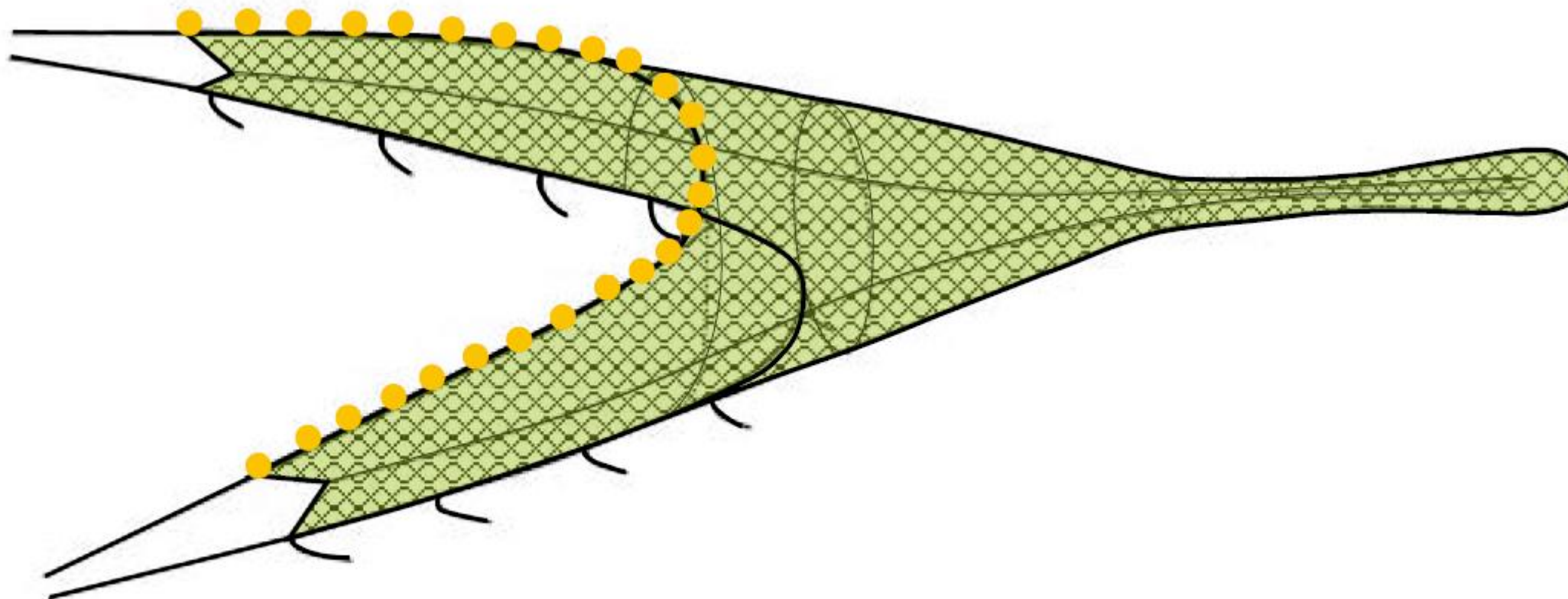


# Raised foot rope

## Raised Footrope Trawl (RFT) for *Loligo* Squid with Grid Bycatch Reduction Device (BRD) CONCEPTUAL DESIGN



# Drop chain



Source: Pol, 2003

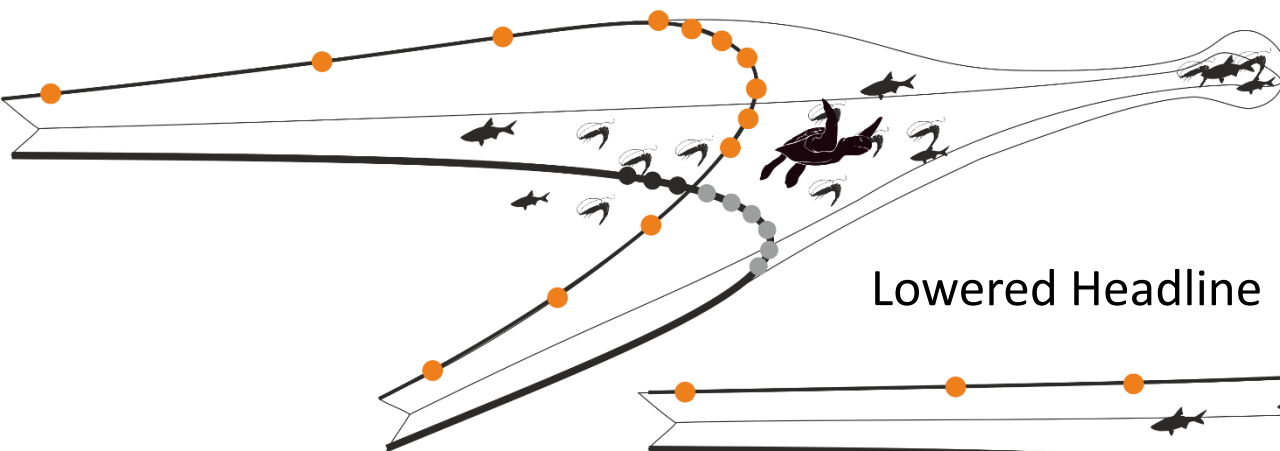
# Ground gear modification



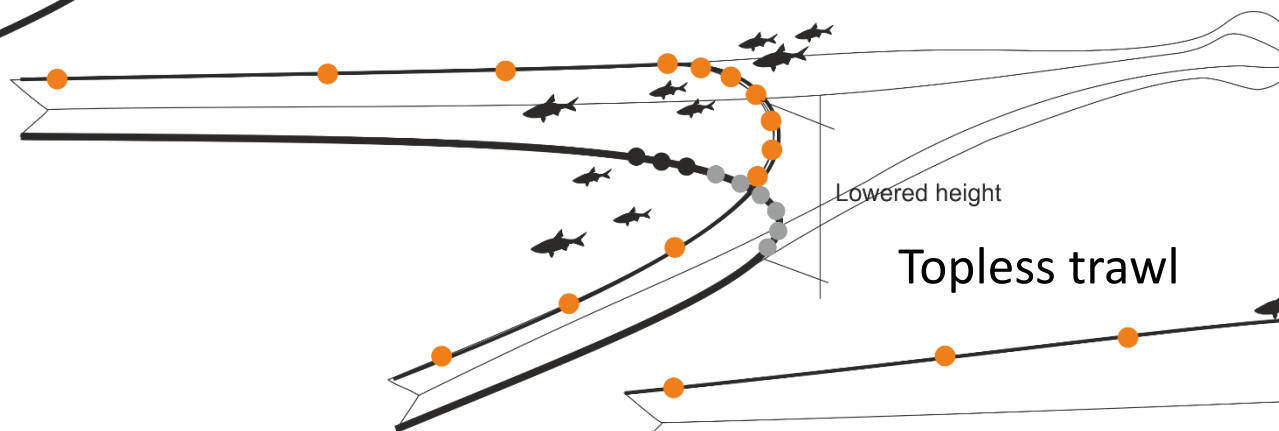


# Head rope modifications

Bottom trawl

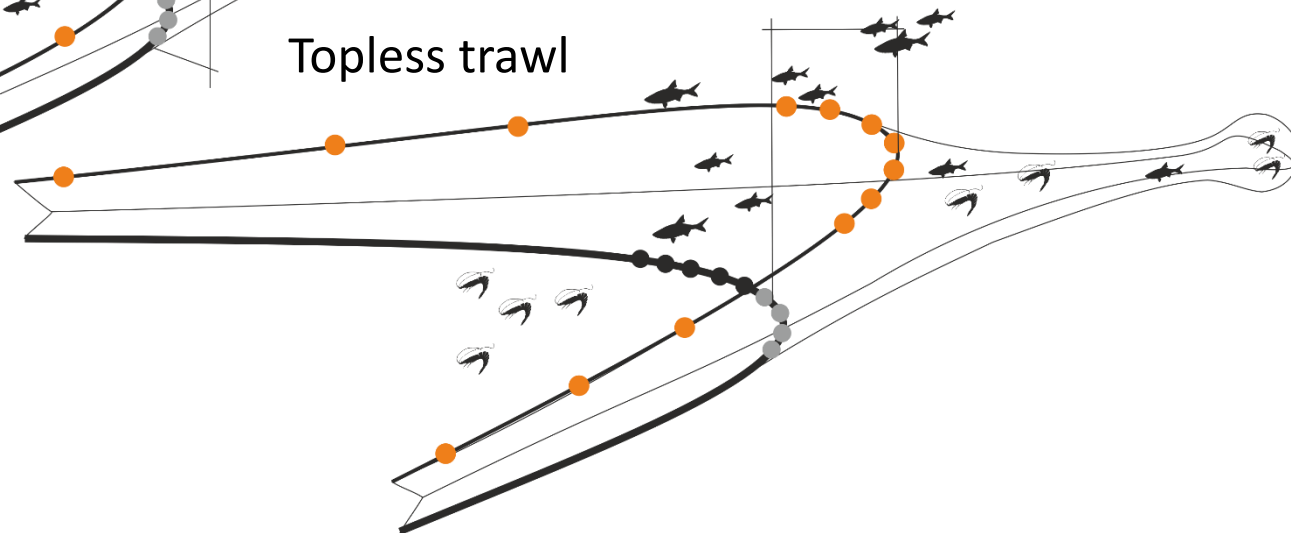


Lowered Headline



Lowered height

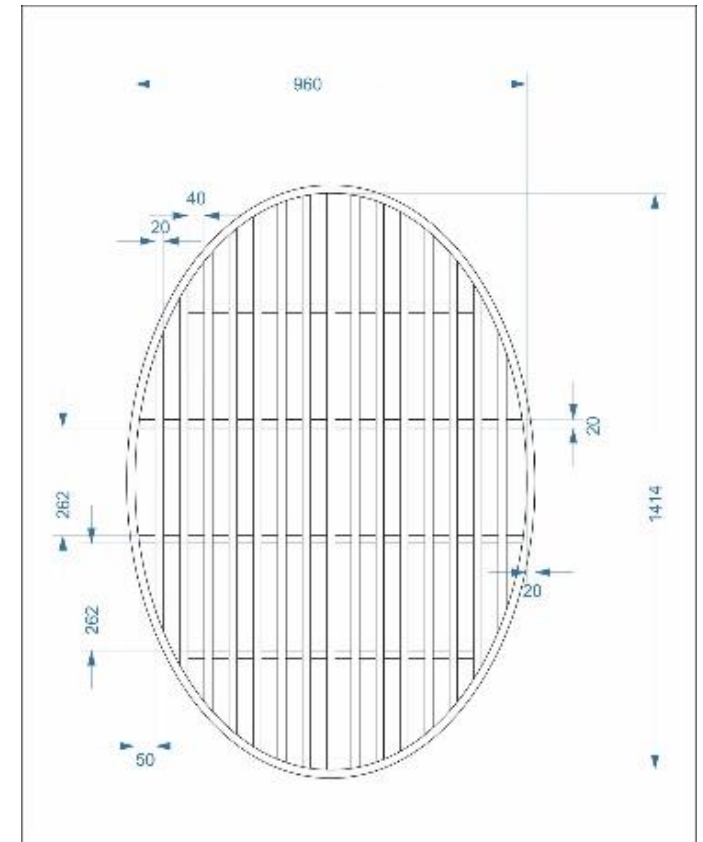
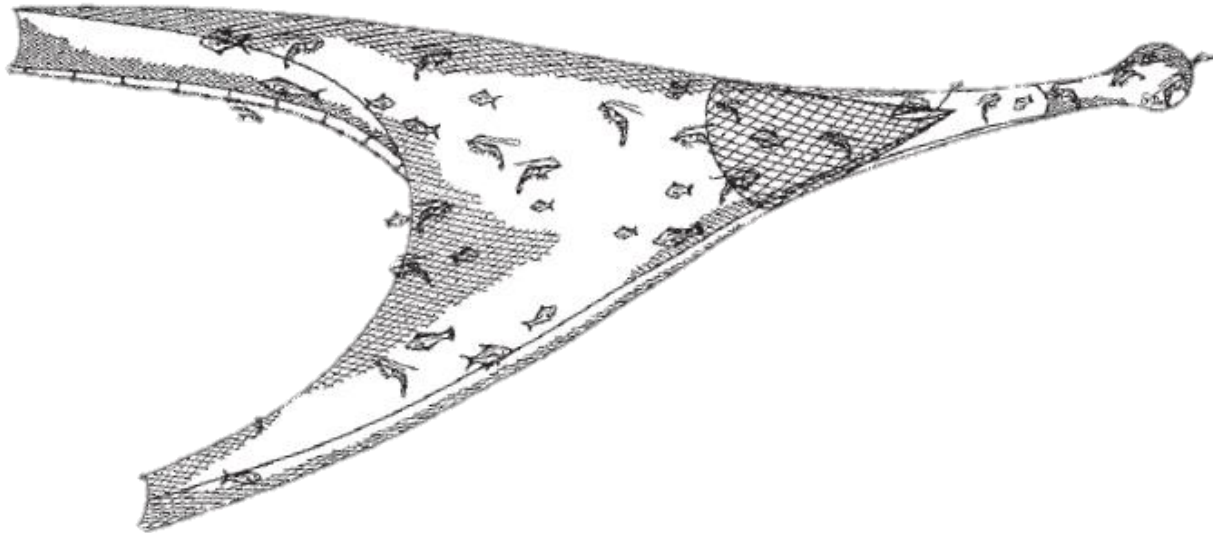
Topless trawl





# Attached Equipment

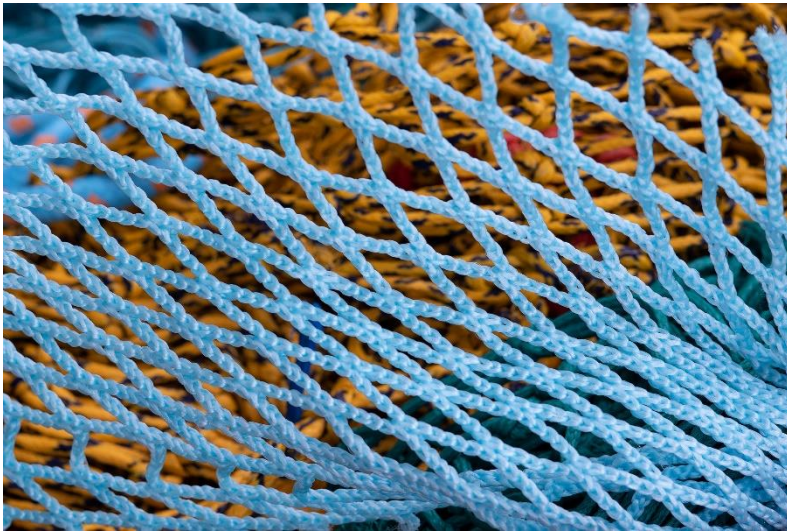
- Soft
- Rigid



# Attached Equipment

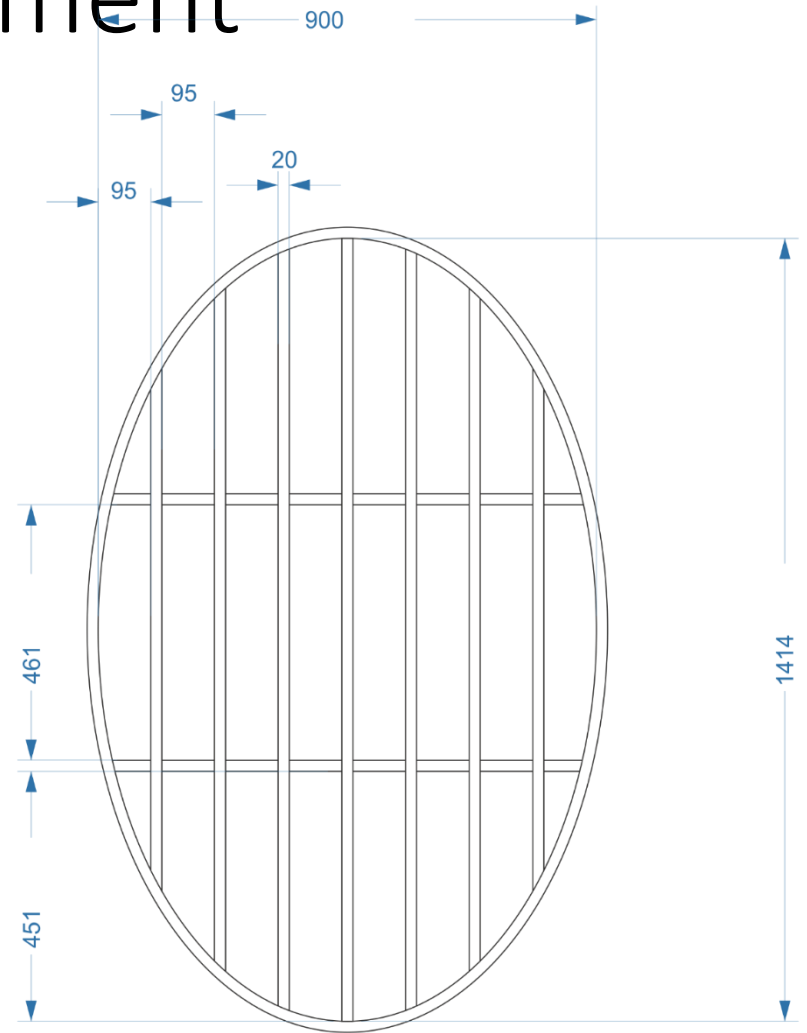
Soft

Net  
Rope



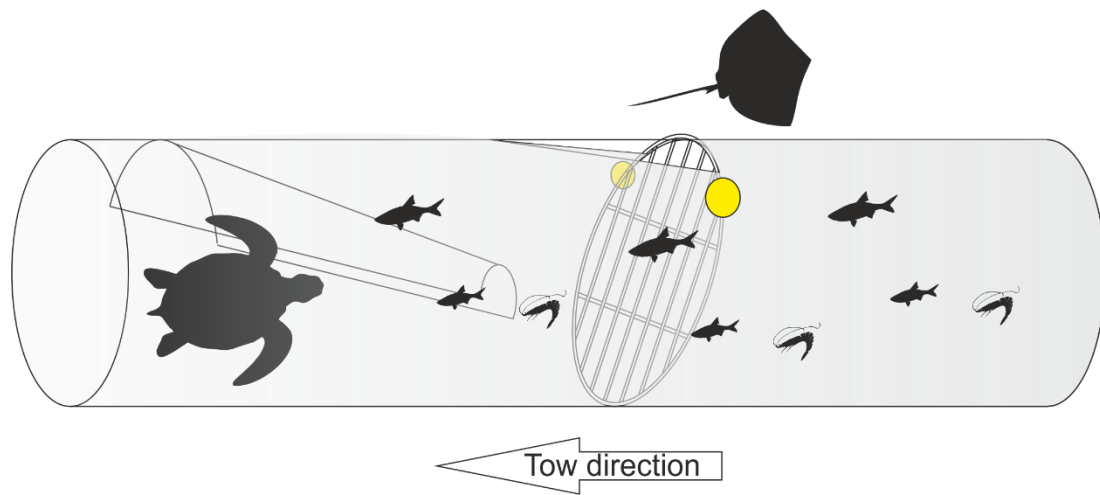
Hard

Rigid  
Flexible

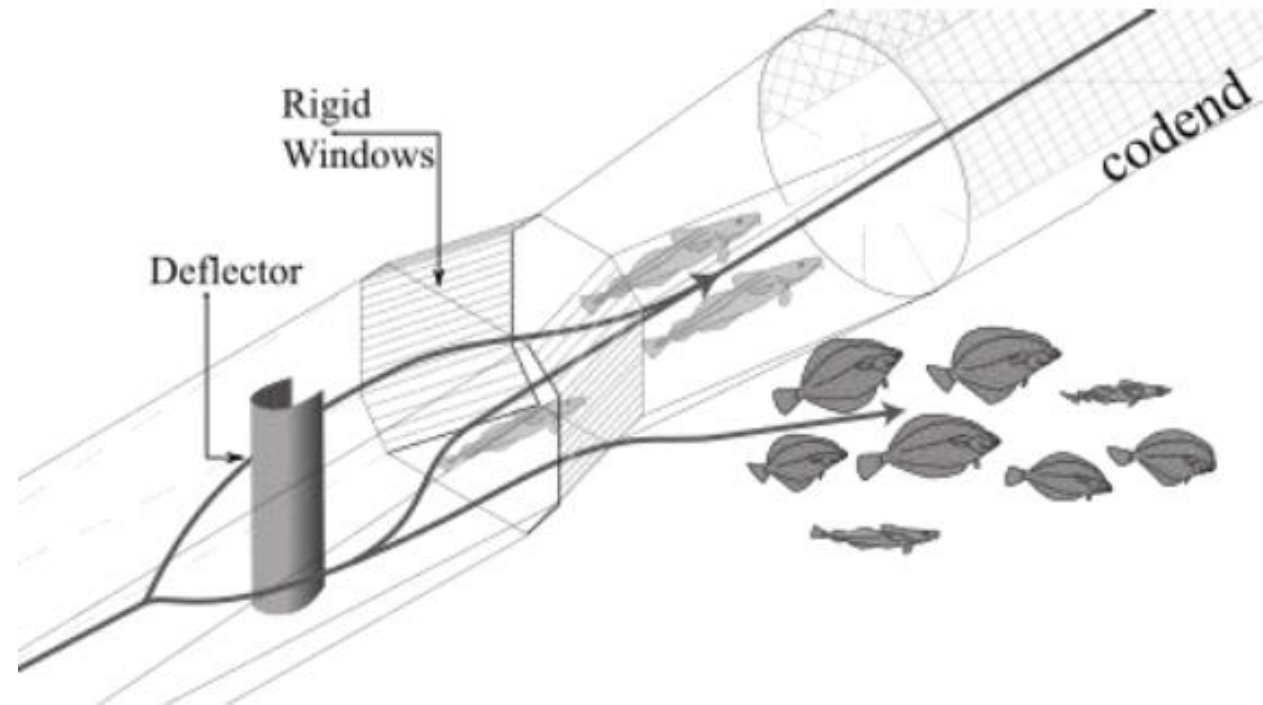


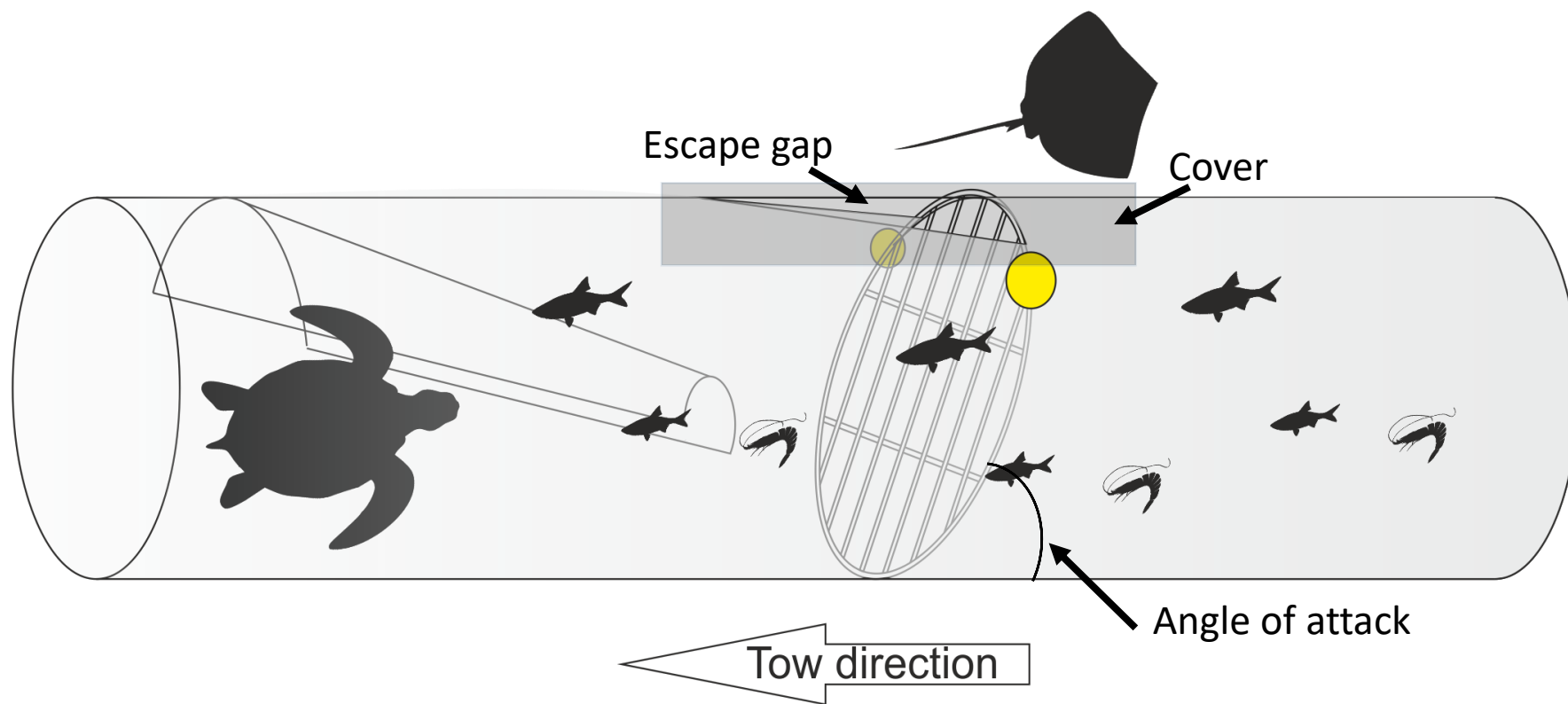
# Attached Equipment

Perpendicular

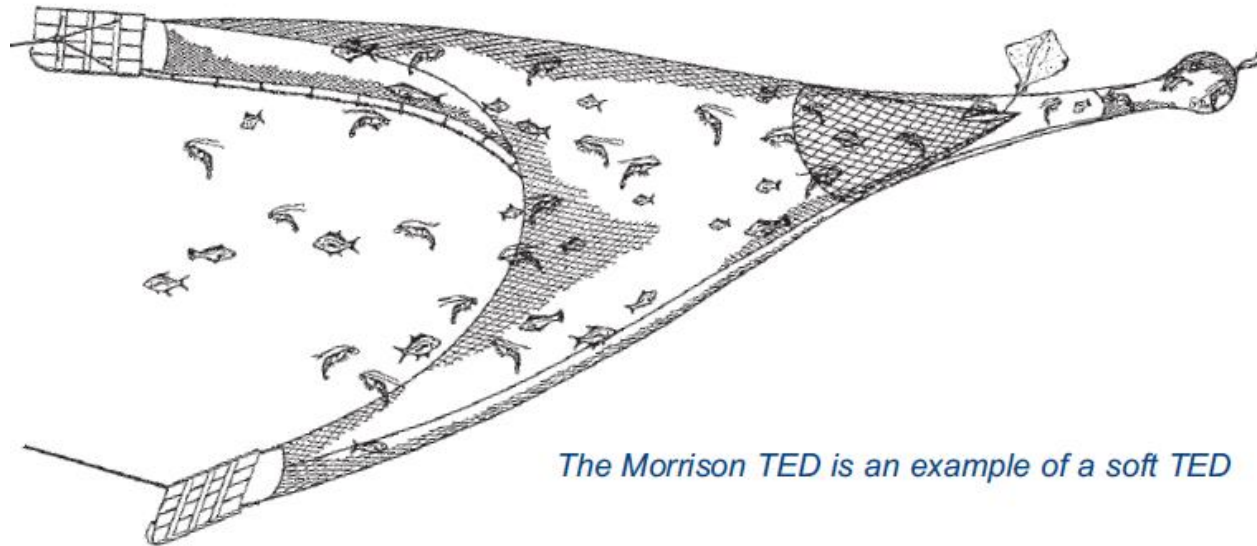


Parallel





# Soft TED

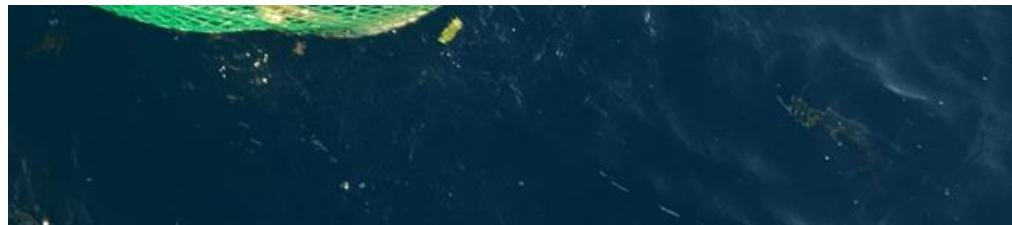


*The Morrison TED is an example of a soft TED*

## TED

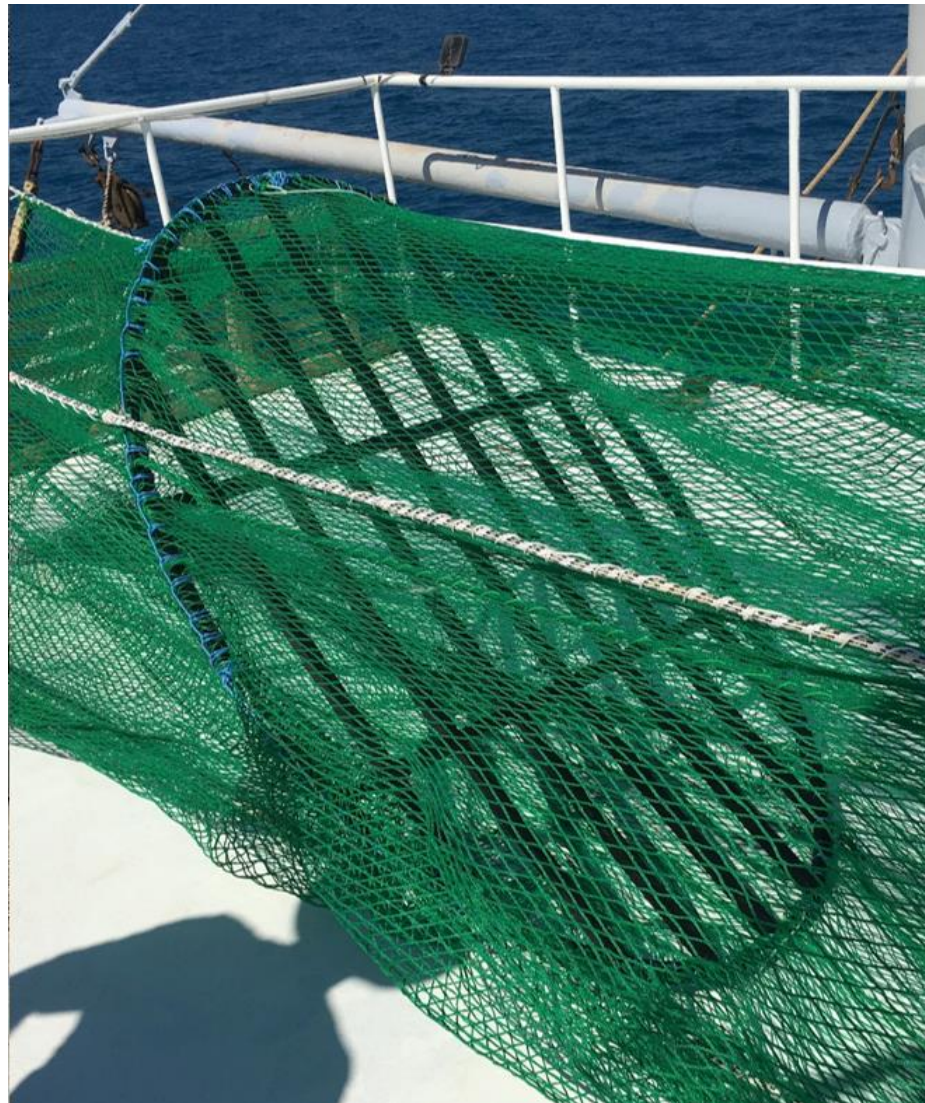


The Nordmore Grid is an example of a hard TED  
(note the ~~square mesh window~~ Guitarfish also fitted to the  
codend)

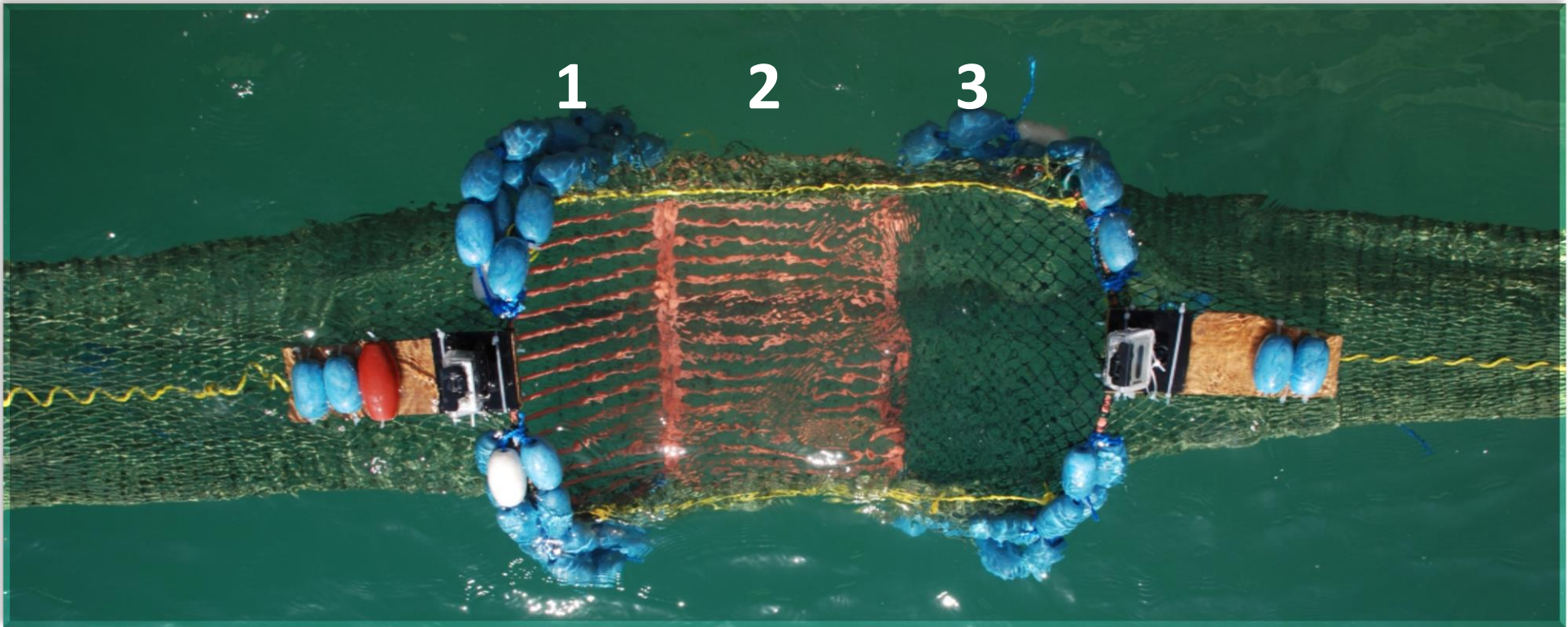




# Flexible TED

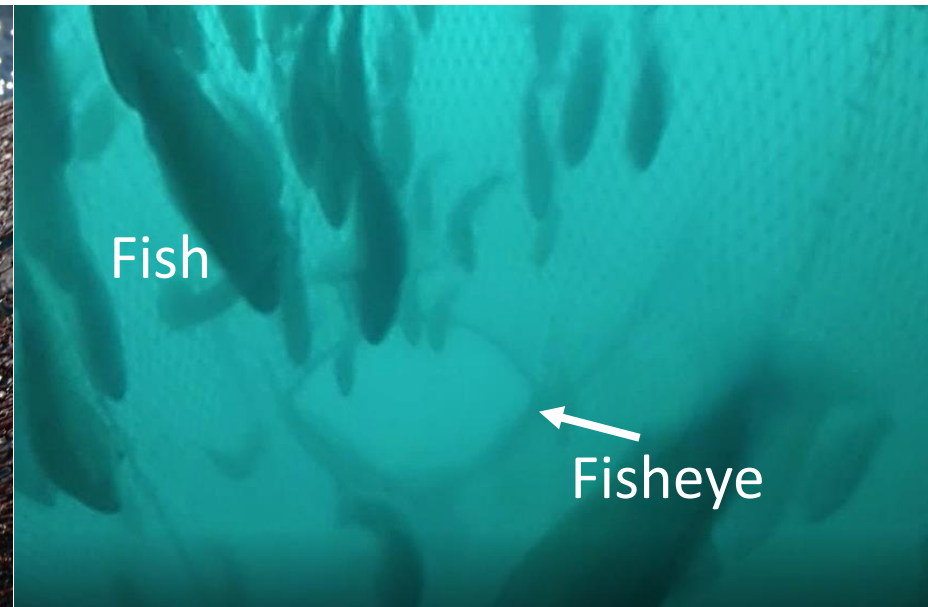
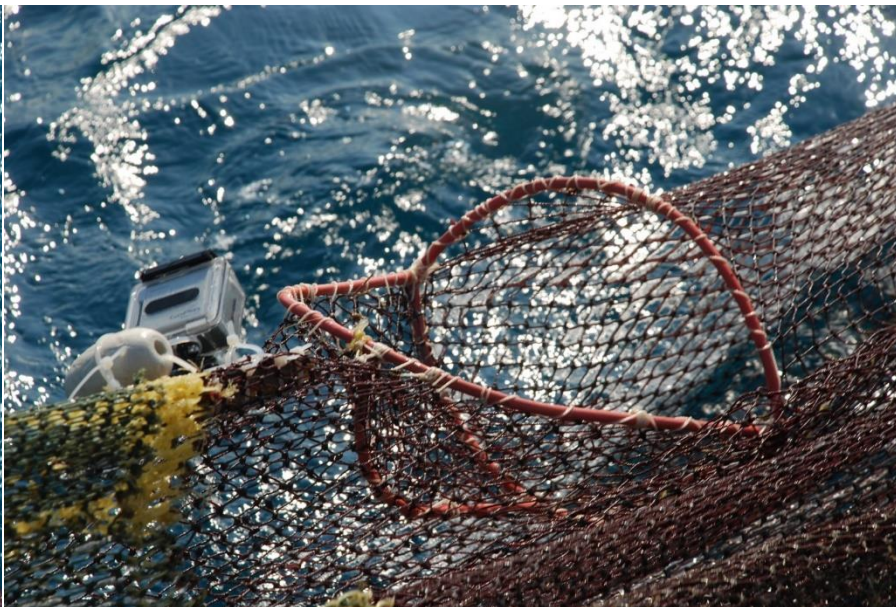


# JTED





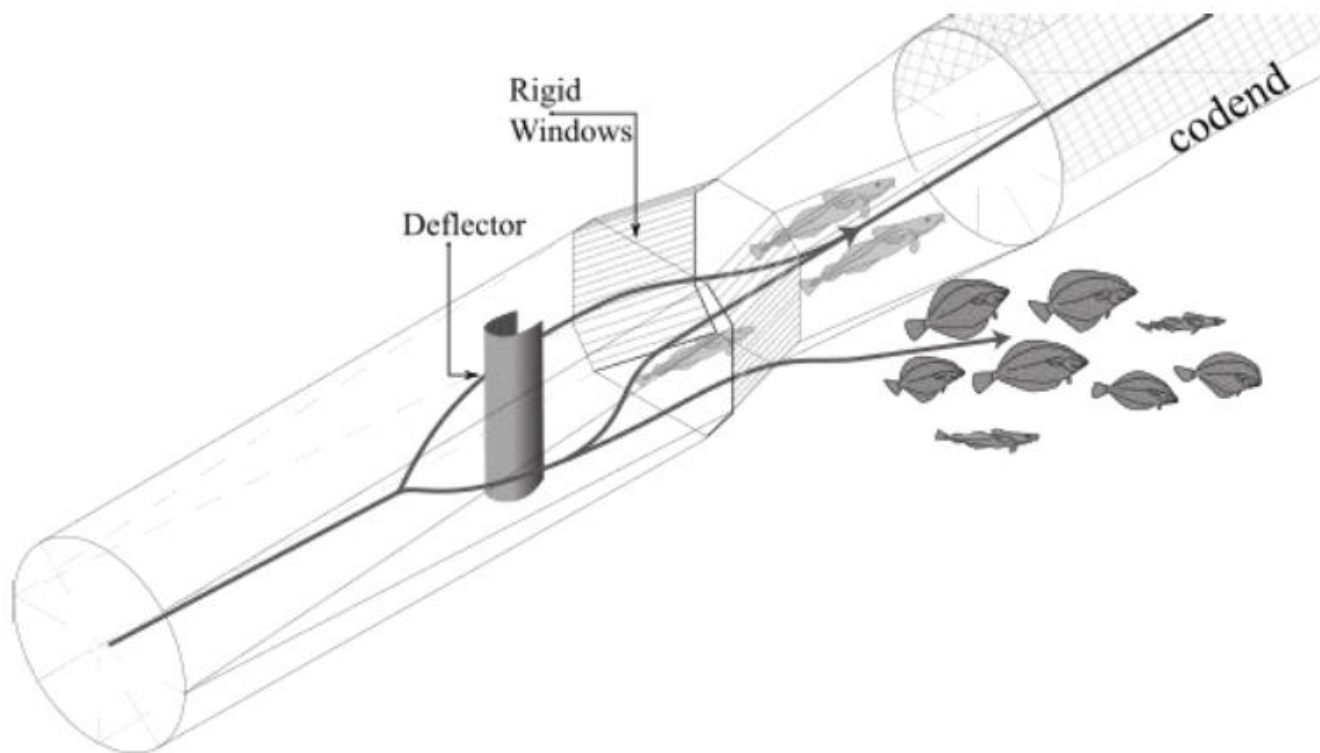
# Fisheye





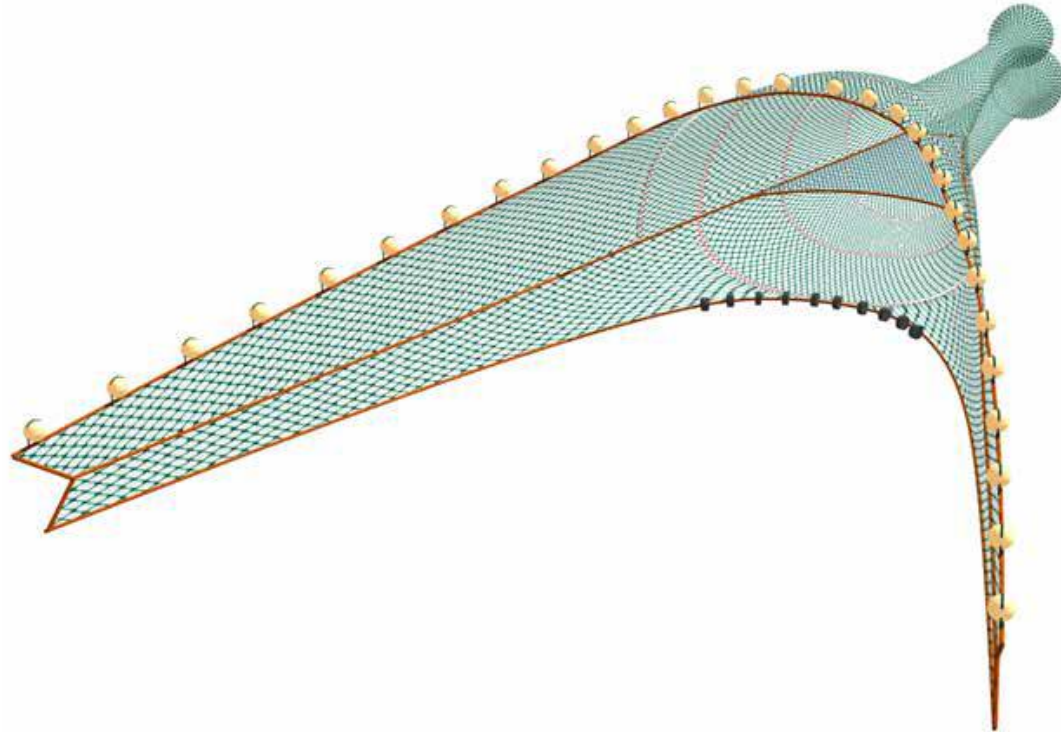
WWF Smart Gear completion  
2014 Runner-Up!

# FRESWIND





# Horizontal separator panel

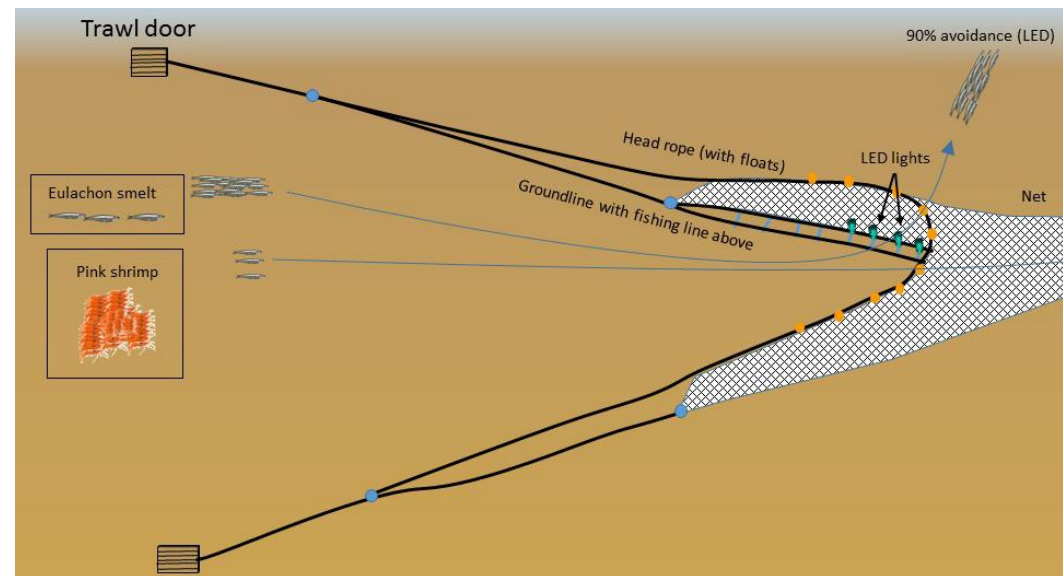
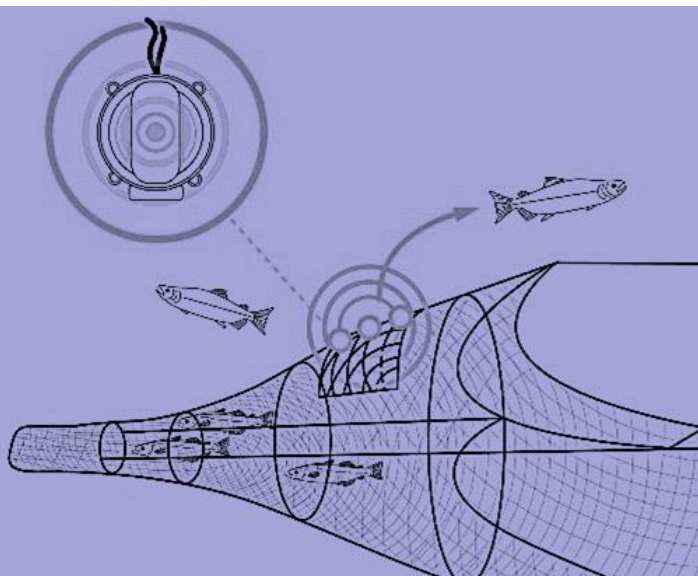
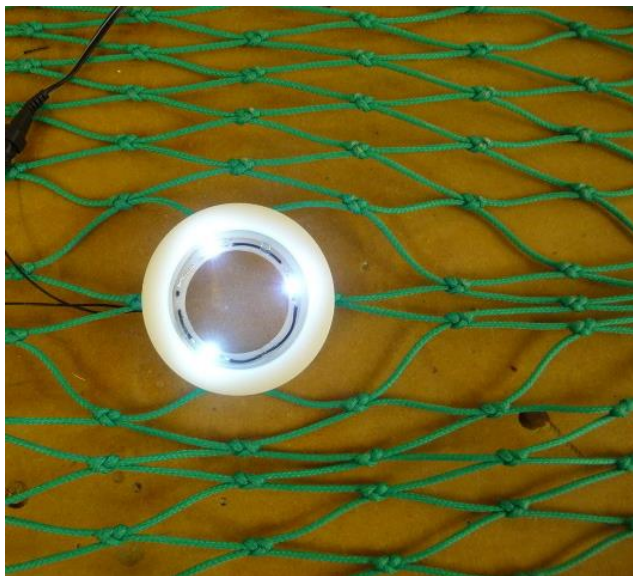


# Novel tools

- LED Lights



# LED Lights



# PROS & CONS

[illegible]

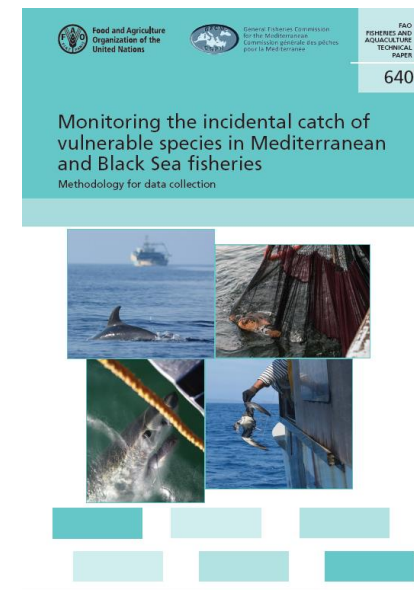
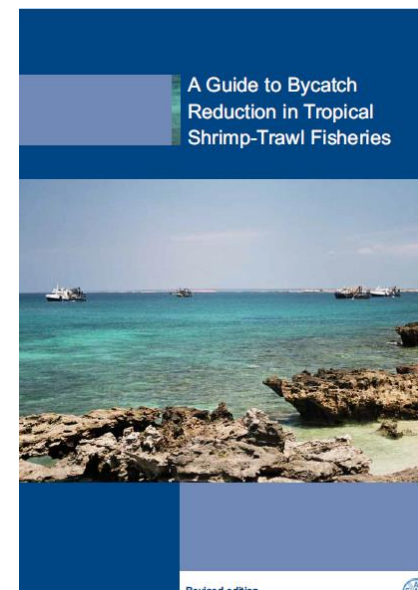
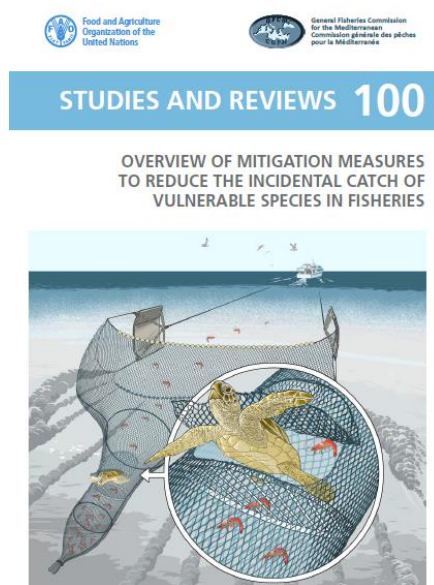
<https://www.wordclouds.com/>

# Need technical assistance

Manuel

Literature

Research organisation





1 2 3 4

# Efficiency

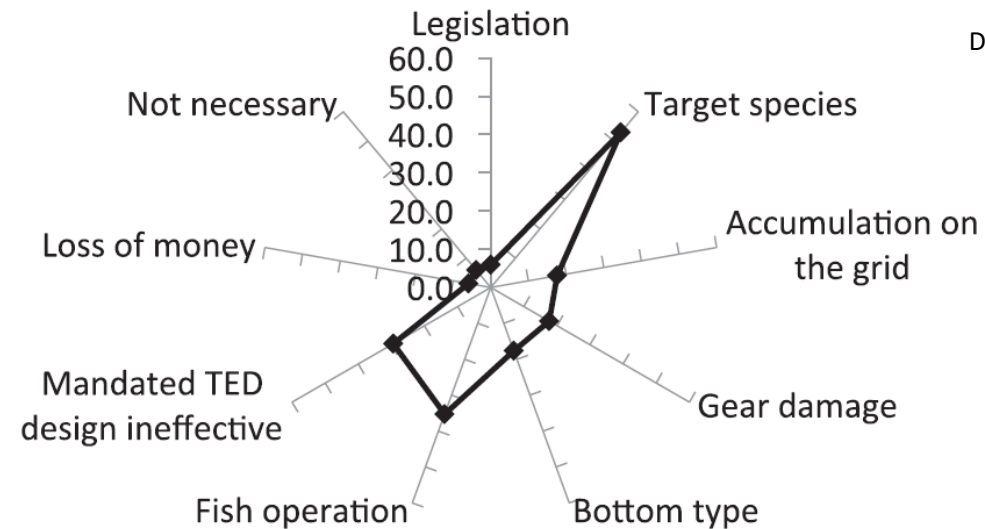


<https://gregburdine.com/making-the-impossible-possible/>



# Efficiency and Acceptability

- Ecological impact
- Fishing mortality?
- Acceptability



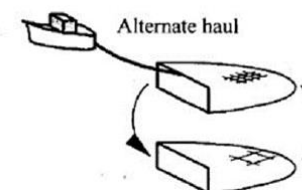
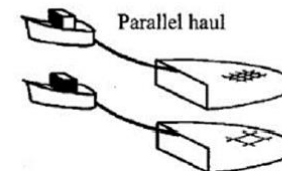
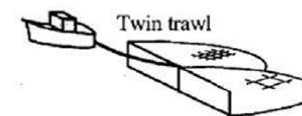
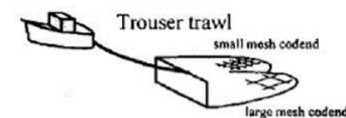
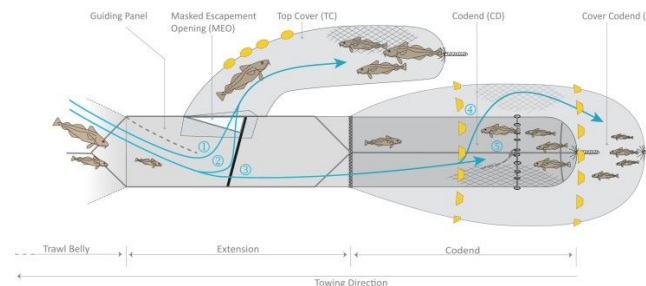
Duarte et al. 2019

**Fig. 2.** Radar graph depicting industrial penaeid-trawl captains' descriptions of the TED problems and their reasons for rejection in southern Brazil. The scale is % frequency of the occurrence of each answer.

# Sea Trials

## Sampling Methods

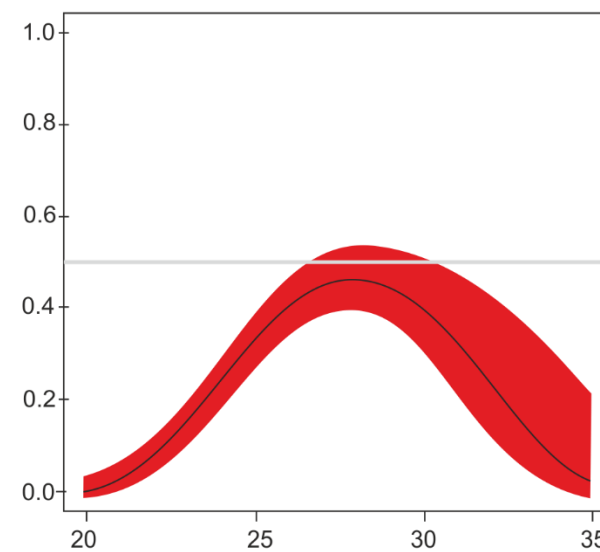
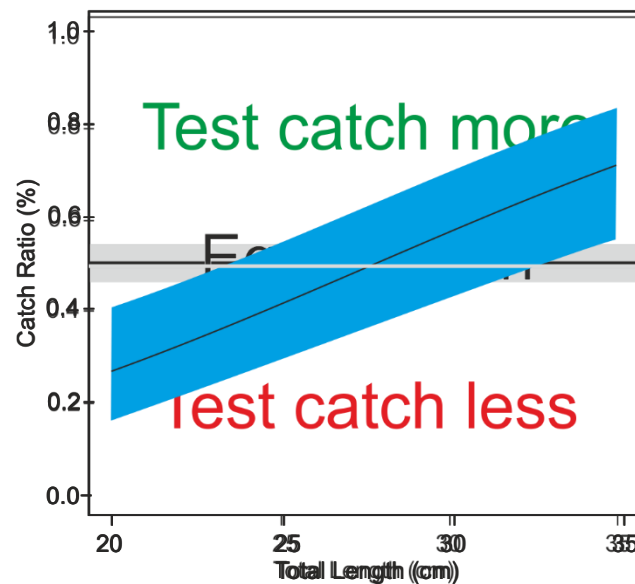
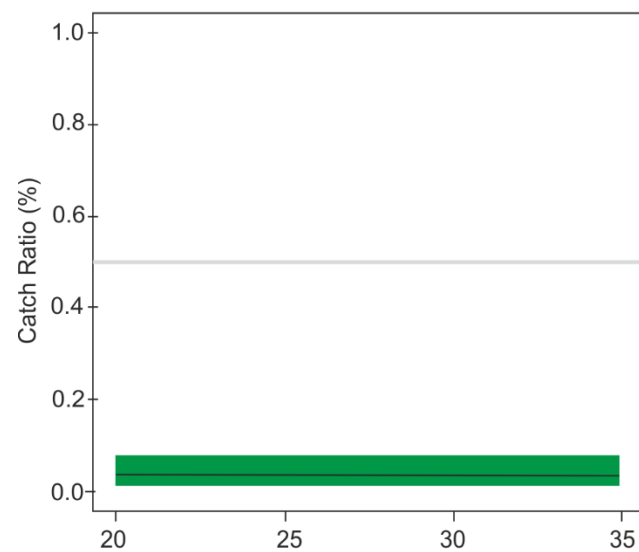
- Cover
- Trawler trawl
- Twin trawl
- Parallel haul
- Alternative haul



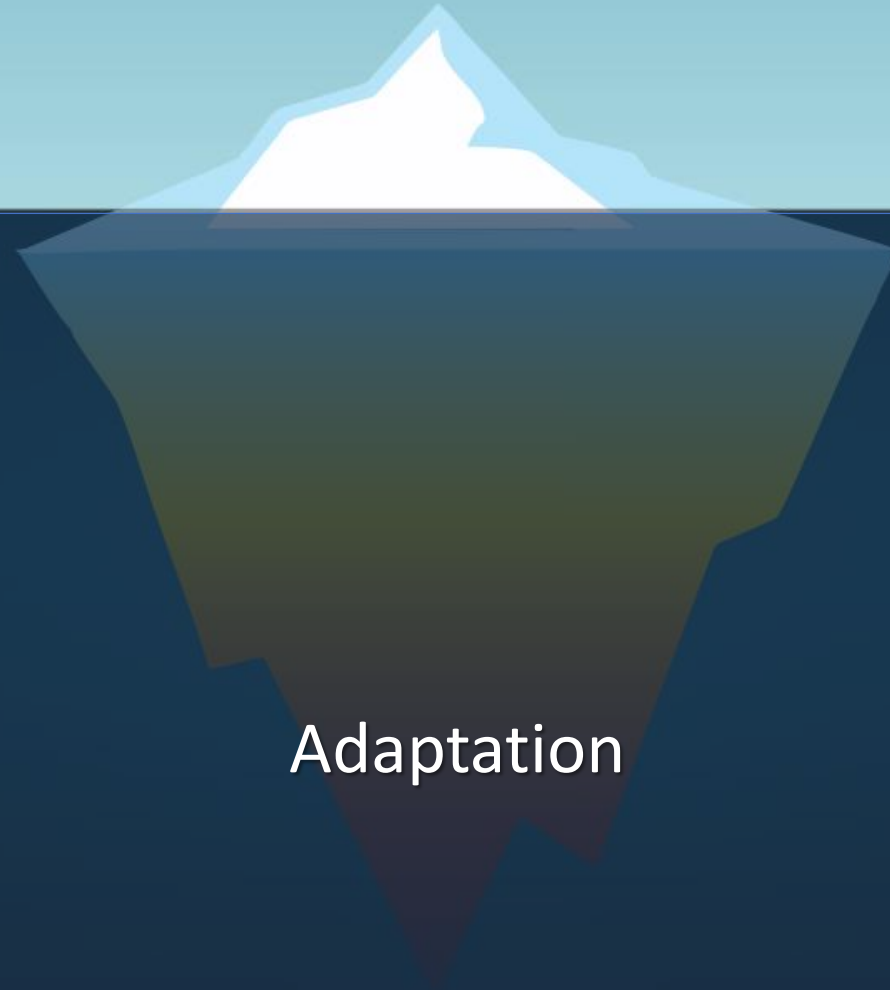
1 2 3 4 5

# Catch Comparison (GLMM)

(Modified from Holst and Revill, 2009)



## Sea trials and Technical Issues



Adaptation

1 2  
'BRD' 'TED' 'FED' 'BED' 'RES' 'Grid' 'JTED' 'Nordmore Grid' 'Super shooter' 'Separator Panel' 'BCF Sortin Grid' 'Vertical Separator Panel' 'American Type Separator Panel' 'V Type' 'X Type' 'Flex Grid' 'Flexible TED' 'FLEX' 'FRESHWIND' 'Vertical Separator Panel' 'NMFS TED' 'LA TED' 'GA TED' 'TX TED' 'HH Sorting Panel' 'Morrison Soft TED' 'Short Nets' 'Hard and Soft TEDS' 'Fisheyes' 'Parrish TED' 'Skylights' 'Georgia TED' 'Fish Shooter' 'Florida Fisheye' 'Kiffe BRD' 'AUS Ted' 'Ledet Excluder' 'Bacoma' 'Cameron Shooter' 'Lake Arthur Excluder' 'Eymard Accelerator' 'NAF TED' 'DISELA II' 'Square-mesh Codend' 'Square-mesh Panel' 'Large Mesh Codend' 'Large Mesh Wings' 'Lower Headline' 'Topless Trawl' 'Ground Gear Modification' 'Drop Chain' 'Raised Foot Rope' 'LED Lights' 'Flip Flap Netting' 'FCAP Netting' 'Horizontal separator panel' 'Guiding Ropes' 'Jones-Davis BRD' 'Deflector' 'Horizondal seperator' 'Diamond Mesh Pannel' 'Hexagonal Mesh'

# What is crucial for adapting BRD?

REGULATION (EU) 2019/1241 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL  
of 20 June 2019

on the conservation of fisheries resources and the protection of marine ecosystems through technical measures, amending Council Regulations (EC) No 1967/2006, (EC) No 1224/2009 and Regulations (EU) No 1380/2013, (EU) No 2016/1139, (EU) No 2018/973, (EU) No 2019/472 and (EU) 2019/1022 of the European Parliament and of the Council, and repealing Council Regulations (EC) No 894/97, (EC) No 810/97, (EC) No 2539/2000, (EC) No 54/2003, (EC) No 812/2004 and (EC) No 2187/2005

The following mesh sizes shall apply in the Mediterranean Sea.

Mesh Size <sup>(1)</sup>	Geographical Areas	Conditions
At least 40 mm square mesh codend <sup>(2)</sup>	Whole area	A diamond mesh codend of 50 mm <sup>2</sup> may be used as an alternative to the 40 mm square mesh codend at the duly justified request of the vessel owner
At least 20 mm	Whole area	Directed fishing for sardine and anchovy

<sup>(1)</sup> It shall be prohibited to use netting with a twine thickness greater than 3 mm or with multiple twines; or netting with a twine thickness of greater than 6 mm in any part of a bottom trawl.  
<sup>(2)</sup> Only one type of net (either 40 mm square mesh or 50 mm diamond mesh) is allowed to be kept on board or deployed.

Federal Register / Vol. 78, No. 144 / Friday, July 26, 2013 / Notices					45285
Modality of completion	Number of respondents	Frequency of response	Average burden per response (minutes)	Estimated total annual burden (hours)	
405.20 .....	5,310	1	10	885	
Totals .....	75,850			22,533	

Dated: July 23, 2013.  
Fayyaz Hussain,  
Report Clearance Director, Social Security  
Administration.  
[FR Doc. 2013-15800 Filed 7-23-13; 845 pages]  
BILLING CODE 4191-02

DEPARTMENT OF STATE  
[Public Notice 8391]  
Certifications Pursuant to Section 609  
of Public Law 101-162  
SUMMARY: On May 2, 2013, the

published in the Federal Register on July 2, 1999 (Vol. 64, No. 130, Public Notice 3088).  
On May 2, 2013, the Department certified 13 nations on the basis that their sea turtle protection programs are compatible with that of the United States. Colombia, Costa Rica, Ecuador, El Salvador, Guatemala, Guyana, Honduras, Mexico, Nicaragua, Nigeria, Pakistan, Panama, and Suriname. The Department also certified 26 shrimp harvesting nations and one economy as having fishing environments that do not pose a danger to sea turtles. Sixteen

forms. At this time, the Department has made such a determination only with respect to Australia, Brazil and France. Thus, the importation of TED-caught shrimp from any other uncertified nation or economy will not be allowed. For Brazil, only shrimp harvested in the northern shrimp fishery are eligible for entry under this provision. For Australia, shrimp harvested in the Exmouth Gulf Prawn Fishery, the Northern Prawn Fishery, the Queensland East Coast Trawl Fishery, and the Torres Strait Prawn Fishery are eligible for entry under this provision.

103 STAT. 1038

PUBLIC LAW 101-162—NOV. 21, 1989

Reports.

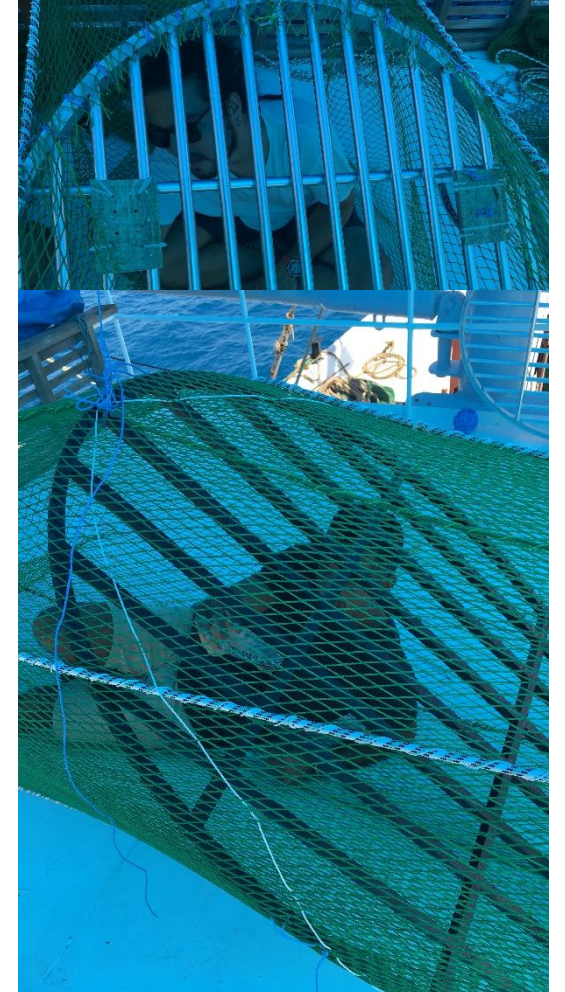
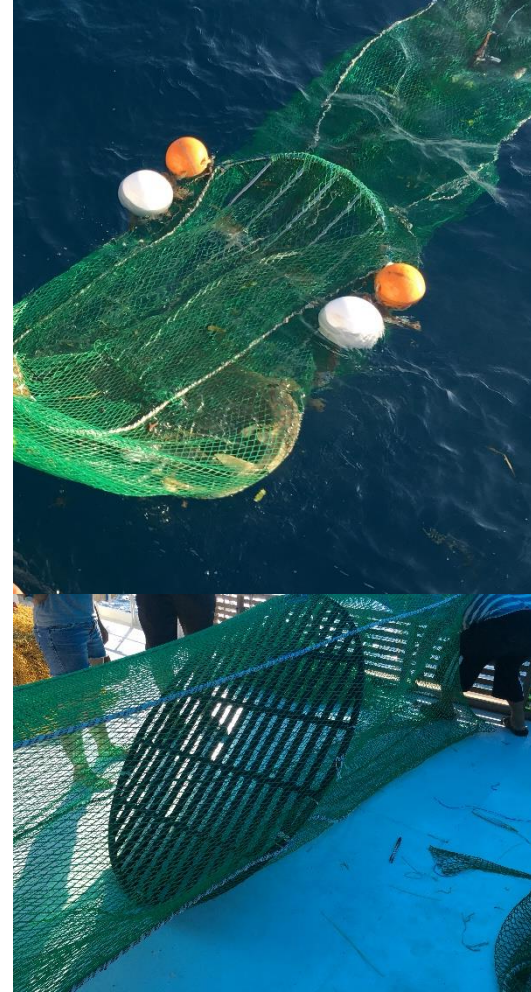
(C) a full report on—  
(i) the results of his efforts under this section; and  
(ii) the status of measures taken by each nation listed pursuant to paragraph (A) or (B) to protect and conserve such sea turtles.

Imports.

(b)(1) IN GENERAL.—The importation of shrimp or products from shrimp which have been harvested with commercial fishing technology which may affect adversely such species of sea turtles shall be prohibited not later than May 1, 1991, except as provided in paragraph (2).



# Examples from the Northeast Mediterranean





# Readings



QR codes for the links



## Selectivity in Trawl Fishing Gears

Scottish Marine and Freshwater Science Vol 8 No 01

F.G. O'Neill and K. Mutch



### REVIEWS

## A review of bycatch reduction in demersal fish trawls

Steven J. Kennedy · Matt K. Broadhurst

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**Abstract** Other trawling for fish is one of the world's most productive yet problematic fishing methods due to its bycatch and discards; issues that have been mitigated in some fisheries by developing more selective trawls. This paper systematically reviews efforts published in international peer-reviewed papers over the past 30 years to identify beneficial (and limiting) factors and propose a way forward in this field. In total, 203 papers were assessed, encompassing many of the world's fishing regions, and involving > 147 species, although 74% of efforts occurred in Europe mainly focussing on haddock (*Merlangius merlangus*) (64 papers) and cod (*Gadus morhua*) (59 papers). Common, simple modifications have involved increasing lateral-mesh openings to match the morphology of unwanted catches via

larger diamond-shaped mesh, or simply tuning meshes 45° or 90°, either throughout codends or as strategic windows in the posterior trawl. In some fisheries, more complex grids have improved size or species selection. Fewer attempts have been made to modify the anterior trawl, but varying sweep/bridle lengths, horizontal separator panels and longer headropes have realized benefits depending on species-specific behavioural responses. While the utility of many modifications is indisputable, experimental designs (mostly involving covers, but also alternate hauls and paired comparisons) have, in many cases, suffered low replication and/or confounding variables. These deficits may have compromised some results and contributed to repeated efforts in particular fisheries. We conclude that rigorous empirical assessments, initially focusing on the posterior trawl, but eventually encompassing anterior changes, combined with straightforward interpretation of results for stakeholders, are as important as the simplicity and reliability of modifications. Finally, by assessing the utility, applicability, advantages and disadvantages of the modifications developed, we provide a framework which could be followed in future work to reduce bycatch in these fisheries.

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**Keywords** Bycatch · Discard · Demersal fish trawl · Multi-species · Selectivity



## Modifications to reduce bycatch in prawn trawls: A review and framework for development

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**Key words:** bycatch reduction devices, fishing gear technology, prawn trawls, selectivity

### Abstract

The incidental capture of non-target species from prawn trawling has recently attracted worldwide attention. Primarily, concerns arise from the perception that prawn trawls catch and discard large numbers of juveniles of species that, when larger, are targeted in other commercial and recreational fisheries. While several management options are available, the majority of fisheries in the world have attempted to address this issue through physical modifications to trawls, designed to improve selectivity. The types of modifications used reflect fishery-specific characteristics; however, most can be broadly classified into two categories, including: (1) those that separate species by differences in behaviour, and (2) those that mechanically exclude unwanted organisms according to their size. In the present paper, I provide a chronological review of publications in the primary literature that describe experiments examining modifications within these categories. This review shows that inherent variabilities among different fisheries greatly influence the types of designs that need to be applied and although some designs have the potential for application across different fisheries, significant modification and re-evaluation are often required. By collating information from previous studies, I also propose a framework encompassing the various stages involved in developing and applying successful modifications in prawn-trawl fisheries. The key stages identified include: (1) quantification of bycatches and accumulation of fishery-related information; (2) examination and re-evaluation of modifications; (3) assessment of damage inflicted on escaping individuals; and (4) promotion of recommended designs.



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### Fishing Gear

### Bycatch Species

### Reduction technique

### Include Non Field Studies

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Displaying 1 - 10 of 15

Location	Gear	Catch	Technique	Bycatch Species	Type
Western Mediterranean (Spain)	Trawls			Caretta caretta (Loggerhead turtle)	Summary study
<p><b>Summary:</b> A questionnaire administered to the bottom trawling fleet in the western Mediterranean (northeastern Spain) reported 238 bycatch events involving loggerhead sea turtles (<i>Caretta caretta</i>), calculated as a monthly CPUE of .09. The authors discuss this figure relative to nearby coastal regions and suggest some possible mitigation measures.</p> <p><b>Effect on Bycatch:</b> <b>Reference:</b> <a href="#">Domenich, F., de Quevedo, I.R.A., Marchán, M.M., Revuelta, O., Vilez-Rubio, G., Bitón, S., Carona, L., and Tomás, J., 2014, Incidental catch of marine turtles by Spanish bottom trawlers in the western Mediterranean</a></p>					





## TAKE-AWAY MESSAGES

Involve Stakeholders!

Be sure about solution  
There may be easier ways!

Communicate  
long term gain

Do not assume  
bycatch survive!