Supporting Information. Quantifying the impact of habitat modifications on species behavior and mortality: A case study of tropical tuna. Amaël Dupaix, Laurent Dagorn, Jean-Louis Deneubourg, & Manuela Capello. Ecological Applications.

Appendix S1: Development and limits of the mean Continuous Absence Time ($\overline{\text{CAT}}$)

1 CAT formula

We have,

$$\overline{\text{CAT}_{\text{diff}}}(\rho) = \frac{a_d}{\rho^{b_d}} \tag{S1}$$

$$\overline{\text{CAT}_{\text{return}}}(\rho) = 1 + \frac{a_r}{\rho^{b_r}} \tag{S2}$$

and

$$R(\rho) = a\rho^c \exp(b \times \rho) \tag{S3}$$

with $(a_d, b_d, a_r, b_r, a, b, c) \in \mathbb{R}_+^7$

Hence,

$$\overline{\text{CAT}}(\rho) = \frac{A(\rho)\overline{\text{CAT}_{\text{diff}}}(\rho) + B(\rho)\overline{\text{CAT}_{\text{return}}}(\rho)}{A(\rho) + B(\rho)}$$

$$= \frac{R(\rho)\overline{\text{CAT}_{\text{diff}}}(\rho) + \overline{\text{CAT}_{\text{return}}}(\rho)}{R(\rho) + 1}$$

$$= \frac{a\rho^c \exp(b\rho) a_d \rho^{-b_d} + 1 + a_r \rho^{-b_r}}{a\rho^c \exp(b\rho) + 1}$$

2 Limit when $\rho \mapsto +\infty$

$$\overline{\text{CAT}}(\rho) = \frac{a\rho^c \exp(b\rho) a_d \rho^{-b_d} + 1 + a_r \rho^{-b_r}}{a\rho^c \exp(b\rho) + 1}$$

$$= \frac{a_d \rho^{-b_d} + \frac{1}{a}\rho^{-c}\exp(-b\rho) + \frac{a_r}{a}\rho^{-b_r - c}\exp(-b\rho)}{1 + \frac{1}{a}\rho^{-c}\exp(-b\rho)} \tag{S4}$$

We note $N_{inf} = a_d \rho^{-b_d} + \frac{1}{a}\rho^{-c}\exp(-b\rho) + \frac{a_r}{a}\rho^{-b_r - c}\exp(-b\rho)$
and $D_{inf} = 1 + \frac{1}{a}\rho^{-c}\exp(-b\rho)$

We have,

$$\lim_{\rho \to +\infty} a_d \rho^{-b_d} = 0$$

$$\lim_{\rho \to +\infty} \frac{1}{a} \rho^{-c} \exp(-b\rho) = 0$$

and

$$\lim_{\rho \to +\infty} \frac{a_r}{a} \rho^{-b_r - c} \exp(-b\rho) = 0$$

So

$$\lim_{\rho \to +\infty} N_{inf} = 0$$

and

$$\lim_{\rho \to +\infty} D_{inf} = 1$$

Hence

$$\lim_{\rho \to +\infty} \overline{\mathsf{CAT}}(\rho) = 0 \tag{S5}$$

3 Limit when $\rho \mapsto 0$

$$\begin{aligned} \overline{\mathsf{CAT}}(\rho) &= \frac{a\rho^c \exp(b \times \rho) \times a_d \rho^{-b_d} + 1 + a_r \rho^{-b_r}}{a\rho^c \exp(b \times \rho) + 1} \\ &= \frac{a \times a_d \times \rho^{c-b_d} \exp(b \times \rho) + 1 + a_r \rho^{-b_r}}{a\rho^c \exp(b \times \rho) + 1} \end{aligned} \tag{S6}$$

We note $N_0 = a \times a_d \times \rho^{c-b_d} \exp(b \times \rho) + 1 + a_r \rho^{-b_r}$
and $D_0 = a\rho^c \exp(b \times \rho) + 1$

3.1 Denominator (D_0)

We have

$$\lim_{\rho \to 0} a\rho^c \exp(b\rho) = 0$$

So

$$\lim_{\rho \to 0} D_0 = \lim_{\rho \to 0} a\rho^c \exp(b\rho) + 1 = 1$$

3.2 Numerator (N_0)

We have

$$\lim_{\rho \to 0} \left(1 + a_r \rho^{-b_r}\right) = +\infty$$

If $c - b_d > 0$

$$\lim_{\rho \to 0} \left(a\ a_d\ \rho^{c-b_d} \exp(b\rho)\right) = 0$$

and

$$\lim_{\rho \to 0} N_0 = +\infty$$

If $c - b_d < 0$

$$\lim_{\rho \to 0} \left(a\ a_d\ \rho^{c-b_d} \exp(b\rho)\right) = +\infty$$

hence

$$\lim_{\rho \to 0} N_0 = +\infty$$

If $c - b_d = 0$

$$\lim_{\rho \to 0} \left(a\ a_d\ \rho^{c-b_d} \exp(b\rho)\right) = a\ a_d$$

hence

$$\lim_{\rho \to 0} N_0 = +\infty$$

Conclusion

$\forall\ (c, b_d)\ \in \mathbb{R}_+^2 \quad \lim_{\rho \to 0} N_0 = +\infty$ and $\lim_{\rho \to 0} D_0 = 1$, hence,

$$\lim_{\rho \to 0} \overline{\mathrm{CAT}}(\rho) = +\infty \tag{S7}$$