

Yunlin Offshore Wind Farm

Black-faced Spoonbill

Survey Program

Offshore Construction Phase

Fall 2021 (September-November)

Marine Radar Survey combined with Visual Survey from a Fixed Position and Satellite Tracking Survey

Final

Developer : Yunneng Wind Power Co., Ltd.

Monitoring Unit : Unitech New Energy Engineering Co., Ltd.

Submitted on : February, 2022

Revision	Drafted by		Checked by		Approved by	
Draft	Unitech	03.01.2022				
01	Unitech	04.01.2022				
02	Unitech	16.02.2022				
Printed versions are not subject to document control						

Printed versions are not subject to document control

Revision

Revision	Section/ Chapter	Changes	by
01	1.2	Text modification and rephrasing	Shike Ng
02	2.2, 3.1, 3.2	Text modification and rephrasing, updated table 2.2-1, paragraph restructure, updated note 1 of figure 2.2-1, updated 2.2 migration routes content, added table 3.1-1 and 3.3-2, updated suggestions section	Shike Ng

Applicable Documents

Title	Date

Contents

Preface	1
Chapter I Monitoring Summary	3
1.1 Construction Progress	3
1.2 Survey Statement	3
1.3 Survey Summary.....	3
1.4 Survey Method.....	7
1.4.1 Marine Radar Survey combined with Visual Survey from a Fixed Position	7
1.4.2 Satellite Tracking Survey.....	12
1.5 Operation Process of QA/QC.....	16
1.5.1 Marine Radar combined with Visual Survey from a Fixed Position ..	16
1.5.2 Satellite tracking	19
Chapter II Analysis of survey results.....	20
2.1 Marine Radar Survey Combined with Visual Survey from a Fixed Position	20
2.2 Satellite Tracking Survey.....	39
Chapter III Review and suggestions	63
3.1 Review on monitoring results and response	63
3.2 Suggestions	65
Reference.....	66
 Appendix 1 QA/QC Inspection Records	
Appendix 2 Raw Data from Surveys	
Appendix 2.1 Offshore visual survey	
Appendix 2.2 Marine radar survey	
Appendix 2.3 Satellite tracking survey	
Appendix 3 Photos from Onsite Surveys	
Appendix 3.1 Offshore visual and marine radar survey	
Appendix 3.2 Satellite tracking survey	

Figures

Figure 1.4.1-1 Survey Location of Marine Radar Survey combined with Visual Survey from a Fixed Position for BFS.....	7
Figure 1.4.1-2 Radar Antenna Installed on the Vessel	9
Figure 1.4.1-3 Instruction of Radar Return Map	10
Figure 1.4.2-1 Distribution Map of BFS in Taiwan (2020).....	14
Figure 1.4.2-2 Example of Foot-snare Trap.....	15
Figure 1.5.1-1 Work procedure of this project	16
Figure 2.1-1 Bird Flying Direction from Horizontal Radar of the 5 surveys in fall 2021 (24hr).....	25
Figure 2.1-2 Bird Flying Direction during Daytime and Nighttime from Horizontal Radar of the 5 surveys in fall 2021	25
Figure 2.1-3 Flying Trajectories from the First Horizontal Radar Survey (Sep. 29)	26
Figure 2.1-4 Flying Trajectories from the Second Horizontal Radar Survey (Sep. 30)	27
Figure 2.1-5 Flying Trajectories from the Third Horizontal Radar Survey (Nov. 20)	28
Figure 2.1-6 Flying Trajectories from the Fourth Horizontal Radar Survey (Nov. 28)	29
Figure 2.1-7 Flying Trajectories from the Fifth Horizontal Radar Survey (Nov. 29)	30
Figure 2.1-8 Flying Speed of Trajectories Over 1 km from Horizontal Radar (Sep. to Nov. 2021)	31
Figure 2.1-9 Altitude Distribution from Vertical Radar (Sep. to Nov. 2021)	32
Figure 2.1-10 Altitude Distribution from Vertical Radar during Daytime (left) and Nighttime (right) (Sep. to Nov. 2021)	32
Figure 2.1-11 Altitude Distribution from Vertical Radar (24hrs) in the 1 st to 5 th Survey (Sep. to Nov. 2021).....	33
Figure 2.1-12 Altitude Distribution within Sweeping Area from Vertical Radar (24 hrs) (Sep. to Nov. 2021).....	34
Figure 2.1-13 Altitude Distribution during Daytime (left) and Nighttime (right) within Sweeping Area from Vertical Radar (Sep. to Nov. 2021)....	34

Figure 2.1-14 Time Distribution from Vertical Radar (Sep. to Nov. 2021)	35
Figure 2.1-15 Time Distribution from Vertical Radar from the 1 st to 5 th Survey (Sep. to Nov. 2021)	36
Figure 2.1-16 Time Distribution from Horizontal Radar (Sep. to Nov. 2021)	37
Figure 2.1-17 Time Distribution from Horizontal Radar from the 1 st to 5 th Surveys (Sep. to Nov. 2021)	38
Figure 2.2-1 Departure Dates of Spring Migrating BFS (n=15) in 2021 up till 13 th of June, 2021	43
Figure 2.2-2 Arrival Dates of Fall Migrating BFS (n=4) in 2021 up till December 1 st , 2021	44
Figure 2.2-3 Spring Migrating BFS (n=15) Departure Times from Taiwan up till 13 th of June, 2021	44
Figure 2.2-4 Fall Migrating BFS (n=4) Arrival Times in Taiwan up till December 1 st , 2021	45
Figure 2.2-5 Route of BFS in Spring, March-June, (n=15, solid lines) and BFS in Fall, October to November, (n=4, dotted lines) across Taiwan Strait (up till December 1 st , 2021)	47
Figure 2.2-6 Route of BFS in Spring, March-June, (n=15, solid lines) and BFS in Fall, October to November, (n=4, dotted lines) near Yunlin Wind Farm. The First Departure in March 10th of BFS (blue leg band- 6837) almost Passed the Vicinity of the Wind Farm Area. (up till December 1 st , 2021)	48
Figure 2.2-7 The Migration Route of BFS in Spring, March-June, (n=15, solid lines) and BFS in Fall, October to November, (n=4, dotted lines) (up till December 1 st , 2021)	49
Figure 2.2-8 BFS Migration Routes that Passed Through Other Offshore Wind Farms While Crossing Taiwan Strait during Spring 2021 (Areas Highlighted in Orange) (up till December 1 st , 2021)	50
Figure 2.2-9 BFS Migration Routes that Passed Through Zhufeng and Formosa II Offshore Wind Farms during Spring 2021 (Device no. Highlighted in Yellow)	51
Figure 2.2-10 BFS Migration Routes that Passed Through Changhua Offshore Wind Farms during Spring 2021 (Device no. Highlighted in Yellow)	52

Figure 2.2-11 BFS Migration Routes that passed through Changhua Near Offshore Wind Farms during Spring 2021 (Device no. Highlighted in Yellow) (up till December 1st, 2021)	53
Figure 2.2-12 BFS Migration Routes that Passed Through Other Offshore Wind Farms in Taiwan Strait during Fall 2021 (Areas Highlighted in Orange)	54
Figure 2.2-13 BFS Migration Routes that Pass Through Changhua Offshore Wind Farms during Fall 2021 (Device no. Highlighted in Yellow)	55
Figure 2.2-14 BFS Departure Locations between March-June 2021	58
Figure 2.2-15 BFS Departure Routes between 2012-Spring 2018 (Wang 2016 and Kisup Lee, unpublished data)	59
Figure 2.2-16 BFS Arrival Locations in Taiwan between October-November 2021 (locations for some individuals could not be accurately determined due to low positioning frequencies, dotted lines) (up till December 1 st , 2021)	60
Figure 2.2-17 Percentage of Flying Altitudes within Each Interval for BFS Positionings in Taiwan Strait (March-June, 2021)	62

Tables

Table 1.2-1 Monitoring Summary of BFS during Offshore Construction Phase (2021 Fall) (1/2).....	4
Table 1.2-1 Monitoring Summary of BFS during Offshore Construction Phase (2021 Spring) (2/2)	5
Table 1.3-1 BFS Monitoring Schedule during Offshore Construction Phase	6
Table 1.4.1-1 Radar Specification	9
Table 1.4.1-2 Survey Methods for Horizontal and Vertical Radar	10
Table 1.4.1-3 Shift arrangement of surveyors in this project	12
Table 2.1-1 Survey Time and Date in Fall 2021.....	20
Table 2.1-2 Resource Table of Visual Survey from a Fixed Position	21
Table 2.1-3 Flying Heights Recorded in Visual Survey from a Fixed Position	22
Table 2.1-4 Bird Activity Per Hour of Fixed Position Visual Survey	22
Table 2.1-5 Number of Echoes from Marine Radar Survey	23
Table 2.2-1 Black-faced spoonbill tagging information	40
Table 2.2-2 Time and Date of BFS Migration Passing Through Other Offshore Wind Farms during Spring 2021 (up till December 1 st , 2021)	56
Table 2.2-3 Time and Date of BFS Migration Passing Through Other Offshore Wind Farms during Fall 2021 (up till December 1 st , 2021).....	57
Table 2.2-4 BFS Arrival Locations in Taiwan between October-November 2021	61
Table 2.2-5 Percentage of Flying Altitudes within Each Height Interval for BFS Positionings in Taiwan Strait (October-November, 2021)	62
Table 3.1-1 Overlook of Marine Radar survey combined with Visual Survey from a Fixed Position	64
Table 3.1-2 Overlook of Satellite Tracking Survey	65

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 IFC PS6 standard. The protocol includes descriptions of the survey methods for bird and bat monitorings during the offshore pre-construction, construction and operation phases of “Yunlin Offshore Wind Farm Project” (hereinafter referred to 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 only species deemed as “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 marine radar survey combined with visual survey from a fixed position and 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

Marine radar survey combined with visual survey from a fixed position during offshore construction phase have been carried out since October 2020 (Fall). Nine surveys are arranged during each migratory season of BFS (spring: March-May and fall: September-November). Satellite tracking survey has been started in January 2021, sixteen BFS are currently being tracked.

This BFS monitoring report consists of marine radar survey combined with visual survey from a fixed position and satellite tracking survey during the offshore construction phase in Fall 2021 (September-November).

III. Monitoring Unit

This BFS monitoring project is compiled by Unitech New Energy Engineering Co., Ltd., who is also responsible for the writing of monitoring report. Professional ecological company, academic researchers and experts were commissioned to carry out the environmental monitoring works.

The units for each monitoring item in this quarter are listed as follows:

1. Marine radar survey combined with visual survey from a fixed position: Hong Yi Ecological Co.
2. Satellite tracking: National Pingtung University of Science and Technology

Chapter I Monitoring Summary

1.1 Construction Progress

Construction of the Project was divided into onshore and offshore construction phase; the onshore portion includes construction of onshore transmission facilities and the marine portion includes construction of marine wind farm and submarine cable.

For onshore construction, the civil engineering for Taixi and Sihui booster station have been completed; operation license of Sihui booster station was obtained in July 2020; civil construction of the cable between Taixi booster station and Taixi substation, and between Sihui booster station and Sihui substation have been completed; site preparation for the submarine cable landing connection to Taixi and Sihui booster stations have been completed. For offshore construction, the piling for wind turbine foundations began in November, 2020.

1.2 Survey Statement

Marine radar survey combined with visual survey from a fixed position were carried out since fall 2020 (October 2020). However, only 2 surveys were carried out in fall due to sea states. In spring 2021 (March to May 2021), the scheduled 9 surveys and the 7 surveys remaining from fall 2020 were carried out. In Fall 2021 (this season, September-November), only 5 surveys were carried out due to bad weather condition. A total of 23 surveys were carried out in the 3 seasons. Satellite tracking survey began in January 2021, and as of February, all 16 BFS have been banded. Monitoring data this season is summarized in Table 1.2-1.

1.3 Survey Summary

The survey items, locations, frequencies and survey dates during this

season of the BFS monitoring plan are compiled in Table 1.3-1.

Table 1.2-1 Monitoring Summary of BFS during Offshore Construction Phase (2021 Fall) (1/2)

Survey Item	Survey Summary
Marine radar survey combined with visual survey from a fixed position	Marine radar survey combined with visual survey from a fixed position were conducted 5 times this season. The summary of survey results are as follows: <u>Visual survey from a Fixed Position</u> 1. Recorded species: 99 individuals were recorded. A total of 7 species were recorded, with Cattle egret contributing the most individuals (n=66) and 1 protected species, Greater crested tern, was recorded (n=1). No BFS was recorded during this season. 2. Flying altitude: Flying altitude of all birds recorded in this season were below 20 m. Most individuals flew between 0-5 m (89 individuals). 3. Bird activity per hour: The number of bird activity per hour this season is 1.6500 individuals/hr. <u>Marine radar survey from a fixed position</u> In regard to horizontal and vertical radar surveys, 937 trajectories were recorded in the horizontal radar; and 16,518 flying trajectories were recorded in the vertical radar. 1. Flying direction and speed The main flying direction is toward SSW (39.6%, 371 records). The second main flying direction is toward S (20.8%). Distribution of flying directions did not vary a lot regarding daytime and nighttime, and the main flying directions were toward SSW. Trajectories with more than 1 km of distance is analyzed, there are 936 trajectories in this range, the main flying speed of birds fell between 11-14 m/s (39.1%, 366 records). The average flying speed this quarter is 11.1 ± 4.5 m/s. 2. Flying altitude Flying altitude for birds is mainly above 200 m (9,201 records), which is 55.7% of total recordings. There are no differences in results of flying altitude distribution between daytime and nighttime. Most recordings during daytime and nighttime are above 200 m, accounting for 55.9% and 55.6% for daytime and nighttime, respectively. If analyzed with flying altitude within the sweeping zone (25-200 m), daytime records accounts for 43.8% and nighttime records accounts for 43.9%. Average flying altitude in this season is 264.8 ± 196.9 m. 3. Time distribution Overall results of the vertical radar survey indicate that flying activity of birds mostly occur during the night accounting for 65.0% of the overall records. The same is also indicated by results of horizontal surveys, with most recordings occurring during the nighttime, consisting of 60.3% of total recordings.

Table 1.2-1 Monitoring Summary of BFS during Offshore Construction Phase (2021 Spring) (2/2)

Survey Item	Survey Summary	Response
Satellite tracking	Survey results starting from January 2021, are as summarized below: <u>Banding results</u> In February, a total of 16 BFS were banded and tracked, including 11 individuals that were rehabilitated and 5 individuals that were caught and banded in Tainan. <u>Migration date and time</u> (1)Date of migration In this survey, departure offshore during spring migration of BFS occurred between March 10th to June 13th. April was the main migration departure month, accounting for 46.7% of the records. The earliest BFS arrived in Taiwan on October 18th. (2)Time of migration The departure time for most BFS in spring migration was in the early morning, followed by departure between evening and midnight. In analysis of three hour periods, 11 individuals (accounting for 73.3%) departed offshore between 5:00 to 8:00; 2 individuals (accounting for 13.3%) departed offshore between 17:00 to 20:00; and 1 individual departed offshore between 2:00-5:00 and 20:00 -23:00 respectively (accounting for 6.7%). During fall migration, 2 individuals arrived between 2:00-5:00, while 1 individual each arrived between 14:00-17:00 and 17:00-20:00. <u>Migration route</u> (1)Departure route in the Taiwan Strait Of the 16 BFS for the satellite tracking, the transmitters for 1 individuals (N01-6819) malfunctioned in Taiwan, the remaining 15 individuals all successfully departed offshore. additionally, 4 individuals were recorded successfully migrating south. 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, almost brushed pass the wind farm area, it flew a mere 400 metres 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, it is known that the arrival location of BFS fell between Miaoli and Chiayi.	—

Table 1.3-1 BFS Monitoring Schedule during Offshore Construction Phase

Genre	Survey Item	Survey Location	Survey Frequency	Survey Dates in this Season
BFS	Marine radar combined with visual survey from a fixed position	1 spot in the wind farm area	9 surveys were arranged in the spring migratory season of BFS (March-May) and 7 additional were conducted during spring season as substitute for unfulfilled fall surveys	2021.09.29-30 2021.09.30-10.1 2021.11.20-21 2021.11.28-29 2021.11.29-30
	Satellite tracking	Tainan and Chiayi area	16 BFS should be tracked in 2021	2021.2.01 (3 BFS banded) 2021.2.02 (1 BFS banded) 2021.2.03 (1 BFS banded) 2021.2.04 (3 BFS banded) 2021.2.05 (1 BFS banded) 2021.2.10 (1 BFS banded) 2021.2.19 (2 BFS banded) 2021.2.24 (2 BFS banded) 2021.2.27 (2 BFS banded)

Note: 16 surveys were conducted in 2021 spring, including 7 surveys that were not able to conduct in 2020 Fall. Only 5 surveys were carried out in 2021 Fall due to unfavorable sea condition,.

1.4 Survey Method

1.4.1 Marine Radar Survey combined with Visual Survey from a Fixed Position

In the Project, marine radar survey and visual survey from a fixed position will be conducted simultaneously. In every survey, vessel will stay at the same location for a continuous 24 hours. Daytime (adjusted according to the time of sunrise and sunset and the brightness on-site) visual survey and 24-hour radar survey will be conducted. Survey location is shown as Figure 1.4.1-1.

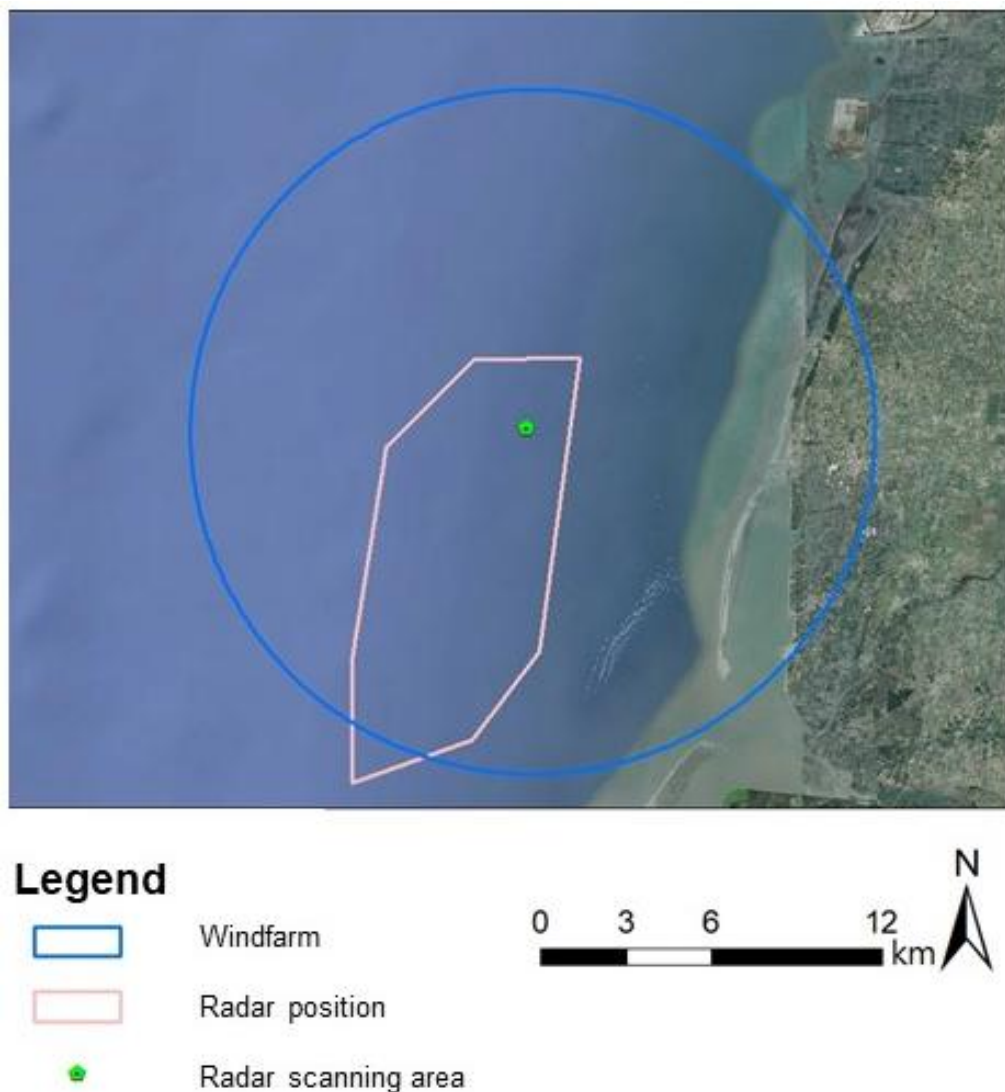


Figure 1.4.1-1 Survey Location of Marine Radar Survey combined with Visual Survey from a Fixed Position for BFS

According to satellite tracking results on BFS wintering in 2012-2018 conducted by teams from Taiwan and Korea, it is estimated that about 2,785 BFS will winter in Taiwan in 2020, approximately 428 BFS among them may pass through Yunlin wind farm. Among the 428 BFS, 65.4% would fly within the height of WTG sweeping zone.

BFS migrates in groups of an average of 21 birds. Thus, it is estimated that migratory route of 20.4 flocks ($=428/21$) will pass the wind farm during BFS main migratory season (Sep.-Nov. and Mar.-May, 183 days in total) each year. That means it will take on average 8.9 days ($=183 \text{ days} / 20.4 \text{ flocks}$) for a boat-based surveyor to spot a BFS flock. Survey frequency is planned according to the above data.

Survey methods for marine radar survey combined with visual survey from a fixed position are described as follows.

I. Marine radar survey from the anchoring vessel at a fixed position

Radar survey has been used for a long while among scholars in tracking bird activities. Since 1960s, many scholars have used low power radar devices that were originally attached on vessels or aircrafts to track bird activities (Casement, 1966; Graber and Hassler, 1962). Afterwards, low power (5-25 kW) vessel radars were frequently used in investigating patterns of bird migrations or influence on bird activities caused by large artificial facilities such as wind farm, cable and bridge (Desholm et al., 2006; Kahlert et al., 2004). The radar is also used in environmental monitoring in airport to reduce the risk of bird collision on aircrafts by previous warning. It is further applied in instant operating management to reduce bird collision on wind turbine.

Common low power radars can detect activities of bird in near distance. Radar with higher power can detect activities of birds that are 100km away (Desholm et al., 2006). Comparing to visual survey, distance of radar survey won't be restricted greatly by poor source of light at nighttime. Further, electromagnetic wave sent by radar will not influence flying behaviors of the birds (Bruderer et al., 1999). As a result, radar serves as a supplement to

visual survey in observing birds that migrate during nighttime.

1. Regulation of the Radar

Regulation of the radar is shown as Table 1.4.1-1.

Table 1.4.1-1 Radar Specification

Frequency Band	X-band
Power	25 kW
Length of the Antenna	6 foot
Maximum Range	96 Nm

2. Radar scanning

During the survey, radar system will be installed on the vessel (Figure 1.4.1-2) to record the return waves for clarification of bird flying routes.

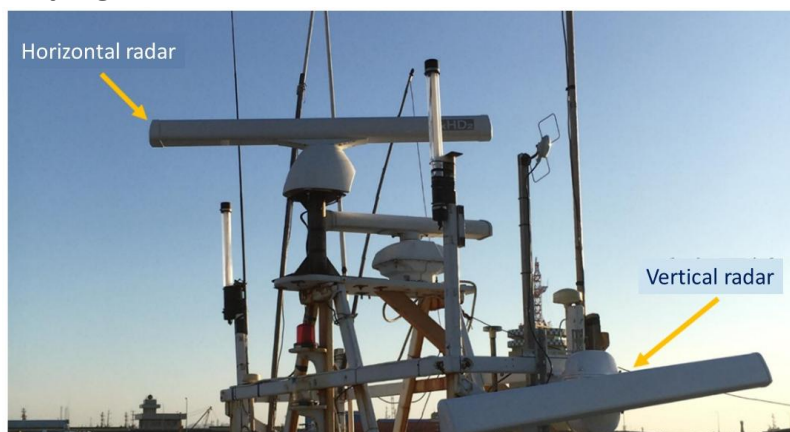


Figure 1.4.1-2 Radar Antenna Installed on the Vessel

3. Analysis of Flying Track

Observers will record bird flying activities captured on the radar return graphics, use GIS to mark coordination of spotted birds, calculate continuing location during flying, present the location in GIS system by layers, and present the information on map to clarify the connection between bird flying route and the targeted area. Radar return map is shown as Figure 1.4.1-3.

4. Survey method and recording method of radar survey are decided

referring to StUK 4 technical instruction (BSH, StUK 4, 2013). Settings and operation of horizontal and vertical radar are shown as Table 1.4.1-2.

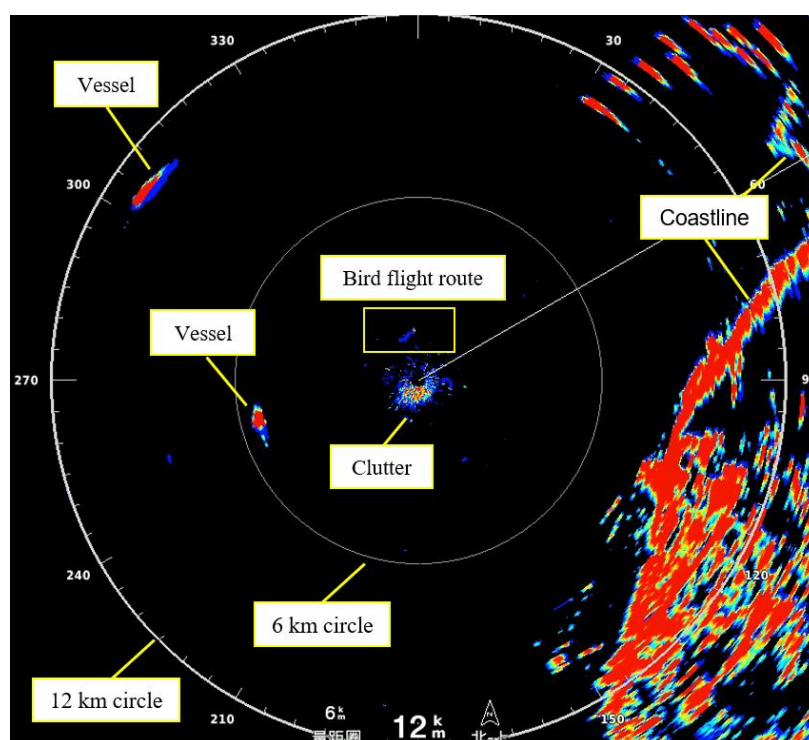


Figure 1.4.1-3 Instruction of Radar Return Map

Table 1.4.1-2 Survey Methods for Horizontal and Vertical Radar

	Horizontal Radar	Vertical Radar
Goal	Estimation of migration flying route and time distribution of activities.	Estimation of migration intensity, flight altitudes, and time distribution of activities. Quantification of flight intensity* of birds in 50-m groups up to flying altitude at 2,000 m. *Number of birds per unit height
Limitation	Wind under 4 Bft and wave height under 1 m	
Radar Regulation	25 kW output, a vertical beam width of 20° to 25°, a horizontal beam width of 0.9° to 1.2° and a transmission frequency of about 9.4 GHz (X-band radar) with 6 feet antenna.	
Operation Range	12 km	2 km
Others	- Without filter for sea clutter (SEA) and rain (RAIN). The radar device setting will be identical throughout the entire assessment period. - The raw data of radar recorded is stored in flash drive and brought back to the office for analysis.	

II. Marine visual survey from the anchoring vessel at a fixed position:

1. To conduct visual surveys, 2 visual observers will be equipped with binoculars and a digital camera with an equivalent focal length of 500 mm or more.
2. Recording methods will follow StUK 4 technical instruction (BSH, StUK 4, 2013), explanation is as follows:
 - (1) Observer will record species and number of birds sighted in an angular field of view extending from the horizon to 45° up to 1.5 km in distance (Binoculars with 10x magnification). Undetermined birds will also be recorded (e.g. as pipit spec. or grey geese). In addition, birds > 1.5 km distance will be recorded in a separate genre.
 - (2) If bird activity is sighted, observers should record the species, distance, flying altitude and flying pattern of the birds, as well as their species, number, relative ages and feather (plumage & moult). Distance of resting bird is indicated by 5 levels, which are 0-50 meters, 50-100 meters, 100-200 meters, 200-300 meters and 300 meters or higher. Flying altitude of flying birds are indicated in 7 levels, which are 0-5 m, 5-10 m, 10-20 m, 20-50 m, 50-100 m, 100-200 m and > 200 m.
 - (3) Counting intervals are adopted. Visual observers will record every 15 minutes. Individual events such as bird sightings within the 15-minute intervals will be recorded separately.
 - (4) The assignation of flight direction data must be detailed as 45° (N, NE, E, SE, S, SW, W, NW).

III. Marine radar survey combined with visual survey from a fixed position

In daytime, bird activity will be monitored and recorded simultaneously by the visual observer and the radar operator. The radar operator and the visual observer will keep in contact. If the visual observer spots BFS, the radar operator will continue tracking the BFS. This is to prolong the tracking

distance as far as possible so that complete migratory routes of BFS inside and around the wind farm can be presented. Radar survey will be continued at night to accumulate the bird data inside and around the wind farm area. This survey will require long-term observation and coordination. Shift schedule and recording methods are summarized as Table 1.4.1-3.

Table 1.4.1-3 Shift arrangement of surveyors in this project

Item	Shift arrangement and recording
Visual observer	• In the survey period, 2 personnel will conduct the visual survey in shifts. Only 1 main surveyor will carry out the observation at a time. • During the observation, a 15-minute rest will be taken every 15 minutes to avoid visual fatigue.
Radar operator	• In the survey period, 2 personnel will conduct the visual survey in shifts during daytime. The operators will stay in contact with the visual observers. Only 1 main radar operator will carry out the observation at a time. • During the observation, a 15-minute rest will be taken every 15 minutes to avoid seasick owing to visual fatigue

1.4.2 Satellite Tracking Survey

The habitat of BFS during the winter mainly includes aquaculture fish farms, abandoned salt fields, estuaries, grass swamps and et cetera. For BFS wintering in Taiwan, around 70 % winter in Tainan, 26% winter in Chiayi, < 10% winter in Qieding, Kaohsiung, and the remaning BFS are scattered around other areas (Dong Hui, Kuo 2016). The eBird Taiwan database shows the largest number of BFS distributed in various areas in a single day (as shown in Figure 1.4.2-1). For the Yunlin project, satellite tracking for BFS will be 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 BFS

In 2002-2003, mass mortality of BFS caused by botulism infection

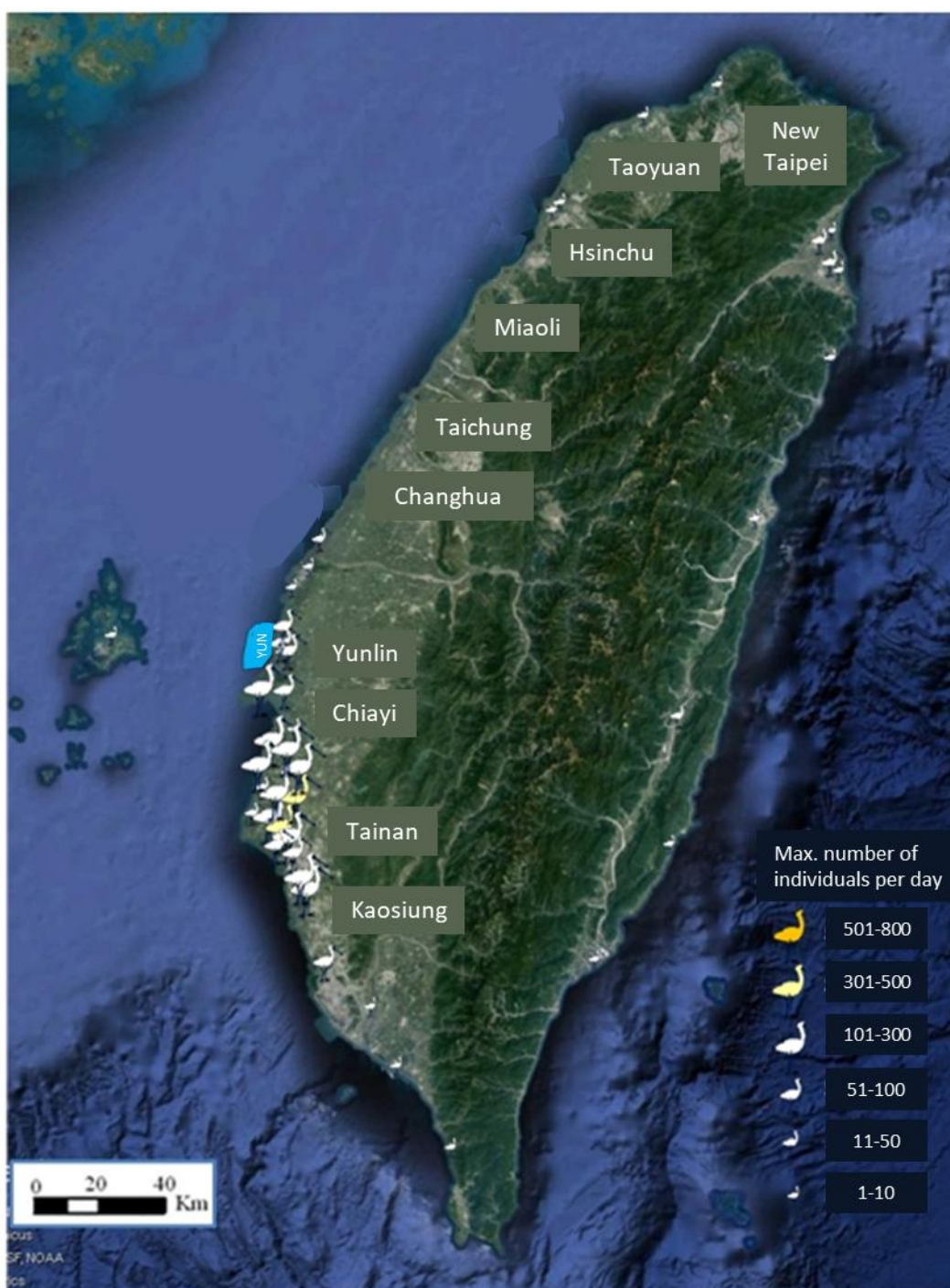
occurred in Tainan during BFS's wintering season in Taiwan. Since then, Tainan City Government has been cooperating with non-governmental organizations in developing a BFS rescuing process that includes BFS rescuing tasks and habitat maintenance carried out every year. If BFS with suspected Botulism infections is spotted by bird lovers, wildlife preservation organizations or patrol, the individual will be sent to an animal hospital for treatment, and 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, it will be released in its original habitat.

To reduce the chance of frightening BFS when they are captured by foot-snare during banding operations, the Project will primarily use rescued BFS for banding as suggested by experts in this program. After being assessed as "fully recovered" by the Endemic Species Research Institute, Council of Agriculture, Executive Yuan, the rescued individuals will be banded with a transmitter and released in their original habitat.

II. Setting Foot-snare –Banding of captured BFS

Foot-snare method will be deployed at BFS foraging sites. This trap is made up of about 200 snares (15 cm in diameter) tied onto a 20 m rope (Figure 1.4.2-2). Both ends of the rope are fastened to an iron bar that is plugged into shallow water. 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 the satellite tracking in the Project. The transmitters can provide positioning spots in a 1-hour interval. Each positioning spot will include coordinate, altitude, and speed. The interval can be tuned into 20-second when bird stays aloft and with sufficient battery power. Lifespans of the transmitter is generally ≤ 3 years.



Source of data: eBird Taiwan (2019.12-2020.2)

Figure 1.4.2-1 Distribution Map of BFS in Taiwan (2020)



Figure 1.4.2-2 Example of Foot-snare Trap

1.5 Operation Process of QA/QC

1.5.1 Marine Radar combined with Visual Survey from a Fixed Position

To ensure the accuracy and integrity of survey data quality, the following quality assurance and quality management measures are made to be the operation principles for QA/QC. The flowchart is shown in Figure 1.5.1-1.

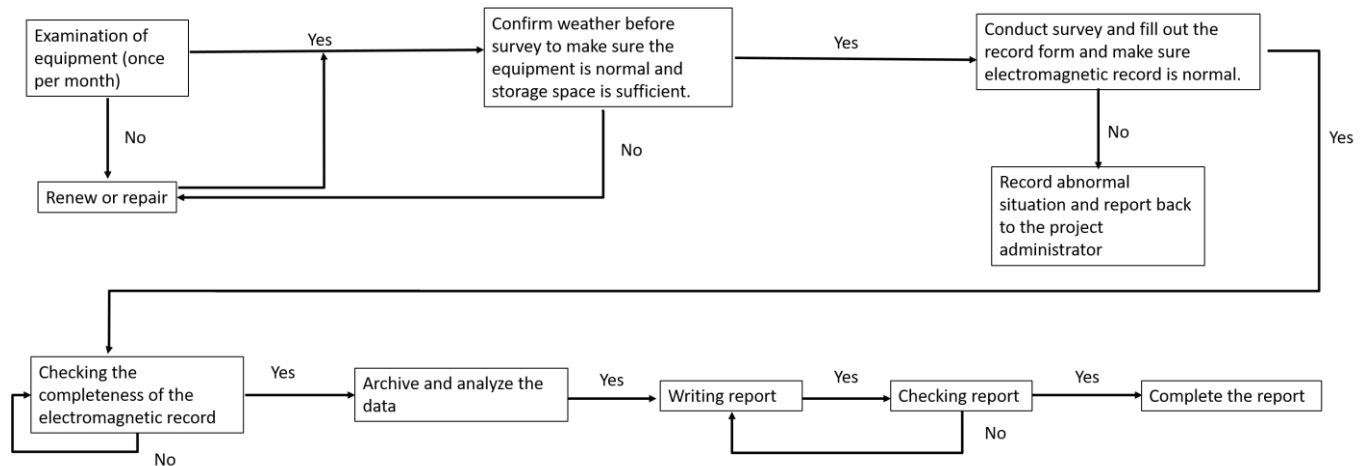


Figure 1.5.1-1 Work procedure of this project

The operation principles are described as follows:

I. Personnel training

1. All crews of survey shall be eligible for the qualifications regulated by relevant government authorities.
2. The company shall hold regular safety seminars to raise the safety awareness of working environment.
3. The company shall hold regular educational training to cultivate the professionalism in crews.
4. Single/individual operation is strictly prohibited to avoid absence of assistance under emergency situations.
5. Prior to conducting surveys, operators of electronic equipment shall complete the complete training of company and pass evaluation.

II. Facility maintenance

1. Thoroughly check the equipment once per month to ensure the availability.
2. Prior to every trip, inspect equipment and prepare spare part. If any equipment is damaged, repair and complete procurement before trips.
3. Check the equipment promptly before using it. Replace it with spare parts if any equipment is damaged.
4. All the ship-borne equipment shall be aware of salinity and corrosion problems to avoid malfunction of electronic equipment and shortening of service-life.

III. In-situ survey and data storage

1. Prior to the field survey, confirm the weather condition of the operation day.
2. Arrange crew schedules.
3. Inspect and confirm the conditions of equipment.
4. Confirm the conditions of record sheets and electromagnetic recording devices.
5. Properly label the samples of each survey. Number of each sample shall be labelled after arriving at the sampling station to prevent mistaken labelling.
6. Record the environment status via camera. If any special circumstances occur, record it and report to relevant supervisors.
7. When staying at a fixed position for a long time, be aware of the movements vessels nearby to prevent accidents and collisions.
8. After completion of a survey, promptly fill in the record sheet.
9. For sample of electronic recording, promptly examine the integrity of data after completion of a survey.

10. After completion of a test, keep the record sheets and equipment according to regulations.

IV. Data analysis

1. Data transfer

- (1) After returning to the laboratory, the analysts shall promptly transfer the data.
- (2) Mobile electromagnetic data shall be promptly transferred into designated disk arrays.
- (3) Paper form data shall be scanned, achieved and saved.

2. Data analysis

- (1) Analysts review the rationality of survey parameters based on weather conditions.
- (2) Decode the electromagnetic data by specific programs.
- (3) Analyzing electromagnetic data hour by hour, record time, coordinates, wind speed and wind direction at each location.
- (4) Create tables for analyzed data.

3. Data review

The analysts shall review the electromagnetic data with handwritten records for reference and confirmation.

V. Data analysis and report writing

1. Data compilation and analysis statistics

- (1) While archiving the data, the format (including unit) shall be consistent for better analysis, report writing and lesser errors.
- (2) After compiling the data, select the part with significant difference from all data and examine again. Label it after confirming with the data in order to help report writers to have better interpretation.
- (3) All data sets shall be examined and signed by two personnel or above and keep more than two back-up copies.

2. Report writing

- (1) Take note of word choice and consistency of format to avoid influential description.
- (2) Except for self-checking after completion of report writing, it shall be reviewed by two persons and above to avoid careless mistakes and errors in reports.

1.5.2 Satellite tracking

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

Personnel will take photo and measure the body of the captured birds (as shown in appendix 2.3). The birds will be banded with satellite transmitters of different types, depending on their weight (weighting $< 3\%$ of the bird's weight) and set free on-site. BFS are birds weighting over 500 g, thus GSM/GPS transmitter Debut Lego [3G] (Druid Technology, Inc.), weighting 22 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 can provide positioning spots in a 1-hour interval. Each positioning spot will include coordinate, altitude, and speed. The interval can be tuned into 20-second when bird stays aloft and with sufficient battery power. Lifespans of the transmitter is generally ≤ 3 years.

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 actual altitude.

Chapter II Analysis of survey results

2.1 Marine Radar Survey Combined with Visual Survey from a Fixed Position

Marine radar combined with visual survey from a fixed position were conducted 5 times in Fall 2021 (September-November), monitoring location is shown in Figure 1.4.1-1; survey time and date this season is shown in Table 2.1-1.

Table 2.1-1 Survey Time and Date in Fall 2021

Season	Survey	Survey Items	Survey Time and Date
2021 Fall	1 st	Offshore radar	29 Sep. 10:51– 30 Sep. 10:55
		Set visual survey	29 Sep. 11:00–18:00 30 Sep. 5:50– 10:50
	2 nd (Rain)	Offshore radar	30 Sep. 10:56–1 Oct. 11:00
		Set visual survey	29 Sep. 11:00–18:00 1 Oct. 5:55– 10:55
	3 rd	Offshore radar	20 Nov. 06:05–21 Nov. 06:10
		Set visual survey	20 Nov. 06:00–18:00
	4 th (Rain)	Offshore radar	28 Nov. 08:53–29 Nov. 08:53
		Set visual survey	28 Nov. 09:00–18:30 29 Nov. 06:30–8:30
	5 th	Offshore radar	29 Nov. 08:55–30 Nov. 08:55
		Set visual survey	29 Nov. 09:00–18:30 30 Nov 06:25–08:25

Note 1: “Rain” indicates that rainfall was recorded on the survey day. Weather in 12:00-12:16 in the second survey was drizzle, Weather in 14:45 – 15:13, 17:26 – 17:49 and 18:18 – 20:08 in the fourth survey was shower.

Note 2: The time for visual survey is adjusted according to the time of sunrise and sunset as well as the brightness on-site.

I. Environmental data from onsite surveys

Precipitation were recorded in the second (September 30) and the fourth (November 28) surveys. The third radar survey began at 6:05, the largest

wind velocity recorded during bird activity was recorded at 14.5 m/s, sea state reached “rough sea” conditions; the fourth radar survey began at 8:53, the largest wind velocity recorded during bird activity was recorded at 14.0 m/s, sea state reached “rough sea” conditions; the thirteenth radar survey began at 8:55 hr, the largest wind velocity recorded during bird activity was recorded at 14.0 m/s, sea state reached “rough sea” conditions. The detailed information is as shown in Table 1 Raw Data for Horizontal Radar, Appendix 2.2.

II. Visual survey from the anchoring vessel at a fixed position

(1) Recorded species

In total, 99 individuals were recorded during the visual survey from a fixed position, as shown in Table 2.1-2. A total of 7 species were recorded, with Cattle egret contributing the most individuals (n= 66) and 1 protected species was recorded, no BFS was recorded.

Table 2.1-2 Resource Table of Visual Survey from a Fixed Position

Order	Family	Species	Scientific Name	Protected Level*	Migratory Habit in Taiwan**	2021			Total
						Sep.	Oct.	Nov.	
Pelecaniformes	Ardeidae	Cattle egret	<i>Bubulcus ibis</i>	-	R, S, W, P	66	-	-	66
		Little egret	<i>Egretta garzetta</i>	-	R, S, W, P	16	-	-	16
Charadriiformes	Laridae	Whiskered tern	<i>Chlidonias hybrida</i>	-	W, P	8	-	-	8
		Greater crested tern	<i>Thalasseus bergii</i>	II	S	1	-	-	1
		European herring gull	<i>Larus argentatus</i>	-	W	-	-	1	1
Procellariiformes	Procellariidae	Bulwer's Petrel	<i>Bulweria bulwerii</i>	-	Sea	-	-	2	2
	Scolopaciidae	Red-necked phalarope	<i>Phalaropus lobatus</i>	-	P	-	-	5	5
Total (Individuals)						91	-	8	99

Note 1: Protected level “II” indicates rare and protected wildlife.

Note 2: The migratory habit in Taiwan is referenced from the 2020 edition of the Taiwan bird directory announced by the Taiwan Wild Bird Federation. Nature of migratory birds in Taiwan, “W” indicates winter migrant, “S” indicates summer migrant, “Sea” indicates sea birds, “R” indicates resident, “P” indicates passage bird.

Note 3: “-” indicates no data was recorded.

(2) Flying altitude recorded during visual surveys

In regard to flying altitude, all individuals were recorded during visual survey, and the corresponding flying altitudes are as shown in Table

2.1-3. Flying altitude of most birds recorded in this season were between 0-5 m (89 individuals). No individual was observed flying above 20 m.

(3) Bird activity per hour recorded during visual surveys

According to StUK 4 guidelines, the offshore bird activity per hour in this season can be calculated from the survey duration of each visual survey (Table 2.1-1), and the result is 1.6500 individuals/hr as shown in Table 2.1-4.

Table 2.1-3 Flying Heights Recorded in Visual Survey from a Fixed Position

Order	Family	Species	Altitude (m)				Total
			0-5	5-10	10-20	20-50	
Pelecaniformes	Ardeidae	Cattle egret	66	-	-	-	66
	Ardeidae	Little egret	16	-	-	-	16
Charadriiformes	Laridae	Whiskered tern	-	-	8	-	8
	Laridae	Greater crested tern	1	-	-	-	1
	Laridae	European herring gull	-	-	1	-	1
Procellariiformes	Procellariidae	Bulwer' s Petrel	1	1	-	-	2
Charadriiformes	Scolopacidae	Red-necked phalarope	5	-	-	-	5
Total (Individuals)			89	1	9	0	9

Table 2.1-4 Bird Activity Per Hour of Fixed Position Visual Survey

Order	Family	Species	2021 Fall			Bird activity per hour
			Sep.	Oct.	Nov.	
Pelecaniformes	Ardeidae	Cattle egret	2.7500	-	-	1.1000
		Little egret	0.6667	-	-	0.2667
Charadriiformes	Laridae	Whiskered tern	0.3333	-	-	0.1333
		Greater crested tern	0.0417	-	-	0.0167
		European herring gull	-	-	0.0278	0.0167
Procellariiformes	Procellariidae	Bulwer' s Petrel	-	-	0.0556	0.0333
Charadriiformes	Scolopacidae	Red-necked phalarope	-	-	0.1389	0.0833
Total (Individuals/hr)			3.7916	-	0.2222	1.6500

Note 1: Bird activity per hour is defined as number of recorded individuals/survey duration of visual survey

Note 2: 24 hrs of visual monitoring was conducted for the 2 surveys in September; 36 hrs of visual monitoring was conducted for the 3 surveys in November.

III. Marine Radar Survey

Radar monitoring includes survey results from horizontal and vertical radars. In fall (2021), 937 flying trajectories were recorded in the horizontal radar; 16,518 flying trajectories were recorded in the vertical radar. As affected by wave condition, horizontal radar recorded less bird activities in the third (November 20th), fourth (November 28th) and fifth survey (November 29th). The number of echoes for each radar survey is shown in Table 2.1-5.

Table 2.1-5 Number of Echoes from Marine Radar Survey

Survey	Date	Horizontal radar recordings	Vertical radar recordings
1 st	2021.09.29-30	221	4,644
2 nd	2021.09.30-10.01	589	4,048
3 rd	2021.11.20-21	44	3,894
4 th	2021.11.28-29	38	1,714
5 th	2021.11.29-30	45	2,218
Total		937	16,518

(1) Flying direction and speed

The flying direction of birds was analyzed using results from the horizontal radar. The main flying direction during the survey period was toward SSW (371 records), which is 39.6% of recorded trajectories by the horizontal radar. The second main flying direction was toward S (195 records), with 20.8% of recorded trajectories by the horizontal radar (Figure 2.1-1). Comparison of daytime and nighttime data indicate that distribution of flying directions did not vary a lot regarding daytime and nighttime, and the main flying directions were toward SSW, accounting for 40.6% and 38.9% respectively (Figure 2.1-2). The flying trajectories recorded during each survey are shown in Figure 2.1-3 to Figure 2.1-7.

Furthermore, the flying speed of birds was also analyzed using results

from the horizontal radar. Speed is susceptible to discrepancies due to seconds of differences when analyzing trajectories with shorter distances. Therefore, only trajectories with more than 1 km of distance is analyzed. There are 936 total trajectories with more than 1 km of distance. The main flying speed of birds is between 11-14 m/s, with 366 (39.1%) total recordings (Figure 2.1-8). The average flying speed this quarter is 11.1 ± 4.5 m/s.

(2) Flying altitude

The flying altitude of birds was analyzed using results from the vertical radar. 16,518 records were recorded in the 5 surveys. Flying altitude of birds during migration appears most frequent above 200 m range (9,201 records), which is 55.7% of total recordings. Distribution of flying altitudes did not vary a lot regarding daytime and nighttime; most birds were recorded above 200 m (daytime 3,227 records, 55.9%; nighttime: 5,974 records, 55.6%) (Figure 2.1-9 to Figure 2.1-11). A total of 7,242 records within the sweeping area (25-200 m) accounts for 43.8% of the total records (Figure 2.1-12) during daytime accounts for 43.8% (2,531 records) of the overall daytime recordings and 43.9% (4,711 records) of the overall nighttime recordings. The average flying altitude this season is 264.8 ± 196.9 m. (Figure 2.1-13).

(3) Time of flying activity

Overall results of the vertical radar survey indicate that flying activity of birds mostly occur during the night. For the vertical radar, flying birds observed between 18:00 to 06:00 (10,742 records) accounts for 65.0% of the overall records (Figure 2.1-14 to Figure 2.1-15). The same is also indicated by results of horizontal surveys, with most recordings occurring during the nighttime, consisting of 60.3% of total recordings (Figure 2.1-16 to Figure 2.1-17).

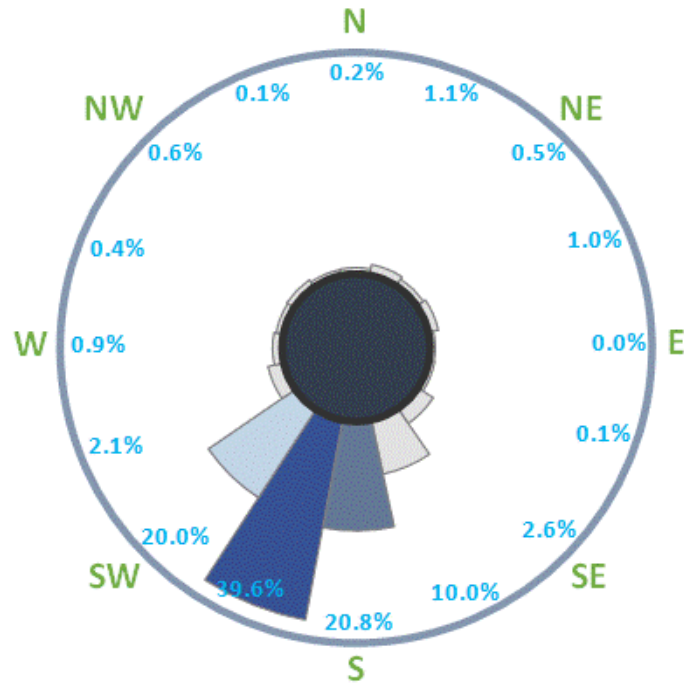
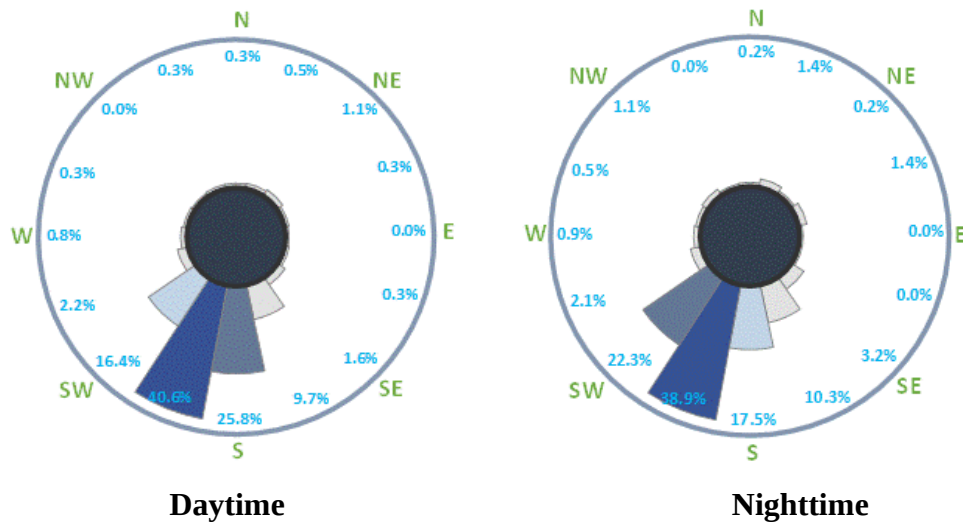
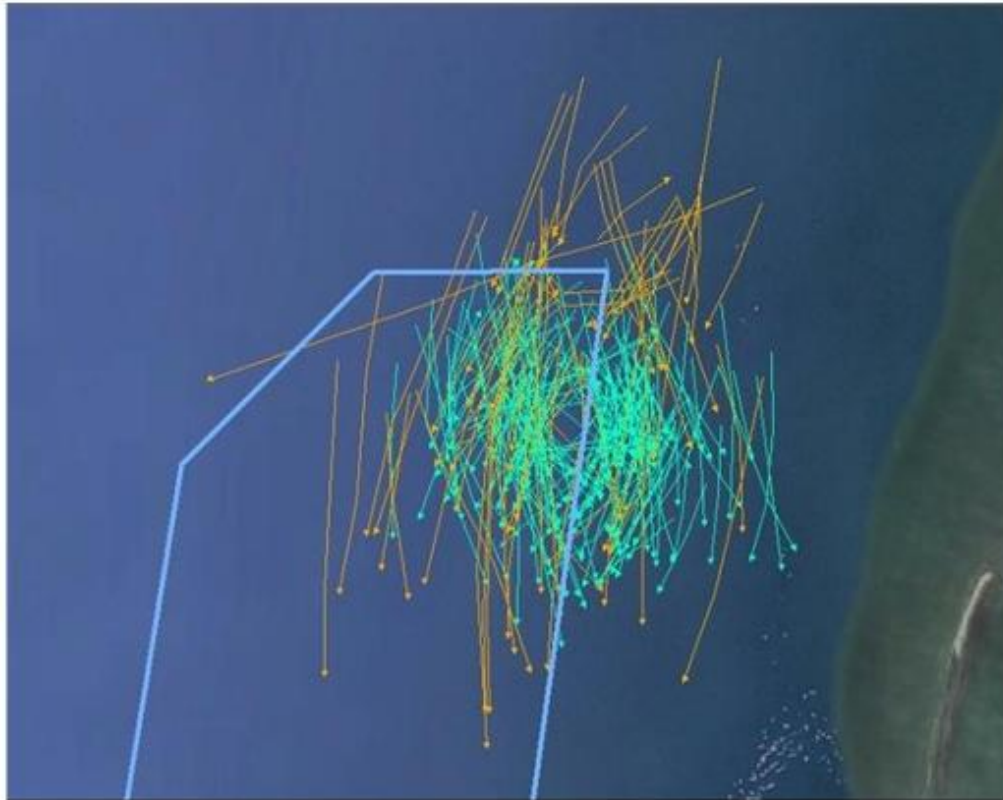


Figure 2.1-1 Bird Flying Direction from Horizontal Radar of the 5 surveys in fall 2021 (24hr)

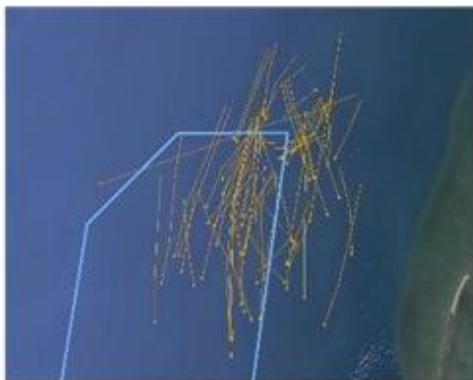


Note: Daytime is from 06:00 to 18:00; nighttime is from 18:00 to 06:00

Figure 2.1-2 Bird Flying Direction during Daytime and Nighttime from Horizontal Radar of the 5 surveys in fall 2021

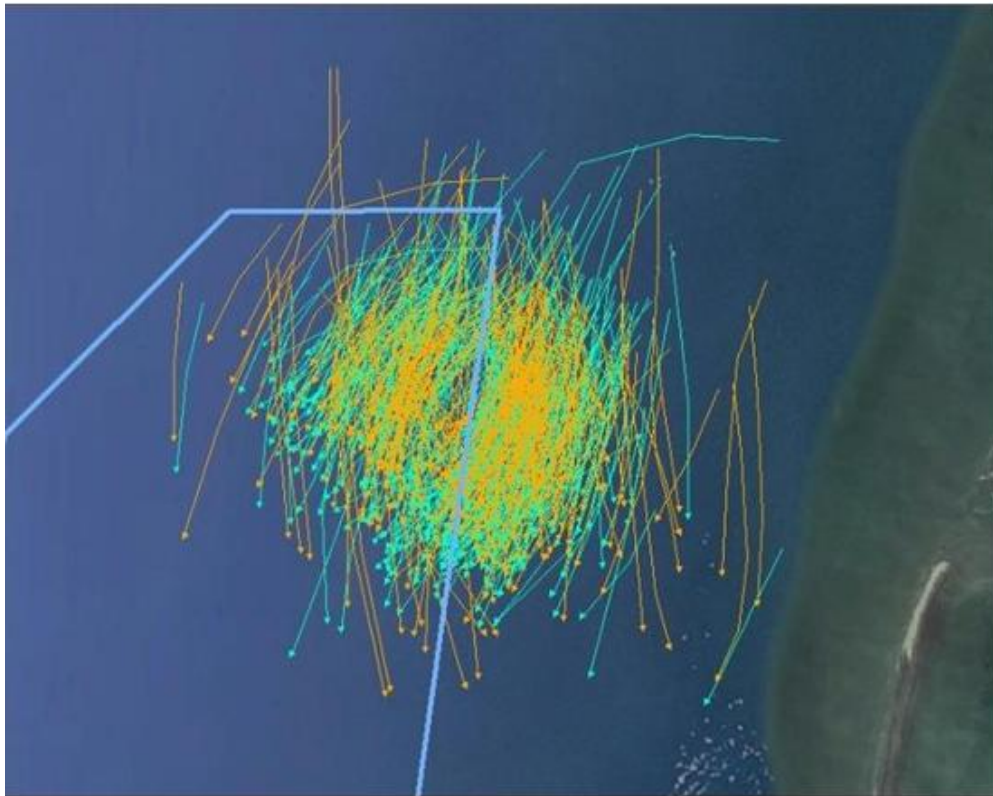


Legend



Note: Daytime is from 06:00 to 18:00; nighttime is from 18:00 to 06:00

Figure 2.1-3 Flying Trajectories from the First Horizontal Radar Survey (Sep. 29)



Legend



Wind farm area

0

1.5

3

6

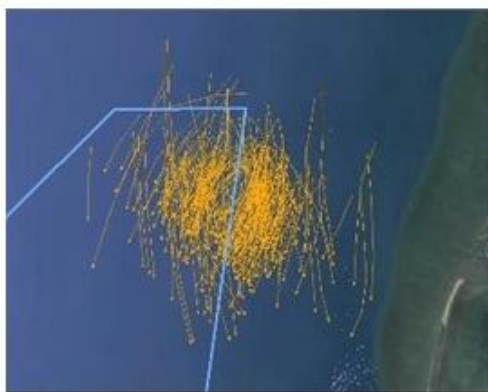
km



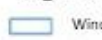
20210930_day



20210930_night



Legend



Wind farm area

1.5

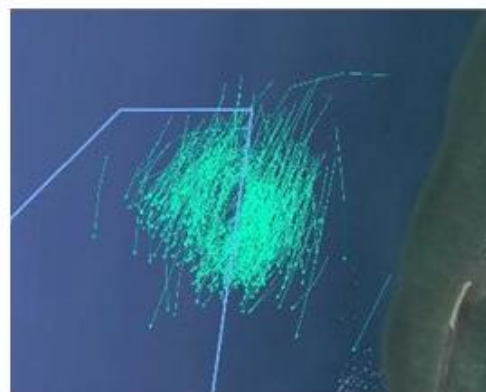
3

6

km



20210930_day



Legend



Wind farm area

1.5

3

6

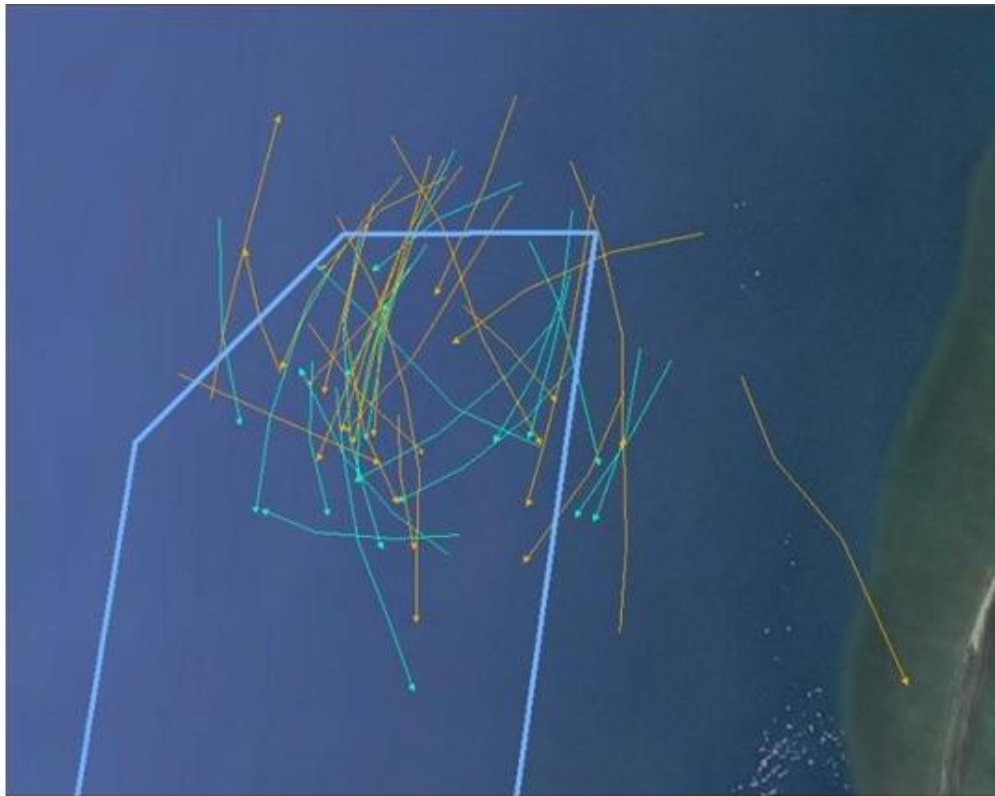
km



20210930_night

Note: Daytime is from 06:00 to 18:00; nighttime is from 18:00 to 06:00

Figure 2.1-4 Flying Trajectories from the Second Horizontal Radar Survey (Sep. 30)



Legend



Wind farm area



20211120_day



20211120_night



Legend



Wind farm area

20211120_day



Legend



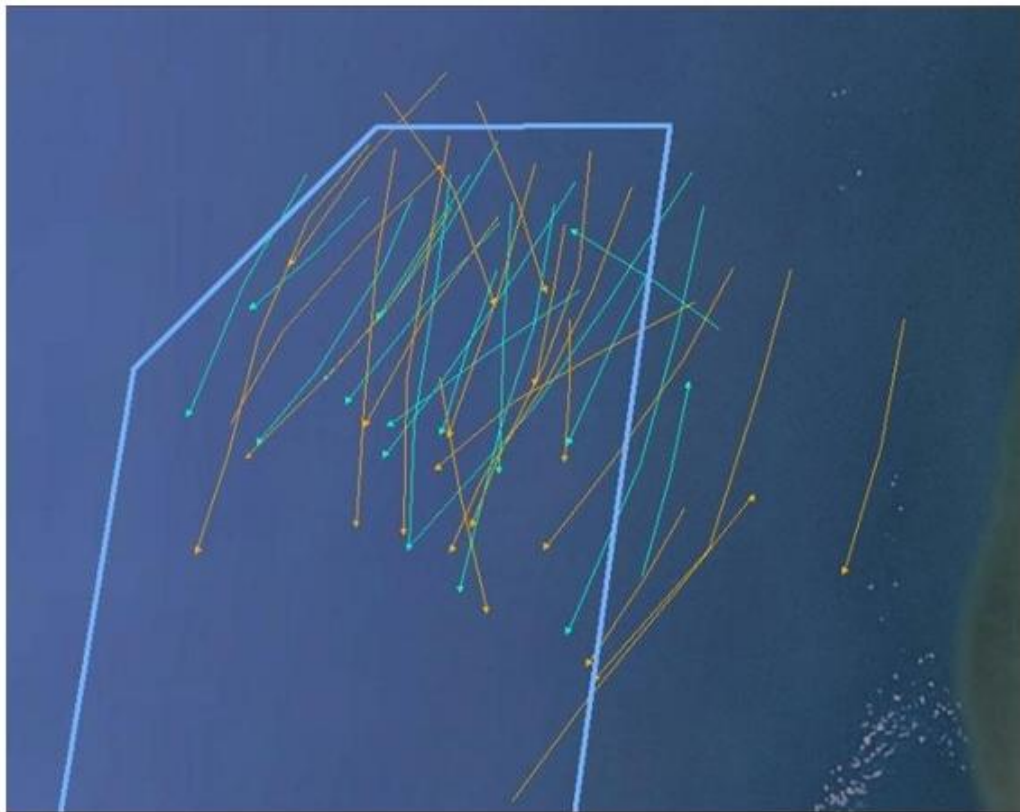
Wind farm area

20211120_night

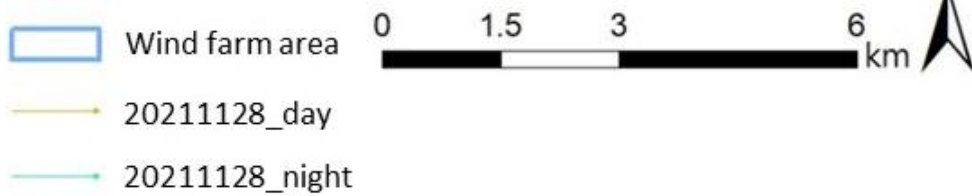


Note: Daytime is between 06:00 to 18:00; Nighttime is between 18:00 to 06:00

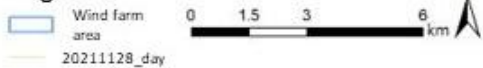
Figure 2.1-5 Flying Trajectories from the Third Horizontal Radar Survey (Nov. 20)



Legend



Legend

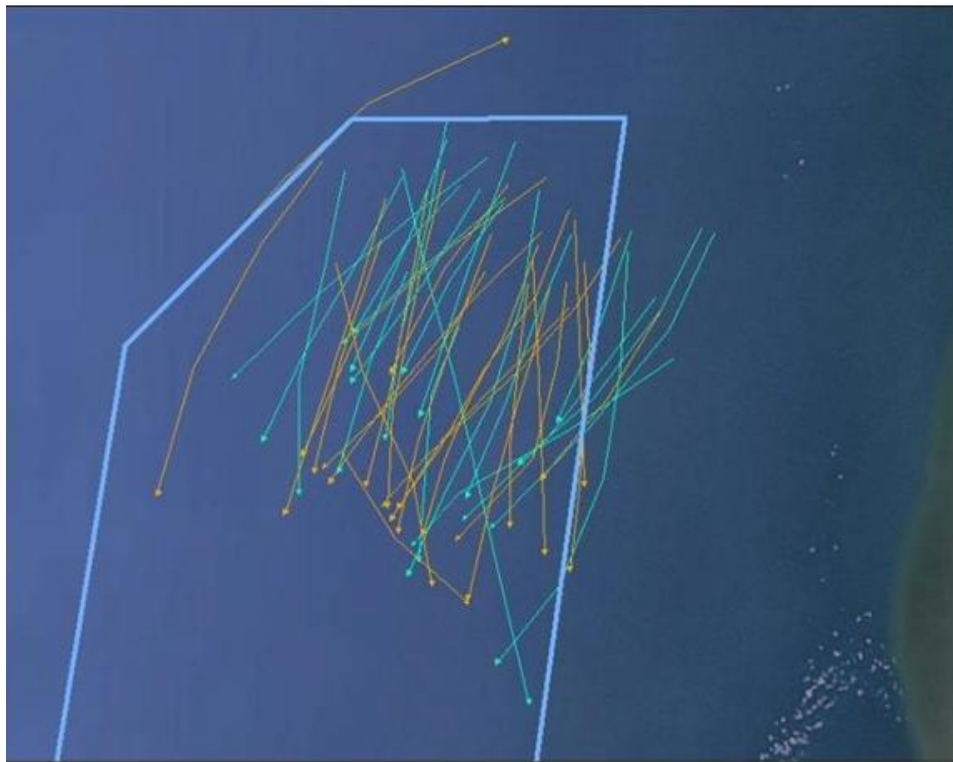


Legend



Note: Daytime is between 06:00 to 18:00; Nighttime is between 18:00 to 06:00

Figure 2.1-6 Flying Trajectories from the Fourth Horizontal Radar Survey (Nov. 28)



Legend

- Wind farm area
- 20211129_day
- 20211129_night



Legend

- Wind farm area
- 20211129_day



Legend

- Wind farm area
- 20211129_night



Note: Daytime is between 06:00 to 18:00; Nighttime is between 18:00 to 06:00

Figure 2.1-7 Flying Trajectories from the Fifth Horizontal Radar Survey (Nov. 29)

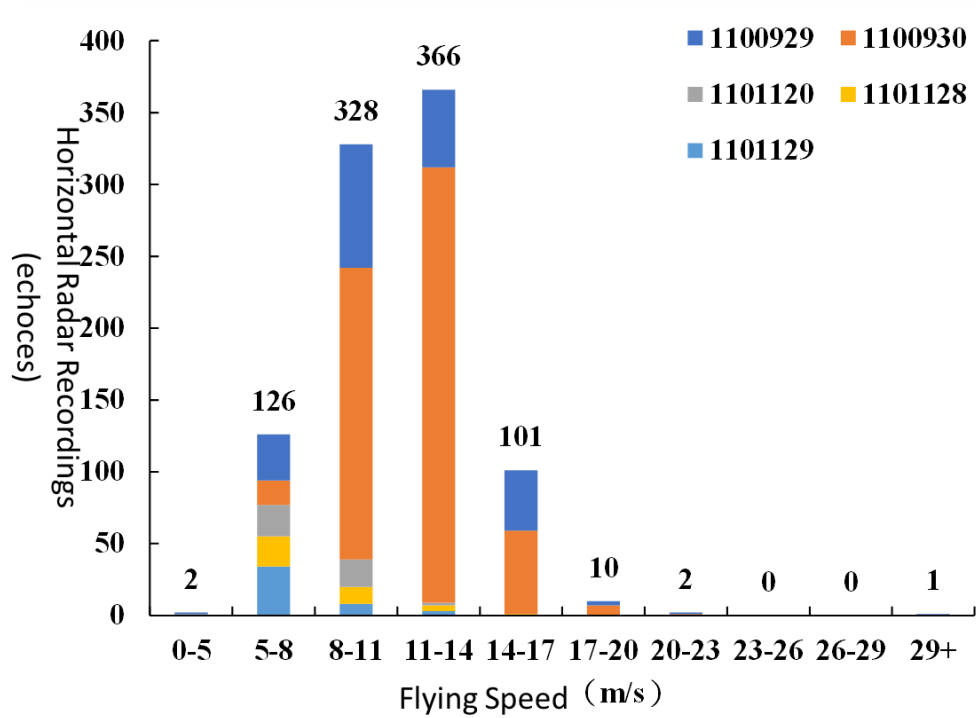


Figure 2.1-8 Flying Speed of Trajectories Over 1 km from Horizontal Radar (Sep. to Nov. 2021)

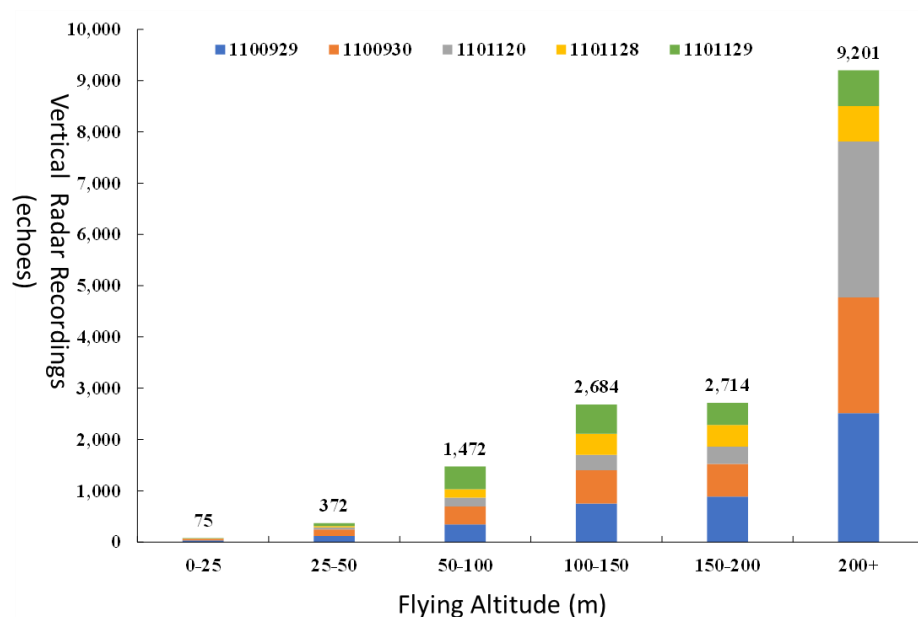
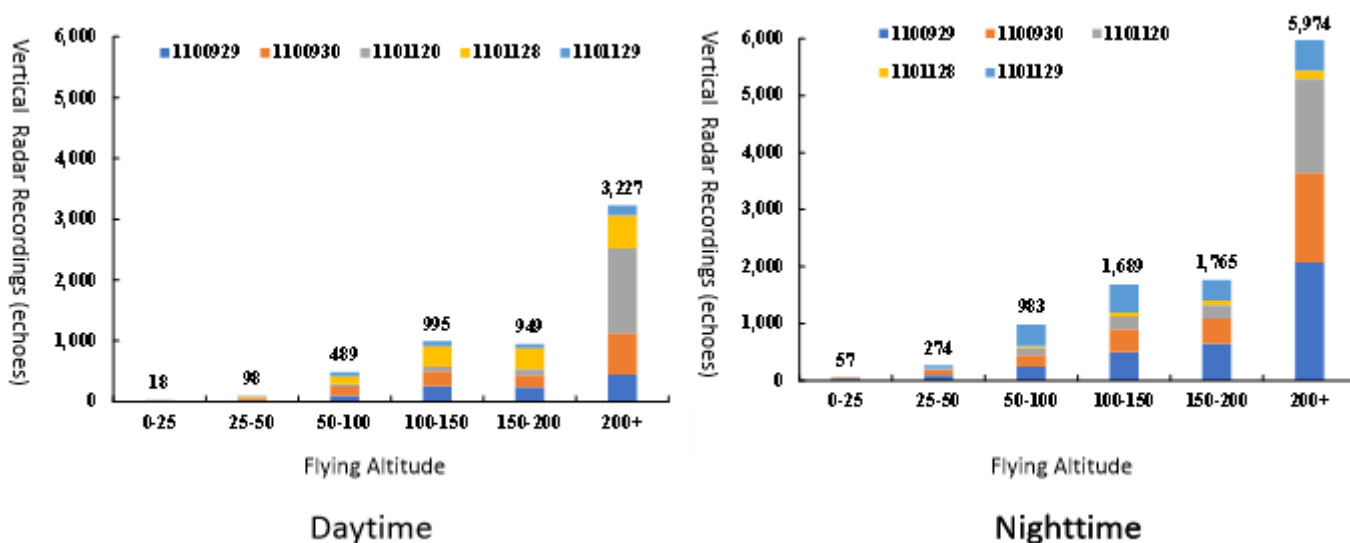
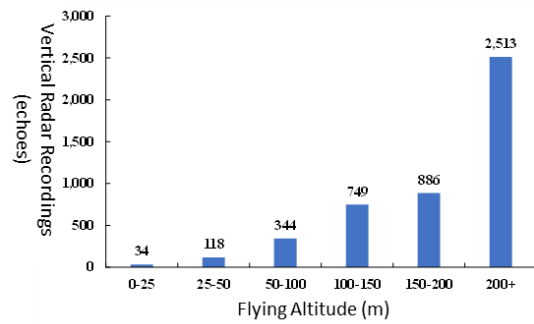


Figure 2.1-9 Altitude Distribution from Vertical Radar (Sep. to Nov. 2021)

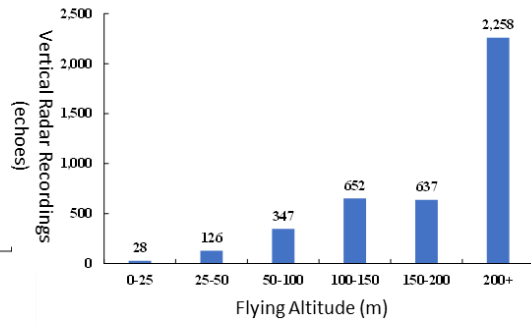


Note: Daytime is between 06:00 to 18:00; Nighttime is between 18:00 to 06:00

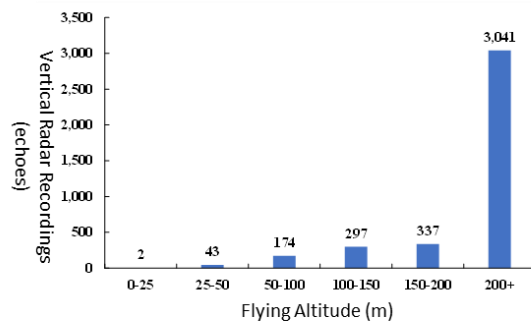
Figure 2.1-10 Altitude Distribution from Vertical Radar during Daytime (left) and Nighttime (right) (Sep. to Nov. 2021)



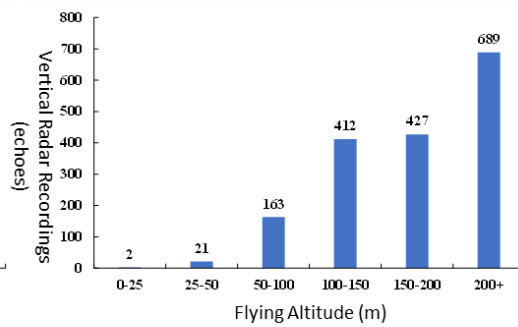
First Survey (2021.09.29)



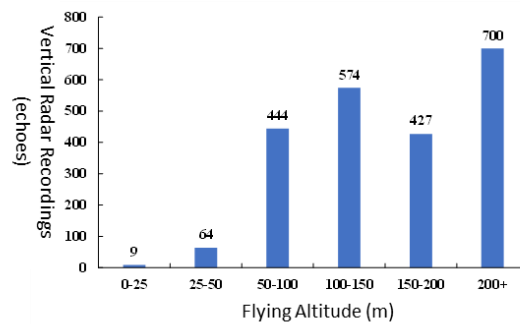
Second Survey (2021.09.30)



Third Survey (2021.11.20)



Fourth Survey (2021.11.28)



Fifth Survey (2021.11.29)

Figure 2.1-11 Altitude Distribution from Vertical Radar (24hrs) in the 1st to 5th Survey (Sep. to Nov. 2021)

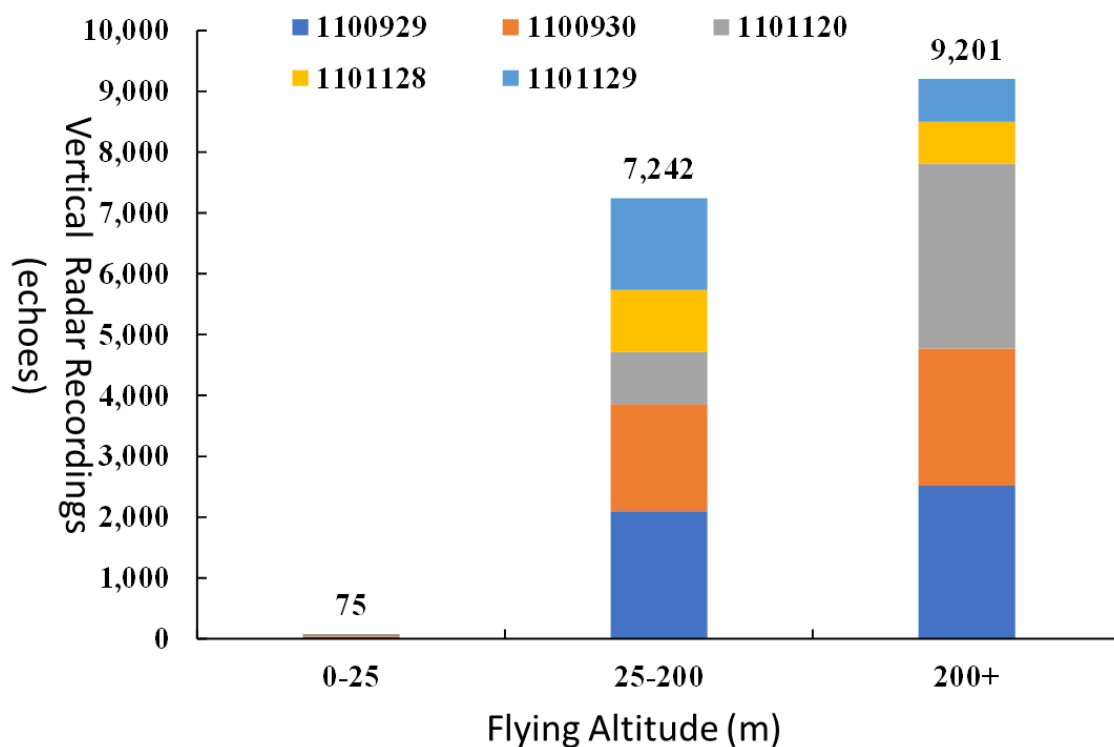
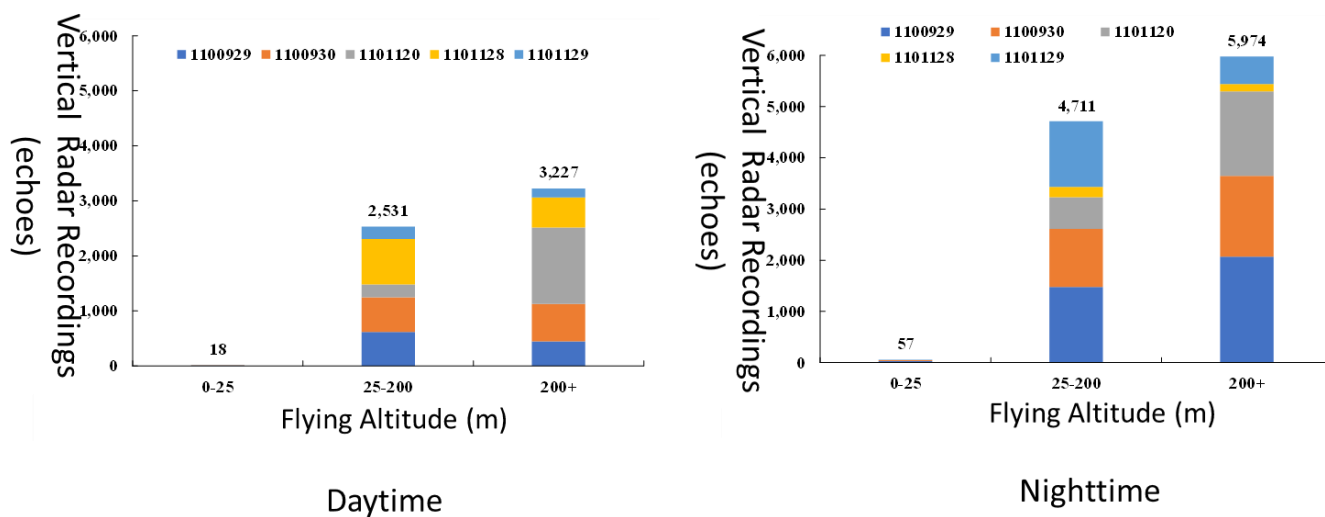


Figure 2.1-12 Altitude Distribution within Sweeping Area from Vertical Radar (24 hrs) (Sep. to Nov. 2021)



Note: Daytime is from 06:00 to 18:00; nighttime is from 18:00 to 06:00

Figure 2.1-13 Altitude Distribution during Daytime (left) and Nighttime (right) within Sweeping Area from Vertical Radar (Sep. to Nov. 2021)

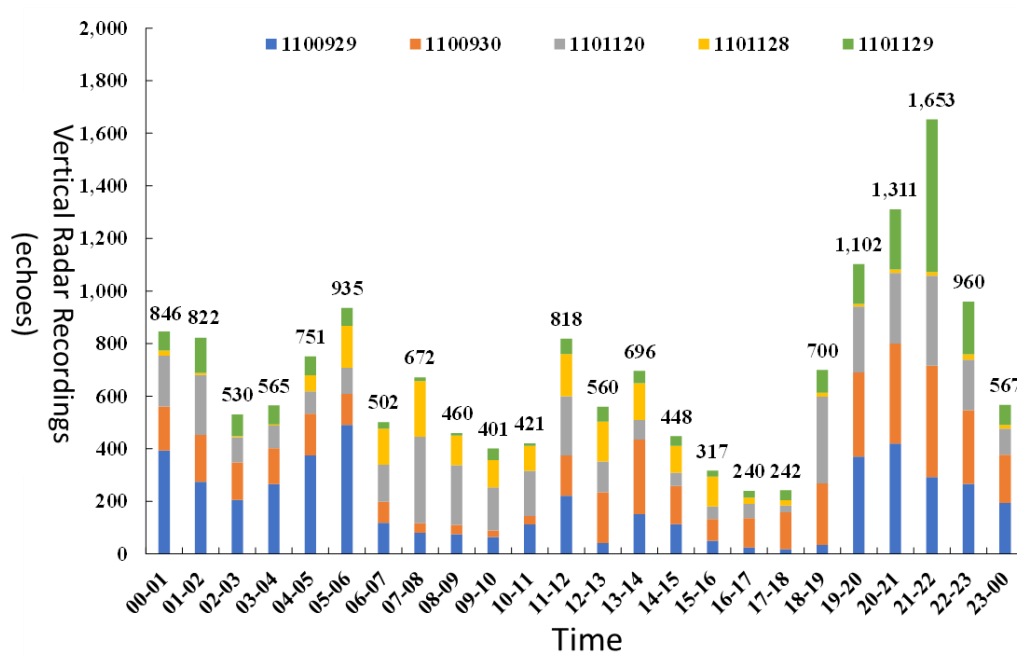


Figure 2.1-14 Time Distribution from Vertical Radar (Sep. to Nov. 2021)

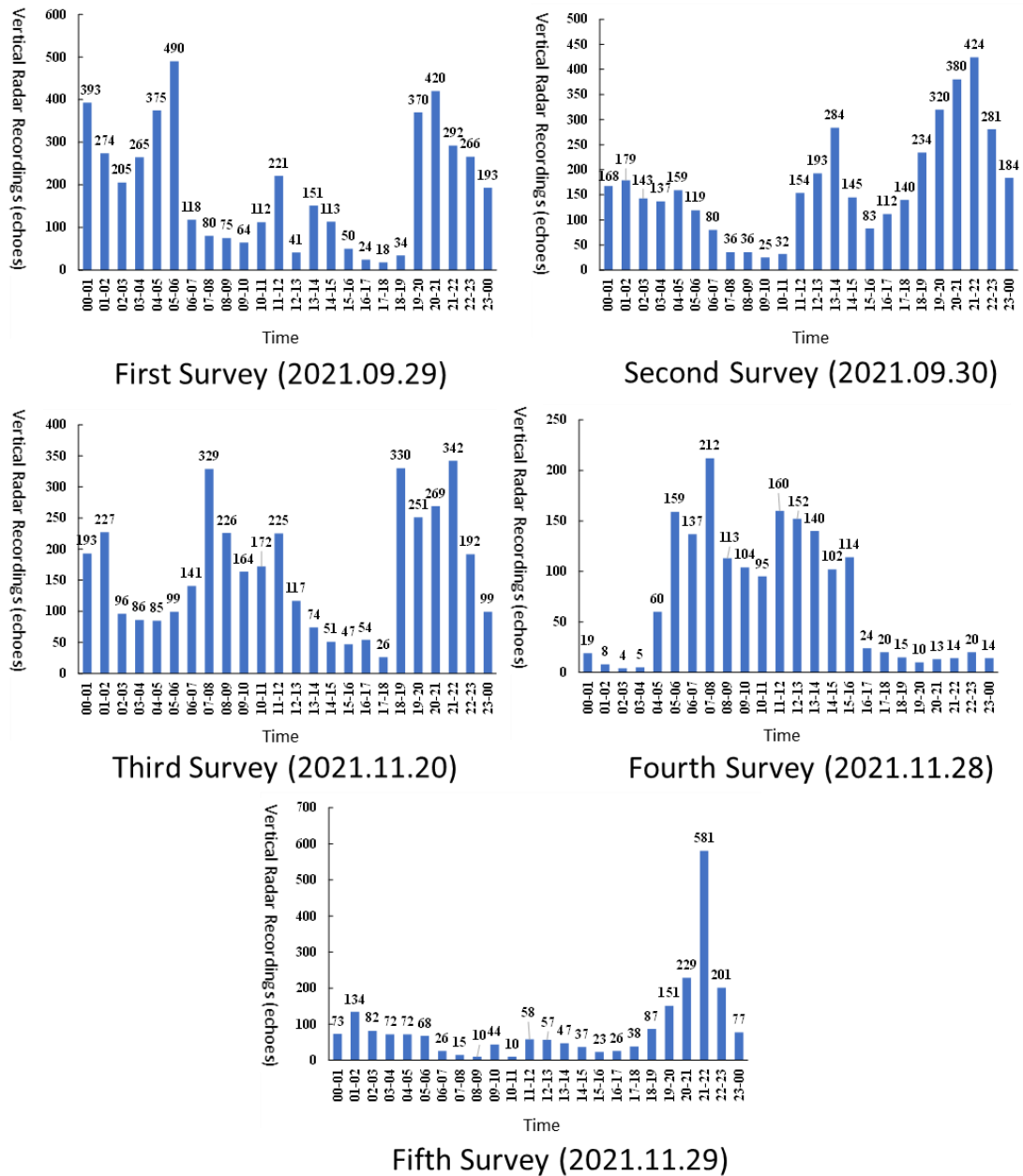


Figure 2.1-15 Time Distribution from Vertical Radar from the 1st to 5th Survey (Sep. to Nov. 2021)

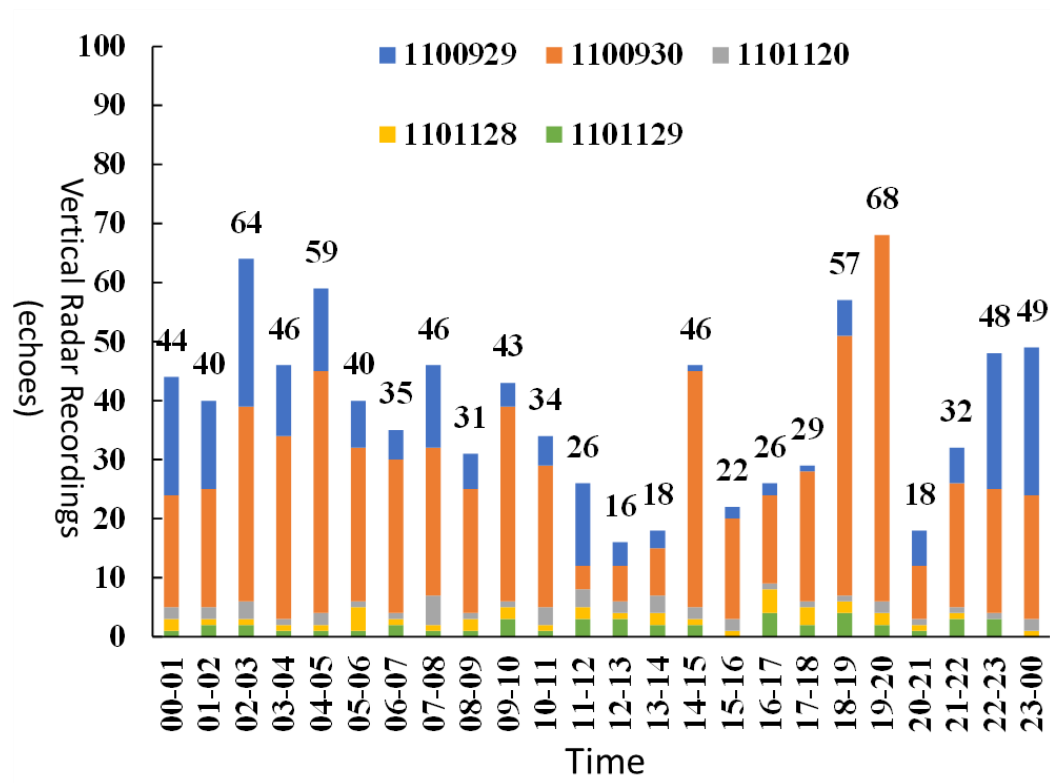
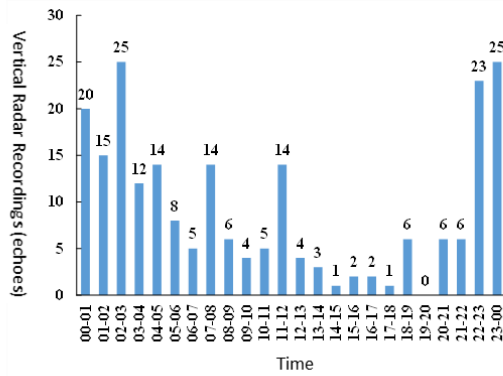
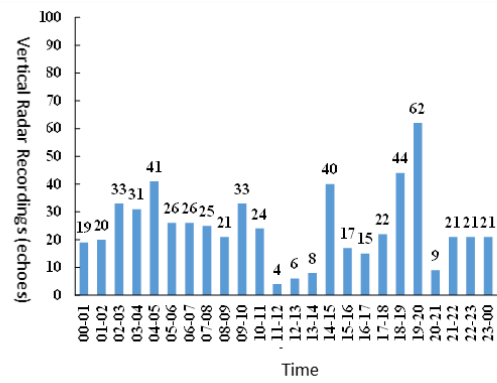


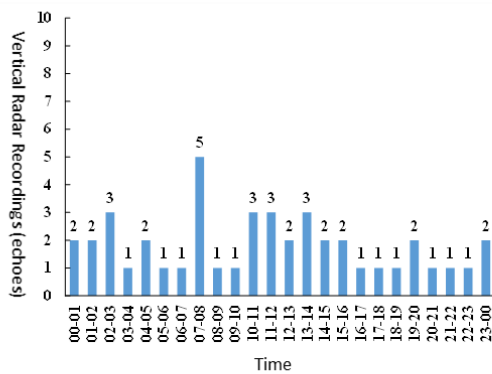
Figure 2.1-16 Time Distribution from Horizontal Radar (Sep. to Nov. 2021)



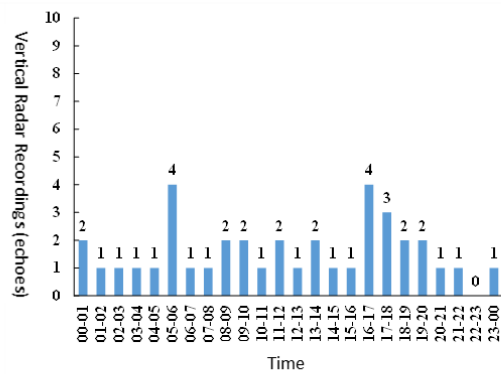
First Survey (2021.09.29)



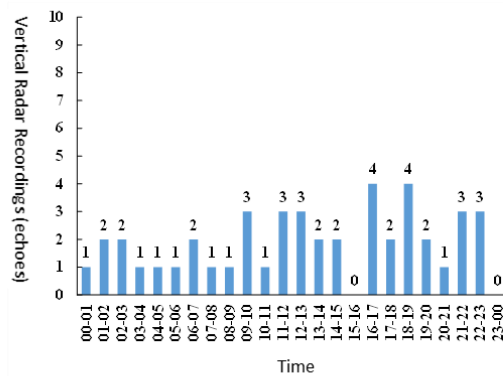
Second Survey (2021.09.30)



Third Survey (2021.11.20)



Fourth Survey (2021.11.28)



Fifth Survey (2021.11.29)

Figure 2.1-17 Time Distribution from Horizontal Radar from the 1st to 5th Surveys (Sep. to Nov. 2021)

2.2 Satellite Tracking Survey

The satellite tracking of BFS began in January, 2021. The survey results for are as follows.

I. Banding Results

In February 2021, a total of 16 BFS were banded and tracked for this project, including 11 individuals that were rescued from illness and 5 individuals that were caught and banded in Tainan area (Table 2.2-1). Among the rescued BFS, one juvenile female (Y43-6838) was already banded by a Korean team, and a transmitter was attached 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. As of June 13th, the transmitter for 1 individual (N01-6819) malfunctioned in Taiwan after a brief tracking period, the remaining 15 individuals all successfully departed offshore. Among them, 4 have returned to Taiwan and are currently being tracked (T95-6820, T00-6814, N02-6831, N05-6822); 1 individual in Korea (N03-6053) and 2 individuals in China (Y43-6838, N08-6823) are currently tracked; 4 individuals in Korea (T97-6834, T99-6817, Right Brown-6830, N09-6835) and 2 individuals in China (No Band-6826, N04-6818) lost signal; and 2 individuals last transmitted signals between late September and late October (T98-6833, Right Blue-6837), currently awaiting further transmissions.

Table 2.2-1 Black-faced spoonbill tagging information

No.	Device	Age	Tagging date	Tagging location	Source	International Identification band		Date of Departure and Arrival	Tracking Status
						Number band	Colour band		
1	6820	Adult	2021/2/1	Yanshui River, Tainan	Rescued	T95	White, blue, green	4/12 From Taiwan to China 4/29 From China to Korea 10/17 From Korea to China, continued migrating to Taiwan 10/18	Disconnected since 10/26, waiting for signal
2	6834	Adult	2021/2/1	Sicao, Tainan	Rescued	T97	White, green, red	4/8 From Taiwan to China 4/26 From China to Korea	Disconnected since 4/29
3	6833	Adult	2021/2/1	Sicao, Tainan	Rescued	T98	White, green, yellow	5/8 From Taiwan to China 5/22 From China to Korea 5/23	Disconnected since 9/21, waiting for signal
4	6817	Subadult	2021/2/2	Sicao, Tainan	Rescued	T99	White, green, blue	3/28 From Taiwan to China 4/5 From China to Korea 4/6	Disconnected since 8/13
5	6838	Juvenile	2021/2/3	Budai, Chiayi	Rescued	Y43	Yellow, blue, green	6/13 From Taiwan to China	Disconnected since 10/22, waiting for signal
6	6814	Adult	2021/2/4	Sicao, Tainan	Rescued	T00	White, green, white	4/12 From Taiwan to China Disconnected since 4/28, received signal again on 5/1 showing location already in Korea 10/22 From Korea to China 10/23 10/30 From China to Taiwan 10/31	Tracking in Chiayi
7	6830	Adult	2021/2/4	Yanshui River, Tainan	Captured	--	Right brown	3/16 From Taiwan to China 3/26 From China to Korea	Disconnected since 6/25

No.	Device	Age	Tagging date	Tagging location	Source	International Identification band		Date of Departure and Arrival	Tracking Status
						Number band	Colour band		
8	6837	Subadult	2021/2/4	Qigu, Tainan	Captured	--	Right blue	3/10 From Taiwan to China 3/22 From China to Korea	Disconnected since 10/22, waiting for signal
9	6826	Juvenile	2021/2/5	Qigu, Tainan	Captured	--	No band	5/31 From Taiwan to China 6/1	Disconnected since 8/21
10	6819	Adult	2021/2/10	Sicao, Tainan	Rescued	N01	Blue, red	Disconnected before the migration	Disconnected since 2/16
11	6831	Juvenile	2021/2/19	Budai, Chiayi	Rescued	N02	Blue, yellow	4/20 From Taiwan to China 5/15 From China to Korea 5/16 10/17 From Korea to China 11/9 From China to Taiwan	Tracking in Chiayi
12	6053	Subadult	2021/2/19	Budai, Chiayi	Rescued	N03	Blue, green	4/27 From Taiwan to China 5/19 From China to Korea 5/20	Disconnected since 10/20, waiting for signal
13	6823	Subadult	2021/2/24	Tucheng, Tainan	Rescued	N08	Green, white	5/22 From Taiwan to China 5/23	Disconnected since 10/24, waiting for signal
14	6835	Juvenile	2021/2/24	Qigu, Tainan	Rescued	N09	White, red	4/12 From Taiwan to China 4/29 From China to Korea	Disconnected since 5/15
15	6818	Adult	2021/2/27	Qigu, Tainan	Captured	N04	Blue, white	3/24 From Taiwan to China 3/25	Disconnected since 3/25
16	6822	Subadult	2021/2/27	Qigu, Tainan	Captured	N05	Green, red	4/30 From Taiwan to China 5/15 From China to Korea 5/16 10/19 From Korea to China 10/21 From China to Taiwan	Tracking in Tainan.

II. Date and Time of Migration

(1) Date of Migration

In this survey, departure offshore during spring migration of BFS occurred between March 10th to June 13th. The first half (including the 15th) and second half of each month is 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. The date of departure correlates with age, as the adult departed first, followed by subadult, then finally the yearlings (Figure 2.2-1). An adult (T98-6833) migrated in the first half of May, this may be due to its illness delaying its departure.

The trend for adult BFS to depart earlier during spring migration has been observed and described in the past (Chen, C. L. 2003). In addition, in the past some subadult 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).

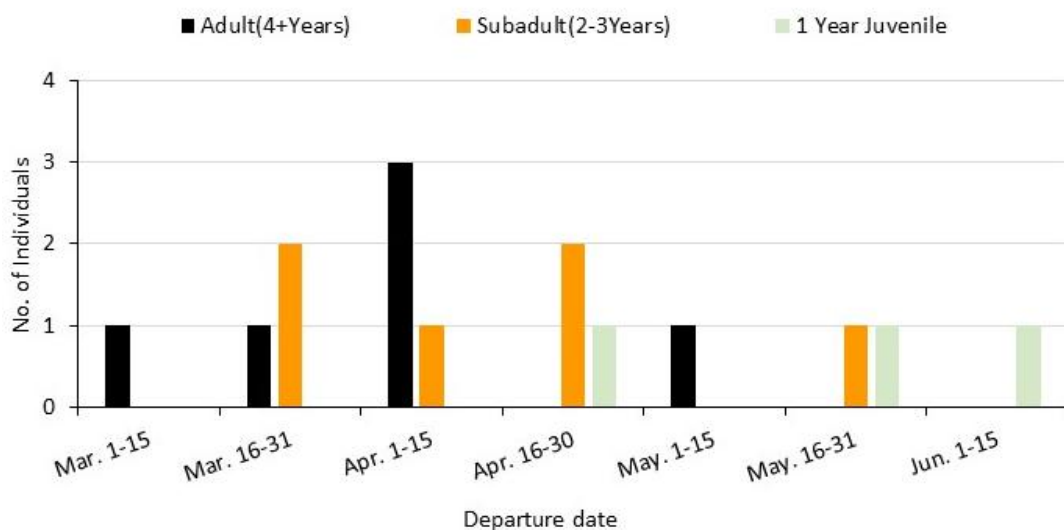
In addition to age, recovery from illness is another possible factor that impacts the date that BFS start northern migration. In this survey, the 3 adult/subadult birds that were ≥ 3 years old and started migration the earliest, were all BFS that are healthy and were captured. The dates for their departure were March 10th, 16th and 24th, respectively. In comparison, the 4 rescued adult/subadult birds that were ≥ 3 years old and started migration the earliest, departed around 2-3 weeks later. The dates for their departure were March 28th, April 8th and 12th.

During fall of the same year, tracking of 2 adult and 2 subadult indicated they had began southern migration. Among them, 2 adults and 1 subadult arrived Taiwan in the second half of October, while 1 subadult

arrived in the first half of November (Figure 2.2-2).

(2)Time of Migration

In analysis of three hour periods, 11 individuals departed offshore between 5:00 hr to 8:00 hr (accounting for 73.3%) during spring migration; 2 individuals departed offshore between 17:00 hr to 20:00 hr (accounting for 13.3%); and 1 individual each departed offshore between 2:00 hr to 5:00 hr as well as 20:00hr to 23:00hr (accounting for 6.7% each). The departure time for most BFS was during early morning, followed by evening and midnight (Figure 2.2-3). During fall migration, 2 individuals arrived between 2:00-5:00, while 1 individual each arrived between 14:00-17:00 and 17:00-20:00 (Figure 2.2-4).



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 15th) and second half of each month is seperated on the 15th.

Figure 2.2-1 Departure Dates of Spring Migrating BFS (n=15) in 2021 up till 13th of June, 2021

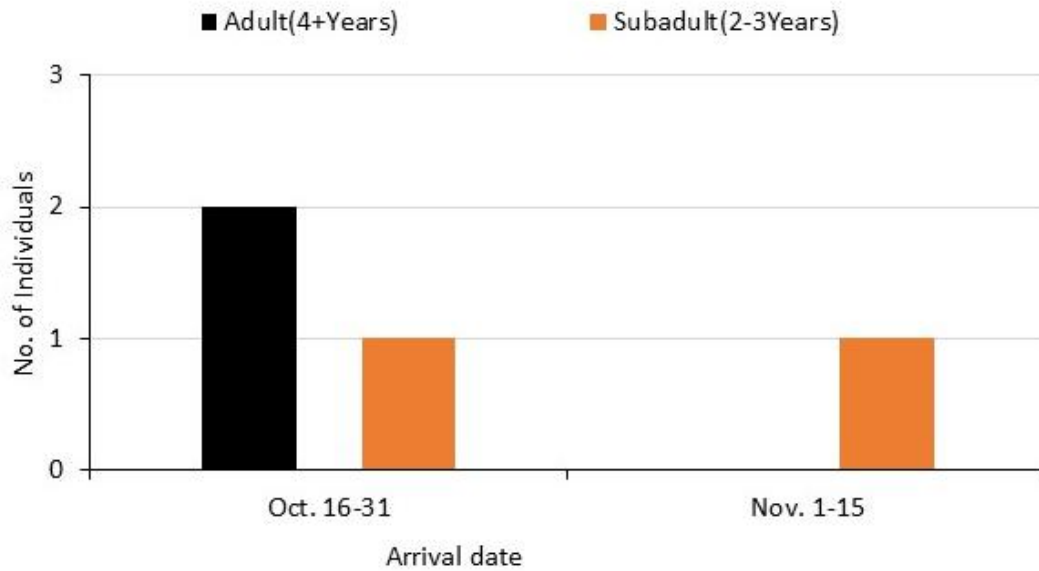


Figure 2.2-2 Arrival Dates of Fall Migrating BFS (n=4) in 2021 up till December 1st, 2021

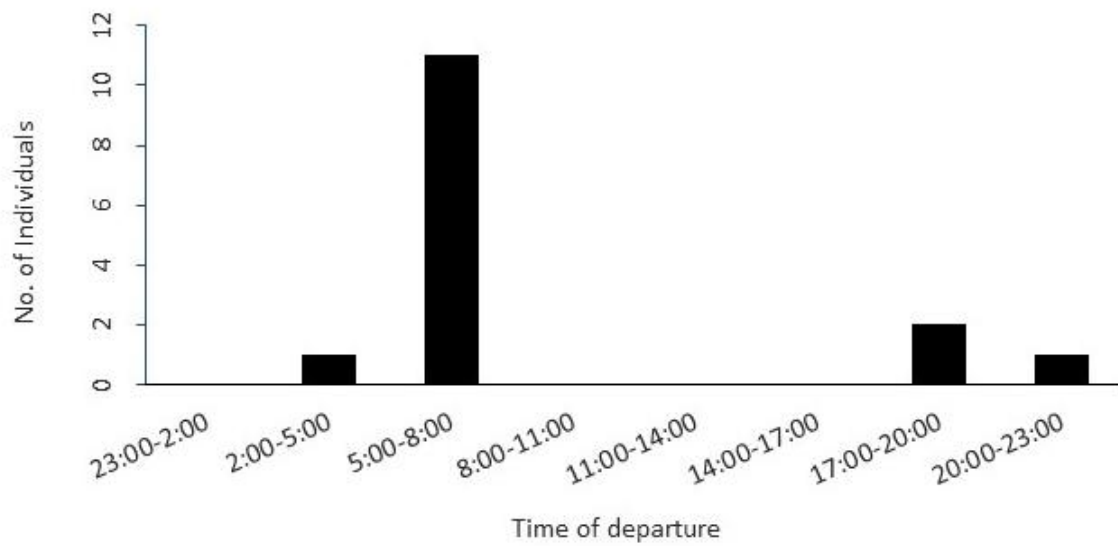


Figure 2.2-3 Spring Migrating BFS (n=15) Departure Times from Taiwan up till 13th of June, 2021

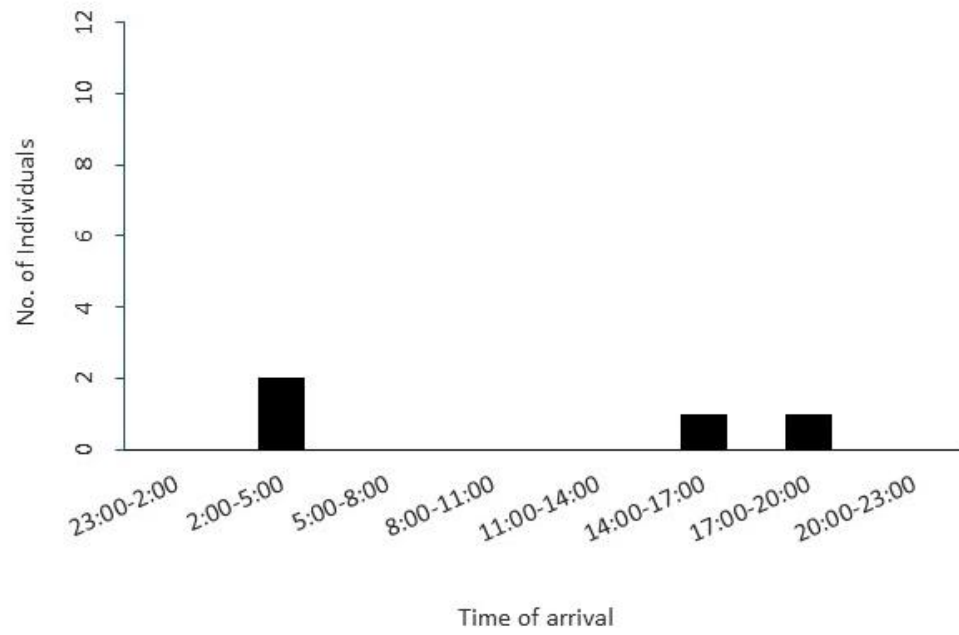


Figure 2.2-4 Fall Migrating BFS (n=4) Arrival Times in Taiwan up till December 1st, 2021

(3) Migration Route

Of the 16 satellite tracking BFS, the transmitter for 1 bird (N01-6819) malfunctioned in Taiwan after a brief tracking period, the remaining 15 birds all successfully departed offshore (Figure 2.2-5), additionally, 4 individuals were recorded migrating south. According to the departure and arrival routes, none of the BFS flew across Yunlin wind farm. Only the bird (blue leg band-6837) that departed the earliest, 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 2.2-6). After departing offshore, the 15 BFS flew northward along the coast of southeastern China. Among the 15 BFS, 11 individuals were observed heading to Korea, and flying routes of 10 individuals during departure were successfully tracked in this route. Meanwhile, 4 individuals were successfully tracked upon their arrival during the fall migration. The locations for departure and arrival were mainly between Shanghai and Yancheng, China (Figure 2.2-7).

If other offshore wind farms are taken into consideration, during the spring migration, out of the 15 tracked, 9 BFS passed through other offshore wind farms while flying across Taiwan Strait. The 9 BFS combined to pass through 14 offshore wind farms, including: Zhufeng, Formosa II, TPC Phase II, Xidao, Changfang, Fufang, Zhongneng, Greater Changhua SW, NE, and NW, Formosa III Offshore Wind Project site 11, 16, and 17, and Hai Long #2 (Figure 2.2-8 to Figure 2.2-11). Changfang and Zhongneng Offshore Wind Farm had the most data, with 5 devices passing through, followed by Fufang Offshore Wind Farm, with 4 devices and the remaining wind farms with between 1-3 devices passing through. During the fall migration, out of 4 successfully tracked, 1 BFS passed through the TPC Phase II and Xidao Offshore Wind Farm (Figure 2.2-12 to Figure 2.2-13). The detailed time and date recorded when the devices passed through the wind farms are as shown in Table 2.2-2 and Table 2.2-3.

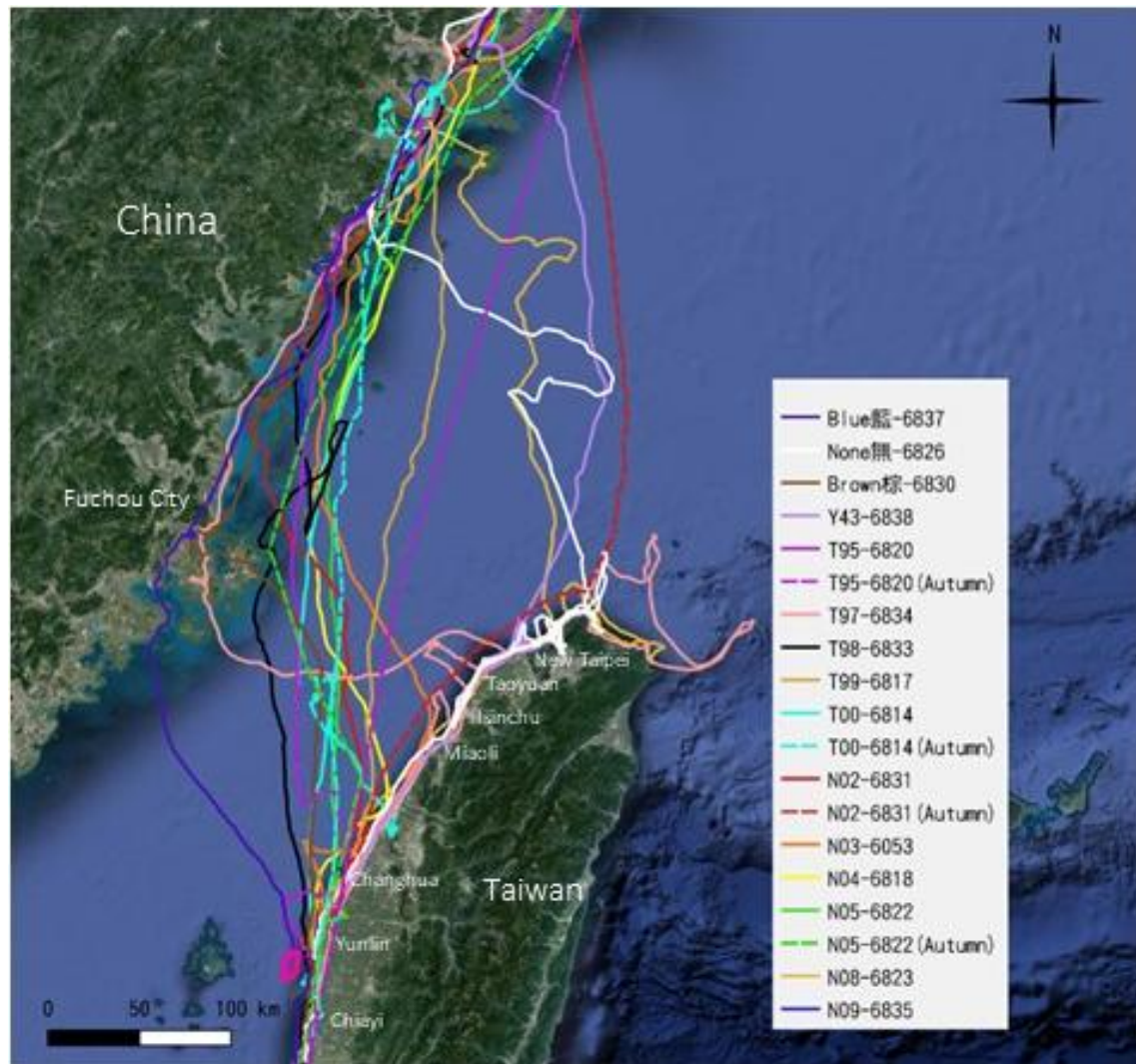
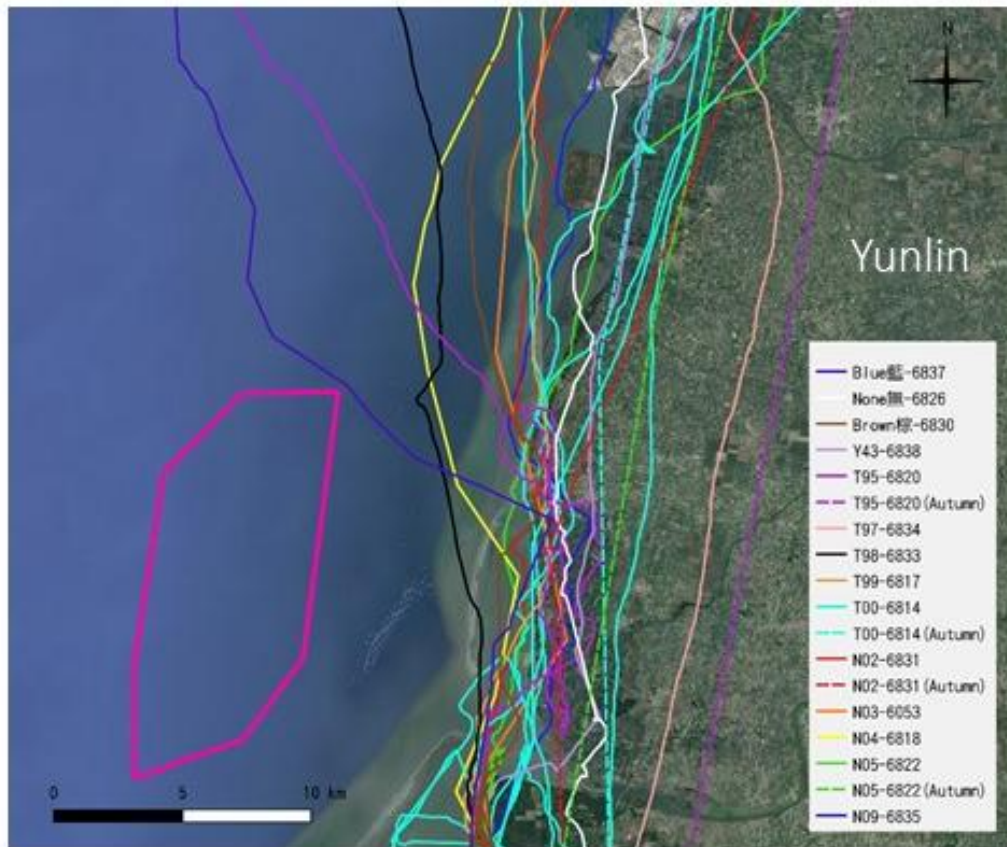


Figure 2.2-5 Route of BFS in Spring, March-June, (n=15, solid lines) and BFS in Fall, October to November, (n=4, dotted lines) across Taiwan Strait (up till December 1st, 2021)



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

Figure 2.2-6 Route of BFS in Spring, March-June, (n=15, solid lines) and BFS in Fall, October to November, (n=4, dotted lines) near Yunlin Wind Farm. The First Departure in March 10th of BFS (blue leg band-6837) almost Passed the Vicinity of the Wind Farm Area. (up till December 1st, 2021)

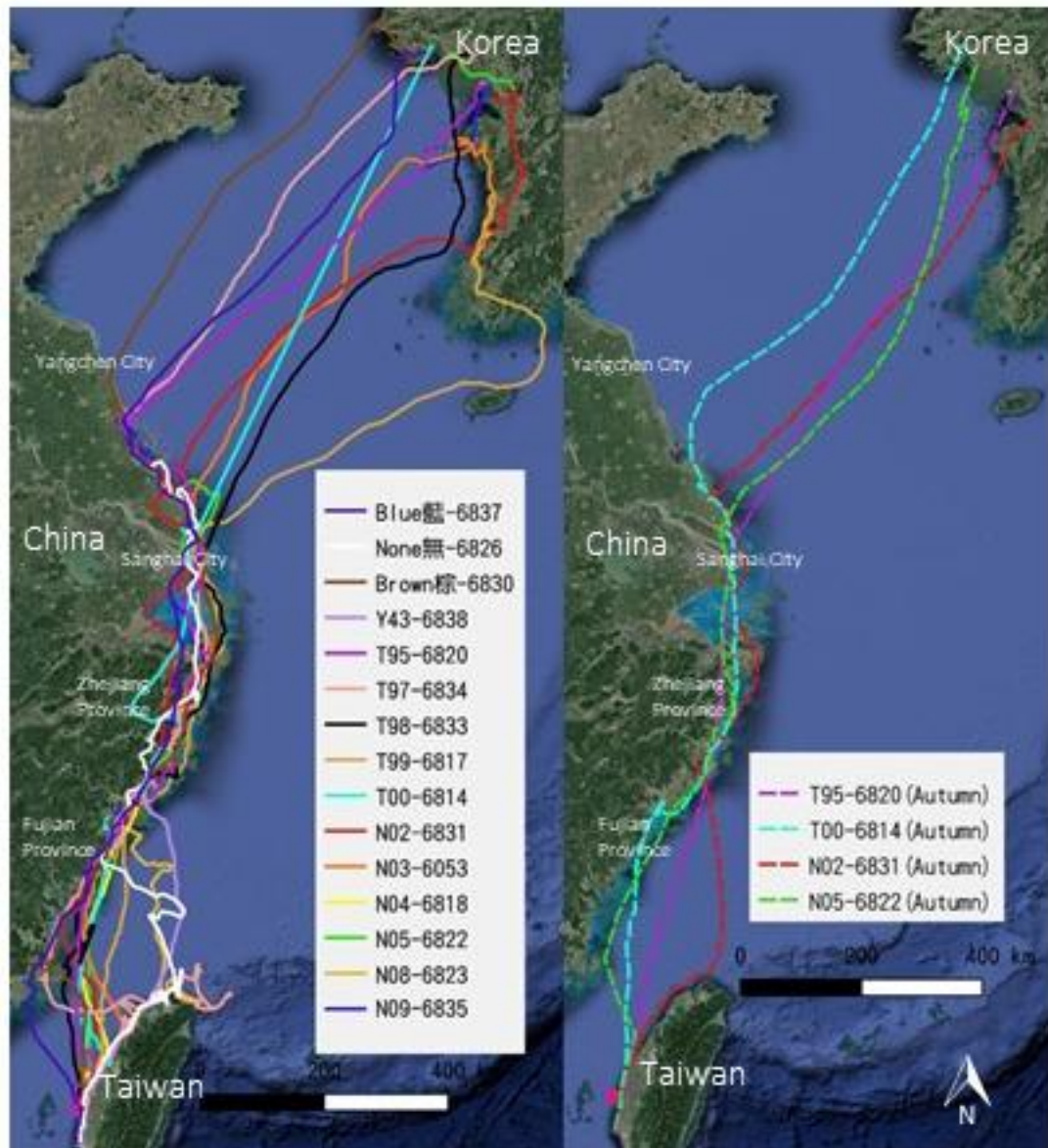


Figure 2.2-7 The Migration Route of BFS in Spring, March-June, (n=15, solid lines) and BFS in Fall, October to November, (n=4, dotted lines) (up till December 1st, 2021)

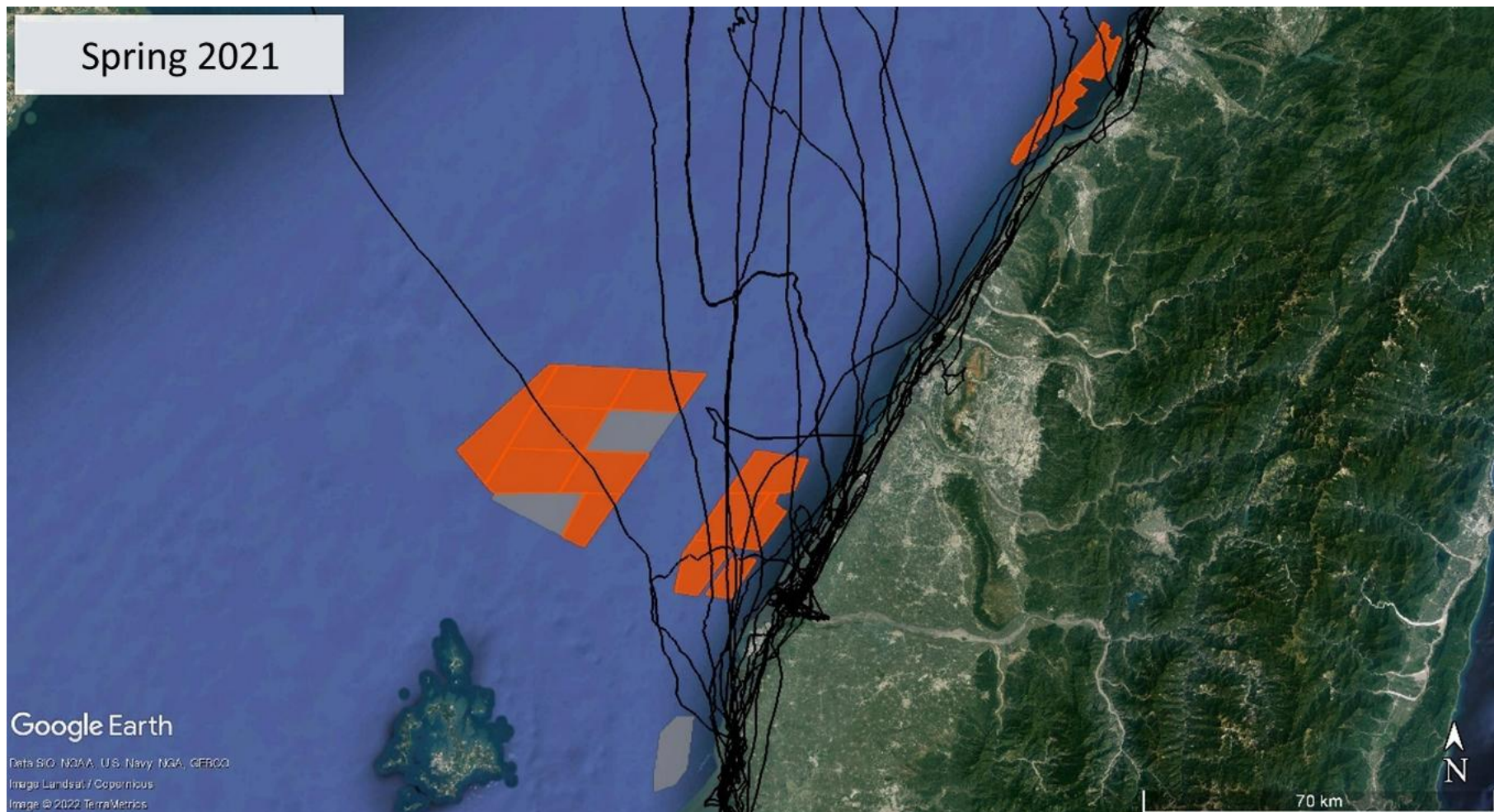


Figure 2.2-8 BFS Migration Routes that Passed Through Other Offshore Wind Farms While Crossing Taiwan Strait during Spring 2021 (Areas Highlighted in Orange) (up till December 1st, 2021)

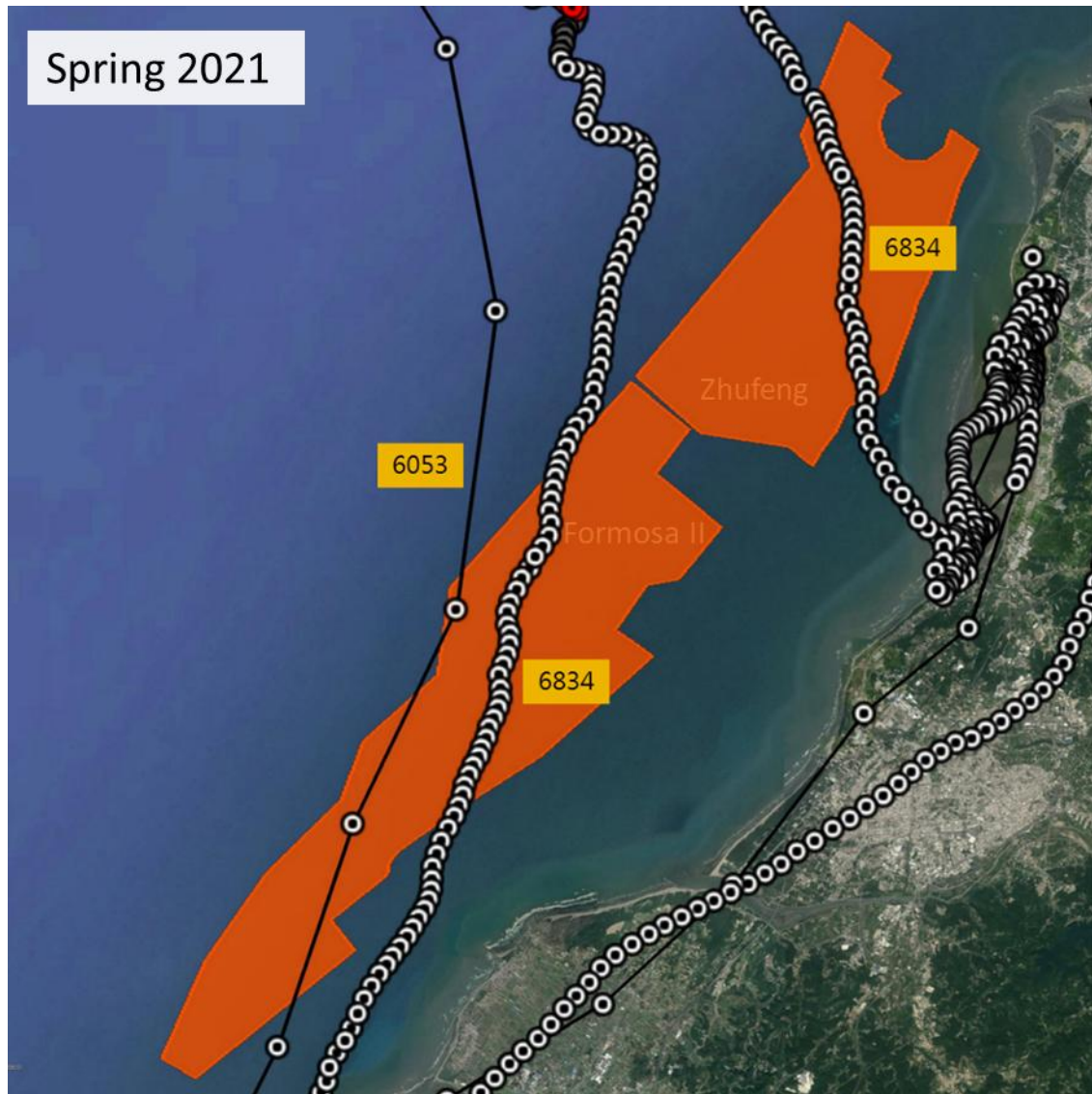


Figure 2.2-9 BFS Migration Routes that Passed Through Zhufeng and Formosa II Offshore Wind Farms during Spring 2021 (Device no. Highlighted in Yellow) (up till December 1st, 2021)

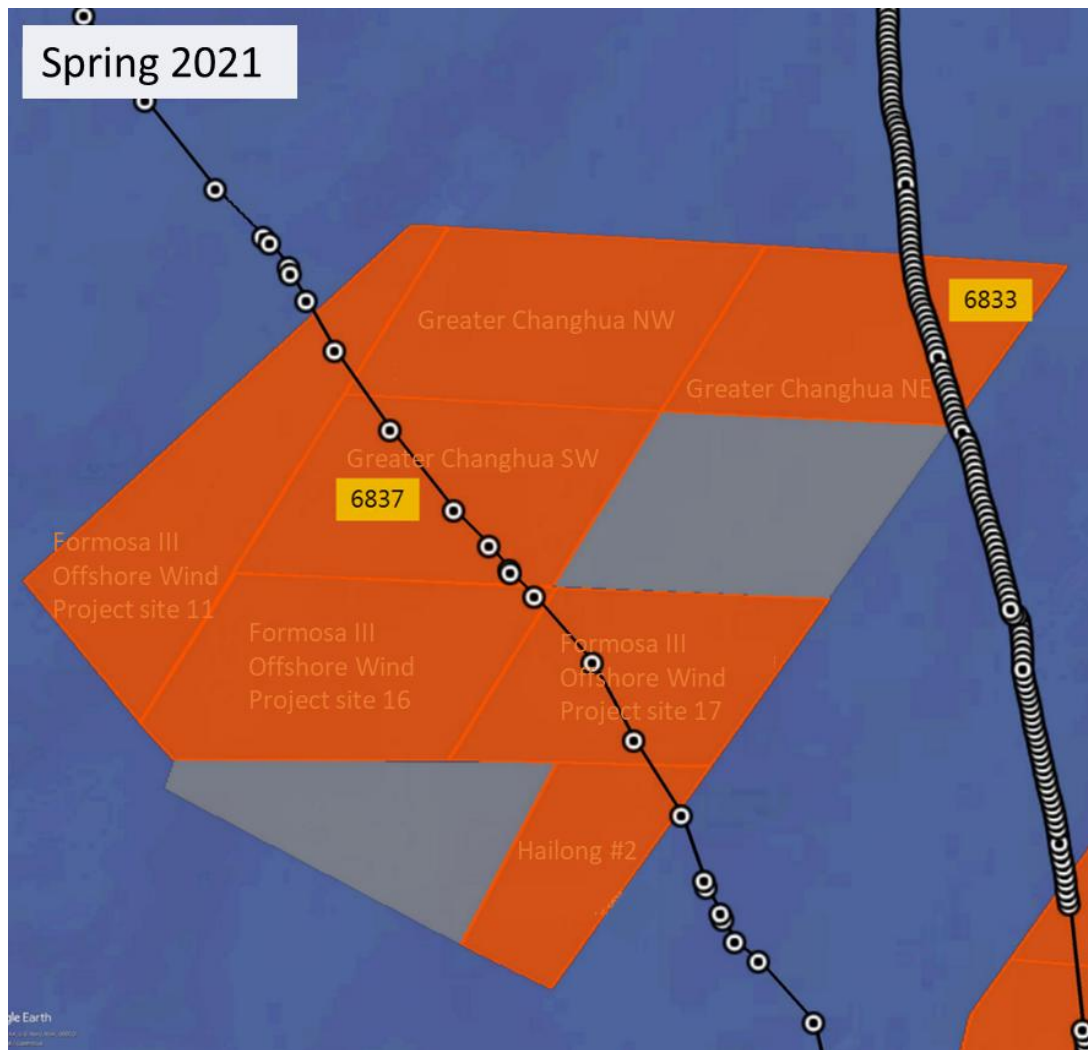


Figure 2.2-10 BFS Migration Routes that Passed Through Changhua Offshore Wind Farms during Spring 2021 (Device no. Highlighted in Yellow) (up till December 1st, 2021)

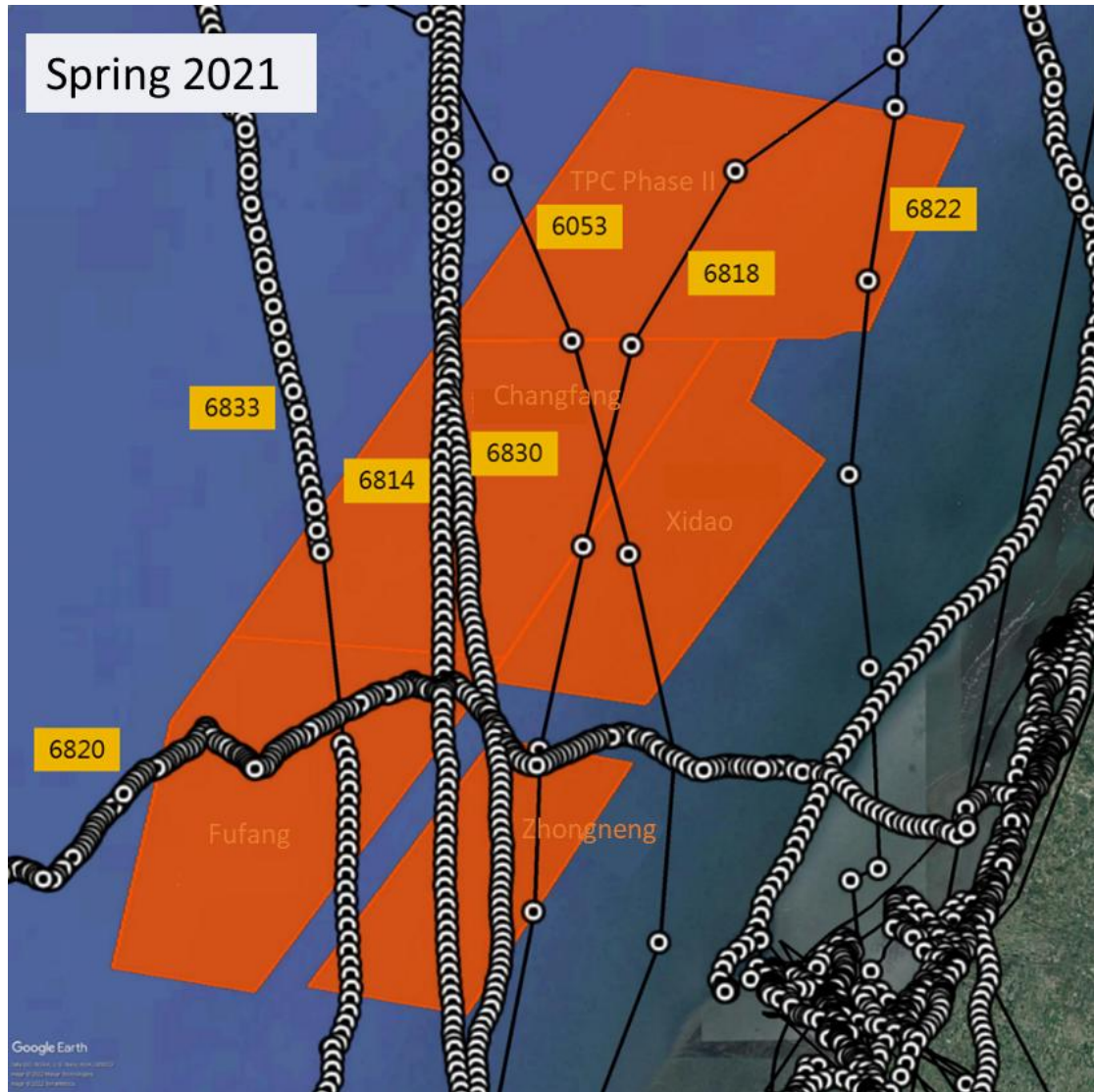


Figure 2.2-11 BFS Migration Routes that passed through Changhua Near Offshore Wind Farms during Spring 2021 (Device no. Highlighted in Yellow) (up till December 1st, 2021)



Figure 2.2-12 BFS Migration Routes that Passed Through Other Offshore Wind Farms in Taiwan Strait during Fall 2021 (Areas Highlighted in Orange) (up till December 1st, 2021)

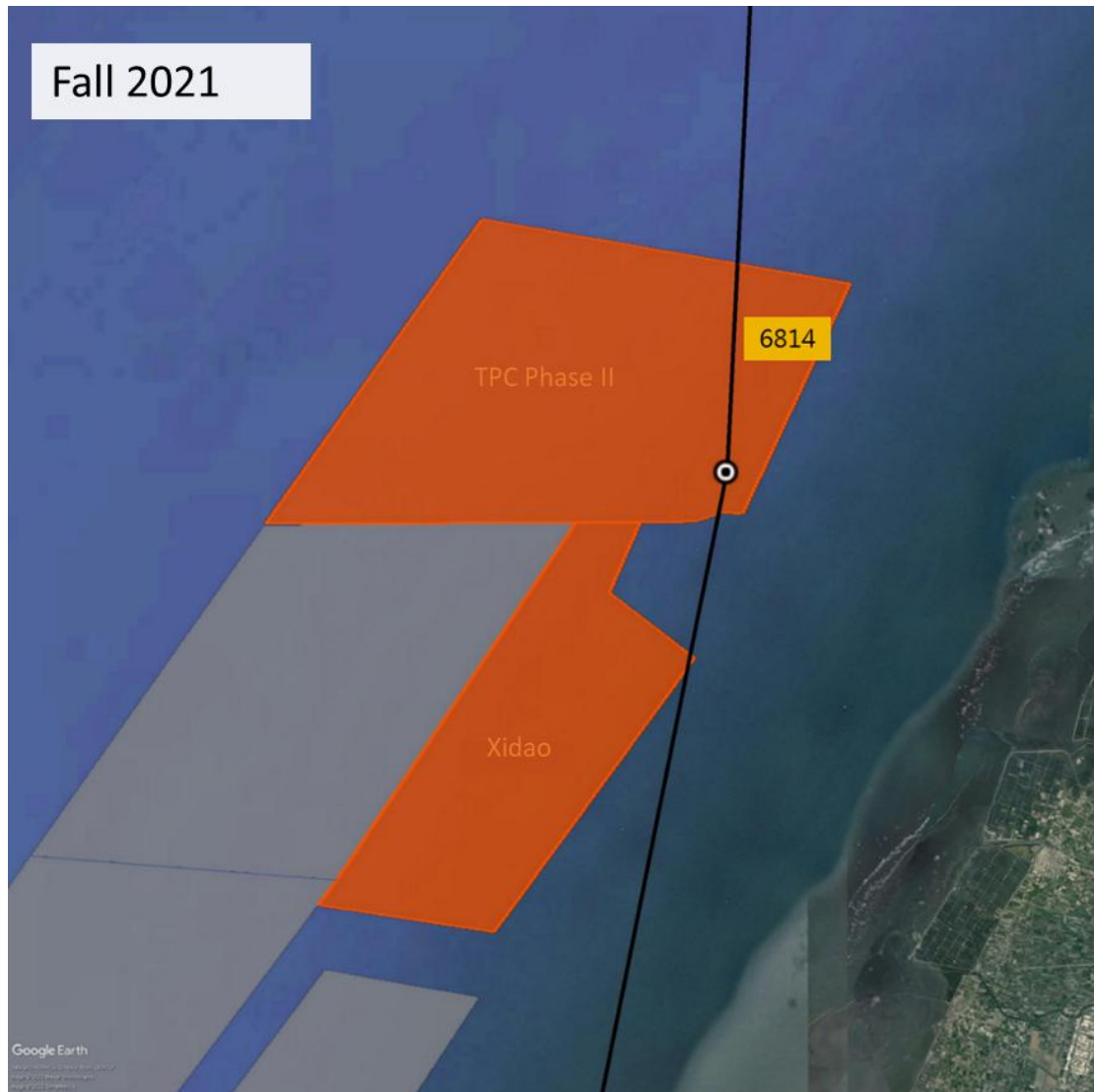


Figure 2.2-13 BFS Migration Routes that Pass Through Changhua Offshore Wind Farms during Fall 2021 (Device no. Highlighted in Yellow) (up till December 1st, 2021)

Table 2.2-2 Time and Date of BFS Migration Passing Through Other Offshore Wind Farms during Spring 2021 (up till December 1st, 2021)

Wind Farm	Device no.	Date/ Time
Zhufeng Offshore Wind Farm	6834	2021/03/28 20:16-20:24
Formosa II Offshore Wind Farm	6053	2021/04/27 08:02-08:12
	6834	2021/03/28 19:26-19:37
TPC Phase II Offshore Wind Farm	6053	2021/04/26 07:32
	6818	2021/03/24 20:14
	6822	2021/04/30 06:00
Xidao Offshore Wind Farm	6053	2021/04/26 07:22
	6818	2021/03/24 19:54
Changfang Offshore Wind Farm	6053	2021/04/26
	6814	2021/04/02 06:58-07:07
	6818	2021/03/24 20:04
	6830	2021/03/16 18:42-18:53
	6833	2021/05/08 08:10-08:11
Fufang Offshore Wind Farm	6814	2021/04/02 06:56-06:58
	6820	2021/04/10 08:56-09:21
	6830	2021/03/16 18:41-18:42
	6833	2021/05/08 08:00-08:04
Zhongneng Offshore Wind Farm	6814	2021/04/02 06:47-06:53
	6818	2021/03/24 19:35-19:44
	6820	2021/04/10 09:24-09:28
	6830	2021/03/16 18:31-18:39
	6833	2021/05/08 07:57-07:58
Greater Changhua NE Offshore Wind Farm	6833	2021/05/08 08:34-08:43
Greater Changhua NW Offshore Wind Farm	6837	2021/03/10
Greater Changhua SW Offshore Wind Farm	6837	2021/03/10 12:52-13:10
Formosa III Offshore Wind Project site 11	6837	2021/03/10 13:20
Formosa III Offshore Wind Project site 16	6837	2021/03/10 12:49
Formosa III Offshore Wind Project site 17	6837	2021/03/10 12:30-12:40
Hai Long #2 Offshore Wind Farm	6837	2021/03/10

Note: Only date is showed for migration routes that passed through wind farm but located no positioning point.

Table 2.2-3 Time and Date of BFS Migration Passing Through Other Offshore Wind Farms during Fall 2021 (up till December 1st, 2021)

Wind Farm	Device no.	Date/ Time
TPC Phase II Offshore Wind Farm	6814	2021/10/31 02:27
Xidao Offshore Wind Farm	6814	2021/10/31

Note: Only date is showed for migration routes that passed through wind farm but located no positioning point.

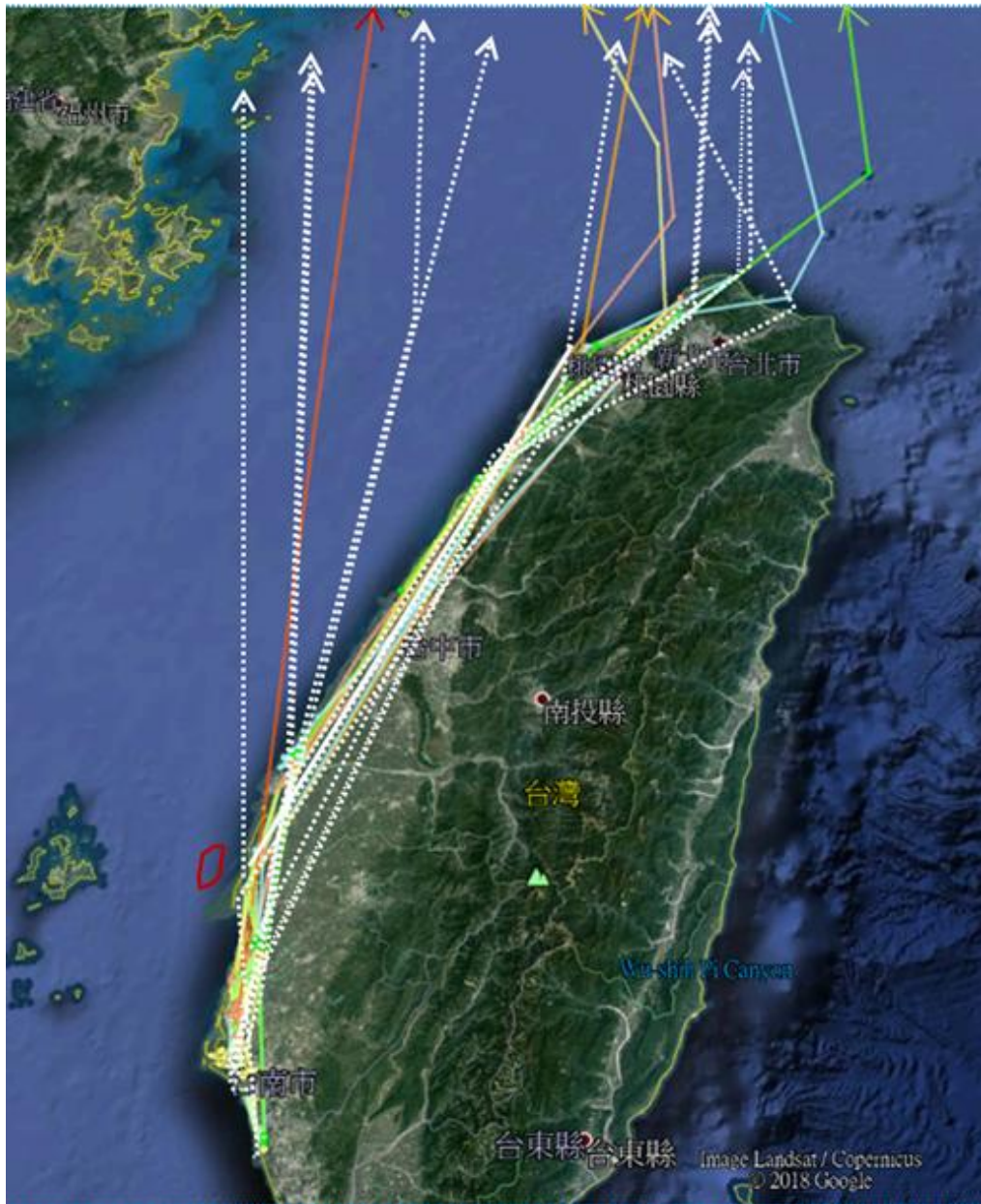
(4) Departure and Arrival Location

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, 1 individual (6.7%) departed from Miaoli and Tainan (Figure 2.2-14). In comparison with estimated routes from the satellite tracking of BFS conducted by Taiwan and Korea between 2012-2018 (Figure 2.2-15; Wang 2016 and Kisup Lee, unpublished data), the departure routes from this survey includes 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 Northern Taiwan.

During southern migration in fall, as the BFS had already underwent long trips of flight, the battery life of the transmitters were 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. As of December 1st, 2021, only the arrival location of 6831 in Changhua was confirmed, for the remaining 3 individuals, the arrival location were between Miaoli and Chiayi. (Figure 2.2-16, Table 2.2-4)



Figure 2.2-14 BFS Departure Locations between March-June 2021



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

Figure 2.2-15 BFS Departure Routes between 2012-Spring 2018 (Wang 2016 and Kisup Lee, unpublished data)

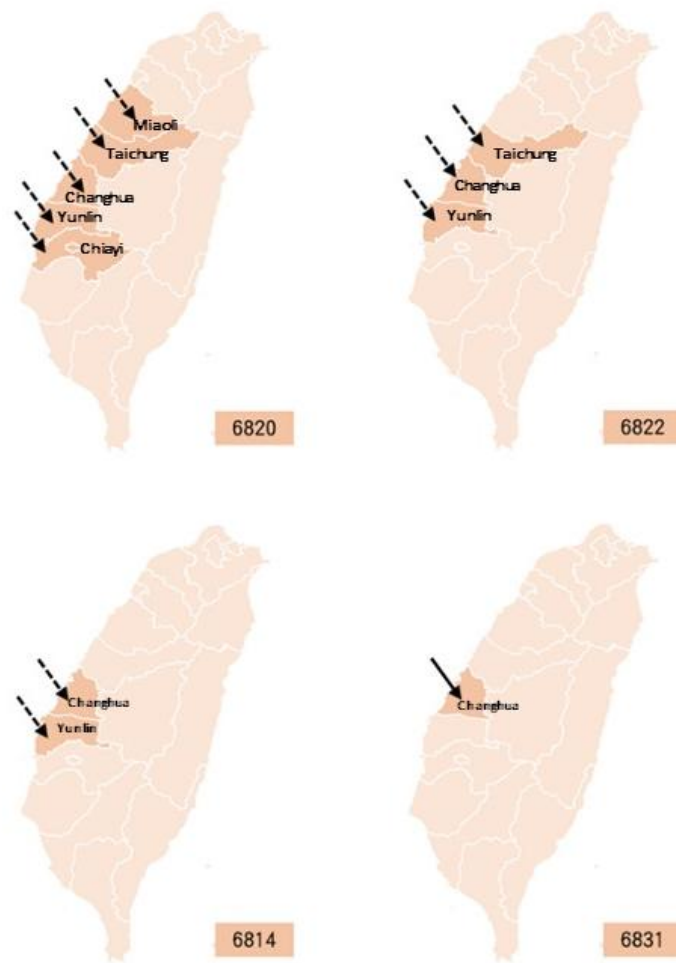


Figure 2.2-16 BFS Arrival Locations in Taiwan between October-November 2021 (locations for some individuals could not be accurately determined due to low positioning frequencies, dotted lines) (up till December 1st, 2021)

**Table 2.2-4 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

(5) Flying Altitude

During the spring migration, the percentage of flying altitudes that were between the sweeping area (25-200 m) during flight in the Taiwan Strait varies between the 15 BFS. An average of $51 \pm 26\%$ of positionings for all individuals were between the sweeping area, with the highest percentage at 88% and the lowest at 4% (as shown in Figure 2.2-17). An average of $44 \pm 28\%$ of positionings for all individuals were below 25 m, while only an average of 4% of positionings were over 200 m. 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 fall migration, the positioning points of the 4 individuals within the Taiwan strait were not frequent, hence presented in a Table. The 4 individuals only included 27 positioning points, with the highest percentage (44%) being between the sweeping area (Table 2.2-5).

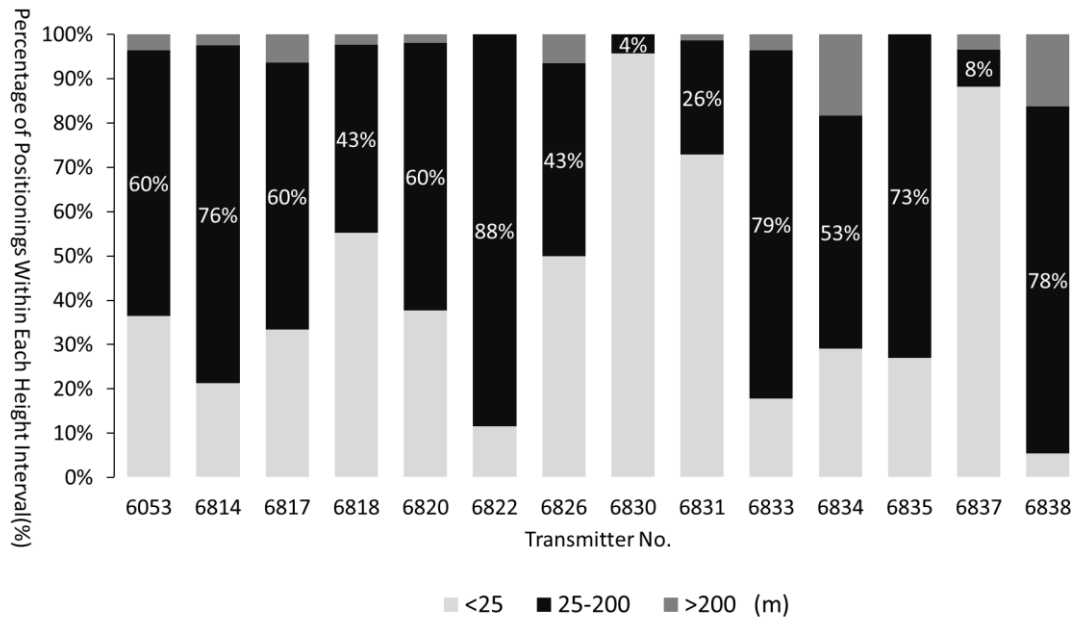


Figure 2.2-17 Percentage of Flying Altitudes within Each Interval for BFS Positionings in Taiwan Strait (March-June, 2021)

Table 2.2-5 Percentage of Flying Altitudes within Each Height Interval for BFS Positionings in Taiwan Strait (October-November, 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%

Chapter III Review and suggestions

3.1 Review on monitoring results and response

I. Marine Radar survey combined with Visual Survey from a Fixed Position

This is the third season of survey. In the first season (September to November 2020) 2 surveys were conducted; in the second season (March to May 2021) 16 surveys were conducted; and in this season (September to November 2021) 5 surveys were conducted. A total of 23 surveys were conducted in these 3 seasons. Two species were recorded in the first season, including Rock dove and an unknown species in the Laridae family; eight species were recorded in the second season including Red-necked phalarope, Bulwer's Petrel, Streaked Shearwater, Swinhoe's storm petrel, Whiskered tern, European herring gull, common tern and 1 protected species, Greater crested tern; 7 species were recorded in the third season including Cattle egret, Little egret, Whiskered tern, European herring gull, Bulwer's petrel, Red-necked phalarope and 1 protected species, Greater crested tern. Flying altitude recorded during visual survey was below 50 m throughout all seasons. Survey should carry on to build up effort.

In regard to marine radar survey for birds, this project has used 2 radars, horizontal radar and vertical radar, to conduct surveys. The purpose of the 2 radars are different, with different settings and scanning range. The horizontal radar is used to assess the flying route, direction and speed of birds; the vertical radar is used to assess the activity time and flying altitude of birds. During the planning for the survey, the survey range for the vertical radar was set smaller in order to collect more accurate data on flying altitude. The echo signal received by the vertical radar has a higher resolution due to the characteristics of the electromagnetic wave of radars. Even single individuals may be detected. The survey range for the horizontal radar was set larger in order to obtain the larger scale flying

route of birds in the wind farm and marine areas in the vicinity. The horizontal radar requires relatively larger group of individuals to be detected from a long distance. During surveys conducted on 15th, 27th, 28th, 29th March and 1st April this season, the horizontal radar have higher number of recordings compared to the vertical radar. Theoretically, it is normal that number of horizontal radar recordings surpass that of the vertical radar because of the larger survey range. But in fact, horizontal radar is easily affected by sea state and rainfall, resulting in lower number of recordings, only sometimes when weather and sea state are good, the number of horizontal radar recordings will exceed the vertical radar recordings. In fall 2020, the main flying direction recorded was SSW; in spring 2021, the main flying direction was NNE; and in fall 2021, the main flying direction was SSW. The main flying altitude of bird during the first season was at 50-100 m; The main flying altitude of bird during the second season was at 100-150 m; and The main flying altitude of bird during this season was above 200 m.

Table 3.1-1 Overview of Survey Result of Marine Radar survey combined with Visual Survey from a Fixed Position

No.	Survey period	Visual Survey			Radar Survey	
		Number of surveys	Number of species	Flying altitude	Main flying direction	Main flying altitude
1	September to November 2020	2	2	<50 m	SSW	50-100 m
2	March to May 2021	16	8	<50 m	NNE	100-150 m
3	September to November 2021	5	7	<50 m	SSW	> 200 m
Total		23	17	NA	NA	NA

II. Satellite Tracking Survey

Satellite tracking of BFS began in January 2021. Sixteen BFS were tracked in February. As of June 13th, 2021, the transmitters for 1 individuals malfunctioned in Taiwan before departure, and the remaining 15 individuals all successfully departed towards China or South Korea.

Among them, 9 individuals are currently tracked, as 2 individual lost signal in China and 4 individuals lost signal in Korea. Out of those being tracked, 4 were successfully tracked during their southern migration to Taiwan. This season, none of the BFS flew across the Yunlin wind farm. Only 1 individual almost brushed pass the wind farm, its departure route was 400 m away from the wind farm perimeter. However, if other offshore wind farms in the Taiwan Strait were added to the discussion, some BFS did cross the vicinity of some wind farms that are located at Hsinchu, Miaoli and Changhua outer sea.

Table 3.1-2 Overview of Survey Result of Satellite Tracking Survey

No.	Status	Period	Number of BFS
1	BFS Tagging	January 2021	16
2	Malfunctioned	Spring 2021	1
3	Departed to China/South Korea	Spring 2021	5
4	Lost signal in China/South Korea	Spring 2021	6
5	Migrated South, back to Taiwan	Fall 2021	4

3.2 Suggestions

Ongoing survey is recommended to build up survey effort and accumulate long term survey data.

Reference

- (1) Bruderer, B., D. Peter, T. Steuri. (1999) Behaviour of migrating birds exposed to X-band radar and a bright light beam. *Journal of Experimental Biology* 202: 1015-1022
- (2) Bundesamt für Seeschifffahrt und Hydrographie (publisher) - BSH (2013): Standard - Investigation of the Impacts of Offshore Wind Turbines on the Marine Environment (StUK4). Hamburg & Rostock (EN).
- (3) Caccamise, D.F. and R.S. Hedin. 1985. An aerodynamic basis for selecting transmitter loads in birds. *Wilson Bull* 97: 306-318.
- (4) Casement, M.B. 1966. Migration across the Mediterranean observed by radar. *Ibis* 109: 461-491.
- (5) Chen, C. L. 2003. International symposium proceedings of black-faced spoonbill. 25-38. Council of Agriculture.
- (6) 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.
- (7) Cochran, W. W. 1980. Wildlife telemetry. Pp. 507-520 in *Wildlife management techniques manual* (S. D. Schemnitz, ed.). The Wildlife Society, Washington, D.C.
- (8) Desholm, M., A.D. Fox, P.D.L. Beasley, J. Kahlert. (2006) Remote techniques for counting and estimating the number of bird–wind turbine collisions at sea: a review. *Ibis* 148: 76-89.
- (9) Formosa natural history information Ltd. 2016a. Environmental impact assessment of Dong energy Changhua(#14)offshore wind farm- an overview of bird and terrestrial ecological survey

projects and environmental impacts.

- (10)Formosa natural history information Ltd. 2016b. Environmental impact assessment of Dong energy Changhua(#15)offshore wind farm- an overview of bird and terrestrial ecological survey projects and environmental impacts.
- (11)Graber, R.R., S.S. Hassler. (1962) The effectiveness of aircraft-type (APS) radar in detecting birds. The Wilson Bulletin 74: 367-380.
- (12)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.
- (13)Kahlert, J., I.K. Petersen, A.D. Fox, M. Desholm, I. Clausager. (2004) Investigations of birds during construction and operation of Nysted offshore wind farm at Rødsand, Annual status report 2003. National Environmental Research Institute, Rønde, Denmark.
- (14)Langley, R. B. 1999. Dilution of precision. GPS World 5: 54–59.
- (15)Liang, S. 1996. Application of the Post-Processing DGPS- A Case Study of Intake Site Poitioning Along Taoyuan Irrigation Channel. Journal of Soil and Water Conservation, 28(2): 45-62.
- (16)Liao, B.H. 2012a. A Field Guide to the Birds of Taiwan: Water Birds. Morning Star Publishing, Taichung City.
- (17)Lin, W.H. 2006. A Field Guide to the Raptors of Taiwan. Yuan-Liou Publishing Co., Ltd, Taipei City.
- (18)Ministry of the interior. 2018. Analysis report of Chenglong

wetland.

- (19)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.
- (20)The Hong Kong bird watching society. 2020. The international black-faced spoonbill census report 2020.
- (21) Unitech Engineering Co., Ltd. 2020. Project report of satellite tracking birds in coastal areas of greater-Changhua south east and south west offshore wind farms.
- (22)Wang, Y. 2016. The ecological study and habitat management of the black-faced spoonbill in Taijiang national park. Project report of Taijiang national park.
- (23)Wang, Y. K. and C. Y. Chiang. 2015. Banding report of associated species of black-faced spoonbill in Taijiang national park and surrounding areas, 103. Project report of Taijiang national park.
- (24)Water resources agency. 2008. Investigation of stream status of Bei-gang river. The 5th river management office water resources agency.