Evaluating the impacts of fixing or estimating growth parameters, across life histories and data availability

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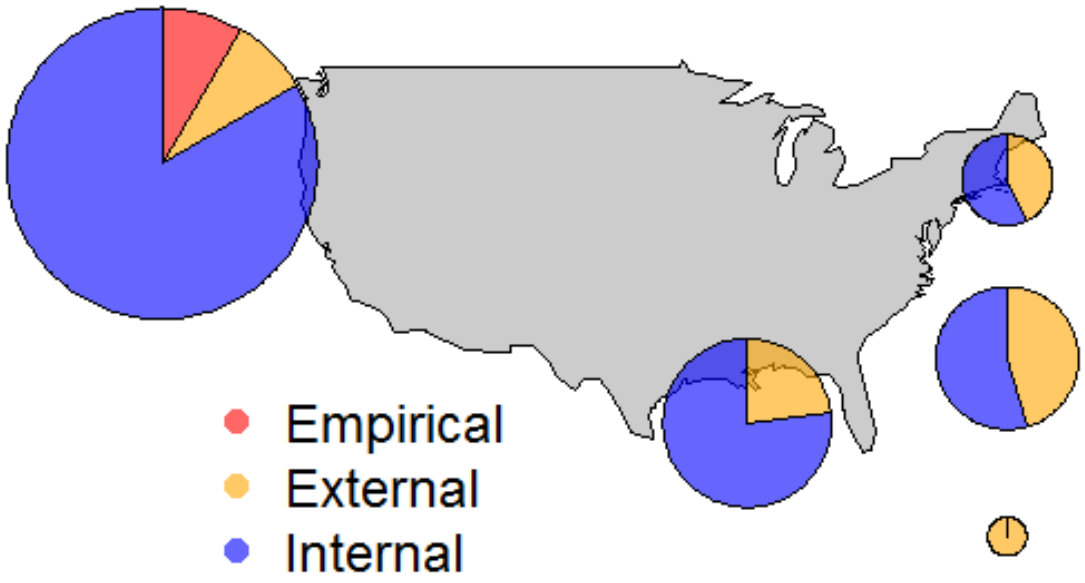
CAPAM

SFU

Treatment of growth in assessments*



* Not exhaustive, n = 58

Main questions

- What data types are informative for estimating growth inside an integrated model?
- Data quantity needed to estimate growth inside an integrated model?
- Tradeoffs between using external estimates of growth versus estimating growth inside an integrated model?
- Growth estimation across methods, data type/quantity, and life history?

`ss3sim` Developers

Sean Anderson – Simon Fraser University, PhD student; Lead developer and technical guru (sean_anderson@sfu.ca)

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Juan Valero – CAPAM, Research Scientist (jvalero@iattc.org)

WCSAM Participants contributed conceptually and technically: Curry Cunningham, Felipe Hurtado-Ferro, Roberto Licandeo, Carey McGilliard, Melissa Muradian, Cody Szuwalski, Katyana Vert-pre, Athol Whitten

`ss3sim`: Big picture

Reproducible, **flexible**, and **rapid** end-to-end simulation framework:

OM -> Data -> EM -> analysis

- all within `R`, using SS3 for both models

- Designed to programmatically induce structural differences to SS3 models (control, data, starter files)
- Useful for testing: model performance, model misspecification, value of data, etc.

ss3sim work

Publications

Anderson, S., C. Monnahan, K. Johnson, K. Ono, J. Valero. 2014. ss3sim: An **R package** for fisheries stock assessment simulation with Stock Synthesis. PLoS One.

Ono, K., R. Licandeo, M. Muradian, C. Cunningham, S. Anderson, F. Hurtado-Ferro, K. Johnson, C. McGilliard, C. Monnahan, C. Szuwalski, J. Valero, K. Vert-pre, A. Whitten, A. Punt. 2014. The importance of **length and age composition data** in statistical age-structured models for marine species. ICES JMS.

Johnson, K., C. Monnahan, C. McGilliard, K. Vert-pre, S. Anderson, C. Cunningham, F. Hurtado-Ferro, R. Licandeo, M. Muradian, K. Ono, C. Szuwalski, J. Valero, A. Whitten, A. Punt. 2014 Time-varying **natural mortality** in fisheries stock assessment models: Identifying a default approach. ICES JMS.

Hurtado-Ferro, F., C. Szuwalski, J. Valero, S. Anderson, C. Cunningham, K. Johnson, R. Licandeo, C. McGilliard, C. Monnahan, M. Muradian, K. Ono, K. Vert-pre, A. Whitten. *In Press*. Looking in the rear-view mirror: reflections on **bias and retrospective** patterns from a fisheries stock assessment simulation study. ICES JMS.

Upcoming presentations

Valero, J., K. Johnson, C. Stawitz, R. Licandeo, S. Anderson, A. Hicks, F. Hurtado-Ferro, P. Kuriyama, C. Monnahan, K. Ono, I. Taylor, M. Rudd. Evaluating the impacts of fixing or **estimating growth** parameters, across life histories and data availability.

Monnahan, C., S. Anderson, F. Hurtado-Ferro, K. Ono, M. Rudd, J. Valero, K. Johnson, R. Licandeo, C. Stawitz, A. Hicks, I. Taylor. An evaluation of alternative **binning approaches** for composition data in integrated stock assessments.

Kuriyama, P., A. Hicks, K. Johnson, I. Taylor, S. Anderson, F. Hurtado-Ferro, R. Licandeo, C. Monnahan, K. Ono, M. Rudd, C. Stawitz, J. Valero. An investigation of using **empirical weight-at-age** instead of modeling parametric growth in statistical age-structured population models

`ss3sim`: Package details

Software

- Open source, cross platform (Windows, OS X, Linux).
- Requires: SS3.24O, `R` >= 3.0.0, `r4ss`

Availability

- CRAN (http://cran.r-project.org/package=ss3sim)
- Development version (www.github.com/ss3sim/ss3sim)

Contents

- SS3 models, modified for simulation with `ss3sim`
- `R` functions for modifying models, running simulations, and extracting/plotting results

Data scenarios

- 0. Length composition and age compositions
- 1. Only length composition
- 2. Length composition and conditional age at length
- 3. Length composition, age composition and conditional age at length

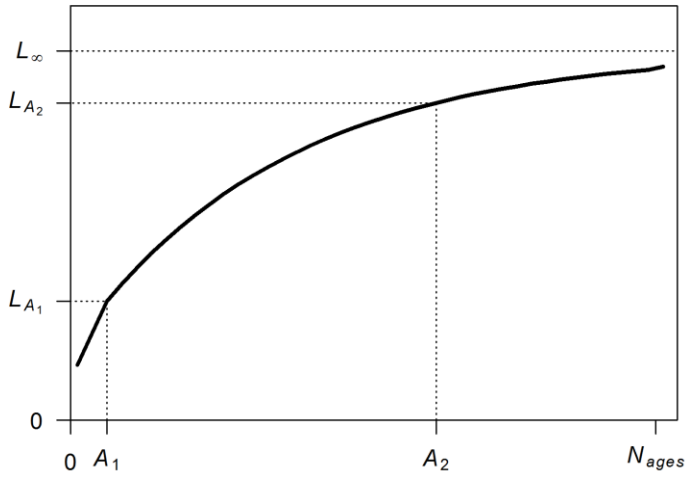
Sampling Design

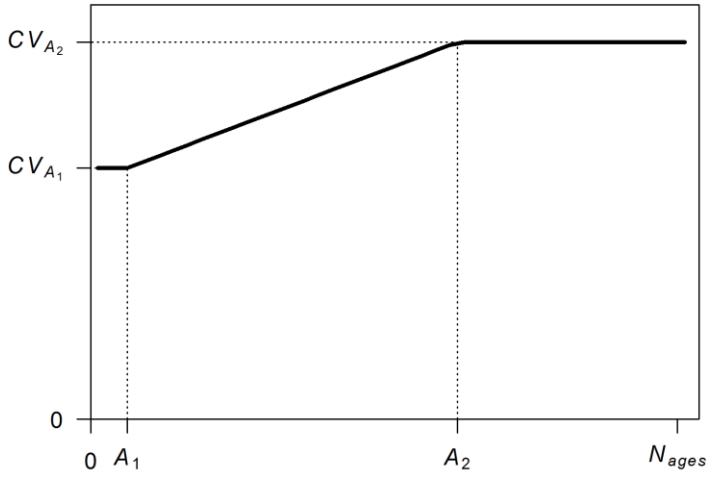
- Length comps and age comps sampled as multinomial (although overdispersion is an option)
- Mean length at age
  - Fishery
  - Fraction of samples by age based on observed age composition
  - Used in external estimation of growth

Experimental Design

Biological assumptions

- Life history: cod-like (North Sea cod).
- Natural mortality fixed at truth
- BH SR function w/ *h* fixed at truth, R_0 estimated.
- Weight/length and maturity fixed at truth
- VBK growth in OM and EM



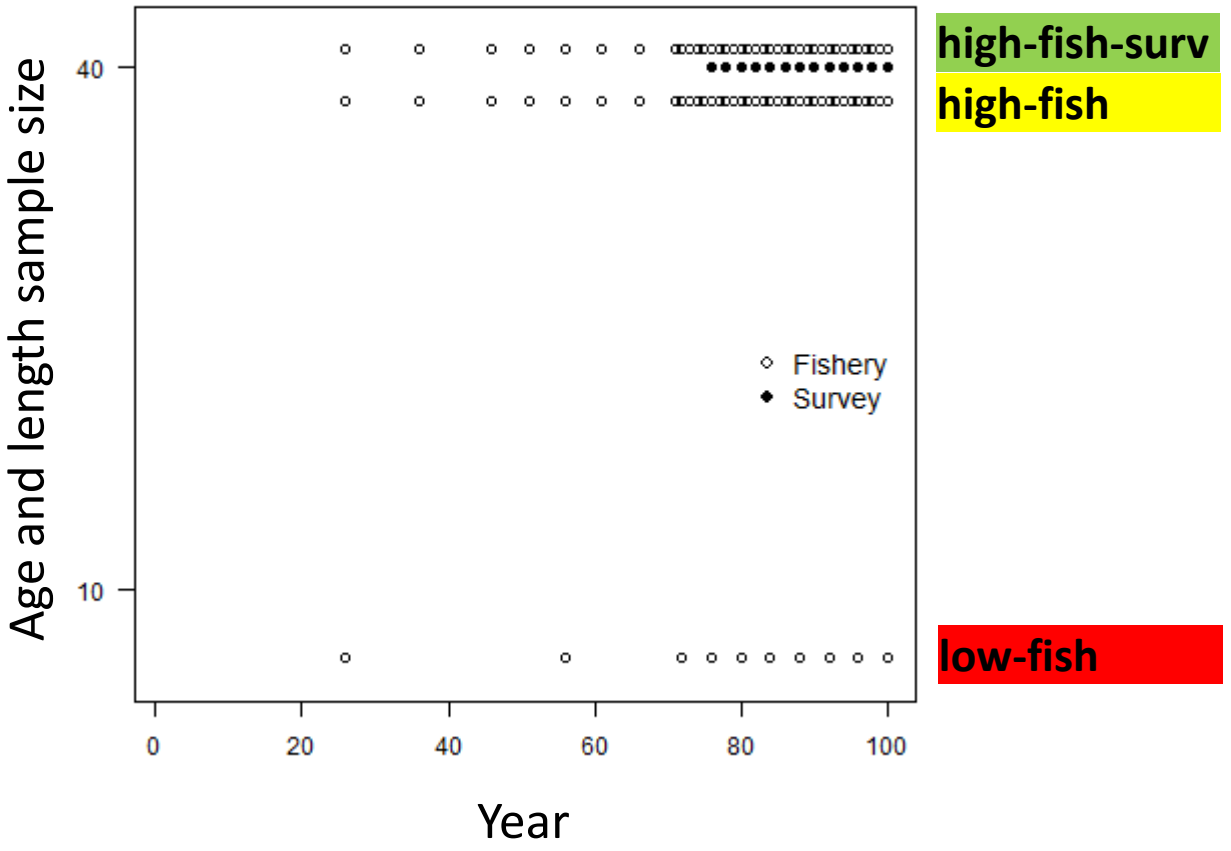


Experimental Design

Fishery and survey assumptions

- 1 fishery starting in year 25, with two fishing patterns (constant and two-way trip); 1 survey after year 75
- Catchability coefficients constant + estimated
- No ageing error (for now)
- Process error through recruitment
- OM Selectivities
  - Size, Time-invariant Asymptotic (Survey, Fishery)
  - Size, Time-invariant Asymptotic (Survey) and Dome (Fishery)
- EM Selectivities
  - Size, Time-invariant Asymptotic (Survey, Fishery)

Sample intensity and sizes for Age, Lengths



Growth estimation scenarios

- 5-parameter VBGF with K, Lyoung, Lold and CV for young and old
- estimated or fixed based on 4 scenarios:

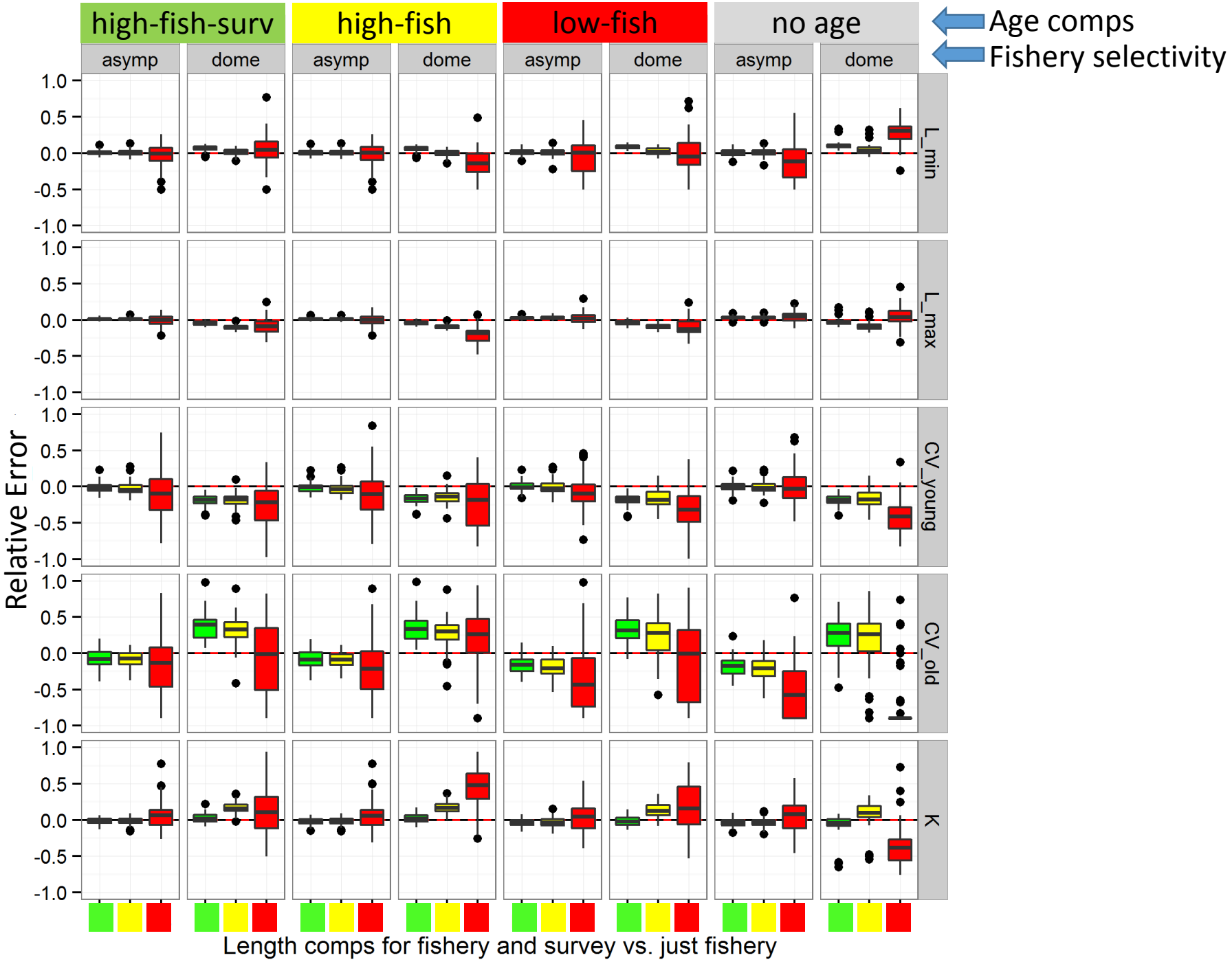
Internal: Lyoung, Lold, K and CVs estimated internally

External: Lyoung, Lold, K and CVs fixed at external estimates

Ext_CV: Lyoung, Lold and K estimated internally and CVs fixed at external estimates

Ext_LK: Lyoung, Lold and K fixed at external estimates and CVs estimated internally

Some Preliminary Results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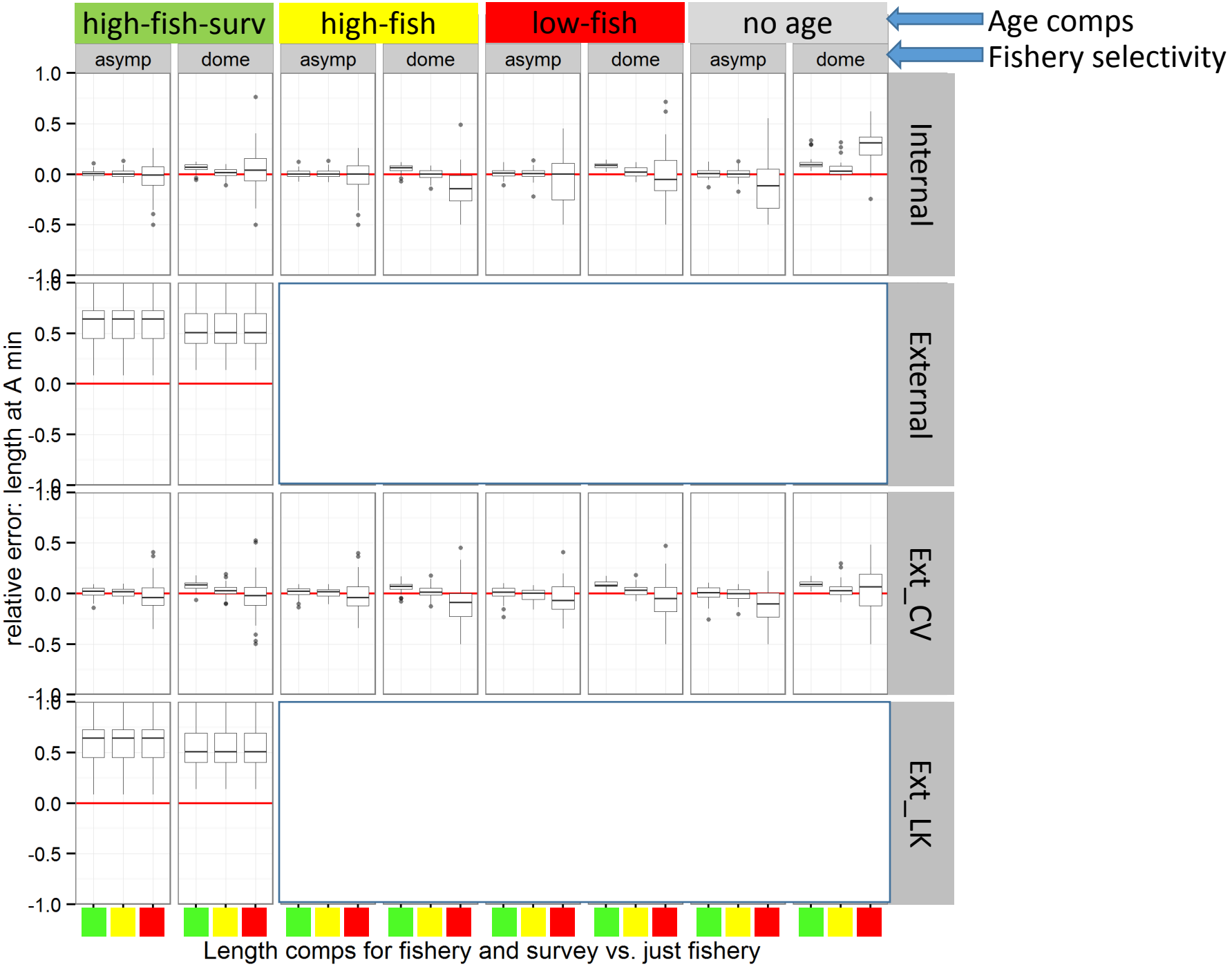
Length comps for fishery and survey vs. just fishery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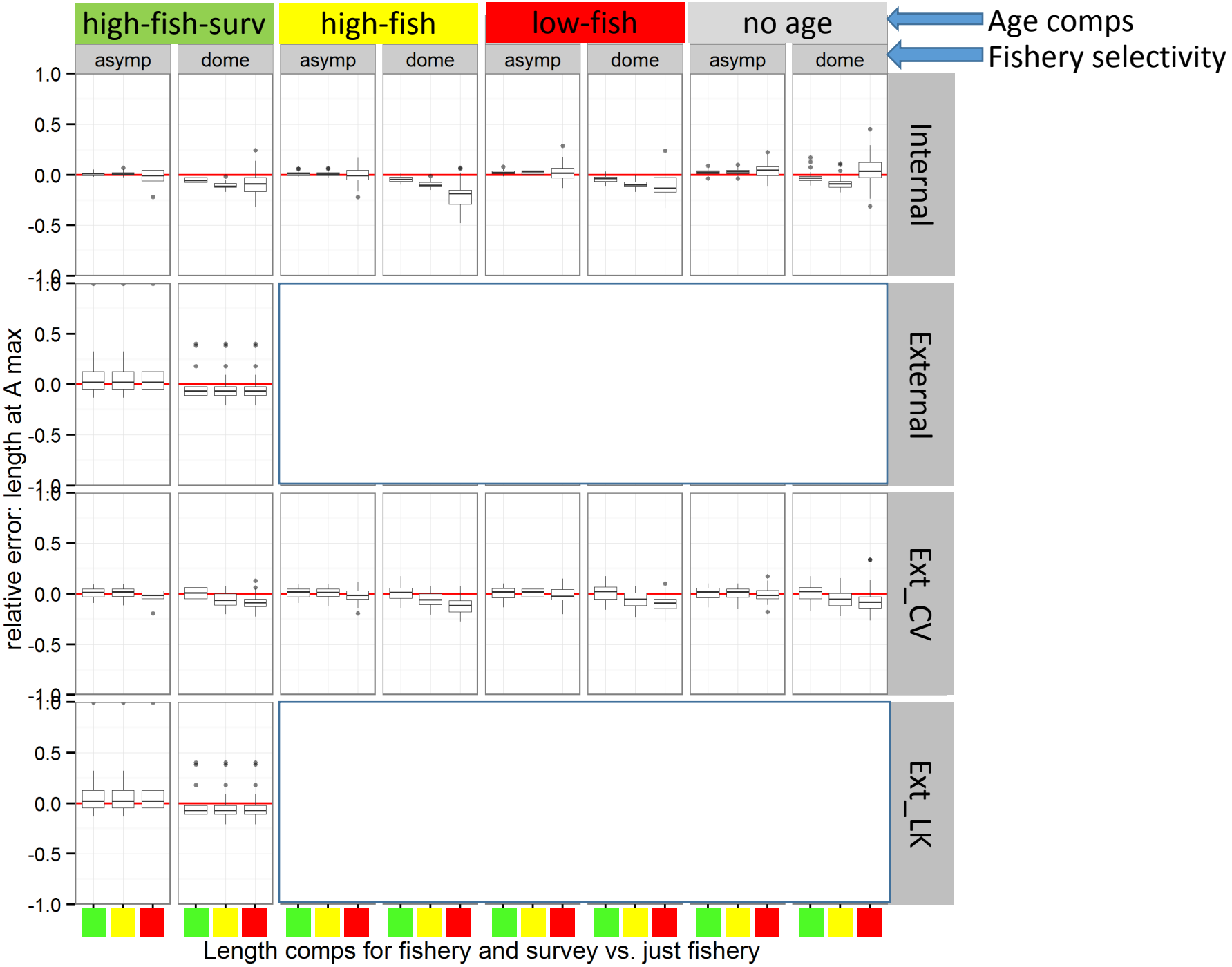
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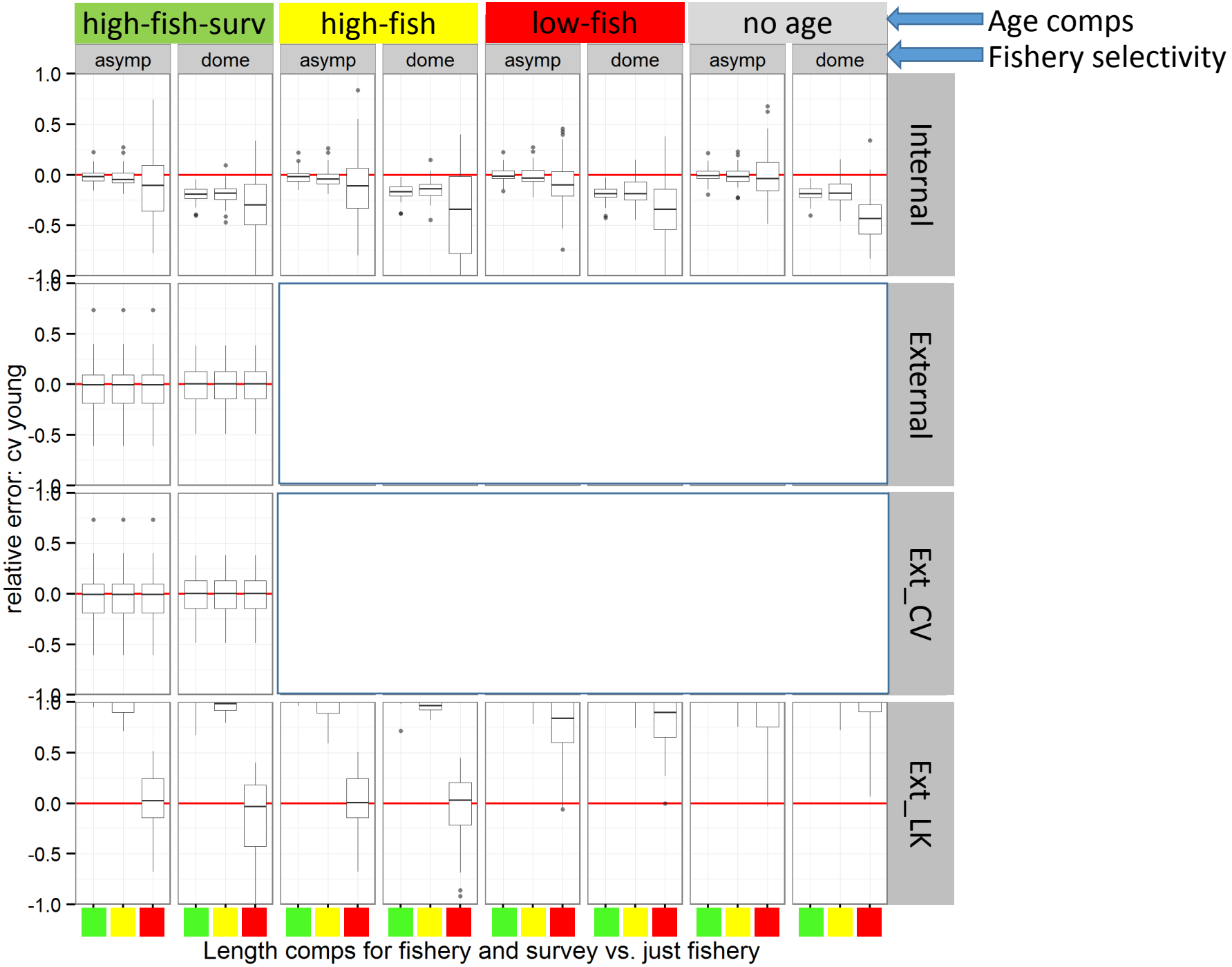
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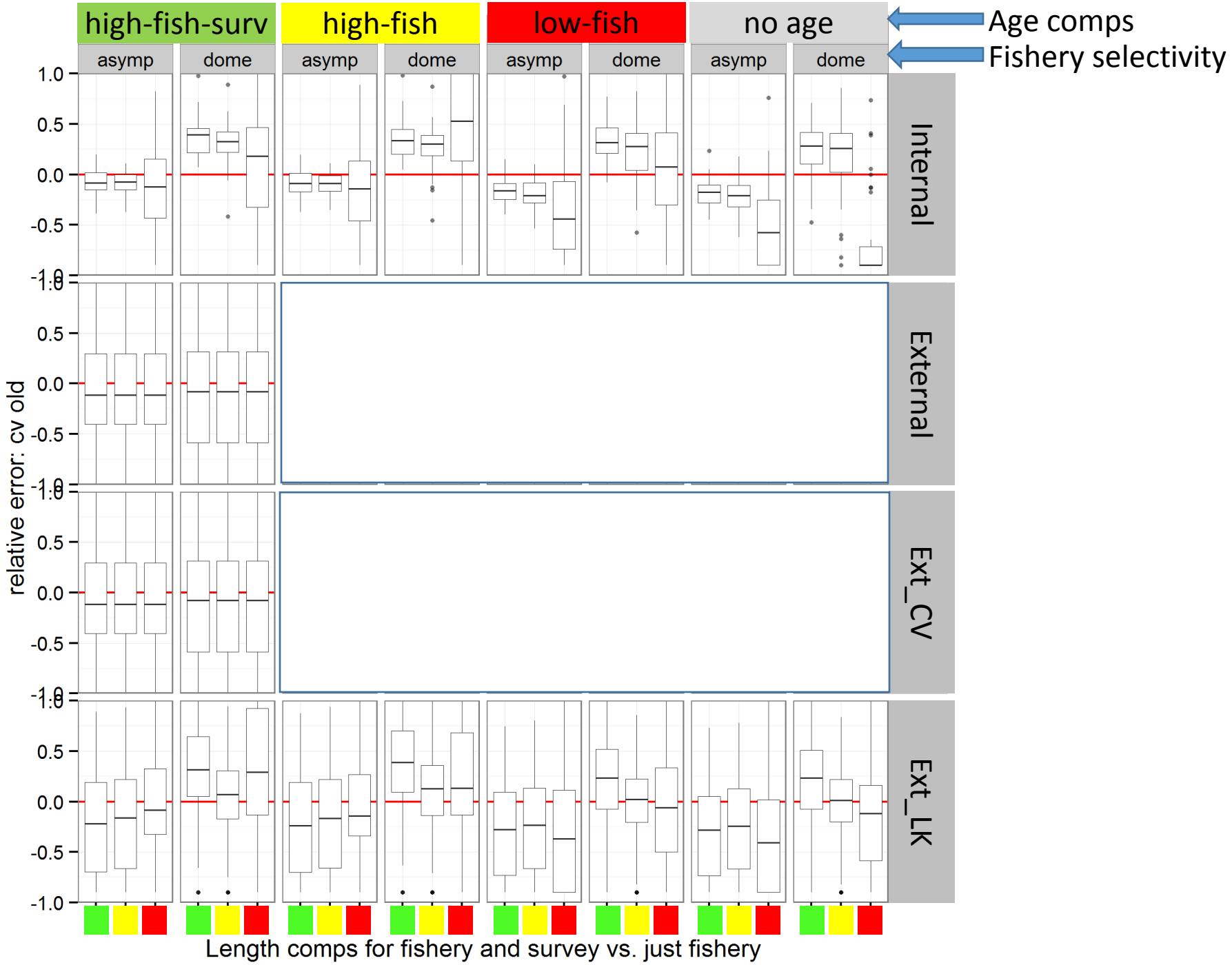
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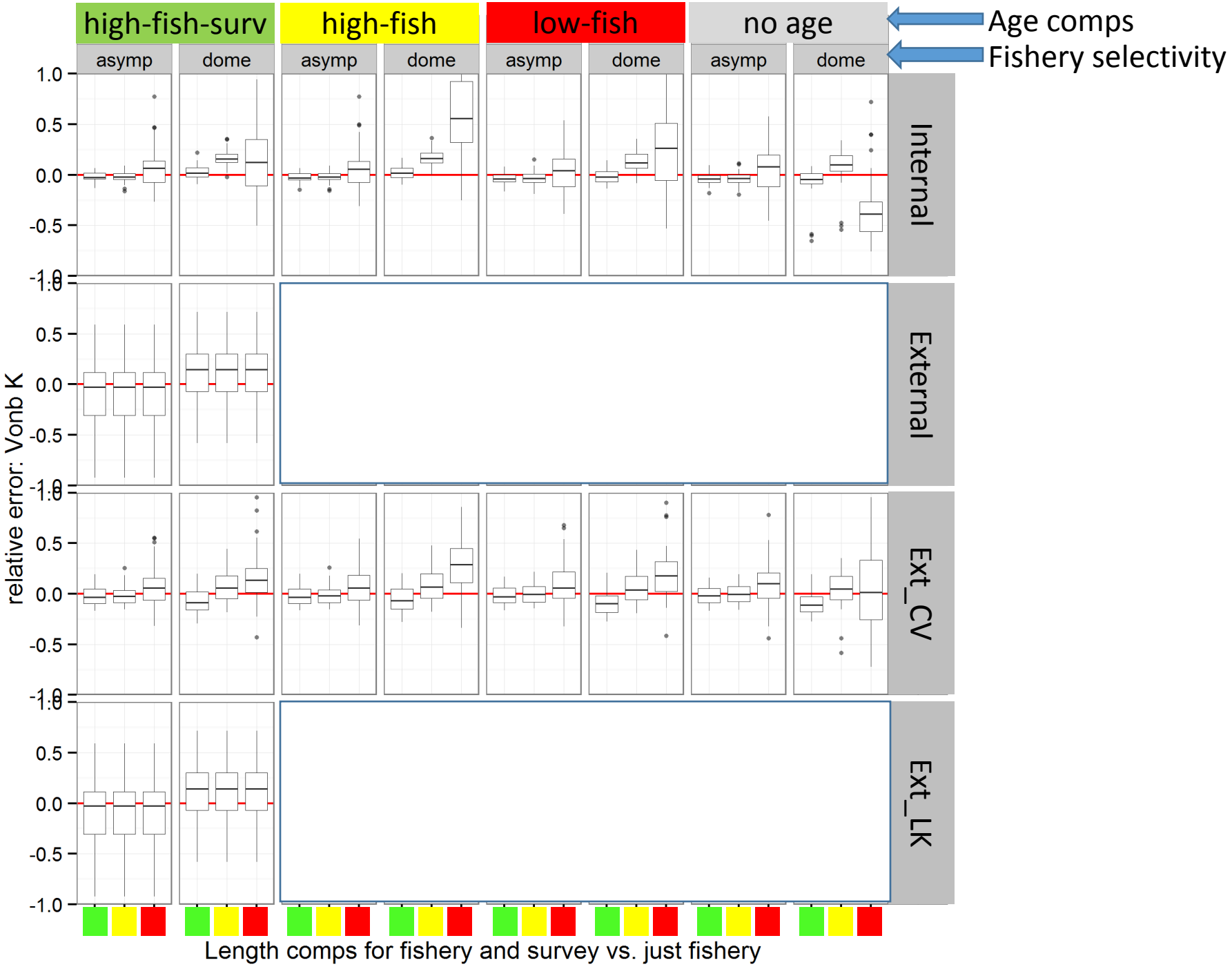
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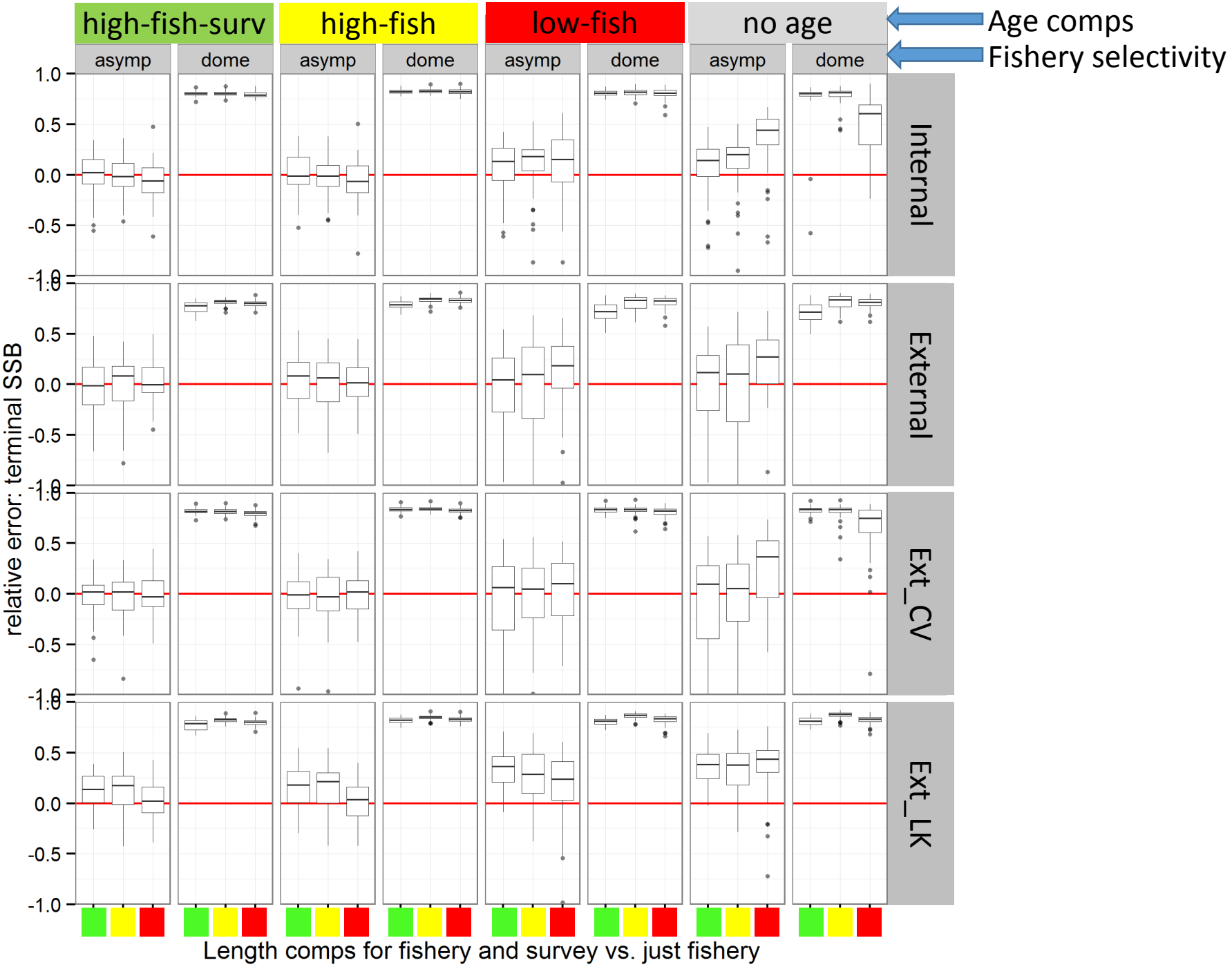
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Length comps for fishery and survey vs. just fishery

Summary of results

*Selectivity misspecification

*Positive bias in LAmin and K in external estimator

*Fewer length data results in biased internal estimates of growth, particularly with no age data

*External estimates perform comparably to internal estimates with poor data and selectivity misspecification

Future research

Incorporate Conditional Age-at-Length

Incorporate alternatives to the data used externally

Expand analyses to 3 life histories

1. Short-lived, fast-growing small pelagic (P. mackerel)
2. Long-lived, slow-growing (Rockfish)
3. Medium-lived, moderate-growing type (P. hake)