

# Yunlin Offshore Wind Farm

# Black-faced Spoonbill

# Survey Program

## Offshore Construction Phase

## Spring 2021 (March-May)

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

# Final

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## Applicable Documents

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# 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 Windfarm: 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 Spring 2021 (March-May).

### 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. A total of 16 surveys were conducted this season, spring 2021 (March to May 2021), including 9 surveys from spring and 7 surveys remaining from fall 2020. 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 Spring) (1/2)**

| Survey Item                                                           | Survey Summary                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Response                   |
|-----------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|
| Marine radar survey combined with visual survey from a fixed position | <p>Marine radar survey combined with visual survey from a fixed position were conducted 16 times this season, including 9 surveys from spring and 7 surveys remaining from 2020 fall and were therefore carried out during spring season. The summary of survey results are as follows:</p> <p><u>Visual survey from a Fixed Position</u></p> <ol style="list-style-type: none"> <li>1. Recorded species: 85 individuals were recorded. A total of 8 species were recorded, with Red-necked phalarope contributing the most individuals (n=27) and 1 protected species, Greater crested tern was recorded (n=12). No BFS was recorded during this season.</li> <li>2. Flying altitude: Flying altitude of all birds recorded in this season were below 50 m. Most individuals flew between 20-50 m (37 individuals).</li> <li>3. Bird activity per hour: The number of bird activity per hour this season is 0.4427 individuals/hr.</li> </ol> <p><u>Marine radar survey from a fixed position (see Table 1.4.1-2)</u></p> <p>In regard to horizontal and vertical radar surveys, 3,058 trajectories were recorded in the horizontal radar; and 7,391 flying trajectories were recorded in the vertical radar.</p> <ol style="list-style-type: none"> <li>1. Flying direction and speed<br/>The main flying direction is toward NNE (566 records), with 18.5% of all recorded trajectories. The second main flying direction is toward N, with 16.9% of all recorded trajectories. During daytime, flying directions are mainly toward NNW, with 21.8% of recorded daytime trajectories. During nighttime, flying directions are mainly toward NNE, with 20.6% of recorded nighttime trajectories.</li> <li>2. Flying altitude<br/>Flying altitude for birds is mainly between 100-150 m (2,224 records), which is 30.1% of total recordings. There are no differences in results of flying altitude distribution between daytime and nighttime. Most recordings during daytime and nighttime are between 100-150 m, accounting for 28.0% and 30.5% for daytime and nighttime, respectively.<br/><br/>If analyzed with flying altitude within the sweeping zone (25-200 m). The altitude accounts for 74.0% in daytime records and 68.8% in nighttime records. Average flying altitude in this season is 167.1 ±130.6 m.</li> <li>3. Time distribution<br/>Overall results of the vertical radar survey indicate that flying activity of birds mostly occur during the night accounting for 84.0% of the overall records. The same is also indicated by results of horizontal surveys, with most recordings occurring during the nighttime, consisting of 59.0% of total recordings.</li> </ol> | No abnormal issue observed |

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

| Survey Item        | Survey Summary                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Response |
|--------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| Satellite tracking | <p>Survey results starting from January 2021, are as summarized below:</p> <p><u>Banding results</u></p> <p>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.</p> <p><u>Departure date and time</u></p> <ol style="list-style-type: none"> <li>1. Date of departure</li> </ol> <p>In this survey, departure offshore during spring migration of BFS occurred between March 10<sup>th</sup> to June 13<sup>th</sup>. April was the main migration departure month, accounting for 50% of the records.</p> <ol style="list-style-type: none"> <li>2. Time of departure</li> </ol> <p>The departure time for most BFS was in the early morning, followed by departure between evening and midnight. In analysis of three hour periods, 11 individuals (accounting for 78.6%) departed offshore between 5:00 hr to 8:00 hr; 2 individuals (accounting for 14.3%) departed offshore between 17:00 hr to 20:00 hr; and 1 individual (accounting for 7.1%) departed offshore between 20:00 hr and 23:00 hr.</p> <p><u>Departure route</u></p> <ol style="list-style-type: none"> <li>1. Departure route in the Taiwan Strait</li> </ol> <p>Of the 16 BFS for the satellite tracking, the transmitters for 2 individuals (N01-6819, N08-6823) malfunctioned in Taiwan, the remaining 14 individuals all successfully departed offshore. According to the departure 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 10<sup>th</sup> 2021, almost brushed pass the wind farm area, it flew a mere 400 metres away from the wind farm perimeter at its nearest.</p> <ol style="list-style-type: none"> <li>2. Departure location</li> </ol> <p>By identifying the location of departure for BFS using the administrative districts for cities and counties, 5 individuals (35.7%) departed from Changhua, and 2 individuals each (14.3%) departed from districts including Chiayi, Yunlin and Taoyuan, the remaining 3 individuals (21.4%) departed from New Taipei, Miaoli and Tainan, respectively.</p> | —        |

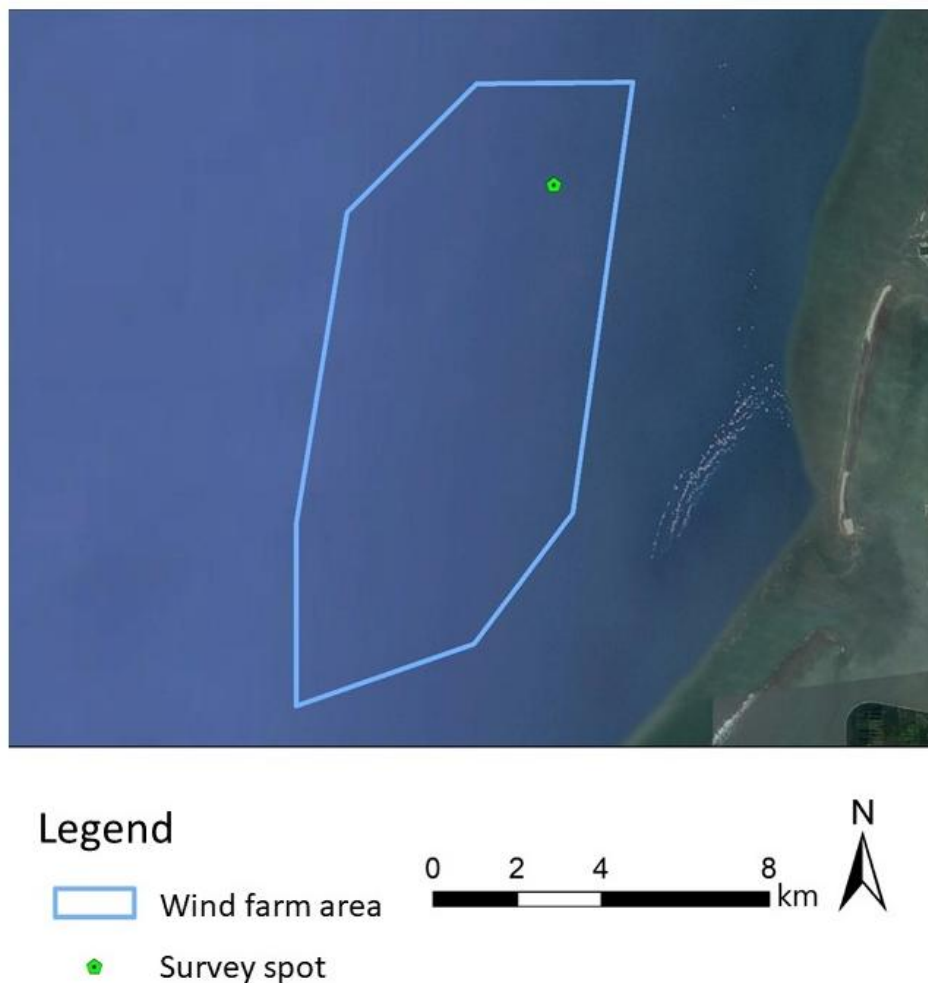
**Table 1.3-1 BFS Monitoring Schedule during Offshore Construction Phase**

| 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 | 2021.03.15-16<br>2021.03.16-17<br>2021.03.17-18<br>2021.03.18-19<br>2021.03.27-28<br>2021.03.28-29<br>2021.03.29-30<br>2021.03.30-31<br>2021.03.31-04.01<br>2021.04.01-02<br>2021.05.12-13<br>2021.05.13-14<br>2021.05.19-20<br>2021.05.20-21<br>2021.05.21-22<br>2021.05.22-23 |
|       | Satellite tracking                                             | Tainan and Chiayi area       | 16 BFS should be tracked in 2021                                                                                                                                          | 2021.2.01 (3 BFS banded)<br>2021.2.02 (1 BFS banded)<br>2021.2.03 (1 BFS banded)<br>2021.2.04 (3 BFS banded)<br>2021.2.05 (1 BFS banded)<br>2021.2.10 (1 BFS banded)<br>2021.2.19 (2 BFS banded)<br>2021.2.24 (2 BFS banded)<br>2021.2.27 (2 BFS banded)                        |

## 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 total days) 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 radar 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.

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.

**Table 1.4.1-1 Radar Specification**

|                       |        |
|-----------------------|--------|
| Frequency Band        | X-band |
| Power                 | 25 kW  |
| Length of the Antenna | 6 foot |
| Maximum Range         | 72 Nm  |



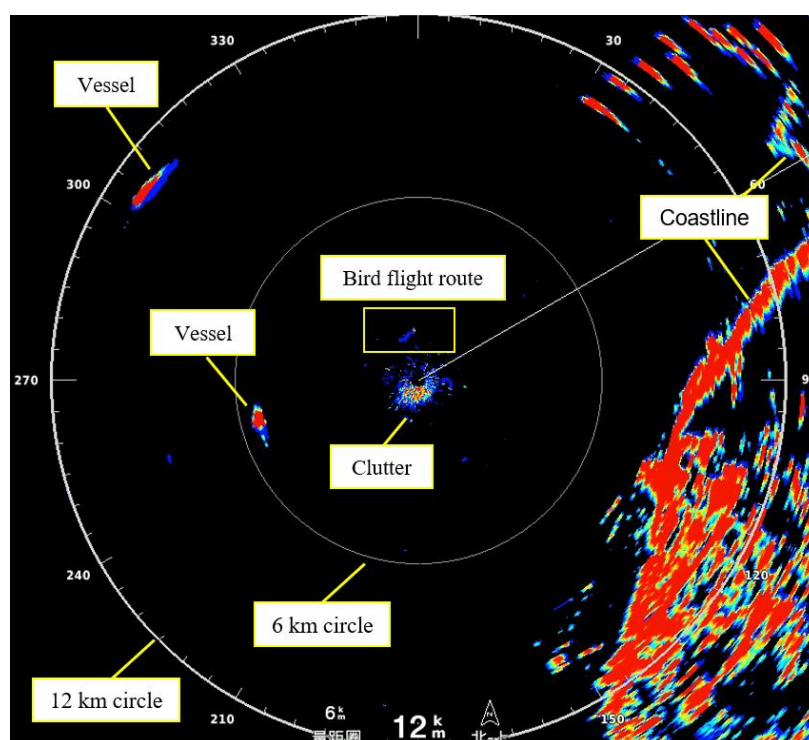
**Figure 1.4.1-2 Radar Antenna Installed on the Vessel**

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.<br>Quantification of flight intensity* of birds in 50-m groups up to flying altitude at 2,000 m.<br>*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           | <ol style="list-style-type: none"> <li>Without filter for sea clutter (SEA) and rain (RAIN). The radar device setting will be identical throughout the entire assessment period.</li> <li>The raw data of radar recorded is stored in flash drive and brought back to the office for analysis.</li> </ol> |                                                                                                                                                                                                                                |

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 | <ul style="list-style-type: none"> <li>• 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.</li> <li>• During the observation, a 15-minute rest will be taken every 15 minutes to avoid visual fatigue.</li> </ul>                                                                                                    |
| Radar operator  | <ul style="list-style-type: none"> <li>• 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.</li> <li>• During the observation, a 15-minute rest will be taken every 15 minutes to avoid seasick owing to visual fatigue</li> </ul> |

## 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

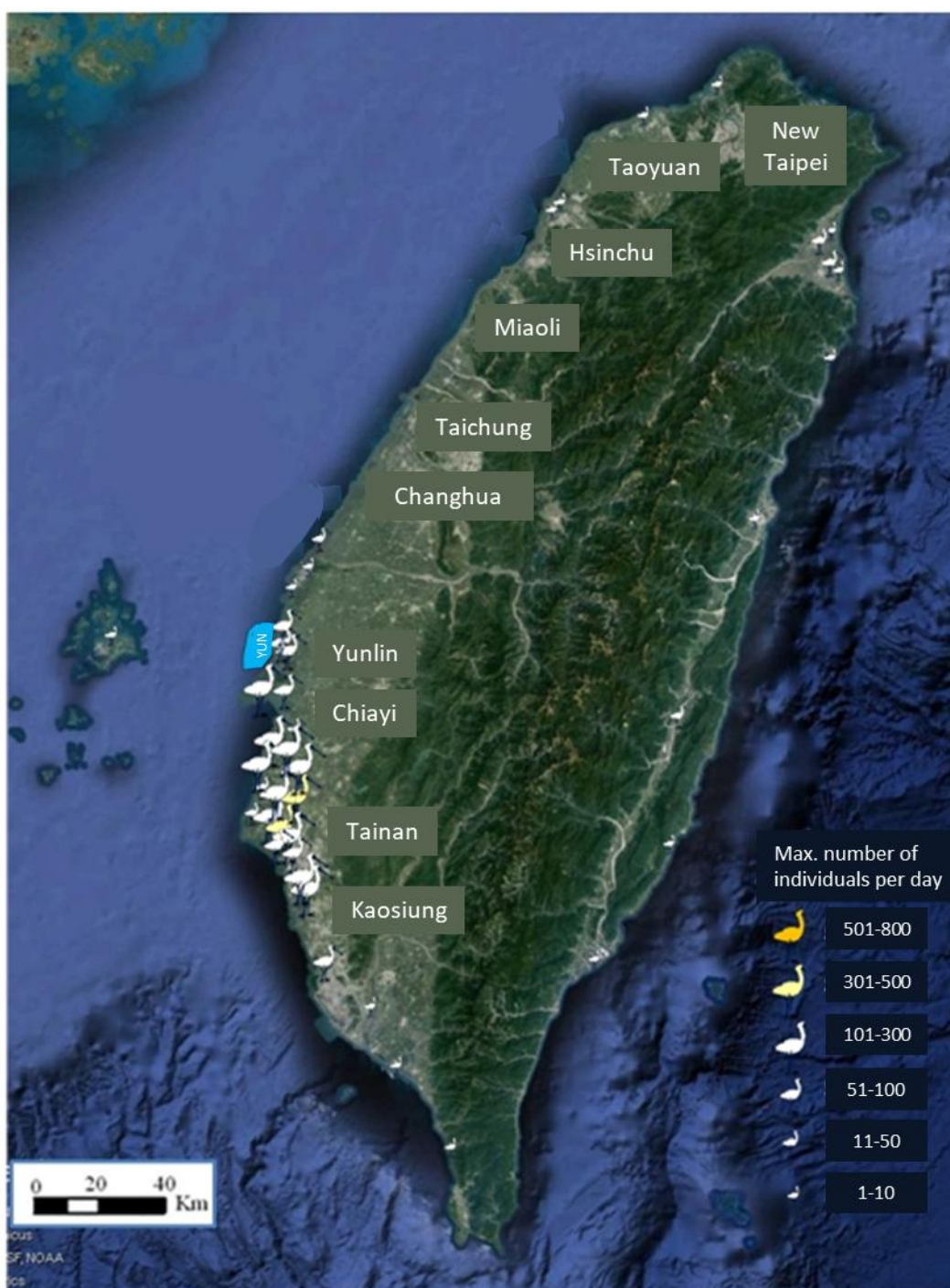
occurred in Tainan during BFS's wintering season in Taiwan. Since then, Tainan City Government has been cooperating with non-governmental organizations in developing a BFS rescuing process that includes BFS rescuing tasks and habitat maintenance carried out every year. If BFS with suspected Botulism 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  $\leq 3$  years.



Source of data: eBird Taiwan (2019.12-2020.2)

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

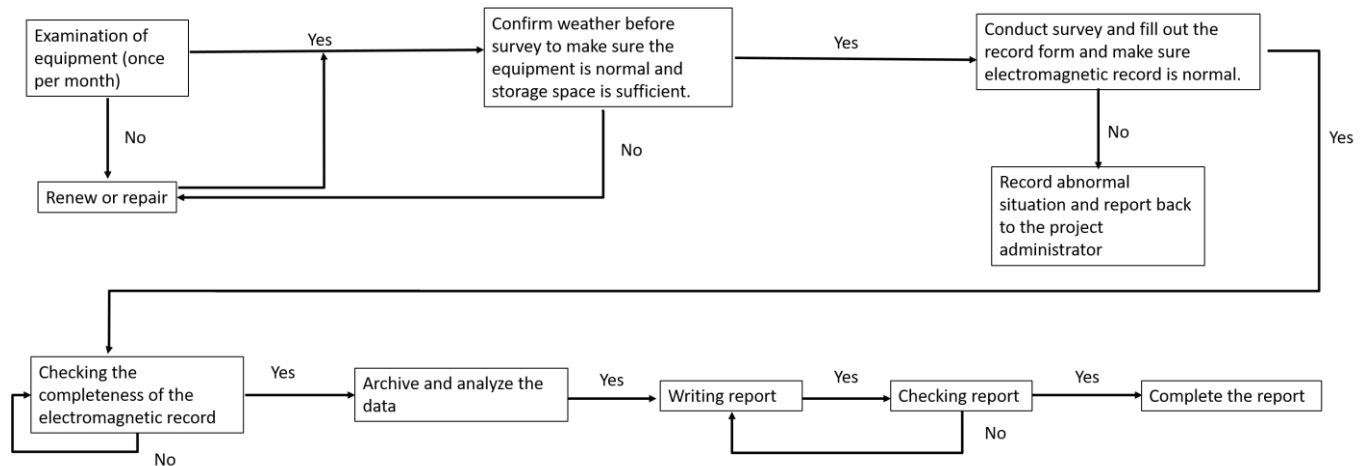


**Figure 1.4.2-2 Example of Foot-snare Trap**

## 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  $\leq 3$  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 16 times in Spring 2021 (March-May), monitoring location is shown in Figure 1.4.1-1; survey times this season are shown in Table 2.1-1.

**Table 2.1-1 Survey Times in spring 2021**

| Season         | Survey           | Survey Items      | Survey times                 |
|----------------|------------------|-------------------|------------------------------|
| 2021<br>Spring | 1 <sup>st</sup>  | Marine radar      | 15 Mar. 06:17– 16 Mar. 06:19 |
|                |                  | Set visual survey | 15 Mar. 06:00–18:00          |
|                | 2 <sup>nd</sup>  | Marine radar      | 16 Mar. 06:21–17 Mar. 06:25  |
|                |                  | Set visual survey | 16 Mar. 06:00–18:00          |
|                | 3 <sup>rd</sup>  | Marine radar      | 17 Mar. 06:30–18 Mar. 06:40  |
|                |                  | Set visual survey | 17 Mar. 06:00–18:00          |
|                | 4 <sup>th</sup>  | Marine radar      | 18 Mar. 06:49–19 Mar. 06:50  |
|                |                  | Set visual survey | 18 Mar. 06:00–18:00          |
|                | 5 <sup>th</sup>  | Marine radar      | 27 Mar. 05:47–28 Mar. 05:50  |
|                |                  | Set visual survey | 27 Mar. 06:00–18:00          |
|                | 6 <sup>th</sup>  | Marine radar      | 28 Mar. 06:03–29 Mar. 06:04  |
|                |                  | Set visual survey | 28 Mar. 06:00–18:00          |
|                | 7 <sup>th</sup>  | Marine radar      | 29 Mar. 06:07–30 Mar. 06:08  |
|                |                  | Set visual survey | 29 Mar. 06:00–18:00          |
|                | 8 <sup>th</sup>  | Marine radar      | 30 Mar. 06:12–31 Mar. 06:12  |
|                |                  | Set visual survey | 30 Mar. 06:00–18:00          |
|                | 9 <sup>th</sup>  | Marine radar      | 31 Mar. 06:12– 1 Apr. 06:13  |
|                |                  | Set visual survey | 31 Mar. 06:00–18:00          |
|                | 10 <sup>th</sup> | Marine radar      | 1 Apr. 06:14–2 Apr. 06:15    |
|                |                  | Set visual survey | 1 Apr. 06:00–18:00           |
|                | 11 <sup>th</sup> | Marine radar      | 12 May 09:00–13 May 09:01    |
|                |                  | Set visual survey | 12 May 05:30–17:30           |
|                | 12 <sup>th</sup> | Marine radar      | 13 May 09:03–14 May 09:04    |
|                |                  | Set visual survey | 13 May 5:30–17:30            |
|                | 13 <sup>th</sup> | Marine radar      | 19 May 07:32–20 May 07:33    |
|                |                  | Set visual survey | 19 May 05:15–17:15           |
|                | 14 <sup>th</sup> | Marine radar      | 20 May 07:34–21 May 07:36    |
|                |                  | Set visual survey | 20 May 05:15–17:15           |
|                | 15 <sup>th</sup> | Marine radar      | 21 May 07:50–22 May 07:51    |
|                |                  | Set visual survey | 21 May 05:00–17:00           |
|                | 16 <sup>th</sup> | Marine radar      | 22 May 07:52–23 May 07:54    |
|                |                  | Set visual survey | 22 May 05:00–17:00           |

Note: 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

The third radar survey began at 6:30 hr, the largest wind velocity recorded during bird activity was recorded at 10.3 m/s, sea state reached “moderate sea” conditions; the fourth radar survey began at 6:49 hr, the largest wind velocity recorded during bird activity was recorded at 9.0 m/s, sea state reached “moderate sea” conditions; the thirteenth radar survey began at 7:32 hr, the largest wind velocity recorded during bird activity was recorded at 14.6 m/s, sea state reached “rough sea” conditions; and the fourteenth radar survey began at 7:34 hr, the largest wind velocity recorded during bird activity was recorded at 9.0 m/s, sea state reached “moderate sea” conditions. The detailed information is as shown in Table 1 Raw Data for Horizontal Radar, Appendix 2.2. Rain was not recorded during the survey period.

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

### 1. Recorded species

In total, 85 individuals were recorded during visual survey from a fixed position as shown in Table 2.1-2. No birds were recorded during the March 17<sup>th</sup> and 18<sup>th</sup> surveys. 8 total species were recorded, with Red-necked phalarope contributing the most individuals (n = 27) and 1 protected species was recorded, which is the Greater crested tern (n=12), no BFS was recorded.

### 2. Flying altitude recorded during visual surveys

In regard to flying altitude, 85 individuals were recorded during visual survey, and the corresponding flying altitudes are as shown in Table 2.1-3. Flying altitude of all birds recorded in this season were below 50 m. Most individuals flew between 20-50 m (n=37).

### 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 0.4427 individuals/hr as shown in Table 2.1-4.

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

| Order               | Family         | Species                | Scientific Name               | Protected Level | Migratory Habit in | 2021 |      |     | Total |
|---------------------|----------------|------------------------|-------------------------------|-----------------|--------------------|------|------|-----|-------|
|                     |                |                        |                               |                 |                    | Mar. | Apr. | May |       |
| Procellariiformes   | Procellariidae | Streaked Shearwater    | <i>Calonectris leucomelas</i> | -               | Sea                | 1    | -    | 1   | 2     |
| Procellariiformes   | Procellariidae | Bulwer's Petrel        | <i>Bulweria bulwerii</i>      | -               | Sea                | 3    | -    | 4   | 7     |
| Charadriiformes     | Scolopacidae   | Red-necked phalarope   | <i>Phalaropus lobatus</i>     | -               | P                  | 11   | 9    | 7   | 27    |
| Procellariiformes   | Hydrobatidae   | Swinhoe's storm petrel | <i>Oceanodroma monorhis</i>   | -               | Sea                | 4    | -    | -   | 4     |
| Charadriiformes     | Laridae        | Whiskered tern         | <i>Chlidonias hybrida</i>     | -               | W, P               | 15   | 3    | -   | 18    |
| Charadriiformes     | Laridae        | European herring gull  | <i>Larus argentatus</i>       | -               | W                  | 4    | -    | -   | 4     |
| Charadriiformes     | Laridae        | Greater crested tern   | <i>Thalasseus bergii</i>      | II              | S                  | 6    | -    | 6   | 12    |
| Charadriiformes     | Laridae        | Tern                   | <i>Sterna hirundo</i>         | -               | P                  | 7    | -    | 4   | 11    |
| Total (Individuals) |                |                        |                               |                 |                    | 51   | 12   | 22  | 85    |

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, "P" indicates passage bird.

Note 3: "-" indicates no data was recorded.

**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 |       |
| Procellariiformes   | Procellariidae | Streaked Shearwater    | -            | 2    | -     | -     | 2     |
| Procellariiformes   | Procellariidae | Bulwer's Petrel        | -            | 3    | 3     | 1     | 7     |
| Charadriiformes     | Scolopacidae   | Red-necked phalarope   | 5            | 4    | 3     | 15    | 27    |
| Procellariiformes   | Hydrobatidae   | Swinhoe's storm petrel | -            | -    | -     | 4     | 4     |
| Charadriiformes     | Laridae        | Whiskered tern         | -            | 4    | 3     | 11    | 18    |
| Charadriiformes     | Laridae        | European herring gull  | -            | 1    | 3     | -     | 4     |
| Charadriiformes     | Laridae        | Greater crested tern   | 4            | 3    | 5     | -     | 12    |
| Charadriiformes     | Laridae        | Tern                   | -            | -    | 5     | 6     | 11    |
| Total (Individuals) |                |                        | 9            | 17   | 22    | 37    | 85    |

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

| Order                  | Family         | Species                | 2021 Spring |        |        | Bird activity per hour |
|------------------------|----------------|------------------------|-------------|--------|--------|------------------------|
|                        |                |                        | March       | April  | May    |                        |
| Procellariiformes      | Procellariidae | Streaked Shearwater    | 0.0093      | -      | 0.0139 | 0.0104                 |
| Procellariiformes      | Procellariidae | Bulwer's Petrel        | 0.0278      | -      | 0.0556 | 0.0365                 |
| Charadriiformes        | Scolopacidae   | Red-necked phalarope   | 0.1019      | 0.7500 | 0.0972 | 0.1406                 |
| Procellariiformes      | Hydrobatidae   | Swinhoe's storm petrel | 0.0370      | -      | -      | 0.0208                 |
| Charadriiformes        | Laridae        | Whiskered tern         | 0.1389      | 0.2500 | -      | 0.0938                 |
| Charadriiformes        | Laridae        | European herring gull  | 0.0370      | -      | -      | 0.0208                 |
| Charadriiformes        | Laridae        | Greater crested tern   | 0.0556      | -      | 0.0833 | 0.0625                 |
| Charadriiformes        | Laridae        | Tern                   | 0.0648      | -      | 0.0556 | 0.0573                 |
| Total (individuals/hr) |                |                        | 0.4722      | 1.0000 | 0.3056 | 0.4427                 |

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

Note 2: 108 hrs of visual monitoring was conducted for the 9 surveys in March; 12 hrs of visual monitoring was conducted for the 1 survey in April; 72 hrs of visual monitoring was conducted for the 6 surveys in May.

### III. Marine Radar Survey

Radar monitoring includes survey results from horizontal and vertical radars. In spring (2020), 3,058 flying trajectories were recorded in the horizontal radar; 7,391 flying trajectories were recorded in the vertical radar. The number of echoes for each radar survey is shown in Table 2.1-5. The distribution figure of flying trajectory, direction, altitude, and time of each survey is shown as follows:

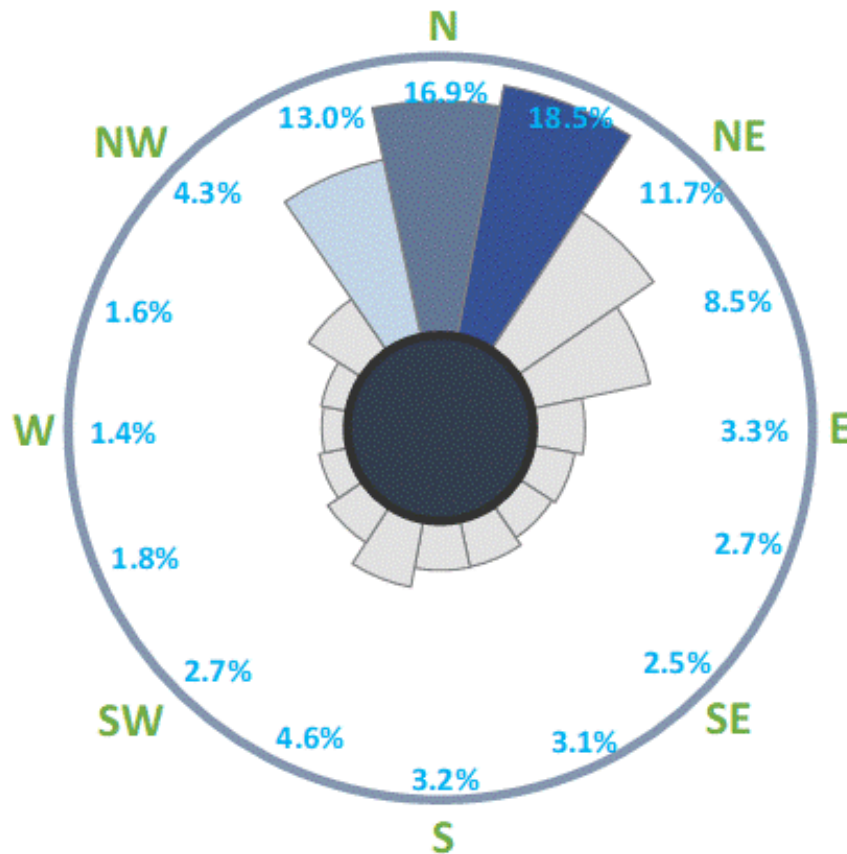
**Table 2.1-5 Number of Echoes from Marine Radar Survey**

| Survey           | Date             | Horizontal radar recordings | Vertical radar recordings |
|------------------|------------------|-----------------------------|---------------------------|
| 1 <sup>st</sup>  | 2021.03.15-16    | 213                         | 200                       |
| 2 <sup>nd</sup>  | 2021.03.16-17    | 184                         | 288                       |
| 3 <sup>rd</sup>  | 2021.03.17-18    | 17                          | 322                       |
| 4 <sup>th</sup>  | 2021.03.18-19    | 29                          | 500                       |
| 5 <sup>th</sup>  | 2021.03.27-28    | 464                         | 276                       |
| 6 <sup>th</sup>  | 2021.03.28-29    | 426                         | 98                        |
| 7 <sup>th</sup>  | 2021.03.29-30    | 455                         | 236                       |
| 8 <sup>th</sup>  | 2021.03.30-31    | 259                         | 611                       |
| 9 <sup>th</sup>  | 2021.03.31-04.01 | 290                         | 842                       |
| 10 <sup>th</sup> | 2021.04.01-02    | 287                         | 196                       |
| 11 <sup>th</sup> | 2021.05.12-13    | 100                         | 390                       |
| 12 <sup>th</sup> | 2021.05.13-14    | 69                          | 375                       |
| 13 <sup>th</sup> | 2021.05.19-20    | 11                          | 736                       |
| 14 <sup>th</sup> | 2021.05.20-21    | 16                          | 863                       |
| 15 <sup>th</sup> | 2021.05.21-22    | 27                          | 517                       |
| 16 <sup>th</sup> | 2021.05.22-23    | 211                         | 941                       |
| Total            |                  | 3,058                       | 7,391                     |

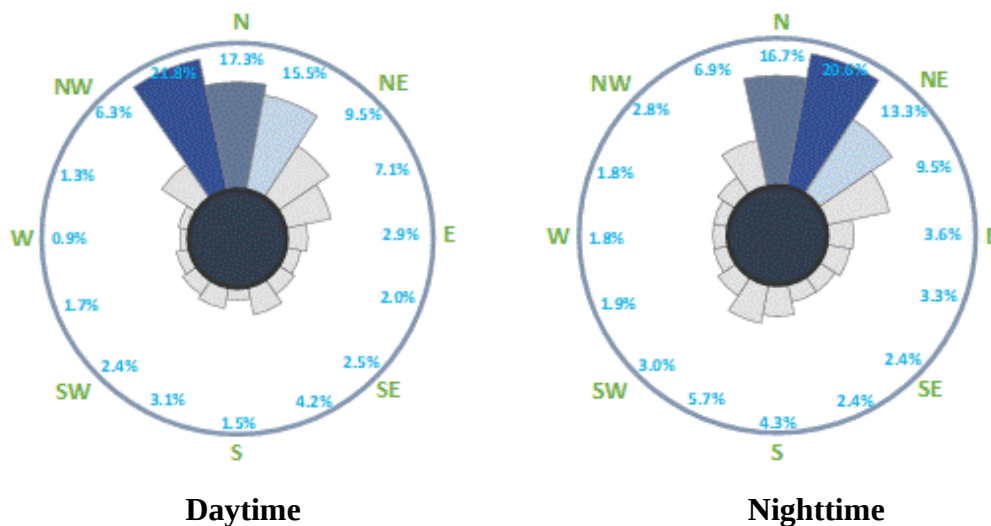
## 1. Flying direction and speed

The flying direction of birds was analyzed using results from the horizontal radar. The main flying direction during the survey period was toward NNE (566 records), which is 18.5% of recorded trajectories by the horizontal radar. The second main flying direction was toward N (518 records), with 16.9% of recorded trajectories by the horizontal radar (Figure 2.1-1). Comparison of daytime and nighttime data indicate that, main flying direction in daytime was NNW, accounting for 21.8%. Main flying direction in nighttime was NNE, accounting for 20.6% (Figure 2.1-2). The flying trajectories recorded during each survey are shown in Figure 2.1-3 to Figure 2.1-18.

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 2,517 total trajectories with more than 1 km of distance. The main flying speed of birds is between 5-8 m/s and 8-11 m/s, with 1,037 (41.2%) and 1,034 (41.1%) total recordings (Figure 2.1-9). The average flying speed this quarter is  $8.0 \pm 3.1$  m/s.

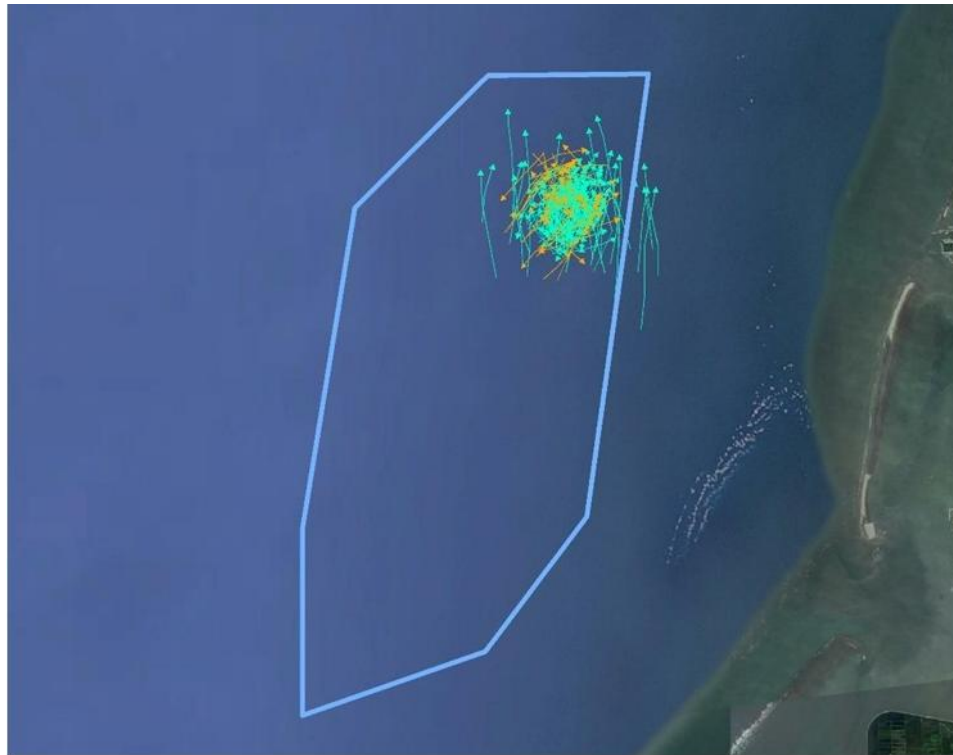


**Figure 2.1-1 Bird Flying Direction from Horizontal Radar of the 16 surveys in spring 2021 (24hr)**



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 16 surveys in spring 2021**



## Legend

 Wind farm area

 1100315 Day

 1100315 Night



## Legend

 Wind farm area

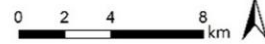
 1100315\_ Day



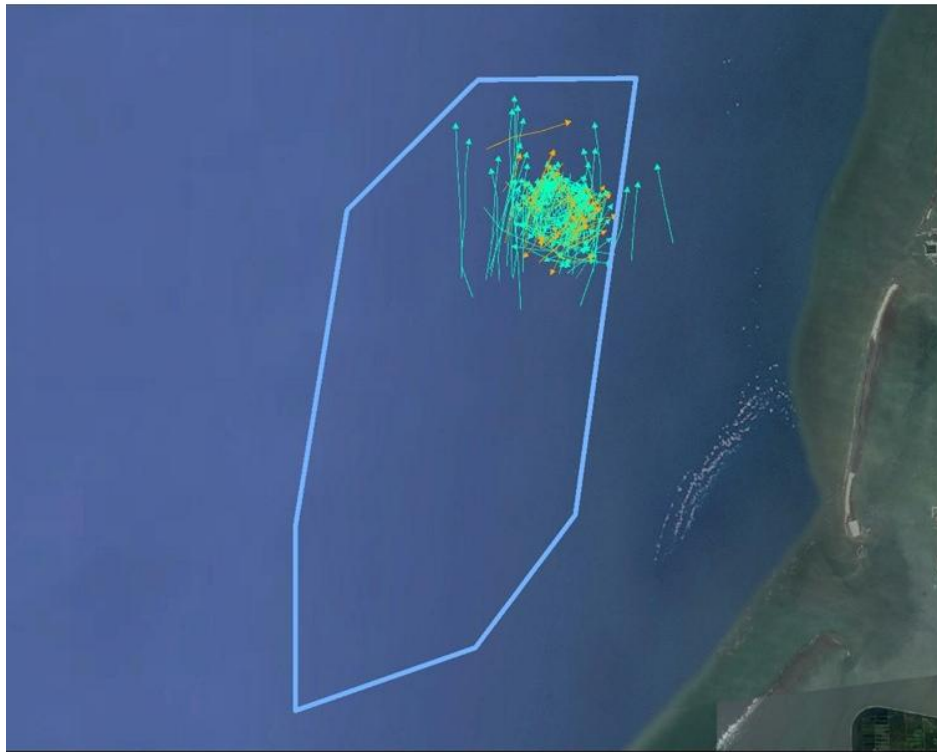
## Legend

 Wind farm area

 1100315\_ Night



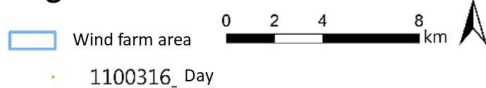
**Figure 2.1-3 Flying Trajectories from the First Horizontal Radar Survey (Mar. 15<sup>th</sup> 2021)**



## Legend



## Legend



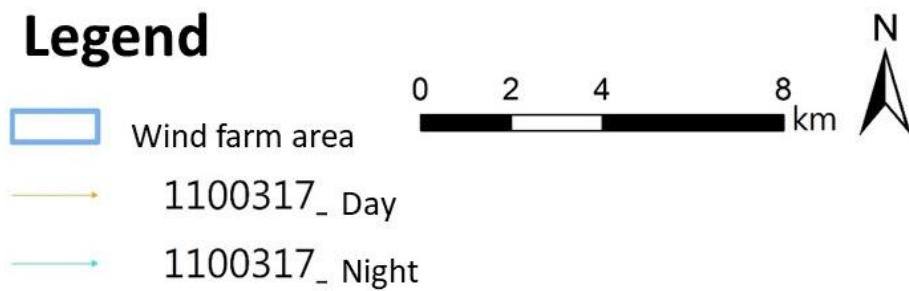
## Legend



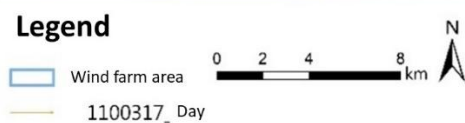
**Figure 2.1-4 Flying Trajectories from the Second Horizontal Radar Survey (Mar. 16<sup>th</sup> 2021)**



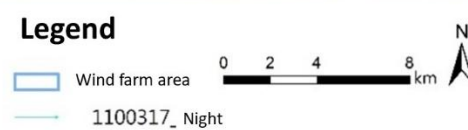
## Legend



## Legend



## Legend



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 (Mar. 17<sup>th</sup> 2021)**



## Legend

-  Wind farm area
-  1100318\_ Day
-  1100318\_ Night



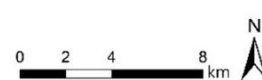
## Legend

-  Wind farm area
-  1100318\_ Day



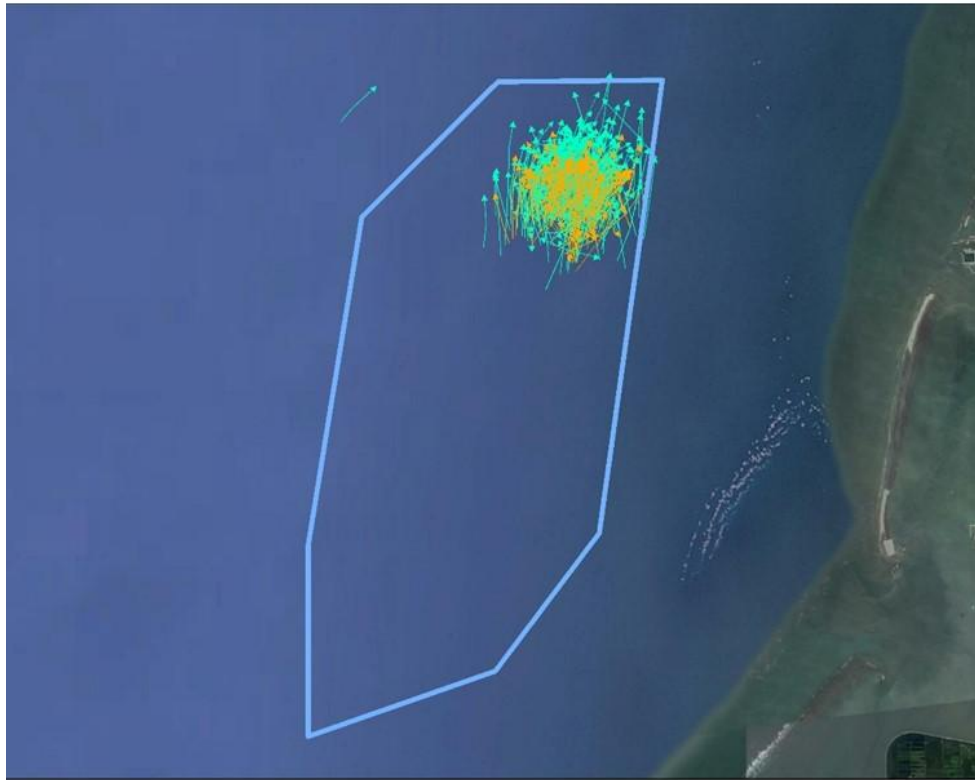
## Legend

-  Wind farm area
-  1100318\_ Night

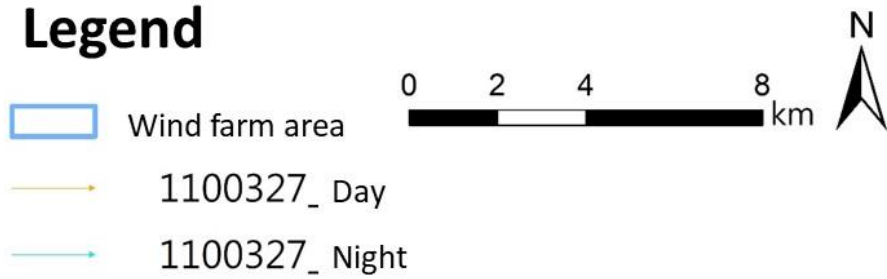


Note: Daytime is between 06:00 to 18:00; Nighttime is between 18:00 to 06:00

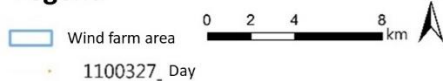
**Figure 2.1-6 Flying Trajectories from the Fourth Horizontal Radar Survey (Mar. 18<sup>th</sup> 2021)**



## Legend



## Legend

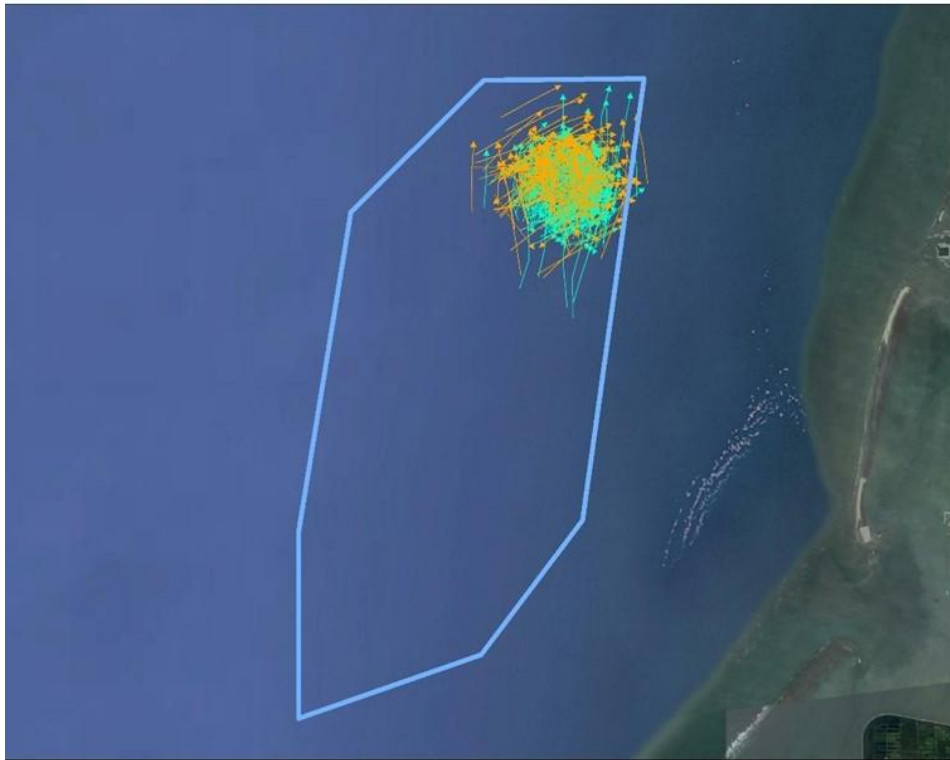


## Legend



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 (Mar. 27<sup>th</sup> 2021)**



## Legend

- Wind farm area
- 1100328\_ Day
- 1100328\_ Night



## Legend

- Wind farm area
- 1100328\_ Day

## Legend

- Wind farm area
- 1100328\_ Night

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

**Figure 2.1-8 Flying Trajectories from the Sixth Horizontal Radar Survey (Mar. 28<sup>th</sup> 2021)**



## Legend



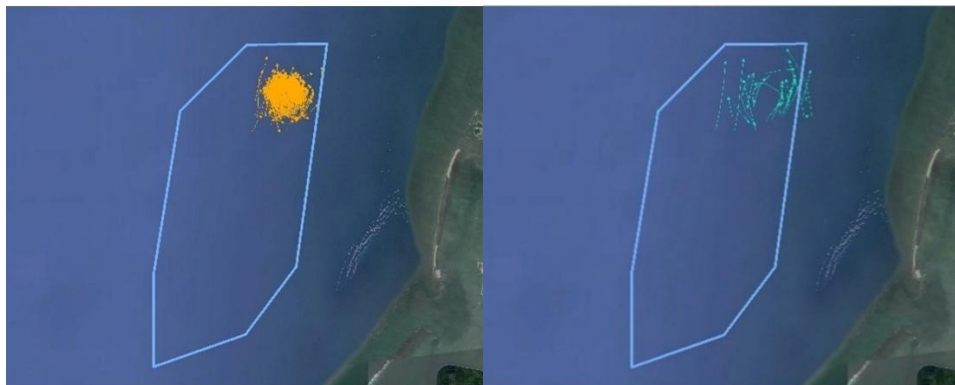
Wind farm area



1100329\_Day



1100329\_Night



## Legend



Wind farm area



1100329\_Day

## Legend



Wind farm area



1100329\_Night



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

**Figure 2.1-9 Flying Trajectories from the Seventh Horizontal Radar Survey (Mar. 29<sup>th</sup> 2021)**



## Legend



Wind farm area



1100330\_Day



1100330\_Night



## Legend



Wind farm area



1100330\_Day

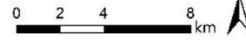
## Legend



Wind farm area



1100330\_Night

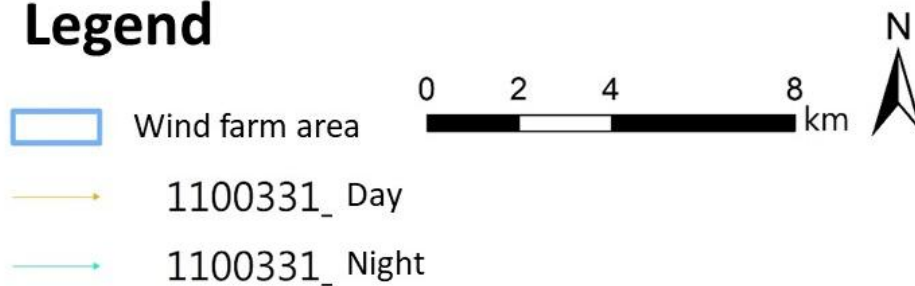


Note: Daytime is between 06:00 to 18:00; Nighttime is between 18:00 to 06:00

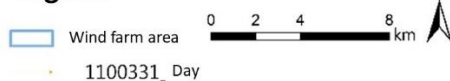
**Figure 2.1-10 Flying Trajectories from the Eighth Horizontal Radar Survey (Mar. 30<sup>th</sup> 2021)**



## Legend



## Legend



## Legend

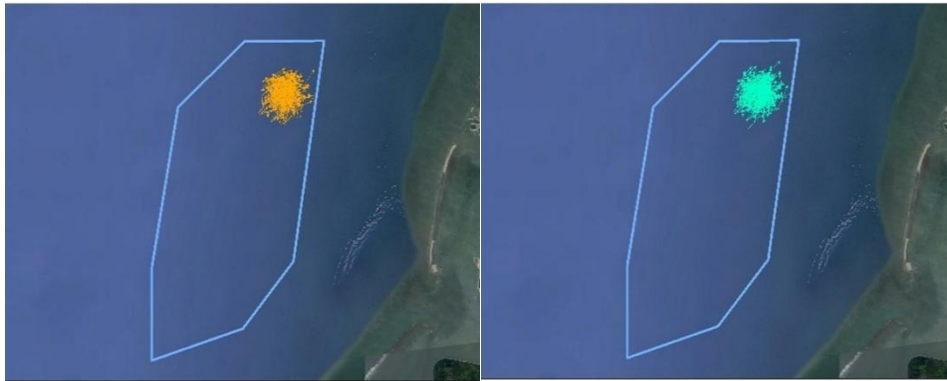


Note: Daytime is between 06:00 to 18:00; Nighttime is between 18:00 to 06:00

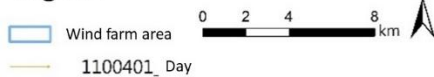
**Figure 2.1-11 Flying Trajectories from the Ninth Horizontal Radar Survey (Mar. 31<sup>st</sup> 2021)**



## Legend



## Legend



## Legend



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

**Figure 2.1-12 Flying Trajectories from the Tenth Horizontal Radar Survey (Apr. 1<sup>st</sup> 2021)**



## Legend

- Wind farm area
- 1100512\_ Day
- 1100512\_ Night



## Legend

- Wind farm area
- 1100512\_ Day



## Legend

- Wind farm area
- 1100512\_ Night



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

**Figure 2.1-13 Flying Trajectories from the Eleventh Horizontal Radar Survey (May 12<sup>th</sup> 2021)**



## Legend



## Legend



## Legend



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

**Figure 2.1-14 Flying Trajectories from the Twelfth Horizontal Radar Survey (Mar. 13<sup>th</sup> 2021)**



## Legend



Wind farm area



1100519\_ Day



1100519\_ Night



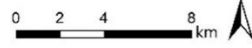
## Legend



Wind farm area



1100519\_ Day



## Legend



Wind farm area



1100519\_ Night



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

**Figure 2.1-15 Flying Trajectories from the Thirteenth Horizontal Radar Survey (May 19<sup>th</sup> 2021)**



## Legend



Wind farm area

0 2 4 8 km



1100520\_Day



1100520\_Night



## Legend



Wind farm area

0 2 4 8 km



1100520\_Day



## Legend



Wind farm area

0 2 4 8 km



1100520\_Night

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

**Figure 2.1-16 Flying Trajectories from the Fourteenth Horizontal Radar Survey (May 20<sup>th</sup> 2021)**



## Legend



Wind farm area



1100521\_ Day



1100521\_ Night



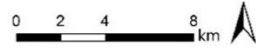
## Legend



Wind farm area



1100521\_ Day



## Legend



Wind farm area



1100521\_ Night



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

**Figure 2.1-17 Flying Trajectories from the Fifteenth Horizontal Radar Survey (Mar. 21<sup>st</sup> 2021)**



## Legend



Wind farm area



1100522\_ Day



1100522\_ Night



## Legend



Wind farm area



1100522\_ Day

## Legend



Wind farm area

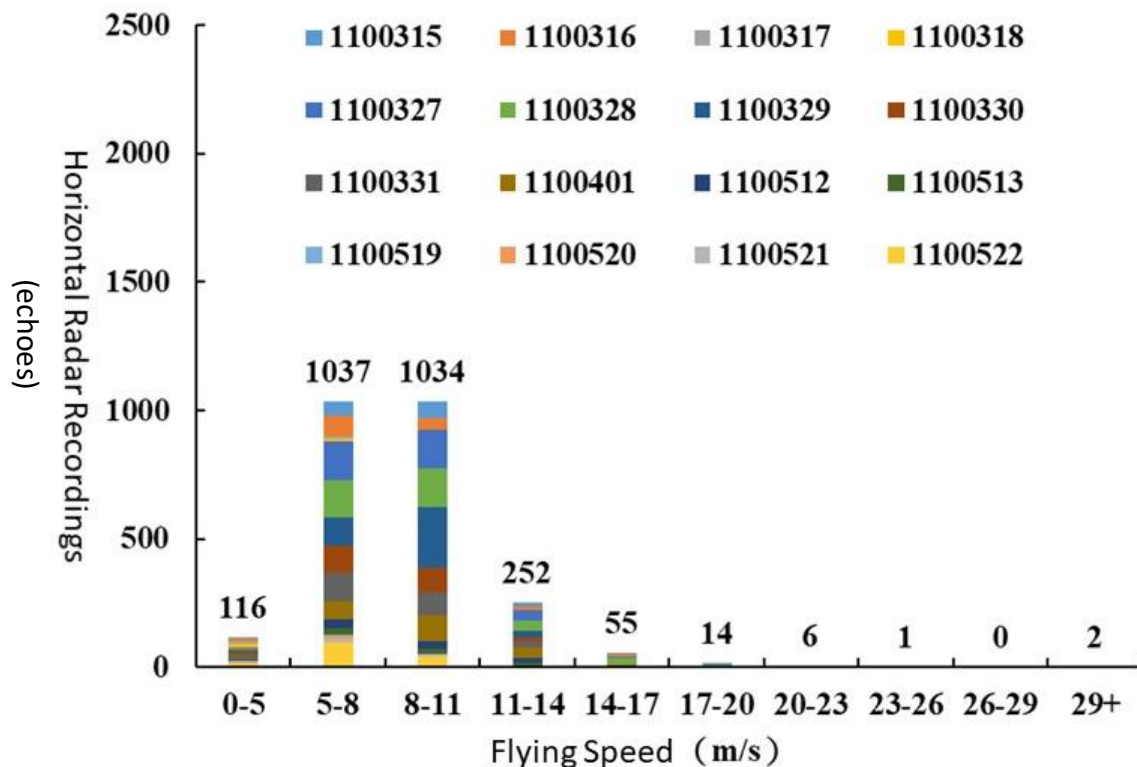


1100522\_ Night



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

**Figure 2.1-18 Flying Trajectories from the Sixteenth Horizontal Radar Survey (May 22<sup>nd</sup> 2021)**



**Figure 2.1-19 Flying Speed of Trajectories Over 1 km from Horizontal Radar between 1<sup>st</sup> of March to 31<sup>st</sup> of May 2021**

## 2. Flying altitude

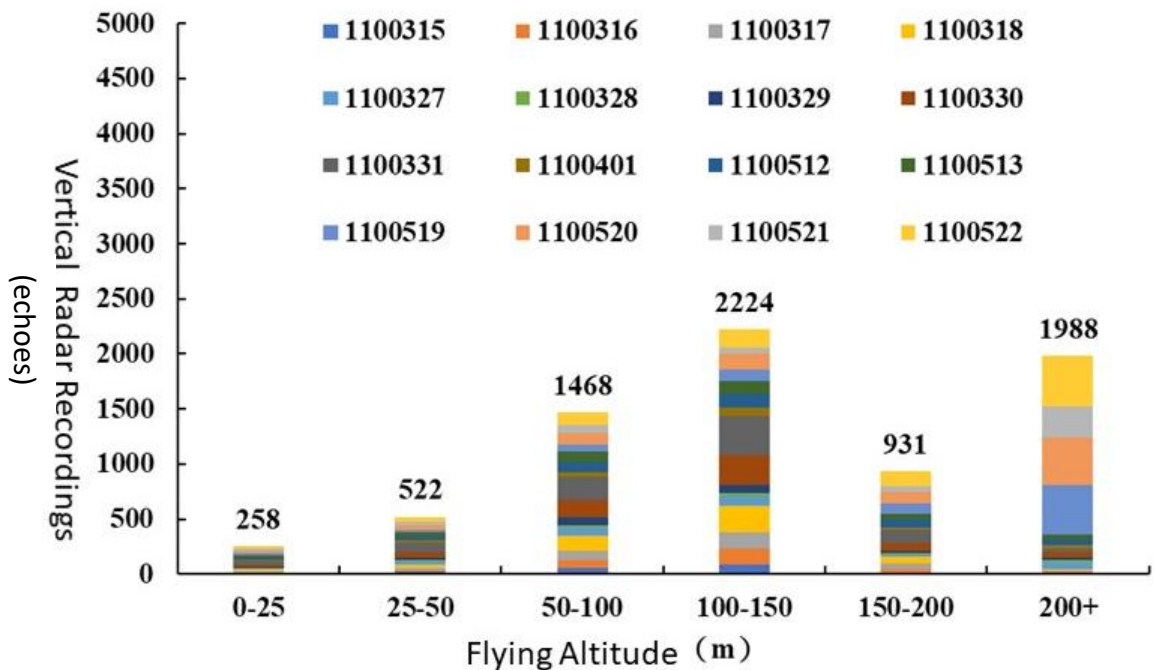
The flying altitude of birds was analyzed using results from the vertical radar. 7,391 records in total were recorded in the 16 surveys. Flying altitude of birds during migration appears most frequent between the 100-150 m range (2,224 records), which is 30.1% of total recordings (Figure 2.1-20 to Figure 2.1-21).

Comparison of daytime and nighttime data indicate there are no differences in results of flying altitude distribution between daytime and nighttime. Most recordings in both daytime and nighttime are between 100-150 m (28.0% in daytime and 30.5% in nighttime) (Figure 2.1-22). Whilst records within the sweeping area (25-200 m) during daytime accounts for 74.0% of the overall

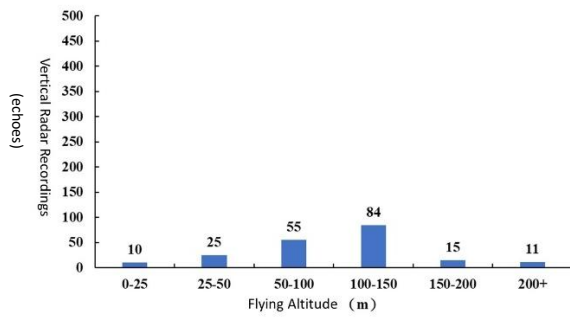
daytime recordings and 68.8% of the overall nighttime recordings. The average flying altitude this season is  $167.1 \pm 130.6$  m. (Figure 2.1-23 to Figure 2.1-24).

### 3. Time of flying activity

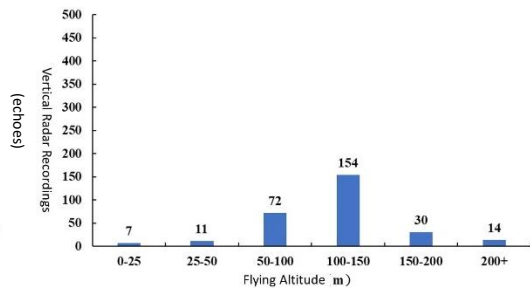
Overall results of the vertical radar survey indicate that flying activity of birds mostly occur during the night. For the vertical radar, flying birds observed between 18:00 to 06:00 accounts for 84.0% of the overall records (6,208 records) (Figure 2.1-25). The same is also indicated by results of horizontal surveys, with most recordings occurring during the nighttime, consisting of 59.0% of total recordings (Figure 2.1-26 to Figure 2.1.27).



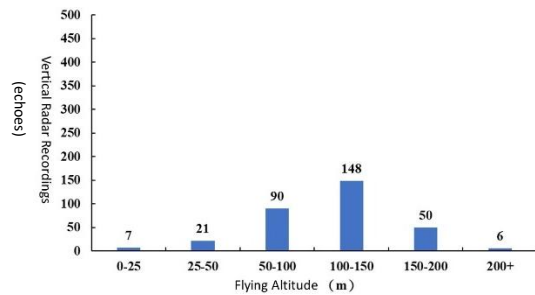
**Figure 2.1-20 Altitude Distribution from Vertical Radar between 1<sup>st</sup> of March to 31<sup>st</sup> of May 2021 (24 hrs)**



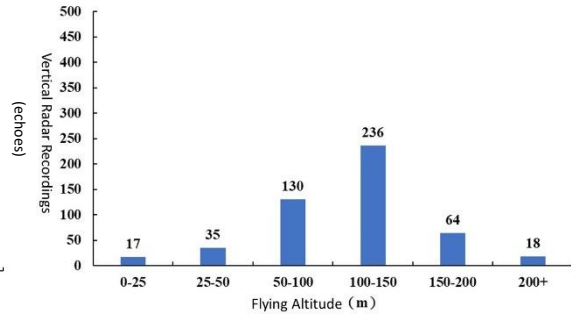
**1<sup>st</sup> Survey (2021.03.15)**



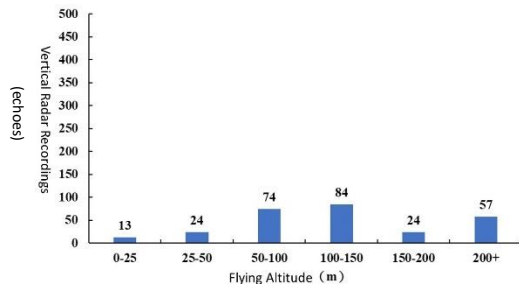
**2<sup>nd</sup> Survey (2021.03.16)**



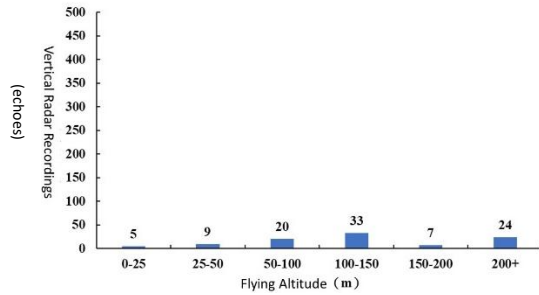
**3<sup>rd</sup> Survey (2021.03.17)**



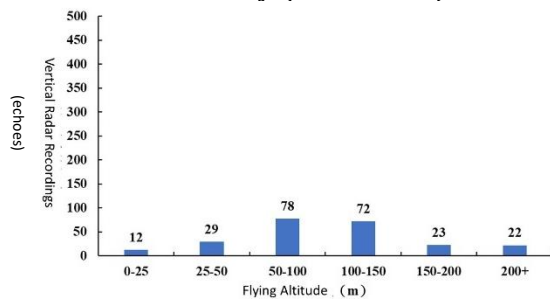
**4<sup>th</sup> Survey (2021.03.18)**



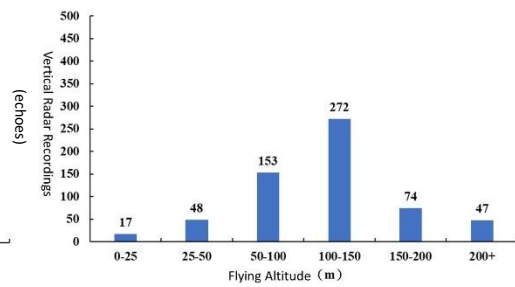
**5<sup>th</sup> Survey (2021.03.27)**



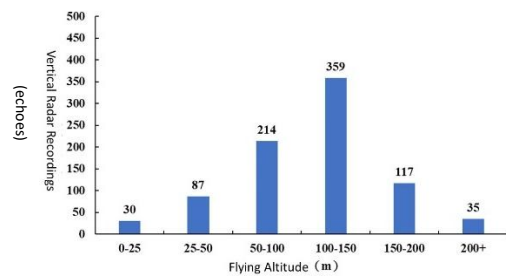
**6<sup>th</sup> Survey (2021.03.28)**



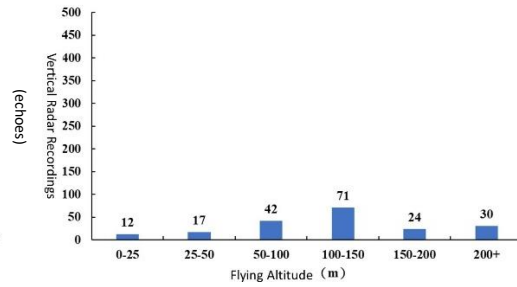
**7<sup>th</sup> Survey (2021.03.29)**



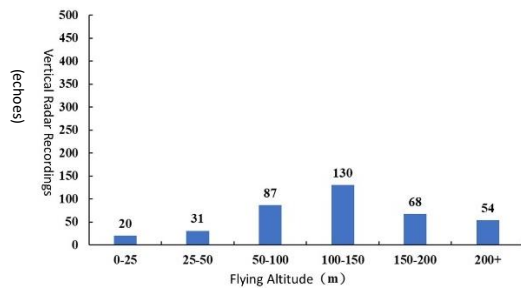
**8<sup>th</sup> Survey (2021.03.30)**



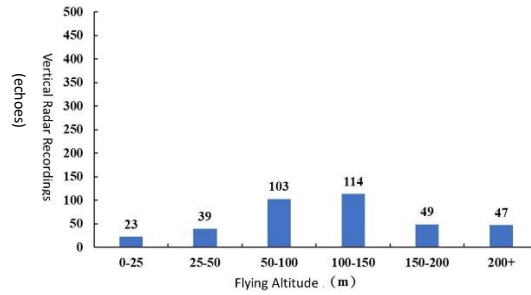
**9<sup>th</sup> Survey (2021.03.31)**



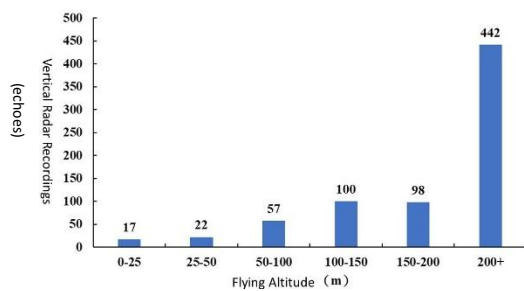
**10<sup>th</sup> Survey (2021.04.01)**



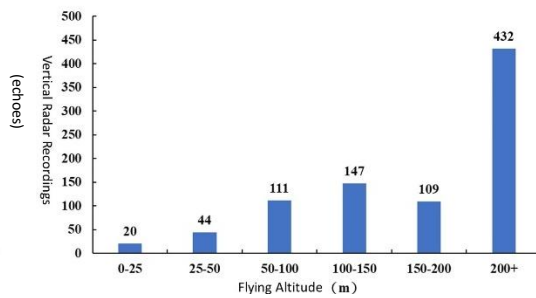
**11<sup>th</sup> Survey (2021.05.12)**



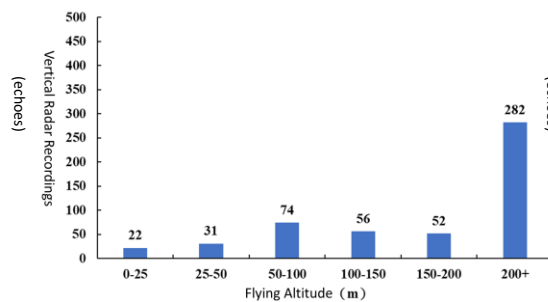
**12<sup>th</sup> Survey (2021.05.13)**



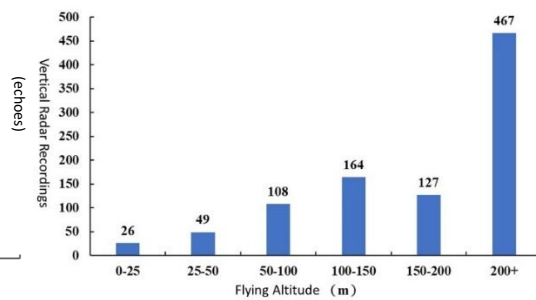
**13<sup>th</sup> Survey (2021.05.19)**



**14<sup>th</sup> Survey (2021.05.20)**

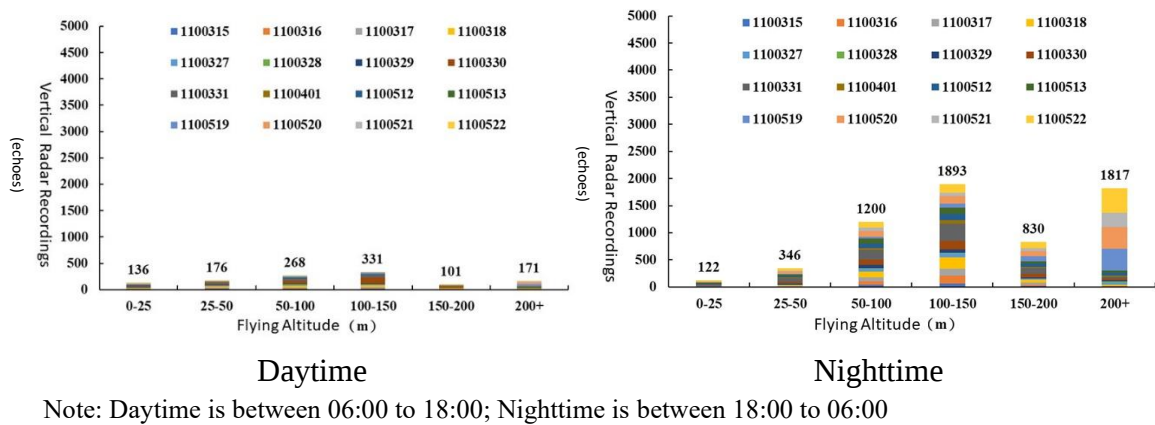


**15<sup>th</sup> Survey (2021.05.21)**

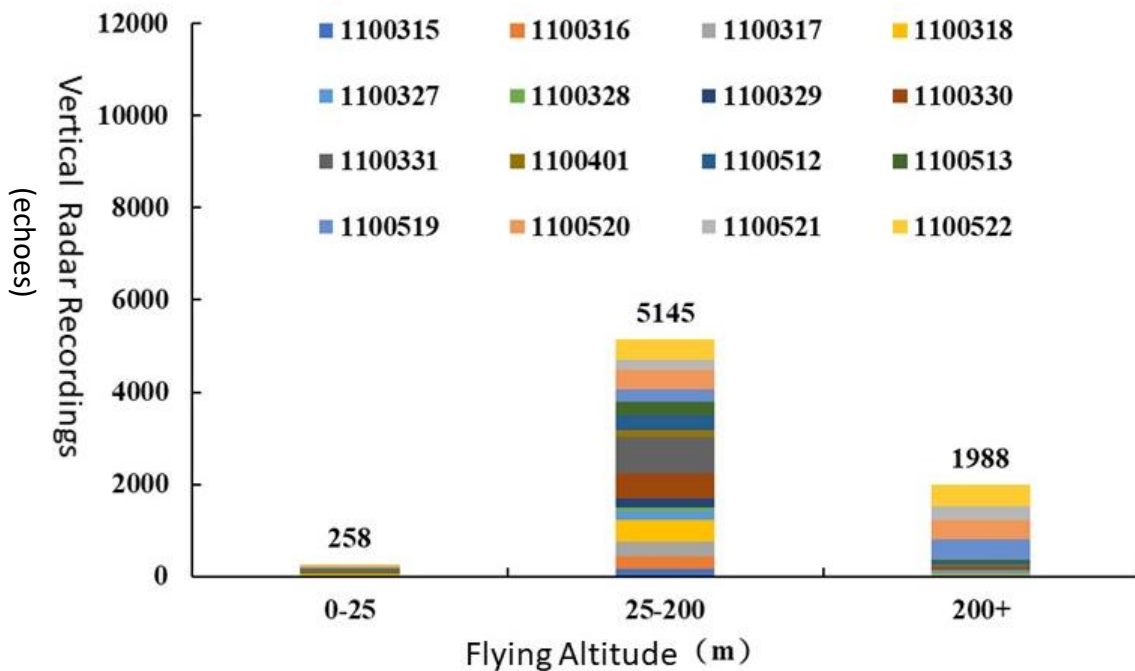


**16<sup>th</sup> Survey (2021.05.22)**

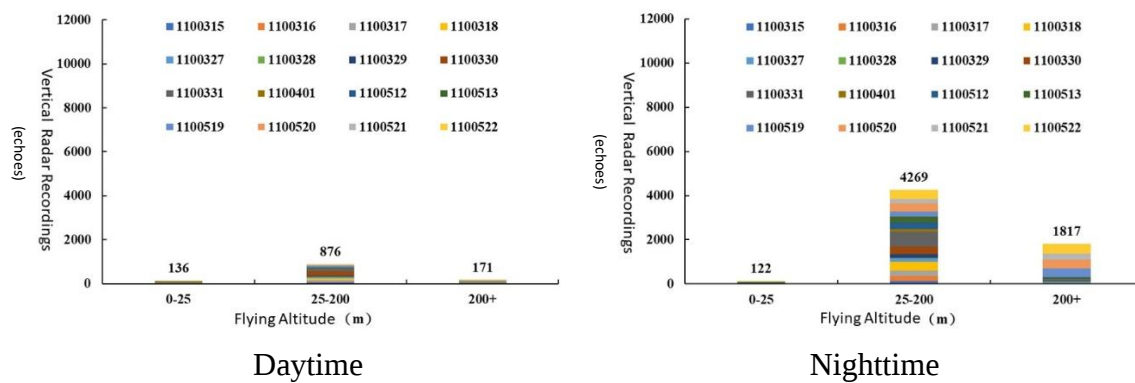
**Figure 2.1-21 Altitude Distribution from Vertical Radar (24hrs)  
between 1<sup>st</sup> of March to 31<sup>st</sup> of May 2021 (1<sup>st</sup>-16<sup>th</sup> survey)**



**Figure 2.1-22 Altitude Distribution during Daytime (left) and Nighttime (right) from Vertical Radar between 1<sup>st</sup> of March to 31<sup>st</sup> of May 2021**

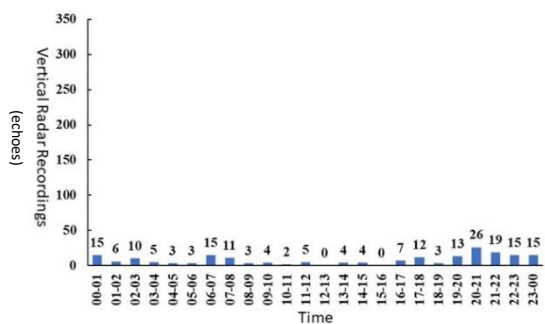


**Figure 2.1-23 Altitude Distribution within Sweeping Area from Vertical Radar between 1<sup>st</sup> of March to 31<sup>st</sup> of May 2021 (24 hrs)**

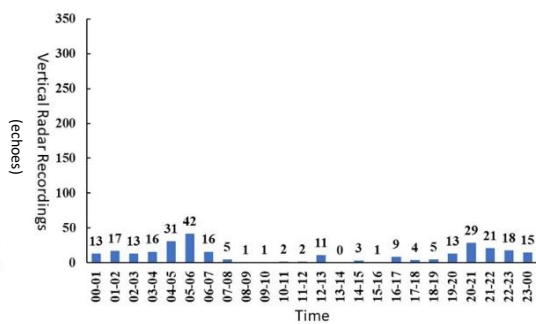


Note: Daytime is from 06:00 to 18:00; nighttime is from 18:00 to 06:00

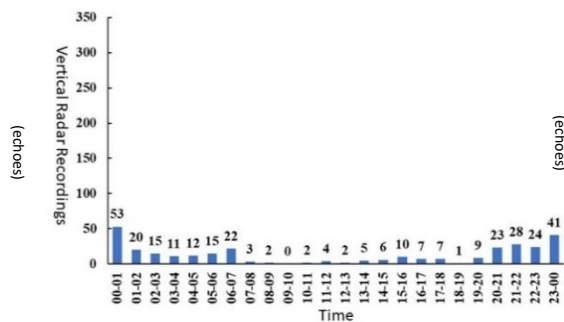
**Figure 2.1-24 Altitude Distribution during Daytime (left) and Nighttime (right) within Sweeping Area from Vertical Radar between 1<sup>st</sup> of March to 31<sup>st</sup> of May 2021**



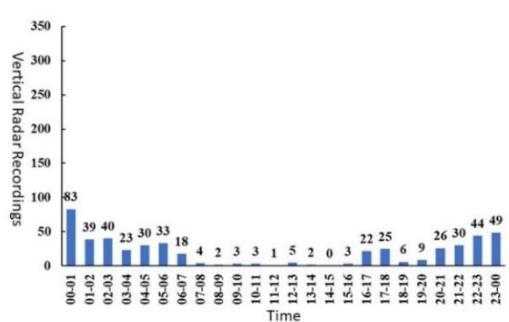
**1<sup>st</sup> Survey (2021.03.15)**



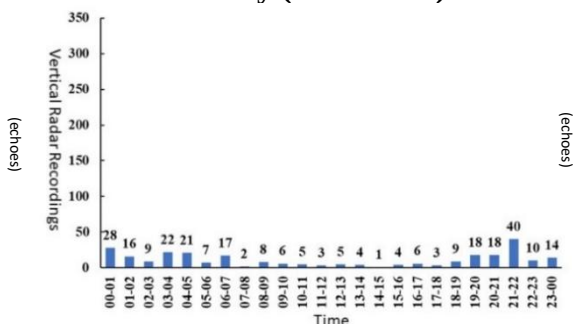
**2<sup>nd</sup> Survey (2021.03.16)**



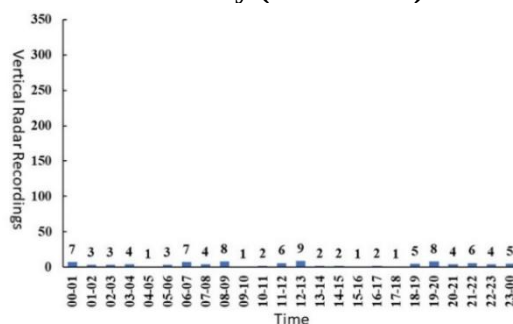
**3<sup>rd</sup> Survey (2021.03.17)**



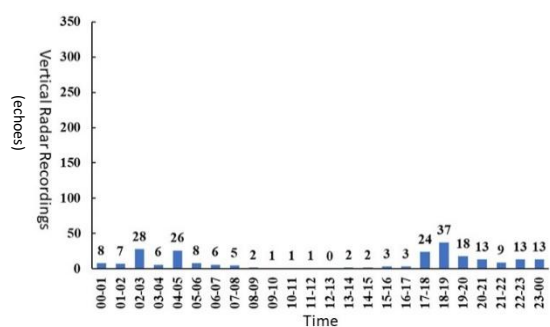
**4<sup>th</sup> Survey (2021.03.18)**



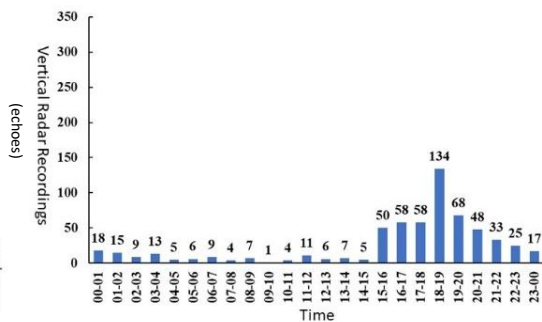
**5<sup>th</sup> Survey (2021.03.27)**



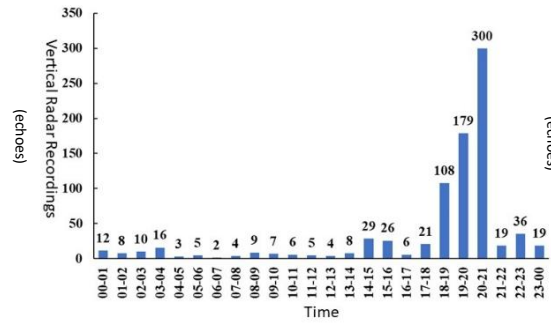
**6<sup>th</sup> Survey (2021.03.28)**



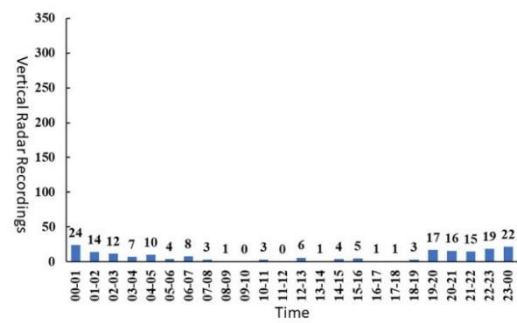
**7<sup>th</sup> Survey (2021.03.29)**



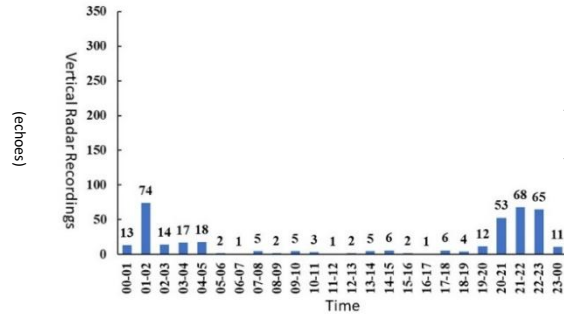
**8<sup>th</sup> Survey (2021.03.30)**



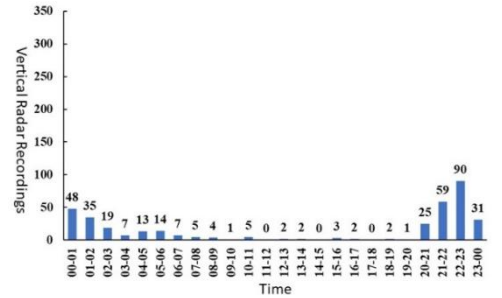
**9<sup>th</sup> Survey (2021.03.31)**



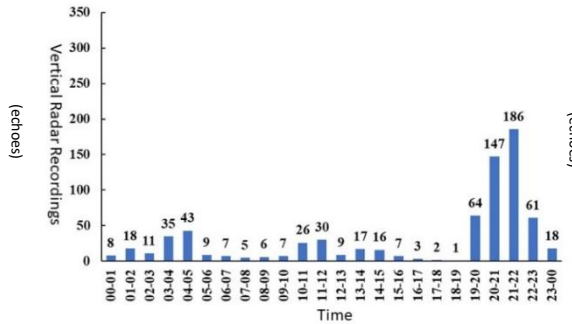
**10<sup>th</sup> Survey (2021.04.01)**



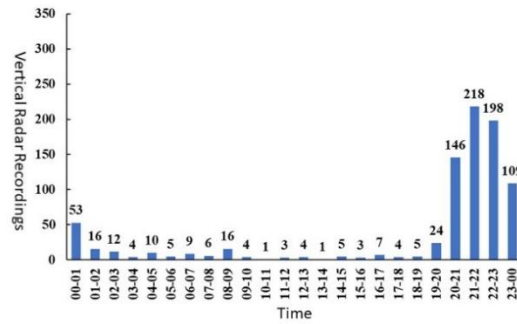
**11<sup>th</sup> Survey (2021.05.12)**



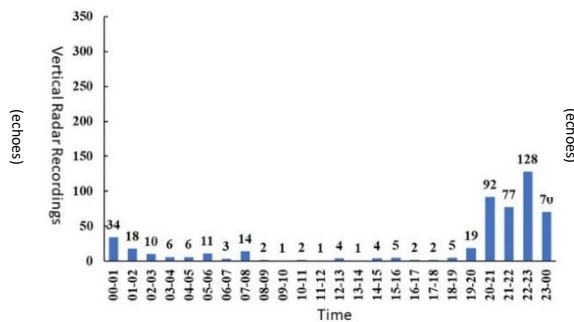
**12<sup>th</sup> Survey (2021.05.13)**



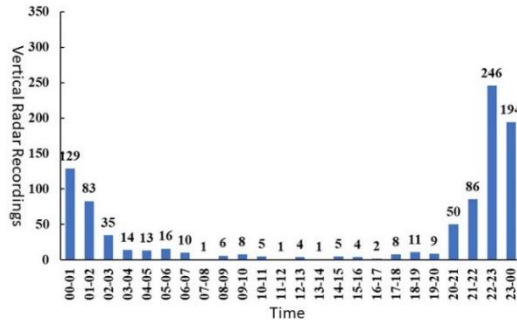
**13<sup>th</sup> Survey (2021.05.19)**



**14<sup>th</sup> Survey (2021.05.20)**

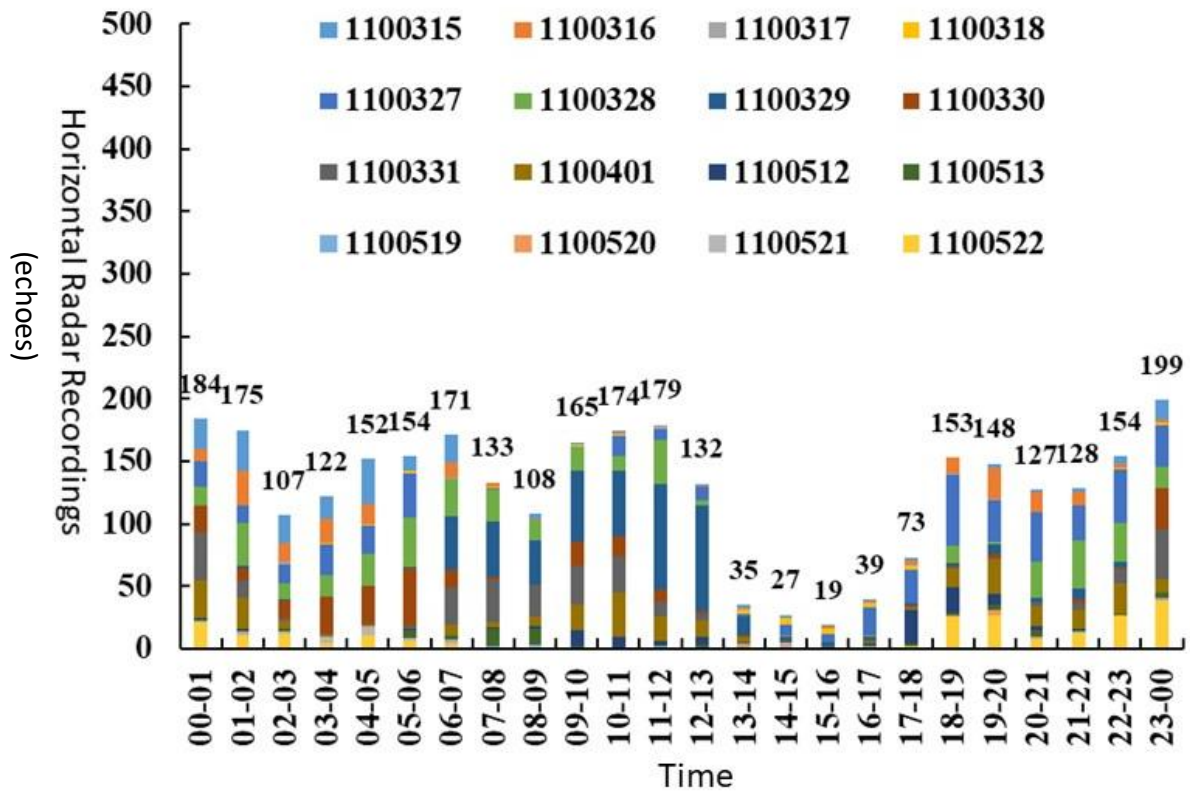


**15<sup>th</sup> Survey (2021.05.21)**

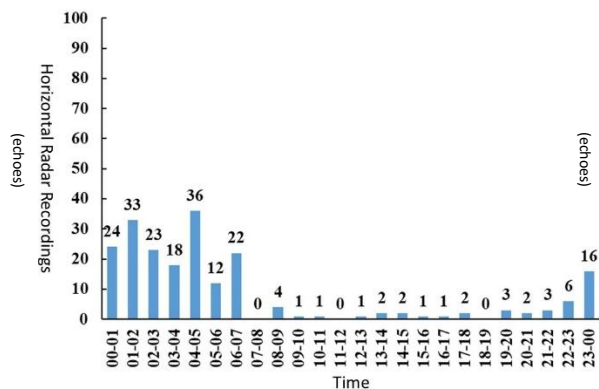


**16<sup>th</sup> Survey (2021.05.22)**

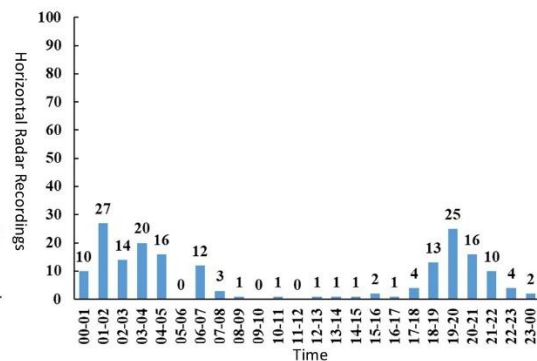
**Figure 2.1-25 Time Distribution from Vertical Radar between 1<sup>st</sup> of March to 31<sup>st</sup> of May 2021 (1<sup>st</sup>-16<sup>th</sup> survey)**



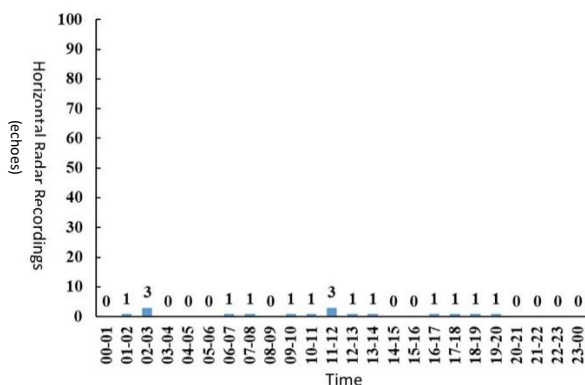
**Figure 2.1-26 Time Distribution from Horizontal Radar between 1<sup>st</sup> of March to 31<sup>st</sup> of May 2021**



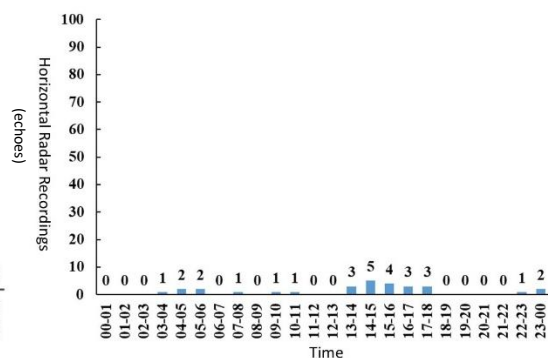
**1<sup>st</sup> Survey (2021.03.15)**



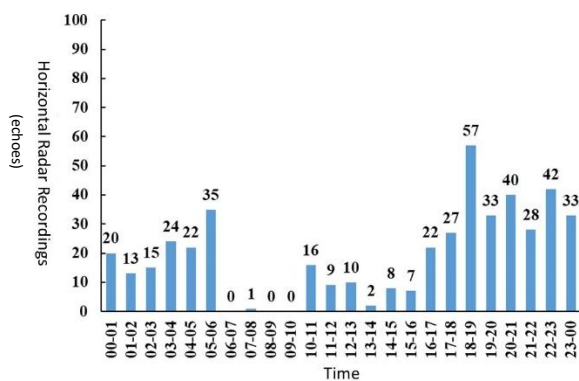
**2<sup>nd</sup> Survey (2021.03.16)**



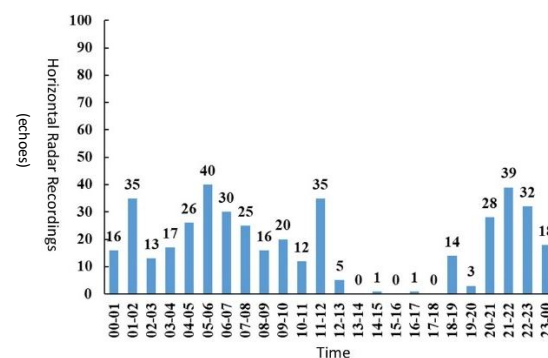
**3<sup>rd</sup> Survey (2021.03.17)**



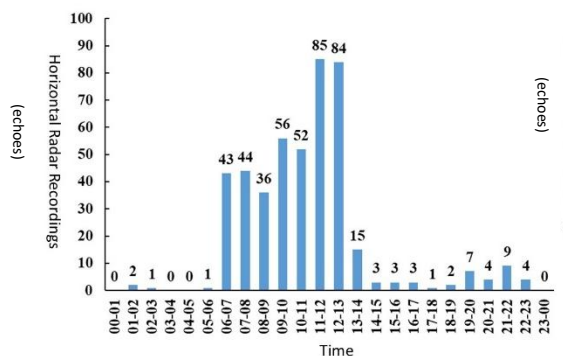
**4<sup>th</sup> Survey (2021.03.18)**



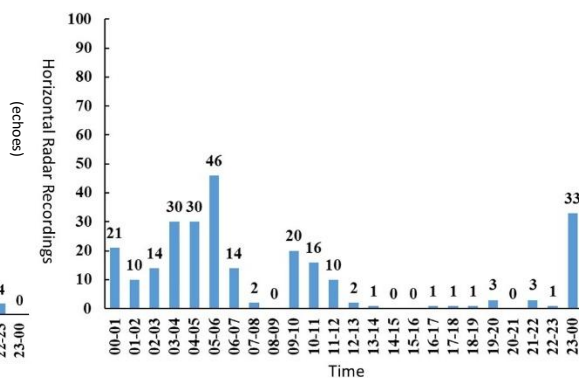
**5<sup>th</sup> Survey (2021.03.27)**



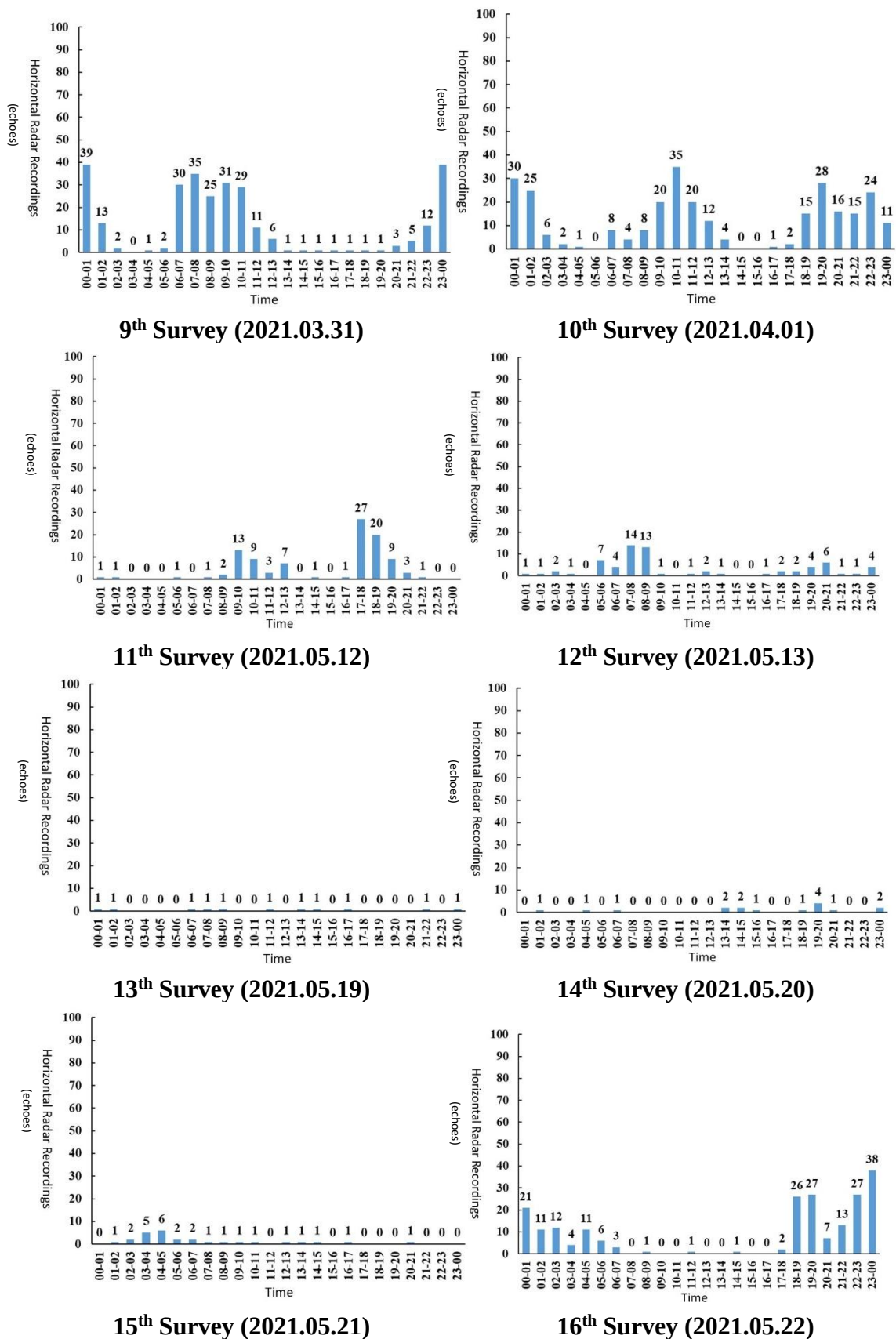
**6<sup>th</sup> Survey (2021.03.28)**



**7<sup>th</sup> Survey (2021.03.29)**



**8<sup>th</sup> Survey (2021.03.30)**



**Figure 2.1-27 Time Distribution from Horizontal Radar between 1<sup>st</sup> of March to 31<sup>st</sup> of May 2021 (1<sup>st</sup>-16<sup>th</sup> survey)**

## 2.2 Satellite Tracking Survey

The satellite tracking of BFS began in January, 2021. The survey results for this quarter 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, a transmitter was attached before releasing; another adult bird (T98-6833) got sick once again for unknown reason other than botulism infection on April 8<sup>th</sup>, the individual was released after recovering on April 30<sup>th</sup> and departed offshore on May 8<sup>th</sup>. As of June 13<sup>th</sup>, the transmitters for 2 individuals (N01-6819, N08-6823) malfunctioned in Taiwan after a brief tracking period, the remaining 14 individuals all successfully departed offshore. Among them, 1 individual lost signal in China (N04-6818); 2 individuals are currently tracked in China; 3 individuals lost signal in Korea (T97-6834, N09-6835, N05-6822); and 8 individuals are currently tracked in Korea.

**Table 2.2-1 Black-faced spoonbill tagging information**

| No. | Device | Age      | Tagging date | Tagging location      | Source  | International Identification band |                      |
|-----|--------|----------|--------------|-----------------------|---------|-----------------------------------|----------------------|
|     |        |          |              |                       |         | Number band                       | Colour band          |
| 1   | 6820   | Adult    | 2021/2/1     | Yanshui River, Tainan | Rescued | T95                               | White, blue, green   |
| 2   | 6834   | Adult    | 2021/2/1     | Sicao, Tainan         | Rescued | T97                               | White, green, red    |
| 3   | 6833   | Adult    | 2021/2/1     | Sicao, Tainan         | Rescued | T98                               | White, green, yellow |
| 4   | 6817   | Subadult | 2021/2/2     | Sicao, Tainan         | Rescued | T99                               | White, green, blue   |
| 5   | 6838   | Juvenile | 2021/2/3     | Budai, Chiayi         | Rescued | Y43                               | Yellow, blue, green  |

|    |      |          |           |                       |          |     |                     |
|----|------|----------|-----------|-----------------------|----------|-----|---------------------|
| 6  | 6814 | Adult    | 2021/2/4  | Sicao, Tainan         | Rescued  | T00 | White, green, white |
| 7  | 6830 | Adult    | 2021/2/4  | Yanshui River, Tainan | Captured | --  | Right brown         |
| 8  | 6837 | Subadult | 2021/2/4  | Qigu, Tainan          | Captured | --  | Right blue          |
| 9  | 6826 | Juvenile | 2021/2/5  | Qigu, Tainan          | Captured | --  | No band             |
| 10 | 6819 | Adult    | 2021/2/10 | Sicao, Tainan         | Rescued  | N01 | Blue, red           |
| 11 | 6831 | Juvenile | 2021/2/19 | Budai, Chiayi         | Rescued  | N02 | Blue, yellow        |
| 12 | 6053 | Subadult | 2021/2/19 | Budai, Chiayi         | Rescued  | N03 | Blue, green         |
| 13 | 6823 | Subadult | 2021/2/24 | Tucheng, Tainan       | Rescued  | N08 | Green, white        |
| 14 | 6835 | Juvenile | 2021/2/24 | Qigu, Tainan          | Rescued  | N09 | White, red          |
| 15 | 6818 | Adult    | 2021/2/27 | Qigu, Tainan          | Captured | N04 | Blue, white         |
| 16 | 6822 | Subadult | 2021/2/27 | Qigu, Tainan          | Captured | N05 | Green, red          |

## II. Date and Time of Offshore Activity

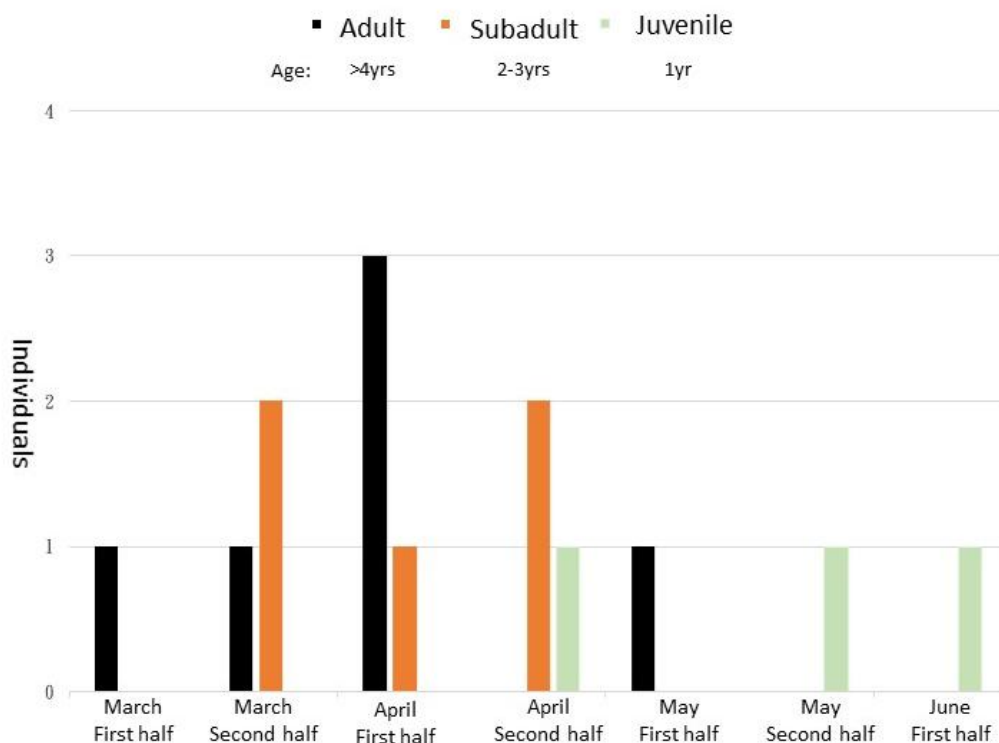
### 1. Date of Departure

In this survey, departure offshore during spring migration of BFS occurred between March 10<sup>th</sup> to June 13<sup>th</sup>. The first half (including the 15<sup>th</sup>) and second half of each month is separated on the 15<sup>th</sup>. 4 individuals (28.6%) departed in March; 7 individuals (50%) departed in April and is the main month for migration departure; 2 individuals departed in May; and 1 individual (7.1%) departed in June. The date of departure correlates with age, as the adult birds departed first, followed by subadult birds, then finally the yearlings (Figure 2.2-1). One adult bird (T98) 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 for migration in spring has been observed and described in the past (Chen, C. L. 2003). In addition, in the past some subadult birds have chosen to stay in Taiwan after 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  $\geq 3$  years old and started migration the earliest, were all BFS that are healthy and were captured. The dates for their departure were March 10<sup>th</sup>, 16<sup>th</sup> and 24<sup>th</sup>. In comparison, the 4 rescued adult/subadult birds that were  $\geq 3$  years old and started migration the earliest, departed around 2-3 weeks later. The dates for their departure were March 28<sup>th</sup>, April 7<sup>th</sup>, 8<sup>th</sup> and 12<sup>th</sup>.



Note 1: As 2 BFS lost signal before leaving Taiwan, the sample size of this data is n=14.

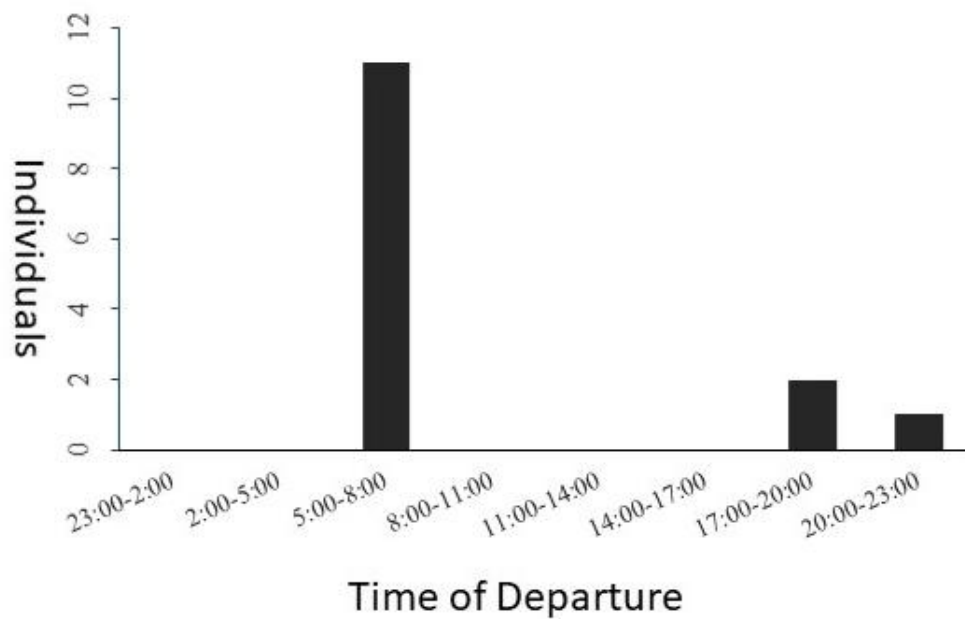
Note 2: The first half (including the 15<sup>th</sup>) and second half of each month is separated on the 15<sup>th</sup>.

**Figure 2.2-1 Departure Dates of Migrating BFS (n=14) up till 13<sup>th</sup> of June**

## 2. Time of Departure

In analysis of three hour periods, 11 individuals departed offshore

between 5:00 hr to 8:00 hr (accounting for 78.6%); 2 individuals departed offshore between 17:00 hr to 20:00 hr (accounting for 14.3%); and 1 individual departed offshore between 20:00 hr to 23:00 hr (accounting for 7.1%). The departure time for most BFS was during early morning, and departure also occurred between evening and midnight (Figure 2.2-2).

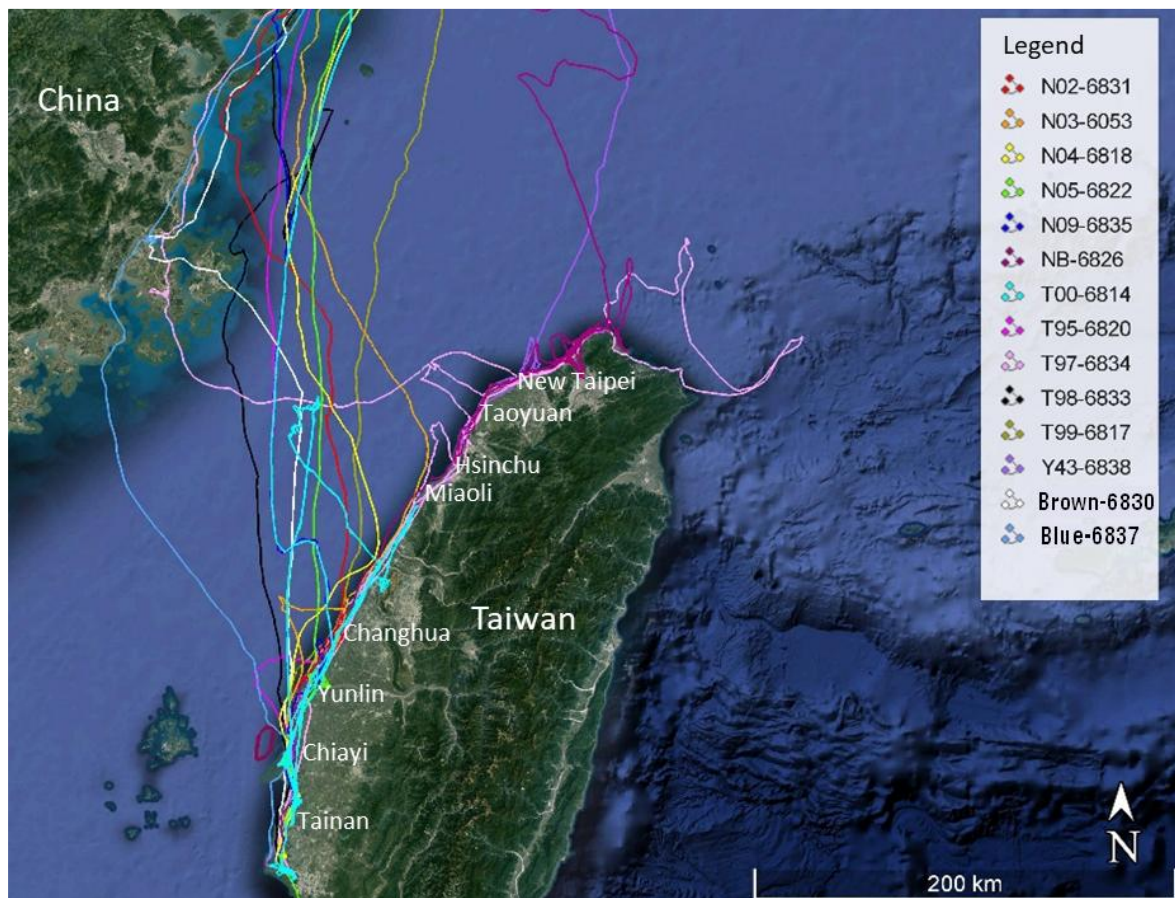


**Figure 2.2-2 BFS Departure Times from Taiwan up till 13<sup>th</sup> of June**

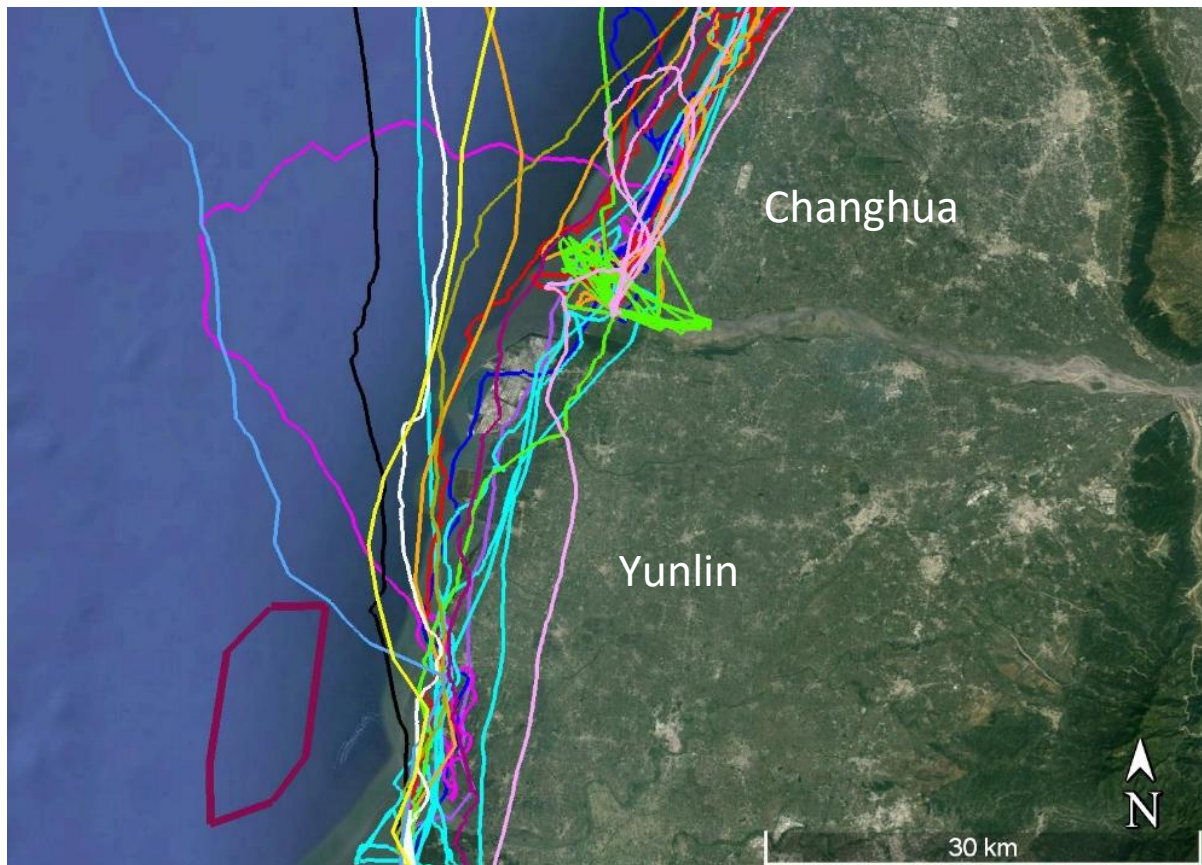
### 3. Spring Migration Route

Of the 16 satellite tracking BFS, the transmitters for 2 birds (N01-6819, N08-6823) malfunctioned in Taiwan after a brief tracking period, the remaining 14 birds all successfully departed offshore (Figure 2.2-3).

According to the departure routes, none of the BFS flew across the Yunlin wind farm. Only the bird (blue leg band-6837) that departed the earliest, on March 10<sup>th</sup>, 2021, almost passed the vicinity of the wind farm on its departure day, the departure route was 400 m away from the wind farm perimeter (Figure 2.2-4). After departing offshore, the 14 BFS flew northward along the coast of southeastern China. Among the 14 BFS, 11 individuals were observed heading to Korea, and flying routes of 10 individuals were successfully tracked, then from between Shanghai and Yancheng, China they departed towards their final destination-Korea (Figure 2.2-5).

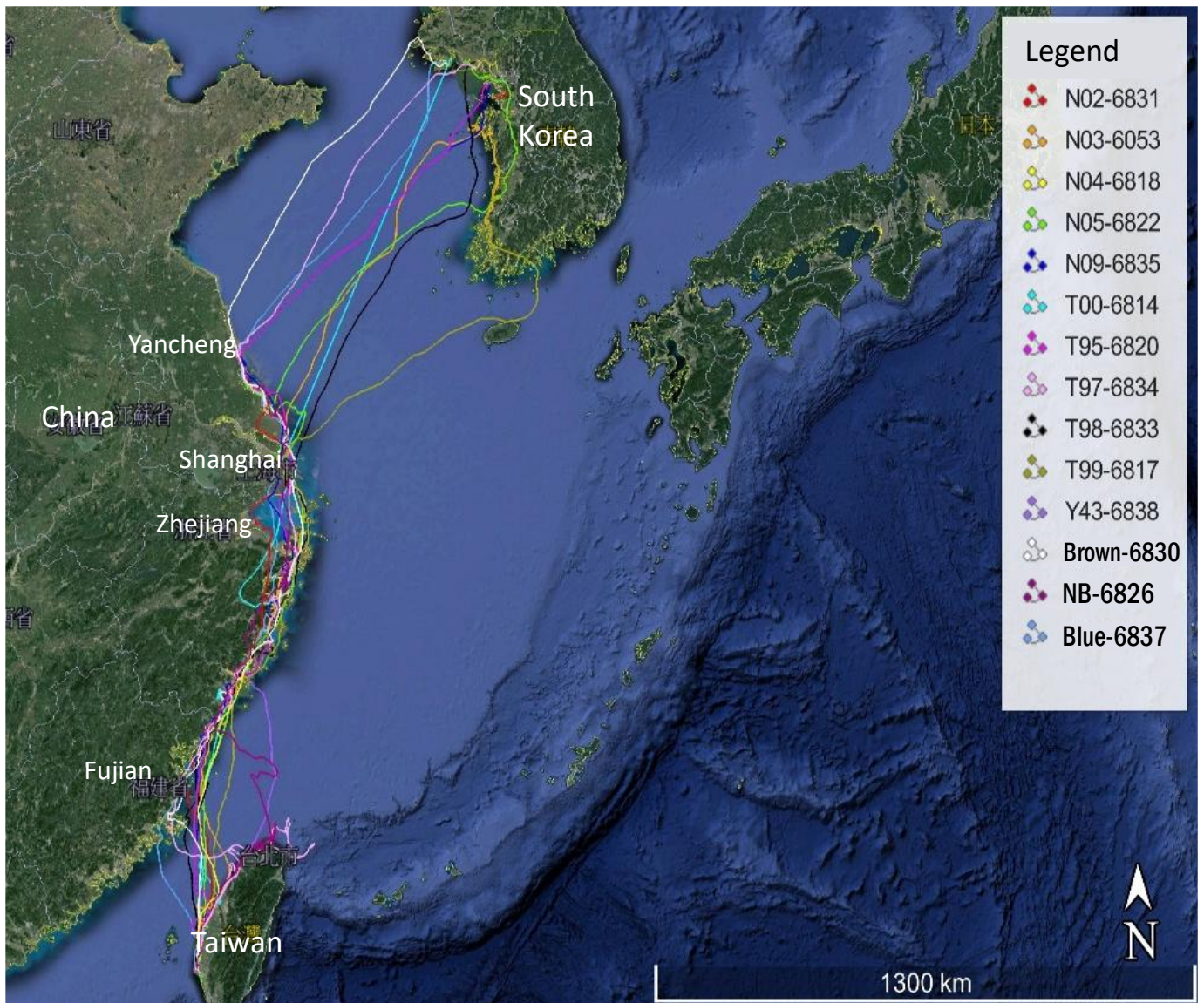


**Figure 2.2-3 Route of BFS (n=14) across Taiwan Strait during Northern Migration up till 13<sup>th</sup> of June**



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

**Figure 2.2-4 The First Departure of BFS (blue leg band-6837) that Passed the Vicinity of the Wind Farm Area on the Day of Departure**

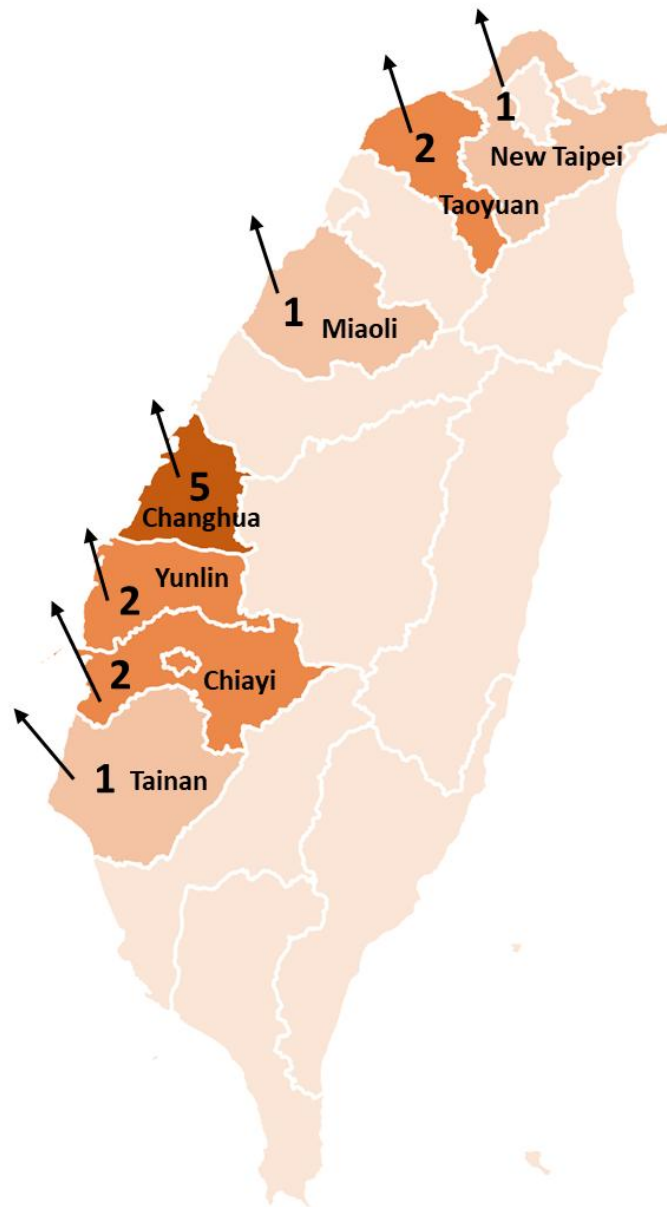


**Figure 2.2-5 The Spring Migration Route of BFS up till 13<sup>th</sup> of June**

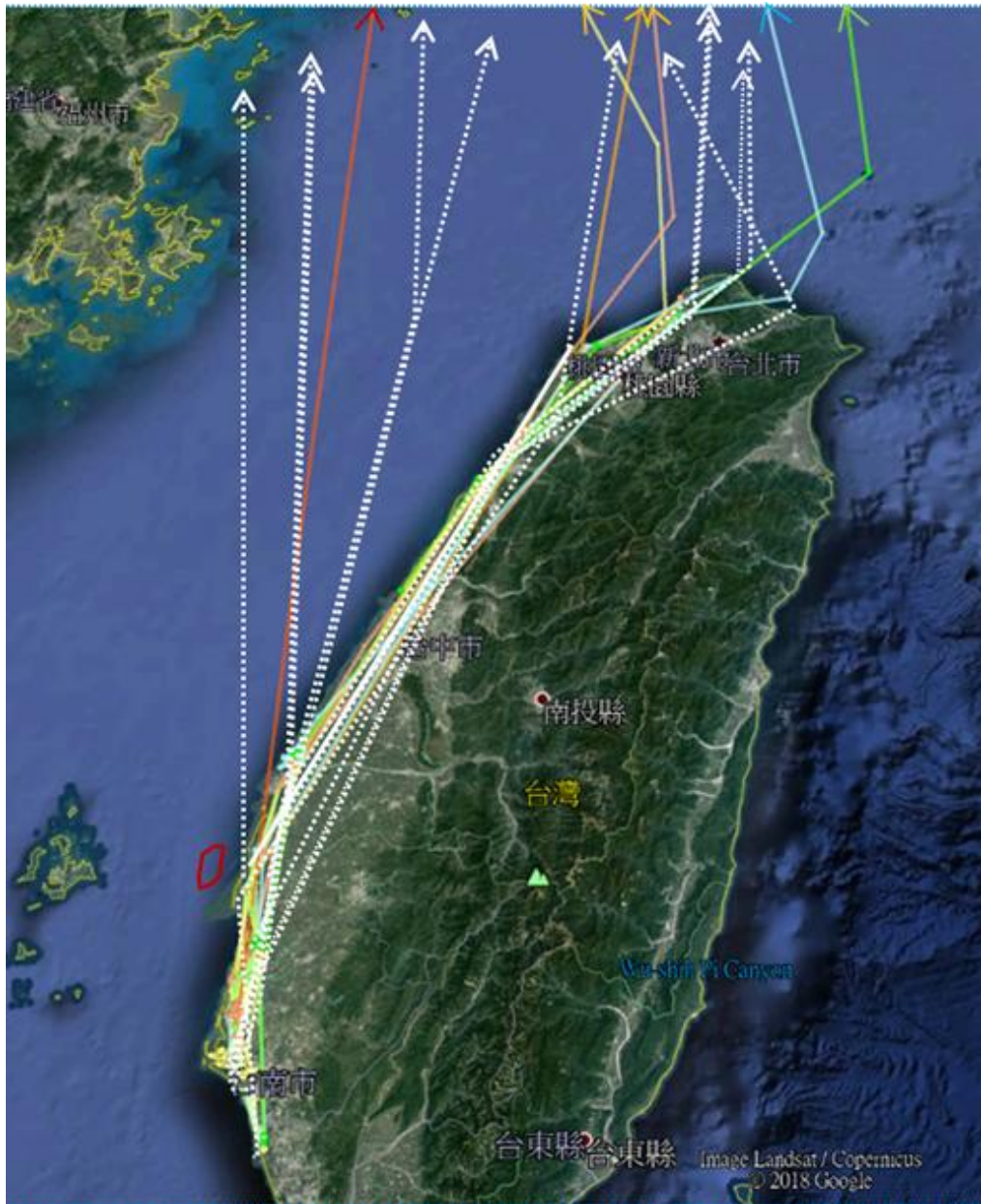
#### 4. Departure Location

By identifying the location of departure for BFS using the administrative districts for cities and counties, 5 individuals (35.7%) departed from Changhua, and 2 individuals each (14.3%) departed from districts including Chiayi, Yunlin and Taoyuan, the remaining 3 individuals (21.4%) departed from New Taipei, Miaoli and Tainan (Figure 2.2-6). In comparison with estimated routes from the satellite tracking of BFS conducted by Taiwan and Korea between 2012-2018 (Figure 2.2-7 ; 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.



**Figure 2.2-6 BFS Departure Locations up till 13<sup>th</sup> of June**

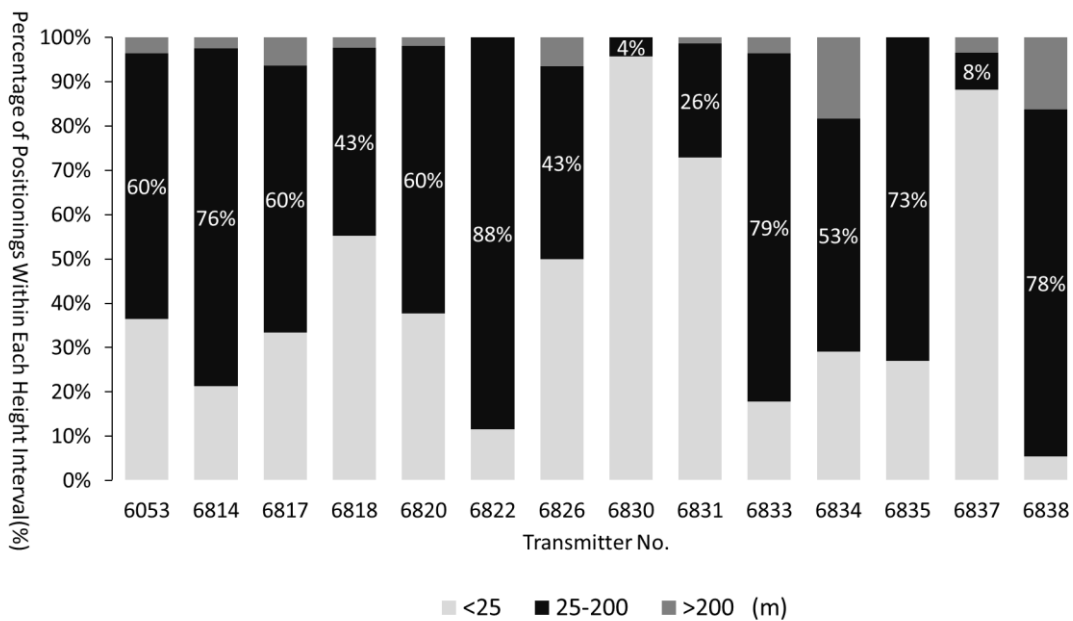


Note: Dotted lines indicate tracking between 2012-2015, and the solid lines indicate tracking between 2015-2018

**Figure 2.2-7 BFS Departure Routes between 2012-Spring 2018 (Wang 2016 and Kisup Lee, unpublished data)**

## 5. Offshore Flying Altitude

The percentage of flying altitudes that were between the sweeping area (25-200 m) during flight in the Taiwan Strait varies between the 14 BFS. An average of  $54 \pm 25\%$  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 2.2-8). An average of  $42 \pm 27\%$  of positionings for all individuals were below 25 m, while only an average of 5% 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.



**Figure 2.2-8 Percentage of Flying Altitudes within Each Interval for BFS Positionings in Taiwan Strait (up till 13th of June)**

# 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 second season of survey. In the first season (September to November 2020) 2 surveys were conducted, while in this season 16 surveys were conducted, therefore, a total of 18 surveys were conducted in these 2 seasons. Two species were recorded in the first season, including Rock dove and an unknown species in the Laridae family, while eight species were recorded in this 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. No BFS were recorded during any of the fixed position visual surveys. Flying altitude recorded during visual survey in both seasons were below 50 metres. Survey should be continued 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. The main flying direction recorded by marine radar in the first season was toward SSW and toward NNE this season. The flying altitude of birds during migration appears most frequent between the 50-100 m range in the first season, while in this season the range was 100-150 m.

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 15<sup>th</sup>, 27<sup>th</sup>, 28<sup>th</sup>, 29<sup>th</sup> March and 1<sup>st</sup> 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. The main flying direction recorded during marine radar survey last season was SSW, while this season was NNE. The main flying height of bird during the last season is at 50-100 m, while this season the main flying height is at 100-150 m.

## II. Satellite Tracking Survey

Satellite tracking of BFS began in January 2021. Sixteen BFS were tracked this season. As of June 13th, 2021, the transmitters for 2 individuals malfunctioned in Taiwan before departure, and the remaining 14 individuals all successfully departed towards China or South Korea. Among them, 10 individuals are currently tracked, as 1 individual lost signal in China and 3 individuals lost signal in Korea. 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 400m away from the wind farm perimeter.

## 3.2 Suggestions

Surveys will continue in fall of 2021 to build up survey effort and accumulate long term survey data.

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