



「環境生物與漁業科學學系研究所第一屆學術交流會」

時間：111年5月14日(六)09:00至15:00

地點：本校中正漁學館103、206、305

因疫情緣故，故更改為線上參與形式

EBFS

環境生物與漁業科學學系

Department of Environmental Biology and Fisheries Science

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**110 學年度環境生物與漁業科學學系**  
**研究所研究生論文成果暨進度公開發表時間表**

**時間：111 年 5 月 14 日（六）**

**地點：中正漁學館 103 室 上午場 線上會議**

**上午場次參與教師：曾煥昇老師、呂昱姮老師**

時間	發表人	指導教授	主持人	論文題目
08:50-9:00	師長期勉			
09:00-09:15	李依柔	廖正信	李依柔 & 黃鼎傑	台灣沿近海拖網漁業活動與漁撈屬性： 多漁獲物種漁業管理之啟示
09:15-09:30	吳秀鳳	歐慶賢		評估表面流人工溼地水質淨化效能-以 大漢溪華江人工溼地為例
09:30-09:45	劉本莉	廖正信		台灣媒體對於海洋議題報導內容演變之 分析
09:45-10:00	林雅晴	蘇楠傑		離岸風機對漁業的影響
10:00-10:15	蔡建星	歐慶賢		臺灣東北部沿岸徒手潛水捕魚可持續性 漁業之研究
10:15-10:30	黃鼎傑	呂學榮		以科學魚探與試驗作業分析宜蘭灣鯖魚 產卵熱區及現存量
10:30-10:45	綜合討論/休息			
10:45-11:00	奈尹	藍國璋	奈尹 & 伍晟禮	The influence of climate events on the trap fishery dynamics and habitat characteristics of swimming crabs in the Taiwan Strait
11:00-11:15	李極涵	蘇楠傑		漁業行為對於海洋碳匯的影響
11:15-11:30	林祈泓	曾煥昇		我國減少廢棄漁具政策之研究
11:30-11:45	高鈞和	藍國璋		紅星梭子蟹與善泳鱒的籠具選擇性
11:45-12:00	蕭文庭	曾煥昇		兩岸漁業政策發展與漁權衝突之研究- 以臺灣海峽為例
12:00-12:15	陳韋仲	歐慶賢		台日中合理利用釣魚台列嶼周邊海域漁 業資源之研究
12:15-13:30	綜合討論暨餐敘交流			

**103 線上會議連結：** <https://meet.google.com/zpg-yahp-qff>

**110 學年度環境生物與漁業科學學系**  
**研究所研究生論文成果暨進度公開發表時間表**

**時間：111 年 5 月 14 日（六）**

**地點：中正漁學館 103 室 下午場 線上會議**

**下午場次參與教師：曾煥昇老師、呂昱姮老師**

時間	發表人	指導教授	主持人	論文題目
12:15-13:30	綜合討論暨餐敘交流			
13:30-13:45	蔡其恆	曾煥昇	蔡其恆 & 伍晟禮	我國海洋保護區之管理現況與未來整合-以各國海洋保護區有效管理方法為例
13:45-14:00	鄭資穎	呂昱姮		臺灣消費者對日本水產品之偏好研究—以帆立貝為例
14:00-14:15	周縈珍	藍國璋		生態旅遊帶動漁村永續發展之經濟效益評估-以雲林縣湖口鄉為例
14:15-14:30	陳鈺儒	呂昱姮		臺灣消費者購買水產品之偏好研究：以超市為例
14:30-14:45	何立德	廖正信		探討青年協力夥伴網路協助海岸聚落發展之研究-以東北角海岸聚落為例
14:45-15:00	尤彥凱	莊守正		臺灣漁業忌避措施與漁獲量之關聯性探究
15:00 ~~~	綜合討論暨閉幕			

**103 線上會議連結：** <https://meet.google.com/zpg-yahp-qff>

# 110 學年度環境生物與漁業科學學系

## 研究所研究生論文成果暨進度公開發表時間表

時間：111 年 5 月 14 日（六）上午場

地點：中正漁學館 206 室 [線上會議](#)

上午場次參與教師：李明安老師、王佳惠老師、呂學榮老師

時間	發表人	指導教授	主持人	論文題目
08:50-9:00	師長期勉			
09:00-09:15	粘育苓	王佳惠	粘育苓 & 伊菴	臺灣河口三個隱蔽種烏魚苗之初期生活史
09:15-09:30	廖翊君	莊守正		利用穩定性同位素分析臺灣東北部海域鮡鮫之棲地利用與攝食生態
09:30-09:45	黃伊翎	李明安		由澎湖海域拖網漁獲觀察底棲與非底棲魚類攝食生態之異同
09:45-10:00	王偉	廖正信		台灣西南海域中國槍鎖管生殖生物學與漁場環境之研究
10:00-10:15	林娜	莊守正		利用穩定性同位素分析中西太平洋海域污斑白眼鮫之棲地與攝食偏好
10:15-10:30	伊菴	李明安		台灣西南沿海黑鯛攝食生態與分佈
10:30-10:45	綜合討論/休息			
10:45-11:00	蘇珊慧	莊守正	蘇珊慧 & 蕾亞拉	西北太平洋紅肉丫髻鮫之移動與系群判別
11:00-11:15	李佳蓉	王佳惠		馬來西亞石首魚科魚類生活史之研究
11:15-11:30	郭佳臻	呂學榮		環境變動對臺灣東北部白腹鯖生殖生態學及產卵行為影響之研究
11:30-11:45	廖怡煊	莊守正		臺灣西南部海域梭氏蜥鮫生殖生物學研究
11:45-12:00	高郁婷	呂學榮		臺灣東北部海域藍圓鯪年齡成長與生殖生物學之研究
12:00-12:15	蕾亞拉	李明安		台灣西南海域皮刀魚空間分佈與攝食生態之研究
12:15-13:30	綜合討論暨餐敘交流			

206 線上會議連結: <https://meet.google.com/dpq-ewes-jvm>

# 110 學年度環境生物與漁業科學學系

## 研究所研究生論文成果暨進度公開發表時間表

時間：111 年 5 月 14 日（六）下午場

地點：中正漁學館 206 室 [線上會議](#)

下午場次參與教師：王佳惠老師、莊守正老師

時間	發表人	指導教授	主持人	論文題目
12:15-13:30	綜合討論暨餐敘交流			
13:30-13:45	莫巴列	李明安	莫巴列 & 游紀汝	臺灣海峽環境因子對杜氏鰻時空分佈型態之影響
13:45-14:00	李閔萱	莊守正		臺灣西南部海域梭氏蜥鮫攝食生態學研究
14:00-14:15	高立瓴	王佳惠		臺灣海域日本帶魚初期生活史之研究
14:15-14:30	黃玟毓	莊守正		臺灣西南部海域梭氏蜥鮫年齡與成長研究
14:30-14:45	黃郁心	李明安		建構晚春臺灣淺灘周邊水域之食物網
14:45-15:00	戴欣怡	王勝平		以模擬分析方法分析資源評估模式之運作表現 - 應用於西北太平洋鬼頭刀漁業資源
15:00~~~	綜合討論暨閉幕			

206 [線上會議連結](https://meet.google.com/dpq-ewes-jvm): <https://meet.google.com/dpq-ewes-jvm>

**110 學年度環境生物與漁業科學學系**  
**研究所研究生論文成果暨進度公開發表時間表**

時間：**111 年 5 月 14 日 (六)**

地點：**中正漁學館 305 室 上午場 線上會議**

上午場次參與教師：**王勝平老師、蘇楠傑老師**

時間	發表人	指導教授	主持人	論文題目
08:50-9:00	師長期勉			
09:00-09:15	吳研綸	藍國璋	吳研綸 & 許雯淇	年代氣候變異指數對印度-太平洋黃鰭鮪釣獲率及棲地適合指數之時空間分布影響
09:15-09:30	陳薪宇	李明安		利用多衛星遙測資料建立印度洋薔薇帶鰭及鱗網帶鰭之棲地適合度經驗模式
09:30-09:45	許意玟	蘇楠傑		臺灣西北海域多鱗四絲馬鮫棲地模式建構
09:45-10:00	梁婷滄	藍國璋		印度洋經濟性鮪類棲地與餌料生物競合關係之研究
10:00-10:15	胡珺歲	李明安		臺灣淺灘周邊水域中國槍鎖管棲地模式建構之研究
10:15-10:30	許雯淇	王勝平		西北太平洋鬼頭刀漁業管理策略評估之建構與分析
10:30-10:45	綜合討論/休息			
10:45-11:00	鄧勝元	李明安	鄧勝元 & 林治瑜	氣候變遷對西北太平洋烏魚洄游和棲地衝擊之評估
11:00-11:15	林品妤	呂學榮		臺灣東北海域鯖魚棲地經驗模式之建構
11:15-11:30	許哲璋	藍國璋		探討太平洋大目鮪與黃鰭鮪棲地與豐度同步變動之特性
11:30-11:45	黃韋翔	蘇楠傑		臺灣西北海域烏魚洄游動態與漁況指標建構
11:45-12:00	李東曄	藍國璋		南方震盪對臺灣東北部海域日本竹筴魚棲地與漁況變動之影響
12:00-12:15	林治瑜	王勝平		臺灣東部海域漁業資源之可持續影響生態風險評估
12:15-13:30	綜合討論暨餐敘交流			

**305 線上會議連結:**<https://meet.google.com/tcf-fkdj-pyt>

**110 學年度環境生物與漁業科學學系  
研究所研究生論文成果暨進度公開發表時間表**

**時間：111 年 5 月 14 日（六）**

**地點：中正漁學館 305 室 下午場 線上會議**

**下午場次參與教師：藍國璋老師、魯謹萍老師**

時間	發表人	指導教授	主持人	論文題目
12:15-13:30	綜合討論暨餐敘交流			
13:30-13:45	杉迪邦	李明安	杉迪邦 & 蕭博元	多衛星和台灣延繩釣漁業數據應用於印度洋長鰭鮪( <i>Thunnus alalunga</i> )棲息地適宜性模式之研究
13:45-14:00	李韋濤	藍國璋		臺灣西南海域生態系統結構及受漁業捕撈之影響
14:00-14:15	林宥燊	蘇楠傑		以生態模式評估離岸風場對漁業資源結構之影響
14:15-14:30	楊雨溱	藍國璋		氣候變遷對臺灣沿近海重要經濟性頭足類之影響
14:30-14:45	周芷萱	廖正信		苗栗離岸風電場漁業結構變動之探討
14:45-15:00	蕭博元	藍國璋		臺灣淺灘生態系統結構變動受氣候變異影響之研究
15:00~~~	綜合討論暨閉幕			

**305 線上會議連結：<https://meet.google.com/tcf-fkdj-pyt>**

注意事項：

- 一、每人論文發表時間為 15 分鐘，其中 10 分鐘響鈴一次，12 分鐘時按鈴二次，應立即結論報告，3 分鐘問答時間避免拖延論文發表之議程。
- 二、每人應準備研究論文之中文摘要或研究要旨（非論文發表之簡報資料），於會場上提供與會人員瞭解發表論文之研究內容。
- 三、請主持同學計時，俾利時間控制。

**四、依據本系 101 年 3 月 30 日召開 100 學年第 2 學期第 2 次系務會議決議，當天排定之各場次發表學生，應在該場次全程參與發表會，以瞭解同儕間之研究成果及進度。**

# 臺灣沿近海拖網漁業活動與漁撈屬性：

## 多漁獲物種漁業管理之啟示

李依柔<sup>1</sup>、廖正信<sup>1</sup>、蘇楠傑<sup>1</sup>、李宏泰<sup>1</sup>

<sup>1</sup>國立臺灣海洋大學環境生物與漁業科學學系

### 摘要

拖網是臺灣沿近海主要漁業之一，漁撈型態複雜且漁獲組成多樣，難以監控漁業資源利用狀況。為究明我國主要拖網漁具之作業特性，目標物種與其漁獲組成。本研究蒐集 2010-2019 年拖網漁業卸漁資料、漁撈紀錄簿，與航跡資訊，探究漁撈行為並定義拖網作業船速標準，以解析漁撈動態變化；同時利用兩階段集群分析法彙整漁獲組成特性，歸納拖網漁業共有 18 種漁撈屬性 (Catch métier)，詮釋主要漁業資源利用型態。研究建議，未來可針對拖網主要目標物種：帶魚、真鱸、鎖管、魷魚、櫻花蝦、赤尾青蝦，剖析漁撈行為與資源動態之關係，提供拖網漁業管理之參考資訊。

關鍵詞：拖網漁業、漁船航程紀錄器、資訊探勘、多漁獲物種漁業管理

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# Activities and catch métiers of coastal trawlers in Taiwan: opportunities for multispecies fisheries management

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<sup>1</sup>Department of Environment Biology and Fishery Science, National Taiwan Ocean University

## Abstract

Trawl is an important fishery sector in the coastal and offshore waters of Taiwan, characterized by multispecies composition and fishing patterns diversity that difficult to monitor the status of fish resources. Aims to investigate the information on fishing activities of distinct trawl gears and the main catch composition, we collected the landing declarations, logbooks, and Voyage Data Recorder data from 2010 to 2019. Establishment of speed criteria for classifying the fishing activity from VDR tracks, revealing the fishing dynamics of mixed-trawl fisheries. The two-step clustering approach summarizes the dominant fishing patterns of fishery resources and then identified 18 catch métiers based on catch composition. These findings suggest that Hairtails (*Trichiurus* spp.), Japanese jack mackerel (*Trachurus japonicus*), Neritic squids (*Uroteuthis* spp.), Laval anchovy (*Engraulis* spp. and *Encrasicholina* spp.), Sakura shrimp (*Lucensosergia lucens*), and Taiwan Mauxia shrimp (*Acetes intermedius*) are the major target species explored by trawlers, use to assess their interactions between fishing operations and abundance dynamics that help to facilitate the further trawl fisheries management.

Keywords : Mixed-trawl fisheries, Voyage Data Recorders, Data mining, Multispecies fisheries management

# 評估表面流人工溼地水質淨化效能-以大漢溪華江人工濕地為例

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<sup>1</sup>國立臺灣海洋大學環境生物與漁業科學學系

## 摘要

本研究以大漢溪華江表面流人工濕地為研究對象，透過文獻分析法，以評估 2012~2020 年間華江人工濕地之入流口、出流口及各淨水單元水質數據，以期瞭解水質濃度變化之處理效能，並探討可能之影響因子，提供後續管理維護之參考。研究結果顯示，華江人工濕地出流水之溶氧(DO)、酸鹼值(pH)呈顯著的改善，污水的導電度、氨氮(NH<sub>3</sub>-N)、總氮(TN)與總磷(TP)也具有顯著的去除效果，但生化需氧量(BOD<sub>5</sub>)及懸浮固體(SS)之削減效果並不顯著，建議保持水文穩定，使各單元連通管線的排水通暢，並定期池槽清淤、植栽補植，以活化濕地。

關鍵詞：人工濕地、水質淨化、華江人工濕地、淨水

# 台灣媒體對於海洋議題報導內容演變之分析

劉本莉

國立臺灣海洋大學環境生物與漁業科學學系

## 摘要

台灣是一個海島國家，四面環海，從早期民間林默娘(媽祖)口耳代代相傳的經典故事，不難發現四面環海的民族性對於這片大海的憧憬。但可惜的是，一般大眾對於海洋知識瞭解有限，這樣的侷限主要由於有二：一是教育、二是媒體。我們的教育是背離海洋的(廖鴻基，十六歲的海洋課程)，我們得到的教導大海是危險的、漁撈是辛苦的、學習漁業是沒有前途的，輔以透過大眾媒體廣而告知，多負面建設在海線沿岸，讓台灣大眾不論是對於海洋的教育、瞭解及保育都是有其侷限的。媒體在民主社會中有兩個重要角色：一是作為監督權力機制的第四權，檢視國家施政、二是要成為促成公討論，讓不同意見彼此交流的溝通平台。過去被稱為無冕王的新聞媒體，握有第四權的新聞媒體，究竟在海洋議題上的關注方向與內容和演變的趨勢為何?希望能藉由大眾媒體報導了解台灣新聞媒體對於海洋議題的報導內容分析及演變，和證明媒體對於海洋議題相關貢獻。

關鍵詞：海洋、大眾媒體、聯合知識庫、永續發展、永續發展目標(SDGs)

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# **An analysis of the evolution of marine-themed content in Taiwanese media**

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## **Abstract**

Taiwan is surrounded by the sea on all sides. From the classic stories handed down from generation to generation by the early folk Lin Mo Niang (Mazu), it is not difficult to find the longing of the nationality surrounded by the sea for this sea. But unfortunately, the general public has limited understanding of marine knowledge. There are two main reasons for this limitation: one is Education, and the other is the Media. Our education is against the ocean (Liao Hongji, 16-year-old ocean course), the textbook tells us that the sea is dangerous, fishing is hard, and learning fishing has no future. Negative depictions are built along the coastline, which limits the Taiwanese public's education, understanding and conservation of the ocean. Media has two important roles in a democratic society: as the fourth power to supervise the power mechanism, and also to examine national governance; In the past, the NEWS media that was called the uncrowned king and the NEWS media that held the fourth power, what is the direction, content and evolution trend of ocean issues? Wished through mass media reports, we can understand the analysis and evolution of Taiwan's news media's coverage of marine issues, and to prove the media's relevant contributions to marine issues.

Keywords : Oceans, Mass Media, Joint Knowledge Base, Sustainability, Sustainable Development Goals (SDGs)

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# 離岸風機對漁業資源之影響評估

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## 摘要

臺灣近年致力開發綠色能源，其中離岸風機被認為是發展最為成熟的海洋再生能源之一，但是離岸風機的開發階段，仍會導致一定的棲地破壞與漁業干擾，比如地基建設、漁業場域被劃為限制作業區…等，漁獲組成變動的究責歸因，亦牽扯到漁民的生計及建設公司的責任歸屬。本研究將評估離岸風機從基礎建設施工至商轉階段對沿近海漁業之潛在影響，利用 R 軟體與 EwE 軟體進行基礎的可視化圖表並建構生態食物網模擬模型。除定棲性漁業資源外，更重要可瞭解指標性洄游魚種在風機營建與商轉後的改變，包括洄游路徑改變及當地漁獲量影響等，以便後續進行沿近海漁業作業型態調適與因應，達成離岸風機與漁業產業的共榮共存與永續發展。

關鍵字：Ecopath with Ecosim、Ecopath、海洋再生能源、生態系方法、漁業

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# **The impact assessment of offshore wind turbines on fishery resources**

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## **Abstract**

Taiwan has committed to develop green energy in recent years. The offshore wind farms (OWF) is considered one of mature technology in marine renewable energy, but the construction of OWF may lead to habitat destruction (foundation construction) and catch reduction due to the fishing grounds limited outside the construction areas. The variation in catch composition and associated economic issues should be investigated for the fishermen responded by the OWF construction companies. The present study evaluates the potential effect of OWF on fisheries resources during the construction and operation. The Ecopath with Ecosim (EwE) and R software were used to develop the simulation ecosystem models and the basic visualization for trophic levels and food webs of marine ecosystem. In addition to the sedentary fish, it is more important to understand the impacts on typical migratory fish after the construction of wind turbines and then during the operation, as well as the impacts on their migration route and the reduction in catch. To mitigating the impacts by accommodation of the fishery and operation activity, it is expected the OWF and coastal fisheries can coexist and develop sustainably.

Keywords: Marine Renewable Energy、Ecosystem-based approach、Fishery

# 以科學魚探與試驗作業分析宜蘭灣鯖魚產卵熱區及現存量

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## 摘要

台灣目前產量最高的沿近海漁業為鯖鱈漁業，然而花腹鯖、白腹鯖以及真鱈等主要漁獲物有著過漁的問題，其資源狀況和相關管理政策一直受到社會各界的高度關注。台灣東北海域的宜蘭灣是花腹鯖主要產卵場之一，產卵期為每年1至5月，透過宜蘭灣產卵期的鯖魚現存量調查，可作為產卵期資源評估的先行指標。本研究於產卵期使用攜帶式科學魚探 SIMRAD EY60 搭載 200kHz 音鼓，在宜蘭灣進行了穿越線調查並配合一支釣進行採樣。一支釣主要捕獲對象為花腹鯖 (>80%)，以此初步篩選出花腹鯖的回訊，並建立花腹鯖的 TS-TL 轉換式 ( $R^2$  為 0.98)。根據穿越線調查發現鯖魚在地理分布上，並不隨體長不同而有所差異，而密度則分別以龜山島南側以及宜蘭灣北側較高。

關鍵詞：科學魚探、鯖魚、熱區、單體標物反射強度

# **Estimating of the spawning hotspot and biomass of mackerel by using echo sounder and experimental fishing in Yilan Bay**

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## **Abstract**

Mackerel fishery is currently the coastal fishery with the highest production in Taiwan. However, the overfishing issue regarding the main catches, including blue mackerel, chub mackerel, and horse mackerel, has been highly concerned by the general public as well as their stock status and relevant management policies. Yilan Bay in the northeastern waters of Taiwan is one of the main spawning grounds for blue mackerel, and the spawning period is January to May each year. The standing crop of blue mackerel migrated in spawning season in Yilan Bay can serve as a leading index of the reproductive success rate prior to spawning season. We used a portable scientific echo sounder SIMRAD EY60 system equipped with 200 kHz transmitter together with pole-and-line fishing to conduct line transect surveys in the Yilan Bay at the beginning of the spawning season. At the pole-and-line fishing, blue mackerel were the major species (> 80%), and the TS-TL conversion formula for blue mackerel were then being established ( $R^2$  is 0.98). According to the line transect surveys, there is not obvious relationship between fish size and geographical distribution in Yilan Bay, and the highest density detected in the south of Guishan Island and the north of Yilan Bay, respectively.

Keywords: scientific echo sounder, mackerel, hotspot, target strength

# 聖嬰事件對台灣周邊海域梭子蟹科籠具漁船動態與棲地特性之影響

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## 摘要

海洋環境和氣候變遷變化對於台灣海峽梭子蟹科漁獲量和棲地分布相關研究較少著墨，本研究收集梭子蟹科中紅星梭子蟹、鏽斑蟳和遠海梭子蟹漁獲資料與籠具漁船航程紀錄器資料(2013-2019)，計算梭子蟹科捕獲率並利用棲地適合度探討聖嬰事件對台灣海峽梭子蟹科捕獲率和棲地分布之影響。分析結果顯示鏽斑蟳和遠海梭子蟹在反聖嬰年期間捕獲率較高，與正常年份和聖嬰年下的捕獲率相比增加了 40.0% 以上。對於紅星梭子蟹與正常年份相比，反聖嬰年和聖嬰年 (>8.0 kg/h) 的捕獲率均較高。反聖嬰年秋季因海表水溫增高與鹽度的變化為導致三種梭子蟹捕獲率上升的主要原因之一。此外鏽斑蟳和遠海梭子蟹的高獲捕獲率區域則會隨著棲息地指數進行空間之推移，同樣發現反聖嬰年的最適棲地海域分布較正常年和聖嬰年廣泛，然紅星梭子蟹因分布範圍遍布整個臺灣海峽，對於氣候變異事件影響變動較不顯著。透過本研究結果表明，ENSO 事件強烈影響了臺灣海峽秋季期間梭子蟹的捕獲量和棲息地適宜性。

關鍵詞：甲殼類，梭子蟹科，氣候變化，棲地模型，籠具漁業

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# The influence of climate events on the trap fishery dynamics and habitat characteristics of swimming crabs in the Taiwan Strait

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## Abstract

Information regarding the oceanic environment and climate variability is crucial for determining swimming crab catch and habitat preferences. However, in studies on swimming crabs, such information remains poorly utilized, and its effects on crab communities in the Taiwan Strait (TS) has not been well documented. The purpose of this study was to understand the impacts of El Niño–Southern Oscillation (ENSO) events on the catch rates (CRs) and habitat suitability of *Charybdis feriatus*, *Portunus pelagicus*, and *Portunus sanguinolentus* in the TS during autumn. Therefore, a weighted habitat suitability index (HSI) model was constructed using logbooks and voyage data records from Taiwanese crab vessels (2013–2019) with the addition of environmental variables. In the present study, the CRs for *C. feriatus* and *P. pelagicus* were higher (>7.0 and >8.0 kg/h) during La Niña events, with the increase being more than 40.0% compared with normal and El Niño events in autumn. For *P. sanguinolentus*, the CRs were higher during both La Niña and El Niño events (>8.0 kg/h) compared with normal years. Furthermore, the high CRs for three swimming crab species were observed in areas with high HSI areas. The low CRs for *C. feriatus* and *P. pelagicus* during normal and El Niño years and the low CRs for *P. sanguinolentus* in normal years during autumn were highly consistent with substantial shrinkage of suitable habitats. Our findings suggest that ENSO events strongly affected the catch and habitat suitability of *C. feriatus*, *P. pelagicus*, and *P. sanguinolentus* during autumn in the TS.

Keywords: crustacean, Portunidae, climate change, habitat modeling, crab fishery

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# 漁業行為對於海洋碳匯的影響

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## 摘要

工業革命後石化燃料燃燒和人類行為帶來二氧化碳排放，造成在近 200 年來全球平均溫度大幅上升，為面對全球性氣候變遷災害，COP21 於 2015 年簽訂《巴黎協定》，規範締約國致力推動減碳政策，並期望在世紀末控制溫度上升幅度在 2°C 以內（理想於 1.5°C）且 CO<sub>2</sub> 濃度 <490 ppm。台灣於去年(2021)宣示 2050 淨零碳排，「負碳領域」已成為達成目標相當重要的一環，分為碳捕捉再利用及封存(CCUS)及自然碳匯兩個面向。本研究以自然碳匯中的藍碳為目標，彙整藍碳來源及流動，並探討漁業行為對海洋碳匯的影響，期望以此作為建立漁業部門邁向 2050 淨零碳排路徑依據。

關鍵字：碳匯、生物幫浦、淨零碳排、負碳排、固碳、氣候變遷

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# **The fishing impact on ocean carbon sequestration**

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## **Abstract**

The continuous increase in CO<sub>2</sub> emissions from fossil burning and human activity after the Industrial Revolution leads to a dramatic increase in global temperature since 200 years ago. The Paris Agreement adopted an objective in 2015 to limit global warming below 2°C (preferably to 1.5°C) relative to the preindustrial level by keeping atmospheric CO<sub>2</sub> concentration below 490 ppm by 2100. In last year (2021), Taiwan pledged to achieve net-zero emissions by 2050, through an economy that either emits no greenhouse gas emissions or offsets its emissions. To tackle climate change and to achieve net-zero emitters of CO<sub>2</sub> by 2050, carbon-negative tools have been more important, which means to offset more carbon, through carbon capture, sequestration, or avoidance, than the contribution to the environment. Based on the concept in blue carbon and natural carbon sequestration, this study aims to sort out the sources and flows of blue carbon to examine the impact on blue carbon extraction by fishing. It is expected that this study serves as the basis for establishing the fisheries sector towards net zero carbon emissions by 2050.

Key Words : carbon sequestration · biological pump · net zero emissions · carbon negative · fixed carbon · climate change

# 我國減少廢棄漁具政策之研究

林祈泓、曾煥昇

## 摘要

漁業供應全球 33 億人的食用水產品，2018 年約有 456 萬艘漁船在世界各地進行漁撈作業，漁獲產量達 8440 萬噸(FAO,2020)，隨捕撈活動也會伴隨發生意外、故意丟棄漁具現象。遭拋棄、遺失或其他原因的無主漁業廢棄物稱為廢棄漁具 (Abandoned, lost or otherwise discarded fishing gear, ALDFG)，因天候問題、礁石或其他漁具交纏造成漁具損壞而遺失、拋棄於海洋，這也是對於海洋生物與海洋棲地最具傷害性的海洋垃圾(Wilcox 等, 2016)，對於海洋生物與海洋環境的健康，幽靈漁具已成為亟需優先面對的事項之一，尤其是瀕危的物種來說至關重要，世界各國目前也針對如何減少、回收或標示廢棄漁具提出應對策略。海洋廢棄物目前為全球共同面對的問題，全球的 ALDFG 約有 6.4 萬噸(United States Academy of Sciences)，為海洋廢棄物中的 10%，其中 46%的太平洋垃圾是由漁具製成(Lebreton, L 等 2018)，廢棄漁具則會為漁業資源與棲地產生最直接的傷害，包含漁獲與經濟來源的減少，甚至威脅物種多樣與豐富性，另一方面，廢棄漁具也會衍伸海上航行的安全，不論是漁業資源、環境或是航行等問題都與人類有直接相關。聯合國呼籲各成員國針對減少廢棄漁具採取行動，並在 2030 永續發展目標 (Sustainable Development Goals, SDGs) 中訂下了目標 14，「保育及永續利用海洋生態系，以確保生物多樣性並防止海洋環境劣化」，FAO 也透過各漁業委員會、負責任漁業守則等強調了減少廢棄漁具與報告的重要性，各大漁業組織與國家也針對廢棄漁具提出相關的作業規則與法規來應對全球面臨的廢棄漁具問題。海洋保育署海洋廢棄物清理狀況統計中，110 年台灣周邊海洋廢棄物約有 3.45 萬噸，其中有 3%廢棄漁網、2.4%保麗龍與 14.6%竹木，但統計值僅為呈現台灣周邊海灘活動所清理的情形，廢棄漁網遍布各水域與海底礁岩，因此國內廢棄漁具實際數量應有低估的行情。關於減少廢棄漁具或相關處置再各國已有相關的法規與政策，目前在國內主要是以廢棄物清理法、地方政府的實名制規定(如基隆市)與回收獎勵辦法等。本研究預計蒐集其他國家中廢棄漁具對該國的影響，減少廢棄漁具與廢棄漁具處置相關規定、政策與做法，再與目前我做的相對應作法，比較出其中差異與不足處，並給予適當的法規、政策建議，作為往後擬定相關策略或行動計畫的參考。

# 籠具漁業中梭子蟹科燈光誘集效果與逃脫環設置選擇之研究

高鈺和

## 摘要

目前國內對籠具漁業相關研究相當甚少，本研究之研究目的為探討燈光誘集效果可否增加梭子蟹科捕獲率，同時評估最適形狀與大小逃脫環設置減少幼蟹捕獲率之效益，盼燈光誘集能夠增加梭子蟹捕獲率以增加漁民願意裝設逃脫環之意願。本研究先以死蟹進行逃脫環尺寸逃脫比例之模擬，再從中挑選出合適的規格對活蟹進行測試。本研究初步結果顯示以死遠海梭子蟹進行方型逃脫環選擇實驗，試驗先以殼高為參考點，殼高 2.6~3.0 公分通過 7.5\*3.0 公分之逃脫環的比例為 100%，3.1~3.5 公分與大於 3.5 公分比例則分別降至 36.3% 和 0%。後續將以活蟹進行籠具模擬實驗，將餌料放置實驗缸的一側，吸引梭子蟹從逃脫環中脫離進行索餌，同時以動物軌跡追蹤系統觀察梭子蟹科之行為動態。另外再比較餌料與不同波長燈光放置前後，梭子蟹科進行逃脫比例與時間是否會較沒設置燈光時有效。

關鍵字：梭子蟹科、動物軌跡追蹤系統、燈光誘集、逃脫環

# **Study on the effect of light induction and selection of escape ring setting for Portunoidea in the trap fishery**

## **Abstract**

Studies on Portunidae crab and trap fishing in Taiwanese waters are insufficiently documented. Thus, this study investigated the effect of light as an artificial bait on Portunidae catch rate and to estimate the optimal escape ring shape and size to reduce Portunidae sub-legal bycatch. The size of the escape ring will be simulated using a dead crab to determine the optimal shape and size, and the optimal specifications of the escape ring would test on live crab in a captivity experiment. Our results revealed that experiment of selection of square escape ring with dead sea Portunidae based on carapace height, the pass ratio of 2.5~3.0 cm (carapace height) on escape ring (7.5\*3.0 cm) were 100%, and decreased to 27.2% and 0% for the groups of 3.1~3.5 cm and 3.6~4.0 cm. Then, the cage simulation experiment will be carried out with live crabs. Natural bait will be placed on the other side of the trap to encourage the crab to pass the escape ring for further study and an animal trajectory tracking system will be used to analyze the crab's behavior with the different escape rings size. In addition, the performance of the light with different wavelength colors will be tested to determine the crab behavior in the captivity experiment.

**Keywords:** *Portunoidea* 、 animal trajectory tracking system 、 light induction 、 escape ring

# 臺日中合理利用釣魚臺列嶼周邊海域漁業資源之研究

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## 摘要

東海因黑潮與中國沿岸水匯集形成潮境而成為世界著名的大陸棚漁場,而釣魚臺列嶼又正好突出於此陸棚邊緣上,故其周邊海域自然形成潮目而成為漁業資源豐富的優良漁場。長期以來,臺灣、日本、中國的漁船在此作業,而前兩者因地緣關係利用較多。釣魚臺列嶼周邊海域屬於東海的一部份,中日自 1955 年以來針對東海一直有締結雙邊漁業協定藉以維持東海漁業資源之合理有效利用,但對 27°N 以南海域因有釣魚臺列嶼的主權及臺灣問題之考量而未有具體規範。臺日中均主張擁有釣魚臺列嶼之主權,兩岸的論證基本上是一致的,但眼下不作聯合聲明,日本則竭盡所能堅持對其最有利的論證。臺日於 2013 年擱置主權簽訂臺日漁業協議以利雙方共同利用管理該海域漁業資源,對此中國則積極擴大海警船隊規模並修訂海警法以實際行動來維護其對釣魚臺列嶼之權益,日本自然承受極大的壓力,並力求反制。惟主權歸屬目前仍然無解,當前三方的焦點宜重視漁業資源的共同合理有效利用,較為務實,而可行的模式係藉由日本在中日與臺日之雙邊漁業協定與協議居中協調達成三方之共識。

關鍵詞:釣魚臺列嶼、臺日漁業協議、中日漁業協定、臺灣、日本、中國

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# 探討我國海洋保護區之管理現況與未來整合

## -以各國海洋保護區有效管理方法為例

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### 摘要

全球漁業資源因氣候變異、過度捕撈、人為破壞等各項因素正面枯竭的危機，各國為拯救海洋資源並永續發展，長期以來透過劃設海洋保護區已被視為重要的海洋資源保育和管理工具。本研究旨在研析我國海洋保護區的沿革與現況，了解劃設至今的成果，並分析我國海洋保育主管機關未來的管理方針，以探討其是否有精進及改善之處，亦分析各國海洋保護區的成功案例，並以之為借鏡，探討各國海洋保護區的管理策略，以剖析適合我國的管理方法，進而提升我國管理的效能，俾利我國海洋保育主管機關加強對海洋保護區的管理與整合，並與國際的海洋保育理念接軌，使我國的海洋資源得以永續發展。

關鍵詞：我國海洋保護區、海洋保護區的整合與規劃、分區管理、各國海洋保護區

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# **Discussion on the status and future integration of management of marine protected areas in Taiwan-refer to the effective management methods of MPA in various countries**

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## **Abstract**

The global fishery resources are facing a crisis of depletion due to various factors such as climate variability, overfishing, and man-made destruction. In order to save marine resources and develop sustainably, the establishment of Marine Protected Areas (MPA) has long been regarded as an important tool for marine resource conservation and management by countries.

The purpose of this research is to analyze the evolution and current situation of Taiwan's MPA, to understand the achievements made so far. In addition, this research also analyzes the future management policies of Taiwan's marine conservation authorities and gives suggestion. By analyzing the successful cases of MPA in various countries and discuss their management strategies, this research refers them as the models of improving the efficiency of Taiwan's management, so as to benefit Taiwan's marine conservation authorities to strengthen the management and integration of MPA. In order to in line with the international concept of marine conservation and having sustainable development, we need to enforce the ability of management in MPA.

Key words: Taiwan's MPA, integration and planning of MPA, zoning management, MPA in various countries

# 臺灣消費者對日本水產品之偏好研究－以帆立貝為例

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## 摘要

台灣水產品的糧食自給率相當充足，但進口水產品的進口量值，皆有逐年攀升的趨勢，帆立貝又是進口高單價水產品之一。雖有日本進口農產品的相關研究，卻缺乏水產品相關分析，且除十年前外目前也沒有在進行中的政府機構主導分析調查。故本研究預計針對台灣消費者的消費行為及其意識進行調查，目的是找出消費者願意購買高單價水產品的因素，並使用有序邏輯模型(OLM)歸整分析這些資料。

本研究在疫情下，為維持樣本多樣性，預計採用線上問卷的方式，依據台灣人口分布，發放1,000份調查問卷，以希冀在後續研究中，透過結合歷史記事及經濟成長相關資訊，以作為提供水產業界對於消費者飲食習慣趨勢的預測，或協助在地漁民在進行漁業經營時，能給予提升未來水產品附加價值的參考。

關鍵字：消費者偏好、日本水產品、日本帆立貝、OLM

# 臺灣消費者對日本水產品之偏好研究－以帆立貝為例

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## Abstract

The food self-sufficiency rate of aquatic products in Taiwan is quite sufficient, but both the import volume and value of imported aquatic products have a trend of increasing year by year. Most important of all is that the Yesso scallop is one of high-priced aquatic products. Although there are relevant studies on imported agricultural products in Japan, there is a lack of consumer preference analysis related to aquatic products. Coupled with that there is no the analysis and survey of aquatic product consumption led by government agencies more than ten years, neither ongoing one. Therefore, this study is expected to investigate the consumption behavior and consumption awareness of Taiwanese consumers, the purpose is to find out the factors which consumers are willing to buy high-priced aquatic products, and to use the ordered logic model (OLM) to classify and analyze these data.

While the covid-19 has not yet eased, to maintain sample diversity, this study is expected to use online questionnaires according to Taiwan's population distribution, and distribute 1,000 questionnaires. It is hoped that in the follow-up research by combining historical records and information related to economic growth, it can be used as a forecast for the aquaculture industry on the trend of consumers' eating habits, or to assist local fishermen in their fishery operations which can give a basis and reference for enhancing the added value of aquatic products in the future.

Keywords : consumer preference ◊ Japanese seafood ◊ the Yesso scallop ◊ OLM

# 生態旅遊帶動漁村永續發展之經濟效益評估-以雲林縣口湖鄉為例

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## 摘要

雲林縣口湖鄉為養殖漁業重鎮，當地產業結構及居民的謀生方式與其密不可分，然而，從國內外相關研究得知，近年因氣候變遷、海洋污染等因素影響，致使漁業生產量逐年下降，產值也起伏不定，同時對當地的生活、生產、生態造成衝擊。在國內外的生態旅遊發展、地方創生策略以及漁業轉型的研究已有部分成果，有別於過去的旅遊型態，臺灣觀光也逐漸轉型為發掘在地特色的旅遊方式，本研究進行田野調查以及國內外文獻蒐整後，發現當地業者有意進行相關發展，但在地情形以觀光工廠為多，少有遊程發展。因此以條件評估法為基礎設計生態旅遊遊程問卷，建立假設性市場進行願付價格等相關分析，結果發現若發展生態旅遊遊程，每位遊客可為當地帶來約 1042 元的效益。

關鍵字:生態旅遊、漁業轉型、地方創生、條件評估法

# **Economic Benefit Evaluation on Ecotourism driving the Sustainable Development of Traditional Fishing Village -Case of Kouhu Township in Yunlin County**

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## **Abstract**

Kou-hu Township, Yunlin County, is an important aquaculture town. The industry structure and the livelihood of residents are inseparable from aquaculture. However, the climate change, marine pollution and the other factors have encountered on fishery. The production of fishery decline year by year as well as the output value is instability. In the same way, these factors affect the sociality, ecology, and economy of the coastal zone in Kou-hu Township. Previous research has found that the development of ecotourism, the regional revitalization strategy and fishery reformation were bring a more positive impact on traditional fishery. Different from the past, the travel types in Taiwan has transformed to experience local characteristics. After field survey and literature review. It was found that local operators intend to carry out related development, but there are more tourism factories in real situation and few tourism development. Therefore, the study based on contingent valuation method ,designing the ecotourism questionnaire. Establishing a hypothetical market to conduct relevant analysis such as willingness to pay, it was found that if the ecotourism tour is developed, each tourist can bring about NT\$1042 of benefits to the local area.

Key words: Ecotourism, Fishery Reformation, Regional Revitalization, Contingent Valuation Method(CVM)

# 臺灣消費者購買水產品之偏好研究：以超市為例

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## 摘要

近年，臺灣水產品人均消費量下降，影響了水產品供給方的收入。為了增加供給方收入，需要提升市場價格及擴大消費市場。因此要掌握消費者需求、偏好及特徵。而消費者的需求會受零售型態影響，現今多樣化的零售型態對應了不同需求的消費者。水產品的銷售從過去以傳統市場為主，到近年超級市場的比率已逐漸增加。

本研究利用網路問卷調查，以臺灣南北兩大消費地-臺北市和高雄市為調查地點，以 20 歲以上且為家計內主要購買水產品者為調查對象。以序列邏輯模型分析法(Ordered Logit Model)，分析臺灣消費者購買水產品時的重視因素及偏好，及日漸增加的主要透過超市購買水產品的消費者的特徵，以期能作為水產品供給方後續提升水產品消費量及水產品附加價值之重要依據。

關鍵詞：水產品、消費量、消費者偏好、零售型態、超市

# **A study on Taiwanese consumers' preference for purchasing aquatic products: Taking supermarkets as an example**

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## **Abstract**

In recent years, Taiwan's per capita consumption of aquatic products has declined, affecting the income of aquatic product suppliers. In order to increase the income of the supply side, it is necessary to increase the market price and expand the consumer market. Therefore, it is necessary to grasp consumer needs, preferences and characteristics. And consumer demand will be affected by retail patterns. Today's diversified retail patterns correspond to consumers with different needs. The sales of aquatic products have gradually increased from traditional markets in the past to supermarkets in recent years.

This study uses an online questionnaire survey to take Taipei City and Kaohsiung City, two major consumption areas in the north and the south of Taiwan, as the survey locations. Using the Ordered Logit Model, to analyze the importance factors and preferences of Taiwanese consumers when purchasing aquatic products, as well as the characteristics of the increasing number of consumers who mainly purchase aquatic products through supermarkets. In order to serve as an important basis for aquatic product suppliers to increase the consumption of aquatic products and the added value of aquatic products in the future.

Keywords : Aquatic products, consumption, consumer preference, retail type, supermarket

# 探討青年協力夥伴網絡協助海岸聚落發展之研究—以東北角海岸聚落為

## 例

何立德、廖正信、莊慶達

### 摘要

臺灣海岸聚落發展的過程中累積了深厚的海洋文化成分，而非僅只有漁村和漁業的文化範疇，還涉及海洋的經濟、社會等各方面之活絡條件。但是目前人口外移問題嚴重地區，大都集中在非六都區域，對於逐漸提升的人口高齡化社會問題及城鄉過度發展不均衡問題，迫切需要被解決、被改善。如何整合區域資源，創造地域生活與產業可持續發展的機制，協助地方發揮特色，吸引產業進駐及青年人口回流，繁榮地方經濟，進而促成城鄉及區域均衡適性發展。海岸聚落人口的流失與傳統漁業產業外移的情形十分嚴重，導致海岸聚落的發展早已出現人口與技術的斷層與產業外移。然而，在地方創生的潮流下，倡議青年下鄉或返鄉似乎成為了解決海岸社區發展的解藥之一。因此，本研究以東北角海岸聚落為主要研究對象，並實際協助地方青年組成協力夥伴網絡及成立地方合作平台，共同挖掘東北角海岸聚落的地方 DNA，從而探討青年協力夥伴網絡如何振興活化海岸之聚落、翻轉傳統產業產能，並兼顧保存地域文化，思考海岸聚落活化之可行性。期待未來海岸聚落的發展可以透過漁業起始，加值以豐富多元且深具地方色彩的海洋文化，創造更多發展的機會，達到海岸聚落永續發展之願景。

**關鍵字：**海岸聚落、地域活化、區域發展、青年協力夥伴網絡、東北角海岸

# **Exploring a Youth Collaborative Network to Implement Coastal Settlement Revitalization: A Case Study of Coastal Settlement in Northeast Coast**

Ho, Li-Te, Liao, Cheng-Hsin, Chuang, Ching-Ta

## **Abstract**

The development of coastal settlements has accumulated deep-rooted cultures related to the ocean. The scope is not just about cultures in fishery or fishing villages. Additionally, it involves the conditions of the economy and society. How to designate the mechanism to incorporate regional resources to create sustainable life and industry and to urge the balanced urban-rural development has thus led to the promotion of local specialties, startups, and the reflow of the youth. In Taiwan, the out-migration of youth has been a serious issue that happens primarily out of the region of six metropolitan cities. Furthermore, issues about the aging population and unbalanced development of urban-rural areas are needed to be solved. The population loss and industry are changed in the coastal settlements have caused a lack of people and technology. However, the trending concept of regional revitalization that takes the initiative in the reflow of the youth seems to be a resolution to development for coastal communities. Thus, this study chose coastal settlements in northeast coast as subjects to practically assist local youth in organizing collaborative network and cooperation platform. By discovering the local DNA of the coastal settlements in northeast coast, this study explores how this youth collaborative network revitalizes coastal settlements and traditional fishery industries, and preserves local cultures. It's anticipated that the future development of coastal settlements could start with fisheries, accompanied by a rich and locally featured marine culture, to create much more development opportunities. Eventually, let the coastal settlements achieve the vision of sustainable development.

**Keywords:** Coastal Settlements, Regional Revitalization, Regional Development, Youth-adult Collaborative Network, Northeast Coast

# 台灣沿近海延繩釣漁業忌避措施之成果效益研究

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## 摘要

近年來海洋保育類生物被意外捕獲導致漁業經營者和保育人士之間的衝突對立時有所聞。不論是意外捕獲導致保育類物種受傷死亡,或是漁獲過程中目標漁種遭受咬食等損失皆為目前所面臨的問題,為此許多管理方開始嘗試以忌避措施降低保育類物種與漁業互動機率。本研究以台灣沿近海之延繩釣漁船為研究對象,委託樣本船在部分釣組分別裝設 LED 燈以及小型水中音波器 (pinger),並比較裝設及未裝設忌避措施之釣組的單位努力漁獲量(CPUE)與互動頻率(意外捕獲及咬食)。自 2021 年 6 月至今已回收來自宜蘭南方澳、台東成功以及屏東東港共 11 艘漁船總計 261 次作業紀錄資料。未來將持續尋找樣本船協助實驗同時進行數據分析,期盼本研究之結果有助於了解忌避措施之成效性。

關鍵字: 延繩釣漁業、LED 燈、小型水中音波器、意外捕獲、咬食

# **Assessing the effectiveness of mitigation measures on interactions between marine protected species and Taiwanese artisanal longline fisheries**

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## **Abstract**

The accidental catch of marine protected species is a worldwide issue in recent years, often trigger conflicts between fisheries and conservationists. Problems including injuries and mortality in bycaught protected species, and economic loss caused by depredation on catches and fish baits, still remain unresolved. As such, mitigation measures are gradually developing to minimize the interaction between the protected species and fisheries. In the present study, LED lights and pingers are attached on the branch line from some artisanal longline vessels in Taiwan. CPUE and interactions (bycatch and depredation) are compared between attached line and control set. Since June 2021, data of 261 hauls from 11 vessels from Nanfangao, Yilan County, Chengkung, Taitung county and Donggang, Pingtung county, are obtained. More vessels will be found for experiments, and data analyses will be conducted, so as to determine the effectiveness of different mitigation measures.

Key words: longline fishery, LED lights, pingers, accidental catch , depredation

# 利用穩定性同位素分析臺灣東北部海域鮠鮫(*Galeocerdo cuvier*)的棲地和攝食生態

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## 摘要

鮠鮫(*Galeocerdo cuvier*)有成長緩慢、壽命長的k選擇特性，是生態系中的關鍵物種。本種具有經濟價值和棲息水域與人類活動範圍接近，因此易受漁業壓力影響，被國際自然保護聯盟(IUCN)列為近危物種。然而目前本種於西北太平洋的相關研究較仍屬缺乏。本研究目的在透過脊椎骨穩定性同位素分析了解西北太平洋鮠鮫不同生活史的棲地利用和攝食生態。在2020年12月至2022年3月間，共採樣得22尾鮠鮫個體的脊椎骨樣本(雌魚10尾，雄魚12尾)，尾叉長(Fork length, FL)範圍為88-354公分。初步以尾部脊椎骨進行讀論與定齡以觀察本種的不同生活史階段，再嘗試刮取脊椎骨上的不同輪紋粉末樣本進行 $\delta^{15}\text{N}$ 、 $\delta^{13}\text{C}$ 同位素分析。期盼本研究能透過 $\delta^{15}\text{N}$ 、 $\delta^{13}\text{C}$ 可探討本種在不同性別、生活史階段的棲地利用和攝食生態。

關鍵字:鮠鮫、穩定同位素分析、脊椎骨、棲地利用

# **Habitat and feeding ecology of the tiger shark (*Galeocerdo cuvier*) in the northeastern water off Taiwan based on stable isotope analysis**

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## **Abstract**

The tiger sharks (*Galeocerdo cuvier*) have k-selection traits such as slow-growing and high longevity, therefore they are often regarded as keystone species in the marine ecosystem. Being economically important and having high habitat proximity to human activities, they are exposed to fisheries, so they are listed as a near-threatened (NT) species by the International Union for Conservation of Nature (IUCN). Compared with other regions, studies on this cosmopolitan species are rather limited studies comparing the Northwest Pacific ocean. The study aims at investigating the habitat use and feeding ecology of the tiger shark in the northeastern waters off Taiwan within different life history stages based on stable isotope analysis of vertebra collagen. From December 2020 to March 2022, vertebrae from 22 tiger sharks (10 females, 12 males), ranging from 88 – 354 cm fork length (FL) were collected. Caudal vertebrae were selected for aging in order to determine the life history stage. Powder samples were obtained through scraping on growth band of the vertebrae, so as to carry out further carbon and nitrogen stable isotope analysis, and explore their habitat utilization and feeding ecology with regards of different sexes and life history stages.

Keywords: tiger sharks, stable isotopes analysis, vertebrae, habitat use

# 由澎湖海域拖網漁獲觀察底棲與非底棲魚類攝食生態之異同

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## 摘要

本研究於 2019 年季節間(3、6、9、12 月)，在澎湖海域利用拖網採集樣本以探究底棲及非底棲魚類及其季節變動下之攝食差異。本研究以口器特徵、外部型態之方式，挑選出非底棲魚類(含日本緋鯉、小牙鰻、半線鸚天竺鯛)及底棲魚類(含花斑蛇鰻、準大頭狗母魚、松葉倒棘牛尾魚)。結果顯示，非底棲魚類之主要攝食種類為浮游動物(29.12-100%)，底棲魚類則以魚類及螃蟹(30.75-83.47%)較優勢，其次為浮游蝦類和大型蝦類(16.53-40.1%)，顯示魚類攝食種類有水層上之差異；攝食重疊度上，春跟夏季底棲和非底棲魚類的攝食種類很接近，在秋跟冬季時的攝食種類很不接近；在各季節之底層及非底層魚類的餌料組成群聚分析上，其結果呈現略有差異、但不顯著。綜上所述，不同水層間或各季節間之攝食差異可能受水文環境之影響所致，造成可能結果之因素為水溫、餌料生物的季節組成變動等。

關鍵詞：澎湖海域、拖網、底棲與非底棲魚類、攝食生態

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# Comparison on Feeding ecology of Demersal and Non-Demersal fish caught by Trawl net fishery, Penghu

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## Abstract

The research used trawl net to collect samples in seasonal (March, June, September, December) of 2019. The purpose of the research is to observe the different of feeding ecology with demersal and non-demersal fish. Use the characteristic of mouth part and the shape of the fish body to choose non-demersal fish (*Upeneus japonicus*、*Gazza minuta*、*Ostorhinchus semilineatus*) and demersal fish (*Saurida undosquamis*、*Trachinocephalus myops*、*Rogadius asper*). The results shows the most important food organism that non-demersal fish are the zooplankton (29.12-100%). The feeding of the most important food organism with demersal fish are fishes and crabs (30.75-83.47%), the second categories of feeding food organism are the shrimps ((16.53-40.1%). The results represents the water layer will cause the different of feeding food organism category with demersal and non-demersal fish. In dietary overlap, the demersal and non-demersal fish of the food organism category in spring and summer season is similar.

In autumn and winter, the food organism category is not similar. In Cluster analysis, the seasonal of the demersal and non-demersal fish in food organism composition shows that the category has a little different but not significant. In summary, different water layer and different season to compare feeding differences may influence by hydrological environment. The factors causing this result are the temperature、the food organisms composition in the seasonal changes.

Keywords :Penghu、Trawl net、Demersal and Non-Demersal、Feeding ecology

# 臺灣西南海域中國槍鎖管生殖生物學與漁場環境

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## 摘要

中國槍鎖管(*Uroteuthis (Photololigo) chinensis*)為臺灣沿近海域重要經濟物種之一。目前對生殖生物學已有初步瞭解，但對其在成熟階段與產卵場相關資訊尚不明確。為探究各成熟階段之中國槍鎖管在臺灣西南海域分布情形及與漁場之間的關係，本研究按月蒐集2013年至2021年於該海域商業性捕獲之樣本共10360尾，藉由生物學量測，該物種全年均可產卵，且以整體之成熟與孵化比例，皆顯示有春季(2~4月)與秋季(8~10月)兩個主要產卵群。同時將各成熟階段生物資訊，搭配航跡資料、漁撈努力量資訊與環境因子，觀察空間分佈結果顯示，多數個體主要分布於119.9-120.7°E，22.1-23°N水域，且各成熟階段的鎖管多分布於水深50-100公尺之間。以上結果將可作為未來推估產卵場分布，與觀察其棲地環境之重要參考資訊。

關鍵詞：中國槍鎖管(*Uroteuthis (Photololigo) chinensis*)、生殖生物學、臺灣西南海域

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# **Growth and reproduction of *Uroteuthis (Photololigo) chinensis* in coastal water off Taiwan**

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## **Abstract**

*Uroteuthis (Photololigo) chinensis* is a common species and economically important species in the coastal water off Taiwan. According to previous studies have preliminary understanding of growth and reproduction of *U. (P.) chinensis*. However, the information about its mature stage and spawning grounds is still unclear. The present study aims to investigate the relationship between the distribution of *U. (P.) chinensis* in each stages of sexual development and environmental factors around Taiwan. A total of 10360 specimens were routinely collected from commercial capture in the water off southwestern Taiwan between 2013 and 2021. Through the result of mature stage frequencies and the hatch dates of all specimens, indicated that *U. (P.) chinensis* can spawn in the whole year and with two spawning peaks in spring (February to April) and autumn (August to October). Each sexual development stages of *U. (P.) chinensis* biological information were analyzed form trajectory data, the fishing effort data and environmental factors, and the observation of the spatial distribution. Show that most individuals are mainly distributed in waters off 119.9-120.7°E and 22.1-23°N, and each stages of sexual development is mainly distributed in the bottom depth of 50-100 meters. This result could provide scientific evidence for estimating the distribution of spawning grounds and observing the habitat environment in the future.

Key words: *Uroteuthis (Photololigo) chinensis*, growth and reproduction, southwestern waters of Taiwan

# 利用穩定性同位素分析中西太平洋海域污斑白眼鯊(*Carcharhinus longimanus*)之棲

## 地與攝食偏好

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### 摘要

污斑白眼鯊(*Carcharhinus longimanus*)擁有成長慢、成熟晚、胎仔數少等 K 選擇特性，且為大洋中的高階掠食者，其資源量變動會影響海洋生態系統的平衡。有鑒於此，區域性漁業管理組織陸續將本種列為禁捕，然而本種於西太平洋水域之研究尚且不足。本研究利用行政院農委會漁業署於 2018 年度扣查之非法遠洋漁船在中西太平洋海域捕撈的 61 尾污斑白眼鯊。為了解本種在不同性別、生活史階段中的攝食狀態與棲地利用情形，本研究選擇 6 尾雄魚(椎徑 15.96-18.58 mm)與 6 尾雌魚(椎徑 14.16-17.15 mm)之個體脊椎骨樣本，嘗試刮蝕其不同生活史階段的輪紋樣本，並以碳氮穩定性同位素分析進行探討。目前讀輪之最大年齡為雄魚 11 歲及雌魚 9 歲，期盼本研究之結果可提供本種於中西太平洋的生活史與生物學訊息。

關鍵詞: 中西太平洋、污斑白眼鯊、穩定性同位素、攝食偏好、棲地利用

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# **Habitat and feeding preference of the oceanic whitetip shark (*Carcharhinus longimanus*) in the central western Pacific Ocean based on stable isotope analysis**

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## **Abstract**

The oceanic whitetip shark (*Carcharhinus longimanus*) has typical k-selection characters such as slow growth, late maturity and low fecundity. Being large, they are usually top predators in the marine ecosystem. Therefore, changes in their biomass may indirectly affect the food web. As a prohibited species in the Atlantic and the central western Pacific Ocean, the migration behavior and feeding habits during their lifetime remain largely unknown. Here, our study aims at estimating the habitat and feeding preference of the oceanic whitetip shark in the central western Pacific, by using stable isotope analysis. A total of 61 illegally fished *Carcharhinus longimanus* (12 males, 6 females, and 43 unknown) were confiscated by the Taiwan Fisheries Agency in 2018. Ontogenetic shift in the habitat and feeding preference for both sex will be examined. Vertebral band pairs from 6 males (15.96-18.58 mm vertebral radius, VR) and 6 females (14.16-17.15 mm VR) were scraped for stable isotope analysis. Results of age reading revealed age ranges from 4 to 11 years for males and 5 to 9 years for females.

Keywords: the central western Pacific Ocean, *Carcharhinus longimanus*, stable isotopes, habitat, feeding preference

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# **Trophic ecology and spatial distribution of black sea bream (*Acanthopogon schlegelii*) on the coastal waters of southwestern Taiwan**

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## **Abstract**

Black sea breams are valuable commercial fish in Asia, especially in Taiwan due to the meat quality. Taiwan has put an effort to enhance the stock size such as fry release and establishing the brackish water farm located on southern, mid-west and northeast coast of Taiwan. The survival rate and adaptation have shown a good result for fry release to reach maturity. In this research, the investigation of the important prey selections, the trophic ecology, and spatial distribution of black sea breams on southwestern part of Taiwan are essential for identifying the habitat requirements for feeding areas and determining the fishing ground. This study will be conducted by the stomach analysis, stable isotope analysis, and developing habitat model.

**Keywords:** black sea bream, southwestern Taiwan, stomach analysis, stable isotope analysis, habitat models

# 西北太平洋紅肉丫髻鮫之移動與系群判別

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## 摘要

紅肉丫髻鮫(*Sphyrna lewini*)為海洋生態系中頂端的掠食者，其資源變動在生態系中有著舉足輕重的影響。CITES 已將其列入附錄 II 名錄，而 IUCN 最新的評估將其保育等級提升至極危 (Critically Endangered, CR)。紅肉丫髻鮫是臺灣主要的鯊魚漁獲物種之一，然而有關西北太平洋本種的系群結構之研究仍然闕如，這些研究缺口阻礙了本種的資源評估與管理的進行。因此，本計畫之第一年係針對西北太平洋之紅肉丫髻鮫，以變異從 7 到 21、異型核子觀測值以及期望值分別為 0.370 到 0.870 以及 0.505 到 0.724 的 9 個微衛星基因座，進行系群判別之分析，並且透過國際交流合作，分析日本海域之樣本，以確定紅肉丫髻鮫系群結構。截至目前已蒐集 172 個日本資料樣本以及 219 個臺灣東西部樣本。已進行之 107 尾個體微衛星基因座分析結果顯示，臺灣東北部漁獲之個體與日本有基因交流的狀況，此狀況或許與台日作業海域重疊有關。然而，最大概似法的計算結果顯示臺灣與日本為不同的族群。未來將繼續進行其餘樣本之分析，並嘗試與其他國家進行合作，以確認西北太平洋紅肉丫髻鮫之系群結構，以做為未來擬定相關資源管理之參考。

關鍵詞：系群判別、微衛星基因座、異型核子、基因群、洄游性軟骨魚類

# 馬來西亞石首魚科生活史之研究

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## 摘要

石首魚為高經濟價值漁獲物種，中國名貴中藥材花膠即是利用其魚鰾製成，而小牙潘納石首魚為馬來西亞當地常見魚種之一，然而目前各國僅針對少數石首魚種類的生活史有初步探討，對其族群現狀無法進行資源評估。另外由於部分石首魚種類分類地位尚未明瞭，例如波利黃唇魚，故生態研究資訊將可提供系統分類之參考。本研究自馬來西亞採集30尾小牙潘納石首魚(*Panna microdon*) 及28尾波利黃唇魚(*Bahaba polykladiskos*) 樣本，利用耳石輪紋進行年齡成長研究，套入VBGE、Robertson及Gompertz三種成長方程式，再以赤池信息量準則(AIC) 來選出最適成長方程式，利用耳石中鋁濃度和海水鹽度呈正相關之特性，分析耳石核心至邊緣之成長時序列鋁鈣比，以探討其生活史參數及洄游生態。結果顯示：小牙潘納石首魚和波利黃唇魚之最適成長方程式皆為VBGE，其成長方程式分別為 $L_t = 31.32 \times (1 - e^{-0.20(t + 1.50)})$  及 $L_t = 87.22 \times (1 - e^{-0.29(t + 0.37)})$ ，而小牙潘納石首魚主要生活於海水中，波利黃唇魚則於海水出生，主要棲息於半淡鹹水。在石首魚科中，僅25個物種棲息於淡水，大部分石首魚皆生活於海水，因此波利黃唇魚之生活史應可作為未來分類依據參考，兩物種之棲地利用情形，亦將有助於日後訂定相關保育措施或政策。

關鍵字：小牙潘納石首魚、波利黃唇魚、生活史、年齡成長、耳石

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## Study on the life history of Sciaenidae fishes in Malaysia

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### Abstract

Croaker is one of the high value fishery targets species. Their swim bladders are made for expensive medicine in China. *Panna microdon* is a common croaker species in Malaysia. However, only few croaker species have completed life history information so far, therefore information on the population status is sufficient for resource management. Also, taxonomy of some croaker is still ongoing e.g *Bahaba polykladiskos*, so more ecological studies could offer information on species identification. A total of 30 of *P. microdon* and 28 of *B. polykladiskos* were collected from Malaysia, and their otolith annulus were used for age and growth studies. The age data was fitted in three growth functions including VBGE, Robertson and Gompertz and then using the Akaike information criterion (AIC) to select most suitable growth function. Meanwhile, by applying the positive correlation of otolith Sr concentration on ambient salinity, Sr/Ca ratio of otolith core to edge was analyze to explore life history parameter and migratory ecology. The results show that VBGE is the most suitable growth function for both species. Their growth functions are  $L_t = 31.32 \times (1 - e^{-0.20(t + 1.50)})$  and  $L_t = 87.22 \times (1 - e^{-0.29(t + 0.37)})$  for *P. microdon* and *B. polykladiskos* respectively. Furthermore, *P. microdon* was mainly habituated in seawater, while *B. polykladiskos* was born in seawater and inhabit in brackish water. Only 25 sciaenidae species inhabit freshwater in current knowledge, as most croakers are seawater species. Thus, life history of *B. polykladiskos* may provide a reference for taxonomy in the future. Their habitat use will help for formulating relevant conservation measures or policies.

Keywords : *Panna microdon*, *Bahaba polykladiskos*, life history, age growth, otolith

# 台灣東北部白腹鯖(*Scomber japonicas*)生殖生物學及產卵行為之研究

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## 摘要

根據漁業年報統計指出白腹鯖漁獲比例從 2009 年 55% 下降至 2021 年 13%，顯示近年來台灣白腹鯖漁獲比例有下降的趨勢，此期間白腹鯖生殖策略是否有所改變。為了瞭解白腹鯖之產卵行為及近年白腹鯖之生殖生物學，本研究探討 2019 年 1 月至 2021 年 12 月白腹鯖之生殖生物學，研究期間採集雌魚 1553 尾，進行生殖腺之分析，以生殖腺切片結果顯示生殖其為 1-5 月，顛峰期為 1-2 月。雌魚性成熟體長為 25.82 cm。其中 87 尾進行孕卵數算，總孕卵數為  $93316 \pm 61325$  粒，相對孕卵數  $267 \pm 125$  粒/g，平均批次孕卵數  $29950 \pm 31478$  粒，產卵頻率為 0.13(7.6 天)。本次研究結果與張(2014)相比，生殖期有提早的現象，性成熟體長下降，孕卵數也略微下降。

關鍵字:白腹鯖、生殖生物學、產卵頻率

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# **Reproductive biology and Spawning Behavior of Chub mackerel, *Scomber japonicas* in the northeastern waters off Taiwan**

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## **Abstract**

According to Fisheries Yearbook revealed proportion of Chub mackerel in 2009 is 55% and it's decline to 13% in 2021. The result illustrate that the proportion of Chub mackerel catch and have a significant trend of decline in Taiwan. Whether the reproductive strategy of Chub mackerel reproduction strategy seem to be different. To realize the spawning behavior and reproductive biology of Chub mackerel, the research consider the reproductive biology of Chub mackerel from Jan 2019 to Dec 2021. We collect about 1553 females to do reproductive analyze during the study. The results of gonad slices show that the reproductive period is 1-5 months, and the peak period is 1-2 months. The fork length of mature is 28.82cm. Other 87 females count of pregnant eggs. The total fecundity is  $93316 \pm 61325$  oocytes(mean  $\pm$  SD). The batch fecundity is  $29950 \pm 31478$  oocytes(mean  $\pm$  SD), and the spawning frequency is 0.13(7.6 days). Compared with Zhang (2014), the results of this study show that the reproductive period is earlier, the sexually mature body length decreases, and the number of fecundity also slightly decreases.

Key word: Chub mackerel(*Scomber japonicas*)、Reproductive biology、Spawning frequency

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# 臺灣西南部海域梭氏蜥鮫之生殖生物學研究

廖怡媗

## 摘要

梭氏蜥鮫(*Galeus sauteri*) 屬於底棲性物種，廣泛分布於臺灣西南海域水深 60–200 m 的砂泥底海床環境。其體型小、經濟價值低，常作為下雜魚處理，因此過去於臺灣西南海域的研究相當缺乏。本研究擬針對屏東東港底拖網船在台灣西南部海域所捕獲的梭氏蜥鮫進行生殖生物學研究。目前自 2021 年 11 月至 2022 年 2 月間共採樣得 354 尾樣本，雄魚有 190 尾 (8.2–39.1cm total length, TL)，雌魚則有 164 尾 (10.7–42.5cm TL)。雌魚的生殖腺重 0.01–23.05 g，子宮寬 0.5–17.19 mm，最大卵徑 0.8–20.82 mm，雄魚的生殖腺重 0.01–16.75 g。未來將透過組織染色切片法，觀察不同成熟階段的生殖腺發育狀態。並透過生殖腺指數(GSI)、性比(SR)，以及肝臟指數(HSI)呈現本種的生殖階段變化，最後利用各體長組距中成熟個體所佔百分比與全長之邏輯曲線關係來推估性成熟體長 (TL50)，以提供臺灣西南部海域梭氏蜥鮫的生殖生物學參數資訊。

關鍵字:梭氏蜥鮫、生殖生物學、生殖腺指數、性成熟體長

## **Reproductive biology of blacktip sawtail catshark *Galeus sauteri* from southwestern waters off Taiwan**

### **Abstract**

The blacktip sawtail catshark, *Galeus sauteri* is a benthic shark widely distributed in sandy habitats under depth 60 – 200m off southwestern Taiwanese waters. They are often treated as fish meal due to their small size. Information on their reproductive biology is limited. Samples will be collected from bottom trawlers in Donggang port, Pingtung county, Taiwan during November 2021 to November 2022. Currently, 356 samples have been processed, including 190 males and 164 females. In the future, histomorphologies of testis and ovary will be applied to determine different maturation stages of the gonads. Gonadosomatic index (GSI), Sex ratio (SR), Hepatosomatic index (HSI) will be applied to characterize variations between maturity stages, and length at maturity (TL50) will be estimated based on relationship between proportion of mature specimens and total length, so as to provide comprehensive reproductive parameters on *G. sauteri*.

Keywords: *Galeus sauteri*, reproductive biology, gonadosomatic index, length at maturity

# 台灣東北部海域藍圓鯪年齡成長與生殖生物學之研究

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## 摘要

藍圓鯪為臺灣沿近海常見的魚種，也是扒網漁業捕撈量居第4位的魚種，近年來捕獲量甚至超過真鯪。由於漁獲量大增可能造成過漁情形，但藍圓鯪之基礎研究及資源評估工作從未進行，因此首先需針對該魚種之基礎生物學進行了解，爾後才能與國外的研究進行比較與進行資源管理。本研究採集2021年3月至2022年五月來自臺灣東北部海域之扒網、定置網及一支釣等漁法共2870尾的藍圓鯪樣本，進行年齡成長與生殖生物學的研究。其中耳石切片樣本225個，生殖腺切片樣本289個。透過耳石讀輪建立出 von Bertalanffy 成長方程式為  $L_t=31.6[1-e^{-0.225(t+3.25)}]$ ，從生殖腺指數及性腺成熟度可得知藍圓鯪生殖季為4~6月，五月為產卵高峰期，雌性50%性成熟體長為21.35公分。孕卵數約在5萬~30萬粒之間，相對孕卵數1216粒/g;批次產卵數約在3萬~10萬粒之間，相對批次孕卵數為408粒/g。本研究藍圓鯪的極限體長相較國外研究出現較小的情形原因可能為採集的樣本個體較小，以及性成熟體長有較大的情形原因可能為生殖季未採集到小於19公分的樣本，因此未來需要持續採集各種體長的樣本以及探討台灣藍圓鯪系群問題。

關鍵詞：藍圓鯪、耳石、VBGE 成長方程式、生殖腺指數。

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# Age, growth and reproduction of round scad (*Decapterus maruadsi*) in the Northeastern Waters off Taiwan

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## Abstract

Round scad (*Decapterus maruadsi*) is one of common species in surrounding water of Taiwan. Round scad is the forth main catch of taiwanese seine, even was caught more than jack mackerel in recent years. To avoid overfishing which may cause by yield increasing, so we need to learn about round scad fundamental biology. A total of 1740 samples were used for age, growth and reproduction study caught by the taiwanese seine, fixed net and pole and Lines Boote between March to December 2021. The sample number of otolith sections is 225, the sample number of ovaries macroscopically is 289. A VBGE growth equation estimated by otolith age count is  $L_t = 31.6[1 - e^{-0.225(t+3.25)}]$ . According to Gonsomatic Index and oocyte development stage, the occurrences of spawning for round scad were during April-June and high spawning period is in May. The 50% mature fork length was 21.35 cm. The spawning fecundity was 50-300 thousand oocytes, 1216 oocytes per g of ovary-free fish weight. The batch fecundity ranged 30-100 thousand oocytes, 408 oocytes per g of ovary-free fish weight. The limit lengths of this study was smaller than other studies, because this study samples lengths were smaller. The 50% mature fork length of this study was bigger than other studies, because this study samples lengths were not smaller than 19 cm in spawning season. Therefore, the collection of different sample or discussion round scad stock structure were needed in the future.

Key word: round scad, *Decapterus maruadsi*, otolith, VBGE, Gonsomatic Index

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# **Understanding the spatial and temporal distribution and trophic ecology of Moonfish (*Mene maculata*) in the southwestern waters of Taiwan**

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## **Abstract**

The moonfish, *Mene Maculata*, is a subtropical, temperate, brackish water fish that is distributed in the Indo-West Pacific waters spanning from East Africa to South Africa, from south Japan to north-eastern Australia, and east to New Caledonia. It is the only species and genus found in the world in its family. It is a reef-associated species with an optimum depth range of 50-200 m that grows up to a length of 20 cm. It is seen to dwell in deeper coastal regions, continental shelves, in and around islands, and sometimes in estuarine waters. This species is present in the waters in and around Taiwan and it represents a significant commercial fish in recent times. The first incidence of this species in Taiwan was recorded in Takao, Formosa in 1908. The catch distribution of the species also differs seasonally among various locations. The major fishing season in the south-eastern Taiwan waters is from October to April, but from April to August in the eastern bay. Previous literature considers moonfish mainly as fish feeders, smaller-sized schooling fish. This is a very scarcely studied species and the biological data is very limited about its age, growth, feeding ecology, fishery, reproduction, catch rates, and population ecology. All of these parameters are significantly important to analysing the stock assessment of moonfish. This project will elucidate the habitat ecology of moonfish in southwestern Taiwan waters and also will entail a detailed analysis of the feeding and trophic ecology of the species in this region as it has not been studied before. In addition, this work will also provide a detailed finding of new habitat models for the species here.

Keywords: *Mene maculata*, habitat models, habitat hotspot, feeding ecology, trophic position

# 臺灣海峽環境因子對杜氏鰱時空分佈型態之影響

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## 摘要

台灣海峽 (TS) 的環境特徵與杜氏鰱 (*Seriola dumerili*) 種群的豐度和分佈變化有關。杜氏鰱是生態系統中具有商業和生態價值的物種，其空間分佈模式對漁業管理和保護至關重要。然而，捕獲率與環境變化對魚類群落的影響之間的關係仍未確定。在這項研究中，我們應用台灣漁船日誌和航行數據記錄器的時空漁業數據(2014-2017)透過泛加成模型(GAM)模擬了杜氏鰱在台灣海峽中與環境因素相關的時空分佈模式。然後，我們基於最有效的 GAM 開發了一個物種分佈模型。該模型預測夏季台灣海峽西北部延伸至中國大陸沿岸地區的捕撈率較高；此外，儘管捕獲率相對較高，但該物種在冬季廣泛分佈。目標物種受生物物理環境條件的強烈影響，潛在的捕撈區位於整個台灣海峽水域。這項研究的結果有助於說明杜氏鰱種群如何響應時空環境變量並預測物種分佈。有關杜氏鰱棲息地偏好和分佈模式的數據對於了解台灣海峽的環境條件至關重要，這可以為未來保護規劃和管理的優先事項提供資訊。

關鍵詞： *Seriola dumerili*、廣義加法模型、空間和時間分佈、台灣海峽、季節性變化

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# **Spatial and temporal distribution patterns of greater amberjack in response to environmental factors in the Taiwan strait**

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## **Abstract**

The environmental characteristics of the Taiwan Strait (TS) have been linked to variations in the abundance and distribution of greater amberjack (*Seriola dumerili*) populations. Greater amberjack is a commercially and ecologically valuable species in ecosystems, and its spatial distribution patterns are pivotal to fisheries management and conservation. However, the relationship between catch rates and the influence of environmental changes on fish communities remains undetermined. In this study, we modeled the spatiotemporal distribution pattern of *S. dumerili* in relation to environmental factors in the TS, applying generalized additive models (GAMs) to spatiotemporal fisheries data from logbooks and voyage data recorders from Taiwanese fishing vessels (2014–2017). We then developed a species distribution model based on the most effective GAMs. The model predicted a relatively high *S. dumerili* catch rate in the northwestern region of the TS in summer, with the area extending to the coastal seas of mainland China; moreover, despite the relatively high catch rate, the species would be widely distributed again in the winter. The target species is strongly influenced by biophysical environmental conditions, and potential fishing areas are located throughout the waters of the TS. The findings of this study help elucidate how *S. dumerili* populations respond to spatiotemporal environmental variables and predict species distributions. Data on the habitat preferences and distribution patterns of *S. dumerili* are essential for understanding the environmental conditions of the TS, which can inform future priorities for conservation planning and management.

Keywords: greater amberjack; *Seriola dumerili*; generalized additive models; spatial and temporal distribution; Taiwan Strait; seasonal variations

# 臺灣西南部海域梭氏蜥鮫攝食生態學研究

李閔萱

## 摘要

梭氏蜥鮫(*Galeus sauteri*)是臺灣周邊海域多獲性的小型鯊魚，數量龐大，因此在生態系中扮演著重要的角色。但在台灣西南部海域卻缺乏對本物種的相關研究。本研究欲透過攝食生態學研究，了解梭氏蜥鮫在生態系中所扮演的角色和與其他生物間的相互關係。本研究預計自 2021 年 11 月起至 2022 年 10 月於屏東縣東港進行樣本採集，目前至 2022 年 2 月共得 354 尾樣本(雌魚 164 尾，雄魚 190 尾)。透過 25 尾個體的胃內容物分析發現，本種攝食的餌料生物種類具有甲殼類，頭足類以及硬骨魚類。未來將由空胃率(%VI)、相對重要性指數(%IRI)、攝食寬度(B)、餌料生物多樣性指數(H')，以及攝食重疊度( $C_{xy}$ )等計算方法，了解梭氏蜥鮫的餌料生物組成，並探討其在不同的性別、性成熟階段、體長範圍以及季節等變因間餌料生物組成的差異。

關鍵字:梭氏蜥鮫、攝食生態、胃內容物分析、餌料生物

# Feeding ecology of the blacktip sawtail catshark *Galeus sauteri* from southwestern waters off Taiwan

## Abstract

The blacktip sawtail catshark (*Galeus sauteri*) is a neritic small shark species inhabiting coastal waters off Taiwan, playing an important role in marine ecosystem owing to its biomass. However, there is a lack of research on fishery biology of this species in southwestern waters off Taiwan. Investigating the feeding ecology can provide insight into their ecological role, as well as their relationships with other organisms. In this study, samples are expected to be collected in Donggang, Pingtung County from November 2021 to October 2022. Until February 2022, a total of 354 specimens (164 females and 190 males) were collected. Preliminary results of stomach content analysis from 25 specimens revealed a diet composition of crustaceans, cephalopods and teleosts. Vacuity index (%VI), index of relative importance (%IRI), dietary breadth (B), diversity index ( $H'$ ), and diet overlap index ( $C_{xy}$ ) will be used to characterize their feeding habits. Potential dietary difference between sex, sexual maturity, size and seasons will also be explored.

Keywords: *Galeus sauteri*, feeding ecology, stomach content analysis, prey

# 臺灣周邊海域日本帶魚(*Trichiurus japonicus*)初期生活史之研究

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## 摘要

帶魚是臺灣沿近海漁業重要的經濟物種之一，本研究欲解析該屬的優勢種-日本帶魚(*Trichiurus japonicus*)是否具地理差異，利用耳石進行日齡判讀與化學分析，以期瞭解臺灣南、北海域日本帶魚的初期生活史，並探討其是否為同一系群，以提供後續漁業管理參考。

樣本採集時間為2020年10月至2021年11月，採樣區域為北部的宜蘭縣大溪漁港與南部的屏東縣東港漁港，總計採樣907尾樣本，肛前長介於33-234 mm，體重介於0.32-132.76 g之間，性別比為1:1.09。隨機挑選南、北兩地，四季共164尾樣本進行日齡判讀，南部樣本之肛前長為40-146 mm，日齡為122-321天、北部樣本之肛前長為39-144 mm，日齡為112-306天。後續將進一步分析耳石微量元素(Mg、Mn、Ba、Sr)組成與耳石碳氧同位素組成的差異，以探討其棲息水域之異同。

關鍵字：日本帶魚(*Trichiurus japonicus*)、耳石日輪、耳石微化學、年齡成長。

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## **Investigation early life history of hairtail (*Trichiurus japonicus*) around Taiwan**

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### **Abstract**

Hairtail is one of the commercially important species in Taiwan coastal fishery. The geographic differences of the most dominant species in the genus, *Trichiurus japonicus* was studied, by applying both otolith daily increment analyses and chemical composition, to analysis the early life history of samples from northern and southern Taiwan waters, and to investigate if geographic stock exists for further fishery management information. Seasonal samples were collected between October 2020 to November 2021, from two fishery ports, including Dasi (Ilan) and Dongang (Pingdong). A total of 907 specimens were measured with preanal length ranged at 31-234 mm, and body weight ranged at 0.32-132.76 g, and sex ratio was 1:1.09. Sixty individuals were randomly selected for otolith daily increments counting, and the results showed the south group with daily age ranged at 122-321 day and north group at 112-306 day. Further analyses on trace elements (Mg, Mn, Ba and Sr) and stable isotopes ( $\delta^{18}\text{O}$  and  $\delta^{13}\text{C}$ ) will be carried out for comparison the differences between the habitat.

Key words: *Trichiurus japonicus*, otolith daily increment, microchemistry, age and growth

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# 台灣西南部海域梭氏蜥鮫之年齡與成長研究

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## 摘要

本研究針對台灣西南部海域之梭氏蜥鮫進行年齡與成長研究。自 2021 年 11 月至 2022 年 2 月期間至屏東東港採樣，共採得 354 尾樣本，雄魚 190 尾(9.0 – 39.1 cm total length, TL)，雌魚 164 尾(10.7 – 42.5 cm TL)。年齡形質選定以腹腔與第一背鰭間的脊椎骨，先以熱水氽燙去除肌肉和結締組織，接著以 5% 氫氧化鉀 (KOH) 溶液浸泡 20 – 60 分鐘去除剩餘結締組織，風乾、包埋後進行切片，再嘗試以不同處理方法增加輪紋的對比度，以便後續進行年齡判讀。預計套用 von Bertalanffy、von Bertalanffy with length at birth  $L_0$  ( $L_0 = 6.7$  cm TL)、Gompertz 和 Robretson 四種成長方程式，從中選出最佳成長方程式並推估本種的年齡成長參數，以供未來進行資源評估與管理策略擬定之參考依據。

關鍵字：梭氏蜥鮫、板鰓類、椎體定齡、成長方程式

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# **Age and growth of the blacktip sawtail catshark *Galeus sauteri* from southwestern waters off Taiwan.**

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## **Abstract**

This study aimed at studying the age and growth of *Galeus sauteri* from southwestern waters off Taiwan. A total of 354 samples was collected from Donggang, Pingtung during November 2021 to February 2022, including 190 males (9.0 – 9.1 cm total length, TL) and 164 females (10.7 – 42.5 cm TL). The vertebrae between the abdominal cavity and the first dorsal fin were selected for age determination. Muscles and connective tissue were removed by boiling water, then the remaining connective tissue was removed by soaking in 5% potassium hydroxide (KOH) solution for 20 – 60 minutes. The vertebrae were subsequently dried, embedded, sliced, and the band pairs were processed by different methods to increase the accuracy for age reading. Four growth models, including von Bertalanffy, von Bertalanffy with length at birth  $L_0$  ( $L_0 = 6.7$  cm TL), Gompertz and Robretson would be fitted, and the most suitable model would be determined to estimate the age growth parameters of this species. The parameters can be used as a reference for further stock assessments and management strategies in Taiwan.

**Keywords :** *Galeus sauteri*, Elasmobranch, Vertebral ageing, Growth modelling

# 建構晚春臺灣淺灘周邊水域之食物網

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## 摘要

臺灣淺灘水域湧昇漁場之一，其春夏季時因為有地形性湧昇現象，所以帶來高基礎生產力和豐富的生物。本研究期望透過商業性拖網以盡可能完整採集此水域之生物樣本，並建立該水域之生物相(包含魚蝦蟹貝類等)。本研究於 2020 年晚春(5 月)進行採樣，共採集到魚類 1260 隻 34 科 61 種、蝦類 7 科 10 種、蝦蛄類 1 科 7 種、蟹類 9 科 19 種、頭足類 1 科 3 種、螺貝類 4 科 4 種及底棲生物等；透過觀察所有魚種之胃內容物組成，並計算其餌料生物之相對性百分比指標(IRI%)後，初步可知最優勢餌料生物為端足類；並會以穩定同位素分析計算各魚種之營養位階；最後再透過物種之生態習性、胃內容物組成及營養位階等結果，劃分出 Ecopath with Ecosim 模式所需之物種功能群，再透過此模式來建構該水域之生物食物網和探討混合營養效益分析。

關鍵詞:臺灣淺灘、胃內容物組成、穩定同位素分析、EWE 生態系統模式

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## **To construct the food web of Taiwan Bank surrounding sea area in late spring**

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### **Abstract**

Taiwan Bank is one of the upwelling fishing grounds. In spring and summer season, the topographic upwelling bring about the high primary productivity with rich organism and diversity. In present study, we use the commercial trawl to collect the organism in the waters as far as possible to construct the biota (including fish, shrimp, crabs, and shells). The samples were collected in the late spring of 2020 (May). There are total 1260 fish include 34 families 61 species, 7 families 10 species of shrimp, 1 family 7 species of mantis shrimp, 9 families 19 species of crabs, 4 families 4 species of shells, 1 family 3 species of squids, sponge, sea slugs, echinoderm, and other benthos in samples. By observing the stomach content composition of all fish species and calculating the index of relative important percentage (IRI%), we preliminary found the Amphipoda is the most dominant prey item. Then, using stable isotope analysis to calculate trophic position of each fish species. Lastly, dividing the functional groups (needed by EWE) by species identify, stomach content composition, and trophic position. Trough this model to construct the biological food web and mix trophic impacts analysis of this waters.

Keywords: Taiwan Bank, Stomach content composition, Stable isotope analysis, Ecopath with Ecosim

# 以模擬分析方法分析資源評估模式之運作表現 – 應用於西北太平洋鬼頭刀漁業資

## 源

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## 摘要

傳統資源評估過程中，通常需要三項資料：(一) 死亡率、性別比、補充群量等生物學參數；(二) 體長、年齡等漁獲資料；及(三) 代表漁業利用趨勢之資源變動指標單(例如：單位努力漁獲量)。然而，並非所有漁業都有足夠資料來支持部份資源模式作為評估分析，因此，近年來亦陸續開發了多種不同種資料類型之資源評估模式。此研究中，以西北太平洋鬼頭刀為系群，使用過去根據年齡結構模式所估計之族群動態相關資訊，以模擬西北太平洋鬼頭刀族群之「真實」狀態。利用所得之「真實」相關族群動態資訊，分別套適於 Catch-Only 模式及剩餘生產模式(Schaefer 和 Fox)，並以蒙地卡羅模擬(Monte Carlo simulation)方法產生缺乏之觀測資料。分析在不同資料需求下，各類評估模式之運作表現與可靠程度。

關鍵詞：資源評估、鬼頭刀、剩餘生產模式、Catch-only 模式

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# **The performance analysis of stock assessment models applied to dolphinfish (*Coryphaena hippurus*) in the Northwest Pacific using a simulation approach**

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## **Abstract**

Scientists have been devoted to developing statistic methods and stock assessment models in the past few decades, in order to estimate Maximum Sustainable Yield (MSY) and reference points, both of which requires some information about abundance, catch, fishing effort from species. Generally, stock assessment models require more than one of these data. Unlike “data-rich” fishery, providing a variety of data sources, assessment of “data-poor” fishery has insufficient available data to support these approaches. Thus, different types of stock assessment methods to available data, which often give different estimations, were developed. This study focuses on three stock assessment models: (1) Age-structured models— assuming that all individuals are not equivalent to each other, but within a particular age groups are assumed to be equal. (2) Catch-only models—a method relying only on catch data. (3) Surplus production models (e.g. the Schaefer, Fox, and Pella–Tomlinson models)—combining catch data with fishing effort, but do not represent biological and fishing processes. In this paper, we simulate a “true” fishery population for a certain fishery by using age-structured model at first. Then, compared it with the result of surplus production models and of catch-only models. We wonder the performance of surplus production models and of catch-only models. Which will be more “realistic” under the resource status remains to be seen.

Keywords : stock assessment, *Coryphaena hippurus*, Catch-only models, Surplus production models

# 年代氣候變異指數對印度-太平洋黃鰭鮪豐度與棲地之空間變動特性研究

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## 摘要

本研究主要探討長時間尺度氣候變異因子相位變化對黃鰭鮪釣獲率及棲地影響。本研究整合 1971~2018 年區域性漁業管理組織黃鰭鮪之漁獲資料並結合氣候因子數據，探討大西洋多年代際震盪(AMO)以及太平洋十年震盪(PDO)對印度-太平洋黃鰭鮪釣獲率及棲地適合指數(HSI)之時空間分佈影響。結果表明印度-太平洋黃鰭鮪釣獲率之中位數在 AMO 負相位以及 PDO 正相位呈現較高值 PDO 為主要影響印度-太平洋黃鰭鮪釣獲率與棲地變動之主要氣候變異指數；然而，黃鰭鮪高 HSI 範圍並未在 AMO 相位由正轉負時有變大之趨勢，本研究推測其原因為 1980 年代之後過度捕撈議題逐漸被重視、遠洋漁業捕撈策略發生改變；此外，海水暖化亦可能為影響印度-太平洋黃鰭鮪 HSI 未能隨 AMO 相位轉換而變化的原因之一。

Keywords: 氣候變遷、年代際氣候變異指數、空間變動模式、棲地適合指數

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# Effects of decadal climate variability on spatiotemporal distribution of Indo-Pacific yellowfin tuna population

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## Abstract

Variations in tuna population and abundance distribution have been observed to have strong linkages to large-scale climate variabilities, such as the Pacific decadal oscillation (PDO), Atlantic multidecadal oscillation (AMO). However, the mechanism between climatic indices and yellowfin tuna abundance and habitat preference still not indicated unclear. We analyzed globally yellowfin tuna catches data and the indices of these oceanic climate variabilities during 1971–2018. The standardized catch per unit effort (CPUE) of Indo-Pacific Ocean yellowfin tuna was observed to be higher during negative AMO and positive PDO phases. The standardized CPUE and habitat preference of yellowfin tuna in the Indo-Pacific Ocean were significantly influenced by the PDO phase. We figure out the PDO changed the environmental parameters throughout the Indian Ocean such that the habitat preference of yellowfin tuna remained consistent throughout. However, the variations in habitat suitability did not correspond to the distribution or standardized CPUE of yellowfin tuna throughout the Indo-Pacific Ocean during AMO events. We speculated the ocean warming and overexploitation of tuna species influenced strongly. This may make us have deviation when we analyzed the result of significant correlations. External influences mentioned-above would make us misleading the AMO could significantly cause the Indo-Pacific Ocean yellowfin CPUE variation.

Keywords: Climate change, Decadal climate indices, Spatial distribution, Habitat preference

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# 利用多衛星遙測資料建立印度洋薔薇帶鰭及鱗網帶鰭之棲地適合度經驗模式

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## 摘要

印度洋為我國遠洋漁業的重點作業海域之一，目前在印度洋作業的臺灣油魚漁船數已達 100 餘艘，近年來年漁獲量更是達到 1 萬 6 千公噸。油魚又可細分為薔薇帶鰭(*Ruvettus pretiosus*)與鱗網帶鰭(*Lepidocybium flavobrunneum*)兩個物種，本研究蒐集 2010–2014 年印度洋兩種油魚的資料，結合衛星遙測之水文資料建構棲地適合度指數(Habitat Suitability Index, HSI)，探討潛在的漁場及時空變動，使用的衛星資料包含海表面水溫(SST)、葉綠素濃度(SSC)、海表面鹽度(SSS)、海表面高度(SSH)、混合層深度(MLD)以及渦流動能(EKE)等六種海洋環境資料。結果顯示薔薇帶鰭與鱗網帶鰭高預測值的部分皆出現在 30 - 45°E、25 - 40°S 的區域，以 4 至 9 月為主，並且有隨著月別變動來回推移的趨勢，觀察實際漁獲位置後，發現此分佈情形與實際漁獲位置一致。

關鍵詞：薔薇帶鰭、鱗網帶鰭、棲地適合度指數、衛星資料

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# 臺灣西北海域多鱗四絲馬鮫棲地模式建構

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## 摘要

多鱗四絲馬鮫(*Eleutheronema rhadinum*)為臺灣西北部海域重要經濟魚種，然而近年來漁獲量日漸減少中，本研究為瞭解多鱗四指馬鮫棲地分布模式，蒐集研究場域刺網標本船作業資料與環境因子包括海表溫度、海表鹽度、海表高度與海底深度，建立不同棲地模式包括過程取向模式(棲地適合度指標 HSI)、傳統統計模式(泛加成模式 GAM)及機器學習模式(提升回歸樹 BRT)，分析海洋環境因子對棲地分布時空變化的影響，比較空間分布與漁獲量變動關係。初步結果顯示每年 11 月為主要漁獲季節，海表溫 15~25°C、海表鹽 33.6~34.3 psu、海表高 0.6~0.8 m 及海深<55 m 為最適棲地環境範圍，模式所分析季節性棲地變動可作為資源動態及漁業管理之科學依據。

關鍵詞：多鱗四絲馬鮫、棲地模式、棲地適合度指標、泛加成模式、提升回歸樹

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# **Modeling the spatial pattern of *Eleutheronema rhadinum* habitat in coastal waters off northwestern Taiwan**

## **Abstract**

Fourfinger threadfin (*Eleutheronema rhadinum*) is a commercially important species for coastal gillnet fishery in waters off northwestern Taiwan. In order to understand the spatial pattern of habitat distribution, we collected fishery data from the sampled fishing vessels and oceanographic variables including sea surface temperature (SST), sea surface height (SSH), sea surface salinity (SSS) and bathymetry (BTM). Various habitat models were developed including using Habitat Suitability Index (HSI), Generalized Additive Model (GAM) and Boosted Regression Tree (BRT), for analyzing the influence of marine environmental impacts on the spatial distribution of this species. The preliminary results showed that November is the major fishing season and preferred range of SST, SSS, SSH and BTM centering at 15~25°C, 33.6~34.3 psu, 0.6~0.8 m and <55 m, respectively. Seasonal habitat distributions inferred from the models could provide basic scientific information on the population dynamics and fisheries management of this species.

Keywords: fourfinger threadfin, habitat model, Habitat Suitability Index, Generalized Additive Model, Boosted Regression Tree

# 印度洋經濟性鮪類豐度變動特性與餌料生物資源結構關係之研究

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## 摘要

本研究收集印度洋鮪類委員會鮪延繩釣漁獲資料與 Sea Around Us Project 網站中印度洋鮪類餌料生物漁獲資料，計算三種鮪類(黃鰭鮪、大目鮪與長鰭鮪)標準化 CPUE 並比較年別時序列變動。結果顯示，黃鰭鮪與大目鮪有高相關性( $r^2=0.714$ )，但與長鰭鮪變動關係較不顯著，進一步透過小波交叉關聯性分析得知黃鰭鮪與大目鮪於 1980~2000 年有 4~8 年正相關變動週期;黃鰭鮪與長鰭鮪於 1980~2019 年間有 4~16 年負相關變動週期;大目鮪與長鰭鮪於 1980~1995 年有 4~8 年負相關變動週期。比較三種鮪類空間分佈可發現，黃鰭鮪和大目鮪共同高釣獲區域在西印度洋;黃鰭鮪和長鰭鮪位於西南印度洋;大目鮪和長鰭鮪則位在東南印度洋。餌料分析結果顯示黃鰭鮪與餌料生物中甲殼類的釣獲率相關行為最高( $r^2=0.82$ )；大目鮪則分別以頭足類( $r^2=0.72$ )和甲殼類( $r^2=0.74$ )相關性較高，長鰭鮪則為頭足類( $r^2=0.59$ )，後續將探討鮪類豐度變動特性與餌料生物資源結構互相變動特性。

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關鍵字:印度洋、經濟性鮪類、餌料生物資源結構、上行控制特性

# **The relationship between the variation characteristics of economic tuna abundance and the structure of biological resources for food organisms in the Indian Ocean**

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## **Abstract**

In this study, longline fisheries data were collected from the Indian Ocean Commission, and food organism data of tunas were collected from the Sea Around Us Project website. Three tuna species (yellowfin tuna, bigeye tuna, and albacore) data were calculated standardized CPUE and compared time series variations. The results revealed high correlation of standardized CPUE between yellowfin tuna and bigeye tuna ( $r^2=0.714$ ), but lower correlation between the yellowfin tuna and bigeye tuna with albacore. In the wavelet cross-correlation analysis, the results showed that the yellowfin tuna and bigeye tuna had a 4-8 year positive correlation periodicity from 1980 to 2000, yellowfin tuna with albacore had a 4-16 year negative correlation cycle from 1980 to 2019 and bigeye tuna with albacore had 4-8 year negative correlation cycle from 1980-1995. For the spatial distribution of the three tuna species, the high catch rate overlapping areas for yellowfin and bigeye tuna was in the western Indian Ocean, for yellowfin with albacore tuna and bigeye with albacore tuna were respectively in the southwest Indian Ocean and southeast Indian Ocean. Furthermore, the standardized CPUE of yellowfin tuna had higher correlation with primarily prey of crustaceans ( $r^2=0.82$ ), the standardized CPUE of bigeye tuna had higher correlation with mainly feed on cephalopods ( $r^2=0.72$ ) and crustaceans ( $r^2=0.74$ ) while the standardized CPUE of albacore tuna feed on fish and cephalopods ( $r^2=0.59$ ). Further study will compare CPUE trends and estimated primarily preys' variations between tunas to evaluate competition for limited prey and habitat area resources.

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Key words: Indian Ocean, economical tuna, bioresource structure of food organism, upward control characteristics

# 西北太平洋鬼頭漁業管理策略評估之建構與分析

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## 摘要

鬼頭刀 (*Coryphaena hippurus*) 為臺灣沿近海漁業資源中重要的經濟性魚種，然而，目前太平洋鬼頭刀漁業屬於管理不善之漁業，而臺灣之鬼頭刀延繩釣漁業亦被列入需要執行漁業改進計畫 (Fishery Improvement Project ; FIP) 的國家之一。目前鬼頭刀資源管理正在透過相關之研究分析結果定義出明確的參考基準，因此如何基於漁業利用與資源動態之相互關係以建立鬼頭刀漁業管理的科學管理依據成為當務之急。管理策略評估 (Management Strategy Evaluation ; MSE) 為根據資源評估結果得之歷史族群動態，並透過模擬的方式建構未來的族群，以評估各種漁撈策略能否實現管理目標之分析方法。此外，由於此評估方法亦同時考慮了漁業與族群動態的各種不確定性，從而減少資源的過度利用以及提升管理成功的機率。因此，本研究將透過管理策略評估之方法針對西北太平洋鬼頭刀漁業進行分析，以供作為未來制定漁業管理措施之科學參考依據。

關鍵詞：西北太平洋海域、鬼頭刀、資源評估、管理策略評估

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# **Development and analysis of management strategy assessment for dolphinfish (*Coryphaena hippurus*) in the Northwest Pacific Ocean**

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## **Abstract**

Dolphinfish (*Coryphaena hippurus*) is an important economic species for Taiwanese coastal and offshore fishery. However, dolphinfish in the Pacific is a poorly managed fishery, and the Fishery Improvement Project (FIP) is also required for Taiwanese dolphinfish longline fishery. A clear reference benchmark is being defined for the management of dolphinfish through relevant research and analysis. Therefore, it is urgent to establish scientific management basis for dolphinfish management based on the relationship between fishery exploitation and population dynamics. Management Strategy Evaluation (MSE) is an analytical method to evaluate the performance of achieving the management objectives under various fishing strategies for future populations through simulations based on historical population dynamics derived from the stock assessment. In addition, various uncertainties of fishery and population dynamics are also considered in MSE for reducing the likelihood of overexploitation and increasing the feasibility of the management. Therefore, MSE will be developed and analyzed for the dolphinfish in the northwestern Pacific Ocean in this study to provide an applicable scientific reference guideline for formulating future management measures.

Keywords: Northwest Pacific Ocean, dolphinfish (*Coryphaena hippurus*), stock assessment, management strategy assessment

# 臺灣東北部海域鯖魚棲地經驗模型之建構

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## 摘要

白腹鯖與花腹鯖皆為臺灣沿近海重要商業性漁業資源之一，根據漁業統計年報，我國鯖魚漁獲量有逐年下降之趨勢。為使此漁業能永續發展並進行後續的資源管理，本研究蒐集 2013 年至 2020 年間臺灣東北部海域之漁獲資料及衛星遙測資料，包含海表面溫度(sea surface temperature, SST)、葉綠素濃度(sea surface chlorophyll-a, chl-a)、海表面高度(sea surface height, SSH)、混合層深度(mixed layer depths, MLD)、海表面鹽度(sea surface salinity, SSS)以及初級生產力(net primary production, NPP)。利用研究期間作業地點的各個環境參數值出現之頻度，計算個別參數之適合度指數(SI)，而後計算 3 種不同模式的棲地適合度指數(Habitat Suitability Index, HSI)，最後利用泛線性模型(General Linear Model, GLM)篩選出最佳的經驗模式，分析棲地適合度指數之變動，預測鯖魚之潛在漁場變化及最適棲地。

關鍵字：鯖魚、棲地適合度指數、泛線性模型、潛在漁場

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# **Habitat empirical model establishment of mackerels in the northeast waters off Taiwan**

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## **Abstract**

Chub mackerel (*Scomber japonicus*) and blue mackerel (*Scomber australasicus*) both are economically important fish species of coastal and off shore in Taiwan, according to Taiwan's Fisheries Yearbook, the catch of mackerels in Taiwan has decreased year by year. In order to achieve sustainable development of the fishery and to carry out resource management in the future, this study collects fishing data and satellite remote sensing data in the northeast waters off Taiwan from 2013 to 2020, including sea surface temperature(SST), sea surface chlorophyll-a(chl-a), sea surface height(SSH), mixed layer depths(MLD), sea surface salinity(SSS) and net primary production(NPP). According to the frequency distribution of each factor on which mackerels were caught, we calculated the values of each factor to get suitability index(SI), then combined SI values into three different empirical habitat suitability index(HSI) model, and the optimum model were selected by General Linear Model(GLM). At last, analysis the changes of HSI to predict potential fishing ground and the optimum habitat of mackerels.

Keywords : mackerel, habitat suitability index, general linear models, potential fishing ground

# 探討影響太平洋鮪類豐度同步變動關係因子特性之研究

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## 摘要

蒐集 1979 至 2018 年太平洋區域性漁業管理組織之鮪延繩釣資料、海洋環境資料以及餌料生物資料，並建構兩種鮪類之棲地適宜度模式(Habitat suitability index；HSI)，探討影響兩種頂端掠食者豐度同步變動特性因子之特性。分析結果顯示太平洋大目鮪與黃鰭鮪豐度年間時序列變動主要呈現同步變動趨勢( $r=0.93$ )，然卻存在空間上的差異，且主要與兩種鮪類棲地分布和 20°C 等溫線深度變動有關。以低同步變動相關性( $r<0.3$ )海域為例，該海域主要出現在兩種鮪類同時具有高 HSI 值( $>0.6$ )與高釣獲率( $>60\%$ )重疊且 20°C 等溫線深度較淺(180m)之海域。另在低同步變動相關性之區域其兩種鮪類和餌料生物豐度間之時序列變動多呈現低相關( $r<0.3$ )，反之相關性較高之區域鮪類和餌料生物豐度變動亦呈現高相關。由上述結果可推測兩種鮪類在棲地重疊之區域中，會因 20°C 等溫線深度變化影響兩種鮪類棲息之垂直水層，導致兩種鮪類其豐度呈現非同步變動之現象。

關鍵字: 釣獲率、空間分布、族群變動、同步與非同步關係

# Explore the simultaneous characteristics of the abundance of tuna species in the Pacific Ocean

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## Abstract

In the past, the study on the marine environment and ecosystems affecting the habitat distribution and abundance of tunas mainly focused on a single species, few studies were focused on the competition between tuna and similar trophic levels. Therefore, the synchronous dynamics in abundance and habitat suitability for bigeye and yellowfin tuna of this study were investigated by using weighted habitat suitability index (HSI) models in the Pacific Ocean. The tuna longline data were collected from Pacific Regional Fisheries Management Organisation from 1979 to 2018 with the addition of environmental variables and bait biological data (cephalopods and crustaceans). The results showed that the annual time series of the abundance between bigeye and yellowfin tuna mainly displays a high synchronous correlation trend ( $r=0.93$ ). Furthermore, the spatial differences of synchronous correlation are related to the habitat distributions of the two tuna species and the 20°C isotherm depth. For the area with a low synchronous correlation ( $r < 0.3$ ) were located in high HSI values ( $>0.6$ ) and high catch rates ( $>60\%$ ), with shallow 20°C isotherm depth (180m). The low synchronous correlation areas also revealed low correlation ( $r < 0.3$ ) between the catch rates? tuna species and their primarily preys' variations. Our results suggested that the change of isotherm depth of 20 °C in the higher HSI overlapping areas of two tuna species were changed the vertical inhabited layer. The changed vertical inhabited layer of two tuna species were compete for limited prey and habitat area resources with asynchronous abundance changes.

Keywords :Catch rate 、 Spatial distribution 、 Population fluctuation, Synchronous and asynchronous relationship

# 臺灣西北海域烏魚洄游動態與漁況指標建構

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## 摘要

烏魚為臺灣沿近海漁業重要經濟物種，準確預測烏魚洄游時段與漁況，對烏魚漁業有莫大助益。本研究蒐集彙整臺灣西北海域刺網漁業 2015-2020 年冬季烏魚的漁獲資訊，定義累積漁獲量為漁訊開始之日期，透過相關分析判別水溫網格對漁獲量變動之重要性，以滑動窗口之泛線性模式(GLM)套適烏魚漁獲量與過去水溫關係，並進一步比較分析等溫線的時空變動模式，以驗證烏魚洄游最適水溫範圍的移動趨勢。初步結果發現歷年烏魚漁訊開始日期落在每年 11 月底至 12 月初，受 15-20 天前水溫變化影響，並隨著海表水溫 21.0-21.4°C 洄游至台灣西北外海。

關鍵字：烏魚、洄游動態、水溫網格、滑動窗口、相關分析

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# **The migration pattern and fishing conditions indicator of mullet in waters off northwestern Taiwan**

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## **Abstract**

Mullet (*Mugil cephalus*) is one of economically important species in the coastal fisheries of Taiwan. Predicting the migration timing and fishing conditions accurately for mullet is of great help to the fishery. We collected and aggregated catch information of mullet from the coastal gillnet fishery in waters off northwestern Taiwan during the winter of 2015-2020, and defined the fishing condition using accumulative catch information. The migration route and range of mullet was determined based in selected surface water temperature on that day of each year, and identify the importance of each water temperature grid to the changes in catch through correlation analysis. We fitted a general linear model (GLM) in sliding window algorithm to examine the relationship between mullet catch and surface water temperature grids. The spatial and temporal variations of the isotherms were compared and analyzed to verify the migration route and determine the preferred water temperature range for mullet. Preliminary results showed that the mullet migrate, influence on sea surface change 15-20 days before that day of catch, along the sea surface temperature 21.0-21.4°C, to the area off northwest Taiwan between the late November and early December.

**Keywords:** mullet (*Mugil cephalus*), migration pattern, water temperature grids, sliding window, correlation analysis

# 氣候變異對台灣周邊海域日本竹筴魚 (*Trachurus japonicus*)棲地與漁況變動之影響

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## 摘要

本研究收集 2014 年至 2019 年間臺灣周邊海域鱈科之漁獲資料與衛星遙測資料，其中包含海面水面溫度、葉綠素 a 濃度、海水表面高度及海水表面鹽度值等資料，並利用泛加成模式 (Generalized additive models, GAM) 分析漁獲率與海洋環境變動之關係。分析結果顯示，期間扒網漁業佔所有漁獲量之 88.7%，其中又以日本竹筴魚(*Trachurus japonicus*)佔總漁獲量之 85.1% 為最高。日本竹筴魚東北漁場會隨著時間推移而有所改變，春季高漁獲分布最為集中而夏季最為零星。本研究所分析之四項環境因子(SST、Chl-a、SSS、SSH)皆對日本竹筴魚漁獲率具顯著之影響( $p < 0.01$ )。臺灣周邊海域日本竹筴魚的分布可能受到東北季風之影響，且在聖嬰-南方震盪時期黑潮及湧升會出現較平常年不同之情況，導致改變臺灣周邊海域日本竹筴魚的漁產量及分布情形。

關鍵詞：鱈科、日本竹筴魚(*Trachurus japonicus*)、南方震盪、泛加成模式、臺灣東北部海域。

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**Southern Oscillation in related to habitat suitability and abundance of japanese  
jack mackerel  
(*Trachurus japonicus*) in the northeastern waters of Taiwan**

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**Abstract**

This study fitted generalized additive models (GAMs) to spatiotemporal fishery data of 2014 to 2019 to investigate the habitat suitability and abundance of carangidae in relation to changes in oceanographic conditions including sea surface temperature (SST), chlorophyll-a (Chl) concentration, sea surface Salinity (SSS), sea surface height (SSH) and developed a habitat preference model. During the period, danish seine fishing accounted for 88.7% of all catches, among them, japanese jack mackerel has the highest catch, accounting for 85.1% of the total catch. The northeastern fishing grounds of Japanese jack mackerel will change over time, with the most concentrated distribution of high catches in spring and the most sporadic distribution in summer. The four environmental factors (SST, Chl, SSS, SSH) analyzed in this study all have significant effects on the catch rate of japanese jack mackerel ( $p < 0.01$ ). The distribution of the Japanese jack mackerel in the waters around Taiwan may be affected by the northeast monsoon, and the Kuroshio and the upwelling in the eastern part of Taiwan during the Holy Innocent-Southern Oscillation period will be different from normal years, resulting in changes in the waters of the Japanese mackerel in the surrounding waters of Taiwan. fish production and distribution.

Keyword : carangidae, japanese jack mackerel, Southern Oscillation, Generalized Additive Models, sea area in northeastern Taiwan.

# 臺灣東部海域漁業資源之可持續影響生態風險評估

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## 摘要

臺灣東部海域不僅是臺灣沿近海最重要的漁場之一，無論是在漁業類別或漁獲物種亦具有高度多樣性。過去研究曾針對此海域之漁業資源進行半計量之生產力與敏感性分析(productivity and susceptibility analysis, PSA)，評估結果顯示，高脆弱性魚種共有 8 種，中脆弱性魚種共有 20 種，其餘 24 種為低脆弱性。然而，該方法由於生產力與敏感性屬性之分類數值，無法簡單量化多種漁業利用的累積影響，此外，劃分物種脆弱性之參考點並無明確的定義。因此，本研究擬進一步採用計量之漁業可持續影響的生態評估方法(Ecological Assessment of the Sustainable Impacts of Fisheries, EASI-Fish)，針對脆弱性程度較高的物種及重要漁業資源進行評估。

關鍵詞：資料受限、脆弱度、生態風險評估

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# **Evaluation of the sustainable impacts by multiple fisheries for the species in the waters off eastern Taiwan**

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## **Abstract**

The waters around eastern Taiwan is one of the most important fishing ground for Taiwanese coastal and offshore fisheries. The types of fisheries and species of catches are highly diverse in this area. The semi-quantitative productivity and susceptibility analysis (PSA) have been conducted for 52 species caught by fisheries in the waters off eastern Taiwan. The results indicated that 8 species were classified as having high vulnerability, 20 species were classified as having moderate vulnerability, and the remaining 24 species were classified as having low vulnerability. However, PSA cannot easily quantify cumulative impacts of multiple fisheries because of categorical productivity and susceptibility attributes, and the vulnerability reference points are arbitrary defined. Therefore, this study will conduct a new quantitative Ecological Assessment of the Sustainable Impacts of Fisheries (EASI-Fish) for species with high and moderate vulnerability and some important species in the waters off eastern Taiwan.

Keywords: data-poor, vulnerability, ecological risk assessment

# 台灣西南海域生態系統結構季節組成特性及受捕撈之影響

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## 摘要

臺灣西南海域的高營養鹽湧昇海域，為臺灣之重要漁場，然過去研究較少著墨於此海域生態系統建構及受捕撈之影響。故本研究蒐集 2013 到 2019 年臺灣西南海域漁船捕撈作業點位資料，設置 37 組功能組並根據棲性分為中表層與底棲物種，接著使用 Ecopath with Ecosim 建構夏、冬兩季生態系統模型，並分析生態系統結構差異及受漁船捕撈之影響。網絡分析果顯示，系統所含總能量、總生產量和總消耗量均冬季較夏季高，唯移出系統的能量及流入碎屑的能量夏季較冬季高(875.59>756.87 t/km<sup>2</sup>/year ; 832.34>830.64 t/km<sup>2</sup>/year)，推測因夏季捕撈過多，導致系統結構、規模不完整。綜合生態影響力分析顯示夏季關鍵物種(臺灣鎖管、帶魚科)和冬季關鍵物種(鯖科、杜氏鰱)在扒網、拖網捕撈量增加為原本的兩倍時，會產生比原本多 20%~40%的負面影響，系統相對影響力指數也會比原本下降約 5%~18%，代表其在生態系統中重要性降低。

關鍵詞：台灣西南海域、質量平衡營養模型、生態系統結構、捕撈

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# Seasonal ecosystem structures and the influence of fishing activities in the southwestern Taiwan Strait

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## Abstract

The southwestern waters of Taiwan are high-nutrient upwelling areas and also important fishing grounds in Taiwan. However, previous research has rarely focused on the construction of ecosystems in this area with the effects of fishing activities. Therefore, by using various fishing data in the southwestern Taiwan waters from 2013 to 2019 and Set up 37 functional groups and divide them into pelagic and benthic species according to their habitats. The Ecopath with Ecosim were used to construct two ecosystem models during summer and winter to analyze the differences in ecosystem structure and the impact of fishing activities. Results of network analysis show that the total system throughput (TST), total production, and total consumption of the system are higher in winter compared to summer, whereas the energy export from the system and the energy flows into detritus were higher in summer than in winter (875.59 > 756.87 t/km<sup>2</sup>/year; 832.34 > 830.64 t/km<sup>2</sup>/year). The results suggested the relatively incomplete structure and scale of the system were relatively incomplete due to over-fishing in summer. Mixed Trophic Impact (MTI) analysis predicated that when increased 200% total catches of Taiwanese seine and trawling would lead to 20-40% negative influences for the key species of *Uroteuthis chinensis*, *Trichiuridae* in summertime and *Scombridae*, *Seriola dumerili* in wintertime, respectively. Furthermore, the system relative total impact would also decrease to 5-18%, indicates decreased importance in the ecosystem.

Keywords: Southwestern Waters of Taiwan, mass balance ecosystem model, ecosystem structure, catch.

# 以生態模式評估離岸風場對漁業資源結構之影響

林宥燊

## 摘要

臺灣第一座離岸風場「海洋風電(Formosa I)」於2019年底進行商轉，風場建設營運勢必對當地生態環境產生衝擊，為模擬離岸風場對漁業資源的可能影響，本研究蒐集開發前(2018年)、施工期(2019年)及商轉期(2020年)漁業資料，設立實驗組及對照組進行比較，利用生態模式(Ecopath with Ecosim)分析各營養階層之關係，以能量收支平衡原理建構研究場域生態模式，並透過生態網路分析比較風場建置前後生態系統與漁業資源之變動。結果顯示風機場域漁獲量明顯下降，但對鄰近其他場域的影響不大，以生態循環指數判斷竹南風場生態系的成熟度。

關鍵詞：離岸風場、生態循環指數、生態功能成熟度

# **Evaluating the impact of offshore wind farms on the fishery resources with an ecological model**

You-Shen Lin

## **Abstract**

The first offshore wind farm (OWF) in Taiwan, "Ocean Wind Power (Formosa I)" operated commercially in the end of 2019. The construction and operation of OWF is bound to have an ecological impact on local marine environment. To examine the OWF impacts, we collected fishery data for various periods: before (2018) and under construction (2019) and during operation (2020), and set up the experimental and control groups for comparison. Based on energy balance principle, we analyzed the relationships among trophic levels using ecological models (Ecopath with Ecosim), and examined the changes in fishery resources before and after the operation of OWF through ecological network analysis. Results showed that the catch in the OWF decreased, little impact in nearby areas were found. We used Finn's cycling index (FCI) to compare the maturity indicator of the ecosystem.

Keywords : offshore wind farm, Finn's Cycling index, ecosystem function maturity

# 不同氣候變遷情境模擬對臺灣沿近海重要經濟性頭足類棲地分布之影響

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## 摘要

本研究收集臺灣沿近海重要經濟性頭足類之歷年漁獲量變化與各漁法作業現況，探討各漁法捕撈主要漁獲頭足類釣獲率與時空分布變動特性。分析結果顯示五種頭足類之漁獲量於1970~2020年間皆呈現年際波動，另主要捕撈漁法臺灣鎖管以火誘網(68%)為主，萊氏擬烏賊、虎斑烏賊、真烏賊和章魚科皆以拖網為主要漁法(38~84%)。另空間分布變化則顯示虎斑烏賊、萊氏擬烏賊在臺灣西北部與東部沿岸有較高漁獲熱點，真烏賊則分布澎湖與西南海域，臺灣鎖管、章魚科在臺灣四周沿岸海域皆有高漁獲重心。後續將進一步利用聯合國政府間氣候變遷專門委員會(IPCC) (AR6)採用三種共享社會經濟路徑(SSP1-1.9、SSP1-2.6、SSP5-8.5)結合棲地適合度模式預測氣候變遷對臺灣沿近海海洋環境與頭足類漁場之長期變動之特性，評估氣候變遷的潛在影響與可能衝擊，以達到頭足類資源永續利用之目的。

關鍵字：頭足類、漁法組成、氣候變遷

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# **Effects of different climate change scenarios on the distribution of economically important cephalopod habitats along Taiwan's coastal waters**

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## **Abstract**

In this study, we collected the historical catch variation of economically important cephalopods along Taiwan's coastal waters and the current status of each fishing method to investigate the catch rate and spatial temporal distribution of the major cephalopods caught by each fishing method. The results showed that the catches of the five cephalopod species showed interannual fluctuations from 1970 to 2020. The mitre squid was mainly caught using light fishing (68%), while trawling was the main fishing method (38~84%) for the bigfin reef squid, pharaoh cuttlefish, golden cuttlefish, and octopus. The spatial distribution of the squid showed that the pharaoh cuttlefish and bigfin reef squid were mostly distributed in the northwestern and eastern coast of Taiwan, whereas golden cuttlefish were distributed in Penghu Island and southwestern waters of Taiwan. While, for the mitre squid and octopus, the spatial distribution were mostly distributed in the coastal waters around Taiwan. The three shared socio-economic pathways (SSP1-1.9, SSP1-2.6, and SSP5-8.5) used by the United Nations Intergovernmental Panel on Climate Change (IPCC) (AR6) combined with the habitat suitability model will be used to predict the long-term changes of climate change on the marine environment and cephalopod fishery along the Taiwan coast, and to assess the potential impacts of climate change. In order to achieve the sustainable use of cephalopod resources, we have been working on the following projects.

Keywords: cephalopods, fishing methods, climate change.

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## 苗栗離岸風電場域漁業結構變動之探討

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### 摘要

離岸風電開發是臺灣現今重要議題之一，亦影響我國沿近海漁業結構與漁撈活動。苗栗外海之海洋風電(Formosa1)為臺灣首座正式營運的離岸風電場域，然而風場周邊海域的漁業活動特性，可能受不同的發展階段(施工前、施工中與營運後)而異。因此，為瞭解風電開發階段，對漁業結構與漁業資源利用型態之潛在影響。本研究蒐集2013-2020年間，主要於苗栗縣管轄水域內作業的查報卸魚資訊、漁船航程紀錄器資料，分析不同發展階段下的漁業結構、漁業資源組成，與漁撈努力量之時空間分布特性。結果顯示，該海域以刺網漁業為主，且其作業分布不受開發階段影響，然而在風電場營運後，作業漁船數及漁獲量有明顯下降；其主要漁獲魚種為烏魚，然而在建設階段，烏魚的漁獲量並沒有顯著影響。未來預計於風電場域周邊劃設對照樣區，觀察漁獲物種豐度、組成變動特性，與不同開發階段之相關性，以提供評估風電場域漁業資源量變動之參考資訊。

關鍵字: 海域空間規劃、商業性卸魚資料、沿近海漁業、離岸風電

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## **An investigation of fishery structure changes in Miaoli offshore wind farm**

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### **Abstract**

The development of offshore wind farms is currently one of the major issues in Taiwan and it also affects Taiwan's coastal fishery structure and fishing activities. Offshore wind power in Miaoli (Formosa 1) is the first officially operating offshore wind farm in Taiwan. However, according to different development stages (before construction, during construction and operation), the characteristics of fishing activities surrounding the wind farm may change. Therefore, in order to understand the potential impact of the wind power development stage on the fishery structure and fishery resource utilization patterns. Our study collects information on fish unloading and fishing vessel voyage recorders from 2013 to 2020, under the jurisdiction of Miaoli jurisdiction waters, and analyzes the fishery structure, fishery resource composition, and the temporal and spatial distribution of fishing effort at different development stages. The results show that gillnet fishery is the main fishery in this area, and its fishing distribution is not affected by the development of the offshore wind farm. However, during the operation of the wind farm, the number of fishing boats and the amount of catching numbers have dropped significantly; the main fish species are mullet, the catch of mullet was not significantly affected during the construction and operation phase. In order to provide reference information for assessing changes in fishery resources, our future study will be expect to set up a reference area around the wind farm to observe the changes of fish abundance and species composition, and their correlation with different development stages, so as to provide reference information for assessing changes in fishery resources in the wind farm area.

Keywords: marine spatial planning, commercial landing data, coastal fisheries, offshore wind farm

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# 臺灣淺灘生態系統結構變動受氣候變異影響之研究

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## 摘要

臺灣淺灘夏季底層水流沿陸棚向上流動形成湧升區為一重要漁場。先前研究已證實氣候變遷導致海洋環境變動會影響本海域生物組成與資源量變化，然捕食和競爭作用如何逐層影響生態系統中種間關係則尚待釐清。本研究收集研究海域各漁法漁獲資料與海洋環境資料，透過 Ecopath with Ecosim(EWE)建立臺灣淺灘生態系統模型，分析在氣候變遷下洄游與定棲物種變動與生態系統結構之關係。結果顯示臺灣淺灘生態系統模型物種間平均能量傳遞效率為 13.85%，總系統通量約在 32071 (t km<sup>-2</sup>yr<sup>-1</sup>)。以黃鰭鮪及正鯉為主要關鍵物種且下行控制影響力對生態系統影響力較大。另在聖嬰及反聖嬰年時生物量及總系統通量皆增加，然反聖嬰年時期多樣性指數和系統關聯指數較低，兩時期在生態系統結構上具不同變化情形。

關鍵詞：臺灣淺灘、生態系統、湧升、氣候變遷

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# Impacts of climate change-induced environmental fluctuations on the structure of marine ecosystem around the Taiwan Bank

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## Abstract

Taiwan Bank (TB) is located in the southern Taiwan Strait, where the marine environment is influenced by South China Sea Warm Current and Kuroshio Branch Current during summer. The uplifted continental slope and bottom currents bring upwelling areas and create an important fishing ground. Previous studies have confirmed that climate-induced fluctuations in marine fish populations have been demonstrated in the Taiwan Strait region. However, how predation and competition affect the interspecies relationships in the ecosystem remains to be clarified. In this study, fishery data and environment data was collected to construct an ecosystem models by using Ecopath with Ecosim (EWE). The relationship between migratory and sedentary species changes and ecosystem structure. The functional groups include representative pelagic, benthic, and reef species were collected for analyzes the relationship between migratory and sedentary species in ecosystem structure variation under climate change. The results show that the system total throughput (TST) is about 32071 (t km<sup>-2</sup>yr<sup>-1</sup>), average energy transfer efficiency is 13.85%. The keystone index reveals *Thunnus albacares* and *Katsuwonus pelamis* are the main key species, and top-down control has a relatively high impact on the ecosystem. In addition, both biomass and TST increased during the El Nino and La Nina years. However, the diversity index and connectance index were relatively low during La Nina years, and the two periods had different variation in ecosystem structure.

Keywords : Taiwan Bank, Ecosystem, Climate change, Upwelling