Area-specific growth rates of skipjack in the Indian Ocean using tagging data.

By Daniel Gaertner [1] , Jean Pierre Hallier [1, 2] , Francis Marsac [1], and Beenesh A. Motah [1, 3]

[1] IRD – UMR EME, CRH, BP 171, 34203 Sete Cedex, France
[2] Regional Tuna Tagging Project - Indian Ocean (RTTP-IO), Victoria, Seychelles
[3] University of Cap Town, Cap Town, South Africa

INDIAN OCEAN TUNA TAGGING SYMPOSIUM
- Grand Baie, Mauritius, 30th October – 02nd November 2012

Before comparing growth rates between Indian ocean regions:

How to characterize growth rate over length at release for I.O. skipjack ?

i.e., a conventional linear decrease suggesting a Von Bertalanffy growth curve or a more complex shape model as the two-stanza approach evidenced for yellowfin and bigeye tuna ?

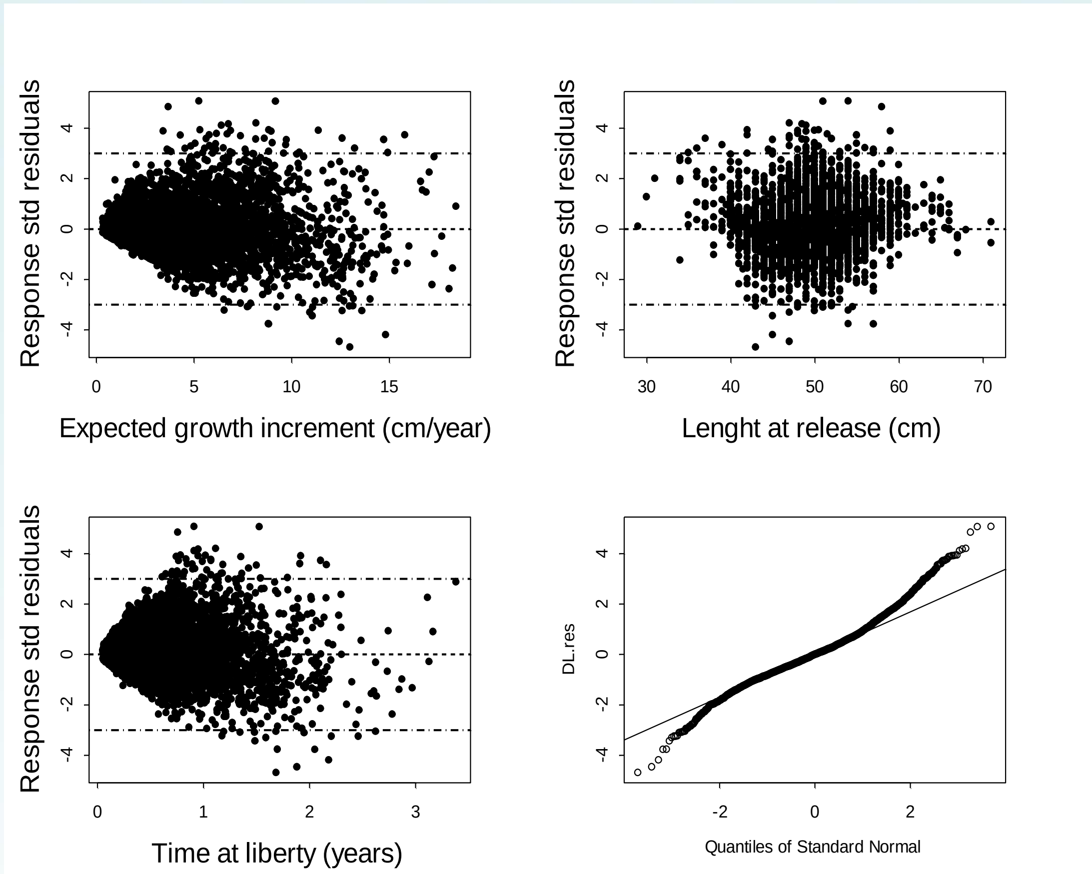
Data

Days at sea >=1 (even if traumatic effects due to the tagging operation may be suspected)

Growth rate = $$g_i = \frac{Lc_i - Lr_i}{D_i}$$

Lc = Lenght at recapture; Lr = Lenght at recovery; D = Days at sea
Growth rates <= Quantile 0.025 and >= Quantile 0.0975 were excluded reducing the data set to 7601 SKJ.

Previous analysis did not show evidence for rejecting the conventional Von Bertalanffy-Fabens growth curve



Gaertner et al. (2011)

CRH Centre de Recherche Halieutique Méditerranéenne et Tropicale
UMR 212 Écosystèmes marins exploités

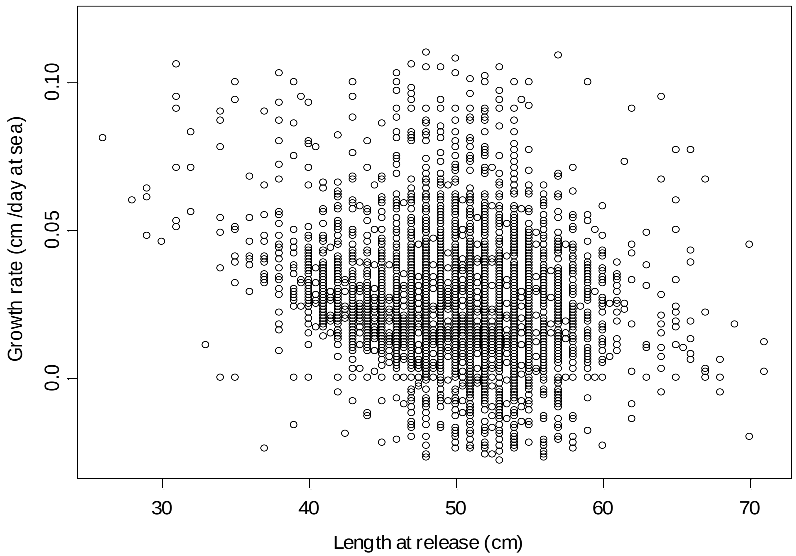
And the estimates of the VB-Fabens parameters were in agreement with other SKJ worldwide studies

Table 2. Summary of bootstrapped statistics for the von Bertalanffy-Fabens model from Indian Ocean tagging data

Estimate	K	L_∞
mean	0.282	76.897
median	0.282	76.876
C.I.	0.256-0.306	74.978-79.187

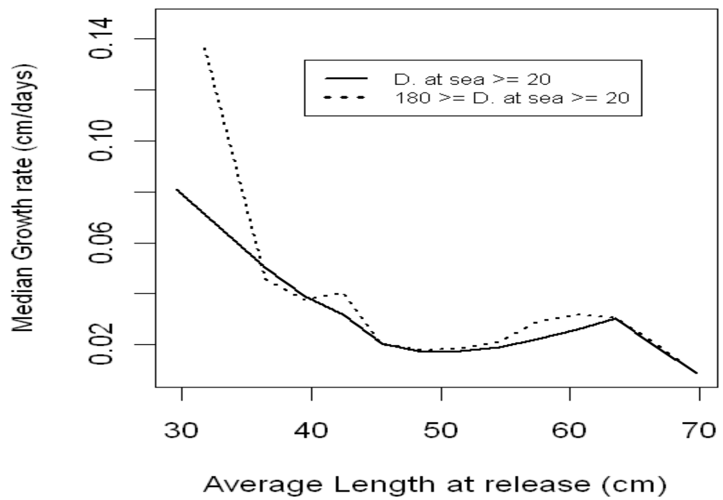
Table 3. Estimates of growth parameters from different studies for skipjack in the world's oceans.

Area	L_∞	K	Method	Reference
E. Atlantic G. of Guinea	80	0.32	Tagging	Bard and Antoine, 1986
E. Atlantic N. trop	80	0.60	Tagging	Bard and Antoine, 1986
E. Atlantic G. of Guinea	86.7	0.31	Spines	Chur and Zharov, 1983
E. Atlantic Senegal	62	2.08	Tagging	Cayré et al, 1986
E. Atlantic Cap Vert	60	1.54	Tagging	Cayré et al, 1986
E. Atlantic North 10°N	91.82	0.35	Tagging	Gaertner et al, 2008
E. Atlantic South 10°N	85	0.22	Tagging	Gaertner et al, 2008
W. Atlantic Caribbean sea	94.9	0.34	Length-freq	Pagavino and Gaertner, 1995
W. Atlantic Brasil	87.12	0.22	Spines	Vilela and Costello, 1991
Indian Ocean	60.6	0.93	Length-freq	Marcille and Stequert, 1976
Indian Ocean Maldives	64.3	0.55	Tagging	Adams, 1999
Indian Ocean Maldives	82	0.45	Length-freq	Hafiz, 1987, in Adams 1999
Indian Ocean Sri Lanka	85	0.62	Length-freq	Amarasiri and Joseph, 1987
Indian Ocean Sri Lanka	77	0.52	Length-freq	Sivasubramanium, 1985; in Adams, 1999
Indian Ocean Minicoy	90	0.49	Length-freq	Mohan and Kunhikoya, 1985; in Adams, 1999
E. Pacific	75.5	0.77	Tagging	Sibert et al, 1979
E. Pacific	79	0.64	Tagging	Josse et al, 1979
E. Pacific N	96.3	0.52	Tagging	Bayliff, 1988
E. Pacific S	66.5	1.81	Tagging	Bayliff, 1988
E. Pacific	73	0.82	Tagging	Joseph and Calkins, 1969
E. Pacific	107	0.42	Length-freq	Joseph and Calkins, 1969
W. Pacific	61.3	1.25	Tagging	Sibert et al, 1979
W. Pacific	65.5	0.95	Tagging	Josse et al, 1979
W. Pacific Vanuatu	60	0.75	Length-freq	Brouard et al, 1984
W. Pacific Trop. & Jap.	93.6	0.43	Otolith	Tanabe et al, 2003
W. Pacific Japan	76.6	0.60	Length-freq	Yao, 1981; in Wild and Hampton, 1994
W. Pacific Taiwan	103.6	0.30	Vertebrae	Chi and Yang, 1973; in Wild and Hampton, 1994
Central Pacific	102.2	0.55	Otolith	Uchiyama and Struhsaker, 1981
Central Pacific	80	0.95	Grouped L-freq	Brock, 1954; in Adams, 1999
Central Pacific West	74.8	0.52	Length-freq	Wankowski, 1981



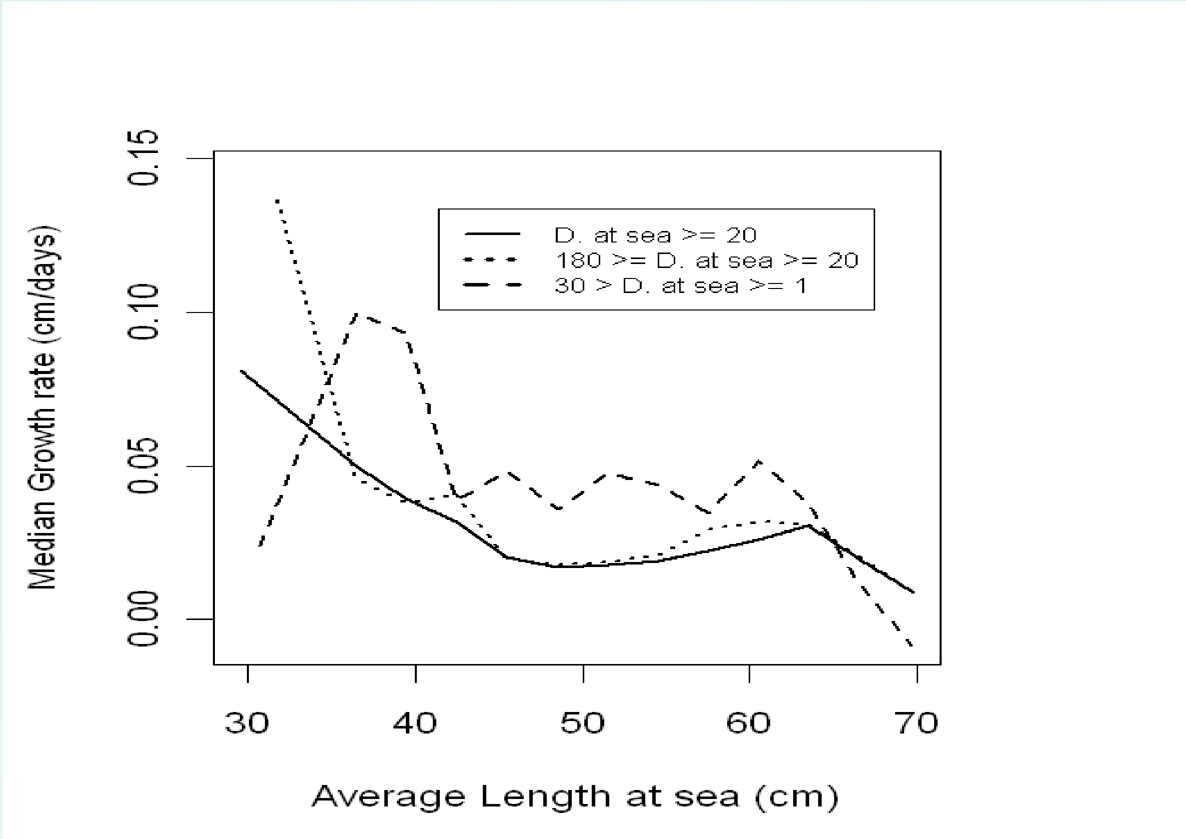
Now, instead of screening growth rate vs Length at release for the whole data set

If we represent the median of growth rates by length we obtain a different perception

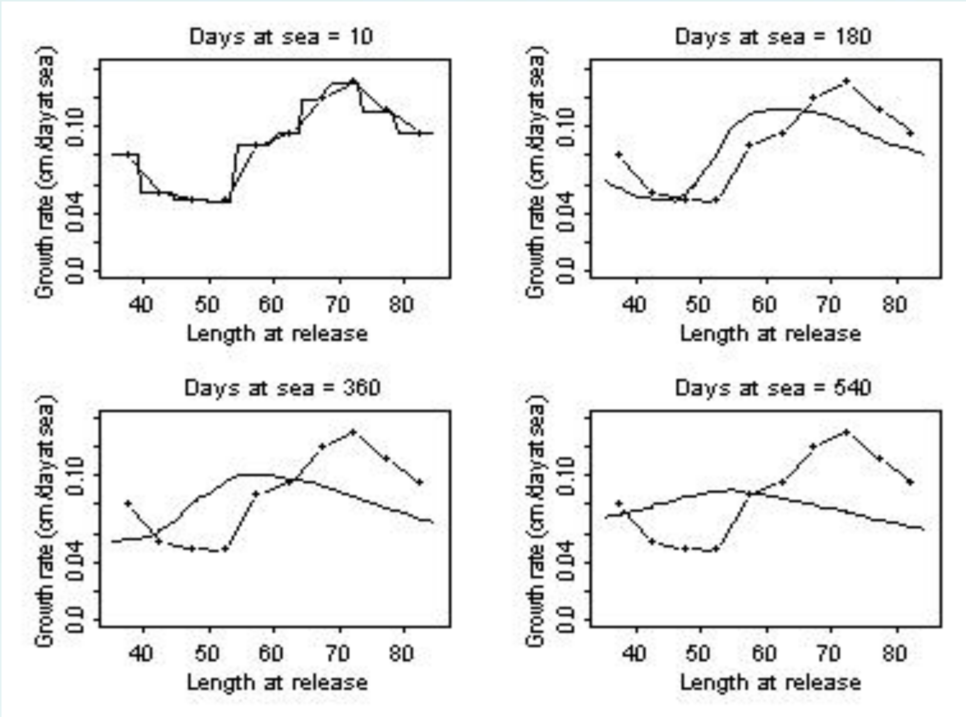


CRH Centre de Recherche Halieutique Méditerranéenne et Tropicale

UMR 212 Écosystèmes marins exploités



Including, if we use a subset of data with shorter time at liberty (e.g., days at sea < 30),
(1) we confirm that growth rate does not depict the linear decrease characterizing the VB-Fabens model and
(2) in addition that not accounting for time at liberty likely under-estimate growth rate by length

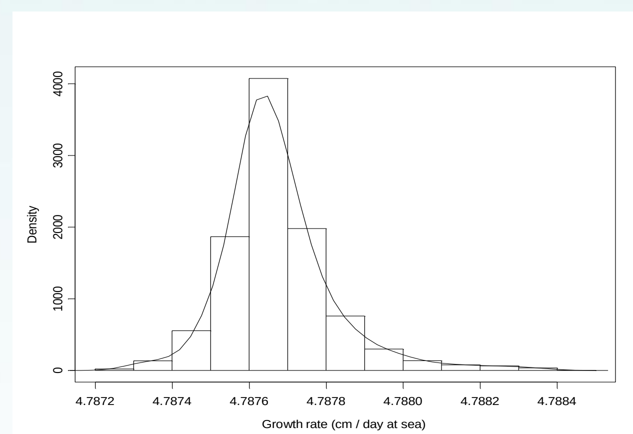


The potential biais caused by diifferent time at liberty on growth rate was showed previously by simulation for YFT (Gaertner et al., 2010): Increasing days at sea smooth growth rate by length and likely conducts to an apparent linear decrease in growth rate

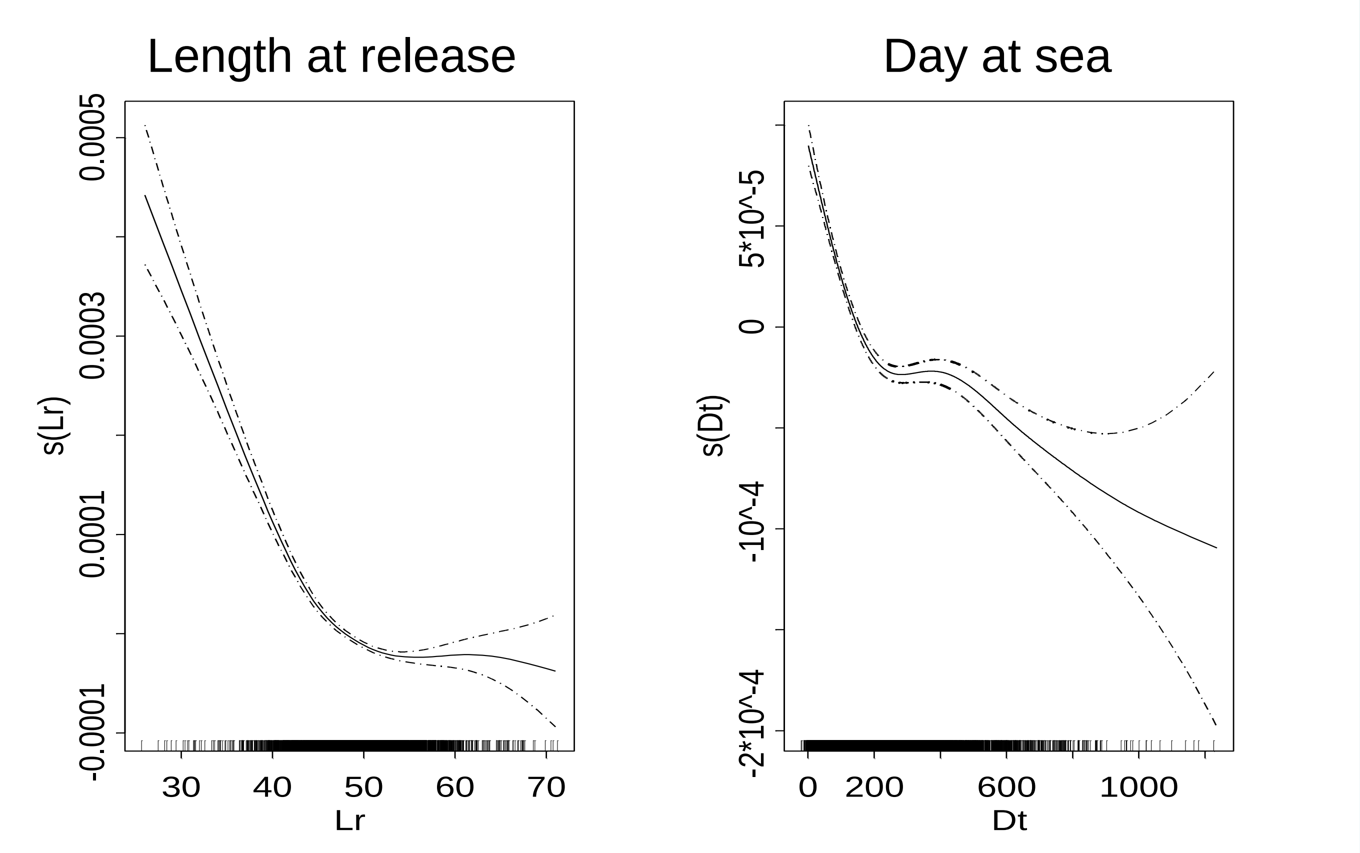
Consequently, the same approach was followed in the present study: Growth rate was fitted by a GAM model accounting for Lr and Dt

$Gr_i \sim ct + s(Lr_i) + s(Dt_i)$

Growth rates were previously log transformed i.e., Ln(Gr+120)

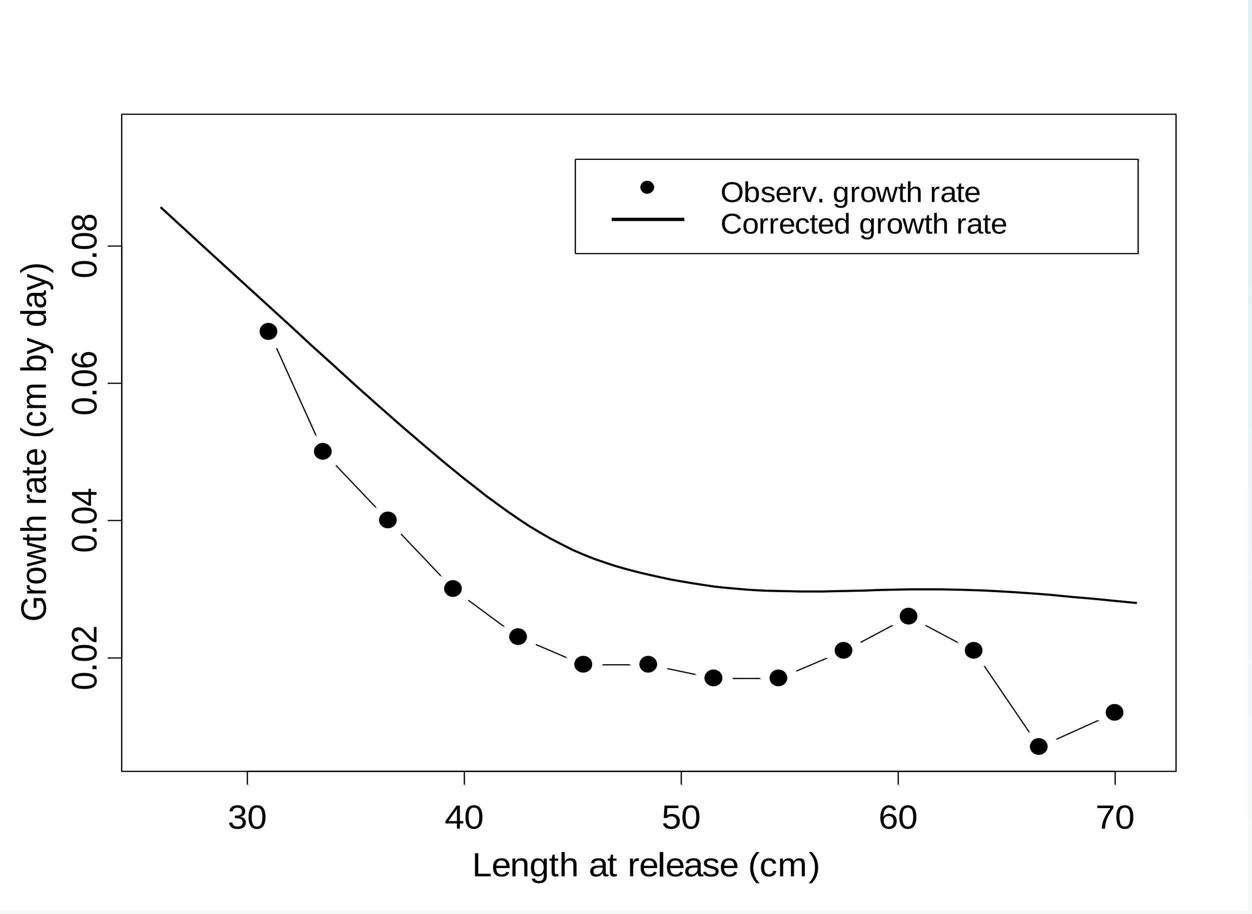


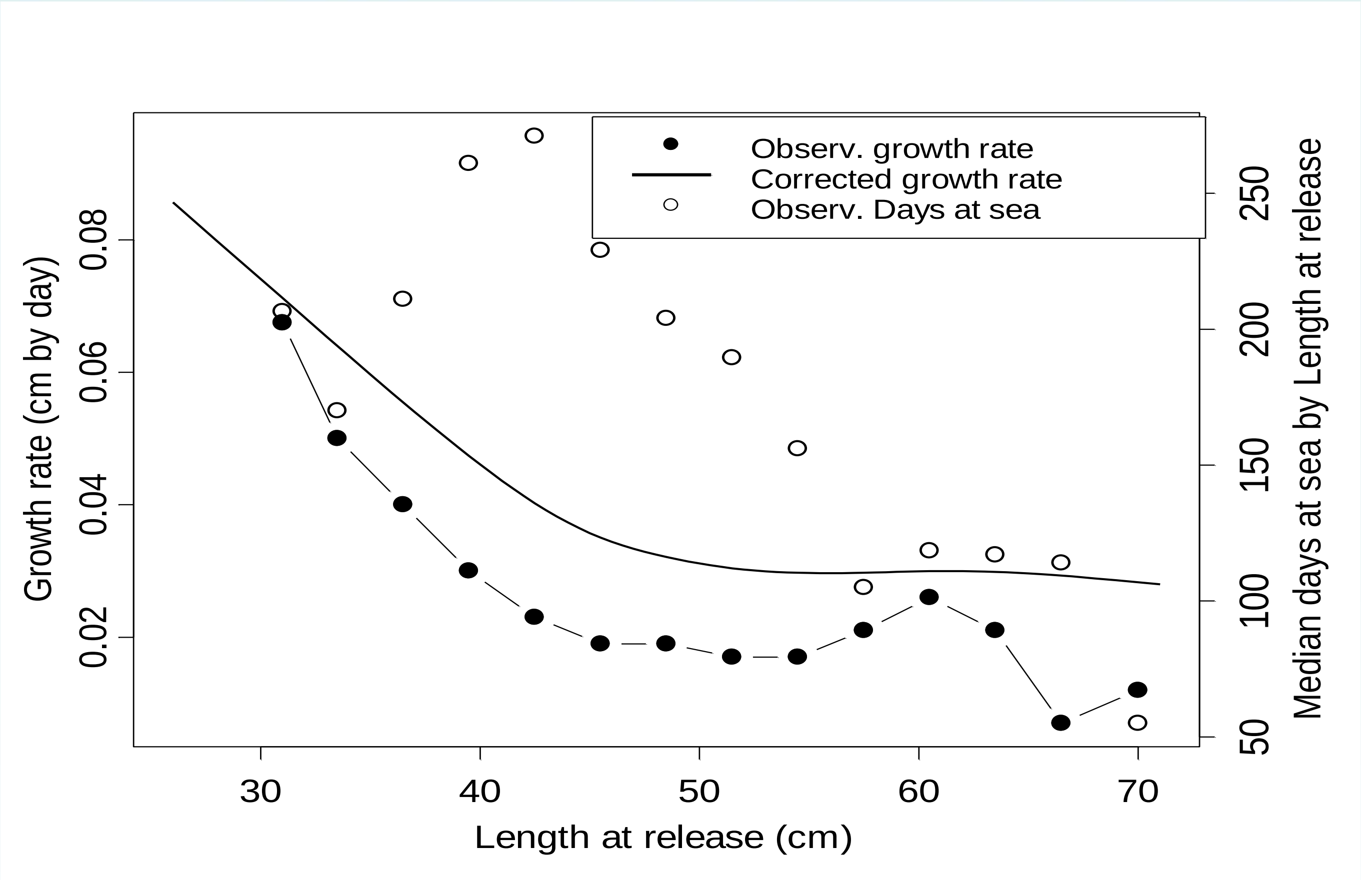
Results from the GAM



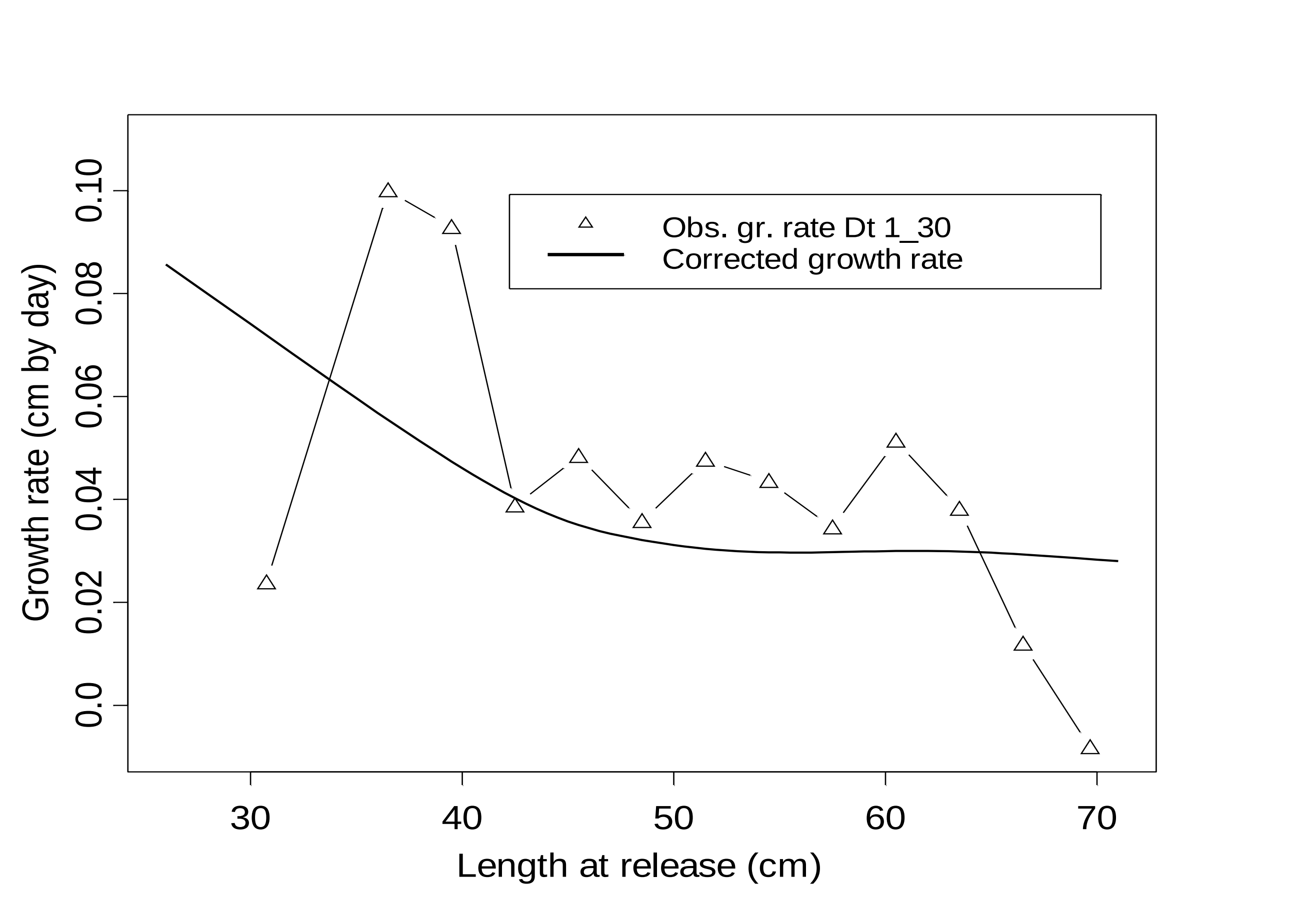
Then a new data set was created with Lr = range of observed Lr and Dt fixed at one day at sea with the aim to estimate as closely as possible the instantaneous growth rate per length

Results of the GAM corrected growth rate after fixing time at liberty at one day





Under-estimation of growth rate may be due to larger days at sea for the corresponding size classes



The bias is dramatically reduced for days at sea lower than 30, even if there is a large variability dur to low sample size by length class

Next step

Based on the fact that phenotypic plasticity exhibited by growth of skipjack among latitudinal regions has been evidenced in different parts of the world ocean (Bard and Antoine 1986; Bayliff 1988, Gaertner et al, 2008), comparison in growth rate between different Indian ocean regions known to support different environmental conditions are going to be conducted after removing the noisy effect of time at liberty.

Thanks for your attention