國際海洋資訊

International Ocean Information

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2020臺灣鯨豚及海龜擱淺報告

2020 Taiwan Cetacean and Sea Turtle Strandings Report

加拿大海洋資訊

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救援保育護鯨豚 海洋永續大「加」分

主任委員：李仲威

海洋國家坐擁豐富的藍色資源，也要全盤思考海洋管理如何永續發展。本期介紹世界海洋強國之一的加拿大，加拿大1997年通過的海洋專法《海洋法》（Oceans Act），是全球第1部以海洋生態系統為基礎的海域管理專法，不僅為後續的海洋策略以及海洋行動計畫提供指導原則，更規劃漁業與海洋部（Fisheries and Oceans Canada, DFO）在協調整合政府機關方面的功能，以負責全國海洋綜合管理的工作。而加拿大政府不僅是整合海洋立法的國際先行者，2018年9月也與其他海洋國家（一共14國）共同成立永續海洋經濟高層委員會（High Level Panel for a Sustainable Ocean Economy），會員國組成橫跨三大洋、五大洲，致力於2025年以前將所有會員國的所有管轄海域納入永續管理，並從海洋財富、海洋健康、海洋平等、海洋知識以及海洋財務等5大關鍵領域來落實永續海洋經濟轉型。

除此之外，賞鯨人數為全球第3高的加拿大，以《漁業法》（Fisheries Act）的「海洋哺乳動物細則」來管理所有海洋哺乳動物的商業遊憩行為，以《瀕危物種法》（Species at Risk Act）更嚴格制定賞鯨規範以保護瀕危或受威脅的物種與其棲地，其管理模式值得參考；而我國2020年發布《海洋委員會海洋保育署2020全年度臺灣鯨豚及海龜擱淺報告》，透過海洋保育類野生動物救援組織網（Marine Animal Rescue Network, MARN）團隊成員的救援與記錄，和海洋保育署的彙整、定期發布擱淺報告，未來期望藉由官民共同合作，建構海洋野生生物救援緊急應變處理機制及保育安全網絡，使海洋野生動物救援推動更加順利，也呼籲大眾可一起關心海洋生物與生態環境。

圖說／海洋保育署2020年6月20日於臺南安平漁港出發野放小虎鯨
圖片提供／海洋保育署

2020臺灣鯨豚及海龜擱淺報告

撰文／海洋保育署
關鍵字／鯨豚、海龜、擱淺、小虎鯨、藍鯨

全球7種海龜有5種分布在臺灣周遭海域，而全世界鯨豚種類約90餘種，2020年在臺灣海岸目擊鯨豚就有22種，自投入救援以來累積發現28種以上的鯨豚物種。海洋保育署（簡稱海保署）統籌的「海洋保育類野生動物救援組織網（海保救援網）」（Marine Animal Rescue Network, MARN）團隊[1]，是海洋野生動物救傷的前鋒部隊，專責處理我國海岸擱淺的鯨豚與海龜，依據2020年統計結果[2]，共受理161隻鯨豚及335隻海龜擱淺通報案件，MARN成立以來，擱淺通報程序與救援網成員權責分工日益成熟，以及各單位宣導奏效，MARN團隊將持續運作，讓臺灣海域周遭真實野生動物擱淺的樣貌能完整呈現。

鯨豚擱淺分布

2020年鯨豚擱淺分布以金門縣、連江縣各19件居冠，澎湖縣、高雄市各18件次之，新北市和臺東縣也有10隻以上的紀錄。相較於2019年，2020年擱淺分布仍以離島的擱淺數量較多，而高雄市的擱淺數量顯著增加則是因小虎鯨的集體擱淺事件所造成。另2019年未發生擱淺案件的嘉義縣、新竹縣與新竹市，2020年則有案例發生。

鯨豚擱淺種類

2020年共有21種鯨豚擱淺，數量最多的前3名物種與2019年相同，為露脊鼠海豚46隻（28.6%）、小虎鯨27隻（16.8%）、瓶鼻海豚25隻（15.5%），占全部擱淺數量約61%。

鯨豚擱淺原因分析

2020年擱淺的161隻鯨豚，成功野放8隻，活體擱淺比例較2019年顯著增加，剩餘153隻擱淺個案，經檢查或解剖後擱淺原因分析如下：

一、動物因大體過於腐敗而無法判斷死因占多數，共有85隻，占153隻動物的56%。

二、解剖發現動物體內器官有嚴重病變，經研判為疾病感染導致死亡的動物共有38隻，占25%。

三、體表具有網痕、胃內有未消化完的食物可判斷近期有進食的情況、吻部或上下顎有骨折或胸鰭、背鰭與尾鰭有被外力切除等徵狀的動物大體，經研判可能為漁業混獲導致死亡的動物共有24隻，占16%。

四、經斷層掃描發現有骨骼斷裂、易位或脫位、或肌肉有異常大面積鬱血等徵狀，研判遭撞擊致死的動物有2隻，占1%。

五、其餘2隻擱淺後遭浪捲走未尋獲，2隻尚待檢驗。

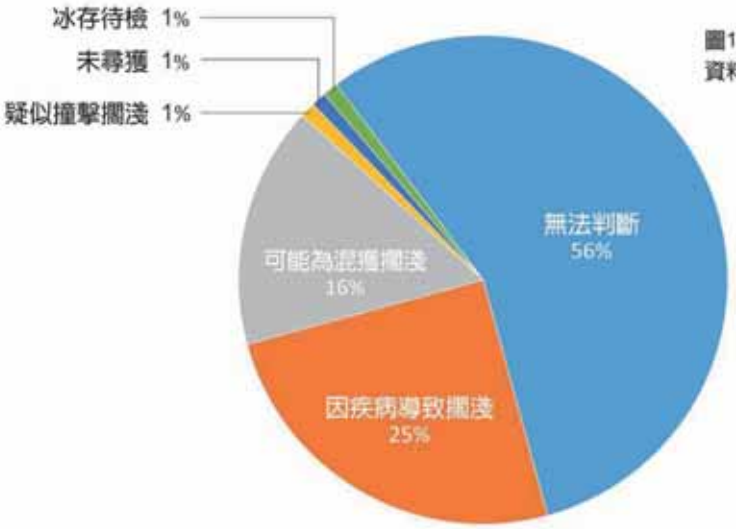

圖1／2020年全臺鯨豚擱淺原因分析（不含活體擱淺）
資料提供／海洋保育署

鯨豚擱淺病理分析

因疾病感染導致死亡的38隻鯨豚，經病理解剖分析，器官皆有病變，28隻（74%）有肺部病變，其中有9隻動物有明顯嗆水跡象；16隻（42%）有脾臟病變；15隻（39%）有心臟病變。

海龜擱淺分布

2020年臺灣通報海龜擱淺數量總計335隻，276隻死亡擱淺（82%），59隻活體擱淺（18%）；擱淺數量以新北市最多，屏東縣次之，再者為臺東縣及澎湖縣；活體擱淺中，有37隻原地釋回，22隻收容醫療，其中7隻經收容後野放；擱淺種類以綠蠵龜最多。

與2019年的269隻（死亡擱淺207隻，活體擱淺62隻）相比，死亡擱淺增加69隻，活體擱淺減少3隻，總數量增加66隻。

海龜擱淺月份分布

2020年海龜擱淺隻數依月份分布統計，3～5月（春季）共82隻，6～8月（夏季）共68隻，9～11月（秋季）共74隻，1～2月及12月（冬季）共111隻，擱淺月份以秋季到春季為大宗，2020年度8月計有42件海龜擱淺通報，與歷年夏季數據相比屬異常高峰，主因為颱丁發生的24隻小海龜集體迷航事件。

擱淺海龜體長分布

依MARN團隊資料顯示，雖然各地區擱淺數量不同，但是主要擱淺皆以體長介於20～65公分的青年龜為主。其原因可能是因為秋季到春季氣溫變化大，大型海龜較能忍受低溫，小型海龜因肺部發育尚未完成，在天氣劇烈的變化下，無法快速地潛到深處或是游出外海，被困在海況差的近海中造成擱淺。

海龜擱淺原因分析[3]

擱淺原因以漂流為主因，而迷航在2020年比例大增是因為颱丁所發生的小海龜迷航事件。針對2020年死亡擱淺的海龜，MARN團隊共解剖74件（國立臺灣海洋大學解剖25件、國立海洋生物博物館

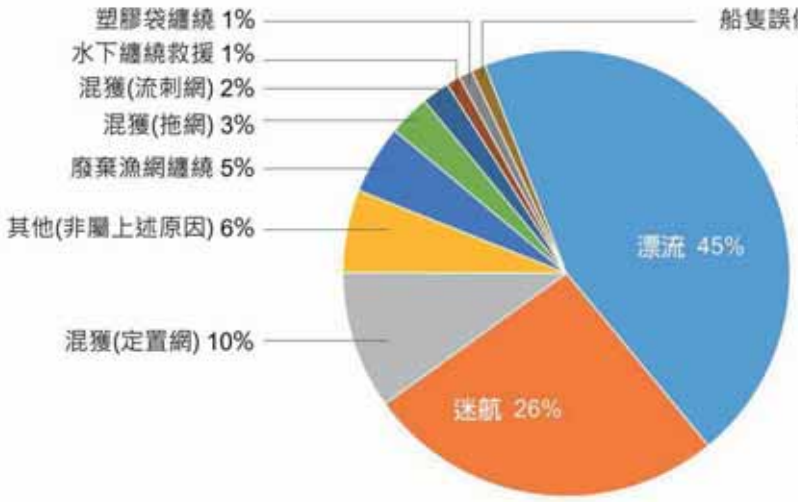

圖2／2020年全臺海龜擱淺可判斷原因分析
資料提供／海洋保育署

26件，澎湖縣政府23件）。經分析，可歸類死因中以寄生蟲感染最多，其次為螺旋槳致傷，多重原因致死、疑似遭撞擊等原因。

人為活動對海龜的衝擊[4][5]

對2020年擱淺海龜中的75隻個體進行消化道內容物採樣，在70隻海龜消化道內發現人造物，經統計發現人造物比例為93.3%，依品種為2隻玳瑁、2隻赤蠵龜、1隻欖蠵龜及65隻綠蠵龜，另有2隻綠蠵龜待處理。

依消化道發現位置分成：食道、嗉囊、胃、小腸、大腸；再依照人造物材質分為9類：軟塑膠、硬塑膠、棉線、塑膠線、保麗龍、泡綿、橡膠、金屬及其他。

將發現的人造物依種類及件數分析可知，發現最多人造物的位置為大腸（71%），其次為小腸（15%）；在大腸內發現最多的人造物為塑膠線（26%），其次為軟和硬塑膠（均為21%），再其次是保麗龍（16%），其餘均少於3%。由消化道內容物採樣分布可知，在腸道內發現各種類人造物的比例都遠大於其他部位，這代表人造廢棄物在海龜體內已經停留數週到數月之久了。

特殊擱淺案例1：高雄港小虎鯨迷航

依據1994年至2020年鯨豚擱淺統計資料，最早於1996年即有小虎鯨集體擱淺紀錄，後續在1997年、2002年、2005年、2010年、2013年、2014年、2018年至2020年的2月到5月之間，臺南、高雄到屏東沿岸地區都曾發生小虎鯨集體擱淺。

2020年4月25日晚間MARN團隊收到通報，在高雄港發現20隻小虎鯨迷航，隨即啓動救援機制，同一群體中有些游出，有些因感染而擱淺死亡，其中有1隻長約2.3公尺的雌性小虎鯨擱淺在高雄港消波塊上，剛進入搶救站時，必須24小時由志工下水協助保定，狀況並不樂觀；經過長達56天，持續提供照護及醫療措施，終於可自行游動換氣與漂浮，傷口癒合良好，各項檢驗結果趨於穩定，且對人類警戒心提升，進行水中保定醫療困難度提高，經過團隊獸醫師綜合判斷，決定進行野放。

6月20日凌晨5點，所有工作人員集結於四草搶救站，懷著不捨又期待的心情開始作業，6點50分左右，載著小虎鯨的海巡巡防艇，從臺南安平漁港出發，前往外海水深約110公尺處進行野放，在當天上午8點30分左右小虎鯨終於順利回到大海。

圖3／小虎鯨進入搶救站，由MARN團隊持續提供照護及醫療措施
圖片提供／海洋保育署

特殊擱淺案例2：臺東長濱藍鯨擱淺

2020年1月25日適逢大年初一，接獲海巡署第十巡防區的夥伴回報，有民眾在臺東縣長濱鄉城子埔海灘發現1隻長達20公尺的大型鯨魚擱淺。接獲通報第一時間MARN團隊立刻啓動，海巡夥伴先行維持現場狀況及秩序，行動小組及縣政府夥伴緊急協調大型吊車，並立刻趕往現場處理。當時長濱海岸風浪不小，死亡鬚鯨身體非常靠近浪緣，且與海岸平行、向其身體縱軸左側傾斜，體表表皮已經脫落，但由於擱淺鯨魚有明顯的喉腹摺，下顎皮膚為白色，經由解剖及粒線體DNA序列比對判斷為分布範圍廣、數量少，過去臺灣罕有擱淺紀錄的第1級保育類物種：藍鯨。

臺灣少有藍鯨出沒的紀錄，2020年發生的擱淺事件更是有鯨豚擱淺救援紀錄以來第1起的藍鯨擱淺。這隻擱淺的藍鯨長20公尺，鰭部長度達3公尺，胸鰭的長度也超過1位成年男性的高度。為了充分瞭解藍鯨，救援團隊耗費了2天將動物成功運往臺南解剖預定地，並歷時3天完成解剖任務。經判斷，死亡原因應與纏繞在頭部的網具有關，此網具長約6公尺，直徑約4公分，整圈纏繞在藍鯨上下顎的嘴裂處，且造成明顯的勒痕，推測因纏繞導致動物長期進食不順利，因此體態偏瘦、鯨脂厚度不足、營養不良等狀況，最後導致死亡且擱淺。

本案為臺灣有史以來的第1筆藍鯨正式擱淺紀錄，由於各國藍鯨擱淺案件並不常見，大型鯨類標本取得不易，相關研究十分有限。為了能從這次擱淺藍鯨的個案，尋找更多海洋生態的訊息，海保署邀集國內鯨豚相關領域的專家，共同進行學術研究及骨骼標本的重建，並舉辦「2020擱淺藍鯨處理成果發表會」，向大眾公開說明擱淺藍鯨的處理成果及藍鯨科普知識的介紹。

圖4／臺灣首次由公部門主持協調的大型擱淺鯨魚完整解剖合作
圖片提供／海洋保育署

特殊擱淺案例3：墾丁小海龜迷航事件

2020年8月9日晚間，在墾丁沙灘上發現24隻迷航的小海龜，經通報MARN團隊，由海生館帶回測量記錄後，全數送回原地釋放，並引導小海龜游向大海回歸自然。

經研判這些稚龜在孵化後，應該要越過沙灘回到大海，但是因為該處附近飯店的燈光強烈，在夜晚的沙灘上格外醒目，使得這些小海龜在破殼後，因為趨光性而被誤導往亮光處爬行而迷途。

距離上次在墾丁發現海龜上岸產卵已是2017年8月的事，這次事件的發生，帶給所有關心海龜保育的民眾信心，顯示了墾丁沙灘環境改善已有成效，但爾後仍應避免在夏季夜晚沙灘活動，才能提供海龜友善的孵化環境。

2020年回顧

MARN團隊2020年在全臺各臨海19個縣市，共處理161隻鯨豚擱淺通報、335隻海龜擱淺通報，蒐集科學樣本475件、標本69件，野放鯨豚8隻，原地釋回海龜37隻、野放海龜7隻、持續收容海龜15隻。

2020年是特別值得紀念的一年，除了在臺東長濱海岸所發生的藍鯨擱淺事件，是臺灣有史以來的第1筆藍鯨正式擱淺紀錄，更發生了高雄港小虎鯨集體擱淺事件，鯨豚集體擱淺事件的次數不多，但每次發生都需要投入巨量的人力物力，往往亦伴隨許多動物的傷亡，透過MARN團隊成員每一次儘可能記錄海洋生物擱淺資訊，並由海保署彙整、定期發布擱淺報告，讓大眾瞭解人為活動（如：漁業活動、船舶航行、海洋廢棄物等）對於海洋生物的影響與衝擊，期望透過數據分析研究，取得科學數據的佐證，以分析擱淺發生可能原因，降低人為衝擊，達到海洋野生動物保育的目的。

海洋野生生物救援緊急應變處理機制及保育安全網絡建構，有賴海保署與海巡署、地方政府、環境保護及海洋保育相關非政府組織等共同合作，整合軟硬體資源，並透過民眾參與擴大救援行動量能，提升國人保育意識，對於海保署成立海洋保育類野生動物救援組織網（MARN）也會更加支持與認同，方可使海洋野生動物救援推動更加順利，共同關心海洋生物與生態環境。

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[5] 國立海洋生物博物館（2020），《109年海龜救傷收容暨全國海龜標本管理計畫成果報告》（高雄市：海洋委員會海洋保育署）

永續海洋經濟轉型：實踐海洋保護、生產和繁榮的願景

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鑒於海洋對於人類福祉的重要和影響，以及許多海洋生態系面臨威脅，橫跨三大洋的14個國家領袖，於2018年9月成立永續海洋經濟高層委員會（High Level Panel for a Sustainable Ocean Economy，簡稱海洋高層委員會）。該委員會致力於環境保護和保育，以及經濟生產和繁榮共同並行的永續海洋經濟轉型。此外，委員會致力於2025年以前，所有會員國的管轄海域百分之百納入永續管理，同時支持2030年以前，全球至少30%的海洋受到保護的目標。永續海洋經濟轉型涉及5個關鍵領域—海洋財富（Ocean Wealth）、海洋健康（Ocean Health）、海洋平等（Ocean Equity）、海洋知識（Ocean Knowledge），以及海洋財務（Ocean Finance）。僅基礎建設部分，預計未來10年投入90兆美元，大部分將在海岸地區。本文介紹此新成立的委員會，以及達成永續海洋經濟轉型的各關鍵領域的優先行動（本文內容主要摘自[1]）。

永續海洋經濟高層委員會

海洋高層委員會是一個海洋政策組織，由14個國家領袖組成，包括澳洲、加拿大、智利、斐濟、迦納、印尼、牙買加、日本、肯亞、墨西哥、納米比亞、挪威、帛琉和葡萄牙，由挪威和帛琉兩國領袖共同擔任主席。這些國家具有高度多元的海洋、經濟和政治觀點，分別位於亞洲、大洋洲、歐洲、美洲、非洲等5大洲，代表著所有洋區的人民、40%的全球海岸線、30%的專屬經濟海域、20%的全球漁業，以及20%的海上運輸活動。

海洋高層委員會和政府、商業財政機構、科學社群以及民間團體共同合作，在政策面、科技面和財務面，啓動大膽且務實的解決方案，以建立一個轉型至永續海洋經濟的行動議程。在「永續海洋計畫」（Sustainable Ocean Plans）的指引下，委員會致力於2025年以前，所有會員國的管轄海域百分之百納入永續管理，並鼓勵所有海岸／海洋國家加入這個承諾，以達成2030年以前，所有國家的管轄海域都納入永續管理的目標。此外，永續海洋計畫將於2030年成為確保海洋長期健康和韌性的可靠基礎，同時吸引投資和創造工作機會，造福海岸社區和國家經濟。

永續海洋計畫目的在促進海洋永續使用，為當代和未來世代帶來最大化利益和價值。此計畫包括法規改革、對新興產業的策略投資、海洋空間規劃、整合性海岸和集水區管理、設立和落實海洋保護區，以及其他以區域為基礎的保育措施。此計畫必需和2030永續發展議程（2030 Agenda for Sustainable Development）一致、建立在整合型海洋管理和生態系知識之上，以解決源自於陸域和

海域的壓力，以及考量氣候變遷的可能影響。此外，研擬和執行此計畫必須經由一個各利益關係人參與的、透明的和可歸責的過程。

永續海洋經濟轉型的5大關鍵領域

落實永續海洋經濟轉型建立在一個5大關鍵領域的架構上，包括海洋財富、海洋健康、海洋平等、海洋知識以及海洋財務[2]。每個關鍵領域關切不同的焦點議題，且每個焦點議題有對應的2030年成果和優先行動（Priority Actions）。限於篇幅，本文僅列出每個關鍵領域議題的2030年成果和二項優先行動。

圖1／永續海洋經濟轉型涉及5大關鍵領域
圖片來源／https://www.oceanpanel.org [2]

領域一：海洋財富

●永續海洋食物

2030年成果：野生魚類系群恢復和捕撈到可永續使用的水準，養殖永續成長到可滿足全球的需求，且在整個價值鏈（value chain）過程中，管理垃圾數量並使其達最少化。

優先行動：一、消除非法、未報告及不受規範漁業（illegal, unreported and unregulated fishing, IUU fishing）鼓勵使用最新科技（如數位追蹤），以增加漁業活動透明度、加強活動監測控制、改善船籍國管制、有效執行港口國措施協定（英文全名為Agreement on Port State Measures to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing, PSMA）。此協定由聯合國糧農組織（Food and Agriculture Organization, FAO）通過，2016年6月5日生效，其訂定最低標準的措施，港口國可針對進入和停泊於其港口的外國船隻執行該等措施，以消除非法、未報告及不受規範漁業活動[3]），以及提升價值鏈中所有利益關係人之間的合作。

二、禁止有損害漁業的補貼，這些補貼造成漁撈能力過大、過度捕撈，以及非法、未報告及不受規範漁業。

●永續海洋能源

2030年成果：以海洋為基礎的再生能源快速成長，且正成為世界領先的能源來源。

優先行動：一、投資研究、科技研發和試驗性計畫，協助所有類型的海洋再生能源（包括風、波浪、潮汐、洋流、熱能和太陽能等）具有成本競爭力、所有人都可及的，以及環境友善的特性。

二、與業者及利益關係人合作，擬訂明確架構，解決海洋再生能源的環境衝擊，以及促使再生能源和其他海洋使用共同存在和整合。

●永續海洋旅遊

2030年成果：海岸和海洋旅遊是永續的和韌性的、解決氣候變遷、減少污染、支持生態系再生和生物多樣性保育，以及投資於地方工作和社區。

優先行動：一、投注於永續旅遊，建立海岸社區和原住民的韌性，促進公平機會和利益公平分配。

二、投注於下水道和廢污水基礎設施，改善海岸社區健康和減少旅遊對海岸／海洋生態系的衝擊。

●永續海洋運輸

2030年成果：運輸投資以有效加速零排放和低衝擊的船舶轉型。

優先行動：一、提前規劃國家目標和策略，支持船舶去碳化。

二、獎勵永續和低碳港口，透過再生能源和零碳燃料供應鏈，使海洋運輸和船隊朝去碳轉型。

●永續新興海洋產業

2030年成果：以創新與投資海洋新興產業促進環境負責任的經濟成長。

優先行動：一、擴大環境負責任的海草和海藻商業養殖，以提供食物和產品的替代選項，如燃料、養殖和農業飼料、生技和塑膠的替代產品。

二、透過國際合作，適當誘因，以及具貯存潛力的海底或海床地質形成物繪圖，精進海底或海床下碳捕捉和儲存的技術。

●以預防性措施進行海底採礦

2030年成果：足夠的科學知識和法規就位，確保任何海底或海床開採相關活動是科學導向且生態永續的。

優先行動：一、建立夥伴關係，提升研究、創新，以及都市採礦（從用過的產品、建物和廢棄物中萃取和回收金屬）和創新科技的布署，以減少新來源的金屬和稀土的需求。

二、開啓國際研究議程，以增進瞭解海底或海床礦物開採的環境衝擊和風險，尤其是深海生態系的開採活動。

圖2／永續海洋旅遊可減少污染、促進生態系再生，以及為海岸社區帶來工作機會
圖片提供／陳璋玲

圖3／低碳港口和去碳的海洋運輸是永續海洋經濟轉型的優先行動之一
圖片提供／陳璋玲

領域二：海洋健康

●減少溫室氣體排放

2030年成果：大膽的氣候行動已使世界在達成《巴黎協定》（Paris Agreement）目標和恢復海洋健康之路途上。

優先行動：一、建立和執行各領域的排放減量措施，達成《巴黎協定》的目標—限制地球溫度增加範圍在1.5°C以內。

二、擴大投資於海洋再生能源、綠色運輸、永續水產品生產，以及海底或海床下碳捕捉和儲存技術等。

●保護和恢復海岸／海洋生態系

2030年成果：海岸／海洋生態系是健康的、韌性的和具生產力的，且以自然為基礎的方案是海岸基礎設施的重要元素。

優先行動：一、停止淨損失，改善海岸／海洋生態系，尤其是關鍵的生態系，例如紅樹林、海藻、鹽沼、大型海藻床、沙丘、岩礁和深海生態系。

二、設立和有效管理海洋保護區，以保護生物多樣性並帶來氣候、食物、社會經濟和文化的效益。

●減少海洋污染

2030年成果：海洋不再是污染的棄置場所，且海洋死亡區（dead zones）面積最小化。

優先行動：一、獎勵塑膠的永續性替代產品的研發、生產和使用，以逐漸淘汰有問題和不需要的塑膠。

二、使用經濟誘因、貿易機會和生產者延伸責任（extended producer responsibility）鼓勵永續產品設計；促進減量、再利用和回收最大量標準化，以追求循環經濟；以及研發可生物分解材料，取代塑膠。

領域三：海洋平等

●促進人類有平等的機會從海洋獲致利益

2030年成果：人類有平等機會接近海洋資源，利益公平地分配，最脆弱社區受到保護免於危害的風險。

優先行動：一、要求透明和負責任的商業行為，海岸社區得參與並受益，且所有海洋產業工作者的權益受到保障。

二、促進女性全面參與海洋活動，協助其開啓經濟和社會潛能，建置她們保護自然資源的能力，及提升其獲取適宜工作的機會。

領域四：海洋知識

●建置海洋素養和技能

2030年成果：透過聯合國海洋科學十年（UN Decade of Ocean Science），全世界海洋素養普遍提升。人類瞭解海洋的價值，且取得必要的技能和知識來參與永續海洋經濟。

優先行動：一、使每個人都能接觸海洋知識，且投入公民海洋素養和意識的建置，包括透過正規教育。

二、投入海洋保育和管理，以及未來永續海洋產業所需的知識、科技和技能訓練。

●計算海洋價值

2030年成果：影響海洋的政策決定反映出海洋自然資產（natural capital）的價值和對此資產的影響。

優先行動：一、盤點完整的國家海洋資產表，供決策參考。

二、建立全球夥伴關係，共享國家海洋資產的最佳統計方式，以及建置國家海洋資產製作的能力。

●利用海洋科學、科技和資料

2030年成果：一個全球共享的資訊變革促進全球海洋永續管理。

優先行動：一、促進透明、公開分享和取得海洋資訊。

二、擴大地區到全球的整合觀測。

領域五：海洋財務

2030年成果：永續海洋財務對所有會員國是可及的，且其促使生態永續和社會平等兼具的經濟成長。

優先行動：一、公部門財務投資於永續海洋經濟，以帶動私部門財務投入。

二、支持研發和應用「全球海洋風險地圖（ocean-risk map）」和「風險指標（risk index）」，以催化一個負責任和永續的海洋保險市場，以及島嶼和海岸社區韌性的投資。

結論

跨三大洋的14個國家領袖，於2018年成立海洋高層委員會。該委員會致力永續海洋經濟轉型，在2025年以前，達成所有會員國的國家管轄海域百分之百納入永續管理。為達成此願景，委員會擬訂永續海洋經濟轉型的5大關鍵領域、各領域的焦點和優先行動，以及每個焦點的2030年成果。採取這些行動能確保海洋再生的能力，如此海洋始能帶來經濟、環境與社會價值，以及解決全球面臨的挑戰，尤其是氣候變遷、海洋酸化、海洋暖化、海洋污染、過漁，以及棲地和生物多樣性消失。

參考資料

[1] High Level Panel for a Sustainable Ocean Economy (2020). Transformations for a Sustainable Ocean Economy https://www.oceanpanel.org/ocean-action/transformations.html
[2] https://oceanpanel.org
[3] http://www.fao.org/port-state-measures/en/

加拿大賞鯨業之制度規範

撰文／曾鉦琮（中華鯨豚協會秘書長）
關鍵字／加拿大、白鯨、賞鯨

加拿大魁北克省（Québec）東方約750公里的小海灣希爾福德港（Port Hilford），2020年初由一非營利團體鯨魚保護區專案（The Whale Sanctuary Project）提議設立為海岸鯨豚庇護所，計劃在海灣中收容那些從小被圈養或是受傷等無法釋放回海洋的鯨豚，並預計在2022年底開始收容水族館的鯨豚，例如白鯨（Beluga whale）等，讓這些圈養動物能在自然環境中安穩的退休[1][2]。這也讓筆者好奇是怎樣的條件讓科學家選中這特別的海灣？圈養的白鯨適合在這裡生存嗎？庇護海域成立之後的教育規劃會如何進行？以及庇護所成立後勢必會因為籌措收容資金而開放賞鯨活動，那加拿大的賞鯨規範為何？這一切的疑問讓筆者想更深入的瞭解加拿大的賞鯨歷史與政策，因此本篇將從收容白鯨的庇護所的故事來認識加拿大的賞鯨產業。

加拿大的賞鯨區域

被大西洋、北冰洋與太平洋圍繞的加拿大，除了魁北克省與加拿大北極地區（Canadian Arctic）是白鯨的主要野外賞鯨點，另有數個知名賞鯨區域，包含西岸太平洋區的卑詩省（British Columbia），以及東岸臨大西洋的魁北克省周邊的諾瓦斯科西亞與紐布朗斯維克省（Nova Scotia and New Brunswick）與紐芬蘭暨拉布拉多省（Newfoundland and Labrador）等，並有超過10種以上的各式大小鯨豚可觀賞，特別是齒鯨（Toothed whales）中的虎鯨（Killer whales）與白鯨，鬚鯨（Baleen whales）中的大翅鯨（Humpback whale）、灰鯨（Gray whales）與國際自然保護聯盟（International Union for Conservation of Nature and Natural Resources, IUCN）列入極危（Critically Endangered, CR）的北大西洋露脊鯨（North Atlantic Right whales），更是鯨豚愛好者的朝聖物種[3]。

白鯨廣泛分布於北極與亞北極地區，目前在IUCN瀕危物種紅色名錄中被歸類為近危物種（Near Threatened, NT），成體最長可超過4公尺，體重可超過1,000公斤，通常雄性個體體型會略大於雌性。自古以來白鯨一直是北極原住民社會中重要的食物、燃油、皮革等商品來源，近代更因特殊的外貌、頸椎癒合程度低讓白鯨能較大幅度的轉動頭部的特性、多變的叫聲與臉部表情、以及可接受訓練等因素，使得白鯨成為全球海

圖1／虎鯨為加拿大最熱門的賞鯨物種
圖片提供／中華鯨豚協會

洋世界的主要圈養物種，當然，白鯨棲息海域也成為野外觀察的賞鯨景點，包括加拿大東部的聖羅倫斯河口（St. Lawrence River）與聖羅倫斯灣（Gulf of Saint Lawrence）等，而少有颶風侵襲的希爾福德港庇護所剛好就位於聖羅倫斯灣外圍的諾瓦斯科西亞半島，鄰近白鯨的自然棲地，因此庇護所當地自然環境條件也與原始白鯨棲地類似[4][5][6]。

表1／加拿大賞鯨區域簡介

地區	賞鯨地點	賞鯨型態	鯨豚物種
大西洋區			
魁北克省	聖羅倫斯河口、薩格奈峽灣、明安地區	動力小艇與陸觀	白腰鼠海豚、港灣鼠海豚、大西洋斑紋海豚、白喙斑紋海豚、白鯨、小鬚鯨、北大西洋露脊鯨、大翅鯨、長須鯨、藍鯨
諾瓦斯科西亞與紐布朗斯維克省	芬迪灣、哈利法克斯、布雷頓角	動力小艇、非動力小艇與陸觀	港灣鼠海豚、大西洋斑紋海豚、長肢領航鯨、小鬚鯨、北大西洋露脊鯨、大翅鯨、長須鯨
紐芬蘭暨拉布拉多省	聖約翰、阿瓦隆半島	動力小艇、非動力小艇與陸觀	港灣鼠海豚、大西洋斑紋海豚、虎鯨、小鬚鯨、大翅鯨
北極區			
加拿大北極地區	丘吉爾、龐德因萊特和巴芬島	動力小艇、非動力小艇與直升機	白鯨、獨角鯨、弓頭鯨
太平洋區			
卑詩省	溫哥華島、維多利亞、長灘、電報灣、坎貝爾河、托菲諾	動力小艇、非動力小艇與陸觀	白腰鼠海豚、港灣鼠海豚、太平洋斑紋海豚、虎鯨、小鬚鯨、大翅鯨、灰鯨

資料來源／[3]

加拿大的賞鯨規範

加拿大的「海洋哺乳動物細則」（Marine Mammal Regulations）隸屬於《漁業法》（Fisheries Act），於1993年2月24日生效，並於2018年進行最近的一次修正[7]，此法主要用於管理所有海洋哺乳動物的商業遊憩行為。然而，針對加拿大海域出現的瀕危物種，像是白鯨、虎鯨、北大西洋露脊鯨、灰鯨與藍鯨等，《瀕危物種法》（Species at Risk Act）則有更嚴格的賞鯨規範，以保護這些瀕危或受威脅的物種與其棲地，避免物種的消失[8]。

加拿大賞鯨是以望遠鏡遠距離觀察鯨豚，並與鯨豚保持至少100公尺以上的距離，而遇到鯨豚休息時或是遇到母子對時則須保持至少200公尺的距離，但當動物主動接近船隻時，以下行為都是禁止的：

- 餵食鯨豚。
- 與鯨豚一起游泳、潛水或有互動行為。
- 移動鯨豚、包圍鯨豚或誘使鯨豚移動。
- 快速改變船隻方向或將船隻停留在鯨豚的移動路徑上。
- 在鯨豚休息時（漂浮於水面沒有明顯移動）接近他們。
- 將鯨豚群體分散或拆散母子對。
- 在船隻和海岸之間，或船隻與其他船隻之間捕捉鯨豚或其群體。
- 多艘船隻同時接近鯨豚。
- 船隻從正面或從後面接近鯨豚，因為這會中斷鯨豚的行動。
- 標記鯨豚。
- 即使鯨豚來到碼頭或岸邊，禁止觸摸、餵食或干擾動物。
- 使用飛機接近鯨豚。
- 如果遇見鼠海豚（Porpoises）或海豚（Dolphins）接近船隻乘浪時，避免突然改變船隻航向，應維持航向並減速行駛，禁止穿越鼠海豚或海豚群體。

此外為了避免空拍機對鯨豚造成無謂的噪音干擾，若要使用空拍機拍攝鯨豚，使用上也有一定的規範，例如空拍機需與鯨豚保持305公尺（1,000 呎）的垂直高度，並且不得進入鯨豚半徑915公尺（3,000 呎）內的空域，此外拍攝過程中也不得有起飛、降落、改變航向與改變飛行高度等情況發生。

賞鯨管理制度也會參考科學研究結果進行調整，例如：名根島鯨豚研究站（Mingan Island Cetacean Study, MICS）就在白鯨與藍鯨出沒的聖羅倫斯灣進行了長達40年的鬚鯨研究，透過其研究結果協助加拿大政府將藍鯨納入瀕危物種的管理，研究站成員並共同參與政府的復育工作，透過鯨豚個體影像辨識（photo-identification surveys）確認聖羅倫斯灣的藍鯨族群數量、分布範圍與密度，並協助劃設藍鯨重要棲地位置（critical habitat），納入《瀕危物種法》中管理[9]。

而在特定區域或遇見特定物種時，賞鯨的距離限制也會有所調整，以保護鯨豚族群的穩定，舉例而言：東北太平洋的南方居留型虎鯨群（southern resident killer whales of the Pacific Northwest, SRKW）目前族群量估算少於80隻，每年的4月至10月會出沒於加拿大的卑詩省至美國華盛頓州（Washington State）海域，由於族群數量少，在加拿大跟美國都分別列為瀕危物種（endangered）並執行嚴格的管理與研究，為了避免賞鯨船對虎鯨群造成過多的噪音干擾與潛在的船擊事件發生，在卑詩省，其賞鯨規範中就有較嚴格的距離規範，在此區域若遇見虎鯨群時，賞鯨船航速需在7節以下，並與虎鯨群保持至少400公尺以上的距離（但其他地區遇見虎鯨群僅需維持200公尺），以減少船隻干擾的發生；相同管理模式也應用於棲地範圍較狹小的聖羅倫斯河流域及薩格奈河（Saguenay River）流域，在此區域的賞鯨船遇見瀕危的白鯨與藍鯨時，也須維持較其他區域多1倍的安全距離（400公尺），以避免無謂的干擾發生（圖2&3）[8][10][11]。

圖2／加拿大不同賞鯨區域規範
圖片來源／https://www.dfo-mpo.gc.ca/about-notre-sujet/publications/infographics-infographies/marine-mammals-regs-mammiferes-marins-eng.html

圖3／加拿大與美國賞鯨船遇見東北太平洋的南方居留型虎鯨群的賞鯨規範
圖片來源／https://www.bewhalewise.org/

遇到正在休息的鯨魚、海豚或鼠海豚，或是遇到未成年鯨豚，均須保持200公尺距離；在美國與加拿大，所有其他海洋哺乳動物皆訂有100公尺/碼禁止接近區的規範。

結語

「可遠觀而不可褻玩焉」這句話是筆者認為最適合解釋加拿大的賞鯨模式，2008年國際捕鯨協會（International Whaling Commission, IWC）公布的賞鯨調查數據，內容顯示全球每年有超過1,300萬人參與賞鯨活動，賞鯨業及週邊產值更高達21億美元，其中加拿大的賞鯨遊客數量高達110萬人次，為全世界賞鯨人數第3高的國家，僅次於美國與澳洲[12]，不論遊客量多高，賞鯨活動多活躍，所有的賞鯨船皆需以望遠鏡觀察鯨豚，船隻至少保持100公尺的距離，加上透過鯨豚研究結果協助調整政府的管理模式，並依物種、地點、瀕危程度制定最能保護當地物種的規範機制，以保護動物為賞鯨核心架構，雖然遊客賞鯨時與動物有距離感，但因為低干擾的賞鯨模式造就海上鯨豚能有最自然的行為表現，像是躍身擊浪、舉尾擊浪、躬身下潛等等，反而能讓遊客留下最好的回憶，帶動大量的賞鯨人潮。

而白鯨庇護所希爾福德港位處緯度較高，少有颶風侵襲，鄰近聖羅倫斯灣，其環境條件也與原始白鯨棲地相似，加上位於諾瓦斯科西亞的賞鯨區域中，相信在庇護所成立及營運之後，不論是在賞鯨旅程、鯨豚互動的遊憩行為與教育活動中，都能依嚴謹的加拿大賞鯨規範來執行，讓這些長期被圈養的白鯨在退役後能享有最好生存環境與最高的生活品質，以達鯨豚保育之效果。

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加拿大海洋策略與海洋相關部門

撰文／施義哲（國家海洋研究院綜合規劃及人力培訓中心主任）
關鍵字／漁業與海洋部、環境與氣候變化部、海洋法、加拿大

加拿大是世界上海洋強國之一，是整合海洋立法的國際先行者，《海洋法》（Oceans Act）的頒布賦予海洋專責機關管理與協調聯邦海洋事務的職責，負責全國海洋綜合管理的工作，本文介紹該國海洋法規體系、海洋科技研究體系、海洋相關政策之實踐以及海洋管理之目標與願景，能提供我國在邁向海洋國家各個面向上的學習標竿。

加拿大簡要概述

加拿大（簡稱加國）位於北美洲的北半部，地理位置上三面臨海，為大西洋、北冰洋與太平洋所圍繞，是北美主要的海洋國家。其南與美國接壤，擁有廣大的陸地國土及專屬經濟區，國土面積世界排名第2，海岸線長達243,792公里，為世界之最。海洋是支持加國許多沿海地區發展的生命線，國內外運輸都以海上運輸為主，全國四分之一人口居住在沿海地區，故加國重要的城市中心及人口聚落都位於海岸地區，政府對於海岸保育及救災防護工作的管理投入相當的心力與經費，海洋產業對加國經濟也有重大的貢獻。

圖1／加拿大國土面積與海岸線
圖片來源／Coastline, Boundaries and Names of Canada
https://open.canada.ca/data/en/dataset/55d5eb69-f866-5be9-89c1-736e92df425e

加拿大海洋相關部門

筆者於2001年隨指導教授邱文彥老師（當年獲得加拿大馬偕獎）訪問加國，期間參訪加拿大漁業與海洋部（Fisheries and Oceans Canada, DFO）、加拿大海岸防衛學院（Canada Coast Guard College, CCGC）、海岸防衛隊達特茅斯區域總部（CCG Maritimes, Dartmouth）、環境部（Environment Canada, EC）、東加拿大應變公司（Eastern Canada Response Corporation, ECRC）等單位，瞭解海洋污染應變機制（因為當年臺灣發生了阿瑪斯號漏油事件），獲益良多。隨後於2005年筆者獲國科會千里馬獎學金赴加拿大聯邦政府貝德福海洋研究所（Bedford Institute of Oceanography, BIO）進行博士論文之研究1年，對於加國之海洋政策與相關部門的運作更加瞭解，藉由此文擇要介紹。

一、漁業與海洋部（DFO）

加拿大於1995年成立漁業與海洋部（或直接稱為DFO），是加國的聯邦機構，負責制定、實施和支援加國海洋和內陸水域的經濟、生態和科學研究及政策的部門，其任務包括保護和永續利用加拿大的漁業資源，繼續提供安全、有效和健康環境的海洋服務，支持海洋和漁業經濟成長的後盾，以及水產養殖和生物技術等領域的創新。漁業與海洋部有優秀傑出的科學家與科學研究船，透過研究、監測與分析，提供政府施政參考，DFO特別重視海洋漁業、海洋環境與生態學、海洋學等學科研究，例如2020年加拿大漁業與海洋部宣布在紐芬蘭（Newfoundland）暨拉布拉多（Labrador）省海岸外的雪蟹（Snow Crab）捕撈區，能提高漁民「總容許漁獲量」（Total Allowable Catch, TAC）限制，允許TAC增加10%的捕撈額度，此項政策乃基於扎實的科學研究根基，提供海洋資源保護、永續漁業措施值得參考。

二、加拿大環境與氣候變化部（ECCC）

加拿大環境部（Environment Canada, EC），於2015年更名為加拿大環境與氣候變化部（Environment and Climate Change Canada, ECCC），是加國環境事務的主管機關，同時也是海洋環境管理重要的部會，為促使海洋環境與資源的保護、防止污染、提高自然環境品質，加國環境與氣候變化部的主要任務包含制定有關環境政策和發展的計畫、負責國家公園內資源的經營與管理、與其他聯邦部門和地方政府共同參與保護區的規劃、管理與建設、協調加國政府關於保護並提高自然環境品質的政策與實施方案等，以促進海洋環境和資源的保護，防止海洋污染、清除有害物質和提高自然環境質量、再生資源及水資源。

三、東加拿大應變公司（ECRC）

依據加國《海運法》（Canada Shipping Act），海岸防衛隊負責大規模海污事件應變處理及監督一般海污事件，一般中小型海洋油污染案件交由民間應變組織（Response Organization, RO），如東加拿大應變公司（ECRC）。加拿大運輸部依據《海運法》建置民間應變組織認證機制，東加拿大應變公司是加國運輸部認證之最大應變組織。在加拿大經由各省權責機關統計後，加拿大環境與氣候變化部則根據各省統計資料繼續建立溢油的資料庫。

私人企業的油污染應變組織方面，目前加拿大依照地理分區，由石油業所籌組，協助政府應變的私人公司如圖（圖2）。

由於船舶交通、海上石油勘探和開發的不斷增加，加拿大東海岸存在重大的海上溢油風險。再加上與北大西洋相關的自然災害（如天氣和冰層）以及重要自然資源（如野生動植物和漁業）的存在，以及可能造成重大石油洩漏對海洋環境造成重大影響。根據從過去溢油事件吸取的經驗教訓，大西洋地區的溢油應變已經形成了一個溢油應變網絡，重點是預防溢油和損害恢復相關的各種程序。這些活動的積極參與者是地區環境緊急應變小組（Regional Environmental Emergencies Team, REET）[1]，在環境溢油方面協力處理。這些團隊的成員來自不同地方，他們來自聯邦、省、國家組織等。在海洋溢油應變的處理上，地區應變團隊提供技術建議給海岸防衛隊，供現場指揮官（On-Scene Commander, OSC）參考。

圖2／私人企業應變組織地理應變區域
圖片來源／Eastern Canada Response Corporation Ltd., Canada's Marine Oil Spill Response Organizations (1999)

四、加拿大海岸防衛隊（CCG）

加拿大海岸防衛隊（Canadian Coast Guard, CCG）於1962年成立，隸屬於漁業與海洋部，總部位於渥太華（Ottawa），成員約有4,500多人，每年預算約2億8千多萬加幣（約新臺幣64億多元），並於1995年併入加拿大漁業與海洋部。其主要職能包括：代表漁業與海洋部漁業管理部門執行海洋漁政執法、海上航行服務、破冰與維護北極主權、海上通信與交通服務、綜合技術支援、海上搜索與救助、環境應變、海事安全與船舶管理等，是個非軍事機關，卻可成為軍事行動後盾的重要單位。加國海岸防衛隊的功能與定位也非常明確，在2010年加拿大國際理事會發布「開放的加拿大：網絡時代的全球地位策略（Open Canada: A Global Positioning Strategy for a Networked Age）」報告[2]，建議加拿大海岸防衛隊全面負責加國（除軍事安全外）的海洋安全事務，因此，發展全方位的海洋執法機關是加國海岸防衛隊的目標。在油污應變部分，加拿大海岸防衛隊在油污染發生時，只有兩種情況會介入：第一是無主的油污染，加國稱為神秘的油污染（mystery oil spill），亦即找不到漏油者；第二是超過民間公司的承載範圍（10,000噸以上），才會由海岸防衛隊動用國家能量介入除污。

五、貝德福海洋研究所（BIO）

貝德福海洋研究所（Bedford Institute of Oceanography, BIO），位於加拿大諾瓦斯科西亞省（Nova Scotia）達特茅斯（Dartmouth），由加拿大聯邦政府於1962年創立，已經發展成為加國最大的海洋研究中心。它受加國政府的委託，同時提供政府施政意見，支持政府決策，主要研究領域包括一系列海洋問題研究，包括主權、國防、環境保護、安全與健康、漁業、自然資源和環境及海洋管理與規劃。

自成立以來，有著一流設備和遠洋航行能力的貝德福海洋研究所已經成為世界一流的跨學科海洋

研究機構。其人員組成主要來自國防部（National Defence, DND）、環境與氣候變化部、漁業與海洋部、資源部（Natural Resources Canada, NRCan）等4個聯邦部門，並和許多大學、產業、先進國家和非政府組織建立了合作夥伴關係。在貝德福海洋研究所建立之初，便著手加拿大與世界洋流體系和氣候變遷的許多計畫有深入的研究，同時也針對大西洋加國海域的廣泛海洋地質進行研究，奠定後來石油、天然氣探勘的基礎，貝德福海洋研究所在某種程度上都有重要的貢獻。

貝德福海洋研究所的機構設置與人員組成

貝德福海洋研究所目前有600多名科學家、工程師、技術員、自然資源和環境管理人員等不同領域進行研究與合作。4個聯邦部門每年舉辦聯席會議，研究確定重大事項與研究課題，具體管理事務由所長負責，4個部門的分支機構具有一定的自主權，實驗室、研究空間、數據資料、研究設備等資源共享。在資源共享方面，貝德福海洋研究所建立了科學數據「完全與開放」的共享管理機制，要求保障科學研究人員以及社會各階層人員均可以便宜的費用、最方便的方式取得科學數據。海洋科研機構都十分重視科技數據的建置和數據的共享，使其成為科學研究的重要基礎和成果，並做為社會服務、爭取民衆支持的重要方式。

貝德福海洋研究所非常重視科學教育，而且科學教育是BIO貢獻社會計畫的重點，提供社會大衆教育經驗和資源。在人才培養的部分，BIO的員工會定期志願付出工作訓練。BIO進行的海洋科學研究，包括瀕危物種、海洋科學、海洋環境科學、水文調查、棲地管理研究、海洋法、科學諮詢委員會與出版刊物年報、相關出版品等。此外，為了紀念海洋科學家亨茲曼（Archibald Gowanlock Huntsman）博士，設置了亨茲曼獎（Huntsman Award），該獎是由加拿大海洋科學聯盟頒發，表彰在海洋科研有貢獻的科學家。加國的政府部門與科研單位諸多的資訊與政策作為都可以提供參採。

圖3／貝德福海洋研究所研究室一隅
圖片提供／施義哲

加拿大海洋策略的制定背景

1987年加拿大漁業與海洋部公布的「海洋策略」（Oceans Strategy）對加拿大來說是挑戰和機會，加國海洋策略宗旨是確保加國從海洋獲得最大的社會、經濟、科學和主權方面的利益，並全力提

升全體國民的海洋策略意識。加拿大的海洋策略是根據加國《海洋法》提出的立法和政策需求，《海洋法》授權加拿大漁業與海洋部長負責組織領導監督加拿大海洋策略，訂定加拿大21世紀海洋策略。海洋策略主要宗旨在制定明確的目標，促進所有海洋管理權益相關者之間的合作。

一、加拿大的海洋立法與策略

加拿大從1867年建國迄今150幾年，其海洋立法對於規範海洋開發秩序、爭取國家海洋權益尤為重要。加拿大對於海洋立法有悠久的歷史，在建國之初（1868年），就頒布了第1部《漁業法》（Fisheries Act），1869年又通過《沿海漁業保護法》（Coastal Fisheries Protection Act），這兩部法律至今仍是加國漁業管理的法律基礎。1997年頒布了《海洋法》，成為世界上第1個進行整合性海洋立法的國家，《海洋法》規範了各部門的職責，並統籌一切海洋事務，將《聯合國海洋法公約》（United Nations Convention on the Law of the Sea, UNCLOS）賦予各沿海國的權利以國內立法的形式具體化，將國家海洋策略及政策用法律的形式固定下來，以適應海洋法公約生效後海洋形勢的新發展。此外，聯邦海洋相關法律亦相當全面，例如《海洋法》、《環境保護法》（Canadian Environment Protection Act）、《漁業法》、《海運法》、《野生動物保護法》（Canada Wildlife Act），《北極水污染防治法》（Arctic Waters Pollution Prevention Act）等。

二、加拿大海洋策略

加拿大頒布施行《海洋法》，使加國成為世界上第1個具有整合性海洋管理立法的國家，為了落實《海洋法》，2002年加國頒布加拿大海洋策略（Canada's Oceans Strategy），海洋策略確定了加拿大水域和生態系統的管理願景、原則與政策目標，其重點是瞭解和保護加拿大海洋環境的計畫與政策，為加國經濟永續發展提供計畫和政策，確保該國在國際海洋領域領先地位的政策與計畫。例如，採用科學方法瞭解和保護海洋生態系統，對海洋科學進行研究，劃定生物界限，確定重要生態系統的範圍，開發評估技術，制定生態系統的管理目標，評估生態系統健康情況等。為了達成此目標，制定了各種具體措施，如加強海洋的研究、保護海洋生物多樣性、海洋環境保護、制定整合管理計畫、確保海事安全、振興海洋產業、促進國際合作、加強公衆教育等。

小結

21世紀是以海洋為重心的世紀，海洋亦是臺灣未來主要的出路，第1屆世界海洋日總統曾提示海洋委員會在「健全海洋法制，做好生態保育工作」、「配合政策，推動海洋產業」及「強化海洋研究能量，培育海洋人才」3個方向努力，借鏡加拿大的經驗，將來在海洋經濟的發展、海洋生態環境保護和管理，維護海洋國土安全，爭取海洋權益，都需要海洋科技的研發與創新做為國家海洋政策擬定的後盾，以推展海洋永續的發展，立足臺灣，航向海洋的海洋國家。

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可偵測非法、未報告及不受規範（IUU）漁業的遙感探測技術

撰文／劉正千（成功大學地球科學系特聘教授暨全球觀測與資料分析中心主任）
關鍵字／雷達衛星、遙感探測、非法未報告及不受規範漁業、自動識別系統、暗船、哨兵一號、國家海洋衛星影像服務平臺、冰眼、低軌道微衛星星系

非法、未報告及不受規範（Illegal, unreported and unregulated, IUU）漁業泛指各種異常的漁業行為，是在1997年召開的南極海洋生物資源養護委員會年會中所提出的一個新名詞。聯合國糧農組織（Food and Agriculture Organization of the United Nations, FAO）後於2001年制定了「預防、制止和消除IUU國際行動計畫（International Plan of Action to prevent, deter and eliminate IUU fishing, IPOA-IUU），詳細定義了IUU漁業，並指出其根本原因係部分國家授予漁船船旗後，無法對所屬漁船進行足夠之監督與控制，使該等漁船從事IUU漁業而未受懲罰。為展現政治意願，共同合作打擊IUU漁業，世界多國已制定各自之國家行動計畫（National Plan of Action, NPOA），臺灣亦於2013年訂定「預防、制止和消除非法、未報告及不受規範捕魚之中華民國（臺灣）國家行動計畫」，展現打擊IUU之決心[1]。然而一般的沿岸環境監測系統及漁業非法捕撈管理尚未完善，亟需提升監控技術才能達成遏阻IUU漁業之目標。本文介紹衛星遙感探測技術在雷達衛星遙感探測影像獲取，與時間序列資料分析上的突破，以及海洋委員會國家海洋研究院應用這些技術所提供的服務，盼望未來能善加發揮這項技術與服務的優勢，達成遏阻IUU漁業之目標。

衛星遙感探測的優勢與光學影像的限制

遙感探測（Remote Sensing）是對於調查的物體、區域或現象以不接觸的方式獲取資訊並加以分析的科學與技術[2]。透過運行在環繞地球軌道上的衛星平臺來進行遙感探測，更具有長時間、大範圍、穩定週期和近即時監測的優點，因此自1972年美國國家航空太空總署（NASA）將第1枚專為進行地球資源探勘的陸地衛星1號（Landsat-1）送入軌道後，近50年以來，根據聯合國外太空事務辦公室（United Nations Office for Outer Space Affairs）統計，已有超過7千顆不同的衛星升空運行[3]。當年因為美蘇強權軍事競賽而發展的衛星遙感探測科技，現在成為人類監控地球最有利的工具，各種商業服務與應用蓬勃發展。

在衛星可以拍攝的各種影像中，使用可見光和近紅外波段範圍的光學影像和人眼所見之景象最為接近，也最容易判讀解釋，因此一直是關注的重點，不斷努力提升其時間與空間的解析度。然而在任何時刻中地球表面有52%的區域是被雲層所覆蓋[4]，若單單考量海洋範圍，這個比率還要再提高為55.0～56.5%[5]，因此無法穿透雲層的光學衛星影像，在實務應用上受到先天的限制。對於在關鍵時空中監測IUU漁業的工作，需要突破雲層遮蔽的限制。

雷達衛星遙感探測與合成孔徑雷達成像原理

雷達衛星是藉著衛星主動發出特定波長之雷達波與地表地物交互作用後，偵測其產生的回波訊號以獲取地表地物之性質，屬於主動遙測。雷達衛星不需依靠太陽所發出的電磁波作為訊號來源，所使用的電磁波波長又比組成雲霧的水滴尺寸更長，可以繞過水滴不受阻擋，因此，和光學衛星影像相比，雷達衛星影像具有全天候日夜取像和穿透雲層的優勢。

雷達衛星影像的空間分辨率會受到軌道高度和實體雷達天線長度的限制，無法滿足較高空間分辨率的需求，但運用合成孔徑雷達（Synthetic Aperture Radar）成像原理，將衛星高速飛行過程中在不同的時間發送的電磁波，由不同的位置接收，再把這些連續且重疊的電磁回波資料加以解算，就可以達到提升影像解析度的效果。因此，利用合成孔徑雷達成像的技術，雷達衛星已經可以提供公尺等級的高空間分辨率影像，某些衛星甚至可以提供25公分等級的超高空間分辨率影像。

暗船識別與IUU漁業監測

安裝在船舶上的自動識別系統（Automatic Identification System, AIS），可以透過與鄰近船舶、岸臺、以及衛星等交換電子資料，提供辨識及定位的即時資訊。《國際海上人命安全公約》（International Convention for the Safety of Life at Sea, SOLAS）規定，總噸位在300噸以上之船舶，以及所有大小噸位的客船，都必須裝載AIS。船舶藉此於航行途中可經由沿線的AIS基地臺與衛星系統，傳送包括GPS的精確位置、國際海事組織（International Maritime Organization, IMO）編號、海上移動服務標誌（Maritime Mobile Service Identity, MMSI）和如名稱、船型、尺寸、速度、航向等其他訊息，提供監測及管理所需之關鍵資訊。然而AIS訊息的內容並不總是正確可靠的，因為不法船舶可以偽造其AIS訊息中的字段，甚至提供預先捏造的航線經緯度坐標。而所謂的「暗船」（Dark vessel），就是刻意關閉AIS以避免被監測追蹤，藉以從事包括IUU漁業等非法行為。因此，若能快速準確地從不受天候和雲層影響的雷達衛星影像中，辨識出海上船隻的位置，再與船舶的AIS位置訊息與軌跡比對，就可以快速識別並標記出暗船，進一步掌握其是否正在從事IUU漁業等非法行為。加拿大政府於2021年初便啓動了一項經費高達7百萬美元的國際合作計畫，應用雷達衛星遙感探測技術快速識別暗船，藉以打擊IUU漁業[6]。

雷達衛星影像資料來源的大爆發

首枚商用雷達衛星是由加拿大在1995年發射升空的RADARSAT-1，之後包含美國、德國、日本、中國、印度、以色列等國都推出了自己的合成孔徑雷達衛星任務。雖然雷達衛星影像的各種商業服務與應用也是蓬勃發展，但因為主動遙測需要大功率的雷達發射裝置，衛星酬載（payload）較重，技術門檻也較高，建造、發射和營運的成本較高，因此一般商用市場上可獲取之雷達衛星影像資料來源較少，價格也比光學影像高得多。對於在關鍵時空中監測IUU漁業的工作，雖然使用雷達衛星影像可以突破雲層遮蔽的限制，但一般研究單位很少負擔得起購置同一個地點長期觀測的時間序列資料，因此始終停留在技術上可行，但實務上不行的尷尬階段。

歐洲理事會於2012年將全球環境與安全監測計畫更名為哥白尼計畫（Copernicus initiative），次年規劃了一系列的哨兵衛星任務，其第一項任務就是發射Sentinel-1雷達衛星，不分晝夜且不受天

候影響，以長時間、大範圍和穩定週期拍攝陸地及海洋之合成孔徑雷達衛星影像。Sentinel-1為軌道高度693公里之太陽同步衛星，由2014年4月Sentinel-1A及2016年4月Sentinel-1B分別發射的兩顆運行於相同軌道之衛星構成。哥白尼計畫完全支持資料開放政策，除了建構哨兵中心（Sentinel Hub），透過網路平臺無償對各界提供哨兵衛星任務所拍攝巨量且高品質的遙感探測影像，並開發了功能強大的哨兵應用平臺（Sentinel Application Platform, SNAP）軟體，讓使用者可以自行從原始影像處理成各級產品，可說是雷達衛星影像資料來源的大爆發。

ICEYE是芬蘭阿爾托大學無線電技術系於2014年所設立的衍生公司，專攻微型衛星製造。2018年1月，重量僅70公斤的ICEYE-X1衛星，成功進入軌道運轉，是全世界第1枚重量100公斤以下的合成孔徑雷達衛星，主要應用就是監測海冰運動、海洋石油洩漏、以及防止IUU漁業。第2枚衛星ICEYE-X2也於2018年12月成功進入軌道。與ICEYE-X1相比，ICEYE-X2擁有多種成像模式，包括解析度為3公尺的帶狀圖（Stripmap）模式，或50公分超高解析度的聚光（Spotlight）模式。2019年7月再成功發射了兩枚SAR衛星，組成星系。空間分辨率達1公尺的雷達衛星影像產品正式於2019年10月商業運轉；具廣域成像能力，可覆蓋10,000平方公里範圍的服務，也正式於2021年5月商業運轉。至2021年已有10枚ICEYE衛星在軌道運行組成星系，預計到2022年會增至18枚，這可說是雷達衛星影像資料另一來源的大爆發。

雷達影像時間序列分析與變異偵測

雷達波對水體反應非常靈敏，只要偵測區域覆蓋了薄薄的一層水，對於直線前進的雷達波就會發生鏡面反射，導致回波訊號的強度非常低，從回波強度的影像上看起來就會很暗。也因此應用雷達影像偵測海面上的船隻，船隻和海面之間的回波強度差異通常會非常大，對比效果也會很好。然而必須注意的是，海面也會受到風的影響而產生許多波浪，導致漫射，偶爾會產生較強的回波訊號，稱之為海雜波。雖然在一幅影像中要決定濾除雜訊的標準容易產生混淆，誤報偵測到的船隻，但因為前述雷達衛星影像資料來源的大爆發，吾人可以獲取同一個地點長期觀測的雷達衛星時間序列影像，這相當於提供了多次觀測的「多視」數據，因此可以利用時間序列資料分析的技術，更客觀地界定出雜訊的範圍，進而準確地偵測出真正的變異—船隻。

就變異偵測的工作而言，Reed and Yu[7]提出了計算自適化恆定誤警率（Constant False Alarm Rate, CFAR）來偵測多頻譜光學影像異常區的方法，其基本假設是大部分的光學影像背景干擾可使用一個快速擾動且隨空間變動的平均值，加上一個緩慢變動的共變異數（Covariance）高斯隨機模型來描述。符合這種模型的是背景干擾，不符合的就是異常區，可能就是目標。他們使用了Landsat多頻譜光學影像來建立模擬所需的資料庫，並加以測試，此方法後來於高光譜影像變異偵測之應用上發揚光大[8][9][10]，Reed and Yu[7]也建議可擴展CFAR應用於雷達目標偵測的問題。SNAP軟體就根據一個雙參數的CFAR模型，提供了船隻自動偵測的產品，其整個處理的過程包含了產製海陸遮罩（Land Sea Mask）、校準（Calibration），再以Crisp[11]提出之方法進行船隻偵測，包含適應定限（Adaptive Thresholding）與物件辨識（Object Discrimination）兩個步驟。ICEYE更建構了一個機器學習的卷積神經網路（CNN）架構，經過充分的訓練和驗證後，可以區分船隻的重要特徵，分類不同的船隻類型[12]。以此為基礎，更擴展至利用可見的船隻尾流檢測和確定船隻的航向及速度[13]。

國家海洋研究院衛星暨海洋資料庫服務

海洋委員會主管全國海洋事務，特設國家海洋研究院，負責海洋研究與發展之資訊蒐集、成果及技術之推廣。自2021年起有系統地蒐集、建置與處理臺灣周遭海域衛星影像，並提供各種加值服務產品，其中就包含了運用2014年至2021年共計約620幅之Sentinel-1雷達衛星Level-1 GRD影像，以及海水表面船隻分布的產品。以2020年6月4日臺灣時間上午10點左右拍攝之影像為例，Sentinel-1雷達衛星IW模式GRD產品空間解析度為10公尺，所能偵測之目標物大小約為30公尺。海水表面船隻分布的產品包含各目標物的中心點經緯度坐標，以及該目標物之長、寬。當日海水表面船隻分布的產品套疊於當日之Sentinel-1雷達衛星影像，可在國家海洋衛星影像服務（National Ocean Satellite Image Service, NOSIS）平臺（https://nosis.geonet.tw）上瀏覽。

Sentinel-1雷達衛星在臺灣地區約每2至4天（包含升軌及降軌）可拍攝一幅影像，國家海洋研究院在獲取資料後會使用SNAP軟體產製海水表面船隻分布的產品，並發布於國家海洋衛星影像服務平臺上。將此產品結合海洋交通（Marine Traffic）網站（https://www.marinetraffic.com/）所提供的AIS資料，同樣可以識別暗船，藉以打擊IUU漁業。以2020年6月4日Sentinel-1雷達衛星拍攝臺灣附近影像的時刻為例，可查詢海洋交通網站AIS資料所顯示的船舶位置。

為了仔細比對，將上兩段提及之國家海洋衛星影像服務平臺與海洋交通網站上的高雄小港區放大，並對比顯示於圖1，可以發現圖1（a）雷達影像中海水表面船隻位置，與圖1（b）AIS資料中顏色較鮮明的紅點或綠點分布狀態接近，看得出Sentinel-1雷達衛星影像海水表面船隻分布的產品有一定的精確度。另外，圖1（b）中顏色較淡的紅點跟綠點所指為最後偵測到AIS資料的位置，該船可能在關閉AIS後駛離。這些就是快速識別並標記出的暗船，根據這些資料就可以進一步掌握其是否正在從事IUU漁業等非法行為。

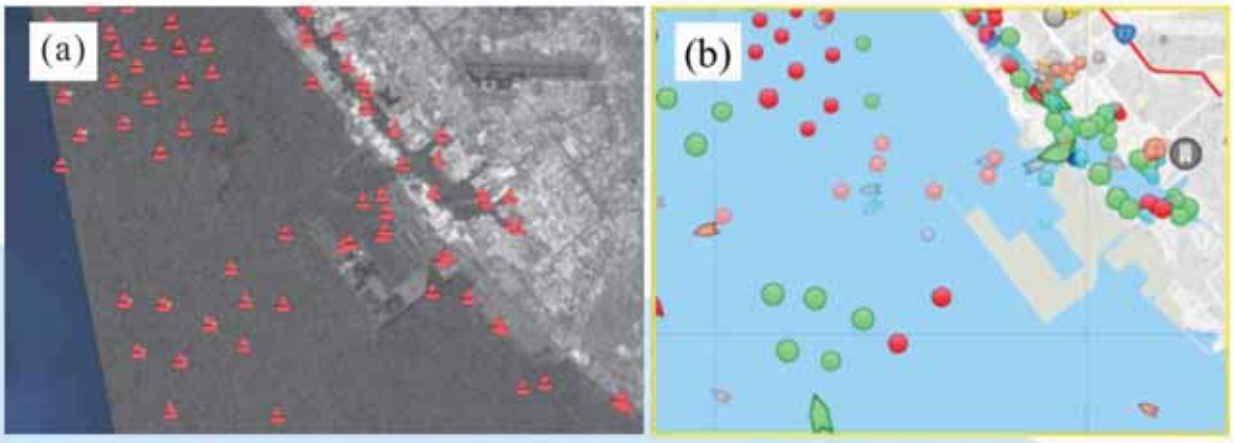

圖1／（a）NOSIS平臺2020年6月4日臺灣時間上午10點左右拍攝之高雄小港區Sentinel-1雷達衛星影像；（b）海洋交通網站AIS資料所顯示的船舶位置

圖片來源／（a）https://nosis.geonet.tw；（b）https://www.marinetraffic.com/

結論

「遏阻IUU漁業」是聯合國糧農組織所發起，並得到世界多國（包含臺灣）積極響應的重要計畫。衛星遙感探測具有長時間、大範圍、穩定週期和近即時監測的優點，對於在關鍵時空中監測IUU漁業的工作，可以利用雷達衛星全天候日夜取像和穿透雲層的優勢，但一般研究單位很少負擔得起購置同一個地點，長期的雷達衛星影像時間序列資料，因此始終停留在技術上可行，但實務上不行的尷尬階段。近年來完全支持資料開放政策的哥白尼計畫，無償對各界提供哨兵衛星任務所拍攝巨量且高品質的遙感探測影像，再加上芬蘭阿爾托大學衍生公司ICEYE所建置的雷達微衛星星系也成功商業運轉，提供了許多優質的產品，可說是雷達衛星影像資料來源的大爆發。而關於從雷達影像上快速準確自動偵測船隻的技術也已成熟，再與船舶的AIS位置訊息與軌跡比對，就可以快速識別並標記出暗船，進一步掌握其是否正在從事IUU漁業等非法行為。

國家海洋研究院自2021年起蒐集、建置與處理了2014年至2021年共計約620幅之Sentinel-1雷達衛星Level-1 GRD影像，以及海水表面船隻分布的產品，發布在國家海洋衛星影像服務平臺上。將此產品結合海洋交通網站所提供的AIS資料，同樣可以識別暗船，進一步掌握其是否正在從事IUU漁業等非法行為。雖然使用從哨兵中心下載的Sentinel-1雷達衛星影像無須付費，但會有1～2天的時間落差，無法提供即時資訊與服務，但此項工作所建立的服務模式與能力，只要再挹注購置ICEYE雷達微衛星星系的商業影像服務經費，就可以縮短時間落差。未來還可以根據此項工作所累積的經驗，建構臺灣自主低軌道微衛星星系。

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加拿大《海洋法》之簡介

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關鍵字／海洋法、加拿大

加拿大於1997年通過海洋專法《海洋法》，同時也是世界上第1部以海洋生態系統為基礎的海域管理專法，被視為可供世界其他國家或區域參採的典範。

背景與發展歷程

有別於多數海洋國家，其海洋相關的法律係分散式規定在各類交通、漁業、海防、生態保育等的法規當中，而欠缺一部統合性的海洋專法；加拿大於1997年即通過一部海洋專法《海洋法》（該法全稱為「Oceans Act S.C. 1996, c. 31」，依據該法第1條規定，係簡稱為「Oceans Act」），且由於該法被譽為是一部旗艦級（flagship）的海洋保護法，同時也是世界上第1部以海洋生態系統為基礎的海域管理專法。由於其於國際間具有領先地位，也因此各國對於這部法律的實踐經驗以及如何成功地管理其海洋領域，給予一定程度的關注[1]。

在加拿大完成《海洋法》的立法之前，即採取了許多果斷的措施來捍衛其海洋領域及海洋資源，最具代表性的實例是，為了解決歐洲國家長期以來在加拿大紐芬蘭島東南方的北美洲大陸礁層上覆水域，亦即所謂的「紐芬蘭大淺灘」（The Grand Banks）過度捕撈的問題，遂於1977年當時的漁業部長（Fisheries Minister）羅密歐勒布朗先生（Roméo LeBlanc）的領導下，將加拿大的漁業管轄範圍擴大到200海哩[2]。而此一200海哩的海洋資源專屬權利的宣示，後來即被1982年《聯合國海洋法公約》（United Nations Convention on the Law of the Sea, UNCLOS）納入成為今日「專屬經濟海域」（Exclusive Economic Zone）之制度。

至於以立法方式作為海洋管理之必要基礎的構想，則可追溯至1987年加拿大所提出的第1個海洋策略（Oceans Strategy），蓋此一海洋策略當中除了主要包含4個政策目標之外（沿海經濟發展與海洋產業的促進、海洋科學、海洋資源與環境的管理及保護、主權），也同時確立必須透過立法來建構新的海洋管理基礎[2]。儘管在前述1987年海洋策略提出之後，歷經了10年之久始完成了《海洋法》的立法工程，甚至過程當中曾一度呈現停滯的狀態[3]。但在1994年由直屬於首相的國家科學技術顧問委員會發布了以「來自於我們海洋的機會」（Opportunities from our Oceans）為題的研究報告，以及漁業與海洋部長布萊恩托賓（Brian Tobin）於1994年發布的「海洋管理願景」（A Vision for Oceans Management）等重要政策文件，皆為《海洋法》的制定奠立了重要基礎與推力[2][4]。

加拿大《海洋法》於1997年1月正式生效施行，其內容的主要特色包括有：援引UNCLOS當中有關海域劃界之規定，透過法律明文規定加拿大的海洋領域擴大到包括專屬經濟區、鄰接區及領海（相較於加拿大，我國之《專屬經濟海域及大陸礁層法》係公布於1998年1月21日）。亦將負責海上執法的加拿大海岸防衛隊（Canadian Coast Guard）的組織隸屬從原本的加拿大交通部（Transport Canada）移轉到加拿大漁業與海洋部（Fisheries and Oceans Canada, DFO）。以及制定一項全面性的海洋管理策略，以履行UNCLOS中所規定的國際海洋管理義務，同時也藉此讓爾後策劃的國際環境政策活動獲得更強的力道。

整體而言，1997年生效的加拿大《海洋法》被視為可供世界其他國家或區域參採的典範，尤其是其所應對的現代海洋管理3個挑戰：納入永續發展原則與方法；意圖解決海洋管理向來的零碎化；以更整合性的以及基於生態系統的方式進行管理[5]。

法規內容梗概之介紹

一、基本架構

《海洋法》的規範內容主要係由3部分所組成，第1部分即如前所述，透過法律主張加拿大所得管轄的海域，同時與UNCLOS條款一致，界定了其領海、鄰接區、專屬經濟海域和大陸礁層等海域，並承諾加拿大政府在這些海域履行其保護和管理責任。

《海洋法》的第2部分則為有關漁業與海洋部長之具體政策和計畫執掌，例如第29節之加拿大海洋策略，又例如對於3個具體規劃工具的規定：一、海洋保護區；二、海洋環境質量；三、綜合管理計畫。這些計畫是實施國家海洋政策目標的關鍵工具，能有助於瞭解和保護海洋環境、支持永續的經濟機會和海洋管理之國際領導地位。

第3部分則規定了該法的責任，依據該法第2節之規定漁業與海洋部長為負責加拿大境內海洋管理的主責聯邦機關，並將該部門現有的資源管理、科學、水文、海岸防衛隊和其他職責置於海洋管理範圍內。

二、策略與行動方案

如前所述，加拿大《海洋法》於1997年完成立法並施行，而目前的版本係屬2019年5月最新修正的版本，但其內容主要架構仍建立於1997年的《海洋法》。

加拿大《海洋法》在一開始即透過其序言（preamble），清楚地闡明了加拿大聯邦政府意圖成為海洋管理領域世界領導者的企圖心，同時也明確規定該法係建立在永續發展、預防方法和整合性管理的3大基本原則之上（第29節及第30節）。

該法案的主要成果是海洋策略（oceans strategy）、整合管理計畫（integrated management plans）和國家海洋保護區網絡（national network of marine protected areas）。首先，根據《海洋法》第29節規定，漁業與海洋部長的一項重要工作是根據該法第30節規定的基本原則，並邀集其他權責相關之聯邦政府機關、各級政府、原住民族團體以及受影響之海岸地區社區等利益相關者，並採用新的整合性海洋管理措施與方式共同制定海洋策略。

至於所謂的整合海洋管理係指，評估範圍必須包含河口、沿海水域及海洋水域，同時評估對象包括影響前述水域範圍內的所有活動或措施（第31節）。而有關國家海洋保護區網絡的部分，主要係鑒於其他聯邦政府機關（例如加拿大國家公園部及加拿大環境與氣候變化部）依法亦得設置建立海洋保護區，因此《海洋法》即授權加拿大漁業與海洋部長得以「代表聯邦政府引導和協調國家海洋保護區系統的規劃和實施」（第35節第1項）。除了前述統整各機關事權之協調功能外，《海洋法》還特別賦予加拿大漁業與海洋部得設立新類別的海洋保護區（第35節第1項）。

《海洋法》生效5年後，加拿大海洋策略（Canada's Oceans Strategy, COS）終於在2002年發布，並為加拿大的海洋管理提供了政策框架[6]，並在《海洋法》的永續原則指導之下，引導開發、綜合管理和預防管理方法之使用。再者，2005年時亦發布了一項海洋行動計畫（Canada's Oceans Action Plan, OAP），當中係以4個相互關聯的支柱進行組織：國際領導力、主權和安全；促進永續發展的綜合海洋管理；海洋健康以及海洋科學技術。OAP確定了將在兩年內完成的一系列行動，以實施《海洋法》和海洋策略，當中包含一系列措施以及相關之經費來源[3]。

三、協調整合政府機關之功能

《海洋法》最受到推崇的規定之一者，即是加拿大漁業與海洋部於協調整合政府機關方面的功能，該法第32節第1項（b）款規定：「為實施整合管理計畫，（漁業與海洋部）部長……（b）得與加拿大政府的其他部長、委員會和機構協調政府之間與沿海水域和海洋水域或影響沿海水域和海洋水域的所有活動或措施的政策和計畫的實施。」透過漁業與海洋部長與聯邦政府其他部長和機構之間的協調，其目的在於為加拿大的海洋管理帶來更多一致性的機制。

此外，一方面既有的海洋事務本來即被分散地分配到各別的聯邦政府機關，但另一方面海洋事務仍不斷推陳出新地發展著，因此《海洋法》即賦予漁業與海洋部一個統括式的事務管轄權，亦即只要有尚未被分配到其他聯邦政府機關或組織的海洋事務，即皆屬漁業與海洋部之權力和職責（第40節）。此外，漁業與海洋部尚需提出策略以「促進開展必要的活動，以增進對海洋和海洋資源的理解、管理和永續發展」（第32節第2項）。

儘管如此，亦有論者對於執行成效抱持懷疑的立場，而認為雖然《海洋法》致力於對海洋管理採取整合方法，但相關事務實施上仍舊是依據現有部門的立法和法規，並批評「處理海洋或沿海治理的一系列分散式的法規和相關聯邦部門卻完好無損，沒有變化……」[7]。依據學者的分析，主要原因在於不只是聯邦之間各政府機關，甚至聯邦與州政府之間的政府機關無不小心翼翼地守護著自己的管轄權與主管法規。此外，《海洋法》實施之良窳主要仍取決於海洋事務相關權責機關之間的合作，然而各權責機關本即有各自的立法、任務、資源以及優先施政事項。在沒有足夠的誘因的情形下難以產生各權責機關之間的合作動力。因此即使《海洋法》透過規定來期許海洋事務相關之聯邦機構間能進行合作與對話，以及賦予漁業與海洋部有引導各機關政策協調之權責，但在激勵措施不足並囿於當前之治理結構，仍舊導致立法的理想目標被大打折扣[3][8]，由此足見，政府機關之間的權責協調與整合並非只單靠立法即可克盡其功。

新修正《海洋法》之展望—代結語

2019年5月加拿大聯邦政府已通過《海洋法》修正草案，修正重點綜合整理如下：一、加速海洋保護區的指定程序及提高海洋保護區的效率；二、新增「生態完整性」（ecological integrity）的法律定義；三、明定預防方法之採用（the application of the precautionary approach），確立即使對海洋活動造成的風險缺乏科學確定性，亦應採取預防措施之立場。

此外，為了加強海洋非生物資源的保護，加拿大衆議院通過了對《石油資源法》（Petroleum Resources Act）的修正案，以作為《海洋法》的補充法規，亦即授權加拿大自然資源部（Natural Resources Canada）、加拿大原住民族關係部（Crown-Indigenous Relations）和加拿大北部事務部（Northern Affairs Canada）可以透過協商的方式讓權利人或權利團體自願放棄石油和天然氣權益，倘若前述之權利因海洋保護區之指定而必須廢止時，應給予合理的補償。

有關海洋保護區的部分，新法授權聯邦政府在為了可以採取迅速的保育行動，得劃定暫時保護重要的自然區域。此一修法將有助於確保稀有物種和重要棲息環境在海洋保護區正式劃定之前可以受到法律保護，並確保在正式劃定保護區所需的冗長協商和談判過程中是安全無虞的。此一緊急保護原則上為5年，在這5年的期間亦是為了讓主管機關有充足的時間與各州、地區、利益相關者、原住民社區和公衆進行磋商，以利取得雙贏的共識。

在本次修法公告之前，加拿大所劃定之海洋保護區範圍已達加拿大海域的8.27%，加拿大聯邦政府擬透過該次修法來標誌加拿大朝向2020年海洋保護區達到10%海洋區域之國際承諾的決心。此外，更於2021年6月表示加拿大承諾將於2025年將海洋保護區擴大到所轄海域的25%，並期待在2030年擴大保護到30%[9]。

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Saving and Protecting Cetaceans, Striving Towards Ocean Sustainability

Translated by Linguitronics

Minister of the Ocean Affairs Council: Chung-Wei Lee

Maritime nations are endowed with rich marine resources. This is why they must design comprehensive policies for oceans management that are focused on sustainable development. In this issue, we introduced one of the world's strongest maritime nations—Canada. Canada passed the Oceans Act in 1997, the first oceans management law in the world that aims to protect marine ecosystems at its core. The Oceans Act not only became a guiding principle for subsequent oceans strategies and oceans action plans, but also gave the Fisheries and Oceans Canada (DFO) the obligations and powers to coordinate across different government agencies, and set the DFO as the responsible agency for integrating oceans management in Canada. The Canadian government isn't just an international leader in terms of integrated oceans legislation. In September 2018, the country's government established the High Level Panel for a Sustainable Ocean Economy with other maritime nations (a total of 14). Panel members include nations from five continents and across three oceans. The goal is to include all territorial waters under the jurisdiction of the panel nations into sustainable management by 2025. This is in hopes of facilitating the economic transformation of sustainable oceans in five critical fields—ocean wealth, ocean health, ocean equity, ocean knowledge, and ocean finance.

In addition, Canada—the third country with the highest number of whale watchers in the world—implemented the "Marine Mammal Regulations" of the Fisheries Act to manage all marine mammal related business and tourism activities. The Species at Risk Act has strict regulations regarding the distance of whale watching to protect endangered species and threatened habitats; its management model can serve as a notable reference. The government of Taiwan released the "2020 Annual Report on Cetacean and Sea Turtle Strandings in Taiwan by the Ocean Conservation Administration of the Ocean Affairs Council." Through the recording and rescue work of the Marine Animal Rescue Network (MARN), as well as summarized and periodically announced reports by the Ocean Conservation Administration, we hope to build an emergency mechanism and conservation safety net for wild marine animals with collaborations between the government and the public. By doing so, we hope to improve wild marine animal rescue work and encourage the public to take care of marine animals and their ecosystems.

Ocean Conservation Administration releasing pygmy killer whales back into the wild. The ship set out from Anping Harbor in Tainan on June 20, 2020.
Image by Ocean Conservation Administration

2020 Taiwan Cetacean and Sea Turtle Strandings Report

Ocean Conservation Administration
Translated by Linguitronics
Keywords: Cetacean, sea turtle, stranding, pygmy killer whale, blue whale

5 in 7 species of sea turtles around the world are distributed in sea areas near Taiwan; so are around 90 species of cetaceans worldwide. In 2020, 22 species of cetaceans were witnessed along the coastlines of Taiwan. We found more than 28 species of them after joining rescue efforts. The Marine Animal Rescue Network (MARN) team [1] coordinated by the Ocean Conservation Administration (OCA) spearheads the rescue operations of injured wildlife marine animals. The team is responsible for taking charge of stranded cetaceans and sea turtles along the coastlines of Taiwan. According to statistical results in 2020 [2], the team received stranding reports of 161 cetaceans and 335 sea turtles. Since the founding of MARN, the procedures for reporting stranded marine animals and the division of labor for MARN members are increasingly mature. Advocacy efforts from each unit are effective, which allows the MARN team to continue with their work. This leads to a more comprehensive understanding of actual marine wildlife strandings in sea areas near Taiwan.

Distribution of stranded cetaceans

In 2020, there were 19 cases of stranded cetaceans in Kinmen and Lienchiang County each, the highest among all. Penghu County and Kaohsiung City each had 18 cases, coming in second. New Taipei City and Taitung County each also had more than 10 recorded cases. Compared to 2019, in 2020, there were more stranding cases in outlying islands. As for the significant increase of strandings in Kaohsiung, this was due to the mass strandings of pygmy killer whales there. Additionally, no strandings occurred in Chiayi County, Hsinchu County, and Hsinchu City in 2019, but all of these saw strandings in 2020.

Different species of stranded cetaceans

In 2020, a total of 21 cetacean species were stranded, the three species with the highest number of animals stranded was the same as in 2019: 46 finless porpoises (28.6%), 27 pygmy killer whales (16.8%), and 25 bottlenose dolphins (15.5%). These three species account for approximately 61% of all stranding cases.

Analysis on the reasons of cetacean strandings

Among the 161 cetaceans that were stranded in 2020, 8 were rescued and released back into the wild. The proportion of live marine animals stranded on land was significantly higher than in 2019. After examining and performing necropsy on the remaining 153 creatures, we made the following analysis for the reasons these animals were stranded:

I. It was impossible to discern the reasons of death for 85 of them because their bodies were severely decomposed. These account for 56% of the 153 animals that were dead.

II. 38 of these marine animals were found to have severe lesions in their internal organs after necropsy, and it was determined that infections caused the deaths of these cetaceans. They account for 25% of all 153 animals that were dead.

III. Furthermore, 24 of them had net marks and undigested food in their stomachs. It was determined that these cetaceans had food intake shortly before their deaths. They also had fractured snouts or upper and lower jaws as well as signs of dorsal and caudal fins having been cut off by external force. Through careful examination, their deaths may have been caused due to fishery bycatch. They account for 16% of all 153 animals that were dead.

IV. Tomographic scans revealed symptoms such as bone fracture, displacement or dislocation, or abnormally large soft tissue contusions. It was determined that 2 marine animals were killed by blunt force trauma, accounting for 1% of all 153.

V. Lastly, 2 were swept away by the waves after becoming stranded and weren't found while the other 2 have yet to be examined.

Pathological analysis of cetacean strandings

The deaths of 38 cetaceans were caused by infections. After going through pathological analysis, all were found to have organ lesions: 28 (74%) had pulmonary lesions and 9 of them showed obvious signs of asphyxiation; 16 (42%) had splenic lesions; and 15 (39%) had cardiac lesions.

Distribution of stranded sea turtles

In 2020, 335 stranded sea turtles were reported in Taiwan in total. 276 were dead stranded animals (82%) while 59 were live stranded animals (18%); The highest number of stranding cases were in New Taipei City. Pingtung County came in second, and Taitung and Penghu County both came in third. Among the live stranded animals, 37 were released back into the sea on the spot; 22 were hospitalized, 7 of which were released back into the ocean eventually. Green sea turtles are the most common species to become stranded.

Compared to 269 stranded green sea turtles in 2019 (207 dead, 62 alive), in 2020, there were an additional 69 dead animal strandings and 3 less live animal strandings. The total number of stranded green sea turtles rose by 66 in number.

Monthly distribution of sea turtle strandings

According to statistics, the monthly distribution of sea turtle strandings in 2020 consisted of 82 between March and May (spring), 68 between June and August (summer), 74 between September and November (autumn), and 111 between December and February (winter). Strandings occurred most often between autumn and spring. There were 42 reports of sea turtle strandings in August 2020, an unexpectedly high number of cases compared with previous summer, mainly due to 24 sea turtle hatchlings who lost direction in Kenting.

Body size distribution of sea turtle strandings

According to data presented by the MARN team, though each region has a different number of stranding cases, a majority of them are juvenile sea turtles between 20–65 cm in length. The reason may be that changes in temperature are more intense from autumn till spring. Adult sea turtles have higher resistance against lower temperature. However, juvenile sea turtles are smaller in size and their lungs have not matured yet. Under intense changes in the weather, they are unable to quickly dive deeper into the sea or swim to open seas. They subsequently become stranded in offshore areas that are not suited for swimming.

Analysis on the reasons of sea turtle strandings [3]

The main cause of stranding was drifting at sea. Strandings caused by loss of direction accounted for more cases in 2020 due to the incident of lost sea turtle hatchlings in Kenting. In regards to dead sea

turtle strandings in 2020, the MARN team carried out 74 necropsies (25 in National Taiwan Ocean University, 26 in the National Museum of Marine Biology and Aquarium, and 23 in Penghu County Government). After analysis, most deaths were due to parasitic infections, and the second highest reason of death consisted of traumas caused by boat propellers. As for deaths caused by multiple reasons, these may have been due to blunt force traumas.

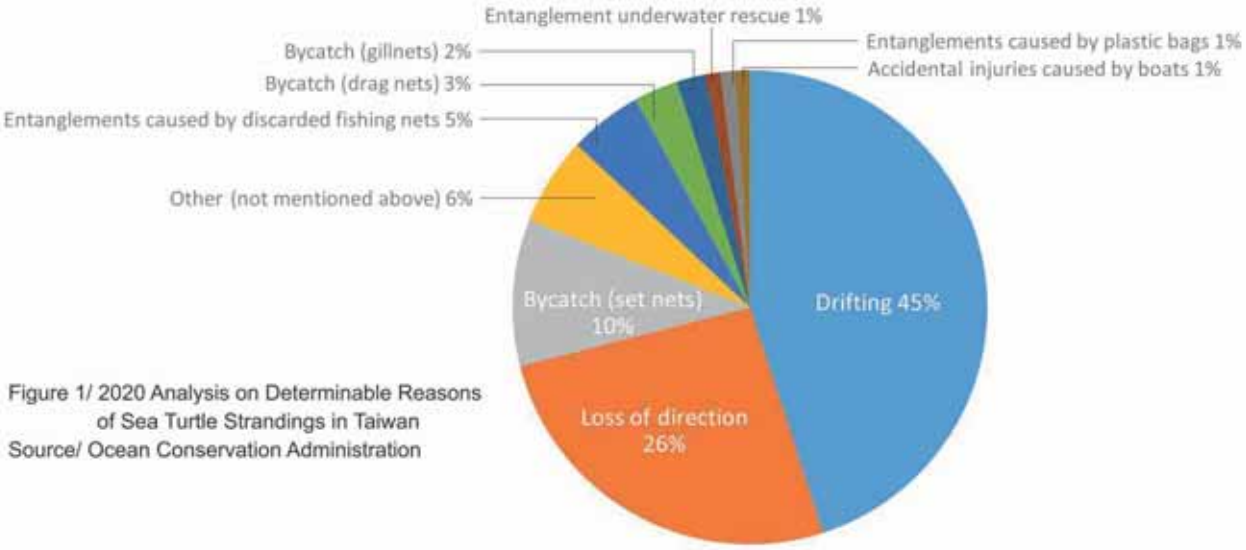

Figure 1/ 2020 Analysis on Determinable Reasons of Sea Turtle Strandings in Taiwan
Source/ Ocean Conservation Administration

Impact of Human Activities on Sea Turtles [4][5]

Sampling of digestive contents from 75 stranded sea turtles in 2020 showed that in 70 of them, man-made substances were found in their digestive tracts, accounting for 93.3% of digestive contents found. With regard to species, there were 2 hawksbill sea turtles, 1 olive ridley sea turtle and 65 green sea turtles. Another 2 green sea turtles have yet to be analyzed.

Contents were found in the different digestive tracts below: food pipe, crop, stomach, small intestines, and large intestines. These man-made substances can be divided into 9 categories: soft plastics, hard plastics, cotton threads, plastic threads, polysterene foam, foam, rubber, metals and others.

We know from the analysis of different categories of man-made substances and deaths that the most common digestive tracts to have man-made contents are the large intestines (71%) and the small intestines (15%). The man-made substances found in the largest quantities within these turtles' larges intestines were plastic threads (26%), soft and hard plastics (each account for 21%), and polysterene foam (16%); the rest account for less than 3%. From the sampling and distribution of these gastrointestinal contents, we know that man-made substances are found in far larger quantities within the intestines than other organs. This means that these man-made wastes have been inside sea turtles' bodies for weeks or even months.

Special stranding case 1: Lost pygmy killer whales in the Port of Kaohsiung

According to statistical data of cetacean strandings from 1994 to 2020, the earliest record of a pygmy killer whale mass stranding dates from 1996. After that, pygmy killer whale mass strandings were reported to happen along the coastlines of Tainan, Kaohsiung, and Pingtung in 1997, 2002, 2005, 2010, 2013, 2014, 2018, and 2020 from February till May.

On the night of April 25, 2020, the MARN team received a report that there were 20 pygmy killer whales lost and stranded in the Port of Kaohsiung. The team immediately activated rescue mechanisms. Some didn't follow up the herd, while some suffered from infections, which resulted in dead animal strandings. Among them, a female pygmy killer whale, about 2.3 m in length, was stranded on tetrapods

in the Port of Kaohsiung. When she arrived at the rescue center, volunteers had to stabilize her underwater 24 hours round the clock; the situation was rather dire. After 56 days of care and medical treatment, the female pygmy killer whale could finally breathe and float on her own. Her wounds had healed well and all test results showed her situation had stabilized. She also became more alert and wary of humans. Hence, it was even more difficult to perform underwater medical treatment. Through comprehensive judgements by the team's veterinarian, the team decided to release her back into the wild.

At 5 a.m. on June 20, all team members gathered at the Sicao Rescue Center. With feelings of eagerness but also a tinge of sadness, the team executed the operation. Around 6:50 a.m., the Coast Guard patrol boat carried the pygmy killer whale from Tainan's Anping Harbor and released her back into the wild, to the open sea about 110 meters deep. At 8:30 a.m. that same day, the pygmy killer whale finally went back to the ocean.

Special stranding case 2: Blue whale stranded on the shores of Changbin Township, Taitung

January 25, 2020 was the first day of the Lunar New Year. Members of the 10th Zone under the Coast Guard Administration (CGA) reported that people found a large blue whale, about 20 meters in length, stranded on Chengzipu Beach in Changbin Township, Taitung. The MARN team immediately activated rescue mechanisms upon receiving the report. Members of the CGA first rushed to the scene to maintain order. The MARN team and county government personnel then urgently dispatched a large crane to the site to immediately start necessary procedures. There were strong winds and waves along the coastline of Changbin. The dead body of the blue whale was very close to the edge wave and lay parallel with the coastline. The body was tilted towards its vertical left side and its epidermis had also fallen off. However, stranded whales usually have obvious throat pleats and their lower jaw skin is white. After necropsy and mitochondrial DNA sequence comparison, the species of the whale was determined to be one widely spread with a small population, a national first-class protected species that has very few stranding records in Taiwan: the blue whale.

There are few records of blue whales in Taiwan, and the stranding incident in 2020 is the first blue whale stranding since the rescue record of cetacean strandings began. The stranded whale was 20 meters in length; its mouth was 3 meters long and the length of its pectoral fin was over the height of an adult male human. To gain sufficient knowledge about the blue whale, the rescue team spent two days to transport the creature to a designated necropsy site in Tainan and took three days to perform necropsy on the blue whale. After examination, the cause of death was determined to be related to the net entangled around its head. The net was around 6 meters long and had a diameter of roughly 4cm. It was entangled around the gape between the upper and lower jaw of the blue whale and caused visible ligature marks. It was deduced that the entanglement led to long-term difficulty of food intake for the blue whale as it was slightly skinny, with signs of insufficient blubber and malnutrition. This subsequently led to its death and stranding.

This is the first ever official record of a blue whale stranding in the history of Taiwan. Blue whale strandings are not common around the world, therefore, it is not easy to obtain specimens of large whales and related research is limited. To seek more information about marine ecology from this blue whale stranding, the OCA invited and gathered cetacean experts in Taiwan to collectively conduct academic research and restore bone specimens. OCA also held a "Presentation on Handling of the 2020 Blue Whale Stranding" to openly describe the process and results of the incident as well as to impart general knowledge on the blue whale to the public.

Special stranding case 3: Lost sea turtle hatchlings in Kenting

On the night of August 9, 2020, 24 sea turtle hatchlings were found on a beach in Kenting. The case was reported to the MARN team and the hatchlings were then taken to the National Museum of Marine Biology and Aquarium for measurement and recording. The sea turtle hatchlings were then released back into the ocean at the original site with the guidance of the team.

It was determined that after these tiny sea turtles were hatched, they should have crossed the beach back to the ocean. However, nearby hotels have strong lights which looked especially bright on the beach at night. This misled these newly hatched sea turtles, which moved towards the light and got lost due to their phototactic behavior.

The last time that sea turtles were found to have laid eggs in Kenting was in August 2017. This incident has given confidence to sea turtle conservation activists, as it indicates that the environment around Kenting's beaches has improved. That being said, night activities on beaches at night should be avoided during summer to provide a friendly hatching environment for sea turtles.

2020 in Retrospect

The MARN team handled cases in 19 coastal counties and cities in Taiwan in 2020. There were a total of 161 cetacean strandings and 335 sea turtles strandings reported. The team also collected 475 scientific samples and 69 specimens. 8 cetaceans were released back into the wild and 37 sea turtles were released into the ocean from the original site. In addition, 7 sea turtles were released back into the wild while 15 remained under care.

2020 is a year worth commemorating. In addition to the blue whale stranding on the coastline of Changbin Township, Taitung—which was the first ever official record of a blue whale stranding in the history of Taiwan, there was also the pygmy killer whale mass stranding in the Port of Kaohsiung. There are few cases of cetacean mass strandings, but each time it happens, a lot of resources and personnel are required to handle it. The deaths of many animals is also inevitable. Through the efforts by the MARN team to record as much information as possible on marine animal strandings and through summarized and periodical stranding reports presented by OCA, the public is able to understand the influence and impact that human activities have on marine animals (e.g., fishery, boat navigation, marine litter, etc.) We hope to gain scientific evidence through data analysis to understand possible reasons for stranding and lower the negative impact caused by humans. This is in hopes to reach the goal of preserving the lives of wild marine animals.

The emergency mechanism for rescuing wild marine animals as well as the establishment of MARN are all possible thanks to joint efforts by OCA, CGA, local governments and NGOs dedicated to environmental protection and marine conservation. With the integration of different physical and virtual resources and the expanded range of action achieved by including the public in rescue work, Taiwan's people have heightened awareness towards wildlife conservation. The people are also more supportive and acknowledge the efforts of the MARN, established by OCA. This can all lead to a more successful result in promoting marine animal rescue work and jointly care for marine animals and marine ecology.

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Transformation Towards a Sustainable Ocean Economy: Realizing a Vision for Marine Protection, Production and Prosperity

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Keywords: Sustainable ocean economy, transformation, ocean policy body

Given the significance and influence of ocean on people's well-being and many marine ecosystems facing significant threats, 14 national leaders across the three oceans collaboratively established the High Level Panel for a Sustainable Ocean Economy (Ocean Panel) in September 2018. The Ocean Panel commits to transformation towards a sustainable ocean economy where environmental protection and conservation, and economic production and prosperity, go hand in hand. Moreover, the Ocean Panel commits to sustainably manage 100% of the ocean area under national jurisdiction of all member states by 2025 and supports a global target to protect 30% of the ocean by 2030. The transformation involves five key areas: Ocean Wealth, Ocean Health, Ocean Equity, Ocean Knowledge, Ocean Finance. US$90 trillion is projected to be invested over the next decade on infrastructure alone, much of which will be on the coast. This article introduces this newly established Ocean Panel and the priorities actions of each area in achieving the transformation towards a sustainable ocean economy [1].

High Level Panel for a Sustainable Ocean Economy

The Ocean Panel is an ocean policy body made up of 14 world leaders. Co-chaired by Norway and Palau, it has members, including Australia, Canada, Chile, Fuji, Ghana, Indonesia, Jamaica, Japan, Kenya, Mexico, Namibia, Norway, Palau, Portugal. Members represent highly diverse oceanic, economic and political perspectives and are situated in five continents of Asia, Oceania, Europe, America, and Africa, respectively. The 14 members represent people across all ocean basins, nearly 40% of the world's coastlines, 30% of exclusive economic zones, 20% of the world's fisheries and 20% of the world's shipping fleet.

The Ocean Panel has been working with government, business and financial institutions, the science community and civil society to catalyze bold, pragmatic solutions across policy, governance, technology and finance to ultimately develop an action agenda for transitioning to a sustainable ocean economy. Guided by the Sustainable Ocean Plan, the Ocean Panel commits to sustainably manage 100% of the ocean area under national jurisdiction of all member states by 2025 and urges all coastal and ocean states to join this commitment so that by 2030 all ocean areas under national jurisdiction area sustainably managed. Furthermore, the Sustainable Ocean Plan will serve as a credible basis in 2030 for safeguarding the long-term health and resilience of the ocean, attracting investment and creating jobs to the benefit of coastal communities and national economics.

The Plan aims to facilitate sustainable use of the ocean and maximize benefits and value creation for current and future generations. It includes regulatory reform, strategic investments in emerging sectors, marine spatial planning, integrated coastal and watershed management, and the establishment and implementation of marine protected areas and other effective area-based conservation measures. It should be in line with the 2030 Agenda for Sustainable Development, build on integrated ocean management and ecosystem knowledge, address pressures from all land- and sea-based sources, and take account of predicated impacts of climate change. In addition, the plan should be developed and implemented through an inclusive, participative, transparent and accountable process.

Five key areas in transformation to a sustainable ocean economy

The transformation for a sustainable ocean economy is built on a framework with five key areas: Ocean Wealth, Ocean Health, Ocean Equity, Ocean Knowledge and Ocean Finance [2]. Each of these areas has its own focuses and each focus has its corresponding 2030 outcome and priorities action. Constraint by the space, only the 2030 outcome and two priority actions pertaining to each focus are presented.

Area I: Ocean Wealth

- Sustainable ocean food

2030 outcome:

Wild fish stocks are restored and harvested at sustainable levels, aquaculture is sustainably grown to meet global needs, and waste is minimized and managed throughout the value chain.

Priority actions:

i. Eliminate illegal, unreported and unregulated fishing by incentivizing the use of the latest innovations and technologies, such as digital traceability, to increase transparency; strengthening monitoring, control and surveillance; improving flag state control; effectively implementing the Port State Measures Agreement [3]; and enabling enhanced collaboration among all stakeholders in the supply chain.

ii. Prohibit harmful fisheries subsidies that contribute to overcapacity, overfishing, and illegal, unreported and unregulated fishing.

- Sustainable ocean energy

2030 outcome:

Ocean-based renewable energy is fast-growing and on the path to becoming a leading source of energy for the world.

Priority actions:

i. Invest in research, technology development and demonstration projects to help make all forms of ocean-based renewable energy, including wind, wave, tidal current, thermal and solar, cost competitive, accessible to all and environmentally sustainable.

ii. Work collaboratively with industry and stakeholders to develop clear frameworks addressing environmental impacts of ocean-based renewable energy and enabling co-existence and integration with other uses of the ocean.

- Sustainable ocean-based tourism

2030 outcome:

Coastal and ocean-based tourism is sustainable, resilient, address climate change, reduces pollution, supports ecosystems regeneration and biodiversity conservation and invests in local jobs and communities.

Priority actions:

i. Invest in sustainable tourism, build the resilience of coastal communities and indigenous people, promotes equal opportunity and equitable distribution of benefits.

ii. Invest in sewage and wastewater infrastructure for coastal and marine tourism to improve the health of coastal communities and reduce the impacts on coastal and marine ecosystems.

● Sustainable ocean transport

2030 outcome:

Shipping investments have effectively accelerated the shift towards zero-emission and low-impact marine vessels.

Priority actions:

i. Establish early national targets and strategies to support decarbonization of vessels.

ii. Incentivize sustainable, low-carbon ports that enable the transition to decarbonized marine transport and shipping fleets through renewable and zero-carbon fuel supply chains.

● Sustainable new ocean industries

2030 outcome:

Innovation and investments in new ocean industries have boosted environmentally responsible economic growth.

Priority actions:

i. Scale up environmentally responsible commercial farming of seaweed and algae to provide food and create alternatives for products such as fuels, aquaculture and agriculture feedstocks, biotech, and plastic alternatives.

ii. Advance carbon capture and storage in the sub-seabed through international collaboration, appropriate incentives and mapping the storage potential of sub-seabed geological formations.

● A precautionary approach to seabed mining

2030 outcome:

Sufficient knowledge and regulations are in place to ensure that any activity related to seabed mining is informed by science and ecological sustainable.

Priority actions:

i. Build partnership to increase research, innovation and deployment of urban mining (reclaiming and recycling metals from spent products, buildings and waste), and of innovative technologies that will reduce the need for new sources of metals and rare earth minerals.

ii. Initiate an international research agenda to improve understanding of the environmental impacts and risks of seabed mineral activities, especially regarding deep ocean ecosystems.

Area II: Ocean Health

● Reduce greenhouse gas emissions

2030 outcome:

Ambitious climate action has set the world on track to achieve the goals of the Paris Agreement and restore ocean health.

Priority actions:

i. Establish and implement emission reductions, covering all sectors, consistent with the Paris Agreement goal of pursuing efforts to limit global temperature increase to 1.5°C.

ii. Scale up investment in ocean-based renewable energy, green shipping, sustainable seafood production, and carbon capture and storage in sub-seabed geological formations.

● Protect and restore coastal and marine ecosystems

2030 outcome:

Coastal and marine ecosystems are healthy, resilient and productive, and nature-based solutions are key elements in developing coastal infrastructure.

Priority actions:

i. Halt the net loss and improve the conditions of coastal and marine ecosystems, in particular critical ecosystems such as mangroves, seagrasses, slat marshes, kelp beds, sand dunes, reefs and deep ocean ecosystems.

ii. Establish and effectively manage marine protected areas to conserve biodiversity and deliver climate, food, socioeconomic and cultural benefits.

● Reduce ocean pollution

2030 outcome:

The ocean is no longer a sink for pollution and ocean dead zones are minimized.

Priority actions:

i. Incentivize the development, production and use of sustainable alternatives to plastics to enable the phase out of problematic and unnecessary plastics.

ii. Use financial incentives, trade opportunities and extended producer responsibility to encourage sustainable product design and promote standards to maximize reduction, reuse and recycling in pursuit of a circular economy, as well as research on new biodegradable materials that substitute plastics.

Area III: Ocean Equity

● Promote equal opportunity for people to benefit from the ocean

2030 outcome:

People have equitable access to ocean resources, benefits are fairly distributed and the most vulnerable are protected from the risk of harm.

Priority actions:

i. Require transparent, responsible business practices that engage and benefit coastal communities, and protect the rights of all workers in ocean industries.

ii. Facilitate the full engagement of women in ocean activities to help unlock their economic and social potential, empower them to safeguard natural resources, and enhance opportunities to access decent work.

Area IV: Ocean Knowledge

● Build ocean literacy and skills

2030 outcome:

Through the UN Decade of Ocean Science ocean literacy has been enhanced worldwide. People understand the value of the ocean and have acquired the skills and knowledge to participate in the sustainable ocean economy.

Priority actions:

i. Make ocean knowledge available to everyone and invest in building ocean literacy and awareness among citizens, including through formal education.

ii. Invest in knowledge, technology and skills training for ocean conservation and management that the sustainable ocean industries of the future.

● Account for the value of the Ocean

2030 outcome:

Decision-making affecting the ocean reflects the value of and impacts on the ocean's natural capital.

Priority actions:

i. Develop a complete sequence of national ocean accounts that are actively used to inform decision-making.

ii. Establishing global partnerships to share best practices and build capacity in national ocean accounting.

● Harness ocean science, technology and data

2030 outcome:

A globally shared data revolution has contributed to sustainable ocean management worldwide.

Priority actions:

i. Promote transparent and open sharing and accessibility of ocean data.

ii. Scale up integrated local-to-global observation.

Area V: Ocean Finance

2030 outcome:

Sustainable ocean finance is accessible for all and drives ecologically sustainable and socially equitable economic growth.

Priority actions:

i. Direct public sector financing to investments in the sustainable ocean economy to unlock private sector financing.

ii. Support the development and application of a global 'ocean risk map' and 'risk index' to catalyze a responsible and sustainable ocean insurance market and investments in the resilience of islands and coastal communities.

Conclusion

14 national leaders across the three oceans established the Ocean Panel in 2018. The Panel commits to transformations towards a sustainable ocean economy and to sustainably manage 100% of the ocean under national jurisdiction. To fulfill this vision, the Ocean Panel set out five key areas pertaining to the transformation and their associated focuses and priority actions as well as the 2030 outcome of each focus. Taking these actions can safeguard the ocean's capacity to regenerate such that the ocean can deliver substantial economic, environmental and social values and offer solutions to global challenges, in particular climate change, acidification, ocean warming, marine pollution, overfishing, and loss of habitat and biodiversity.

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Systems and Regulations of Canada's Whale Watching Industry

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Keywords: Canada, Beluga Whale, Whale Watching

In early 2020, Port Hilford, a small sea port on the bay 750 km east of Québec, Canada, was proposed by the Whale Sanctuary Project, a non-profit organization, to be established as a coastal cetacean sanctuary due to the features of its natural environment. The sanctuary will house cetaceans in the bay that have been kept in captivity since they were young or that are injured and cannot be released back into the ocean. It is also expected to house cetaceans, such as the beluga whale (Delphinapterus leucas), from aquariums starting from the end of 2022. This will provide those creatures that were kept in captivity with a safe and stable place where they can retire [1][2]. This made the author of this article wonder what was the criteria that served as the basis for scientists' decision to choose this bay? Can captive beluga whales survive here? How will the educational planning of the sanctuary be conducted once the sanctuary is established? And, once the sanctuary is established, in order to collect funds, it may be inevitable to open the sanctuary for whale watching activities, so what are the regulations for whale watching in Canada? All of these questions prompted the author to want to have a deeper understanding of Canada's whale watching history and policies. In this article, the author will talk about the whale watching industry in Canada starting from the stories of the beluga whale sanctuary.

Whale Watching Areas in Canada

Québec and the Canadian Arctic regions are popular places for watching beluga whales in the wild. Besides the two places mentioned above, Canada also boasts other famous whale watching areas because the nation is surrounded by the Atlantic, the Arctic, and the Pacific Oceans. The waters near British Columbia, Nova Scotia and New Brunswick, and Newfoundland and Labrador all offer more than ten species of whales of all shapes and sizes to gaze at. These include: killer whales and belugas of the toothed-whale group (Odontocetes), humpback whales and gray whales of the baleen-whale group (Mysticetes), and the critically endangered North Atlantic right whales (according to International Union for Conservation of Nature and Natural Resources, IUCN). All of them are beloved and treasured species for cetacean lovers [3].

Figure 1/ Killer whales are the most popular species for whale watching in Canada
Image by Taiwan Cetacean Society

The beluga whale is widely found in the Arctic and sub-Arctic regions. It has been listed as a Near Threatened (NT) species on the Red List of Threatened Species by the IUCN. A matured beluga whale can be more than 4 m long and weigh more than 1,000 kg. The body size of a male beluga whale is usually slightly larger than a female one. Since ancient times, beluga whales have been an important source of food, oil, and leather to the indigenous peoples of the Artic. In modern times, beluga whales have become one of the most common captive species among sea creatures around the world because of different factors. These factors include the fact that their neck vertebrae are not fused together, giving the species greater mobility and flexibility in their necks; in addition, they have a wide range of facial expressions and sounds, and they can be trained. Of course, the beluga whale's habitats have also become a place for watching whales in the wild, including St. Lawrence River and the Gulf of St. Lawrence, both of which are in Eastern Canada. Port Hilford is seldom ravaged by hurricanes. It is also situated in the Nova Scotia peninsula that bounds the Gulf of St. Lawrence. It is near the natural habitat of the beluga whale, and therefore, the characteristics of the sanctuary's natural environment are very similar to the whales' original habitat [4][5][6].

Table 1/ Overview of Whale Watching Areas in Canada

Region	Whale watching places	Form of whale watching	Species seen while whale watching
Atlantic region			
Québec	St. Lawrence River Estuary, Saguenay Fjord, Mingan region	Motorized boat, land-based	Dall's Porpoise Harbour porpoise Atlantic white-sided dolphin White-beaked dolphin Beluga whale Minke whale North Atlantic Right Whale Humpback whale Fin whale Blue whale
Nova Scotia and New Brunswick	Bay of Fundy, Halifax, Cape Breton	Motorized vessel, non-motorized craft, land-based	Harbour porpoise Atlantic white-sided dolphin Long-finned pilot whale Minke whale North Atlantic Right Whale Humpback whale Fin whale
Newfoundland and Labrador	St. John's, Avalon Peninsula	Motorized vessel, non-motorized craft, land-based	Harbour porpoise Atlantic white-sided dolphin Killer whale Minke whale Humpback whale
Arctic region			
Canadian Arctic	Churchill, Pond Inlet and Baffin Island	Motorized vessel, non-motorized vessels, helicopter	Beluga whale Narwhal Bowhead whale
Pacific region			
British Columbia	Vancouver Island, Victoria, Long Beach, Telegraph Cove, Campbell River, Tofino	Motorized boat, non-motorized boats, and land-based	Dall's Porpoise Harbour porpoise Pacific white-sided dolphin Killer whale Minke whale Humpback whale Gray whale

Source/ [3]

Whale Watching Regulations in Canada

The Marine Mammal Regulations of Canada are part of the country's Fisheries Act. It became effective on February 24, 1993, and went through its latest amendment in 2018 [7]. These regulations mainly encompass the management of commercial tourism of marine mammals. However, to better protect endangered species that appear in the seas of Canada, such as beluga whales, killer whales, North Atlantic right whales, grey whales, and blue whales, the Species at Risk Act has stricter regulations regarding whale watching activities. This is not only to protect endangered species and their threatened habitats, but to prevent these species from disappearing [8].

In Canada, whale watching is done through a telescope which allows people to watch cetaceans from a safe distance. Whale watchers must keep a distance of at least 100 meters from the creatures. If whale watchers encounter resting whales or mother whales with their babies, they must keep a distance of at least 200 meters. However, when sea animals actively approach a vessel, the following behaviors are prohibited:

- Feeding cetaceans.
- Swimming, diving or interacting with cetaceans.
- Moving, surrounding whales or luring whales to move.
- Quickly changing the direction of the vessel or leaving the vessel in the way of cetaceans.
- Going near cetaceans when they are resting (when they appear to be floating without moving).
- Separating a herd of cetaceans or separating mother whales from their babies.
- Capturing one or a herd of cetaceans between vessels and coastlines or between two vessels.
- Multiple vessels approaching cetaceans at the same time.
- Vessels approaching cetaceans from the front or from behind, as this will interrupt their movement.
- Marking cetaceans.
- Even if cetaceans approach a port or coast, touching, feeding or disturbing them is prohibited.
- Going near cetaceans on airplanes.
- If whale watchers see porpoises or dolphins coming near the vessel to ride waves, they must avoid changing the direction of the vessel abruptly. Whale watching vessels should stay on the same route and reduce their speed; crossing herds of porpoises or dolphins is prohibited.

In addition, to avoid drones from causing unnecessary noise that may disturb the cetaceans, if whale watchers use a drone to take pictures or film videos, they must follow certain rules. For example, drones need to keep a vertical distance of 1,000 feet from the cetaceans. Drones also cannot enter an area with cetaceans within a 3,000 feet radius. Moreover, when a drone is taking photos or filming videos, it cannot take off, land or change its course or flying height.

In addition, whale watching regulations will be adjusted based on scientific research results. For instance, the Mingan Island Cetacean Study (MICS) conducted more than 40 years of research on baleen whales in the Gulf of St. Lawrence where beluga and blue whales appear. Thanks to the research results of the MICS, the Canadian government was able to list blue whales as endangered species for further protection. The members of the investigation station have also collaborated with the government to rehabilitate blue whales. Through photo-identification surveys of cetaceans, they were able to confirm the number of blue whale herds, their distribution areas, and distribution density in the Gulf of St. Lawrence. The surveys have also helped to plan a critical habitat for blue whales and to include them under the protection of the Species at Risk Act [9].

As for specific areas or seeing special species, the distance for whale watching will also be adjusted to protect the stability of cetacean herds. For example: Southern resident killer whales (SRKW) of the Pacific Northwest are now estimated to be less than 80 in total. They appear every year in the waters along British Columbia all the way down to Washington State from April to October. Because they are few in number, SRKWs are listed as endangered species in both Canada and the US, and are strictly protected and researched. To avoid whale watching vessels from causing too much noise and potential vessel crashes, there are stricter regulations in regards to the required distance for whale watching in British Columbia. If whale watchers encounter a herd of killer whales in this area, the speed of the whale watching vessel must be less than 7 knots and it must keep a distance of more than 400 meters from the herd (in other areas, whale watchers just need to keep a distance of 200 meters) to prevent vessels from disturbing killer whales. The same management method can also be applied to habitats

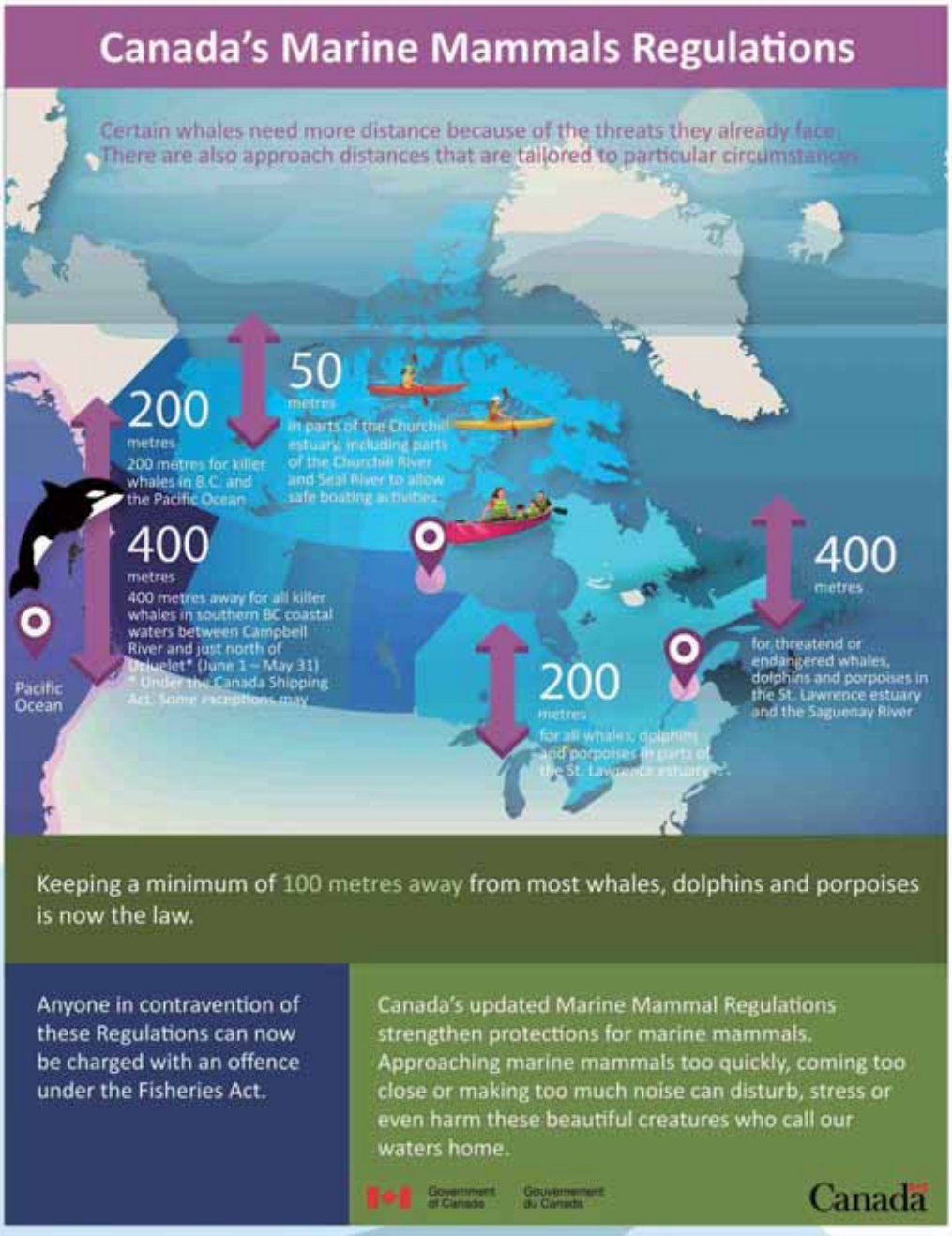

Figure 2/ Regulations of Different Whale Watching Areas in Canada
Source/ https://www.dfo-mpo.gc.ca/about-notre-sujet/publications/infographics-infographies/marine-mammals-regs-mammiferes-marins-eng.html

with narrow areas like the St. Lawrence River Basin and Saguenay River Basin. In these areas, if a whale watching vessel encounters endangered beluga and blue whales, the vessel must keep a safe distance of 400 meters, two times farther than in other areas to prevent vessels from disturbing these whales (Figure 2) [8][10][11].

Conclusion

In the author's opinion, there is a Chinese saying that best describes whale watching methods in Canada: "They can only be appreciated distantly, but not touched blasphemously." In 2008, the International Whaling Commission (IWC) published whale watching survey data showing that more than 13 million people around the world participate in whale watching activities every year. The whale watching industry and relevant industries are worth more than 2.1 billion USD. The number of whale watching tourists in Canada is as high as 1.1 million, the third highest number of whale watching countries in the world, just behind the US and Australia [12]. No matter how many tourists there are or how prosperous whale watching activities are, all who participate in whale watching must observe cetaceans through a telescope and all vessels must keep a distance of at least 100 meters. Furthermore, cetacean research results will continue to help adjust the management methods of the government. Regulation mechanisms are there to best protect local creatures according to the species, locations, and levels of conservation to ensure a protection-centered whale watching framework. Although there is some distance between whales and whale watchers, by reducing human disturbance, these beautiful creatures can behave in the most natural way. Watching whales jump, raise their tails to hit waves, and dive into the sea is an amazing experience, which can become one of the most cherished memories for tourists. This is what whale watchers cherish the most.

The Whale Sanctuary located in Port Hilford is at a higher latitude and is rarely hit by hurricanes. And its being nearby the Gulf of Saint Lawrence makes its environmental conditions similar to those of the original beluga whale habitat. In addition, it is believed that after the sanctuary in the whale watching area in Nova Scotia has been established and begins operations, its whale watching trips, recreational whale interaction, and educational activities can all be implemented in strict accordance with Canadian whale watching regulations. Let these beluga whales in long-term captivity enjoy their retirement in the best living environment and with the highest quality of life, for that is the purpose of whale and dolphin conservation.

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Canada's Oceans Strategy and Ocean-related Organizations

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Keywords: Fisheries and Oceans Canada, Environment and Climate Change Canada, Oceans Act, Canada

Canada is one of the world's strongest maritime nations and a pioneer in integrating maritime legislation. The Oceans Act authorizes maritime agencies to manage and coordinate matters related to oceans and the seas. In this article, the author introduces the Oceans Act system, marine science and technology research system, implementation of maritime policies, as well as goals and visions of marine management in Canada. Taiwan can learn from these various aspects of Canada's strategy to become a true maritime country.

A Brief Introduction Of Canada

Canada is situated in the northern half of North America. Geographically, it is surrounded by the Atlantic Ocean, the Arctic Ocean, and the Pacific Ocean. Canada is a major maritime nation in North America. It shares its southern border with the United States of America and has a massive land territory and exclusive economic zones. Canada is the second largest country in the world and has a coastline of 243,792 km, the longest in the world. The oceans are like lifelines, supporting the development of various coastal areas in Canada. Transportation both domestic and abroad is mainly by sea. One fourth of the population in Canada lives in coastal areas. Therefore, Canada's important urban centers and populated areas are all located along the coastlines. The government invests much effort and funds in the management of coastline environmental conservation and disaster relief and protection work. The marine industry is a significant contributor to Canada's economy.

Figure 1/ Territorial areas and coastlines of Canada
Source/ Coastline, Boundaries and Names of Canada
https://open.canada.ca/data/en/dataset/55d5eb69-f866-5be9-89c1-736e92df425e

Canada's Marine Strategy and Maritime Agencies

The author of this article (Yi-Che Shih) went to Canada in 2001 with Professor Wen-Yan Chiau (who received the Canadian MacKay Award back then) and visited the Fisheries and Oceans Canada (DFO), Canada Coast Guard College (CCGC), CCG Maritimes (Dartmouth), Environment Canada (EC), and Eastern Canada Response Corporation (ECRC), among others. We learned a lot from these units and came to understand their response mechanisms towards marine pollution (the Amorgos oil spill occurred that year in Taiwan). The author then received a scholarship from the National Science Council of Taiwan in 2005 and conducted a year of doctoral level research at the Bedford Institute of Oceanography (BIO), Canada. The author became even more knowledgeable about Canada's marine policies and the operations of related departments. This article is dedicated to introduce the key points of the author's takeaways from the experience.

I. Fisheries and Oceans Canada (DFO)

Canada established the Fisheries and Oceans Canada (DFO) in 1995. DFO belongs to the federal government and is responsible for drafting, implementing, and supporting the economic activities in Canada's marine and inland waters, as well as ecological and scientific research and policies. DFO is also in charge of protecting and ensuring sustainable use of Canada's fishery resources. DFO continuously provides safe, effective, and healthy environmental marine services and is a pillar for supporting the economic growth of marine and fishing activities. Furthermore, it leads innovation in the fields of aquaculture and biotechnology. DFO has excellent scientists and scientific research vessels. Through research, monitoring, and analysis, DFO provides policy suggestions to the government. DFO places great emphasis on the fishing industry, marine environment and ecology, and oceanography. For instance, in 2020, DFO raised the limit of Total Allowable Catch (TAC) for fishermen by 10% in the snow crab fishing areas offshore of Newfoundland and Labrador. This policy was conducted based on concrete scientific research and is a valuable reference for marine resource protection and sustainable fishing.

II. Environment and Climate Change Canada (ECCC)

Environment Canada (EC) was renamed as Environment and Climate Change Canada (ECCC) in 2015. It is the competent authority for environmental affairs in Canada and also an important department in managing the marine environment. To promote the protection of marine ecosystems and resources, as well as to prevent pollution and ensure a clean natural environment, ECCC's main responsibility is to formulate environmental policies and development plans, as well as the operation and management of resources in national parks. In addition, it also takes part in planning, managing, and establishing protected areas with federal and local departments. Last but not least, ECCC coordinates policies and practical means of protecting natural resources for the Canadian government. It enhances the protection of the marine environment and resources, prevents marine pollution, cleans up toxic waste, ensures a clean natural environment, and provides reusable resources and aquatic resources.

III. Eastern Canada Response Corporation (ECRC)

According to the Canada Shipping Act, CCG is responsible for handling and responding to large-scale marine pollution incidents and supervising other instances of marine pollution. Generally, private-sector Response Organizations (ROs) are in charge of tackling small and medium-sized oil spills; ECRC is one of them. The Transport Canada (TC) established an accreditation mechanism for private-sector ROs in accordance with the Canada Shipping Act. ECRC is the largest accredited RO in Canada. ECCC has built an oil spill database according to the statistical data compiled by each province.

With regard to countermeasures against oil spills caused by private companies, many private oil companies in Canada have established ROs based on geographic divisions to assist the government in handling relevant incidents. (Figure 2)

Figure 2/ Geographical mapping of private-sector ROs
Source/ Eastern Canada Response Corporation Ltd., Canada's Marine Oil Spill Response Organizations (1999)

A significant risk of a marine oil spill exists along the east coast of Canada due to increasing ship traffic and offshore oil exploration and development. Combine this with the natural hazards (such as weather and ice) associated with the North Atlantic Ocean and the presence of significant natural resources (such as wildlife and fishery) and the potential for a major oil spill with significant environmental impacts is created. Based on the lessons learned from past spills, the oil spill response community in the Atlantic Region has evolved an oil spill response network that focuses on improving the various procedures relating to spill prevention, preparedness, response, and damage restoration. An active player in these activities is the Regional Environmental Emergencies Team (REET) [1]. The members of these teams are from different federal, provincial, and national organizations. When tackling marine oil spills, REET provide technical suggestions as reference to the On-Scene Commander (OSC) of CCG.

IV. Canadian Coast Guard (CCG)

The Canadian Coast Guard (CCG) was established in 1962 and is subordinate to DFO. CCG is headquartered in Ottawa and has around 4,500 members. It has a budget of around CA$280 million (approx. NT$6.4 billion) per year. CCG became a part of DFO in 1995. Its main responsibilities include: CCG represents DFO in enforcing fisheries law, providing maritime navigation services, breaking ice, and safeguarding Canada's sovereignty in the Arctic region. It also provides maritime communication and traffic services, comprehensive technical support, and maritime search and rescue, not to mention responding to environmental emergencies and managing maritime security and fleets. It is a non-military institution but serves as an important support for military operations. The functions and responsibilities of CCG are very clear. In 2010, the Canadian International Council released the "Open Canada: A Global Positioning Strategy for a Networked Age Report" [2] and suggested that CCG should be fully in charge of Canada's marine security affairs (excluding military security). Therefore, developing a comprehensive maritime law enforcement plan is the goal of CCG. With regard to oil spills,

CCG will only interfere under these two conditions: First, the oil spill is caused by unknown parties—Canada calls it a "mystery oil spill"; second, the oil spill exceeds the cleaning capacity of private organizations (over 10,000 tons). Then only will the CCG use national resources to clean up the oil spill.

V. Bedford Institute of Oceanography (BIO)

The Bedford Institute of Oceanography (BIO) is located in Dartmouth, Nova Scotia. The federal government of Canada established it in 1962. BIO has become one of the largest research centers for oceanography in Canada. It is mandated by the Canadian government and also provides policy advice to the government as well as supports it during decision-making. Its major areas of research include a series of maritime issues, such as sovereignty, national defense, environmental protection, security and health, fishery, and natural resources, as well as marine and environmental management and planning.

Since its establishment, BIO has owned first-class equipment and had superb ocean navigation capabilities. It has become a world-class research institute in cross-disciplinary oceanography. Most of its members hail from departments from the federal government in Canada, such as the National Defence (DND), ECCC, DFO, and Natural Resources Canada (NRCan). BIO also partners with various universities, industries, advanced countries, and NGOs. Since its establishment, BIO has conducted insightful research regarding current systems around the world and in Canada, as well as climate change issues. BIO has also studied the marine geology of the Canadian Atlantic Ocean, which subsequently sets the foundation for oil and gas exploration. BIO is a significant contributor in this regard.

Organizational Establishment and Members of the Bedford Institute of Oceanography

Currently, the BIO has more than 600 scientists, engineers, technicians, and natural resource and environmental managers. Members of the BIO possess different fields of expertise, but do research together and collaborate with each other. The four departments of the federal government hold joint conferences every year to decide on major matters and research topics. The Director is in charge of management, whereas sub-agencies of the four departments have a certain level of autonomy and share resources such as laboratories, research office space, data, and equipment. In this aspect, BIO has built a sharing management mechanism for all scientific data to be "complete and open". BIO requires that scientific researchers and people from all levels of society should have convenient access to scientific data at an affordable cost. BIO highly values the building of technology data and the sharing of data. This has led BIO to become a crucial foundation for scientific research thanks to its prolific output. It is also a means for BIO to serve society and gain support from the people.

BIO places great emphasis on science education. It is the main focus of BIO's contribution to society, as it strives to provide educational experiences and resources to everyone. Regarding the training of professionals, employees at BIO provide training voluntarily on a regular basis. Marine scientific research conducted by BIO includes endangered species, oceanography, marine environmental science, hydrographic survey, habitat management research, the Oceans Act, the scientific advisory committee, and publications and annual reports, as well as related publications. Furthermore, to commemorate Dr. Archibald Gowanlock Huntsman, a great oceanographer, BIO established the Huntsman Award. The Award is presented by the Royal Society of Canada to recognize marine scientists that have made excellent contributions to oceanography. Numerous data and policies of government departments and research units in Canada can all serve as reference.

Background of Canada's Oceans Strategy

In 1987, DFO announced the Oceans Strategy, which despite posing a great challenge, also brought forth opportunities for Canada. The purpose of Canada's Oceans Strategy is to ensure that Canada gains the greatest social, economic, scientific and sovereign interests, as well as to raise awareness regarding the Oceans Strategy among all Canadians. Canada's marine policy is based on the legislative and policy

requirements of the Oceans Act. The Oceans Act empowers the Director of DFO to organize and monitor Canada's Oceans Strategy. DFO formulated Canada's Oceans Strategy for the 21st century. The purpose of Canada's Oceans Strategy is to draft clear goals and enhance collaboration between all stakeholders of marine management.

I. Canada's Oceans Strategy and Maritime Legislation

Around 150 years have elapsed since Canada's independence in 1867, and maritime legislation remains of great importance for securing order in maritime development and ensuring the nation's maritime rights and interests. Hence, Canada's maritime legislation has a long history. During the early years of its independence (1868), Canada promulgated its first Fisheries Act. In 1869, it passed the Coastal Fisheries Protection Act; the two laws have been the basis for Canada's fisheries management up until the present day. In 1997, Canada promulgated the Oceans Act and became the first country in the world to integrate maritime legislation. The Oceans Act stipulates the responsibilities of different units and coordinates all maritime affairs. The Act put the rights conferred to coastal countries by the United Nations Convention on the Law of the Sea (UNCLOS) to have their own domestic legislation into actual practice. Canada defined concrete standards for national marine strategies and policies through legislation to keep pace with changes regarding the oceans and seas after UNCLOS was enacted. In addition, maritime laws enacted by the federal government in Canada are quite comprehensive, including the Oceans Act, Canadian Environment Protection Act, Fisheries Act, Canada Shipping Act, Canada Wildlife Act, and Arctic Waters Pollution Prevention Act.

II. Canada's Oceans Strategy

Canada promulgated the Oceans Act and became the first country in the world to integrate maritime legislation. To implement the Oceans Act, Canada announced Canada's Oceans Strategy in 2002 to draw clear visions, principles, and goals for Canadian waters and ecosystems. Its main purpose is to understand and protect Canada's marine environmental plans and policies as well as to provide plans and policies to ensure sustainable development of Canada's economy. This has kept Canada at the vanguard of international maritime policies and plans. For example, Canada uses scientific methods to understand and protect marine ecosystems, conduct oceanographic research, and set boundaries for different species and important ecosystems. In addition, scientific methods allow Canada to develop assessment technology and set management goals for the ecosystem as well as to assess its health. To achieve these goals, Canada has formulated specific measures including putting more emphasis on marine research, protecting biodiversity of sea creatures, protecting the marine environment, drafting integration management plans, ensuring maritime security, encouraging the marine industry, promoting international collaboration, and enhancing public education.

Conclusion

The 21st century revolves around the oceans. The oceans and seas are the future of Taiwan. On the first World Ocean Day, the President reminded the Ocean Affairs Council to endeavor towards "robust oceans laws and ecological conservation", "promote the marine industry in response to policies", and "put more emphasis on oceanography and train experts in the field". From Canada's experiences, we know that the future development of an Ocean Economy, protection and management of marine ecosystems, safeguarding of marine security, and assurance of marine rights and interests all require research and innovation in the fields of marine science and technology to serve as pillar for our marine legislation. Then only can we promote sustainable development of the oceans and seas and become a true maritime nation.

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Remote Sensing Technology of Detecting Illegal, Unreported and Unregulated (IUU) Fishing

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Keywords: radar satellite, remote sensing, illegal, unreported and unregulated (IUU) fishing, Automatic Identification System (AIS), dark vessel, Sentinel-1, National Ocean Satellite Image Service (NOSIS), ICEYE, low-orbit micro-satellite constellation

Illegal, unreported and unregulated (IUU) fishing refers all types of abnormal fishing activities, and is a new term coined during the annual meeting of the Convention for the Conservation of Antarctic Marine Living Resources in 1997. The Food and Agriculture Organization of the United Nations (FAO) subsequently formulated the International Plan of Action to prevent, deter and eliminate IUU fishing (IPOA-IUU) in 2001, and defined IUU fishing in detail. It pointed out that the fundamental cause of IUU fishing is that some countries are unable to sufficiently supervise and control their fishing boats after granting fishing vessels the right to fly its flag, so the fishing vessels are not punished for engaging in IUU fishing. Many countries around the world have formulated their own National Plan of Action (NPOA) to show their political intention to jointly fight IUU fishing. Taiwan also established a NPOA for the prevention and elimination of IUU fishing in 2013 to show its determination to combat IUU [1]. However, general coastal environment monitoring system and illegal fishing management still has room for improvement, and monitoring technologies urgently need to be improved to achieve the goal of preventing IUU fishing. This article introduces breakthroughs in radar satellite remote sensing image acquisition and time series data analysis, as well as services provided by the National Academy of Marine Research, Ocean Affairs Council using these technologies, in hopes of utilizing the technologies and services to achieve the goal of preventing IUU fishing.

Advantages of satellite remote sensing and limitations of optical images

Remote sensing is the science and technology for obtaining information and analyzing objects, regions, or phenomena without making contact [2]. Using Earth-orbiting satellites for remote sensing provides the advantage of longer time period, larger range, stable cycle, and almost real-time monitoring. Hence, NASA sent the first satellite dedicated to exploring Earth's resources Landsat-1 into orbit in 1972. Over the past nearly 50 years, according to the United Nations Office for Outer Space Affairs, over 7 thousand satellites were sent into orbit [3]. Satellite remote sensing technology developed during the arms race between the United States and Soviet Union has not become mankind's most powerful tool for monitoring Earth, and various commercial services and applications have flourished.

Among the images that can be photographed by a satellite, optical images in the visible light and near infrared range are the closest to what is seen by the naked eye and also the easiest to determine. Hence, efforts have been focused on increasing temporal and spatial resolution. However, 52% of the area on Earth's surface is covered by clouds at any given moment [4], and the

ratio is increased to 55.0-56.5% if only oceans are considered [5]. Hence, optical satellite images that cannot see through clouds are inherently limited in practical applications. A breakthrough in the limitation of clouds blocking images is needed to monitor IUU fishing at key times and locations.

Radar satellite remote sensing and synthetic aperture radar imaging principles

Radar satellites detect the echo signal of specific wave length radar waves emitted by the satellite after interacting with the surface to determine surface properties, and is categorized as active remote sensing. Radar satellites do not rely on electromagnetic waves emitted by the sun as a signal source, and the wave length of electromagnetic waves used by the satellites is longer than water droplets in clouds, so the waves are not blocked by water droplets. Hence, compared with optical satellite images, radar satellite images provide the advantage of being able to acquire images and penetrate clouds at any time of the day.

The spatial resolution of radar satellite images is limited by the orbit altitude and length of the radar's antenna, and cannot meet requirements on higher spatial resolutions. However, using a synthetic aperture radar, continuous and overlapping electromagnetic waves that were emitted at different times during the satellite's high speed flight and received at different locations can be used for calculation to increase image resolution. Hence, radar satellites can provide meter-level spatial resolution images using synthetic aperture radar technology, and some satellites are even able to provide 25 cm-level ultra high spatial resolution images.

Dark vessel identification and IUU fishing monitoring

The Automatic Identification System (AIS) on vessels can exchange electronic data with nearby vessels, base stations, and satellites, providing real-time information for identification and positioning. The International Convention for the Safety of Life at Sea (SOLAS) requires vessels with a total tonnage of 300 tons and above and all passenger vessels regardless of tonnage to install an AIS. During a voyage, vessels can send its accurate GPS location, International Maritime Organization (IMO) No., MMSI, name, vessel type, dimensions, speed, and course to AIS base stations and satellite systems, providing key information needed for monitoring and management. Yet, the contents of AIS messages are not always correct and reliable, because illegal vessels can falsify text in their AIS message, and even provide prefabricated coordinates of their course. A so called dark vessel is a vessel that intentionally turns off its AIS to avoid being monitored and tracked, in order to engage in IUU fishing. Therefore, if the location of vessels at sea can be rapidly and accurately identified in radar satellite images without being affected by the weather and clouds, dark vessels can be rapidly identified and marked by comparing the vessels with AIS location information, so as to further determine if they are engaging in IUU fishing. The Canadian government launched an international cooperation project with a budget of US$7 million at the beginning of 2021. The project uses radar satellite remote sensing technology to quickly identify dark vessels and thereby combat IUU fishing [6].

Explosive growth in radar satellite image sources

The first commercial radar satellite is the RADARSAT-1 launched by Canada in 1995. The United States, Germany, Japan, China, India, and Israel subsequently launched their own synthetic aperture satellite missions. Even though commercial services and applications of radar satellite images have flourished, active remote sensing requires a high power radar transmitter, satellites have a relatively high payload and technical threshold, and also have relatively high construction, launch, and operating costs. Hence, there are relatively few sources of commercial radar satellite images in the market, and prices are much higher than optical images. Even though the use of radar satellite images can break through limitations of clouds covering images when monitoring IUU fishing at key times and locations, typical research institutes can rarely afford long-term time series data from observations of the same location. As a result, we are currently in an awkward phase where the technology is feasible but not practical.

The European Commission renamed the Global Monitoring for Environment and Security the Copernicus initiative in 2012, and planned a series of sentinel satellite missions the following year. The first mission was to launch the radar satellite Sentinel-1, which is able to generated synthetic aperture radar satellite images of land and ocean that is not affected by the time of day and weather. The images cover large areas photographed over a long period of time at stable cycles. Sentinel-1 is a sun synchronous orbit satellite at an altitude of 693 km, ad consists of two satellites in the same orbit - Sentinel-1A and Sentinel-1B, which were launched in April 2014 and April 2016. The Copernicus initiative fully supports the open data policy, and not only established a Sentinel Hub, but also provides the massive amount of high quality remote sensing images photographed during the sentinel satellite missions. It also developed software with powerful functions - the Sentinel Application Platform (SNAP), so that users can process the images into different level products, significantly increasing sources of radar satellite images.

ICEYE is a spin-off of the Radiologic Technology Department of Alto University in Finland in 2014, and specializes in the manufacturing of micro satellites. The ICEYE-X1 satellite, which only weighs 70 kg, successfully entered orbit in January 2018. It is the world's first synthetic aperture radar satellite to weigh less than 100 kg, and is mainly used to monitor sea ice movement, marine oil leaks, and prevent IUU fishing. The second satellite ICEYE-X2 also successfully entered orbit in December 2018. Compared with ICEYE-X1, ICEYE-X2 has multiple imaging modes, including the Stripmap mode with a resolution of 3 meters and Spotlight mode with ultra high resolution of 50 cm. Two more SAR satellites were successfully launched in July 2019 to form a satellite constellation. Radar satellite image products with a spatial resolution of 1 meter formally began commercial operation in October 2019; wide area imaging services that can cover an area of 10,000km^2 also formally began commercial operation in May 2021. As of 2021, there are 10 ICEYE satellites in orbit to form a satellite constellation, and the number is expected to increase to 18 in 2022. This is another form of explosive growth in the source of radar satellite images.

Radar image time series analysis and variance detection

Radar waves are highly sensitive to bodies of water, and a thin layer of water covering the area being detected will cause mirror reflection of the radar waves, resulting in an extremely weak echo signal, which will look very dark on the image. Hence, there is usually a significant difference in the strength of echo signals from vessels and the ocean surface when using radar images to detect vessels at sea, so there is very good contrast. It is worth noting that waves on the ocean surface caused by wind will result in scattered reflection, and the occasional relatively strong echo signal is known as sea clutter. The standard used to filter noise in an image can easily result in confusion and incorrectly report vessels that are detected. Thanks to the explosive growth in sources of radar satellite images, we can use time series images from radar satellites making long-term observation of the same location. This is the equivalent of providing multiple perspectives from multiple observations. Hence, time series data analysis technology can more objectively determine the area of noise and accurately detect true variance - vessels.

In terms of variance detection work, Reed and Yu [7] proposed calculating the constant false alarm rate (CFAR) to detect abnormal areas in multispectral optical images. Their basic assumption is that background interference of most optical images can be described using a Gaussian stochastic model with a rapidly changing average that changes with location plus a slowly changing covariance. Anything that matches this model is background interference, anything that does not match is an abnormal area and a potential target. They used multispectral optical images from Landsat to build the database needed for simulations and conducted tests. The method was later applied in the detection of variance in hyperspectral images [8][9][10]. Reed and Yu [7] also recommended expanding CFAR

applications to radar target detection. SNAP software is an automatic vessel detection product based on a dual parameter CFAR model. The entire processing process includes land sea mask, calibration, and the method proposed by Crisp [11], which consists of two steps - adaptive thresholding and object discrimination. ICEYE established a machine learning convolutional neural network (CNN) framework, which is able to identify important features of vessels and classify different types of vessels after sufficient training and verification [12]. It further expanded to visible ship wake detection on this basis to determine the course and speed of vessels [13].

National Academy of Marine Research Satellite and Marine Database Services

The Ocean Affairs Council, Executive Yuan oversees ocean affairs, and established the National Academy of Marine Research to handle information collection for ocean research and development and promote results and technologies. The National Academy of Marine Research began systematically collecting, building, and processing satellite images of Taiwan's surrounding sea areas in 2021, and provides a variety of value-added services and products, including approximately 620 Level-1 GRD images from radar satellite Sentinel-1 between 2014 and 2021, as well as products of ocean surface vessel distribution. Using the image photographed at around 10:00 A.M. on June 4, 2020 Taiwan time as an example, the spatial resolution of the GRD product taken by radar satellite Sentinel-1 in IW mode was 10 meters, and the size of objects that can be detected is approximately 30 meters. Products of vessel distribution on the ocean surface include the coordinates of the center of each target, as well as the length and width of the target. The product of ocean surface vessel distribution overlapped with images from radar satellite Sentinel-1 on the same day, and results are displayed on the National Ocean Satellite Image Service (NOSIS) platform (https://nosis.geonet.tw).

Radar satellite Sentinel-1 can photograph one image of Taiwan every 2-4 days (including raising and lowering altitude). After the National Academy of Marine Research obtains the data, it will use SNAP software to produce a product of vessel distribution on the ocean surface, and publish it on NOSIS. The product can be used to identify dark vessels and combat IUU fishing when combined with AIS data provided on the website Marine Traffic (https://www.marinetraffic.com/). The location of vessels according to AIS data can retrieved from the website Marine Traffic (https://www.marinetraffic.com/) when Sentinel-1 was photographing an image of Taiwan on June 4, 2020.

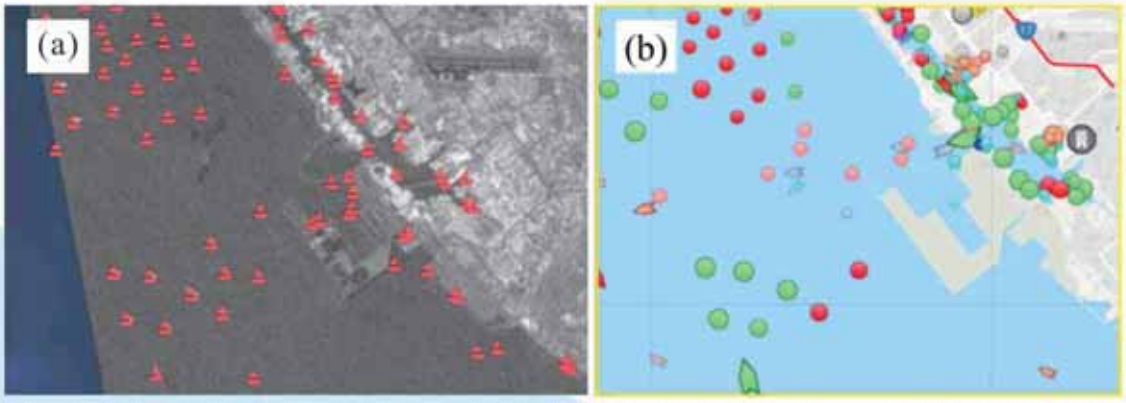

Figure 1/ (a) Image of Kaohsiung City Xiaogang Distrct photographed by Sentinel-1 at around 10:00 A.M. Taiwan time on June 4, 2020, (b) Vessel location according to AIS data retrieved from the website Marine Traffic
Source/ (a) https://nosis.geonet.tw; (b) https://www.marinetraffic.com/

Kaohsiung City Xiaogang District is enlarged and displayed in Figure 1 for more thorough comparison. Vessels on the ocean surface displayed in the radar image shown in Figure 1(a) is similar to the distribution of bright red or green dots in the AIS data displayed in Figure 1(b). This shows the accuracy of vessel distribution on the ocean surface in images from Sentinel-1. Furthermore, the lighter red and green dots in Figure 1(b) are the last location of vessels according to AIS data, and the vessels may have

turned off their AIS and left the location. These are dark vessels that were rapidly identified and marked, and whether or not the vessels are engaging in IUU fishing can be determined based on the data.

Conclusions

The prevention of IUU fishing is an important project launched by the Food and Agriculture Organization of the United Nations that has gained the support of many countries (including Taiwan) around the world. Satellite remote sensing has the advantages of long-term, large area, stable cycle, and almost real-time monitoring. Radar satellites have the advantage of acquiring images in any weather at any time of the day regardless of clouds, which can be used to monitor IUU fishing at key times and locations. However, typical research institutes can rarely afford long-term time series data from observations of the same location. As a result, we are currently in an awkward phase where the technology is feasible but not practical. The Copernicus initiative, which has fully supported the open data policy in recent years, provides a large number of high quality remote sensing images photographed during sentinel satellite missions to all sectors free of charge. The radar satellite constellation of ICEYE, a spin-off of Finland's Alto University, has also successfully begun commercial operation, and provides many high quality products. Hence, there has been explosive growth in sources of radar satellite images. Technology to rapidly, accurately, and automatically detect vessels on radar images is already mature, and dark vessels can be rapidly identified and marked by comparing the vessels with AIS location information, so as to further determine if they are engaging in IUU fishing.

The National Academy of Marine Research began systematically collecting, building, and processing satellite images of Taiwan's surrounding sea areas in 2021, and provides a variety of value-added services and products, including approximately 620 Level-1 GRD images from radar satellite Sentinel-1 between 2014 and 2021, as well as products of ocean surface vessel distribution. These are published on the NOSIS. When combined with AIS data provided by the website Marine Traffic, the product can also be used to identify dark vessels, and further determine if the vessels are engaging in IUU fishing. Even though it is free to download images photographed by Sentinel-1 from Sentinel Hub, there is a 1-2 day time gap. Real-time information and services are not available. However, using the service model and capabilities obtained through the work and then purchasing the commercial image services from the radar satellite constellation of ICEYE will reduce this time gap. Experience accumulated from the work can be used to establish Taiwan's own low-orbit micro-satellite constellation in the future.

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Introduction to Canada's Oceans Act

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Keywords: Oceans Act, Canada

Canada passed the Oceans Act in 1997. The Act is the first maritime law in the world committed to protecting marine ecosystems at its core. It is also regarded as a model for other nations and regions.

Background and Development

Different from most maritime nations, Canada's maritime related laws were scattered across the regulations for transportation, fishery, naval defense, and ecological conservation. The nation lacked a comprehensive act specifically for maritime related regulations. Canada passed its first maritime law in 1997—the Oceans Act S.C. 1996, c. 31. According to the Act's first Article, it may be cited as the Oceans Act. The Oceans Act is said to be the first flagship maritime protection law. It is also the first maritime law in the world with the protection of marine ecosystems at its core. Canada's Oceans Act has been regarded as a pioneering law by the international community, hence, other nations have paid close attention to its practical experience and success in managing territorial waters [1].

Before Canada completed the legislation of the Oceans Act, the nation implemented many decisive measures to defend its territorial waters and marine resources. In 1977, when Canada wanted to solve long-term overfishing issues by European countries on the Grand Banks, which are the waters overlaying with the North American continental shelf in the southeast of Newfoundland, under the leadership of the Fisheries Minister at the time, Mr. Roméo LeBlanc, Canada extended its fisheries jurisdiction to 200 nautical miles [2]. This is the most iconic example of the many decisive measures the Canadian government took. The declaration of the exclusive rights of 200 nautical miles of marine resources later became what we know as an Exclusive Economic Zone, included by the United Nations Convention on the Law of the Sea (UNCLOS) in 1982.

As for the intention of using legislation as the necessary basis for oceans management, this can be traced back to the first Oceans Strategy proposed by Canada in 1987. In addition to the four policy goals of the Oceans Strategy (coastline economic development and marine industry promotion, oceanography, management and protection of marine resources and environment, sovereignty), Canada also needed to establish a new oceans management basis through legislation [2]. After the Oceans Strategy was proposed in 1987, it took 10 years, since the process had stagnated for some time, to complete the legislation of the Oceans Act [3]. Despite that, the Advisory Council on Science and Technology of Canada, which directly reported to the Prime Minister, released a research report called "Opportunities from our Oceans" in 1994. That same year, Brian Tobin, the Minister of Fisheries and Oceans Canada (DFO), also released "A Vision for Oceans Management." Both of these important policies became crucial for the foundation and enactment of the Oceans Act [2][4].

Canada's Oceans Act came into effect in January, 1997. Its main elements include: In reference to regulations on delimitation of maritime boundaries from the UNCLOS, the maritime zones of Canada were extended to include the exclusive economic zones, contiguous zones, and territorial waters through legislation. (Compared to Canada, Taiwan's Law on the Exclusive Economic Zone and the Continental Shelf of the Republic of China was announced on January 21, 1998.) The Canadian Coast Guard, which used to be under the leadership of the Transport Canada (TC), was transferred to the DFO.

Canada also built a comprehensive oceans management strategy to fulfill its obligations of international oceans management as stipulated in the UNCLOS. At the same time, it also allowed subsequent planning of international environmental policy activities to gain more momentum.

All in all, Canada's Oceans Act, enacted in 1997, is regarded as a model for other nations and regions. Especially in terms of tackling three contemporary oceans management challenges: incorporate the principles and methods of Sustainable Development, intend to solve the fragmentation of marine management, and manage the oceans in a more integrated and ecosystem-centered manner [5].

Overview of the Oceans Act

I. Basic Structure

Regulations in the Oceans Act are mainly divided into three parts. As mentioned above, the first part is to regulate Canada's jurisdiction in territorial waters through legislation. In addition, the Act is consistent with the provisions of the UNCLOS. It defines Canada's territorial waters, contiguous zones, exclusive economic zones, and continental shelf. It also states the Canadian government's compromise to protect and manage these waters.

The second part of the Oceans Act is related to specific policies and plans that the Minister of DFO is in charge of. For instance, Canada's Maritime Strategy according to Article 29, as well as three specific regulations regarding planning tools: I. Marine Protected Areas (MPAs); II. Quality of the marine environment; III. Comprehensive management plan. These plans are critical tools to implement national maritime strategy goals. They help Canada understand and protect marine environments, support sustainable economic opportunities, and be an international leader in oceans management.

The third part states the duties of the Oceans Act. According to Article 2, the Minister of DFO is the main federal institution responsible for oceans management within Canada. This section also includes resource management, science, hydrology, Coast Guard team, and other responsibilities into the scope of oceans management.

II. Strategies and Action Plans

As mentioned before, Canada's Oceans Act was enacted and came into effect in 1997. The current Act is the latest version since the amendment in May, 2019, but its main structure is still based on the Oceans Act of 1997.

The preamble of Canada's Oceans Act clearly interprets the Canadian federal government's intention to become a world leader in oceans and marine resource management. The preamble also states that the Act will be based on the three fundamental principles of sustainable development, precautionary methods, and integrated management (Article 29 and 30).

The prominent results of the Act are: oceans strategy, integrated management plans, and national network of MPAs. First, according to Article 29 of the Oceans Act, one of the important roles of the Minister of DFO is to facilitate the new integrated management plans in collaboration with federal government agencies, government institutions at all levels, aboriginal organizations and affected coastal communities, among other interested parties to collectively form an oceans strategy in accordance with the principles of Article 30.

In regards to integrated oceans management, the evaluation scope must include estuarine, coastal and marine waters. In addition, all activities or measures in or affecting estuaries, coastal waters and marine

waters are also included (Article 31). As for the network of national MPAs, it is mainly the responsibility of other federal government agencies (e.g., the Parks Canada Agency and Environment and Climate Change Canada) to set up MPAs, according to law. Hence, the Oceans Act authorizes the Minister of DFO "to coordinate and provide related assistance for the purposes of planning and implementing MPAs on behalf of the federal government" (Section 1, Article 35). In addition to coordinating with different agencies, the Oceans Act also gives powers to the Minister of DFO to establish new MPAs (Section 1, Article 35).

Five years after the Oceans Act came into effect, Canada's Oceans Strategy (COS) was finally enacted in 2002, which provided a policy framework for Canada's ocean management [6]. And under the sustainable principle of the Oceans Act, COS is used to bring forth development, integrated management, and precautionary approaches. Furthermore, Canada launched the Canada's Oceans Action Plan (OAP) in 2005, which was organized with four mutually related pillars: international leadership, sovereignty and security, comprehensive ocean management that promotes sustainable development, and health of the oceans and oceanography technology. The OAP warrants that a series of actions will be completed in two years to implement the Oceans Act and oceans strategy. This includes a series of measures and relevant funding sources [3].

III. Coordinating and Integrating the Functions of Government Agencies

One of the highly acclaimed regulations of the Oceans Act is that the Minister of DFO shall coordinate and integrate with government agencies, as stated in Subsection (b), Section 1, Article 32: "For the purpose of the implementation of integrated management plans, the Minister (of DFO) (b) shall coordinate with other ministers, boards and agencies of the Government of Canada the implementation of policies and programs of the Government with respect to all activities or measures in or affecting coastal waters and marine waters." Through coordination between the Minister of DFO and other ministers, boards and agencies of the Government of Canada, the goal is to create a more consistent mechanism for oceans management in Canada.

In addition, on one hand, existing maritime affairs are spread across different agencies within the federal government. On the other hand, maritime affairs are always changing and developing. Hence, the Oceans Act gives the DFO the power to implement integrated management. When there are maritime affairs not assigned to any other department or agency of the federal government, the DFO shall hold power and duties over the matter (Article 40). Furthermore, the DFO shall propose strategies that "promote necessary development activities to enhance understanding, management, and sustainable development of the oceans and maritime resources" (Section 2, Article 32).

Despite all of this, some critics are skeptical of the implementation results and think that although the Oceans Act is dedicated to integrate oceans management plans, when it comes to relevant affairs, implementation plans still follow existing departmental laws and regulations. "There are no visible changes made to the fact that oceans and coastline management is still divided among different government agencies and regulations are still fragmented..." [7]. According to analysis by scholars, the main reason is that all agencies are very cautious about retaining their duties and power, not only departments within the federal government, but also federal and state government agencies. Moreover, the Oceans Act is based on collaborations between different maritime agencies, but each agency has their own legislation, missions, resources and prioritized policies. Without adequate incentives, it can be difficult to promote collaboration across different agencies. Therefore, although the Oceans Act aims to promote collaboration and dialog between different maritime agencies through regulations, as well as giving the DFO the powers and duties to coordinate policies across government agencies, without

adequate incentives and under the current governing framework, the outcome of the legislation has fallen short of its ideal goals [3][8]. In light of this, we know that coordination and integration between various government agencies cannot be achieved just by legislation alone.

Prospects of New Amendments to the Oceans Act— Concluding Remarks

In May 2019, the federal government of Canada passed draft amendments to the Oceans Act. The amendments are summarized as follows: I. Speed up the designation process of MPAs, as well as enhance their efficiency; II. Add the legal definition of "ecological integrity"; III. Clarify the application of the precautionary approach, upholding that even without scientific certainty of the risks related to marine activities, precautionary measures should still be implemented.

Furthermore, to enhance protection of non-biological resources in oceans, the Canadian House of Commons passed amendments to the Petroleum Resources Act as a supplementary regulation to the Oceans Act. The amendments authorize Natural Resources Canada, Crown-Indigenous Relations, and Northern Affairs Canada to ask rights-holders and rights groups to voluntarily give up their rights to petroleum and natural gas through negotiations. If the mentioned rights are to be abolished due to the designation of MPAs, reasonable compensations should be given.

In regards to MPAs, the new amendments authorize the federal government to temporarily delimitate important natural areas to swiftly implement conservation measures. These amendments shall help ensure that rare species and important habitats can be protected by law before being officially designated as MPAs. It also ensures the safety of the species and habitats during the long negotiations before being officially listed as MPAs. This emergency protection usually lasts for five years, and aims to provide sufficient time for agencies to negotiate with each state, region, rights-holders, aboriginal communities, and the public to reach a win-win consensus.

Before the amendments were announced, MPAs, as designated by Canada, already account for 8.27% of Canada's territorial waters. Through these amendments, the federal government of Canada aims to designate 10% of its territorial waters as MPAs in 2020, which will serve as a testament to the country's commitment to the world. In June 2021, Canada further committed to expanding MPAs to 25% of its territorial waters by 2025, and expects to expand MPAs to 30% of its territorial waters by 2030 [9].

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