Yunlin Offshore Wind Farm
Black-faced Spoonbill
Satellite Tracking Survey Program

July 2022-December 2022
Result Report

Developer : Yunneng Wind Power Co., Ltd.

Monitoring Unit : National Pingtung University of Science and Technology

Submitted on : January, 2023

Contents

Figures

Tables

Preface

I. Regulatory

Yunneng Wind Power Co., Ltd. has formed a Bird and Bat Survey Protocol based on Article no. 20 in "Environment and Social Action Plan" and the IFC PS6 standard. The protocol includes descriptions of the survey methods for bird and bat monitoring during the offshore pre-construction, construction and operation phases of "Yunlin Offshore Wind Farm Project" (hereinafter abbreviated as "the Project"). In the Project, proper survey methods are established according to the protocol to evaluate the changes in birds/bats population and to estimate the possible impacts of the Project. It is expected that the quality of bird and bat monitoring tasks can therefore be ensured.

In addition, according to the "Yunlin Offshore Wind Farm: Critical Habitat and Net Gain Assessment" (March 2020) released by ERM, black-faced spoonbill (hereinafter abbreviated as "BFS") is the potential "candidate critical habitat species" in the Project site. To clarify if there is any impact of the Project on BFS, the Project has developed a BFS monitoring plan following the prescribed protocol. The plan includes a satellite tracking survey of BFS to get a clearer picture of the activity area and flying routes of BFS near the Project area.

II. Monitoring Period

The satellite tracking survey has been separated into two phases, phase I started in January 2021, and phase II started in November 2021. This report is the survey result report from July 2022 to December 2022.

III. Monitoring Unit

The result report of BFS satellite tracking survey phase I is compiled and written by Unitech New Energy Engineering Co., Ltd., and the National Pingtung University of Science and Technology (hereinafter referred to as “NPUST”) was commissioned to carry out the satellite tracking survey works. The result report and works of phase II are carried out by NPUST.

Chapter I Monitoring Summary

1.1 Survey Statement

Satellite tracking survey phase I began in January 2021, and as of February, all 16 BFSs have been banded; satellite tracking survey phase II began in November 2021, and as of April 2022, all 17 BFSs have been banded. Monitoring data this season are summarized in Table 1.1-1.

1.2 Survey Summary

The survey items, locations, frequencies, and survey dates of the BFS satellite tracking survey are compiled in Table 1.2-1.

Table 1.1-1 Monitoring Summary of BFS Satellite Tracking Survey

Survey Item	Survey Summary
Black-faced Spoonbill Satellite Tracking Survey Phase I	Survey results starting from January 2021, are as summarized below: 1. Banding results In February 2021, a total of 16 BFSs were banded and tracked, including 11 individuals that were rehabbed and 5 individuals that were captured in Tainan and Chiayi. 2. Migration date and time (1) Date of migration Among the 16 BFSs tracked in this project, the transmitter of 1 individual (N01-6819) malfunctioned in Taiwan, and the remaining 15 individuals all successfully departed offshore in spring migration in 2021. Departure dates were between March 10th and June 13th. April was the main migration departure month, accounting for 46.7% of the records. In the autumn migration of BFS in 2021, 5 birds were still being tracked after returning to Taiwan, but one bird lost signal during the migration period (Y43-6838), the migration data of 4 individuals were obtained. Arrival dates were between October 18th and November 9th. (2) Time of migration The departure time for most BFS was in the early morning, followed by departure between evening and midnight. In the analysis of three-hour periods, 11 individuals (accounting for 73.3%) departed offshore between 5:00-8:00; 2 individuals (accounting for 13.3%) departed offshore between 17:00-20:00, and 1 individual departed offshore between 2:00-5:00 and 20:00-23:00 respectively (accounting for 6.7%).

	In autumn, two individuals arrived between 2:00-5:00, while 1 individual each arrived from 14:00-17:00 and from 17:00-20:00. 3. <u>Migration routes</u> (1) Departure routes in the Taiwan Strait According to the departure/arrival routes, none of the BFS flew over the Yunlin wind farm area. Only the blue leg band individual (right blue-6837) that departed the earliest, on March 10th, 2021, flew a mere 400 meters from the wind farm perimeter at its nearest. (2) Departure/arrival location By identifying the location of departure for BFS using the administrative districts for cities and counties, 5 individuals (33.3%) departed from Changhua, and 2 individuals each (13.3%) departed from districts including Chiayi, Yunlin, Taoyuan, and New Taipei; the remaining 2 individuals (6.7%) departed from Miaoli and Tainan, respectively. During the southern migratory routes of 4 individuals, it is known that the arrival location of BFS fell between Miaoli and Chiayi.
Black-faced Spoonbill Satellite Tracking Survey Phase II	Survey results starting from November 2021, are as summarized below: 1. <u>Banding results</u> From November 2021 to April 2022, a total of 17 BFSs were banded and tracked, including 7 individuals that were rehabbed and 10 individuals that were captured in Tainan and Chiayi. 2. <u>Migration date and time</u> (1) Date of migration Among the 17 BFSs tracked in this project, the transmitter of 4 individuals (N12-6827, N13-6821, N14-6836, N32-11541) malfunctioned in Taiwan, and 1 juvenile bird (N16-7378) stay in Taiwan during the breeding season of 2022. The remaining 12 individuals in phase II and 1 individual in phase I all successfully departed offshore in the Spring migration of 2022. The migration data of 13 individuals were obtained. Departure dates were between March 13th and April 24th. In March and April, 6 (46.2%) and 7 (53.8%) birds departed offshore respectively. In the autumn migration of BFS in 2022, there were 9 birds that returned to Taiwan, but one bird lost signal during the migration period (N31-11553), the migration data of 8 individuals were obtained. Arrival dates were between October 7th and December 27th. (2) Time of migration In spring, the departure time for most BFS was in the morning. In the analysis of three-hour periods, 3 individuals (accounting for 25%) departed offshore between 5:00-8:00 and 8:00-11:00 respectively; and the rest of the time periods were from 0 to 1 bird, with no apparent peak. In autumn, four individuals arrived between 8:00-11:00, while 1 individual each arrived from 5:00-8:00, 11:00-14:00, 17:00-20:00 and 20:00-23:00. 3. <u>Migration routes</u>

	(1) Departure routes in the Taiwan Strait According to the departure/arrival routes, only one route passes potentially through the Yunlin wind farm area. The positioning frequency of that device is with 1 hour very rough, therefore we cannot be sure, if the bird actually flew over the Yunlin wind farm area. (2) Departure location By identifying the location of departure for BFS using the administrative districts for cities and counties, 5 individuals (38.5%) departed from Changhua, followed by 4 individuals (30.8%) departed from New Taipei, 2 individuals (15.4%) departed from Yunlin, the remaining 2 individuals (7.7%) departed from Taoyuan and Hsinchu, respectively. During the southern migratory routes of 8 individuals, it is known that the arrival location fell between Taoyuan and Chiayi.

Table 1.2-1 BFS Monitoring Schedule

Survey Item	Survey Location	Survey quantity	Survey Dates
Black-faced Spoonbill Satellite Tracking Survey Phase I	Tainan City and Chiayi County	16 birds were tracked in 2021	2021.2.1 (3 birds were banded) 2021.2.2 (1 bird was banded) 2021.2.3 (1 bird was banded) 2021.2.4 (3 birds were banded) 2021.2.5 (1 bird was banded) 2021.2.10 (1 bird was banded) 2021.2.19 (2 birds were banded) 2021.2.24 (2 birds were banded) 2021.2.27 (2 birds were banded)
Black-faced Spoonbill Satellite Tracking Survey Phase II	Tainan City and Chiayi County	17 birds* were tracked in 2022	2021.11.11 (1 bird was banded) 2021.12.8 (2 birds were banded) 2021.12.15 (1 bird was banded) 2021.12.17 (1 bird was banded) 2021.12.31 (1 bird was banded) 2022.1.11 (3 birds were banded) 2022.1.12 (1 bird was banded) 2022.1.13 (1 bird was banded) 2022.2.8 (2 birds were banded) 2022.2.24 (1 bird was banded) 2022.2.26 (1 bird was banded) 2022.3.5 (1 bird was banded) 2022.4.1 (1 bird was banded)

*Note: the 17th individual is to supplement the one that stops tracking before spring migration in 2021.

1.3 Survey Method

The habitat of BFS in the wintering sites mainly includes aquaculture fish farms, abandoned salt fields, estuaries, grass swamps, et cetera. For BFS wintering in Taiwan, around 70 % winter in Tainan, 26% winter in Chiayi, < 10% winter in Qieding, Kaohsiung, and the remaining BFS are scattered around other areas (Kuo 2016). The census data from Taiwan Wild Bird Federation shows the largest number of BFS distributed in various areas in a single day (as shown in Figure 1.3-1). For the Yunlin project, satellite tracking for BFS was conducted along the coast of Tainan and Chiayi.

The project adopts two methods for BFS banding:

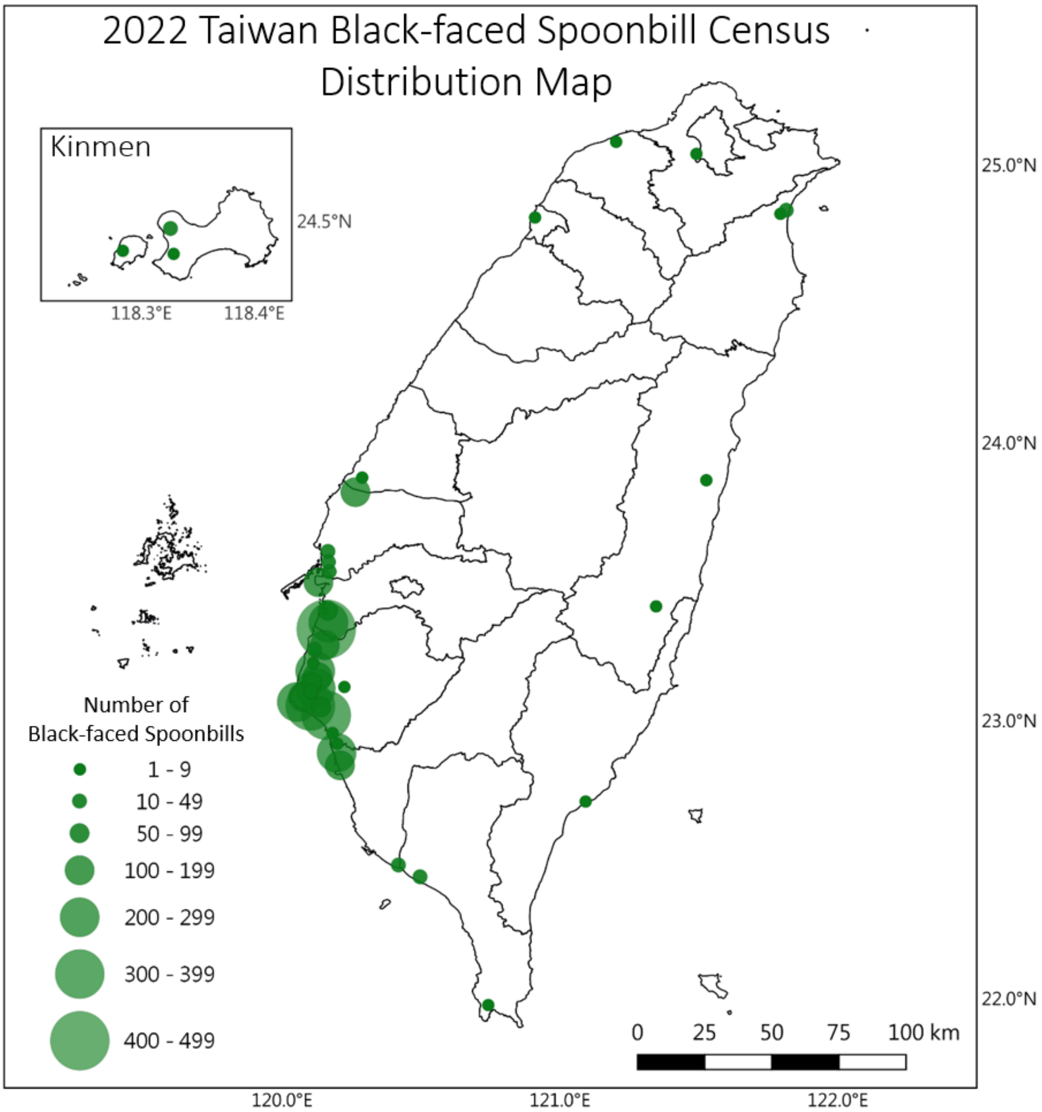
I. Cooperating with BFS Protection Organization— Banding of rescued birds

In 2002-2003, mass mortality of BFS caused by botulism infection occurred in Tainan during wintering season. Since then, Tainan City Government has been cooperating with non-governmental organizations in developing a BFS rescuing process that includes BFS rescuing tasks and habitat maintenance carried out every year. If BFS with suspected Botulism infections is spotted by bird lovers, wildlife preservation organizations, or patrol, the individual will be sent to an animal hospital for treatment, and the Wild Bird Society of Tainan will be informed. After recovery, the BFS will be sent to the Endemic Species Research Institute, Council of Agriculture, Executive Yuan for physical assessment. If the individual's physical strength is fully restored upon assessment, our team will band it with a transmitter and release it into its original habitat.

II. Setting snare trap –Banding of captured birds

The snare method will be deployed at suitable sites. This trap is made up of about 200 snares (15 cm in diameter) tied onto a 20 m rope. Both ends of the rope are fastened to an iron bar that is plugged into shallow water (Figure 1.3-2). Each trapping site will contain 5-10 ropes depending on the number of BFS. The captured BFS will be released on site after the transmitter is attached.

GSM/GPS solar-powered transmitters made in China will be used for satellite tracking in the project. The transmitters can provide positioning spots at a 1-hour interval. Each positioning spot will include GPS coordinate, altitude, and speed. The interval can be tuned into 20-second when the bird stays aloft and with sufficient battery power.



Source of data: Taiwan Wild Bird Federation (https://www.bird.org.tw/news/1892)

Figure 1.3-1 Distribution Map of BFS in Taiwan (2022)

Figure 1.3-2 Example of Snare Trap

1.4 Operation Process of QA/QC

Preparation of this survey includes the application of purchasing and importing satellite transmitters, sampling site inspection, and trap deployment. Researchers will set snare traps at places where targeted species are frequently seen, and stand by near the trap.

Researchers will take photos and measure the external features of the captured birds (as shown in appendix 1). The birds will be banded with satellite transmitters (weighting < 3% of the bird's weight) and set free on-site. BFS are large water birds weighing over 1000 g, thus GSM/GPS Debut Lego 3G transmitter (Druid Technology, Inc.), weighting 25.4 g, is applied.

The satellite transmitter may receive data from the tracked bird including GPS coordinates, flying altitude, direction, flying speed, and remaining battery life. The transmitters were preset to provide positioning spots at a 1-hour interval. Each positioning spot will include GPS coordinate, altitude, and speed. The interval can be tuned into 20-second when the bird stays aloft and with sufficient battery power.

The satellite transmitter should be placed at a known altitude before banding in order to calculate the positioning altitude and calibrate discrepancies between actual altitude. This is conducted due to the discrepancy between the GPS positioning altitude and the actual altitude.

Chapter II Analysis of Survey results

2.1 Satellite Tracking Survey

The satellite tracking survey has been separated into two phases, phase I started in January 2021, and phase II started in November 2021. The survey results are as follows.

I. Banding Results of Black-faced Spoonbill Satellite Tracking Survey Phase I

In February 2021, a total of 16 BFSs were banded and tracked for this project, including 11 rescued birds and 5 captured birds banded in Tainan and Chiayi (Table 2.1-1). Among the rescued birds, one juvenile female (Y43-6838) was already banded by a Korean team, and a transmitter was attached by our team before releasing; another adult bird (T98-6833) got sick once again for an unknown reason other than botulism infection on April 8th, the individual was released after recovering on April 30th and departed offshore on May 8th.

The transmitter of 1 individual (N01-6819) malfunctioned in Taiwan after a brief tracking period, the remaining 15 individuals all successfully departed offshore. Among them, 7 birds (T98-6833, T97-6834, T99-6817, right brown-6830, right blue -6837, N09-6835, N03-6053) had disconnected in Korea, 3 birds (NB-6826, N04-6818, N08-6823) had disconnected in China, 5 birds (T95-6820, T00-6814, N02-6831, N05-6822) had returned to Taiwan in autumn 2021. In the autumn migration of 2021, one device stopped working during migration (Y43-6838), and the migration data of 4 individuals were obtained. Among the 5 birds that return to Taiwan in autumn 2021, 3 birds had disconnected in Taiwan, 1 bird was found dead (Y43-6838), and the other one departed offshore in spring 2022 (N05-6822), and is currently being tracked in South Korea.

II. Banding Results of Black-faced Spoonbill Satellite Tracking Survey Phase II

From November 2021 to April 2022, a total of 17 BFSs were banded and tracked for this project, including 7 rescued birds and 10 captured birds banded in Tainan and Chiayi (Table 2.1-2).

The transmitter of 4 individuals (N12-6827, N13-6821, N14-6836, N32-11541) malfunctioned in Taiwan after a brief tracking period, and 1 juvenile stayed in Taiwan (N16-7378) during the breeding season of 2022, the remaining 12 individuals all successfully departed offshore in the Spring of 2022. Among them, 2 birds (N15-7371, N35-12506) had disconnected in China, 1 bird (N29-11543) had disconnected in Korea, and 9 birds (N33-11551, N24-11534, N26-11540, N25-11536, N28-11548, N21-7377, N22-7379, N23-11330, N31-11553) stayed in Korea during the breeding season of 2022 then went back to Taiwan in autumn. Currently, there were 2 devices that disconnected in Taiwan for less than 3 months and are still waiting for the signal.

Table 2.1-1 Tagging Information of Black-faced Spoonbill Satellite Tracking Survey Phase I

No.	Tracking No.	International identification band		Age	Tagging date	Tagging location	Source	Departure date and location from Taiwan	Location found overseas	Arrival date and location in Taiwan	Tracking Status (Note[1])
		Number band	Colour band								
1	6820	T95	White, blue, green	Adult	2021/2/1	Yanshui River, Tainan	Rescued	2021/4/12, Changhua	2021/4/12, left Taiwan to China. 2021/4/29, left China to South Korea. 2021/10/17, left South Korea to China and then returned to Taiwan on 10/18	2021/10/18, between Miaoli and Chiayi	N (2021/10/26)
2	6834	T97	White, green, red	Adult	2021/2/1	Sicao, Tainan	Rescued	2021/4/8, Taoyuan	2021/4/8, left Taiwan to China 2021/4/26, left China to South Korea	-	N (2021/4/29)
3	6833	T98	White, green, yellow	Adult	2021/2/1	Sicao, Tainan	Rescued	2021/5/8, Chiayi	2021/5/8, left Taiwan to China 2021/5/22, left China and arrived in South Korea on 5/23	-	N (2021/9/21)
4	6817	T99	White, green, blue	Subadult	2021/2/2	Sicao, Tainan	Rescued	2021/3/28, Yunlin	2021/3/28, left Taiwan to China 2021/4/5, left China and arrived South Korea on 4/6	-	N (2021/8/13)

No.	Tracking No.	International identification band		Age	Tagging date	Tagging location	Source	Departure date and location from Taiwan	Location found overseas	Arrival date and location in Taiwan	Tracking Status (Note[1])
		Number band	Colour band								
5	6838	Y43	Yellow, blue, green	Juvenile	2021/2/3	Budai, Chiayi	Rescued	2021/6/13, Taoyuan	2021/6/13, left Taiwan to China Left China and then returned to Taiwan from 2021/10/22 to 12/24	Battery power was too low to locating from 2021/10/22 to 12/24	S (2022/4/12) (Note[2])
6	6814	T00	White, green, white	Adult	2021/2/4	Sicao, Tainan	Rescued	2021/4/12, Changhua	2021/4/12, left Taiwan to China 2021/4/28 Signal transmission lost, yet 5/1 signal recovered showing location in South Korea 2021/10/22-23, left South Korea to China 2021/10/30-31, left China to Taiwan	2021/10/31, between Changhua and Yunlin	N (2022/2/28)
7	6830	--	Right brown	Adult	2021/2/4	Yanshui River, Tainan	Captured	2021/3/16, Chiayi	2021/3/16, left Taiwan to China 2021/3/26, left China to South Korea	-	N (2021/6/25)
8	6837	--	Right blue	Subadult	2021/2/4	Qigu, Tainan	Captured	2021/3/10, Tainan	2021/3/10, left Taiwan to China 2021/3/22, left China to South Korea	-	N (2021/10/22); no GPS (2021/6/24)

No.	Tracking No.	International identification band		Age	Tagging date	Tagging location	Source	Departure date and location from Taiwan	Location found overseas	Arrival date and location in Taiwan	Tracking Status (Note[1])
		Number band	Colour band								
											(Note[3])
9	6826	--	No band	Juvenile	2021/2/5	Qigu, Tainan	Captured	2021/5/31, New Taipei	2021/5/31, left Taiwan and arrived China on 6/1	-	N (2021/8/21)
10	6819	N01	Blue, red	Adult	2021/2/10	Sicao, Tainan	Rescued	2021/2/16 Last active in Tainan area.			N (2021/2/16)
11	6831	N02	Blue, yellow	Juvenile	2021/2/19	Budai, Chiayi	Rescued	2021/4/20, Changhua	2021/4/20, left Taiwan to China 2021/5/15, left China and arrived South Korea on 5/16 2021/10/17, left South Korea to China 2021/11/9, left China to Taiwan	2021/11/9, Changhua	N (2022/2/23)
12	6053	N03	Blue, green	Subadult	2021/2/19	Budai, Chiayi	Rescued	2021/4/27, Miaoli	2021/4/27, left Taiwan to China 2021/5/19, left China and arrived South Korea on 5/20	-	N (2021/10/20)
13	6823	N08	Green, white	Juvenile	2021/2/24	Tucheng, Tainan	Rescued	2021/5/22, New Taipei	2021/5/22, left Taiwan and arrived China on 5/23	-	N (2021/10/24)

No.	Tracking No.	International identification band		Age	Tagging date	Tagging location	Source	Departure date and location from Taiwan	Location found overseas	Arrival date and location in Taiwan	Tracking Status (Note[1])
		Number band	Colour band								
14	6835	N09	White, red	Subadult	2021/2/24	Qigu, Tainan	Rescued	2021/4/12, Changhua	2021/4/12, left Taiwan to China 2021/4/29, left China to South Korea	-	N (2021/5/15)
15	6818	N04	Blue, white	Adult	2021/2/27	Qigu, Tainan	Captured	2021/3/24, Yunlin	2021/3/24, left Taiwan and arrived China on 3/25	-	N (2021/3/25)
16	6822	N05	Green, red	Subadult	2021/2/27	Qigu, Tainan	Captured	2021/4/30, Changhua 2022/4/14, New Taipei	2021/4/30, left Taiwan to China 2021/5/15, left China and arrived South Korea on 5/16 2021/10/19, left South Korea to China 2021/10/21, left China to Taiwan 2022/4/14, left Taiwan to China 2022/5/9, left China to South Korea	2021/10/21, between Taichung and Yunlin	N (2022/7/7)

*Note[1]: T stands for tracking; no GPS stands for GPS data pending; N stands for no signal transmission; S stands for stop tracking since the device fell off or the BFS died; bracket shows the last signal transmission date.

*Note [2]: This bird has been found dead in April 2022 in Taiwan Tainan with no obvious trauma.

*Note [3]: In some tracking device, it is observed that GPS data is only partially transmitted or GPS has not been able to locate successfully, resulting in no GPS situation.

Table 2.1-2 Tagging Information of Black-faced Spoonbill Satellite Tracking Survey Phase II

No.	Tracking No.	International identification band		Age	Tagging date	Tagging location	Source	Departure date and location from Taiwan	Location found overseas	Arrival date and location in Taiwan	Tracking Status (Note[1])
		Number band	Colour band								
1	6836	N14	Red, blue	Adult	2021/12/8	Qigu, Tainan	Rescued	Haven't departed			N (2021/12/25)
2	6821	N13	Red, yellow	Adult	2021/12/8	Qigu, Tainan	Rescued	Haven't departed			N (2022/1/29)
3	11541	N32	Blue, green, white	Juvenile	2022/2/26	Qigu, Tainan	Captured	Haven't departed			N (2022/4/7)
4	6827	N12	White, green	Juvenile	2021/11/11	Aogu, Chiayi	Captured	Haven't departed			N (2022/4/27)
5	7378	N16	Red, white	Juvenile	2021/12/15	Aogu, Chiayi	Captured	Haven't departed			T (2022/12/31)
6	7371	N15	Red, green	Adult	2021/12/17	Qigu, Tainan	Rescued	2022/3/18, Taoyuan	2022/3/18, left Taiwan to China		S (2022/3/23)
7	12506	N35	Blue, white, blue	Adult	2022/4/1	Qigu, Tainan	Rescued	2022/4/23, Changhua	2022/4/23, left Taiwan to China		N (2022/4/27)
8	11543	N29	Blue, green, red	Subadult	2022/2/8	Qigu, Tainan	Captured	2022/4/22, Changhua	2022/4/23, left Taiwan to China 2022/5/14, left China and arrived North Korea on 5/15		N (2022/5/19)
9	11540	N26	Blue, yellow, blue	Subadult	2022/1/13	Aogu, Chiayi	Captured	2022/4/22, New Taipei	2022/4/22, left Taiwan to China 2022/5/14, left China	2022/10/18, between Changhua and Chiayi	T (2022/12/31)

No.	Tracking No.	International identification band		Age	Tagging date	Tagging location	Source	Departure date and location from Taiwan	Location found overseas	Arrival date and location in Taiwan	Tracking Status (Note[1])
		Number band	Colour band								
									and arrived South Korea on 5/15 2022/10/11, left South Korea to China 2022/10/18, left China to Taiwan		
10	11548	N28	Blue, yellow, white	Juvenile	2022/2/8	Qigu, Tainan	Captured	2022/4/21, Yunlin	2022/4/21, left Taiwan to China 2022/4/22, left China to North Korea 2022/10/14, left South Korea to China 2022/10/25, left China to Taiwan	2022/10/25, Changhua	W (2022/12/12)
11	11551	N33	Blue, green, red	Subadult	2022/3/5	Qigu, Tainan	Rescued	2022/4/21, Changhua	2022/4/21, left Taiwan and arrived China on 4/22 2022/5/23, left China and arrived North Korea on 5/24 2022/10/18, left South Korea to China 2022/10/19, left China to Taiwan	2022/10/19, between Yunlin and Chiayi	T (2022/12/31)

No.	Tracking No.	International identification band		Age	Tagging date	Tagging location	Source	Departure date and location from Taiwan	Location found overseas	Arrival date and location in Taiwan	Tracking Status (Note[1])
		Number band	Colour band								
12	11553	N31	Blue, green, blue	Subadult	2022/2/24	Qigu, Tainan	Rescued	2022/4/24, New Taipei	2022/4/24, left Taiwan to China 2022/5/18, left China to South Korea 2022/10/13 signal transmission lost in North Korea, yet 11/4 signal recovered showing location in China 2022/11/26 signal transmission lost in China, yet 12/28 signal recovered showing location in Taiwan	Without locating from 2022/11/26 to 12/28	W (2022/12/28)
13	11534	N24	Blue, red, white	Adult	2022/1/11	Qigu, Tainan	Captured	2022/3/25, Changhua	2022/3/25, left Taiwan to China 2022/4/8, left China and arrived South Korea on 4/9 2022/10/26, left South Korea and arrived China on 10/27 2022/11/5, left China and arrived Taiwan on 11/6	2022/11/6, Yunlin	T (2022/12/31)

No.	Tracking No.	International identification band		Age	Tagging date	Tagging location	Source	Departure date and location from Taiwan	Location found overseas	Arrival date and location in Taiwan	Tracking Status (Note[1])
		Number band	Colour band								
14	11536	N25	Blue, yellow, red	Adult	2022/1/12	Qigu, Tainan	Captured	2022/3/25, Yunlin	2022/3/25, left Taiwan to China 2022/4/8, left China and arrived South Korea on 4/10 2022/10/6, left South Korea to China 2022/10/7, left China to Taiwan	2022/10/7, between Taoyuan and Miaoli	T (2022/12/31)
15	7377	N21	Blue, red, yellow	Adult	2021/12/31	Sicao, Tainan	Rescued	2022/3/26, Hsinchu	2022/3/26, left Taiwan to China 2022/5/1, left China and arrived North Korea on 5/2 2022/11/11, left North Korea and arrived China on 11/12 2022/12/27, left China to Taiwan	2022/12/27, Chiayi	T (2022/12/31)
16	7379	N22	Blue, red, blue	Adult	2022/1/11	Qigu, Tainan	Captured	2022/3/13, Changhua	2022/3/13, left Taiwan to China 2022/3/15, left China and arrived South Korea on 3/16 2022/10/8, left South Korea to China 2022/10/10, left	2022/10/10, Chiayi	T (2022/12/31)

No.	Tracking No.	International identification band		Age	Tagging date	Tagging location	Source	Departure date and location from Taiwan	Location found overseas	Arrival date and location in Taiwan	Tracking Status (Note[1])
		Number band	Colour band								
									China to Taiwan		
17	11330	N23	Blue, red, green	Adult	2022/1/11	Qigu, Tainan	Captured	2022/3/25, New Taipei	2022/3/25, left Taiwan and arrived China on 3/26 2022/4/3, left China to North Korea 2022/10/5, left South Korea to China 2022/10/11, left China to Taiwan	2022/10/11, Chiayi	T (2022/12/31)

*Note[1]: T stands for tracking; W stands for waiting for signal transmission; N stands for no signal transmission; S stands for stop tracking since the device fell off or the BFS died; bracket shows the last signal transmission date.

*Note[2]: The GPS coordinates are fixed in a small area, and the ODBA(behavior) value is lower than normal, by which we determine the bird was either dead or the transmitter fell off.

2.2 Date and Time of Migration

I. Date of Migration

In this survey, departure offshore during spring migration in 2021 occurred between March 10th to June 13th, and the migration data of 15 individuals were obtained. The first half (including the 15th) and the second half of each month are separated on the 15th. A total of 4 individuals (26.7%) departed in March; 7 individuals (46.7%) departed in April, this is the main migration departure month; 3 individuals (20%) departed in May, and 1 individual (6.7%) departed in June. In the Spring migration of 2022, the migration data of 13 individuals were obtained. The date of departure is from March 13th to April 24th. In March and April, 6 (46.2%) and 7 (53.8%) individuals departed respectively. The date of departure correlates with age, as the adult departed first, followed by the subadult, then finally the juvenile (Figure 2.2-1, Figure 2.2-2). Noteworthy, the adult (T98-6833) migrated in the first half of May 2021, and the adult (N35-12506) migrated in the second half of April 2022, these may be due to their illness delaying the departure.

The trend for adult BFS to depart earlier during spring migration has been observed and described in the past (Chen 2003). In addition, in the past, some subadults have chosen to stay in Taiwan for wintering instead of migrating North (Wang 2016; Jung et al. 2018). These subadult and juvenile birds do not face the pressures of procreation, and therefore, chose a different mode of migration from the adult birds (Pugesek et al. 1999; Choi and Lee 2005). The juvenile bird N16-7378 tagged in 2022 had spent the whole breeding season in Taiwan, and it is likely on this model.

During autumn in 2021, tracking of 2 adults and 2 subadults indicated they had begun southern migration. Among them, 2 adults and

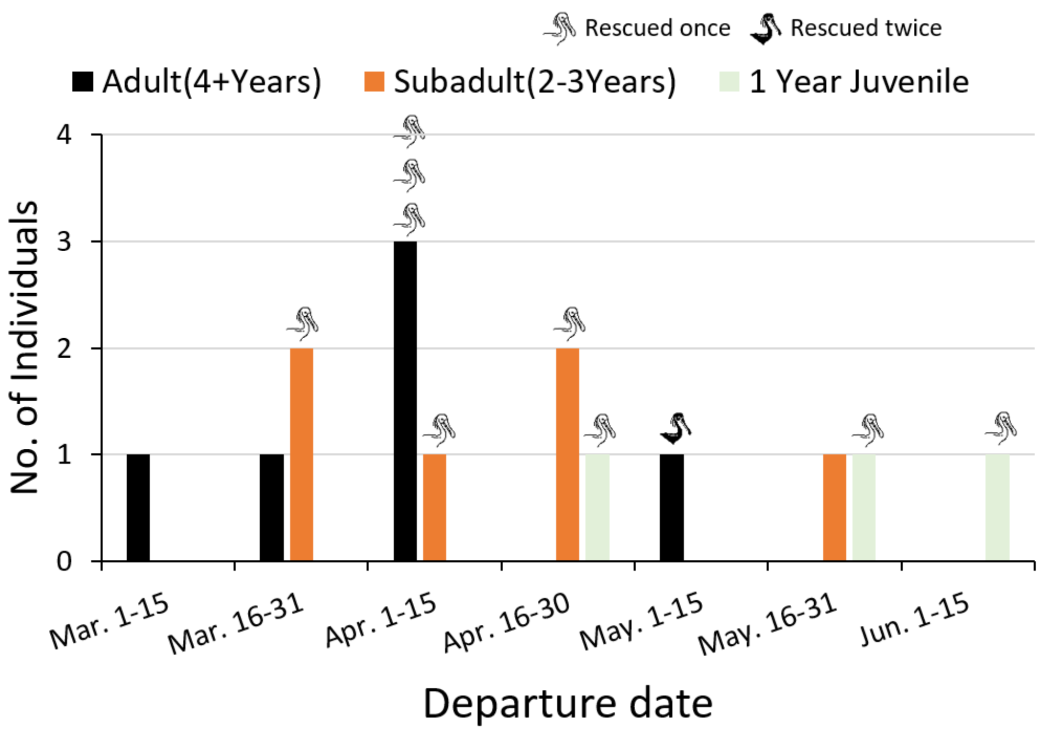
1 subadult arrived in Taiwan in the second half of October, while 1 subadult arrived in the first half of November (Figure 2.2-3). And in the autumn of 2022, out of 9 birds tracked on their way back to Taiwan, 1 adult went back to Taiwan in late December, there is no obvious difference in departure time between adults and juveniles of southern migration (Figure 2.2-4).

II. Time of Migration

In the analysis of three-hour periods, 11 individuals departed offshore between 5:00-8:00 during spring migration in 2021; 2 individuals departed offshore between 17:00-20:00, and 1 individual each departed offshore between 2:00-5:00 as well as 20:00-23:00 (Figure 2.2-5). The trend in 2022 is not as obvious as in 2021, but it can still be seen that most birds departed offshore between 5:00-11:00 (Figure 2.2-6).

An overview of the two-year data, 5:00-8:00 has the most, with a total of 14 times (accounting for 51.9%), followed by 8:00-11:00 and 17:00-20:00 each with 3 times (accounting for 11.1%), indicating that the departure time for most BFS was from early morning to noon, followed by evening.

During autumn migration in 2021, 2 individuals arrived between 2:00-5:00, while 1 individual each arrived between 14:00-17:00 and 17:00-20:00 (Figure 2.2-7). The autumn migration of 2022, 8:00-11:00 has the most, with 4 individuals arriving (Figure 2.2-8).



Note 1: As 1 BFS lost signal before leaving Taiwan, the sample size of this data is n=15.

Note 2: The first half (including the 15^{th}) and second half of each month is seperated on the 15^{th} .

Figure 2.2-1 Departure Dates of Spring Migration of BFS (n=15) in 2021

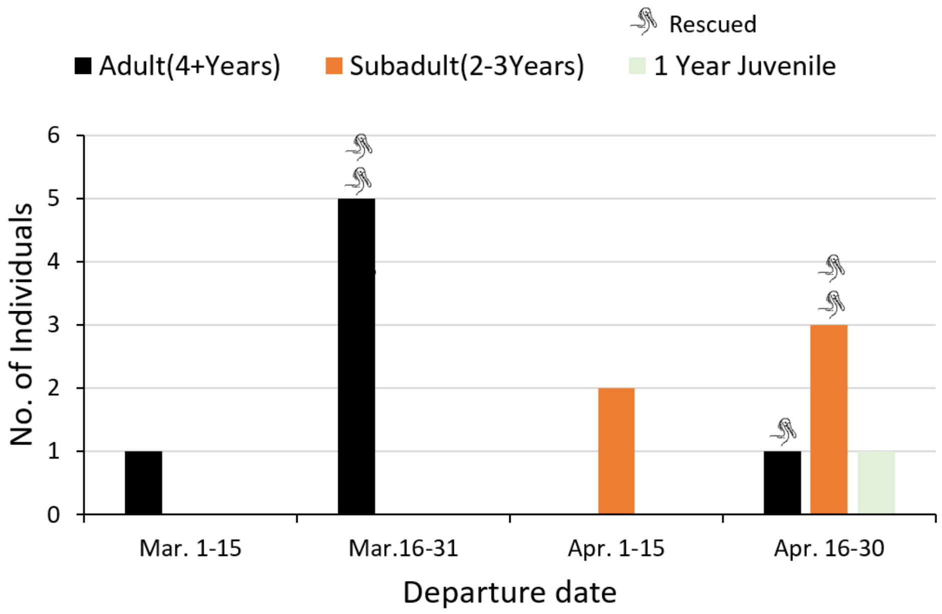
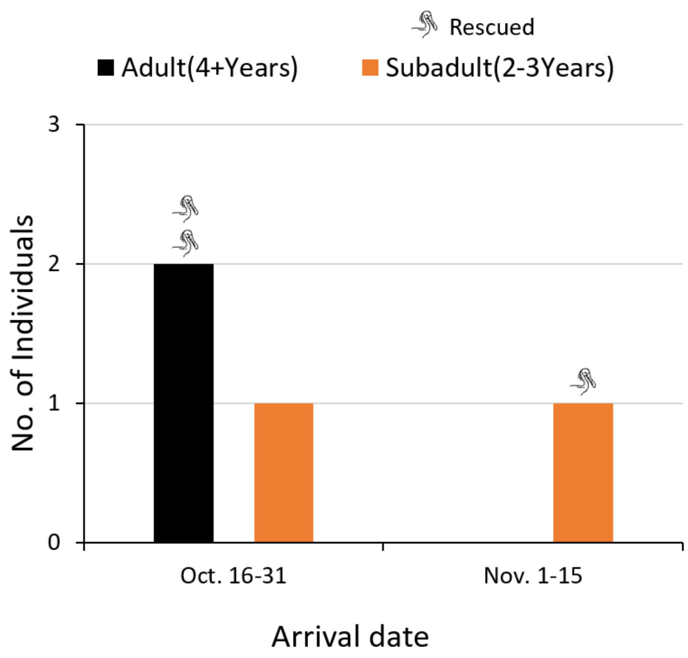
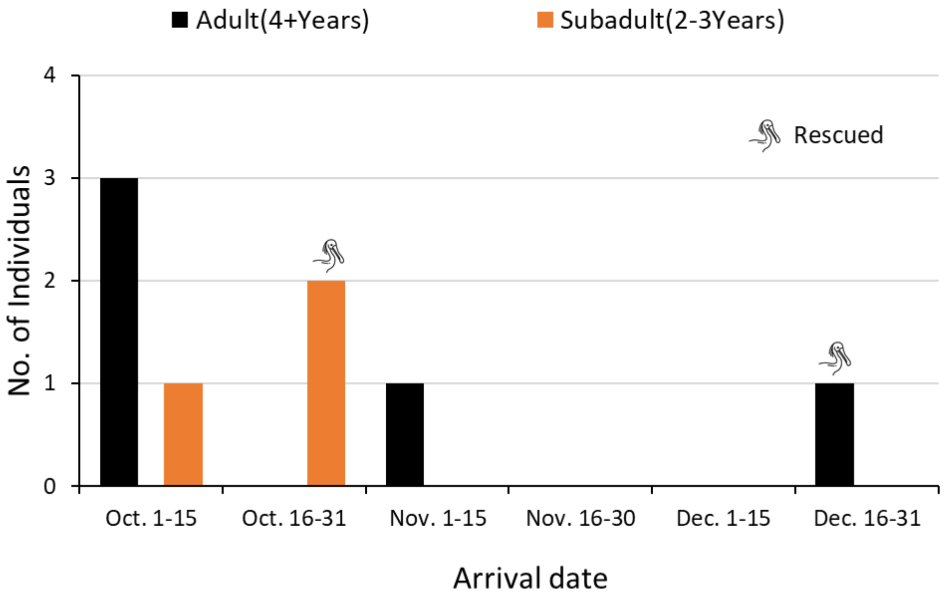


Figure 2.2-2 Departure Dates of Spring Migration of BFS (n=13) in 2022



Note: Y43-6838 lost signal during autumn migration 2021

Figure 2.2-3 Arrival Dates of Autumn Migration of BFS (n=4) in 2021



Note: N31-11553 lost signal during autumn migration 2022

Figure 2.2-4 Arrival Dates of Autumn Migration of BFS (n=8) in 2022

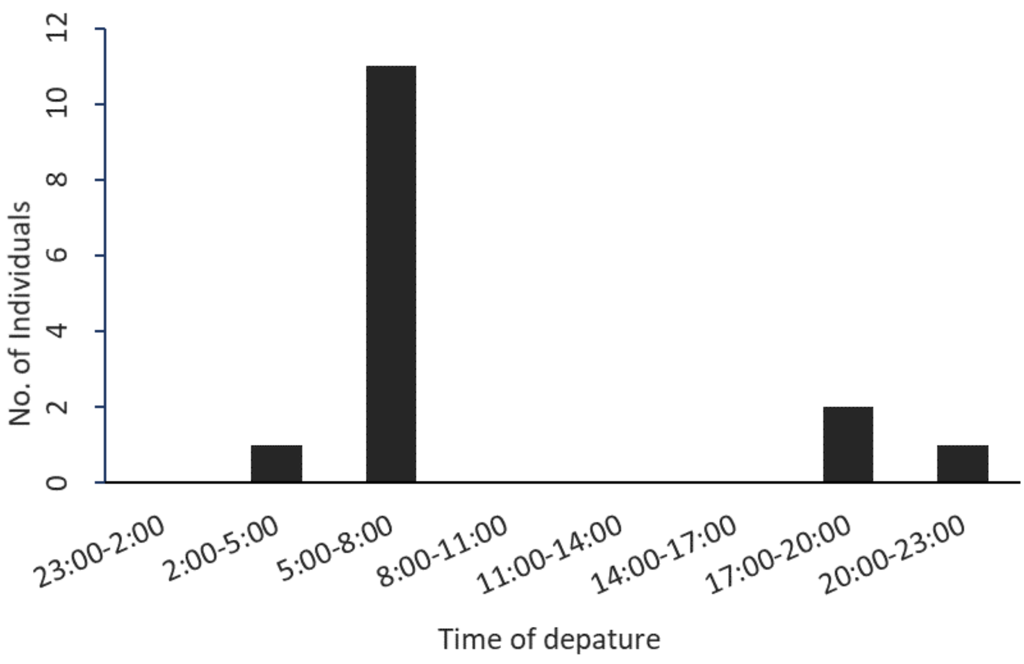
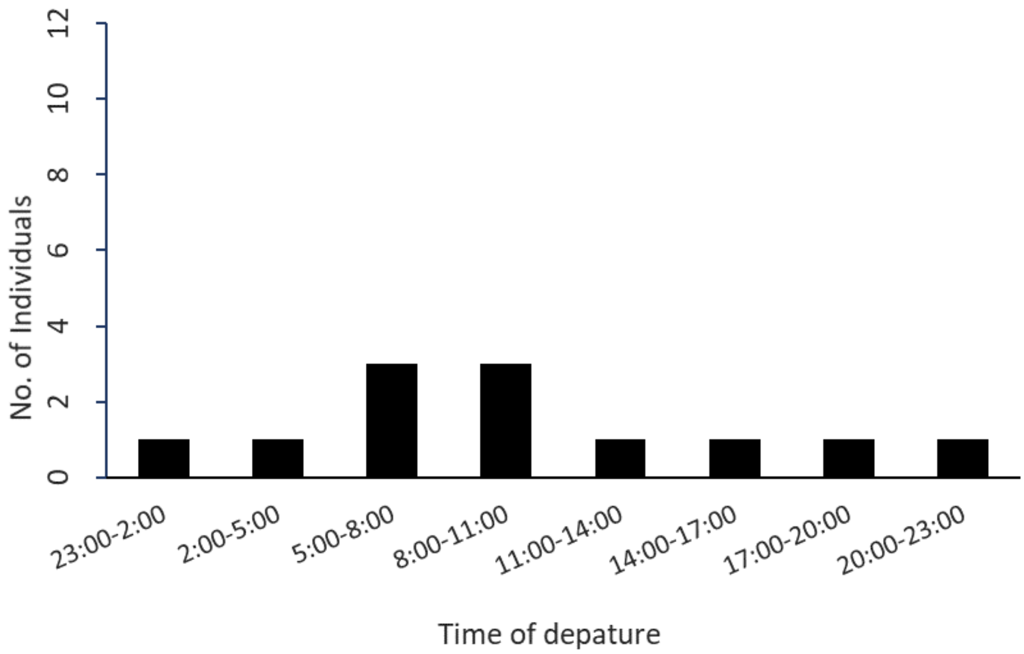
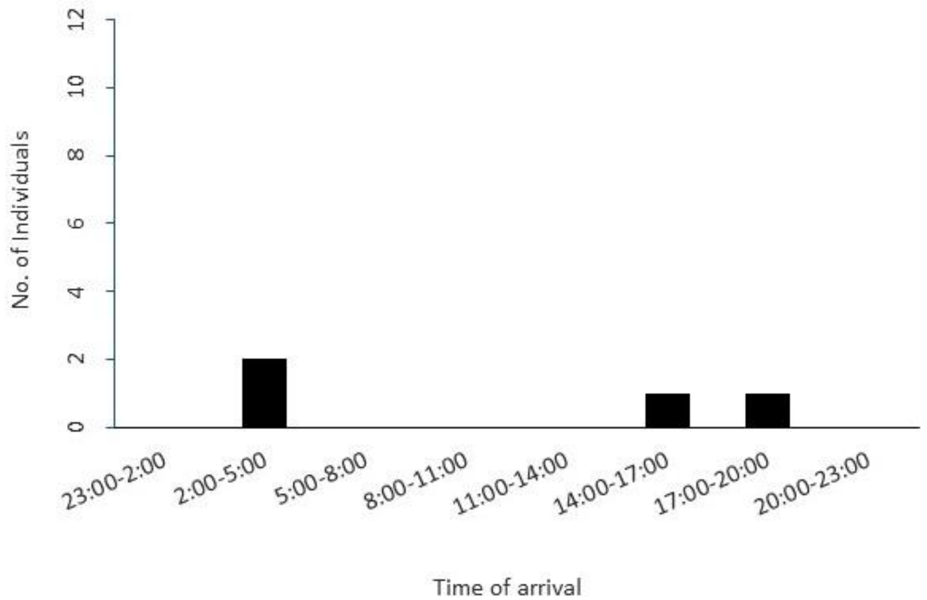


Figure 2.2-5 Departure Times of Spring Migration of BFS (n=15) from Taiwan in 2021



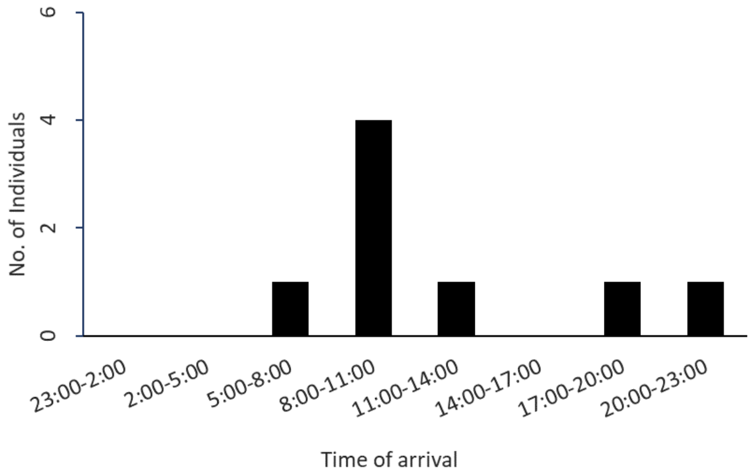
Note: The GPS position of N05-6822 was too less to determine the departure time, so it is not shown in this picture

Figure 2.2-6 Departure Times of Spring Migration of BFS (n=12) from Taiwan in 2022



Note: Y43-6838 lost signal during autumn migration 2021

Figure 2.2-7 Arrival Times of Autumn Migration of BFS (n=4) in Taiwan in 2021



Note: N31-11553 lost signal during autumn migration 2022

Figure 2.2-8 Arrival Times of Autumn Migration of BFS (n=8) in Taiwan in 2022

2.3 Migration Routes

Of the 16 satellite tracking BFS in 2021, the transmitter of 1 bird (N01-6819) malfunctioned in Taiwan after a brief tracking period, the remaining 15 birds all successfully departed offshore (Figure 2.3-1), additionally, 4 individuals were recorded migrating south (Figure 2.3-2). Of the 17 satellite tracking BFS in 2022, the transmitter of 4 birds (N12-6827, N13-6821, N14-6836, N32-11541) malfunctioned in Taiwan after a brief tracking period, 1 bird stayed in Taiwan, and the remaining 12 birds, together with the 1 individual that tagged in phase I, a total of 13 birds all successfully departed offshore (Figure 2.3-1). In the southern migration of 2022, 9 birds went back to Taiwan, while 1 device without GPS location during the migration period (Figure 2.3-2).

According to the departure and arrival routes (Figure 2.3-3 to Figure 2.3-6), only one BFS's (N23-11330, Figure 2.3-6) route crosses potentially Yunlin wind farm, but the positioning frequency of that device is 1 hour, so the dashed line route may not be the real flying route. The flying altitude of both sides of the dashed line is 59.3 and 61.9. Another bird (Right blue-6837) that departed on March 10th, 2021, almost passed the vicinity of the wind farm on the day of its departure, the departure route was 400 m away from the wind farm perimeter (Figure 2.3-3)

After departing offshore in Spring 2021, the 15 BFSs flew northward along the coast of southeastern China. Among the 15 BFSs, 11 individuals were observed heading to Korea, and the flying routes of 11 individuals during departure were successfully tracked (Figure 2.3-7). Meanwhile, 4 individuals were successfully tracked upon their arrival during the autumn migration in 2021 (Figure 2.3-8). In Spring 2022, 11 individuals were observed heading to Korea. The locations for departure and arrival were mainly between Shanghai and Yancheng, China (Figure 2.3-7). This time, 8 individuals were successfully tracked upon their arrival during the autumn migration in 2022 (Figure 2.3-8).

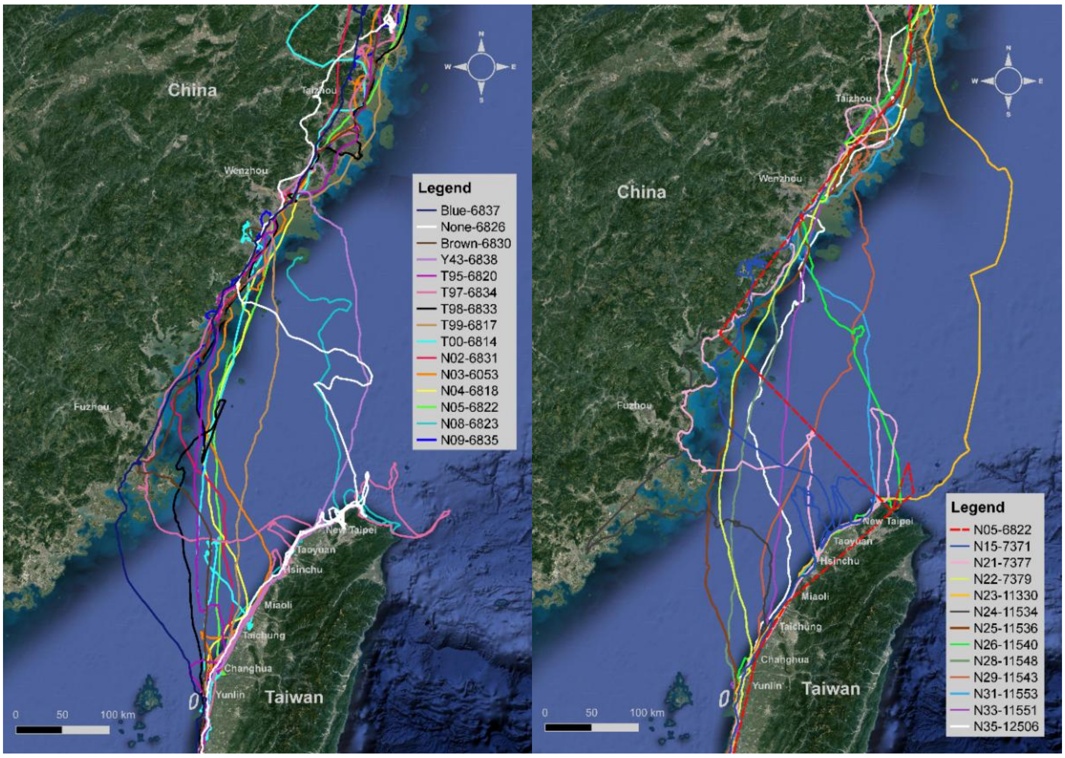


Figure 2.3-1 Routes of Spring Migration of BFS Across Taiwan Strait in 2021 (left, n=15) and 2022 (right, n=13) (dashed line: lower positioning frequency)

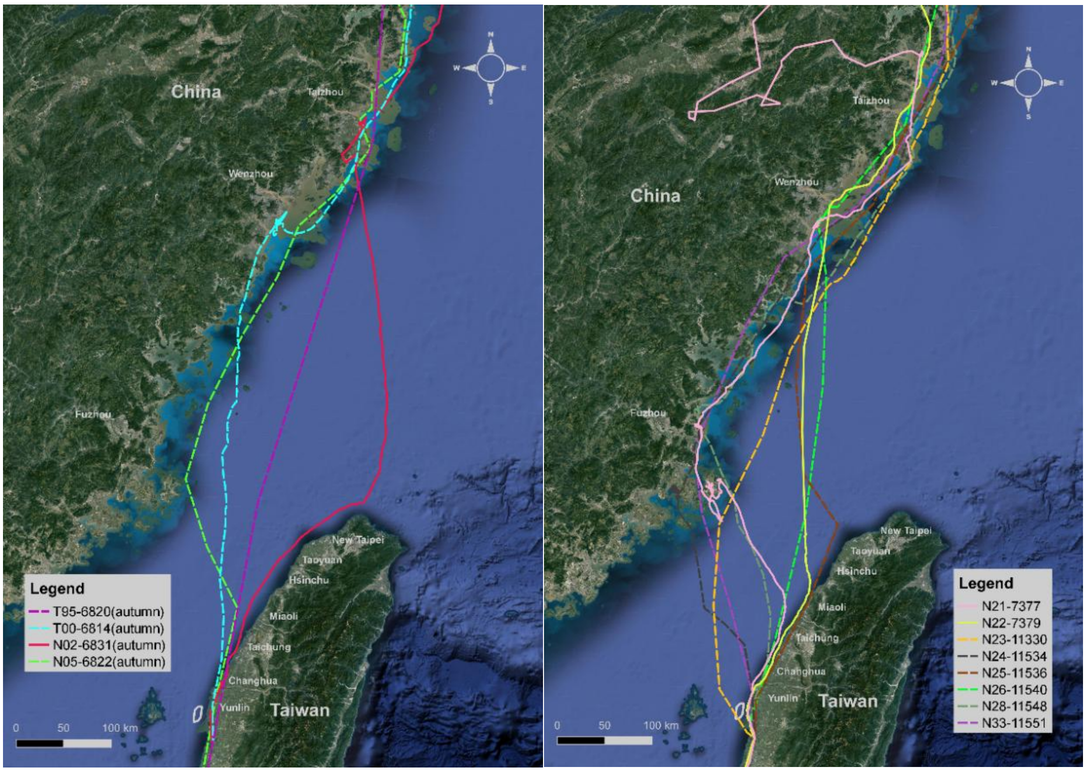
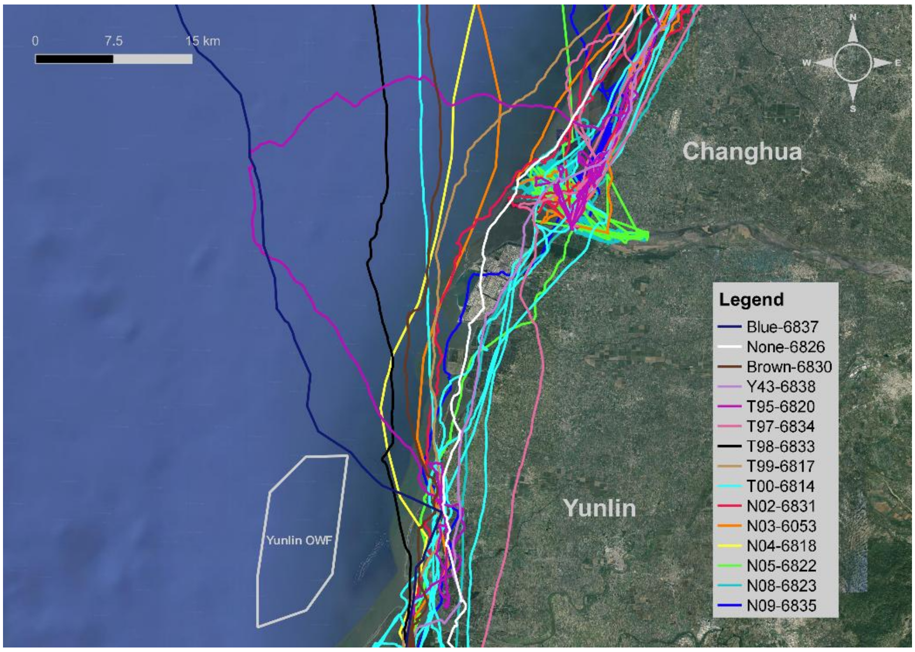


Figure 2.3-2 Routes of Autumn Migration of BFS Across Taiwan Strait in 2021 (left, n=4) and 2022 (right, n=8) (dashed line: lower positioning frequency)



Note: Day of departure of Right blue-6837 was on March 10th, 2021

Figure 2.3-3 Routes of Spring Migration of BFS (n=15) near Yunlin Wind Farm in 2021. The First Departure on March 10th of BFS (Right blue-6837) Almost Passed the Vicinity of the Wind Farm Area

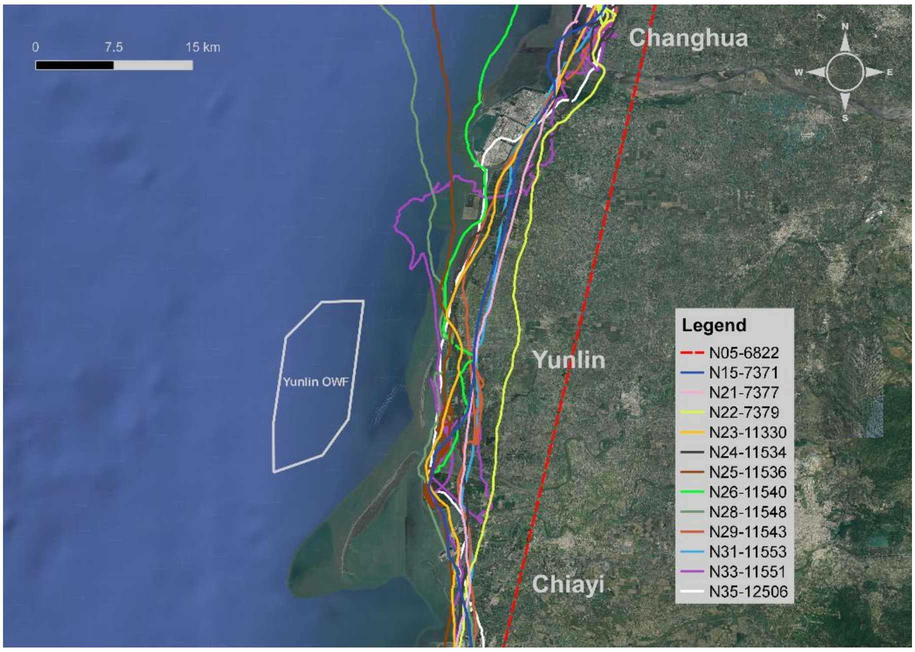


Figure 2.3-4 Routes of Spring Migration of BFS (n=13) near Yunlin Wind Farm in 2022 (dashed line: lower positioning frequency)

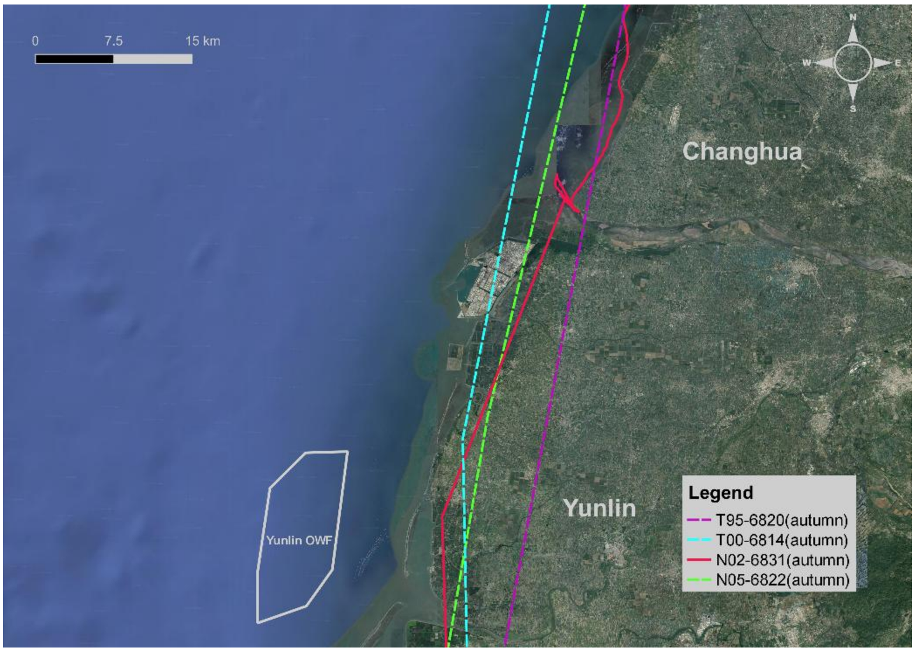


Figure 2.3-5 Routes of Autumn Migration of BFS(n=4) near Yunlin Wind Farm in 2021 (dashed line: lower positioning frequency)

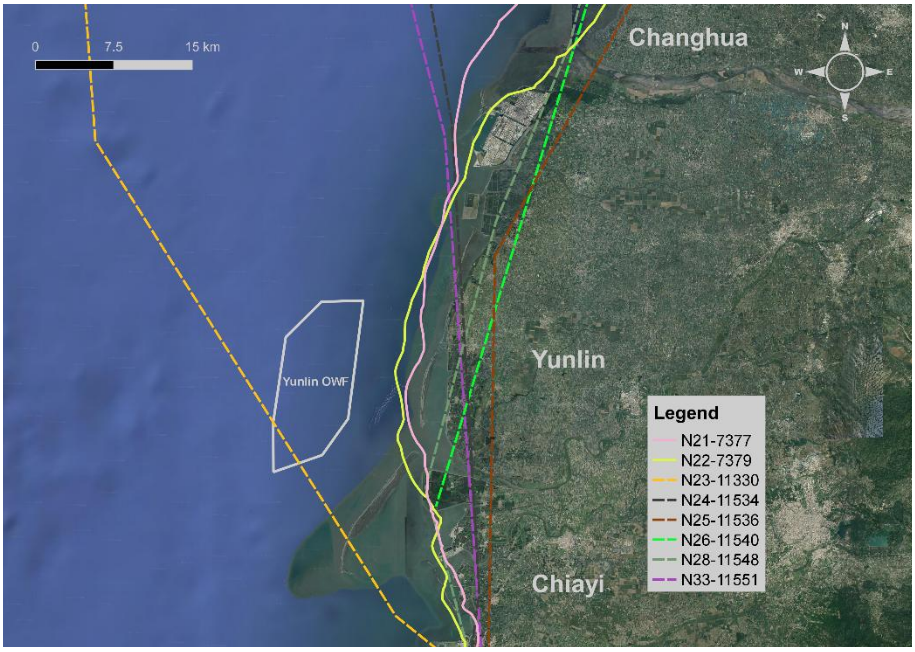


Figure 2.3-6 Routes of Autumn Migration of BFS (n=8) near Yunlin Wind Farm in 2022. (dashed line: lower positioning frequency) One dashed line route passes through Yunlin wind farm, not sure if the bird (N23-11330) flew over the Yunlin wind farm

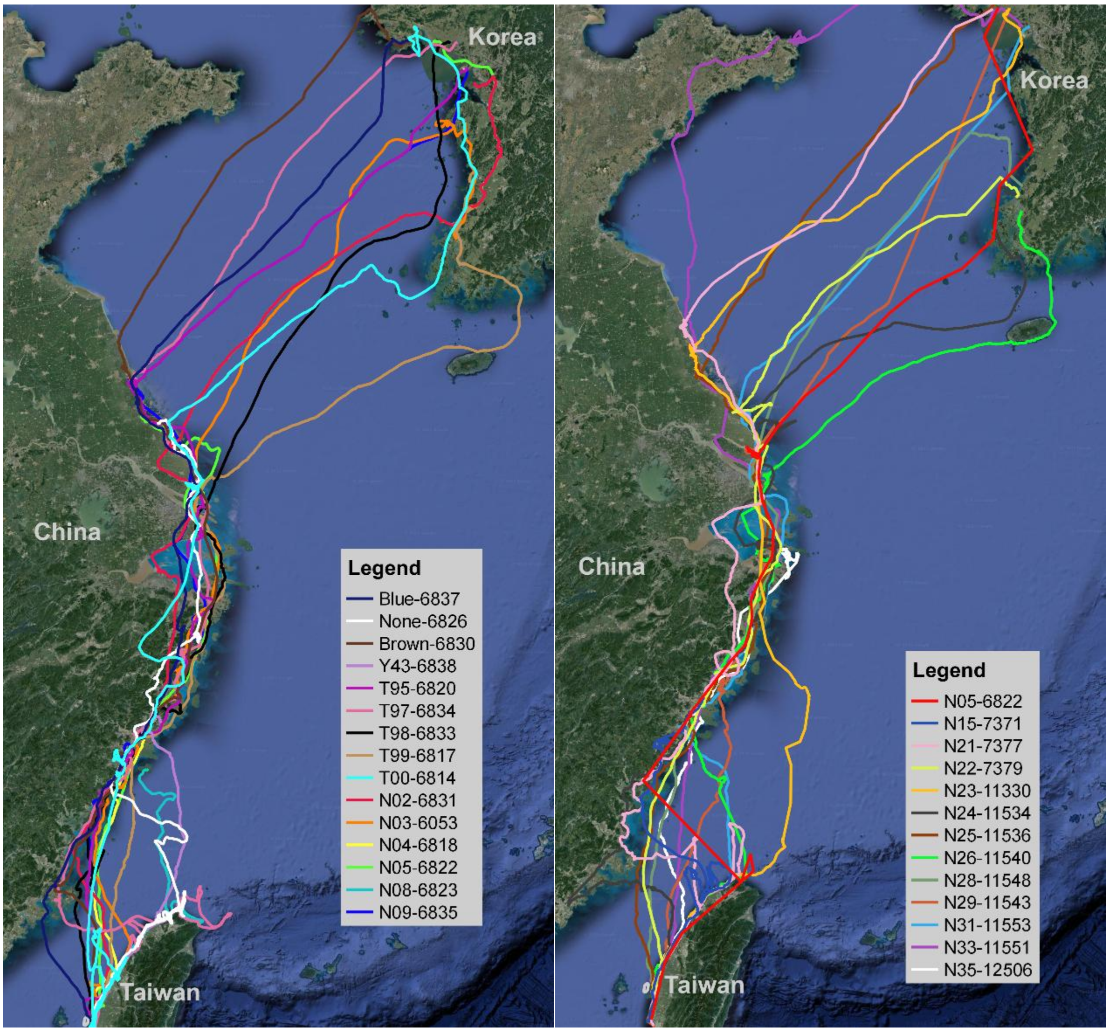
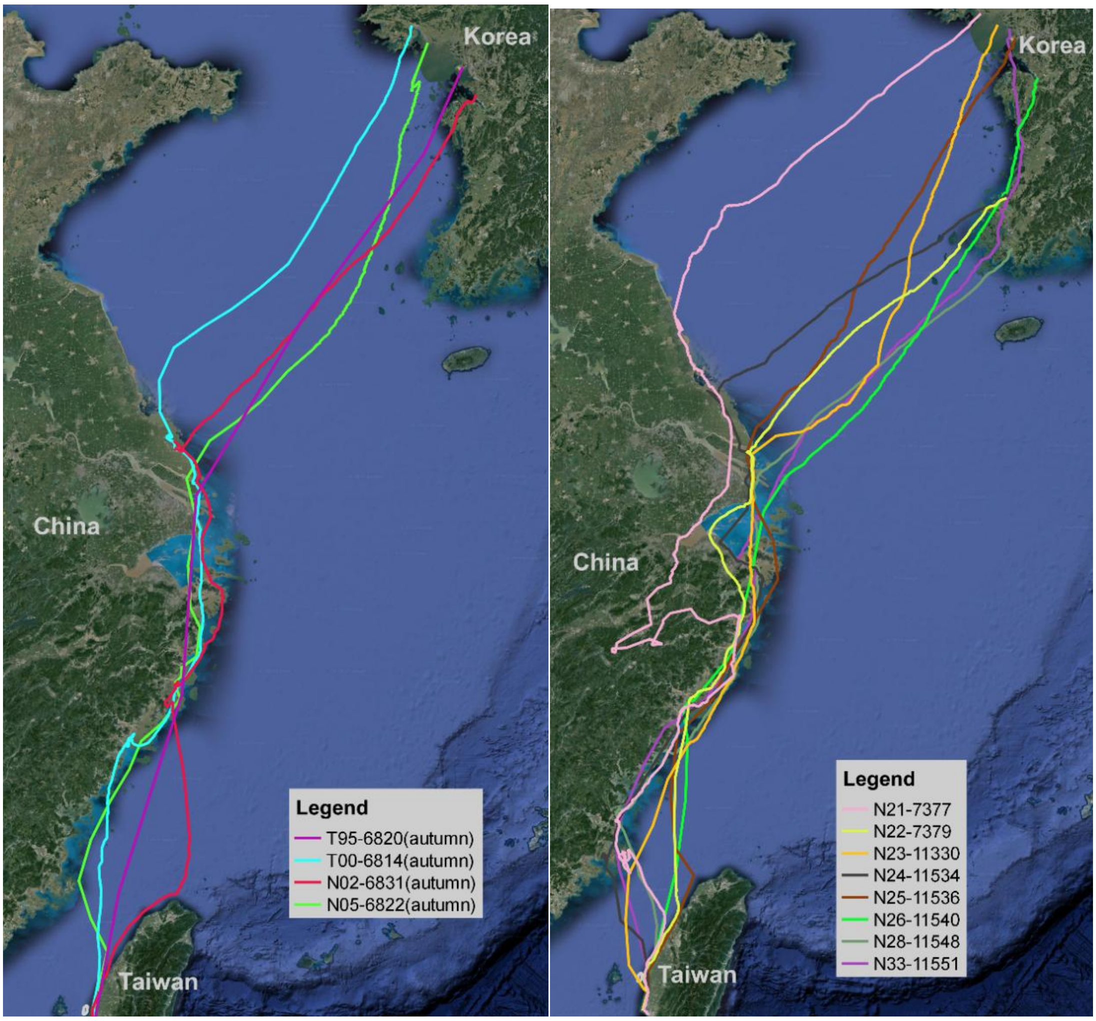


Figure 2.3-7 The Spring Migration Routes of BFS in 2021 (n=15) and 2022 (n=13)



Note1: Y43-6838 lost signal during autumn migration 2021
Note:2 N31-11553 lost signal during autumn migration 2022

Figure 2.3-8 The Autumn Migration Routes of BFS in 2021 (n=4) and 2022 (n=8)

2.4 Departure and Arrival Location

By identifying the location of departure for BFS using the cities and counties, and discussing the combined data of two years, there are 10 times (36%) from Changhua, 6 times (21%) from New Taipei, 4 times from Yunlin (14%), 3 times from Taoyuan (11%), 2 times from Chiayi (7%), and 1 time (4%) departed from Hsinchu, Miaoli, and Tainan (Figure 2.4-1). In comparison with estimated routes from the satellite tracking of BFS conducted by Taiwan and Korea between 2012-2018 (Figure 2.4-2; Wang 2016 and Kisup Lee, unpublished data), the departure routes from this survey include more twists and turns and even has an individual that departed from the north coast and then returned immediately. This is due to the intervals for the positioning in this survey being shorter. Another difference is the main location of departure in this survey is Changhua, and an additional location of departure is added, Miaoli. In comparison, the main location of departure for tracking between 2012-2018 was mainly in Nothern Taiwan.

During southern migration in autumn of two years, as the BFS had already undergone long trips of flight, the battery life of the transmitters was in varying degrees of usage, and the frequencies for positioning were adjusted automatically. Therefore, the exact locations of arrival in Taiwan for some of the individuals could not be accurately determined. The arrival location of 6 birds was confirmed, 1 in Yunlin, 2 in Changhua and 3 in Chiayi, for the remaining 6 individuals, the arrival location was between Taoyuan and Chiayi (Figure 2.4-3, Figure 2.4-4, Table 2.4-1, Table 2.4-2).

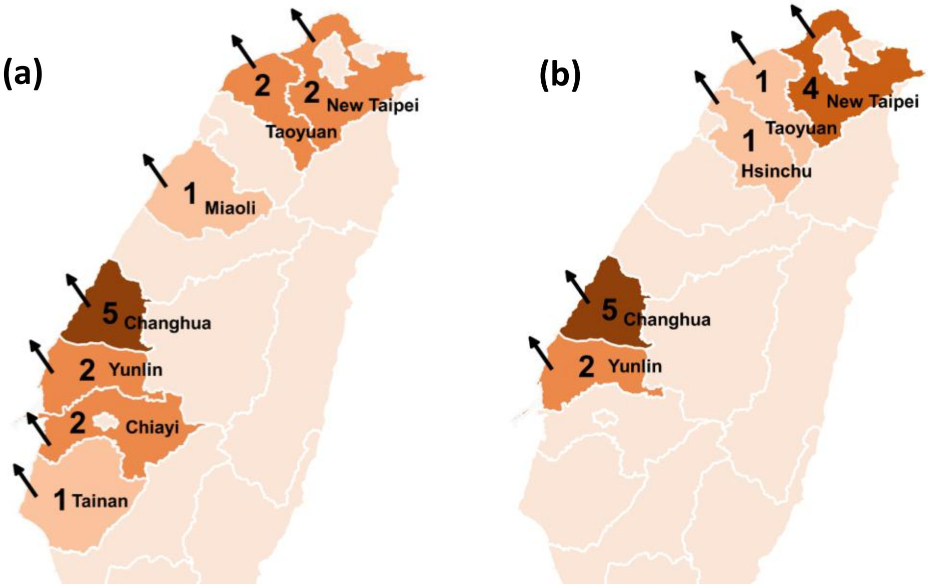
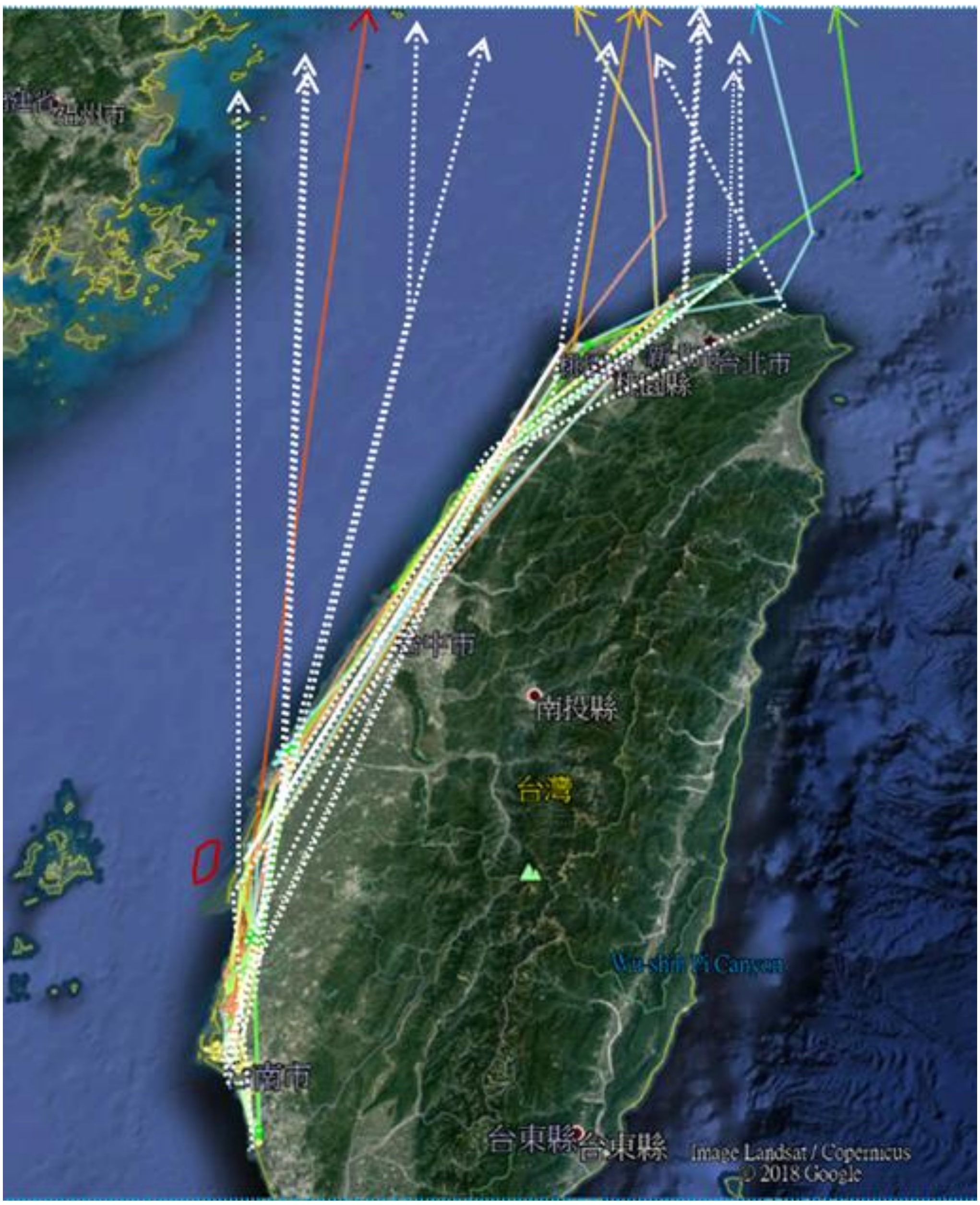
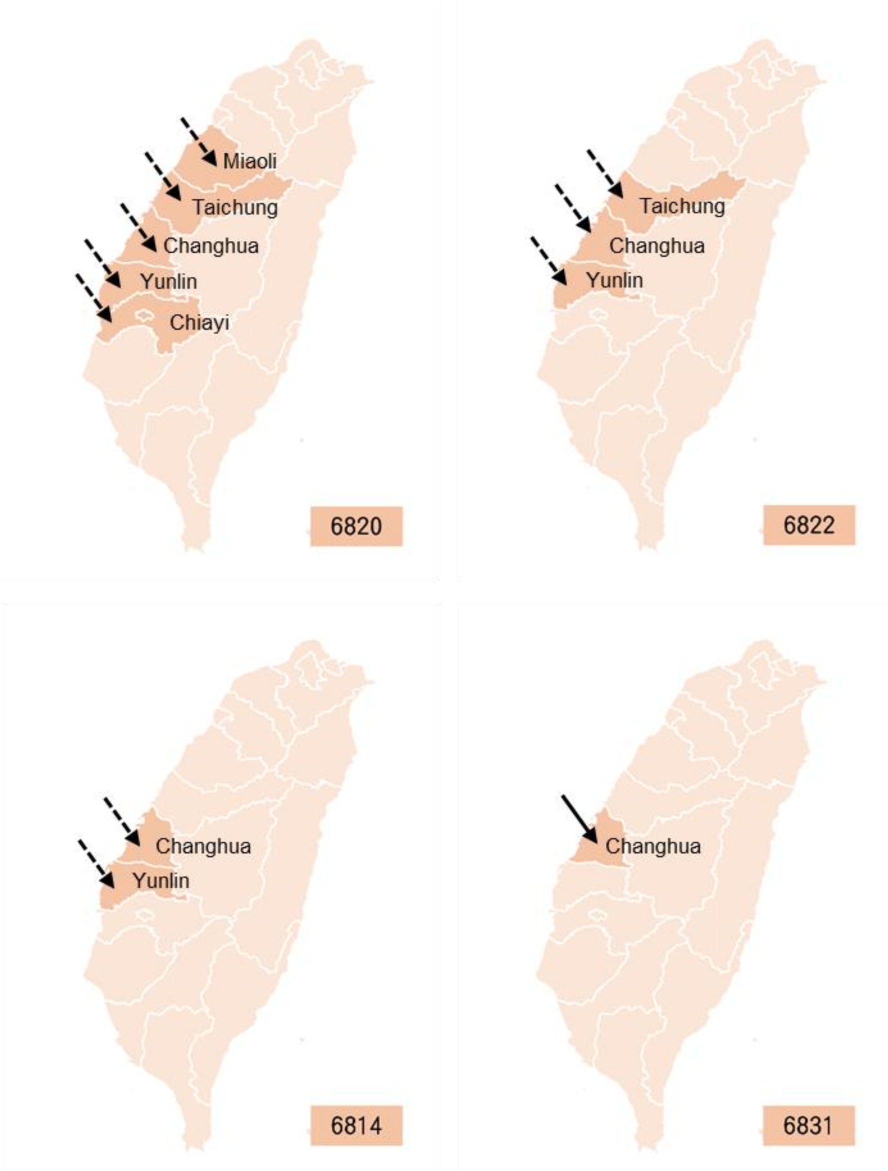


Figure 2.4-1 (a) BFS Departure Locations between March-June 2021; (b) BFS Departure Locations between March-April 2022



Note: Dotted lines indicate tracking between 2012-2015, and the solid lines indicate tracking between 2015-2018.

Figure 2.4-2 BFS Departure Routes between 2012-Spring 2018 (Wang 2016 and Kisup Lee, unpublished data)



Note: Y43-6838 lost signal during autumn migration 2021.

Figure 2.4-3 BFS Arrival Locations in Taiwan between October-November 2021 (locations for some individuals could not be accurately determined due to low positioning frequencies, dashed arrows)

Note: N31-11553 lost signal during autumn migration 2022.

Figure 2.4-4 BFS Arrival Locations in Taiwan between October-December 2022 (locations for some individuals could not be accurately determined due to low positioning frequencies, dashed arrows)

Table 2.4-1 BFS Arrival Locations in Taiwan between October-November 2021

Transmitter No.	Arrival Location	Positioning Frequency
6820	Between Miaoli and Chiayi	4 hr
6814	Between Changhua and Yunlin	30 min
6831	Changhua	20 sec
6822	Between Taichung and Yunlin	1 hr
6838	-*	-

*Y43-6838 lost signal during autumn migration 2021.

Table 2.4-2 BFS Arrival Locations in Taiwan between October-December 2022

Transmitter No.	Arrival Location	Positioning Frequency
7379	Chiayi	20 sec
11330	Chiayi	1 hr
11534	Yunlin	30 min
11536	Between Taoyuan and Miaoli	1 hr
11540	Between Changhua and Chiay	1 hr
11548	Changhua	30 min
11551	Between Yunlin and Chiayi	1 hr
7377	Chiayi	20 sec
11553	-*	-

*N31-11553 lost signal during autumn migration 2022.

2.5 Flying Altitude

During the spring migration in 2021, the percentage of flying altitudes that were between the sweeping area (25-200 m) during the flight in Taiwan Strait varies between the 15 BFSs. An average of 51±26% of positionings for all individuals were between the sweeping area, with the highest percentage at 88% and the lowest at 4% (Table 2.5-

1, Figure 2.5-1). An average of 44±28% of positionings for all individuals were below 25 m; during the spring migration of 2022, an average of 66±24% of positionings for all individuals were between the sweeping area (Table 2.5-1, Figure 2.5-2). In an overview of the two-year data, some individuals do not even fly above 200 m, which indicates that BFS generally keep to low altitudes during migration, and over half of the positionings are within the sweeping area.

During the autumn migration of both 2021 and 2022, the positioning points of the 12 individuals within the Taiwan strait were not frequent, hence presented in a Table. In 2021, the 4 individuals only included 27 positioning points, with the highest percentage (44%) being between the sweeping area (Table 2.5-2, Figure 2.5-3). In 2022, the 8 individuals included 33 positioning points, also with the highest percentage (44%) being between the sweeping area (Table 2.5-3, Figure 2.5-4).

Table 2.5-1 Percentage of Flying Altitudes within Each Height Interval for BFS Positionings in Taiwan Strait (Spring in 2021 and 2022)

Interval / Period	< 25 m	25 - 200 m	> 200 m
Spring, 2021	44±28%	51±26%	4±5%
Spring, 2022	22±21%	66±24%	13±22%

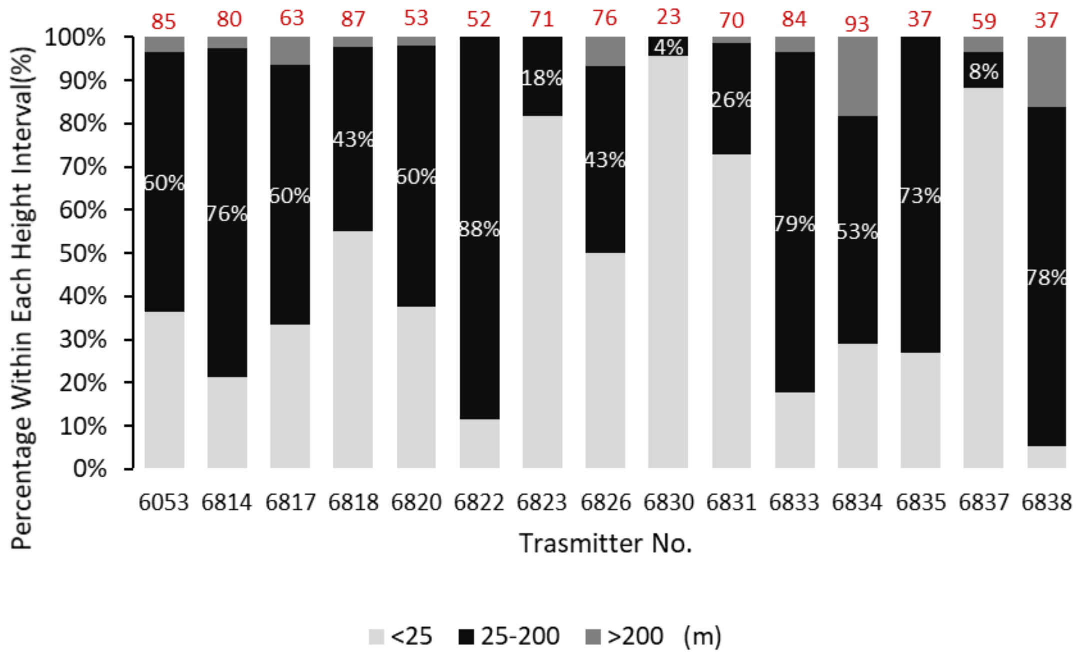


Figure 2.5-1 Percentage of Flying Altitudes within Each Interval for BFS Positionings in Taiwan Strait (March-June, Spring, 2021) (Red number: sample size)

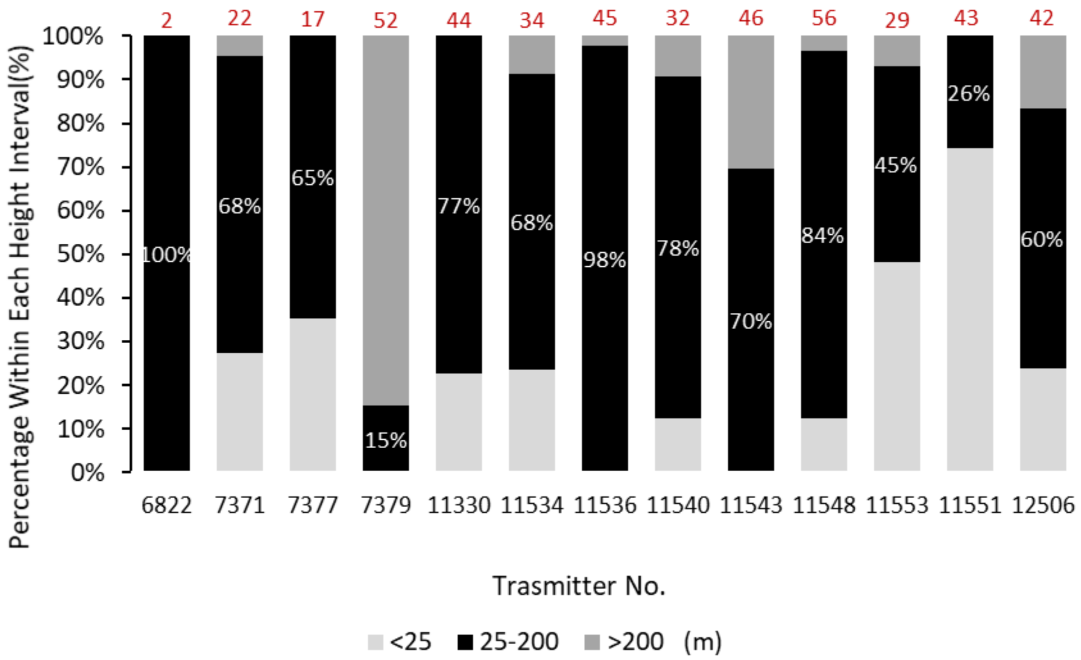


Figure 2.5-2 Percentage of Flying Altitudes within Each Interval for BFS Positionings in Taiwan Strait (March-April, Spring, 2022) (Red number: sample size)

Table 2.5-2 Percentage of Flying Altitudes within Each Height Interval for BFS Positionings in Taiwan Strait (October-November, Autumn, 2021)

Interval / Transmitter No.	< 25 m	25 - 200 m	> 200 m
6814	1	3	4
6822	3	4	0
6831	0	4	7
6820	0	1	0
Total	4	12	11
Percentage (%)	15%	44%	41%

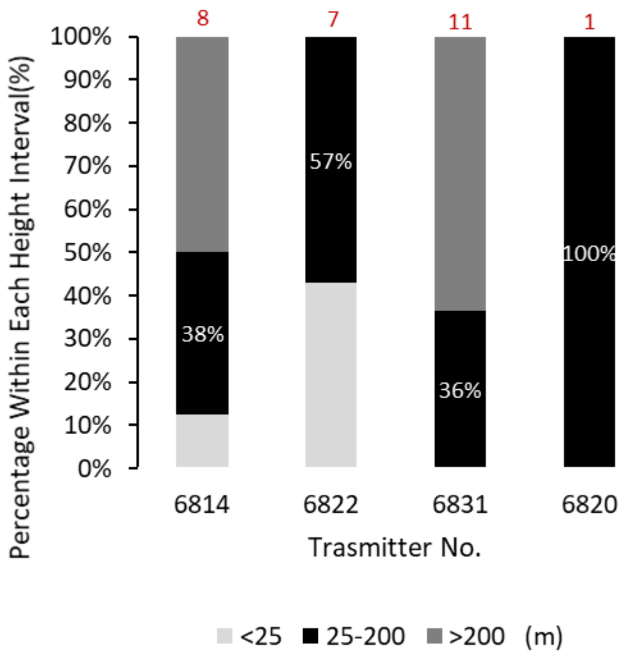


Figure 2.5-3 Percentage of Flying Altitudes within Each Interval for BFS Positionings in Taiwan Strait (October-November, Autumn, 2021) (Red number: sample size)

Table 2.5-3 Percentage of Flying Altitudes within Each Height Interval for BFS Positionings in Taiwan Strait (October-December, Autumn, 2022)

Interval / Transmitter No.	< 25 m	25 - 200 m	> 200 m
7379	0	2	4
11330	0	4	2
11534	1	2	0
11536	1	2	0
11540	0	2	2
11548	1	3	0
11551	1	1	1
7377	0	4	0
Total	4	20	9
Percentage (%)	12%	61%	27%

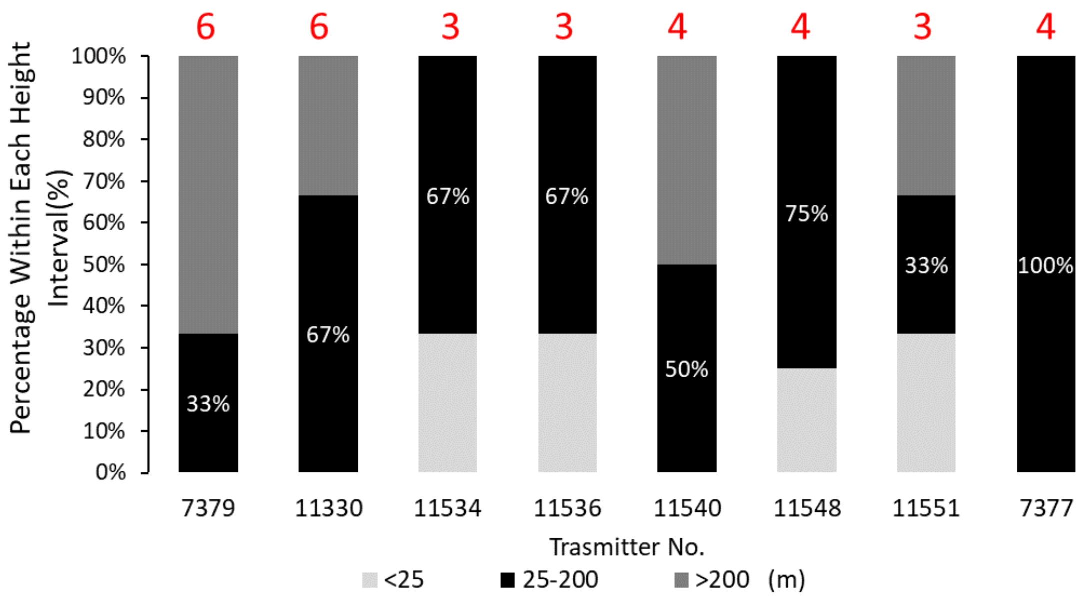


Figure 2.5-4 Percentage of Flying Altitudes within Each Interval for BFS Positionings in Taiwan Strait (October-December, Autumn, 2022) (Red number: sample size)

2.6 Avoidance Behavior

Basically, birds respond differently when approaching wind farm. They may detour and avoid entering into wind farm perimeter extending 500 m outward from the base of the outmost turbines (marco-avoidance response), enter into the wind farm but avoid wind turbines (meso-avoidance response), enter the rotor swept area (RSA) plus a 3-D distance of 10 m from blades and avoid the blades (mirco-avoidance response) (Cook et al. 2014). However, our GPS device cannot record mirco-avoidance response well because the minimum time interval between two GPS points is 20 seconds. Therefore, for the samples that entered the RSA as either mirco-avoidance or without-avoidance, we will all classify them as "possible micro-avoidance or without avoidance, but not detectable".

In addition, Cook et al. (2014) didn’t define the 3-D boundary (i.e. roof) of the wind farm. For this reason, neither did they assure whether birds show a vertical macro-avoidance response as that of meso- or micro-avoidance responses, due to technical limitation in measurement, instead of horizontal avoidance one. Using GPS-tracking technology, the limitation has been lifted. Here, we define the roof of wind farm as a 100-m distance upward from the upper rim of RSA. This is due to that there is a roughly 100-m bias in recording BFS flight altitude by GPS.

In terms of how far birds can show macro-avoidance response. Christensen et al. (2004) found that birds can response up to a distance of 6 km from the wind farm by marine radar. Here we extend the distance to 12 km because the larger Yulin offshore wind turbines can be seen at that distance by human eyes from onshore.

The definitions of each avoidance behavior are as follows:

1. Macro avoidance: The bird flies within 12 km of the wind farm, with flight altitude below the vertical boundary (roof) high of the wind farm, and changes the flying direction (horizontal macro) or altitude (vertical macro) to avoid the 3-D boundary of the wind farm (horizontal and vertical could be seen at the same time)

2. Meso avoidance: The bird flies within the 3-D boundary of the wind farm, and changes the flying direction (horizontal meso) or flying altitude (vertical meso) to avoid the RSA. (horizontal and vertical could be seen at the same time)

3. Possible micro-avoidance or without avoidance, but not detectable: Birds fly within the RSA of the wind farm.

Each avoidance result is shown in Table 2.6-1 and Table 2.6-2.

The total number of avoidance behavior that can be defined is 13, with 10 times horizontal macro avoidance and 3 times horizontal meso avoidance, and the remaining invalid samples total 33 times. The route of N05-6822 passes through one operating wind turbine, the GPS positioning frequency is too low to know whether it enters RSA or not, and the speed is about 36 km/hr. Therefore, we classify it as meso-avoidance (Figure 2.6-3). According to our results, the avoidance rate of the BFS is 100% (without flying into the rotor sweeping range of the wind farm), but this may be due to the low number of samples. More wind farm projects will be completed in the future, and more samples are expected to be obtained.

Table 2.6-1 Avoidance Behavior in Taiwan Strait within Each Migration Perios

Behavior / Period	Horizontal Macro-avoidance	Horizontal Meso-avoidance	Without-avoidance	Invalid Sample
Spring of 2021	5	3	0	11
Autumn of 2021	0	0	0	4
Spring of 2022	5	0	0	10
Autumn of 2022	0	0	0	8

Table 2.6-2 Avoidance Behavior within Each Offshore Wind farm in Taiwan Strait

Period	No.	Avoidance Behavior	OWF	Date	Figure No.
Spring of 2021	6835	Horizontal Meso-avoidance	Taipower Phase I	2021/4/7	Figure 2.6-1
	6826	Horizontal Meso-avoidance	Formosa I	2021/5/16	Figure 2.6-2
	6822	Horizontal Meso-avoidance	Taipower Phase I	2021/4/29	Figure 2.6-3
	6820	Horizontal Macro-avoidance	Taipower Phase I	2021/4/10	Figure 2.6-4
	6834	Horizontal Macro-avoidance	Taipower Phase I	2021/3/27	Figure 2.6-5
	6838	Horizontal Macro-avoidance	Formosa I	2021/5/29	Figure 2.6-6
	6053	Horizontal Macro-avoidance	Taipower Phase I	2021/4/25	Figure 2.6-7
	6053	Horizontal Macro-avoidance	Formosa I	2021/4/27	Figure 2.6-8
Spring of 2022	7379	Horizontal Macro-avoidance	Taipower Phase I	2022/3/12	Figure 2.6-9
	7371	Horizontal Macro-avoidance	Formosa I	2022/3/16	Figure 2.6-10
	11534	Horizontal Macro-avoidance	Formosa I	2022/3/21	Figure 2.6-11
	11540	Horizontal Macro-avoidance	Taipower Phase I	2022/4/21	Figure 2.6-12
	11540	Horizontal Macro-avoidance	Formosa I	2022/4/21	Figure 2.6-13

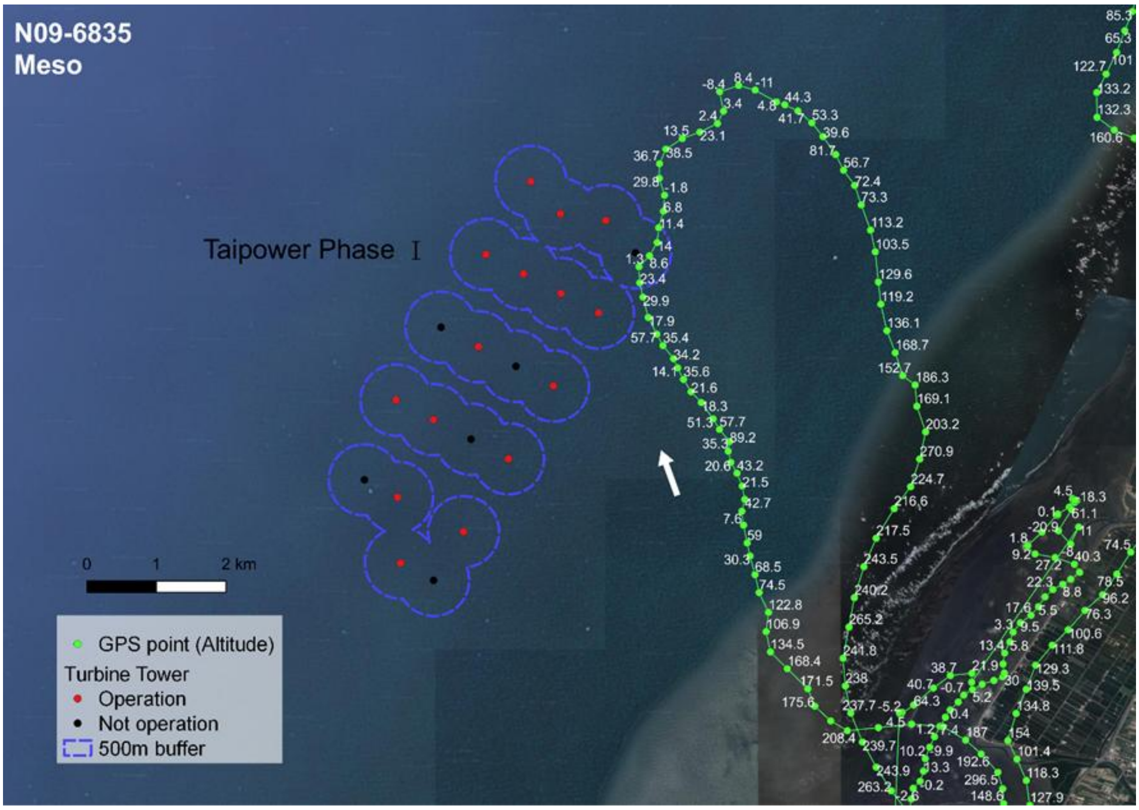


Figure 2.6-1 Horizontal Meso-Avoidance Behavior of N09-6835 in Taipower Phase I in Spring of 2021

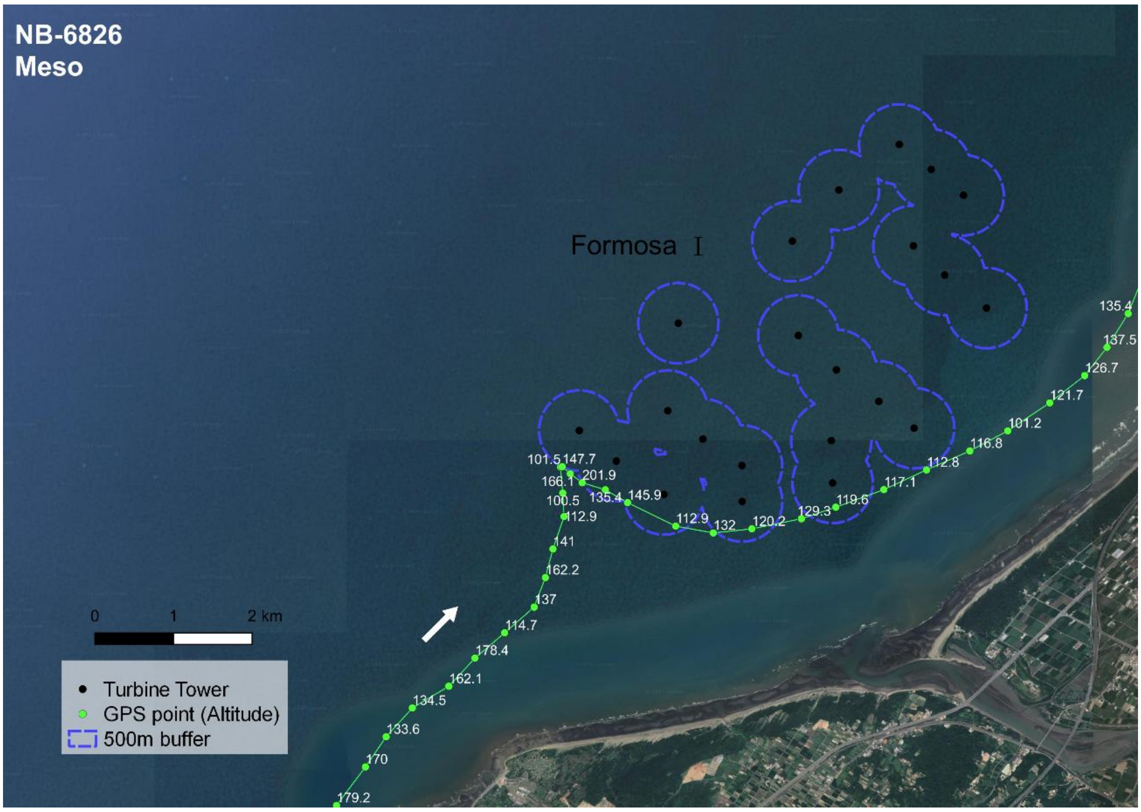


Figure 2.6-2 Horizontal Meso-Avoidance Behavior of NB-6826 in Formosa I in Spring of 2021

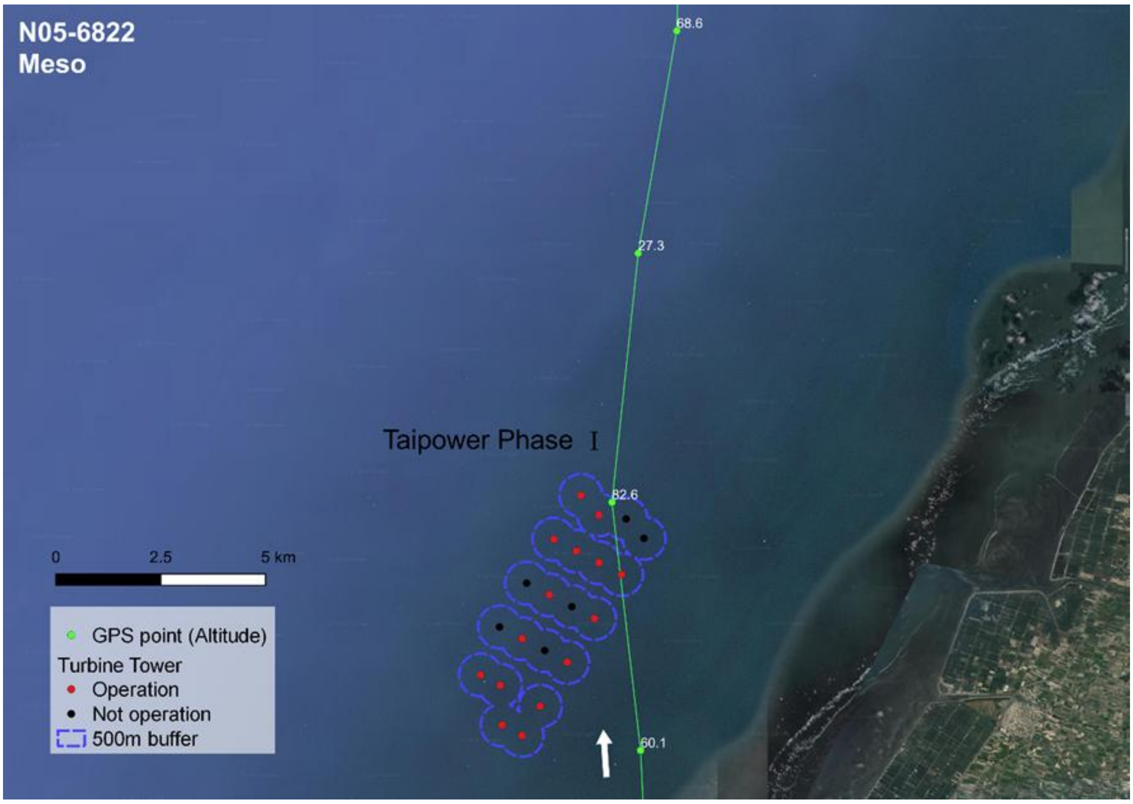


Figure 2.6-3 Horizontal Meso-Avoidance Behavior of N05-6822 in Taipower Phase I in Spring of 2021

Figure 2.6-4 Horizontal Macro-Avoidance Behavior of T95-6820 in Taipower Phase I in Spring of 2021

Figure 2.6-5 Horizontal Macro-Avoidance Behavior of T97-6834 in Taipower Phase I in Spring of 2021

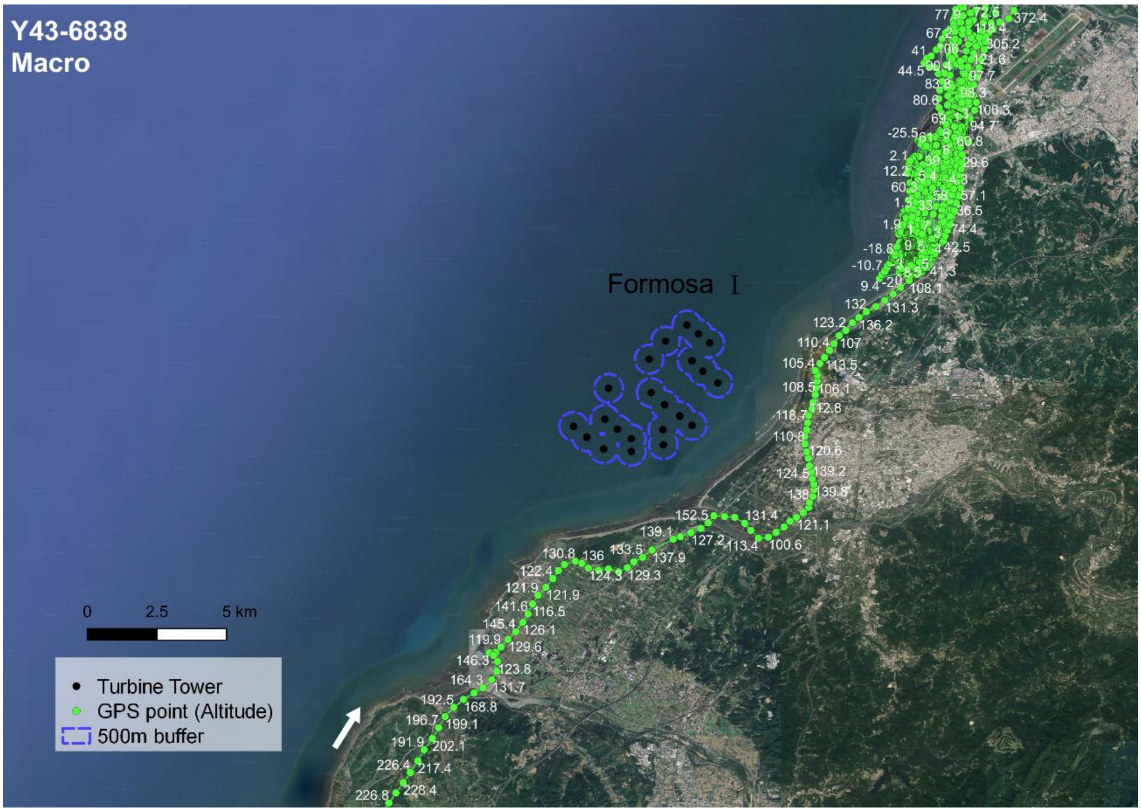


Figure 2.6-6 Horizontal Macro-Avoidance Behavior of Y43-6838 in Formosa I in Spring of 2021

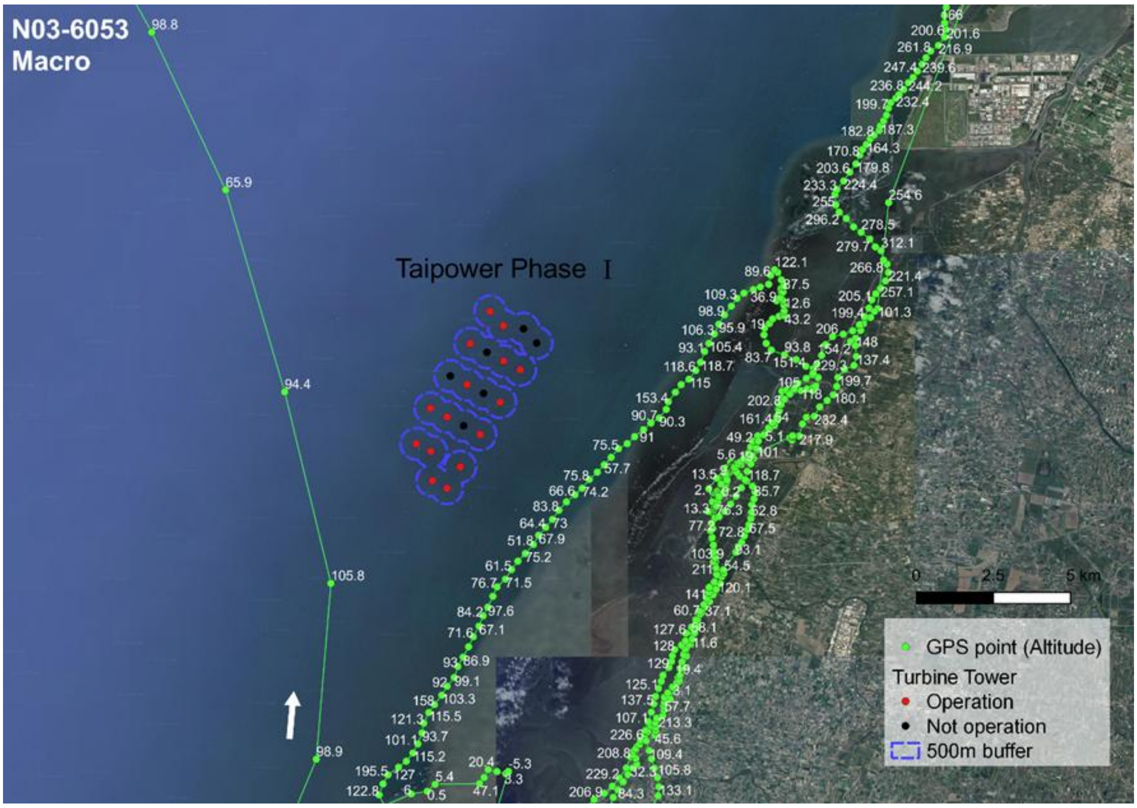


Figure 2.6-7 Horizontal Macro-Avoidance Behavior of N03-6053 in Taipower Phase I in Spring of 2021

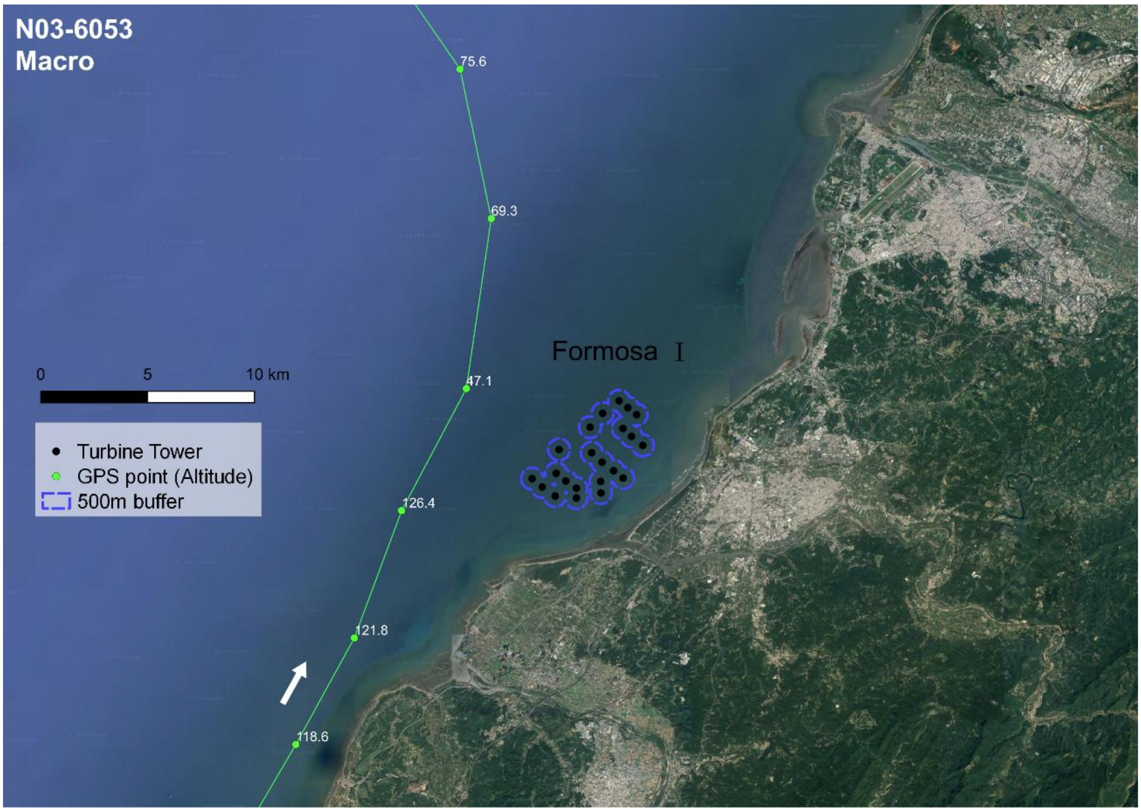


Figure 2.6-8 Horizontal Macro-Avoidance Behavior of N03-6053 in Formosa I in Spring of 2021

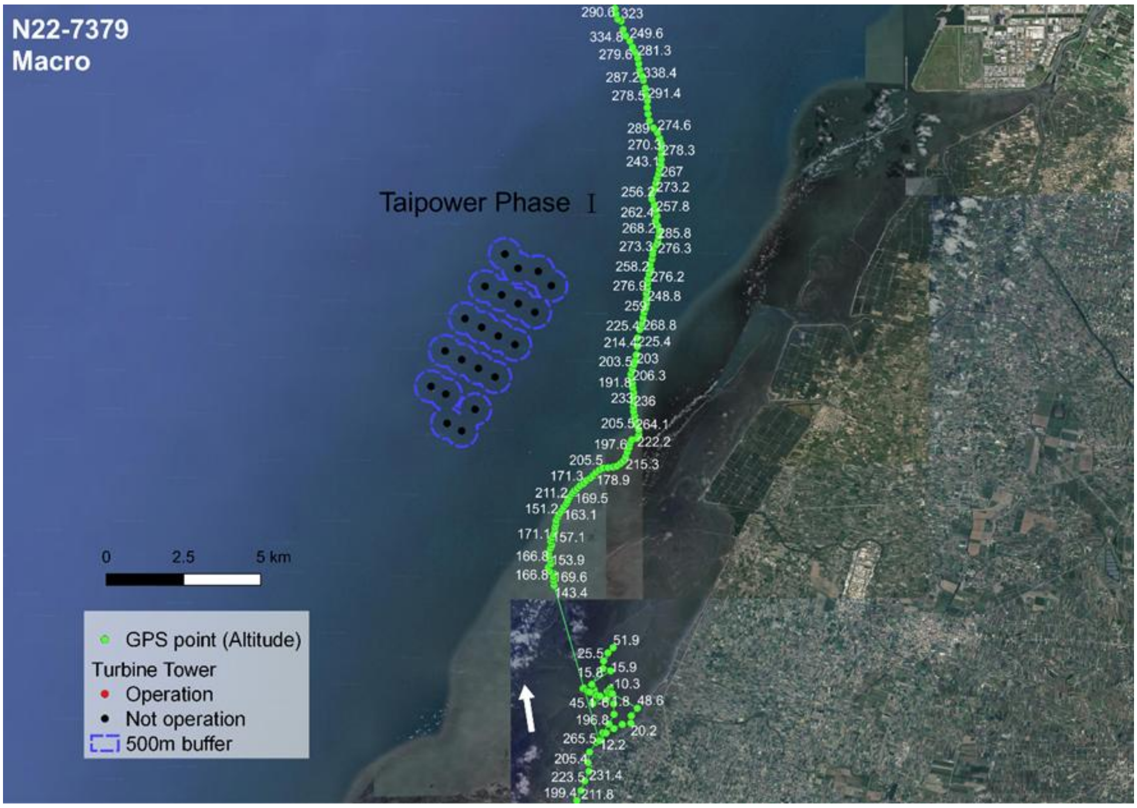


Figure 2.6-9 Horizontal Macro-Avoidance Behavior of N22-7379 in Taipower Phase I in Spring of 2022

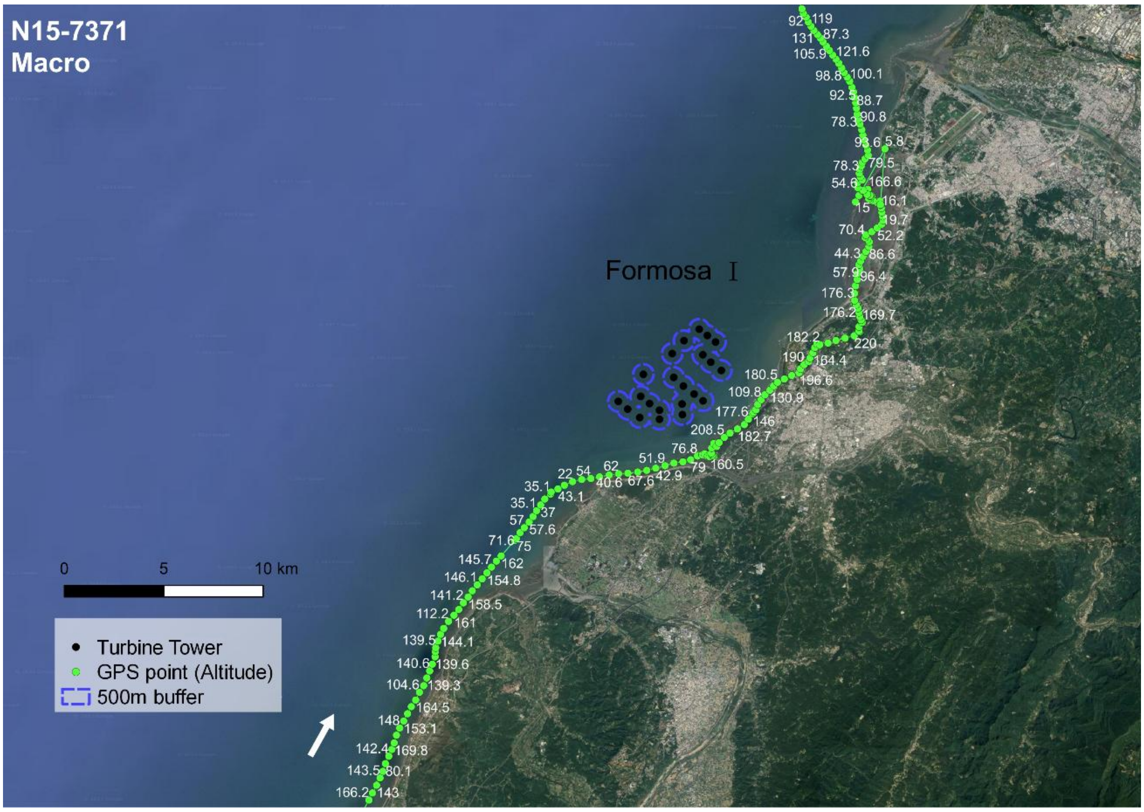


Figure 2.6-10 Horizontal Macro-Avoidance Behavior of N15-7371 in Formosa I in Spring of 2022

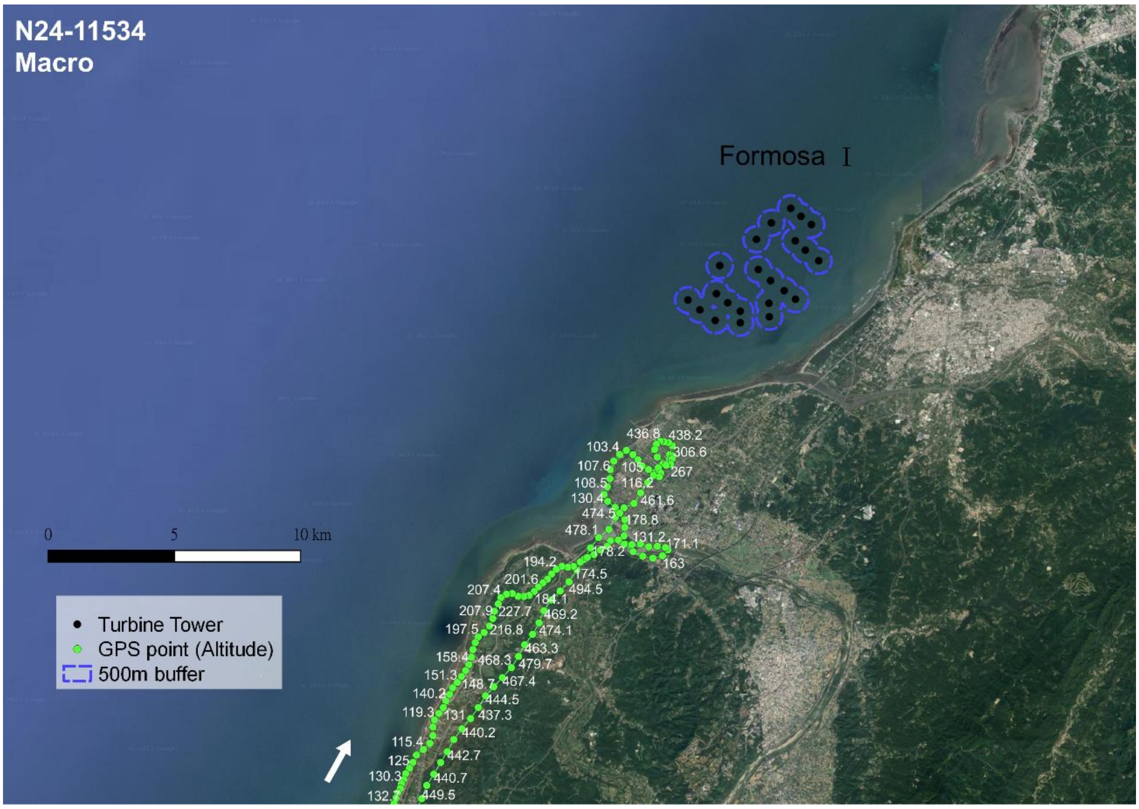


Figure 2.6-11 Horizontal Macro-Avoidance Behavior of N24-11534 in Formosa I in Spring of 2022

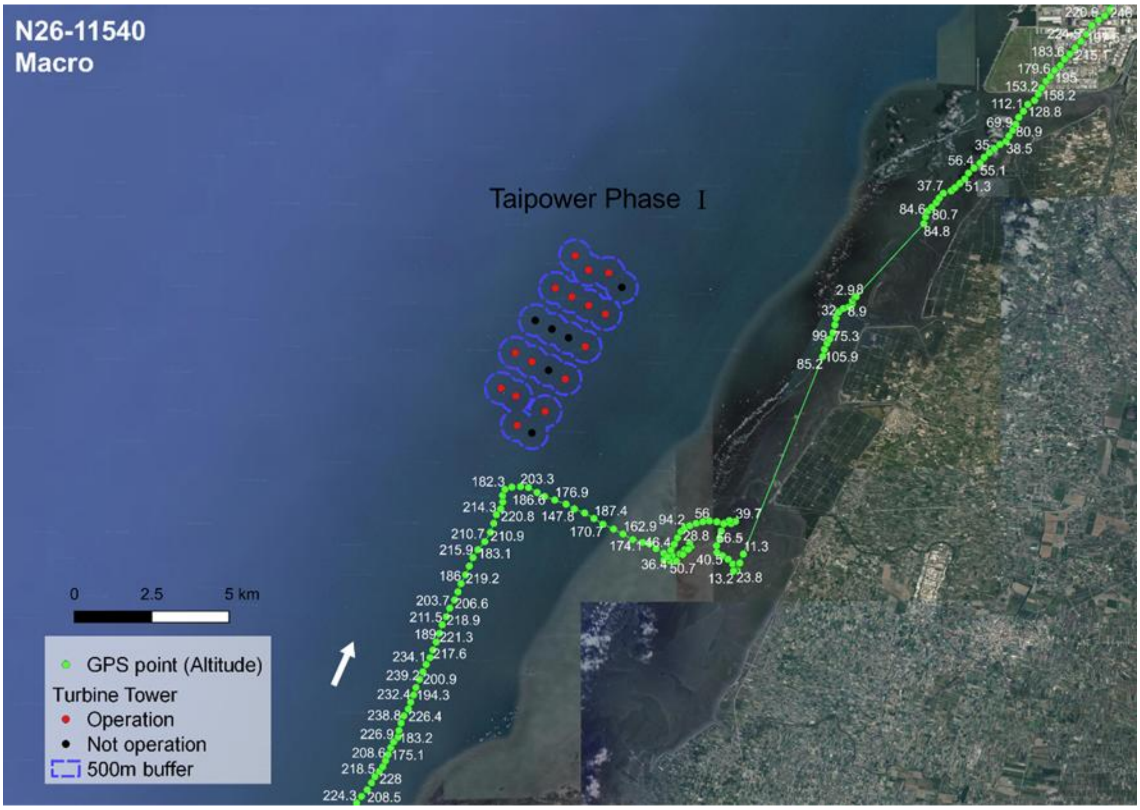


Figure 2.6-12 Horizontal Macro-Avoidance Behavior of N26-11540 in Taipower Phase I in Spring of 2022

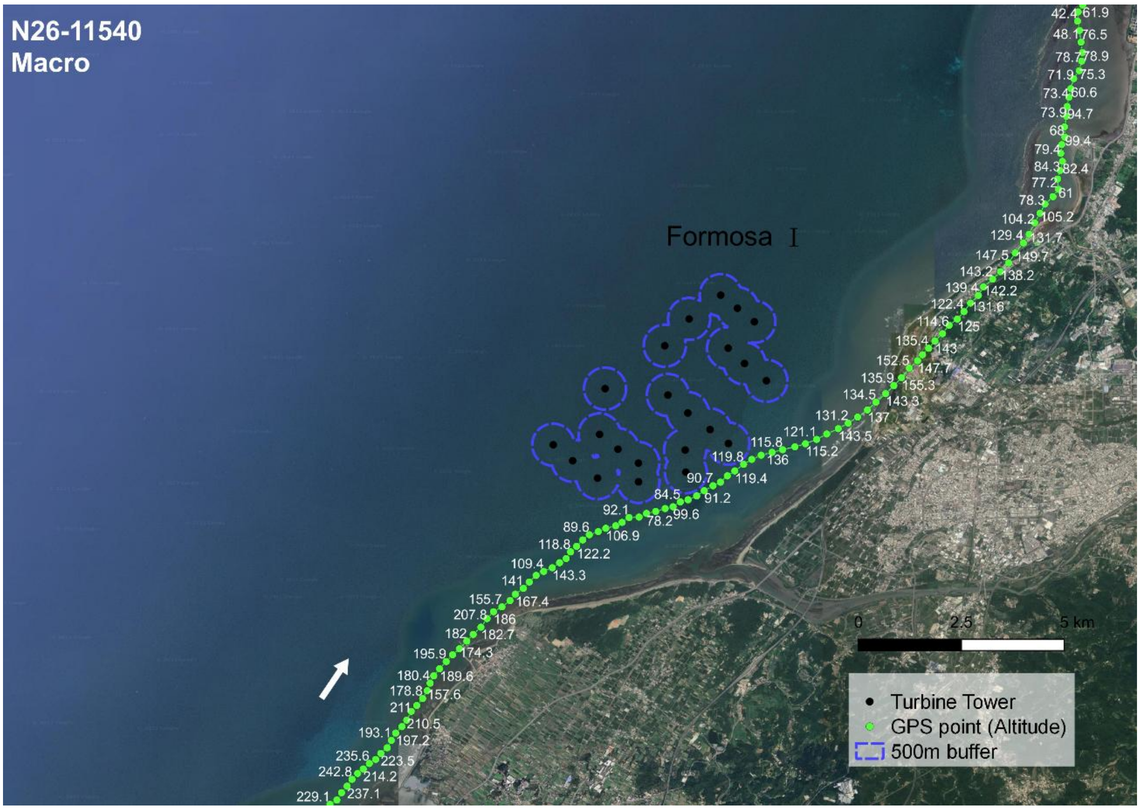


Figure 2.6-13 Horizontal Macro-Avoidance Behavior of N26-11540 in Formosa I in Spring of 2022

While considering the avoidance behavior with the operation of the wind turbine, there are 2 times horizontal meso- and 5 times horizontal macro-avoidance behavior in Taipower Phase I.

BFS N09-6835 shows horizontal meso-avoidance at a distance of 204 meters from wind turbines and tended to be closer to non-operating wind turbines (Figure 2.6-1, Table 2.6-3).

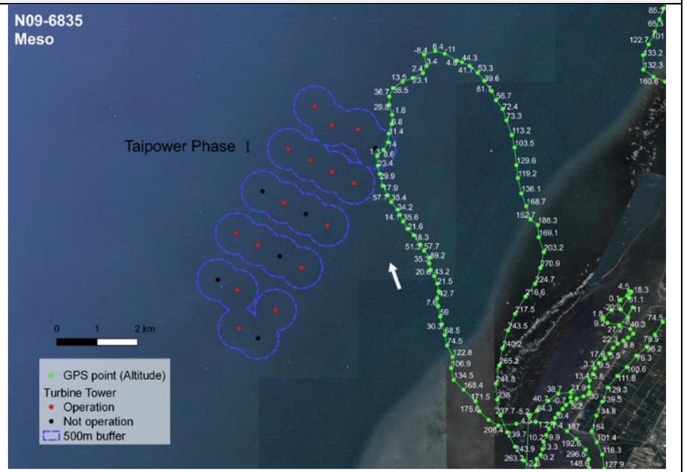
In the 5 horizontal macro-avoidance, there were 2 times when all the turbines were non-operating, and BFS shows avoidance behavior at a distance of 5 kilometers (Figure 2.6-4, Figure 2.6-9, Table 2.6-3).

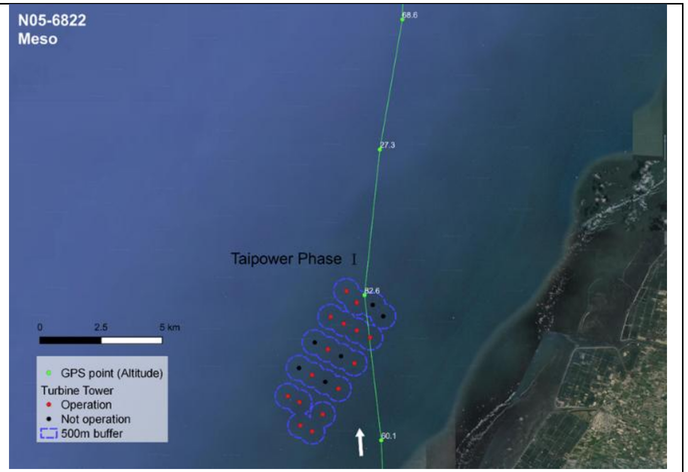
In the remaining 3 horizontal macro-avoidance, 15, 15, and 17 wind turbines were in operation, of which BFS T97-6834 shows avoidance behavior at a distance of 2116 meters (Figure 2.6-5, Table 2.6-3), BFS N03-6053 avoids the wind farm at a distance of 4.5-9.5 kilometers (Figure

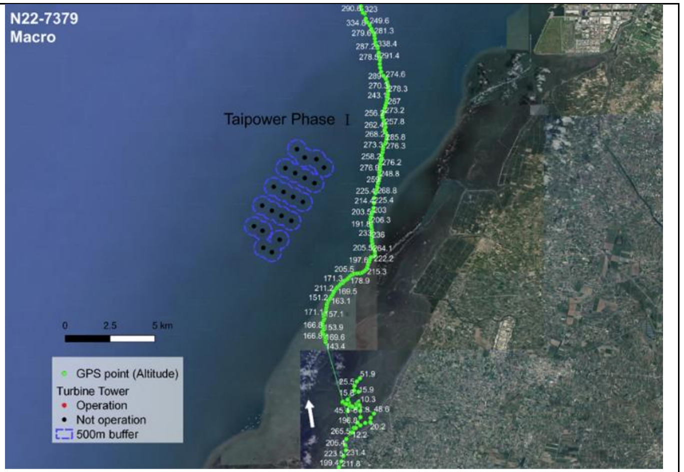
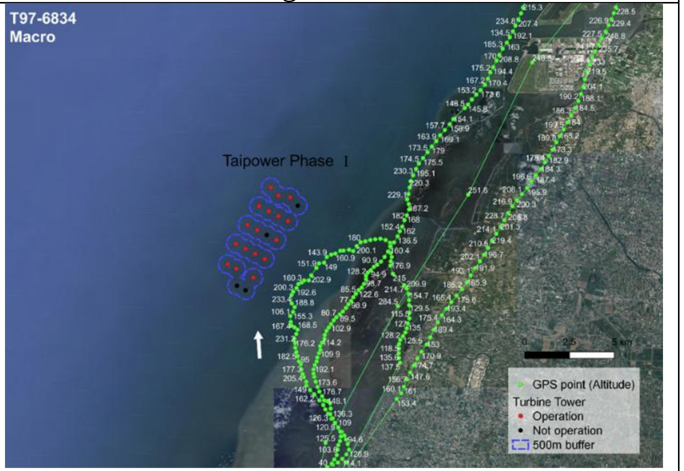
2.6-7, Table 2.6-3), BFS N26-11540 avoids at a distance of 1987 meters, and the nearest turbine is non-operating (Figure 2.6-12, Table 2.6-3).

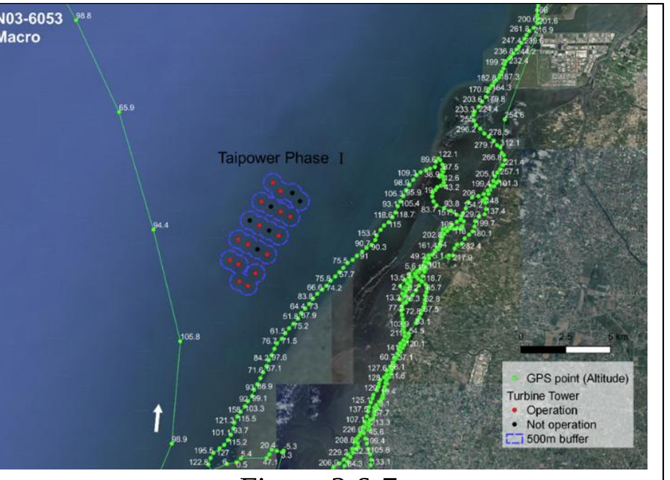
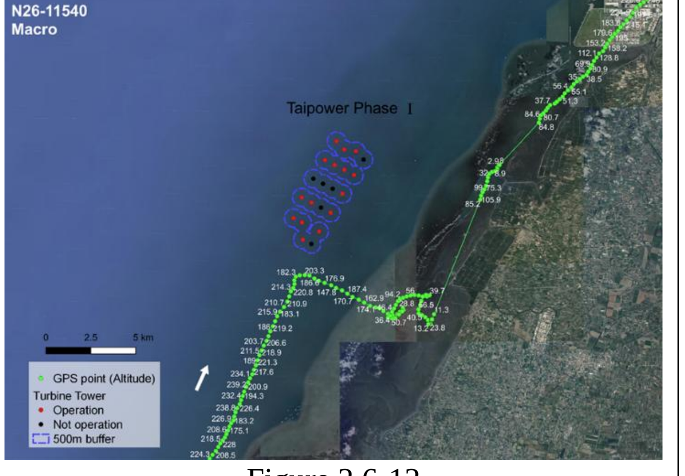
As far as the current results are concerned, the strength and distance of avoidance behavior are not obviously affected by whether the turbine is operating or not.

Table 2.6-3 Avoidance Behavior with the Operation of the Wind Turbine in Taipower Phase I

No.	Avoidance Behavior	Distance of avoidance behavior from wind turbines	Operating wind turbines / non-operating wind turbines	Other description	Figure No.
6835	Horizontal Meso-avoidance	204 m	15/6	Tended to be closer to non-operating wind turbines	 Figure2.6-1

6822	Horizontal Meso-avoidance	Not detectable	15/6	-	 Figure2.6-3
6820	Horizontal Macro-avoidance	5 km	All non-operating	-	 Figure 2.6-4

7379	Horizontal Macro-avoidance	4.7 km	All non-operating	-	 Figure 2.6-9
6834	Horizontal Meso-avoidance	2116 m	17/4	-	 Figure 2.6-5

6053	Horizontal Meso-avoidance	4.5-9.5 km	15/6	-	 Figure 2.6-7
11540	Horizontal Meso-avoidance	1987 m	15/6	The nearest turbine is non-operating	 Figure 2.6-12

Chapter III Review and Suggestions

3.1 Review on Monitoring Results and Response

The transmitter used in this project has a boost power system, which can shorten the time interval of the positioning point to 20 seconds. Which provides a powerful tool for the study of detailed migration route and avoidance behavior of BFS, and is also the only option on the market at present. However, the disadvantage is that the yield rate of this system is lower than that of other brands, this can be seen as the tradeoff between a higher position frequency with higher accuracy and device life, and this part can only be additionally captured in the future to make up for the preset samples.

Other potential reasons can also influence the lifetime of transmitters, for example, the monsoon season in Korea may reduce charging efficiency, and some places of North Korea may have poor GSM signal, which can make the device in low battery. This year we try to lower the position frequency of devices that had entered Korea from 1 hour to 2 hours, to extend the life of transmitters. When the time of autumn migration is approaching, the frequency will be adjusted back to 1 hour.

Table 3.1-1 Overview of Survey Result of Satellite Tracking Survey

No.	Status	Period	Number of BFS
1	BFS Tagging	February 2021	16
2	Malfunctioned	February 2021	1
3	Departed to China/South Korea	March to June 2021	15
4	Lost signal in China/South Korea	March to October 2021	10
5	Migrated South, back to Taiwan	October to November 2021	5
6	Lost signal in Taiwan	October 2021 to February 2022	4
7	BFS Tagging	November 2021 to April 2022	17
8	Malfunctioned	December 2021 to April 2022	4
9	Departed to China/South Korea	March to April 2022	13
10	Haven't departed	December 2021 to December 2022	1
11	Lost signal in China/South Korea	March to July 2022	4
12	Migrated South, back to Taiwan	October to December 2022	9
13	Active in Taiwan	Up till December 31th, 2022	7

3.2 Suggestions

The satellite tracking results of the past two years show that there is less probability of BFS passing through Yunlin wind farm, and the migration group of BFS does have some avoidance behavior near offshore wind farms.

Due to the yield rate of the transmitter, the number of individuals returning in autumn is relatively small, and the general situation of the autumn migration route passing through the wind farm is not yet clear.

It is recommended to continue the survey to increase the effort and to cooperate with the construction information of other offshore wind farms to accumulate long-term and more detailed investigation data.

Reference

Caccamise, D.F. and R.S. Hedin. 1985. An aerodynamic basis for selecting transmitter loads in birds. Wilson Bull 97: 306-318.

Chen, C. L. 2003. International symposium proceedings of black-faced spoonbill. 25-38. Council of Agriculture.

Choi, C. Y. and W. S. Lee. 2005. The wintering ecology of black-faced spoonbill (*Platalea minor*) in Seongsanpo, Jeju Province, South Korea. School of Forest Sciences, Seoul National University.

Cochran, W. W. 1980. Wildlife telemetry. Pp. 507-520 in Wildlife management techniques manual (S. D. Schemnitz, ed.). The Wildlife Society, Washington, D.C.

Cook, A. S.C. P., E. M. Humphreys, E.A. Masden and N. H. K. Burton. 2014. The Avoidance Rates of Collision Between Birds and Offshore Turbines. Scottish Marine and Freshwater Science 5(16).

Christensen, T.K., J.P. Hounisen, I. Clausager and I.K. Petersen. 2004. Visual and radar observations of birds in relation to collision risk at the Horns Rev offshore wind farm. Annual status report 2003. Commissioned report to Elsam Engineering A/S. National Environmental Research Institute.

Jung, S. M., J. H. Kang, I. K. Kim, H. S. Lee, S. W. Lee and H.S. Oh. 2018. Autumn migration of black-faced spoonbill (*Platalea minor*) tracked by wild-tracker in East Asia. Korean Journal of Environment and Ecology 32: 478–485.

Kuo, D. H. 2016. Quantity survey of black-faced spoonbill and associated bird species in its surrounding areas in Taijian National Park. Project report of Taijiang national park.

Pugesek, B. H., K. L. Diem and C. L. Cordes. 1999. Seasonal movements, migration, and range sizes of subadult and adult Bamforth Lake

California gulls. Lake. The International Journal of Waterbird Biology 22:29–36.

Wang, Y. 2016. The ecological study and habitat management of the black-faced spoonbill in Taijiang national park. Project report of Taijiang national park.

Appendix 1 External Features of Black-faced Spoonbill

a.2021

No.	Device No.	Band No.	Weight (g)	Tarsometatarsus length (mm)	Beak length (mm)	Whole head length (mm)	Notes
1	6820	T95	1220	119	153	200.3	
2	6834	T97	1670	128.4	185	240	
3	6833	T98	1630	129.5	188	246	
4	6817	T99	1226	123.5	154	207	
5	6838	Y43	--	118	157	212	Measure in 2022/4
6	6814	T00	1513	135.8	189	245	
7	6830	--	1850	123	168.5	218	
8	6837	--	1850	119	159	210	
9	6826	--	1400	103	151	208	
10	6819	N01	1317	117.1	155	206	
11	6831	N02	1134	106	149	200	
12	6053	N03	1173	111	163	212	
13	6823	N08	1283	--	155.9	210	
14	6835	N09	1213	188.5	162.3	215	
15	6818	N04	2300	121	191	247	
16	6822	N05	1600	122.5	160	220	

b.2022

No.	Device No.	Band No.	Weight (g)	Tarsometatarsus length (mm)	Beak length (mm)	Whole head length (mm)	Notes
1	6827	N12	1192	117	148	200	
2	6821	N13	1152	111	150	204	
3	6836	N14	1378	119	166	220	
4	7371	N15	1208	116.5	160	219	
5	7378	N16	1404	120	155.5	207	
6	7377	N21	1432	137	186.5	245	
7	7379	N22	1590	116.9	171.7	225	
8	11330	N23	1725	113.1	162.9	213	
9	11534	N24	1755	117.8	158.7	213	
10	11536	N25	1790	119.2	169	22.3	
11	11540	N26	1356	127.1	160	210	
12	11548	N28	1690	119	163	218	
13	11543	N29	1830	140	181	235	
14	11553	N31	1232	115	158.7	208	
15	11541	N32	1325	114	154	210	
16	11551	N33	1498	124.8	164.2	220	
17	12506	N35	1470	129	190.5	250	

Appendix 2 Survey Photos

Figure 1. Tagging of BFS

Figure 2. Releasing of BFS

Figure 3. T95-6820: rescued adult female

Figure 4. T97-6834: rescued adult male

Figure 5. T98-6833: rescued adult male

Figure 6. T99-6817: rescued subadult female

Figure 7. T00-6814: rescued adult male

Figure 8. Y43-6838: rescued 1 year bird (banded by Korea) (Courtesy of Dung Hui, Kuo)

Figure 9. Right brown-6830: captured adult male

Figure 10. Right blue-6837: captured adult male

Figure 11. Right brown and right blue paired in Korea with 2 chicks (Courtesy of Kisup, Lee)

	
Figure 12. N01-6819: adult female with the tag malfunctioned before migration	Figure 13. N01-6819: the bird was resighted in Taiwan after tag malfunctioned (Courtesy of BFSA*)
	
Figure 14. NB-6826: captured 1 year juvenile	Figure 15. N08-6823: rescued 1 year female (Courtesy of Dung Hui, Kuo)
	
Figure 16. N04-6818: captured adult	Figure 17. N04-6818: was resighted by Korean team in Gujido, South Korea in May (Courtesy of Kisup, Lee)

	
Figure 18. N05-6822: captured subadult	Figure 19. N03-6053: rescued subadult female (Courtesy of Dung Hui, Kuo)
	
Figure 20. N09-6835: rescued subadult female (Courtesy of Dung Hui, Kuo)	Figure 21. N02-6831: rescued 1 year female (Courtesy of Dung Hui, Kuo)
	
Figure 22. N12-6827: captured juvenile female	Figure 23. N13-6821: rescued adult female

Figure 24. N14-6836: rescued adult male


Figure 25. N15-7371: rescued adult


Figure 26. N16-7378: captured juvenile female


Figure 27. N21-7377: rescued adult male


Figure 28. N22-7379: captured adult female


Figure 29. N23-11330: captured adult female

Figure 30. N24-11534: captured adult female

Figure 31. N25-11536: captured adult female

Figure 32. N26-11540: captured subadult female

Figure 33. N28-11548: captured juvenile

Figure 34. N29-11543: captured subadult male

Figure 35. N31-11553: rescued subadult female

	
Figure 36. N32-11541: captured juvenile	Figure 37. N33-11551: rescued subadult female
	
Figure 38. N35-12506: the rescued adult male was found by satellite tracking data cooperating with patrol work	Figure 39. Y43-6838 was found dead on April 2022 in Tainan with no obvious trauma

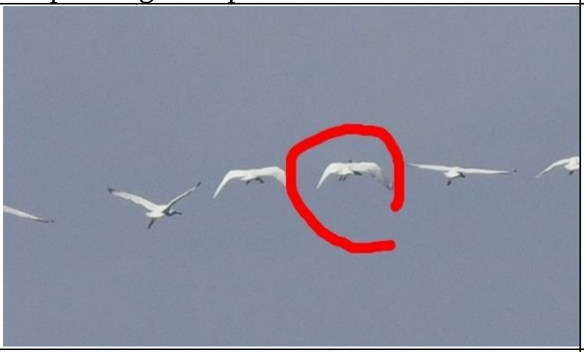



Figure 40. Juvenile bird N28-11548 was recorded by researchers while migrating through Taichung offshore on April 21, 2022(red circle) (Courtesy of Chung Han, Hong)	Figure 41. Juvenile bird N28-11548 migrated with a group of 75 individuals (Courtesy of Chung Han, Hong)

*Taiwan Black-Faced Spoonbill Conservation Association