

## **Swan Track – A software for monitoring the movements of Mute Swans (*Cygnus olor*)**

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### *Abstract*

*Swan Track was built to track the movements of Lincoln swans as part of the Lincoln Swan Project. Lincoln swans are tagged with an individual colour ring number, and community scientists report swan sightings through the EpiCollect5 App, social media or email. Previously, these sighting locations were recorded on a spreadsheet. I wanted to plot these sighting locations on a map so the researchers and the data collectors could visually see the movements of the swans. Microsoft Power BI was used to create the maps for Swan Track. The foundation of Swan Track was developed under the Undergraduate Research Opportunity Scheme (UROS). UROS is an opportunity at the University of Lincoln for undergraduate students to work alongside academic researchers on a project to develop their skills, experience and knowledge. Maps have been created which display the locations where a swan has been sighted. A coloured dot represents each sighting, and hovering over each dot provides the sighting date. There are three different map types – one for territorial swans, non-territorial swans and cygnet dispersal maps. These maps will frequently be updated with new sightings of current and future ringed swans. Potentially, Swan Track could be extended to other animal ringing projects like the Yorkshire Swan Project.*

*Keywords: Swans, Tracking, Mapping, Community Science, Power BI*

### **Introduction**

The *Lincoln Swan Project* monitors the movements of Lincoln swans in and around Lincoln. Swans are tagged with a metal ring on one leg and a yellow plastic ring on the other (Figure 1). The metal ring is part of the British Trust for Ornithology (BTO) project, and the yellow ring is for the *Lincoln Swan Project*. Members of the public record sightings of swans via the EpiCollect5 App, social media (Twitter, Instagram or Facebook) or email (Aanensen et al., 2009). One of my roles as a member of the Lincoln Swan Project is to reply to data collector emails interested in knowing the sighting history of a swan they have sighted. I search the sighting database and provide a written overview of where the swan has been sighted since being ringed. From this role, I developed the idea of mapping out the movements of swans so data collectors could visualise a swan's movements. I suggested the idea to my swan project supervisors (Dr Jenny Dunn and Dr Laetitia Marechal), and they

recommended we do the project under the Undergraduate Research Opportunities Scheme (UROS). UROS is an opportunity for undergraduate students at the University of Lincoln to work with an academic on a project contributing to the universities research (Lincoln Academy of Learning & Teaching, 2022). The UROS project would build the foundation of a wider-scale project where all Lincoln-ringed swans would have their movements mapped.

Figure 1: The first swan tagged for the Lincoln Swan Project and one of Lincoln's breeding females. Each swan is tagged with a Lincoln Swan ring and a British Trust for Ornithology ring.



## Project Background

Tracking animals long-term and over a wide scale has provided important and interesting knowledge in understanding animals (Wikelski et al., 2007). GPS tracking systems are often used for worldwide projects, and then these movements are plotted onto maps for the researchers and sometimes the general public to view. I was inspired by the maps that the organisation Fahlo creates when working with animal charities like *Save the Elephants* and *Conserve Turtles*, which use GPS tags to track their animals. I wanted to create a mapping system which can be used for animal tracking projects which use colour-marking rings to track their animals, like *The Lincoln Swan Project*. Before the mapping software was used, the locations of the swans were entered manually into a spreadsheet. With this system, it wasn't easy to understand the movements of a swan as we couldn't visually see them. I created an example of what mapping out a swan's movement would be like using Google Maps and presented it to my supervisors. This example map showed the movements of a swan in a much better format, and this kickstarted the development of the Swan Track software.

## Literature Review

Today, science uses technology to track animals to understand better migration patterns, conservation monitoring, animal health, disease management, and many other reasons (Hobson and Wassenaar, 2018; Schieltz et al., 2017; Deem et al., 2001). In the 1960s, radio telemetry came about, and since then, scientists have been using it to track animals (Habib et al., 2014). More advanced tracking systems like GPS and satellite tracking have been developed and are used to track long-distance movements (Rodgers et al., 2001). Animals (usually birds) can also be tagged with a unique ring number, and then members of the public record sightings when they see a tagged animal to the project researchers. This is how the *Lincoln Swan Project* works. Community science is often used in animal tracking projects as community scientists allow researchers to collect a large amount of data at a low cost (McCaffrey, 2005). Involving community scientists in research gives them more engagement and understanding of the work of the research project (Riesch and Potter, 2014). Bird watching is a popular activity, so bird research projects are often the most successful in involving community scientists (McCaffrey, 2005). The *Lincoln Swan Project* is receiving large amounts of data on the movements of Lincoln swans thanks to the project data collectors. We are in a time where wildlife conservation efforts need to reach peak levels, and understanding animal movements is essential for these efforts to succeed (Kays et al., 2015).

## Methodology

When discussing how the mapping software should be set up, we wanted to create the most straightforward system so the maps could be easily updated with new swan sightings. We looked at creating maps using R coding, but in the end, we decided to use Microsoft Power BI (R Studio IDE, 2011). The end goal of the long-term project is to have a system where swan sightings are automatically updated on the map when sent in. Each ringed swan will have their movements plotted on a map. The maps will show where cygnets from each brood of breeding pairs have dispersed, any long-distance movements and other aspects. The first part was to arrange the swan sighting data into an Excel spreadsheet which Power BI could process. Searching through the database, I collected the sighting history for the territorial and non-territorial swans that would build the foundation of the tracking software. Data gathered included the swan's ring number, date of sighting and the latitude and longitude of the swan's location. Once on the Excel spreadsheet, it was imported onto Power BI, where the movements could be plotted on the map. In Power BI, I dragged the Swan ID, sighting dates and locations data (latitude and longitude) into the visualisations panel. With the Swan ID in the legend bar, location data under the latitude and longitude bars, and then sighting date data under the tooltips bars (Figure 2). The same steps were followed when building on the Swan Track software to other Lincoln ringed swans.

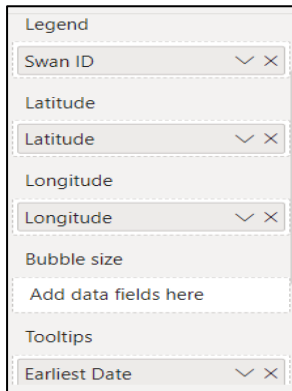


Figure 2: Arrangement of data categories in the visualisations tab on Power BI for displaying swan movements on maps.

## Results

Figures 3 – 5 show the maps displaying the movements of the territorial swans (Figure 3), the non-territorial swans (Figure 4) and an example of the cygnet dispersal maps (Figure 5).

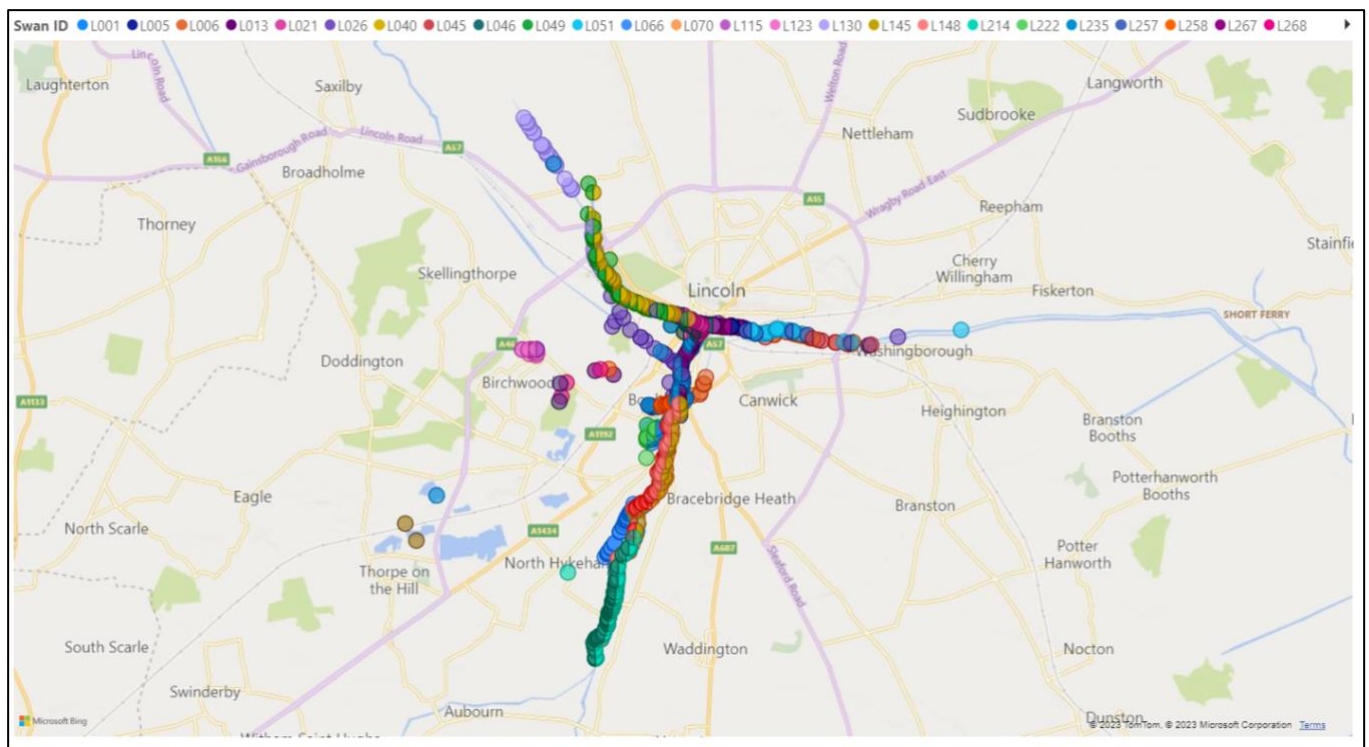


Figure 3: The movements of the territorial swans in Lincoln.

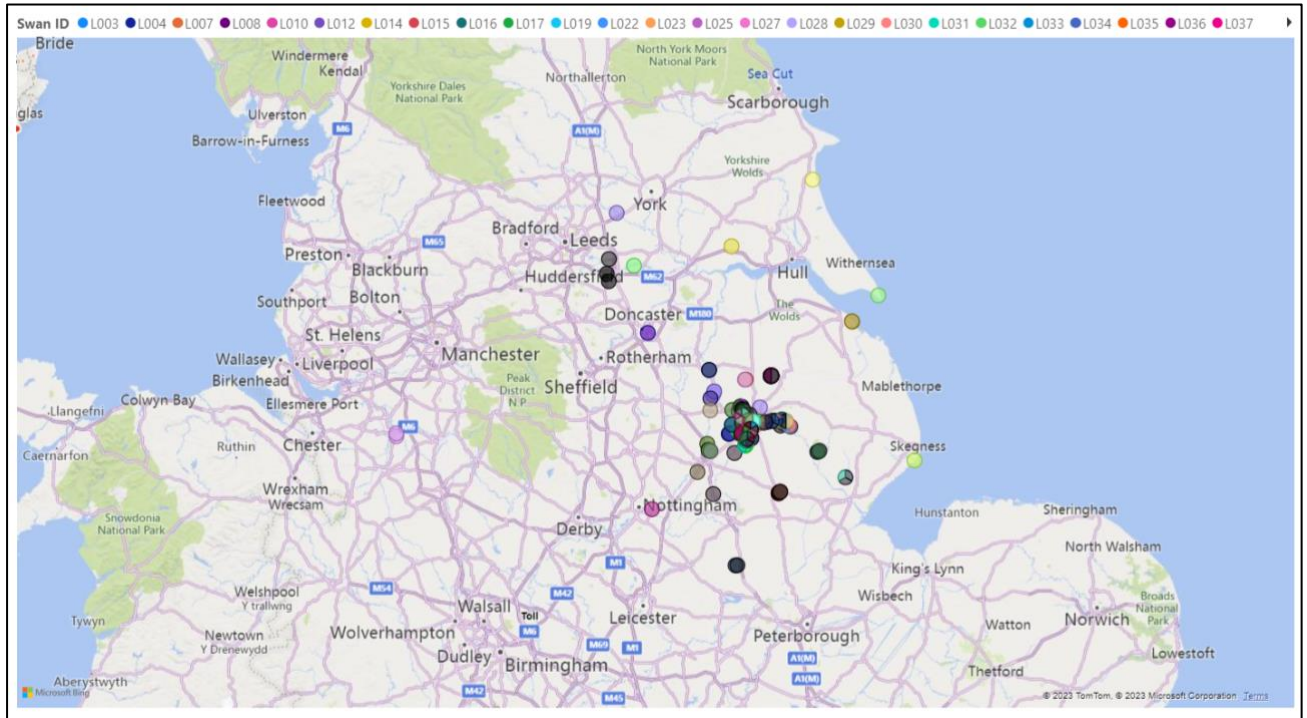


Figure 4: The movements of the Lincoln-tagged non-territorial swans

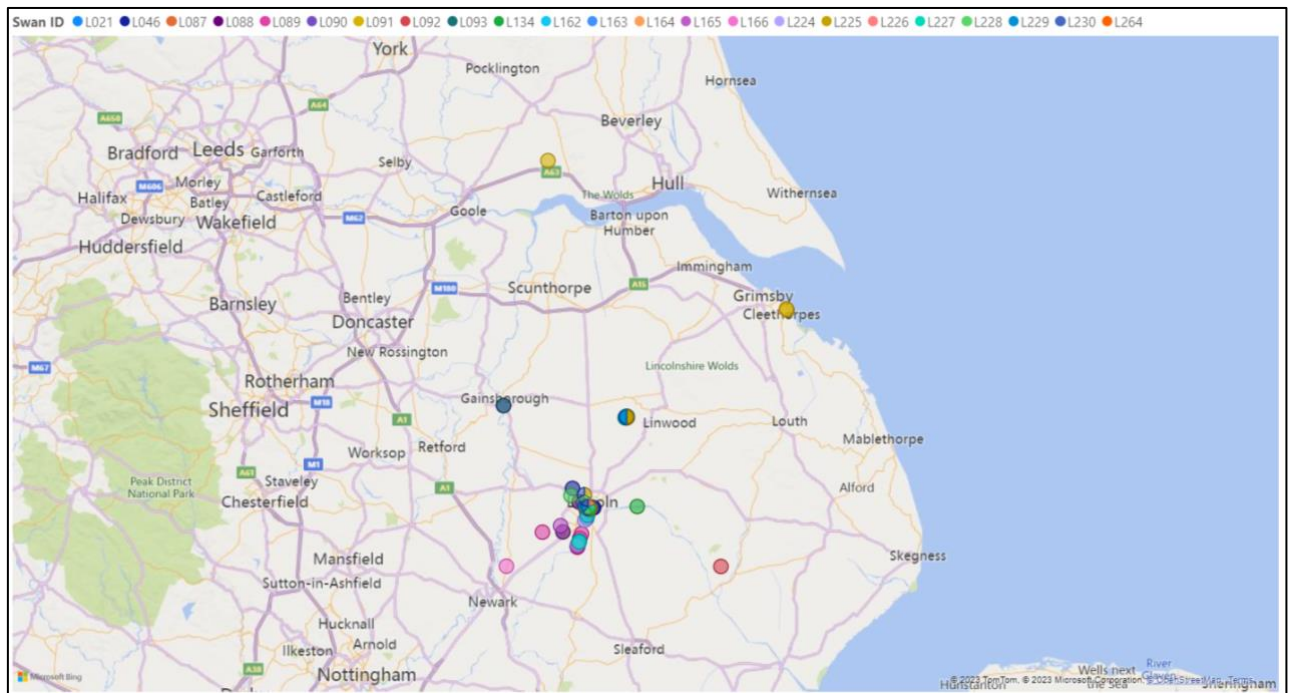


Figure 5: Cygnet dispersal of broods from a territorial breeding pair (L021 and L046) on the Brayford, Lincoln from 2019 – 2022.  
2019 Brood: L087 - L093, L134. 2020 Brood: L162 – L166. 2021 Brood: L224 – L230.  
2022 Brood: L264

Visit the *Lincoln Swan Project* website and head over to the Swan Track maps tab to view the maps in greater detail: <https://lincolnswans.blogs.lincoln.ac.uk/swan-sightings/>

The maps currently have not yet been published as we are currently discussing the best format in which to release them but they will be available soon.

## UROS Experience

I have been a member of the *Lincoln Swan Project* research team since the summer of 2021, starting with a School of Life Sciences Summer Studentship Scheme project, then focusing my dissertation on the Behavioural Consequences of Human-Swan Interactions and now a UROS project. Undertaking a UROS Project has allowed me to develop my skills, including data handling, project management, and data presentation. Developing these skills will be an asset to me when I begin my Masters and a career working in ecology and conservation. With the platform UROS has provided me, I have built an animal movement software that could be extended to other animal ringing projects across the UK and elsewhere. I have enjoyed working with my supervisors, Dr Jenny Dunn and Dr Laetitia Marechal, and learning from them when seeking guidance for my project. My supervisors have been thoroughly supportive in the completion of my UROS project. When encountering problems during the project, discussions with my supervisors helped me overcome them. My problem-solving skills have been tested and improved over the UROS project, which will help me in future research I'm involved in. Problem-solving skills were a key skill which I wanted to develop during my UROS experience, and I have been able to do so. The UROS project coordinator, Clare Cotton, has been supportive in answering questions and assisting with project difficulties. I look forward to building on the foundation of the Swan Track project, extending it to new Lincoln tagged swans and potentially other animal-ringing projects.

## Conclusion

Swan Track has been a great addition to the *Lincoln Swan Project*. With these maps, we can better understand the movements of Lincoln's swans, a key aim of the research project. Lincoln swans often travel outside Lincoln to places like Nottingham, Cheshire and Yorkshire. We have a breeding female in Sleaford with five cygnets. I have often received emails regarding the sighting history of this female; now, with these maps, I can provide the data collectors with a better viewing of the sighting history. The maps show where these swans were hatched (if ringed as a cygnet) and how they dispersed. The *Lincoln Swan Project* relies on public engagement with the project to receive swan sightings, and these maps will help engage the public in the research of the project. The tracking system will continue to be developed from the foundation UROS has provided us. We are excited to see the new steps Swan Track will take over the coming years and its contribution to the research of the *Lincoln Swan Project*.

**Word Count: 1750**

**Word Limit: 2000**

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