

Estimating fish growth for stock assessments using both age-length and tagging-increment data

R.I.C. Chris Francis

francischris@protonmail.com

AMSFc Method

(Francis et al. 2016, Fish. Res. 180: 77–86)

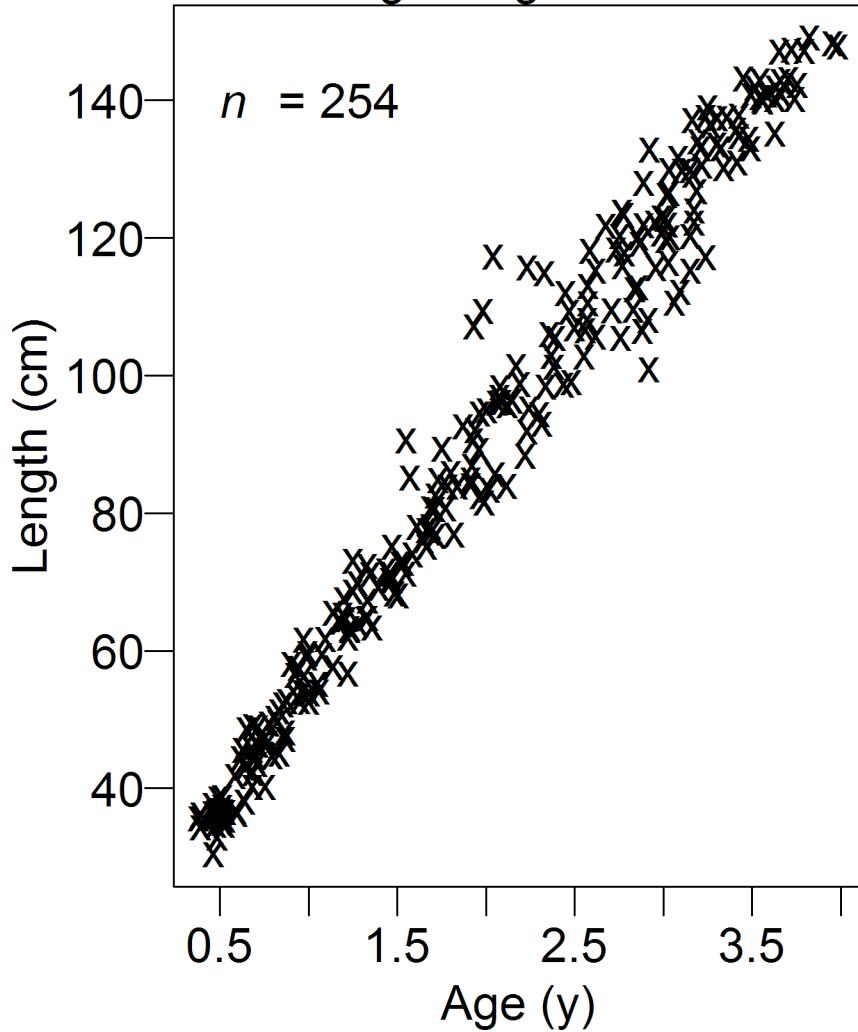
Produces age-based growth estimates from tagging data by treating A_{tag} as a random effect

Age-length data fitted by conventional maximum likelihood

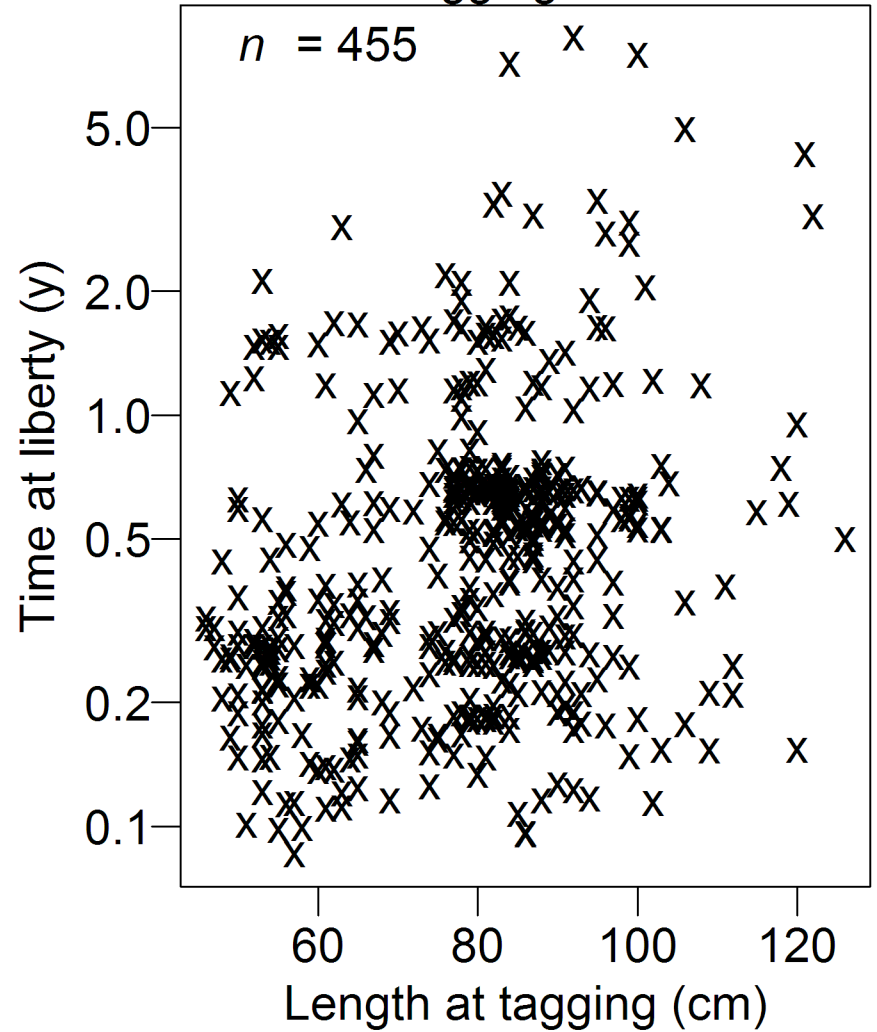
Implemented originally ADMB-RE; now in TMB

Bigeye data

Age-length data

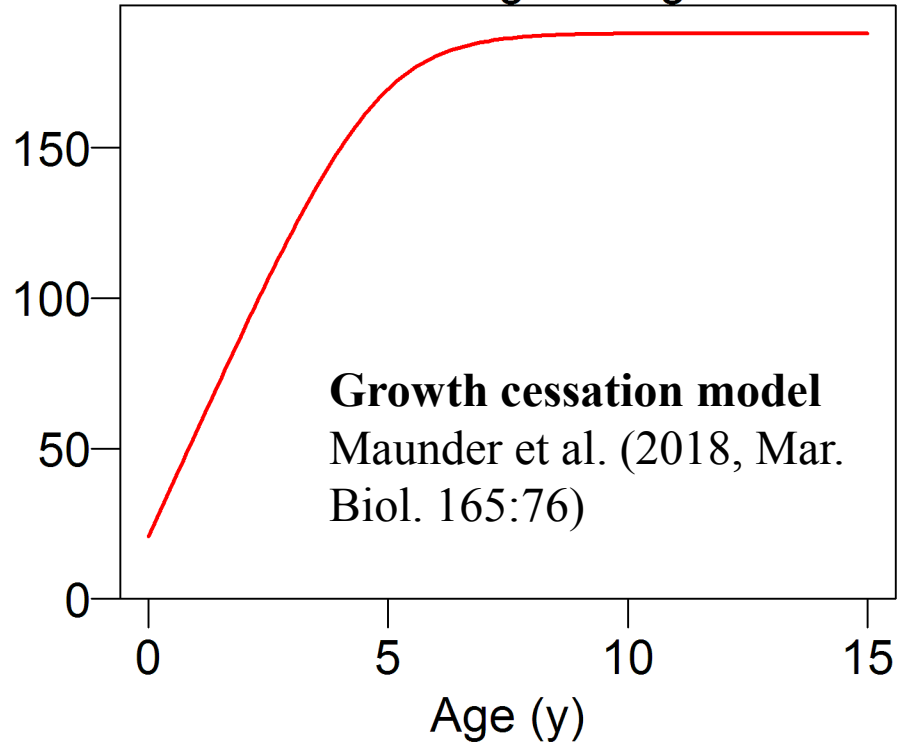


Tagging data

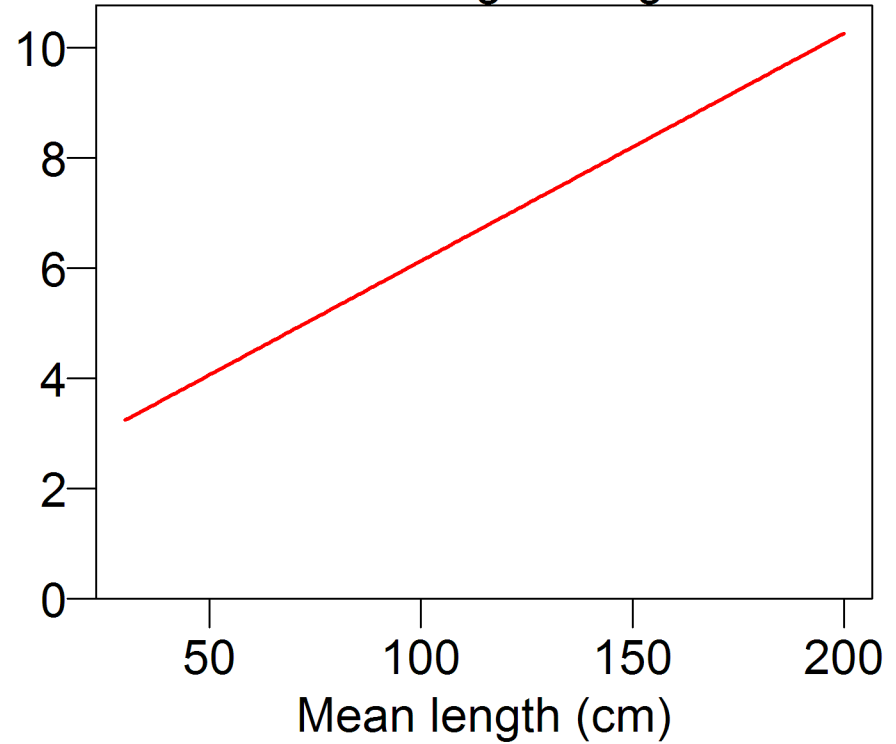


Initial Base Model

Mean length at age



SD of length at age



Tried all combinations of normal and **lognormal** length at age and

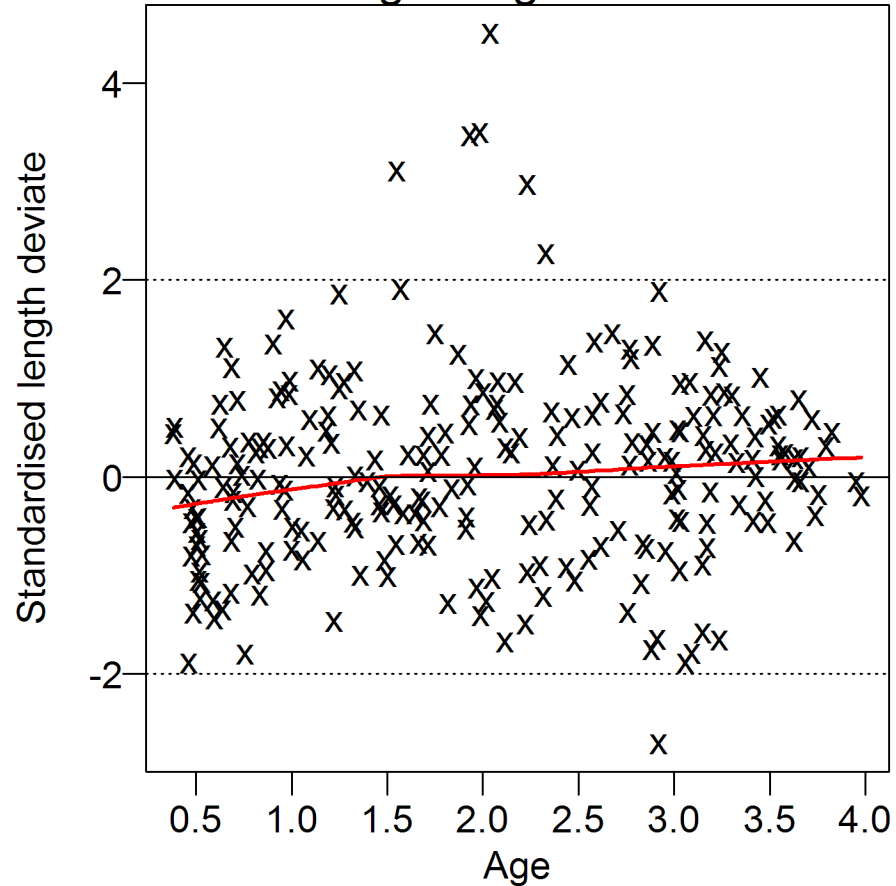
$$sd(L | A) = a + b\bar{L}_A$$

$$cv(L | A) = a + b\bar{L}_A$$

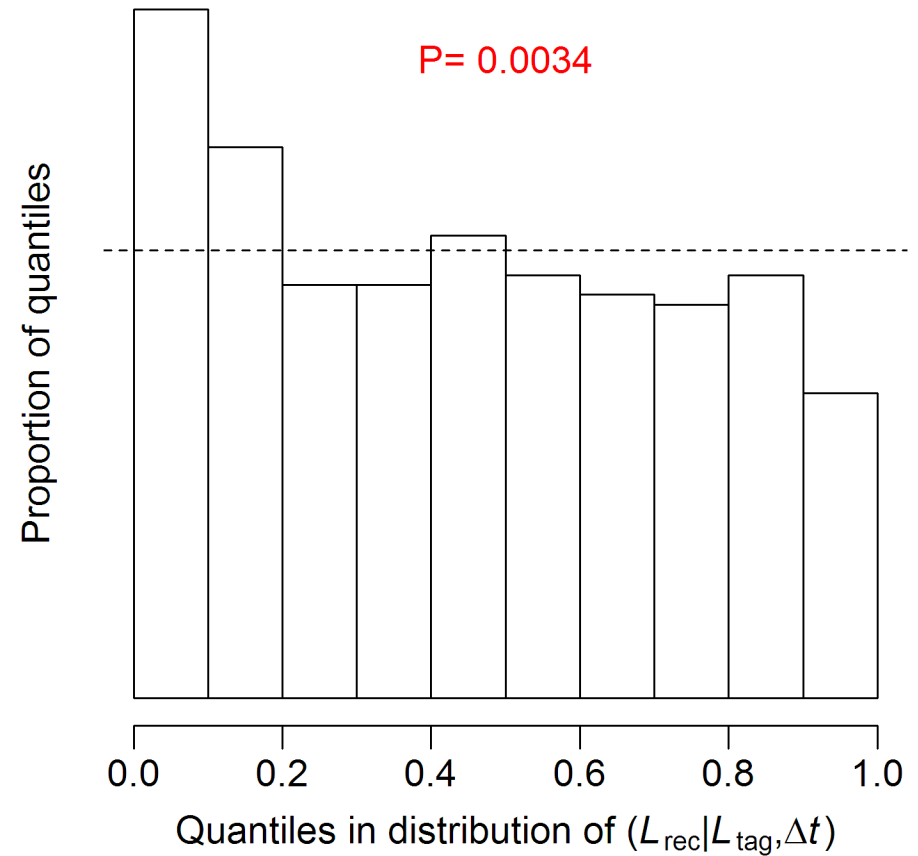
$$cv(L | A) = b\bar{L}_A$$

Goodness-of-fit diagnostics

Age-length data



Tagging data



Possible Causes of Poor Tagging Diagnostic

Cited in our paper

- **shrinkage** of recaptured fish with freezing and thawing
- temporary **growth inhibition** from tagging trauma

Later idea

- **ageing bias** in age-length data

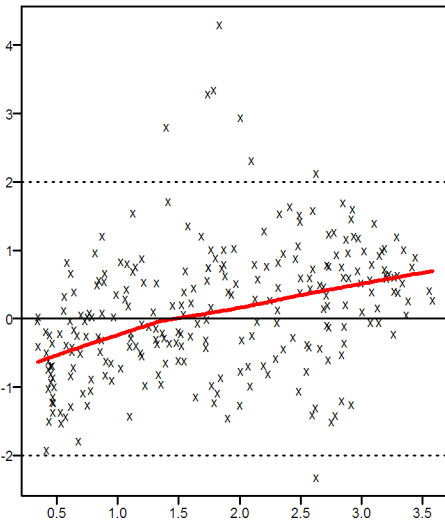
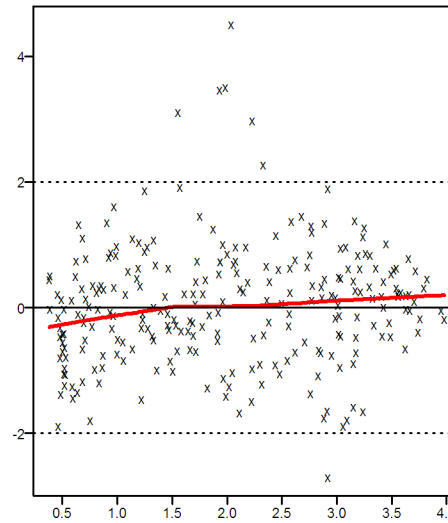
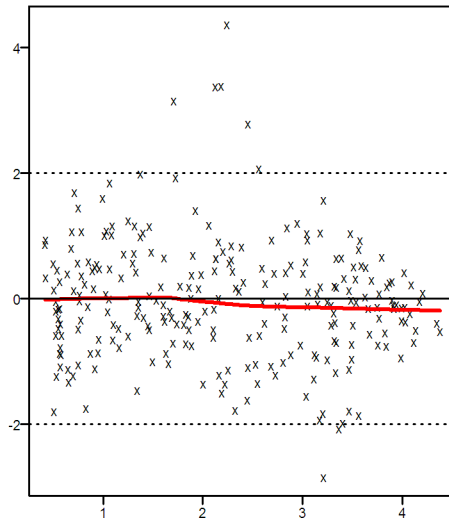
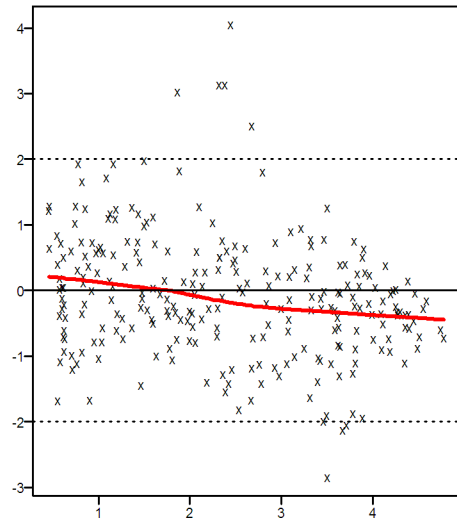
Effect of ageing bias on diagnostics

-20% bias

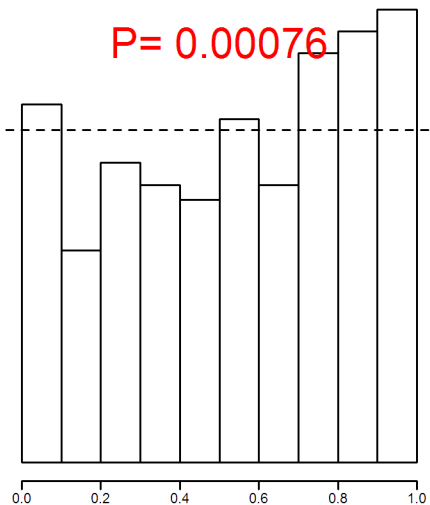
-10% bias

Base

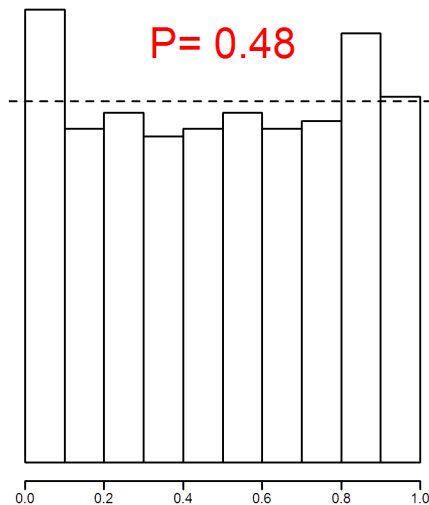
+10% bias



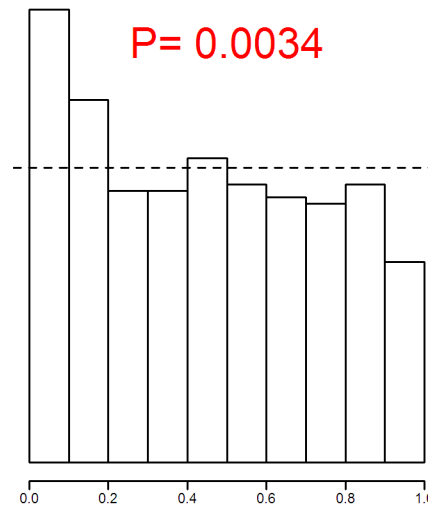
$P = 0.00076$



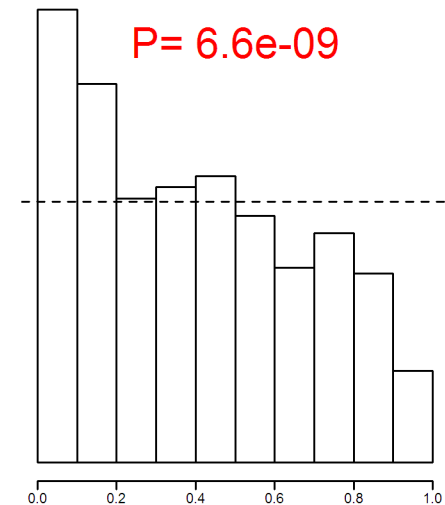
$P = 0.48$



$P = 0.0034$



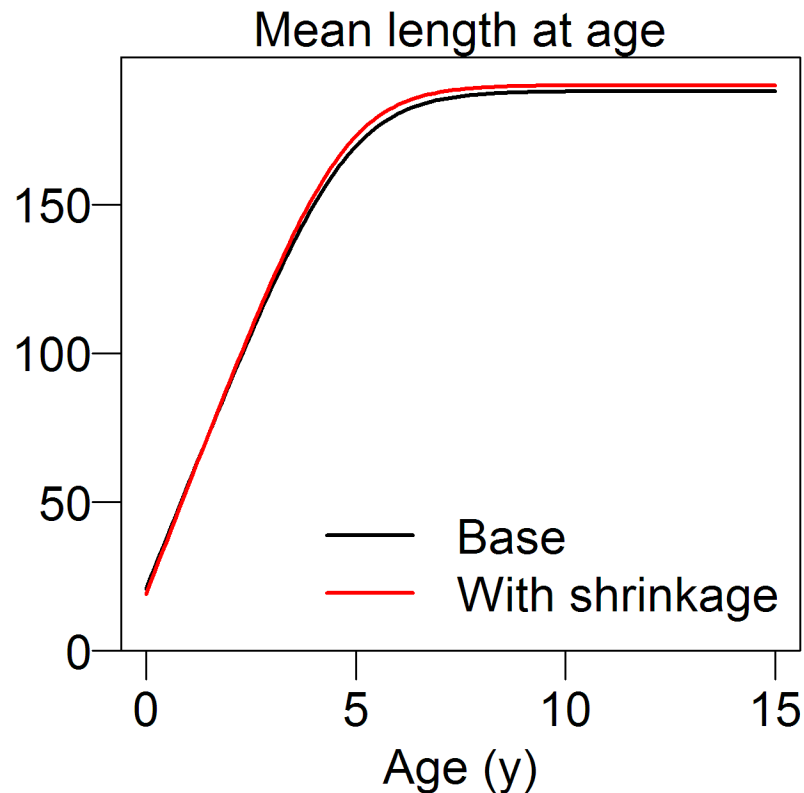
$P = 6.6e-09$



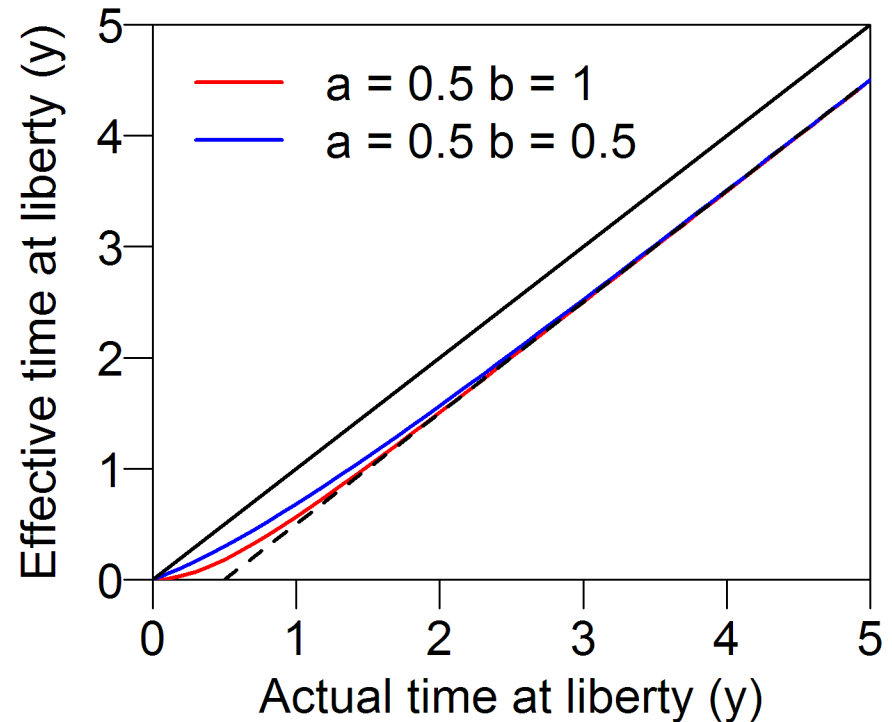
Shrinkage and Growth inhibition

Shrinkage

- Estimate 2% shrinkage
- Affects both data sets
- Little effect on growth model



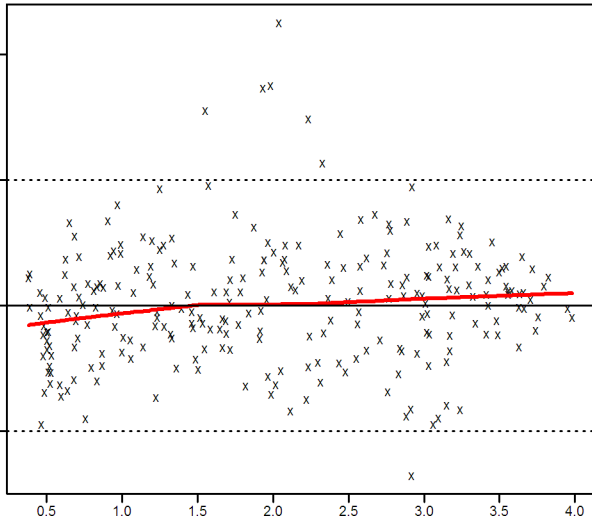
Growth inhibition



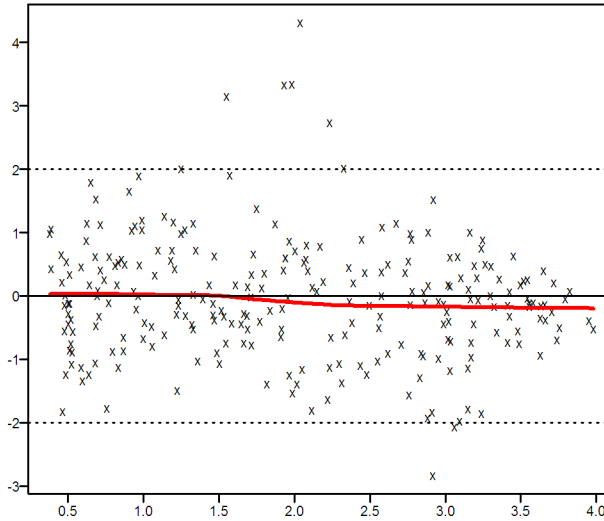
Significant improvement without shrinkage, but not with shrinkage

Effect of shrinkage and ageing bias

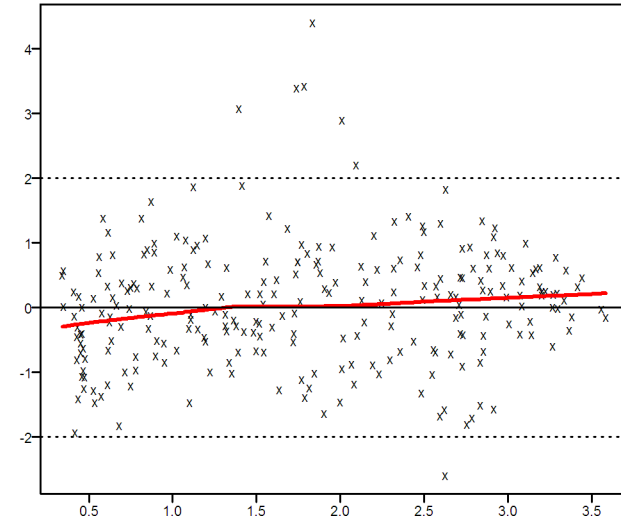
Base



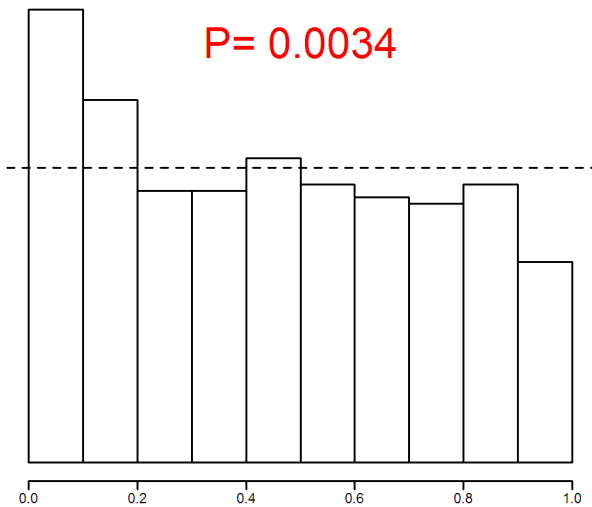
+shrink



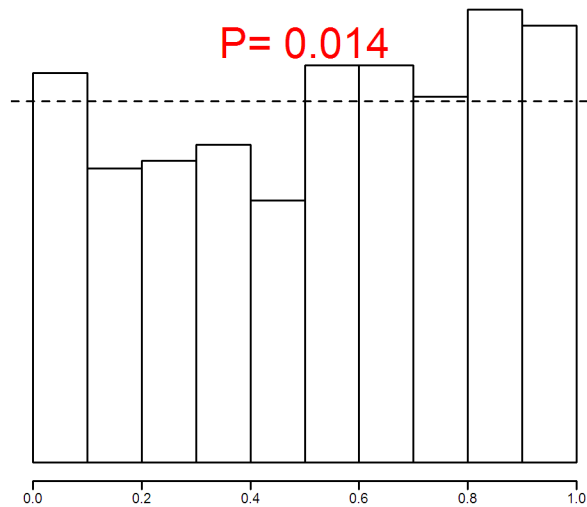
+shrink, 10%bias



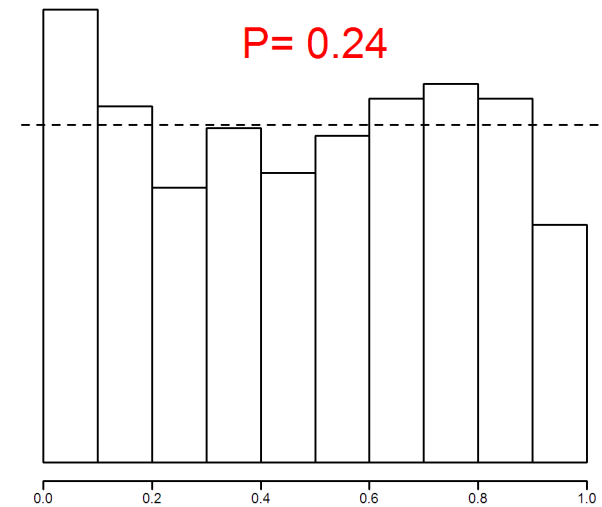
P= 0.0034



P= 0.014

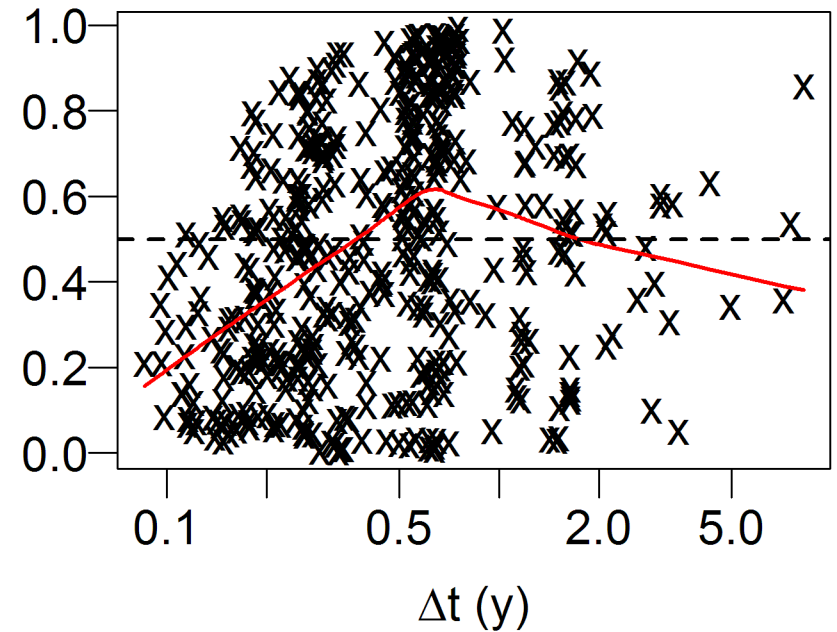
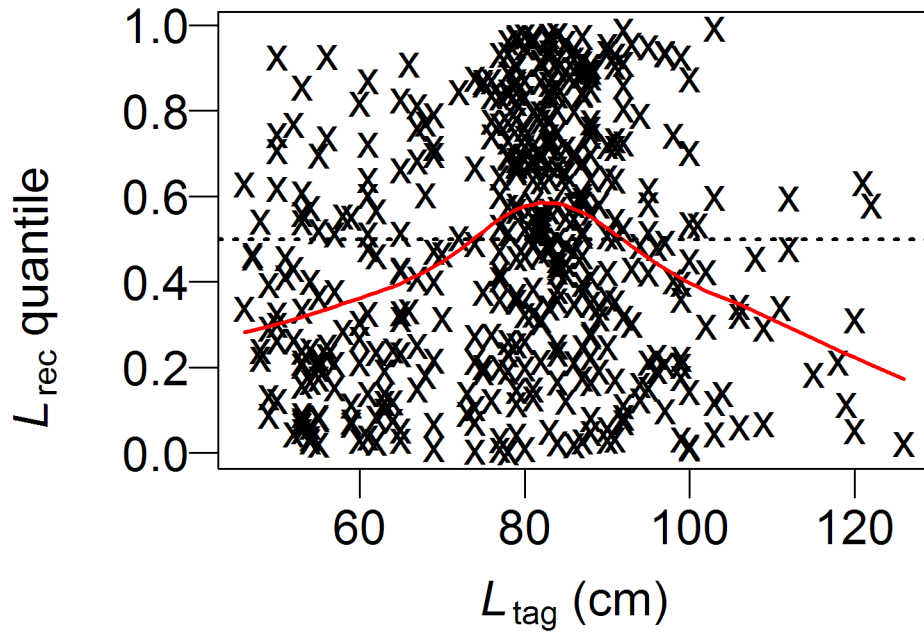


P= 0.24

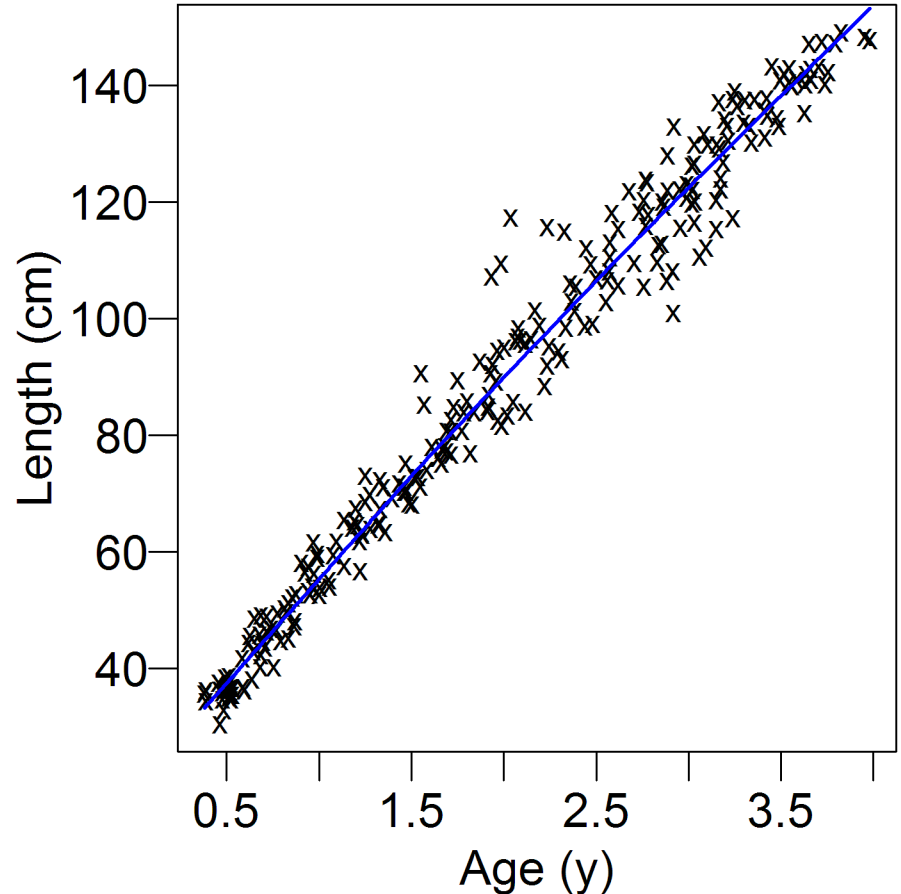
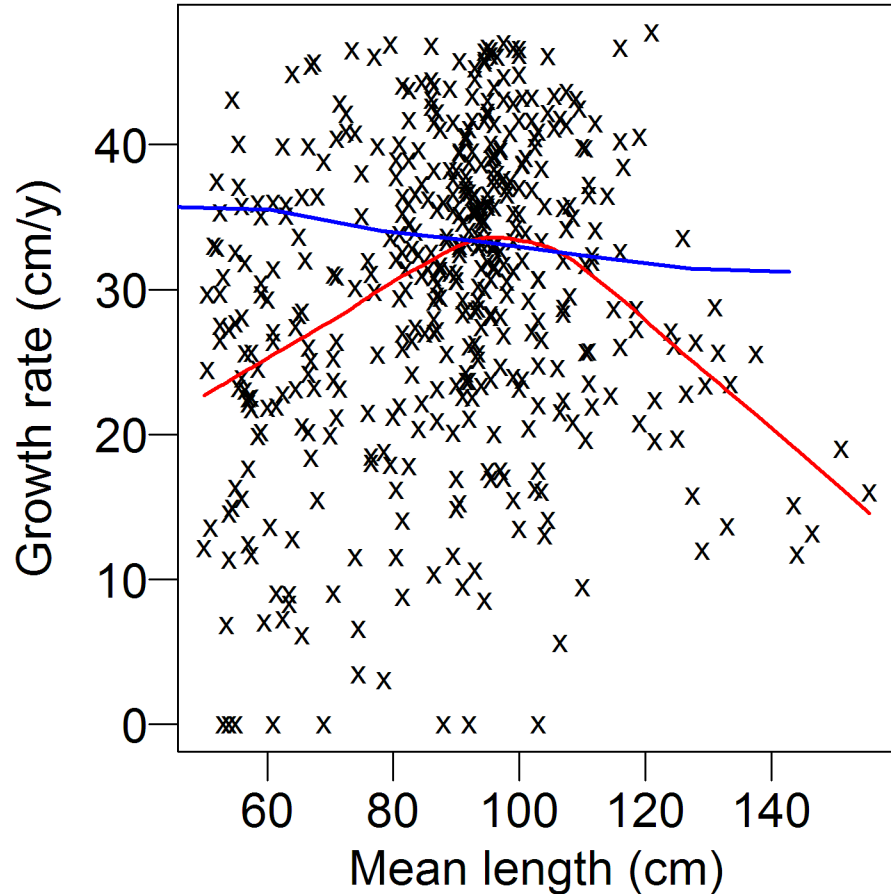


Looking more closely at tagging diagnostic

Fit to real tag data alone



Eveson et al (2015) tagging diagnostic

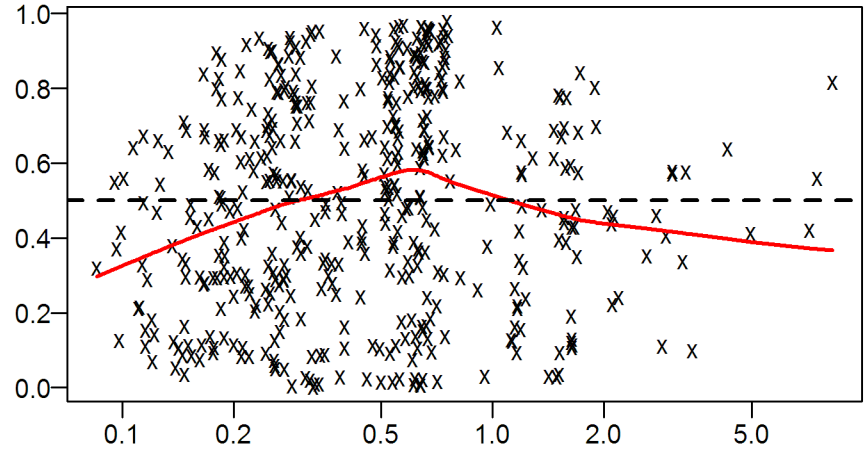
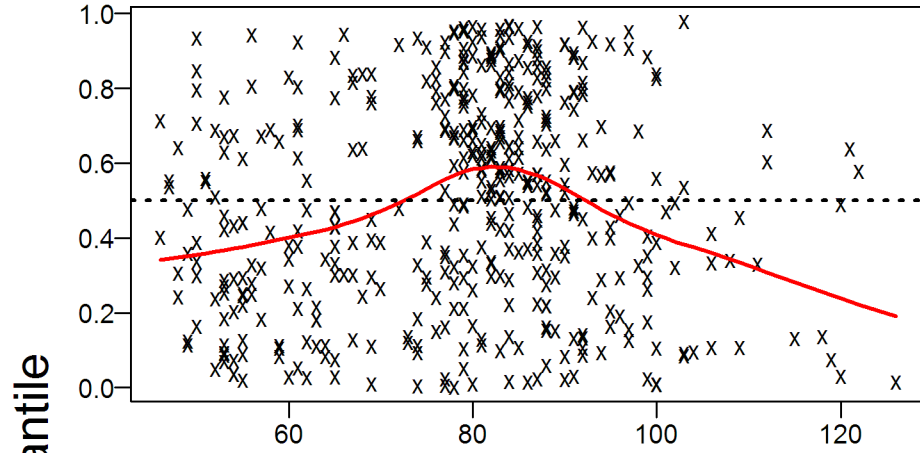


Implies 2-phase growth

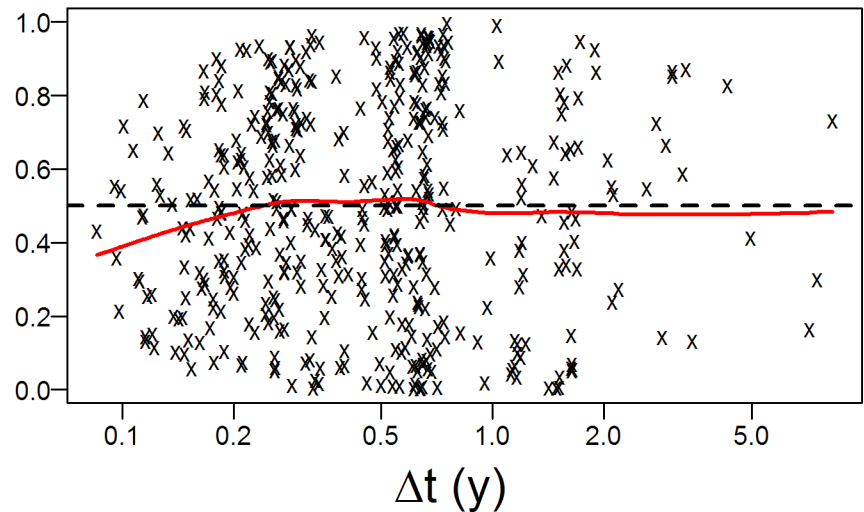
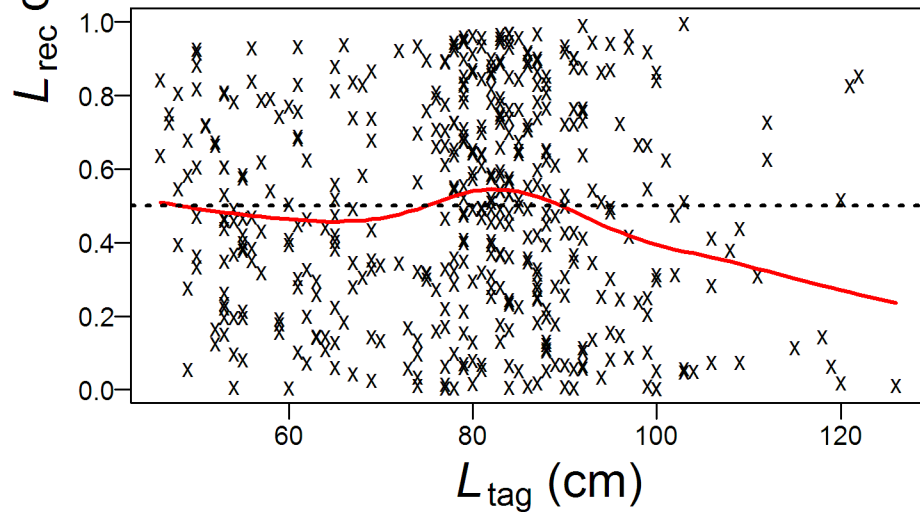
Implies 1-phase growth

Better diagnostics with 2-phase growth

Fits to tag and shrinkage data alone

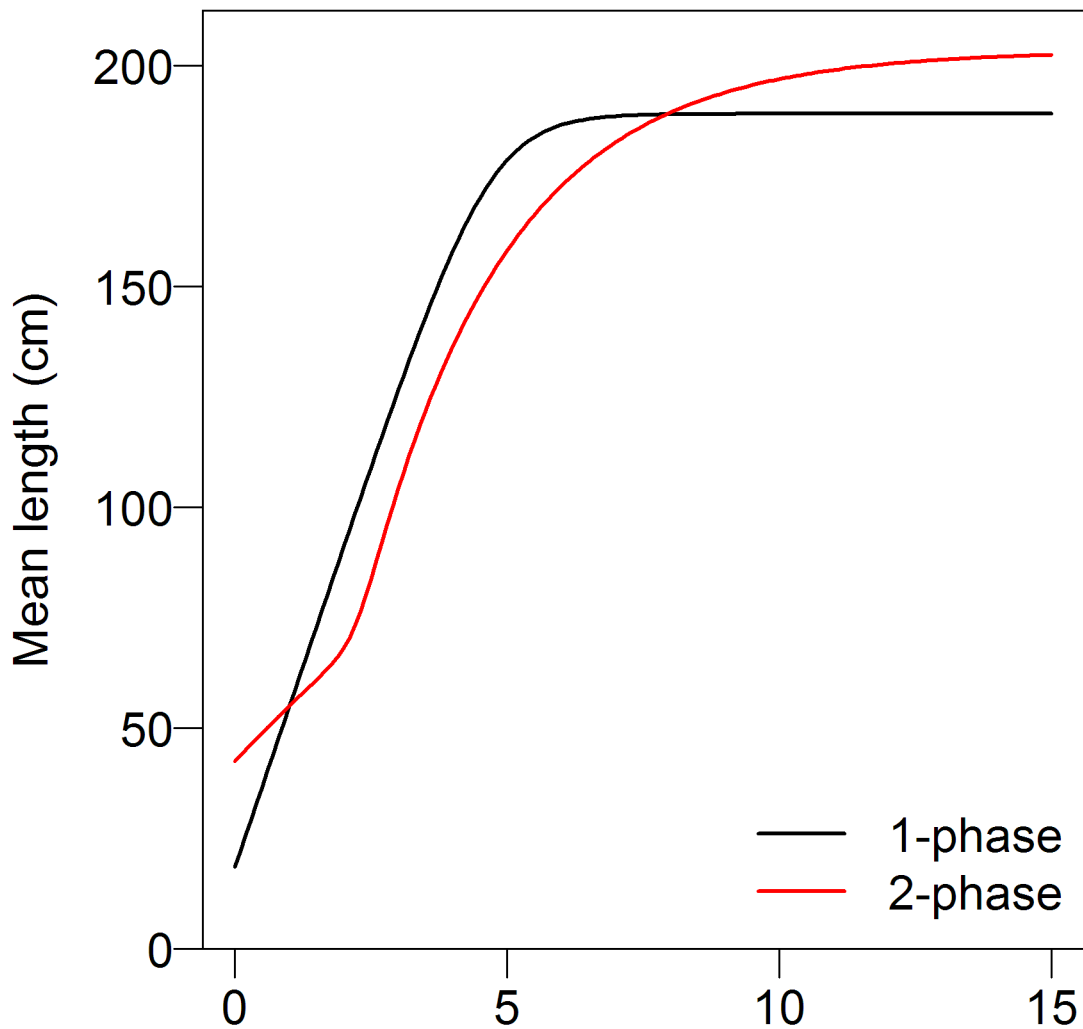


1-phase, GrowCess



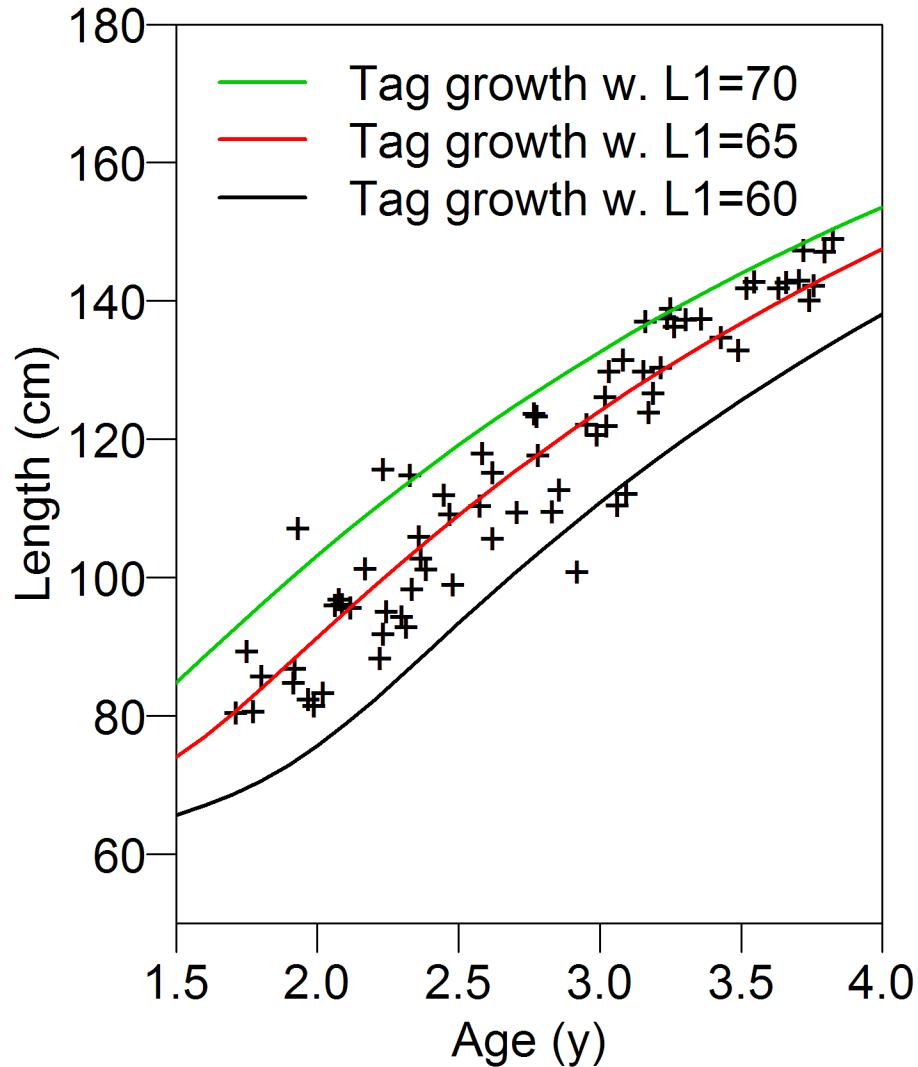
2-phase, VBlogk

1-phase & 2-phase growth curves (using tagging and shrinkage data)



Consistency of paired otolith ages with tagging

Ages from daily rings



Ages from annual rings

