JNCC Report 732

Review of data used to calculate avoidance rates for collision risk modelling of seabirds

Annex 4
Bird Collision Avoidance: follow-on analysis

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1 Overview

In the time since Ozsanlav-Harris *et al*. (2023) released their review of avoidance rates for collision risk modelling, the 'stochCRM' Shiny app originally implemented by McGregor *et al.* (2018), has stopped being supported, and is being replaced by a new tool: 'sCRM' (https://github.com/dmpstats/sCRM), which is a Shiny app built using the {stochLAB} package (Caneco 2022). Given that the functions in {stochLAB} (which underlie all computations done by sCRM) are not identical to those used by stochCRM, there are concerns that though collisions calculated by stochCRM and sCRM are likely to be similar to one another, even small differences may cumulatively produce meaningful divergences in calculated collision rates. To future-proof guidance from JNCC and the other statutory nature conservation bodies (SNCBs) on undertaking CRM in the marine environment, the revisions included here aim to bring the previous avoidance rate calculations in line with the new methods used by sCRM.

Below is a summary of the three key changes made to the Ozsanlav-Harris *et al.* (2023) RMarkdown code (JNCC Report 732: Annex 3) which was originally used to calculate avoidance rates. Code and data outputs of the original Ozsanlav-Harris *et al.* (2023) are referred to in text, figures, and code as 'v1', while the code and outputs of revised code are referred to as 'v2' (see supplementary v2 code document for details of changes from v1):

1. Loading and use of {stochLAB}, which the sCRM shiny app uses as the source of all functions for CRM calculations. Alongside the key functions referenced below we also make use of {stochLAB}'s `generate_rotor_grids()`, `chord_prof_5MW()`, and `get_lac_factor()` functions.
2. Two uses of the custom `pcoll()` function (the Basic Band calculations in Section 4 and the Stochastic Basic Band calculations in Section 8) are now replaced with the `get_avg_prob_collision()` function from {stochLAB}.
3. Two uses of the custom `coll.int()` function (Extended Band calculations in Section 6 and Stochastic Extended Band Calculations in Section 10) are now replaced with a custom version of the `get_collisions_extended()` function from {stochLAB}, which has been revised to only output the Collision Integer (see the functions section of supplementary code document for details of the code revisions made to create this function).

NB: v1 and v2 outputs below were created using a collision data file ('Data/Ozsanlav-Harris *et al.* (2022) Collision Data.csv') which included data rows from Boudwijnkanaal that cannot be made publicly available. As a result, the specific tables and figures included below cannot be accurately reproduced by the code published alongside this report (though values will be largely similar). It should also be noted that these differences mean the v1 values shown below may differ slightly from those published in the original report by Ozsanlav-Harris *et al.* (2023).

2 Updated Basic Band avoidance rate calculations

Following a replacement of the existing `*pcoll()*` function with {stochLAB}'s `*get_avg_prob_collision()*` function, code was re-run and outputs saved alongside the previous versions (v1) outputs. For both the Basic Band and Stochastic Basic Band avoidance rates, v2 avoidance rates values appear to closely reflect v1 values (Table 1–2, Figures 1–2).

Table 1: Basic Band avoidance rates comparison between original Cook (2021) values, and Ozsanlav-Harris *et al.* (2022) v1 and v2 values. Percentage change in rate column refers to the change in rate between Cook (2021) and Ozsanlav-Harris *et al.* (2022) v2. **Green** values (*) indicate positive changes and **red** (#) indicate negative changes.

Species/ Species group	Cook (2021)	Ozsanlav-Harris *et al.* (2023) v1	Ozsanlav-Harris *et al.* (2023) v2	% change in rate
Kittiwake	0.9970 (0.0015; 0.9940–1)	0.9970 (0.0015; 0.9940–1)	0.9970 (0.0015; 0.9940–1)	**0 ***
Black-headed gull	0.9873 (0.0009; 0.9856–0.989)	0.9920 (0.0006; 0.9909–0.993)	0.9920 (0.0006; 0.9909–0.993)	**0.473 ***
Herring gull	0.9953 (0.0002; 0.9948–0.9957)	0.9952 (0.0002; 0.9948–0.9957)	0.9952 (0.0002; 0.9948–0.9957)	**-0.003 #**
Lesser black-backed gull	0.9950 (0.0003; 0.9944–0.9956)	0.9954 (0.0003; 0.9948–0.9959)	0.9954 (0.0003; 0.9948–0.9959)	**0.036 ***
Great black-backed gull	0.9991 (0.0002; 0.9986–0.9995)	0.9991 (0.0002; 0.9987–0.9995)	0.9991 (0.0002; 0.9987–0.9995)	**0.007 ***
All gull	0.9874 (0.0003; 0.9868–0.9879)	0.9923 (0.0001; 0.9921–0.9926)	0.9923 (0.0001; 0.9921–0.9926)	**0.502 ***
Large gull	0.9860 (0.0007; 0.9846–0.9874)	0.9936 (0.0002; 0.9933–0.9939)	0.9936 (0.0002; 0.9933–0.9939)	**0.772 ***
Small gull	0.9919 (0.0004; 0.9911–0.9927)	0.9947 (0.0003; 0.9942–0.9952)	0.9947 (0.0003; 0.9942–0.9952)	**0.282 ***
Sandwich tern	0.9722 (0.0016; 0.9690–0.9753)	0.9722 (0.0016; 0.9691–0.9753)	0.9722 (0.0016; 0.9691–0.9753)	**0.002 ***
All tern	0.9712 (0.0007; 0.9697–0.9726)	0.9713 (0.0007; 0.9698–0.9727)	0.9713 (0.0007; 0.9698–0.9727)	**0.009 ***
Gulls & terns	0.9856 (0.0002; 0.9860–0.9852)	0.9902 (0.0001; 0.9904–0.9899)	0.9902 (0.0001; 0.9904–0.9899)	**0.462 ***

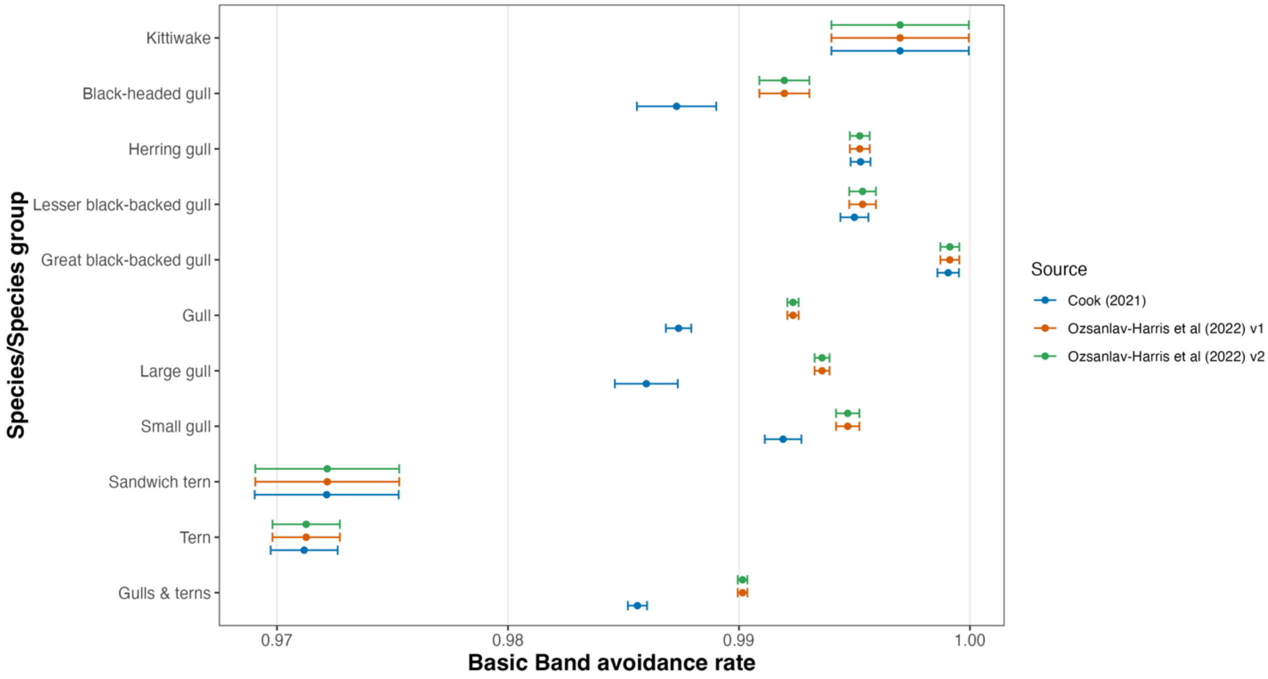

Figure 1: Basic Band avoidance rates computed by the three methods. Error bars represent the 95% confidence interval calculated using the delta method.

Table 2: Stochastic Basic Band avoidance rates comparison between original Cook (2021) values, and Ozsanlav-Harris *et al.* (2022) v1 and v2 values. Percentage change in rate column refers to the change in rate between Cook (2021) and Ozsanlav-Harris *et al.* (2022) v2. **Green** values (*) indicate positive changes.

Species/ Species group	Cook (2021)	Ozsanlav-Harris *et al.* (2023) v1	Ozsanlav-Harris *et al.* (2023) v2	% change in rate
Kittiwake	0.9979 (0.0013; 0.9954–0.9993)	0.9979 (0.0013; 0.9954–0.9993)	0.9979 (0.0013; 0.9954–0.9992)	**0.005 ***
Black-headed gull	0.9874 (0.0007; 0.9859–0.9887)	0.9920 (0.0005; 0.9910–0.9929)	0.9922 (0.0005; 0.9912–0.9931)	**0.483 ***
Herring gull	0.9953 (0.0003; 0.9947–0.9959)	0.9953 (0.0003; 0.9947–0.9958)	0.9953 (0.0003; 0.9947–0.9958)	0
Lesser black-backed gull	0.9950 (0.0003; 0.9943–0.9957)	0.9954 (0.0003; 0.9948–0.9959)	0.9954 (0.0003; 0.9947–0.9961)	**0.041 ***
Great black-backed gull	0.9991 (0.0002; 0.9986–0.9993)	0.9991 (0.0002; 0.9987–0.9994)	0.9991 (0.0002; 0.9987–0.9994)	**0.007 ***
All gull	0.9879 (0.0005; 0.9870–0.9889)	0.9928 (0.0004; 0.0021–0.9934)	0.9929 (0.0003; 0.0022–0.9935)	**0.5 ***
Large gull	0.9861 (0.0006; 0.9849–0.9872)	0.9940 (0.0004; 0.9931–0.9947)	0.9940 (0.0003; 0.9932–0.9948)	**0.798 ***
Small gull	0.9921 (0.0004; 0.9913–0.9929)	0.9948 (0.0003; 0.9943–0.9953)	0.9949 (0.0003; 0.9943–0.9954)	**0.286 ***
Sandwich tern	0.9723 (0.0004; 0.9714–0.9731)	0.9722 (0.0005; 0.9714–0.9732)	0.9724 (0.0005; 0.0715–0.9733)	**0.019 ***
All tern	0.9713 (0.0004; 0.9704–0.9722)	0.9714 (0.0004; 0.9705–0.9723)	0.9717 (0.0005; 0.9708–0.9727)	**0.044 ***
Gulls & terns	0.9862 (0.0005; 0.9852–0.9872)	0.9906 (0.0004; 0.9899–0.9914)	0.9908 (0.0004; 0.9900–0.9915)	**0.468 ***

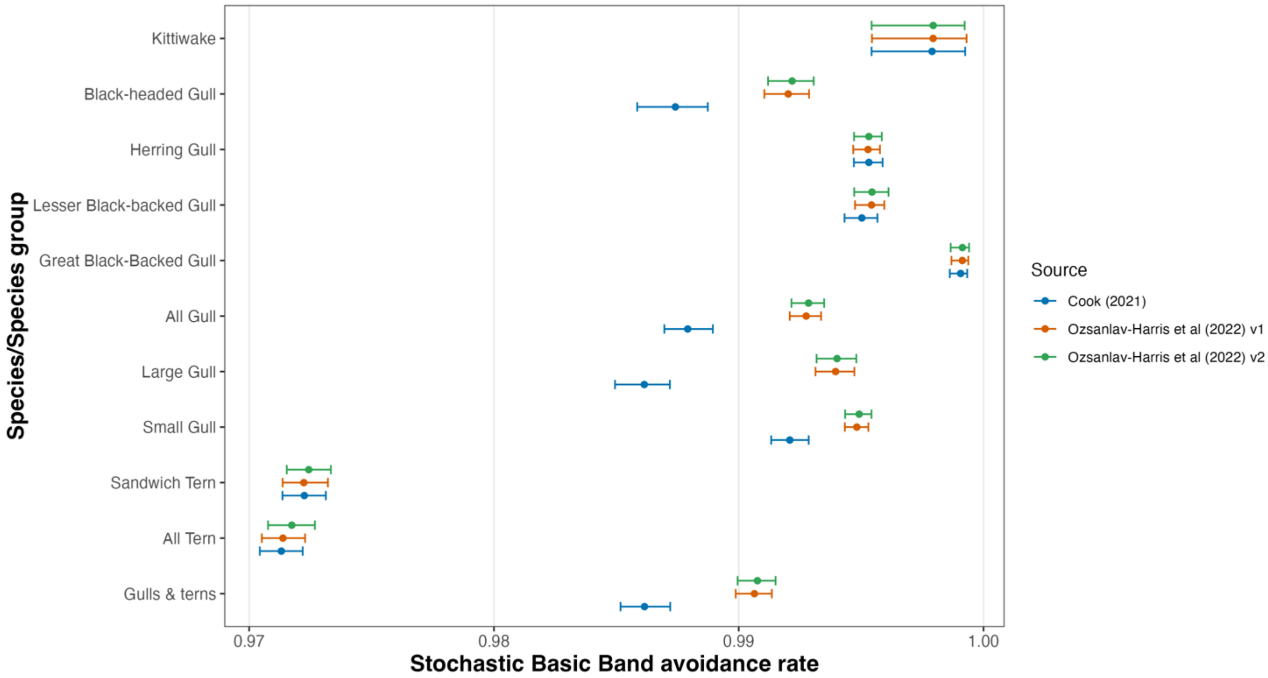

Figure 2: Stochastic Basic Band avoidance rates computed by the three methods. Error bars represent the 95% confidence interval calculated from 1,000 random iterations where input parameters were varied.

Following implementation of the new function for calculating collision probabilities, avoidance rates for both Basic Band and Stochastic Basic Band were found to very closely resemble v1 avoidance rates. Understanding what exactly is driving the minor differences is challenging, as the underlying equations behind `*get_avg_prob_collision()*` do appear to differ considerably to the `*pcoll()*` function implemented by Ozsanlav-Harris *et al.* (2023) — which itself was originally written by Cook (2021). If it was necessary to establish the source of these differences in greater detail and more confidence, additional sensitivity analyses may be required.

3 Updated Extended Band avoidance rate calculations

Following replacement of the `*coll.int()*` function with a custom version of {stochLAB}'s `*get_extended_collisions()*` (revised to only output the collision integer), we re-ran code for both the Extended Band and Stochastic Extended Band avoidance rates (Table 3–4 and Figures 3–4).

Table 3: Extended Band avoidance rates comparison between original Cook (2021) values, and Ozsanlav-Harris *et al.* (2022) v1 and v2 values. Percentage change in rate refers to the change in rate between Cook (2021) and Ozsanlav-Harris *et al.* (2022) v2. **Green** values (*) indicate positive changes and **red** (#) indicate negative changes.

Species/ Species group	Cook (2021)	Ozsanlav-Harris *et al.* (2023) v1	Ozsanlav-Harris *et al.* (2023) v2	% change in rate
Kittiwake	0.9924 (0.0038; 0.9848–0.9999)	0.9924 (0.0038; 0.9848–0.9999)	0.9923 (0.0039; 0.9847–0.9999)	**-0.007 #**
Black-headed gull	0.8978 (0.0086; 0.8809–0.9147)	0.9124 (0.0005; 0.9027–0.9221)	0.9117 (0.0005; 0.9020–0.9215)	**1.555 ***
Herring gull	0.9825 (0.0008; 0.9810–0.9841)	0.9826 (0.0008; 0.9810–0.9841)	0.9825 (0.0008; 0.9810–0.9840)	**-0.005 #**
Lesser black-backed gull	0.9789 (0.0012; 0.9766–0.9813)	0.9799 (0.0012; 0.9776–0.9822)	0.9798 (0.0012; 0.9775–0.9820)	**0.083 ***
Great black-backed gull	0.9965 (0.0009; 0.9948–0.9983)	0.9966 (0.0008; 0.9950–0.9983)	0.9966 (0.0008; 0.9950–0.9983)	**0.007 ***
All gull	0.9532 (0.0010; 0.9512–0.9553)	0.9719 (0.0005; 0.9710–0.9728)	0.9717 (0.0005; 0.9708–0.9726)	**1.938 ***
Large gull	0.9448 (0.0028; 0.9393–0.9503)	0.9774 (0.0006; 0.9762–0.9786)	0.9773 (0.0006; 0.9760–0.9785)	**3.435 ***
Small gull	0.9354 (0.0034; 0.9288–0.9420)	0.9428 (0.0022; 0.9384–0.9471)	0.9423 (0.0023; 0.9379–0.9467)	**0.741 ***
Sandwich tern	0.9645 (0.0019; 0.9609–0.9682)	0.9646 (0.0019; 0.9609–0.9682)	0.9645 (0.0019; 0.9608–0.9682)	**-0.001 #**
All tern	0.9344 (0.0016; 0.9313–0.9375)	0.9347 (0.0016; 0.9316–0.9378)	0.9347 (0.0016; 0.9316–0.9377)	**0.029 ***
Gulls & terns	0.9501 (0.0007; 0.9515–0.9486)	0.9661 (0.0004; 0.9668–0.9654)	0.9658 (0.0004; 0.9666–0.9651)	**1.660 ***

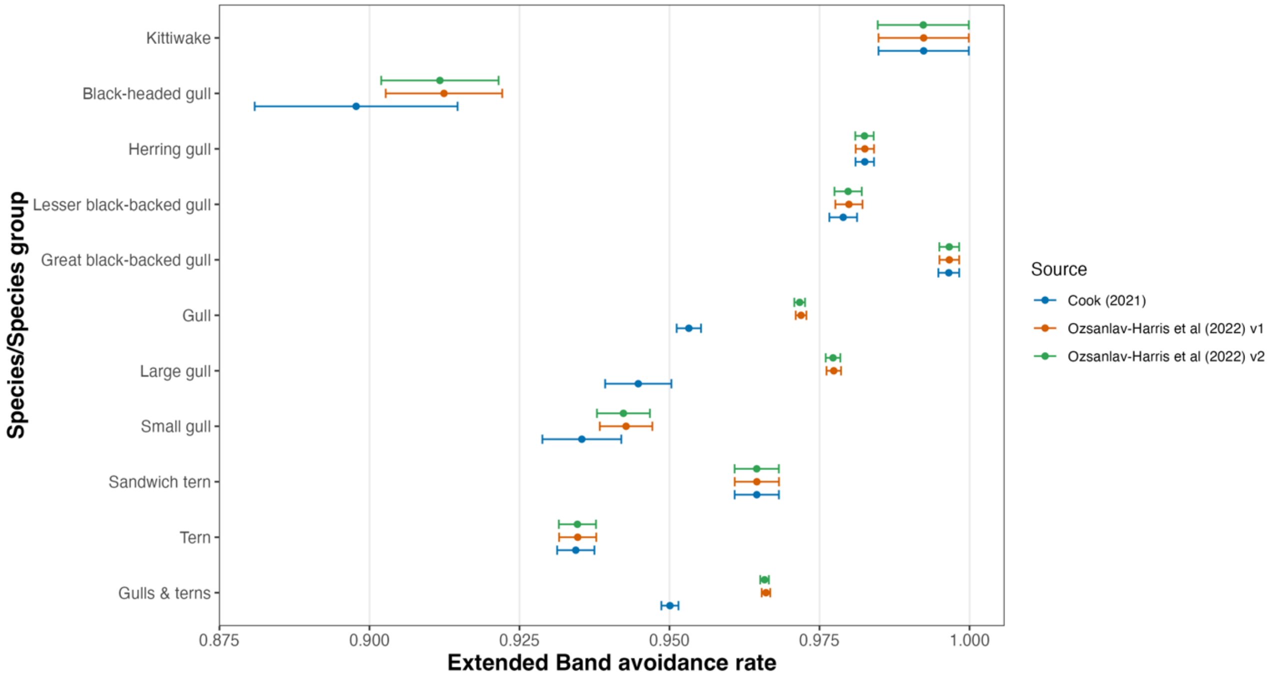

Figure 3: Extended Band avoidance rates computed by the three methods. Error bars represent the 95% confidence interval calculated using the delta method.

Table 4: Stochastic Extended Band avoidance rates comparison between original Cook (2021) values, and Ozsanlav-Harris *et al.* (2022) v1 and v2 values. Percentage change in rate refers to the change in rate between Cook (2021) and Ozsanlav-Harris *et al.* (2022) v2. **Green** values (*) indicate positive changes.

Species/ Species group	Cook (2021)	Ozsanlav-Harris et al. (2023) v1	Ozsanlav-Harris et al. (2023) v2	% change in rate
Kittiwake	0.9947 (0.1455; 0.3900–0.9981)	0.9948 (0.1403; 0.4136–0.9983)	0.9947 (0.1366; 0.4429–0.9980)	**0.004 ***
Black-headed gull	0.9043 (0.0202; 0.8543–0.9348)	0.9191 (0.00183; 0.8798–0.9496)	0.9217 (0.0179; 0.8839–0.9516)	**1.925 ***
Herring gull	0.9498 (0.0091; 0.9290–0.9649)	0.9510 (0.0084; 0.9323–0.9654)	0.9505 (0.0085; 0.9328–0.9652)	**0.072 ***
Lesser black-backed gull	0.9800 (0.0022; 0.9760–0.9843)	0.9811 (0.0021; 0.9770–0.9854)	0.9811 (0.0021; 0.9769–0.9851)	**0.111 ***
Great black-backed gull	0.9970 (0.0008; 0.9950–0.9982)	0.9970 (0.0008; 0.9950–0.9982)	0.9970 (0.0009; 0.9949–0.9982)	**0.008 ***
All gull	0.9258 (0.0067; 0.9129–0.9393)	0.9535 (0.0047; 0.9439–0.9618)	0.9534 (0.0045; 0.9441–0.9613)	**2.981 ***
Large gull	0.9104 (0.0083; 0.8940–0.9265)	0/9616 (0.0046; 0.9527–0.9709)	0.9619 (0.0045; 0.9535–0.9703)	**5.652 ***
Small gull	0.9427 (0.0080; 0.9250–0.9562)	0.9506 (0.0078; 0.9335–0.9640)	0.9513 (0.0079; 0.9340–0.9654)	**0.910 ***
Sandwich tern	0.9705 (0.0028; 0.9652–0.9758)	0.9704 (0.0029; 0.9647–0.9757)	0.9707 (0.0028; 0.9652–0.9761)	**0.017 ***
All tern	0.9400 (0.0032; 0.9338–0.9464)	0.9402 (0.0032; 0.9336–0.9461)	0.9407 (0.0032; 0.9344–0.9474)	**0.077 ***
Gulls & terns	0.9295 (0.0049; 0.9204–0.9395)	0.9501 (0.0039; 0.9427–0.9571)	0.9503 (0.0036; 0.9431–0.9569)	**2.231 ***

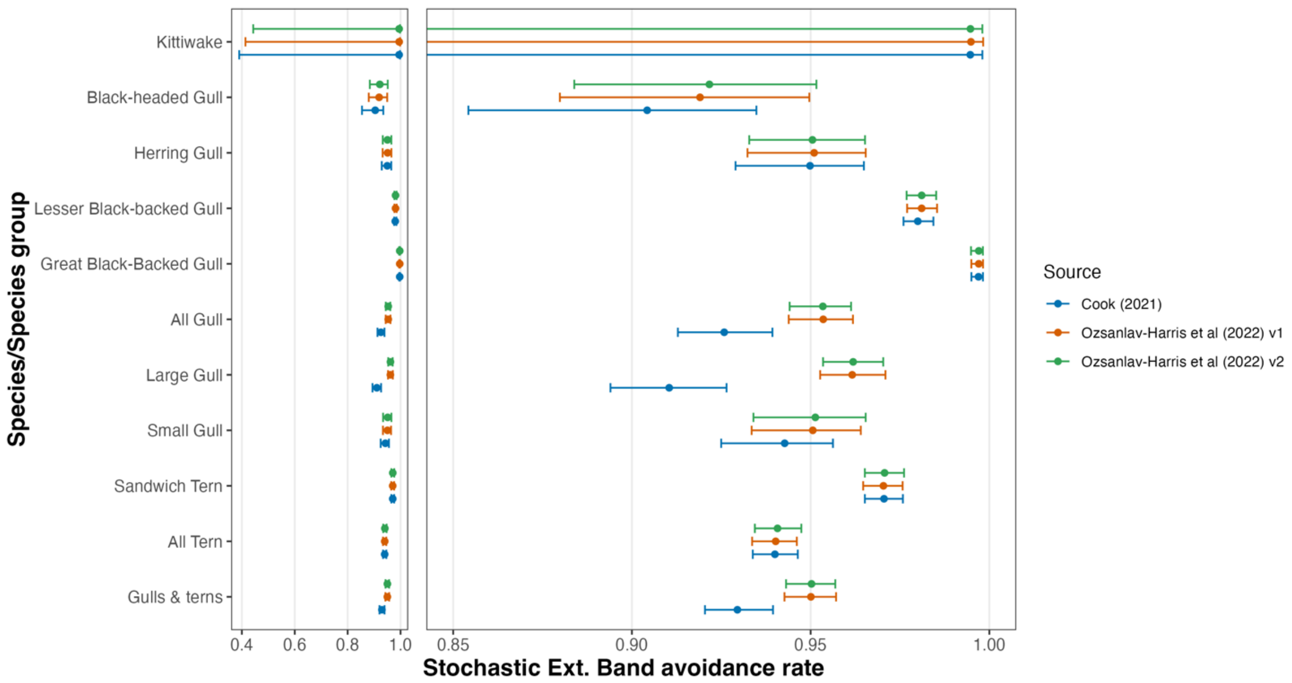

Figure 4: Stochastic Extended Band avoidance rates computed by the three methods. To aid interpretation, the same data is shown at two scales (left: wide uncropped; right: narrow cropped). Error bars represent the 95% confidence interval calculated from 1,000 iterations where input parameters were varied.

After implementing the revised `*get_collisions_extended_custom*` function, avoidance rates for Extended Band were the similar or higher, and for Stochastic Extended Band calculations were consistently higher for all species and species groups (Tables 3 and 4 and Figures 3 and 4). As previously mentioned, for larger discrepancies between v1 and v2 rates for several categories (e.g. ‘Black headed gull’, ‘All Gull’, ‘Large Gull’, and ‘Gulls & terns’), additional work may be required to understand the source of this variation.

4 Additional considerations

The `*get_collisions_extended()*` function from {stochLAB} (and consequently the `*get_collisions_extended_custom()'* we created) expects monthly operational time – which is not available for the current data. In the revised code we calculated avoidance rates assuming constant operational proportion of 1 (i.e. operation time fixed at 100%) for all calculations. If required data was to become become available later, operational time could be added for Extended Band calculations (fixed per array), and randomly sampled for the Stochastic Extended Band (i.e. allowing operational time to vary). Additional details and commented-out code examples of random sampling approaches are included in code.

5 References

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