Hunter Bird Observers Club

Affiliated with BirdLife Australia

Report on the Trial of a Drone for Counting Birds at Hexham Swamp and Tomago Wetlands

1. Background

Following a formal request by the Hunter Bird Observers Club (HBOC), permission was granted by the Chief Executive of the Office of Environment and Heritage for a three-month trial (13 March to 13 June 2019) for the use of a drone to count shorebirds and waterbirds at Hexham Swamp and Tomago Wetlands within Hunter Wetlands National Park. This report details the results of that trial.

Trials were conducted over eight mornings from 22 March to 15 April 2019. Because of low bird numbers and the unavailability of key people involved, no further trials were conducted during the remainder of the trial period.

The aims of the trial were to:

- Determine the best launching distance and approach height for no or minimal impact on birds;
- Determine the best approach speed and direction for no or minimal impact on birds;
- Assess the impact of the drone on individual bird species present;
- Assess the use of existing software for semi-automated and automated counting;
- Trial the use of Litchi drone software for setting waypoints and automating drone movements and taking photos.

The drone used was a DJI Mavic 2 Pro (weight 907 grams) with a Hasselblad camera (1" sensor, 28mm, f2.8-f11) and a battery flight life of approximately 30 minutes.

All conditions stipulated in *Schedule 2 (Additional Covenants)* of the *Consent* document were strictly adhered to during the trial.

Figure 1: Flying the drone at Hexham Swamp

2. Effects on Birds

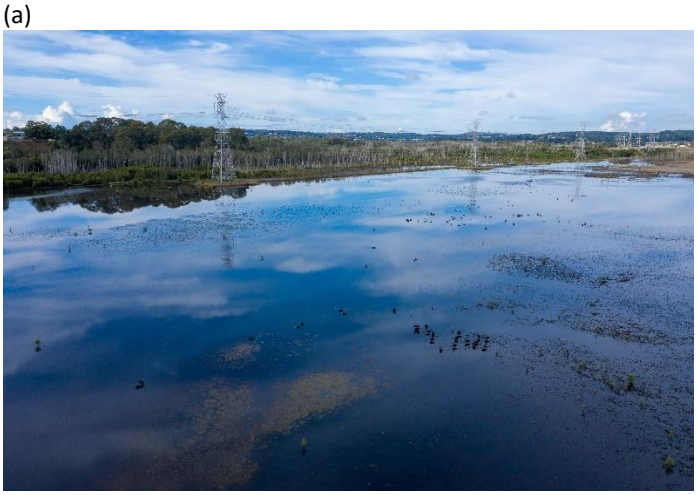
So that we could readily assess the impact of the drone, most of the trials were conducted in areas where we could easily observe its impact (either visual or sound) on bird populations. The main findings are summarised below.

- *Launch distance*. Because of the louder noise when launching, we found this was best undertaken at least 75 metres from the nearest birds, to avoid disturbance
- *Approach height*. Based on the literature, we knew it was best that the drone was not launched vertically to a high altitude high (for example, to 100 metres) and then directly lowered over a bird population as the drone would more likely be perceived as a predator. We thus tested a variety of horizontal approach heights

and found that most birds were able to be approached without disturbance with the drone flying at a height of 15-20 metres.

- *Approach speed*. We found that the ideal approach speed when the drone was within *c.* 100 metres of birds was 1.0 to 2.5 kilometres per hour. If birds were disturbed, either because of the drone or for some other reason (for example a nearby predator), than pausing the drone for a short period until they were settled was effective. On several occasions incoming birds landed near the drone and in some cases directly below it, thus demonstrating that the drone was not perceived *per se* as a threat.
- *Approach direction*. This was not able to be adequately tested as the approach was usually from where we were parked and hence did not take into account sun or wind direction.
- *Species variation*. While bird numbers were usually low, species that were present during the trial included: Chestnut Teal, Grey Teal, Black-winged Stilt, Common Greenshank, Sharp-tailed Sandpiper, Red-necked Avocet, White-faced Heron, Black-necked Stork, Masked Lapwing, Silver Gull, Great and Intermediate Egret, Australian Pelican and Black Swan. While all these species could be approached using the above conditions, some larger species (for example, Black-necked Stork, Australian Pelican and Black Swan) could be approached at lower heights and more quickly.

(a)



(b)

(c)

(d)

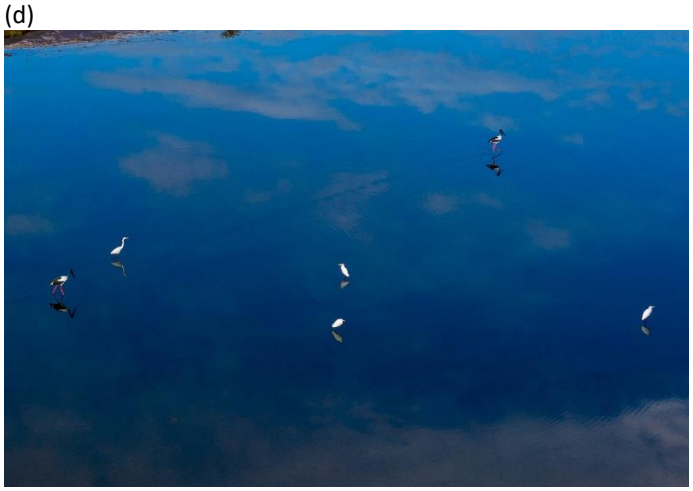


Figure 2: View of a section of the wetlands at (a) Hexham Swamp and (b)/(c) Tomago Wetlands, (d) Black-necked Storks with Great Egrets at Hexham Swamp

3. Some Challenges

Several challenges were encountered during the trial. The main ones are described below.

- *Aligning drone with bird locations.* Steering the drone manually to a visual target was not easy and took longer than expected, because the landscape from above often looked quite different to the horizontal perspective. While the exact distance from the controller to the drone and the drone's bearing is continuously updated on the drone controller, it proved difficult to estimate how much further the drone

needed to advance such that it was at an optimal location for taking photos for later bird counting. There are two ways that could be further examined to address this with a future trial.

i. For relatively inaccessible areas that are intended would be routinely surveyed (for example, the wetland between Ironbark and Fishery Creeks south of the Pipeline Track), a series of waypoints could be coded into a pre-determined flight plan. We started to trial a new app (Litchi) that allows a flight route to be pre-planned by inputting a number of variables including GPS coordinates, drone heights and speeds, along with camera angle, photo directions and type. The route can be saved and then re-loaded as required. The initial results using Litchi were promising; further work is needed to test this more thoroughly.

ii. Where a one-off bird count might be required (for example, outside an area that waypoints have been set up for), and the birds are visible from the ground, another potential aid to consider would be the use of a laser distance tool to accurately measure the distance from the drone operator to the birds (or to some nearby landmark). Using the compass bearing of both the drone and birds from the operator, it would be much easier to position the drone in the right location/s.

- *Bird disturbances*. At Hexham Swamp, we had to cancel two drone trials because of ultralight plane activity. The ultralights were clearly seen to disturb bird populations when they flew low over the National Park. The other disturbance that unsettled the birds were predators flying over the swamps. Extreme caution was always taken by the drone operator in these types of situations, with the drone usually being "parked" in mid-air (or on the ground) until the disturbance was finished.
- *Bird numbers*. There were large numbers of waterbirds on the two early days of testing; however, at that stage we were still sorting out various basic points. Later on, in the trial period bird numbers unfortunately had become relatively low; this was due to seasonal factors (departure of migratory shorebirds) and the relatively low water levels because of lack of rain. For determining the best methods for bird counting it is preferable to have greater numbers of birds and for them to be present as mixed flocks.
- *Bird identification.* While flying the drone, it proved difficult to identify small to medium sized bird species on the screen because of the wide-angle lens (28mm equivalent lens) that is used by most drones. Bird identification is thus best undertaken later using enlarged high-resolution photos on a large computer monitor (see below).

4. Bird Counting

There are now several published research papers showing that using a drone is a more accurate way to count birds than can be done manually by experienced bird observers with binoculars and telescopes[1].

As only large birds (for example, Black-necked Stork, Australian Pelican and Black Swan) could be counted while the drone is actually in flight, we concluded that the most reliable way to obtain a bird count was by taking still images (or video) and post-processing these and examining on a computer monitor. A more-automated alternative that has shown positive results with our trial is to import the images to open source software (for example, *ImageJ*[2] where they can be counted semi-automatically by clicking on each bird. The advantage of this is that you cannot count a bird twice and it is not possible to miss birds as counted birds are highlighted and numbered. Investigations are continuing with this software package and the option of using it to fully automate counting where high numbers of birds can be counted very rapidly (see Figure 3 below for a simple example with a very small number of birds). We would also like to compare this software with two other packages that have been used elsewhere for bird counting. One challenge with automated counting is the ability for the software to consistently distinguish between similar sized and similar patterned birds, particularly if they are close together.

[1] For example, one comprehensive comparative study with plastic bird decoys showed that *"Drone-derived data were between 43 percent and 96 percent more accurate than ground counts. The variation was due to how many pixels represented each bird, which in turn is related to the height that the drone was flown and the resolution of the camera."* Retrieved (April 2019) from https://www.smithsonianmag.com/science-nature/drones-better-counting-wildlife-than-people-180968276/#miGuoUSfCrm6heag.99

[2] An open source image processing program designed for scientific multidimensional images. https://imagej.net/ImageJ

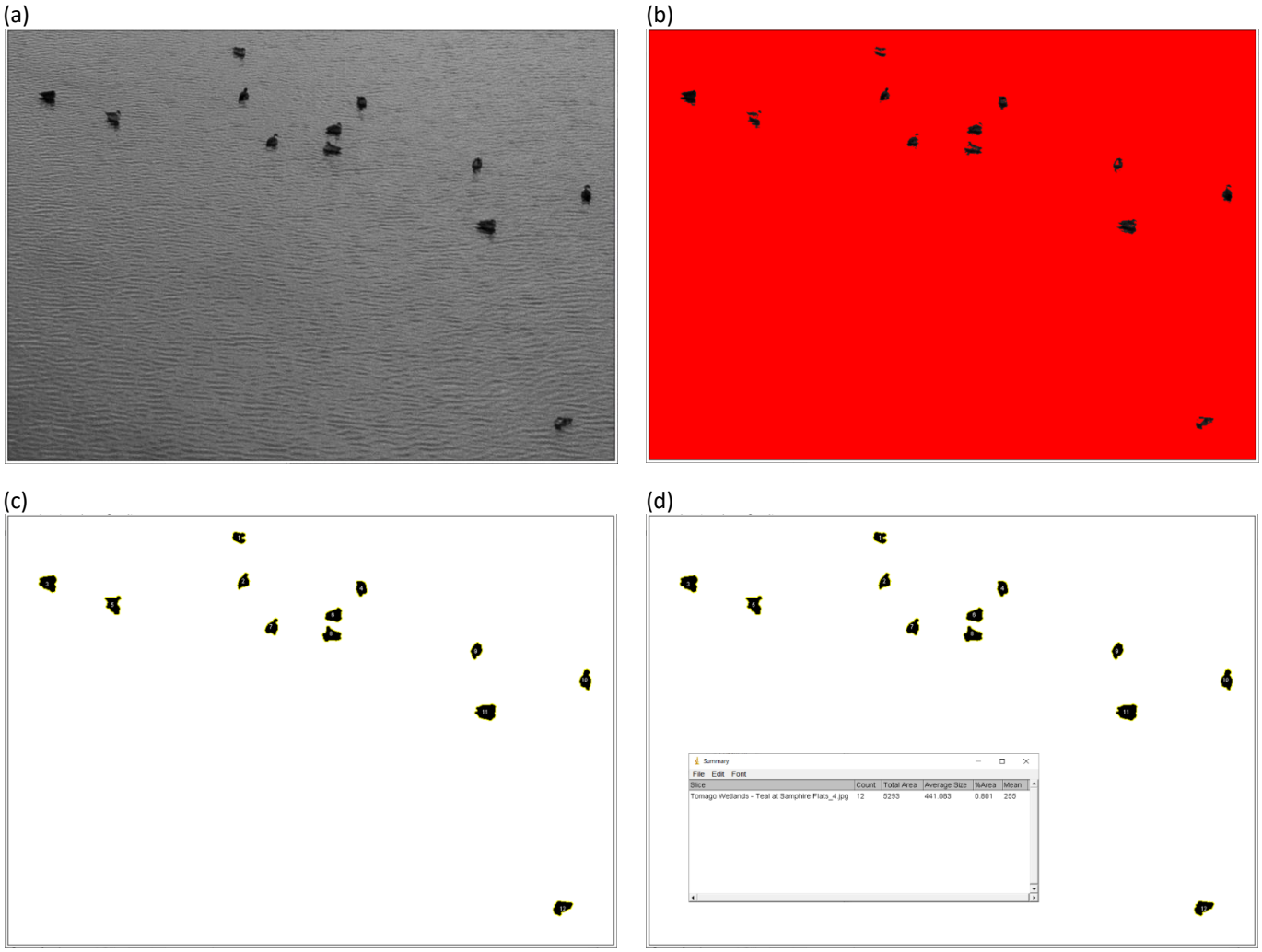


Figure 3: Simplified automatic bird counting example with ImageJ. (a) Cropped photo of 12 teal imported into ImageJ, (b) Removal of background elements, (c) Further processing (eg sharpening and filling in 'holes'), (d) Automatic counting with each bird labelled (n=12). Note: This process took two minutes and can be used for much larger numbers.

5. Process for Counting Wetland Birds

Based on the trials to date, we consider that a count of birds in a target area can be obtained using the following methodology:

i. Fly the drone between a series of pre-programmed waypoints based on the findings from above (2. *Effect on Birds)* with respect to launch distance, approach height and speed.

ii. At each waypoint, program the drone to hover and take a series of photographs such that a full or partial panorama view (depending on the location of each waypoint) is obtained. Note that if there is a reason to return the drone to home or to rapidly descend because of, for example, an approaching plane, the automated flight to waypoints can be manually overridden.

iii. Download the photos from the drone post-flight and, depending on the number and spread of birds, process the images using software such as Lightroom and then ImageJ (or equivalent) to provide a semi-automatic or automatic count of birds present.

With this methodology, it should be possible to monitor the wetland in a systematic way each time. However, this needs to be further tested when there are more birds and the opportunity to further experiment with bird counting software.

6. Other applications

- We flew the drone over two Black-necked Stork nest trees (nests not currently active) (Figure 4(a)) and are of the opinion that it will be a viable way in future to check the status of those nests or the nests of raptors. The drone could be flown quite high for this application, so that the birds are not disturbed.
- We flew the drone on a trajectory over reeds in Hexham Swamp alongside the Pipeline Track, to look for flattened areas as indicators of possible presence of an Australasian Bittern. Although we didn't spot anything interesting in that single transect we think this worth pursuing further after we have the waypoint / fixed route matter fully sorted.
- Monitoring changes in habitat (for example, see Figure 4(b) where an extensive rehabilitation program has been put in place). This can be carried out using the waypoint methodology and returning to the exact same locations on a six-monthly or annual basis and recording the vegetation. Often, there can be a clear relationship between species and numbers present and changes in habitat.

(a) (b)

Figure 4: (a) Black-necked Stork nest at Tomago wetlands that was successfully used in 2017-18, (b) Wetland rehabilitation at Tomago

7. Intention to request for another three-month trial

We are optimistic following the initial trial and have made good progress with assessing the suitability of using a drone for counting birds at less accessible areas of Hexham Swamp and Tomago Wetlands (and in similar applications elsewhere). At this stage, we believe that the drone would be a useful tool for the HBOC to use to supplement its monthly bird surveying in these two locations within Hunter Wetlands National Park. We believe a follow-up trial is warranted, later this year when bird numbers have risen in the estuary. The main issues we would like to resolve with another three-month trial are:

- Best drone height and camera gimbal angle for photographing dense blocks of birds for accurate counting
- Best waypoint methodology for several different locations
- Identify the best software and approach for obtaining accurate bird numbers, ideally by species.

We would suggest that the idea time for a second three-month trial would be from mid-October 2019 onwards. We will make an application for approval for the trial in due course.

8. Bibliography

The following is a list of some of the international literature examined as part of the drone trial.

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18 July 2019
