

# Discard and bycatch monitoring program at industrial demersal fisheries in Chile: Where we are eight years from its implementation?

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## Abstract

Discard and bycatch have been a problem in world fisheries. During 2012, modifications on the Chilean Fisheries Law, including a permanent discard and bycatch research monitoring program (DBRMP) through scientific observers on-board in fisheries, were established to know and address this problem. With the aim of showing the steps and evolution of this process, indicators of discard and bycatch at demersal industrial fisheries between 2013 and 2020 years were assessed. Additionally, a summary of main regulatory measures were identified. The results showed that the involvement of fishermen was an important element to ensure the success of DBRMP and development of discard reduction plans. One of the biggest challenges to start the DBRMP was to achieve the engagement of them in a participatory process. Thus, meetings were held to provide information outreach about the law and DBRMP. After eight years from the beginning of the DBRMP, important improvements have been observed. Discard in trawling fisheries decreased on average 70% respect to initial values, while in long-line fisheries dropped 60%. Same trend was observed regarding bycatch of seabirds and sea lions. These results represent a key input to understand the discard problematic and the difficulties associated with their measurement, as well as the understanding of the underlying causes and solutions. Among the mandatory measures that has been implemented are; the discard ban of target species, adjustment of the non-target species catch rate, prohibition of bycatch, the mandatory use of bycatch mitigation measures systems as the grid device and tori lines used to avoid sea lions and seabirds, and the recent implementation of electronic monitoring. This work shows a brief overview of the main advances and solutions taken by Chilean fisheries government institutions regarding discard and bycatch, hoping to serve as a guideline for other countries which are advocated to address this matter.

**Keywords:** Discard, bycatch, demersal fisheries

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## Introduction

Discard and bycatch have been a problem in world fisheries. Considering the significant decreases in fish landing as of 1995 and increasing of stocks overfished, during 2012, modifications on the Chilean Fisheries Law with an ecosystem approach, including a permanent discard and bycatch research monitoring program (DBRMP) through scientific observers on-board in fisheries, were established to know and address this problem (SanMartin2016; Roman2021). The main objectives of this monitoring program included the determination of levels of discards in each fishery, quantify bycatch (marine mammals, seabirds and marine turtles) and identify the causes. Results obtained by DBRMP have been key to implement the mandatory reduction measures to reduce the levels of discard and bycatch at industrial demersal fisheries in Chile.

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## Monitoring approach

With the aim of showing the steps and evolution of this process, indicators of discard and bycatch at demersal industrial fisheries between 2013 and 2020 years were assessed. A total of ten industrial fisheries, distributed from 28 S to 57 S, including longline and trawling gear were considered (Figure 1). Additionally, a summary of main regulatory measures were identified.

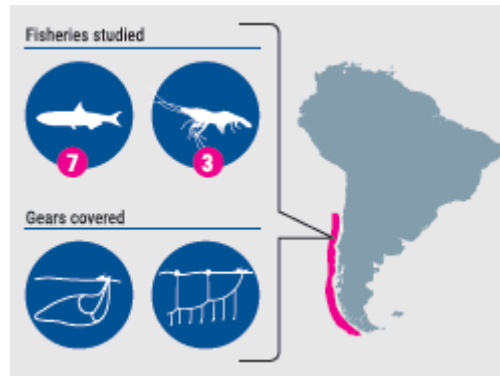


Figure 1: Chilean industrial demersal fisheries studied and spatial coverage

## Results

The results showed that the involvement of fishermen was an important element to ensure the success of DBRMP and development of discard reduction plans. One of the biggest challenges to start the DBRMP was to achieve the engagement of them in a participatory process. Thus, meetings were held to provide information outreach about the law and DBRMP. After eight years from the beginning of the DBRMP, important improvements have been observed. Discard in trawling fisheries showed variations in period evaluated, but in general decreased on average 70% respect to initial values. The same trend was observed in long-line fisheries, dropping around 60% with respect to the first years (Figure 2 A). Similar trend was observed regarding bycatch of seabirds and sea lions, nonetheless, longline fisheries have not registered bycatch of marine mammals and bycatch of seabird has been almost absent at crustacean fisheries (Figure 2, B y C). Four general kinds of causes of discard were identified; regulations, operational, quality and factors associated with commercial issues. The last cause was the most important with factors such as catch of non-commercial species and non-commercial size. Bycatch of sea lions and seabirds were associated with entanglement and when the animals feeding the catch or bait.

### 1. Bibliography styles

Here are two sample references: (author?)<sup>1</sup> (author?)<sup>2</sup> (author?)<sup>3</sup> (author?)<sup>4</sup>.

By default, natbib will be used with the authoryear style, set in classoption variable in YAML. You can set extra options with natbiboptions variable in YAML header. Example

```
natbiboptions: longnamesfirst,angle,semicolon
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#### 1.1. Using CSL

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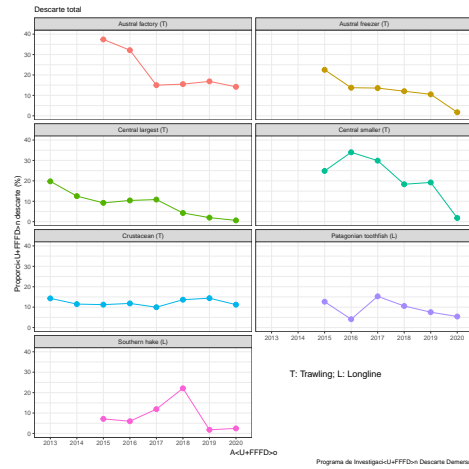


Figure 2: Discards.

## 2. Equations

Here is an equation:

$$f_X(x) = \left(\frac{\alpha}{\beta}\right) \left(\frac{x}{\beta}\right)^{\alpha-1} e^{-\left(\frac{x}{\beta}\right)^\alpha}; \alpha, \beta, x > 0.$$

Inline equations work as well:  $\sum_{i=2}^{\infty} \{\alpha_i^\beta\}$

## 3. Figures and tables

Figure 3 is generated using an R chunk.

## 4. Tables coming from R

Tables can also be generated using R chunks, as shown in Table 1 example.

```
knitr::kable(head(mtcars)[,1:4])
```

Table 1: Caption centered above table

	mpg	cyl	disp	hp
Mazda RX4	21.0	6	160	110
Mazda RX4 Wag	21.0	6	160	110
Datsun 710	22.8	4	108	93
Hornet 4 Drive	21.4	6	258	110
Hornet Sportabout	18.7	8	360	175
Valiant	18.1	6	225	105

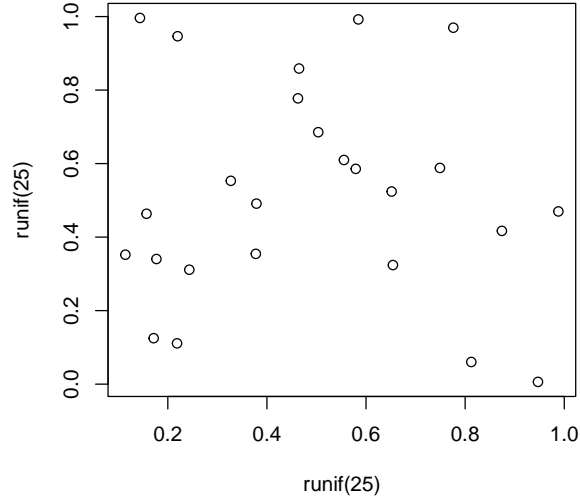


Figure 3: A meaningless scatterplot

## References

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