Tag-shedding estimates for tropical tuna species in the Atlantic Ocean from AOTTP data

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ICCAT / AOTTP SYMPOSIUM

12 - 14 JANUARY 2021

Analysis conducted within the framework of the consortium CISEF: Cap Vert, Cote d'Ivoire, Senegal, Spain, France
(ICCAT-AOTTP 22/2018)

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Context:

Mark-recapture models are commonly used to estimate **mortality rates**. However, the results of tagging studies can be compromised if tags or data are lost (i.e., through tag shedding and non-reporting). Both occurrences can lead to **underestimations in tag-return rates**, which create a **negative bia**s in fishing mortality estimates, rates of fishery interactions, etc.

Objective:

The current paper is only estimating the Type I and II tag shedding components of total losses.

There are two types of tag losses:

- **Type-I losses**, which reduce the number of tags initially put out (immediate tag shedding, immediate tagging mortality, and non-reporting),

- **Type-II losses** which occur steadily over time (natural mortality, fishing mortality, permanent emigration, and long-term tag shedding).

Thus, for modelling the proportion of tags lost over time: $P.Fit_t = 1 - Q_t$

with **individual time at liberty,** we used the constant-rate shedding model to express the probability Q_t of a tag being retained at time t after release e.g.:

$$Q_t = \propto e^{-(L\,t)}$$

α = type-1 retention probability (i.e., 1 - immediate type-1 shedding rate),
L = continuous type-2 shedding rate,

Assuming that all tags not immediately shed have independent and identical probabilities, the probabilities of 2, 1 and no tags being retained at time t after release are, respectively:

$$P_t(2) = Q_t^2$$

2 tags retained

$$P_t(1) = 2\,Q_t\,[1 - Q_t]$$

1 tag retained

$$P_t(0) = [1 - Q_t]^2$$

no tag retained

Since **identifiable recaptures** consist only of **fish retaining either one tag or two tags**, conditional on retention of at least one tag, the probability of capturing a fish retaining 2 tags at time t is:

$$P_t(2) / (1 - P_t(0))$$

and retaining only one tag at time t is:

$$P_t(1) / (1 - P_t(0))$$

Estimates of the model parameters are obtained by minimizing the negative log-likelihood of the data conditional on recapture times:

$$LL = -\sum Ln\left[P_t(2) / (1 - P_t(0))\right] - \sum Ln\left[P_t(1) / (1 - P_t(0))\right]$$

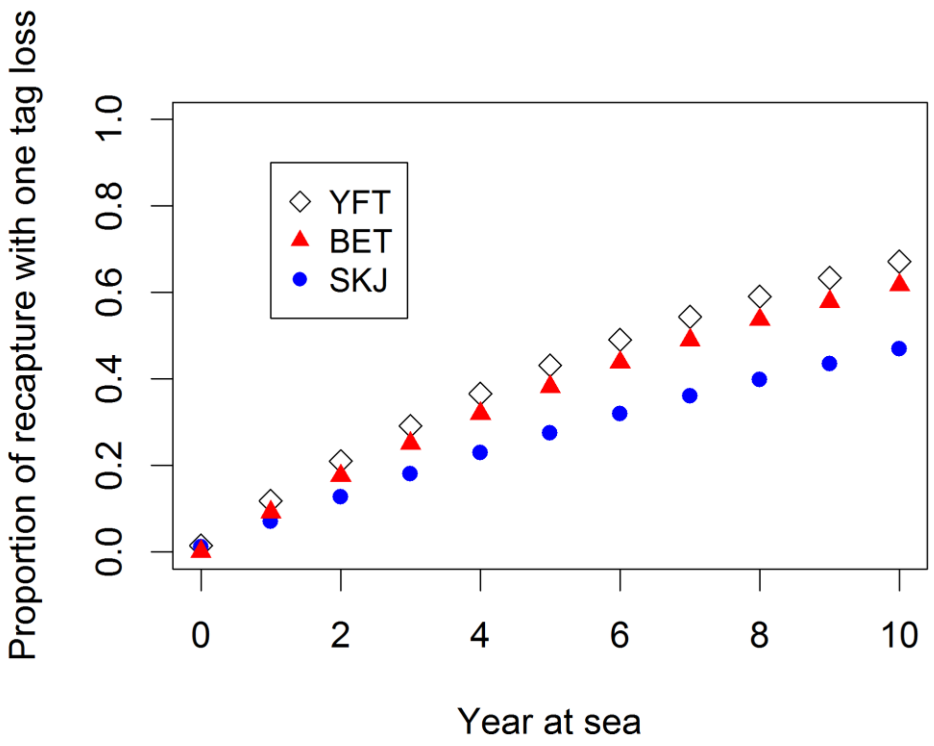
Results:

Species	α	$\alpha_{2.5th}$	$\alpha_{97.5th}$	L	$L_{2.5th}$	$L_{97.5th}$	N2 tags	N1 tag
BET	0.999	0.995	1.000	0.096	0.080	0.108	568	35
SKJ	0.988	0.972	1.000	0.062	0.000	0.120	228	13
YFT	0.985	0.974	0.996	0.110	0.055	0.164	709	56

Parameter estimates with bootstrapped 95% confidence intervals for the constant-rate shedding model by species; bigeye (BET), skipjack (SKJ), and yellowfin (YFT).

Assuming a constant-rate model the proportion of tags lost by year is:

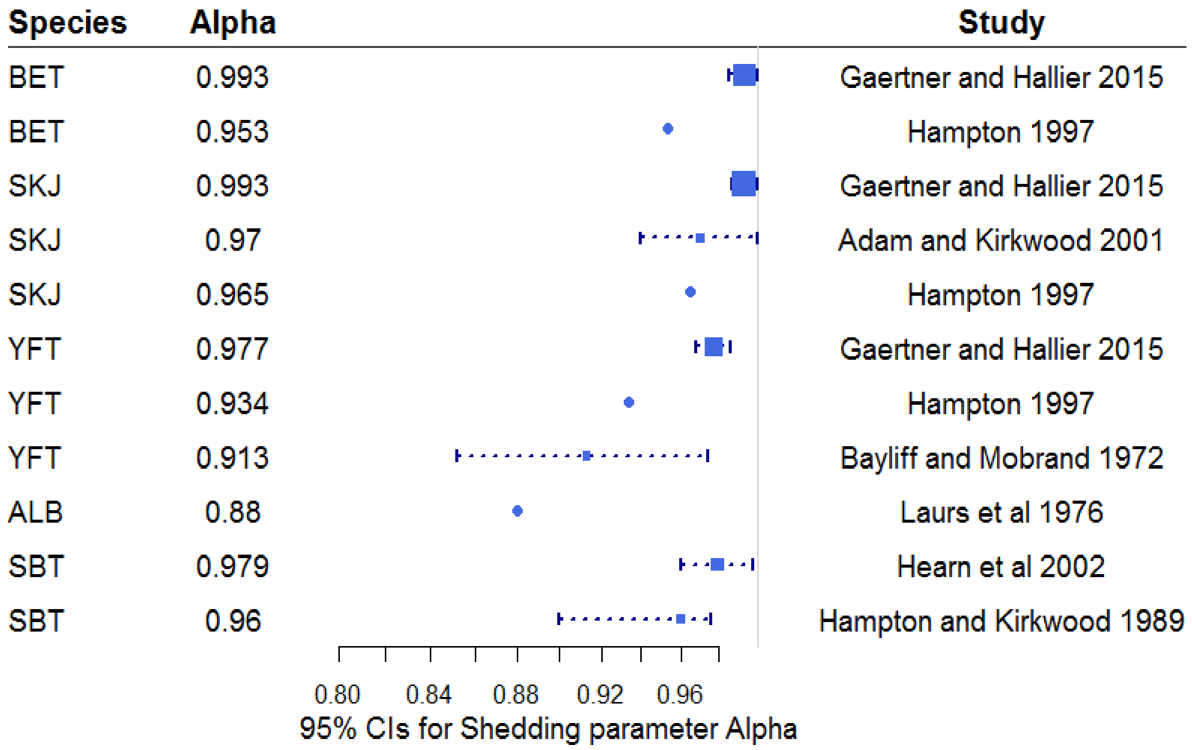
Year	0	1	2	3	4	5	6	7	8	9	10
BET	0.001	0.092	0.176	0.251	0.320	0.382	0.438	0.490	0.537	0.579	0.617
SKJ	0.012	0.071	0.127	0.180	0.229	0.275	0.319	0.360	0.398	0.435	0.469
YFT	0.015	0.118	0.210	0.292	0.366	0.432	0.491	0.544	0.591	0.634	0.672

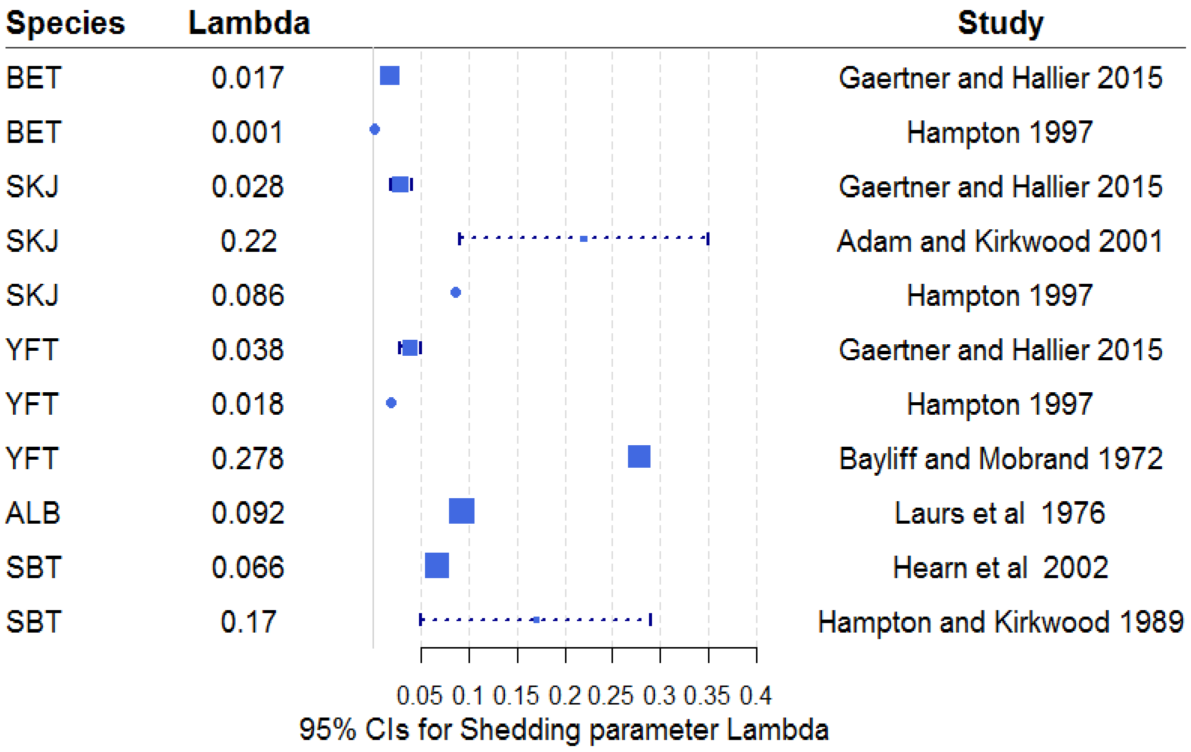


Results coherent with previous studies on the same species:

AOTTP results

Species	α	L
BET	0.999	0.096
SKJ	0.988	0.062
YFT	0.985	0.110





Elicitation of priors for potential improvements by Bayesian approaches