Spatial Simulation Experiment: SPASAM Application

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Spatial Processes And Stock Assessment Models (SPASAM)

- Developed in ~2016 as a generic simulation/estimation tool
- Capable of multiple OM/EM structures: panmictic, heterogeneity, metapopulation, and natal homing
- Age-based, assumes annual time step, and instantaneous Markovian movement among areas
- EM can fit to tagging data and the usual suite of inputs (e.g., catch, age composition, indices of abundance)
- Written in ADMB, but may move to TMB/R with added MSE capacity (our group is actively seeking a post-doc)
- Never used for an “actual” stock assessment and a relatively small group of users

SPASAM Projects

- Biological Reference Points (BRPs)
  - Impacts of population structure and movement on BRPs (1), spatial quota allocation approaches (2)
- Assessment Performance
  - Detriments of misdiagnosing movement/population structure (3), influence of tagging data on estimation (4), robust movement parametrizations (5)
- Management Implications
  - Effects of misaligning biological, assessment, and management boundaries (6)


ARTICLE

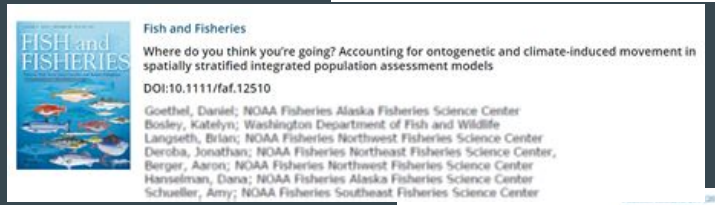
Accounting for spatial complexities in the calculation of biological reference points: effects of misdiagnosing population structure for stock status indicators[1]

Daniel R. Goethel and Aaron M. Berger


Fisheries Research

Overcoming challenges of harvest quota allocation in spatially structured populations

Katelyn M. Bosley, Daniel R. Goethel, Aaron M. Berger, Jonathan J. Deroba, Kari H. Fenske, Dana H. Hanselman, Brian J. Langseth, Amy M. Schueller


Fish and Fisheries

Where do you think you're going? Accounting for ontogenetic and climate-induced movement in spatially stratified integrated population assessment models

DOI:10.1111/faf.12510

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Berger, Aaron; NOAA Fisheries Northwest Fisheries Science Center
Hanselman, Dana; NOAA Fisheries Alaska Fisheries Science Center
Schueller, Amy; NOAA Fisheries Southeast Fisheries Science Center


Fisheries Research

Exploring the utility of different tag-recovery experimental designs for use in spatially explicit, tag-integrated stock assessment models

Daniel R. Goethel, Katelyn M. Bosley, Dana H. Hanselman, Aaron M. Berger, Jonathan J. Deroba, Brian J. Langseth, Amy M. Schueller

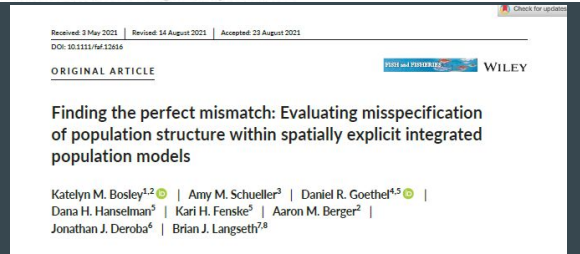

ICES Journal of Marine Science

ICES CIEM

Original Article

Incoherent dimensionality in fisheries management: consequences of misaligned stock assessment and population boundaries

Aaron M. Berger, Jonathan J. Deroba, Katelyn M. Bosley, Daniel R. Goethel, Brian J. Langseth, Amy M. Schueller, and Dana H. Hanselman


Received: 3 May 2021 | Revised: 14 August 2021 | Accepted: 23 August 2021

DOI: 10.1111/faf.12616

ORIGINAL ARTICLE

WILEY

Finding the perfect mismatch: Evaluating misspecification of population structure within spatially explicit integrated population models

Katelyn M. Bosley | Amy M. Schueller | Daniel R. Goethel | Dana H. Hanselman | Kari H. Fenske | Aaron M. Berger | Jonathan J. Deroba | Brian J. Langseth

SPASAM: Application to Yellowfin Tuna

- We added a lot of new features and corrected some old errors
  - Allow fleets to have different selectivities
  - Corrected an error in the double logistic selectivity function
  - Allow survey selectivity to mirror a fleet
  - Corrected some likelihood penalties
  - Develop more generic diagnostic (e.g., residuals) code
- Huge time suck
- Did not leave time for extensive data exploration or alternative model explorations

SPASAM: Application to Yellowfin Tuna - 1 area model

- Start “simple”
  - 1 area, 7 fleets
  - no tagging data
  - no accounting of spatial structure
  - 256 pseudo-years, at least to start
  - 28 pseudo-ages
- Age comp calculated using the age-length key provided and SD of length|age = 0.1
- Life-history at age fixed at true values provided in Table A1
  - https://aaronmberger-nwfsc.github.io/Spatial-Assessment-Modeling-Workshop/articles/OM_description_YFT.html

SPASAM: Application to Yellowfin Tuna - 1 area model

- Longline selectivity was logistic and all others double logistic, at least to start
- Single catchability for longline CPUE, with mirrored selectivity
- Recruitment deviations estimated using a penalty from an underlying Bev-Holt with SD = 0.6 (steepness fixed at true value)
- Fully-selected F parameter estimated for each fleet and pseudo-year
- Abundance-at-age estimated in pseudo-year 1, except recruitment which equaled R0
- 1,266 parameters (I think)
- SE of catches = 0.01 for all fleets and pseudo-years, at least to start
- SE of survey = 0.2 in all pseudo-years
- ESS = 5 for all fleets and pseudo-years, at least to start

SPASAM: Application to Yellowfin Tuna - 1 area model

- Initially, long run-times were prohibitive even without a hessian matrix (3.5 hours at best, 20 hours at worst), and gradients and diagnostics were terrible
- Ran in circles for a bit playing with phases, starting values, and penalties aimed at improving speed and stability
- Ultimately reduced the size of the data and subsequent parameters and run-time
    - Deleted the first 105 pseudo-years because most fleets have 0 catch before then, and had odd F estimates for some fleets
    - Moved to 4 fleets from 7 by combining PS, troll, and other, and gill-net with handline; based on similar selectivities of preliminary fits

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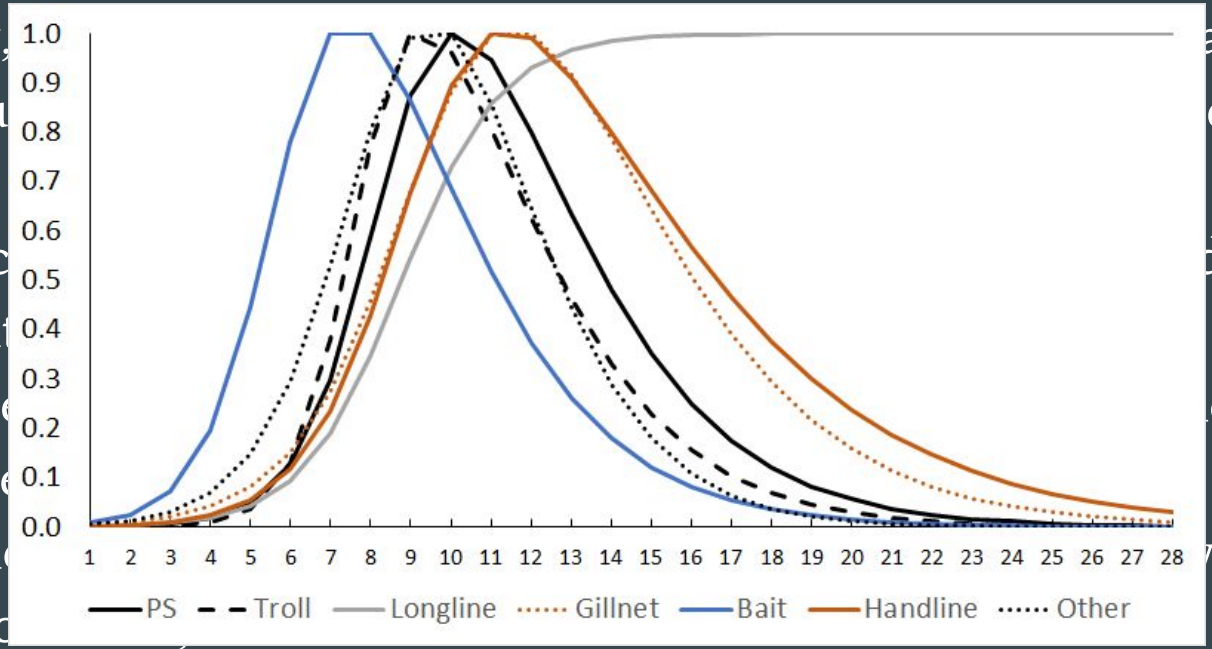
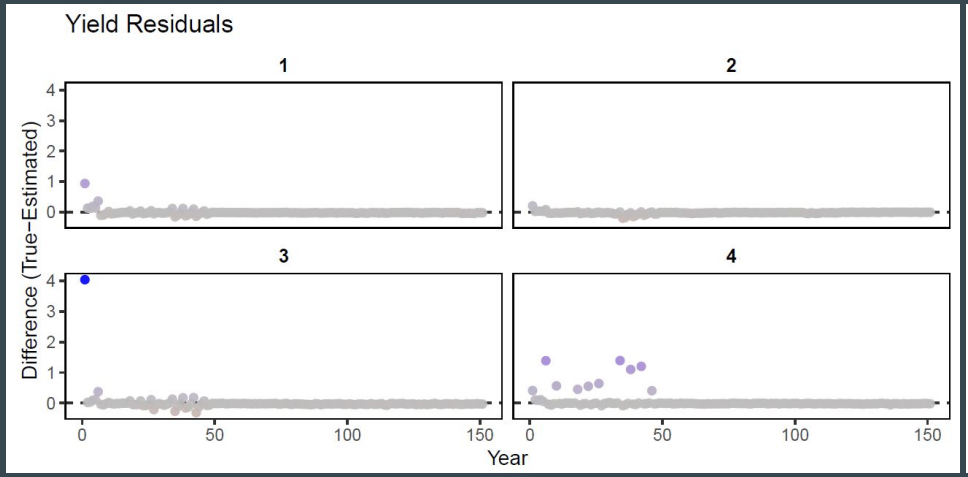
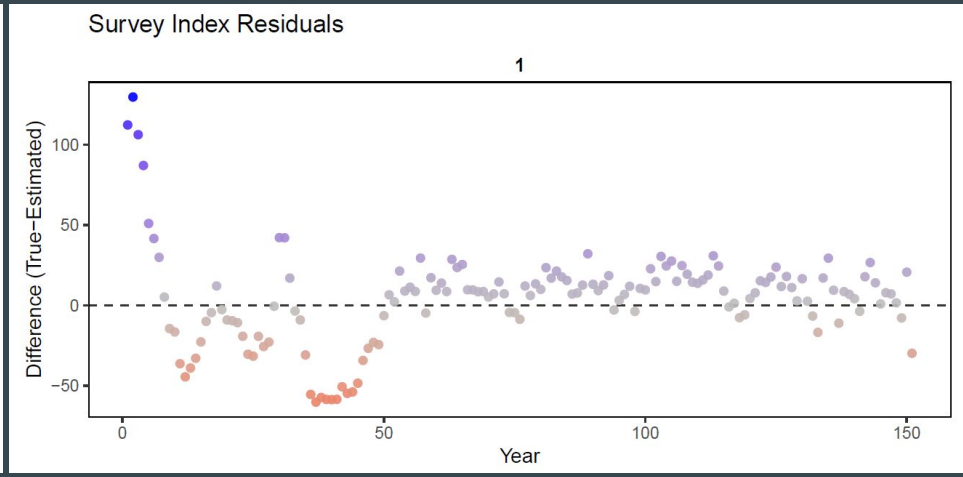


SPASAM: Application to Yellowfin Tuna - 1 area model

- Data reductions and some phase changes helped (run-times ~1 hour), but fit to the index was poor, we were overfitting catch, and odd F & selectivity estimates





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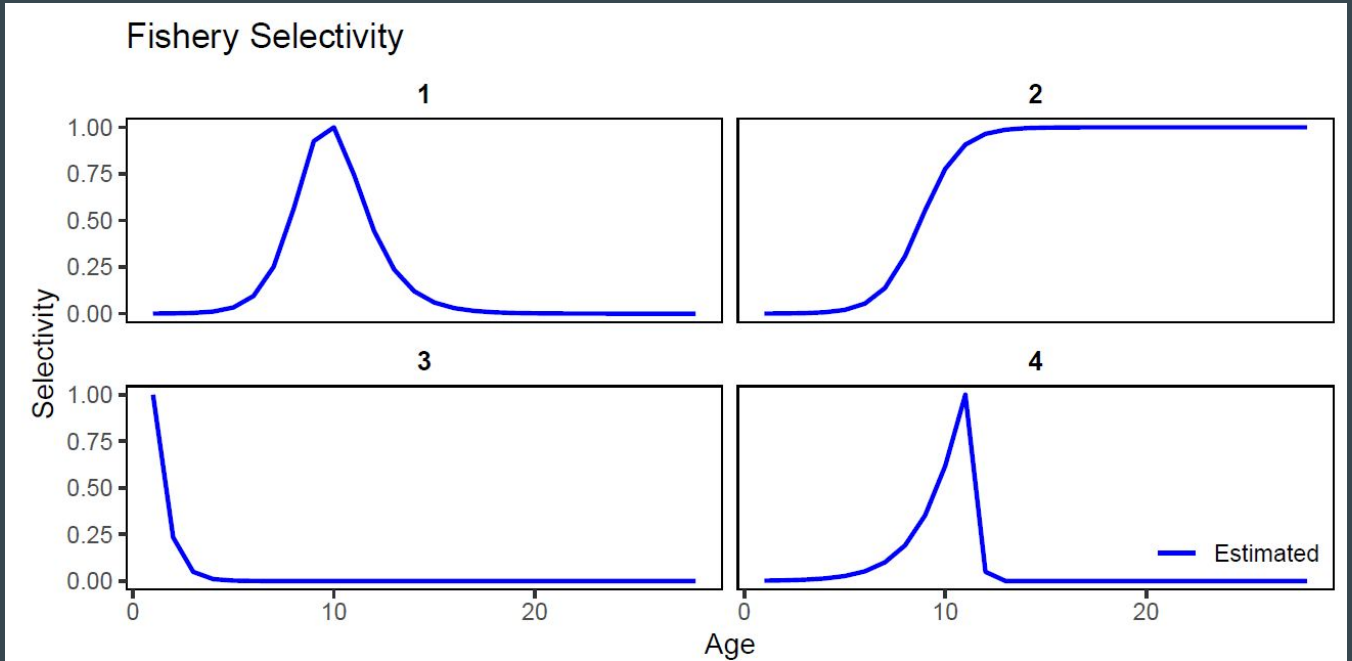

SPASAM: Ap…odel

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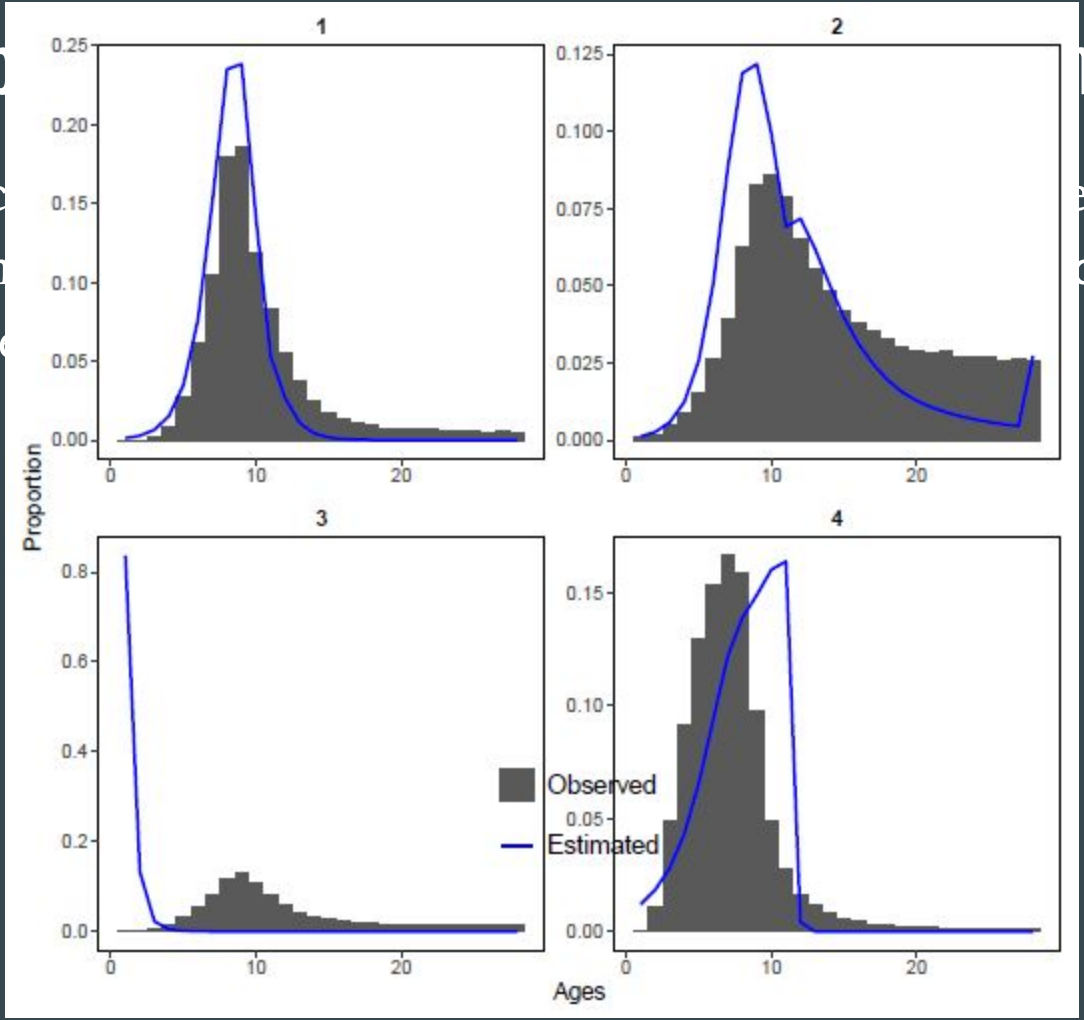
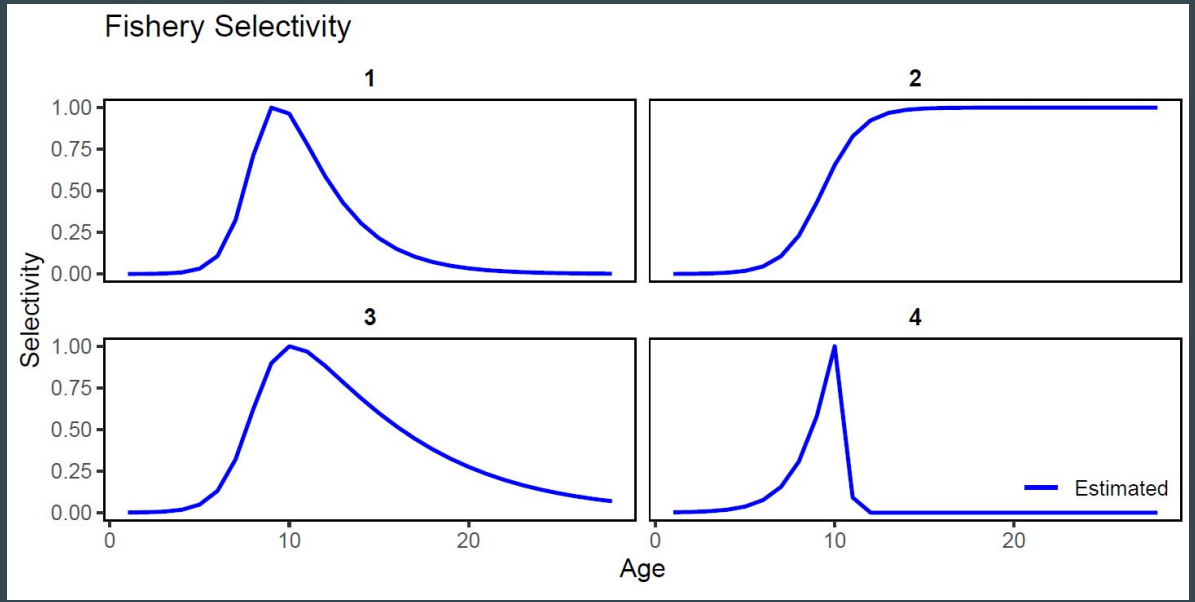


SPASAM: Application to Yellowfin Tuna - 1 area model

- Started playing with data weighting
- Increased catch SE from 0.01 to 0.2 for all fleets and years: improved the gradient (0.0001), fit, and some of the selectivity/F oddities



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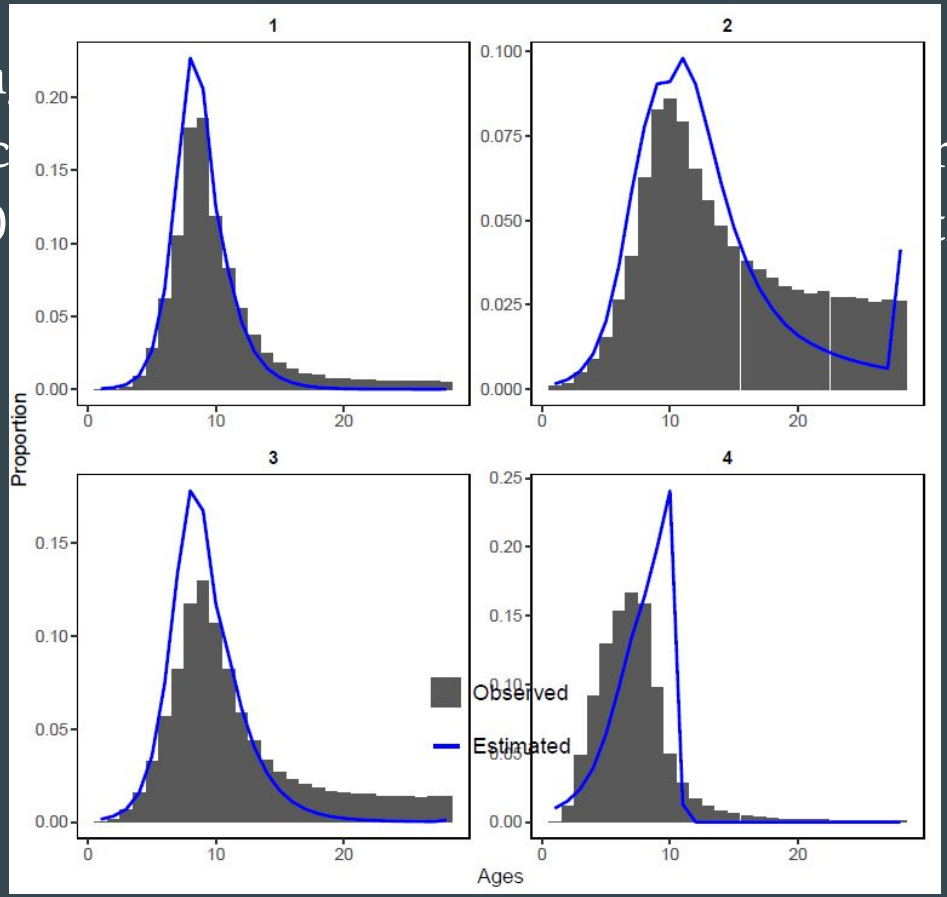
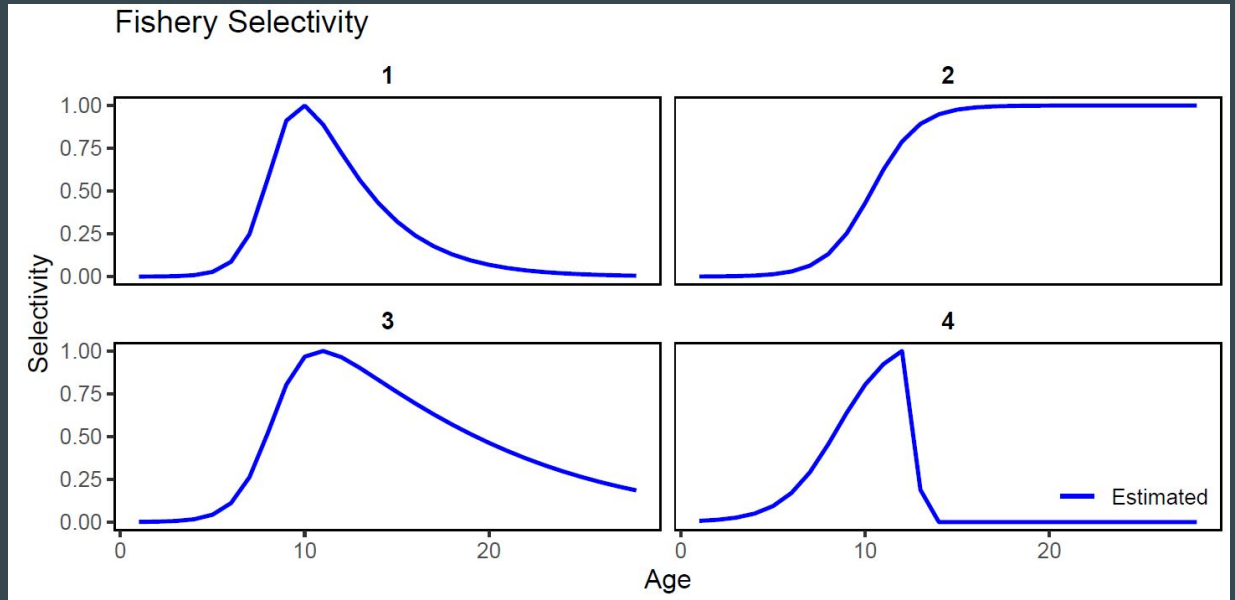


SPASAM: Application to Yellowfin Tuna - 1 area model

- Ran in circles a bit playing with data weighting aimed at getting a better fit to comps and the index
- Increase ESS for all fleets and years from 5 to 15, except fleet 4 (handline and gillnet) which equaled 25



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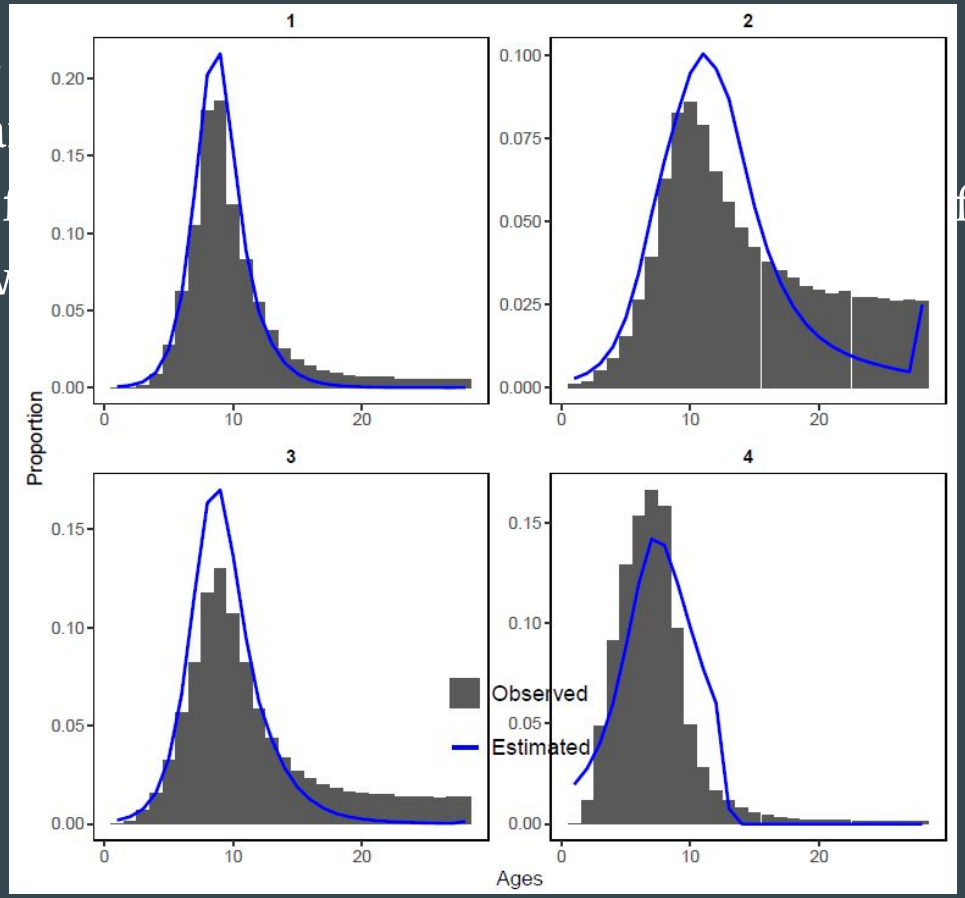

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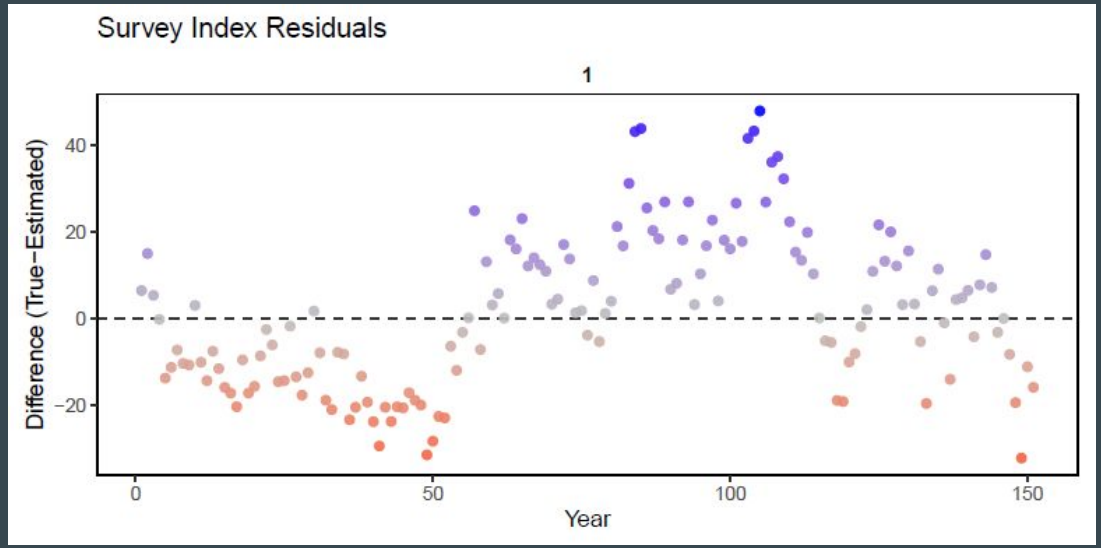
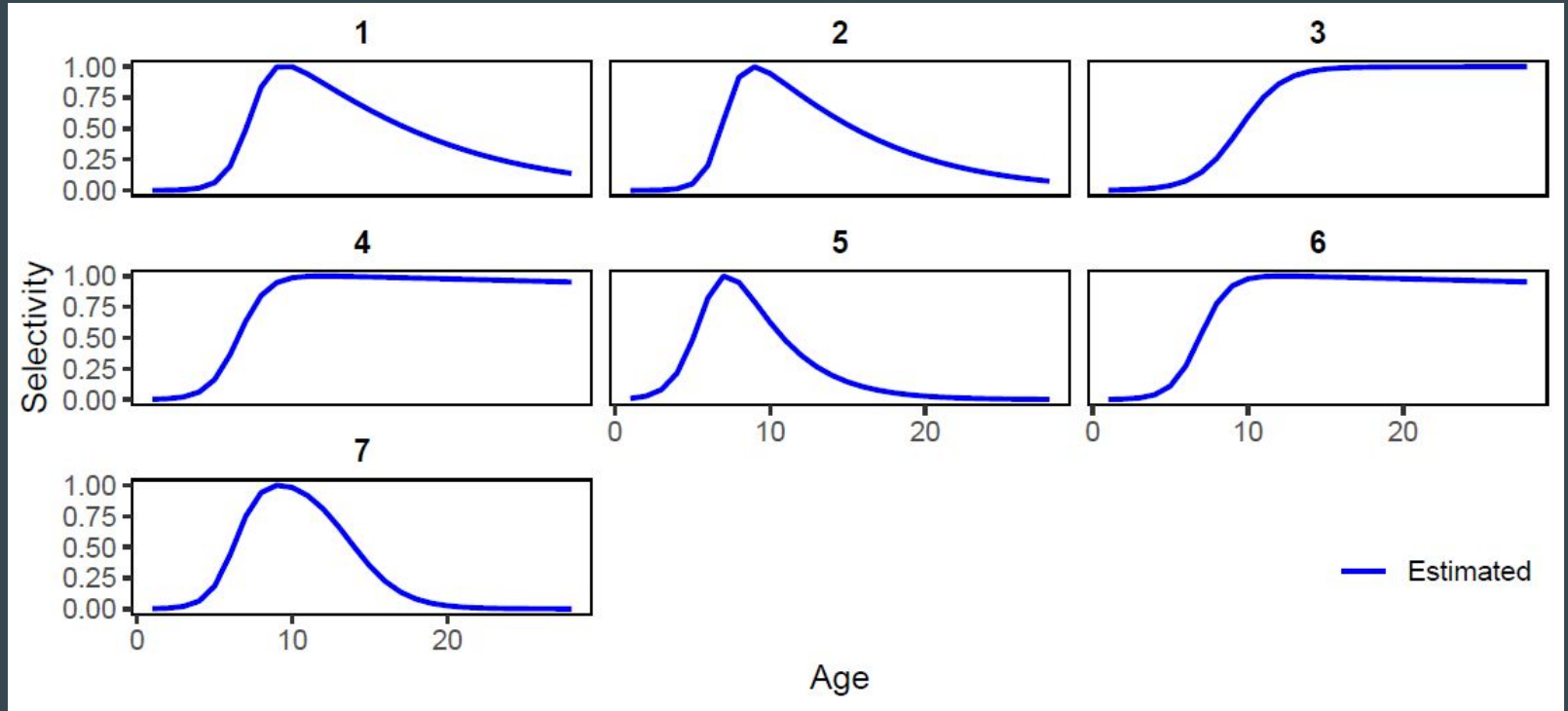


SPASAM: Application to Yellowfin Tuna - 1 area model

- That garbage fit was the best we could do for a time
- Fit to the 100 datasets and ~half had terrible gradients and were trash
- Led us to a jitter analysis and the model was clearly unstable
- On a whim, we tried a 7 fleet model again

SPASAM: Application to Yellowfin Tuna - 1 area model

- Gradient <0.000001, converged with hessian, fit took ~1.5 hrs, much better fit, and jitter was stable!



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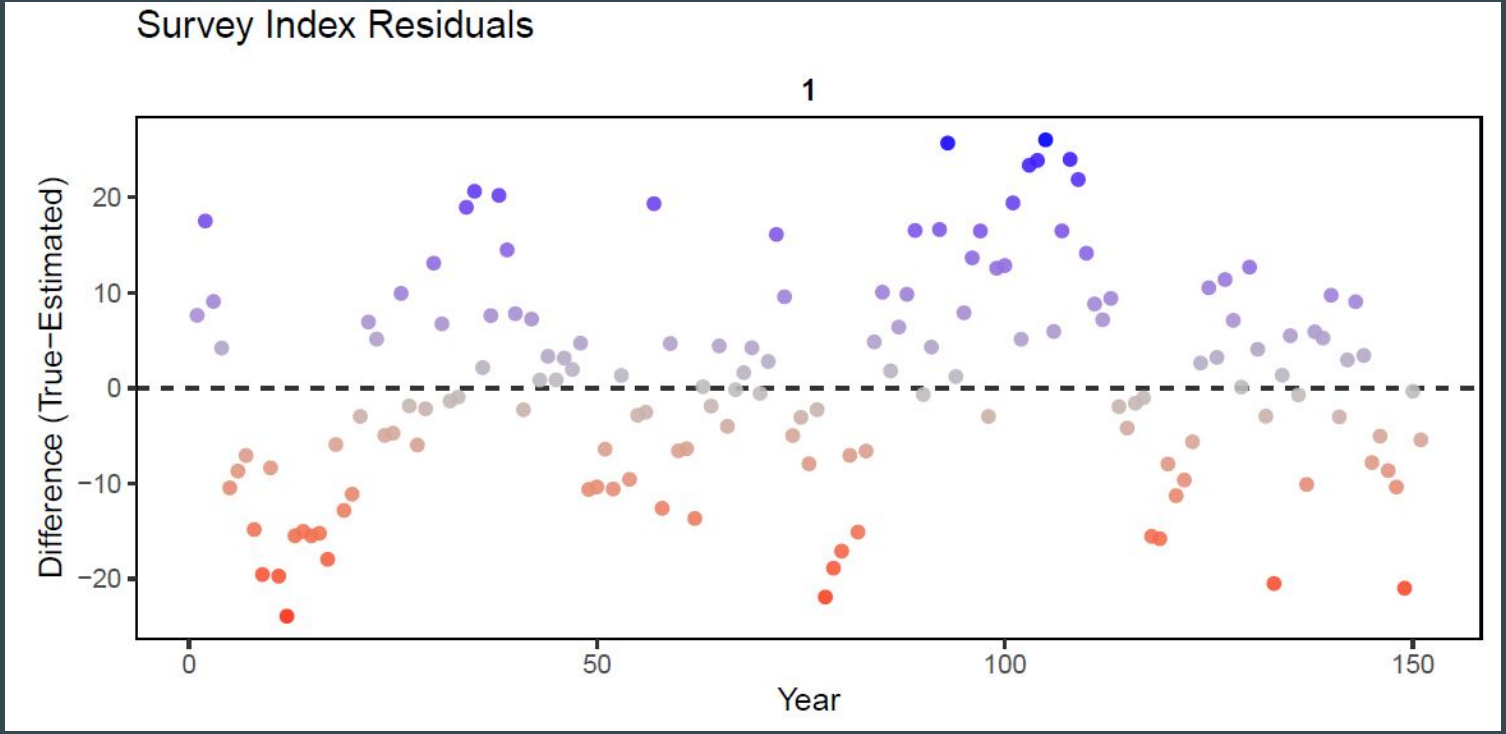

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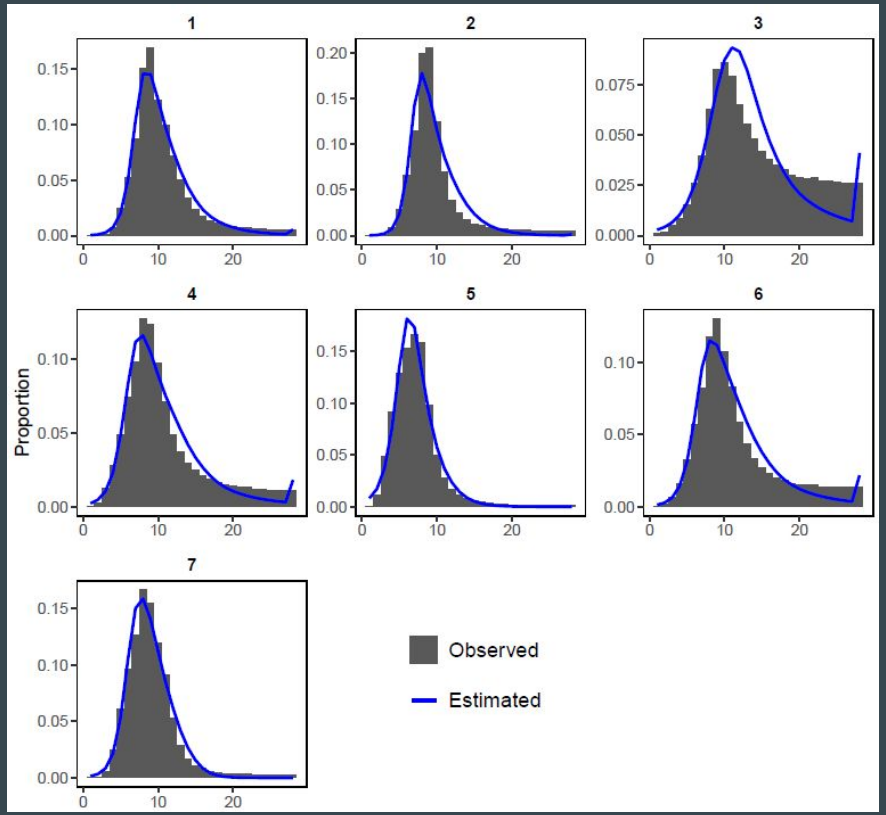
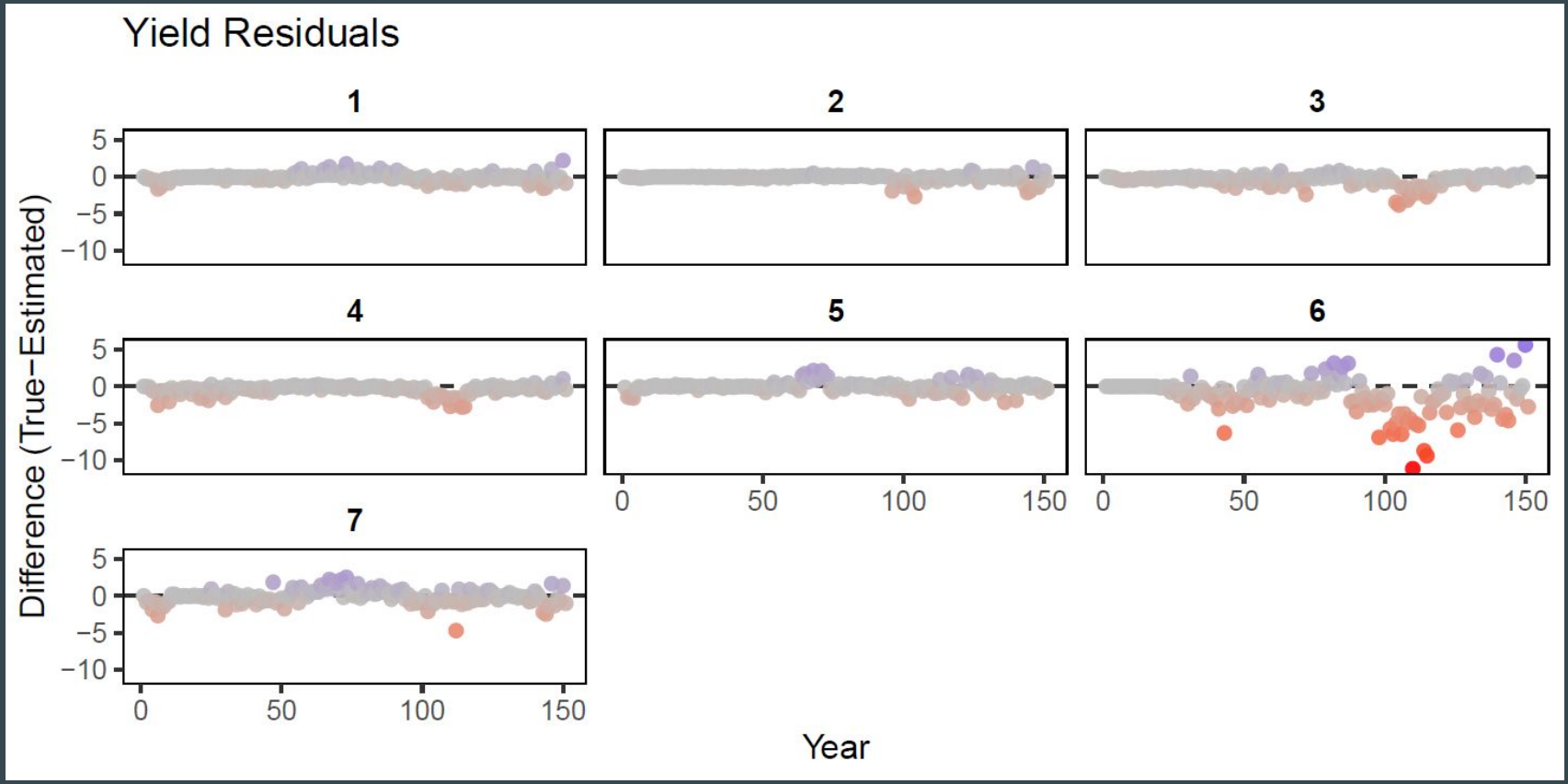


SPASAM: Application to Yellowfin Tuna - 1 area model

- Gradient <0.000001, converged with hessian, fit took ~1.5 hrs, much better fit, and jitter was stable!
- Also tried using all years, but gradient was terrible, fit took 8 hours, and the fits and estimates were nearly identical to truncated model
- So we fit to the 100 datasets again, and…..half were trash
- Found that selectivity parameters for the gillnet and handline fleets were on bounds and effectively estimating a flat-topped logistic
- Changed those fleets to logistic, even though we know that is mis-specified
- This became our final 1-area model
  - Gradient = 0.0003 and converged with hessian
  - ln(R0) = 11.943 (true= 11.48)

SPASAM: Application to Yellowfin Tuna - 1 area model



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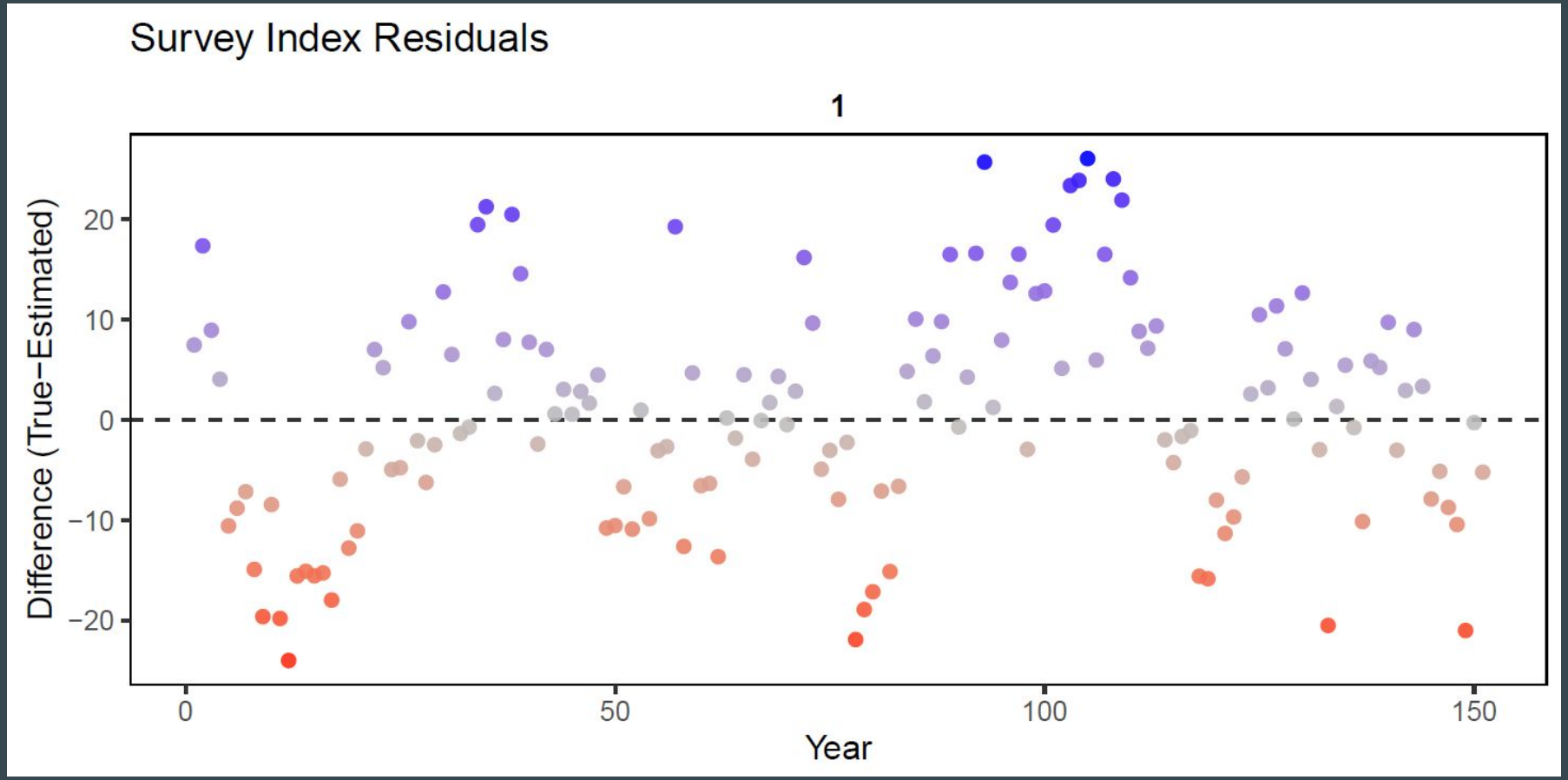

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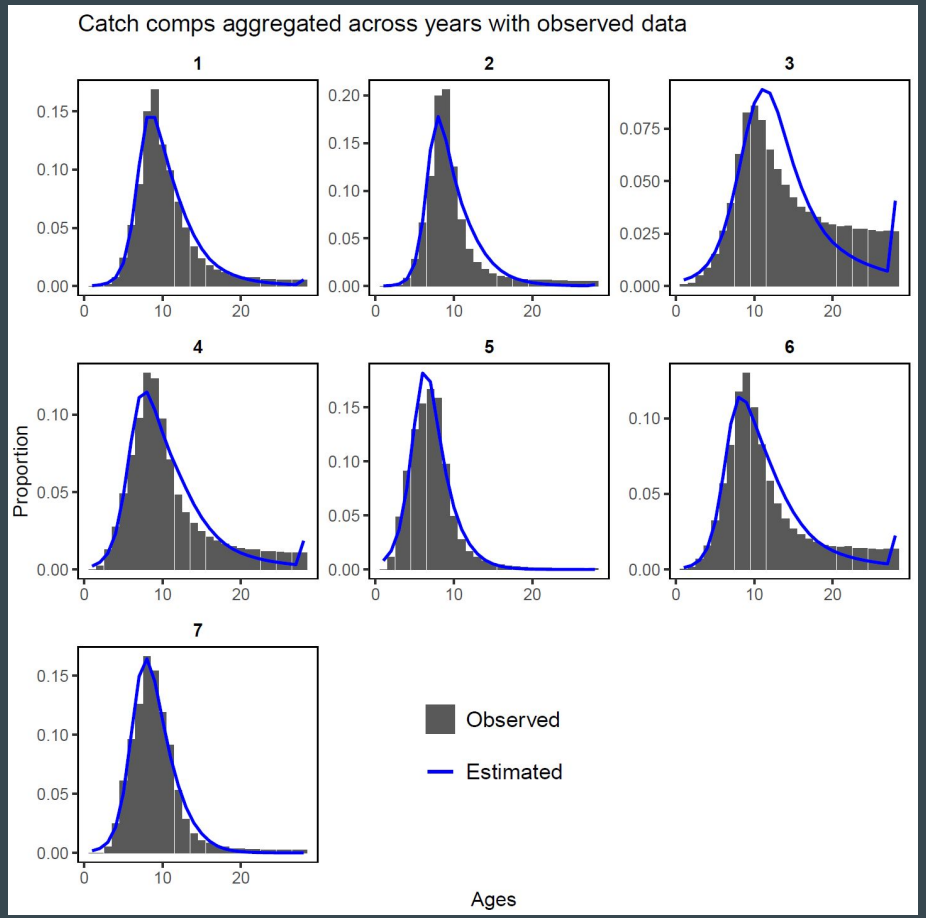

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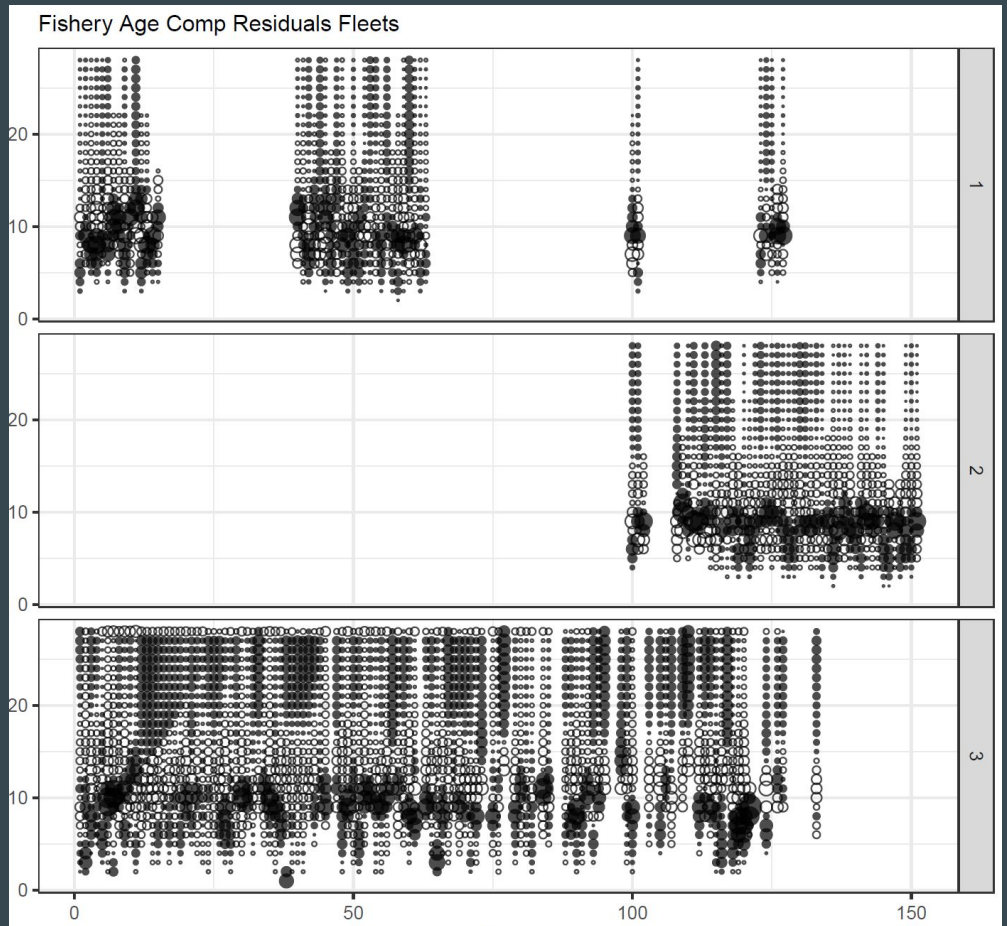

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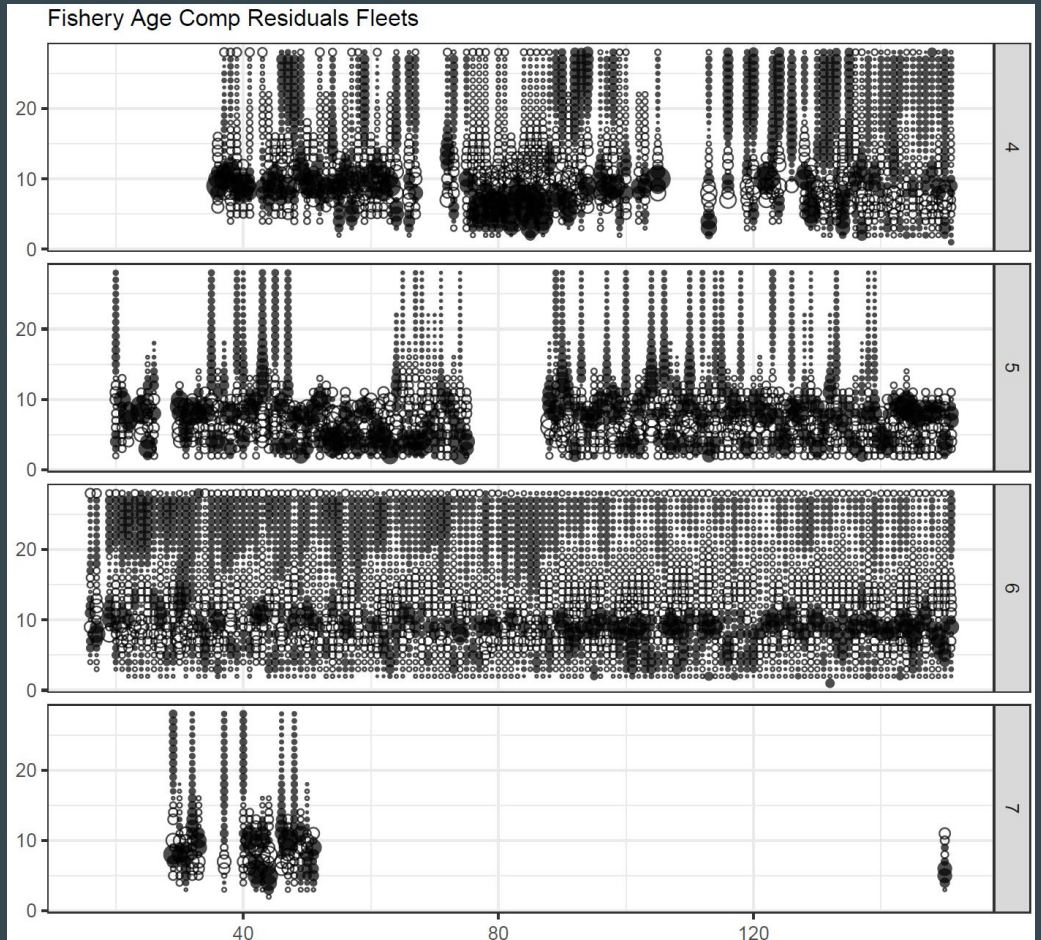

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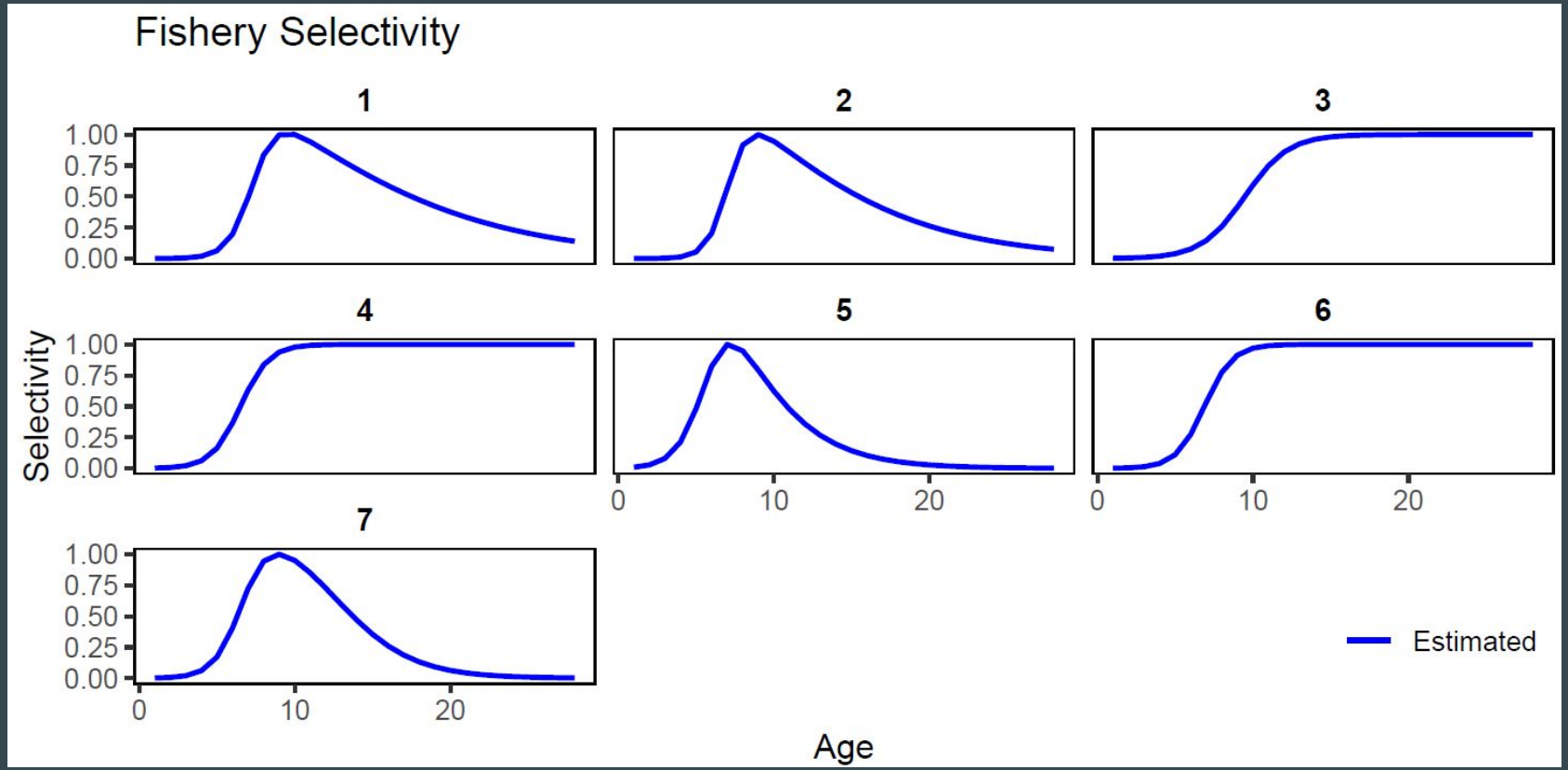

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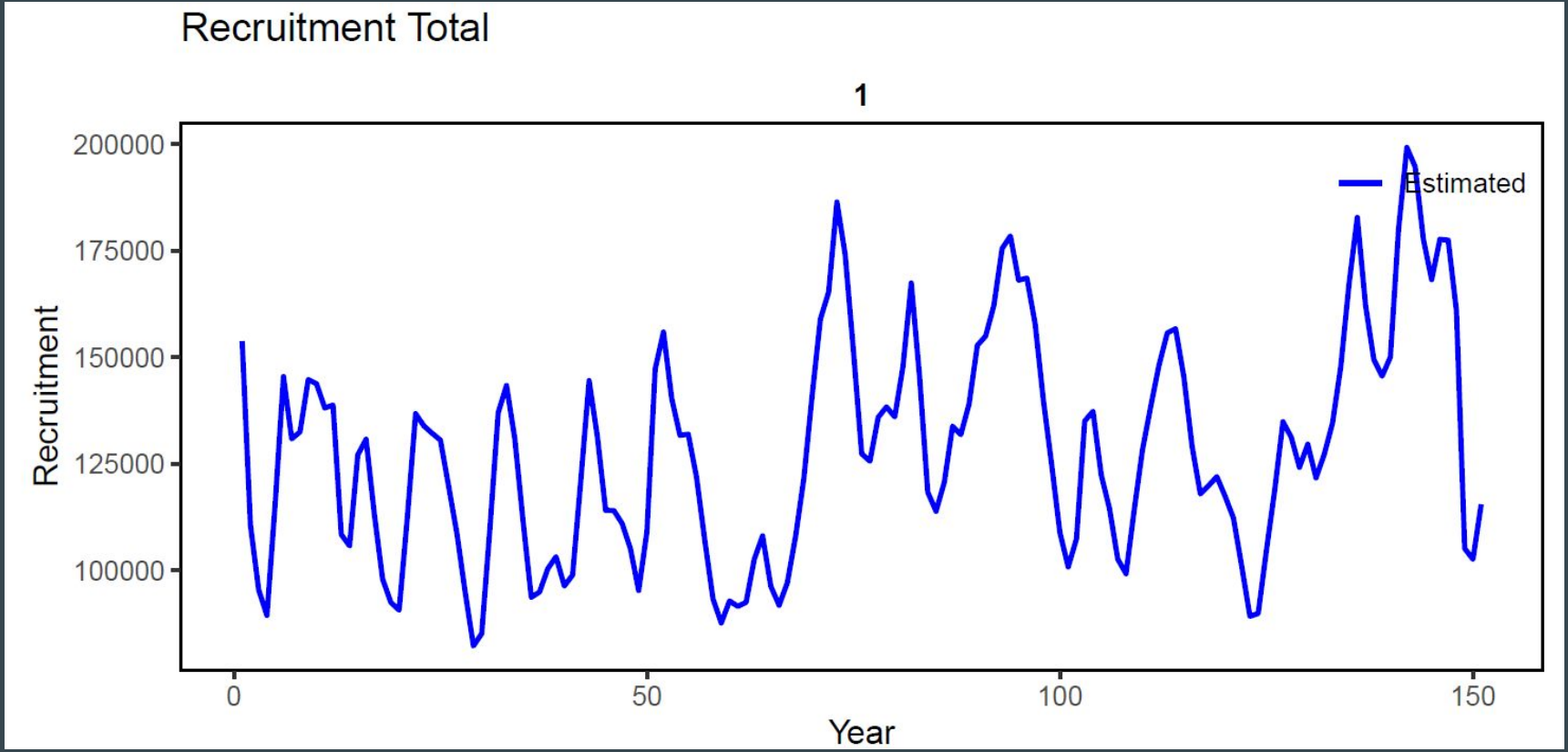

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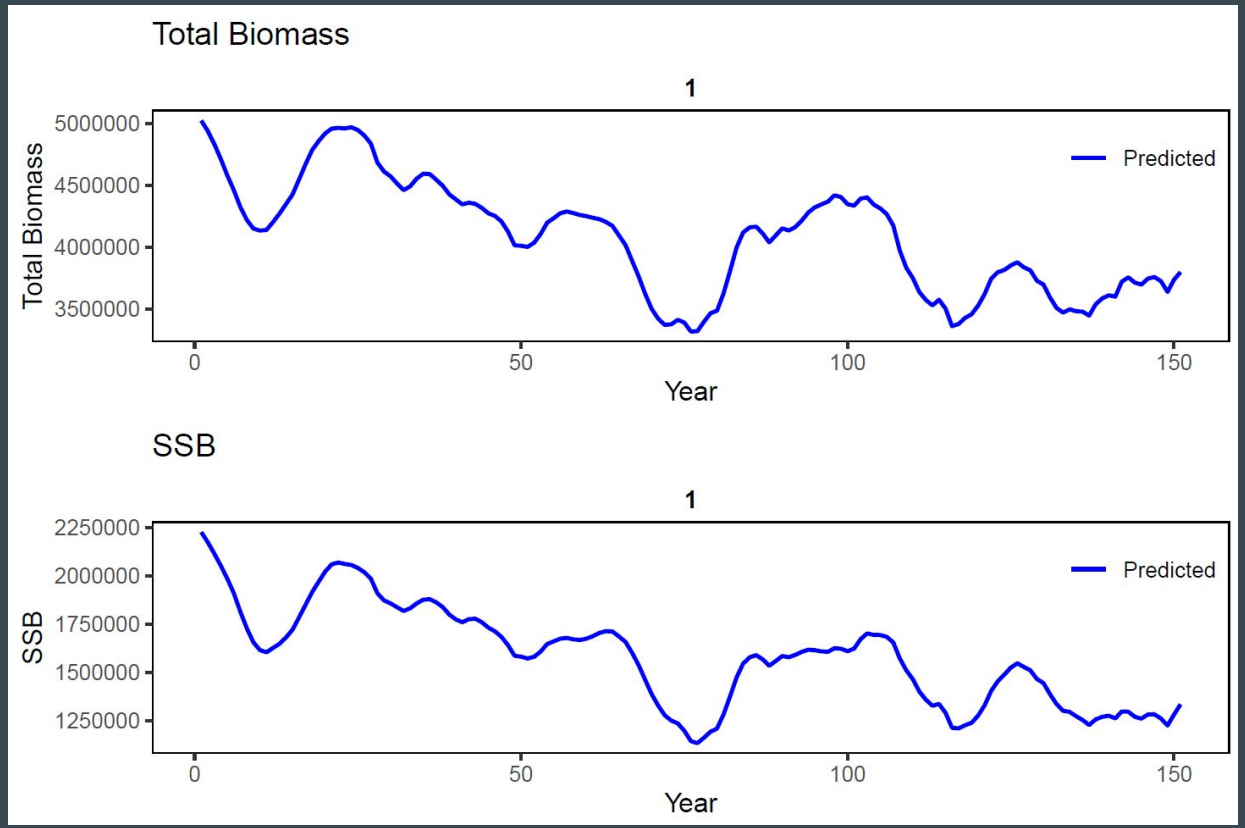

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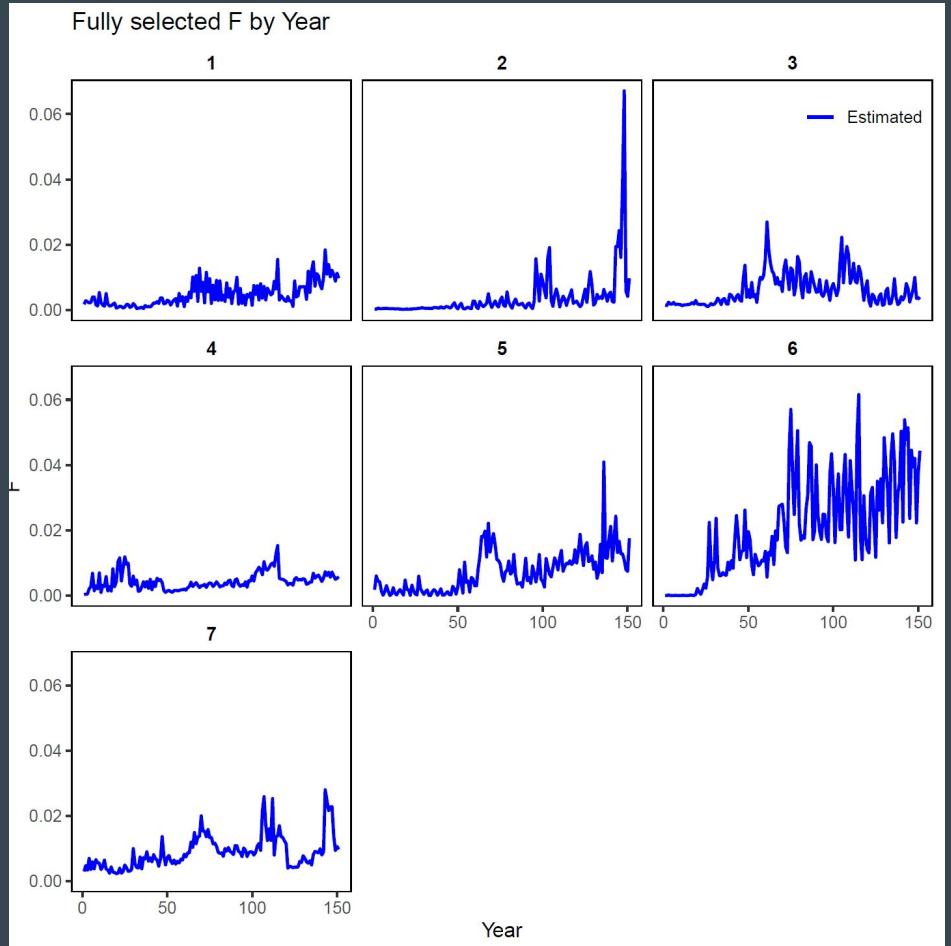
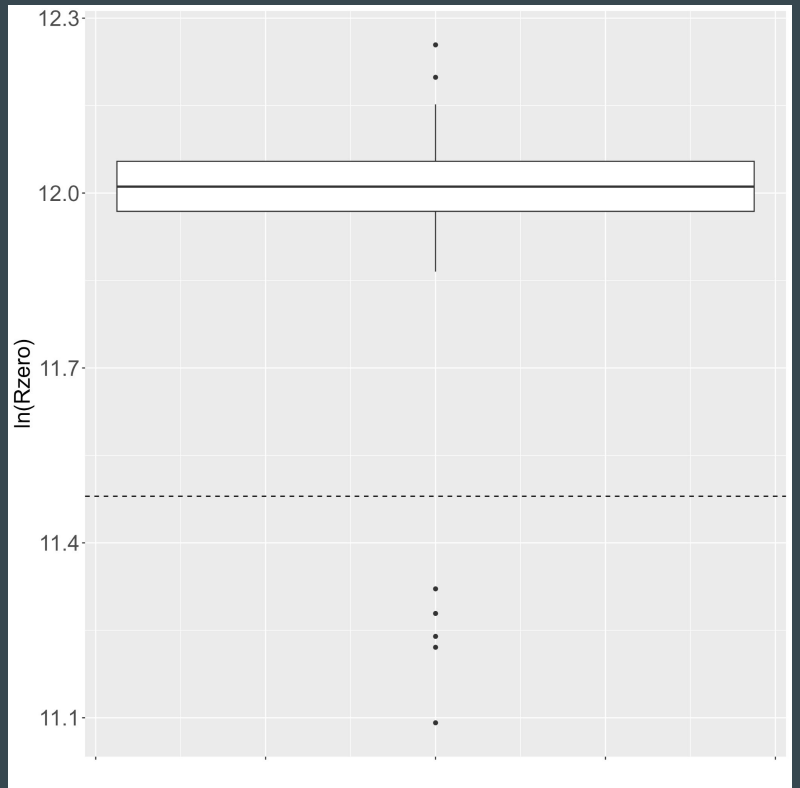


SPASAM: Application to Yellowfin Tuna - 1 area model

- Application to 100 datasets
  - Did not estimate hessian for all datasets; 17 datasets had gradient >1



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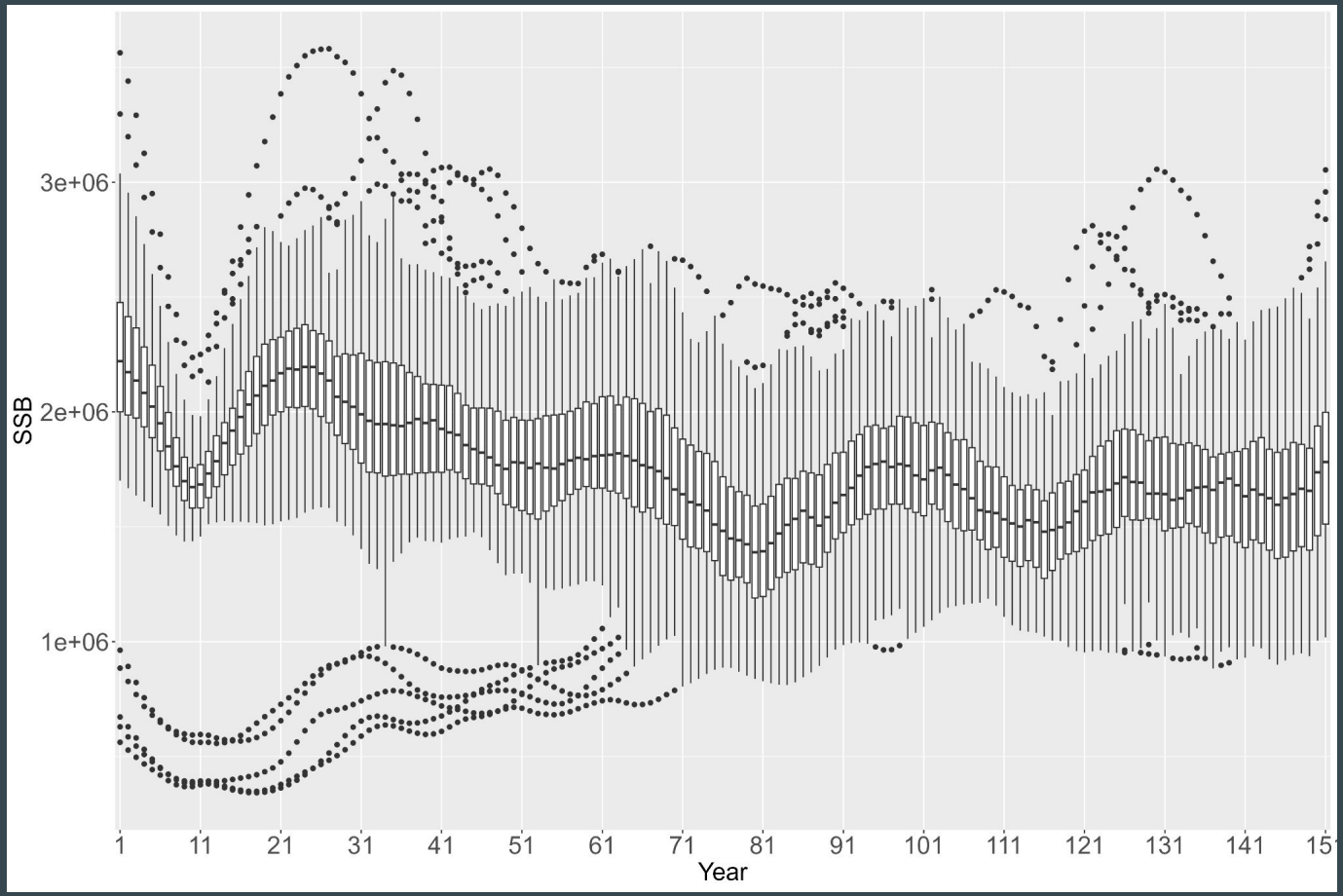

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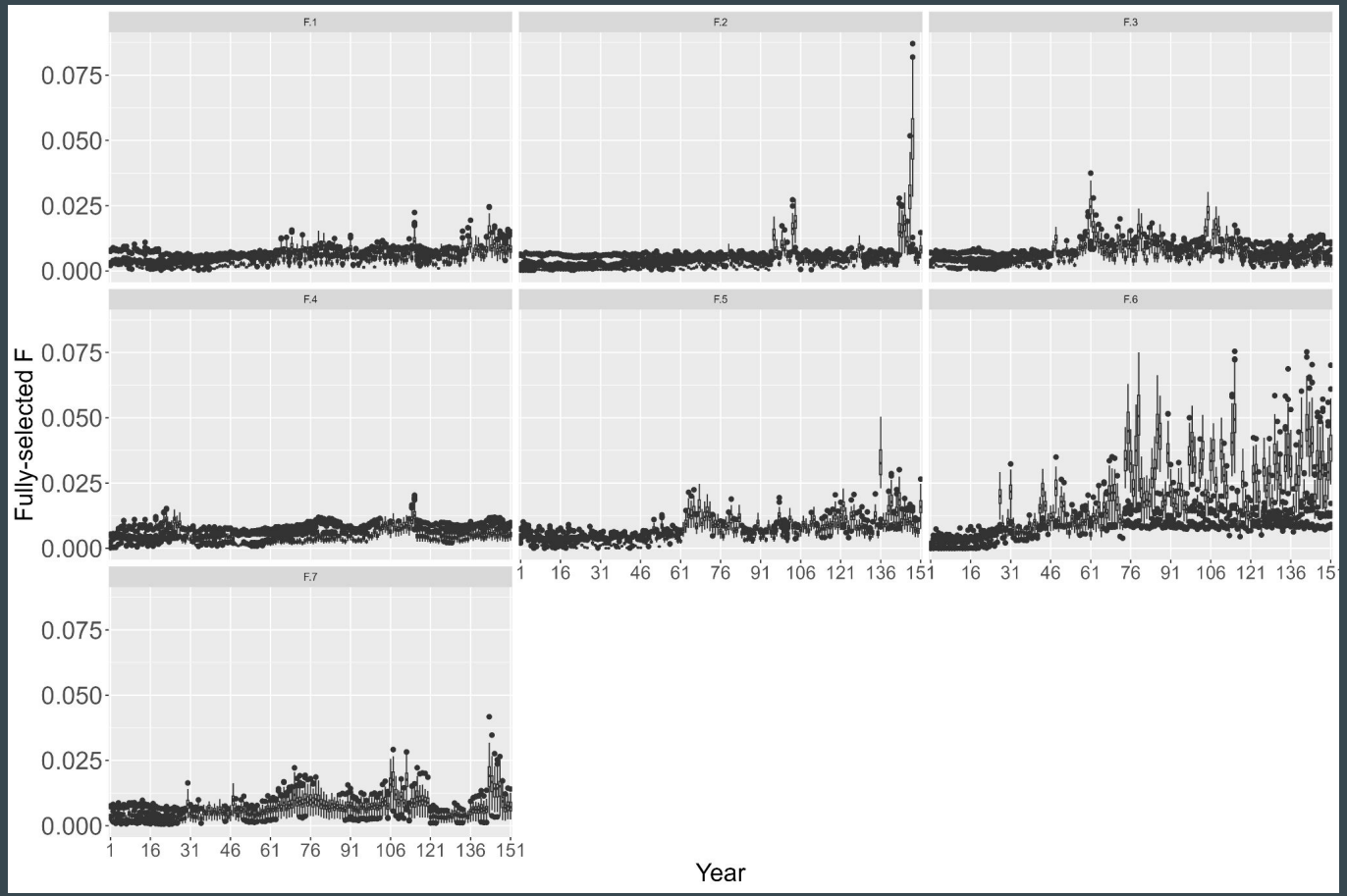

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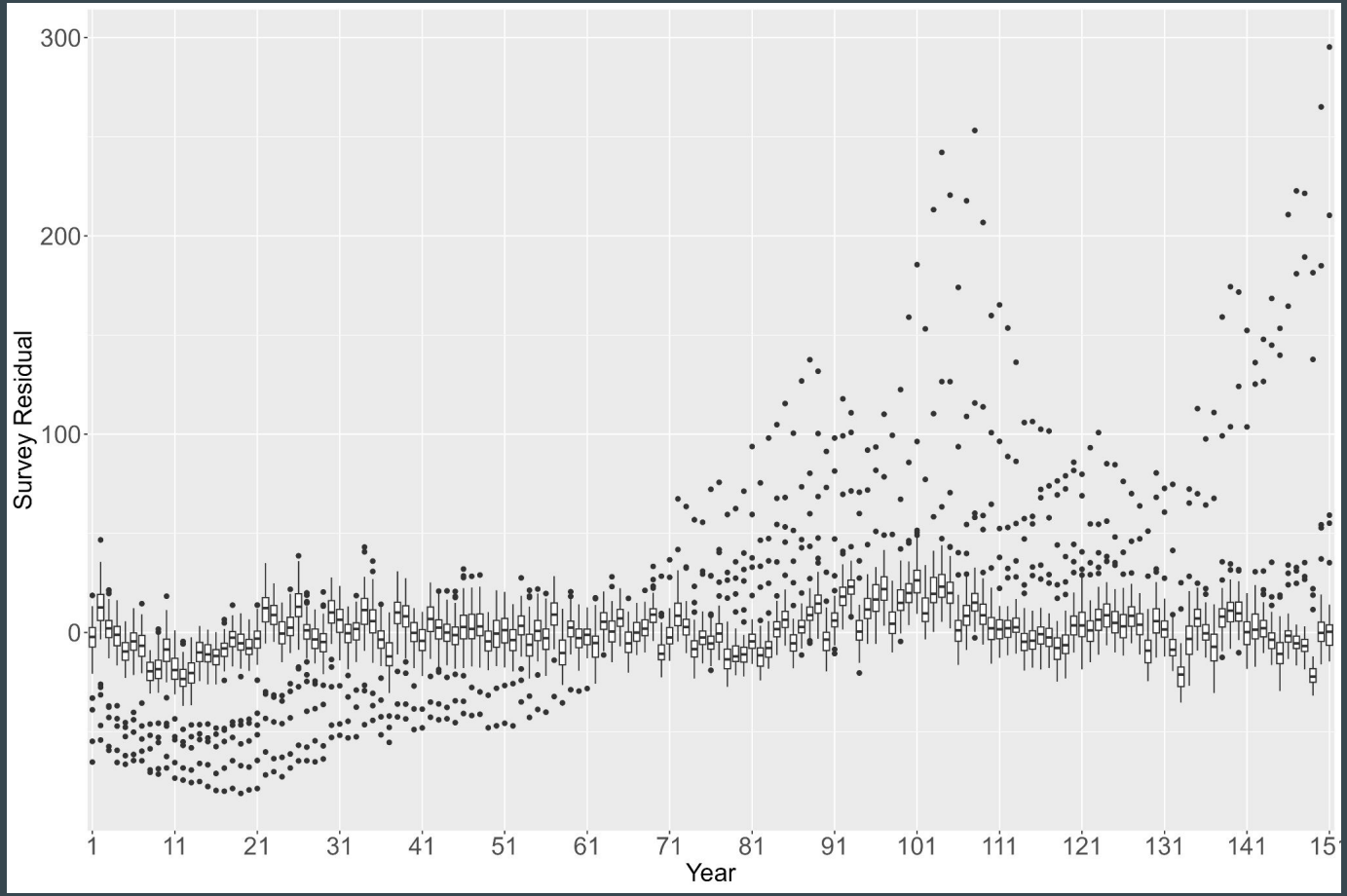

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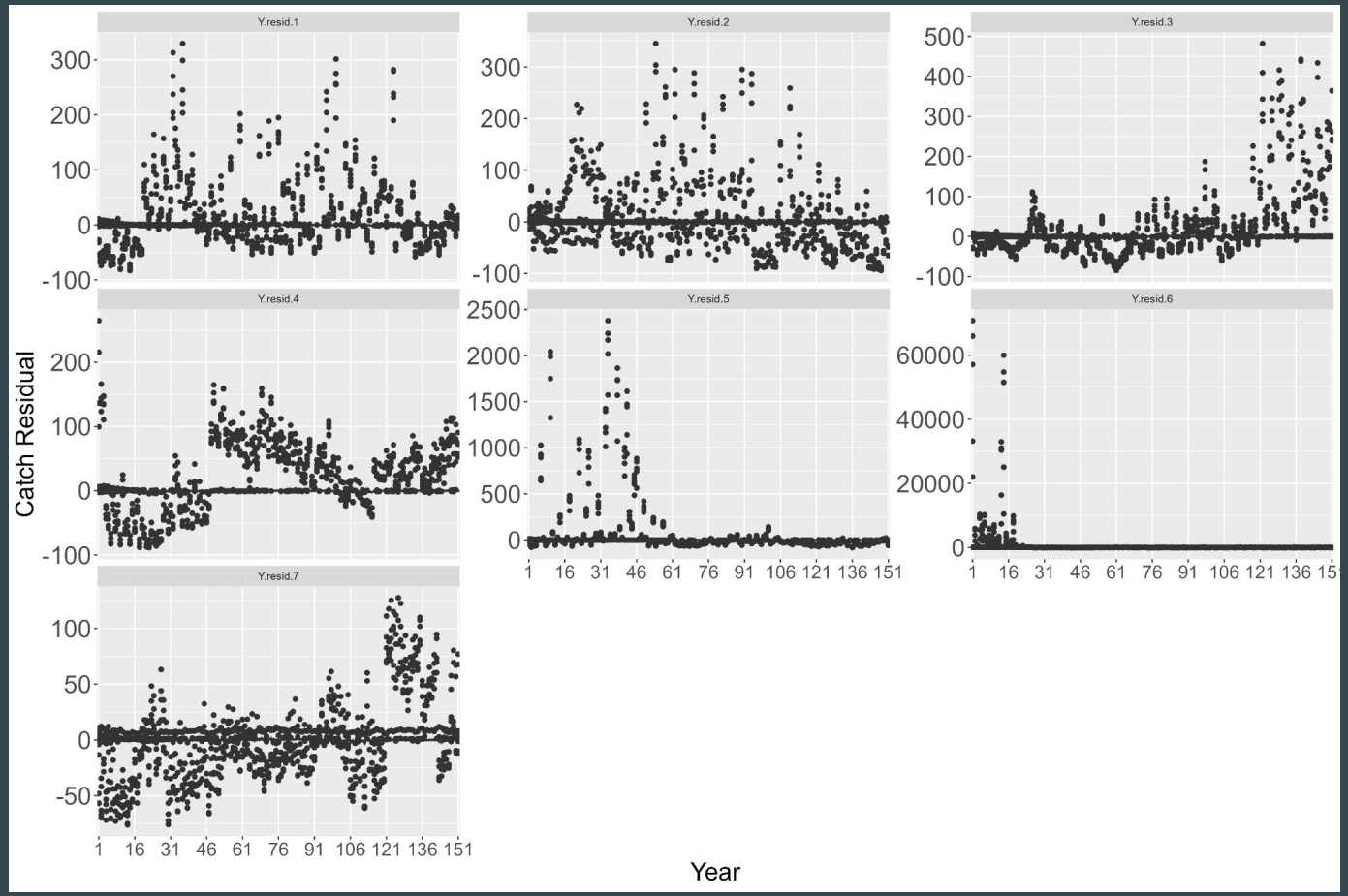

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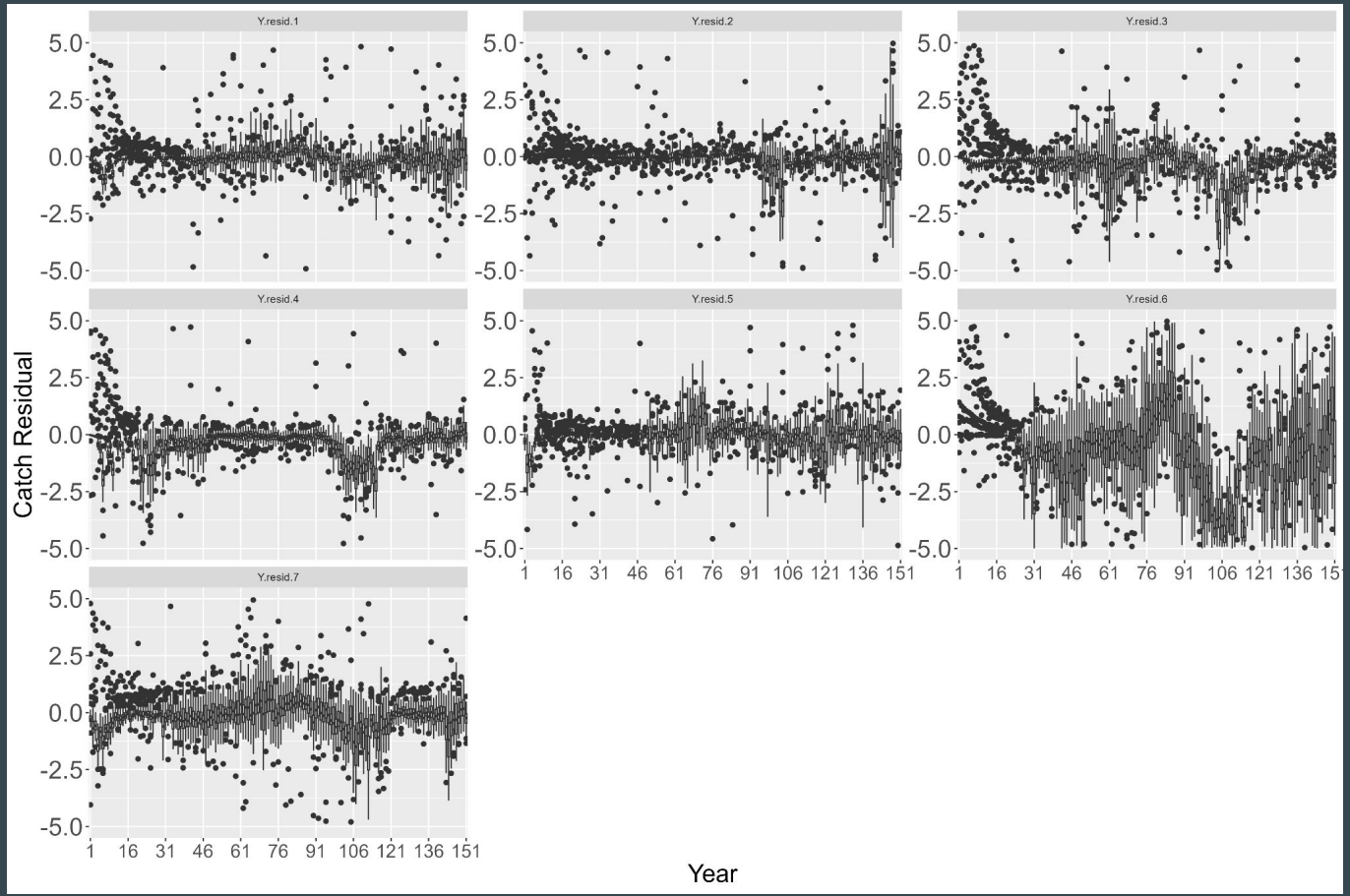


SPASAM: Application to Yellowfin Tuna - 1 area model

- Summary of our one-area experience
  - Platform limitations were formidable, but not insurmountable
    - There is benefit to a community of users
  - Collapsing fleets and deleting years was useful for early development and reducing run-times; suggest starting simple
  - As we know, data weighting is influential
    - Do state-space models offer more objective solutions?
  - Standard diagnostics informative (e.g., residuals, jitter, gradients, etc.)
  - Trust your whimsy and intuition
  - In this case, there was benefit to maintaining 7 fleets, likely due to spatial and seasonal variation among fleet operations
    - At what level of complexity does this remain beneficial?

SPASAM: Application to Yellowfin Tuna - 4 area model . . .

. . . at least to start

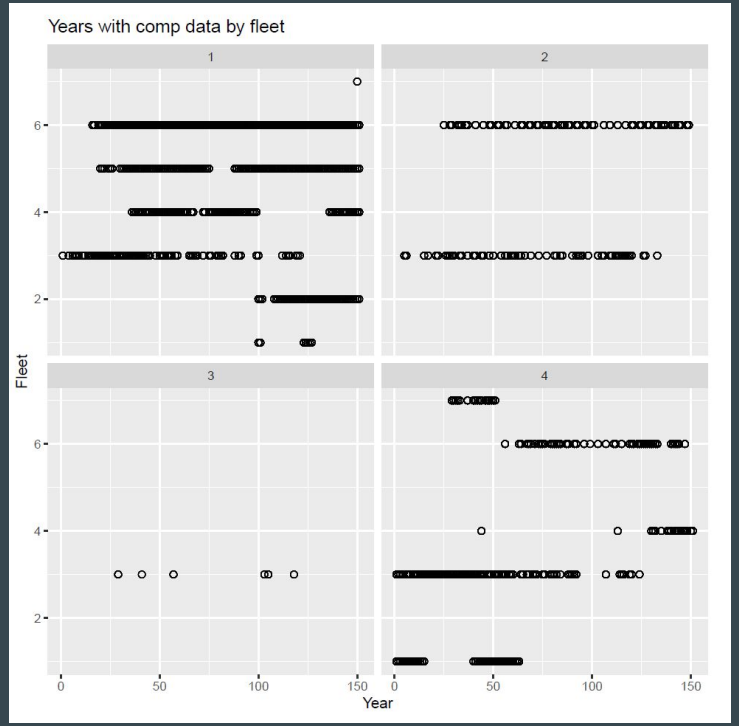
SPASAM: Application to Yellowfin Tuna - 4 area model

- Start “simple” from best 1-area setup
  - 4 area, 7 fleets
  - include tagging data
  - no movement
  - Assume single SR curve, starting with provided R0
    - Recruitment apportioned equally among regions
  - 151 pseudo-years
  - 28 pseudo-ages
  - Keep updates from 1 area exploration
    - ESS set to 15 or 25, survey se = 0.2
  - Not estimating initial abundance

SPASAM: Application to Yellowfin Tuna - 4 area model

- Long run times (~20 hrs) and structural constraints required further simplifications
  - Reduced from 4 to 2 areas (1-2, 3-4)
    - Sum catches
    - Sum tag recapture proportions
    - Discard all other comps

Combinations with observed catches		Region 1	2	3	4
Fleet	1	X			X
	2	X			
	3	X	X	X	X
	4	X			X
	5	X			
	6	X	X		X
	7	X	X		X



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	3	X	X	X	X
	4	X			X
	5	X			
	6	X	X		X
	7	X	X		X

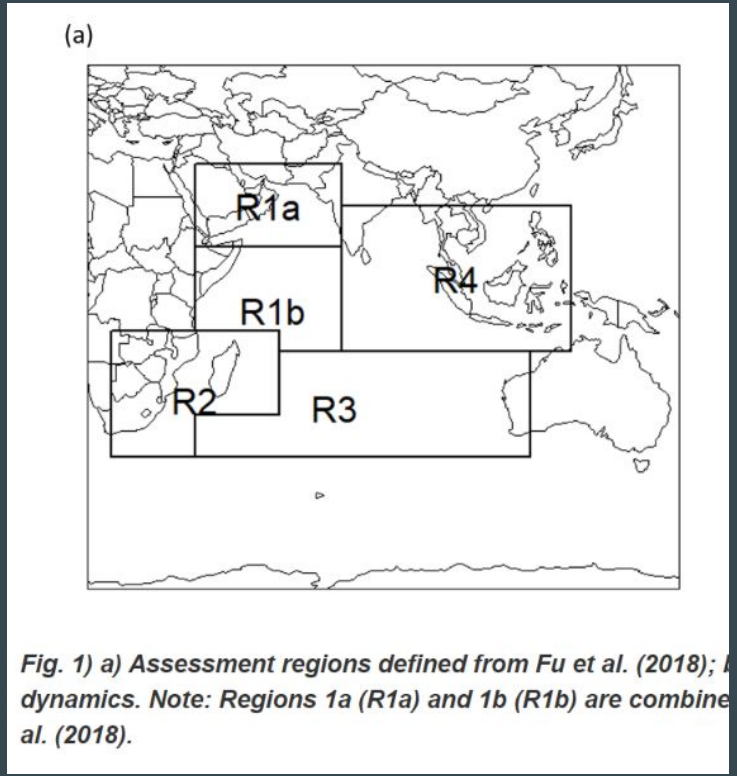
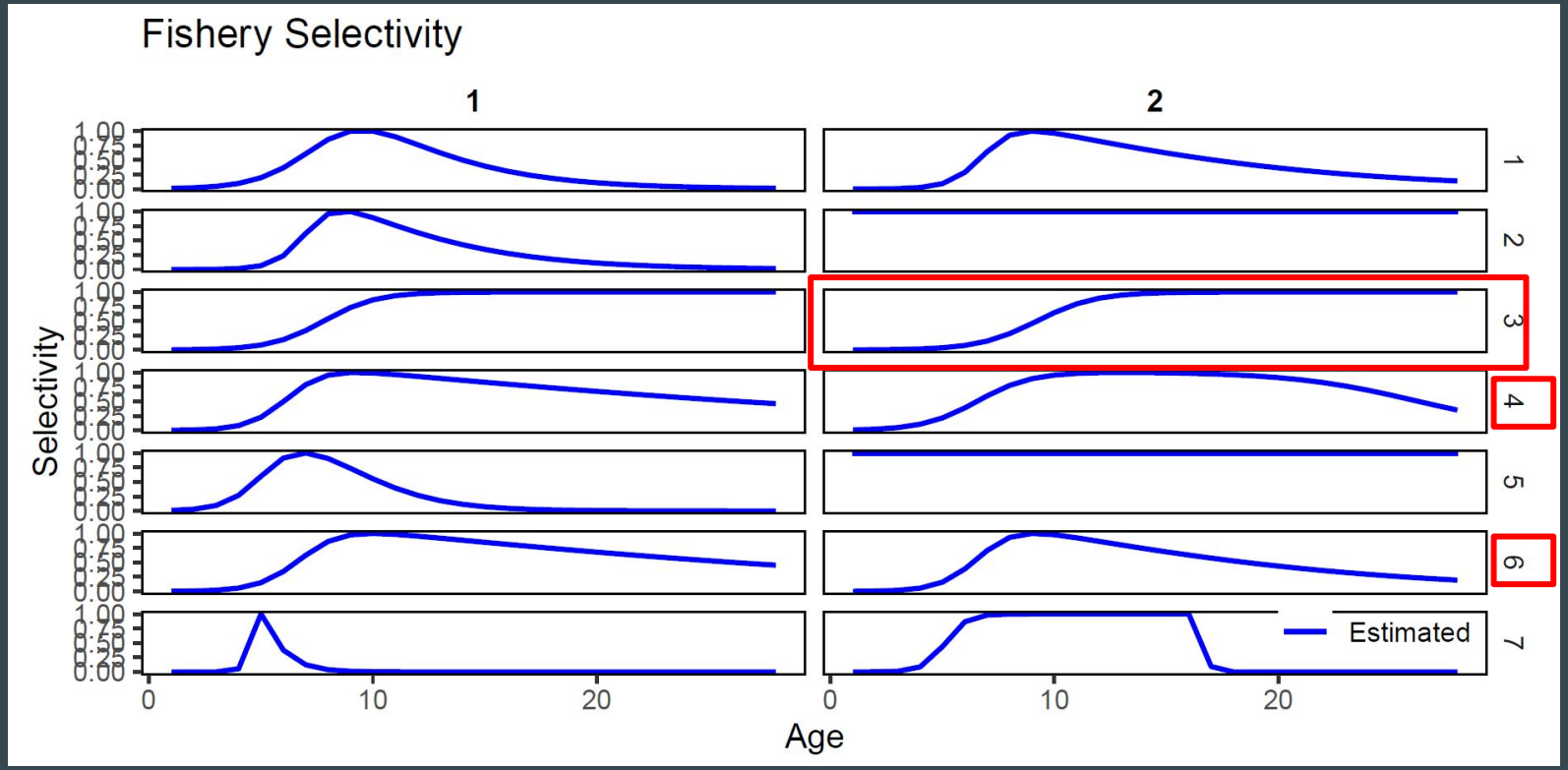


Fig. 1) a) Assessment regions defined from Fu et al. (2018); l dynamics. Note: Regions 1a (R1a) and 1b (R1b) are combine al. (2018).

SPASAM: Application to Yellowfin Tuna - 2 area model results

- Explorations are ongoing - Current best case model
  - Age-invariant and time-invariant movement added
  - Movement penalty around ~80% residency stabilized estimation

SPASAM: Application to Yellowfin Tuna - 2 area model results



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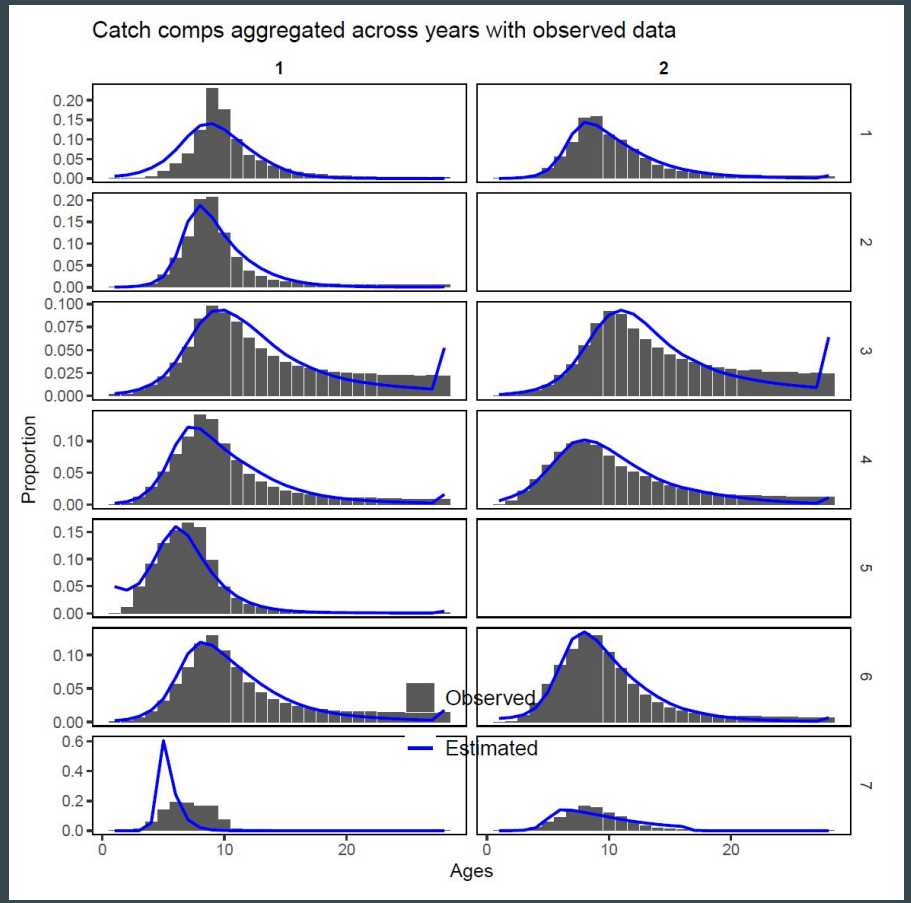
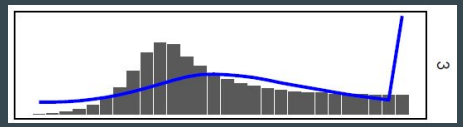
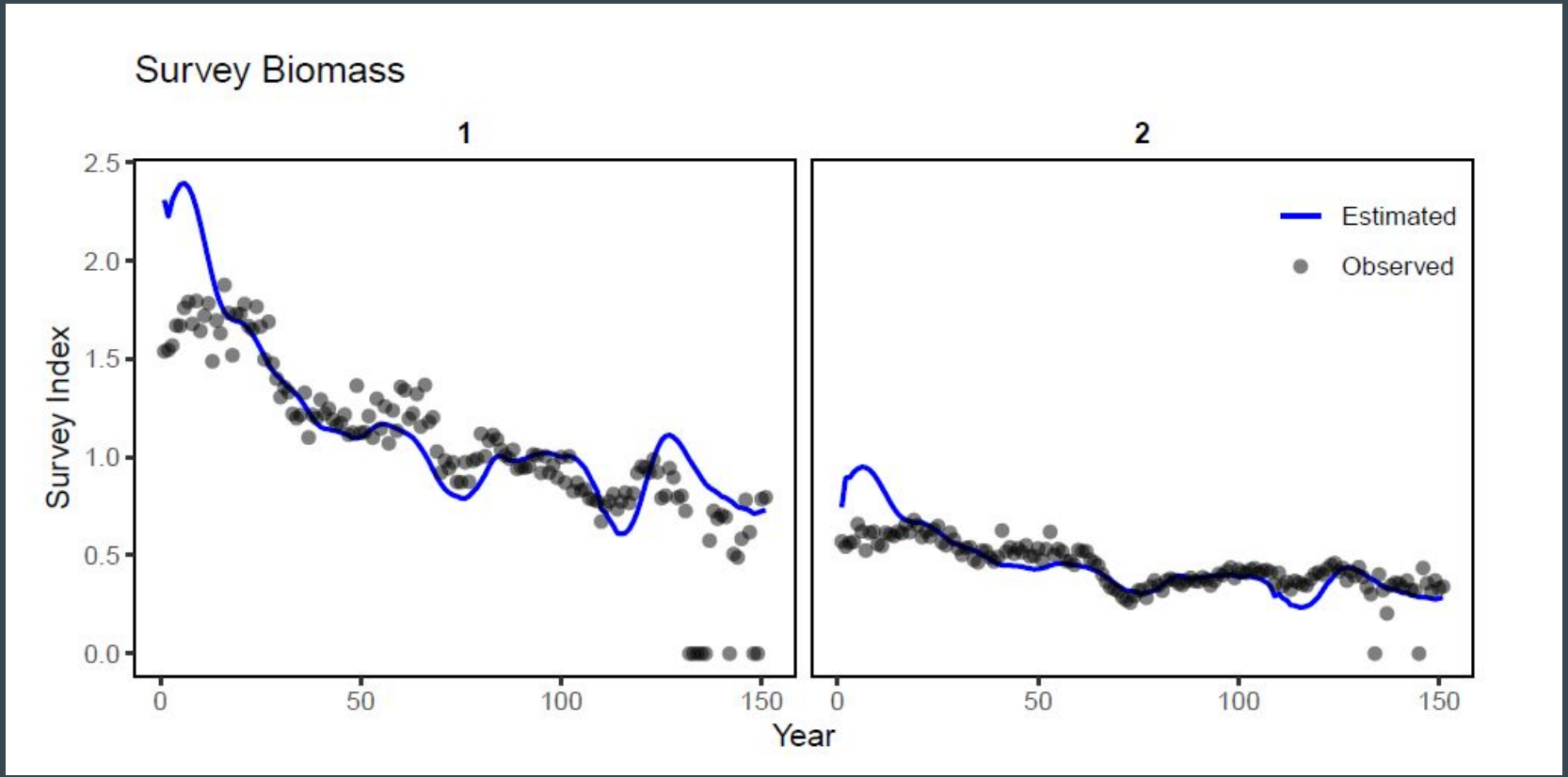


Fit to fleet 3 in area 2 often looks like

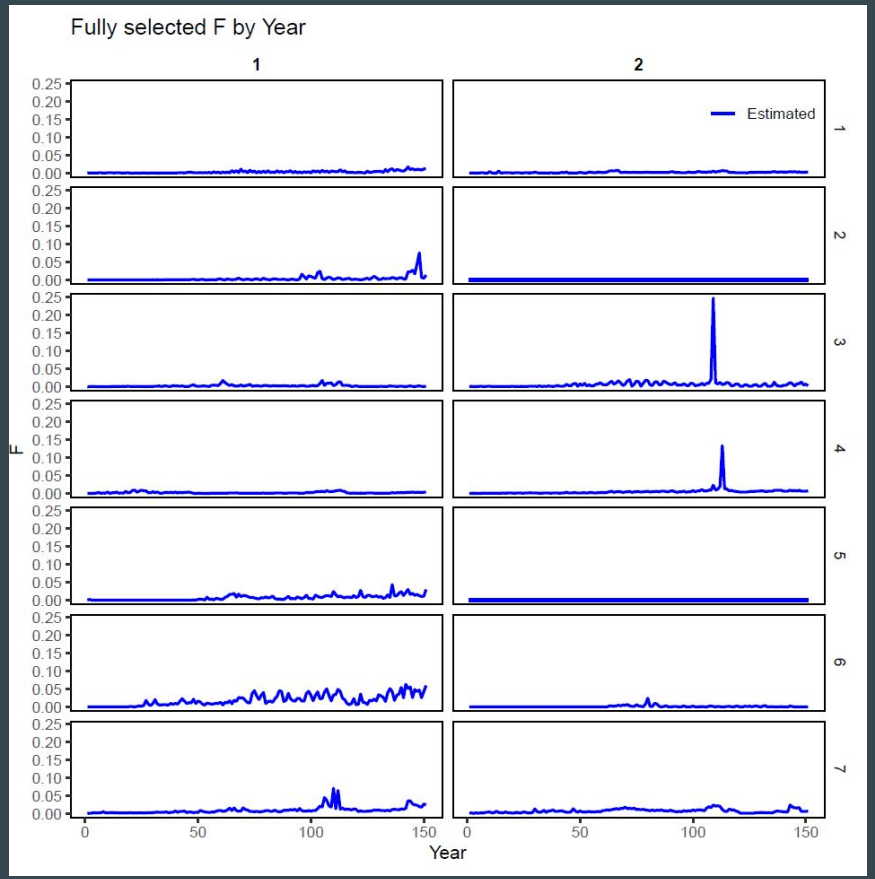


Likely due to tradeoffs between fitting index (single q among areas) and comps (selectivity is mirrored to survey)

SPASAM: Application to Yellowfin Tuna - 2 area model results



SPASAM: Application to Yellowfin Tuna - 2 area model results



Spikes in F appear when estimating movement

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- Summary of our four-area experience to date
  - Platform limitations are formidable
  - Collapsing fleets and deleting years was useful for early development and reducing run-times; suggest starting simple
  - More work remains to speed up run time

SPASAM: Application to Yellowfin Tuna - 2 area model

- Summary of our four-area experience to date
  - Platform limitations are formidable
  - Collapsing fleets and deleting years was useful for early development and reducing run-times; suggest starting simple
  - More work remains to speed up run time
- Questions we've encountered
  - What should inform areal-reductions?
  - When movement is 'unknown' what assumptions to start with?
    - We are starting simple
  - How to balance recruitment (apportionment) and movement and mortality?

Many thanks!!

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  - Amy Schueller
  - Dan Goethel
  - Aaron Berger
  - Dana Hanselman
  - Katelyn Bosley
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