THE IMPACT OF MARINE RESERVES IN THE BALEARIC SEA

Monitoring fish populations: biomass and diversity of species

White Sea Bream (*Diplodus sargus*). Photo: **Miquel Gomila.**

The impact of marine reserves in the Balearic Sea

The Balearic Sea has a network of eleven marine reserves of fishing interest that occupy a total surface area of 613.7 km², of which 42.6 km²are totally closed to fishing - for more information see the MPA briefing. The marine reserves are under the responsibility of the Regional Ministry of Agriculture, Fisheries and Food (Govern de les Illes Balears) and were created with the main objective of regenerating fish resources. But regardless of their economic interest they also have positive effects on the conservation of vulnerable habitats and species. This document analyses and summarises the impact of the network of marine reserves on fish stocks of commercial interest.

Various scientific studies in marine reserves in the Balearic Sea show that controlling fishing activity is a key factor in the improvement of fish populations.[1,2] In the reserves that do improve, the so-called "reserve effect" can be observed - a term used in biology which refers to a recovery of fish that is directly proportional to its time under protection. In particular, increases in fish populations are observed for: diversity of species, density, size, biomass, catches around the reserve and export of larvae outside the reserve.[3] In the Balearic Islands the reserve effect is evident to some extent, but some areas haven't seen the desired results.

METHOD - How do you evaluate whether a marine reserve improves over time?

To evaluate the state of marine reserves, indicators of the state of fish that are vulnerable to fishing are studied[4], such as total biomass and the diversity and richness of species. These studies are carried out by the Directorate General for Fisheries and the Marine Environment through TRAGSATEC, the Socio-Environmental Observatory of Menorca (OBSAM) and the Spanish Institute of Oceanography (COB-IEO) through the Jaume Ferrer Research Station (EIJF).

This briefing shows data from eight marine reserves and one natural park. Underwater observations and censuses are carried out via transects which range from 8-54 depending on the reserve size. Transects are done in surface waters (3-15 m) and for three reserves (North of Menorca, Freus in Ibiza and Formentera and Llevant in Mallorca) also in deep waters (20-25 m). The transects are 50 m long x 5 m wide (250 m²) and are carried out in each marine reserve in three different areas:

1) **Integral reserve**: Areas inside the reserve where all types of fishing activity are prohibited, also known as no-take zones (Figs. 1 and 2, in yellow);

2) **Partial reserve**: Areas within the reserve where trawling is prohibited and where artisanal and recreational fishing are regulated (Figs. 1 and 2, navy blue);

3) **Control areas**: Areas outside the reserve, but with environmental characteristics that allow direct comparison with the reserve areas (Figs. 1 and 2, light blue).

Monitoring covers twenty-one species of fish that are vulnerable to fishing (Table 1), as they are

- Species valued in the market, mainly with a long lifespan and late sexual maturity;
- Key elements of the ecosystem;
- Indicators of the degree of fishing exploitation;
- Indicators of fisheries management.

Common name	Scientific name	Richness of species	Total biomass
Conger eel	*Conger conger*	✓	✓
Dentex	*Dentex dentex*	✓	
Seabass	*Dicentrarchus labrax*	✓	
Sharpsnout seabream	*Diplodus puntazzo*	✓	✓
White seabream	*Diplodus sargus*	✓	✓
Two-banded seabream	*Diplodus vulgaris*	✓	✓
Golden grouper	*Epinephelus costae*	✓	✓
Dusky grouper	*Epinephelus marginatus*	✓	✓
Brown wrasse	*Labrus merula*	✓	✓
Green wrasse	*Labrus viridis*	✓	✓
Moray eel	*Muraena helena*	✓	✓
Comb grouper	*Mycteroperca rubra*	✓	✓
Red porgy	*Pagrus pagrus*	✓	✓
Forkbeard	*Phycis physis*	✓	✓
Brown meagre	*Sciaena umbra*	✓	✓
Black scorpionfish	*Scorpaena porcus*	✓	✓
Red scorpionfish	*Scorpaena scrofa*	✓	✓
Greater amberjack	*Seriola dumerili*	✓	
Gilthead seabream	*Sparus aurata*	✓	✓
Yellormouth barracuda	*Sphyraena spp.*	✓	
Black seabream	*Spondyliosoma cantharus*	✓	✓

Table 1. Fish species vulnerable to fishing used in the study of specific diversity/richness and total biomass.

RESULTS - Do marine reserves improve after being established?

In general, fish stocks that are vulnerable to fishing have recovered in several marine reserves. However, this analysis shows that the impact is still below its potential (Figs. 1 and 2). We describe the data for each reserve in chronological order:

• Bahía de Palma Marine Reserve (1982)

- **Total biomass**: in 18 years, it increased by +2.5 kg/250 m ² in the integral reserve; followed by the partial reserve, with + 1 kg/250 m². The maximum biomass is of 3.4 kg/250 m².

- **Species diversity and richness**: little temporal variation, possibly due to the fact that it is a low-complexity habitat (with shallow, sandy floors), often found to have less species diversity. In eighteen years, there has been an increase of +1.3 species/250 m² in the integral reserve. The maximum variety and richness level is 4.1 species/250 m².

• Northern Menorca Marine Reserve (1999)

- **Total biomass**: values fluctuate, and results aren't as expected, as the partial reserve has a greater temporary increase in biomass (+3.5 kg/250 m²) than the integral reserve (+2.1 kg/250 m²). A maximum biomass of surface water of 6.2 kg/250 m² is observed in 2011, which then decreases in 2018. Deep waters reach a maximum of 14.3 kg/250 m² in both reserves. Fluctuations could be typical of areas with changes in fishing intensity.

- **Species diversity and richness**: increases < 1 species/250 m² in surface waters, and +1.1 species/250m² in deep waters. Maximums are ~4.5 species/250 m² in both surface and deep waters. These random variations could indicate that there are factors at play which are independent of the level of protection, such as uncontrolled professional and recreational fishing activity.

• Freus d'Eivissa i Formentera Marine Reserve (1999)

- **Total biomass**: shows the highest values and the greatest fishing recovery of all marine reserves. In nineteen years it increases with +13.6 kg/250 m² in the integral reserve of surface waters, and with +14.4 kg/250 m² in deep waters. The surface and deep waters of the integral reserve reach maximum levels of 15.6 kg/250 m² and 26.5 kg/250 m², respectively.

- **Species diversity and richness**: the number of species increases, especially in the integral reserve of surface waters, with +3.5 species/250 m²; a maximum of 7 species/250 m² is reached. The deep waters of the reserve show no change over time, ranging from 6-7 species/250 m². Only in the deep water monitoring area (outside the reserve) do we observe a recovery of +2 species/250 m² .

• Migjorn, Mallorca Marine Reserve (2002)

- **Total biomass**: inconclusive results on the effect of the reserve, as the greatest increase of +1.4 kg/250 m² is within the control area. This is followed by the integral reserve in the Santanyí area, with +1.2 kg/250 m². This could be due to: (i) less monitoring in the integral reserve: 8 years, compared to 15 years for the rest; (ii) higher fishing pressure in the Llucmajor area; and (iii) less exposure to summer winds from the East in Llucmajor. The maximum biomass reaches 4.3 kg/250 m² in the integral reserve.

- **Species diversity and richness**: no appreciable changes (< 1 species/250 m2) outside the error limits. The maximum is 4.5 species/250 m².

• Albufera d'es Grau Natural Park (2003)

- **Total biomass**: one of the lowest values of biomass compared to the other reserves, as the maximum is 2.4 kg/250 m².

- **Riqueza de especies**: this decreases in 2018 in all the areas and depths sampled. However, in all areas except Sa Galera (-2.2 species/250 m²), this decrease is within error intervals. The maximum is 5.3 species/250 m² in 2011, but in 2018 no area exceeds 4 species/250 m².

• Illa del Toro and Illes Malgrats Marine Reserves (2004)

- **Total biomass**: the Illa del Toro Marine Reserve quadrupled its results in 13 years. The maximum biomass of 16.2 kg/250 m² occured in the last year of monitoring. El Toro is the second reserve to experience the greatest increase, with +12.2 kg/250 m², after Freus d'Eivissa i Formentera (+13.6 kg/250 m²); although it must be noted that El Toro has been monitored for five years less than the rest.

The highest value collected at a sampling point in all the marine reserves studied is in the waters of the Illa del Toro reserve, reaching 24.8 kg/250 m² of total biomass.5 This high recovery is possibly aided by environmental and oceanographic conditions, such as steeper slopes and greater depths. The Illes Malgrats reserve does not show these improvements, reaching an increase of +3.2 kg/250 m² and a maximum of 5 kg/250 m² in 2018, which is lower than the values for 2016 (8.2 kg/250 m²).

- **Species diversity and richness**: only in the Illa del Toro marine reserve do we find a temporary increase of +1.3 kg/250 m². This reserve reaches a maximum of 5 species/250 m² in 2018, while Illes Malgrats oscillates around 4 species/250 m².

A yet-to-be-evaluated study on the differences between El Toro and Illes Malgrats is based on the fact that Illes Malgrats has acquired its carrying capacity. Furthermore, El Toro has a greater abundance of large predators, such as dentex and groupers. Finally, it should be considered that recreational fishing is permitted for longer in Illes Malgrats, with more fishing equipment.

• Llevant de Mallorca Marine Reserve (2007)

- **Total biomass**: in 11 years, it has gradually increased to around +3 kg/250 m² in both the integral and partial reserves. The maximum in surface waters is 5.6 kg/250 m², while in deep waters it is 23.5 kg/250 m², in Faralló de Cala Gat.

- **Species diversity and richness**: the greatest increase of +1.3 species/250 m² is observed in the partial reserve, resulting in a maximum of 4.6 species/250 m². It is especially high, with 6 species/250 m², in the deep water areas of Farallons d'Aubarca and Cala Gat.

• Freu de Sa Dragonera Marine Reserve (2016)

- **Total biomass**: in only two years of monitoring, an increase of +3.6 kg/250 m² was observed in the area of Cala Llebeig and +2.9 kg/250 m² in Cala Lladó. The maximum was reached in Cala Llebeig, with 8.8 kg/ m².

- **Species diversity and richness**: increase of +1 species/250 m² in the partial reserve of Cala Llebeig. The maximum was reached in this same area, with 4.8 species/250 m².

• Illa de l'Aire Marine Reserve (2019)

This data is previous to establishing the reserve.

- **Total biomass**: increase with +1.1 kg/250 m², with a maximum of 4.3 kg/250 m², although it may be within the error margins.

- **Species diversity and richness**: the increase is +0.9 species/250 m², although within error intervals, giving a maximum of 5.5 species/250 m².

Figure 1. Map of the Balearic Islands showing the location of the marine reserves where the total fish biomass is studied. All are marine reserves of fishing interest, with the exception of D'es Grau Natural Park Reserve. The vertical scale allows comparison between reserves. Data source: D.G. Pesca i Medi Marí, OBSAM, COB-IEO EIJF.

DISCUSSION - What can we do to ensure that MPAs reach their full recovery potential?

• We must continue to increase monitoring studies of reserve networks. The true potential of the diversity, richness and biomass of the Balearic Sea is not yet known; we need to keep up the research to determine reference values. Knowing the different environmental factors is essential to correct and compare between areas.6 In addition, the natural and environmental conditioning factors of each area must be considered. The carrying capacity of each reserve is different, and therefore the same results cannot be reached under the same level of protection.7

• Declare catches from all fishing methods in the reserve, so conclusions about the effect of the reserve can be reached. The lack of information about the intensity of fishing carried out, however, doesn't allow for more robust conclusions.

• Strengthen fisheries management legislation. Especially in terms of fishing effort and the type of equipment permitted,; and increase the area occupied by integral reserve areas (no-take zones).

• Maintain and improve fishing surveillance, to put an end to poaching; strengthen inspection in the catering sector, to put an end to illegal marketing.

• Improve the coordination of all organisations involved in the management of marine reserves of fishing interest and other marine protected areas.

• Increase funding. Current investment is below what's needed in the future.

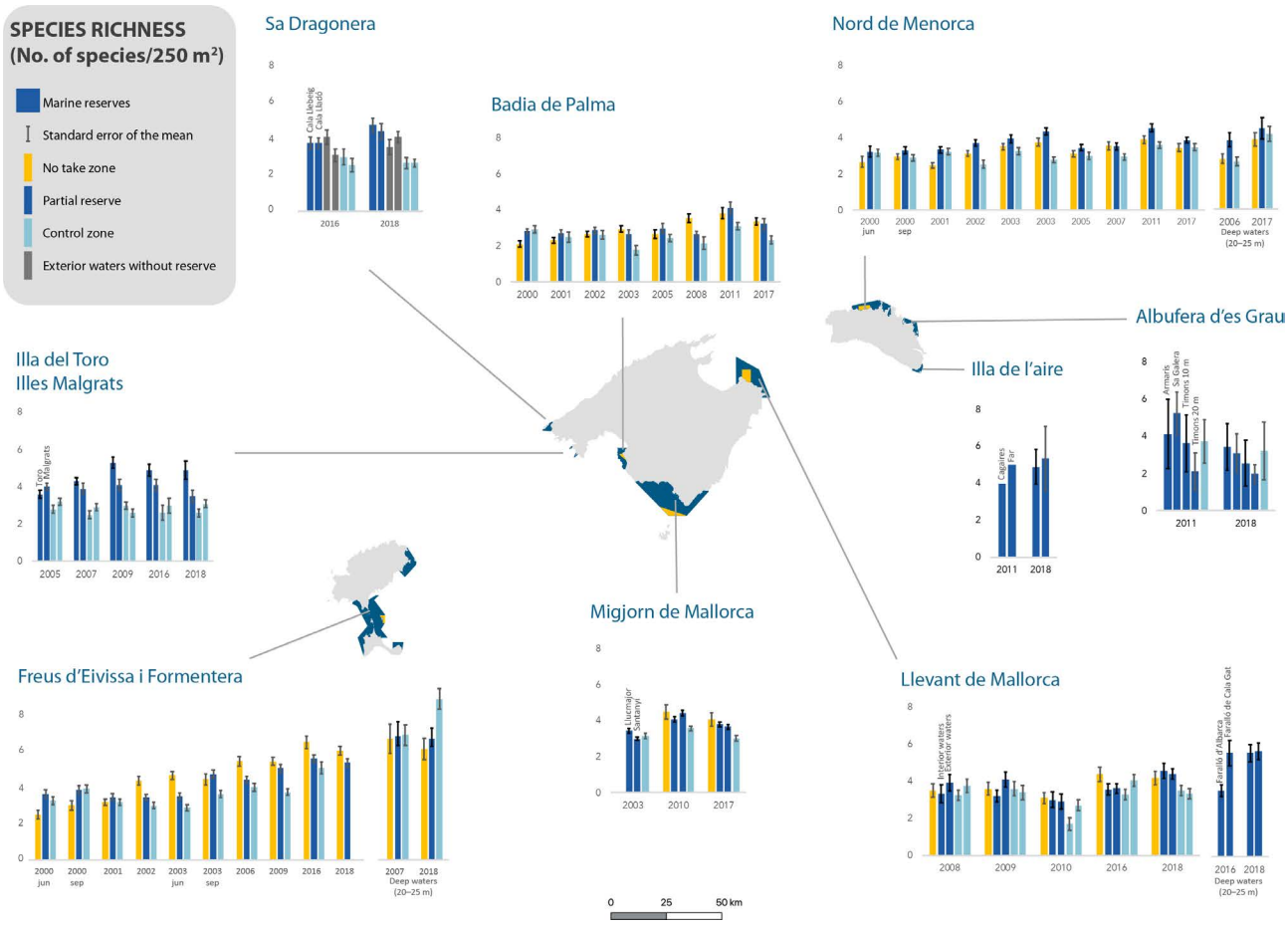

Figure 2. Map of the Balearic Islands showing the location of the marine reserves where the diversity and richness of fish species is studied. All are marine reserves of fishing interest, with the exception of D'es Grau Natural Park Reserve. The graphs maintain the same vertical scale, allowing for comparison between reserves. Data source: D.G. Pesca i Medi Marí, OBSAM, COB-IEO EIJF.

For more information:

- Briefing: The marine protected areas of the Balearic Sea https://marilles.org/storage/media/2020/06/581/en-briefing-amp-maig2020.pdf
- Balearic Sea Report: - Monitoring of fish stocks vulnerable to coastal fishing, pages 88-101.. www.informemarbalear.org

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