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Manifestation of long term collision rate

Prepared for Ark Energy, 20 November 2023 updated 2024-03-14, Ver. 1.0

This document provides the plausible range of cumulative collisions after a given number of years under the assumption of a given long term annual average (with a assumed distribution).

We have calculated the annual collision rate with a 90 and 95% avoidance rate for TWTE, with WTG curtailment systems employed. The mitigation rates are based on an estimate between 50% and 67% reduction in mortality ([DNV GL 2019](#)) over the baseline estimate . For visualisation of the long term manifestation of this annual rate, we used 58.5% reduction (the midpoint of 50% and 67%) as a conservative prediction (summarised in Table 1).

Given a predicted annual collision rate, we model cumulative collisions based on a Poisson distribution. The Poisson distribution assumes collisions of individuals are independent of the time since the last event, and is suitable for most collision risk estimates. The plausible range of cumulative collisions (along top), over a 30 year period (left hand side) are shown in [Figure 1](#) assuming 90% avoidance and in [Figure 2](#) assuming 95% avoidance. The dark green band approximately represents the 95% confidence interval and the dark yellow represents the 99% confidence interval.

Table 1: Annual TWTE collision prediction, based on WTG curtailment system options and collision reduction of 58.5%

Avoidance	Un-curtailed	Curtailed
0.90	4.89	2.03
0.95	2.44	1.01



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At 90% avoidance we predict a long term average of 2.03 per year. The long-term manifestation of this is shown in Figure 1

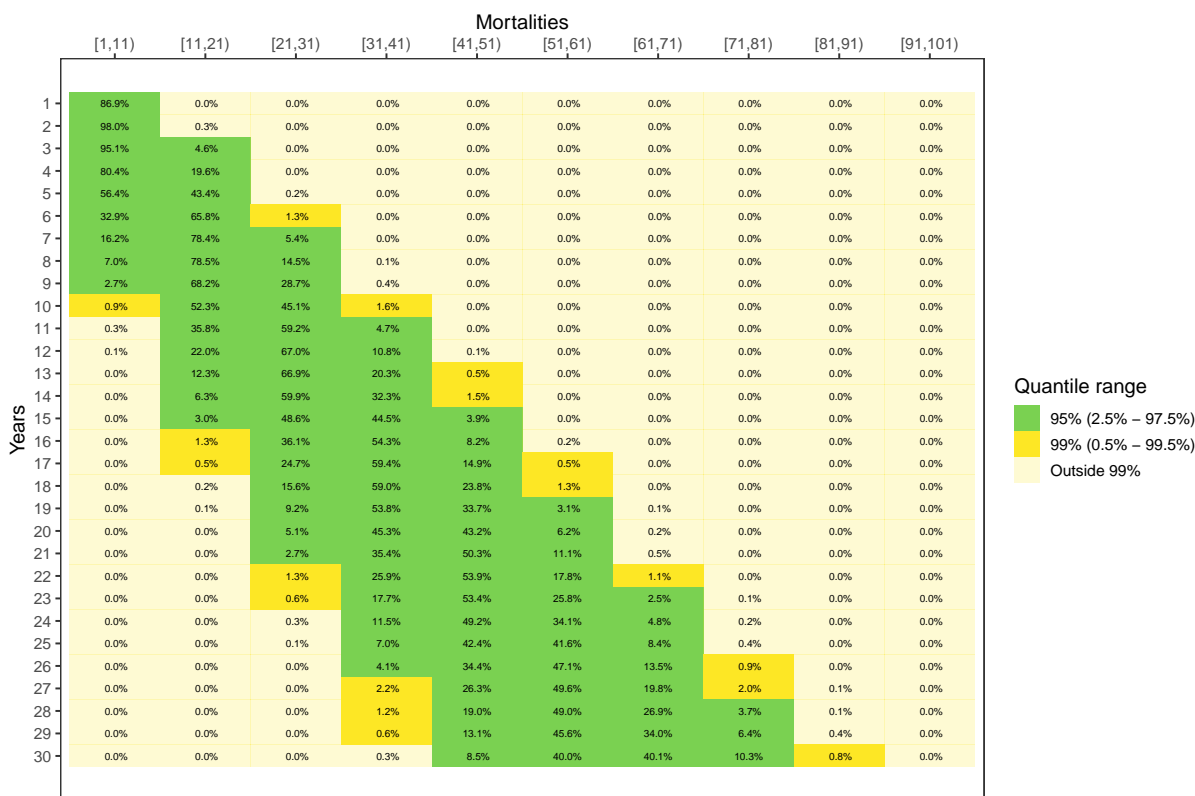


Figure 1: Long-term manifestation of TWTE collisions based on 90% avoidance rate.



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At 95% avoidance we predict a long term average of 1.01 per year. The long-term manifestation of this is shown in Figure 2

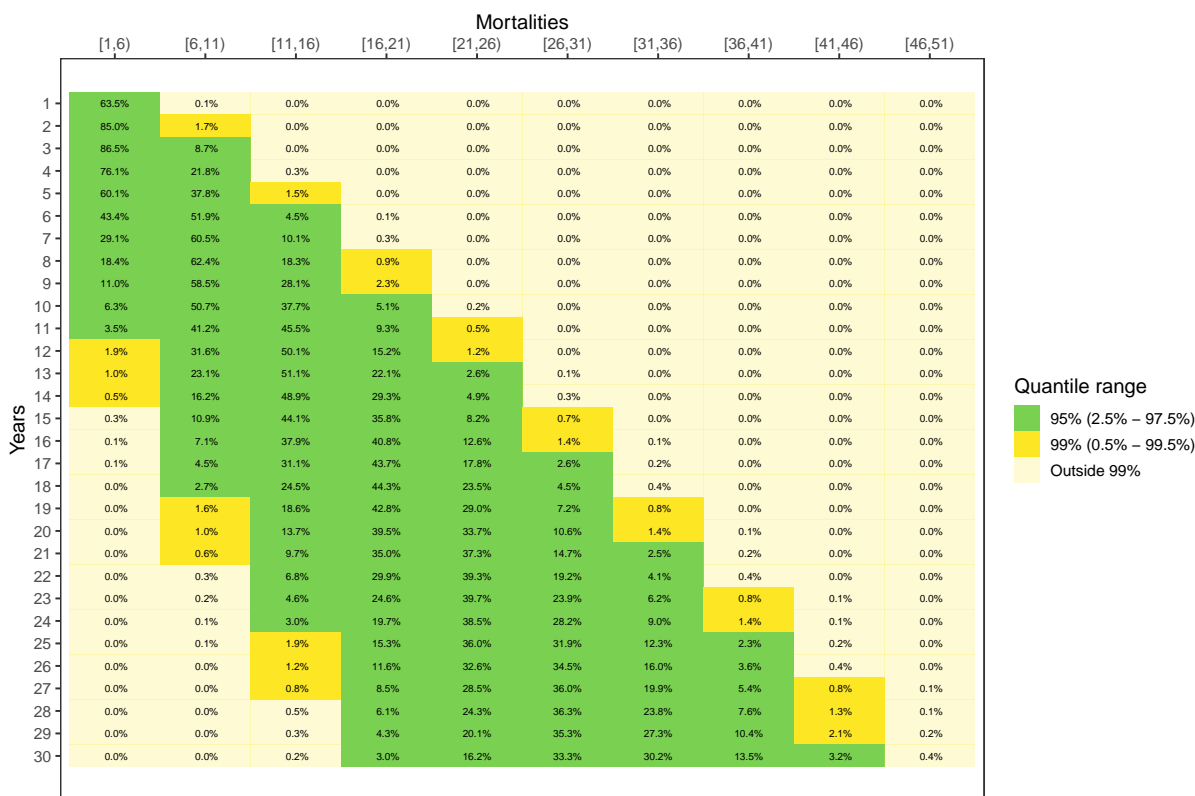


Figure 2: Long-term manifestation of TWTE collisions based on 95% avoidance rate.

1 References

DNV GL. 2019. "Identiflight Operational Simulation Models - Deceleration Impacts." Identiflight International.



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This document provides the plausible range of cumulative collisions after a given number of years under the assumption of a given long term annual average (with a assumed distribution).

We have calculated the annual collision rate with a 90 and 95% avoidance rate for TWTE, with WTG curtailment systems employed, assuming total curtailed collision rate of 15% (i.e. an 85% reduction) of the un-curtailed prediction (McClure et al. (2021), McClure et al. (2022)). This is summarised in Table 1.

Given a predicted annual collision rate, we model cumulative collisions based on a Poisson distribution. The Poisson distribution assumes collisions of individuals are independent of the time since the last event, and is suitable for most collision risk estimates. The plausible range of cumulative collisions (along top), over a 30 year period (left hand side) are shown in Figure 1 assuming 90% avoidance and in Figure 2 assuming 95% avoidance. The dark green band approximately represents the 95% confidence interval and the dark yellow represents the 99% confidence interval.

Table 1: Annual TWTE collision prediction, based on WTG curtailment system options and collision reduction of 85%

Avoidance	Un-curtailed	Curtailed
0.90	4.89	0.7335
0.95	2.44	0.3660



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At 90% avoidance we predict a long term average of 0.7335 per year. The long-term manifestation of this is shown in Figure 1

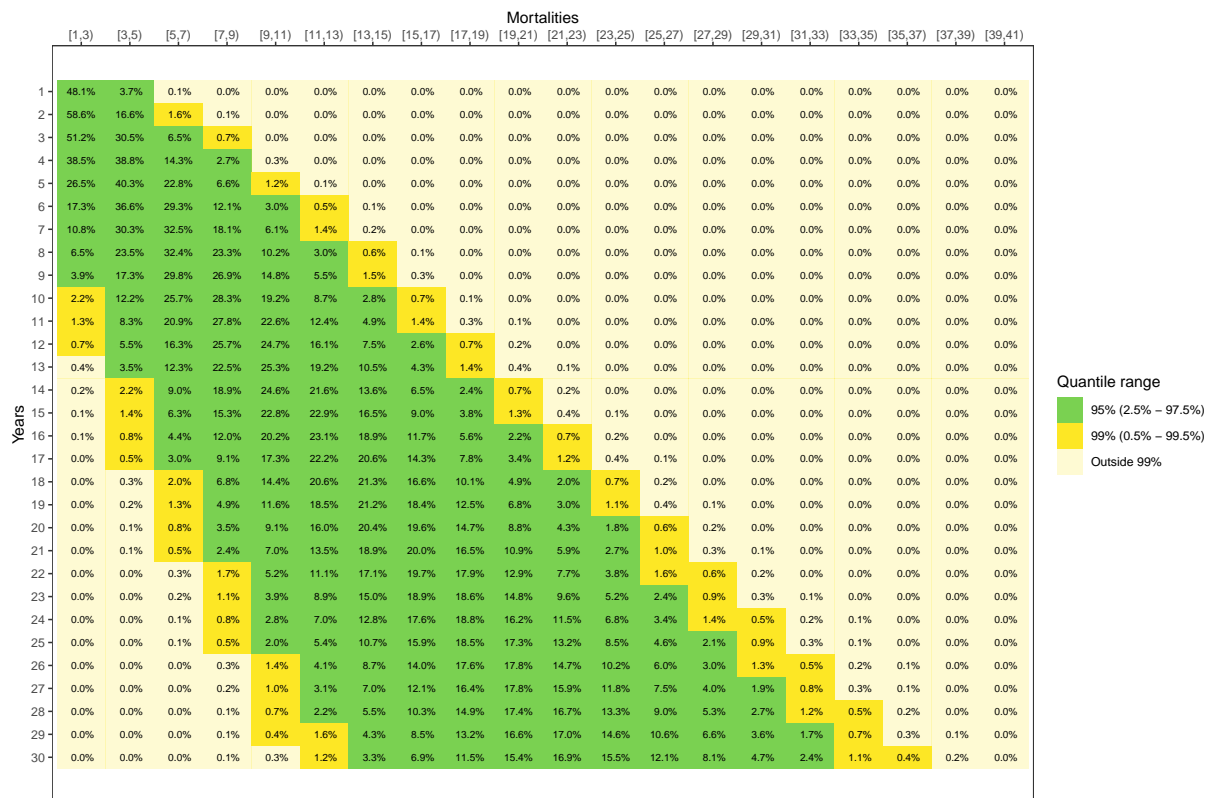


Figure 1: Long-term manifestation of TWTE collisions based on 90% avoidance rate.



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At 95% avoidance we predict a long term average of 0.366 per year. The long-term manifestation of this is shown in Figure 2

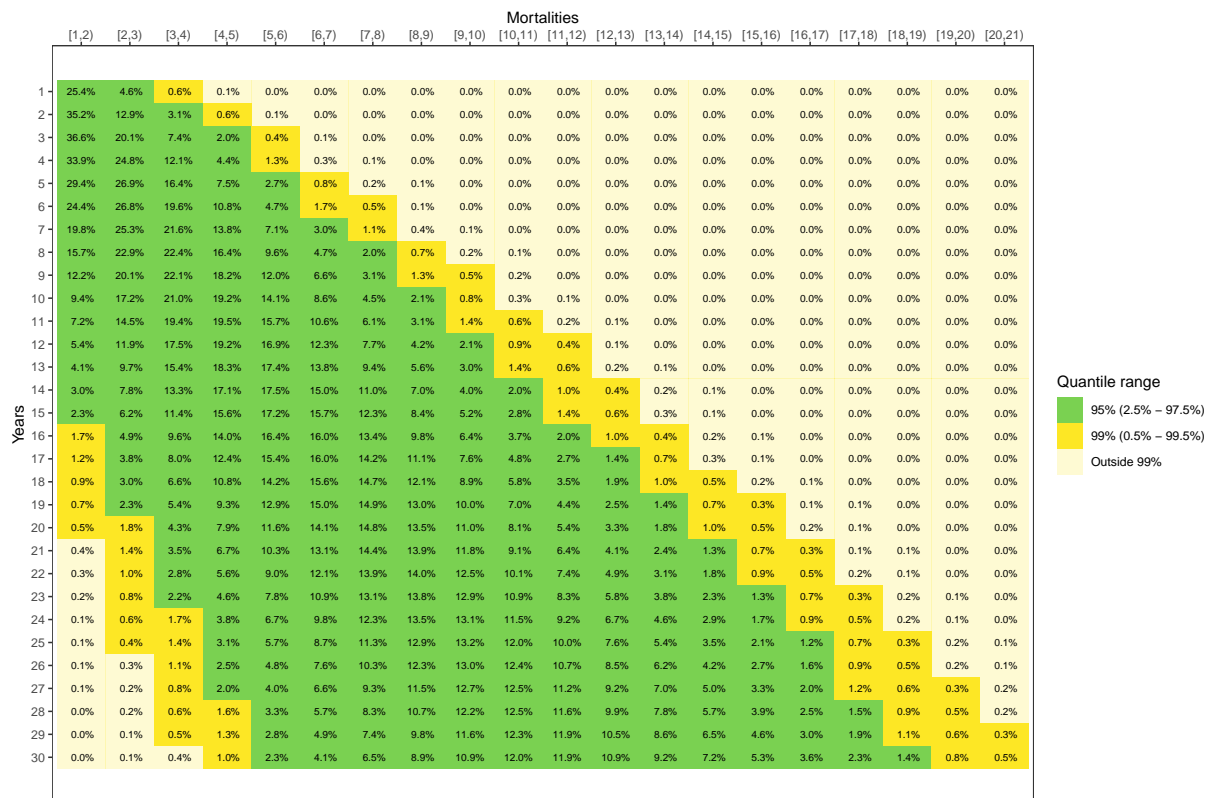


Figure 2: Long-term manifestation of TWTE collisions based on 95% avoidance rate.

1 References

McClure, Christopher J. W., Brian W. Rolek, Leah Dunn, Jennifer D. McCabe, Luke Martinson, and Todd Katzner. 2021. "Eagle Fatalities Are Reduced by Automated Curtailment of Wind Turbines." Edited by Kulbhushansingh Suryawanshi. *Journal of Applied Ecology* 58 (3): 446–52. <https://doi.org/10.1111/1365-2664.13831>.

———. 2022. "Confirmation That Eagle Fatalities Can Be Reduced by Automated Curtailment of Wind Turbines." *Ecological Solutions and Evidence*, March, 12173.