Nouvelles directives pour les auteurs de documents scientifiques pour le SCRS de l'ICCAT et le Recueil de documents scientifiques

1. Introduction

Les Recueils de documents scientifiques de l'ICCAT (connus également sous le nom de « Livres rouges ») sont produits chaque année et se composent des Rapports des Groupes de travail du SCRS, des Rapports détaillés des sessions d'évaluation des stocks ainsi que des documents scientifiques présentés (non révisés par des pairs) soumis au SCRS. Il y a généralement 1 volume de 4 à 10 tomes par an.

Les documents que nous sollicitons aux scientifiques et qu'ils nous soumettent peuvent être rédigés en anglais, espagnol ou français. Il n'existe pas de limites de pages bien qu'il soit demandé aux auteurs de limiter le contenu de leurs documents au matériel indispensable pour leur compréhension. Ces documents ne sont pas révisés par des pairs, à l'exception de certaines éditions spéciales, et la responsabilité de leur contenu relève des auteurs et non de l'ICCAT.

2. Processus de soumission

Afin d'être plus cohérent avec le processus de soumission d'autres revues scientifiques, mais sans sacrifier la qualité, les auteurs sont priés de suivre attentivement les instructions de formatage. En cas de non-respect des formats, votre document peut vous être renvoyé afin d'être re-formaté. La publication de votre document peut être retardée ou annulée en conséquence. Veuillez consulter la liste de vérification à la fin du présent document avant de soumettre votre document.

Avant chaque réunion du SCRS, un appel à contributions est lancé. Les auteurs doivent remettre au Secrétariat une copie électronique en MS Word ou un logiciel équivalent (sur un support de stockage ou par courrier électronique) de tous les documents, y compris les tableaux et les figures. La date limite de réception des documents est fixée à une semaine avant le début de la réunion au cours de laquelle le document est présenté. Après les réunions du SCRS, un avis est envoyé à tous les auteurs correspondants des documents du SCRS, leur demandant d'indiquer leur intention de publier leurs documents dans le Recueil des documents scientifiques de l'ICCAT, et de soumettre leurs documents avant la date limite stipulée dans l'avis.

3. Formats

La ***première page du document*** doit comporter le titre, le nom des auteurs et leurs adresses, y compris leurs adresses e-mail, en notes de bas de page, le résumé (limité à 180 mots) et les mots clés. Les résumés seront traduits par le Secrétariat dans les trois langues officielles de l'ICCAT et incorporés à la première page du document. Les résumés doivent inclure l'objet de la recherche, une brève description des procédures appliquées et des résultats ainsi que les conclusions tirées (le cas échéant). Les résumés étant ensuite inclus dans une base de données bibliographiques (ASFA, ICCAT), il est important qu'ils décrivent la recherche de façon claire et concise.

Les ***mots clés*** : sélectionnez jusqu'à 10 mots clés de la liste disponible ici ou ceux inclus à l'**addendum 1 à l'appendice 10.** La liste comporte les mots clés les plus courants concernant les pêcheries (en anglais seulement), utilisés dans la base de données de l'ASFA. Indépendamment de la langue d'origine du document, les mots clés ne doivent figurer qu'en anglais.

Le ***texte général*** doit être en Cambria 10 (voir les marges ci-dessous). Les titres doivent être courts, refléter un ordre logique et suivre les règles de la sous-division multiple (il ne peut pas y avoir, par exemple, de sous-division sans, au moins, deux sous-titres). La totalité du texte doit être compréhensible pour les lecteurs : les acronymes et les abréviations doivent donc être rédigés en entier et tous les termes techniques moins connus doivent être définis la première fois qu'ils sont mentionnés. Les dates doivent être libellées comme suit : 10 novembre 2026. Les mesures doivent être exprimées en unités métriques, par exemple en tonnes métriques (t).

Les ***tableaux*** doivent être insérés dans le texte, aussi près que possible de l'endroit où ils sont référencés pour la première fois, afin de permettre au lecteur de mieux comprendre ce qu'ils contiennent. Les tableaux doivent être cités par ordre numérique dans le texte. Les tableaux doivent être numérotés (en chiffres arabes) et le titre du tableau doit apparaître au-dessus du tableau ; il convient d'éviter d'utiliser des quadrillages. Les titres dans les tableaux doivent être concis mais suffisamment explicites pour permettre la compréhension du tableau. Les symboles inhabituels doivent être expliqués dans la légende du tableau. Tout autre commentaire éventuel peut être annoté en bas du tableau.

Les ***figures*** doivent être insérées dans le texte, aussi près que possible de l'endroit où elles sont référencées pour la première fois, afin de permettre au lecteur de mieux comprendre ce qu'elles contiennent. Les figures doivent être citées par ordre numérique dans le texte. Les figures doivent être numérotées (en chiffres arabes) et la légende des figures doit apparaître en dessous de la figure ; il convient d'éviter d'utiliser des quadrillages. Identifiez clairement les échelles numériques, les unités et les légendes pour les axes des X et des Y pour chaque figure.

Les ***formules*** apparaîtront en italiques, en maintenant un double espace entre les paragraphes précédent et suivant.

Références aux articles/documents qui ont été publiés : Le format des références apparaissant dans le texte doit suivre le système de nom et année. Dans le texte, écrire « Smith et Jones (1999) », mais si la référence est entre parenthèses, écrire alors « (Smith et Jones, 1999) ». Dans la partie de la bibliographie, répertorier les références par ordre alphabétique en commençant par le nom de famille de l'auteur principal. Les références aux documents rédigés par le(s) même(s) auteur(s) et publiés la même année devront comporter une lettre pour les distinguer (2002a pour le premier, 2002b pour le deuxième, etc.) et devront être ainsi citées dans le texte. L'intégralité des citations relève de la responsabilité des auteurs. Format des références : Auteur (nom de famille suivi des initiales du prénom), année, titre du rapport ou du document, titre abrégé de la série où l'article a été publié, numéro de volume, numéros de pages. Le titre abrégé devra être conforme à la liste des titres abrégés des séries (Liste d'abréviations de mots de titres - ISO 4, publiée par le Centre ISSN international, 45 rue de Turbigo, 75003 Paris, France). Pour les livres, veuillez citer l'éditeur, la ville et le pays (cf. point 4 pour obtenir un modèle).

Pour votre commodité, vous trouverez, ci-dessous, un résumé des instructions de formatage ainsi qu'un modèle.

4. Résumé des instructions de formatage

Logiciel :	MS Word ou logiciel compatible
Format papier :	A4
Marges :	haut, bas, gauche, droite : 2,5 cm En-tête : 1,5 cm, pied de page: 2,0 cm Résumés *:* mis en retrait de 1,2 cm à gauche et à droite.
Espacement :	Texte : simple Entre paragraphes : double Avant tout nouveau titre principal : triple (Les auteurs utilisant la version d'Asie de l'Est de MS Word sont priés de s'assurer que la copie imprimée comporte réellement un espacement simple)
Alignement :	Le texte doit être justifié
Numérotation :	La numération commence à la première page qui portera le numéro 1.
En-tête :	Uniquement sur la première page: SCRS/20XX/XXX [insérer l'année et le numéro du document]
Police de caractères :	Cambria
Taille de police :	Titre du document : Cambria 12 Reste du document : Cambria 10 Notes de bas de page : Cambria 8
Casse :	Seul le titre du document sur la page de titre doit être en MAJUSCULES.
Tabulations :	Pas de retraits de paragraphes, uniquement un retrait suspendu de 0,75 cm dans les références bibliographiques.
Fichiers :	Un fichier MS Word (formaté conformément aux instructions ci-dessus)

5. Liste de vérification

Avant de remettre votre document,

- Avez-vous utilisé MS Word ou un logiciel équivalent ?
- Avez-vous utilisé la taille A4, des marges de 2,5 cm, des en-têtes de 1,5 cm et des bas de page de 2,0 cm ?
- Avez-vous utilisé des majuscules et la police Cambria 12 **uniquement** pour le titre du document, et la police Cambria 10 pour le texte ?
- Avez-vous utilisé un espacement simple pour le texte et un double espacement entre les paragraphes ?
- Avez-vous inclus le résumé et les mots clés ?
- Avez-vous respecté la limite de 180 mots pour le résumé ?
- Avez-vous utilisé la fonction « Insertion- Note de bas de page » de MS Word afin d'inclure l'adresse du/des auteur(s) ?
- Avez-vous cité tous les tableaux et figures dans le texte du document, et les avez-vous numérotés dans l'ordre de leur apparition ?
- Avez-vous fait référence à tous les tableaux et figures en caractère **gras** dans le texte ?
- Avez-vous vérifié les références bibliographiques du texte avec la bibliographie ?
- Avez-vous actualisé la bibliographie si certains documents « sous presse » ont été publiés ?

SCRS/2025/XX [Numéro SCRS (dans l'en-tête et uniquement sur la première page) : Arial 10]

[2 espaces]

TITRE DU DOCUMENT

[Cambria 12, MAJ., **GRAS**, CENTRÉ]

[2 espaces]

[TOUT le texte ensuite en Cambria 10]

John D. Smith, John D. Jones[1]

[Noms des auteurs : 1ère lettre des mots en majuscule, centré]

[2 espaces]

RÉSUMÉ
[*Italique*. Mise en retrait des marges gauche et droite de 1,2 cm.]

Les marges gauche et droite du texte des résumés doivent être MISES EN RETRAIT de 1,2 cm. Le résumé ne doit pas dépasser 180 mots et ne doit pas contenir de citations. Le Secrétariat traduira le résumé dans les deux autres langues de l'ICCAT et les incorporera à la page de titre.

MOTS CLÉS [*Italique*, centré]

À choisir dans la liste disponible ***ici*** *ou ceux figurant à l'****addendum 1 à l'appendice 10****.*

[DÉBUT DU TEXTE DU DOCUMENT]
[Rétablir toutes les marges à 2,5 cm. Paragraphes NON mis en retrait.] Le texte des documents peut être soumis dans l'une des trois langues officielles de la Commission (anglais, espagnol, français).

1. Titres principaux : caractères gras, majuscules en début de phrase [triple espace avant de commencer tout nouveau titre principal]

1.1. Sous-titres : italique, caractères gras et majuscules en début de phrase [double espace avant les sous-titres et entre les paragraphes]

1.1.1 Sous-titres dans les sous-titres : italique et minuscules

Formules

$$ {}^{g}YPR = \sum_{a} Y_a \cdot {}^{g}\overline{R}_a $$

[1] Affiliation, adresse, etc. Adresse électronique de l'auteur principal [Cambria 8] ; veuillez utiliser la fonction « Insertion - Note de bas de page » de MS WORD.

Tableaux et figures

[Les tableaux et figures doivent être numérotés consécutivement (en chiffres arabes). Le titre du tableau doit apparaître **au-dessus** du tableau et la légende de la figure **en dessous** de la figure. Les tableaux et les figures doivent être cités dans le texte et la citation doit être en caractères **gras** (exemple : « …comme l'illustrent le **tableau 1** et la **figure 1**… »).

Tableau 1. Les titres des tableaux doivent être courts, mais suffisamment explicites pour permettre la compréhension du tableau.

Pour les tableaux :

- Utilisez la police Cambria 10.
- Évitez d'utiliser des quadrillages.
- Conservez les marges standard (voir ci-dessus).
- Dans la mesure du possible, ne collez pas d' « images », préparez ou convertissez votre tableau en MS Word.
- Tout symbole inhabituel doit être expliqué dans la légende du tableau.
- Tout autre commentaire éventuel peut être annoté en bas du tableau.

Pour les figures :

- Évitez d'utiliser des quadrillages.
- Conservez les marges standard (voir ci-dessus).
- Identifiez clairement les échelles numériques, les unités et les légendes pour les axes des X et des Y pour chaque figure.
- Tous les symboles doivent être expliqués dans la légende de la figure.
- Dans votre fichier graphique utilisez la fonction « copier » et dans votre fichier MS Word la fonction « coller -> collage spécial –> Image (métafichier amélioré) ».
- Préparez vos figures à une résolution de qualité, en utilisant des applications capables de générer des images en haute résolution (format jpg, .gif ou .tif). Veillez à ce que les chiffres soient clairs et lisibles sans grossissement.
- Cliquez sur l'image, allez ensuite à « format », « format de l'image », « mise en forme» et choisir « devant le texte » pour de meilleurs résultats.

- --

Figure 1. La légende des figures doit être concise mais suffisamment explicite pour permettre la compréhension de la figure.

Bibliographie

Nom du premier auteur, nom ou initiale(s), nom(s) des autres auteurs, nom ou initiales. Année de publication. Titre du document. Journal ou publication Vol. (tome) : pages. DOI (insérer l'adresse web lorsqu'elle est disponible)

Pour les documents publiés dans les Recueils de documents scientifiques de l'ICCAT à partir de 2025, la référence doit être la suivante : Col. Vol. Sci. Pap. ICCAT, 8X(X), SCRS/202X/0XX : 1–22 (202X).

Exemple :

Anon. 2025. Report of the 2025 shortfin mako shark data preparatory meeting. Col. Vol. Sci. Pap. ICCAT, 82(2), SCRS/2025/002: 1-91 (2025).

Smith J.E., Brown C. Assessment of skipjack stocks. FAO Fish. Yearbook 22(5): 262-265.

Acevedo-Iglesias S., Herrera M. , Ramos M.L., Báez J.C., Ruiz J., Rodríguez-Rodríguez G., Rojo V., Pascual-Alayón P.J., Abascal F.J. 2025. Bycatch trend and its fate of the Spanish-owned tuna purse seiners fleet from the Atlantic and Indian oceans: Impacts of the implementation of good practices, Marine Policy, Volume 177, 106694, https://doi.org/10.1016/j.marpol.2025.106694

Wood C. M., 1991. Acid-base and ion balance, metabolism, and their interactions, after exhaustive exercise in fish. Journal of Experimental Biology, 160(1), 285-308. https://doi.org/10.1242/jeb.160.1.285

Un exemple de ce qui précède figure à l'**addendum 2 à l'appendice 10**.

Addendum 1 à l’appendice 10

Liste de mots clés*

Analysis	*Biology*				*Environment*	*Fishery*		*Statistics*	*Management*
Accuracy	Abundance	Electrophoresis	Nursery grounds	Spawning seasons	Bottom topography	Aquaculture products	Fishing nets	Aerial surveys	Coastal zone management
Artificial intelligence	Age at recruitment	Escapement	Otoliths	Stock identification	Climatic data	Aquaculture systems	Fishing technology	Age composition	Ecosystem management
Autocorrelation	Age determination	Ethology	Parasites	Stomach content	Convergence zones	Aquaculture techniques	Floating structures	Biological sampling	Exclusive Economic Zone
Catchability	Algal blooms	Evolution	Plankton	Tagging mortality	Current data	Artisanal fishing	Gillnets	By catch	Exclusive rights
Catch ratio	Animal morphology	Fecundity	Population characteristics	Taxonomy	Dissolved oxygen	Attracting techniques	High seas fisheries	Catch composition	Fishery boundaries
Computer programs	Animal reproductive organs	Feeding behaviour	Population density	Vulnerability	Environmental conditions	Bait fishing	Holding capacity	Catch statistics	Fishery disputes
Econometrics	Annual variations	Feeding migrations	Population dynamics	Yield	Environmental effects	Canning	Joint ventures	Data collections	Fishery management
Economic analysis	Behaviour	Fish diseases	Population genetics	Zoobenthos	Environmental factors	Capture fishery economics	Line fishing	Fish catch statistics	Fishery policy
Economic models	Biomass	Fish eggs	Population numbers	Zooplankton	Fishery oceanography	Coastal fisheries	Long lining	Fish conversion factors	Fishery regulations
Experimental research	Biometrics	Fish larvae	Population structure		Long-term changes	Commercial fishing	Multispecies fisheries	Fishery statistics	International waters
Fishery economics	Biochemical analysis	Fish physiology	Potential resources		Mercury	Echosounders	Net fishing	Fishery surveys	Legislation
Fishing mortality	Biophysics	Fishery biology	Potential yield		Mixed layer	Exploitation	Pelagic fisheries	Fishing effort	Licensing
Fishing power	Biotechnology	Fishery sciences	Predation		Oceanography	Fish detection	Processed fishery products	Imaging techniques	Overfishing
Gear selectivity	Blood cells	Food preferences	Prediction		Pelagic environment	Fish fillets	Purse seining	Length-weight relationships	Quota regulations
Least squares method	Body size	Forage fish	Proteins		Pollution effects	Fish handling	Radar	Logbooks	Resource conservation
Mathematical models	Body temperature	Genetics	Recruitment		River plumes	Fish products	Shark fisheries	Remote sensing	Season regulations
Multivariate analysis	Bones	Geographical distribution	Recruitment rate		Salinity	Fish storage	Ship design	Research vessels	Size limit regulations
Natural mortality	Breeding seasons	Growth curves	Reproductive behaviour		Seasonal variations	Fish utilization	Sport fishing	Size composition	Surveillance and enforcement
Numerical analysis	Breeding sites	Habitat	Reproductive cycle		Short-term changes	Fishery development	Trap fishing	Size distribution	Trade
Random processes	Buoyancy	Homing behaviour	Resource availability		Spatial variations	Fishery engineering	Trawling	Sonic tags	Underutilized species
Simulation	Chemical composition	Identification keys	Schooling behaviour		Surface layers	Fishery industry	Trolling	Statistical sampling	
Steady state	Density dependence	Juveniles	Sex determination		Surface salinity	Fishery products	Tuna fisheries	Tagging	
Stochastic processes	Depleted stocks	Life history	Sex ratio		Surface temperature	Fishery technology			
Stochastic models	Diving	Longevity	Sexual dimorphism		Temporal distribution	Fishing buoys			
Stock assessment	DNA	Migrations	Sexual maturity		Thermocline	Fishing capacity			
Time series analysis	Ecological aggregations	Morphometry	Spawning		Water pollution	Fishing gear			
Variance analysis	Ecological associations	Nervous system	Spawning grounds		Wind-driven circulation	Fishing grounds			
Yield predictions	Ecosystems		Spawning migrations			Fishing lines			
Yield/recruit									

* Des noms d'espèces ou d'autres mots-clés peuvent également être utilisés.

SILKY SHARK POST-RELEASE SURVIVAL IN THE ATLANTIC OCEAN TROPICAL TUNA PURSE SEINE FISHERY: A BASELINE FOR BEST HANDLING AND RELEASE PRACTICES

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SUMMARY

Popup Satellite Archival Tag (PSAT) marking programs are crucial for evaluating post-release survival (PRS) of Endangered, Threatened, and Protected (ETP) species that are incidentally caught in fishing operations. This study presents for the first time, results on post-release survival estimates of silky shark released during a fishing trip following protocols from the Code of Good Practices implemented by the OPAGAC fleet in a purse seine vessel. Twenty-three silky sharks were satellite tagged, and blood samples from 90 sharks were collected to evaluate lactate levels as an indicator of shark PRS. A vitality index based on state and behavior at release was also assigned to all the accidentally caught sharks. Subsequently, the relationship between mortality and vitality status, as well as the relationship between mortality and the lactate concentration in each captured individual, was established. The predicted silky shark survival rate for the overall trip was close to 26% based on satellite tag data and vitality index, while the survival rate predicted using lactate concentration threshold was 49%. Shark survivorship decreased as the brailing operation advanced and vitality index declined.

RÉSUMÉ

Les programmes de marquage par marques-archives pop-up reliées par satellite (PSAT) sont essentiels pour évaluer la survie après remise à l'eau (PRS) des espèces en danger, menacées et protégées (ETP) qui sont capturées accidentellement lors d'opérations de pêche. Cette étude présente pour la première fois des résultats sur les estimations de la survie suivant la remise à l'eau de requins soyeux relâchés lors d'une sortie de pêche suivant les protocoles du Code de Bonnes Pratiques mis en œuvre par la flottille de OPAGAC dans un senneur. Vingt-trois requins soyeux ont été marqués avec des marques satellites et des échantillons de sang de 90 requins ont été prélevés pour évaluer les niveaux de lactate en tant qu'indicateur du SRP des requins. Un indice de vitalité basé sur l'état et le comportement au moment de la remise à l'eau a également été attribué à tous les requins capturés accidentellement. Ensuite, la relation entre la mortalité et l'état de vitalité, ainsi que la relation entre la mortalité et la concentration de lactate dans chaque requin capturé, a été établie. Le taux de survie prédit pour le requin soyeux pour l'ensemble de la sortie était proche de 26% sur la base des données des marques satellites et de l'indice de vitalité, tandis que le taux de survie prédit en utilisant le seuil de concentration de lactate était de 49%. Le taux de survie des requins a diminué à mesure que l'opération de salabardage avançait et l'indice de vitalité a diminué.

RESUMEN

Los programas de marcado con marcas de archivo por satélite emergentes (PSAT) son cruciales para evaluar la supervivencia posterior a la liberación (PRS) de las especies en peligro, amenazadas y protegidas (ETP) que son capturadas incidentalmente en operaciones de pesca. Este estudio presenta por primera vez resultados sobre estimaciones de supervivencia tras la liberación de ejemplares de tiburón jaquetón liberado durante una marea siguiendo los protocolos del código de buenas prácticas implementado por la flota de

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OPAGAC en un buque de cerco. Se marcaron por satélite 23 ejemplares de tiburón jaquetón y se recogieron muestras de sangre de 90 tiburones para evaluar los niveles de lactato como indicador de la PRS del tiburón. También se asignó a todos los tiburones capturados accidentalmente un índice de vitalidad basado en el estado y el comportamiento en el momento de la liberación. Posteriormente, se estableció la relación entre la mortalidad y el estado de vitalidad, así como la relación entre la mortalidad y la concentración de lactato en cada ejemplar capturado. La tasa de supervivencia del tiburón jaquetón prevista para toda la marea se aproximó al 26 % a partir de los datos de las marcas por satélite y el índice de vitalidad, mientras que la tasa de supervivencia prevista utilizando el umbral de concentración de lactato fue del 49 %. La supervivencia de los tiburones disminuyó a medida que avanzaba la operación de salabardeo y disminuía el índice de vitalidad.

KEYWORDS

Silky shark, C. falciformis,
post-release survival, bycatch, FADs, purse seiners, tropical tuna

Introduction

Silky sharks (*Carcharinus falciformis*) are one of the most significant shark species bycaught by tuna fisheries globally (Oliver *et al*. 2015). This species is currently listed as vulnerable by the IUCN Red List of Endangered Species[3]. Silky shark bycatch primarily occurs in gillnets and longlines (Murua *et al*., 2021) but it is also the predominant elasmobranch species bycaught in purse seiners (Ruiz *et al*., 2017; Acevedo-Iglesias *et al*., 2025). Global Ecological Risk Assessments (ERAs) conducted for longline fisheries in the Atlantic have shown that silky sharks are at the highest risk (Cortés *et al*. 2010). Similarly, an ERA conducted in the Indian Ocean, which included longlines, gillnets and purse seiners, indicated that silky sharks are at the highest risk for longlines but not for purse seiners due to the implementation of Best Handling and Release Practices (BHRPs), which reduce their susceptibility to the purse seine gear (Murua *et al*. 2018; Acevedo-Iglesias *et al*., 2025). In this sense, studies on post-release survival of ETP species using satellite archival tags are essential for fishery impact assessment and identification of effective mitigation measures for shark conservation (Ellis *et al*., 2017). For example, best handling and release practices were identified as rapid and cost-effective conservation and management measure for reducing the vulnerability status of *Mobula mobular* in the Inter-American Tropical Tuna Commission (IATTC) area (Griffths and Lezama, 2021). However, studies on PRS in different gears and monitoring of the adoption and implementation of the measure were identified as essential to confirm the effectiveness of the recommended measure (Griffths and Lezama, 2021).

Due to the vulnerability of silky shark in fisheries associated with tuna and other pelagic species, the International Commission for the Conservation of Atlantic Tunas (ICCAT) has implemented measures to protect them. For example, ICCAT recommends that CPCs prohibit the retention, transshipment, or landing of silky sharks, whether dead or alive, and ensure their release back into the ocean (Rec 11-08). Observers are tasked with recording the number of silky sharks discarded or released, along with their status (i.e., dead or alive), to improve data collection and conservation efforts. UE Council Regulations also establish that Member States shall encourage the release of live sea turtles, mobulids and rays, and sharks, and the prompt release unharmed, to the extent practicable, of all non-target species, as well as additional measures to improve the selectivity of fishing gears (EC) Nº 520/2007). The use of non-entangling FADs with no mesh net was also introduced in the ICCAT area to minimize potential entanglement of sharks (Rec. 24-01).

[3] https://www.azti.es/wp-content/uploads/2024/02/AZTI_Guia_BBPP_low.pdf

Due to their natural aggregative behaviour around floating objects and the overlap of juvenile silky shark habitats with tropical tuna purse seine fisheries (Lopez *et al*., 2020), silky sharks occur in FAD sets, representing the principal elasmobranch bycatch species in tropical tuna purse seiners (i.e., 75-95% of all shark interactions) (Filmalter *et al*., 2011; Gilman 2011; Garcia and Herrera, 2018; Hutchinson *et al*., 2019, Ruiz *et al*., 2017; Acevedo-Iglesias *et al*., 2025). Although FAD purse seine shark bycatch ratios remain low when compared to other fisheries (Garcia and Herrera, 2018; Perez-Roda *et al*., 2019; Gilman *et al*., 2020; Murua *et al*., 2021), given the vulnerable status of this species it is important to take actions to minimize any impact.

To reduce at vessel shark mortality, purse seine vessels have adopted Best Handling and Release Practices (BHRPs)[4] mostly based on guidelines by scientists (Poisson *et al*., 2014a; Grande *et al*., 2020; Zollett and Swimmer, 2019; Wain *et al*., 2022; Acevedo *et al*. 2025), often also supported by regional fisheries management organization (RFMO) conservation measures. In the case of the Spanish fleet OPAGAC and ANABAC voluntarily apply a Code of Good Practices (CGPs). The CGP includes BHRPs requirements for ETP species that are, since 2014, regularly revised by their members and scientific staff (Grande *et al*., 2020; Acevedo-Iglesias *et al*. 2025). Recently, the fleet has also started testing and implementing novel bycatch release devices (Murua *et al*., 2025). Some purse seine vessels are installing specific fauna release devices in their upper decks, such as hoppers, ramps, sorting grids, and velcros and in the lower deck, such as bycatch release conveyor belts and gutters (Murua *et al*., 2025). As a result, the percentage of sharks released alive has substantially increased since 2013, when the percentage of live releases was low, to reach 75% in 2022 according to Acevedo *et al*. (2025). PRS studies in purse seiners have indicated that the state of the specimen at release and their survival is highly dependent on the time and place at which the individuals arrive on deck, (e.g., entangled in the net, first brail, posterior brails) (Poisson *et al*. 2014b, Hutchinson *et al*., 2015, Eddy *et al*., 2016; Onandia *et al*., 2021) and the method of handling and release (Hutchinson *et al*., 2015; Onandia *et al*., 2021; Grande *et al*., 2022). At present purse seine silky shark PRS studies using PSATs have focused on the Pacific (Hutchinson *et al*., 2015; Eddy *et al*., 2016; Murua *et al*., 2024) and Indian Oceans (Poisson *et al*., 2014b) but there are no substantial estimates in the Atlantic Ocean to evaluate the impact of BHRPs from the CGPs towards reducing shark mortality. Therefore, this document aims to evaluate for the first time the post-release survival of silky shark in the Atlantic Ocean on a purse seine vessel where sharks have been released following BHRP guidelines.

1. Material and Methods

1.1 Field work

Research was conducted during a fishing trip on an OPAGAC purse seine vessel, in the tropical Atlantic from August 21st to September 19th, 2023. A total of 26 sets were carried out over the course of the trip (25 on floating objects or FOBs and one on a free school, FSC). Interactions with silky sharks were recorded in 25 sets (24 FOB sets and 1 FSC set). Most sets were located in the central part of the eastern tropical Atlantic, between latitudes 5N-10S and longitudes 10E-10W (**Figure 1**).

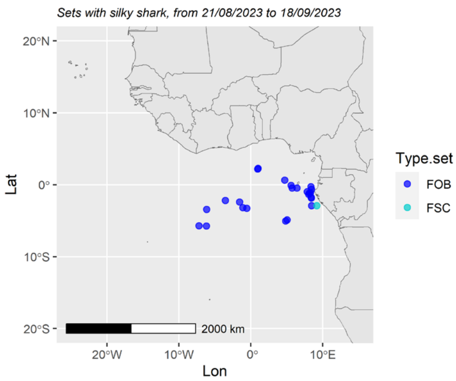

Figure 1. Positions of sets with incidental catch of silky shark (*C. falciformis*). FOB: sets on FADs; FSC: sets on a free school.

[4] https://www.azti.es/wp-content/uploads/2024/02/AZTI_Guia_BBPP_low.pdf

In each interaction with *C. falciformis*, the following information was recorded:

- sex (i.e., female, male, indeterminate or unknown),
- total length in cm (TL),
- number of the brail in which the specimen was taken on board (1st, 2nd, 3rd brail and subsequent),
- position in the brail (up, medium, bottom),
- time when the shark was brailed on board and released,
- mode of release: (i) using the brailer, (ii) using light equipment such as stretcher, fabric, *sarria* or cargo net, (iii) manually from deck, (iv) after disentangling from hauling net;
- vitality index (i.e., state of the animal at release based on the states proposed by Heuter and Manire (1994):

  - (i) excellent (i.e., very active and energetic, strong signs of life on deck and when returned to water);
  - (ii) good (i.e., active and energetic, moderate signs of life on deck and when returned to water);
  - (iii) correct (i.e., tired and sluggish, limited signs of life, moderate revival time required when returned to water, slow or atypical swimming away);
  - (iv) poor (i.e., exhausted, no signs of life, bleeding from gills, jaw or cloaca, long revival time required when returned to water, limited or no swimming observed upon release);
  - (v) very poor or death (i.e., moribund, no signs of life, excess bleeding from gills, jaw, or cloaca, unable to revive upon return to water, no swimming movement, sinks).

  For this analysis, "good" and "correct" vitality indexes were grouped together, as it can often be difficult to distinguish between them.

- behavior after release (swim vigorously, swim slowly near the surface, sinks with little movement).

Additionally, in each interaction, the observer recorded whether the handling and release practices applied followed the guidelines defined in OPAGAC's CGPs[5] (Grande *et al*., 2020; Murua *et al*., 2025).

It is worth noting that at the time of the trip the vessel did not have any special shark release devices on board, such as a hopper, ramp or lower deck gutter. Consequently, all sharks were released from the upper deck, mainly by hand.

A total of 23 sharks were tagged with PSATs, of which 20 were Survivorship-PATs (SPATs)[6] and 3 MiniPATs[7] (Wildlife Computers, Inc.). The tags were attached with a 10 cm long monofilament tether protected by a silicon tube to prevent abrasion. A small titanium dart was used for 12 individuals, while the other 11 were tagged using a Domeier anchor. To facilitate the entry of the anchor, a small cut of two centimeters was previously made with a scalpel at the base of the dorsal fin (i.e., tether, anchor and scalpel were smeared with Betadine Antiseptic Cream 5% povidone iodine to prevent infections).

To evaluate the lactate levels, blood samples of 90 individuals (including the 23 tagged sharks) were taken from vessels in the caudal peduncle of silky sharks and measured "in situ" using a lactate meter[8] (Lactate plus).

1.2 Tag programming

SPAT tags were programmed to be released after 60 days of deployment and set by default to record maximum and minimum daily depths and temperatures, and ten-minute interval depth data for the end of the deployment (i.e., last 4 days). MiniPAT tags were programmed to be released 180 days after deployment. If depth exceeded 1,400-1,700 meters, or remained constant for more than 3 days, both being signs of the animal being dead, the pop-up tags were programmed to automatically release. Daily data recorded with MiniPATs corresponded to temperature, depth, and change in light-level for each UTC day, with light intensity data recorded every 600 seconds.

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[5] https://www.azti.es/wp-content/uploads/2024/02/AZTI_Guia_BBPP_low.pdf
[6] https://wildlifecomputers.com/our-tags/pop-up-satellite-tags-fish/spat/
[7] https://wildlifecomputers.com/our-tags/pop-up-satellite-tags-fish/minipat/
[8] https://www.laktate.com/producto/lactate-plus/

1.3 Post-release survival analysis

For each tagged shark, a fate was determined (i.e., dead or alive) based on the depth records transmitted by the SPATs and MiniPATs and the time elapsed from tagging to detachment. Sharks were considered to have survived the fishing operation if their tags indicated normal daily depth and horizontal migration behaviour for more than 10 days. This time frame was used following standard protocols employed in other shark PRS studies (Hutchinson *et al*., 2015), which are taken as a sign that sharks remained alive after the fishing event. If a premature tag release was identified and was not due to changes in the shark's vertical movement, the depth records, vitality state and lactate levels were analysed to investigate the cause of the tag detachment and assign a fate.

For satellite tagged individuals, a survival rate was assigned to each vitality index category, with differences being assessed by a Chi-square test. Later, the survivorship percentages by vitality index category were applied to predict the overall survivorship for all silky sharks caught in the trip.

In addition, for silky sharks that were both tagged and had blood samples taken, a Wilcoxon rank sum test was used to evaluate differences in lactate between survivors and dead sharks as determined from the PSAT data. This analysis also included four dead individuals that were blood sampled but not tagged. The logistic regression model was used to relate survivorship (based on tagging) and lactate concentration estimated from blood samples. This logistic regression model and maximum likelihood estimation were used to predict the probability of survival for the rest of sharks that were blood sampled but not tagged, using a 50% probability threshold from the survivorship curve (Hutchinson *et al*., 2015). The fitted values were then used to estimate a lactate survival threshold. This lactate threshold was applied to predict survival rates by vitality index and then to predict overall survivorship for all sharks captured during the fishing trip.

2. Results

2.1 Satellite Tagged Sharks

A total of 23 silky sharks were satellite tagged during the fishing trip. All deployed tags recorded and transmitted depth information throughout the tracking period. There were eight post-release mortalities identified. Six tags detached after the sharks reached excessive depths, while the other two detached after three days for unknown reasons. Fifteen sharks survived the fishing operation, with 14 showing normal behavior for at least ten days. In one case, there was a premature release at 9 days from deployment for unknown reasons (i.e. tag ID = 241509), but the shark exhibited normal vertical movements during its tracking period, active behavior (i.e. excellent vitality state) and low lactate levels (4.9 mmol/L) and was therefore counted as alive. Details of the tagged sharks are given in **Table 1**.

Table 1. Shark tagged in the Atlantic Ocean in a purse seiner during 2023.

Tag ID	*Sex*	*TL (cm)*	*Tag deployment date*	*Tag detachment* date	*Detachment reason*	*Days*
221665	male	215	11/09/2023	18/10/2023	premature	37
221668	male	172	15/09/2023	25/10/2023	premature	40
227461	male	198	10/09/2023	09/11/2023	programmed	60
227462	female	209	11/09/2023	10/10/2023	premature	29
227463	female	205	08/09/2023	07/11/2023	programmed	60
227464	male	153	01/09/2023	08/10/2023	premature	37
227465	female	127	03/09/2023	22/10/2023	premature	49
227467	female	142	09/09/2023	12/09/2023	premature	3
227468	female	107	13/09/2023	16/09/2023	depth	3
227469	female	121	03/09/2023	03/09/2023	depth	0

227470	female	113	04/09/2023	15/10/2023	premature	41
227472	male	206	09/09/2023	12/09/2023	premature	3
227473	male	189	13/09/2023	16/09/2023	depth	3
241509	male	193	10/09/2023	19/09/2023	premature	9
241814	male	122	02/09/2023	25/10/2023	premature	53
241816	female	217	28/08/2023	05/10/2023	premature	38
241818	female	185	28/08/2023	16/09/2023	premature	19
241819	male	166	30/08/2023	14/09/2023	premature	15
241824	female	100	28/08/2023	28/08/2023	depth	0
252187	male	171	13/09/2023	16/09/2023	depth	3
252208	female	124	14/09/2023	26/09/2023	depth	12
252210	female	124	17/09/2023	16/11/2023	programmed	60
252213	female	188	15/09/2023	15/09/2023	depth	0

2.2 Sharks bycaught and released

A total of 247 silky sharks were observed during the trip, of which 131 were females (53%), 108 were males (44%), and 8 were not sexed due to the observer not having enough time to identify them, as quick release for survival was prioritized. Individual sizes ranged from a minimum of 81 cm to a maximum of 252 cm, with a bimodal distribution (**Figure 2**).

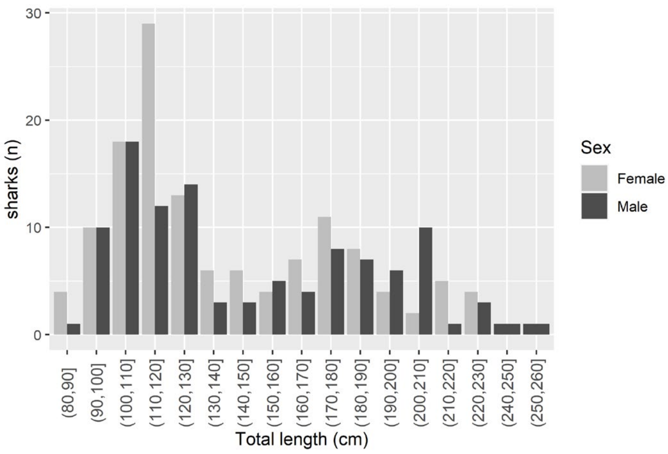

Figure 2. Size distribution of silky shark (*C. falciformis*) observed during the trip.

Vitality index was obtained for all the silky sharks caught during the fishing trip (**Table 2**). Sharks were handled and released applying BHRPs (Grande *et al.*, 2020; Murua *et al.*, 2025), mainly by hand on the upper deck:

- 4.9% (n=12) were entangled in the net when hauling (i.e., sharks entangled in the purse seine net during 'haul back' and removed by fishers as the net reached the deck; thus, these sharks were lifted on board before sacking up and brailing),

- and 95.1% were brailed and released (n=235).

Table 2. Number of sharks released by status and fishing operation stage released (i.e., entangled in the net or brailed).

Phase	VeryPoor/Dead	Poor	Correct_Good	Excelent	TOTAL (n)
Entangled	2	1	7	2	12
1st brail	9	5	8	4	26
2nd brail	20	5	8	2	35
3rd brail or later	115	22	36	1	174
TOTAL (n)	146	33	59	9	247

2.3 Post-release survival based on the vitality index

For tagged sharks, significant differences were detected in survivorship among vitality index categories (p-value < 0.01). The percentage of tagged sharks that survived according to the vitality index was 100% for those released in excellent condition, 84.6% for those in good or correct condition, 16.7% for sharks in poor condition and 0% for very poor or dead condition. By applying the survival rate by vitality index of the tagged individuals to all sharks in the trip, we predicted an overall survival rate of 26.1% for silky sharks accidentally captured (**Table 3**).

Table 3. Number of sharks by fishing stage and vitality index category. The predicted survival (%) is given for each category based in survivorship estimated from tagged animals by vitality index.

Phase	*Very Poor/Dead*	*Poor*	*Correct_Good*	*Excelent*	*Survival (n)*	*%*
Entangled	2	1 (1)	7 (1)	2	8	67.4
1st brail	9	5	8 (5)	4 (3)	12	44.6
2nd brail	20	5 (1)	8 (1)	2	10	27.4
3rd brail or subsequents	115 (1)	22 (4)	36 (6)	1	35	20.2
survival (n)	0	6	50	9	64	26.1
%	0	16.7	84.6	100.0		

(X) Number of tagged sharks.

2.4 Post-release survival based in lactate levels

Significant differences in lactate concentrations were found (Wilcoxon rank sum, n = 27, p-value = 0.01) between tagged and blood sampled sharks that survived the fishing operation (n=15) and dead sharks (n=12, eight tagged and four blood sampled but not tagged). Analyzing survival rates by lactate level intervals obtained from tagged individuals, we calculated the survival probability curve shown in **Figure 3.** We assume a survival threshold at 6.86 mmol/L, concentration at which the probability of survival was estimated as p = 0.5 from the survivorship curve (i.e., if [lactate] < 6.86 mmol/L then it was considered a "survivor" and above a "non-survivor"). Based on this survival threshold, a survivorship rate was estimated for each vitality state for those sharks that were blood-sampled and applied to all sharks in the trip to estimate an overall survival. The overall shark survival estimated using this extrapolation was 49.4% (**Table 4**).

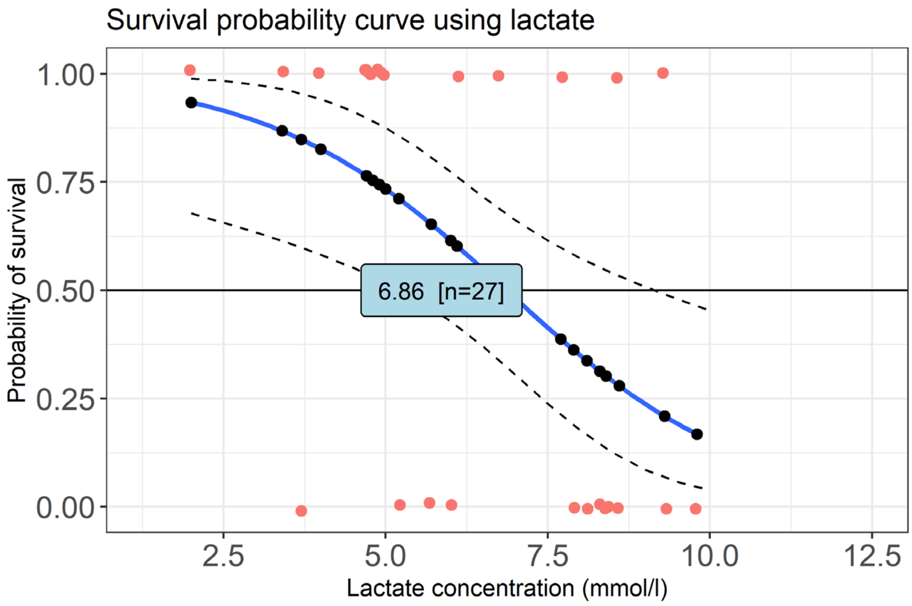

Figure 3. Logistic regression model for the estimated proportion of survival *C. falciformis* at lactate concentration (LC) intervals. Red points are the observations of shark with blood samples that were released and survived or died. Black points represent the predicted proportion of survival sharks. The solid blue line is the logistic regression curve.

Table 4. Predicted survival by fishing operation stage and vitality index. The predicted survival (%) is given for each category based in lactate threshold.

Phase	***Very Poor/Dead***	***Poor***	***Correct_Good***	***Excelent***	***Survival (n)***	***%***
Entangled	2	1	7	2	9	72.1
1st brail	9	5	8	4	16	61.8
2nd brail	20	5	8	2	18	50.4
3rd brail or later	115	22	36	1	79	45.6
survival (n)	48	19	46	9	122	49.4
%	32.6	58.8	77.3	100		

3. Discussion and Conclusions

This study presents, for the first time, post-release survival rates for silky sharks in a tropical tuna purse seiner of the Atlantic Ocean using adopted BHRPs by this fleet's CGPs and which closely align with best practice recommendations by RMFOs. Based on pop up satellite archival tags and vitality index, the overall silky shark survivorship rate for the trip was estimated at 26.1%. When this survivorship rate was estimated by vitality stage linked to blood lactate levels, the overall survivorship estimated reached 49.4%. The differences between both indicators are mainly due to differences in survivorship rate by vitality state determined using telemetry or blood lactate threshold. We observed in previous experiments that there is a significant correlation between lactate levels and vitality states (Grande *et al*., 2022). However, in this research cruise, high variability in blood lactate levels was observed, mainly in larger sized animals, ranging from poor to correct vitality states. Some sharks apparently moribund in behavior did not show high lactate levels. Therefore, when applying the blood lactate threshold to assign a fate they were categorized as alive. This resulted in differences in survival rate estimates by vitality state between methods (**Table 5**). While it is possible that these sharks in the worst vitality state recovered and survived, it is also possible that they were damaged in ways unrelated to lactate levels, such as trauma sustained during the fishing operation.

Table 5. Percentage of survivorship by vitality state using tagging information alone and the blood lactate threshold.

	Survivorship (%)			
Method	***Very Poor***	***Poor***	***Correct_Good***	***Excelent***
Satellite tagging	0	16.6	84.6	100
Blood lactate threshold (6.8 mmol/L)	32.6	58.8	77.3	100

Blood lactate has been used previously as a predictor of shark post-release mortality (Moyes *et al*., 2006; Gallagher *et al*., 2014; Hutchinson *et al*., 2015). When the rate of demand for oxygen in cells exceeds the rate of supply by the cardiovascular system (during exercise, for example), animals undergo a shift from aerobic to anaerobic metabolism, and lactate is generated as a by-product of the anaerobic glycolysis (Wood, 1991). Lactate is gradually diffused from the white muscle into the blood, and the blood oxygenation carrying capacity of blood is diminished resulting in fish asphyxia (Gallagher *et al*., 2014). We observed that the lactate threshold estimated in this study is lower or more restrictive than observed in previous silky shark studies (Hutchinson *et al*., 2015; Onandia *et al*., 2021; Grande *et al*., 2022) (**Table 6**). Blood lactate levels are species specific and influenced by shark size, as rate of lactate accumulation tends to decrease with size and these specimens tend to display a higher ability to recover (Gallagher *et al*., 2014). Therefore, shark size could be one of the factors responsible for differences in lactate threshold estimates between the different studies. To further explore the patterns of the behavioral and physiological post-survival indicators used in this study more samples are needed to reduce variability. Currently, efforts continue to tag and collect more blood samples from sharks in the Atlantic Ocean and worldwide.

Table 6. Silky shark lactate survivorship threshold estimates.

Study	***n tagged***	***n blood sampled***	***Size (cm)***	***Lactate threshold (mmol/L)***
Hutchinson *et al*., 2015	28	87	115.2 ± 17.5	11.3
Onandia *et al*., 2021	28	45	136.8 ±22.8	8.2
This work	23	90	142.7 ± 40.7	6.9

The effects of satellite tag attachments on survival probability are unknown but expected to be low, given the extensive use of archival satellite tags to study the survivorship of bycaught elasmobranchs (Musyl and Gilman, 2019) and if performed by an experienced scientist. We assume that tag deployments had little or no effect on survival probabilities estimated in this study. However, we observed high rates of premature tag releases. With the information gathered, we cannot determine the reason yet, but prior studies have also reported failures related to battery issues (Stewart *et al*., 2024). In this study, the tags provided sufficient information to confirm that the sharks survived the fishing operation, as premature detachments occurred mainly after 10 days from deployment (the time threshold stablished to link the mortality with the fishing operation), except for tags 241509 which was detach in 9 days from deployment and classified as alive given the lactate level and vitality state, and 227467 and 227472 which detached in 3 days from deployment and classified as dead. In this sense, survivals could be masked by tag failure if occurring before the stablished time threshold, as in the case of the tag 241509, and impact on overall survival rate estimates.

As observed in previous studies on tuna purse seine vessels (Poisson *et al*., 2014; Hutchinson *et al*., 2015; Onandia *et al*., 2021; Grande *et al*., 2022), the PRS is higher when elasmobranchs are in good shape while still swimming in the net before sacking up. Mortality starts to rise from the moment the sack is formed and incrementally as time passes with the number of brails. The vitality index observed in our study simultaneously decreased with brail number. The overall survivorship rate estimated is slightly higher than previous studies in which BHRPs were also applied (Poisson *et al*., 2014; Hutchinson *et al*., 2015), but lower than in vessels where specific bycatch release devices were installed for shark release (Onandia *et al*., 2021; Grande *et al*., 2022; Murua *et al*., 2024). Initial estimates in 2014 and 2015 indicated an overall survivorship of 16-19% (Poisson *et al*., 2014; Hutchinson *et al*., 2015). Ten years later, we observed that survivorship estimates are slightly higher. The experience gained by the crew, in collaboration with scientists, could contribute to implementing more efficient practices on board. However, when manual handling is not supported with other specific tools that minimize handling stress and time on deck, the contribution of the experience to increase PRS may not be sufficient. For BHRPs to show greater reductions in elasmobranch mortality, handling and release protocols could be improved with the implementation of specific bycatch release devices, many of which are based on ideas originating from fishers themselves (Murua *et al*., 2025).

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