eBird Southern Ocean Calibration

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

2022-23 Season Report & Progress Update

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The Cornell Lab of Ornithology

VIKING

eBSOC (eBird Southern Ocean Calibration) Project: 2022-23 Season Report & Progress Update

Executive Summary

December 2023

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 fellow 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 production of scientific publications at Cornell.

Season summary

This second field season involved the main data collection effort aboard both *Viking Octantis* and *Viking Polaris* during the 2022-23 Antarctic season.

This season's primary objectives:

1. Conduct at least 200 distance-sampling line transects.
2. Prioritize line transects paired with concurrent eBird checklists.
3. Maximize the temporal and geographic coverage of surveys throughout the Drake Passage.
4. Increase guest engagement and involvement in eBird checklists.

We successfully completed all four objectives, sampling a total 214 unique transect events, and were able to collect 89 concurrent eBird checklists (in addition to other eBird activities with guests during excursions). Involvement by guests and other staff was high, and, despite some challenges, data collection went smoothly.

Key outcomes

Scientific:

- Several interesting spatial and seasonal patterns emerged, in some cases involving stark contrasts between early and late season abundances and frequency of occurrence. More comprehensive analysis of distributions will be possible following completion of modeling work.
- Preliminary work on correcting observed abundance for the effect of birds in flight shows promise and highlights the extent of bias due to bird movement.
- Data quality for eBird checklists will be improved following work to update open ocean automatic filters.

Operational/Educational:

- We recommend that Viking introduce guests and staff new to birding to the Cornell Lab's Merlin app for learning more about the species encountered, and then encourage experienced birders to collect data via eBird.
- The open ocean can be treated more like a destination with unique experiences for guests. We recommend dedicating more time to organized wildlife watching sessions while at sea, and arranging cruise itineraries to target known hotspots, especially continental shelf breaks, during daylight hours.
- The Viking science program would benefit from increased understanding among the whole ship's crew about the importance of rigorous science to the guest experience and long-term success of the expedition cruising business model.

Future directions

The 2022-23 season was a very successful continuation of the eBird Southern Ocean Calibration project and ended with all field data necessary to complete the modeling phase of the project. 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.

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 there are many unknown aspects of how eBirders may detect birds at sea (Fig. 1) 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, allowing researchers to record information on many factors that affect how birds are detected. Detection of birds is very species- and distance-specific, as large, distinctive species are easier to detect from further away than are smaller, cryptic species. 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 continued effort to collect the data required to compare at-sea eBird data with more traditional forms of marine bird surveys, during the second Antarctic season of a partnership between the Cornell Lab and Viking Expeditions. Data collection involved a modified distance-sampling line transect protocol undertaken by the two research scientists, paired with eBird data collected by both the researchers and other staff and guests aboard the vessels. 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 expedition staff and guests ways to directly connect their voyages to groundbreaking ornithology. The project is funded by a grant from Viking Expeditions.

Figure 1: A Snowy Albatross, *Diomedea exulans*, one of the most iconic seabirds of the Southern Ocean.
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After our successful preliminary data collection during the previous season, our goal for the 2022-23 season was to collect enough data to complete the project's main scientific analyses. Our objectives, therefore, focused on data volume, as well as engaging guests and other expedition staff whenever possible in the collection of data.

Season Objectives:

We had the following objectives for 2022-23:

1. Conduct at least 200 distance-sampling line transects using a slightly modified procedure from the previous field season.

   Modeling of the preliminary data from 2021-22 suggested that approximately 200 additional transect samples would be required to achieve desired statistical precision in estimates of detection for certain common species. This target number assumed that we would be able to pool this season's data with those from last season, which also required that we keep the basic sampling protocol nearly identical. However, we were able to make some minor adjustments in how we collected survey metadata, improving efficiency in data entry.

2. Prioritize collecting more line transects paired with concurrent eBird data collection from other vantage points on the vessel.

   The data from 2021-22 showed that inter-observer differences in detection were likely small compared to other sources of variability, allowing us to put less effort into collecting parallel surveys with both scientific observers on the bridge at the same time. This allowed one of the two observers to collect eBird data from the ship's deck while the other remained on the bridge.

3. Collect surveys from the largest diversity of dates, locations, and environmental conditions within the Drake Passage as logistical constraints would allow.

   To use this study to form generalized conclusions for all eBird data from the region, it was necessary to collect data in the same range of conditions generally encountered by eBirders throughout the Antarctic tourism season, and in all parts of the Drake Passage. This was only possible by spreading our efforts across as much of the season as possible and attempting to collect data from any gaps in coverage by the surveys collected earlier in the season or during 2021-22.

4. Increase guest engagement and involvement with data collection to the extent possible.

   As education and outreach are a major focus of the project, we attempted to include guests in as much of the process as we could. This effort was complicated by the fact that observers conducting the line transects were required to be on the bridge (off-limits to guests) and needed to remain undistracted. However, the focus of *Objective 2* on collection of eBird data from deck allowed us to have a much more consistent presence in public areas than during the previous season.

Overview of 2022-23 Voyages:

Project scientists Michael Schrimpf (M.S.) and Charlie Wright (C.W.) were present aboard Viking's expedition vessels for a total of six voyages between Ushuaia, Argentina and the Antarctic Peninsula between November 2022 and March 2023. This included two consecutive voyages aboard *Viking Polaris* (14 Nov–3 Dec) with M.S. as a solo observer, followed by one voyage aboard *Viking Polaris* (19–30 Jan) and three aboard *Viking Octantis* (9 Feb–14 Mar) with both M.S. and C.W. as observers. These six voyages included a total of twelve crossings of the Drake Passage.

As in the previous year of data collection, both M.S. and C.W. were working onboard as expedition staff members, this year with M.S. in the role of Visiting Research Scientist and C.W. as Expedition Guide. We worked directly with the Chief Scientist and Expedition Leader to arrange the necessary logistics for our sampling work and to ensure our contributions to the onboard guest enrichment program made the fullest use of our respective skills.

Sampling Methods:

We employed nearly identical survey methods to the previous year, with only minor adjustments to the collecting of metadata before and after each survey. The largest difference between this season and the prior season was the increased amount of sea-time during which to collect data, resulting in a greater data volume. Our increased focus on collecting concurrent eBird data this season (*Objective 2*) played a major role in how survey types were prioritized.

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 the use of "catch per unit effort" by fisheries managers).

During these voyages, both M.S. and C.W. collected many complete eBird checklists while underway, often with guests, while the other observer was collecting distance-sampling surveys. We also collected opportunistic eBird data when not otherwise engaged in survey work, and while watching wildlife onshore with guests. Similar to last season, 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. Also similar to our experience last season, there were a handful of instances when it was necessary to record checklists on paper and submit them manually using the eBird website (https://ebird.org/submit) later. This was the case when an observation was made inside the superstructure of the ship, when a mobile device's GPS could not receive an accurate location signal. This only occurred during times when the outer decks were completely closed, and observations needed to be completed from behind windows in public areas of the ship. As we wanted to have precise GPS coordinates for all eBird checklists we submitted, these few instances

required that we then later check the ship's minute-by-minute scientific logs for position data.

We collected eBird checklists from several places on deck that offered various vantage points. Most effort was spent on the Deck 5 Promenade, either looking forward from the area just outside of the Explorer's Lounge, on whichever side was more sheltered from the wind, or looking aft from the area outside of the Aquavit Terrace. When wind and sea conditions allowed, we spent time on the bow.

Distance-sampling surveys

Our distance-sampling line transect protocol was largely unchanged from the 2021-22 pilot season, designed to estimate bird densities in a way that could be directly compared to results of 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 from the ship's track-line of any bird within the 300-meter strip was also recorded, using a series of four distance bands: within 50, 100, 200, or 300 m (Fig. 2), measured with the aid of a hand-held rangefinder. Flying birds were recorded in the first band 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 bands. When possible, a flight direction was recorded for each flying bird. Birds ahead of the vessel were considered within one of the four bands if they were near enough to discern the band boundaries. We estimated that this "look-ahead distance" was approximately 500 m. All birds observed outside of the four distance bands were recorded in a fifth, ">300-m" band. 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

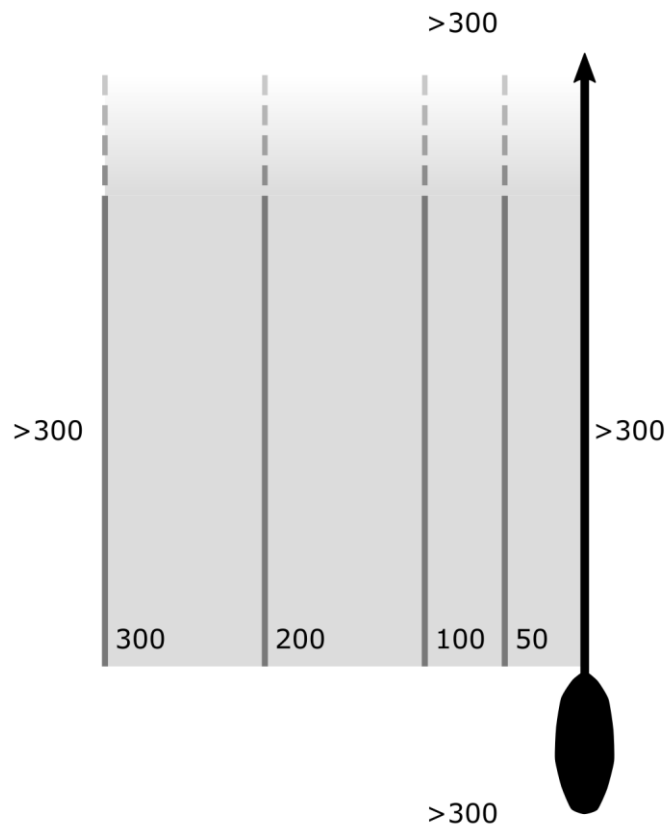

Figure 2: Diagram of the distance bands used, measured in meters, and representing the perpendicular distance from the ship's track line to the edge of the band, illustrated here for a port side survey. A traditional distance-sampling or strip-transect method would only focus on the area highlighted in gray, but complete eBird checklists include any birds detected, requiring that we also recorded those individuals in a ">300" band.

been recorded; 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 distance-sampling methods, but many do not attempt to record birds outside the dedicated distance bands (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. We submitted eBird checklists using these summary totals for each line

transect, to add to the other eBird data collected during the cruise.

Similar to last season, 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 specifically 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. Following our success using EpiCollect5 in the previous season, we did not make many changes to the forms, however we did create specialized forms for different eco-regions in the study area, allowing observers to record the most common species in each region more efficiently.

We obtained minute-by-minute track logs of the ship's position 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). Because these data were only available by accessing the FerryBox computer after surveys were collected, we manually recorded the start and end positions from the bridge GPS monitors for every survey as a backup. Fortunately, we did not need to rely on the backups for any surveys this season, as the FerryBox successfully recorded position data during all survey events.

Results:

Effort Summary

In total, M.S. and C.W. collected line transects during 214 unique survey events during 2022-23 season, including 22 parallel surveys during which both M.S. and C.W. were independently collecting data (Table 1).

Table 1: Distance-sampling line transect survey statistics, grouped by voyage.

Voyage Dates	Observ-ers	Number of surveys			Total surveys (inde-pendent)[4]	Total survey events (unique)[5]	Effort Duration (inde-pendent person-hours)[4]	Unique Survey Distance (km)[5]	Concurrent eBird Checklists[6]
		Parallel[1]	Solo[2]	Joint[3]					
14 Nov – 25 Nov	M.S.	0	25	0	25	25	11.7	340.0	4
25 Nov – 3 Dec	M.S.	0	26	0	26	26	12.6	374.3	0
19 Jan – 30 Jan	M.S. & C.W.	6	24	5	41	35	19.9	487.2	24
9 Feb – 20 Feb	M.S. & C.W.	4	33	4	45	41	22.1	576.1	22
20 Feb – 3 Mar	M.S. & C.W.	5	27	9	46	41	22.6	553.3	20
3 Mar – 14 Mar	M.S. & C.W.	7	32	7	53	46	26.7	627.4	19
Total		22	167	25	236	214	115.6	2958.3	89

[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)
[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
[6] Checklists (some shared) that were directly paired with a line transect, with the same start and end times

In addition to the eBird versions of each line transect, we also collected a total of 89 eBird checklists concurrent with the line transects, when a different observer was placed somewhere other than the bridge. Many of these concurrent checklists included guests among the participants. Although most concurrent checklists were led by either M.S. or C.W. as the primary observer entering data via the eBird mobile app, a few were led by other knowledgeable Viking staff or even guests experienced at collecting eBird data.

Line transects completed throughout the season were spread fairly evenly from north to south across the Drake Passage, albeit with relatively low coverage between approximately 56.5–57°S and 61.5–63°S (Fig. 3). As the cruise schedule was generally consistent, departing either Ushuaia or the Antarctic Peninsula in the evening and traveling through the night, the daylight opportunities for data collection generally occurred at similar latitudes on each cruise, leading to these areas of poor coverage. The second day of a crossing typically began approaching the Antarctic coast (on the trip south) or approaching Cape Horn and the Beagle Channel (on the trip north). The number and location of transects on these days depended heavily on the exact cruise track. Heading north, some trips aimed to arrive off Cape Horn in the early morning hours, allowing added effort over the South American continental shelf, whereas others involved travel directly to the mouth of the Beagle Channel. Most of the journeys south began the second sea day already over the Antarctic continental shelf, headed to the northern end of Anvers Island, but two voyages near the end of the season involved a full second sea day of travel to the Marguerite Bay region. These two voyages each included a daytime crossing of the shelf break.

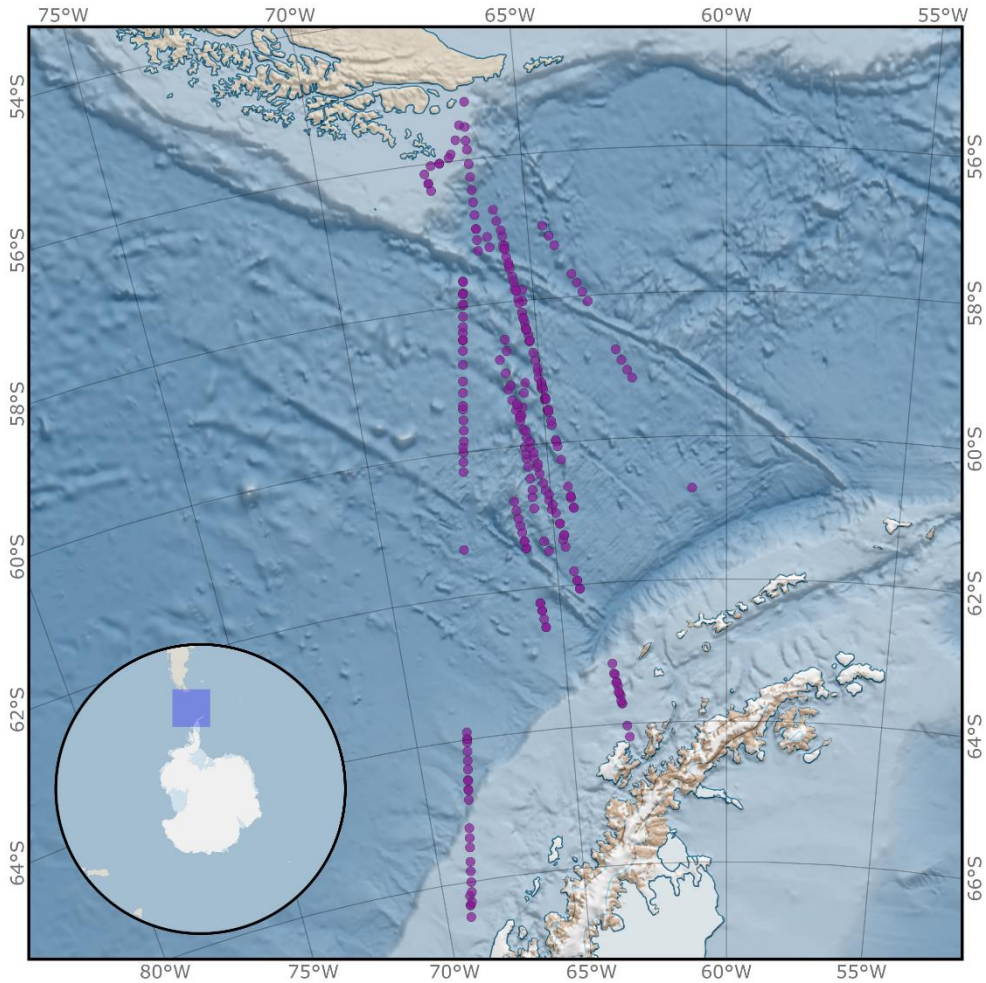

Figure 3: Map of line transects collected during the 2022-23 season.

Longitudinal coverage of the Drake Passage was primarily concentrated along the direct path between the mouth of the Beagle Channel and Anvers Island, as that was the route taken on most crossings. The last two voyages of the season covered more westerly longitudes enroute to Margeurite Bay. The very first day of data collection (Nov 15) was also an exception, being much more easterly, enroute to the South Shetland Islands. Because this first day of operations also involved only a single observer aboard (M.S.) and necessitated other organizational and administrative work, coverage along that leg was relatively sparse.

Although we focused our data collection efforts on the Drake Passage line transects, we took any opportunity to collect ancillary eBird data during each voyage. This included additional checklists on the open ocean, for example, when faced with a small time window between other activities during which relocation to the bridge for a full line transect was unrealistic, or when access to the bridge was restricted (there were a few cases when one of us was excused from participating in the regular crew drill, and therefore capable of observing birds, but not able to access the bridge). We also collected eBird data regularly during excursions, both from small craft on the water and from ashore. All of the checklists from each voyage were summarized using eBird's trip report feature and can be explored by the public via URLs (Table 2). These trip reports also display many of the photographs we obtained.

Table 2: eBird trip reports from the 2022-23 season.

Voyage Dates	Trip Report Link
14 Nov – 25 Nov	https://ebird.org/tripreport/85313
25 Nov – 3 Dec	https://ebird.org/tripreport/86318
19 Jan – 30 Jan	https://ebird.org/tripreport/103169
9 Feb – 20 Feb	https://ebird.org/tripreport/106964
20 Feb – 3 Mar	https://ebird.org/tripreport/108996
3 Mar – 14 Mar	https://ebird.org/tripreport/111470

General Species Distribution Observations

Here we provide a general overview of the patterns of bird distributions we observed throughout the season. As a thorough analysis of the abundance data requires a nuanced treatment of the detection probability for each species in various conditions (see Discussion for a summary of those ongoing efforts), we focus here on summaries of detection/non-detection. For this reason, we include all complete eBird checklists in these figures, including those not associated with line transects.

The total number of species detected varied considerably among checklists, from zero to fourteen (Fig. 4). More formal statistical analyses after corrections for detection bias will be necessary to fully identify areas of high diversity, but anecdotal examination suggests considerable variation in the number of species one can expect to encounter in the open Drake Passage. This likely signals the importance of local oceanographic conditions, as one would expect in the presence of mesoscale features such as fronts and eddies.

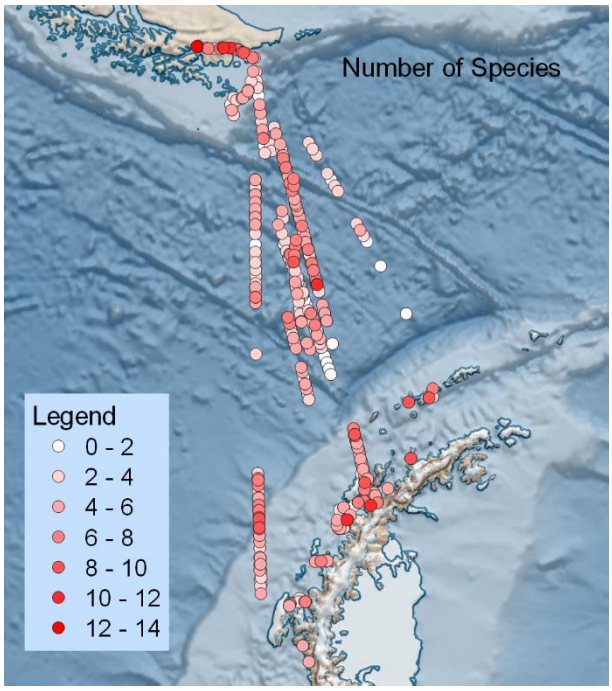

Figure 4: Number of species detected in each eBird checklist.

Of particular note was the increase in number of species detected as the vessel crossed the Antarctic continental shelf break on the last two voyage enroute to Margeurite Bay. The first of these crossings occurred on 22 February, during which we encountered an amazing concentration of wildlife seemingly exactly when the depth readout on the bridge registered the transition to shallower water. During a few short minutes, we observed several hundred long-finned pilot whales (*Globicephala melas*; Fig. 5), accompanied by six hourglass

dolphins (*Lagenorhynchus cruciger*) and dozens of Antarctic fur seals (*Arctocephalus gazella*), Wilson's (*Oceanites oceanicus*), and Black-bellied Storm-Petrels (*Fregetta tropica*), among other birds. The appearance of such abundance was very brief, returning to somewhat normal levels within minutes.

Figure 5: Photos of long-finned pilot whales seen at the Antarctic continental shelf break. © C. Wright

As was to be expected, several species, such as Black-bellied Storm-Petrel were more frequently observed further south (Fig. 6), while others, such as Sooty Shearwater (*Ardenna grisea*), were more frequent further north (Fig. 7). A curious observation of Sooty Shearwater abundance was that in early March, when our past experience led us to expect many of them over the South American continental shelf waters around Cape Horn, we instead encountered relatively few. Instead, we found large flocks, some containing tens of thousands of individuals, once the vessel had entered the Beagle Channel itself. We were unsure what conditions may have caused the birds to congregate in the protected waters of the channel during this brief period, and how common such an occurrence may be.

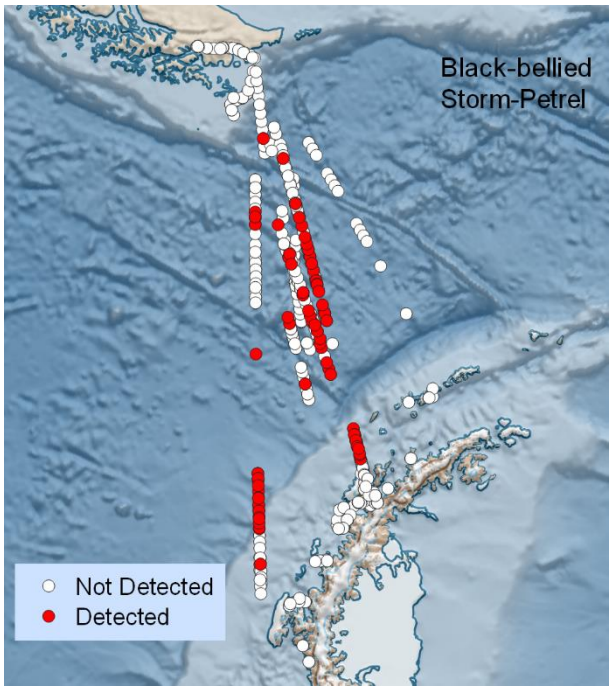

Figure 6: Checklists with and without detections of Black-bellied Storm-Petrels.

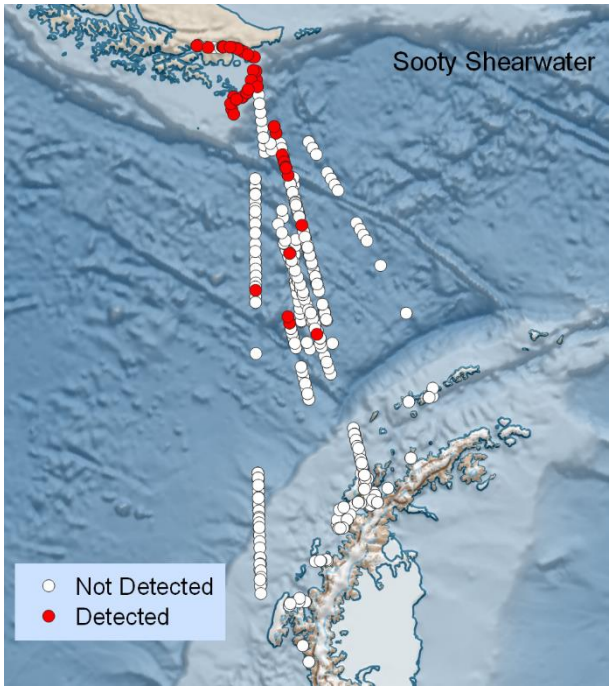

Figure 7: Checklists with and without detections of Sooty Shearwaters.

Species observed throughout the season included those that were relatively frequently encountered, such as Black-browed Albatross (*Thalassarche melanophris*, Fig. 8),

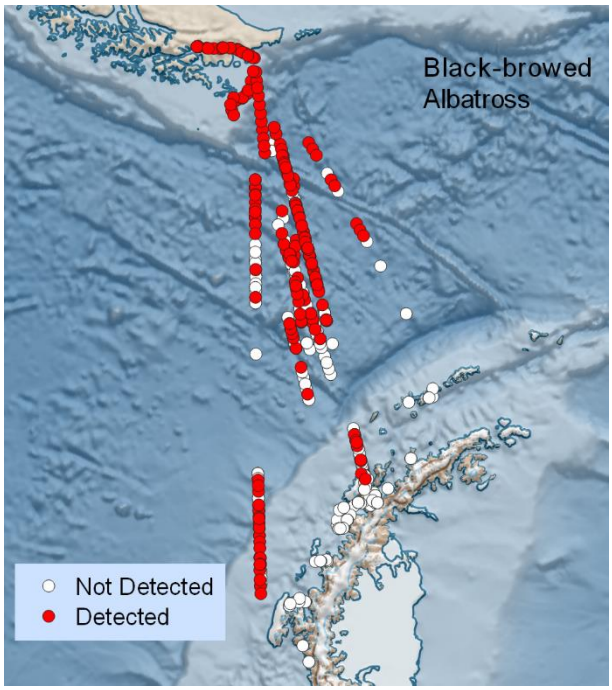

Figure 8: Checklists with and without detections of Back-browed Albatross.

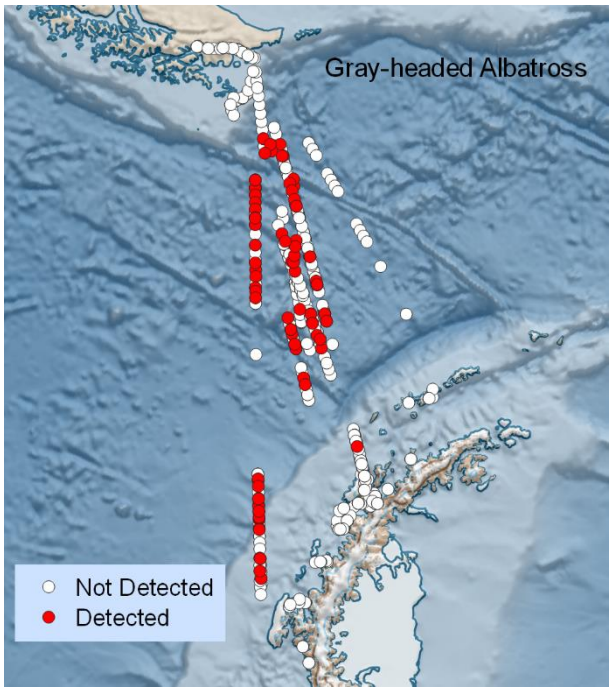

Figure 9: Checklists with and without detections of Gray-headed Albatross.

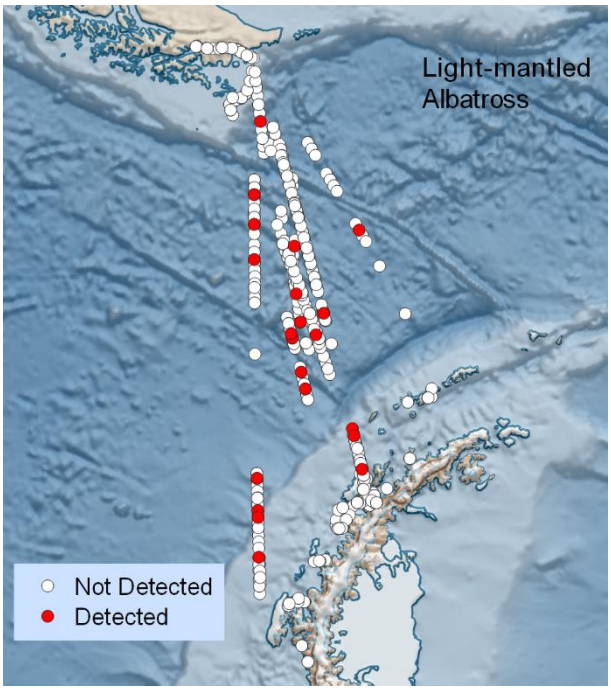

Figure 10: Checklists with and without detections of Light-mantled Albatross.

those that were somewhat less common, such as Gray-headed Albatross (*Thalassarche chrysostoma*, Fig. 9), and those that were uncommon and generated increased excitement among the guests present, such as Light-mantled Albatross (*Phoebetria palpebrate*, Fig. 10). Albatrosses and giant-petrels (*Macronectes* spp.) were often seen following the vessel. Consistent with our observations during the prior season, however, the number of following birds was often lower than M.S.'s prior experience on other expedition vessels. Future analysis of the records of following birds will allow us to assess this anecdotal observation more completely.

Much is already known about bird distributions in the Southern Ocean, however there is a high likelihood that there are little-known nuances in the timing of bird movements. One such example is clearly demonstrated in our detections of Soft-plumaged Petrel (*Pterodroma mollis*), which was mostly absent in the early part of the season (Fig. 11) but was observed very frequently later in the season (Fig. 12). Existing resources on Soft-plumaged Petrel distributions do not discuss seasonal movements at the regional scale like this, and such patterns may be present for many Southern Ocean seabirds.

There were a few unexpected observations during the season, most notably two separate records of Red Phalarope (*Phalaropus fulicarius*), which is common along the west coast of South America during the season, but

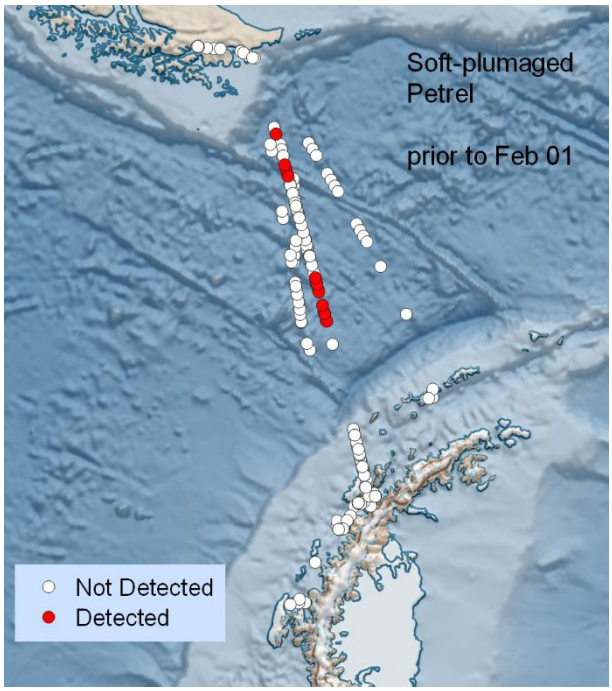

Figure 11: Checklists collected prior to 01 Feb 2023 with and without detections of Soft-plumaged Petrel.

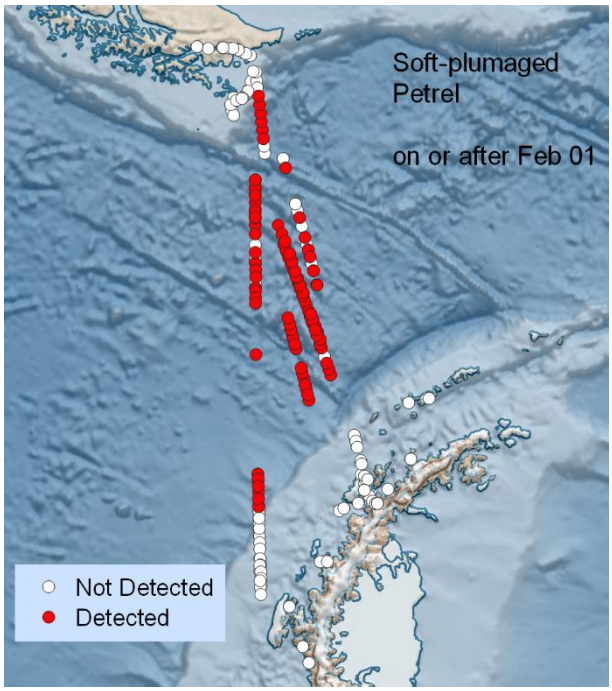

Figure 12: Checklists collected on or after 01 Feb 2023 with and without detections of Soft-plumaged Petrel.

very rare south of the continent. One sighting occurred just south of the Beagle Channel, on 19 February, in an area that has a few other existing records. The other (Fig. 13) was recorded on 10 February in the middle of the Drake Passage, near 59.8°S, 64.8°W, making it the southernmost Red Phalarope record in the eBird database. We also observed a Mottled Petrel (*Pterodroma inexpectata*) on 5 March near 64.2°S, 68.4°W, a bit north of the Antarctic continental shelf. Mottled Petrels typically travel to Antarctic waters south of Australia and New Zealand during the austral summer but are rare as far east as the Antarctic Peninsula. At the time, however, we were further west than most Antarctic expedition ships travel, so it is possible that the lack of records for that area simply reflects low sampling effort.

Figure 13: A Red Phalarope observed in the Drake Passage on 10 Feb 2023, much further south than the species is typically seen. © C. Wright https://macaulaylibrary.org/asset/569124261

Discussion and Ongoing Work:

Season overview

In general, this was a highly successful season for the project, achieving all major objectives, either completely or near-completely. The total of 214 unique transect sampling events surpassed our stated goal of 200, and many of those included concurrent eBird data from other vantage points on the vessel. With a few exceptions, the survey effort spanned much of the Drake Passage, and we managed to collect data from both early and late in the season. We were also very successful in engaging guests with eBird surveys, although strategies for improving such activities are discussed below.

The most important outcome of this work will result from the ongoing comparison between the transect data

and eBird checklists. Even before those results are available, however, we can see intriguing patterns in the data, particularly in the temporal patterns of birds like the Soft-plumaged Petrel that show previously undocumented seasonal shifts in distribution (Figs. 11–12). More thorough analysis of oceanographic conditions around each survey may reveal interesting associations that could help predict where encounters with certain species (particularly rare ones) are most likely, which would be of interest to scientists, conservation managers, and tourism operators.

Challenges and Opportunities

Because these ships were primarily conducting tourism, our data collection process inevitably involved tradeoffs and limitations. Obviously, we spent a great deal of time engaged with guests this season, which was one of our major objectives, but also entailed a tradeoff with the efficiency of data collection. Often the start of the next survey would be delayed because the observer on deck needed to find a suitable break in conversation with guests to look at their phone to begin the next survey and coordinate with the observer on the bridge. This was a natural limitation of our process in comparing eBird data to transect data. Over the course of the season, we improved in our ability to juggle the dual responsibilities of engaging with guests while concurrently collecting data. This highlights the importance of having access to the bridge to collect the line transect data, because while eBird checklists can be completed while interacting with guests, our line transect protocol required greater concentration. We therefore recommend that any project attempting to reproduce our efforts ensure that line transect observers be able to fully concentrate on data collection, either by being isolated from the public or by having another staff person present to engage with guests. Despite the challenge to data collection efficiency, we view this issue as a positive aspect of our work, because it demonstrated how excited the guests were in learning from us about science and nature.

The most obvious limitation from a geographic sampling perspective was that the cruise track was entirely outside of our control, and we were therefore not able to target specific regions of the Drake Passage. Given this constraint, we believe that our geographic coverage of the region was as comprehensive as possible. Other vessels operate on different schedules, however, emphasizing the usefulness of a citizen science program like eBird, which can be used by any observers on any vessels. The calibration results from this project will be instrumental in analyzing eBird data collected by the Polar Citizen Science Collective (https://polarcollective.org/), which can be used to fill those gaps. Naturally the need to keep to a cruise schedule will always be a major determination in such voyages, and scientific surveys aboard such vessels will necessarily need to be opportunistic at some level. However, we believe there are opportunities to adapt itineraries to engage guests via exploration that will serve to expand the geographic scope of bird surveys in the future (detailed more fully in our recommendations to improve guest experiences below).

Another major tradeoff this season resulted from our positions onboard as members of the crew. Naturally, regardless of their job description, crew members have certain responsibilities (e.g. safety training, attention to guests, and human resource logistics) inherent in working aboard a vessel carrying tourists. We believe that we achieved a decent balance between time spent focused on science vs. other duties, which was facilitated by our prior experience last season and a good working relationship with other members of the crew (both among the other expedition staff and the deck department). Special thanks are due to the expedition leaders and assistant leaders, the other expedition science staff, and the officers and sailors on the bridge, all of whom were very accommodating to our needs. Certain crew responsibilities that took us away from data collection were obviously unavoidable, for example participation in mandatory crew safety drills. The fact that such drills always occurred on sea days, and therefore decreased the amount of available time for surveys on every voyage, was simply because most other onboard operations were less impacted by drills on sea days compared to excursion or port days. Other responsibilities, such as safety and HR induction meetings were occasionally able to be moved to other days, thus improving scientific output, but that increased the time commitments of officers responsible for leading them and was not always feasible. Improved communication in advance of us joining the ship, or flexibility for crew members switching between ships could have satisfied these requirements more efficiently.

We found ourselves often explaining our purpose onboard to other crew (both among and outside of the expedition department), many of whom did not see science as a very relevant part of the ship's mission. However, once they understood our project, many crew members were eager to learn more and even assist. We felt that our success in both our scientific and guest

engagement tasks would have been improved had the crew been better informed about how Viking's science program fits into the larger picture of their expedition mission. We see the science program as the means to:

1. Be authentic to the "expedition" nature of the voyage by actually engaging the ship's company in exploration.
2. Provide guests and staff with activities that go beyond entertainment or education into real contributions to the scientific enterprise.
3. Provide the necessary information to protect and conserve the environments they are visiting, ensuring that their travel can be made ethically sound and is a viable long-term business model.

It is natural for the guest experience to remain the primary goal of those onboard, and understandable that crew coming from a typical tourism background are not initially familiar with having scientific research as a core component of the ship's mission. However, we believe that Viking's science program will succeed better if it is not viewed simply as a means to entertain guests, but rather as a distinct and valuable aspect of the vessel's operations.

Modeling Work

The collection of data during the 2022-23 season was crucial to the project's success, but only represents the first phase of work. Analysis of those data is ongoing and progressing well. The most significant challenge to interpreting the transect data is the inclusion of birds in flight, as individuals in motion create bias in the rate at which birds are encountered, and the distance at which they can be detected. Understanding that bias requires advanced modeling work and the adaptation of statistical methods in novel ways. M.S. made important breakthroughs in these efforts by collaborating with researchers at the University of St. Andrews during May-June of 2023. This work is ongoing and has seen remarkable progress using simulations in recent months. When that work has been completed, likely in the next two months, work can begin in earnest to compare eBird data to the calibration data from the transects. This modeling work is the primary job of M.S. in his role as a postdoctoral fellow at the Cornell Lab.

Future Improvements to eBird

Throughout both the 2021-22 and 2022-23 field seasons, we identified several aspects of the typical eBird experience that could be improved. Several of these improvements are related to the functionality of the eBird mobile app. We have communicated those concerns to the developers at the Cornell Lab, who are working on improving the experience of app users in situations commonly encountered on ships (for example, the offline access frequently required when far from shore).

Perhaps the most pressing issue was the lack of appropriate automated filters for open-ocean regions. The eBird system relies on a series of geographic filters that determine what list of birds a user sees when entering data. Due to the nature of the eBird infrastructure, and the system of "closest-point-of-land" used to assign oceanic checklists to a particular region for data review, a creation of global filters for the world's oceans was a challenging problem that had previously not been solved. After consultation with the eBird project leaders, it was decided to have M.S. spend part of this project developing the infrastructure for such a system after the end of the 2022-23 field season. This work has now been completed, and eBird regional data reviewers can now create regionally specific oceanic filters, matched to the closest-point-of-land boundaries (Fig. 14). Filters are currently being released as they are created, and those for the Antarctic Peninsula, Drake Passage, and Scotia Sea were released just prior to the 2023-24 tourist season beginning. This should create an immediate improvement in both data quality and the user experience for guests aboard any expedition vessels in the area and represents an important contribution of the eBird Southern Ocean Calibration Project to global bird monitoring.

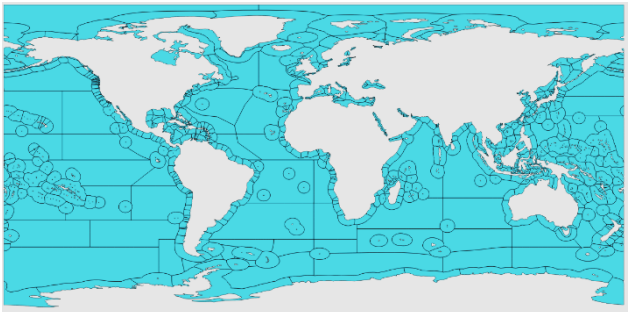

Figure 14: The new set of oceanic eBird polygons created in 2023, capable of supporting custom regional filters for the open ocean.

Future improvements to how users collect data from ships are being considered, particularly the collection of information on the type of vessel, vantage point, and viewing conditions. This will be further informed by the

modeling work planned for the final phase of this project, to be completed in the next 6–8 months.

Improving Guest Experiences

After leading many eBird checklists during wildlife watching activities, and general birdwatching with guests, we have the following recommendations for improving the experiences that Viking guests have with wildlife observations aboard the expedition vessels during the Antarctic season.

- Treat the open ocean (particularly the Drake Passage and Southern Ocean) as a destination, not simply an empty space. Rather than spending sea days entirely in lectures, encourage guests to congregate on deck (where safe) to watch for wildlife.
- Encourage wildlife watching in groups. Although the Viking ethos tends to promote more personal exploration, spotting seabirds is generally much more successful in small groups of 2–10 people.
- Have expedition leaders consider a cruise itinerary that specifically allocates time during daylight hours in areas of the open ocean known to have concentrations of wildlife. This includes areas near ocean fronts, but most especially areas along continental shelf breaks. The Antarctic shelf break is a particular hotspot for rare birds and large concentrations of marine mammals.
- Attempt to get guests out on deck whenever it is safe to do so. This should involve good communication between the deck department and expedition department, accompanied by clear signage, so that specific parts of the outer decks are closed when necessary for safety, and then re-opened as soon as is practical. Expedition staff should be part of this communication, so that they can be outside to assist guests in wildlife identification as soon as possible.
- Encourage keen wildlife watchers to areas where they can get a good vantage point of the ocean without being subjected to high winds. Aboard Viking Expedition's vessels, this includes much of the Deck 5 promenade. Wildlife watch should only be conducted on the bow when the apparent wind there is low.
- For staff and guests who are new to birding or simply wish to learn more about birds, encourage spending time observing with onboard resources like field guides or the Cornell Lab's Merlin bird identification app: (https://merlin.allaboutbirds.org/)
- If staff or guests are fairly comfortable with bird identification (they need not be experts but should feel capable identifying some of the common bird species), encourage them to use eBird to record their sightings. Due to the nuances of using the eBird app on the ship, it is best for at least one member of a birding party to have experience using the app prior to attempting its use from the ship.
- Staff members generally familiar with the birdlife present should be encouraged to take the Polar Citizen Science Collective's seabird survey training, in which M.S. provides instructions on how to collect the most valuable type of eBird survey for mapping bird distributions in the Southern Ocean.
- The use of eBird trip reports (e.g., Table 2) can be an effective way to summarize sightings for guests when eBird is being used regularly.

Final Thoughts:

Following from the 2021-22 pilot season, the 2022-23 season was a very successful continuation of the eBird Southern Ocean Calibration project and ended with all field data necessary to complete the modeling phase of the project. Despite several challenges to conducting seabird survey work onboard expedition vessels, project scientists succeeded at collecting quality data while also engaging guests. Preliminary data analysis revealed interesting patterns, suggesting that the final products from the project will represent an important step forward in mapping bird distributions in the Southern Ocean.

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