Agreement on the Conservation of Albatrosses and Petrels

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Chilean experience in the diagnosis, reduction and control of discards and seabird incidental bycatch

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SUMMARY

Within the framework of the implementation of a fisheries management strategy with an ecosystem approach, and following the recommendations of FAO and other fisheries forums, aimed at guaranteeing the ocean's sustainability and food security, Chile has developed since 2012 a process of diagnosis, reduction and control of discards and incidental bycatch in its national fisheries. This process has involved the joint efforts of the regulatory, research and control agencies along with collaborative work with the fishing users, leading the country to the gradual solution of the problem.

Regarding seabird incidental bycatch specific measures, these have been enacted in 2014, 2019 and 2021 for both industrial and artisanal longline and for industrial trawling fleets, establishing the mandatory use of deterrent devices, the application of codes of good fishing practices and reporting in logbooks, among others. These requirements are of differentiated application depending on the target fishery, gear, and type of fleet.

In addition, and considering the challenges of controlling and registering discards and incidental bycatch at sea, Chile recently incorporated the mandatory use of EMS (Image Recording Devices (DRI) and Electronic Logbook System (SIBE)) to monitor compliance with measures, also with a differentiated application depending on the type of fleet and vessel, along with the maintenance and enhancement of human observation programs onboard for scientific purposes.

The results obtained to date have shown significant reductions in seabird bycatch and mortality, proving that the appropriate implementation of specific mitigation measures and its compliance control may gradually solve the problem.

RECOMMENDATIONS

1. An adequate process of diagnosis, reduction and control of discards and seabird incidental bycatch should be gradually implemented, under transparent framework policies, where the views of the different stakeholders are considered and the realities of each country including technical, human capacities, economic and cultural aspects are also taken into account.
2. Exploring the use of EMS to improve the compliance monitoring coverage of the fishing fleets. However, it is recognized that the use of these technological systems for purposes other than compliance monitoring, such as obtaining scientific information and collecting fishery-dependent data, still requires intense work on the design of current monitoring programs, the exploration of the use of complementary technologies, and its integration with traditional human observer programs in use.
3. The use of EMS for discards and bycatch management yet implies great technical and logistical challenges, so it is recommended that, within the framework of this agreement, assistance be provided to strengthen the capacities of developing countries that are implementing these systems, either through of scientific internships, financing or other schemes that are deemed pertinent.

1. BACKGROUND

Given the current levels of fishing effort and a general lack of management, discards and incidental bycatch have become global issues that threaten fisheries sustainability. Despite its importance, addressing this problem has not shown significant progress over time, as evidenced by a number of FAO global assessments, with currently about 10% of world catches being discarded (Pérez Roda et al., 2019). Similarly, the Interaction of fisheries with seabirds, marine mammals and sea turtles has become significant in some places of the world, which, on top of other environmental pressures, has led many of the populations of these species to critical conservation states. Managing discards and bycatch is therefore an obligation for fishing nations, but achieving this first requires the collection of impartial and independent data on what happens at sea during fishing operations, as these issues are invisible at landing points, which is where most fishing monitoring has focused in the past.

Regarding seabirds, Chile is considered a center of biodiversity. In this sense, 109 species of seabirds have been reported (Schlatter and Simeone, 1999), of which 77 have proven reproduction in national territory (continental, insular, and Antarctic) and 13 are classified globally in some category of threat by the IUCN (IUCN 2023). Furthermore, of the 22 albatross species protected by ACAP[1], at least 12 regularly visit Chilean jurisdictional waters during their migrations, while two have colonies established in southern islands of the national territory. Various stages of the life cycle of these species coincide with fishing activities, which is evident when evaluating the interaction of seabirds with fisheries throughout the entire territorial sea and Exclusive Economic Zone (EEZ). Therefore, both industrial and artisanal fisheries overlap with important reproductive and feeding areas of different species of seabirds, such as the Cape Horn area and the Humboldt Current System, (Suazo et al., 2014; Carle et al., 2019).

[1] The Agreement on the Conservation of Albatrosses and Petrels

Aware of these conditions, and within the framework of the implementation of a fisheries management strategy with an ecosystem approach, aimed at guaranteeing the ocean´s sustainability and food security (as FAO and other fisheries forums have recommended), Chile has developed since 2012 an effective process of diagnosis, reduction and control of discards and incidental bycatch in its national fisheries. This process has involved the joint efforts of the regulatory (SUBPESCA[2]), research (IFOP[3]) and control (SERNAPESCA[4]) agencies along with a collaborative work with the industry users, academics, and NGOs, leading the country to the gradual solution of the problem.

In addition, considering the challenges of controlling and registering discards and incidental bycatch at sea, Chile recently incorporated the mandatory use of EMS (Image Recording Devices (DRI) onboard vessels and Electronic Logbook System (SIBE) to monitor compliance with measures and report fishing activities in real time, respectively, with differentiated application depending on the type of fleet, together with the maintenance and enhancement of human observation programs onboard for scientific purposes (**Figure 1**).

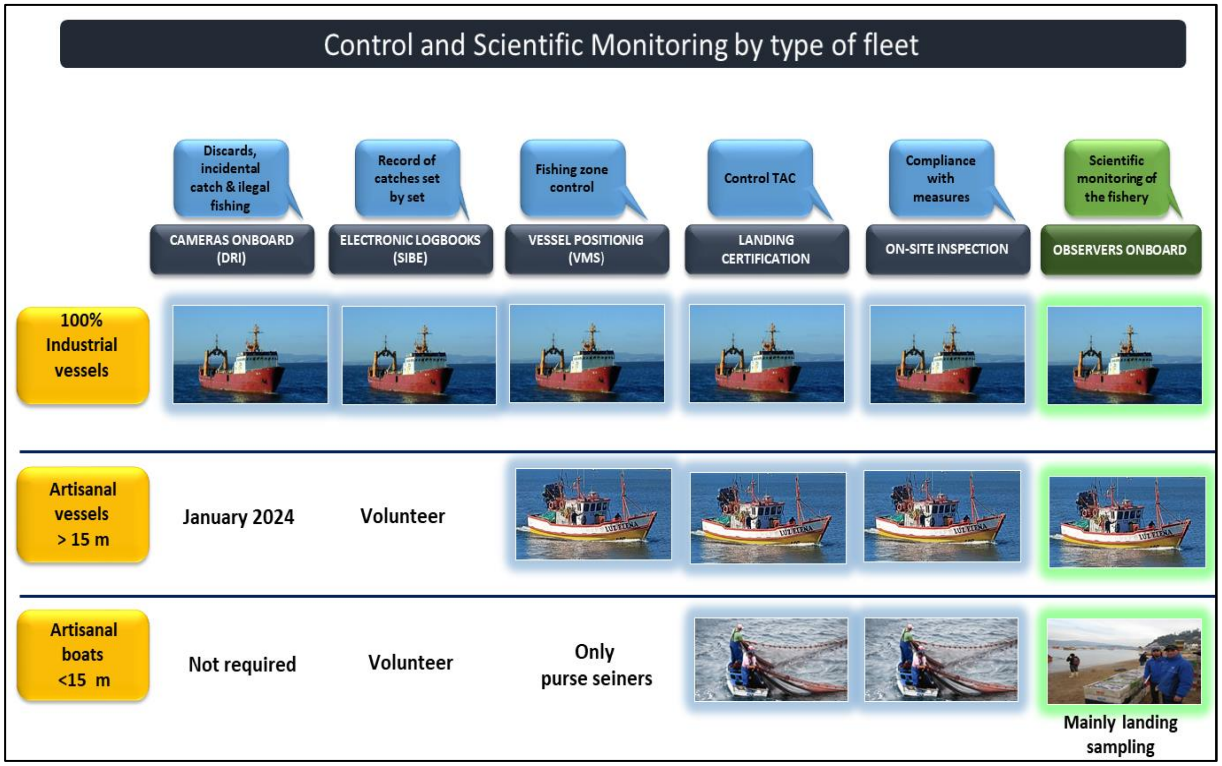

Figure 1. Monitoring tools differentiated by type/size of fleet/vessels to control compliance with fishing regulation including seabirds' bycatch mitigation measures (highlighted in blue) and to collect fishery dependent data for scientific purposes (highlighted in green), implemented in Chilean fisheries.

Notwithstanding these recent actions, it is recognized that the chronology of activities associated with seabird bycatch management in Chile has at least 25 years of history and continuous work in different instances and institutions, which allows the identification of important milestones, such as the initial diagnoses of the problem of bycatch in longline fisheries, the incorporation of Chile to ACAP, the promulgation of the current fishing law where

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the concept of an ecosystem approach is incorporated along with the promulgation of regulations that incorporate mandatory mitigation measures and finally the adoption of electronic monitoring (**Figure 2**).

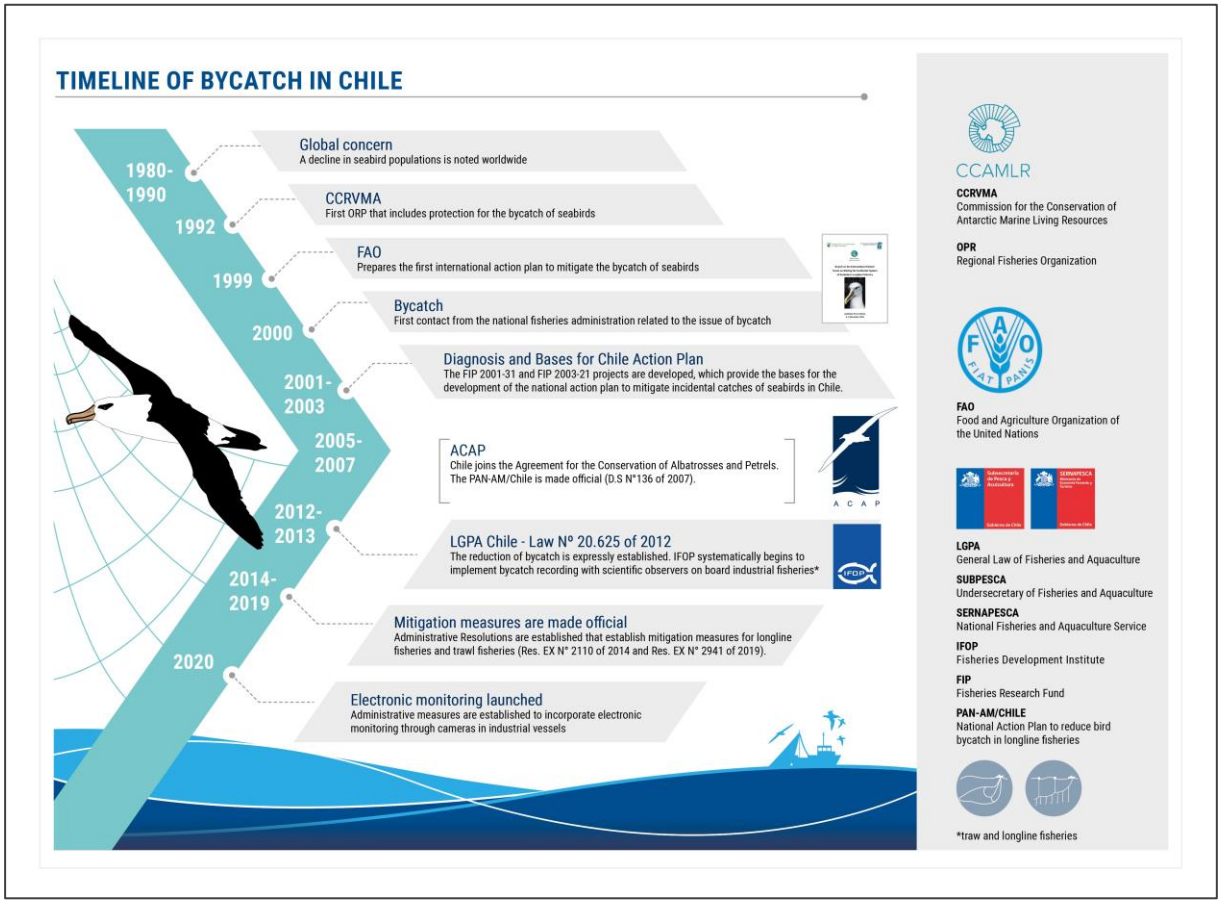

Figure 2. The chronology of activities associated with seabird bycatch in Chile

2. METHODS

There has been a 20-year evolutionary regulatory framework in Chile that has played an essential role in the development of discards and incidental bycatch management strategies to their current state.

In 2001 the term “discard” was first introduced into Chilean legislation under one approach of a general prohibition of discarding that did not distinguish between species or sizes of fish. Heavy sanctions to offenders and the lack of an extensive system to monitor compliance with this regulation at sea, made fishers uncooperative and consequently, the real extent and causes of discards remained unknown to the fishing authorities and management agencies. On the other hand, the direct catch of seabirds, marine mammals, and sea turtles was already eradicated in the 1990s through different laws and regulations (Decreto Exento N° 225 of 1995, N° 179 of 2008 and N° 4 of 2021 and Law N° 20293 of 2008). However, the problem of involuntary catch or incidental bycatch during fishing operations, which was the remaining source of mortality for these groups at sea, was not expressly forbidden and required inclusion in the law.

In recognition of these restrictions, the Chilean government reviewed fisheries legislation in 2012, and through the law N° 20625 of 2012, incorporated the concepts of **discard** "*action of returning to the sea captured hydrobiological species*" and **incidental bycatch** "*marine reptiles, seabirds and marine mammals*" along with sanctions for offenders and modern systems to control compliance with measures at sea. To solve the problem efficiently, the law also incorporated a new step - wise approach, which in a first stage considered exceptions to the penalties, conditional on a minimum of two - three years fishery-based research monitoring programs by observers on board, to quantify and identify the exact causes of discards and incidental bycatch. The exemption to penalties was included to prevent atypical behavior by crews that could bias the results and to gain the trust of fishermen. However, once the research programs stage concluded, the exemption of penalties ended (**Figure 3**).

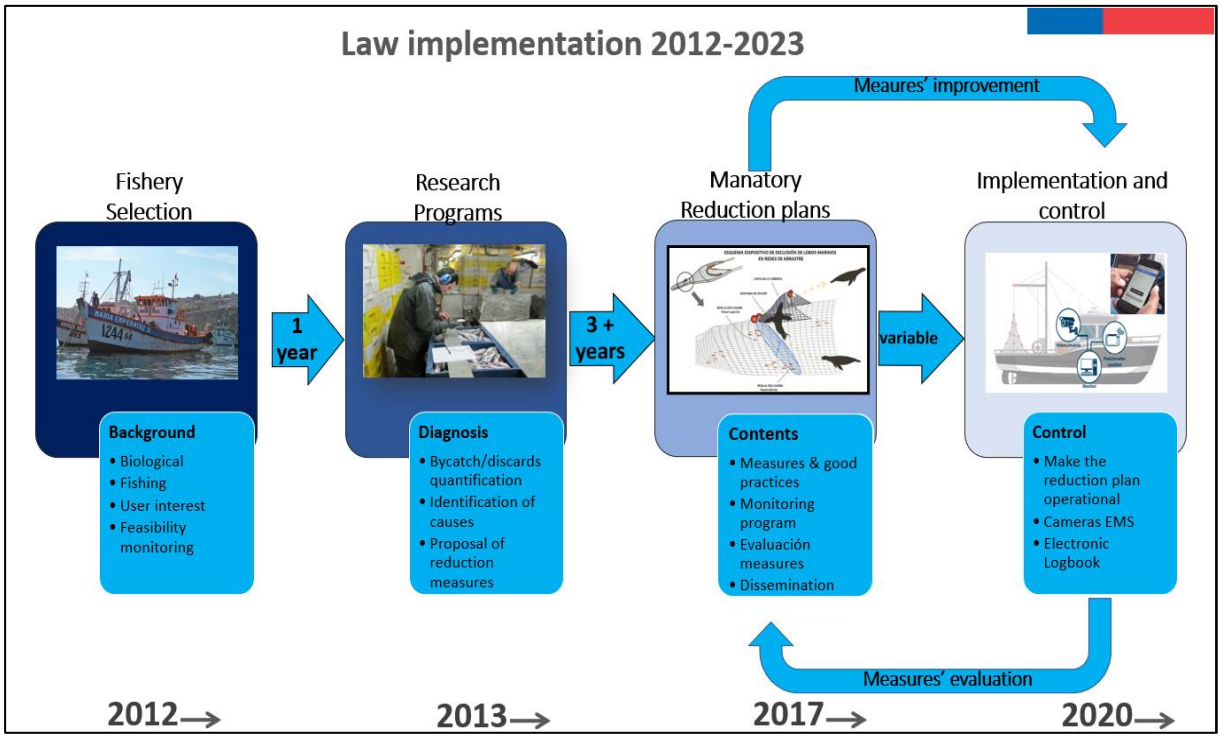

Figure 3. Stepwise approach implemented in Chile to diagnose, reduce, and control discards and incidental bycatch in fisheries.

The technical background obtained through the research programs was used to develop, at a later stage, mandatory reduction plans for discards and incidental bycatch, tailored for each fishery. These reduction plans include ***i***) management and conservation measures along with the technological means (such as the use of deterrent devices, excluders, handling protocols, etc.) necessary to reduce discards of both target and non-target species as well as the incidental bycatch of seabirds, marine mammals and sea turtles, ***ii***) a program to monitor and follow-up the plan's performance, ***iii***) an assessment of the measures adopted to reduce discards and incidental bycatch, ***iv***) training and dissemination programs, ***v***) codes of good practice during fishing operations, and **vi**) incentives for innovation in systems and fishing gear, whose objective is the mitigation or reduction of discards and incidental bycatch.

Consequently, having finished several fishery-based research monitoring programs by observers on board as required by law N° 20625/2012, by 2022, 11 discards and incidental bycatch reduction plans have been established, covering 17 fisheries both artisanal and industrial, while other fisheries are still in the research (exceptions ban) phase. Additionally,

the lists of species subject to the reduction plans for each fishery and the category they belong to (prohibited discard, authorized discard, mandatory return to the sea) are updated annually.

In a final stage and considering the challenges for controlling and registering discards and incidental bycatch at sea, the law N°20625/2012 also incorporated the use of Image Recording Devices or cameras onboard (DRI/EMS) (**Figure 4**). To implement the DRI, in 2015 a Supreme Decree N° 76/2015 established the requirements for these systems on both industrial and artisanal fleets. This regulation set out the DRI's components, DRI technical and design requirements, minimum number, and location of cameras by fishery, the characteristics of the collection, processing and confidentiality of images, obligations to vessel owners, the role of SERNAPESCA, the requirements for removing, downloading, and processing DRI's information, penalties for non-compliance, and requirements for external entities that eventually may get involved in the images review. In Chile, although the law allows the participation of third parties in the images review, currently this task is being performed exclusively by the government, through SERNAPESCA, while is recognized that the experience gained from conducting review internally would guide any future outsourcing process. There are also a set of complementary resolutions from SERNAPESCA, that established the unique technical standard for the DRIs, the procedure for accreditation of DRIs, requirements for the location, height, direction, and angle of each camera by fishery, type of vessel and fishing gear, among others. Finally, a resolution from SERNAPESCA N° 5930/2019, established the start date for the entry into force of this control system (DRI), as January 1, 2020.

In addition, among other modifications to the Fisheries Law, in 2013, through Law N° 20657/2013 (Article 63 letter a), it was incorporated the obligation for vessel owners to report all their catches and landings in logbooks of electronic type in industrial fleets and using paper logbooks in artisanal fleets (**Figure 4**). Consequently, through Supreme Decree N° 129/2013, the regulation that sets the specific requirements for the delivery of fishing information by the vessel owners to SERNAPESCA was established. In the case of the industrial fleets, this information must include the identification of the vessel owner, the dates and port of departure and landing, fishing gear used and also for each fishing set, the amounts of catch by species or groups of species, the geographical position, the date and time of setting and hauling, the amounts discarded by species or groups of species and the incidental bycatch of seabirds, marine mammals, and sea turtles, if any.

Thus, electronic logbooks, mandated by Law, were formally established for the first time in 2015 by Resolution N° 114/2015, and were later replaced in 2020 by another version of electronic logbook provided by the World Wildlife Fund Inc. (WWF) and officialized through Resolution N° 267/2020. This last resolution establishes the Electronic Logbook System (SIBE) currently in use and determines the opportunity and conditions for the delivery of fishing information through this tool. Additionally, it establishes the components of the SIBE (SIBE web and SIBE mobile), its characteristics, the minimum conditions for the mobile devices in which the SIBE will be used, the conditions for downloading and installing the application, the profiles of the different users of the system, their responsibilities, and the procedures when there are failures, among others. In relation to the artisanal fishing fleets, the fishing information must be delivered in paper logbooks, although SIBE can be used voluntarily, for which pilot projects are being developed to explore this tool.

It is important to note that the human fisheries observer programs, carried out since 1990, were extended with the law N° 20625/2012, but have continued with the sole objective of collecting biological and fisheries data to be used exclusively in scientific advice for management, without any jurisdiction with compliance (**Figure 5**).

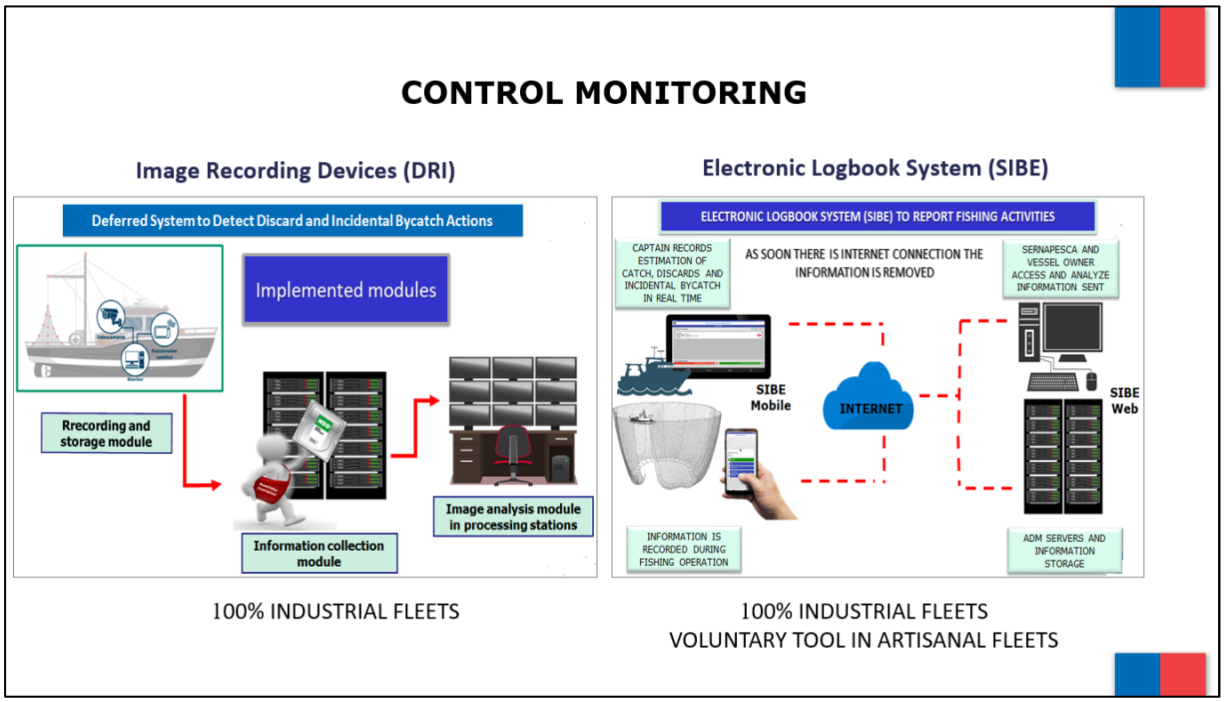

Figure 4. Image Recording Devices (**DRI**) to detect discard and incidental bycatch at sea and Electronic Logbook System (**SIBE**) to report fishing activities (including discards and incidental bycatch) in Chilean fisheries. (Source: SERNAPESCA).

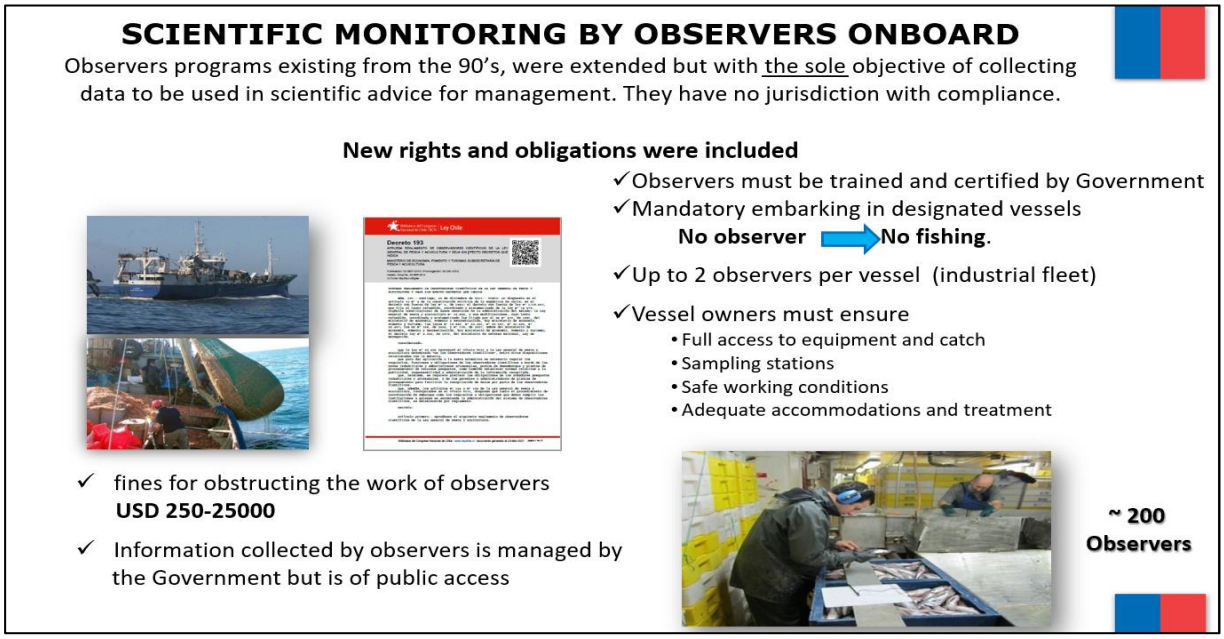

Figure 5. General overview of the scientific observer program in Chile to monitor fishing activities.

3. RESULTS AND DISCUSSION

3.1. Measures to reduce the incidental bycatch of seabirds

Regarding to specific measures aimed at reducing the capture and incidental mortality of seabirds during fishing operations, based on the results obtained by the research programs through observers onboard carried out by IFOP, added to the information provided by SERNAPESCA through cameras onboard and electronic logbooks (DRI and SIBE), in 2014, 2019 and 2021 bycatch reduction measures were enacted for industrial and artisanal longline fleets and for industrial trawling fleets, through Resolutions N° 2110/2014, 2941/2019, and 2569/2021. These measures established the mandatory use of deterrent devices along with the application of codes of good fishing practice and the reporting of bycatch in electronic logbooks, among others (**Figure 6**). The deterrent devices include: ***i***) the use of paired tori lines or bird bafflers depending on the size of the vessel, ***ii***) a curtain to visualize or to alert seabirds, the presence of the third-wire cable whose use is additional to the use of tori lines and ***iii***) the use of a snatch block to pull the third-wire cable close to the water surface to reduce its aerial exposure. Furthermore, good fishing practices consider; ***i***) cleaning the net before setting, ***ii***) night setting, ***iii***) tying the net when setting to increase its sinking rate and minimize the time it is on the water surface and, ***iv***) handling of discards to avoid attracting birds at critical moments of the fishing operation.

These requirements were of differentiated application depending on the target fishery, gear, and type of fleet. It is also important to note that these measures were designed in consultation with experts and presented to the respective Fisheries' Management Committees or users (owners, captains, and crews) of the fisheries involved, for their practical adjustment and validation. Likewise, different aspects were considered in its design that would allow an adequate control through the electronic monitoring systems (DRI and SIBE). Once established, it became prohibited to carry out extractive fishing activities in contravention of the provisions of the aforementioned seabird bycatch reduction regulations.

Additionally, recently through empirical research on board both crustacean and common hake trawl fleets, the Biobío Fishing Industry Association, together with ATF-Chile have explored and tested improvements to the mandatory seabird deterrent devices previously mentioned, in order to make their use safer, more practical and efficient, taking into consideration the diverse characteristics of trawlers, such as the smaller ones observed in crustacean fisheries. The results (Suazo et al., 2024) address the construction, maintenance and deployment of tori lines, the reduction of the third-wire cable impacts on seabird strikes through the use of a netsonde curtain (construction and minimum standards), the assessment of the impacts on seabird strikes for both the warp wire and the exposed top part of the third-wire, the bird baffler's (stern curtain) construction and minimum standards, the use of additional devices for a safe deployment of tori lines such as telescopic arm and telescopic rod and the use of shorter tori lines for crustacean fisheries, where smaller vessels operate (Suazo et al., 2023). The results were translated into recommendations, which have been presented to the respective Fisheries Management Committees for validation and subsequent adjustment of the current regulations (**Figures 7** and **8**).

In addition, the industrial factory trawler fleet has developed and tested by itself an innovation or alternative to the use of the Snatch block currently required, to reduce the exposure of the third wire (Netsonda) (Emdepes, 2024). This innovation consists of adding a weighted wire

along the third wire that minimizes its aerial exposure. These results will also be presented to the respective Fisheries Management Committees for validation and subsequent incorporation into the seabird bycatch reduction regulations (**Figure 9**)

Finally, it is important to point out that all these measures also emphasize compliance with the obligations established in Annex V of the International Convention to Prevent Pollution from Vessels (MARPOL 73/78 Convention), in particular rule 3 that prohibits dumping into the sea all plastic materials, including ropes and synthetic fiber fishing nets and plastic garbage bags. The other types of garbage such as food leftovers and residues resulting from domestic tasks and the routine work of the vessels (excluding fresh fish and any portion thereof), must be treated and disposed of in accordance with the provisions of Annex V of the Agreement.

The results obtained to date have shown significant reductions in seabirds' bycatch and mortality due to the appropriate implementation and compliance control of the measures established, as shown in **Figure 10**. Before 2019 trawl fleets registered important negative interactions with seabirds. However, as of 2020 these fleets began to exhibit lower bycatch of seabirds demonstrating that it is possible to achieve a reduction of incidental seabirds' bycatch in trawl fisheries.

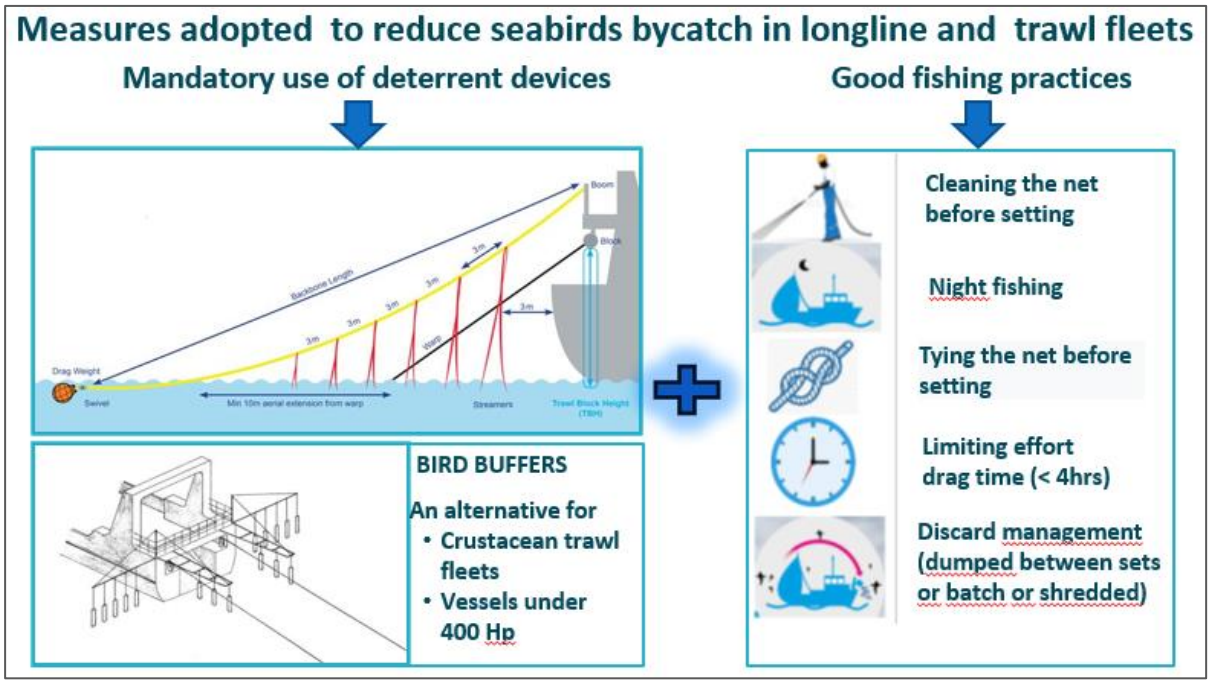

Figure 6. General overview of the measures and actions to reduce the incidental bycatch of seabirds in Chilean fisheries enacted as of May 2023. Details may be reviewed in specific regulations (links provided in references)

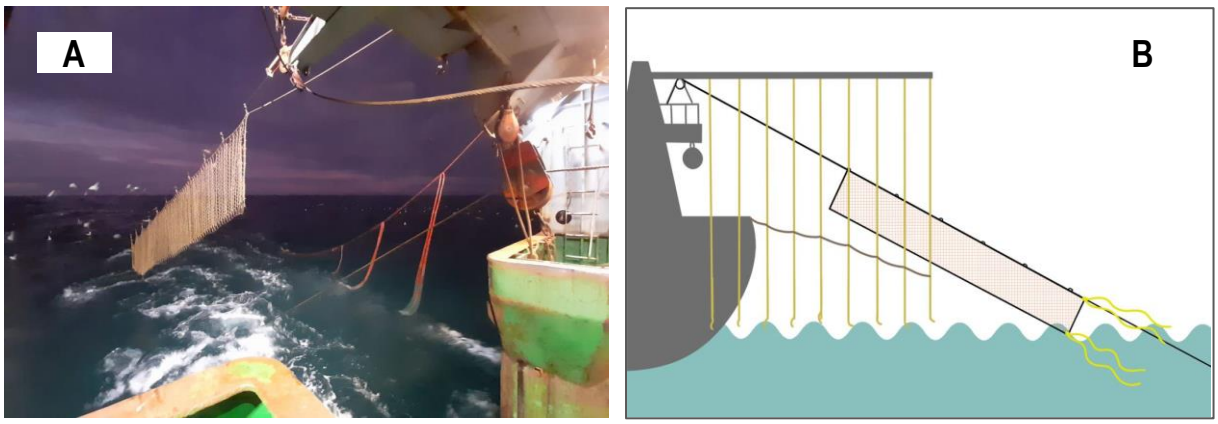

Figure 7. **A**) Netsonda curtain to reduce bird collisions with third wire, **B**) combined Netsonda curtain-bird baffler mitigation measure in demersal hake fishery, south-central Chile (Suazo et al., 2024).

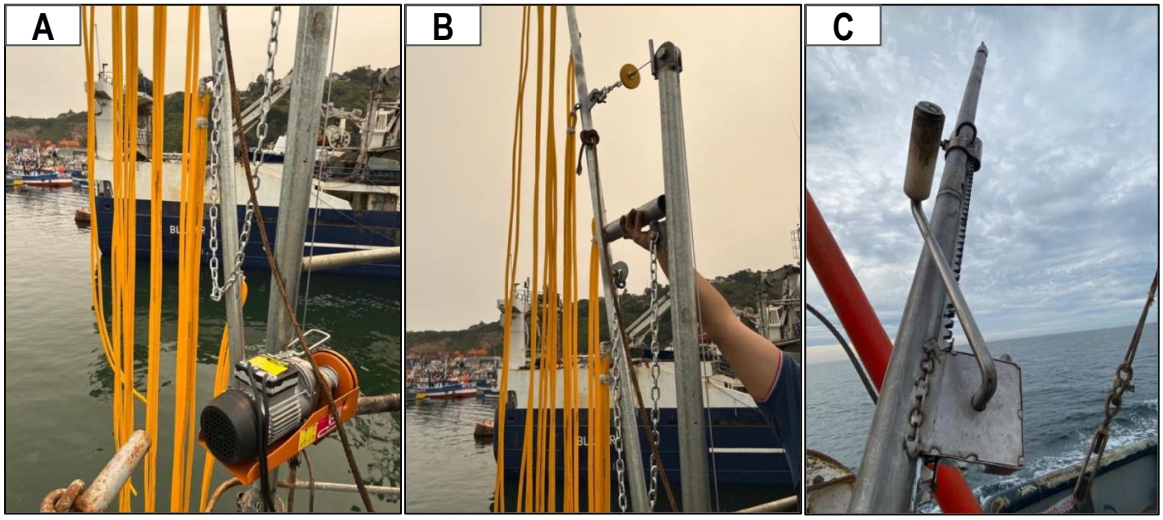

Figure 8. A) and **B)** Bird baffler system with electric winch and **C**) Telescopic arm with crank for mounting LEP in demersal crustacean vessels (Suazo et al., 2023).

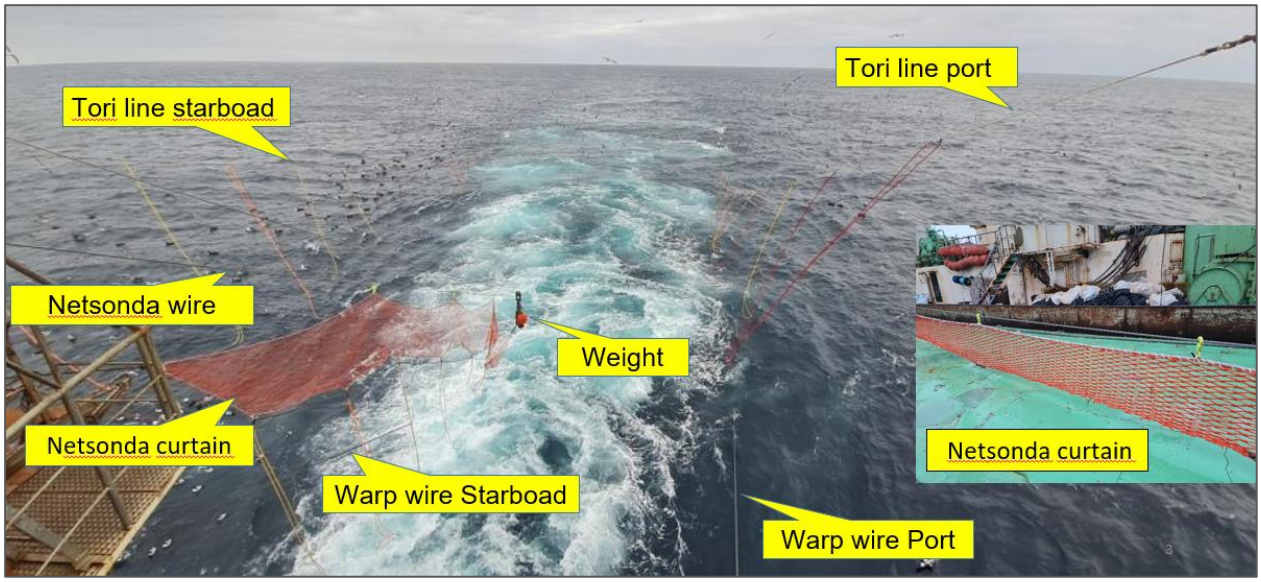

Figure 9. Alternative to the use of the Snatch block to reduce the exposure of the third wire (Netsonda wire). Source: EMDEPES, 2024.

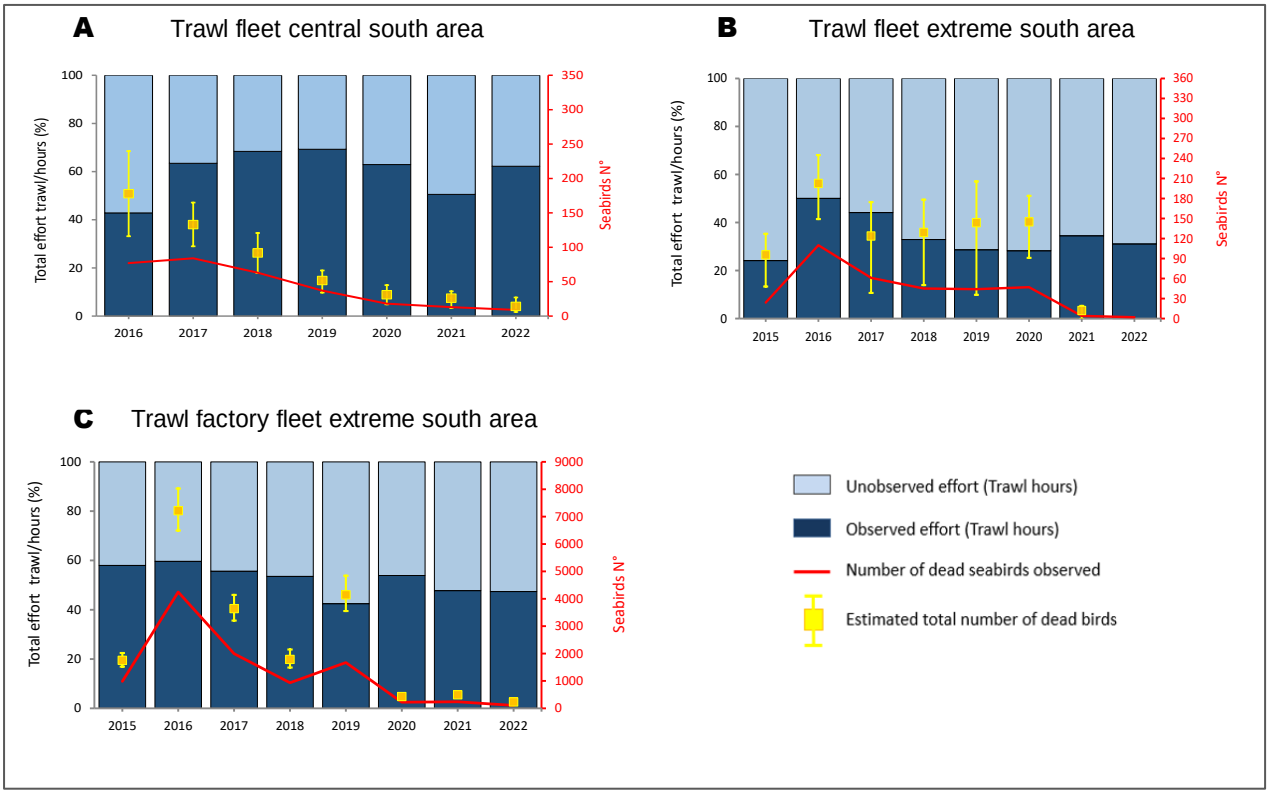

Figure 10. Total fishing effort, observed and unobserved effort for seabirds' bycatch (% of trawl hours), observed mortality of seabirds and estimated total seabirds bycatch per year in: **A**) trawl fleet central south area, **B**) Trawl fleet extreme south area, and **C**) Trawl factory fleet extreme south area, period 2015-2022 (Source: IFOP).

3.2. Discussion

Background reported in previous studies has identified that the incidental catch of seabirds in the artisanal and industrial fisheries that operate in Chilean waters affects a total of 27 species. The main species correspond to albatrosses, shearwaters and penguins of the genus

Spheniscus, with the black-browed albatross (*Thalassarche melanophris*), being the species most impacted by bycatch events in trawl and longline fisheries, and both the pink-footed shearwater (*Ardenna creatopus*) and black shearwater (*Ardenna grisea*) the most impacted in purse seine fisheries (Adasme et al., 2019; Suazo et al., 2014; Vega et al. 2018).

In the context of implementing the law N°20625/2012, that addressed discards and incidental bycatch, and established the use of new monitoring systems (DRI and SIBE) to verify these practices at sea, close collaboration and feedback were required between the agencies responsible for research, management and control of fisheries in Chile. This strategy permitted to change and adapt fishing regulations, incorporating specific measures to reduce seabird incidental bycatch and prevent discards of regulatory origin, while increasing compliance. Likewise, the establishment of some measures, such as the use of devices to reduce incidental bycatch of seabirds (and marine mammals whose reduction measures were not afforded in this paper), has been designed in such a way that they can be efficiently monitored and controlled by the EMS (DRI and SIBE) and the analyst teams. In other cases, improvements have been made once the measures have been implemented, like the addition of cameras in the stern of the trawl vessels for a better detection of the correct use of tori lines, the application of bycatch handling protocols by crews, or the incorporation of additional deterrence devices designed by the fishing industry itself to alert seabirds to the presence of the third-wire cable.

Within this process, the EMS information has greatly contributed to the management agencies' understanding of behavior patterns of the fleets with regard to discards and incidental bycatch and to identifying individuals associated with non-compliance. These conditions have supported a significant improvement in undesirable practices at sea in a way that was not previously possible. Feedback loops, including communication between hardware installers and video reviewers, or data users communicating back to fishers (i.e. ensuring proper catch handling and data quality) have been key elements in the success of the program. In addition, feedback to the industry about the program's implementation, including access to data and videos, has improved fishers' knowledge and acceptance of the EMS program, increased transparency, and improved fishers' efficiency. It is also important to note that providing feedback to fishers has allowed the identification of weaknesses or deficiencies in the systems that have been improved.

Remaining challenges include species identification under some fisheries' operating conditions and catch (and discard) identification and quantification using DRI imagery for quota deductions. An additional challenge relates to the use of DRI for controlling other fishing regulations and illegal fishing as required by a 2019 review of fisheries legislation through Law N° 2113272019 (that extended the DRI´s scope). However, the biggest challenge is the incorporation of the artisanal fleets to the EMS control scheme as of 2024, which, according to the legal requirements, applies to any artisanal boats bigger than 15m in total length (around 500 artisanal boats meet this condition).

Building on the knowledge acquired during the first three years of the EMS program in the industrial fleet, new approaches to sampling imagery for review are being explored, such as the development of fleet-specific criteria and a risk-based process for sample selection. The program will continue to cover 100% of industrial vessels and their fishing activity, while review technologies (using machine learning and artificial intelligence) have been trialed in pilot projects starting in 2022 in the artisanal fleet, supported by The Nature Conservancy (TNC) (**Figure 11**). Work underway also includes integrating various electronic monitoring and

reporting tools. While the program currently uses hard drives for storage, transitioning to wireless transmission over 5G networks and cloud storage are foreseen as future steps, as well as implementing pre-review within the DRI system on board vessels and improving image quality to support a broader range of monitoring objectives.

Furthermore, the recent implementation of technologies (DRI and SIBE) to collect, register, manage and analyze fishing data associated with the control of catches, discards and incidental bycatch, has provided a set of possible solutions to update and modernize the fisheries data systems and significantly expand the collection and analysis of information, also for management and research, creating an opportunity to coordinate and enhance the work of the three national fisheries management agencies (SUBPESCA, SERNAPESCA and IFOP) around the maximization of the use of the information that can be obtained from the new technological monitoring tools.

Figure 11. EMS pilot project supported by TNC and implemented in 2022 in the artisanal Chilean seabass fishery.

4. CONCLUSIONS

The experience gained by Chile in the diagnosis, reduction and control of discards and incidental bycatch recommends the gradual implementation of these processes, under transparent framework policies, where the views of the different stakeholders are considered and the realities of each country are taken into account: technical, human capacities economic and cultural.

In the decision-making process the importance of working with relevant stakeholders, authorities, users, and civil society has been highlighted. This experience has shown that any solution must be subject to further analysis in terms of its effectiveness in solving the problem, as well as its ease of implementation by users, for whom it will always be a new process to which they must adapt. Conceiving these norms and control systems under an adaptive scheme, will facilitate the implementation of improvements and acceptance by users.

Finally, exploring the use of tools like EMS to improve the monitoring coverage of the fishing fleets is also recommended. However, it is recognized that the use of these technological systems for purposes other than monitoring compliance, such as obtaining scientific

information and collecting fishery-dependent data, still requires intense work on the design of current monitoring programs, exploration of the use of complementary technologies such as computer vision (CV) or machine learning (ML), and its integration with traditional human observer programs in use.

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