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SPATIOTEMPORAL DISTRIBUTION AND BYCATCH ASSOCIATED WITH SURFACE LONGLINES USING TRAPLINES IN THE WESTERN MEDITERRANEAN

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SUMMARY

This study provides the first systematic assessment of the use of traplines - a recent modification of surface longline gear - in the western Mediterranean swordfish fishery. Observational data from 303 fishing operations targeting swordfish revealed that trapline sets (LOSET) resulted in lower catch rates of Xiphias gladius *but higher individual (i.e. higher weights) than the traditional hook sets (TRADSET), with a tendency toward capturing larger individuals (mean size 132 cm vs. 112 cm, p < 0.001). Our findings suggest that traplines may represent a promising tool for mitigating bycatch of endangered, threatened, and protected species (ETP) including sea turtles. Sets using trapline showed a dramatic reduction - approximately absolute 0.82 in ratio (LOSET ratio 1.73 ETP individuals/set) - in the number of ETP species caught compared to TRADSET (ratio 2.55 ETP individuals/set), i.e. reduction of 32.22%. However, key uncertainties remain regarding the full ecological impact of traplines and their optimal deployment. Further research is needed to determine whether attaching traplines directly to the mainline or incorporating them into branchlines yields better outcomes in terms of selectivity, efficiency, and gear performance. Given their potential to reduce bycatch significantly without reducing target catch efficiency, we recommend expanded experimental trials under scientific monitoring. Such efforts could support sustainable fisheries and align with EU conservation commitments under regional and international frameworks.*

RÉSUMÉ

Cette étude fournit la première évaluation systématique de l'utilisation des lignes de piégeage- une modification récente de l'engin de palangre de surface - dans la pêcherie d'espadon de la Méditerranée occidentale. Les données d'observation de 303 opérations de pêche ciblant l'espadon ont révélé que les opérations de pêche au moyen de lignes de piégeage (LOSET) ont donné lieu à des taux de capture plus faibles de Xiphias gladius *mais à des spécimens plus nombreux (c'est-à-dire des poids plus élevés) que les opérations de pêche traditionnelles à l'hameçon (TRADSET), avec une tendance à la capture de spécimens plus grands (taille moyenne de 132 cm contre 112 cm, p < 0,001). Nos résultats suggèrent que les lignes de piégeage peuvent représenter un outil prometteur pour atténuer les prises accidentelles d'espèces en danger, menacées et protégées (ETP), y compris les tortues marines. Les opérations à la ligne de piégeage ont montré une réduction spectaculaire - environ 0,82 en ratio absolu (ratio LOSET 1,73 spécimens ETP par opération) - du nombre d'espèces ETP capturées par rapport à TRADSET (ratio 2,55 spécimens ETP par opération), c'est-à-dire une réduction de 32,22%. Toutefois, des incertitudes majeures subsistent quant à l'impact écologique total des lignes de piégeage et à leur déploiement optimal. Des recherches supplémentaires sont nécessaires pour déterminer si le fait d'attacher les lignes de piégeage directement à la ligne principale ou de les incorporer aux avançons donne de meilleurs résultats en termes de sélectivité, d'efficacité et de performance de l'engin. Compte tenu de leur capacité à réduire considérablement les prises accessoires sans réduire l'efficacité des captures, nous recommandons d'étendre les essais expérimentaux dans le cadre d'un suivi scientifique. Ces efforts pourraient favoriser une pêche durable et s'aligner sur les engagements pris par l'UE en matière de conservation dans les cadres régionaux et internationaux.*

RESUMEN

Este estudio proporciona la primera evaluación sistemática del uso de trampillas (traplines)-una modificación reciente del arte de palangre de superficie- en la pesquería de pez espada del Mediterráneo occidental. Los datos de observación de 303 operaciones de pesca dirigidas al pez

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espada revelaron que las operaciones con trampillas (LOSET) dieron lugar a tasas de captura más bajas de Xiphias gladius pero más elevadas de ejemplares (es decir, pesos más elevados) que las operaciones tradicionales con anzuelo (TRADSET), con una tendencia hacia la captura de ejemplares con tallas mayores (talla media 132 cm frente a 112 cm, p < 0,001). Nuestros hallazgos sugieren que las trampillas pueden representar una herramienta prometedora para mitigar la captura fortuita de especies en peligro, amenazadas y protegidas (ETP), incluidas las tortugas marinas. Las operaciones con trampilla mostraron una reducción drástica -aproximadamente absoluta de 0,82 en ratio (ratio LOSET 1,73 ejemplares ETP/operación de pesca)- en el número de especies ETP capturadas en comparación con TRADSET (ratio 2,55 ejemplares ETP/operación de pesca), es decir, una reducción del 32,22%. Sin embargo, sigue habiendo grandes incertidumbres sobre el impacto ecológico de las trampillas y su despliegue óptimo. Es necesario seguir investigando para determinar si la fijación de las trampillas directamente a la línea principal o su incorporación a las brazoladas produce mejores resultados en términos de selectividad, eficacia y rendimiento del arte. Dado su potencial para reducir significativamente las capturas fortuitas sin reducir la eficacia de las capturas de especies objetivo, se recomienda que se amplíen los ensayos experimentales bajo supervisión científica. Tales esfuerzos podrían apoyar la pesca sostenible y ajustarse a los compromisos de conservación de la UE en el marco regional e internacional.

KEYWORDS

Bycatch, loop, swordfish, trapline

1. Introduction

The first description of longline using "trapline" - a modification of the pelagic longline technique—was provided by Garibaldi and collaborators in 2024, in a presentation to the Scientific Committee of ICCAT (Garibaldi *et al*., 2024). Their study was based on observations of swordfish fisheries in the Mediterranean, specifically in the Ligurian Sea, operated by the Italian fleet.

It is now known that this fishing gear is used across the entire Atlantic Ocean and the Mediterranean Sea, and it is likely to have originated in Asian fleets operating in the Pacific Ocean approximately a decade ago. In addition to its use by the Italian fleet, this gear has been identified in the Spanish fleet operating in the central (Cape Verde) and southern Atlantic (Uruguay) (personal communication A. Domingo), as well as in the Mediterranean. Reports from fishing vessel captains also indicate that the Portuguese fleet employs this technique, and there is strong evidence suggesting that Asian fleets operating in the Atlantic have adopted it as well.

The trap or loop device is constructed from nylon or polyamide monofilament, typically with a diameter of 2.0 to 2.5 mm, which is commonly used for secondary branchlines (**Figure 1**). The structure consists of several loops - generally seven, though the number may vary between four and eight-. The thickness of the line used may vary depending on material availability onboard each vessel.

At each side of the bait, and in the center of the strap that binds the loops, a small piece of monofilament is attached to form a ring, secured with crimps and, in some cases, a protective sheath. This ring serves as the attachment point connecting the trap/loop to the branchline and subsequently to the mainline. Artificial (i.e. plastic) bait is consistently used, typically squid, mackerel, or similar species. Various modifications to the bait setup have been observed by onboard scientific observers aboard the Spanish fleet in the Mediterranean, and through interviews conducted with fishing captains operating tuna vessels in Cape Verde and Montevideo. In certain instances, only artificial bait is used; in others, battery-powered or chemical lights are inserted into the bait. Some fishers embed a hook within the artificial bait, or place natural bait inside it.

There are also several methods for attaching the traps/loops to the branchlines. One involves the use of a secondary line of the same dimensions as those used for hooks, terminating in a snap clip ("snap") that connects to the trap/loop. Alternatively, a fixed snap clip is attached directly to the ring connecting the loop structure, which can then be clipped onto the hook of the branchline, effectively replacing the bait.

Garibaldi et al. (2024) did not report any vessels fully equipped with this trap/loop system. They noted, however, that some vessels - particularly those operating in Sicily - are beginning to use the device as a replacement for hooks. Several captains interviewed in the Atlantic indicated that some vessels use a significant number of these devices, sometimes exceeding the number of hooks deployed.

According to the interviewed captains, the primary advantages of the trap/loop system include reduced bait and hooks usage and increased swordfish catch efficiency (smallest Swordfish would pass through the hoop without getting caught). The trap/loop is triggered when the fish attempts to access the artificial bait. Due to the presence of a slipknot and multiple loops of varying sizes, the fish becomes entangled - typically around the head, bill, fins, and gills - making escape highly unlikely, unless the connection between the trap/loop and the branchline breaks. In such cases, the fish is likely to remain entangled in the gear and be lost.

One operational challenge is the retrieval of large individuals. Since the trap/loop does not allow for the fish to be hauled in head-first, it must be lifted sideways, which increases retrieval time and raises the risk of breakage in the secondary lines.

There are not evidences regarding to the bycatch impact of this novel component of the longline system. Some captains claim it is particularly effective for billfish, especially swordfish, and attribute this to the behavioral characteristics of these species (personal communications). However, there is currently a lack of precise information regarding bycatch levels and the potential impact of this new device in longline fisheries. The aim of the present study is to compare both target catches and associated bycatch, with a specific focus on ETP (Endangered, Threatened, and Protected) species.

2. Materials and Methods

The Instituto Español de Oceanografía (IEO-CSIC) maintains a long-term onboard observer program in the Spanish longline fleet, covering over 5% of annual fishing effort. Since 2023, observers have documented the introduction of the trapline system in Mediterranean swordfish fisheries.

During 2024, a total of 310 longline fishing operations conducted in the Mediterranean were observed, across seven different vessels. We observed that trap/loop only were used in fishing operation targeting swordfish. Of these 310 sets, 303 were targeting swordfish. A total of 248 sets employed traplines (LOSET), while 55 did not (TRADSET) (**Table 1; Figure 2**).

Traplines/Loops were either attached directly to the mainline ($n = 10{,}080$) or affixed to standard hooks using the branchline ($n = 131{,}520$), effectively complementing or replacing traditional baited hooks. In total, 147,236 hooks were observed in TRADSET operations in 55 sets. In contrast, LOSET operations included 384,438 hooks plus 141,600 traplines in 248 sets, i.e. 2121 branchlines in average per set in TRADSET versus 2677 branchlines in average per set in LOSET.

3. Results

Significant differences were observed in the mean number of swordfish captured per set between TRADSET (mean= 30.02 swordfish/set) and LOSET (mean= 19.75 swordfish/set), with a higher number of individuals recorded in sets without loops ($U = 5450.5$, $P = 0.02$) (Figure 2). Regarding weight, statistically significant differences were also detected between TRADSET (mean = 103.35 kg/set) and LOSET (mean = 162.79 kg/set) ($U = 4144$, $P < 0.001$) (Figure 3). This is due to swordfish length distributions differed significantly between gear types. Individuals caught using LOSET exhibited a higher mean fork length (132 cm ± 28.13 cm) compared to TRADSET (112 cm ± 26.11 cm), with differences statistically significant according to the Kruskal–Wallis test ($P < 2.2e\text{-}16$) (**Figure 4**).

A significant reduction in ETP species bycatch ($U=12854$, $P<0.001$) was observed in sets utilizing traplines compared to traditional hook configurations. Moreover, we observed a reduction in total bycatch. **Table 2** shows the number of sets with and without bycatch with TRADSET and LOSET indicating a reduction in the number of sets with bycatch with LOSET, especially with the semi-pelagic longline (LLSP). Also a reduction in the total number of individuals caught is observed, especially in the surface longline (LLHB). **Table 3** presents the number of individuals of ETP species bycatch per gear type (TRADSET vs. LOSET). **Table 4** shown the bycatch of these species by metier and setting type. **Figures 5-10** showed ETPs bycatch distribution per set type TRADSET and LOSET.

4. Discussion

The use of traplines in surface longline fisheries appears to be a highly promising innovation, particularly in terms of reducing incidental catch and bycatch of endangered, threatened, and protected (ETP) species. Preliminary results from this study indicate a notable decrease in bycatch—up to 32.22% ETP species—in sets utilizing traplines (LOSET) compared to traditional hook sets (TRADSET). Moreover, the size distribution of swordfish captured using traplines suggests a trend toward larger individuals, which may reflect different selectivity dynamics, though this warrants further investigation.

Despite these promising indications, critical knowledge gaps remain regarding the broader ecological and operational implications of trapline use. Specifically, the potential impacts on species that are not well represented in the current dataset, including some ETP taxa, are still unknown. Likewise, it remains unclear whether the optimal configuration of traplines involves direct attachment to the mainline or integration into existing branchlines. These variables may have significant implications for gear efficiency, entanglement dynamics, and species selectivity.

Given the potential of this gear modification to significantly reduce bycatch—particularly of marine turtles and other ETP species—and in light of the urgent conservation priorities in the Mediterranean and Atlantic regions, we strongly recommend that the Commission support the continuation and expansion of experimental trials on trapline use in surface longline fisheries. Further research should aim to evaluate the ecological, technical, and economic dimensions of this method, with the ultimate goal of identifying best practices for implementation in commercial fleets.

Such investigations are essential to ensure that traplines can be effectively and responsibly integrated into fisheries management strategies, contributing to the broader objectives of sustainable fisheries and the conservation of vulnerable marine species.

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Referencias

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Table 1. Summarises surface drifting longline activity observed during 2024.

Observed sets	303			
Metier	*Type of set*	*Nº sets*	*Nº hooks*	*Nº traps*
LLHB	TRADSET	30	103847	0
	LOSET	26	50998	14002
LLSP	TRADSET	1	1620	0
	LOSET	204	310907	120011
LLPB	TRADSET	24	41769	0
	LOSET	18	22533	7587

Table 2. Total bycatch observed by metier and set type.

Metier	*Type of set*	*Nº sets*	*Nº sets with bycatch*	*Nº bycatch captures*
LLHB	TRADSET	30	30	579
	LOSET	26	20	59
LLSP	TRADSET	1	1	6
	LOSET	204	85	176
LLPB	TRADSET	24	24	273
	LOSET	18	9	14
Total	-	303	169	1107

Table 3. Endangered, threatened, and protected species (ETP) bycatch individuals per species and type of set.

Species	*SET TYPE*		*Nº caught by a trap*
	TRADSET	*LOSET*	
Calonectris diomedea	30	0	0
Caretta caretta	7	0	0
Centrophorus granulosus	3	0	0
Dipturus oxyrinchus	1	0	0
Galeus melastomus	56	7	0
Isurus oxyrinchus	1	4	1
Larus fuscus	1	0	0
Larus michahellis	9	0	0
Mobula mobular	2	0	0
Mola mola	63	2	2
Morus bassanus	1	0	0
Prionace glauca	23	29	5
Pteroplatytrygon violacea	431	52	2
Puffinus mauretanicus	1	0	0
Puffinus yelkouan	2	0	0
Rissa tridactyla	1	0	0
Tursiops truncatus	0	1	0

Table 4. ETPs bycatch observed by metier and set type.

Metier	*Type of set*	*Nº sets*	*Bycatch sets*	*Nº captures*
LLHB	TRADSET	30	29	492
	LOSET	26	13	35
LLSP	TRADSET	1	1	6
	LOSET	204	38	54
LLPB	TRADSET	24	23	134
	LOSET	18	6	6
Total	-	303	110	727

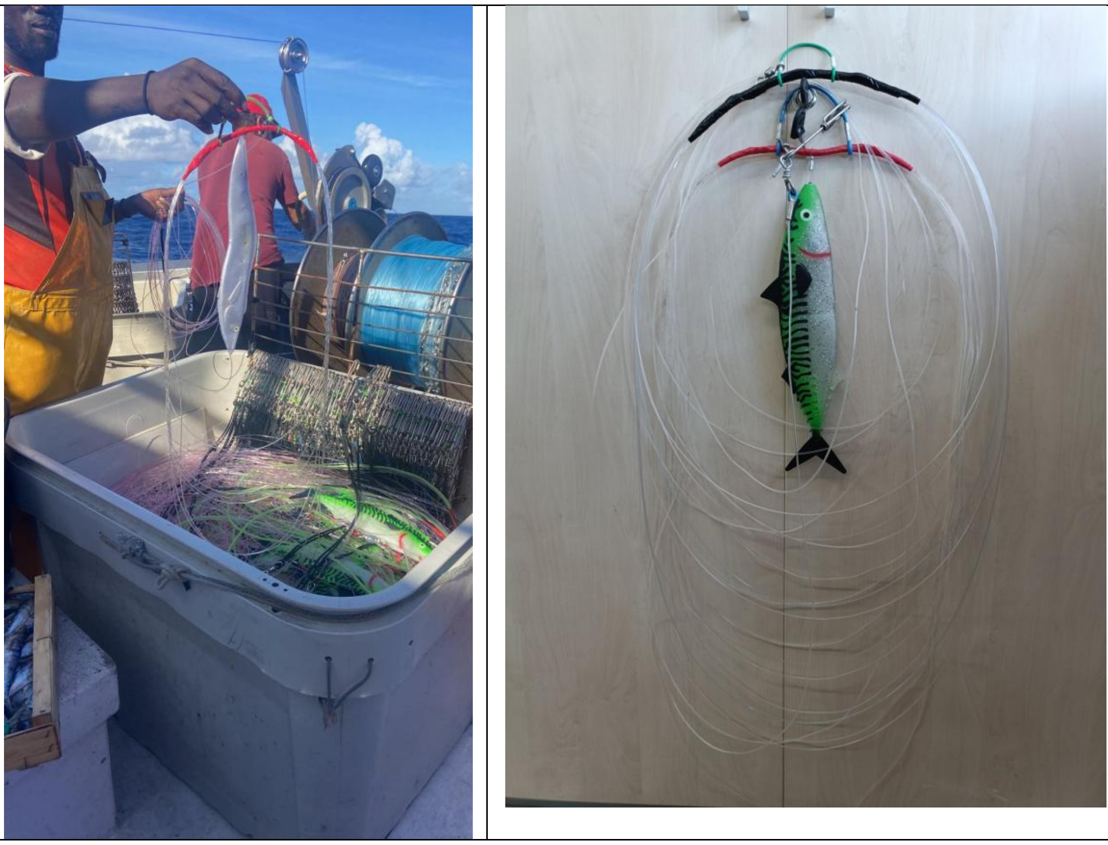

Figure 1. General appearance of two artificially baited traps/loops.

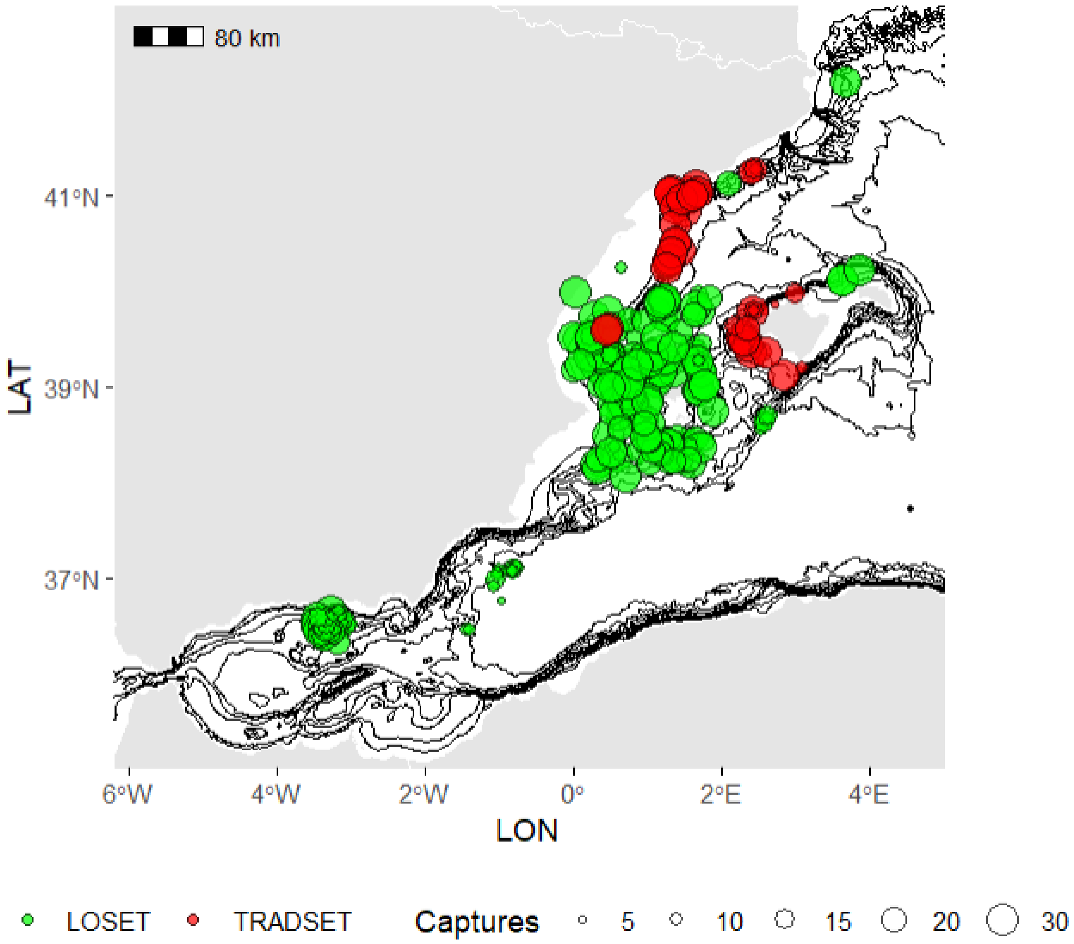

Figure 2. Swordfish catch distribution in number per LOSET and TRADSET.

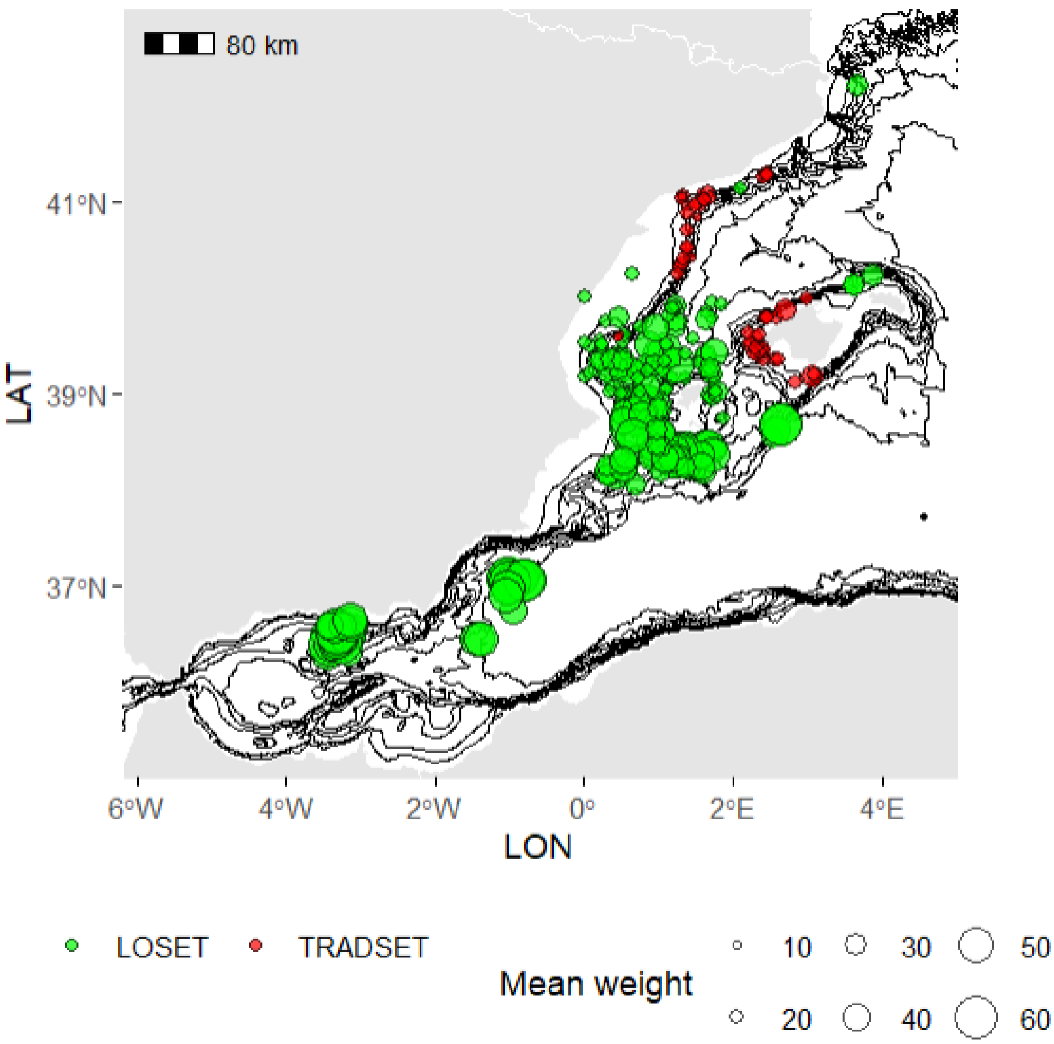

Figure 3. Swordfish catch in weight (kg) distribution in number per LOSET and TRADSET.

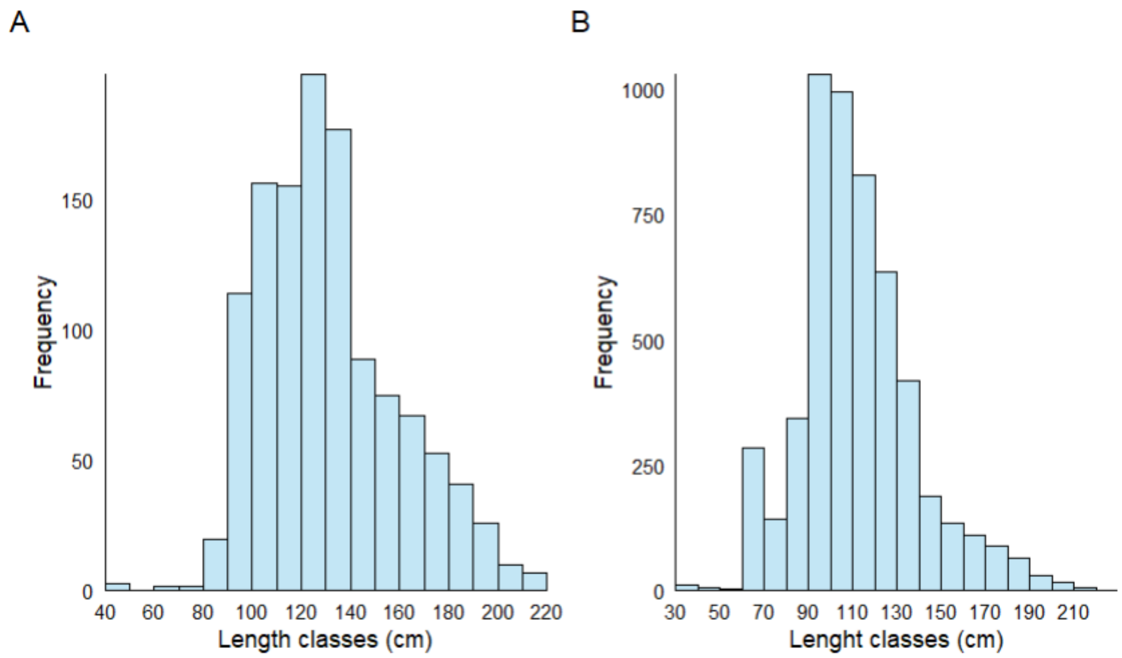

Figure 4. Size distributions of swordfish caught by A) traps, 132 cm ± 28.13 cm, B) traditional hook, mean size =112 cm ± 26.11 cm.

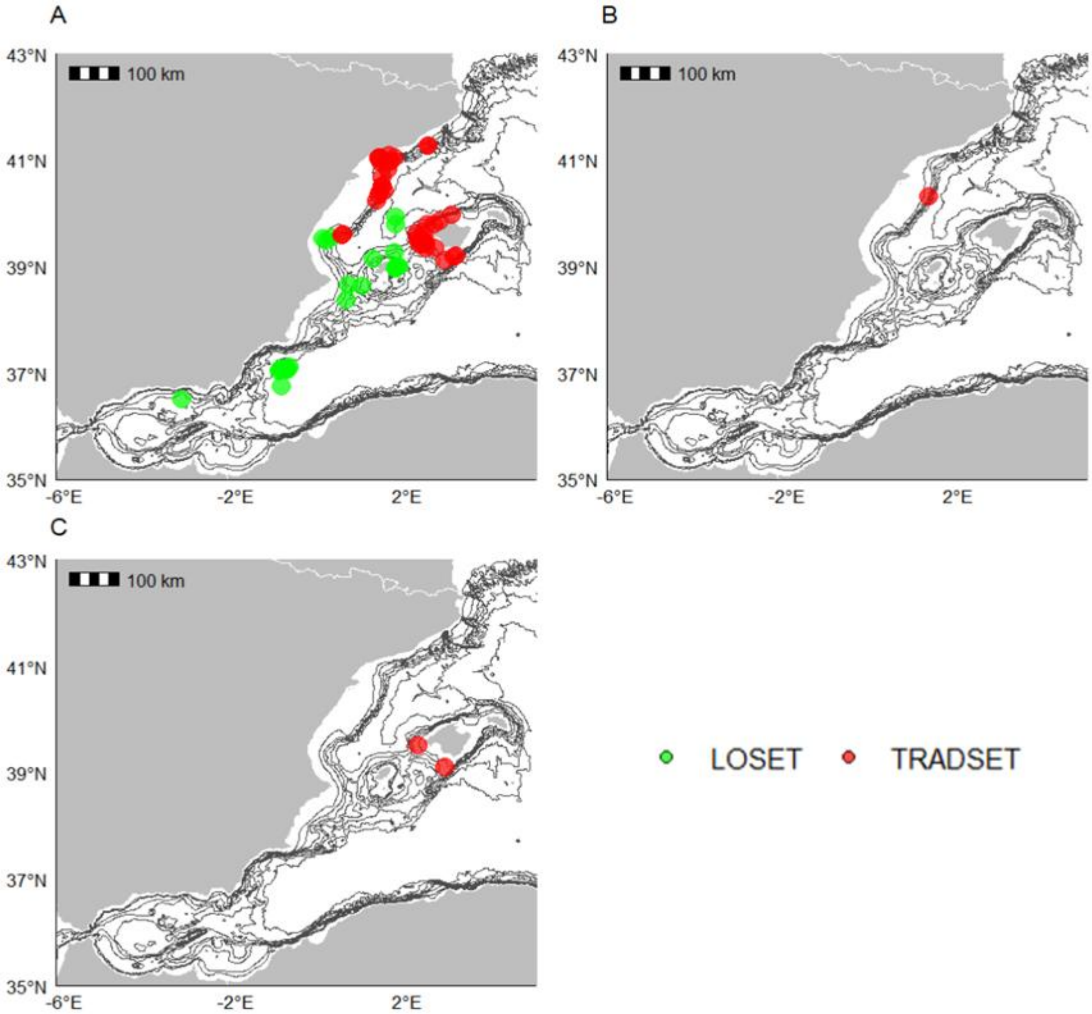

Figure 5. Bycatch distribution of A) *Pteroplatytrygon violacea*, B) *Mobula mobular*, C) *Dipturus oxyrinchus*.

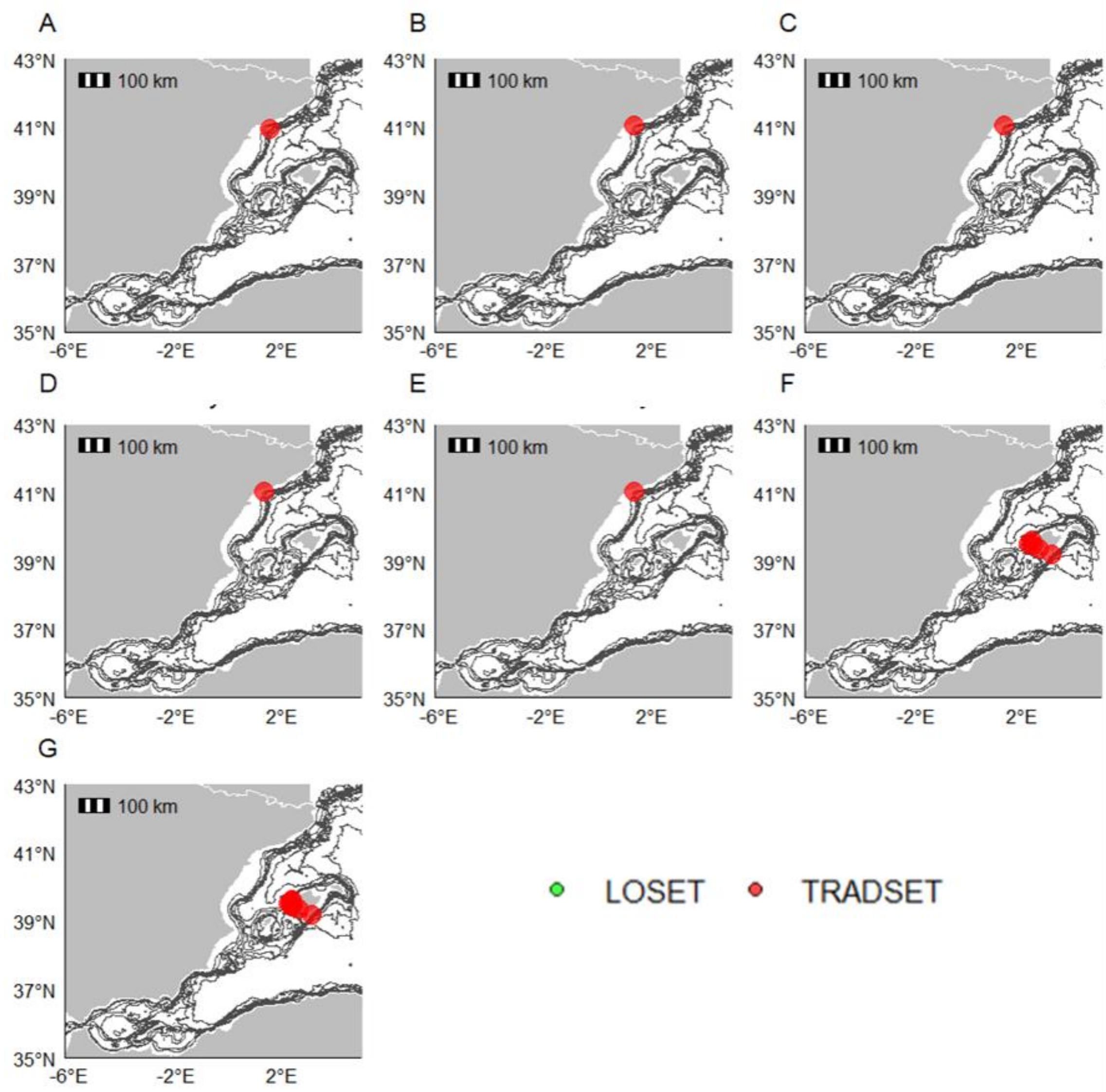

Figure 6. Bycatch distribution of A) *Larus fucus*; B) *Morus bassanus*; C) *Puffinus mauretanicus*; D) *Puffinus yelkouan*; E) *Rissa tridactyla*; F) *Larus michahellis*; G) *Calonectris diomedea*.

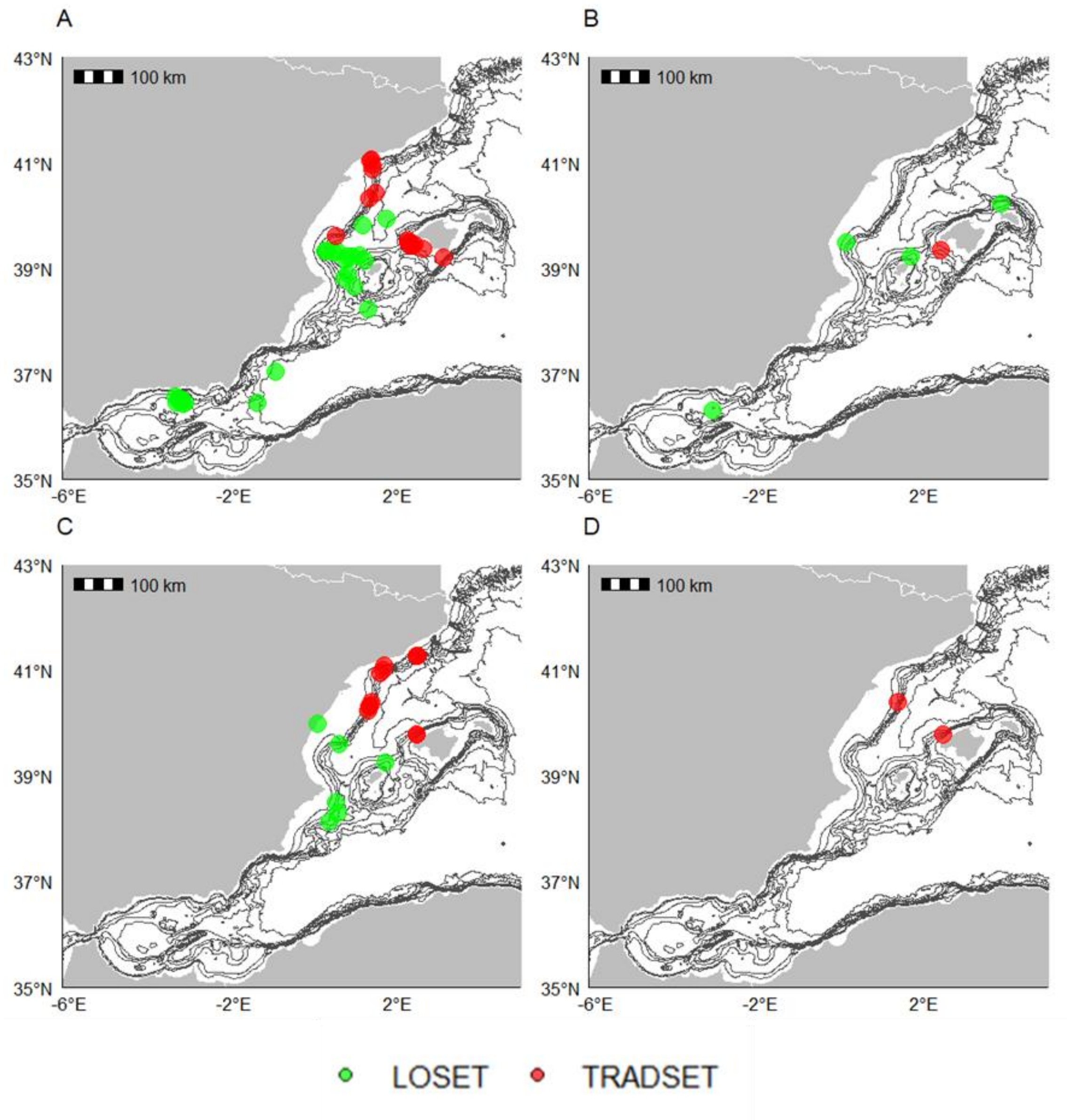

Figure 7. Bycatch distribution of A) *Prionace glauca*, B) *Isurus oxyrinchus*, C) *Galeus melastomus*, D) *Centrophorus granulosus*.

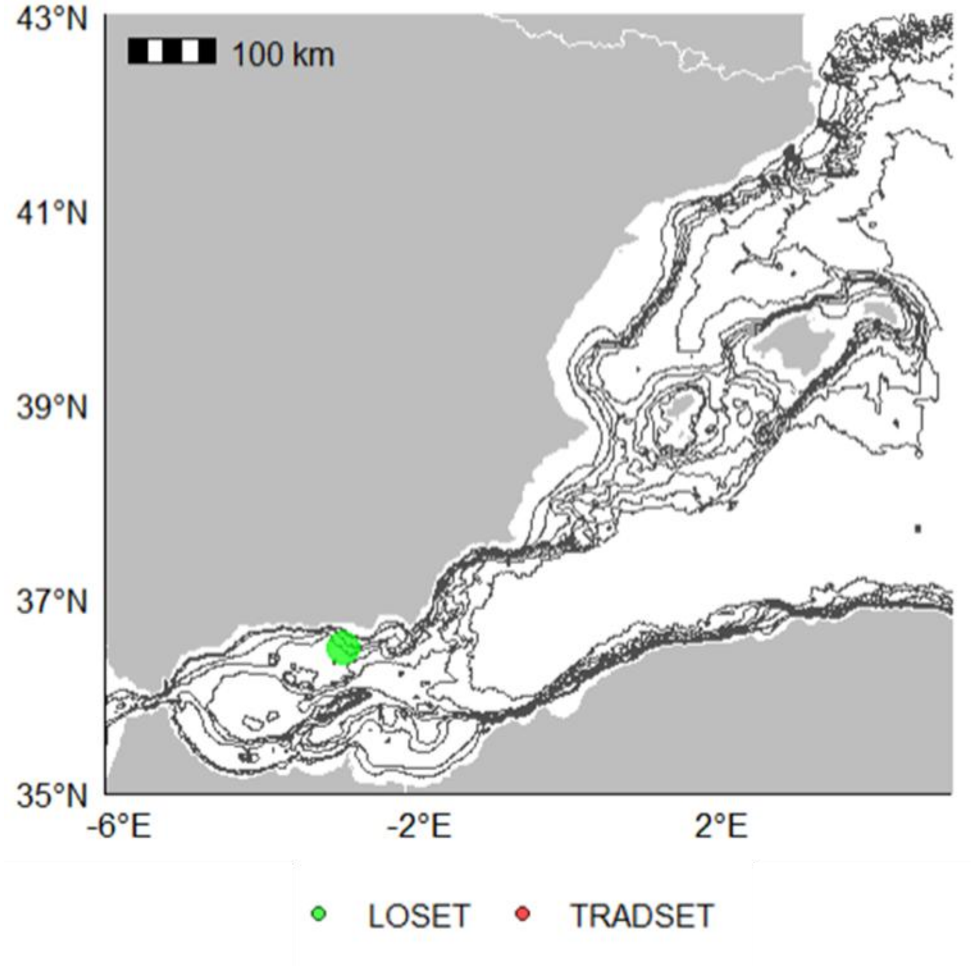

Figure 8. Bycatch distribution of *Tursiops truncatus*.

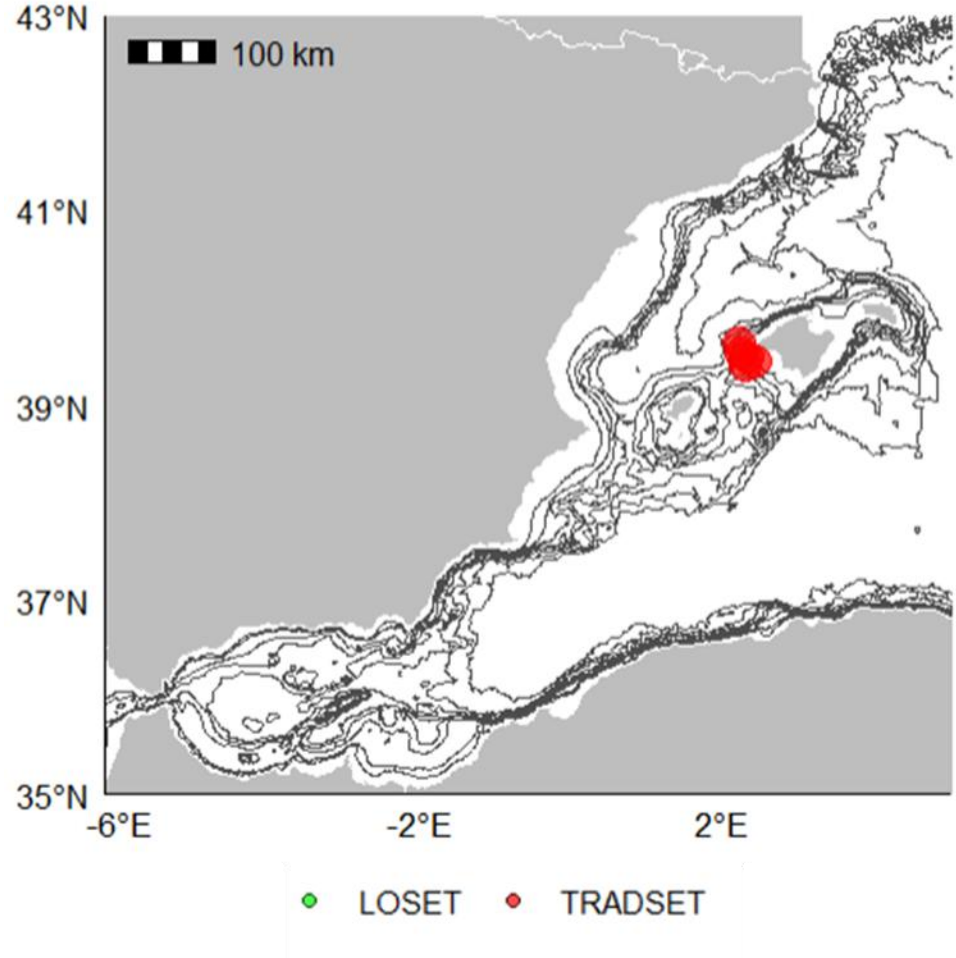

Figure 9. Bycatch distribution of *Caretta caretta.*

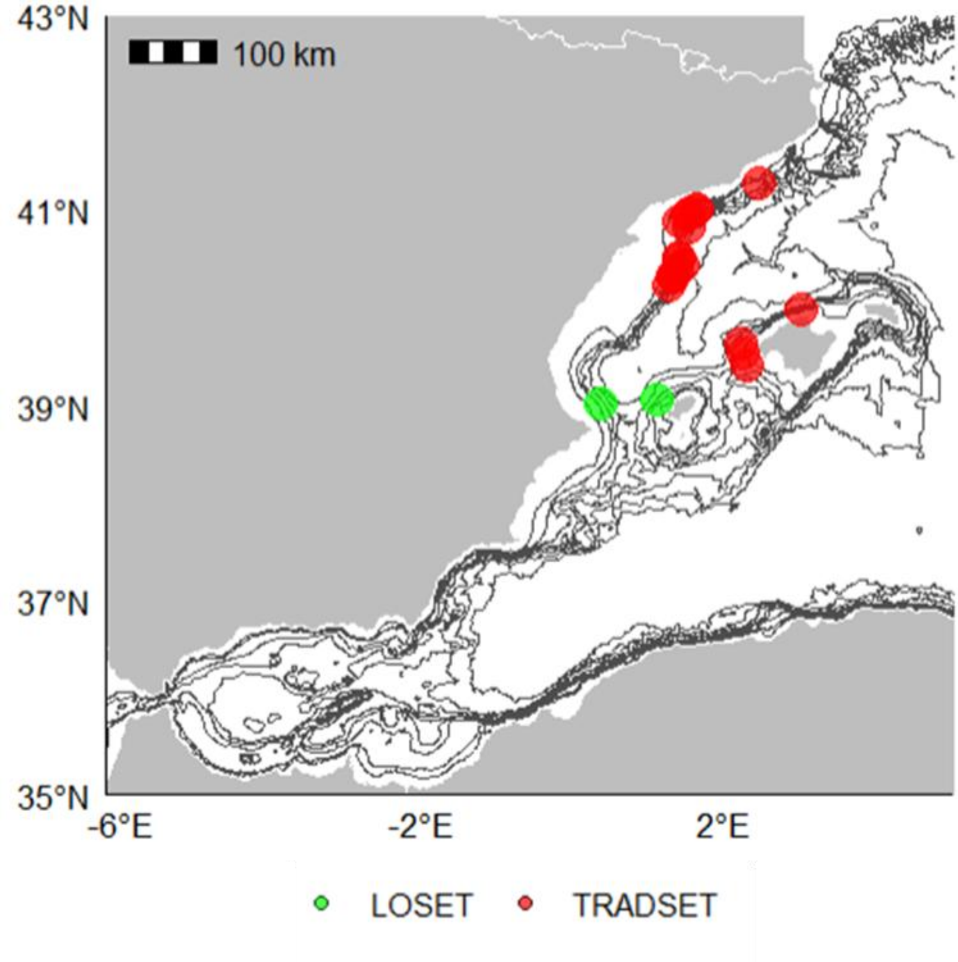

Figure 10. Bycatch distribution of *Mola mola*.