

GLOBE 2025 International Virtual Science Symposium (IVSS)

**「The Ecological Challenges of Whales and
Dolphins from Strandings」**

**Instructor:
Chun Chiao Yeh**

**Yu Hsun Lin
Chih Yun Chao
You Yun Chen**

National ChuTung Senior School

Abstract

On April 15, 2017, a sperm whale died after being stranded at the mouth of Tongxiao Creek; on August 2, 2024, a large and a small cetacean were stranded in the Tongxiao sea area. This study aims to explore the issue of the increase in whale and dolphin stranding incidents on the western coast of Taiwan in recent years. We found that by investigating the data and using existing data, we finally chose the Tongxiao coast of Miaoli as our starting point for the study. During the investigation, we observed the same phenomenon off the coast of Boso Peninsula in Chiba Prefecture, Japan. We found that the biggest reasons for the increase in whale and dolphin stranding incidents were loss of navigation, navigation errors, and changes in tidal currents. After listing the reasons, we used the depth contours, and seabed topography annotation functions of the multi-dimensional marine information service platform, and the GLOBE sea temperature, ocean currents, and NODASS flow field, wind direction, and other related data to further observe and analyze the data to verify our hypothesis and draw conclusions.

Reason for Proposal

1. Motivation

After seeing a news report about a baby killer whale stranded in Tongxiao Sea, we became interested and thought that whales and dolphins are an important part of the marine ecosystem and play a key role in maintaining ecological balance. However, as for the reasons and speculations, we want to use big data to analyze the reasons for whale and dolphin stranding.

On the other hand, these incidents also exposed the shortcomings of local responses to cetacean strandings, including limited emergency rescue capabilities and a lack of targeted preventive measures. As strandings increase, we are beginning to wonder if there are ways to prevent them or reduce their impact. Through this research, we hope to prevent the problem of cetacean strandings, awaken more people's attention to the marine environment, improve civic literacy, and further promote the United Nations' 14th goal of sustainable development.

Finally, we hope to translate our findings into concrete actions to raise public awareness of marine conservation and explore how high school students can contribute to the marine environment through civic engagement.

2. Purpose

- a. Deeper understand the impact of whale and dolphin strandings on the environment and ecology
- b. Using big data analysis to explore the causes of whale and dolphin strandings
- c. Promote the United Nations Sustainable Development Goal 14

Research Methods and Materials

1. Collect data.
2. Find out the possible key reasons for stranding.
3. Use big data to observe whether it roughly matches the inferred reasons.
4. Use big data analysis to compare and find out whether it matches the results.
5. Get data related to cetacean stranding (and know the real reasons).
6. Confirm the variable causes of cetacean stranding.

Current Situation Description and Introduction

1. Cetacean species and habits

1) Common dolphins in western Taiwan - Chinese white dolphins, right porpoises, bottlenose dolphins

- a. **Chinese white dolphins:** It is one of the few species of cetaceans that live close to human activities. It likes to live in shallow coastal waters, especially near estuaries, lagoons and mangroves. The Taiwan subspecies is mainly distributed in the muddy and sandy beaches off the coast of Miaoli to Chiayi in Taiwan. The groups are

usually small groups of less than 10, but sometimes groups of 20-30 are seen. There are close social ties within the group, and communication is done through sound and touch. The populations in Taiwan's waters tend to avoid boats or fishing nets in a negative manner, and rarely forage near specific fishing methods such as trawlers like populations in other waters.

- b. **Right porpoises**: The biggest feature is that they have no dorsal fin. They are divided into narrow-ridged right porpoise and broad-ridged right porpoise. The broad-ridged right porpoise has a wide global distribution, mainly in the shallow waters of the Indo-Pacific region, while the narrow-ridged right porpoise is distributed in the shallow waters of the East Asian continental shelf. Both have been spotted and have been stranded in the outlying islands of the Taiwan Strait and the west coast of Taiwan. They usually move in small groups, with a common group size of 2-4.
- c. **Bottlenose dolphins**: It is widely distributed in the temperate to pan-tropical waters of the three major oceans, and the characteristics of the sea areas where it's active area vary greatly, and can be found in nearshore, estuaries and bays to the open ocean. Currently, it can only be seen in Taiwan's waters along the northern coast, from Yilan to Taitung, and on Green Island and Orchid Island. It is difficult to judge stranding incidents due to their appearance, but currently bottlenose dolphins have been stranded all over the island. The groups commonly range from a few to hundreds of individuals, usually less than 30 individuals.

2) Common whales in western Taiwan - sperm whales, fin whales, and small killer whales

- a. **Sperm whales**: Sperm whales are widely distributed in the deep waters of the three oceans, and mainly appear in the waters between 60 degrees north and south latitude. It has a habit of long-distance seasonal migration, but the time and route vary in different sea areas. The social group composition of sperm whales is relatively complex, and adult and older males often move alone in the polar regions. Long-term stable groups of female whales constitute the core units of

sperm whale society. Such small groups can reach 12 adult female whales, accompanied by their female and young male offspring. According to sightings off the east coast of Taiwan, sperm whales appear in eastern Taiwan from July to August. Recently, there have been cases of juvenile sperm whales stranded in Qixingtang, Hualien.

- b. Fin whales:** Fin whales are widely distributed in the world's oceans and can be found from the polar to tropical waters, and are more commonly seen in waters around 30 degrees north latitude. It is commonly found in deep sea areas and rarely enters shallow coastal waters. They usually act alone or in pairs, but occasionally hundreds of them gather in foraging areas. Seasonal migration is a notable feature of fin whales. They make long-distance north-south migrations every year.
- c. Pygmy killer whales:** It is the smallest whale, with males and females of similar size. It is named because its skeletal shape is similar to that of a killer whale, but its body size is much smaller than that of a killer whale and it is a different species. It is mainly distributed in tropical and subtropical open oceans, often appears in deep waters and rarely approaches the shore. There have been several reports of pygmy killer whales getting stranded en masse in Taiwan's waters in the southwest, Yilan, Hualien, and Taitung waters in the spring, but the cause of the strandings is still unclear. It is more common in the waters of Guishan Island in Yilan, and there have been many sightings in the waters of Lanyu Island and Green Island. The group usually consists of less than 50 individuals, and the community structure is quite stable.

公 開 類	編 製 機 關
季 (年) 報	號

每季終了後20日及次年2月底前填報

海洋保育署（海洋生物保育組）
11272-00-11

國內鯨豚擱淺事件統計

中華民國113年全年度

	通報 件數 (件)	擱淺數 (隻)	發現狀態 (隻)		種類(隻)																
			活體	死亡	中華白 海豚	大翅鯨	抹香鯨	熱帶斑 海豚	飛旋 海豚	瓶鼻 海豚	糙齒 海豚	弗氏 海豚	瑞氏海豚 (花紋海 豚)	露脊 鼠海豚	小虎鯨	偽虎鯨	小抹 香鯨	侏儒 抹香鯨	短肢 领航鯨	柯氏 喙鯨	其他
總 計	159	159	24	135	0	0	2	8	2	13	2	12	4	48	8	0	5	10	5	0	40
新北市	17	17	3	14	0	0	0	2	1	2	1	1	0	2	0	0	4	1	1	0	2
桃園市	10	10	0	10	0	0	0	0	0	1	0	0	0	4	0	0	0	1	0	0	4
宜蘭縣	9	9	2	7	0	0	0	1	0	0	0	3	0	0	0	0	1	3	0	0	1
新竹縣	2	2	0	2	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
基隆市	1	1	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
新竹市	4	4	1	3	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	2
臺中市	9	9	4	5	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	7
苗栗縣	12	12	3	9	0	0	0	2	0	2	0	0	0	1	0	0	0	2	0	0	5
彰化縣	9	9	0	9	0	0	0	1	0	4	0	0	0	1	1	0	0	0	0	0	2
雲林縣	3	3	0	3	0	0	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0
臺南市	5	5	5	0	0	0	0	0	0	0	0	0	1	0	4	0	0	0	0	0	0
高雄市	4	4	2	2	0	0	0	0	0	0	0	1	0	0	0	0	0	1	2	0	0
嘉義縣	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
屏東縣	6	6	2	4	0	0	0	0	0	0	0	2	2	0	1	0	0	0	1	0	0
澎湖縣	21	21	0	21	0	0	0	0	0	3	1	0	0	2	0	0	0	1	1	0	13
臺東縣	9	9	1	8	0	0	1	0	0	0	0	4	1	0	0	0	0	1	0	0	2
花蓮縣	4	4	1	3	0	0	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0
金門縣	9	9	0	9	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0
連江縣	25	25	0	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1

填 表	審 核	業務主管人員 主辦統計人員	機關首長	中華民國114年2月5日編製
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資料來源：由海洋保育署海洋生物保育組依據全國海洋生物擱淺統計表彙編。
填表說明：本表由海洋保育署海洋生物保育組編製一式4份，1份自存，1份送主計室，1份報送本會海洋資源處，1份報送本會主計處。

▲ Distribution map of types and numbers of stranded whales and dolphins in 2024

2. Coastal Environment of Miaoli County, Taiwan

1) Coastal development and utilization

- a. **Economic Development** : Some coastal areas in Miaoli are planned to be used as industrial areas or commercial ports. The main crop in coastal plains is rice, while in hilly plateaus the main crop is tea. On average, there is a fishing port every five kilometers. Longfeng, Waipu, Yuangang, and Hai'an are relatively large in scale and are planned as leisure fishing ports in conjunction with the two-day weekend.
- b. **Utilization of natural resources**:
 - I. The Ocean Offshore Wind Farm, also known as the Ocean Zhunan Wind Farm, is Taiwan's first officially operational offshore wind farm.
 - II. Miaoli's coastline is an important foundation for fisheries and aquaculture, especially coastal fisheries and oyster shell farming, which have a direct impact on the local economy and residents' livelihoods.

2) Geographical Features—Location, Topography

- a. **Location** : Miaoli County is located in the north-central part of Taiwan.

It borders Hsinchu County to the north, Taichung City to the south and southeast across the Da'an River and the Xueshan Mountains, and the Taiwan Strait to the west. Mountains and hills account for more than 80% of the county's area, with more mountains than plains, earning it the title of "Mountain City". The coastline generally refers to the area starting from the north of Qiding in Zhunan Town and extending southward to the south coast of Fangli Coast in Yuanli Town. It is about 50 kilometers long between Yangang River and Da'an River. The coast type is sandy coast with abundant sand transport and scouring of seaside hills.

- b. **Topography**: Offshore sandbars are formed between Houlong and Tongxiao, and new land is developed in Haipu south of Waipu. The coast is eroded by river terraces, forming a gravel coast from the mouth of Houlong Creek to Wanwa, Baishatun, Xinpu and Tongxiao. Severe disasters are often caused by the abundant drifting sand near Yuanli. From Zhonggang Creek to the mouth of Houlong Creek on the coast, the coast is close to hilly areas, and erosion is serious near Waipu and Shuiwei. From the mouth of Houlong Creek to Wanwa, Baishatun, Xinpu and Tongxiao, the river line is close to the alluvial layer and erodes the terrace gravel layer to form a gravel coast.

3) Basic Knowledge about Whale and Dolphin Strandings

a. Reasons

- I. **Lost** : Sometimes cetaceans avoid wind and waves in pursuit of fish or other food, or it may be because of poor physical condition. After entering an unfamiliar area, they get lost and cannot find the exit.
- II. **Disease infection** : When they are injured or sick and unable to move in the sea, weak cetaceans may be blown to shallow shores by currents or wind and become stranded. It is also

speculated that sick cetaceans may actively swim to shallower waters to rest.

- III. **Positioning system failure** : Most toothed whales rely on precise echolocation as an important sense for navigation. Sometimes, due to parasitic infection or other injuries, the hearing organs are damaged, and they are unable to determine the direction and become stranded.

b. Emergency Treatment for Stranded Whales and Dolphins

- I. **Strandings of cetaceans that are dead** : Preliminary examination and sample collection for autopsy to investigate the cause of death.
- II. **Strandings of cetaceans that are still alive** : Three musts and four no's for emergency handling. Three musts—keep it in the right posture, make sure it stays moisturized, record breathing and heart rate. Four no's—don't expose them to the sun, do not stand too close to the tail or head of a whale or dolphin to avoid being hit, do not push, pull or tumble the pectoral fins, tail fin or head of a cetacean, nor roll the animal's body, avoid touching the bodies of whales and dolphins, reduce noise, and isolate the crowd.
- III. **Disposition after rescue** : (1)Return to the sea (2) Euthanasia (3) Rescue and send to rehabilitation.

c. Tongxiao's Stranding Cases over the Years

- I. 2009/9/26 A Chinese white dolphin was stranded and died at Xinpu Beach in Tongxiao Town, Miaoli.
- II. 2015/11/14 A dwarf sperm whale was stranded and died at Qiumaoyuan Coast, Tongxiao, Miaoli.
- III. 2017/4/15 A sperm whale was stranded and died at the mouth of Tongxiao River.
- IV. 2024/8/2 Two cetaceans, one large and one small, were stranded in the Tongxiao Sea area. The rescue was successful and they were sent to the cetacean rescue station for treatment.

- V. 2024/10/10 A melon-headed whale was stranded in the Tongxiao Sea area and was sent to the cetacean rescue station for treatment.

d. Organizations dealing with stranded whales and dolphins

- I. **Marine Conservation Agency:** Every year, the three quarters of cetacean stranding reports are compiled and reported as individual, dead, and alive. The report analyzes the causes of strandings, provides an introduction to various cetacean stranding cases, and other information. Rescue education training, publicity lectures and fisherman conservation promotion activities are held from time to time.
- II. **Taiwan Cetacean Society :** Advocate for the research, appreciation, conservation and education of cetaceans. Provide guidance on emergency procedures and precautions for stranding, as well as possible methods for rescue of live animals. The association includes online donations, volunteer activities, etc. They have been committed to the conservation of whales and dolphins for a long time. To date, they have carried out more than 1,000 rescue operations for stranded whales and dolphins, released more than 100 injured whales and dolphins into the wild, held more than 100 marine conservation courses each year, promoted friendly whale watching behaviors in the eastern whale watching ports, carried out marine whale and dolphin diversity monitoring, and continued to pay attention to the impact of marine development projects on whales and dolphins, helping more injured animals have the opportunity to return to the sea.

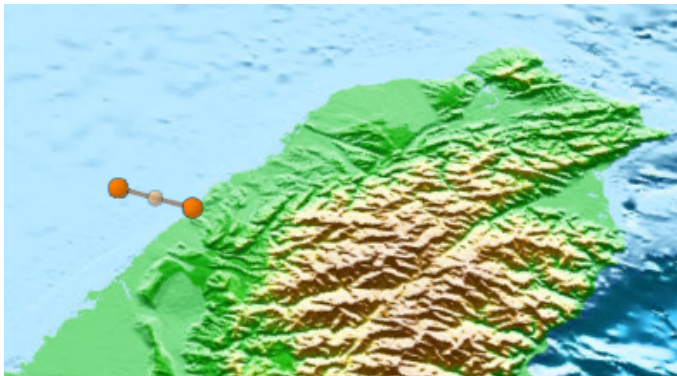
- e. Event Distribution :** According to statistics from the Marine Conservation Administration, the largest number of stranded fish in the third quarter of 2024 was mainly in Yilan County (4 stranded) and New Taipei City (4 stranded), followed by Penghu County (3 stranded)...etc.

Problem Analysis - Lost, Navigation Error

1. Establish Suspected Cause

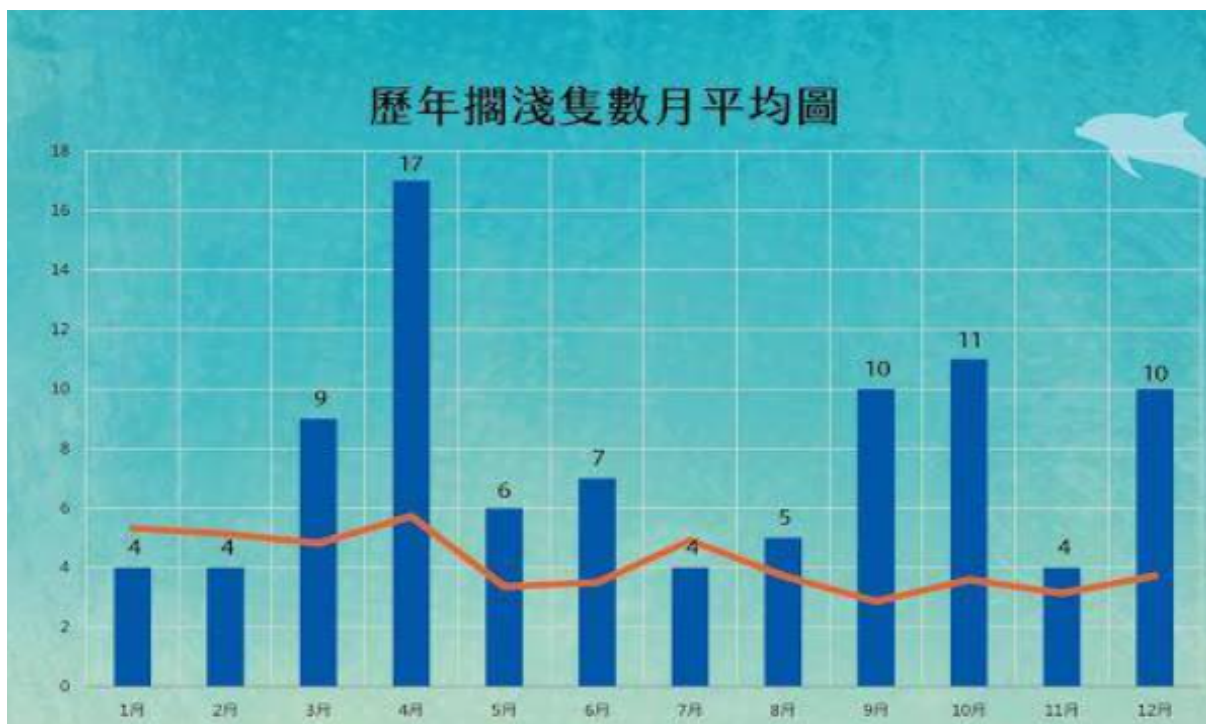
We used the Ministry of the Interior's data system to obtain seafloor topography data in the Tongxiao area to verify whether topography is the cause of cetacean strandings, and used GLOBE and NODASS data to verify whether ocean current temperature is one of the causes of cetacean strandings. Below we first assume that terrain and sea temperature will affect cetacean strandings.

- a. Topography changes** : Cetaceans rely on sonar to determine terrain and direction. If the seabed terrain is complex or changes rapidly, it may cause abnormal reflection of sound waves, which in turn affects their navigation. The coast of Tongxiao in Miaoli has shallows and sandbars, which may interfere with the sonar of whales and dolphins and cause them to get lost.

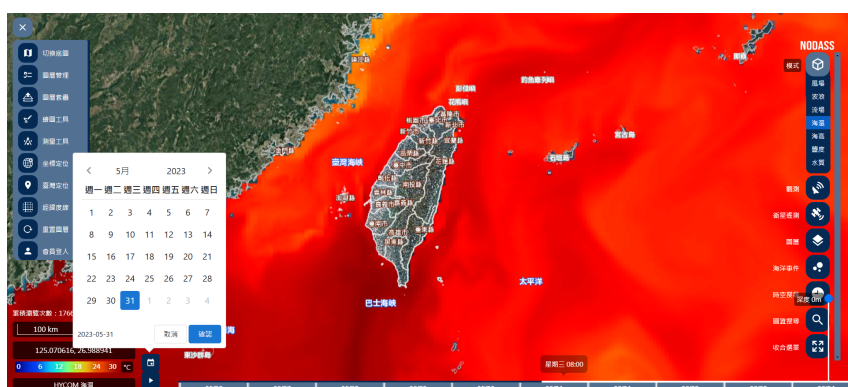
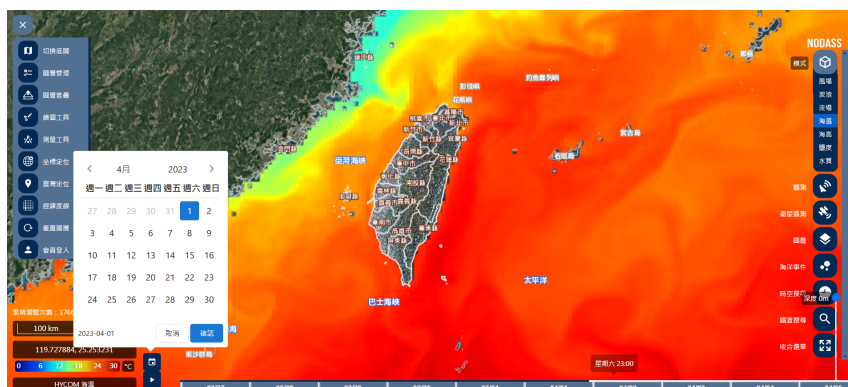


▲The topographic map of the seabed extending 20 kilometers from Tongxiao Beach.

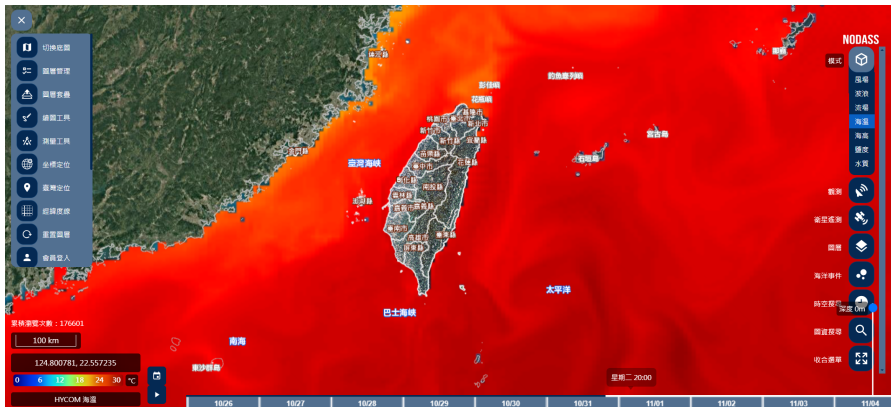
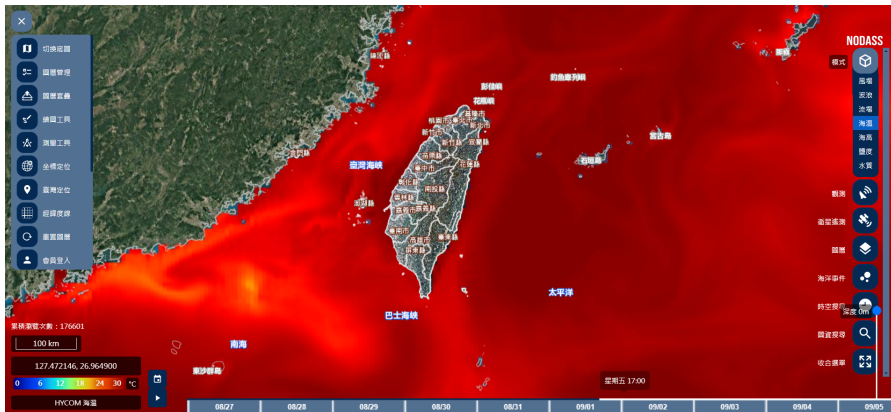
- b. Ocean Current Temperature** : Temperature changes caused by changes in ocean currents can cause cetaceans to lose their sense of direction. From the chart, we found that the number of stranding incidents increases significantly in April-May and September-October each year. In addition, big data shows that the sea temperature changes significantly during the monsoon changes in April-May and September-October, so the ocean current temperature is taken into consideration.



▲ Monthly average of the number of stranded whales and dolphins over the years.



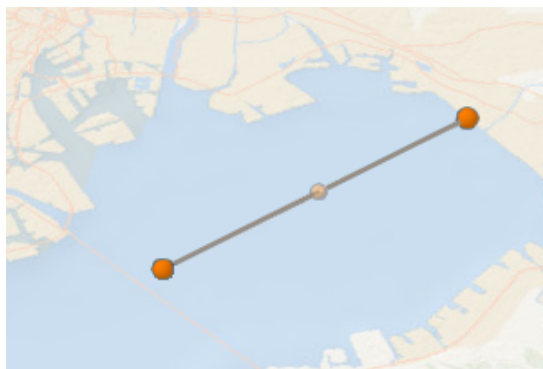
▲ Sea temperature change chart from April 1 to May 31, 2023.



▲ Sea temperature change chart from September 1 to October 31, 2023.

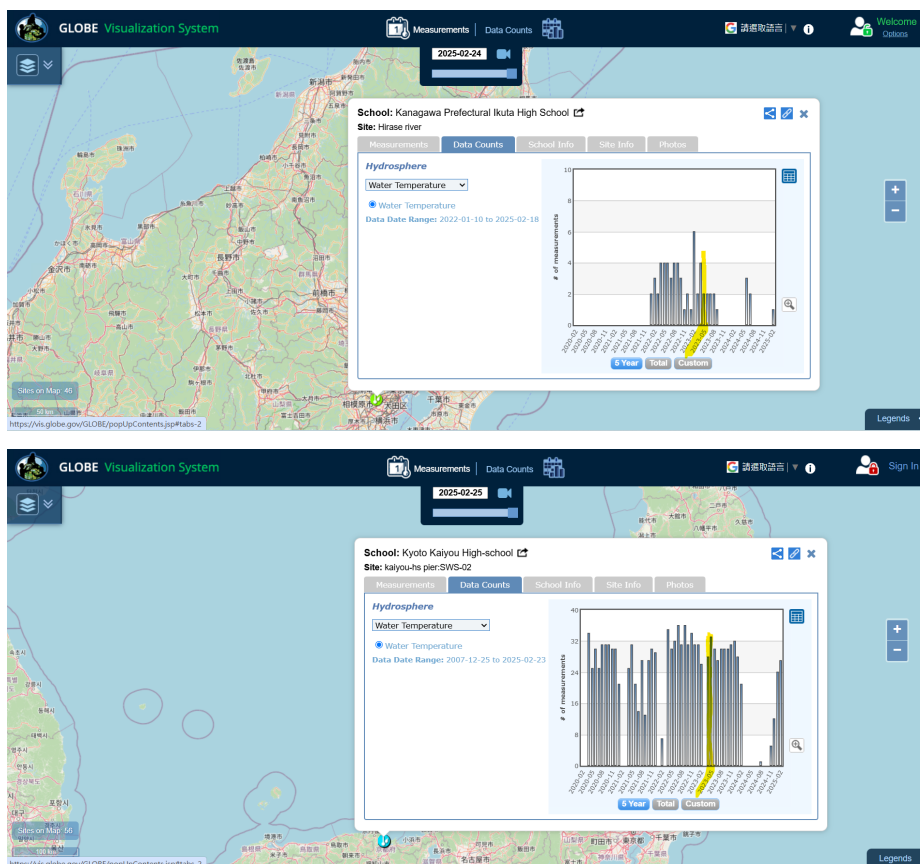
2. Verify

- a. **Exploring the Impact of Terrain Undulation on Cetacean Strandings:**
Cetaceans rely on sonar to determine terrain and direction. If the seabed terrain is complex or changes rapidly, it may cause abnormal reflection of sound waves, which in turn affects their navigation. The coast of Tongxiao in Miaoli has shallows and sandbars, which may interfere with the sonar of whales and dolphins and cause them to get lost.



▲ Map of the seabed topography changes extending 20 kilometers from the coast of Boso Peninsula in Chiba Prefecture, Japan

- b. **Studying the Impact of Ocean Current Temperature Changes on Cetacean Strandings:** The ocean currents in the Tongxiao area are complex, especially during the monsoon changes (April-May and September-October). The temperature changes caused by the changes in ocean currents can cause cetaceans to lose their sense of direction. We found that on April 3, 2023, 32 dolphins were stranded on the coast of Boso Peninsula, Chiba Prefecture, Japan. Using the data in the figure below, we can see that the sea temperature in Japan did change greatly from April to May, which is consistent with the fact that changes in ocean current temperature can cause cetaceans to lose their sense of direction and then become stranded.



▲ Sea surface temperature change in Japan from April to May 2023.

Results and Discussion

1. Topographic.
2. Based on the above sea temperature data and stranding incident statistics, as well as the time of stranding incidents in Japan, we can determine that whale and dolphin strandings are related to changes in ocean current temperature.

Badge Description

1. I make an impact

The research report clearly describes the close relationship between the UN Sustainable Development Goals, social concerns and research, establishing a connection between Taiwan and the world. Students must describe how their research can have a positive impact on society at large by providing recommendations or implementing actions based on their findings. Exploring trends in cetacean strandings can provide us with insights. By analyzing big data and promoting awareness among the public, we can use the findings to protect the ecology and environment and reduce cetacean strandings.

2. I am a data scientist

This study imports data from the cloud. Students will objectively analyze the data, make inferences about past events, and use the data to verify or solve problems. This report includes data from many different sources, such as the GLOBE Japan SST tables, the GLOBE data archive, NODASS flow data, and seafloor topography data provided by the government. With this data, students can make their inferred causes more closely related to real consequences. Make data analysis easier and get clear, reliable results.

3. I am a collaborator

This research report involves data from four different sources: data obtained from GLOBE, information from the Ministry of the Interior, Executive Yuan, and big data from NODASS. We used data from these platforms to collect and analyze the inferences required to be validated in this study. Furthermore, we use the GLOBE repository and hope to contribute to the global community of researchers. By collaborating with others and sharing our research, we aim to increase public

understanding and awareness of cetacean strandings and promote the United Nations Sustainable Development Goal 14. We hope that our efforts can be recognized by big data integration and teamwork.

4. I am a stem storyteller

In this study, we educate middle school students about whale and dolphin strandings. By introducing current research results and discussing potential causes, through interactive discussions and visual demonstrations, we will help students explore the potential causes of these strandings, including: excessive sea temperature changes, rapid terrain fluctuations, etc., in order to increase middle school students' awareness of marine conservation issues and encourage students to explore marine science and citizen participation. This outreach initiative provides an opportunity to bridge the gap between academic research and public awareness, creating a new generation of informed and engaged ocean citizens.





References

1. GLOBE Visualization System<https://vis.globe.gov/GLOBE/>
2. Taiwan's 100 Marine Animals Illustrated Guidehttps://www.oca.gov.tw/ch/home.jsp?id=289&parentpath=0,5&mcustomize=ocamaritime_view.jsp&dataserno=202103160010
3. National Museum of Marine Science & Technology
https://www.nmmst.gov.tw/chhtml/publication_detail/519/6/24
4. Marine Conservation Agency's 109th Annual Stranding Report
<https://www.oca.gov.tw/userfiles/A47020000A/files/109%E5%B9%B4%E5%B9%B4%E5%BA%A6%E6%93%B1%E6%B7%BA%E5%A0%B1%E5%91%8A%E6%9C%80%E6%96%B0.pdf>
5. Marine Conservation Agency
<https://www.oca.gov.tw/ch/home.jsp?id=379&parentpath=0,296,375>
6. Tide table for Tongxiao Township, Miaoli County
<https://www.go-calendar.com/tide/%E8%8B%97%E6%A0%97%E7%B8%A3%E9%80%9A%E9%9C%84%E9%8E%AE>
7. Surfers rescue 32 dolphins after they stranded on Japanese coast
<https://www.cna.com.tw/news/aopl/202304040065.aspx>