eBird Southern Ocean Calibration

A project partnership between
Viking Expeditions and the Cornell Lab of Ornithology

2021-22 Season Report

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eBSOC (eBird Southern Ocean Calibration) Project: 2021-22 season report

Executive Summary

June 2022

Motivation

The Cornell Lab of Ornithology's eBird program (www.ebird.org) collects citizen science data from around the world, but we lack the knowledge to properly calibrate bird counts from ships on the open ocean. Traditional marine bird surveys alongside at-sea eBird surveys will allow us to properly interpret such citizen science data. This lets guests and staff on ships anywhere in the world help scientists understand and conserve seabirds.

Project structure

A grant from Viking to the Cornell Lab of Ornithology supports Dr. Michael Schrimpf as a postdoctoral researcher to conduct the research. This includes fieldwork with an assistant observer aboard Viking Expedition vessels during the Antarctic tour season followed by data analysis and results dissemination during the remainder of the year at Cornell.

Season summary

This first field season involved preliminary data collection during two voyages (15 Feb–9 Mar) aboard *Viking Octantis* during the 2021-22 Antarctic shakedown season.

This season's primary objectives:

1. Assess vantage points aboard the vessel for data collection suitability
2. Become familiar with ship's staff and operations
3. Collect a small amount of data to allow refinement of methods for future work
4. Work with staff to determine how best to make eBird data collection part of Viking's citizen science program

We successfully completed all four objectives and are well-positioned for the main data collection effort during the 2022-23 Antarctic season.

Key outcomes

For tour operators:

- The ship has several vantage points well-suited for eBird activities with guests (Table 1), particularly the outer areas on deck 5, aft. Professional distance-sampling surveys, however, are only effectively accomplished from the bridge.
- Guests displayed high levels of interest in science, and many opportunities exist to involve them in birding activities and data collection, both on shore and at sea.
- Guests interested in spotting wildlife would benefit from a real-time notification system of good viewing conditions.
- Better communication among crew (and, by extension, to guests) about exactly when and which outer decks are closed on open-ocean crossings may avoid missed opportunities for guided birding.

For scientists:

- We collected >43 hours of distance-sampling surveys, recording 30 bird species, and collected an additional 65 eBird checklists.
- The free application EpiCollect5 (https://five.epicollect.net/) can be a viable alternative to existing marine bird survey data-entry software products but poses certain challenges.
- Vessels like *Viking Octantis* provide a useful platform for marine bird surveys but differ from traditional research vessels enough that differences in species detection must be studied further.

Future directions

Our pilot data from this season give us confidence that quantitative assessments and maps of seabird distributions in the region will be possible with future data collection. These will aid in understanding seabird ecology, as well as provide tour operators with better information on where to expect sightings of noteworthy wildlife of interest to guests. We look forward to working with Viking to schedule our work aboard the vessels next season and are excited to participate in Viking Expedition's science program further.

VIKING

Background:

Researchers around the world increasingly rely on citizen science to study wildlife, and the Cornell Lab of Ornithology's eBird program (www.ebird.org) has provided an integral source of data for many projects on birds. To date, however, very little emphasis has been placed on the open ocean records contained within the eBird database, and we do not fully understand how eBirders may detect birds at sea differently from those on land. There have also not been any studies comparing eBird data to the standardized at-sea surveys conducted throughout the world's oceans from scientific research vessels. These professional surveys generally involve specialized protocols, requiring trained seabird observers, and allow researchers to record information on many factors that can affect how birds are detected. Detection of birds is very species- and distance-specific, as large species, like albatross, are easier to detect from further away than smaller species, like prions (Fig. 1). Understanding the process of bird detection is crucial to making these data useful for scientific discovery and conservation management, since an observer is never able to detect all the birds present at a specific place and time. By studying this process, we make it possible to compare data collected by different people in different circumstances.

This report summarizes our efforts to collect the data required to compare at-sea eBird data with more traditional forms of marine bird surveys, during the inaugural Antarctic season of a partnership between the Cornell Lab and Viking Expeditions. Data collection involved a modified distance-sampling protocol undertaken by the two research scientists, paired with eBird data collected by both the researchers and other staff and guests aboard the vessel. The ultimate goal of this work is to make it possible to use eBird data collected from around the world's oceans to monitor seabirds, providing scientists with new information for better conservation strategies, and giving tour staff and guests ways to directly connect their voyages to groundbreaking ornithology. The project is funded by a grant from Viking Expeditions.

Because this was the initial shakedown season for Viking's operation in the Antarctic, and the shortened season offered limited time aboard, this year's objectives were focused on learning how best to conduct marine bird surveys from the company's new expedition ships. Our goal was to gain enough practical experience onboard to allow us to fine-tune methods and prepare materials for the future. With that information we can optimize the sampling scheme for the 2022-23 season, during which we hope to collect enough data to address the project's primary scientific goals described above.

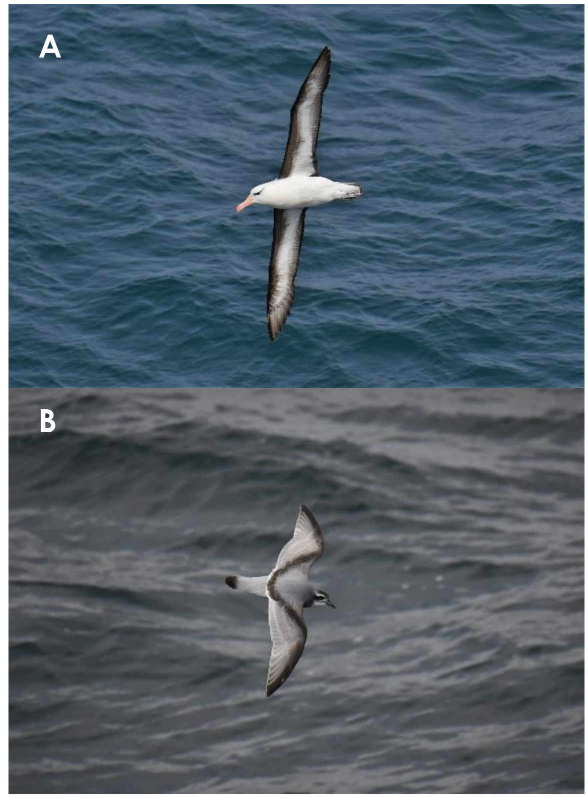

Figure 1: A Black-browed Albatross, *Thalassarche melanophris* (**A**), and Antarctic Prion, *Pachyptila desolata* (**B**), from the Southern Ocean. © M. Schrimpf

Season Objectives:

We had the following objectives for 2021-22:

1. Assess seabird viewing strategies aboard the *Viking Octantis* during her shakedown season in the Antarctic, both for the collection of eBird data and distance-sampling transect surveys.
2. Establish relationships with other Viking staff and learn how best to integrate this project's work with the rest of the cruise operation and scientific research undertaken aboard.
3. Collect preliminary distance-sampling data that will allow the study design to be optimized for the 2022-23 Antarctic season. This included collecting data on several factors that could be controlled or monitored in future years, described in the Methods section below.

4. Work with other Viking staff to assess how best to involve guests in the collection of bird data through citizen science activities.

Overview of 2021-22 voyages:

Project staff included Dr. Michael Schrimpf and Charles (Charlie) Wright (Fig. 2), both working aboard with the expedition team as Field Research Scientists.

Figure 2: Michael Schrimpf (**A**) and Charlie Wright (**B**)

We joined the *Viking Octantis* (Fig. 3) on 15 February 2022 in Ushuaia, Argentina, after spending a mandatory 7-day hotel quarantine in the town of Rio Grande, Argentina. We then worked aboard for a total of 23 days, disembarking on 9 March 2022. During our time aboard, the vessel completed two round-trip voyages to the Antarctic Peninsula, touching at Ushuaia on 25-26 February to disembark and embark guests between voyages.

Data collection for this project involved two types of surveys: (**1**) discrete periods recording sightings with eBird, including the involvement of guests and other shipboard staff, and (**2**) distance-sampling transect surveys completed by the two of us. We focused as much time as possible on distance-sampling transect surveys during daytime transit periods, especially sea days, fitting in eBird use when practical. While the ship was operating in the nearshore Antarctic and running shore excursions, we collected eBird data when possible and assisted with other tour and science operations as needed.

Figure 3: *Viking Octantis* in the Antarctic © C. Wright

Sampling Methods:

eBird checklists

Many eBird data come in the form of "complete checklists", which are counts of all the birds that users were able to detect and identify during a dedicated birding session. Observers record certain metadata, including the location, date, time, duration, and (if moving) the distance traveled. Therefore, in addition to information on the observed abundance of birds, such checklists contain crucial information on "birding effort", allowing us to compare data across checklists (similar to how fisheries managers use "catch per unit effort").

During these voyages, both of us collected many complete eBird checklists while underway, both in planned activities with guests and opportunistically when not otherwise engaged in collecting distance-sampling surveys. Most checklists were collected with the eBird Mobile app (https://ebird.org/about/ebird-mobile/), which collects much of the effort metadata (such as time, distance, and location) automatically. It was occasionally necessary to record the effort information through other means (e.g., handheld GPS), in which case it was recorded on paper and submitted via the website (https://ebird.org/submit) later.

Distance-sampling surveys

Both of us collected seabird counts using a distance-sampling protocol that was modified to allow direct comparison to eBird checklists. This consisted of continuously recording all birds detected while focused on a 300-meter-wide strip along one side of the vessel during 20–30-minute survey periods. These surveys were completed from either the starboard or port bridge wing (whichever side of the vessel provided a clearer view of the water's surface at that time, with less glare). We recorded the time and species (to lowest identifiable taxon, using hand-held, 10×42 binoculars, if necessary) of each sighting. If birds of the same species were observed together in a clearly cohesive group, the group was noted as a single observation, and the number of individuals recorded.

The perpendicular distance of any bird within the 300-meter strip was also recorded, using a series of four distance bins: within 50, 100, 200, or 300 m (Fig. 4), measured with the aid of a hand-held rangefinder. Flying birds were recorded in the first bin in which they were either initially detected, or, if they were detected outside of the 300-m strip, when they first entered one of the four bins. When possible, a flight direction was recorded for each flying bird. Birds ahead of the vessel were considered within one of the four bins if they were near enough to discern the bin boundaries. All birds observed outside of the four distance bins were recorded in a fifth, ">300-m" bin. These distance data allow a statistical model to account for differences in detection for birds further from the ship.

Before each survey period began, we used the aft-looking windows on the bridge wing to note any birds that could be seen following the vessel (a common occurrence in the Southern Ocean). This was then repeated at the end of each survey. Following birds were ignored for any continuous observations once they had been recorded once; however, if they continued to follow during several survey periods, they were recorded among the following birds each time.

Many marine bird survey protocols follow similar methods, but many do not attempt to record birds outside the dedicated distance bins (i.e., >300m), and almost none pause the effort on a regular basis to record following birds (which are generally only recorded the first time they are spotted during a day, and then ignored thereafter). These adaptations to standard techniques allowed us to summarize the total number of each species that would have been recorded, had we instead been collecting a complete eBird checklist over the same stretch of ocean for each distinct survey period.

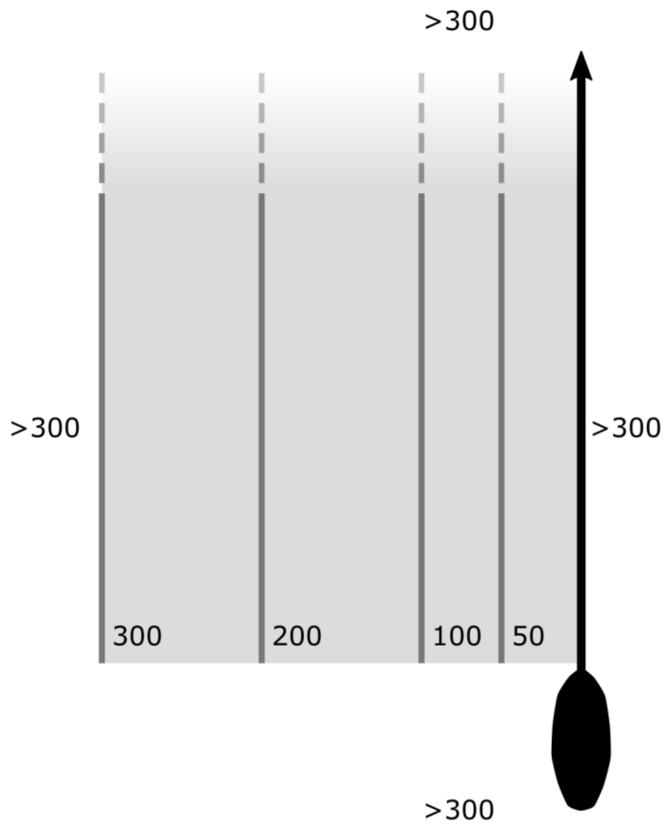

Figure 4: Diagram of the distance bins used, measured in meters, and representing the perpendicular distance from the ship's track line to the edge of the bin, illustrated here for a port side survey. A traditional distance-sampling or strip-transect method would only focus on the area highlighted in gray, but complete eBird checklists include any birds detected, requiring that we also recorded those individuals in a ">300" bin.

Survey data were recorded using custom forms created with the data entry application EpiCollect5 (https://five.epicollect.net/). We could not rely on commonly-used existing data collection software specially designed for marine bird surveys, such as the applications DLog3 (an older piece of software developed by R.G. Ford, Inc., Portland, OR) or SeaScribe (https://briwildlife.org/seascribe/), due to logistical limitations of operating on the bridge of this vessel and, in the case of SeaScribe, the inability to customize the species list. Comparing our surveys to traditional marine bird surveys requires position data to be recorded for each bird. Although it was possible that the GPS data from our mobile devices could be collected through EpiCollect5, prior experience suggested that the GPS signal to those devices might not be very strong while standing on the bridge. Therefore, we obtained minute-by-minute track logs of the ship's position for most surveys from the output of the FerryBox suite of oceanographic sensors installed on the vessel by the Norwegian Institute for Water Research (NIVA; https://www.niva.no/en). As a backup, we manually recorded the start and end positions from the bridge GPS monitors for every survey. The ship maintained a constant speed and heading for almost all surveys, making it possible to calculate the minute-by-minute position later. Assessing the suitability of EpiCollect5 for this project was an important part of accomplishing our objective to optimize the data collection process for future field seasons.

Results:

Assessment of seabird viewing vantage points

We explored different areas of the *Viking Octantis* for the potential to observe birds, both during crossings on the open ocean, and in the enclosed waters of the Antarctic Peninsula. Each vantage point was assessed for its potential in collecting distance-sampling and eBird data, and for its general ability to offer guests views of birds (Table 1). Readers unfamiliar with the vessel may find it helpful to explore the 360-degree views provided on the Viking Expeditions website here: https://www.vikingcruises.com/expeditions/content/expeditions-360/start.html

Table 1: Vantage point assessment

Vantage Point	Location	Exposure	Suitability			Specific Comments
			Distance-sampling	eBird	General viewing	
Bridge	Deck 6, forward	Enclosed	High	High/X	X	Access restricted for guests, so can only be used for data collected by staff
Bow (Deck 3)	Deck 3, forward	Outdoors	Moderate	High	High	Somewhat low to the water, little cover from wind
Bow (Deck 4)	Deck 4, forward	Outdoors	Moderate	High	High	Very little cover from wind
Explorer's Lounge (lower)	Deck 4, forward	Enclosed	Low	Moderate	Moderate	View ahead impacted somewhat by Deck 4 bow railing
Explorer's Lounge (upper)	Deck 5, forward	Enclosed	Low	Moderate	Moderate	Field of view limited by angled windows and structural beams.
Promenade (forward)	Deck 5, forward	Outdoors	Moderate	High	High	Some cover from wind if standing on the leeward side
Aquavit Terrace	Deck 5, aft	Outdoors	X	High	High	Some cover from wind; enclosed view from inside the Aquavit Lounge is also possible, though with more limited field of view
Living Room	Deck 5, midships	Enclosed	X	Low	Moderate	Only offers views abeam
Expedition Central	Deck 2, midships	Enclosed	X	Low	Moderate	Only offers views abeam
Finse Terrace	Deck 2, aft	Outdoors	X	High	High	Low to the water

For the distance-sampling surveys required for this project, the only enclosed space that we found to be truly suitable was the bridge. The large deck-to-overhead windows (Figure 5) provided excellent views of the water ahead and to the side of the vessel and offered the ability to view the ship's real-time location with good precision (most enclosed spaces on the ship block hand-held devices from obtaining a GPS signal).

There were only two notable downsides of conducting distance-sampling surveys from the bridge. First, there were times when ship operations required that access to the bridge be restricted. During these two voyages, however, we did not encounter any situations when we felt lack of access to the bridge substantially limited our data collection, as the few times when the bridge was inaccessible were not times that we could be collecting data, anyway (for example, during a drill). It was necessary to maintain good communication with the officers, so that all parties were aware of the needs of the others, but we did not experience any problems in that regard. We believe this was largely attributable to the efforts of the science coordinator onboard at the time, Dr. Daniel Moore, and having a good liaison between observers and the officers will be crucial for future work. The second downside to surveying from the bridge was that the glass of the windows caused some distortion of photographs, thus impacting documentation of rare species, and potentially limiting species identification in certain cases. However, the photographs taken during this season were usually adequate for the purposes of identification, and therefore the costs imposed by the bridge glass did not outweigh the benefits of the unimpeded view.

It was possible to conduct distance-sampling surveys from several other places on deck, including the bow and promenade, offering unimpeded views ahead of the vessel. However, the likelihood of strong winds and cold temperatures in the Southern Ocean made these vantage points less suitable for longer-duration periods of surveying. In the interest of efficiency, we did not undertake any distance-sampling surveys from these places during this season but may experiment with them in the future.

When considering other seabird observing activities, such as eBird checklists and general wildlife viewing, there were several places (both enclosed and outdoors) that provided good vantage points. On most vessels, forward-looking vantage points offer better views of species on the water that may be flushed by the vessel, and aft-looking views are better for birds following the ship. Outdoor vantage points provide the clearest views unless the wind or temperature limits the

Figure 5: The view ahead of the vessel from the bridge. © M. Schrimpf

use of binoculars or a phone/tablet (for eBird data collection or identification aids). Higher vantage points provide better views of birds at a distance, and lower vantage points often provide better options for getting closer to birds, which can also aid in photography. We found that these general guidelines also apply to the *Viking Octantis*, and for these reasons we decided that the Aquavit Terrace, including the pool area, aft on Deck 5, provided a very good place to collect eBird data with guests. It is outdoors but provides many small places in the lee of prevailing winds. In particularly strong winds or precipitation, observers could also stand inside the enclosed Aquavit Lounge, which has a more limited (but acceptable) field of view of birds behind the vessel. In calmer conditions, especially when in the enclosed waters of the Antarctic Peninsula, the bow provided excellent opportunities to conduct eBird checklists with guests as well.

There were times during this initial season that outer decks were closed due to the sea conditions, especially in the Drake Passage, therefore limiting the ability of guests to view birds from outside. Any future eBird data collection or general birdwatching will need to account for such closures. We recommend establishing a reliable system for keeping staff and guests informed about specific deck closures in a timely manner, so that activities can be canceled when necessary and restarted as soon as conditions allow.

Many of the public enclosed areas of the vessel, such as the Explorer's Lounge, Living Room, and Expedition Central, provided adequate views of the water in a narrower field of view, but had limitations imposed by the windows for spotting birds at many angles. One clear advantage of these spaces when watching birds with guests, however, was the easy access to identification and interpretive resources in books or multimedia displays, and these spaces did serve us as a convenient place to meet and interact with guests who were interested in participating and learning more about birds.

The guest staterooms on *Viking Octantis* are also equipped with large "Nordic Balcony" windows, which also likely offer good views to the side of the vessel. We were not able to assess the potential of this vantage point during this season, but opportunities to do so in the future may provide useful information, as many Viking guests may choose to observe birds from their staterooms. We suspect that the suitability of stateroom windows for bird observing will be greater when the ship is in calmer waters and the upper windows can be lowered.

General species trends

Here we provide a general narrative of the birds seen during the period we were onboard during February-March 2022. The short duration of this season, combined with the variable nature of seabird distributions, makes this a more anecdotal account. A comprehensive quantitative assessment of bird distributions will be possible following the next season's collection of data, and after the various factors that could limit detection (e.g., weather, distance, observer) have been appropriately modeled.

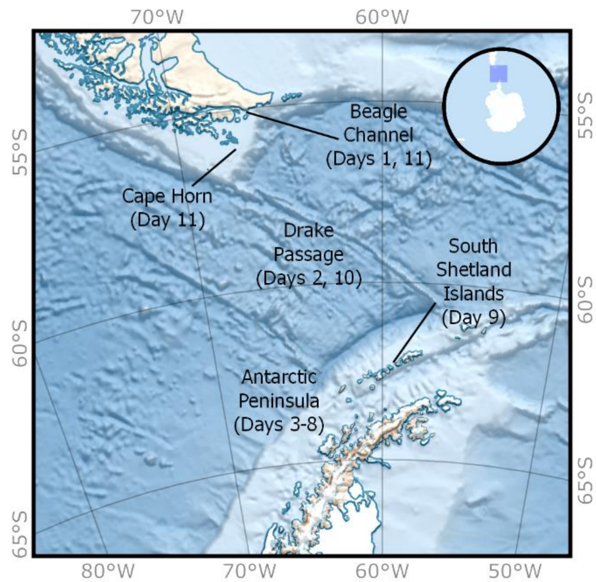

Figure 6: An overview of the general schedule for each voyage during the first season of Viking Expedition's cruises.

On both voyages, which included similar cruise tracks and schedules (Fig. 6) for the embarkation, debarkation, and Drake Passage crossing days, the evening of the first day provided some views of the Beagle Channel, traveling east from Ushuaia. Common birds including good numbers of South American Terns (*Sterna hirundinacea*), Black-browed Albatross, Chilean Skuas (*Stercorarius chilensis*), and young Southern Giant-Petrels (*Macronectes giganteus*). As we were aboard towards the end of the austral summer, evening twilight began to limit viewing opportunities well before we reached the mouth of the channel.

By morning twilight of the next day, the vessel was usually 50–100 km south of the continental shelf break, and into deep oceanic waters. Both species diversity and abundance were relatively low, primarily composed of giant-petrels, prions, and Black-browed Albatross. A few Gray-headed Albatross (*Thalassarche chrysostoma*) were also observed, particularly on the second transit south (Feb. 27). Only a few birds were noticeably following the ship, contrasting somewhat with Michael's prior anecdotal experience aboard other vessels. Other interesting sightings in more northerly latitudes (57°–59°S) included several Common Diving Petrels (*Pelecanoides urinatrix*) and Southern Rockhopper Penguins (*Eudyptes chrysocome*). Over the course of the day, the ship crossed much of the Drake Passage, reaching the Antarctic Convergence (the mixing of Antarctic and Subantarctic waters, roughly 59°S) in the middle of the afternoon. At that point, the ship encountered dense fog on both voyages, greatly reducing the ability to detect birds.

The schedule for both voyages had the ship arriving in Fournier Bay, Anvers Island, around noon on following day. By first light the ship was well south of the Antarctic continental shelf, and the bird community observed as we approached Anvers Island was dominated by Wilson's Storm-Petrels (*Oceanites oceanicus*) and Southern Giant-Petrels. As we approached and entered Fournier Bay, particularly on the second voyage (Feb. 28), we observed large flocks of Southern Fulmars (*Fulmarus glacialoides*) as well.

Following boat excursions in Fournier Bay, the ship spent the next six days on both voyages exploring various parts of the Antarctic Peninsula and South Shetland Islands, with cruise tracks that varied to suit the prevailing weather conditions and schedules of other vessels. As the primary goal of this project was to document seabirds on the open-ocean crossings, we do not give detailed accounts of all the birds observed on excursions in and around breeding colonies during these voyages in this document. However, we do note that most colonies of Gentoo (*Pygoscelis papua*) and Chinstrap (*P. antarcticus*) Penguins had adults that had already entered their post-breeding molt cycles. Some colonies contained breeding adults still rearing chicks. Most of the sites we visited were in the Gerlache Strait vicinity, though the ship did venture down to Matha Strait to cross the Antarctic Circle on Feb. 19, and into Antarctic Sound, on the northern end of the Antarctic Peninsula, on Feb. 22. While in Matha Strait, we observed many Snow Petrels (*Pagodroma nivea*), including several resting on sea ice as the ship approached in the early morning light (Fig. 7). There was also a single Emperor Penguin (*Aptenodytes forsteri*) observed on distant sea ice.

The Drake Passage crossing north on both voyages took roughly one day, similar to the transit south, with daytime observations covering roughly 61°–58°S.

Figure 7: Snow Petrels resting on sea ice in the early morning. © C. Wright

Species observed were largely consistent with the southbound legs, though the northbound legs also produced good numbers of Soft-plumaged Petrels (*Pterodroma mollis*) and a single confirmed Kerguelen Petrel (*Aphrodroma brevirostris*).

By dawn on the second northbound crossing day, the ship was positioned off Cape Horn and proceeded to travel northeast to the mouth of the Beagle Channel, then moving up the channel to Ushuaia, ending the day alongside. This stretch of ocean over the South American continental shelf was very productive for birds (as is often the case) with many Magellanic Penguins (*Spheniscus magellanicus*), Sooty Shearwaters (*Ardenna grisea*), Black-browed Albatross, Southern Giant-Petrels, White-chinned Petrels (*Procellaria aequinoctialis*), and Imperial Cormorants (*Leucocarbo atriceps*). One notable sighting was a single Westland Petrel (*Procellaria westlandica*; Fig. 8), an endangered and relatively rare relative of the White-chinned Petrel, not commonly seen as far east as Cape Horn.

The final species total for the two voyages, not including birds seen from shore or while alongside in South America, was 38.

Figure 8: Westland Petrel observed on Feb. 25, in the vicinity of Cape Horn. © C. Wright

Distance-sampling transects

As much time as possible was dedicated to collecting distance-sampling data on all four of the full sea days and during the portions of the partial sea days involving daylight travel in open waters. Although several surveys were conducted either individually or in a team of two joint observers, much of our effort was in "parallel" sampling events, during which the two of us independently sampled the same stretch of ocean. We completed 64 distance-sampling survey events, including 29 with parallel effort, leading to a total of 93 independent surveys (Table 2). Those surveys covered a total transect distance of 877 km of ocean and included 30 observed species. Most surveys were in the Drake Passage, covering the latitudinal gradient from 57°–61°S, while others were located over the continental shelves of both Antarctica (several north of Anvers Island and a few approaching Antarctic Sound) and South America, between Cape Horn and the Beagle Channel (Fig. 9).

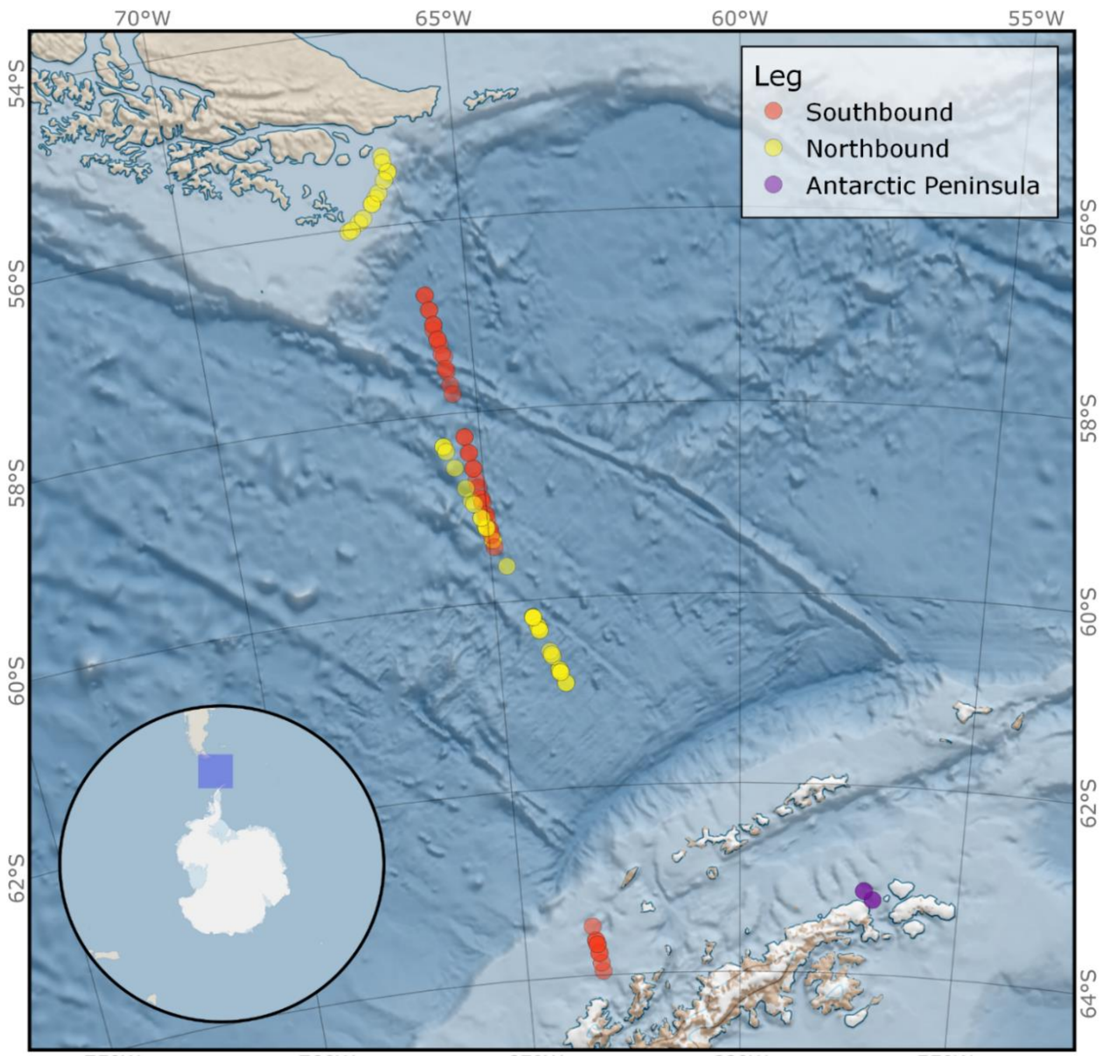

Figure 9: Map of distance-sampling survey start locations, separated into the southbound (Feb 16-17, 28-29), northbound (Feb 24-25, Mar 7-8) legs, as well as those collected while the vessel was in transit among excursion sites in the Antarctic.

Table 2: Distance-sampling survey statistics

Day	Number of surveys			Total surveys (inde-pendent)[4]	Total survey events (unique)[5]	Independent Observation Hours[4]	Unique Observation Hours[5]	Unique Observation Distance (km)[5]
	Parallel[1]	Solo[2]	Joint[3]					
Feb 16	3	0	5	11	8	5.1	3.7	115
Feb 17	1	1	0	3	2	1.2	0.8	26
Feb 22	2	0	0	4	2	2.0	1.0	22
Feb 24	7	3	0	17	10	7.2	4.2	122
Feb 25	1	4	0	6	5	2.4	2.1	69
Feb 27	7	5	4	23	16	11.4	7.8	254
Feb 28	2	0	2	6	4	3.2	2.1	38
Mar 7	5	4	2	16	11	6.8	4.8	154
Mar 8	1	0	5	7	6	3.0	2.7	77
Total	29	17	18	93	64	42.3	29.3	877

[1] Both observers independently collecting data at the same time, from the same vantage point (i.e., a single "event" with replicate surveys). In this column, the survey count refers to the total number of events, each representing two independent surveys.
[2] One observer working alone (often when the other person was concurrently collecting eBird data with guests from a different vantage point—not summarized in this table)
[3] Both observers working together
[4] "Independent" summaries add the effort from both observer's versions of a parallel survey event
[5] "Unique" summaries only count effort from a set of parallel surveys once

Evaluation of Survey Hardware/Software

As suspected, GPS signals to mobile devices on the bridge were extremely limited, making it necessary to obtain all minute-by-minute location data from other sources. Thanks to efforts by other Viking expedition staff members Drs. Brandi Revels and Richard Bates to get the FerryBox system operational, we obtained minute-by-minute ship tracks for 51 of the 64 unique survey events. An additional four survey ship tracks were obtained by placing a hand-held GPS receiver in another part of the vessel that allowed for a clearer signal. The remaining nine ship tracks could be reconstructed easily using the start and end positions and extrapolating the minute-by-minute positions.

Our general assessment of the Epicollect5 application was that it was sufficient for our purposes, though it does pose limitations. The customization tools for the data entry forms allowed us to adapt the field placement to maximize the ease of entering common birds, limiting the time required to look down at a screen. Although the application does allow the collection of location information from the device's GPS, the lack of clear signal inside the ship's superstructure created problems in moving through the form efficiently, as inadvertently clicking the option to receive a location fix would cause the app to pause for several seconds while it attempted to get a signal. We therefore decided to remove the automatic location fields entirely, instead using numeric fields to enter latitude and longitude manually for the start and end of each survey.

Each bird sighting within a survey was recorded using the app's "branch" functionality, which worked well, though does require a few seconds of attention to scroll through the necessary fields (which is less efficient than DLog3, based on Charlie's prior experience). We found that the rate of data entry required in the open Drake Passage was easily managed by a single observer using our custom Epicollect5 forms while also spotting birds. In the high bird densities of the South American continental shelf, however, a single observer struggled to navigate the branch entry form while maintaining sufficient attention on the survey zone. We therefore created a specialized form for that region, which altered the species list to make it more efficient. We also decided to focus less on collecting parallel surveys when in that region, which required each of us to collect data individually, and instead collected more joint surveys during which one person could focus on data entry while the other spotted birds. Next season we will modify the forms to be even more specialized, likely having three versions (one for the South America shelf, one for the open Drake Passage, and another for the Antarctic shelf), while also adapting some fields to autofill with the most common choices/numbers, allowing more efficient data entry in most cases. After making these alterations and continuing to conduct primarily dual-observer surveys when in the vicinity of Cape Horn or other high-density areas, we believe that Epicollect5 will continue to work well for data entry.

We also assessed the functionality of the eBird mobile application while onboard. Current versions of the app regularly connect to the internet and use the device's GPS while loading or beginning a checklist, which did cause some delays and errors when attempting to start checklists while onboard. We found that the most expedient way to begin a checklist was to (**1**) ensure that the appropriate regional "packs" (particularly those for Antarctica, Argentina, Chile, and the High Seas) were installed, (**2**) enable "airplane mode" on the device, (**3**) turn on the phone's location, (**4**) open the eBird app, and (**5**) start a checklist while on deck, with a clear view of the sky. Starting a checklist from within the ship's superstructure would generally fail due to the lack of a clear GPS signal. Paradoxically, having Wi-Fi enabled would make the situation worse, as the device would then interpret the ship's location as being in the harbor in Norway, leading the app to recording false location data. Of course, with Wi-Fi turned off, the checklist could not be submitted when finished, but would need to be saved in the app until Wi-Fi could later be enabled later. Even when following these steps, we would occasionally still encounter errors, especially when the app attempted to "update personal locations". Once a checklist had started, it was necessary to ignore many of the default birds suggested by the app as "common" or "rare", as eBird's system of automatic filters is not suited for open-ocean areas. It was therefore necessary to rely on our own experience for when and what to enter as documentation for species flagged (or not) as "rare".

eBird checklists

In addition to the 93 checklists collected in conjunction with each transect survey, we collected a total of 65 other eBird checklists from the deck of the vessel, 14 checklists from shore while in the Antarctic, and 7 checklists while on zodiacs operating in the nearshore Antarctic. All of the eBird data collected by the two of us, including during travel to and from the vessel, can be viewed in the following eBird trip report: https://ebird.org/tripreport/37343. Note, any eBird data that may have been collected by other observers, including guests or staff, are neither reflected in that trip report, nor in the counts of checklists above. However, these summary reports are easy for an eBird user to create and would provide a valuable tool for summarizing birding effort for guests, staff, and members of the public interested in the cruise. Viking Expeditions may want to incorporate them into their tour operations and marketing materials.

A total of 9 checklists were collected from some other vantage point on the vessel while either Michael or Charlie was concurrently collecting transect data from the bridge. This was occasionally done in an impromptu manner, but when possible was planned up to two days in advance, allowing the activity to be advertised to guests via the *Viking Daily* onboard newsletter. Although the amount of data collected in this manner during the 2021/2022 season was low, this will likely be an important source of data for the remainder of the project, and work in future seasons will increase this activity. In particular, pairing checklists to transect surveys in this manner will allow us to model how the different vantage points aboard the vessel contribute to the detection of different species of birds, for example, penguins that dive as the vessel approaches may be more visible from the bow or bridge, while birds following the vessel are likely much more visible from the stern or promenade.

Discussion and Future Planning:

In general, these two voyages during Viking's initial Antarctic tour season were a very successful start to the project. We accomplished all the objectives that we set out to achieve, and we learned how to fine-tune our protocols for an expanded data collection effort in 2022-23. Most importantly, we forged good working relationships with other Viking staff, and we are looking forward to continued collaboration on future voyages. We wish to thank all of the guests and crew of the *Viking Octantis* who contributed in some way to the success of this season, particularly the other expedition staff and the crew on the bridge, with whom we spent much of the time on the Drake Passage.

Based on our assessment of birding vantage points aboard the vessel, we can confidently conclude that distance-sampling surveys will need to continue from the bridge, although we may experiment with additional surveys on either the bow or forward part of the promenade when weather allows. Those outside locations are public areas, however, so any distance-sampling surveys undertaken there will need to be mindful of guest interaction, because the attention required for collecting the ancillary data from each sighting requires that observers not be regularly disturbed. Depending on the level of activity in that part of the ship at the time of the survey, it is possible that we could still complete distance-sampling surveys in public areas if other staff members are present to respond to guests who have questions or concerns.

Fortunately, eBird surveys can (and should) involve participation by guests, and therefore any of the public areas identified as good vantage points (Table 1) can be targeted for data collection next season. Our initial experiments with such activities this season were successful and expanding them will be very valuable to this project. We look forward to working with Viking staff prior to and during the next season to design more planned activities for guests on transit days. It would also be convenient, however, to have a system for alerting guests interested in watching birds when the birding conditions are good, as changes to viewing conditions or schedules may provide valuable opportunities for guest interaction and data collection. Space on deck to accommodate relatively large numbers of guests will likely not be limiting, so we feel that we can use guided "eBirding" to entertain many guests, if we can make communication flexible enough to alert guests when and where to take advantage of opportunities.

There is also large potential to expand the use of eBird during landings in the Antarctic and when traveling between destinations around the Antarctic. This is obviously the place where most guests experience wildlife in close proximity (e.g. Fig. 10). Many of the opportunistic checklists that we collected during excursions could have more heavily involved guests and other staff by specifically working such activities into the day's plans. As this was a shakedown season, and the other expedition staff were busy fine-tuning other aspects of the ship's operation, we did not press the issue this season. Next season, however, we hope to expand collection of eBird data around the Antarctic Peninsula where possible, even if the primary goal of this project remains focused on the open ocean crossings.

Figure 10: Gentoo Penguins at the breeding colony. © C. Wright

Exact plans for next season will involve working with Viking to schedule our time onboard. However, an important goal will be to maximize our ability to collect relevant open-ocean data in the region. Although the existing eBird database does not have as many checklists from areas along the South American coast, the species community is similar enough there to that of the Southern Ocean that spending some time at slightly higher latitudes may provide useful data. In addition, continuing to maximize time during the few sea days on each voyage will be crucially important. Geographic coverage of the central part of the Drake Passage was quite good this year. One notable omission, however, is the lack of any data from the continental shelf breaks, particularly the Antarctic shelf (Fig. 8). We suspect this region has a higher density of birds, especially of some rarer species not seen close to shore in this region. If the cruise schedule includes (or could be made to include) any passage over those areas during daylight, we would certainly target them for data collection.

The distance-sampling data collected this season, although not numerous enough to say much about bird densities on their own, will be very useful for planning the sampling scheme for next season. In particular, the number of parallel surveys should be sufficient to estimate inter-observer bias between Michael and Charlie, allowing us to assess how much more of those parallel surveys will be required. Doing so will require statistical modeling over the coming months and will guide the allocation of observer time on different types of surveys during 2022-23. Variation in bird density in the existing data will also allow us to better understand how many surveys will be required to address the overall biological questions of interest: namely, how do actual bird densities of several target species, such as Black-browed and Gray-headed Albatross, differ from north to south in the Drake Passage, and how well can bird abundance be explained by existing variation in oceanographic conditions? From the point of view of a guest on a ship, how well can the presence or abundance of specific birds be predicted (i.e., "when, where, and how can I best see them")? These analyses will be explored in future publications.

Final Thoughts

The ultimate goal of the partnership between Viking Expeditions and the Cornell Lab of Ornithology is to better understand eBird citizen science data from the world's oceans, allowing us to use those data to inform science, conservation, and tourism related to seabirds. Based on our experiences on the *Viking Octantis* during February-March 2022, we believe that this partnership has great potential to revolutionize our ability to do world-class seabird science with the help of expedition cruise guests. We are extremely grateful for the opportunity to advance marine ornithology with this partnership and look forward to continuing this work in the future.

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