 <p>Agreement on the Conservation of Albatrosses and Petrels</p>	<p><b>Twelfth Meeting of the Seabird Bycatch Working Group</b></p> <p><i>Lima, Peru, 5 – 7 August 2024</i></p> <p><b>Toolbox for seabird bycatch mitigation advice in purse seine fisheries</b></p> <p><b><i>Cristián G. Suazo, Esteban Frere, Yann Rouxel &amp; Oliver Yates</i></b></p>
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## SUMMARY

The following document is an updated version of the advice on mitigating seabird bycatch in purse seine fisheries, initially compiled in 2021 (Suazo & Alfaro-Shigueto 2021, SBWG10 Doc 19). It encompasses a series of proposed mitigation measures tailored to these net fisheries, considering their operational dynamics, ongoing trials assessing effectiveness, and constraints and considerations for onboard implementation by decision-makers. Additionally, this document provides background information on purse seine fisheries, including insights into identifying sources (hotspots) of seabird bycatch during operations, as discussed in the working group (Suazo et al. 2023, SBWG11 Doc 14). The objective of this document is to serve as a practical resource for communicating the feasibility of seabird bycatch mitigation measures specific to purse seine fisheries. As such, it offers a synthesis of mitigation measures identified as early as 2017 (Suazo et al. 2017, SBWG8 Inf 26), which encompass sensory approaches, physical barriers, and structural modifications to purse seine gear, some of which are complemented by best practices directly applicable to crew members on deck.

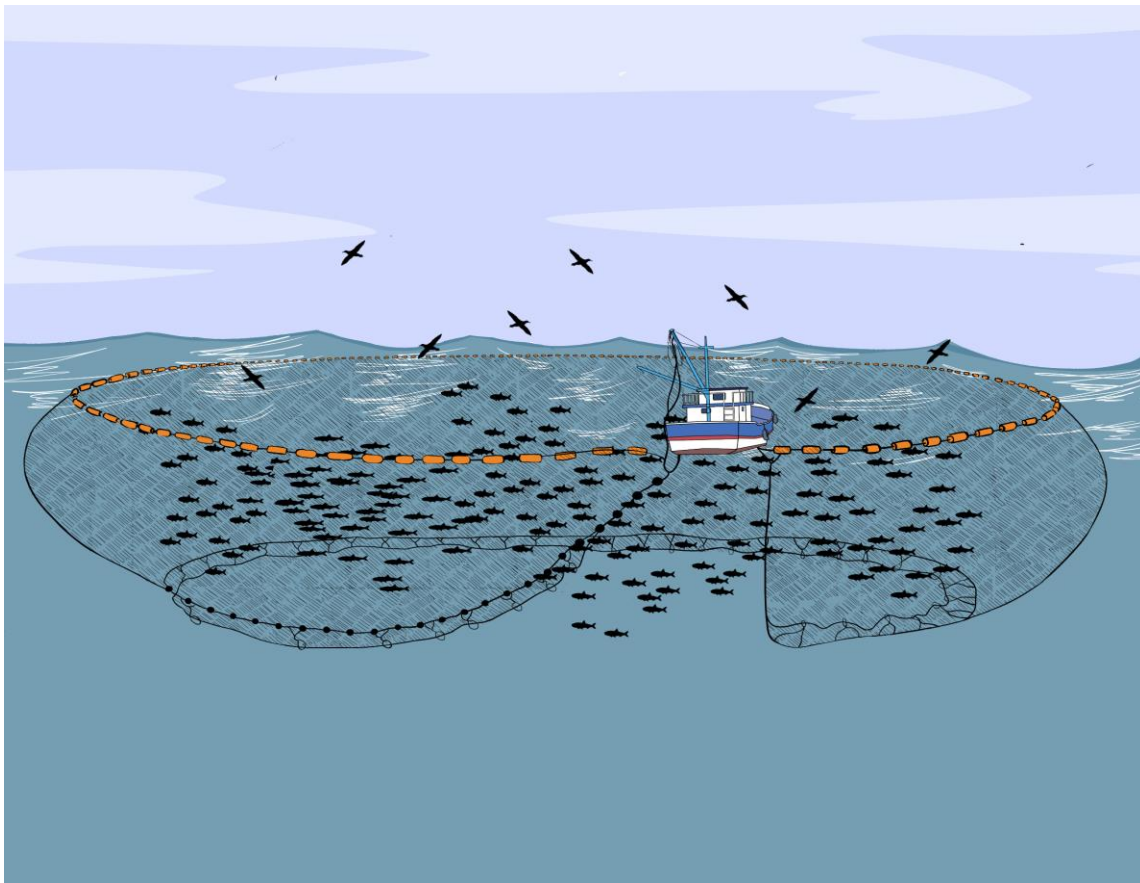
## 1. BACKGROUND

Since 2016, purse seine fisheries have become a part of the ACAP agenda (Baker & Hamilton 2016; Debski et al. 2016; Suazo et al. 2016,). These discussions have focused on understanding the fishing gear and its operation, as well as identifying seabird species involved in bycatch incidents in both industrial and small-scale vessels.

As early as described in Suazo et al. (2017a), the list of purse seine fisheries showing signs of seabird bycatch included at least eight countries, spanning seven FAO marine areas, impacting 33 seabird and 2 waterbird species, primarily concentrated in coastal fishing grounds.

Described in Suazo et al. (2023), purse seine fisheries involve a surrounding net used to encircle shoals of pelagic target species like tuna, sardines, and squids. The fishing gear consists of a wall of netting fitted with an upper line of buoys or floats and a lower line of weights (Fig. 1).

In the lower part of the net, a system of steel rings connected by cables allows for the net to be closed, preventing fish/squid from escaping through the lower part of the net. The dimensions of the net, as well as the mesh size, vary depending on whether the net is for small-scale or industrial vessels and the target species, respectively.



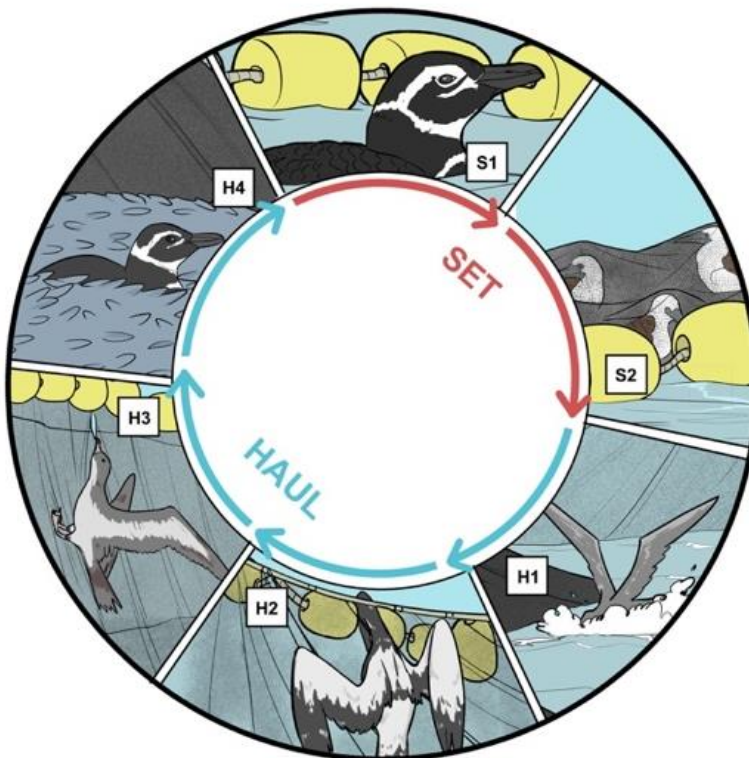
**Figure 1.** Example of a small-scale purse seine fishing operation. The net encircles the fish shoal, with its upper part buoyed and the lower part weighted. Steel wires are then winched together to close the net, forming a bowl shape (© C.G. Suazo).

## **2. A TOOLBOX APPROACH: SEABIRD BYCATCH REDUCTION IN PURSE SEINE FISHERIES**

### **2.1. Identifying seabird bycatch for effective mitigation measures in purse seine fisheries**

Purse seine fisheries are among the least studied in terms of their impact on non-target species, with more frequent records involving marine mammals, marine reptiles, seabirds, and other taxa (Soykan et al. 2008). Thus, in the case of industrial purse seine operations for tuna, these fisheries have been recognized as non-problematic for seabirds. There is a set of voluntary best practices aimed at reducing the chances of bycatch, such as avoiding sets in

areas with a presence of non-target species and implementing fishing gear entanglement prevention measures for cetaceans, sharks, and sea turtles (Swimmer et al. 2020). However, for other industrial and small-scale vessels targeting small pelagic fish, seabird bycatch has been identified, with entanglements occurring during different stages of the fishing operation (i.e., set or haul) and in various sections of the purse seine gear and facilities onboard. It is highly recommended that these features be identified by monitoring systems/observers to recognize hotspots of bycatch in different fleets (Suazo et al. 2016, Fig. 2).



**Figure 2.** Phases of the purse seine fishing and bycatch hotspots identified for set and haul of the gear. Clockwise direction during set: trapped in the buoyline for non-flying seabird species (S1), ceiling for diving seabird species (S2). During haul of the net: Entanglement in folders of the retrieving net (H1), Entanglement in the buoyline (H2), Entanglement in holes and mesh size of zippers (H3), trapped in the bunt for flying and non-flying seabird species (H4). (© C.G. Suazo).

Among mitigation measures, some cases have suggested the use of sound and lasers as deterrents, where coastal seabird species like gulls have shown reduced numbers in response to noise in northern Chile, as opposed to Procellariiform species like shearwaters (Diez, 2017). However, the effectiveness of lasers in purse seine fishing in the same area has not proven to be efficient. Controlled trials for trawl fisheries have detected the effectiveness of lasers under specific operating conditions, such as daylight conditions and vessel speed (Melvin et al. 2016).

Other mitigation measures for purse seine fisheries involve structural modifications of the gear, such as the Modified Purse Seine (MPS). This entails a series of adjustments including buoy mounting and mesh size, among others. These adjustments have demonstrated a reduction in entanglement and capture of birds belonging to ACAP-listed species, such as the pink-

footed shearwater *Ardenna creatopus* and the black-browed albatross *Thalassarche melanophris*, in Chile (Suazo et al. 2017b, 2019). The effectiveness of these structural modification measures has been evaluated against the best practice criteria adopted by ACAP to inform decision-makers (Melvin et al. 2023).

Another modification to the typical structure of purse seine gear involves the opportunistic observation of diving seabirds like shearwaters and penguins using "escape windows," which are sections of the buoyline with no floats that allow seabirds to escape from the encircled net, as noted in northern Chile for industrial vessels targeting anchovy (Auger Lancellotti, 2019).

Recent sensory mitigation measures include the use of a bird-scaring device (scaring kite) in purse seine fisheries in Portugal (Oliveira et al. 2021). This device has proven effective in reducing the number and activity of some seabird species like gulls, but its effect on other seabird species such as shearwaters requires further research. If these measures prove effective, they may contribute to the reduction of bycatch in ACAP-listed species (e.g., Balearic shearwater *Puffinus mauretanicus*) previously reported for purse seine vessels in these waters (Oliveira et al. 2015).

## **2.2. The communication of mitigation effectiveness through the toolbox approach**

The diversity of mitigation measures and the need to clearly communicate these options in terms of their evidence and effectiveness have led to the development of the "toolbox" approach, which serves as an informative instrument to support mitigation decisions (Mangel et al. 2016, 2017). This approach, initially proposed for artisanal and small-scale fisheries, is also applicable to purse seine fisheries.

Moreover, the information summarized in tables reporting the features of each potential measure can be supplemented by guided questions on the feasibility of the measure, which are largely covered in the assessment under the ACAP best practice criteria (Suazo et al. 2017).

The bycatch mitigation toolbox for purse seine fisheries is presented below, including different levels of evaluation in relation to mitigation function, findings, limitations, and its status in reducing seabird bycatch in general, as well as for species belonging to the ACAP-list of priority species (Table 1).

A practical compilation on the status of different levels of our knowledge on emergent and established measures for Best Practices Advice in priority fisheries like purse seine is provided (Baker et al. 2024). This compilation supplies key information for future decision-making, particularly when proposing mitigations require trialled evidence for their effectiveness in important purse seine fleets (López & Vega, 2023).

It addresses important dimensions to consider as our understanding of the interaction between seabirds and purse seine fishing continues to increase in significant fleets globally (e.g., Rivadeneyra-Villafuerte et al. 2021), as well as the increase in emergent ideas for mitigation that must be evaluated for tailored conservation actions in these widely distributed fisheries (Table 1).

**TABLE 1.** MITIGATION TOOLBOX FOR PURSE SEINE FISHERIES WITH STATUS ON EFFICACY. FISHING OPERATION: MITIGATION TO REDUCE BYCATCH EVENTS LINKED TO “SET” OR “HAUL” OF THE PURSE SEINE GEAR. ADDITIONAL BENEFITS: NO AVAILABLE (N/A).

Mitigation	Function	Fishing operation	Findings	Additional benefits	Limitations/ considerations	Source	Status*
Water spraying	Physical barrier for seabirds (Mexico)	Haul	Preliminary trials may affect seabird presence in risk areas into the net (e.g., pelicans)	N/A	<ol style="list-style-type: none"> <li>Needs to be handled by one person in a reduced crew (e.g., small-scale purse seine)</li> <li>Absence of appropriate facilities and training would be harmful for seabirds (water cannon instead of water spraying)</li> <li>The use of waters pumped from the same waste waters may contain edible oils can potentially affect seabird plumage</li> </ol>	Suazo et al. (2017a)	
Edible oil release	Sensorial / physical deterrent to keep away seabirds (Australia)	Set	Trials demonstrated no effects of shark oil vs controls on seabird feeding activity of shearwaters	N/A	<ol style="list-style-type: none"> <li>Oil should attract other seabird or non-target taxa to fishing operations</li> <li>Available re-supplies on board are needed</li> <li>The use of oil may have other detrimental effects (e.g., plumage)</li> </ol>	Puglisi (2007)	

Mitigation	Function	Fishing operation	Findings	Additional benefits	Limitations/ considerations	Source	Status*
Sound	Sensorial deterrent to keep away seabirds (Chile)	Set-Haul	Trials demonstrated effects of noise deterrents on the abundance of some sensitive seabird species (e.g., gulls) in contrast to Procellariiform species	N/A	1. Recommended additional sound devices to influence in other seabird species than gulls with unexpected harmful effects on seabirds and crews 2. Consideration of noise pollution when communal fishing exists (e.g., small scale purse seine)	Diez (2017)	
Laser	Sensorial deterrent to keep away seabirds (Chile)	Set	Preliminary trials showed operational limitations during daylight and for certain seabird species like gulls	N/A	1. Potential detrimental effects on seabirds and crews must be considered and evaluated 2. Not recommended without an appropriate experimental design and safety protocols	Diez (2017)	
Modified purse seine (MPS)	Structural package of on fishing gear for the reduction of entanglement of seabirds with the purse seine gear (Chile)	Set-Haul	Trials showed the reduction in seabird bycatch for diving seabird species by 98% related to the reduction of entanglement in fishing gear	1. Modified purse seine showed improvement in catch success of the target fish species 2. Reduction in netting material with savings in future maintenance or new fishing gear		Suazo <i>et al.</i> (2016; 2017a,b; 2019)	

Mitigation	Function	Fishing operation	Findings	Additional benefits	Limitations/ considerations	Source	Status*
Bird scaring device (Scaring kite)	Physical barrier to reduce the presence of seabirds in risk areas (Portugal)	Set-Haulk	Trials showed the effect of this scaring device on activity of seabirds but with no bycatch events recorded for treatment and control sets.  Reduction in numbers of certain seabird species like gulls but not for ACAP species like the Balearic shearwater	N/A	1. Need operation by a crew member  2. Need to be assessed in areas of high occurrence of ACAP listed species	Oliveira (2021)	
Escape windows of buoyline (Escape windows)	Sections without mounted buoys on the upper mainline allow diving seabirds to escape from the encircled purse seine gear (Chile)	Haul	Occasional records show diving seabird species such as penguins and shearwaters using these gaps in the buoyline to move away from the risk area of the encircled net and its bunt	Potentially beneficial to marine mammals and turtles	1. It is necessary to assess the critical dimensions of windows and materials for the effective escape of non-target species and the efficient performance of gear on target species	Auger Lancellotti (2019)	

\* Legend (proposed categorisation of status in terms of mitigation efficacy):

	Systematically trialled: Reduced bycatch of ACAP species		Need systematic evaluation: Testing in progress
	Systematically trialled: Reduced seabird bycatch, not proven for ACAP species		Need systematic evaluation: Not trialled / no evidence available
	Systematically trialled: No reduction in seabird bycatch, but reduced other bycatch fauna		Need systematic evaluation: Opportunistic observation in the field
	Systematically trialled: No reduction in bycatch		

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