Using size increment data in age-structured stock assessment models

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Acknowledgements

Megan Winton (CFF)
Rick Methot (NMFS)
Alex da Silva, Mark Maunder (IATTC)
Laura Lee (NCDENR)
Geoff Tuck (CSIRO)

UMass | Dartmouth

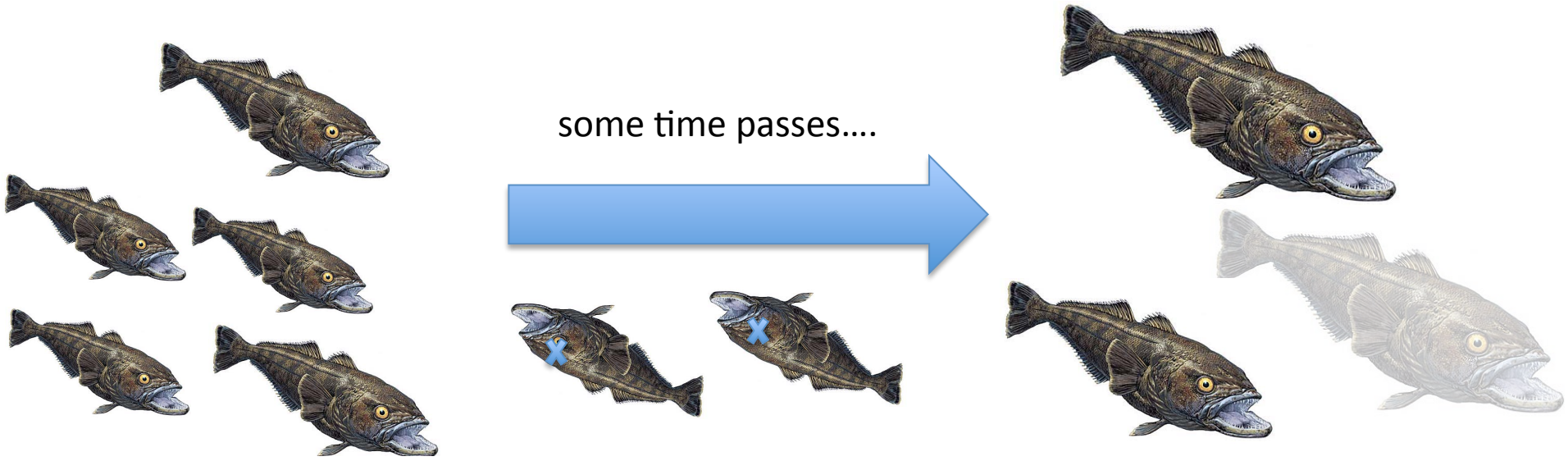
CAPAM growth workshop: Nov 2014

Take home messages:

- Be VERY careful when doing a Google image search for “size increments”.
- Being internally consistent when treating our models and data is A Good Thing.
- Most of the machinery to include size increment data already exists.
- Worthwhile to understand when including additional types of data can be useful.

Size increment data from tag recaptures

- Models external to assessments
- Challenges for including in assessment models
- An Approach (with Synthesis in mind)
- Stock Synthesis modifications for implementation.



How have size increment data been used?

External from assessment model

- Estimate growth parameters

  e.g. Fabens (1965), Laslett et al. (2002)

- Used to corroborate assessment model estimates of growth

Internally in assessment model

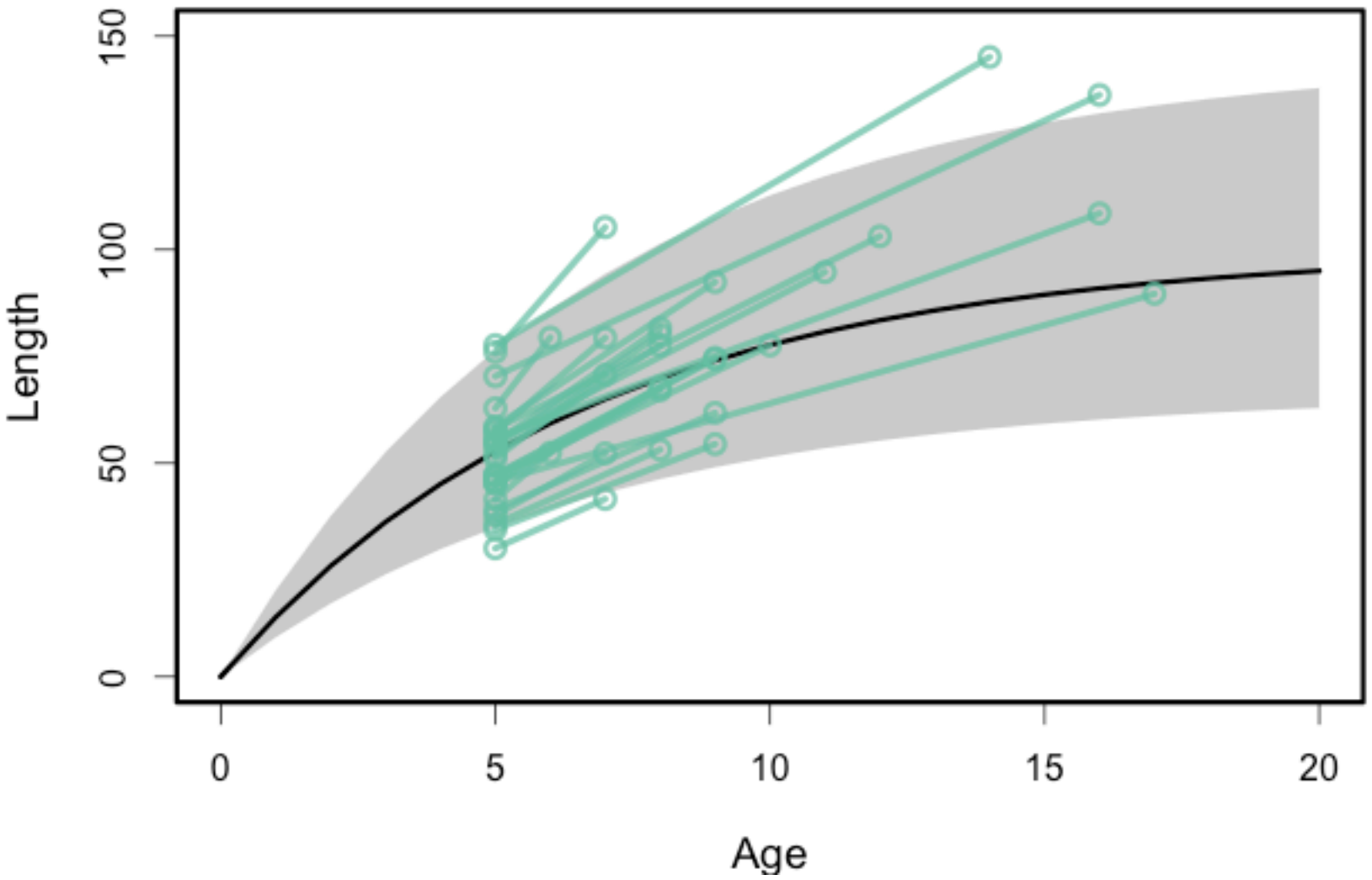
- CASAL (multinomial size at recapture)
- Estimate size transition matrices

  [see Punt later for size-structured models]

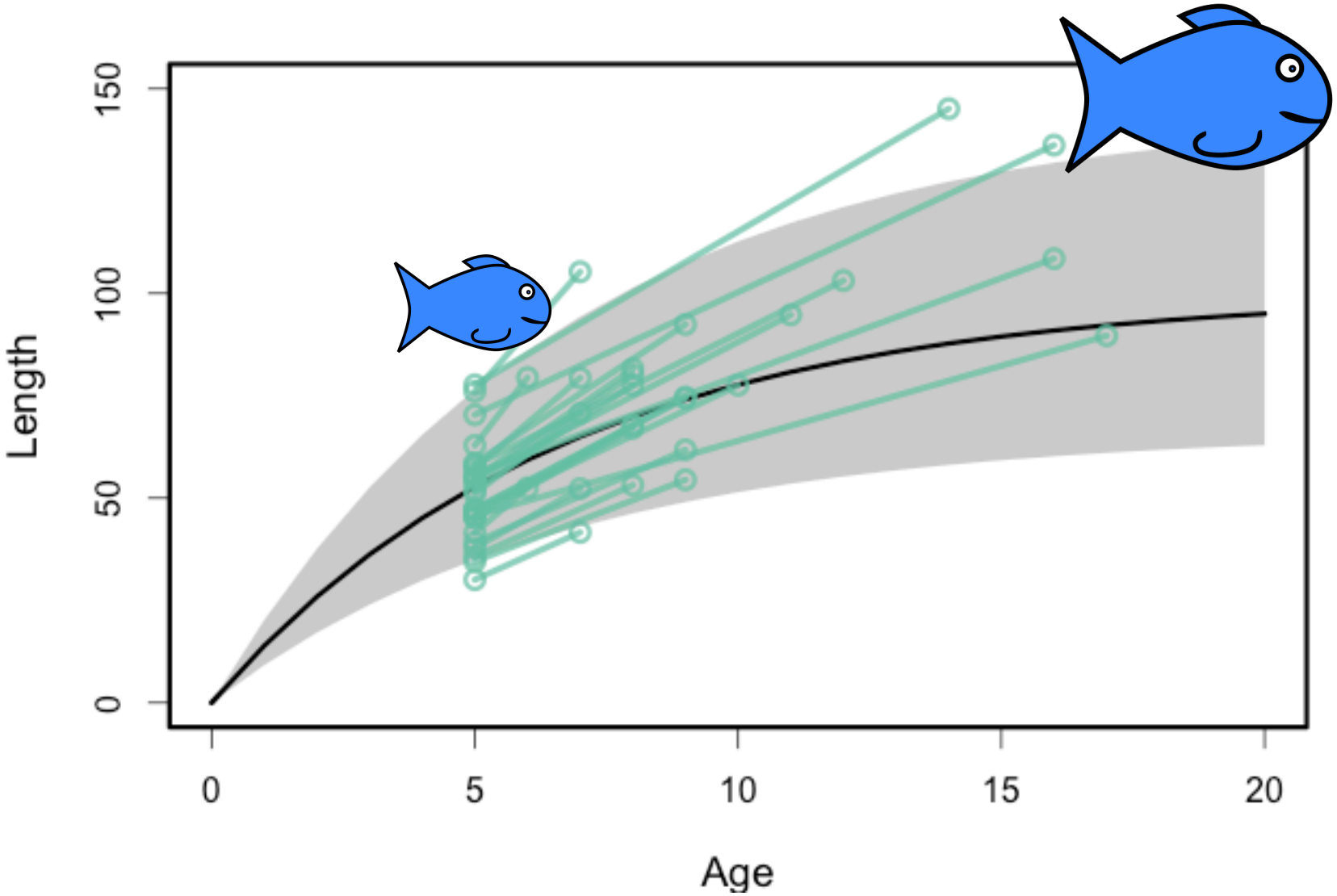
Generally, growth increments have not been included among data used to fit age-structured stock assessment models.

CHALLENGES ARISE

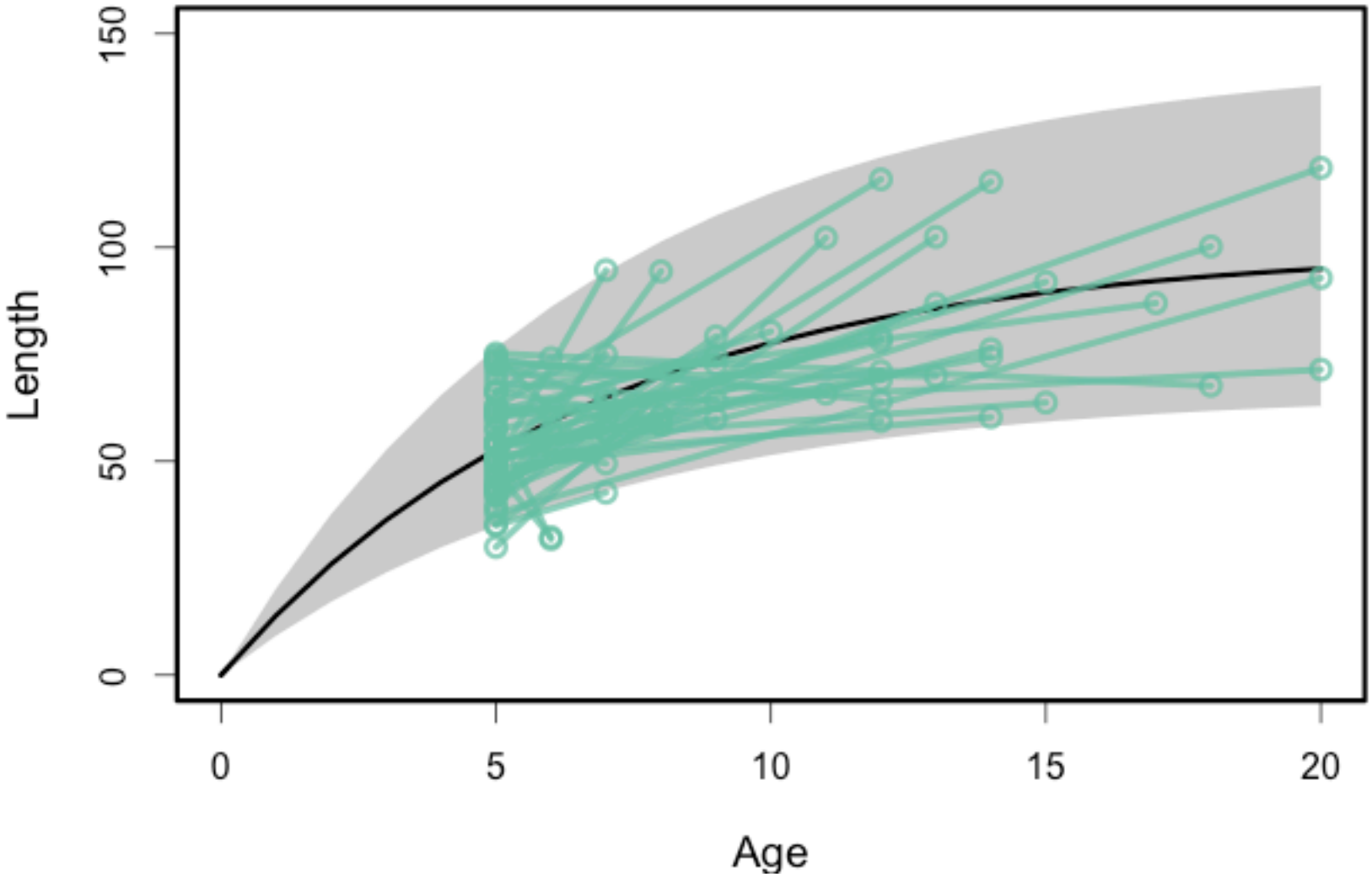
Assumption of growth increment estimators



Assumption of growth increment estimators



Assumption of most age-structured stock assessment models



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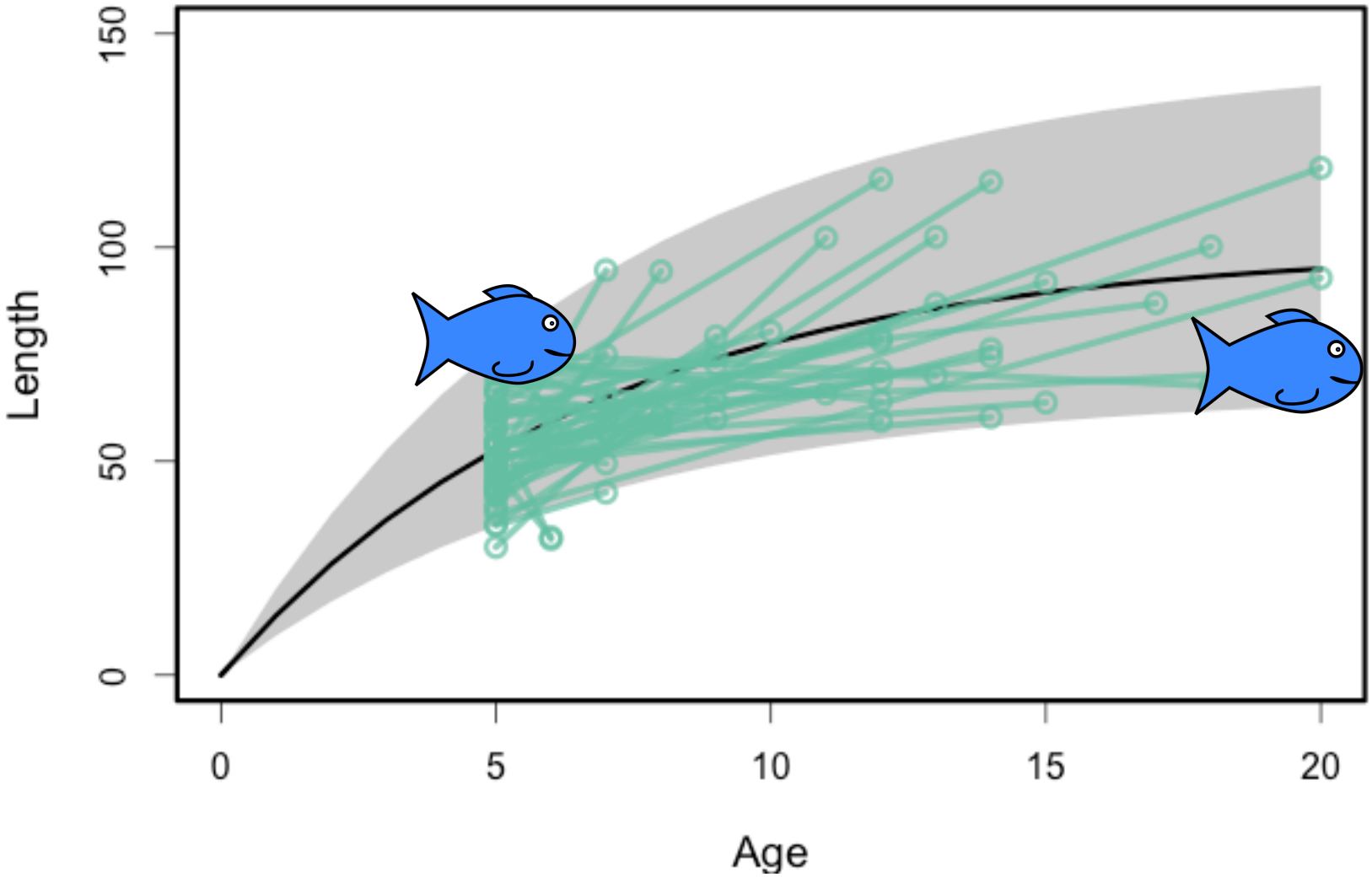
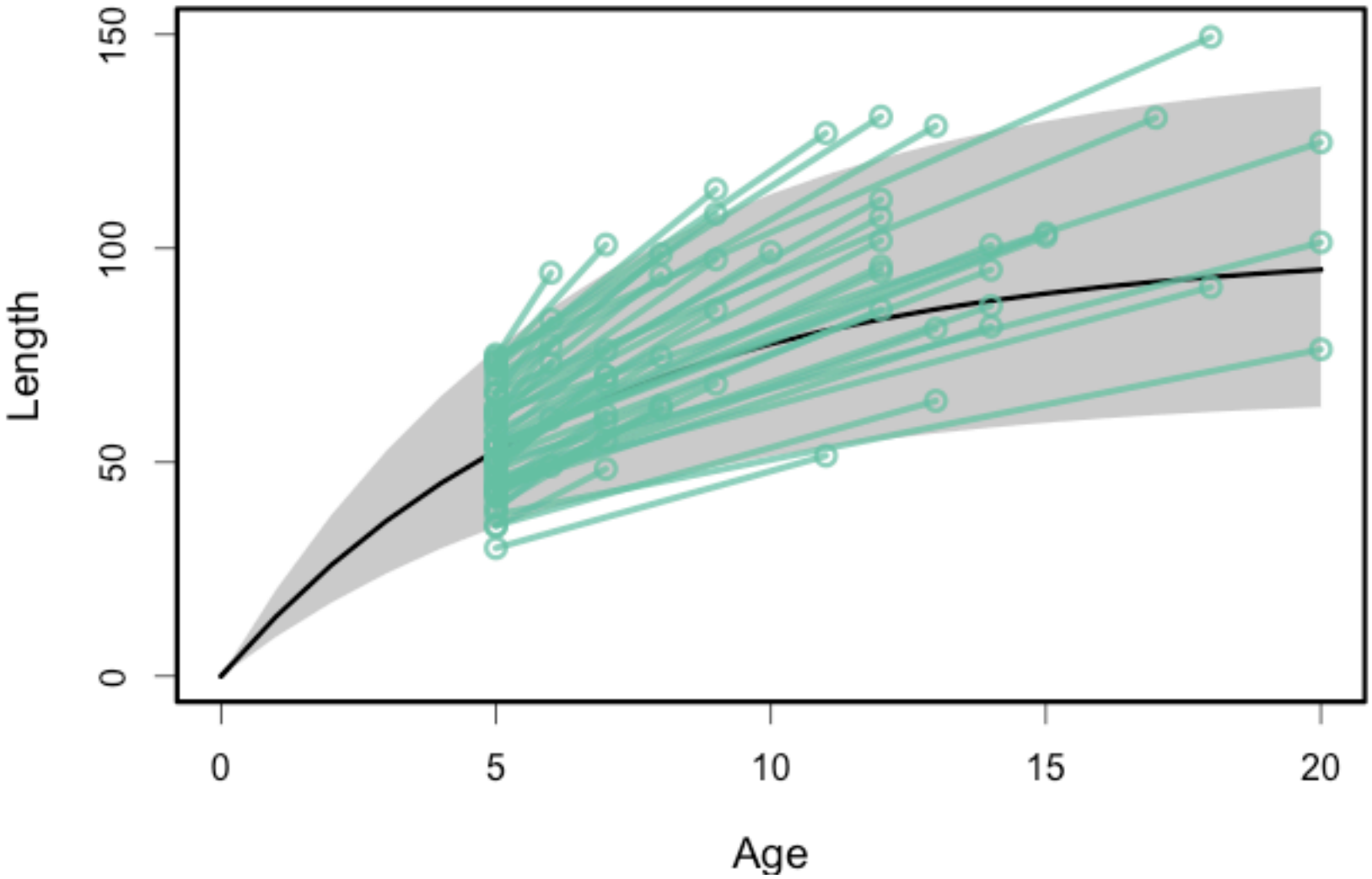


Selectivity can also produce bias



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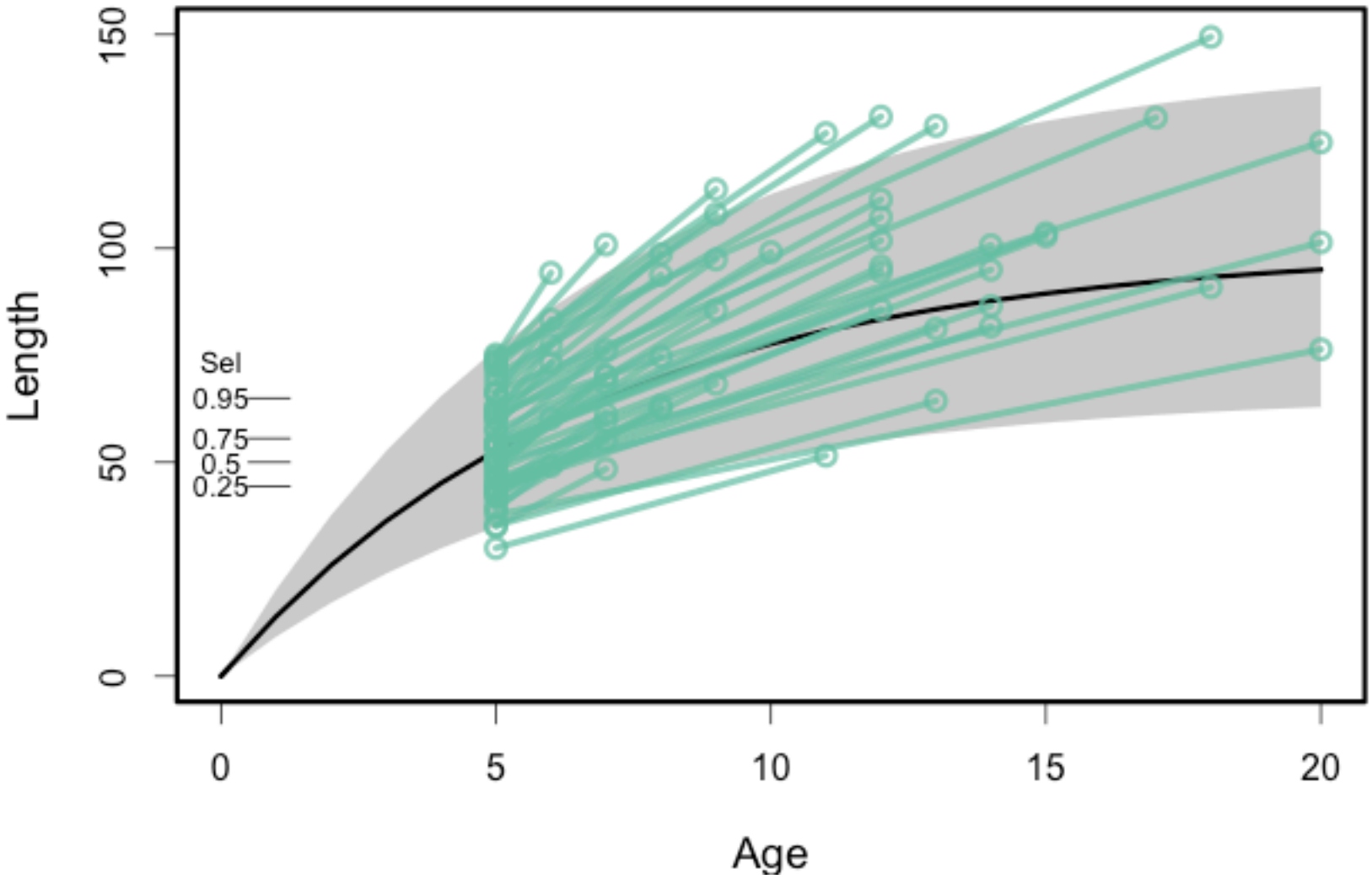

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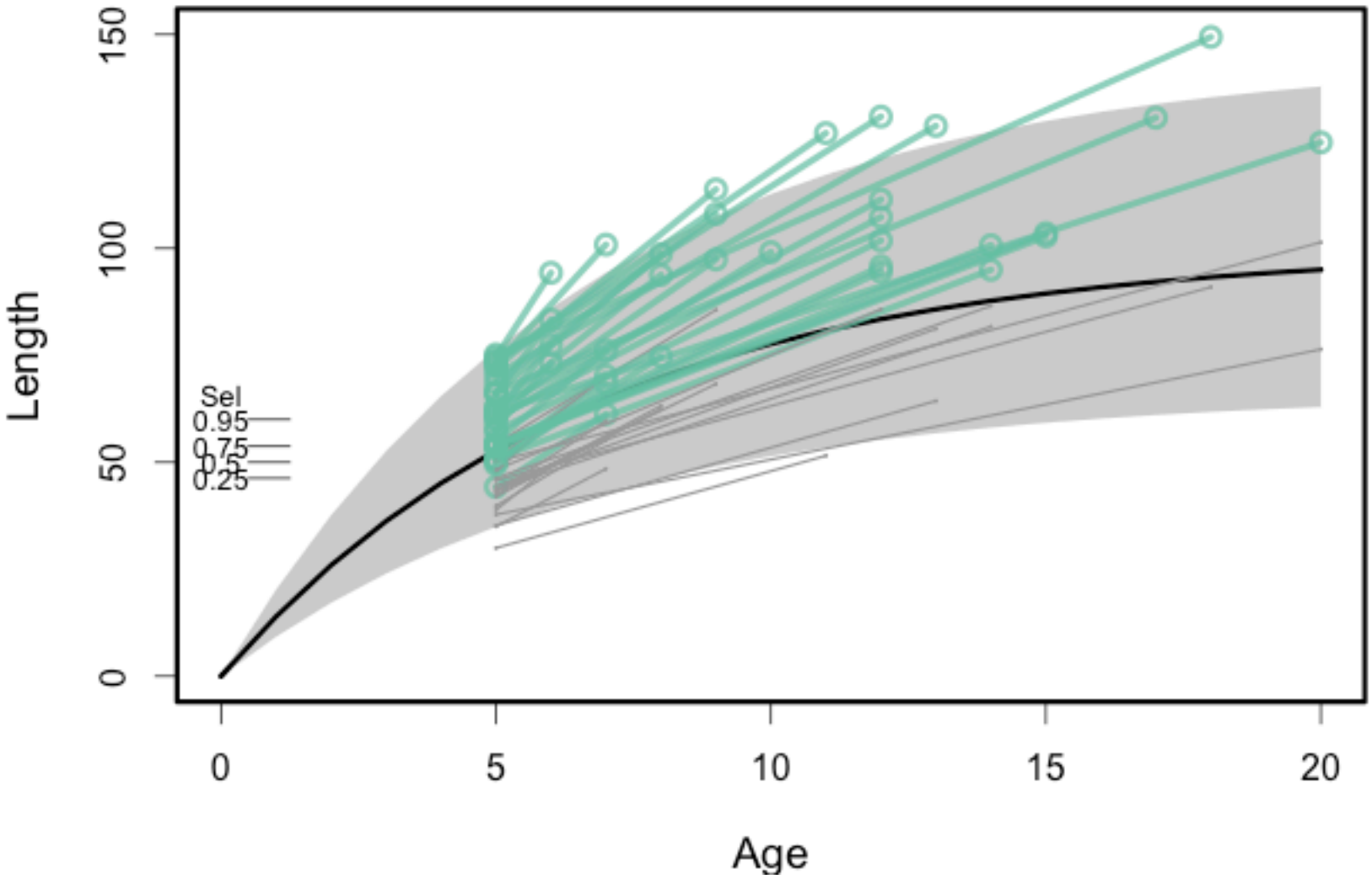


Why fit these data internally?

- Consistency in assumptions associated with estimates.
- Account for biases (e.g. selectivity).
- Incorporate uncertainty associated with growth estimation in to estimates of stock status, reference points, etc.

- Can we borrow from Size structured models?

Methods

- Fabens (1965) [and extensions]
  - Growth increment given time at liberty
  - Often model individual variation in one or more parameters.
- Laslett et al. (2002) [LEP]
  - Join distribution of sizes at release and recapture given time at liberty, integrate over age at release.
  - Individual variation in $L_{infinity}$
- Multinomial size at recapture

Q: When is it OK to use the simple(r) methods?

LEP-ish in something like Stock Synthesis

$$p(L1, L2|\Delta t, \theta) = \int_a f(L1, L2|\Delta t, a, \theta) p(a) da$$

Aires da Silva et al. 2014. Fish Res.

Need to obtain distribution for age at release.

If condition on size at release, this is the conditional age at length!

$$p(L2|L1, \Delta t, \theta) \propto \int_a p(L2|\Delta t, a, \theta) p(a|L1, \theta) da$$

Size at release

Age at release

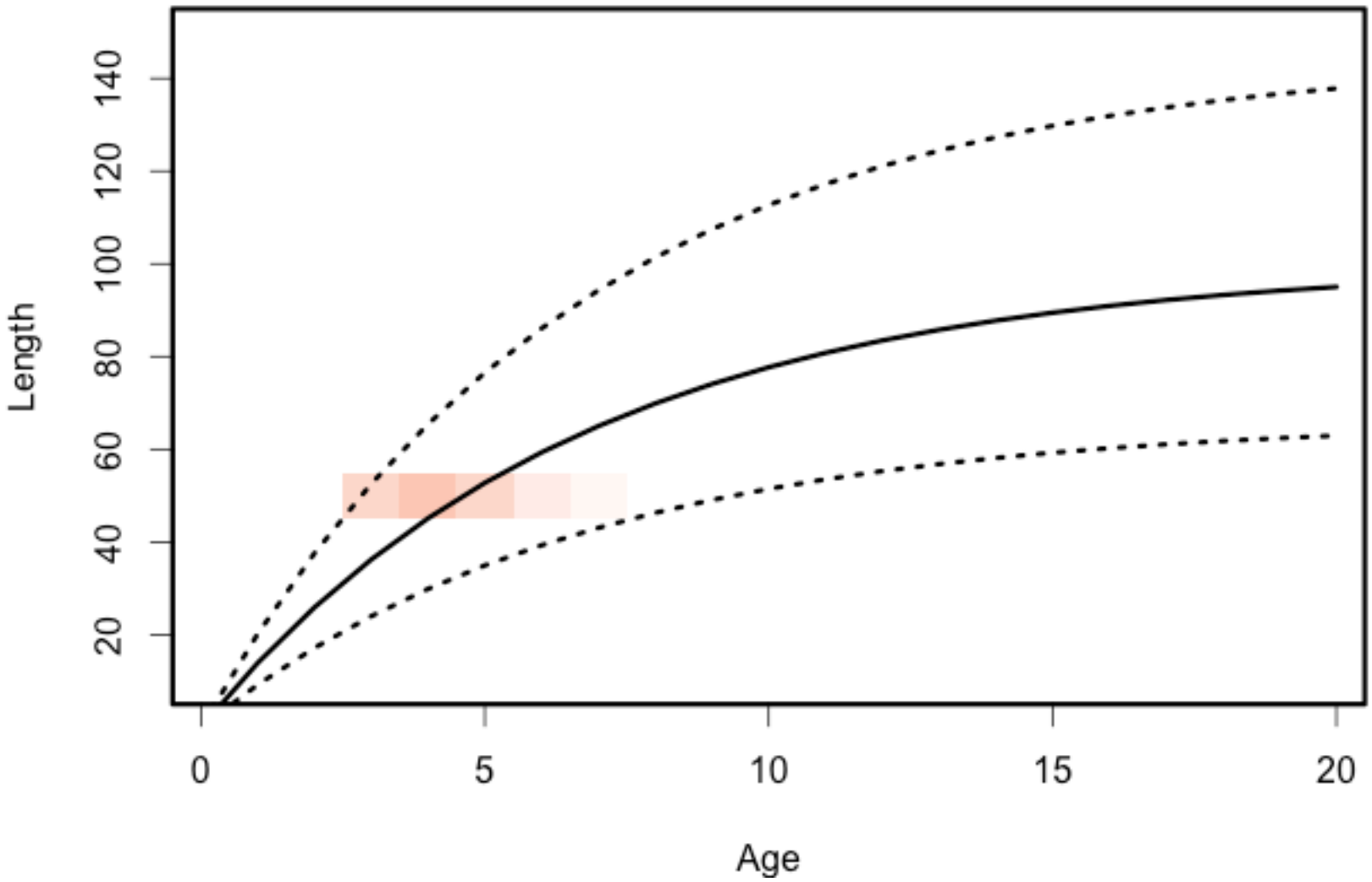
Model parameters

Size at recapture

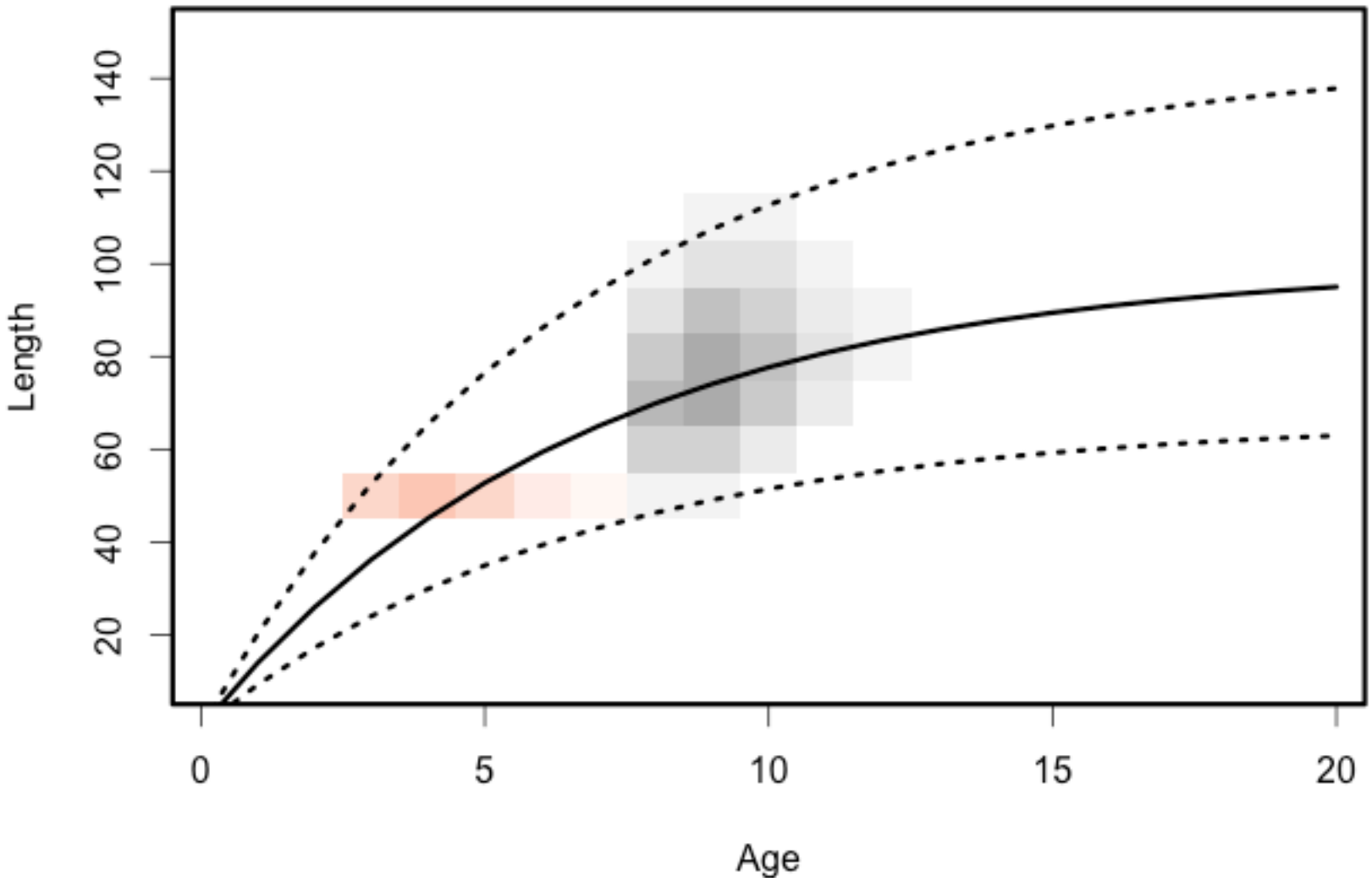
Time at liberty

Conditional age-at-length

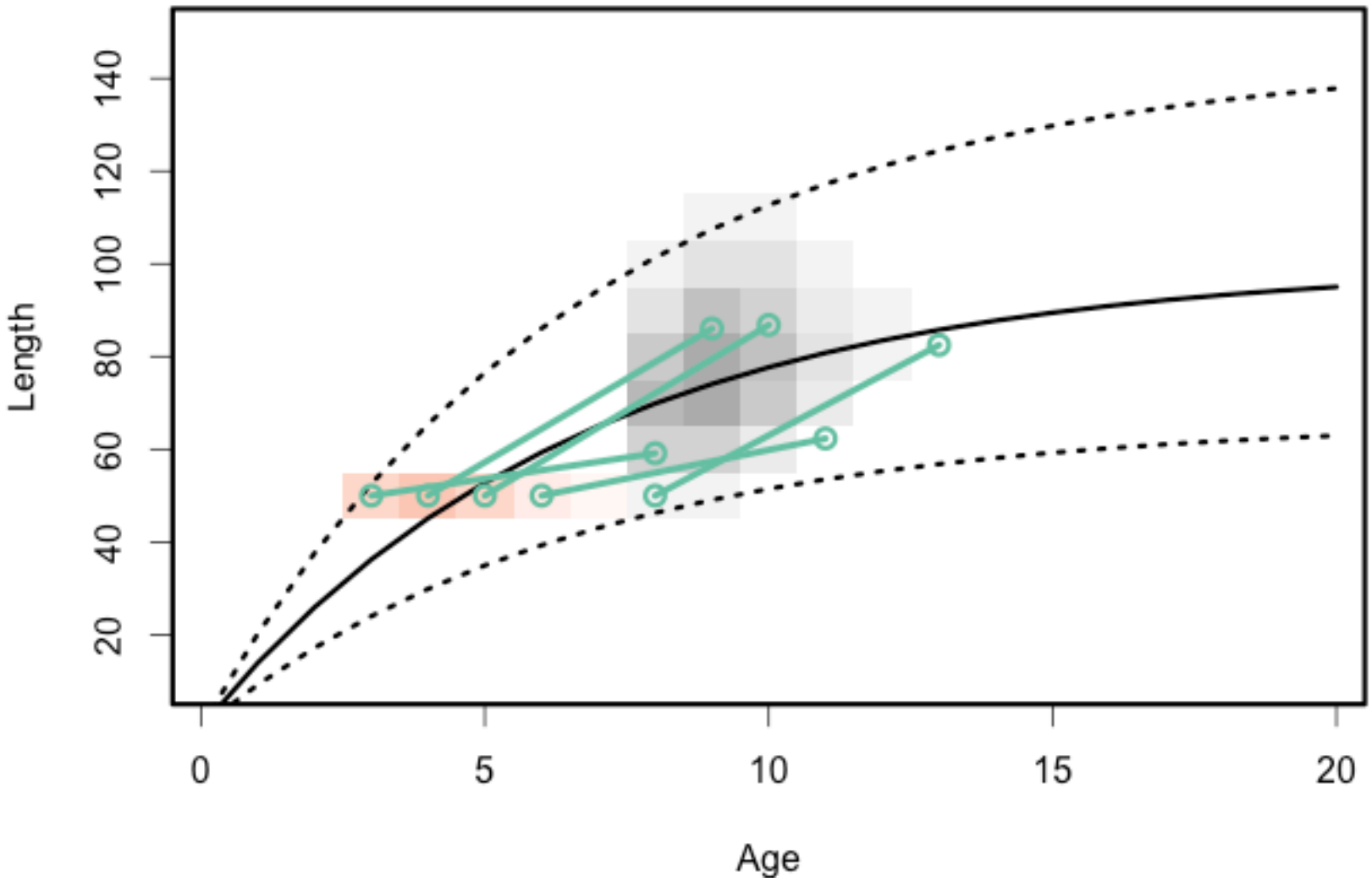
Conditional age given size at release



Predicted size distribution for recaptures



Integrate across ages to compare to observations

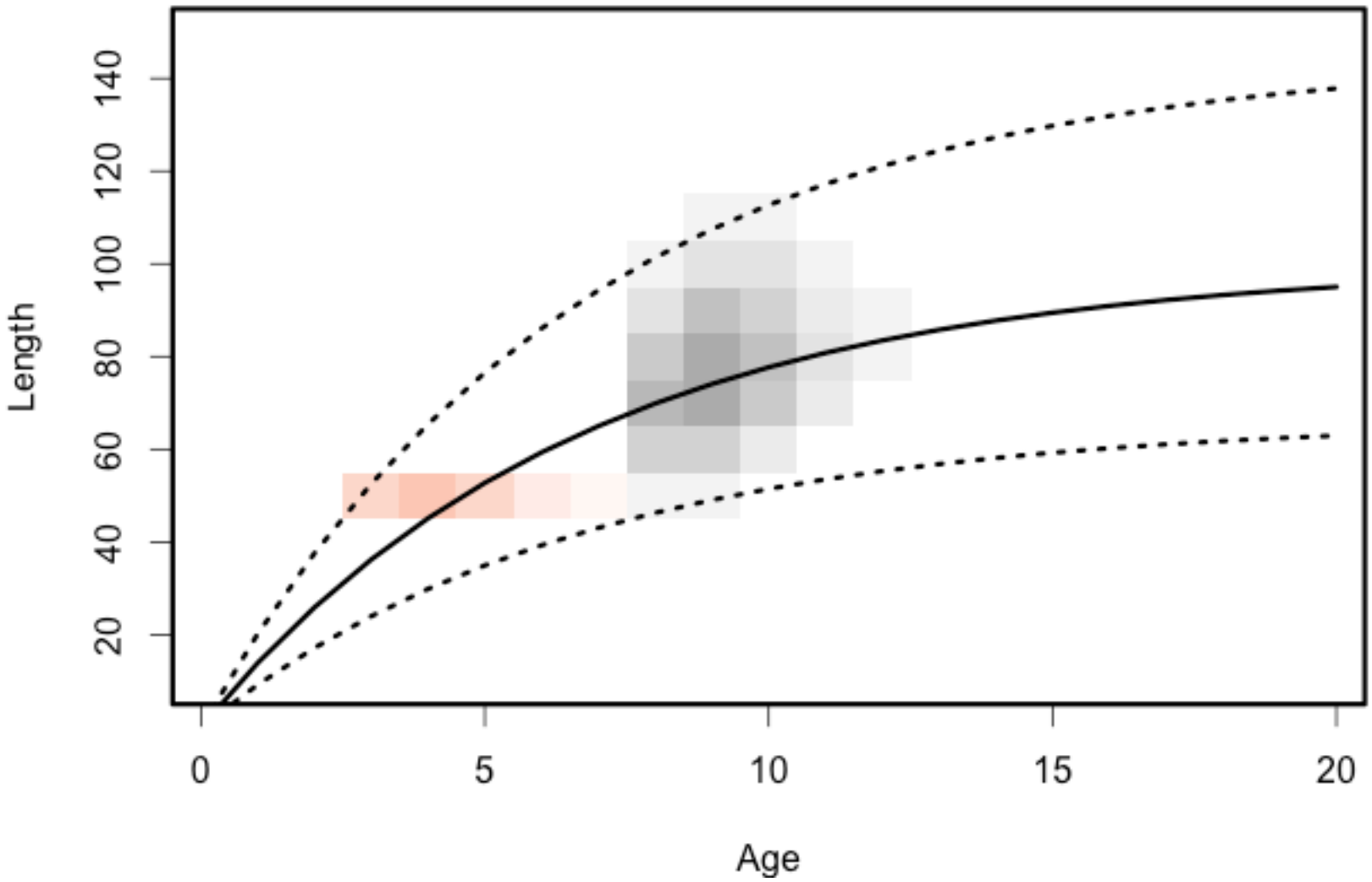


Tagging in Stock Synthesis

- Tag releases assigned to 'tag groups'
  - Collection of tags all released at same time
  - Each group assigned same age at release
- Tag recaptures by group negative binomial
  - Multinomial tag recaptures by fleet/area
  - Why not extend this to length bin?

    (e.g. MAST, Taylor et al.)

Predicted size distribution for recaptures



Modifications to Stock Synthesis

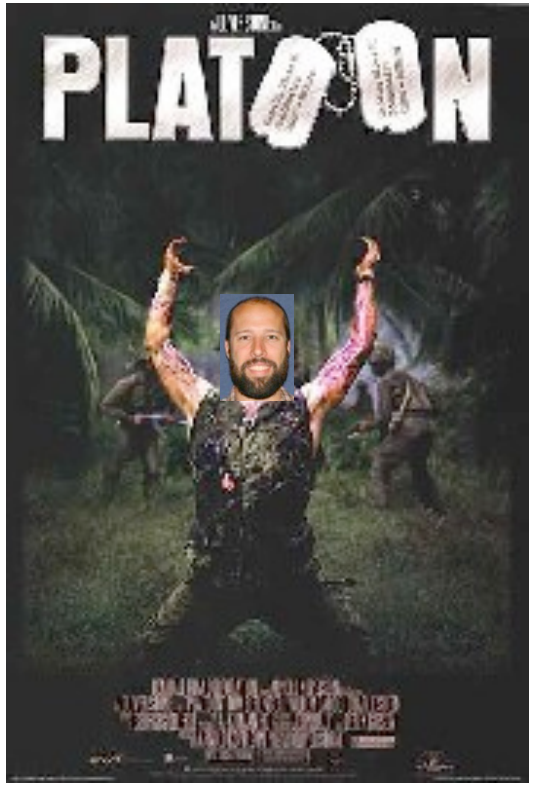
- Likelihood for LEP ‘easily’ added.
- Creates inconsistency with approach used to model tag recaptures.
- Alternative is to model tag recapture numbers by expected size, rather than adding likelihood component.
- Solution? Define tag groups as releases by length.
- Opportunity to expand on tagging module, provide full functionality to tagging parameters.

Curse of longitudinal data….

- Still no correlation between length at release and length at recapture, except for age.

Possible solutions:

- Send in the Platoons?
- Estimate covariance in deviations from mean length? (cf Laslett et al.)



Next steps

- Get this working in a simple SCAA model, step to Stock Synthesis
- Identify case studies with unique properties; what situations do we want to evaluate these data for?
- Simulation testing to understand relative performance of applying different methods.
- What do we gain from including these data?
- Can we expand this to multiple observations of size increments for a single individual?

  e.g. otolith growth chronology

Take home messages:

- Be VERY careful when doing a Google image search for “size increments”.
- Being internally consistent when treating our models and data is A Good Thing.
- Most of the machinery to include size increment data already exists.
- Still not perfect, but we’re not all Thorson.
- Worthwhile to understand when including additional types of data can be useful.

Thank you!

github.com/gavinfay/CAPAMgrowth

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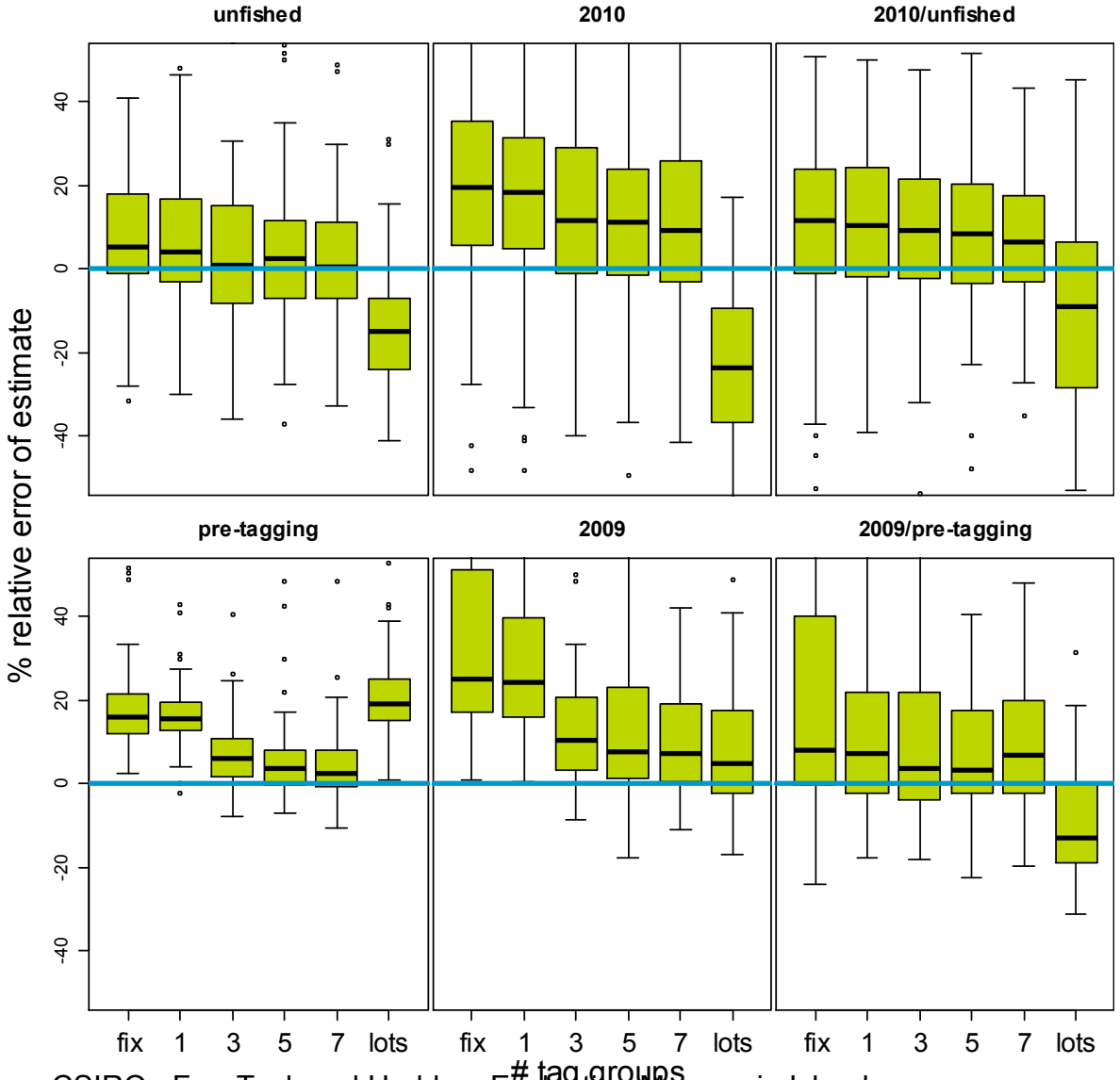
Evaluating Tagging in Stock Synthesis

How does the assignment of ages to tag releases impact the performance of the assessment model?



spawning biomass

fix: assume fixed age of releases

1, 3, 5, 7: number of tag groups

lots: ages assigned individually

trawl available biomass

CSIRO. Fay, Tuck and Haddon. Evaluating Macquarie Island Toothfish Assessment. July 2010