# 我國三大洋捕獲短臂灰鯖鮫之無危害評估

農業部漁業署

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# 第一章　前言

## 1.1 緣由與動機

鯊魚在海洋生態系中扮演非常重要的角色，牠們以頂級掠食者的身分幫助維護海洋中的自然平衡(Cortés, 1999; Stevens et al., 2000; Schindler et al., 2002)。然而自從二次世界大戰以來，由於魚翅的需求大大增加(Clarke, 2004)，鯊魚漁獲量也在 2000 年之後達到歷史新高(FishStatJ, FAO, 2023)。1980 年全球產量不到 2,000 公噸，至 2000 年已超過 11,602 公噸(Clarke et al., 2006)，對鯊魚資源的重度開發也不意外地造成其資源量明顯銳減(Baum et al., 2003)，而且大型鯊魚具有成長緩慢、產仔數少、成熟晚等特性，若未給予適當的漁業管理，很可能會因不當的漁獲壓力導致其資源崩潰枯竭。因此，近年來鯊魚資源保育與管理之議題逐漸成為國際矚目之焦點。

國際自然保育聯盟(International Union for Conservation of Nature, IUCN)鯊魚專家群針對全球半世紀以來 31 種表層鯊魚及魟，以生命地球指數(Living Planet Index, LPI)及 IUCN 紅色名錄(Red List)指數進行資源變動評估，此研究結果顯示自 1970 年以來，由於漁獲壓力增加了 18 倍，這些表層鯊魚及魟資源減少了 71%，且 3/4 的指標性物種有滅絕風險。三大洋鯊魚的 LPI 皆明顯下降，其中以印度洋最為嚴重，太平洋次之，大西洋則在近年有穩定的趨勢。嚴格執行禁捕或基於科學的預警式漁獲量管制，將可避免資源的崩潰(Pacoureau et al., 2021)。

區域性漁業管理組織(Regional Fisheries Management Organizations, RFMOs)已針對鯊魚進行許多的相關管理措施，例如：中西太平洋漁業委員會(Western and Central Pacific Fisheries Commission, WCPFC)將污斑白眼鮫(*Carcharhinus longimanus*)與平滑白眼鮫(*C. falciformis*)列為禁止留艙物種；美洲熱帶鮪魚委員會(Inter-American Tropical Tuna Commission, IATTC)將污斑白眼鮫、蝠鱝屬(Genus *Mobula*)所有物種列為禁止留艙。大西洋鮪類保育委員會(ICCAT)將狐鮫屬(Genus *Alopias*)、丫髻鮫科(family Sphyrnidae)、污斑白眼鮫與平滑白眼鮫列入禁止留艙。印度洋鮪魚委員會(Indian Ocean Tuna Commission, IOTC)將污斑白眼鮫、狐鮫屬、

蝠鱝屬所有物種列為禁止留艙。

此外，瀕危野生動植物國際貿易公約(Convention on International Trade in Endangered Species of Wild Flora and Fauna, CITES)也將瀕危之板鰓類魚種列於附錄中，如鋸鰩科(Pristidae)的 7 個物種：鈍鋸鰩(*Anoxypristis cuspidate*)、侏儒鋸鰩(*Pristis calvata*)、小齒鋸鰩(*P. microdon*)、(*P. pristis*)、(*P. zijsron*)、(*P. porotteti*)、(*P. pectinate*)皆列入附錄一(Appendix I)。而鯨鯊(*Rhincodon typus*)、象鮫(*Cetorhinus maximus*)、食人鮫(*Carcharodon carcharias*)、紅肉丫髻鮫(*Sphyrna lewini*)、丫髻鮫(*S. zygaena*)、八鰭丫髻鮫(*S. mokarran*)、污斑白眼鮫、鼠鯊(*Lamna nasus*)、蝠鱝屬(*Mobula* spp.)、平滑白眼鮫與狐鮫屬(*Alopias* spp.)、灰鯖鮫(*Isurus oxyrinchus*)、長臂灰鯖鮫(*I. paucus*)、琵琶鱝屬(*Glaucostegus* spp.)與鱟頭鱝科(Family Rhinidae)等經濟性物種一併列入附錄二(Appendix II)名錄。2022 年更進一步將白眼鮫科(Family Carcharhinidae)全部 54 個物種及丫髻鮫科(Family Sphyrnidae)剩餘 6 個物種列入附錄二。西北大西洋漁業委員會(Northwest Atlantic Fisheries Commission, NAFO)於 2016 年通過禁止鯊魚割鰭棄身之行為。因此，為了確保鯊魚資源受到合理的保育及管理，鯊魚混獲量及其資源指標之研究是刻不容緩的。

經濟物種被列入附錄二之物種並非不能進行貿易，而是需要提出該物種之「無危害評估 Non-detriment Findings, NDF」，無危害評估係透過科學評估，該物種的出口不會危害到該物種野生族群的資源狀況，才能發出許可出口貿易之證明。如果物種漁獲海域超過 200 海浬經濟海域，還須提出「從海洋引進規定 Introduction from the sea, IFS」之文件。

## 1.2 文獻回顧

歐盟體制之下的德國聯邦自然保育署(Federal Agency for Nature Conservation, Bfn)於 2014 年在第 27 屆華盛頓公約的動物委員會上發表全球第一份關於鯊魚 NDF 的指導綱領手冊，該份指導綱領提供多項評估指標與實施辦法，建立一系列無為害評估之判定流程，主要分成六大步驟(Mundy et al., 2014)。

2018 年由國際野生動植物貿易調查會(Trade Record Analysis of Flora & Fauna in Commerce, TRAFFIC)與德國聯邦自然保育署共同建立的電子化無危害評估(e-NDF)判定法第一版本，根據該份電子評估表內預設的計算公式，得出 NDF 之評估結果。本電子評估表是基於德國 BfN 所出版的鯊魚 NDF 指導綱領所建立出來的，其操作時將每個步驟所需要的數據資料填入至各步驟之中，該份評估表將會根據使用者所填入的數據資料而得出相對應的風險程度，最後再經過公式的計算，於第五步驟得出最終的 NDF 判定結果，提供使用者去判斷該核發正面、負面或是設有附帶條件的 NDF 出口證明文件。

### 1.3 研究目的

無危害評估(NDF)在國際間尚屬於較新的概念，實踐之推動仍然還在努力階段，目前少數國家陸續開始有了實際執行的案例。灰鯖鮫為三大洋鮪延繩釣漁業重要之混獲鯊魚物種之一，以及因應 2019 年 CITES COP18 將灰鯖鮫列入附錄二。因此，本計畫將依據臺灣鯊魚無危害評估之步驟，套用於臺灣鮪延繩釣漁船三大洋捕獲灰鯖鮫進行無危害評估，以及提出相關建議。

## 第二章　實施方法

### 2.1 無危害評估

<u>第一步驟：初步資訊蒐集</u>

此步驟為評估前的事前準備工作，蒐集物種的基本初步資料並彙整，確認物種是否需要 NDF 才得以進行出口。因此，評估的對象須為 CITES 附錄二名單之物種，並且是合法取得之；接著蒐集區域漁業管理組織(RFMOs)之資料，確認物種是否為規範內之禁捕鯊種。若該鯊種在該區域漁業組織之禁捕名單內，即沒有繼續進行 NDF 判定之需要，隨即停止評估；若皆符合以上條件，代表該物種將進入本流程後續步驟之評估。

第二步驟：既有的生物易危性及保育關注程度

此步驟包含了既有的生物易危性及保育關注程度。

1. 既有的生物易危性：

首先評估該物種受到開發利用後，是否會因為物種本身的生物特性而造成資源難以恢復的情形。

生物易危性的評估指標包含成熟年齡($t_{mat}$)、成熟體長($L_m$)、最大年齡($T_m$)、極限體長($TL_\infty$)、自然死亡率(M)、產仔數(f)、族群內在增加率(r)、地理分布範圍、資源評估、行為因素、營養位階等計 11 項指標。

各既有生物易危性指標的判定標準如下：

(1) 成熟年齡($t_{mat}$)

如成熟年齡小於 5 歲代表風險程度低，獲得分數 1 分；介於 5 歲至 15 歲代表風險程度中，獲得分數 2 分；大於 15 歲代表風險程度高，獲得分數 3 分；若缺乏此項數據代表風險程度未知，獲得分數 3 分。

(2) 成熟體長($L_m$)

如成熟體長小於 40 公分代表風險程度低，獲得分數 1 分；介於 40 公分至 200 公分代表風險程度中，獲得分數 2 分；大於 200 公分，代表風險程度高，獲得分數 3 分；若缺乏此項數據代表風險程度未知，獲得分數 3 分。

(3) 最大年齡($T_m$)

如最大年齡小於 10 歲代表風險程度低，獲得分數１分；介於 10 歲至 25 歲代表風險程度中，獲得分數 2 分；大於 25 歲代表風險程度高，獲得分數 3 分；若缺乏此項數據代表風險程度未知，獲得分數 3 分。

(4) 極限體長($TL_{\infty}$)

如極限體長小於 100 公分代表風險程度低，獲得分數 1 分；介於 100 公分至 300 公分代表風險程度中，獲得分數 2 分；大於 300 公分代表風險程度高，獲得分數 3 分；若缺乏此項數據代表風險程度未知，獲得分數 3 分。

(5) 自然死亡率(M)

如自然死亡率 M 值大於 0.4 代表風險程度低,獲得分數 1 分;介於 0.17 至 0.4 代表風險程度中，獲得分數 2 分；小於 0.17 代表風險程度高，獲得分數 3 分；若缺乏此項數據代表風險程度未知，獲得分數 3 分。

(6) 產仔數(f)

如產仔數 f 值大於 15 代表風險程度低，獲得分數 1 分；介於 2 至 15 代表風險程度中，獲得分數 2 分；小於 2 代表風險程度高，獲得分數 3 分；若缺乏此項數據代表風險程度未知，獲得分數 3 分。

(7) 族群內在增加率(r)

如族群內在增加率 r 值大於 0.35 代表風險程度低，獲得分數 1 分；介於 0.15 至 0.35 代表風險程度中，獲得分數 2 分；小於 0.15 代表風險程度高，獲得分數 3 分；若缺乏此項數據代表風險程度未知，獲得分數 3 分。

(8) 地理分布範圍

如物種資源分布於全球性的範圍代表風險程度低，獲得分數 1 分；分布於區域性的範圍代表風險程度中，獲得分數 2 分；分布於國家性的範圍代表風險程度高，獲得分數 3 分；若缺乏此項數據代表風險程度未知，獲得分數 3 分。

(9) 資源評估

如物種資源評估 $F<=F_{MSY}$ 且 $B>=B_{MSY}$ 代表風險程度低,獲得分數 1 分;$F=F_{MSY}$ 且 $B=B_{MSY}$ 代表風險程度中，獲得分數 2 分；$F>=F_{MSY}$ 且 $B<=B_{MSY}$ 代表風險程度高，獲得分數 3 分。

(10) 行為因素

如物種少數行為因素會增加系群風險代表風險程度低,獲得分數 1 分;部分行為因素會增加系群風險代表風險程度中，獲得分數 2 分；多數行為因素會增加系群風險代表風險程度高，獲得分數 3 分；若缺乏此項數據代表風險程度未知，獲得分數 3 分。

(11) 營養位階

如物種位於營養位階底層代表風險程度低，獲得分數 1 分；位於營養位階中間代表風險程度中，獲得分數 2 分；位於營養位階頂層代表風險程度高，獲得分數 3 分；若缺乏此項數據代表風險程度未知，獲得分數 3 分。

以上各生物易危性指標分數加總後，可得出該物種整體生物易危性水平，總分落在 11 分至 17 分代表物種整體生物易危性風險程度為低等；18 分至 26 代表物種整體生物易危性風險程度為中等；27 分至 33 分代表物種整體生物易危性風險程度為高等。風險程度越高代表該物種被開發利用後，因為自身的生物特性而越容易導致其資源量難以恢復。

2. 保育關注程度

根據上述既有的生物易危性參數針對物種被保護的關鍵因子來做更確切的討論。保育關注程度的判定指標共有 3 個，包括保護該物種或資源評估的情況、族群的趨勢、受保育關注的區域範圍。

各保育關注程度指標的判定標準如下：

(1) 保育與資源評估的情況

若該物種資源沒有過漁且目前被 IUCN 列為無危(LC)等級，代表風險程度低，獲得分數 1 分；若物種資源正處於過漁狀態或已經過漁，且目前被 IUCN 列為近危(NT)等級、易危(VU)等級，代表風險程度中，獲得分數 2 分；若物種資源正處於過漁狀態且已經過漁，且目前被 IUCN 列為瀕危(EN)等級、極危(CR)等級，代表風險程度高，獲得分數 3 分；若缺乏此項數據代表風險程度未知，獲得分數 3 分。

(2) 族群趨勢 Population Trend

若物種族群呈現上升趨勢代表風險程度低，可得分數 1 分；若物種族群呈現穩定趨勢代表風險程度中，可得分數 2 分；若物種族群呈現下降趨勢代表風險程度高，可得分數 3 分；若缺乏此項數據代表風險程度未知，獲得分數 3 分。

(3) 受保育關注的區域範圍

若物種面臨的主要威脅僅會影響少數系群代表風險程度低，獲得分數 1 分；若物種面臨的主要威脅會影響部分系群代表風險程度中，獲得分數 2 分；若物種面臨的主要威脅會影響全球系群代表風險程度高，獲得分數 3 分；若缺乏此項數據代表風險程度未知，獲得分數 3 分。

以上各保育關注程度指標分數加總後，可得出該物種整體保育關注水準，3 分至 4 分代表物種整體保育關注風險程度低等；5 分至 7 分代表物種整體保育關注風險程度中等；8 分至 9 分代表物種整體保育關注風險程度高等。理論上，物種的生物易危性水準越高，越容易因為開發利用而造成其資源難以恢復，也將遭受到更多的保育關注程度，尤其是大多數鯊魚是具有 K 選擇的生活史特性，所以族群更容易受捕撈行為影響。

第三步驟：物種承受的壓力(原貿易壓力評估列為參考)

評估該鯊種的漁業壓力，考量內容包含其漁獲死亡率、丟棄活存率、漁具選擇性的大小、IUU 漁業規模等四項來進行評估。

由於臺灣近年才設立丫髻鮫、狐鮫等鯊魚專屬貨品分類號列(CCC code)，因此無法得知詳細之國際貿易輸出量與交易價格等相關市場資料來提供做為貿易壓力的評估。因此，在臺灣目前情況下，為符合國情制定 NDF 之判定步驟，本研究建議將原有之貿易壓力評估改為日後管理建議參考，步驟三先以評估「漁業壓力」為主。

1. 物種所受的漁業壓力

評估該物種受到的漁業壓力，漁業壓力可能導致物種的資源量銳減，影響整體族群結構改變，長時間的影響也可能使物種個體產生生物學上的變化，此部分還需考慮到漁業行為對物種造成的漁獲死亡率、丟棄死亡率、漁具對於年齡、各體型階段與性別的選擇性大小，以及 IUU 漁業的規模。

各漁業壓力指標的判定標準如下：

(1) 漁獲死亡率

若漁業行為減少低比例的族群資源，代表風險程度低，獲得分數 1 分；若漁業行為減少部分比例的族群資源，代表風險程度中，獲得分數 2 分；若

漁業行為減少高比例的族群資源，代表風險程度高，獲得分數 3 分；若缺乏此項數據代表風險程度未知，獲得分數 3 分。

(2) 丟棄活存率

若對於物種少數漁獲被丟棄，且其釋放後存活率偏高，代表風險程度低，獲得分數 1 分；若對於物種部分漁獲被丟棄，且其釋放後存活率中等，代表風險程度中，獲得分數 2 分；若對於物種多數漁獲被丟棄，且其釋放後存活率偏低，代表風險程度高，獲得分數 3 分；若缺乏此項數據代表風險程度未知，獲得分數 3 分。

(3) 漁具的選擇性

若漁具具高度選擇性，能有效針對特定年齡、體型或性別之個體進行捕撈，表示其對族群結構的干擾相對較小，風險程度較低，評分為 1 分。若漁具有中度選擇性，雖對部分族群結構具有限制性捕撈能力，仍可能對族群造成中等程度影響，風險程度屬中等，評分為 2 分。若漁具選擇性低，無法有效區分或排除特定年齡、體型或性別之個體，可能對族群結構造成較大衝擊，風險程度較高，評分為 3 分。若缺乏相關資料以評估漁具選擇性，則風險程度視為未知，亦評分為 3 分以反映潛在不確定性。

(4) IUU 漁業規模

若對於物種有詳細的貿易紀錄，交易鏈透明公開，貿易量與漁獲量大致相符，代表風險程度低，獲得分數 1 分；若對於物種有適當的貿易紀錄，交易鏈難以追蹤，貿易量與漁獲量部分相符，代表風險程度中，獲得分數 2 分；若對於物種的貿易紀錄不齊全，交易鏈不透明公開，貿易量與漁獲量差異甚大，代表風險程度高，獲得分數 3 分；若缺乏此項數據代表風險程度未知，獲得分數 3 分。

以上各漁業壓力指標分數加總後，可得出該物種整體漁業壓力水準，4 分至 6 分代表物種承受低度漁業壓力；7 分至 9 分代表物種承受中度漁業壓力；10 分至 12 分代表物種承受高度漁業壓力。

第四步驟：評估現有的管理措施

此步驟是期許 CITES 附錄二名單內的物種都能有適合的管理措施，以降低利用對物種資源的風險，並且達到永續利用的目標，若上述步驟之物種整體既有的生物易危性、受到保育關注程度，與所受的貿易、漁業壓力之風險程度越高，代表該物種需要更完善並嚴格的管理措施，才能減緩物種面臨到的衝擊。第四步驟之意圖即為評估現今的管理措施，是否發揮其有效性？適當的管理措施能使物種得以減緩貿易與漁業的壓力。

目前依據管理措施項目來評分，無管理措施為高風險 5 分；中度管理為有管理措施但無針對特定物種的管理，如 RFMO 白名單漁船與鯊魚漁獲鰭身比、鰭連身；以符合管理項目的數量 1-2 個來評定為中等風險(3-4 分)；而高度管理則包含上述管理項目外，還針對物種有特定管理措施，如總量管制(TAC)與專屬進出口 ccc code，總共為 4 個管理項目，符合管理項目 3-4 個，評為低等風險(1-2 分)。

第五步驟：進行 NDF 判定

經過上述步驟的判定之後，將於此步驟判定是否頒布給該鯊種正面之 NDF。本研究將第二步驟至第四步驟之風險分數進行加總後分成如下，加總分數在 19 分至 38 分為正面 NDF，39 分至 48 分為有條件 NDF，49 分至 59 分為負面 NDF。若判定為正面 NDF，則代表貿易並不會危害到該鯊種族群的資源狀況，可根據此核發 NDF 進行國際貿易；若判定為有條件式之 NDF，表示現有的管理措施必須要在滿足一些新的條件後，才得以頒布正面 NDF；若判定為負面 NDF，則必須要進入步驟六來進行管理措施之改善。

第六步驟：進一步措施

此步驟為根據前一步驟之 NDF 判定結果找出需要改正的管理問題，提出適合國家之漁業主管機關當局的監控計畫與管理方法，並做出適當的改善。而執行者即可藉由第六步驟的實施後，即可於往後需要重新進行評估時透過此流程檢查修訂 NDF 之最新判定結果。

參照德國 BfN 的指導綱領，NDF 之有效期限訂定為「一年」，故每年到期日後皆須再根據最新資源量情況重新審理及更新判定，才能達到有效控管物種的資源(Mundy et al., 2014)。

# 第三章　無危害評估之表格視覺化結果

第一步驟：初步資訊蒐集

| 物種 | CITES 附錄二 | RFMOs 管制措施 | | 符合 NDF 流程 |
|---|---|---|---|---|
| 灰鯖鮫 | 列入 | 北太平洋 | 未禁捕 | 是 |
| | | 南太平洋 | 未禁捕 | 是 |
| | | 北大西洋 | 有條件留艙 | 是 |
| | | 南大西洋 | 未禁捕 | 是 |
| | | 印度洋 | 未禁捕 | 是 |

符合以上條件，代表該物種將進入本流程後續步驟之評估。

Remark (data source): OFDC (2021) Doc. 21-09

第二步驟：既有的生物易危性及保育關注程度

此步驟包含了既有的生物易危性及保育關注程度。

1. 既有的生物易危性

各既有生物易危性指標的判定結果如下：

| 項目 | | 風險等級 | | | 灰鯖鮫 | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 2.1 生物易危性指標 | | 低(1 分) | 中(2 分) | 高(3 分) | 北太平洋 | 南太平洋 | 北大西洋 | 南大西洋 | 印度洋 |
| 1 | 成熟年齡($t_{mat}$) | <5 | 5-15 | >15 | 20 | ♂8-9<br>♀20 | ♂8<br>♀18 | ♂8<br>♀18 | ♂7<br>♀15 |
| 2 | 成熟體長($L_m$) | <40 | 40-200 | >200 | ♂166<br>♀233<br>(PCL) | 280 | ♂180-185<br>♀275-298 | ♂180<br>♀－ | ♂190<br>♀250 |
| 3 | 最大年齡($T_m$) | <10 | 10-25 | >25 | 40 | 30 | ♂29<br>♀32 | ♂11-18<br>♀23-28 | ♂17<br>♀29-32 |
| 4 | 極限體長($TL_\infty$) | <100 | 100-300 | >300 | ♂332<br>♀413 | ♂302<br>♀820 | ♂253<br>♀366 | ♂261-329<br>♀244-408 | ♂344.34<br>♀392.54 |
| 5 | 自然死亡率(M) | >0.4 | 0.17-0.4 | <0.17 | ♂0.19<br>♀0.17 | 0.14 | 0.339 | 0.339 | 0.217 |
| 6 | 產仔數(f) | >15 | 2-15 | <2 | 12 | 12.5 | 4-6 | 4-6 | 14(10-18<br>中位數) |
| 7 | 族群內在增加率(r) | >0.35 | 0.15-0.35 | <0.15 | 0.317 | 0.32 | 0.30 | 0.3 | 0.0081-<br>0.0484 |
| 8 | 地理分布範圍 | 全球性 | 區域性 | 國家性 | 全球性 | 全球性 | 全球性 | 全球性 | 全球性 |
| 9 | 資源狀態 | $F<=F_{MSY}$<br>$B>=B_{MSY}$ | $F=F_{MSY}$<br>$B=B_{MSY}$ | $F>=F_{MSY}$<br>$B<=B_{MSY}$ | $F<=F_{MSY}$<br>$B>=B_{MSY}$ | $F<=F_{MSY}$<br>$B<=B_{MSY}$ | $F>F_{MSY}$<br>$B<=B_{MSY}$ | $F=F_{MSY}$<br>$B<B_{MSY}$ | $F>F_{MSY}$<br>$B>B_{MSY}$ |
| 10 | 行為因素 | 少數行為 | 部分行為 | 多數行為 | 少數行為 | 少數行為 | 少數行為 | 少數行為 | 少數行為 |
| 11 | 營養位階 | 低 | 中 | 高 | 高 | 高 | 高 | 高 | 高 |
| **總分/等級** | | **11-17** | **18-26** | **27-33** | **24** | **26** | **26** | **25** | **25** |

Remark (data source):

ISC/24/ANNEX/XX (2024), Mollet et al. (2000), Semba et al. (2017), Teo et al. (2024), Liu et al. (2015), Joung and Hsu (2005), Bishop et al. (2006), SC18-SA-WP-02 (2022), Natanson et al. (2006), Maia et al. (2006), Mas et al. (2017), Barreto et al. (2016), Anon (2017), Anon (2019), Brunel et al. (2018), Bonhommeau et al. (2020), Chodrijah et al. (2024)

2. 保育關注程度 Degree of conservation attention

各保育關注程度指標的判定結果如下：

| 項目 | | 風險等級 | | | 灰鯖鮫 | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 2.2 生物易危性指標 | | 低(1 分) | 中(2 分) | 高(3 分) | 北太平洋 | 南太平洋 | 北大西洋 | 南大西洋 | 印度洋 |
| 1 | 保育與資源評估的情況 | LC | NT/VU | EN/CR | EN | EN | EN | EN | EN |
| 2 | 族群趨勢 | 上升 | 穩定 | 下降 | 上升 | 穩定 | 下降 | 下降 | 穩定 |
| 3 | 受保育關注的區域範圍 | 影響少數 | 影響部分 | 影響全球 | 影響少數 | 影響少數 | 影響少數 | 影響少數 | 影響少數 |
| **總分/等級** | | **3-4** | **5-7** | **8-9** | **5** | **6** | **7** | **7** | **6** |

Remark (data source): Rigby et al. (2019), ISC/24/ANNEX/XX (2024), SC18-SA-WP-02 (2022), Anon (2017), Anon (2019), IOTC-2020-WPEB16-17 (2020), Wu et al. (2021).

第三步驟：物種承受的壓力(原貿易壓力評估列為參考)

1. 物種所受的漁業壓力

各漁業壓力指標的判定結果如下：

| 項目 | | 風險等級 | | | 灰鯖鮫 | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 3.1 漁業壓力指標 | | 低(1 分) | 中(2 分) | 高(3 分) | 北太平洋 | 南太平洋 | 北大西洋 | 南大西洋 | 印度洋 |
| 1 | 漁獲死亡率 | 死亡率低 | 死亡率中等 | 死亡率高 | 死亡率高 | 死亡率高 | 死亡率高 | 死亡率高 | 死亡率高 |
| 2 | 丟棄活存率 | 活存率高 | 活存率中等 | 活存率低 | 活存率高 | 活存率高 | 活存率高 | 活存率高 | 活存率高 |
| 3 | 漁具的選擇性 | 漁具選擇性高 | 漁具選擇性中 | 漁具選擇性低 | 漁具選擇性高 | 漁具選擇性高 | 漁具選擇性高 | 漁具選擇性高 | 漁具選擇性高 |
| 4 | IUU 漁業規模 | 紀錄詳細 | 部分記錄 | 紀錄不齊 | 部分記錄 | 部分記錄 | 部分記錄 | 部分記錄 | 部分記錄 |
| **總分/等級** | | **4-6** | **7-9** | **10-12** | **7** | **7** | **7** | **7** | **7** |

Remark (data source): Bowlby et al. (2021), ISC/24/ANNEX/XX (2024), SC18-SA-WP-02 (2022), Anon (2017), Anon (2019), IOTC-2020-WPEB16-17 (2020), Bhanja and Mandal (2024).

漁具選擇性低表示易捕獲大量非目標物種與幼魚，對生態系影響顯著，因此為高風險；漁具選擇性高則表示漁具能有效選擇目標魚種，副捕獲少，對非目標物種及幼魚影響很小，故為低風險。

第四步驟：評估現有的管理措施

| 項目 | | 風險等級 | | | 灰鯖鮫 | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 4 管理措施 | | 低<br>(1-2 分) | 中<br>(3-4 分) | 高<br>(5 分) | 北太平洋 | 南太平洋 | 北大西洋 | 南大西洋 | 印度洋 |
| 1 | 無管理措施。 | - | - | ● | - | - | - | - | - |
| 2 | 中度管理：<br>有管理措施但無針對特定物種的管理。<br>□RFMO 白名單漁船<br>□鯊魚漁獲鰭身比、鰭連身 | - | ● | - | - | - | - | - | - |
| 3 | 高度管理：<br>針對物種有特定管理措施。<br>□RFMO 白名單漁船<br>□鯊魚漁獲鰭身比、鰭連身<br>□總量管制(TAC)<br>□專屬進出口 ccc code | ● | - | - | －3<br>(白名單/鰭身比/ccc code) | －3<br>(白名單/鰭身比/ccc code) | －4<br>(白名單/鰭身比/臺灣自訂每艘配額/ccc code) | －4<br>(白名單/鰭身比/臺灣自訂每艘配額/ccc code) | －3<br>(白名單/鰭身比/ccc code) |
| **總分/等級** | | **1-2** | **3-4** | **5** | **2** | **2** | **1** | **1** | **2** |

Remark (data source): OFDC (2021) Doc. 21-09, OFDC (2022) Doc. 22-11

此步驟之風險等級評估，以無管理措施 5 分表示高風險，而中風險為符合 1-2 項管理措施，低風險則為符合 3-4 項管理措施；由總分 5 分依次以管理項目扣除分數，表示風險隨管理措施的提升而降低。

第五步驟：進行 NDF 判定

| 項目 | 風險等級 | | | 灰鯖鮫 | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | 北太平洋 | 南太平洋 | 北大西洋 | 南大西洋 | 印度洋 |
| 步驟 2.1 | 11-17 | 18-26 | 27-33 | 24 | 26 | 26 | 25 | 25 |
| 步驟 2.2 | 3-4 | 5-7 | 8-9 | 5 | 6 | 7 | 7 | 6 |
| 步驟 3.1 | 4-6 | 7-9 | 10-12 | 7 | 7 | 7 | 7 | 7 |
| 步驟 4 | 1-2 | 3-4 | 5 | 2 | 2 | 1 | 1 | 2 |
| **總分** | **19-38** | **39-48** | **49-59** | **38** | **41** | **41** | **40** | **40** |
| **NDF 評估結果** | **正面** | **有條件** | **負面** | **正面** | **有條件** | **有條件** | **有條件** | **有條件** |

## 第四章　結論與建議

本研究針對我國三大洋鮪延繩釣灰鯖鮫進行無危害評估，其結果北太平洋為正面之 NDF，我國政府得以核發輸出許可證。北大西洋列為有條件留艙，與南太平洋、南大西洋及印度洋等皆為有條件之 NDF，我國政府必須增訂管理措施才予以核准。

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# Non-Detrimental Finding Assessment on the Three Oceans Shortfin Mako Shark (*Isurus oxyrinchus*) Caught by the Taiwanese Longline Fishery

**Fisheries Agency**

**Ministry of Agriculture**

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# Chapter 1 INTRODUCTION

## 1.1 Reason and motivation

Sharks play a crucial role in marine ecosystems as top predators, helping to maintain natural balance in the oceans (Cortés, 1999; Stevens et al., 2000; Schindler et al., 2002). However, since the Second World War, the demand for shark fins has increased significantly (Clarke, 2004), leading to historically high levels of shark fishing after 2000 (FishStatJ, FAO, 2023). Global production was less than 2,000 metric tons in 1980, rising to over 11,602 metric tons by 2000 (Clarke et al., 2006). The intensive exploitation of shark resources has unsurprisingly resulted in a significant decline in their populations (Baum et al., 2003). Moreover, large sharks exhibit characteristics such as slow growth, low reproductive rates, and late maturity. Without proper fisheries management, the undue fishing pressure could lead to the collapse and depletion of their populations. Therefore, the conservation and management of shark resources have become an increasingly prominent international concern in recent years.

The International Union for Conservation of Nature (IUCN) Shark Specialist Group conducted an assessment of 31 species of pelagic sharks and rays globally over the past half-century, using the Living Planet Index (LPI) and IUCN Red List indices. The results of this study indicated that since 1970, due to an 18-fold increase in fishing pressure, the resources of these pelagic sharks and rays have decreased by 71%, with three-quarters of the indicator species at risk of extinction. The LPI of sharks in all three oceans has significantly declined, with the Indian Ocean being the most severely affected, followed by the Pacific Ocean, while the Atlantic Ocean has shown a stable trend in recent years. Strict enforcement of fishing bans or science-based precautionary catch limits could prevent population collapse (Pacoureau et al., 2021).

Regional Fisheries Management Organizations (RFMOs) have implemented various management measures for sharks. For example, the Western and Central Pacific

Fisheries Commission (WCPFC) has prohibited the retention of the oceanic whitetip shark (*Carcharhinus longimanus*) and the silky shark (*C. falciformis*) in their fisheries. The Inter-American Tropical Tuna Commission (IATTC) also has prohibited the retention of the oceanic whitetip shark and Genus *Mobula*. The International Commission for the Conservation of Atlantic Tunas (ICCAT) has prohibited the retention of species from the Genus *Alopias*, the family Sphyrnidae, as well as the oceanic whitetip shark (*Carcharhinus longimanus*) and the silky shark (*C. falciformis*) in their fisheries. The Indian Ocean Tuna Commission (IOTC) has prohibited the retention of oceanic whitetip shark, the Genus *Alopias* and *Mobula*.in their fisheries.

In addition, the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES) has listed endangered elasmobranch species in its appendices. For instance, seven species of sawfish (family Pristidae) including (*Anoxypristis cuspidata*), (*Pristis calvata*), (*P. microdon*), (*P. pristis*), (*P. zijsron*), (*P. porotteti*), and (*P. pectinata*) are listed in Appendix I. Whale shark (*Rhincodon typus*), basking shark (*Cetorhinus maximus*), great white shark (*Carcharodon carcharias*), scalloped hammerhead shark (*Sphyrna lewini*), smooth hammerhead shark (*S. zygaena*), great hammerhead shark (*S. mokarran*), oceanic whitetip shark, porbeagle shark (*Lamna nasus*), manta rays (*Mobula birostris*, *M. alfredi*), species of the genus *Alopias*, shortfin mako shark (*Isurus oxyrinchus*), longfin mako shark (*I. paucus*), species of the genus *Glaucostegus*, and species of the family Rhinidae are listed in Appendix II. Furthermore, in 2022, all 54 species of the family Carcharhinidae and the remaining 6 species of the family Sphyrnidae were also listed in Appendix II. The Northwest Atlantic Fisheries Commission (NAFO) passed a prohibition on the practice of shark finning in 2016. Therefore, urgent research on shark bycatch and population indicators is essential to ensure the proper conservation and management of shark resources.

Species listed in Appendix II are not prohibited from trade; however, it is required to provide a Non-detriment Finding (NDF) for such species. NDF involves a scientific assessment to ensure that the export of the species will not harm the wild population's stock status. Only upon obtaining a permit proving that the trade will not be detrimental to the species' wild population can the trade be allowed. Additionally, if the species is caught beyond the 200 nautical mile exclusive economic zone, an Introduction from the Sea (IFS) document is also required.

## 1.2 Literature Review

Under the framework of the European Union, the Federal Agency for Nature Conservation (Bfn) of Germany presented the world's first guidance manual on Non-detriment Findings (NDF) for shark species at the 27th meeting of the CITES Animals Committee in 2014. This guidance manual, as outlined by Mundy et al. (2014), offers various assessment indicators and implementation methods, establishing a series of procedures for non-detriment assessment, which are delineated into six main steps.

In 2018, the first version of the electronic Non-detriment Finding (e-NDF) assessment method was jointly established by the Trade Record Analysis of Flora & Fauna in Commerce (TRAFFIC) and the Federal Agency for Nature Conservation (BfN) of Germany. This electronic assessment tool is based on the NDF guidance manual for sharks published by BfN. It utilizes predefined calculation formulas within the spread sheet to determine the NDF assessment results. The e-NDF form is designed to guide users through each step of the assessment process, prompting them to input the required data for each step. Based on the data provided by the user, the e-NDF form calculates the corresponding level of risk. Finally, in the fifth step, the e-NDF form computes the final NDF determination result according to the provided data and formulas. This result indicates whether a positive, negative, or conditional NDF export certificate should be issued.

### 1.3 Research purposes

The shortfin mako shark is one of the important shark species caught incidentally in the three ocean tuna longline fishery. In response to inclusion of the shortfin mako shark under Appendix II by CITES COP18 in 2019, the concept of Non-Detriment Findings (NDF) remains relatively new in the international arena, and practical implementation is still in its nascent stages. Therefore, this project aims to apply the steps of shark Non-Detriment Assessment conducted in Taiwan to assess the non-detriment of shortfin mako sharks caught by Taiwanese flagged vessels in the three oceans, and to propose relevant recommendations.

# Chapter 2 MATERIALS AND METHODS

## 2.1 Non-detriment Findings (NDF)

Step 1: Primary information collection

The pre-assessment work includes collecting information and data for assessed species and make sure whether NDF is needed for export. Therefore, the assessed species must be on the CITES Appendix II list and legally captured. The next procedure is to check whether the species is ban retention species in RFMOs. If the species is ban retention in certain RFMOs, then the assessment is stop. If not, the species is assessed with the following steps.

Step 2: Existed vulnerability and conservation attention

This step includes the existing vulnerability and conservation concern of the species.

1. Existing Vulnerability:

Firstly, assess whether the species would face difficulties in recovery due to its biological characteristics after exploitation.

The assessment indicators for existing vulnerability include: Size at maturity ($t_{mat}$), Length at maturity ($L_m$), Maximum age ($T_m$),

Asymptotic length ($TL_{\infty}$),

Natural mortality rate (M),

Little size (f),

Intrinsic rate of population increase (r),

Geographic distribution range,

Stock assessment,

Behavioral factor, and

Trophic position.

These 11 indicators are used to assess the existing vulnerability of the species to exploitation.

(1) Size at maturity ($t_{mat}$)

If $t_{mat} < 5$, it indicates a low risk, the score (S)=1; if $5 < t_{mat} < 15$, it indicates a median risk, S=2; if $t_{mat} > 15$, it indicates a high risk, S =3. If this information is not available, it indicates risk is unknown, S=3.

(2) Length at maturity ($L_m$)

If $L_m < 40$ cm, it indicates a low risk, S=1; if 40 cm < $L_m$ < 200 cm, it indicates a median risk, S =2; if $L_m > 200$ cm, it indicates a high risk, S=3. If this information is not available, it indicates risk is unknown, S=3.

(3) Maximum age ($T_m$)

If $T_m < 10$, it indicates a low risk, S=1; if $10 < T_m < 25$, it indicates a median risk, S=2; if $T_m > 25$ or this information is unknown, it indicates a high risk, S=3.

(4) Asymptotic length ($TL_\infty$)

If $TL_\infty < 100$ cm, it indicates a low risk, S=1; if $100 < TL_\infty < 300$ cm, it indicates A median risk, S=2; if $TL_\infty > 300$ cm or this information is unknown, it indicates a high risk, S=3.

(5) Natural mortality (M)

If $M > 0.4$, it indicates a low risk, S=1; if $0.17 < M < 0.4$, it indicates a median risk, S=2; if $M < 0.17$ or this information is unknown, it indicates a high risk, S=3.

(6) Little size (f)

If $f > 15$, it indicates a low risk level, S = 1; if it falls between 2 and 15, it signifies a moderate risk level, S= 2; if $f < 2$, it denotes a high risk level, S= 3; if this information is unavailable, it signifies an unknown risk level, S= 3.

(7) Intrinsic rate of population increase (r)

If $r > 0.35$, it indicates a low risk level, S = 1; if it falls between 0.15 and 0.35, it signifies a moderate risk level, S= 2; if $f < 0.15$, it denotes a high risk level, S= 3; if this information is unavailable, it signifies an unknown risk level, S= 3.

(8) Geographic distribution range

A global distribution indicates a low risk, S=1; regional distribution indicates a median risk, S=2; national distribution signifies a high risk, S=3. If this information is unknown, S=3.

(9) Stock assessment

If $F<=F_{MSY}$ and $B>=B_{MSY}$, it indicates a low risk, S=1; if $F=F_{MSY}$ and $B=B_{MSY}$, it indicates a median risk, S=2; if $F>=F_{MSY}$ and $B<=B_{MSY}$, it indicates a high risk, S=3.

(10) Behavior factor

If few behavioral factors that increase population risk, it indicates a low risk, S=1; if there are some behavioral factors increasing population risk, it signifies a moderate risk level, S=2; if there are multiple behavioral factors increasing population risk, it denotes a high risk level, S=3. If this data is unavailable, it signifies an unknown risk level, S=3.

(11) Trophic position

Low TP indicates a low risk, S=1; median TP indicates a median risk, S=2; high TP or lacking of TP information signifies a high risk, S=3.

The vulnerability of each species can be expressed by summering of aforementioned scores. The value between 11 and 17 indicates a low risk, 18-26 indicates a median risk, 27-33 indicates a high risk. The higher risk suggested longer time for recovery after being heavy exploited.

2. Degree of conservation attention

According to the existing parameters of biological vulnerability mentioned above, a more precise discussion can be conducted regarding the key factors for species conservation. There are three indicators for determining the level of conservation concern, including the assessment of the conservation and stock status, population trends, and the conservation concern range.

(1) Conservation and Stock Status

If the fish stock has not been overfished and is currently classified by IUCN as Least Concern (LC), it indicates a low risk level, S=1. If the fish stock is in an overfishing state or has been overfished, and is currently classified by IUCN as

Near Threatened (NT) or Vulnerable (VU), it signifies a moderate risk level, S= 2. If the fish stock is in an overfishing state and has been overfished, and is currently classified by IUCN as Endangered (EN) or Critically Endangered (CR), it denotes a high risk level, S= 3. If there is a lack of data for this parameter, it signifies an unknown risk level, S=3.

(2) Population Trend

If the species population is increasing, indicating low risk, S=1. If the species population is stable, indicating moderate risk, S=2. If the species population is decreasing, indicating high risk, S=3. If there is a lack of data on population trend, indicating unknown risk, S=3.

(3) Conservation Concern in Regional Range

If the main threats to the species only affect a few stock, indicating low risk, S=1. If the main threats to the species affect some stocks, indicating moderate risk, S=2. If the main threats to the species affect global stocks, indicating high risk, S=3. If there is a lack of data on the conservation concern in the regional range, indicating unknown risk, S=3.

The total score obtained from the sum of the conservation concern indicators reflects the overall conservation concern level of the species. A score of 3 to 4 indicates low overall conservation concern risk, 5 to 7 indicates moderate overall conservation concern risk, and 8 to 9 indicates high overall conservation concern risk. In theory, species with higher vulnerability levels are more likely to have their resources difficult to recover due to exploitation, and they will also receive higher levels of conservation concern, especially since many shark species exhibit K-selection life history traits, making their populations more susceptible to fishing pressure.

Step 3: Pressures on species

Currently, detailed international trade data for each species such as export quantities and transaction prices are unavailable for assessing trade pressure. Therefore, to align with the national context in establishing Non-Detriment Findings (NDF) determination steps, this study suggests modifying the original trade pressure assessment for future management recommendations. In Step Three, the focus is primarily on assessing fishing pressure.

1. Evaluate Fishing Pressures

To assess the fishing pressure on the shark species, the evaluation considers four aspects: fishing mortality rate, discard mortality rate, selectivity of fishing gear in terms of size, and the scale of IUU fishing. Criteria for determining each fishing pressure indicator are as follows:

(1) Fishing Mortality

If fishing activity reduces a low proportion of population abundance, indicating a low risk, S =1. If fishing activity reduces some proportion of population abundance, indicating a medium risk, S= 2. If fishing activity reduces a high proportion of population abundance, indicating a high risk, S= 3. If data on this item is lacking, indicating unknown risk, S=3.

(2) Survival rate of discarded

If a small proportion of the species catch is discarded, and the survival rate after release is high, indicating a low risk, S=1. If some proportion of the species catch is discarded, and the survival rate after release is moderate, indicating a medium risk, S=2 points. If a large proportion of the species catch is discarded, and the survival rate after release is low, indicating a high risk, S=3. If data on this item is lacking, indicating unknown risk, S=3.

(3) Fishing Gear Selectivity

If the fishing gear has high selectivity, allowing effective targeting of individuals of specific age, size, or sex, it suggests relatively minor disruption to the population structure, indicating a low level of risk, and is assigned a score of 1.

If the fishing gear has moderate selectivity, it may restrict the capture of certain components of the population to some extent, but still pose a moderate impact on the population structure. The risk level is considered moderate, and it is assigned a score of 2. If the fishing gear exhibits low selectivity, being unable to effectively distinguish or exclude individuals of specific age, size, or sex, it may lead to greater impact on the population structure. The risk level is therefore considered high, and it is assigned a score of 3.If relevant data are lacking to assess the gear's selectivity, the risk level is regarded as unknown, and a score of 3 is assigned to reflect potential uncertainty.

(4) IUU Fishing Scale

If there are detailed trade records for the species, transparent and publicly available trade chains, and trade volume roughly matching catch volume, indicating a low risk, S=1. If there are appropriate trade records for the species, difficult-to-trace trade chains, and partial matching of trade volume with catch volume, indicating a medium risk, S=2. If trade records for the species are incomplete, trade chains are not transparent or publicly available, and there is a significant difference between trade volume and catch volume, indicating a high risk, S=3. If data on this item is lacking, indicating unknown risk, S=3.

After summing up scores for each fishing pressure indicator, the overall fishing pressure level for the species can be determined. Scores of 4 to 6 represent a low fishing pressure; 7 to 9 represent a moderate fishing pressure; 10 to 12 represent a high fishing pressure."

Step 4: Evaluate Existing Management Measures

This step aims to ensure that species listed in CITES Appendix II have appropriate management measures to reduce the risk of exploitation on species resources and achieve sustainable utilization goals. If the overall biological vulnerability, conservation concern level, and the risk level of fishing pressure are higher for species identified in the previous steps, it indicates that the species requires more comprehensive and stringent management measures to mitigate the impact it faces. The intention of Step 4 is to assess the effectiveness of current management measures. Adequate management measures can alleviate the pressure on species from trade and fishing.

Risk levels are currently assessed based on the number and specificity of management measures in place. A score of 5, representing high risk, is assigned when no management measures exist. Moderate management—considered medium risk (score of 3–4)—includes general measures that are not species-specific, such as registration on the RFMO white list, implementation of shark fin-to-carcass ratios, or requirements for fins naturally attached. If 1–2 such measures are in place, the fishery is categorized as medium risk. High-level management, which corresponds to low risk (score of 1–2), includes the aforementioned general measures as well as species-specific controls, such as Total Allowable Catch (TAC) limits and the use of designated import/export CCC codes. A total of four management criteria are considered; fisheries meeting 3–4 of these are assessed as low risk.

Step 5: Non-Detriment Finding and Related Advice

After the assessment in the previous steps, this step determines whether a positive Non-Detriment Finding (NDF) is issued for the shark species. This study adds the risk scores from Steps 2 to 4 and divides them into the followings: a total score of 19 to 38 indicates a positive NDF, 39 to 48 indicates a conditional NDF, and 49 to 57 indicates a negative NDF. If determined as a positive NDF, it means that trade will not harm the population's stock status, and an NDF can be issued for international trade based on this. If determined as a conditional NDF, it implies that existing management measures must meet some new conditions before a positive NDF can be issued. If determined as a negative NDF, it is necessary to proceed to Step 6 to improve management measures.

Step 6: Further Measures

This step involves identifying management issues that need correction based on the NDF determination from the previous step. Suitable monitoring plans and management methods for the country's fisheries authorities are proposed, and appropriate improvements are made. Executives can use the results of Step 6 to check and revise the latest NDF determination results when reevaluation is needed in the future.

Referring to the guidelines from the German Federal Agency for Nature Conservation (BfN), the validity period for NDF is set at "one year." Therefore, after the expiration date each year, a reevaluation and update of the determination based on the latest stock status are necessary to effectively manage population (Mundy et al., 2014).

## Chapter 3 TABLE VISUALIZATION RESULTS OF NDF

Step 1: Primary information collection

| Species | CITES Appendix II | RFMOs control measures | | Comply with NDF process |
|---|---|---|---|---|
| Shortfin mako shark | Included | North Pacific | Non-prohibited | Yes |
| | | South Pacific | Non-prohibited | Yes |
| | | North Atlantic | Retention limits | Yes |
| | | South Atlantic | Non-prohibited | Yes |
| | | Indian | Non-prohibited | Yes |

The species meets the above criterion; it indicates that it will proceed to the subsequent steps of the assessment process.

Remark (data source): OFDC (2021) Doc. 21-09

Step 2: Existed vulnerability and conservation attention

## 2.1 Existing Vulnerability:

| Item | | Risk level | | | Shorfin mako shark | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 2.1 Existing Vulnerability | | Low risk (S=1) | Median risk (S=2) | High risk (S=3) | North Pacific | South Pacific | North Atlantic | South Atlantic | Indian |
| 1 | Size at maturity ($t_{mat}$) | <5 | 5-15 | >15 | 20 | ♂ 8-9<br>♀ 20 | ♂ 8<br>♀ 18 | ♂ 8<br>♀ 18 | ♂ 7<br>♀ 15 |
| 2 | Length at maturity ($L_m$) | <40 | 40-200 | >200 | ♂ 166<br>♀ 233<br>(PCL) | 280 | ♂ 180-185<br>♀ 275-298 | ♂ 180<br>♀ – | ♂ 190<br>♀ 250 |
| 3 | Length at maturity ($T_m$) | <10 | 10-25 | >25 | 40 | 30 | ♂ 29<br>♀ 32 | ♂ 11-18<br>♀ 23-28 | ♂ 17<br>♀ 29-32 |
| 4 | Asymptotic length ($TL_\infty$) | <100 | 100-300 | >300 | ♂ 332<br>♀ 413 | ♂ 302<br>♀ 820 | ♂ 253<br>♀ 366 | ♂ 261-329<br>♀ 244-408 | ♂ 344.34<br>♀ 392.54 |
| 5 | Natural mortality (M) | >0.4 | 0.17-0.4 | <0.17 | ♂ 0.19<br>♀ 0.17 | 0.14 | 0.339 | 0.339 | 0.217 |
| 6 | Little size (f) | >15 | 2-15 | <2 | 12 | 12.5 | 4-6 | 4-6 | 14 (10-18 Median) |
| 7 | Intrinsic rate of population increase (r) | >0.35 | 0.15-0.35 | <0.15 | 0.317 | 0.32 | 0.30 | 0.3 | 0.0081-0.0484 |
| 8 | Geographic distribution range | Global | Regional | National | Global | Global | Global | Global | Global |
| 9 | Stock assessment | $F<=F_{MSY}$<br>$B>=B_{MSY}$ | $F=F_{MSY}$<br>$B=B_{MSY}$ | $F>=F_{MSY}$<br>$B<=B_{MSY}$ | $F<=F_{MSY}$<br>$B>=B_{MSY}$ | $F<=F_{MSY}$<br>$B<=B_{MSY}$ | $F>F_{MSY}$<br>$B<=B_{MSY}$ | $F=F_{MSY}$<br>$B<B_{MSY}$ | $F>F_{MSY}$<br>$B>B_{MSY}$ |
| 10 | Behavior factor | Few behavioral factors | Some behavioral factors | Multiple behavioral factors | Few behavioral factors | Few behavioral factors | Few behavioral factors | Few behavioral factors | Few behavioral factors |
| 11 | Trophic position | Low | Median | High | High | High | High | High | High |
| | **Total/Rank** | **11-17** | **18-26** | **27-33** | **24** | **26** | **26** | **25** | **25** |

Remark (data source):

ISC/24/ANNEX/XX (2024), Mollet et al. (2000), Semba et al. (2017), Teo et al. (2024), Liu et al. (2015), Joung and Hsu (2005), Bishop et al. (2006), SC18-SA-WP-02 (2022), Natanson et al. (2006), Maia et al. (2006), Mas et al. (2017), Barreto et al. (2016), Anon (2017), Anon (2019), Brunel et al. (2018), Bonhommeau et al. (2020), Chodrijah et al. (2024).

2.2 Degree of conservation attention

| Item | | Risk level | | | Shorfin mako shark | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 2.2 Degree of conservation attention | | Low risk (S=1) | Median risk (S=2) | High risk (S=3) | North Pacific | South Pacific | North Atlantic | South Atlantic | Indian |
| 1 | Conservation and Stock Status | LC | NT/VU | EN/CR | EN | EN | EN | EN | EN |
| 2 | Population Trend | Increasing | Stable | Decreasing | Increasing | Stable | Decreasing | Decreasing | Stable |
| 3 | Conservation Concern in Regional Range | Few | Some | Global | Few | Few | Few | Few | Few |
| **Total/Rank** | | **3-4** | **5-7** | **8-9** | **5** | **6** | **7** | **7** | **6** |

Remark (data source): Rigby et al. (2019), ISC/24/ANNEX/XX (2024), SC18-SA-WP-02 (2022), Anon (2017), Anon (2019), IOTC-2020-WPEB16-17 (2020), Wu et al. (2021).

Step 3: Pressures on species

3.1 Evaluate Fishing Pressure

| Item | | Risk level | | | Shorfin mako shark | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 3.1 Evaluate Fishing Pressures | | Low risk (S=1) | Median risk (S=2) | High risk (S=3) | North Pacific | South Pacific | North Atlantic | South Atlantic | Indian |
| 1 | Fishing Mortality | Mortality Low | Mortality Median | Mortality High | Mortality High | Mortality High | Mortality High | Mortality High | Mortality High |
| 2 | Survival rate of discarded | High Survival rate | Median Survival rate | Low Survival rate | High Survival rate | High Survival rate | High Survival rate | High Survival rate | High Survival rate |
| 3 | Fishing Gear Selectivity | High gear selectivity | Moderate gear selectivity | Low gear selectivity | High gear selectivity | High gear selectivity | High gear selectivity | High gear selectivity | High gear selectivity |
| 4 | IUU Fishing Scale | Detailed records | Appropriate records | Incomplete | Appropriate records | Appropriate records | Appropriate records | Appropriate records | Appropriate records |
| **Total/Rank** | | **4-6** | **7-9** | **10-12** | **7** | **7** | **7** | **7** | **7** |

Remark (data source): Bowlby et al. (2021), ISC/24/ANNEX/XX (2024), SC18-SA-WP-02 (2022), Anon (2017), Anon (2019), IOTC-2020-WPEB16-17 (2020), Bhanja and Mandal (2024).

Fishing gears with low selectivity pose a high risk, as they are more likely to capture large quantities of non-target species and juveniles, resulting in significant impacts on the ecosystem. In contrast, high-selectivity gears are capable of effectively targeting specific species with minimal bycatch, thereby exerting limited impact on non-target species and juvenile individuals, and are thus considered low-risk.

Step 4: Evaluate Existing Management Measures

| Item | | Risk level | | | Shorfin mako shark | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 4 Management Measures | | Low risk (S=1-2) | Median risk (S=3-4) | High risk (S=5) | North Pacific | South Pacific | North Atlantic | South Atlantic | Indian |
| 1 | Absence of management measures | - | - | ● | - | - | - | - | - |
| 2 | Moderate management : General management measures without specific species focus<br>☐ RFMOs' whitelist fishing vessels<br>☐ Landing sharks with fins naturally attached to the carcass | - | ● | - | - | - | - | - | - |
| 3 | Strict management : Specific management measures for certain species<br>☐ RFMOs' whitelist fishing vessels<br>☐ Landing sharks with fins naturally attached to the carcass<br>☐ Total allowable catch (TAC)<br>☐ ccc code by shark species | ● | - | - | －3 (whitelist/ Fin-body ratio /ccc code) | －3 (whitelist/ Fin-body ratio /ccc code) | －4 (whitelist/ Fin-body ratio /TAC/ccc code) | －4 (whitelist/ Fin-body ratio /TAC/ccc code) | －3 (whitelist/ Fin-body ratio /ccc code) |
| **Total/Rank** | | **1-2** | **3-4** | **5** | **2** | **2** | **1** | **1** | **2** |

Remark (data source): OFDC (2021) Doc. 21-09, OFDC (2022) Doc. 22-11

The risk level in this step is assessed based on the presence of management measures. A score of 5, indicating the absence of any management measures, represents high risk.

Medium risk corresponds to the implementation of 1–2 management measures, while low risk reflects the presence of 3–4 measures. The total score starts at 5 and is reduced according to the number of applicable management measures, indicating that the risk decreases as management improves.

Step 5: Non-Detriment Finding and Related Advice

| Item | Rank level | | | Shorfin mako shark | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | North Pacific | South Pacific | North Atlantic | South Atlantic | Indian |
| Step 2.1 | 11-17 | 18-26 | 27-33 | 24 | 26 | 26 | 25 | 25 |
| Step 2.2 | 3-4 | 5-7 | 8-9 | 5 | 6 | 7 | 7 | 6 |
| Step 3.1 | 4-6 | 7-9 | 10-12 | 7 | 7 | 7 | 7 | 7 |
| Step 4 | 1-2 | 3-4 | 5 | 2 | 2 | 1 | 1 | 2 |
| **Total** | **19-38** | **39-48** | **49-59** | **38** | **41** | **41** | **40** | **40** |
| **Non-Detriment Finding** | **Positive** | **Conditional** | **Negative** | **Positive** | **Conditional** | **Conditional** | **Conditional** | **Conditional** |

## Chapter 4 CONCLUSION

This study conducted a Non-Detriment Finding (NDF) assessment for shortfin mako sharks caught by Taiwanese tuna longline fisheries across the three major oceans. The assessment determined a positive NDF for the North Pacific, enabling the Taiwanese government to issue export permits. For the North Atlantic, the species is classified as conditionally retained, and along with the South Pacific, South Atlantic, and Indian Ocean, the NDFs are considered conditional. Accordingly, the issuance of export permits for these regions is contingent upon the implementation of additional management measures by the Taiwanese government.

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