CNR IRBIM ISTITUTO PER LE RISORSE BIOLOGICHE E LE BIOTECNOLOGIE MARINE

MEDAC MEDITERRANEAN ADVISORY COUNCIL

Stazione Zoologica Anton Dohrn Napoli

MEDAC - FG Strait of Sicily

FH55 Grand Hotel Palatino - Via Cavour 213/m, Roma

26th February 2025

Management measures for mitigating the elasmobranch by-catch

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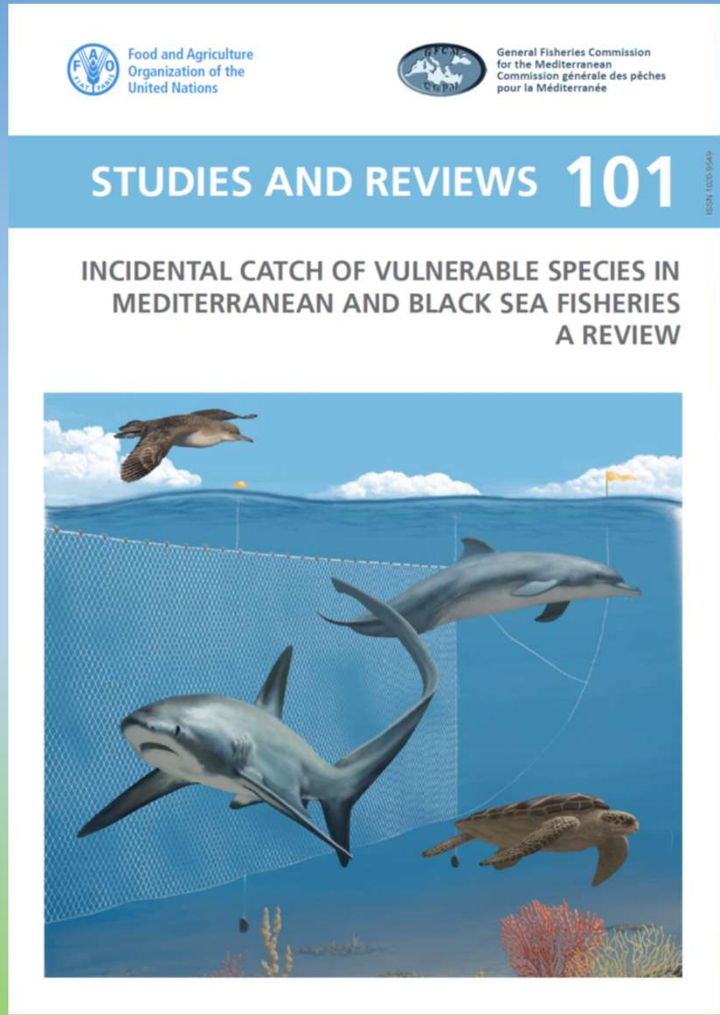
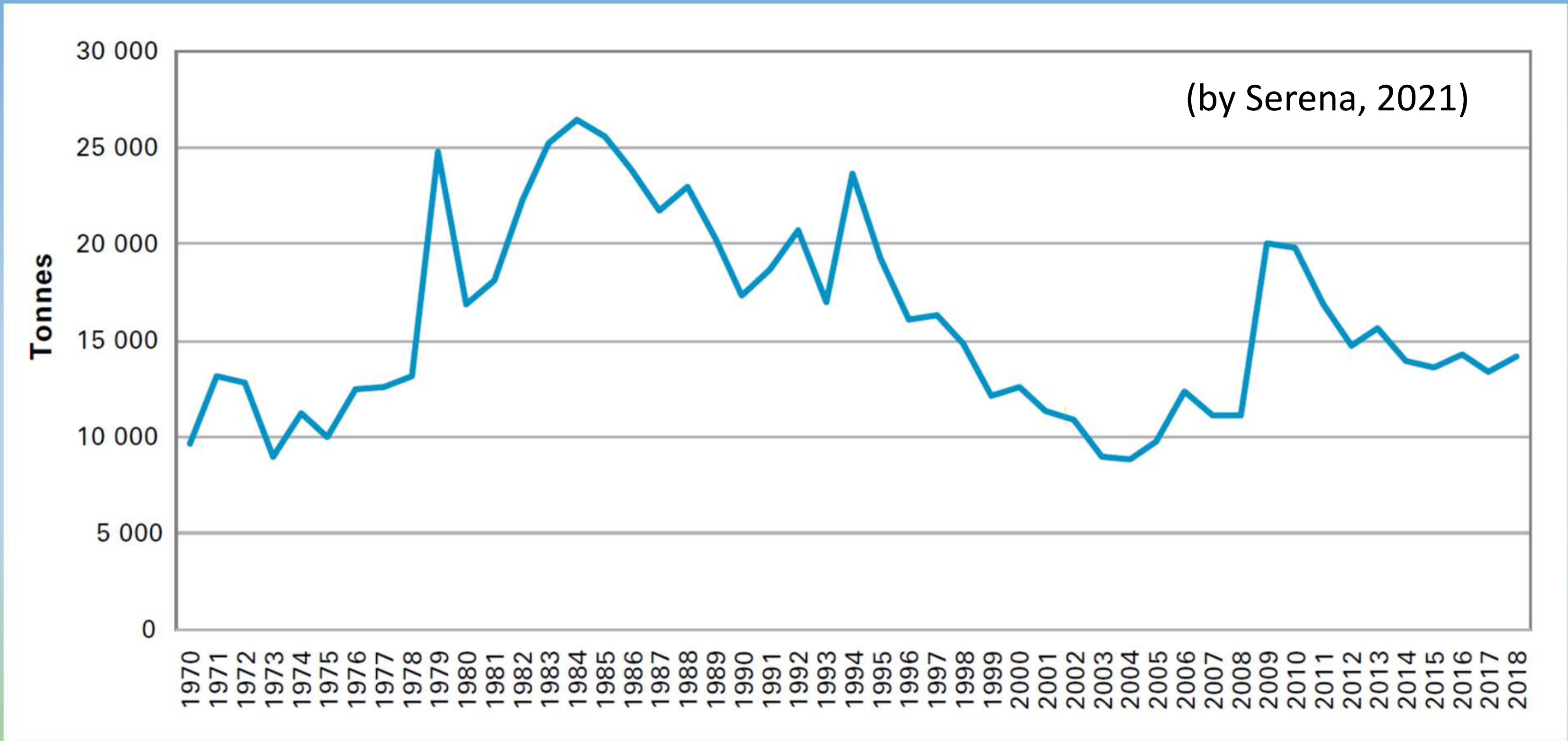
Mediterranean and Black Sea ecosystems contribute about 7% of global chondrichthyan (cartilaginous fishes, including sharks, skates, rays and chimaeras) diversity, with at **least 48 species of sharks** and **38 species of batoids** (rays and skates).

Due to their low population growth rates, late sexual maturity and production of relatively few offspring, **chondrichthyans have low resilience to anthropogenic pressures**, making them particularly **vulnerable** to human activities.

Reducing fisheries **bycatches** of **vulnerable species** is critical to **marine biodiversity conservation** and **sustainable fisheries** development



Development of elasmobranch landing according to the FAO data base



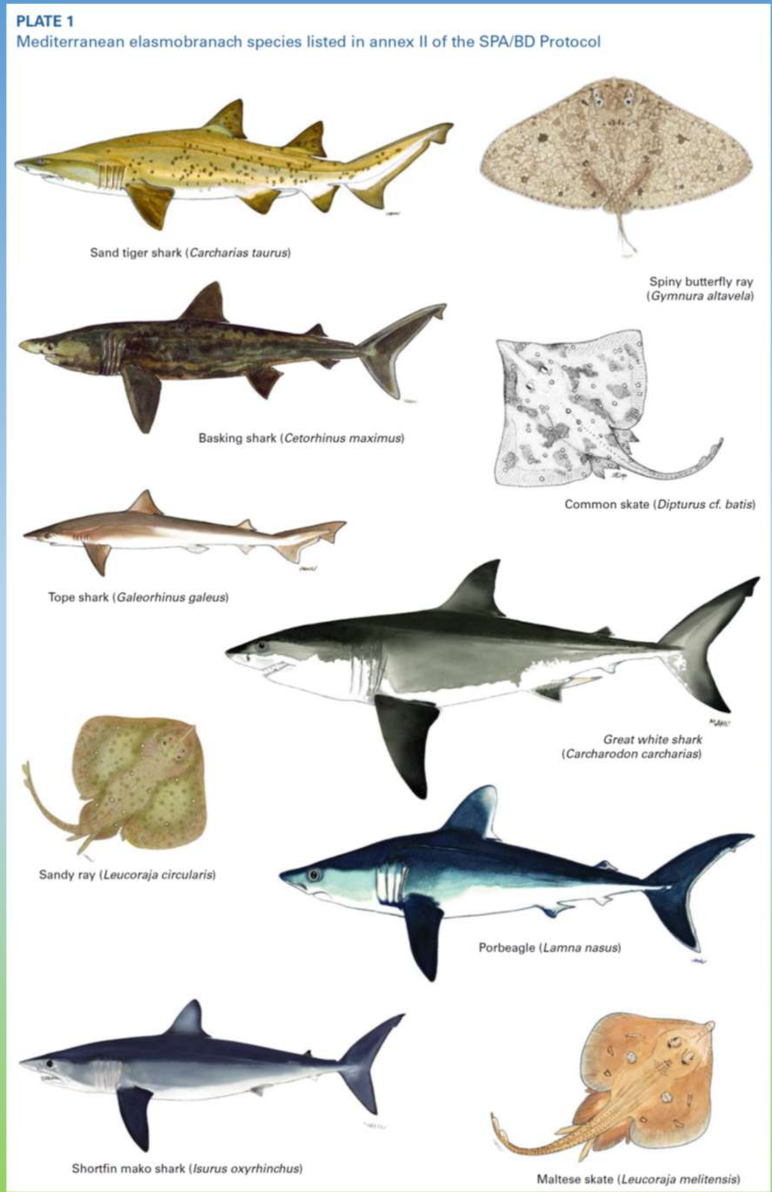
In the EU Mediterranean countries, almost no fishing activity currently targets elasmobranchs, which are often still caught as either discarded or landed bycatch in many fisheries.

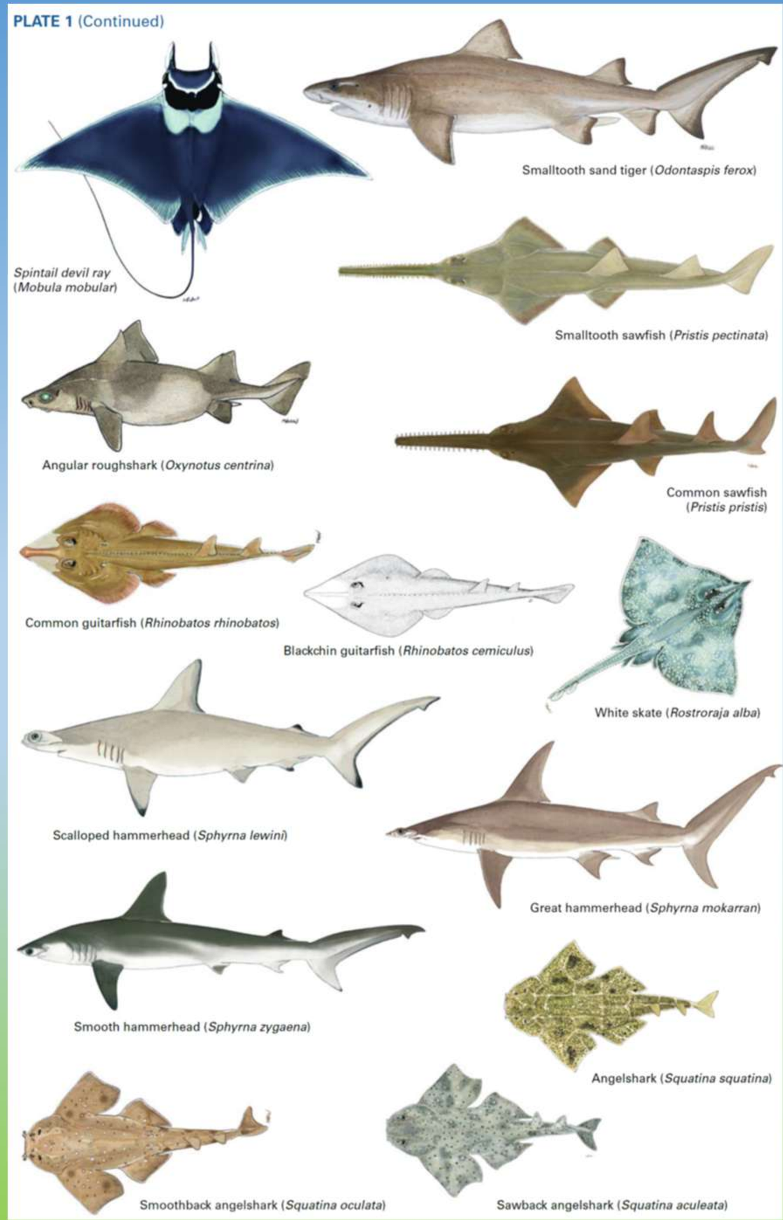
Bycatch estimates of elasmobranchs in the GFCM region

- **In the western Mediterranean**, almost all the elasmobranch bycatch is attributed to **bottom trawlers** (**92 percent**).
- **In the Adriatic Sea**, the bulk of the records comes from **pelagic trawlers** (**81 percent**).
- In the **central Mediterranean, longliners** (**77 percent**) represent the vessel group with the absolute highest number of available records.
- In the **eastern Mediterranean, bottom trawlers** (**44 percent**) still represent the vessel group with the highest incidental catch, with traditional **coastal purse seiners** (**10 percent**) also responsible for a considerable portion of the elasmobranch bycatch in the area.
- In the **Black Sea**, around **97 percent** of the bycatch is attributed to **passive gears** (i.e. trammel nets and gillnets)

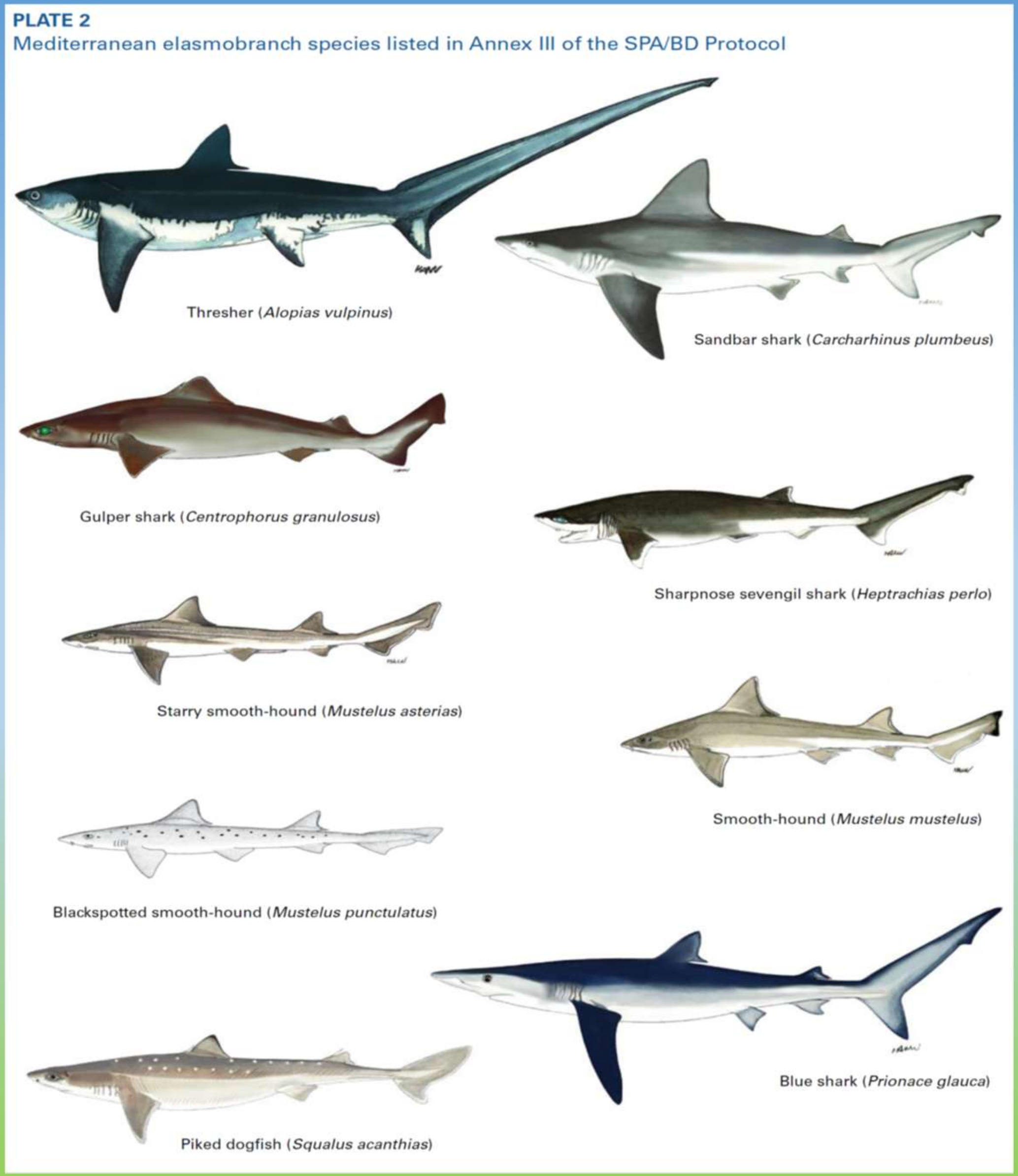
The 24 endangered and threatened Elasmobranchi n Annex II of the SPA/BD Protocol covered by Recommendati ons GFCM/36/2012 /3 and GFCM/42/2018 /2

(by Serena, 2021)





The 9 endangered and threatened Elasmobranchs in Annex III of the SPA/BD Protocol covered by recommendations GFCM/36/2012/3 and GFCM/42/2018/2



(by Serena, 2021)

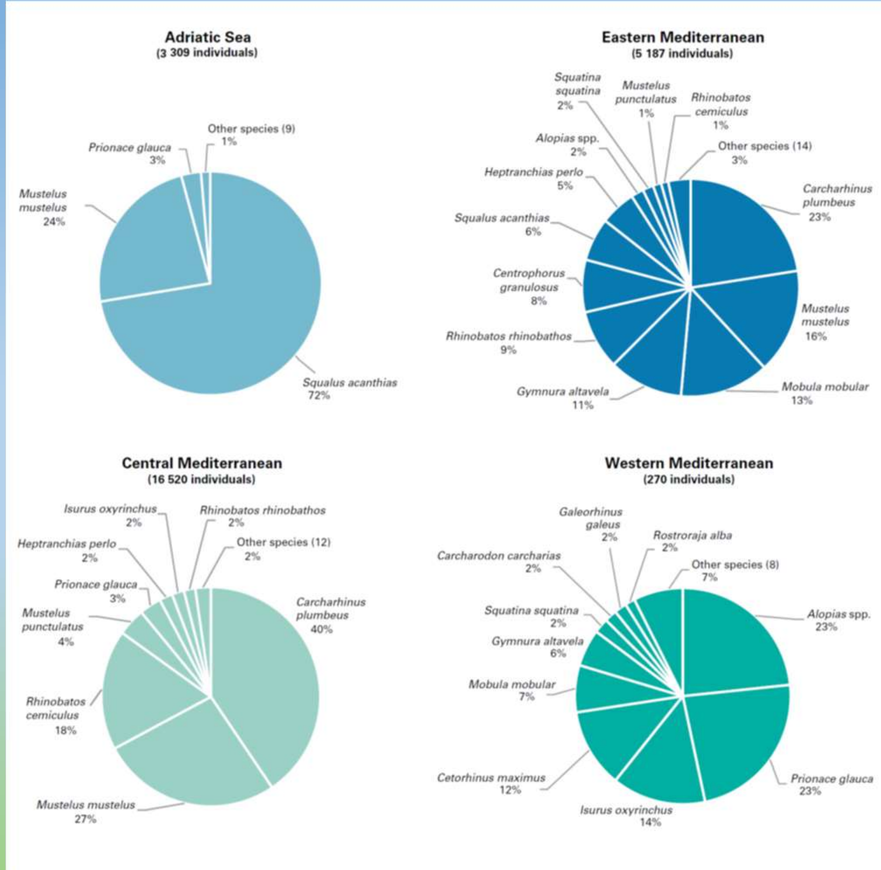
Reported elasmobranch conservation-priority species by Mediterranean subregion (data from literature 2008–2019)

Western Mediterranean: ***Carcharinus plumbeus, <u>Musteuls mustelus</u>, Mobula mobular & Gymnura altavela***

Central Mediterranean: ***Carcharinus plumbeus, <u>M. mustelus & Rhinobatos cemiculus</u>***

Adriatic Sea: ***<u>Squalus acanthias & M. mustelus</u>***

Eastern Mediterranean: ***Plionace glauca, Alopias spp., Isurus oxyrinchus & Cetorhinus maximus***



N.B. *Alopias vulpinus* and *A. superciliosus* records are pulled together as *Alopias* spp.

(by Serena, 2021)

Some information on bottom trawl bycatch in the Strait of Sicily

An assessment of the impact of **trawl fishery** on elasmobrach bycatch in the Strait of Sicily showed that **13 rays and 8 sharks** were caught between 2009 and 2021.

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Bycatch of Demersal Elasmobranchii in the Strait of Sicily

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ABSTRACT

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Table 2. *Percentage (%) of the positive hauls per species during the analyzed period.*

Species	% positive trips	Species	% positive trips
Rays		Sharks	
Raja clavata	13.16	*Scyliorhinus canicula*	17.47
Raja miraletus	11.58	*Squalus blainville*	8.73
Raja montagui	3.62	*Mustelus mustelus*	7.2
Raja radula	1.46	*Scyliorhinus stellaris*	1.13
Raja asterias	1.34	*Mustelus punctulatus*	0.28
Raja polystigma	0.67	*Mustelus asterias*	0.15
Raja brachyura	0.61	*Centrophorus uyato*	0.15
Leucoraja melitensis	0.54	*Heptranchias perlo*	0.06
Rostroraja alba	0.54		
Dipturus oxyrinchus	0.15		
Raja undulata	0.15		
Torpedo torpedo	0.02		
Torpedo marmorata	0.02		

Figure 2: Standardized catch rates (N/h) of Rays(upper) and Sharks (lower). Blue dots represent observed data, solid red lines are the predicted catch rates while the shaded area represents its standard deviation.

The main approaches to mitigate elasmobranch by-catch

(by ACCOMBANS, 2019)

LONGLINES AND LINES

Fishing gear improvements

➢ **Hook type**

- Weak or breakable hook
- Corrodible hooks

➢Bait

- **Bait type**
- Artificial bait
- Luminous lures

➢ Branch lines

Setting improvements

➢ *Time and duration of the set*

➢ *Set depth*

Acoustic mitigation

Chemosensory mitigation

Magnetic or electropositive mitigations

TRAWL

Fishing gear improvements

➢ Tickler chains

➢ **BRD**

➢ Setting improvements

FIXED NET

Fishing gear improvements

➢ **Enmeshment**

➢ **Entanglement**

Setting improvements

➢ *Spatio-temporal closures*

➢ *Restrictions on the minimum net-setting depth*

Magnetic mitigation

OTHER MANAGEMENT MEASURES

Spatial closures

➢ **FRA**, MPA, Other Effective Area-based Conservation Measures (OECMs);…

Temporal closures

➢ **spawning or breeding period**

PURSE SEINE

➢ Excluder device

➢ Ecological FADs

➢Setting improvement

➢ *Acoustic and chemical mitigation*

➢ Safe Handling and Release

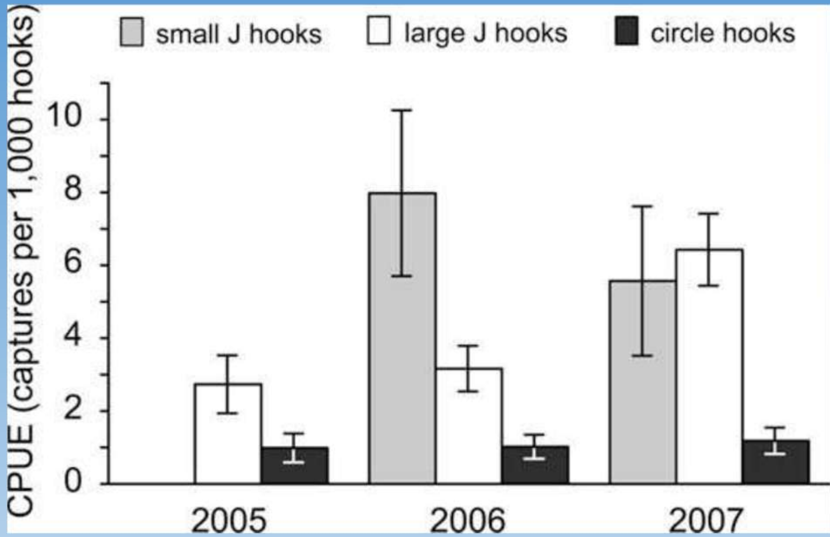
LONGLINES AND LINES- Fishing gear improvements

Ninety-seven longline experimental sets were run on 9 pelagic longliners in the Strait of Sicily for three years.

Results showed that **the larger the J hook, the lower the stingray capture rate.** Moreover, **circle hooks** had a significantly **lower number of pelagic stingrays captured per 1000 hooks than J hooks, up to ~80%.**

Bait size, within the range of sizes assessed**,** and use of **light attractors did not have significant effects**.

These results suggest that the adoption of large circle hooks by commercial and artisanal swordfish longlining may be a measure to reduce their environmental footprint.



(by Piovano et al., 2010)

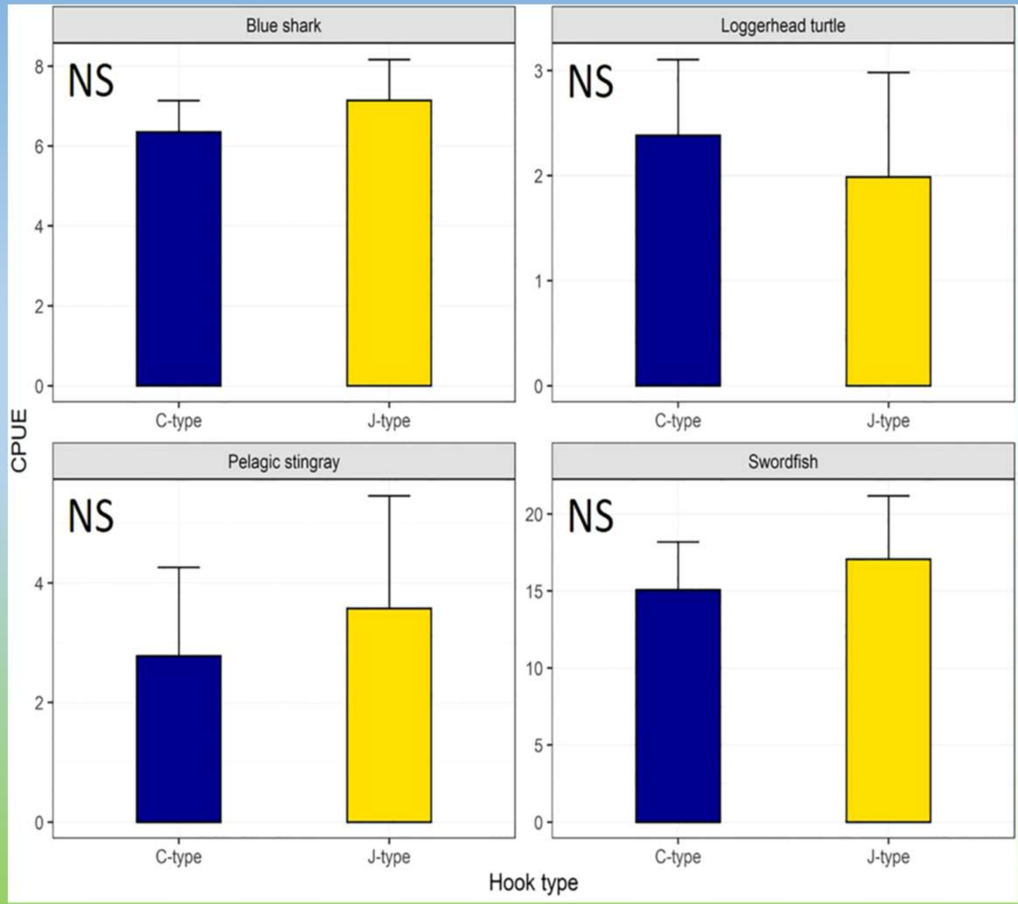
Category	small J hooks	small J hooks	large J hooks	circle hooks
Nominal size	5	4	2	16/0
Offset (°)	20	20	20	10
Gape width (cm)	1.9	2.1	2.6	2.7
Min. tot. width (cm)	2.2	2.4	3.3	4.4

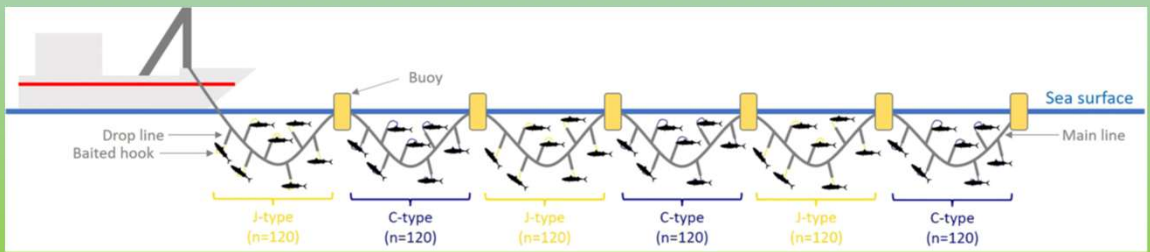
LONGLINES AND LINES- Fishing gear improvements

More recently, the effects of replacing the traditional J-type hook with a circle hook (C-type hook) on target and by-catch species were investigated by seven sets of experimental longline targeting swordfish, Xiphias gladius, in the South Adriatic Sea.

For both targeted swordfish and by-catch specimens caught (*Prionace glauca, Pteroplatytrygon violacea and Caretta caretta*), **no significant difference in CPUE or specimen lengths between the two hook types were found.**

In addition, the hook type did not significantly affect the capture condition of swordfish, pelagic stingray, or loggerhead turtle specimens, but the **percentage of blue shark specimens found in healthy condition was higher when using a C-type hook (71.5%) than when using a J-type hook (22.6%).**



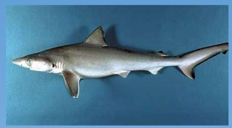


(by Carbonara et al., 2023)

The gill nets - Fishing gear improvements

Experimental fishing to reduce by catch of shars was conducted in coastal waters (0–5 km) off North Carolina, USA and was concentrated on two coastal gill net fisheries, targeted to the Spanish mackerel (*Scomberomorus maculatus*) and the spot bream (*Leiostomus xanthurus*).

The use of gillnets with **increasing the gillnet tension using larger floats on the head-rope and increasing the lead-core lead-line weight** no significant difference in the catch rate of the target species while catch rates of some shark species were significantly reduced.

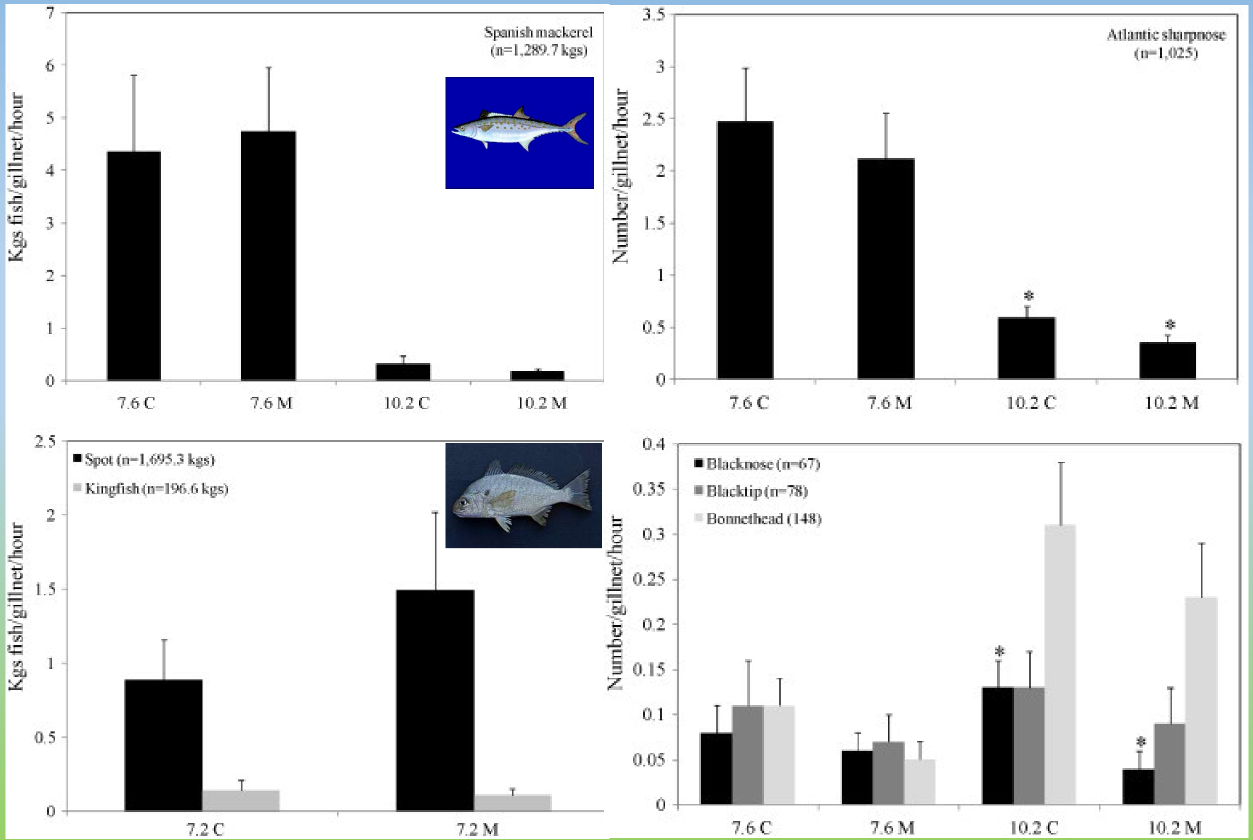


Atlantic sharpnose
Rhizoprionodon terraenovae

Blacktip
Carcharhinus limbatus

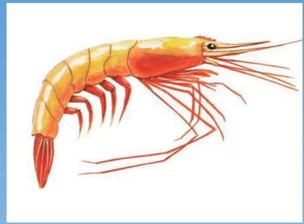
Blacknose
Carcharhinus acronotus

Bonnethead
Sphyrna tiburo



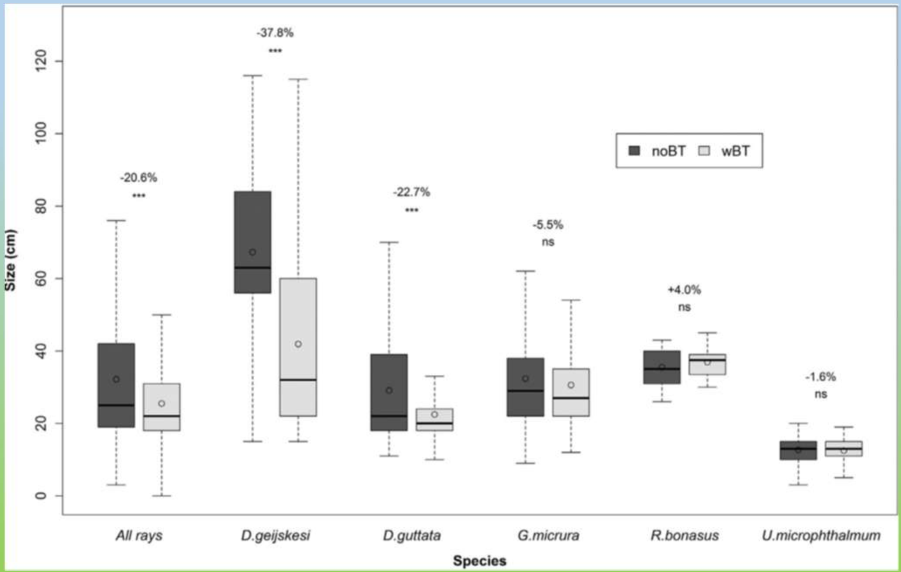
(by Thorpe & Frierson, 2009)

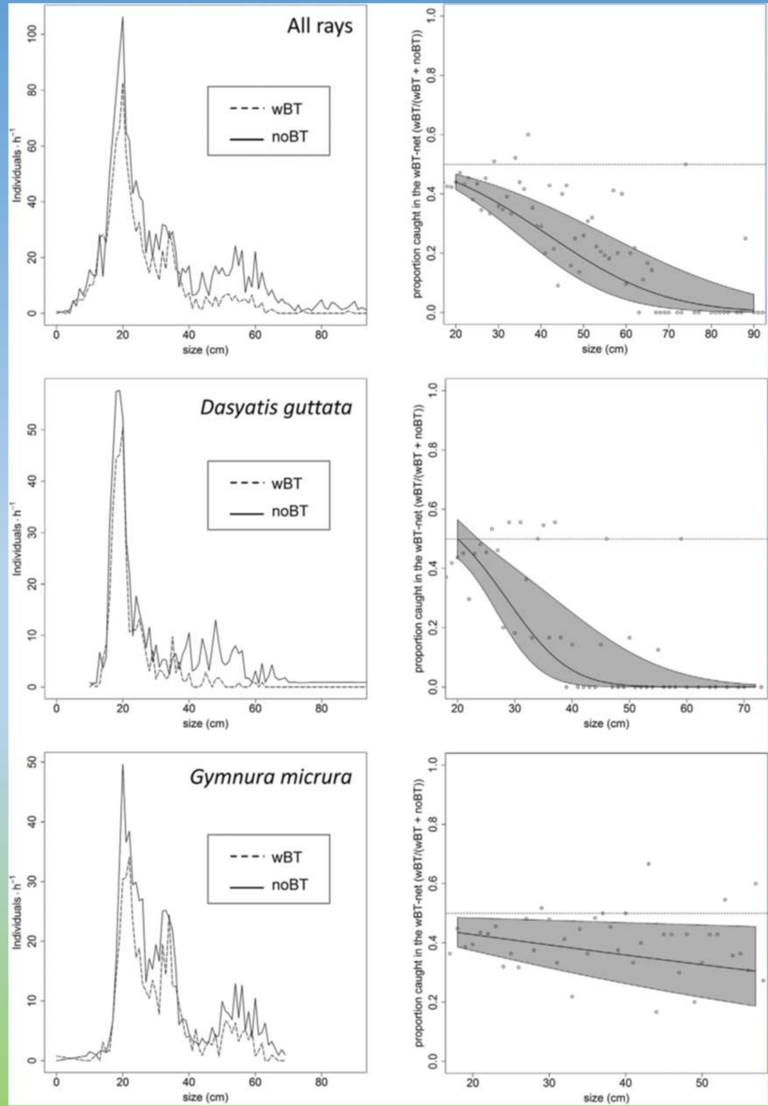
TRAWL - Fishing gear improvements



Xiphopenaeus kroyeri

Evaluating the reduction of elasmobranch by catch in Atlantic seabob shrimp (*Xiphopenaeus kroyeri*) fishery off Suriname, t**rawls with a Bycatch Reduction Devices and Turtle Excluder Devices combination reduced ray catch rate by 36 % with the preferential exclusion of large rays.**



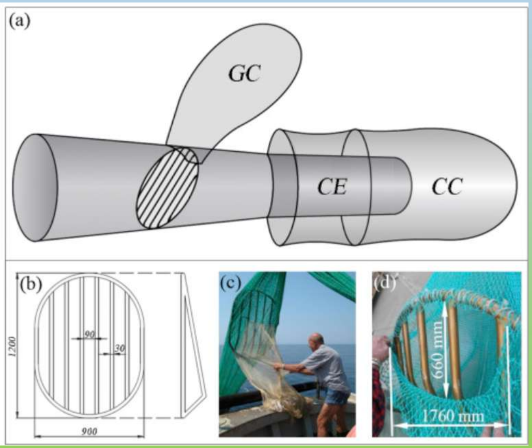


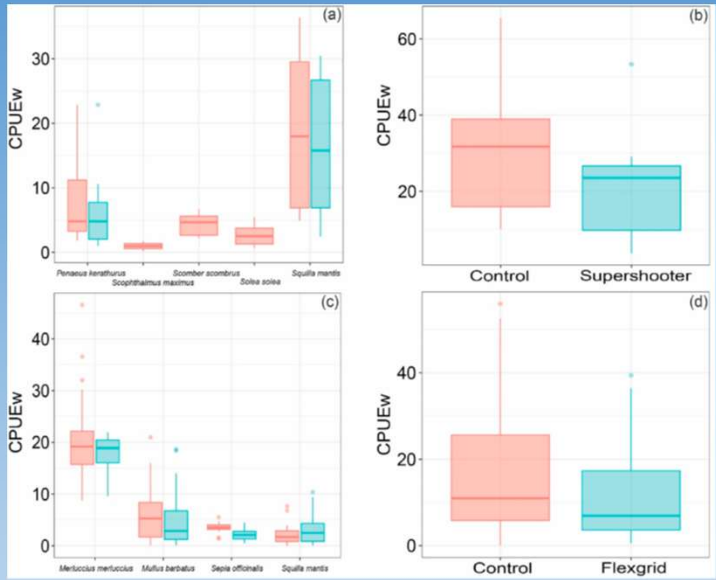
(by Willems et al., 2016)

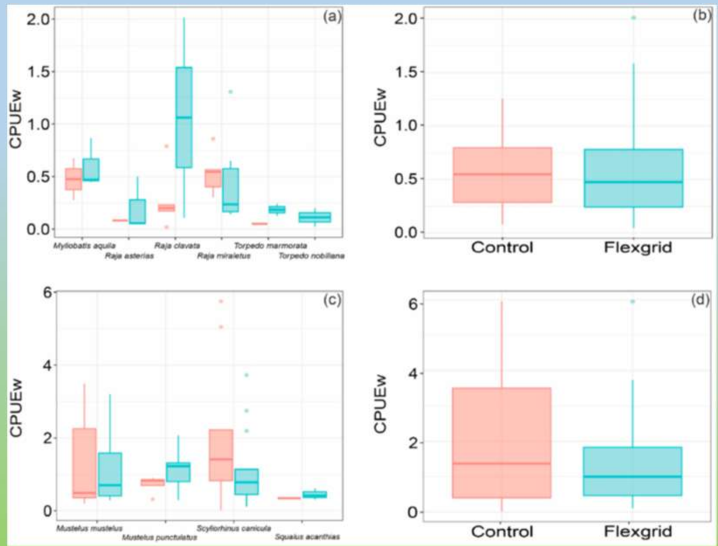
TRAWL -Fishing gear improvements

A **novel shark excluder device (SED) and a flexible grid (Flexgrid)** in the northern central Adriatic Sea showed that **SED** were **effective in excluding elasmobranch species. Catches made with this grid showed no significant difference for targeted crustacean** (*Mantis shrimp*), although **losses** were registered for **some large bony fish.**

Flexgrid did not affect the catches of the main target species, such as the red mullet, European hake and mantis shrimp, **but also retained small sized spotted catshark** (*Scyliorhinus canic*ula). The effectiveness of the grids apparently was affected by the small size of the elasmobranchs captured.







(by Desantis et al., 2024)

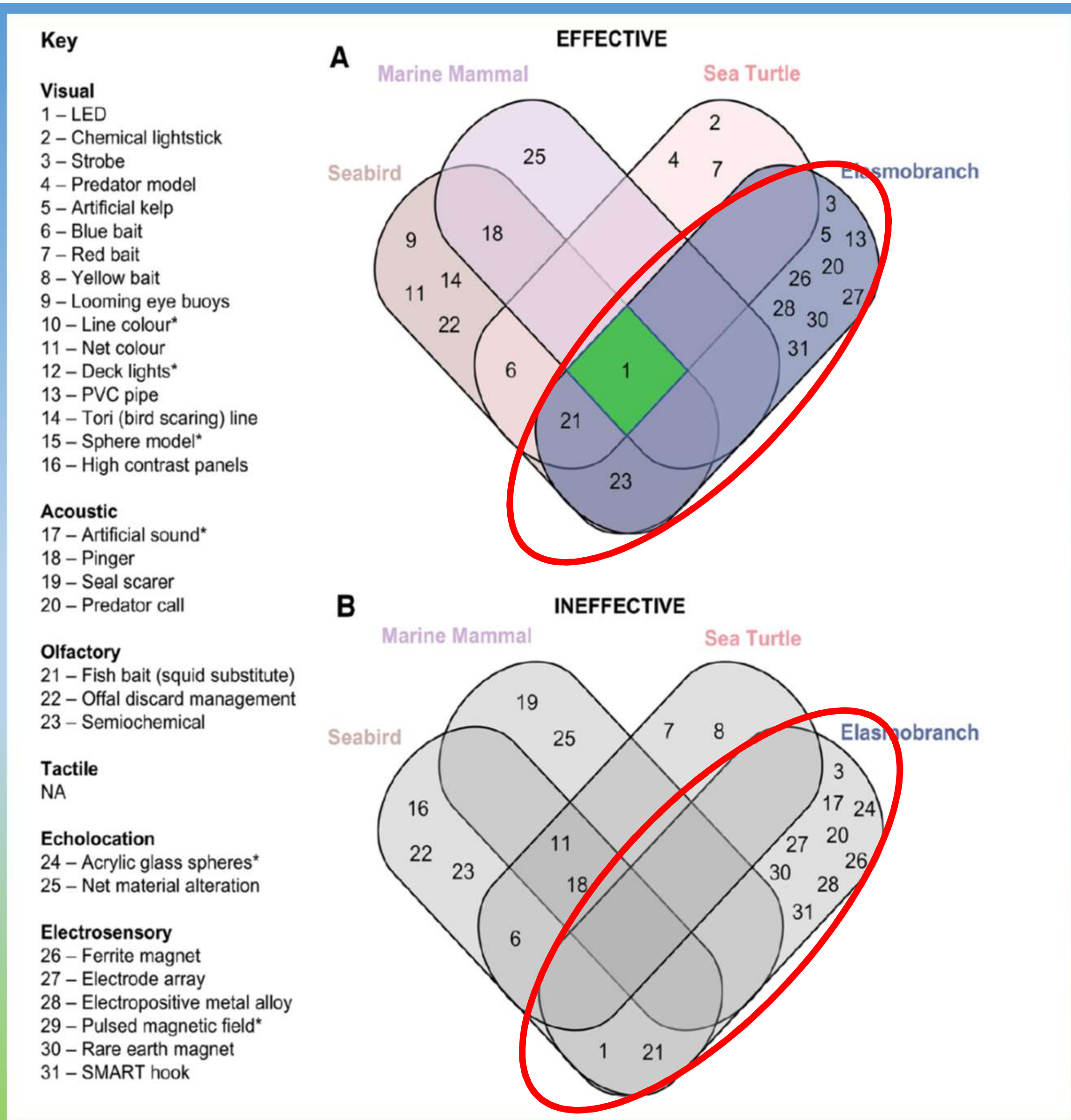
The main results of recent reviews on international journals

Lucas et al., (2023), based on a systematic review of 116 papers, plus 25 literature reviews published between 1991 and 2022, investigated potential for sensory deterrents to mitigate bycatch across marine mammals, sea turtles, seabirds and elasmobranchs.

Lights on gillnets are the only technology showing significant bycatch reductions across all four taxonomic groups.

The efficacy of each method **is context dependent, varying with species, fishery and environmental characteristics.**

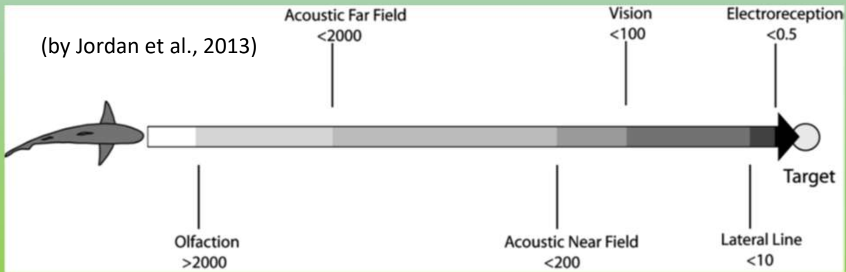
	Acustic	Echolocation	Electroreception	Olfactory	Visual
Skate	2	0	7	0	2
Shark	29	0	75	15	11
Ray	2	0	7	2	3
Unspecified	0	0	0	0	1



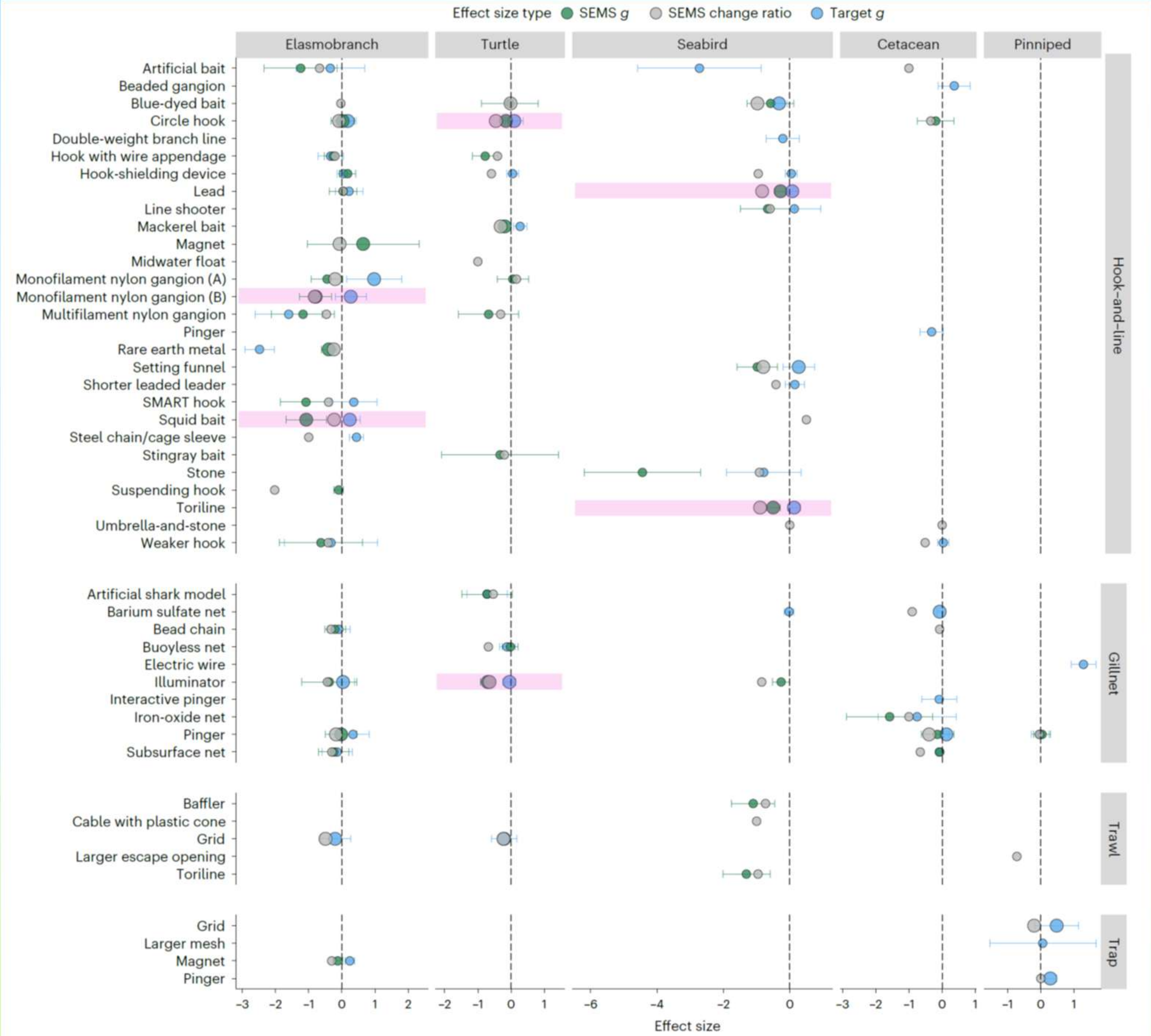
Huang et al. (2024), based on a meta-analysis approach to quantify the effects of 42 technical measures on the target catch and the bycatch of seabirds, elasmobranchs, marine mammals and sea turtles, showed that these measures generally reduced the bycatch while having no statistically significant effect on the target catch.

Sensory-based measures generally outperformed physical-based ones in reducing the bycatch.

Mitigation measures that worked well for several fishing gears or taxa, although useful, were very rare.

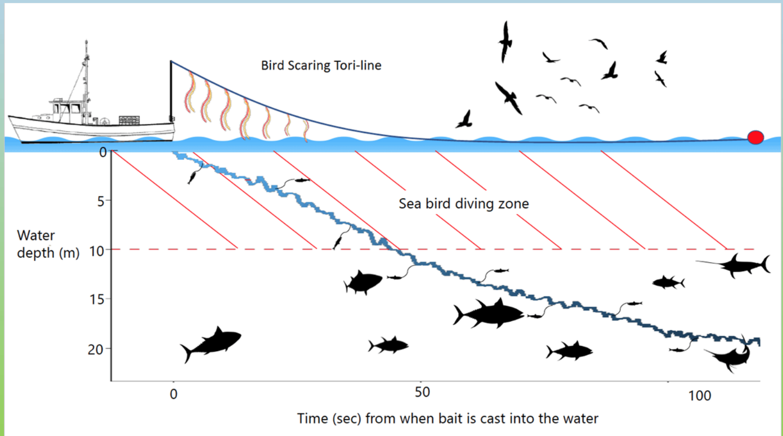


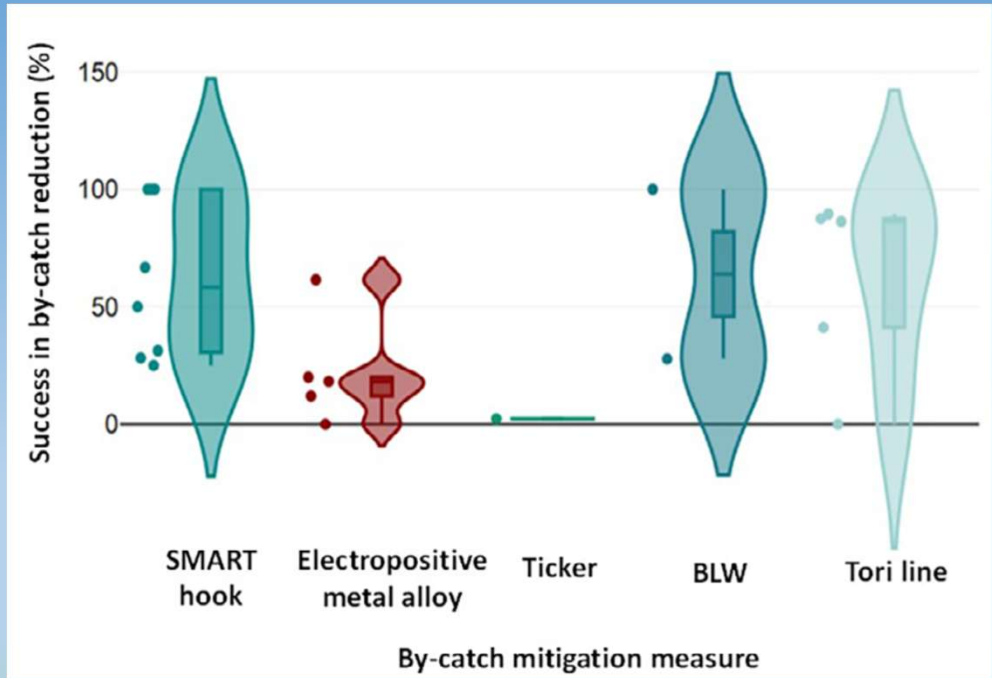
(by Jordan et al., 2013)



Villafáfila et al. (2024), based on 389 papers published between 2010 and 2022, assessed the effectiveness of measures for bycatrch mitigation showed that 'TEDs' (Turtle Excluder Devices) are an effective measure for sea turtles, 'pingers' for marine mammals and 'BSLs' (Bird Scaring Lines), more commonly known as 'tori lines', for seabirds.

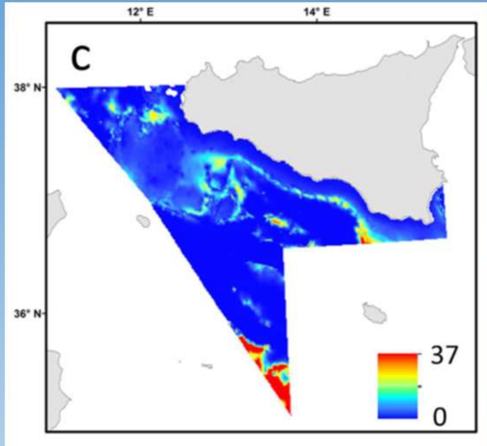
The most complex case is that of elasmobranchs, and the most effective measure has yet to be discovered.



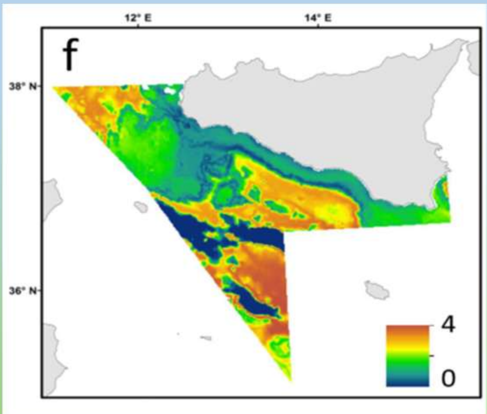


Success in reducing by-catch (%) of Elasmobranchs, by different **by-catch mitigation measures**. The horizontal lines inside each box correspond to the mean, while the vertical lines at the ends of each box refer to SD.

OTHER MANAGEMENT MEASURES - Spatial and temporal closures



Predicted population densities (Nkm−2) of *Raja melitensis* in the Strait of Sicily.



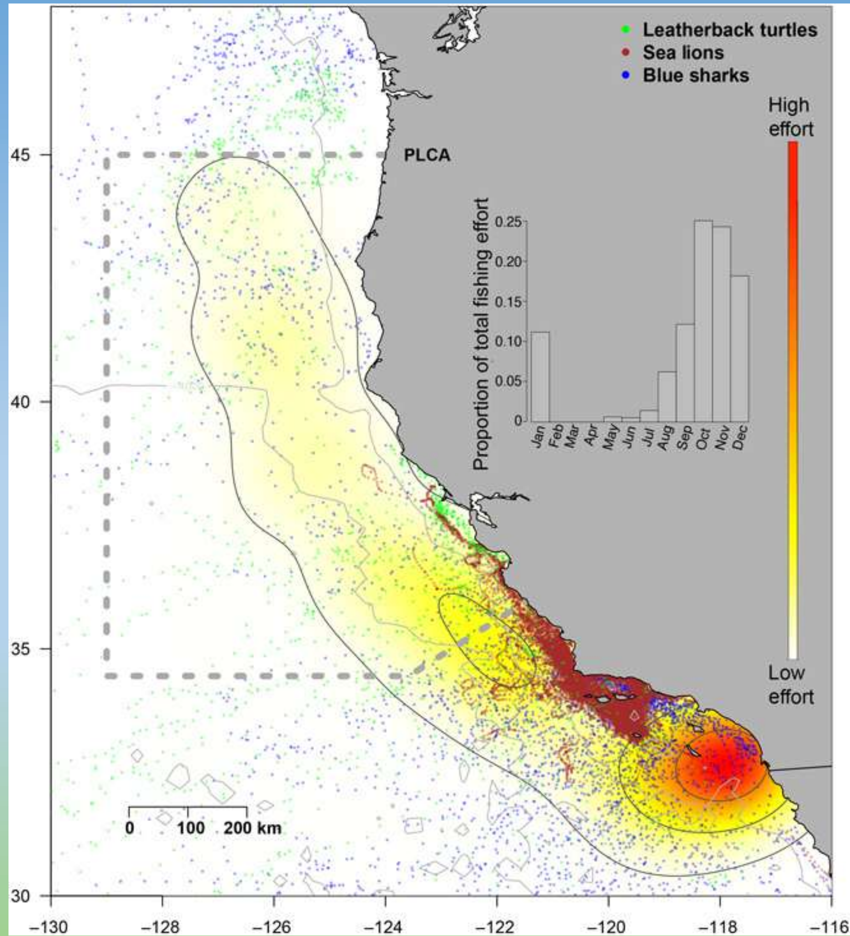
Community diversity of elasmobranchs (37 species) in the Strait of Sicily (by Lauria et al., 2015).

A **new dynamic approach** was proposed by Hazen et al. (2018) that uses **daily satellite data** to track **ocean features** and aligns scales of management, **species movement**, and **fisheries**.

A **species distribution models** for 1 target species and 3 bycatch-sensitive species**, including sharks,** was firstly created **by using both satellite telemetry and fisheries observer dat**a.

Species-specific probabilities of occurrence were then integrated into a **single predictive surface**, weighing the contribution of each species by management concern.

Results showed that **dynamic closures could be 2 to 10 times smaller than existing static closures** while still providing **adequate protection** of **endangered non target species.**

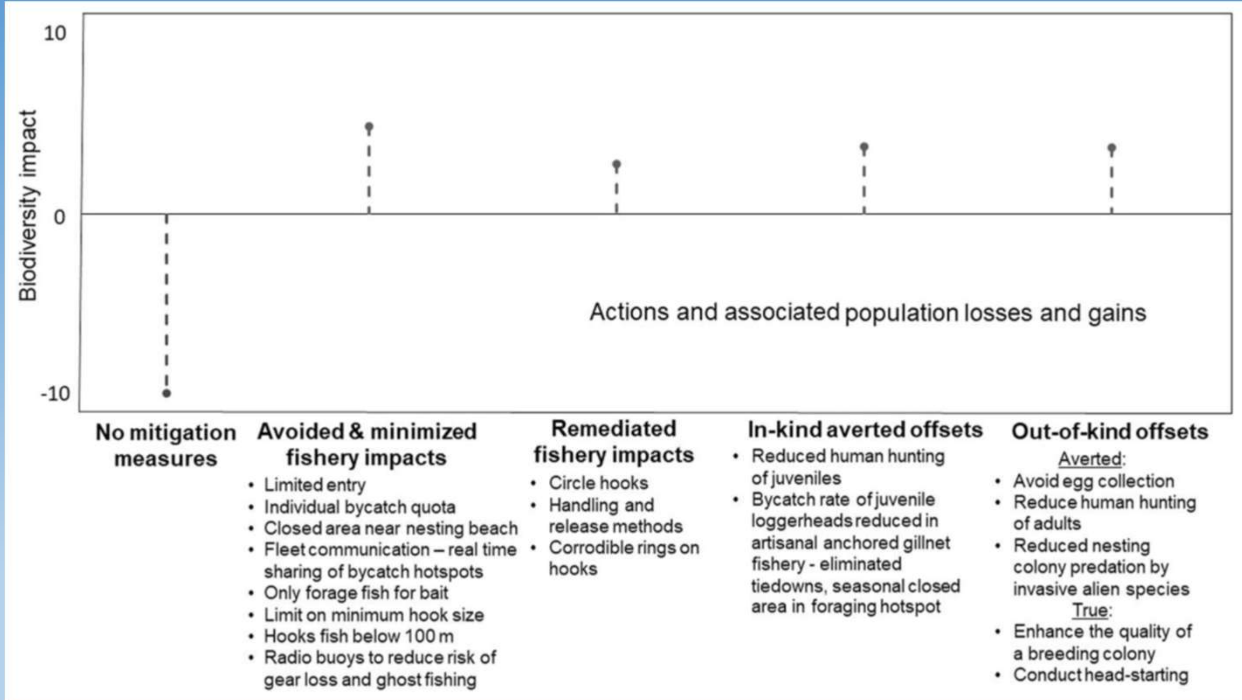


Fisheries observer data are shown from low (yellow) to high (red) effort. The three tagged species are shown as points. The majority of fishing effort (80%) has taken place between August and December throughout the period of the study, with a peak in October (by Hazen et al., 2018)

Somethings on more recent management approaches

Squires et al. (2021) proposed a biodiversity mitigation hierarchy for fisheries bycatch conservation and management using one of four basic approaches:

1) **private solutions, including voluntary, moral suasion, and intrinsic motivation;**
2) **direct or "command-and-control" regulation starting from the fishery management authority down to the vessel;**
3) **incentive- or market-based to alter producer and consumer behavior and decision-making;** and
4) **hybrid of direct and incentive-based regulation through liability laws.**



Gilman et al. (2023) reported that **measures** that **avoid bycatch should be prioritized than those that minimize catch risk.**

These are then followed by **remediation measures** that **reduce fishing mortality** and **sublethal impacts**.

Finally, for residual impacts that could not be avoided, minimised and mitigated, **direct or compensatory measures** can be implemented.

A few last recommendations from a fishery biologist

- The **effectiveness of conservation measures** to reduce elasmobranch bycatch **varies by species, gear, location, time and fishing method**;

- Because of this variability, **robust evaluations** of the effectiveness of **elasmobranch** bycatch **mitigation measures** must be based on **monitoring and testing researches** that include the **different operating conditions** of the fishery;

- It is therefore imperative to build a **collaborative network of stakeholders**, from local fishermen and researchers to national and international organisations, **for a generously planned elasmobranch bycatch programme** to assess **species interactions under different gears and fishing configurations**;

- Only through **cooperation and clear communication** between these **different stakeholders** from all **Mediterranean and Black Sea countries** the **decline of elasmobranch** populations can **be reversed**;

- Issues related to **habituation, habitat exclusion and foraging** around fishing gear **are important**, although **reducing elasmobranch mortality** should remain the **highest priority** for conservation and preservation of the fishery ecosystems;

- A range of **complementary and redundant** measures will be required to achieve **consistent bycatch reduction goals** in many fisheries, where **knowledge of behavioural and sensory interactions of species** with **fishing gear** in space and time **could play an important role** if appropriately enhanced.

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