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Scientific observations indicate zero seabird interaction with trapline/loop long-line terminal devices from Mediterranean Sea

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SUMMARY

This study evaluates the performance of loop line (trapline) terminal devices in pelagic longline fisheries in the western Mediterranean Sea, with particular emphasis on seabird interactions. Loop lines represent a recent innovation in longline fisheries targeting swordfish (*Xiphias gladius*), functioning as entangling devices attached to branch lines rather than traditional hook-based systems. Despite their increasing adoption, scientific knowledge regarding their ecological effects remains limited. Data were collected through an onboard Spanish observer program conducted between 2023 and 2025, complemented by historical observations of traditional longline fisheries between 2015 and 2025. A total of 2,270 traditional sets and 698 sets using loop lines were analyzed across multiple métiers. Results indicate that 793 seabirds were recorded as bycatch in traditional hook-based longline fisheries, with variability among métiers. In contrast, no seabird captures were observed in sets employing loop line devices during the study period.

RECOMMENDATIONS

1. Expand observer coverage to increase sample size and improve the robustness of conclusions regarding seabird interactions.
2. Conduct experimental trials comparing loop lines and traditional hooks under controlled conditions across different regions and seasons.
3. Assess impacts on other taxa, including turtles, sharks, and teleost species, to ensure no unintended ecological effects.
4. Promote pilot implementation of loop lines as a potential bycatch mitigation measure within ACAP and ICCAT frameworks.

Las observaciones científicas indican que no hay interacciones de aves marinas con los dispositivos terminales de trampas/lazo en las pesquerías de palangre del mar Mediterráneo

RESUMEN

Este estudio evalúa el desempeño de los dispositivos terminales de aparejo con lazo (trampa) en las pesquerías de palangre pelágico en el mar Mediterráneo occidental, con especial énfasis en las interacciones con las aves marinas. Los aparejos con lazo representan una innovación reciente en las pesquerías de palangre que pescan pez espada (Xiphias gladius), ya que funcionan como dispositivos de enredo unidos a brazoladas en lugar de los sistemas tradicionales con anzuelos. A pesar de que se están adoptando cada vez más, el conocimiento científico sobre sus efectos ecológicos sigue siendo limitado. Se recabaron datos mediante un programa de observadores españoles a bordo, llevado a cabo entre 2023 y 2025 y complementado con observaciones históricas de las pesquerías de palangre tradicionales entre 2015 y 2025. Se analizaron un total de 2270 conjuntos tradicionales y 698 conjuntos que utilizaban aparejos con lazo en diversos tipos de pesca. Los resultados indican que se registraron 793 aves marinas como captura secundaria en las pesquerías tradicionales de palangre con anzuelo, con variabilidad entre los distintos tipos de pesca. Por el contrario, no se observaron capturas de aves marinas en los conjuntos que empleaban dispositivos de aparejos con lazo durante el período de estudio.

RECOMENDACIONES

1. Ampliar la cobertura de los observadores para aumentar el tamaño de la muestra y mejorar la solidez de las conclusiones sobre las interacciones con las aves marinas.
2. Realizar ensayos experimentales que comparen aparejos con lazo y anzuelos tradicionales en condiciones controladas en diferentes regiones y estaciones del año.
3. Evaluar los impactos en otros taxones, incluidas las especies de tortugas, tiburones y teleósteos, para garantizar que no se produzcan efectos ecológicos no deseados.
4. Promover la implementación piloto de aparejos con lazo como una posible medida de mitigación de captura secundaria dentro de los marcos del ACAP y la CICAA.

Les observations scientifiques indiquent qu'il n'y a aucune interaction entre les oiseaux marins et les dispositifs terminaux des lignes à nœuds coulants (traplines) et des palangres en boucle en mer Méditerranée

RÉSUMÉ

Cette étude évalue les performances des dispositifs terminaux des lignes en boucle (traplines) dans les pêcheries à la palangre pélagique en Méditerranée occidentale, en mettant particulièrement l'accent sur les interactions avec les oiseaux marins. Les lignes en boucle constituent une innovation récente dans les pêcheries à la palangre ciblant l'espadon (*Xiphias gladius*) ; il s'agit de dispositifs d'enchevêtrement fixés à des avançons plutôt qu'à des systèmes traditionnels à hameçons. Malgré leur utilisation croissante, les connaissances scientifiques concernant leurs effets écologiques restent limitées. Les données ont été recueillies dans le cadre d'un programme d'observateurs embarqués espagnols mené entre 2023 et 2025, complété par des observations historiques des pêcheries traditionnelles à la palangre entre 2015 et 2025. Au total, 2 270 opérations de pêche traditionnelles et 698 opérations utilisant des lignes en boucle ont été analysées dans plusieurs métiers. Les résultats indiquent que 793 oiseaux marins ont été recensés comme captures accessoires dans les pêcheries traditionnelles à la palangre à hameçons, avec des variations selon les métiers. En revanche, aucune capture d'oiseaux marins n'a été observée lors des opérations de pêche utilisant des dispositifs à lignes en boucle au cours de la période étudiée.

RECOMMANDATIONS

1. Élargir la couverture des observateurs afin d'augmenter la taille de l'échantillon et d'améliorer la robustesse des conclusions concernant les interactions avec les oiseaux marins.
2. Mener des essais expérimentaux visant à comparer les lignes en boucle et les hameçons traditionnels dans des conditions contrôlées, dans différentes régions et à différentes périodes de l'année.
3. Évaluer les impacts sur d'autres taxons, notamment les tortues, les requins et les espèces de téléostéens, afin de s'assurer de l'absence d'effets écologiques indésirables.
4. Promouvoir la mise en œuvre à titre expérimental de lignes en boucle en tant que mesure potentielle d'atténuation des captures accessoires dans les cadres de l'ACAP et de la CICTA.

1. INTRODUCTION

The emergence of so-called *loop lines* in pelagic longline fisheries represents one of the most recent technological developments in the capture of tuna and tuna-like species, particularly in fisheries targeting swordfish (*Xiphias gladius*) (Domingo et al., 2025). These devices constitute a novel modification to the terminal section of longline gear and, due to their very recent adoption, have not yet been described in major international fishing gear catalogues (e.g., He et al., 2022; Popescu and Breuer, 2024).

From a technical perspective, loop lines are best understood as a terminal device attached to the branch line of pelagic longlines rather than as a completely new fishing gear type. However, their distinctive operational mechanism—based on a system of concentric monofilament loops that entangles target species—sets them apart functionally from conventional hook-based systems (Figure 1). This raises important considerations regarding their classification, selectivity, and ecological implications.

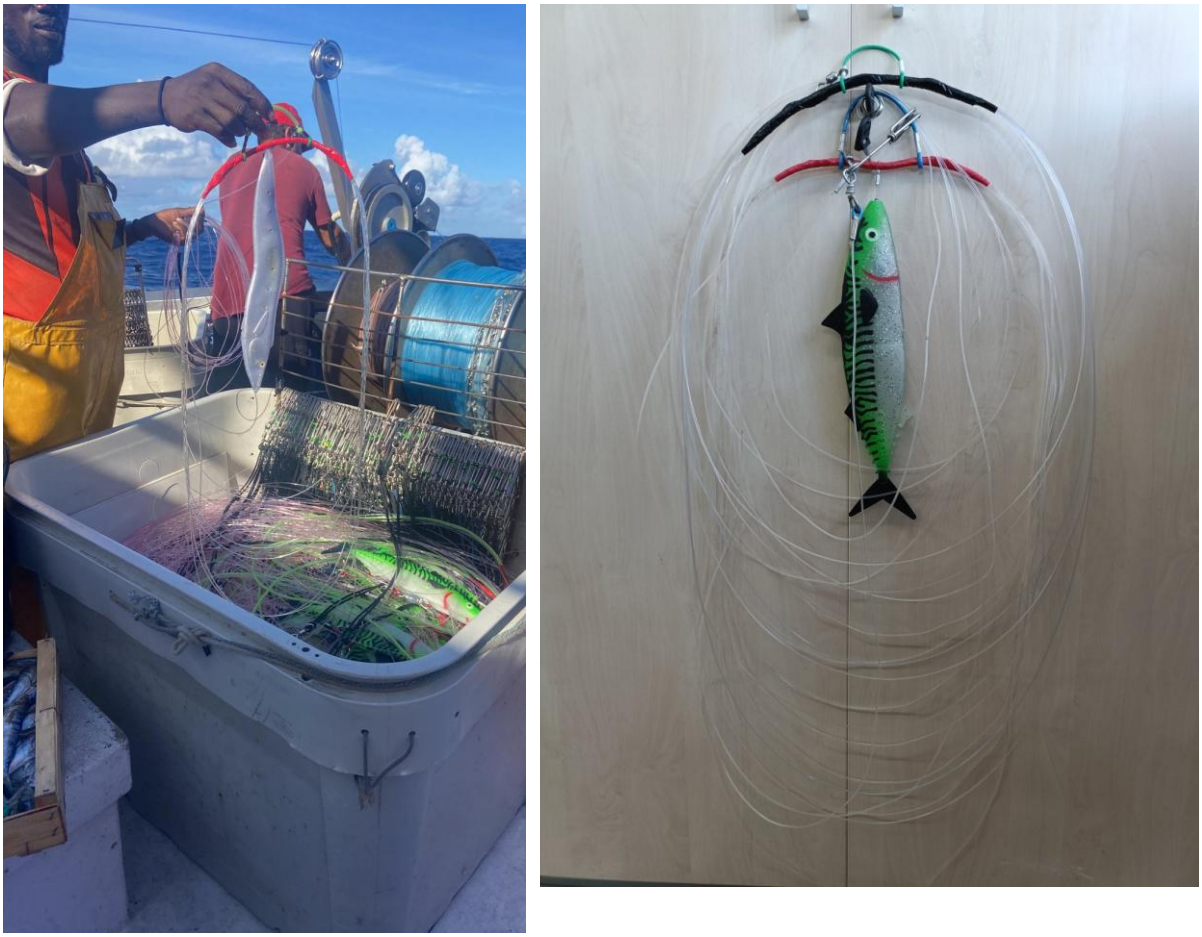


Figure 1. General appearance of two different loops with artificial bait.

Current scientific knowledge on loop lines remains extremely limited. Nevertheless, the available evidence suggests that this device exhibits a high degree of selectivity, primarily targeting medium-sized swordfish. Importantly, preliminary observations based on the limited data available indicate that loop lines are associated with very low levels of bycatch of non-target taxa (Macías et al., 2025a). Notably, and of particular relevance to the Agreement on

the Conservation of Albatrosses and Petrels (ACAP), existing information indicates *zero recorded bycatch of seabirds* in fisheries where loop lines are employed. Although these findings should be interpreted cautiously due to small sample sizes and the lack of comprehensive studies, they highlight the potential of loop lines as a mitigation measure for reducing incidental mortality of seabirds in pelagic longline fisheries.

Given the increasing global concern over bycatch of vulnerable species, particularly seabirds, the rapid spread of loop line technology and its apparent ecological advantages warrant further investigation. A systematic assessment of their performance, selectivity, and broader ecosystem impacts is therefore urgently needed.

The objective of the present study is to report the results of an onboard Spanish observer programme conducted between 2023 and 2025 in the western Mediterranean Sea. Specifically, this work aims to document and compare observed interactions with seabirds, between traditional pelagic longline fisheries using hooks and vessels employing the newly developed loop line terminal devices. By providing empirical observations from commercial fishing operations, this study seeks to contribute to the assessment of the relative bycatch performance of these two gear configurations.

2. MATERIAL AND METHODS

In the Mediterranean Sea, the Spanish pelagic longline fleet operates under a high diversity of métiers, reflecting variations in target species as well as coastal and oceanographic configurations. This operational heterogeneity results in distinct fishing strategies, gear configurations, and deployment patterns across the fleet. Table 1, adapted from Macías et al. (2025b), summarizes the main characteristics associated with each métier, providing an overview of their structural and functional differences.

Table 1. Technical characteristics of each observed métier.

Technical aspects			**SWO**				**BFT**		**ALB**	**LTA**
Unit	Variable	Stadistic	LLHB	LLAM	LLSP	LLPB	LLJAP	LLHB-BFT	LLALB	LLHB-LTA
mainline	Lenght (km)	Mean	46.93 ± 19.28	93.17 ± 15.85	41.46 ± 13.47	17.11 ± 8.73	64.94 ± 24.99	44.45	60.19 ± 18.55	24.66 ± 8.76
		Median	40.74	96.3	37.04	12.96	66.67	44.45	59.26	25.95
		Range	16.67 – 92.6	57.41 – 115.19	18.52 – 74.08	7.41 – 29.63	33.34 – 92.6	-	31.48 – 81.49	12.96 – 33.78
	Hooks	Mean	1906.96 ± 643.09	1265.05 ± 531.89	2088.25 ± 917.25	1193.08 ± 424.02	1290 ± 549.25	3120	3714.33 ± 1072.8	1903.4 ± 565.4
		Median	1800	1120	2000	1200	1100	3120	3445	2100
	Nº sections	Mean	14	15	8	2.5	18	12	13.5	2
		Median	13.33 ± 6.5	14.67 ± 1	7.67 ± 1.94	2.5 ± 1.29	18	12	13.25 ± 0.96	3.8 ± 3.42
		Range	1 – 25	13 – 16	3 – 10	1 – 4	-	-	12 – 14	1 – 8
	Caliber (mm)	Mean	1.91 ± 0.35	3.3 ± 0.66	2.27 ± 0.53	1.83 ± 0.42	3.78 ± 0.78	1.8	1.75 ± 0.15	1.6 ± 0.17
		Median	1.85	3.2	2.2	1.8	3.4	1.8	1.75	1.6
		Range	1.2 – 3.2	1.8 – 4	1.7 – 4	1 – 2.5	3 – 5	1.8	1.6 – 2	1.3 – 1.8
Section	Lenght (km)	Mean	3.71 ± 0.85	7.61 ± 7.76	5.6 ± 1.86	4.69 ± 1.93	7.69 ± 5.88	3.7	3.89 ± 0.61	3.87 ± 0.41
		Median	3.7	6.67	5.74	3.98	5.3	3.7	3.7	3.7
		Range	2.34 – 6.11	0.75 – 38.89	1.67 – 9.26	2.96 – 8.33	3.7 – 22.22	-	3.11 – 4.63	3.44 – 4.63

	Hooks	Mean	163 ± 49.74	71.58 ± 38.76	235.77 ± 72.96	274.11 ± 276.76	85.11 ± 23.92	260	232.33 ± 73.51	298.43 ± 157.9
		Median	150	64	240	156	90	260	231	260
		Range	56 – 264	5 – 200	60 – 300	56 – 900	52 – 126	-	156 – 350	195 – 650
	Nº unit	Mean	16.06 ± 4.98	18.65 ± 12.54	5.87 ± 2.17	9 ± 5.83	17.88 ± 3.76	-	17.2 ± 8.76	24.4 ± 13.05
		Median	16	16	6	8	16	-	13	22
		Range	6 – 24	10 – 66	2 – 10	2 – 17	14 – 25	-	8 – 30	15 – 47
Unit	Length (km)	Mean	0.23 ± 0.08	0.58 ± 0.73	0.87 ± 0.43	0.45 ± 0.88	0.31 ± 0.12	-	0.22 ± 0.04	-
		Median	0.24	0.39	0.94	0.15	0.32		0.22	
		Range	0.12 – 0.36	0.02 – 2.87	0.09 – 1.34	0.04 – 2.78	0.1 – 0.45	-	0.17 – 0.26	-
	Hooks	Mean	17.35 ± 39.8	4.78 ± 1.86	45.18 ± 13.62	38.18 ± 86.87	4.78 ± 0.83	12 ± NA	13.33 ± 2.94	13 ± 1.53
		Median	10	4	42	12	5	12	13	12
		Range	4 – 212	4 – 12	22 – 80	10 – 300	4 – 6	12 – 12	9 – 17	12 – 16
	buoy tail line [1] (m)	Mean	7.43 ± 3.56	15.05 ± 3.34	125.38 ± 9.65	0.84	18.93 ± 10.49	-	5.9 ± 0.84	-
		Median	6.69	16.72	125.38	0.84	16.96		6	
		Range	3.34 – 15.05	8.36 – 16.72	117.03 – 133.74	-	8.36 – 33.44	-	5.02 – 6.69	-
Branchline	Lenght	Mean	7.53 ± 1.9	14.93 ± 3.23	11.98 ± 5.54	6.45 ± 1.89	22.76 ± 11.46	-	5.54 ± 0.77	-
		Median	6.69	15.05	11.7	6.69	23.41		5.02	
		Range	5.02 – 13.37	10 – 20.06	6.69 – 20.06	2.51 – 8.36	8.36 – 35	-	5 – 6.69	5.02 – 13.37
	Caliber (mm)	Mean	1.37 ± 0.2	1.84 ± 0.33	1.43 ± 0.18	1.4 ± 0.34	3.53 ± 1.23	1.4	1.14 ± 0.31	1.15 ± 0.23
		Median	1.35	1.7	1.4	1.25	2.88	1.4	1.23	1.15
		Range	1 – 2	1.4 – 2.5	1.2 – 2	1 – 2	2.5 – 5	-	0.6 – 1.5	0.8 – 1.4
	Distance (m)	Mean	26.73 ± 17.88	80.61 ± 20.81	47.62 ± 43.53	34.49 ± 68.77	63.4 ± 26.42	-	15.97 ± 2.91	-
		Median	23.41	90	29.26	12	66		16	
		Range	12 – 90	18.39 – 90	20.9 – 133.74	4 – 240.74	20.06 – 90	-	12 – 20.06	-
Hook	Width	Mean	3 ± 0.54	3.46 ± 0.5	3.28 ± 0.56	2.6 ± 0.85	4.22 ± 0.89	2.8	1.87 ± 0.12	1.92 ± 0.04
		Median	3	3.7	3.05	2.6	4.3	2.8	1.8	1.9
		Range	2 – 4.2	2.8 – 4.5	2.7 – 4.2	2 – 3.2	3 – 5.5	-	1.8 – 2	1.9 – 2
	High	Mean	7.61 ± 0.43	8.35 ± 0.62	7.5 ± 0.49	6.3 ± 2.55	7.5 ± 1.38	7.5	3.97 ± 0.06	4.16 ± 0.09
		Median	7.65	8.2	7.5	7.5	7.4	7.5	4.2	6.3
		Range	7 – 8.15	7.2 – 9.4	7 – 8	4.5 – 8.1	6 – 9.5	-	3.9 – 4	4 – 4.2

[1] buoy tail line, a short length of rope or small-diameter line used to connect the surface buoy to the mainline. The pendant line serves to suspend the buoy, facilitating location marking, retrieval, or tension distribution along of mainline.

From 2023 onwards, the incorporation of loop line devices into fishing operations was observed. In addition to differences in gear configuration, these devices were also associated with changes in operational practices and fishing procedures. A total of 2,270 traditional longline sets were observed between 2015 and 2025. In contrast, between 2023 and 2025, a total of 698 sets using loop lines were recorded. Table 2 summarizes the observed fishing effort by métier, distinguishing between traditional sets using hooks and those employing loop line devices.

Table 2. Observed fishing effort by métier, distinguishing between traditional sets using hooks and those employing loop line devices.

TRAPLINE/LOOPS	METIER	SETS	HOOKS	LOOPS IN THE BRACHLINE	LOOPS IN THE LINE MAIN
NO LOOPS	LLSP	1054	2274998	0	0
	LLHB	589	148280	0	0
Tradictional longline	LLPB	209	324004	0	0
(2015-2025)	LLHB-LTA	149	323961	0	0
	LLHB-BFT	155	398550	0	0
	LLALB	106	328795	0	0
	LLJAP	8	9440	0	0
Sets Using loops (2023-2025)	LLSP_loop	573	707549	245658	132018
	LLPB_loop	95	134854	43253	6490
	LLHB_loop	30	56928	17327	0

3. RESULTS

In the period 2023 to 2025, the areas where fishing with hooks versus fishing without hooks were observed were similar (Figure 2).

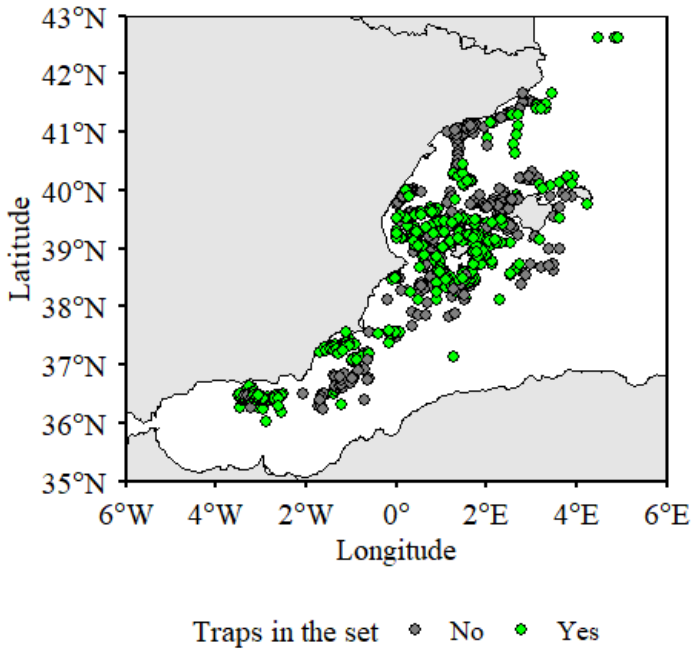


Figure 2. Distribution observed set using loops and traditional longline.

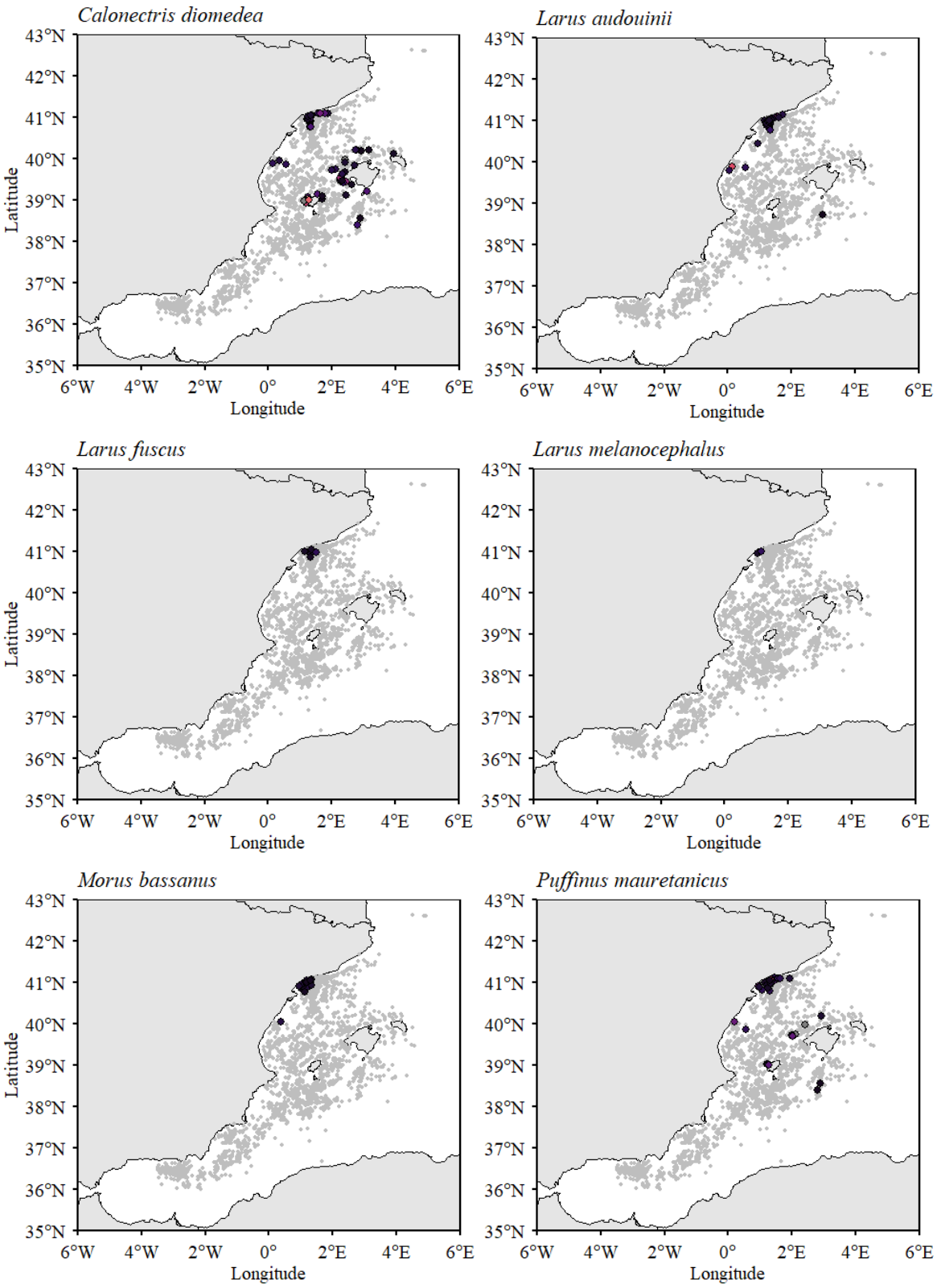
A total of 793 seabirds were recorded as captured in traditional pelagic longline fisheries in the Mediterranean across the different métiers, with the exception of the LLJAP métier, for which no seabird captures were observed (**Tables 2 and 3**), **figure 3** showed the distribution during the period 2023-2025 species and métier. In contrast, no seabird captures were recorded in sets using loop line devices in combination with hooks during the observation period.

Table 2. Summarizes the observed seabird captures by métier, indicating that no captures were registered in LLSP and LLJAP.

Species	METIER					
	LLALB	LLHB	LLHB-LTA	LLHB-BFT	LLPB	TOTAL
Calonectris diomedea	111	106	27	16	-	260
Larus audouinii	1	1	25	63	-	90
Larus fuscus		2	2	3	1	7
Larus melanocephalus	-	4	-	1	-	5
Larus michahellis	3	56	24	32	-	115
Larus spp.	-	-	1		-	1
Morus bassanus	-	18	5	9	-	32
Puffinus griseus	-	1	-	-	-	1
Puffinus mauretanicus	53	37	4	164	-	258
Puffinus yelkouan	8	5	1	3	-	17
Rissa tridactyla	-	2	-	-	-	2
Stercorarius pomarinus	-	-	1	2	-	3
Stercorarius skua	-	-	1	-	-	1
TOTAL	176	232	91	293	1	793

Table 3. Catch per Unit Effort (CPUE) was estimated for each identified species by métier. For the calculation of total CPUE by species, hooks from the LLSP and LLJAP métiers were included.

Species	METIER					CPUE TOTAL
	LLALB	LLHB	LLHB-LTA	LLHB-BFT	LLPB	
Calonectris diomedea	0.338	0.070	0.083	0.040	-	0.043
Larus audouinii	0.003	0.001	0.077	0.158	-	0.015
Larus fuscus	-	0.001	0.006	0.008	0.002	0.001
Larus melanocephalus	-	0.003	-	0.003	-	0.0008
Larus michahellis	0.009	0.037	0.074	0.080	-	0.019
Morus bassanus	-	0.012	0.015	0.023	-	0.005
Puffinus griseus	-	0.001	-	-	-	0.0001
Puffinus mauretanicus	0.161	0.024	0.012	0.411	-	0.043
Puffinus yelkouan	0.024	0.003	0.003	0.008	-	0.003
Rissa tridactyla	-	0.001	-	-	-	0.0003
Stercorarius pomarinus	-	-	0.003	0.005	-	0.0005
Stercorarius skua	-		0.003		-	0.0001
CPUE TOTAL	0.535	0.152	0.281	0.735	0.002	-


Calonectris diomedea
Larus audouinii
Larus fuscus
Larus melanocephalus
Morus bassanus
Puffinus mauretanicus
Latitude
Longitude
43°N
42°N
41°N
40°N
39°N
38°N
37°N
36°N
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6°W
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4°E
6°E

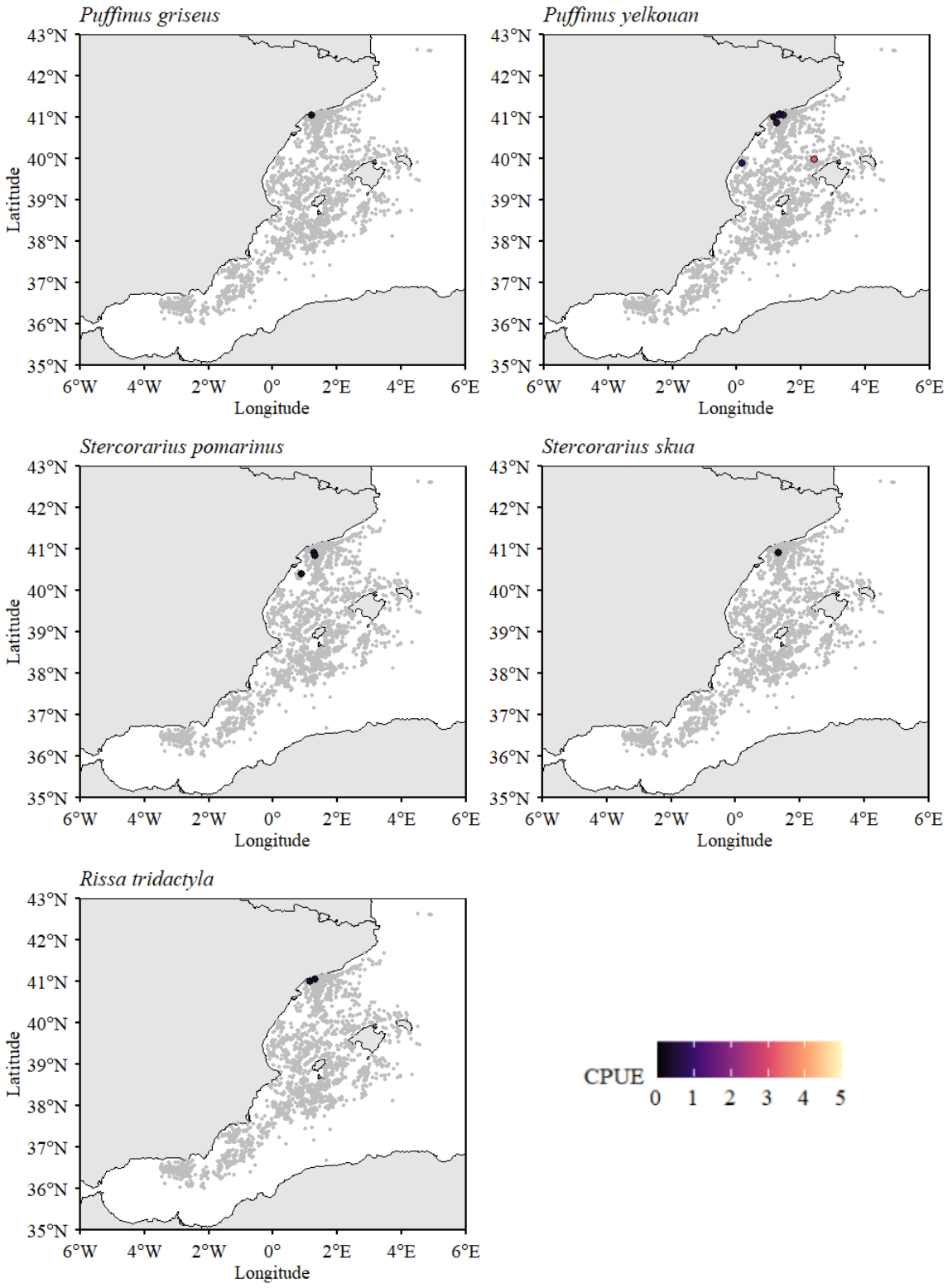

Figure 3. Seabird bycatch distribution observed during the period 2023-2025 by species and métier.

4. DISCUSSION

Loop line devices appear to result in a lower incidence of bycatch and exhibit greater selectivity towards billfish species. No interactions with seabirds were observed during the study period, and available observations suggest that seabirds are not attracted to these devices.

Although these results are promising, they are based on a relatively limited dataset. Further research is required to confirm these findings across broader spatial and temporal scales and to assess potential impacts on other taxa. However, loop lines represent a potentially effective mitigation measure for reducing seabird bycatch in pelagic longline fisheries.

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