SDG14: Life Below Water

SDG 14.2.1 Fresh-water ecosystems (community outreach)

Offer educational programmes on fresh-water ecosystems (water irrigation practices, water management/conservation) for local or national communities

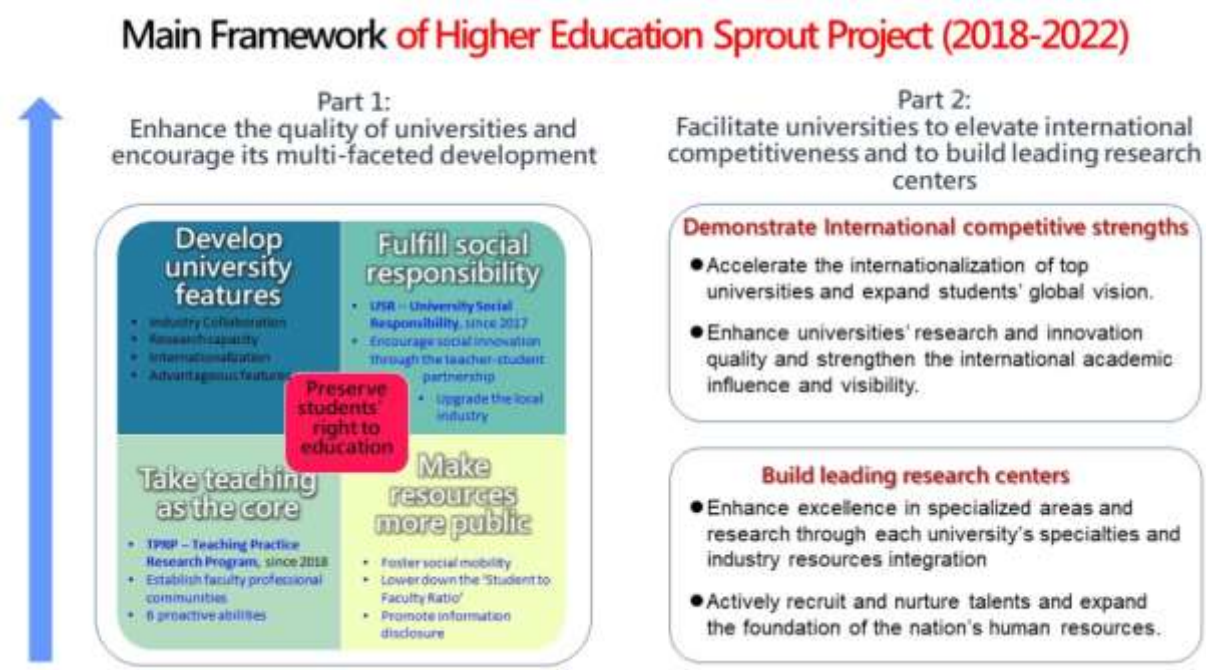
1. Fulfilling Social Responsibilities

NTOU has established and continues to improve its faculty reward system, which encourages instructors to incorporate on-site learning in the planning of course designs to develop cultural sustainability and ecological restoration. The university also continues to establish collaborative partnerships with international universities and appropriated Japan's placemaking experiences and its corresponding translation mechanism. By facilitating the exchange of education and research resources, NTOU furthers local development and fulfills its responsibility of marine education provision.

Evidence:

(1) Higher Education SPROUT Project

The Ministry of Education has launched a new project to spur the enhancement of higher education in Taiwan. The project is code-named "Sprout," the acronym for "Sustained Progress and Rise of Universities in Taiwan."



(2) https://sprout.moe.edu.tw/SproutWeb/Home/Index/en

(3) https://ctl.ntou.edu.tw/bin/home.php

(4) https://www.youtube.com/watch?v=acegbrSaq-A

(5) https://www.youtube.com/watch?v=q6sr_TfEfmI

SDG 14.2.2 Sustainable fisheries (community outreach)

Offer educational programme or outreach for local or national communities on sustainable management of fisheries, aquaculture and tourism

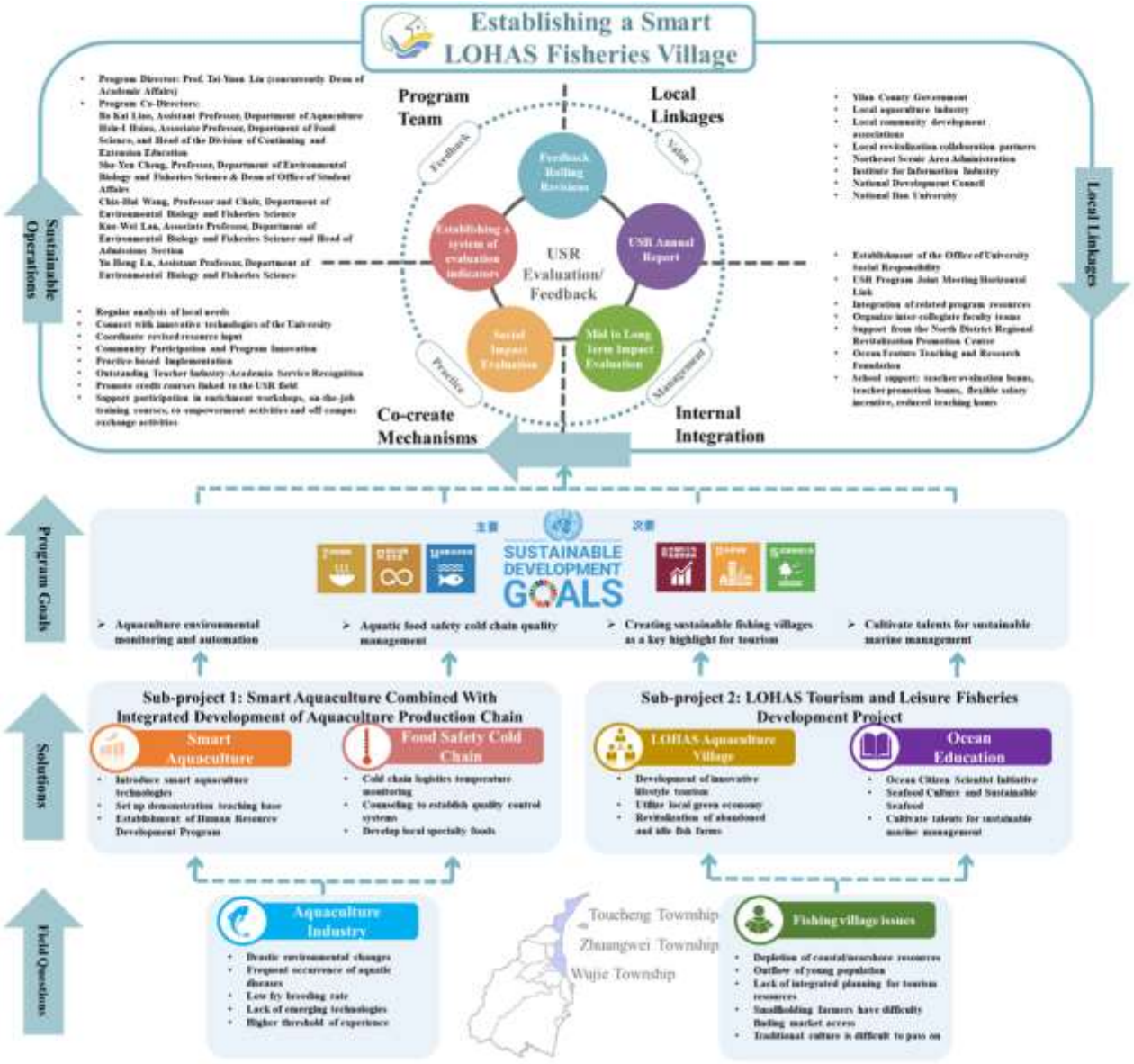
1. The Trip: Agropisciculture Education

Transform traditional agriculture and fisheries into tourism experience activities. Forty-four participants joined this trip in 2021.

Evidence:

(1) "Smart LOHAS Aquaculture Village" project for NTOU

https://reurl.cc/o1nMyD



(2)Traditional Fishing Experience


2. Demonstration Activity of the Fishing Village Environment Education

The Contents of this activity for students included doing the water test, understanding the knowledge of abalone culture, etc. Therefore, it fostered students in the perception of ecological conservation. A total of 30 participants joined this activity in 2021.

Evidence:

(1) Assisting in promoting fishermen's cultural heritage and marine environmental education in the Mao'ao Fishing Community.

https://ctl.ntou.edu.tw/files/11-1014-7523.php

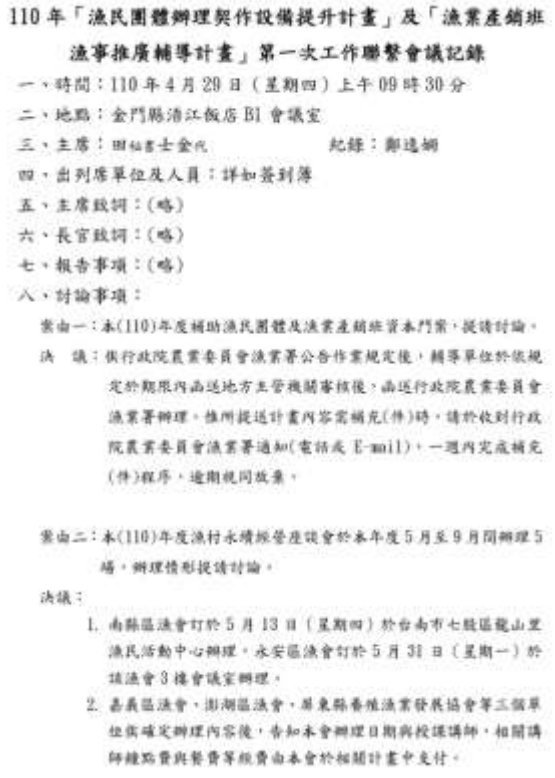
(2) Students experience abalone feeding

3. Executed the "2021 Fishery Production and Marketing Groups Outsourcing Consultation and Guidance Plan."

To strengthen the management guidance of Fishery Production and Marketing Groups, implement training on the operation and development of each Fishery Production and Marketing Group, and increase the opportunities for mutual growth between Fishery Production and Marketing Groups. NTOU's Fisheries Extension Committee invites professional professors in various fields to

go to the countryside to provide on-site consultation and guidance for Fishery Production and Marketing Groups. It is expected to improve the operational capabilities of Fishery Production and Marketing Groups, thereby strengthening the competitiveness of my country's fishery in line with international standards and enabling the sustainable development of fisheries.

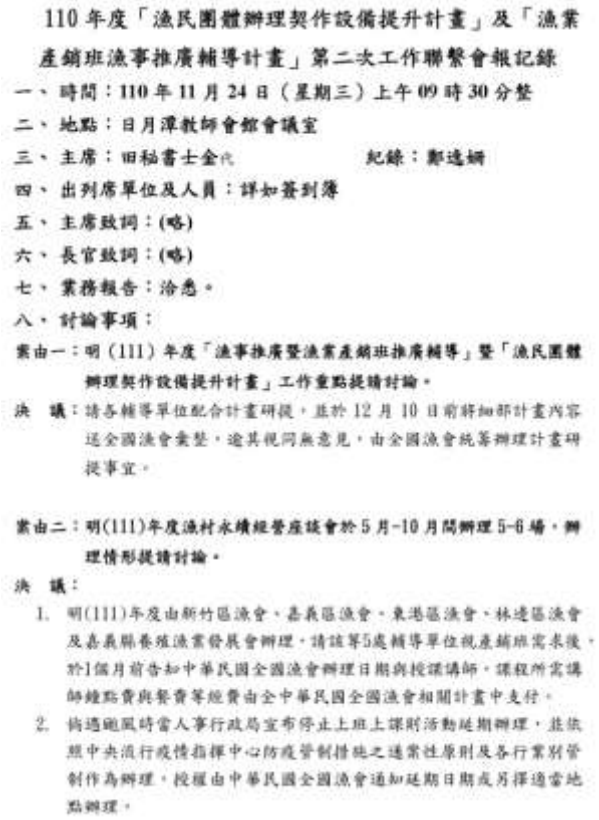
Evidence: Executive Progress Meeting Minutes



110 年「漁民團體辦理契作設備提升計畫」及「漁業產銷班漁事推廣輔導計畫」第一次工作聯繫會議記錄

一、時間：110 年 4 月 20 日（星期四）上午 09 時 30 分
二、地點：金門縣清江飯店 B1 會議室
三、主席：田秘書士金代　　紀錄：鄭逸娴
四、出列席單位及人員：詳如簽到簿
五、主席致詞：(略)
六、長官致詞：(略)
七、報告事項：(略)
八、討論事項：
案由一：本(110)年度補助漁民團體及漁業產銷班資本門案，提請討論。
決　議：俟行政院農業委員會漁業署公告作業規定後，輔導單位於依規定於期限內函送地方主管機關審核後，函送行政院農業委員會漁業署辦理，惟所提送計畫內容需補充(修)時，請於收到行政院農業委員會漁業署通知(電話或 E-mail)，一週內完成補充(修)程序，逾期視同放棄。

案由二：本(110)年度漁村永續經營座談會於本年度 5 月至 9 月間辦理 5 場，辦理情形提請討論。
決議：
1. 南縣區漁會訂於 5 月 13 日（星期四）於台南市七股區龍山里漁民活動中心辦理。永安區漁會訂於 5 月 31 日（星期一）於該漁會 3 樓會議室辦理。
2. 嘉義區漁會、湖區漁會、屏東縣養殖漁業發展協會等三個單位俟確定辦理內容後，告知本會辦理日期與授課講師，相關講師鐘點費與餐費等經費由本會於相關計畫中支付。



110 年度「漁民團體辦理契作設備提升計畫」及「漁業產銷班漁事推廣輔導計畫」第二次工作聯繫會報記錄

一、時間：110 年 11 月 24 日（星期三）上午 09 時 30 分整
二、地點：日月潭教師會館會議室
三、主席：田秘書士金代　　紀錄：鄭逸娴
四、出列席單位及人員：詳如簽到簿
五、主席致詞：(略)
六、長官致詞：(略)
七、業務報告：洽悉。
八、討論事項：
案由一：明（111）年度「漁事推廣暨漁業產銷班推廣輔導」暨「漁民團體辦理契作設備提升計畫」工作重點提請討論。
決　議：請各輔導單位配合計畫研提，並於 12 月 10 日前將細部計畫內容送全國漁會彙整，逾其視同無意見，由全國漁會統籌辦理計畫研提事宜。

案由二：明(111)年度漁村永續經營座談會於 5 月-10 月間辦理 5-6 場，辦理情形提請討論。
決　議：
1. 明(111)年度由新竹區漁會、嘉義區漁會、東港區漁會、林邊區漁會及嘉義縣養殖漁業發展會辦理，請該等5處輔導單位視產銷班需求後，於1個月前告知中華民國全國漁會辦理日期與授課講師，課程所需講師鐘點費與餐費等經費由全中華民國全國漁會相關計畫中支付。
2. 倘遇颱風時當人事行政局宣布停止上班上課則活動延期辦理，並依照中央流行疫情指揮中心防疫管制措施之通案性原則及各行業別管制作為辦理，授權由中華民國全國漁會通知延期日期或另擇適當地點辦理。

4. Provide scientific data and services for the sustainable development of fisheries

In 2021, NTOU was commissioned by the government and private organizations to conduct a resource assessment of oceanic migratory fishes (tuna, sailfish, shark, squid, etc.) and essential fish species along the coast (mackerel, jacks, jacks, mackerel, striped bass, etc.) and research on mitigation of bycatch species to obtain scientific data required for sustainable use of fishery resources and to propose and revise relevant management policies and implement scientific management plans, with the aim of maintaining, in the shortest time possible. In addition, we are responsible for proposing and revising relevant management policies and implementing scientific management plans to maintain the maximum sustainable production of economic fish species in the shortest possible time. In addition, with the External Fisheries Cooperation and Development Association, we also publish a monthly magazine, "International Fisheries Information," to compile information on important international fisheries developments and provide real-time information on the sustainable

development of fisheries in the international arena. To ensure that our country implements international laws, including existing regional and international regimes, to protect and sustainably use marine and ocean resources.

5. Provide outreach services to the community and the industry

The Aquaculture Product Production and Marketing Records Validation and Inspection Center receives requests from private industry to provide services such as drug residue testing, heavy metal testing, microbiological testing, and nucleic acid sequencing. It holds seminars and training courses to promote the concept of hygiene and safety in private industry. The center conducted 1,249 service tests and surveys in 2021.

6. Formation The Fisheries Extension Committee, NTOU

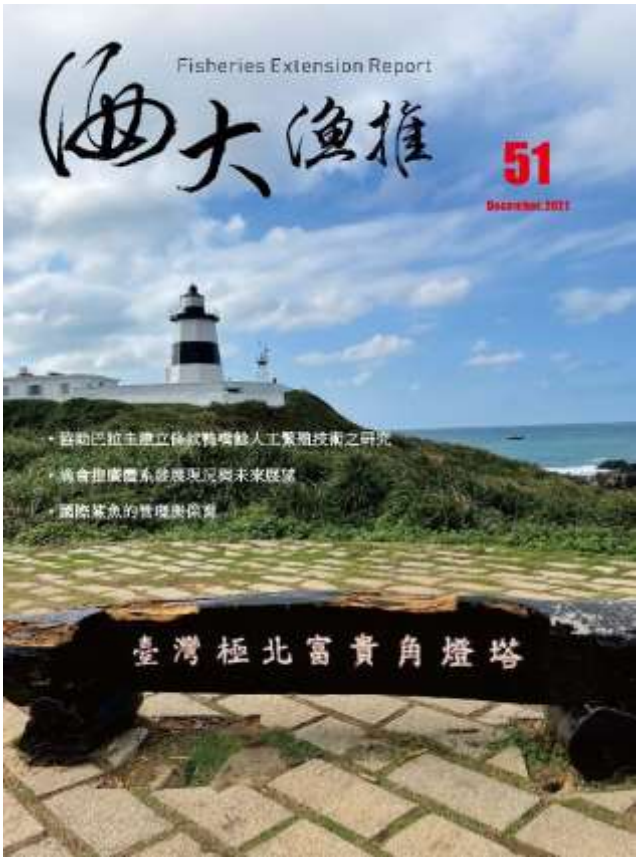
To fully utilize and integrate the human and material resources of the University and establish an integrated system of teaching, research, and promotion, the Fishery Promotion Committee was established in 1986.

Since July 1990, we have established "NTOU Fisheries Extension Report" to introduce new fishery knowledge to fishermen and the general public. For the purpose of service, we provide free reading to fishery units, educational units, fishery personnel, and the general public to promote fishery knowledge and technology.

Evidence:

(1) The Fisheries Extension Committee, NTOU
https://fer.ntou.edu.tw/files/11-1036-7689.php?Lang=zh-tw

(2) NTOU Fisheries Extension Report
https://fer.ntou.edu.tw/files/13-1036-48031.php



7. Fish-eating marine education experience promotion activities

Keelung fishery is well-known in Taiwan, especially the annual neritic squid season series of activities that attract thousands of people to Keelung for sightseeing and experience. But it is challenging for people to receive complete neritic squid information when participating in neritic squid season activities. While in-depth tourism is becoming more and more popular, through slow-travel and slow-taste activities, in addition to improving the quality of Keelung's sightseeing and tourism, it can also upgrade Keelung's marine industry, especially the experience activities that combine industry and education are also important. Therefore, this course aims to bring Keelung's famous neritic squid into the classroom through the experiential learning mode. Through a series of courses, students can learn about the ecology and structure of the neritic squid. They can also understand the relationship between the neritic squid and the environment. Finally, we will teach how to cook the neritic squid so the neritic squid can integrate with a closer connection to life to cultivate students' ocean literacy. The course is based on an experiential learning circle. It is designed with a simple anatomy course, allowing elementary school children to observe the neritic squid's internal and external structure through the learning circle. With presentations and videos, the ecology and structure of the neritic squid are explained, and scientific knowledge is provided to support the content of their observation so that students build awareness of biological anatomy and associations with the neritic squid season.

Evidence: Fish-eating marine education experience promotion activities

https://www.accupass.com/event/210704141833135430702 4

8. 3-in-1 program -Fisheries oceanography course and marine resources mapping course

This program was held by the University of Brawijaya, Indonesia. Its object is focused on the course training for fishery oceanography and marine source mapping with sustainable management. Therefore, it is also linked to the sustainable development targets for marine life below water SDG 14 and Partnerships for the Goals of SDG 17. The partners include the National Taiwan Ocean University and some experts from Japan and Malaysia.

Evidence: 3 in 1 program

9. Enhanced practical education sites

In 2021, NTOU instructors participated in the University Social Responsibility Program. The university opened 25 courses partaken by nearly 1,000 students on the cultural heritage of traditional fishing villages, which utilized local stories to market local cultures and brands. NTOU also promoted cultural exchange with new immigrants and completed six published works. Furthermore, the university helped a local fishermen's association create an e-commerce platform, resulting in a 20-fold growth in sales in 2021 compared to 2017—before NTOU's intervention.

Evidence:

(1) https://usr.ntou.edu.tw/index.php

(2) https://b022.ntou.edu.tw/bin/home.php

(3) https://www.facebook.com/gongliaosatoyama/

(4) https://ctl.ntou.edu.tw/files/11-1014-7468-1.php

(5) https://ctl.ntou.edu.tw/files/11-1014-7521-1.php

SDG 14.2.3 Overfishing (community outreach)

Offer educational outreach activities for local or national communities to raise awareness about overfishing, illegal, unreported and unregulated fishing and destructive fishing practices

1. Assist the government in lifting the yellow card issued by the European Commission

We create a monitor national ocean resources system that operates in real-time and has semi-intelligence to identify illegal, unregulated, and unreported (IUU) fishing activities. With the success of this system and the conjunction of regulations and legal reform, the yellow card issued by the European Commission in October 2015 was lifted in June 2019.

Evidence:

(1) Prof. Hsu assisted the government in lifting the yellow card issued by the European Commission and was awarded the Outstanding ICT Elite Award.

(2) https://www.tca.org.tw/tca_news1.php?n=1622

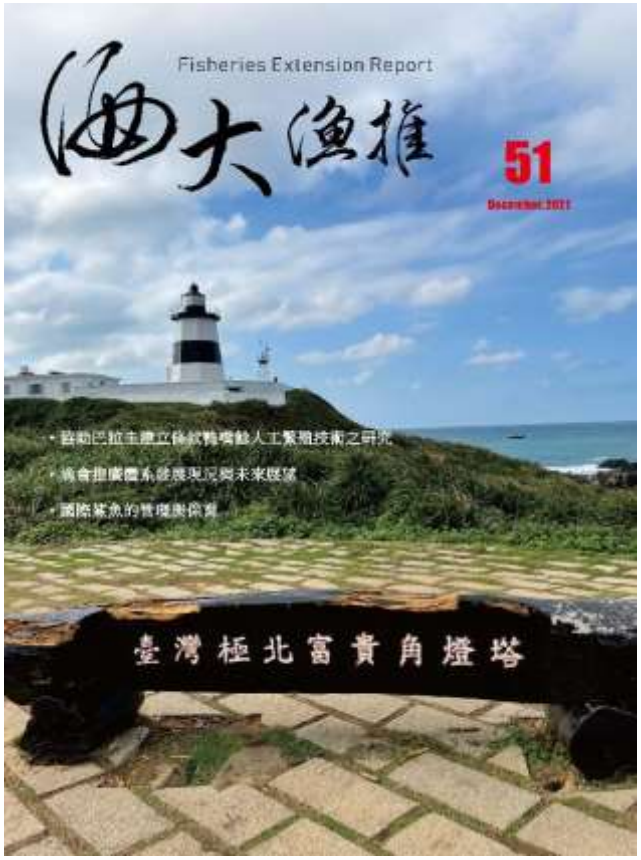
(3) Commended by the President of the Republic of China on January 12, 2021
https://www.youtube.com/watch?v=Am8RhhLNOaw

2. The 51st issue of the Fisheries Extension Report Published

The Fisheries Extension Committee publicly solicits manuscripts from experts and scholars in related fields, publishes the "Fisheries Extension Report" science journal regularly every year, and sends them to various high schools' libraries, district fishermen's associations, or the general public for free, in order to raise awareness of overfishing, illegal, unreported and understanding of

unregulated fishing and destructive fishing practices, for sustainable fisheries production.

Evidence: NTOU Fisheries Extension Report
https://fer.ntou.edu.tw/files/13-1036-48031.php



SDG 14.3.1 Conservation and sustainable utilisation of the oceans (events)

Support or organise events aimed to promote conservation and sustainable utilisation of the oceans, seas, lakes, rivers and marine resources.

1. NTOU promotes environmental and ecological conservation and strives to achieve marine sustainability goals

NTOU has always focused on environmental and ecological conservation and has built a marine biology breeding center on campus to cultivate Taiwan's native species. The teaching and research achievements of NTOU faculty and students are an important foundation for the government to formulate marine development strategies and promote marine policies and an important driving force for Taiwan to become a sustainable marine nation.

Evidence: NTOU was invited by the "Focus on the World team," a three-time TV Golden Bell Award winner, to co-produce "Guardians of Formosa."
https://youtu.be/jMe7qTIYyB8

2. Established Taiwan Ocean Union

The period from 2021 to 2030 is the United Nations Decade of Sustainable Development in Marine Science. Currently, the global ocean is facing "unsustainable exploitation of marine resources," "destruction of coasts and protected areas," "marine pollution," and "the impact of climate change. Therefore, NTOU established the Taiwan Ocean Union(TOU) to promote the integration of cross-disciplinary ocean research. TOU improves basic ocean investigation, upgrades key ocean science and technology facilities, makes forward-looking plans, and laterally connects all related ocean units in Taiwan to make Taiwan a key force in marine research in the Northwest Pacific.

Evidence: 2021 Taiwan Ocean Alliance Union
https://spec.ntu.edu.tw/20211001-report-spec/
https://tou.ntou.edu.tw/

3. Fish and shellfish fry cultivation project in Matsu area.

In order to promote the transformation of the production and marketing model of Matsu aquatic products, this project plans to develop research on the cultivation of mussels (Mytilus edulis) and wakame (Undaria pinnatifida), and use biotechnology to fix excellent traits and develop technology for massive production of seedlings.

At present, the breeding and cultivation experiment of excellent traits of wakame and mussels has been carried out on the National Taiwan Ocean University Matsu campus, and the breeding technique of wakame has been granted to more than ten seaweed breeders.

Furthermore, the joint research of mussels and wakame cultivation will become an eco-tourism resource, which can also be included in the long-term commercial output value of the Matsu area in the future to fulfill the social responsibility of giving back to the local residents.

Evidence: cultivation of mussels (*Mytilus edulis*) and wakame (*Undaria pinnatifida*)
https://www.youtube.com/watch?v=6_1g0JWpf64

4. 2nd International Conference on Fisheries and Marine Research

Grey mullet (*Mugil cephalus L.*) is one of the most important commercial migratory species of fish in winter in the coastal fisheries of Taiwan. We analyzed the long-term (1954–2020) records of grey mullet catch and sea surface temperature in the Taiwan Strait (TS) to investigate the influences of climatic indices on the annual catch of grey mullets at multiple timescales. A wavelet analysis revealed that variations in climatic indices, namely the PDO, NPGO, NPI, and sea surface temperature anomalies (SSTAs), might have affected the winter abundance and migration behavior of grey mullets in the TS.

The annual catch fluctuated and was possibly influenced by a climatic index such as PDO. Due to the subsequently decreased catch, the types of fleet with fishing methods in the coastal waters of Taiwan were changed from the purse seiner with two boats before 1986 to the gill net and trawl net as the abundance was at a low level between 1989 to 2010. Gill net has been the main fishing method

for its low cost as the mullet abundance has increased since 2013. Fishery-based adaption of the resilience between purse seiner and gill net fleet conducted from fishermen responding to the mullet catch fluctuation, climatic index, and cost-benefit is identified.

Evidence: Video Conference

https://proceeding-icofmr.ub.ac.id/index.php/procicofmr/index

5. The only marine publishing center in Taiwan

NTOU is the only university publication center in Taiwan that focuses on "marine." Its publications include not only marine science and technology but also marine-related humanities, covering marine engineering, marine biology, marine literature and history, marine ecology, and sustainable development of resources, and is committed to promoting the dissemination and exchange of marine knowledge and inviting readers to care about the ocean.

Evidence:

(1) The only marine publishing center in Taiwan

https://mprp.ntou.edu.tw/p/406-1017-54954,r1031.php?Lang=zh-tw

(2) Online book show

https://tibeonline.tw/2021/show-publisher/e59c8be7ab8be887bae781a3e6b5b7e6b48be5a4a7e5adb8e587bae78988e4b8ade5bf83/

6. 2021 Marine Education Contribution Awards

To honor those devoted to promoting marine education, the Ministry of Education held the inaugural Marine Education Contribution Awards Ceremony in 2019. In 2021, the Ministry of Education held the third Marine Education Contribution Awards Ceremony. Apart from recognizing individuals or entities that have made outstanding contributions to marine education, the Ministry hopes that establishing exemplary figures in marine education will attract more investment of resources and human resources in the marine education field.

The 2021 Marine Education Contribution Awards recipients included corporations, legal foundations, elementary school teachers and principals, university professors, and entrepreneurs; the wide range of recipients illustrates the diversity of marine education in Taiwan.

Evidence: 2021 Marine Education Contribution Awards

https://tmec.ntou.edu.tw/p/412-1016-9265.php?Lang=zh-tw

https://tmec.ntou.edu.tw/var/file/16/1016/img/1419/483926681.pdf

7. Focusing on ocean sustainability issues through creative design thematic works promote the importance of sustainable ocean development.

Each semester's final exhibition or special exhibition will encourage students to focus on marine sustainability and develop various special works. Through the exhibition, we can publicize the importance of sustainable marine development.

Evidence:

(1) 2021 Exhibition of works with the theme of the ocean.

https://mprp.ntou.edu.tw/p/404-1017-69122.php?Lang=zh-tw

https://mprp.ntou.edu.tw/p/404-1017-68641.php?Lang=zh-tw

https://mprp.ntou.edu.tw/p/404-1017-67528.php?Lang=zh-tw

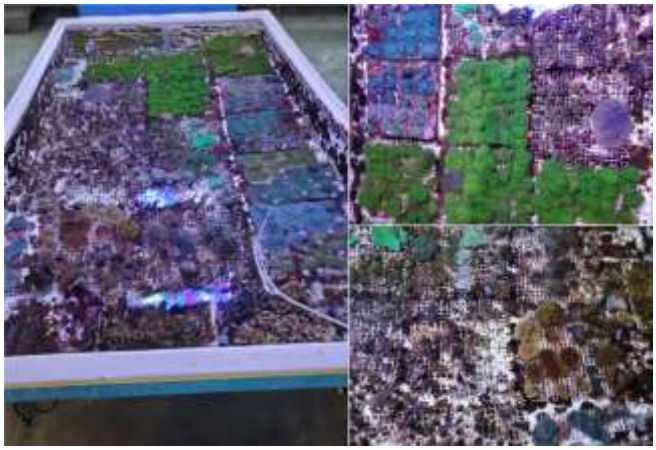
(2) Provide opportunities for students who cannot go to school to attend classes remotely.

https://tronclass.ntou.edu.tw/

8. New Taipei City Coral Marine Education Promotion Program

A free coral education program (珊瑚小學堂) was held at the Marine Resources Restoration Park(新北市政府海洋資源復育園區) in Gongliao. The course will introduce the coral species, characteristics, and ecological challenges in Taiwan, and the coral planting course lets the participants plant coral by themselves. Hopefully, it will inspire them to protect the ocean and coral reefs by planting coral with their own hands. In the Marine Resources Restoration Park, a coral farm has been set up to provide professional coral farming techniques and advice on coral conservation to the technical staff of the New Taipei City Fisheries and Fishing Harbor Management Office to conserve the corals in Northeast Taiwan. 1295 corals are currently being cultivated at the Marine Resources Restoration Park.

Evidence: Introduction of coral education program
https://fishery.ntpc.gov.tw/cht/index.php?act=album&code=view&id=51



9. Pilot project of establishing the stock assessment and reference point for important resources of Taiwanese offshore and coastal fisheries fishery in the eastern waters of Taiwan

The World Trade Organization has been striving to reach an agreement to end harmful fisheries subsidies, which are regarded as a major driving force for overfishing. According to the United Nations Sustainable Development Goals, countries must agree to prohibit subsidies for enhancing fishing capacity to resources considered overfished in their economic waters and waters beyond national jurisdiction. The resources of Taiwanese offshore and coastal fisheries have been depleted gradually due to long-term exploitation. Under these issues, it is an opportunity to establish and develop stock assessments and relevant analyses for the resources of Taiwanese offshore and coastal fisheries. In addition, it is also conducive to the management and conservation of Taiwanese offshore and coastal fisheries. This project conducted stratification and integration analysis to select and arrange the priority of the research species by fisheries based on the productions and values records of the Fisheries Statistical Yearbook of the Fisheries Agency of Taiwan. The fisheries indicators and reference points used to evaluate stock status were also illustrated and described with relevant

analytical approaches, as well as required data and relevant information. The results of this project will be used as suggestions for the subsequent establishment and development of stock assessments and analyses for the resources of Taiwanese offshore and coastal fisheries.

10. 2021 Marine Educators Basic Training Program for Underwater Cultural Heritage

Underwater cultural heritage (UCH) belongs to every citizen, and UCH includes many important historical artifacts, e.g., the shipwreck General No. 1. The investigation of UCH involves several scientific issues. Underwater archaeologists use different equipment and tools to find the UCH relicts on the sea floor. The UCH conservation is related to physical and chemical professional knowledge. So let the teachers and students understand the UCH research process is a meaningful science popular activity. Our work held one lesson plan workshop for teachers. The attendees of the workshops will learn the UCH knowledge (e.g., ROV) and convert the knowledge into their daily teaching. This two-day workshop had 30 attendees. We expect that 900 students would be benefited from this activity.

Evidence: 1.Seed Teacher Training Camps
https://coch.boch.gov.tw/Achievement/Detail/7931d2a8-44e1-45ad-8d97-08e6106ba7a1

SDG 14.3.2 Food from aquatic ecosystems (policies)

Have a policy to ensure that food on campus that comes from aquatic ecosystems is sustainably harvested.

1. The instructions for campus food traceability and safety management.

Ensure that food on campus that comes from aquatic ecosystems is sustainably harvested. We trace back to food sources and utilize safety management.

(1)Food traceability

a. Incorporate "registering the source information of food ingredients " into the content of the contract signed between the school and cafeteria contractors and NTOU catering hygiene management regulations.

b. On business days of the cafeteria, it is necessary to register the "menu, ingredients, and seasonings" on the campus food ingredients registration platform of the Ministry of Education and provide supplier information to facilitate the traceability of food ingredients.

c. The division of health services randomly checks whether the restaurant information is truthfully registered every week. The NTOU catering hygiene management regulations will punish violators.

(2)Safety and self-management measures:

a. The NTOU catering hygiene management regulations regulate food materials acceptance, preservation, preparation, and sample retention, and food ingredients have legal sources that can be traced back, etc.

b. Catering services fill out the self-management of hygiene form daily to confirm compliance with relevant regulations.

c. Hold catering hygiene lectures to improve the knowledge and ability of catering practitioners in our school.

d. The division of health services randomly checks the cafeteria's hygiene status every week to confirm that the cafeteria's food and hygiene management accord with the regulations.

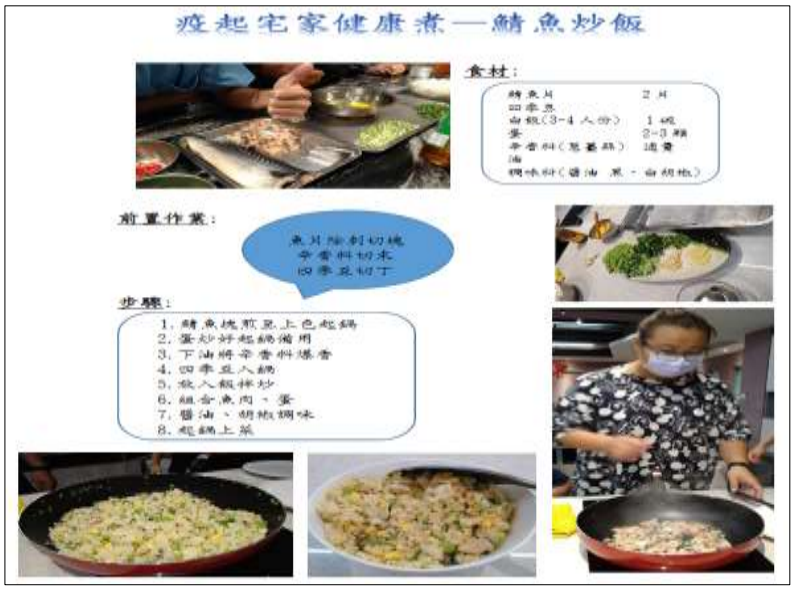
(3)Promote food education

Promote the concept of food education in health dietary promotion activities. By cooperating with the local fishermen's association, school staff and students can learn about local food and dietary culture and practice the food education concepts of marine protection and eternal development.

Evidence:

(1) Cooperate with the fishermen's association to make online teaching videos to teach food education and seafood cooking.

(2) It’s an online coursework that participants upload photos of cooking with local food ingredients.



(3) Catering hygiene lecture on food acceptance and safety management.

(4) Catering hygiene lecture on food hazard analysis and critical control points.

2. Beginner Marine Education Training Courses: Food and Fisheries Theme

During the final weekends in March and April, the Taiwan Marine Education Center (TMEC) hosted two sessions of green-level (beginner) marine education training courses, with food and fisheries education as the theme. Through these courses, the TMEC aims to use the seafood on our dining tables to help participants learn more about the ocean.

The first session was held in Linbian Township, Pingtung County. The participants were taught how to select sustainable seafood at markets and grocery stores. The youth team “Taiwan Fish Forest” presented the grouper, the four-finger threadfin, local farmed fish species, and cooked fish dried overnight. The activities on the following day comprised digital learning, experiential activities, and practical instruction based on curricula.

The second session was held in Taoyuan. On the first day, the participants visited eel farms at the Xucuogang Wetland and the repaired century-old stone weirs in Xinwu District. The chairperson of the Xinwu District Ayshiang Association told the participants about the past abundance of fishery resources. On the second day, a market survey was conducted to explore the principles and applications of Seafood Guide Taiwan. In the classroom, the participants were divided into groups to brainstorm topics for interdisciplinary courses on food and fisheries education.

Notably, marine education resource centers in various cities and counties across Taiwan also hold marine education training courses. Teachers interested in marine education can obtain relevant information in the website's Further Information on In-Service Training section.

Evidence :

(1)First session held in Linbian Township, Pingtung County, Taiwan

(2) Second session was held in Taoyuan.

(3) Beginner Marine Education Training Courses: Food and Fisheries Theme

https://tmec.ntou.edu.tw/p/405-1016-60878,c9829.php?Lang=en

SDG 14.3.3 Maintain ecosystems and their biodiversity (direct work)

Work directly (research and/or engagement with industries) to maintain and extend existing ecosystems and their biodiversity, of both plants and animals, especially ecosystems under threat.

1. Stock assessment of oceanic Sharks and Rays

Professor Guangming Liu of NTOU and his group of shark experts at the International Union for Conservation of Nature (IUCN) have conducted a resource decline assessment of 31 species of surface sharks and rays over the last half-century using the Living Planet Index and Red List Index. The results were published in the latest issue of the world's most prestigious journal Nature on January 28, 2021. The results of this study show that the resources of these species have decreased by 71% since 1970 due to an 18-fold increase in fishing pressure and that 3/4 of the iconic species are at risk of extinction. Strict enforcement of catch bans or scientifically based early warning catch controls will prevent resource collapse. This article collects the most complete biology and fisheries-related literature and data available, and also analyzes the results of resource assessments conducted by regional fisheries organizations in the past. The results obtained are of great academic value and contribute greatly to managing and conserving global surface shark and ray resources.

Evidence:

https://imarm.ntou.edu.tw/p/406-1054-55578,r1034.php?Lang=zh-tw

http://www.sharkleague.org/2021/01/27/oceanic-sharks-and-rays-face-unprecedented-extinction-risk-from-overfishing/?fbclid=IwAR0HAY0mseMHVSEAEgIgmh070Wyr72fvo4bIWB-5fnSG3iqJYnw9gqQ2cDI

2. Feasibility of mitigation strategies on reducing the interaction between protected species and Taiwan coastal fisheries

The conflict between coastal fisheries and conservation organizations has been getting worse in recent years due to accidental catches for protected marine animals, depredation of target catches or baits, and damage to fishing gear. Following the previous investigation in 2020, to further examine the scale of depredation and damage to gears, we distributed questionnaires at main ports, including Ilan, Taitung, Hsinchu, Yunlin, Kaohsiung, and Pingtung so far. There were 21 gillnet vessels enrolled in this project, with a total of 1183 operations in 2020. The landing and depredation data were recorded from 274 longline vessels with a total of 1475 operations and 115 depredation events, be found in the previous result in 2020. What’s more, 209 longline vessels with a total of 1603 operations but 67 depredation events were recorded in 2021, from January to August. The depredation index was found to be higher from May to August both in 2020 and 2021, indicating the Bluefin tuna

season. On the other hand, one accidental catch and report system for the set net fishery was established this year. There were 81 accidental catches of the protected marine animals, including the whale shark (Rhincodon typus), sea turtle, and dolphin. In addition, this program investigated the feasibility of a pinger-on mitigation strategy in order to minimize both the economic loss of fisheries and the accidental catch rate. There was evidence from 25 longline vessels that showed that a pinger is a good way to protect the bait. Also, there were 10 logbooks that recorded the operation with or without a pinger. At least 5 logbook data showed a significantly higher CPUE in the pinger group. However, further experiments on different mitigation strategies, such as pinger in different fisheries or LED light for gill nets, are still needed.

Evidence:
https://drive.google.com/file/d/1yAAySELMiu1GWGy8kE-6crBafwchq794/view

3. Effects of environmental change on the impacts associated with the sustainable development strategies of coastal communities nearby Kouhu Township in the coastal zone of western Taiwan

Environmental (Climate) change poses a key threat to marine/coastal ecosystems and agriculture/fisheries resources as well as to coastal communities that depend on these systems for food and livelihoods. Future earth coasts are working to support sustainability and adaptation governance in response to climate change in the coastal zone. Research and data on aquatic resource management are inherently scarce and imprecise in the demonstration coast area of Kouhu Township, resulting in high levels of uncertainty in resource predictions in coastal zones. There is a need to expand the information databases and capacity to adapt to the effects of environmental change effects. This study tried to build up the standard operating procedures for co-designing and co-production in the integrated social-ecological system (SES, including impacts and vulnerability) of the artisanal fishery, aquaculture, and social culture possibly influenced by environmental change, and then for co-delivering the possible strategy of adaptation governance with the social and economic responsibility on the coastal communities (i.e., Gang-Dong, Tai-tsu fishing villages) along the Yun-Lin coast in western Taiwan. Firstly, the observation and questionnaire data in bi-physical and social-culture economic fields were co-designed and collected by the investigators of subprojects in fishery, aquaculture, ecosystem, and social science, etc. Secondly, assessing the relative vulnerability of fishing communities to anthropogenic stressors is an important first step to identifying mitigation or adaptation strategies. The analytical hierarchy process (AHP) model with the Delphi method was considered and used to measure the weighted criteria of natural (i.e., sea surface temperature, sea level height, current, fishery resource structure, biodiversity) and anthropogenic (i.e., economic and social activity in aquaculture, artisanal fishery or non-fishery industry) for ecological vulnerability in the coastal aquaculture industry. Finally, the communities-based social-ecological system using the

AHP, Delphi method, and the experience of oyster aquaculture SES was further to be integrated with the social-ecological vulnerability and risk perception. Based on the social-ecological vulnerability with the weighted criteria of natural and anthropogenic factors in different communities, a series of stakeholder workshops organized by the related departments and the stakeholders would be held to discuss the local requirement in response to the climate change impact. Therefore, cross-institutional stakeholders (i.e., Fishers, city government) can adopt a number of adaptation strategies that could address vulnerabilities and enhance resilience. But it also requires support from cross-institutional government and other nongovernmental organizations/stakeholders. Strengthening local organizations and communications, rebuilding aquaculture and artisanal fisheries through regional co-management plans and rules, developing complementary livelihoods, and addressing the broad social-economic rights of communities were necessary to address vulnerabilities. Of course, similar examples were also identified in the mentioned fields in this study. Finally, the integrated social-ecological system (vulnerability) and consensus with the trade-off workshop of the community were used for promoting and delivering the knowledge of environmental change associated with the utility, protection, and adaption technology strategy for the sustainable development of Kouhu Township in the coastal zone of Yun-Lin county, and then providing information associated with existing laws and regulations to policy-makers for sustainability and adaptation governance of community resilience in the coming three years.

Evidence:

4. Assessment of mackerel and scad fishery resources in the waters around Taiwan

In this study, we enhance the mackerel resource monitoring work in accordance with the implementation measures of the government under the Carangid and Mackerel Regulation. We continuously collected fishery and biological data of mackerels, established the scientific database, and conducted an in-depth analysis of biological, fisheries, and environmental information in order to know the effect of the management measure and to propose management recommendations. From January to November 2021, blue mackerel, chub mackerel, and jack mackerel comprised 72.01%, 14.29%, and 13.7% of the total catch in weight, respectively. The proportion of blue mackerel

decreased significantly. In the same period, we finished 7563 fish samples from port sampling and 2331 fish of anatomy in the lab. Standardized CPUE by GAM model bycatch and effort data collected from sampling vessels indicated that both blue mackerel and jack mackerel performed increased trend, but chub mackerel maintained stable. The MSY for blue mackerel was estimated at about 39,000~49,000t, and the blue mackerel catch of 2018 was much over the MSY level. However, in 2021, the catch mortality (F) by Y/R analysis decreased, but the value was over F0.1. The SSB/R analysis showed that the fishing mortalities were mostly over F25%. The MSY of chub mackerel and jack mackerel is estimated at about 25,000~32,000t and 6,900~8,100t, respectively. The Y/R and SSB/R analysis illustrated that their efforts of them were over F0.1. Besides, the trend of the Kobe plot indicated that jack mackerel was less optimistic in terms of resource and fishing levels. The preliminary result of VPA indicated that during 2014-2020 relatively strong recruitments occurred in 2016, contributing relatively high biomass of blue mackerel in 2017. In the meantime, the biomass of chub mackerel has declined steadily since 2011, and as a result, the total mackerel biomass shows a declining trend. In the 1st half of next year, the forecast model of catch rate by environmental factors was not yet established, nor was the availability of SST forecast data from CWB. According to NOAA Climate Prediction Center ENSO diagnostic discussion La Niña to continue through the winter, with ENSO-neutral predicted to return during March-May 2022. We may expect a neutral to the optimistic fishing condition due to similar SST of previous La Niña (2018 and beginning of 2020) and the fishing mortalities decreased of mackerels since 2021. In addition, we find that the batch spawning frequency of blue mackerel may be affected by water temperature. Higher temperatures can cause earlier spawning times, shorter spawning periods, and higher batch fecundity. We also find an interaction of fishing conditions among three fishing zones (Diao-Yu-Tai, Northern Three Isles, and Su-Ao). Such information may be important for the future management of spawning grounds, which still needs further analysis.

5. Research of Japanese scad (*Decapterus maruadsi*) stock status in the northern waters of Taiwan

According to Taiwan Fishery Year Book, the Japanese scad (Decapterus maruadsi) is the 4th high catch species by Taiwanese purse seine, even higher than the 3rd high species, jack mackerel (Trachurus japonicus), in recent years. However, there was no basic research regarding reproductive biology or stock assessment has ever been done for the species. Considering the pinciple of sustainable utilization of the fishery resources, it is necessary to establish stock status monitoring for the fish. In this study, we aim to carry out port sampling and measurement for the species to build up important parameters of reproductive biology, age, growth, etc., for further stock assessment and fishery management implemented by the Fishery Administration. In the first year, we begin with reproductive characteristics such as spawning period, age and growth, age structure, and historical catch/effort data compilation in the northern waters off Taiwan. From May to November 2021, we

finished 1433 fish samples from port sampling and 1081 fish of anatomy in the lab. The Gonosomatic Index (GSI) indicated that the spawning period of Japanese scad was between April and June. The female Japanese scad reached a high maturity rate in May, which implied that the spawning period peaked around that time. The minimum fork length of mature was found to be about 19.3 cm, and the fork length of 50% mature was 20.8 cm. The mean fecundity in all stages was 206617±2609 oocytes. The age and growth equation determined by otolith has not yet been carried out. A preliminary von Bertalanffy growth equation ($L\infty$=34.1 cm, k=0.6 yr-1, t0= -0.26 yr) was obtained by using length frequency data collected in previous years. The estimated age composition of Japanese scad caught by Taiwanese seines in the study area was mostly of age-1 and age-0, comprising 69% and 30% of the total catch, respectively. Standardized CPUE by GAM model bycatch and effort data collected from sampling vessels during 2013-2020 indicated that Japanese scad performed the periodic change. However, it is impossible to estimate MSY of the fish before the discrepancy of catch ratio of Japanese scad and jack mackerel recorded by the Taiwan Fishery Yearbook and by port investigators are solved.

6. Studying the impacts of ocean acidification on coral reefs

Adding on the mounting evidences, this study supports the prevailing expectation that ocean acidification (OA) would lead to a reduction in the overall accretion of coral reef ecosystems. However, increased $CaCO_3$ dissolution in response to OA may pose a more serious threat to this reduction than decreased coral calcification. Therefore, although recent studies have found that calcification by some corals may be relatively tolerant to OA, the persistence of coral reefs is still at risk due to enhanced $CaCO_3$ dissolution.

Evidence:

(1) Mesocosm is used to study the impacts of ocean acidification on coral reefs.

(2) Fieldwork in Dongsha Atoll to study the impacts of ocean acidification on coral reefs.

7. Report on the habitat of Chinese White Dolphins in the offshore wind farm No. 1

Survey and research are conducted because of the impact on the activities of white dolphins in a port expansion project. The conservation measures are proposed to reduce the impact. Ecological compensation is considered by taking both development and conservation into account.

SDG 14.3.4 Technologies towards aquatic ecosystem damage prevention (direct work)

Work directly (research and/or engagement with industries) on technologies or practices that enable marine industry to minimise or prevent damage to aquatic ecosystems

1. Fish population monitoring technology on aquafarm

To monitor the state of fish in underwater areas with low optical visibility, imaging sonar systems are often without alternatives. Because the sonar image of fish farms is often noisy, it is not easy to apply traditional techniques of image processing to analyze the fish behavior in sonar images. Besides, due to the limitation of a view of the imaging sonar system, it is also difficult to monitor fish everywhere in the fish farm from a single imaging-sonar view.

Our core technologies for analyzing fish behavior in sonar images will be developed for aquaculture applications. First, convolutional neural networks will be developed to estimate fish density maps in sonar images. Fish density maps are useful tools for analyzing the population and condition of fish in fish farms. Second, two algorithms will be developed to form fish density maps that better cover the fish farm by fusing multiple fish density maps from different imaging-sonar views.

The deep convolutional neural networks (DCNNs) for estimating fish density maps from a single imaging-sonar view will be developed. Because annotating all fishes in sonar images is costly and error-prone, a semi-supervised learning algorithm will be proposed to train the DCNNs on strong and weak pixel-level annotations.

Based on the DCNN developed, we shall develop algorithms for producing fish density maps with better coverage of the fish farm

The algorithms are novel and feasible but rarely developed. The research topics are important to the analysis of fish behavior in fish farms.

Evidence: Deep Learning Approaches to Estimating Fish Density Maps from Multiple Imaging-Sonar Vi Ews

https://www.grb.gov.tw/search/planDetail?id=13872134

2. Studies on the dynamics and management of flying fish roe fishery in the surrounding waters of Taiwan

The objectives of this research are to collect catch, biological and environmental data influencing the flying fish roe fishery of Taiwan, provide managers with to understand the fluctuations of the fishery in relation to environmental changes or human perturbations, assess and monitoring of the resource status, and provide counter measurements for the factors identified.

3. The application of Himawari-8/9 SST associated with the fish distribution in the waters of Taiwan resources in the coastal water off Taiwan maculate in the southwestern waters of Taiwan

Sea surface temperature (SST) is an important physical factor in the interaction between the ocean and the atmosphere. Accurate monitoring and prediction of the temporal and spatial distribution of SST are of great significance in dealing with climate change, disaster prevention, disaster reduction, marine ecological protection, and element fish habitat. This study establishes a prediction model of sea surface temperature using a radial basis function neural network (RBFNN) and Data Interpolating Empirical Orthogonal Functions (DINEOF) for the cloudy area in the waters around Taiwan. It suggested that the model of RBFNN with a bias of 0.2 to 0.5 ℃ is better than that of DINEOF with a bias of 0.5 to 0.8 ℃. The relationship experiment for fish behavior shows that, based on the Himawari -8/9 SST and JSD SST front index, the higher catch is found at the range of 16 to 22 ℃ and JSD 0.6 to 0.9. These two factors are available to find the optimum fishing ground for grey mullet fishery for possible ecological fishing management and reduce the searching time and oil cost for the fisherman in the wintertime.

4. The application of water temperature and current to the coastal fisheries in the coastal water surrounding Taiwan

Uroteuthis chinensis is an important commercial species in the coastal fisheries of southwestern Taiwan, and its distribution is affected by the marine environment. Understanding the relationship between these target species and the environment contributes to fishing exploration and management in Taiwan and is the basis of the prediction for the fishing ground of these species, the main aim of this study. In addition to the coastal fishery data from 2013 to 2019, this study collected oceanographic variables, including Sea-surface Temperature (SST), Sea-surface Chlorophyll-a concentration (SSC), Sea-surface Salinity (SSS), Sea-surface Height (SSH), Mixed-layer Depth (MLD), and Current Velocity (CV), Upwelling Index (UI). Besides, the GAM model was applied to explore the relationship between different environmental factors and squid's spatial distribution. Our results indicated that the range of SST, CV, SSH, SSC, SSS, UI, and MLD for the Uroteuthis chinensis squid in southwestern Taiwan is 25°C-29°C, 0.2-0.5m/s, 0.45-0.7m, 0-2 mg/m3, 33.5-34.5 psu, -1°C-2°C and 20-40m, respectively. Following the GAM analysis, the results of the Habitat

Suitability Index demonstrated that the most significant factor is UI, followed by SSH and SSS. Our research also pointed out that the optimal range of these factors is -0.58°C-0.2°C, 0.48m-0.53m, 33.72psu-34.22psu. Based on the HSI, the arithmetic means method (AMM) was applied to predict the fishing ground of the Uroteuthis chinensis squid in southwestern Taiwan. Finally, we use the Pelagic Habitat Hotpot Index to predict the potential fishing ground of this squid with a value of 0.3.

5. Studying the potential of seagrass meadows in mitigating ocean acidification

This study demonstrates that hydrodynamic regime may largely affect the biogeochemical processes in seagrass meadows, thereby modulating their capacities in OA buffering and CO2 sequestration. This study provides a valuable theoretical consideration for conserving and restoring seagrass meadows as a promising strategy for climate change mitigation.

Evidence:

(1) Fieldwork in Kenting to study the impacts of ocean acidification on coral reefs.

(2) Fieldwork in Dongsha Island to study the potential of seagrass meadows in mitigating ocean acidification.

SDG 14.4.1 Water discharge guidelines and standards

Have water quality standards and guidelines for water discharges (to uphold water quality in order to protect ecosystems, wildlife, and human health and welfare)

1. Demonstration Activity of the Fishing Village Environment Education

The Contents of this activity for students included doing the water test, understanding the knowledge of abalone culture, etc. Therefore, it fostered students in the perception of ecological conservation. 30 participants joined this activity.

Evidence:

(1) Ocean Water Quality Test

2. Testing River Water Quality and Monitoring Salinization of the Abandoned Fish Farms

It assisted in the followings, such as recycling the abandoned fish farms in local communities, testing the River Water Quality and salinization, providing the available planting species based on the results of testing, and transforming the local empty spaces into new agricultural production. 3 sessions of activities were held in 2021.

Evidence:

(1) Testing River Water Quality and Monitoring Salinization of the Abandoned Fish Farm

3. Environmental Education Facilities - NTOU Rainwater Park

The school was certified as an environmental education facility in April 2012. Because Keelung has abundant water resources, rainwater is collected from the roof and facade of buildings. After simple water quality treatment, the goal of energy saving and rainwater utilization can be achieved. Use rainwater recovery and storage systems to collect rainwater from building roofs, water bunkering, rope and hooded water collection, building facade water collection, rainwater filtration systems, rainwater flushing, irrigation systems, etc. The learners can learn through practical observation that water resources are precious and limited, and they should be cherished and fully utilized in order to achieve the effect of environmental protection and sustainable education.

Evidence: NTOU Rainwater Park
https://oga.ntou.edu.tw/ee/

4. School-wide wastewater management

Since 2016, the Binhai Campus has carried out sewage and sewer management operations, and the sewage is sent to the government sewage treatment office for treatment and discharge. In 2017, it

was completed in Xiangfeng Campus, and in 2019, the sewage and sewer management of the Beining Campus was completed. The whole school's sewage management operation has been completed. Since then, the wastewater treatment has been handled by professional treatment plants to meet the regulations

Evidence: Construction of collecting main

5. Campus Drinking Fountain Equipment

There are 140 drinking fountains installed in the public areas of the campus and on each floor of the student dormitories. The maintenance and repair work is entrusted to the manufacturer (currently performed by Lippa Industrial). The machines that do not pass the water quality test will be immediately taken out of service and improved in order to maintain the quality of drinking water on campus. The items are

(1) Normal maintenance: arrive at the campus within 4 hours to carry out troubleshooting and repair work.

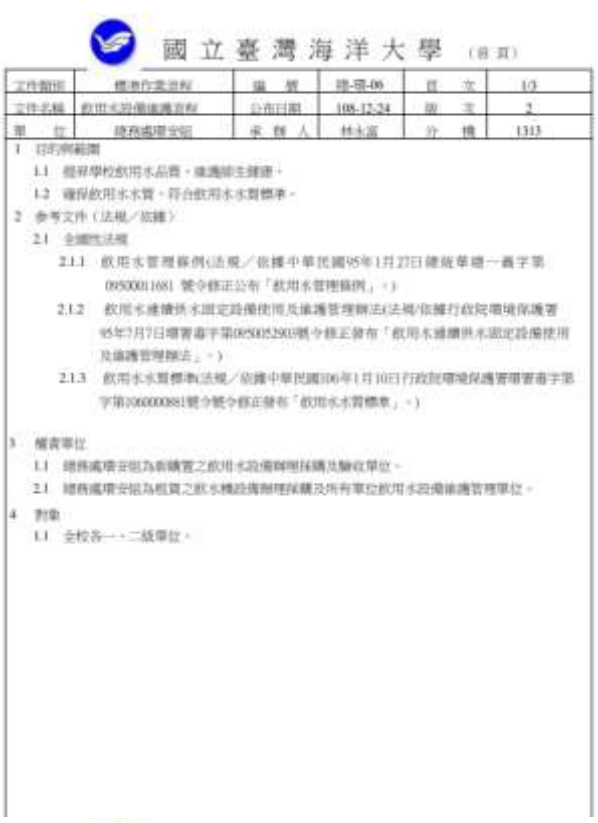
(2) Return to the factory for repair: to be completed within 7 days.

(3) Cleaning and maintenance and regular inspection: 1 time/month.

(4) Form records: maintenance and maintenance records are filled out.

Evidence: NTOU drinking water equipment maintenance process

https://ga.ntou.edu.tw/var/file/15/1015/img/1047/255420623.pdf



國立臺灣海洋大學（首頁）

文件類別	標準作業流程	編號	總-環-06	頁次	1/3
文件名稱	飲用水設備維護流程	公布日期	108-12-24	版次	2
單位	總務處環安組	承辦人	林永富	分機	1313

1 目的與範圍

1.1 提昇學校飲用水品質，維護師生健康。

1.2 確保飲用水水質，符合飲用水水質標準。

2 參考文件（法規／依據）

2.1 全國性法規

2.1.1 飲用水管理條例(法規／依據中華民國95年1月27日總統華總一義字第09500011681號令修正公布「飲用水管理條例」。)

2.1.2 飲用水維續供水固定設備使用及維護管理辦法(法規/依據行政院環境保護署95年7月7日環署毒字第0950052903號令修正發布「飲用水維續供水固定設備使用及維護管理辦法」。)

2.1.3 飲用水水質標準(法規／依據中華民國106年1月10日行政院環境保護署環署毒字第字第1060000881號令修正發布「飲用水水質標準」。)

3 權責單位

3.1 總務處環安組為新購置之飲用水設備辦理採購及驗收單位。

3.1 總務處環安組為租賃之飲水機設備辦理採購及所有單位飲用水設備維護管理單位。

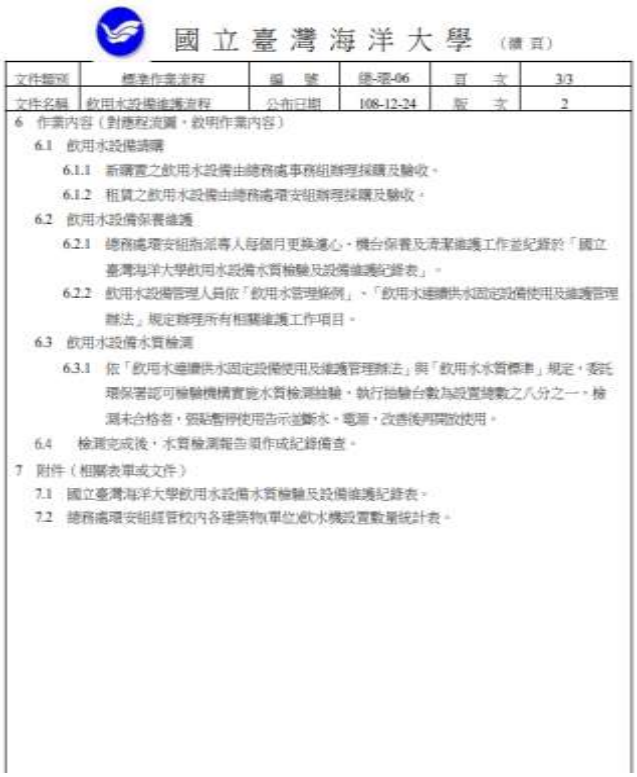
4 對象

4.1 全校各一、二級單位。

國立臺灣海洋大學（續頁）

文件類別	標準作業流程	編號	總-環-06	頁次	2/3
文件名稱	飲用水設備維護流程	公布日期	108-12-24	版次	2

5 流程圖



國立臺灣海洋大學（續頁）

文件類別	標準作業流程	編號	總-環-06	頁次	3/3
文件名稱	飲用水設備維護流程	公布日期	108-12-24	版次	2

6 作業內容（對應程流圖，敘明作業內容）

6.1 飲用水設備請購

6.1.1 新購置之飲用水設備由總務處事務組辦理採購及驗收。

6.1.2 租賃之飲用水設備由總務處環安組辦理採購及驗收。

6.2 飲用水設備保養維護

6.2.1 總務處環安組指派專人每個月更換濾心、機台保養及清潔維護工作並紀錄於「國立臺灣海洋大學飲用水設備水質檢驗及設備維護紀錄表」。

6.2.2 飲用水設備管理人員依「飲用水管理條例」、「飲用水維續供水固定設備使用及維護管理辦法」規定辦理所有相關維護工作項目。

6.3 飲用水設備水質檢測

6.3.1 依「飲用水維續供水固定設備使用及維護管理辦法」與「飲用水水質標準」規定，委託環保署認可檢驗機構實施水質檢測抽驗，執行抽驗台數為設置總數之八分之一，檢測未合格者，張貼暫停使用告示並斷水、電源，改善後再開放使用。

6.4 檢測完成後，水質檢測報告須作成紀錄備查。

7 附件（相關表單或文件）

7.1 國立臺灣海洋大學飲用水設備水質檢驗及設備維護紀錄表。

7.2 總務處環安組經管校內各建築物(單位)飲水機設置數量統計表。

SDG 14.4.2 Action plan to reducing plastic waste

Have an action plan in place to reduce plastic waste on campus

1. Reduce the use of plastic and disposable items

In accordance with the policy of the Environmental Protection Agency of the Executive Yuan, the store does not provide plastic bags and plastic disposable tableware when taking out meals in the school cafeteria, and does not provide disposable tableware such as chopsticks, spoons, knives when dining in, fork, etc., the tableware for internal use has been completely changed to reusable tableware, including chopsticks, spoons, etc. are all made of stainless steel or melamine, and continue to promote on campus that you can bring your own environmentally friendly tableware (green cups) when you go out. , chopsticks, bags), implement energy saving and carbon reduction, and respond to environmental protection policies.

Evidence: Plastic Waste Reduction Promotion

https://ga.ntou.edu.tw/p/412-1015-10931.php?Lang=zh-tw

SDG 14.4.3 Reducing marine pollution (policy)

Have a policy on preventing and reducing marine pollution of all kinds, in particular from land-based activities

1. 2021 Webinar on Marine Debris Solutions

On September 8, 2021, Prof. Ying-Ning Ho of the Institute of Marine Biology of NTOU was invited by the International Cooperation and Development Fund (Taiwan ICDF), a consortium under the Ministry of Foreign Affairs, to give a speech on "Marine Debris Reduction Online Seminar." Participating member countries and identities: Palau, Marshall, Tuvalu, Nuovo Officials of environmental protection or marine units in Shandong, the Philippines, Vietnam, Indonesia, Belize, Haiti, Guatemala, directors/R&D personnel of marine meteorology, waste disposal, and artificial intelligence industries, members of NGOs/international organizations, etc. The topic of the speech is: “Microorganism on marine plastic debris: the ecology and potential risks of plastisphere.”

Evidence: Promotion Poster

2. Social Impact and Legal Impetus of AI Applications in the Ocean

This research will analyze the impact of AI applications on issues such as marine pollution prevention, marine ecology and environmental conservation, and marine industry development on society, as well as make legal and policy research, analysis, and recommendations. This part will analyze how to assess and reduce the impact of AI applied to the ocean on society in terms of regulatory adjustment and policy planning and other soft infrastructure construction, such as employment, prejudice, ethics, regulations, etc., and propose solutions and feedback to AI in the ocean R&D. The specific expected results of this research and the expected results of related governance include a comprehensive review and comparison of my country's marine affairs-related policies, forward-looking policy recommendations for policy construction and legalization of AI application in the ocean, and research on my country's marine industry upgrading and AI.

Development strategies and suggestions for law revisions, research and development of my country's marine industry upgrading and AI development strategies and suggestions for law revisions, and solutions for AI technology development and social impact.

Evidence:
https://colp.ntou.edu.tw/p/412-1047-10786.php?Lang=zh-tw
https://colp.ntou.edu.tw/p/405-1047-77035,c10786.php?Lang=zh-tw

3. Invited talk: "From sea turtles to marine debris"

We invited the founder of the Hiin Studio, Fu Kuo, to give a lecture on the course "General Marine Affairs." Ms. Kuo talked about how her interest in marine conservation was inspired by being a volunteer in sea turtle research when she was an undergraduate student in NTOU. Then, when she studied for her Master's degree in Marine Biology, she found that marine debris has a huge impact on the marine ecosystem. She then established the "Hiin Studio" after graduation. Nowadays, her studio aims to provide marine conservation education, hosts beach cleanup events and supports recycling marine debris.

4. Marine Debris Education and International Coastal Cleanup

Participants learned the knowledge of marine debris and microbeads. They did coastal cleanup and filled out a form for citizen science. There were 44 participants who joined the action.

Evidence: https://reurl.cc/Er3k4R

SDG 14.5.1 Minimizing alteration of aquatic ecosystems (plan)

Have a plan to minimise physical, chemical and biological alterations of related aquatic ecosystems

1. The team led by professors H-J Lin and Z-Q Huang won the 2021 Taipei Biotechnology Award Technology Transfer Cooperation Bronze Award by developing herbal charcoal technology as an antimicrobial agent to overcome the widespread resistance of animal microorganisms to antibiotics.

Evidence: The team of Professor Lin Hanjia and Professor Huang Zhiqing won the 2021 Taipei Biotechnology Award Technology Transfer Cooperation Bronze Award with herbal charcoal technology to solve the problem of animal antibiotics abuse

https://www.biodriven.taipei/tw/awards_2021_3_3.html

https://www.cna.com.tw/postwrite/chi/299458

https://www.youtube.com/watch?v=Pf4MrfKdiQo

2. Prof. Li-Li Chen won the 2021 "Outstanding Technology Transfer Contribution Award" from the Ministry of Science and Technology.

Distinguished Professor Hsin-Yiu Chou from the Department of Aquaculture of National Taiwan Ocean University (NTOU) and Professor Li-Li Chen from the Institute of Marine Biology developed the "Geosphere Oral Preparation Technology of Functional Substances", which can protect various functional substances or live bacteria in the sphere, and effectively improve the absorption of substances in the gastrointestinal tract of fish and shrimp. This invention was licensed to NTOU and spawned a new start-up company - Up Aquatic Technology Co., Ltd. Because this new venture has created output value and improved the competitiveness of domestic aquatic products, the two professors won the 2021 "Outstanding Technology Transfer Contribution Award" by the Ministry of Science and Technology.

Evidence: https://mprp.ntou.edu.tw/p/404-1017-66023.php?Lang=zh-tw

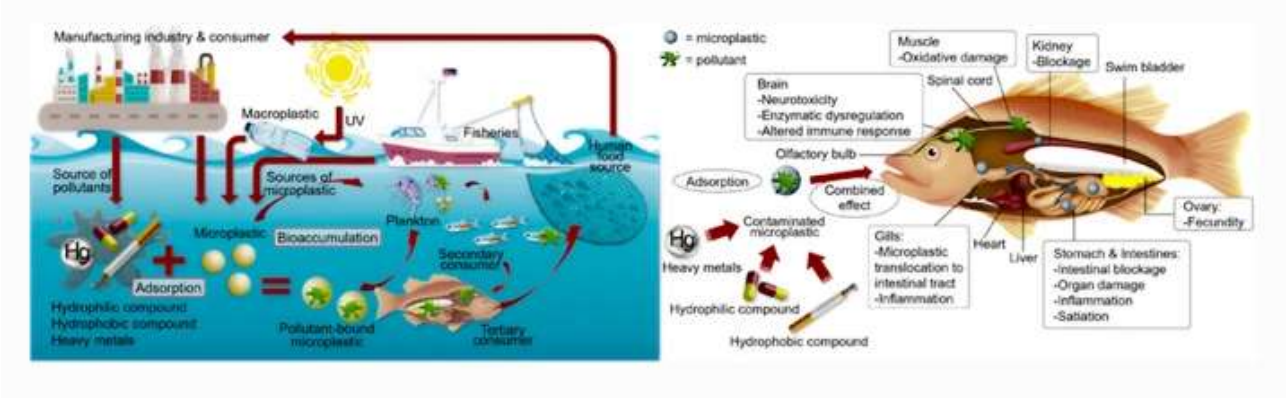
3. Study on the risks of pollutant sorption and bioaccumulation by microplastic toward humans

Microplastic pollutes water, land, air, and groundwater environments not only visually but also ecologically for plants, animals, and humans. Microplastic has been reported to act as vectors by sorbing pollutants and contributing to the bioaccumulation of pollutants, particularly in marine ecosystems, organisms, and subsequently food webs. The inevitable exposure of microplastic to humans emphasizes the need to review the potential effects, exposure pathways, and toxicity of microplastic on human health. Therefore, this review aimed to reveal the risks of pollutant sorption and bioaccumulation by microplastic toward humans, as well as the dominant types of pollutants sorbed by microplastic, and the types of pollutants that are bioaccumulated by microplastic in the living organisms of the marine ecosystem. The possible factors influencing the sorption and bioaccumulation of pollutants by microplastic in marine ecosystems were also reviewed. The review also revealed the prevailing types of microplastic, the abundance of microplastic, and the geographical distribution of microplastic in the aquatic environment globally. The literature review revealed that microplastic characteristics, chemical interactions, and water properties played a role in the sorption of pollutants by microplastic. The evidence of microplastic posing a direct medical threat to humans is still lacking albeit substantial literature has reported the health hazards of microplastic-associated monomers, additives, and pollutants. This review recommends future research on the existing knowledge gaps in microplastic research, which include the toxicity of microplastic, particularly to humans, as well as the factors influencing the sorption and bioaccumulation of pollutants by microplastic.

Evidence: Marine microplastics as vectors of major ocean pollutants and its hazards to the marine ecosystem and humans

https://progearthplanetsci.springeropen.com/articles/10.1186/s40645-020-00405-4

file:///C:/Users/user/Downloads/s40645-020-00405-4.pdf



4. Conducting research projects related to the Department of Aquatic Ecology

Our faculty members will conduct research projects in aquatic and marine-related fields for government departments to integrate research with the development of agricultural science and technology in Taiwan. 65 projects will be conducted in 2021.

Evidence: NTOU undertake research projects related to aquatic ecosystems in 2021

year	Department	Project Director	Title of Proposal	Project Consignment Unit
2021	Institute of Marine Biology	程一駿	2021 年度臺灣北區海龜救傷處理計畫	海洋委員會海洋保育署
2021	Institute of Marine Biology	程一駿	2021 年度臺東縣海洋野生動物及生態保育計畫	臺東縣政府
2021	Institute of Marine Biology	程一駿	2021 年度臺東縣綠蠵龜產卵棲地調查計畫	臺東縣政府
2021	Institute of Marine Biology	程一駿	2021 年臺東縣蘭嶼鄉海龜繁衍受路燈光害影響暨保育改善研究計畫	光寶科技股份有限公司
2021	Department of Food Science	凌明沛	食品添加物標準增修訂之評估	衛生福利部食品藥物管理署
2021	Department of Aquaculture	李柏蒼	箱網養殖主要及新興物種研究	行政院農業委員會漁業署
2021	Institute of Marine Biology	何攖寧	新興污染物-塑膠微粒可能成為傳播特定菌群的載體嗎？塑膠微粒於水產養殖牡蠣、文蛤與其內共生菌相的影響	Ministry of Science and Technology
2021	Department of Aquaculture	黃章文	箱網養殖主要及新興物種研究	漁業署
2021	Department of Environmental Biology and Fisheries Science	王佳惠	以科學方法辨識烏魚子之產地來源研究	行政院農業委員會漁業署
2021	Institute of Marine Affairs and Resource Management	王世斌	臺灣周邊海域飛魚卵資源動態解析及管理之研究	漁業署

year	Department	Project Director	Title of Proposal	Project Consignment Unit
2021	Department of Marine Environmental Informatics	方天熹	麥寮六輕周遭海域水質受濁水溪與新虎尾溪河水排入的影響計畫	台塑石化股份有限公司
2021	Department of Aquaculture	呂明偉	科研創業計畫：以 Lipoplex 口服傳遞平台開發高價值之優質水產種苗	Ministry of Science and Technology
2021	Department of Food Science	陳冠文	示差掃描熱分析檢驗(5)	財政部關務署基隆關
2021	Department of Aquaculture	沈士新	建立低用藥午仔魚友善生產與安全管理技術	行政院農業委員會漁業署
2021	Department of Food Science	陳冠文	示差掃描熱分析檢驗(1)	財政部關務署基隆關
2021	Department of Food Science	陳冠文	示差掃描熱分析檢驗(2)	財政部關務署基隆關
2021	Department of Aquaculture	李柏蒼	水產加工副產物萃取胜肽於白蝦養殖之開發與應用	行政院農業委員會
2021	Department of Aquaculture	潘彥儒	微型橈足類培養技術開發	行政院農業委員會
2021	Department of Aquaculture	徐德華	應用分子標記於台灣原生雀鯛魚種的遺傳管理	行政院農業委員會
2021	Department of Aquaculture	冉繁華	白蝦養殖環境監測與智能生產決策系統研究與開發	行政院農業委員會
2021	Department of Aquaculture	冉繁華	白蝦養殖產業管理研究計畫	行政院農業委員會漁業署
2021	Institute of Marine Biology	陳義雄	臺灣栽培漁業區之跨域統合暨漁場環境調整改善	行政院農業委員會漁業署
2021	Department of Environmental Biology and Fisheries Science	鄭學淵	臺灣栽培漁業區之跨域統合暨漁場環境調整改善	行政院農業委員會漁業署
2021	Department of Environmental	藍國瑋	建立台灣遠洋鮪釣漁業重要經濟性鮪類漁況預報與實船應用研究計畫(第二年)	今隆達海洋股份有限公司

year	Department	Project Director	Title of Proposal	Project Consignment Unit
	Biology and Fisheries Science			
2021	Department of Environmental Biology and Fisheries Science	藍國瑋	台灣栽培漁業區之跨育統合暨漁業環境調整改善	行政院農業委員會漁業署
2021	Institute of Marine Affairs and Resource Management	陳志炘	美洲大赤魷生物學暨資源評估研究及赤魷漁業資料分析	行政院農業委員會漁業署
2021	Institute of Marine Affairs and Resource Management	陳志炘	寶石珊瑚漁業漁獲資料分析及漁場評估研究	行政院農業委員會漁業署
2021	Shark Sustainability Research Center	劉光明	大西洋鯊魚資源調查評估研究	行政院農業委員會漁業署
2021	Shark Sustainability Research Center	劉光明	太平洋鯊魚漁業資源評估研究暨無危害風險評估(NDF)研究	行政院農業委員會漁業署
2021	Department of Food Science	蕭心怡	冷鏈對蔬果污染食媒性微生物之風險管理研究	行政院農委會農業試驗所
2021	Institute of Marine Biology	楊倩惠	龍蝦科及蟬蝦科 (無螯下目) 之物種界定與親緣演化關係研究(2/3)	Ministry of Science and Technology
2021	Department of Aquaculture	冉繁華	「協和電廠更新改建計畫環境影響評估案」-「海域生態及基隆市水產動植物保育區保育物種調查」計畫	泰興工程顧問股份有限公司
2021	Department of Aquaculture	冉繁華	箱網養殖主要及新興物種研究	行政院農業委員會漁業署
2021	Department of Environmental	歐慶賢	「連江縣南北竿跨海大橋(馬祖大橋)綜合規劃及環境	台灣世曦工程顧問股份有限公司

year	Department	Project Director	Title of Proposal	Project Consignment Unit
	Biology and Fisheries Science		評估服務工作 」漁業影響評估案	
2021	Institute of Marine Biology	黃將修	110-111 北部各核能發電廠附近海域之生態調查計畫	台灣電力股份有限公司
2021	Institute of Marine Biology	黃將修	108-109 北部各核能發電廠附近海域之生態調查計畫	台灣電力股份有限公司
2021	Department of Aquaculture	林正輝	箱網養殖主要及新興物種研究	行政院農業委員會漁業署
2021	Department of Aquaculture	林正輝	白蝦養殖產業管理研究計畫	行政院農業委員會漁業署
2021	Department of Environmental Biology and Fisheries Science	呂學榮	南海海域漁船作業及漁業資源調查	行政院農業委員會漁業署
2021	Department of Environmental Biology and Fisheries Science	呂學榮	鯖?漁業資源評估動態解析	行政院農業委員會漁業署
2021	Department of Food Science	陳冠文	示差掃描熱分析檢驗(4)	財政部關務署基隆關
2021	Department of Environmental Biology and Fisheries Science	廖正信	臺灣西南海域鎖管漁業資源評估研究	行政院農業委員會漁業署
2021	Department of Environmental Biology and Fisheries Science	廖正信	臺灣沿近海漁業活動資料庫系統之管理與分析	行政院農業委員會漁業署
2021	Department of Environmental Biology and Fisheries Science	蘇楠傑	大西洋熱帶鮪類資源評估研究	農委會漁業署
2021	Department of Environmental	蘇楠傑	大西洋旗魚與溫帶鮪類資源評估研究	農委會漁業署

year	Department	Project Director	Title of Proposal	Project Consignment Unit
	Biology and Fisheries Science			
2021	Department of Environmental Biology and Fisheries Science	蘇楠傑	桃竹苗離岸風電潛力場域漁業型態與漁獲物調查	行政院農業委員會水產試驗所
2021	Department of Environmental Biology and Fisheries Science	王勝平	鬼頭刀漁業資源評估研究	行政院農委會漁業署
2021	Department of Environmental Biology and Fisheries Science	王勝平	印度洋長鰭鮪與旗魚類資源評估研究	行政院農委會漁業署
2021	Department of Environmental Biology and Fisheries Science	王勝平	臺灣沿近海帶魚資源之生物參考點評估與漁業管理策略應 用	行政院農委會漁業署
2021	Department of Environmental Biology and Fisheries Science	曾煥昇	建置我國海域意識(Maritime Domain Awareness， MDA)之初期研究	海洋委員會
2021	Department of Marine Environmental Informatics	方天熹	109 年度桃園市海岸環境品質監測暨水質連續自動監測設施建置計畫-海岸地區及重要河川出海口水質定期檢測	康廷工程顧問企業有限公司
2021	Institute of Marine Affairs and Resource Management	蔡安益	臺俄(RU)雙邊協議型擴充加值(add-on) 國際合作研究計畫－比較東海及黑海海域環境超微細植物性浮游生物之族群結構及作用(1/3)	Ministry of Science and Technology
2021	Department of Environmental	魯謹萍	南方黑鮪及油魚資源評估及生殖生物學研究	行政院農委會漁業署

year	Department	Project Director	Title of Proposal	Project Consignment Unit
	Biology and Fisheries Science			
2021	Department of Aquaculture	黃振庭	箱網養殖主要及新興物種研究	行政院農業委員會漁業署
2021	Department of Aquaculture	黃振庭	發展觀賞魚產業計畫之周邊產業概況調查	行政院農業委員會漁業署
2021	Department of Aquaculture	黃振庭	適地適養各縣市重點養殖物種分析	行政院農業委員會漁業署
2021	Institute of Marine Biology	陳義雄	第三作液化天然氣接收站建港 及圍堤造地工程施工期間環境 監測河口生態調查	環興科技股份有限公司
2021	Institute of Marine Affairs and Resource Management	蔣國平	海洋學門研究發展及推動計畫	Ministry of Science and Technology
2021	Department of Aquaculture	沈士新	烏魚性別荷爾蒙調控之安全性及效果性試驗研究	行政院農業委員會漁業署
2021	Department of Aquaculture	沈士新	2019 帛琉共和國農漁業輔導計畫	帛琉共和國天然資源環境暨觀光部
2021	Department of Aquaculture	沈士新	2020 帛琉共和國農漁業輔導計畫	帛琉共和國天然資源環境暨觀光部
2021	Institute of Marine Affairs and Resource Management	郭庭君	三大洋減緩混獲物種影響之研究	行政院農委會漁業署
2021	Institute of Marine Affairs and Resource Management	郭庭君	台灣北部棒受網漁業混獲物種之棲地分佈及最適漁場預測	行政院農業委員會
2021	Institute of Marine Biology	邵廣昭	南灣海域珊瑚礁生態系調查監測	國立海洋生物博物館

year	Department	Project Director	Title of Proposal	Project Consignment Unit
2021	Department of Environmental Biology and Fisheries Science	李國添	國際漁業資訊彙整	行政院農業委員會漁業署

SDG 14.5.2 Monitoring the health of aquatic ecosystems.

Monitor the health of aquatic ecosystems.

1. Provide scientific data and services to preserve the marine ecosystem

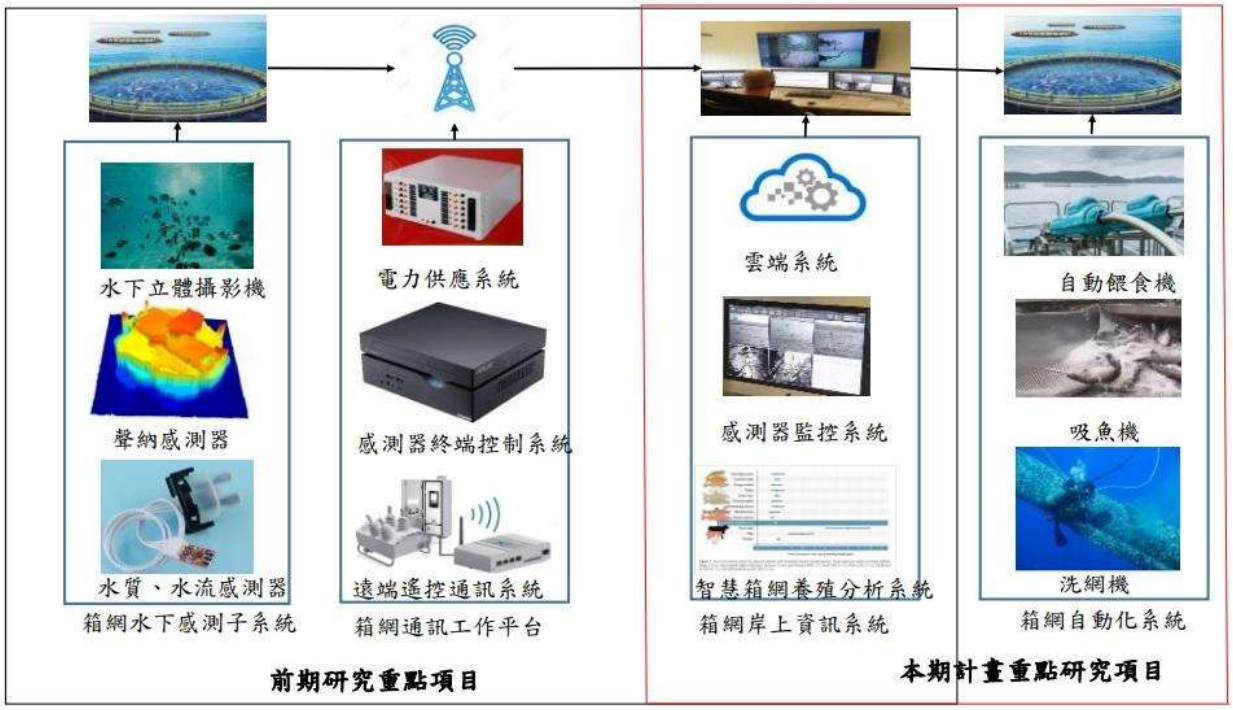
Taiwan is surrounded by sea and has a coastline of over 1,600 kilometers. In addition to more than 70 islands of various sizes, there are also diverse ecological microhabitats such as oceans, shelters, estuaries, mangroves, coral reefs, lagoons, and sandbars, which are important marine assets of Taiwan. Therefore, monitoring and preserving the marine ecosystem is an important issue for the sustainable development of Taiwan's oceans.

In 2021, the University was commissioned by the government and private organizations to conduct research on the biotic and abiotic environment of Taiwan's critical marine areas, and to conduct comprehensive assessment studies on the impact of business development on the marine ecosystem (pollution and ecological damage), as well as to conduct international affairs related to marine conservation and promote marine conservation education programs, in order to provide scientific data and services for the preservation of Taiwan's marine ecosystem. The government will construct sustainable management methods and policies to protect marine and coastal ecology from major adverse impacts.

2. Development of a cloud-based multi-mode underwater monitoring system for smart aquaculture

Artificial intelligence technology based on machine learning/deep learning and big data analytics has shown amazing results in the construction of various intelligent applications. Our previous project completed a cloud-based multi-mode underwater monitoring system for smart aquaculture. The system integrates the analytics of underwater images captured by sonar and underwater stereo cameras to monitor and manage the growth status of target species. At the same time, with the fusion of water sensing and image recognition, this project aims at subsequent planning of fish feeding strategies. The proposed system has been proven to be able to monitor fish schools for a long time in an aquaculture pond to build a cloud-based database for storing high-quality big data of specific fish species. Compared with related projects in this field in the world, this system is one of the few successful examples that can monitor and analyze the status of fish in aquaculture ponds in real-time.

Evidence: (1)Aloud-based multi-mode underwater monitoring system for smart aquaculture



(2) 2021 Smart Net Cage Aquaculture Application Technology Forum
https://mprp.ntou.edu.tw/p/404-1017-68262.php?Lang=zh-tw
https://ctee.com.tw/industrynews/cooperation/568014.html

3. The investigation and stock assessment of Mene maculate in the southwestern waters of Taiwan

To examine variation in the catches of moonfish and to discuss their spatial-temporal distribution in the waters off southwestern Taiwan, this study collected Voyage Data Recorder (VDR) data from 2013 to 2020 and logbook data in the Linyuan area (Kaohsiung City) and Penghu region during the period of May-December of this year. The analysis results indicated that Taiwanese seine was the main fishing method for catching moonfish, and its moonfish catch accounted for 98.96 and was followed by that of the trawl. In terms of the annual moonfish catches, there was a significant increasing trend between 2013 and 2016, then decreased dramatically in the following years. Regarding the monthly moonfish catches and average CPUE, the highest was in January, followed by three months consisting of March, July, and December; as a subsequence, it indicated they had seasonal variation. This study also showed that the longitudinal and latitudinal gravity centers and fishing locations of the moonfish fishery in the waters of southwestern Taiwan would change with the lapse of time. The result of Generalized Addictive Models (GAM) analysis pointed out that variation in the moonfish spatial distribution was mainly caused by sea-surface temperature, and sea-surface height, and slightly affected by other environmental factors: salinity, chlorophyll-a concentration, and mixed-layer depth. Moreover, this study analyzed 645 moonfish samples collected

from the southwestern waters of Taiwan, the result of this study indicates positive allometric growth for moonfish. The L–W relationship of moonfish in this study was illustrated as the following equation: BW=0.00003FL2.9579. According to the frequency distribution of fork lengths and body weights in this study, we suggest that moonfish stock may recruit between June to August. But it still needs more information about reproductive biology to prove. The result of analyzing a total of 118 stomach specimens suggests that the copepod was the main prey of moonfish in the southwestern waters of Taiwan. The stable isotope result indicates that the trophic position values of moonfish collected between June and August were between 3.33 to 3.85 and changed along with the growth of this species. According to the catch and effort of moonfish from 2014 to 2019, we suggested that MSY is 7000 tons. Moreover, the result also shows that the resources of moonfish in the southwestern waters of Taiwan are still in the stage of rational development and utilization. But we still need to be continuously monitored and managed in the future.

Evidence: Biological Sample Processing

4. The ecosystem dynamics associated with the environmental change surrounding the upwelling zone of Taiwan Bank resources in the coastal water off Taiwan maculate in the southwestern waters of Taiwan

Taiwan Bank was located in the south of the Taiwan Strait. Due to the influence of seasonal monsoon with the offshore currents of Kuroshio branch, Mainland China Coastal Current, and South China Sea Warm current, the micro-habitat zones such as upwelling and thermal fronts were formed and then bring various pelagic/demersal fishes by season to form the fishing ground in the waters surrounding the Taiwan Bank. However, the ocean environments and ecosystems were possibly influenced by the marine environment such as the change in sea surface temperature and chlorophyll-a concentration in Taiwan Strait. However, the study focusing on the effects of environmental change on ecosystem dynamics was still rare in the waters surrounding the Taiwan Bank. In this study, we will try to examine the seasonal marine environmental characteristics and investigate the abundance and distribution of pelagic/demersal life which is possibly influenced by environmental change, and then develop the ecosystem dynamics model for explaining the possibility of match/mismatch hypothesis happening in these ecosystem zones near to the waters around Taiwan Bank in the 3-year (2021/8-2024/7) project. Till now, three studied field surveys with 42 CTD stations in August 2018 and April and June 2019 were conducted to investigate the marine environment characteristics with the plankton sampler and pelagic/demersal fish of commercial fishery in this area. Our results indicated that the center of the upwelling zone in the summertime was located near the 50-meter isopleth at the south of Taiwan Bank. The copepod with an abundance 3441.16 ind./m3 (41.31 %) was identified and dominated in the zooplankton sampler. The first 3 dominant species in summer were Temora turbinata (10.72%), Oncaea venusta (9.63%) and Canthocalanus pauper (8.29%), respectively. In addition, the 1797 sampler of ichthyoplankton was also collected and suggested that the Gobiidae(16.65%), Bleekeria mitsukurii (15.33%), and Encrasicholina punctifer (9.04%) were the dominant species in the summertime. In addition, the monthly species composition was varied by month. The round herring may be the key species in summer. Its prey includes small fish, copepods, and shrimp. The isotope analysis suggested the trophic level is about 4.11, even if it was also predated by pelagic species such as dolphin fish. Otherwise, the heavy metal concentration of sediment was also analyzed. Finally, we also examine the marine environmental characteristics that were possibly influenced by the water of the South China Sea and Kuroshio branch current. The above preliminary result in the first two and half years will be available as the initial setting to develop the ecosystem dynamics model and to reconstruct foodweb models of upwelling, thermal front, and other micro-habitat ecosystems, and then to investigate the association to the grazing food chain of commercial species such as amberjack and ecosystem dynamics model in this study. The outcomes of these simulations can then be used to modify the initial parameterization, and the simulations are rerun until external validation is achieved."

5. "Marine Environment Ecological Research Team" conducts water area monitoring activities

(1) The Yunzhang uplift in the western part of the Taiwan Strait is the best site for offshore wind power generation in the world, but little is known about the impact of offshore wind power development and operation on marine ecology. Prior to the development of offshore wind power generation, field observations and studies on the marine ecology in the Yunzhang uplift waters were carried out for the first time throughout the year, and it was found that the most critical marine productivity that affected the marine ecology had obvious seasonal changes, and the highest value appeared in the water quality with strong sunlight, in the clear summer. The lowest value appears in the winter when the sun is weak and the water quality is muddy. The research results can be used as a basis for evaluating the impact of seawater disturbances caused by offshore wind power development and construction on marine ecology.

(2) The South China Sea has the largest internal waves in the world. Studies have found that when internal waves enter shallow waters from the deep sea, they will cool the sea water and increase primary biological productivity, resulting in a decrease in the partial pressure of carbon dioxide in surface water. This result confirms that the transmission of internal waves from deep seas to shallow waters not only helps to increase the biological productivity of oligonutrient in the seas but also improves the ocean’s ability to absorb atmospheric carbon dioxide.

(3) The primary productivity of phytoplankton plays the role of the transport of energy to higher trophic levels in the ocean. After photosynthesis fixes inorganic carbon into organic carbon, a part of it remains in the organism, that is, the particulate primary production (PPP). In addition, a part of the organic carbon will be released into the water body in the form of a dissolved state, that is, the dissolved primary production (DPP), which provides an important carbon source for the microbial cycle. The first simultaneous investigation of microbial carbon flux in the southern part of the East China Sea showed that the DPP accounted for approximately 40.8±12.2% of the total primary productivity. At the same time, the primary productivity in the dissolved state and the primary productivity in the particulate state show an excellent positive correlation, with a slope greater than 1. In warmer earth in the future, the total productivity of the ocean system may decline due to intensified stratification. A slope greater than 1 means that in addition to the decline in the total organic carbon fixed by photosynthesis, the proportion of flow to the microbial cycle will be reduced, making heterogeneity.

(4) Previous studies have suggested that the threat of ocean acidification to coral reef ecosystems is mainly due to the decrease in coral calcification rate. However, in recent years, more studies have shown that the increase in calcium carbonate dissolution rate caused by ocean acidification may also be the cause for the same. The coral reefs are gradually receding, but the relative sensitivity of the two is still unclear because coral reef calcification mainly occurs during the day, and the dissolution of calcium carbonate is prevalent at night. Therefore, two

mesocosm aquariums were used to simulate the difference in the impact of ocean acidification on the diel variation in the calcification rate and dissolution rate of the coral reef ecosystem. The results showed that there was no significant difference in the calcification rate of the net population during the day before and after acidification, while the calcification rate of the net population during the night was significantly reduced after acidification, which proved that the increase in calcium carbonate dissolution may have a lower response to ocean acidification than the decrease in coral calcification rate. In other words, the threat of ocean acidification to the coral reef ecosystem may mainly come from the increase in the dissolution rate of calcium carbonate, rather than the decrease in the rate of calcification as thought in the past.

SDG 14.5.3 Programs towards good aquatic stewardship practices.

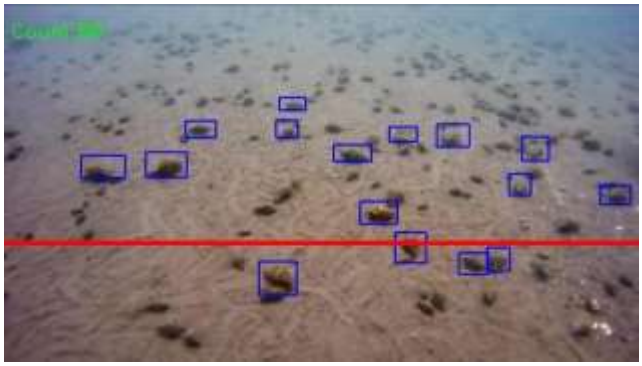
Develop and support programmes and incentives that encourage and maintain good aquatic stewardship practices.

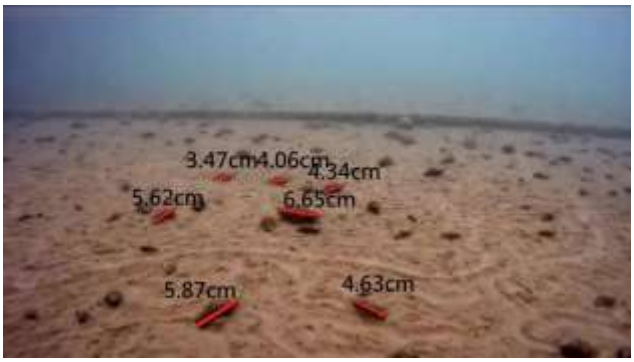
1. To develop an AI recognition system combined with underwater drones to monitor breeding conditions in real-time

The Center for Artificial Intelligence (AI) at NTOU aims to develop key AI technologies and provide a platform for cross-university and cross-national industry-academia cooperation and technology exchange and services to promote the development and upgrading of various industries. The Center uses AI to assist aquaculture operators to reduce repetitive human workload and improve aquaculture productivity. The Center works with the University's Ocean Center team to introduce AI technologies that combine live streaming images from underwater drones (ROVs), AI neural networks, big data, and object tracking to automatically detect the number, length, and weight of aquaculture organisms in real-time. Even mixed culture is not difficult for AI!

Evidence: (1) AI recognition system combined with underwater drones to monitor breeding conditions in real-time

(2)Underwater drones with AI technology to calculate the number and length of yellow conch(*Laevistrombus canarium*)





SDG 14.5.4 Collaboration for shared aquatic ecosystems

Collaborate with the local community in efforts to maintain shared aquatic ecosystems.

1. Research results from the Center of Excellence for the Oceans's "Marine Life Cultivation Hall

"The Center of Excellence for the Oceans houses Taiwan's second "Sea Turtle Rescue Center", which was originally set up at the "Aquatic Biology Research and Conservation Center" in Gongliao off campus. In 2019, it was moved back to the newly built "Marine Biology Cultivation Center" on the campus. The staff of the center took care of the injured sea turtles nearby.

In 2020, the total output of large-scale seaweed by "The Marine Biological Cultivation Center" reached 242.7 kg, of which 10.74 kg were provided to the School of Food Science, Department of Biotechnology, Sun Yat-sen University, Pingtung University of Science and Technology, and Grape King Biotechnology Company, Xpark aquarium, and MHU. We planned several algae exhibitions, 2020/12 to 2021/04 Taichung National Public Information Library Algae special exhibition, 2021/09 to 2021/11 Penghu Seedling Center algae to happiness special exhibition.

A total of 15 sea turtles was taken in 2021, including 8 green loggerhead turtles, 4 hawksbill turtles, 2 olive loggerhead turtles, and 1 red loggerhead turtle, 8 of which have been recovered and released into the wild."

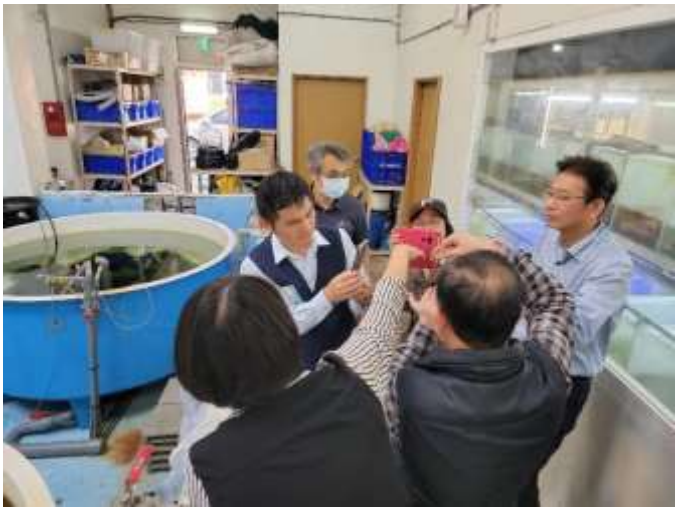
Evidence:

(1) Sea Turtle Lab

https://www.facebook.com/people/%E6%B5%B7%E6%B4%8B%E7%94%9F%E6%85%8B%E6%9A%A8%E4%BF%9D%E8%82%B2%E7%A0%94%E7%A9%B6%E5%AE%A4/100064346213234/

(2) Marine Biological Cultivation Center

(3) Aquatic Biology Research and Conservation Center



2. The Center of Excellence for the Ocean's team actively cooperates with the Lianjiang County Government in research activities

NTOU has established the Matsu campus in 2017. The center team actively cooperated with the Lianjiang County Government in research on lobster restoration, high economic value red-spot grouper, mussel farming, biotechnology cultivation of blue tears, and coastal environmental monitoring to research and create cultural and ecological tourism resources, mutual prosperity and growth space.

(1) Develop artificial seedling technology for Mytilus edulis. We use the seedlings that are cultivated indoors, including artificial insemination and seedling preservation. Detailed records on the fertilization rate, survival rate, and other data after artificial insemination, complete water quality, and bait feeding management records are kept.

(2) Wakame (Undaria pinnatifida) cultivation in Mazu. Undaria pinnatifida requires lower water temperature for breeding. Currently, only the Mazu area is suitable for growth in Taiwan. Undaria pinnatifida is rich in fucoidan, which has been found to be rich in anti-cancer factors, can reduce chemotherapy side effects and inhibit inflammatory reactions, etc. We expect that farmers can provide high-quality seedlings, thereby increasing the production of wakame and developing the local wakame biotechnology industry.

(3) Lobster is a highly valuable economical aquatic product. However, due to the seedling period being very long (half a year to a year), mass reproduction is very difficult. We assisted the Lianjiang County Government to establish a lobster restoration base in the Dongyin Beihai Tunnel.

(4) Matsu Blue Tears Research: The blue tears research team of our center found that the reproduction modes of Noctiluca can be divided into sexual reproduction and asexual reproduction (binary division). The results showed that in the most vigorous growth period of Noctiluca (the late exponential growth period) when the food was insufficient (the

concentration of food/the concentration of Noctiluca < 34500), the incidence of sexual reproduction increased from 1% to more than 10%). Under the condition of insufficient food, the noctilucent population will significantly increase the proportion of sexual reproduction, producing a large number of gametes to survive the period, directly or indirectly causing the end of the noctilucent red tide. Therefore, noctilucent sexual reproduction plays an ecological role at the end of the red tide while preparing for its next outbreak.

Evidence: Matsu Blue Tears Research
https://mprp.ntou.edu.tw/p/406-1017-68517,r1031.php?Lang=zh-tw

3. The Center of Excellence for the Ocean's "Aquatic Biology Research and Conservation Center" cooperates with the New Taipei City Government to conduct research

The "Aquatic Biology Research and Conservation Center" and the New Taipei City Government, taking Gongliao Mao'ao as an example, established the country's first fishery demonstration zone - Mao'ao Cultivation Fishery Demonstration Zone. We have successfully cultivated the famous marine tabby squid (flower branch) and rusty crab (flower crab) in the northern region. From mating and laying eggs to adults, large numbers of seedlings can be reproduced and released. In 2020, there were two promotion activities, Yehliu Huazhi and Mao'ao fry release, with a total of about 200 participants. Hairy crabs, lobsters, fan shrimps, corals, and other cephalopods such as octopus (true octopus) and Lai's pseudo squid were also reproduced and released. Soft silk, flower cuttlefish and economic shellfish, crystal phoenix snail, ivory phoenix snail, and Taiwan axe clam were reproduced via artificial propagation experiment. Other research contributions during the project period of the Aquatic Biology Research and Conservation Center include:

(1) Model construction and management of the cultivation and fishery area:

The goal of the Mao'ao Cultivation and Fishery Demonstration Zone is to integrate the local culture, industry, and people of the Mao'ao Fishing Village, as well as the marine landscape, to

make Mao'ao Bay a symbiotic and slow ocean, a lively- and custom-made fishing village, a leisure tourist attraction in the northeast corner of the scenic area through the breeding and release of low trophic levels such as herbivorous or bottom detrital food chain in the waters near Mao'ao. In addition, the breeding and release of blackfish, molluscs, and sea urchins by the Taiwan Fisheries Sustainable Development Association increases the rate of fish catching. Silver snapper, yellowfin snapper, black snapper, etc., with increasing catches, are continued to be released. The New Taipei City Government and the center team released Pharaoh cuttlefish to a limited extent in order to restore the ecological environment system of Mao'ao waters. Through diving surveys, real-time ecological environment monitoring system observations, and release effectiveness evaluation surveys, it has been shown that in the two to three years after release, various habitats have achieved initial results in nesting and attracting phoenixes, and coral reefs. We continue to track the ecological and economic benefit evaluation, dedicated to the independent management and value-added utilization of economic and non-economic resources in fertile waters to activate fishing villages, and then play a role of model transfer to expand and promote the development of the coastal blue economic corridor.

(2) The sustainable development of Mao'ao Fishing Village-to promote the sustainable development of the Mao'ao Cultivation Fishery Demonstration Zone

To go deep into the Mao'ao fishing village community to conduct long-term research, assist the community in participating in fish fry release trials, promote marine education and small trips, and set up a compound research station that combines tourism information to drive the gradual growth of local tourism. In addition, it also actively carried out industrial innovation and upgrading through processing, cultural creation, branding, planned counseling, and training courses applied for rural regeneration projects and successfully attracted young people from local fishing villages to return to their hometowns to serve and start businesses. In addition, this plan also promotes the sustainable use of resources, actively assists local residents in developing an independent management model, formulates a draft convention on the production and marketing of fisheries in the Mao'ao Bay intertidal zone, and assists in planning and applying for exclusive fishery rights. With the efforts of this plan, the development of the Mao'ao community has gradually achieved results, which will help the residents of this community to maintain a sustainable development model with autonomous operation.

Evidence: Taiwan's first flower crab successfully cultured
https://www.chinatimes.com/newspapers/20211115000457-260107?chdtv

SDG 14.5.5 Watershed management strategy

Have implemented a watershed management strategy based on location specific diversity of aquatic species.

1. Provide scientific data and services on watershed management strategies for specific regional diversity of aquatic species, including.
   (1) cross-regional integration of cultivated fishery areas in Taiwan and improvement of fishery environment adjustment.
   (2) Study of fish diversity and migration in the Mekong River Delta (2/2).
   (3) Offshore sampling and sample analysis of Taoyuan's Datan power plant intake.
   (4) 2021 Blue Tear Survey and Cultivation Program.
   (5) 2021 Ecological survey of large cartilaginous fish in Taiwan's peripheral waters. 6.
   (6) Survey of Marine Conservation Wildlife and Fisheries Interactions in Taiwan's Coastal Waters.
   (7) 2021 Washington Convention Appendix Marine Species Survey Project.
   (8) Transformation of Changhua Offshore Wind Power Fishermen and Sea Resources Restoration Planning Project.
   (9) 2021 Environmental quality monitoring service during the operation of the Tamsui River sewerage system - marine environment survey and sampling analysis.
   (10) Evaluation of the effectiveness of seedling release.
   (11) Analysis of the impact of climate change on the habitat and fishing conditions of the Spanish mackerel along the coastal waters of Taiwan.
   (12) Evaluation of the benefits of releasing additional resources in the cultivated fishery area of Gupta Island.
   (13) Application of biodiversity resources to the industry - Constructing nutrient ranking indices and catch balance indices for fish caught along Taiwan's coastal waters.
   (14) Biodiversity monitoring program - satellite marker release of a giant shark. 15.
   (15) Ecological Processes of the Plankton Food Web in the Subtropical Shelf - Sub-project: Exploration of Dissolved Basic Productivity and Passive Release Mechanisms in the East China Sea (III).
   (16) Long-term observation and study of marine basic productivity in the waters around Taiwan (III).
   (17) The migratory patterns of Lepidoptera squid in the surrounding waters of Taiwan.
   (18) Environmental change to Taiwan shallow beach (Taiwan Bank) welling area around the water eco dynamic characteristics of the study (III) - master plan and sub-project: environmental change to Taiwan shallow beach welling water plankton group diversity distribution of influence.

(19) environmental change to the impact of industry and human society along the coast of Yunjia and adjustment management strategy - environmental change to the impact of industry and human society along the coast of Yunjia and adjustment management strategy (master plan).

(20) To improve scientific knowledge, develop research capacity, transfer marine science and technology, and consider the criteria for transferring marine science and technology across governmental ocean committees in order to improve the health of the ocean and promote the contribution of marine biodiversity to the development of developing countries.

2. Guishan Island Coral Environmental Adaptation Research:

Guishan Island Coral Environmental Adaptation Research: Mainly involved in exploring the reproductive development stages and breeding seasons of corals in the northeast corner of Taiwan. In addition, transcriptome analysis has been conducted to compare the gene expression patterns of the corals in the vicinity of the hot spring area of Guishan Island and the normal marine environment and to explore the impact of extreme environments (high sulfur and high acid) on corals. Published 3 SCI papers in 2021.

Evidence: NTOU studies related to Hydrothermal vent ecosystem
https://www.grb.gov.tw/search;keyword=Hydrothermal%20vent%20ecosystem;type=GRB05;scope=1

3. Biodiversity research

(1) Diversity of crustaceans: The research on the diversity of crustaceans at NTOU has played an important role in the world. This year, we sort out the marine life survey conducted in Indonesia in cooperation with the University of Singapore. A total of 130 species of shrimp were collected. Among them, 11 species are new, and the other 23 species are newly recorded in Indonesia. In addition, in cooperation with scholars from Malaysia and Indonesia, in a trans-national collection study, it was found that the body color of the grass shrimp produced in Aceh Province, the most western part of Indonesia, was different from that of ordinary grass shrimp, and there was no obvious horizontal stripe on the body. The integrated taxonomic method combining morphological and molecular genetic characteristics successfully identified the population of the Aceh area as a new species of Penaeus. The result of this research is a major discovery in the fishery and aquaculture species of shrimp. We also cooperated with IFREMER, the French marine research center, to assist in the identification of shrimp images obtained by deep-sea photography in the Indo-West Pacific, and compare with the physical specimens collected by trawling, integrating and providing a feasible direction for the current popular deep-sea image ecological analysis. The Taiwanese research station published two new species of shrimp, a

new record of crab, and described for the first time the metamorphosis stage of a new species of shrimp discovered in recent years. They used specimens collected in Taiwan and around the world for the evolutionary phylogenetic analysis of the Pyramididae, Proterophyta, Heterospermidae, and even the entire higher taxonomic hierarchy of crustaceans. These multiple and different levels of research results keep NTOU's crustacean taxonomic evolution research dominant in Asia.

(2) Invasive species- hairy crabs: there are currently not many studies on the genomics of crustaceans. Our center researches and integrates different genomics studies to deeply analyze the famous invasive species Chinese mitten crab (commonly known as a hairy crab) to understand the gene regulation mechanism of crustacean environmental adaptation. We analyze the genome and transcriptome of the classic hairy crab to understand the mechanism of environmental tolerance to strong osmotic nodes and the high fertility rate of this migratory organism. The results showed that the F-ATPase series of genes is responsible for the adaptability of this invasive crab. In addition, the transcriptome analysis showed that the development process of abdominal degeneration in crabs is regulated by Hox-gene from the megalophthalmosus seedling stage, and the gene regulation of sexual differentiation can also be understood from the integrated genomics analysis. This study has provided many genetic insights into understanding the evolutionary adaptations of crabs and even crustaceans.

Evidence: NTOU studies related to Biodiversity research
https://www.grb.gov.tw/search;keyword=Hydrothermal%20vent%20ecosystem;type=GRB05;scope=1