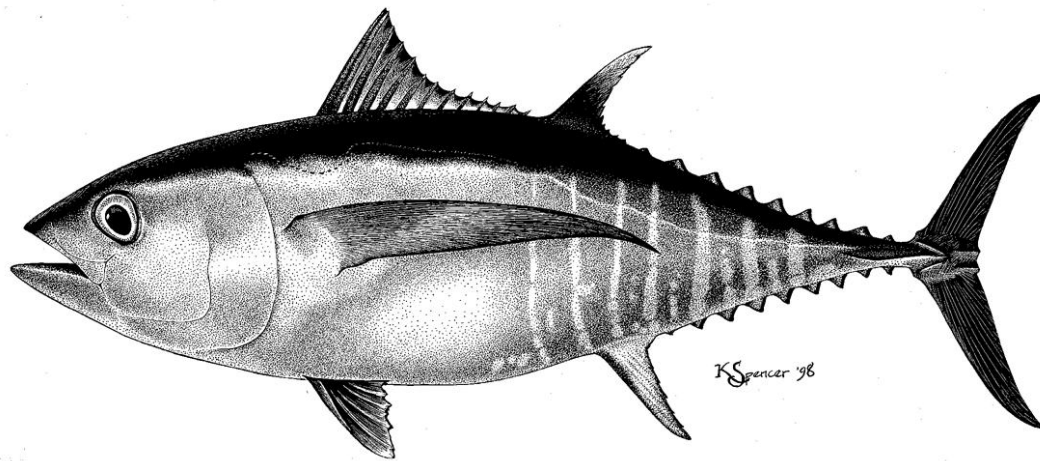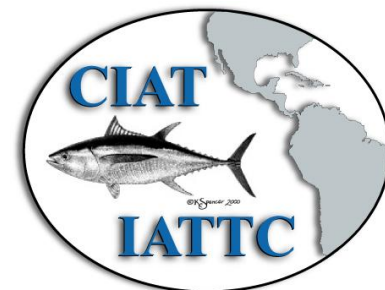# Modeling growth while fitting simultaneously to direct aging and tag-recapture data: example with bigeye tuna
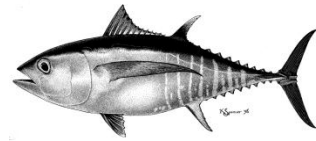
Alex da Silva, Mark Maunder, Kurt Schaefer and Dan Fuller

3rd Meeting of the Scientific Advisory Committee

La Jolla, USA, May 15-18, 2012

Background

- Two most common ways of estimating fish growth

  - Age-at-length data (direct readings of skeletal parts)

  $$L = L_\infty\left[1 - e^{-K(t-t_0)}\right]$$

  - Length increment data from tag-recapture experiments (Fabens 1965)

  $$\Delta L = (L_\infty - L)(1 - e^{-K\Delta T})$$

- Growth parameters generated from both methods are not comparable (Sainsbury 1980; Francis 1988)

  - Curves are fitted using different error structures

  - L@A: residuals between observed L@A and expected L@A

  - Tagging: residuals between observed size inc. and expected at different time intervals
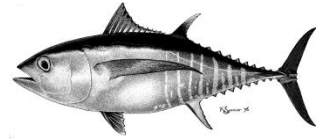
An integrated model
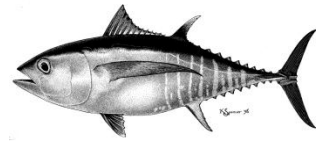
- Maximum likelihood approaches exist that can model the joint density of the release and recapture lengths (Laslett et al. 2002; Eveson 2004)

- For example, if we use the VB the assumed growth curve for the fish is:

$$L_t = L_\infty \left[1 - e^{-K(\textbf{\textit{A}} - t_0)} \right]$$

- *A* = *t*, is the age of each fish and treated as a **random variable** with density p(.) and whose parameters will be estimated in the model

Tag-recapture component

- For a fish *i* tagged at time t_1 with released length L_1 and recaptured at t_2 with L_2

$$L_{1,i} = L_\infty \left[1 - e^{-K(\boldsymbol{A_i} - t_0)} \right]$$

$$L_{2,i} = L_\infty \left[1 - e^{-K(\boldsymbol{A_i} + \boldsymbol{t_{2,i}} - \boldsymbol{t_{1,i}} - t_0)} \right]$$
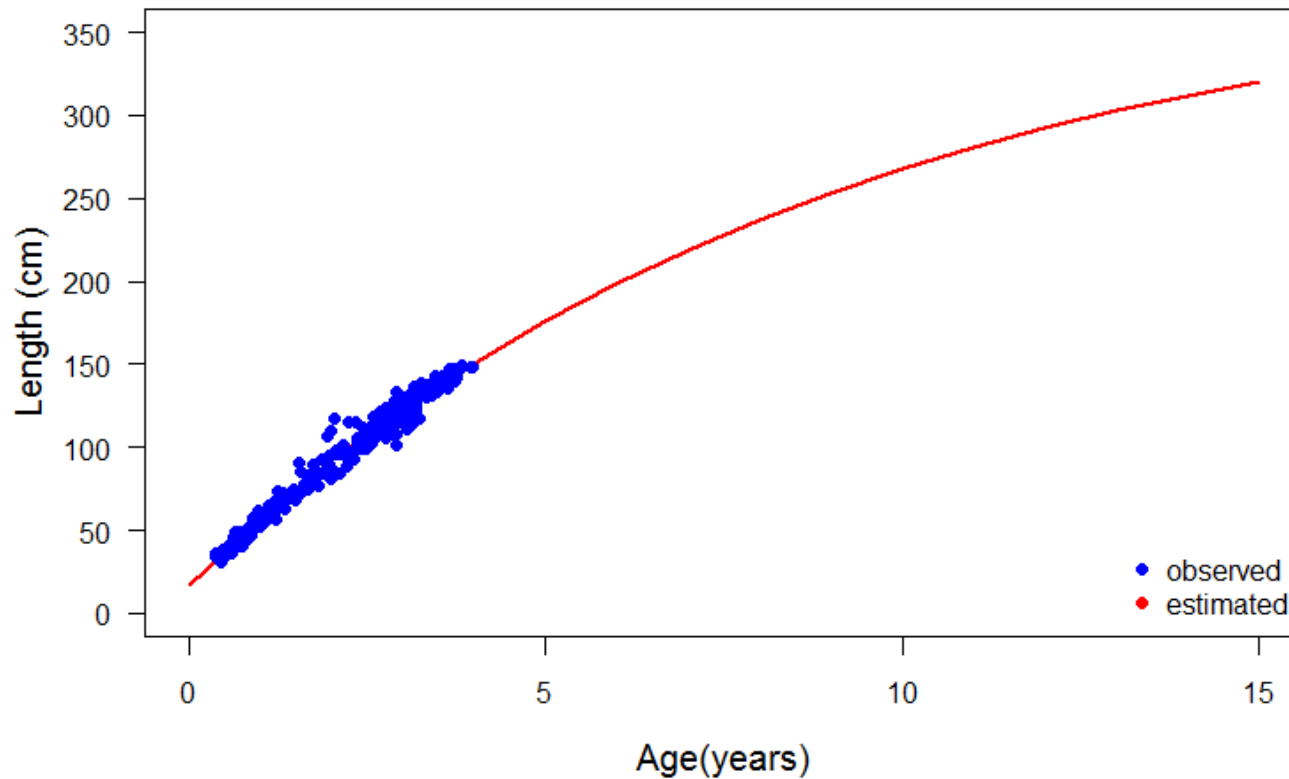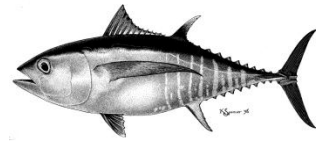
- The joint distribution of $L_{1,i}$ and $L_{2,i}$ can be integrated over A:

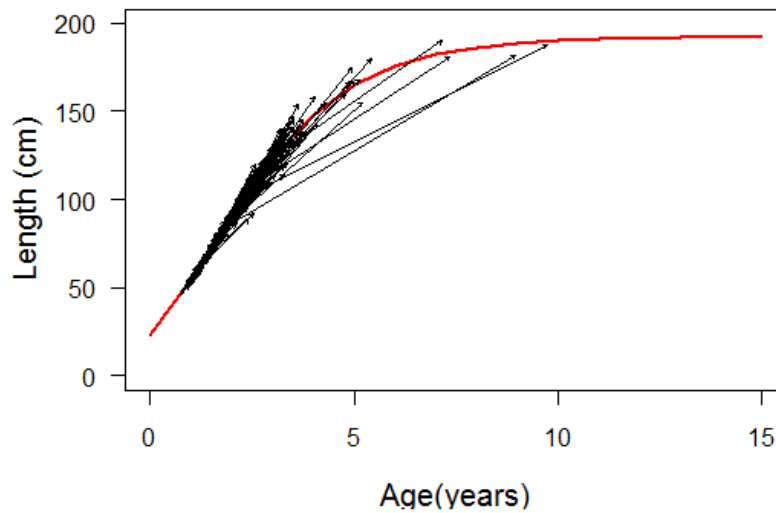$$h(L_{1,i}, L_{2,i}) = \int h(L_{1,i}, L_{2,i} | a) p(a) da$$

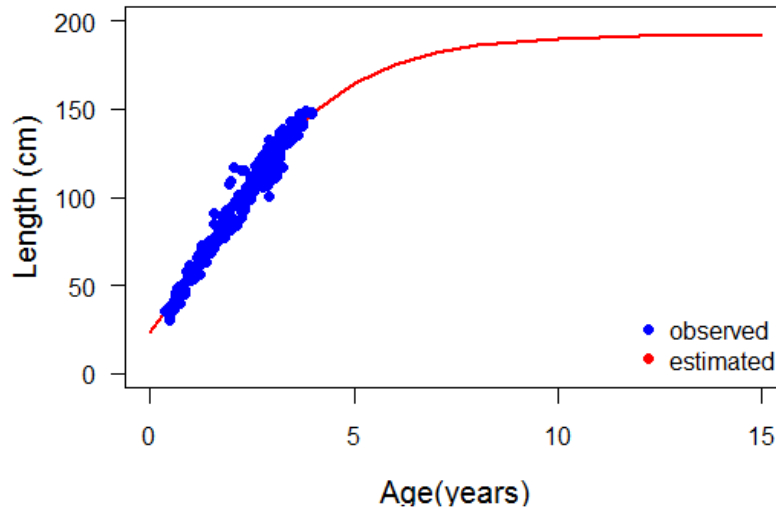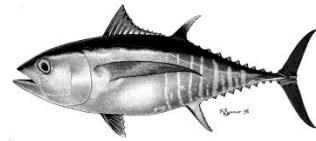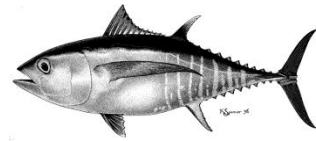- This can be done using AD Model Builder!
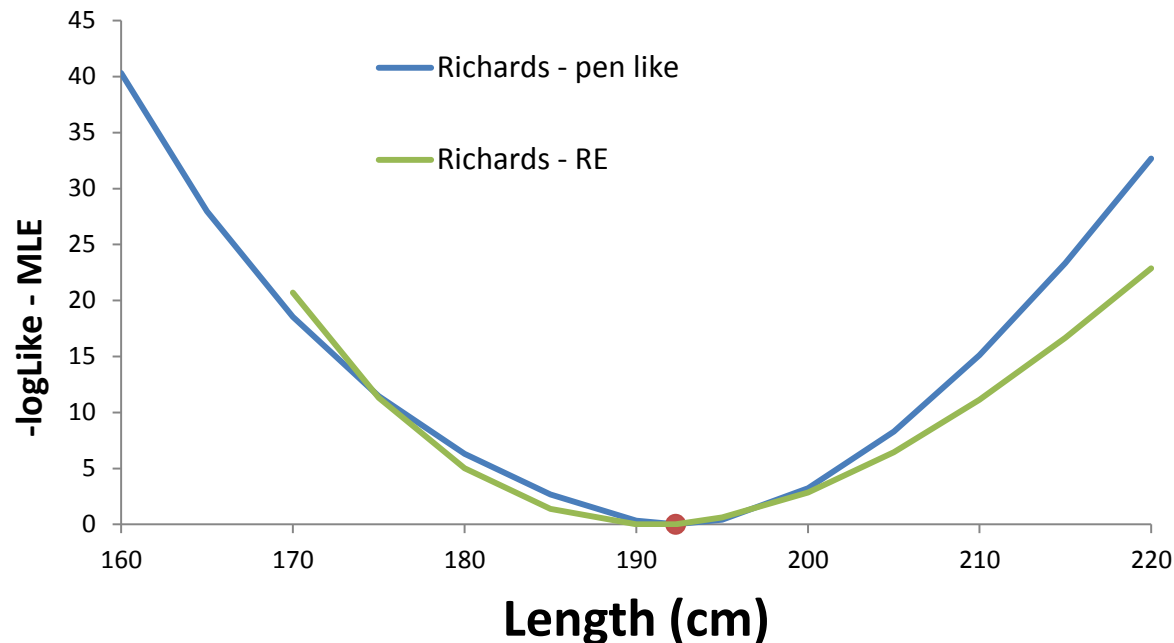
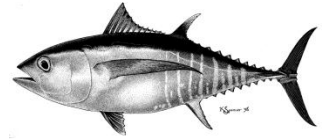# Example with BET

Example with BET

Alternative approaches

- Random effects

- Bayesian (MCMC)

- Penalized likelihood approach

Future work

- Use new curve in Stock Synthesis

- Request implementation of penalized likelihood approach in Stock Synthesis