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# Analytical tools used to produce assessment inputs

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# Outline

- Fishery independent indices of abundance
  - GLMM analysis of trawl surveys
  - GLM analysis of hook and line and IPHC surveys
- Fishery dependent CPUE
- Length and age composition data
- Ageing error
- Discards
- Priors on mortality ( $M$ ) and stock-recruit steepness ( $h$ )
- Maturity and fecundity
- Growth and weight-length relationships
- r4ss

# GLMM analysis of trawl surveys

- Current software written in JAGS, tailored to needs of NWFSC assessments
- Builds on work by Helser and Wallace over past 10 years
- Stratum  $\times$  Year interactions as fixed or random effect
- Random effect for vessel suited to with multi-vessel survey design
- New extreme-catch-events option available for species with large aggregations
- Described in two Thorson & Ward papers

# GLMM analysis of trawl surveys

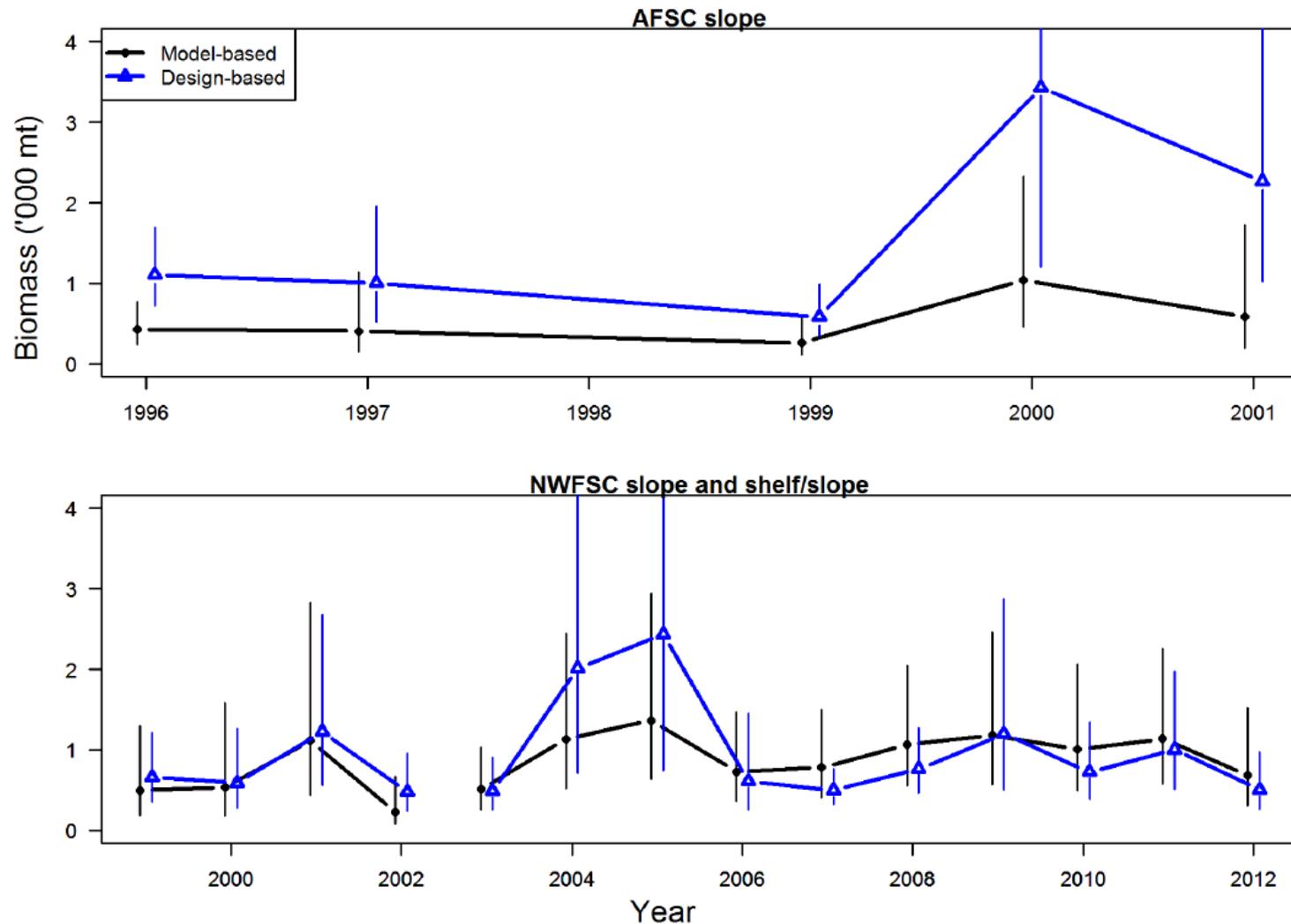


Figure 8: A comparison of the design-based estimates and the model-based estimates for each survey.

Figure from Roughey/Blackspotted assessment

# GLM analysis of hook and line or longline surveys

- Binomial GLM with multiple covariates
- Used for Hook and Line Survey in Southern California (Bocaccio Rockfish)
- IPHC Longline Survey in Washington and Oregon (Spiny Dogfish, Yelloweye Rockfish)
- Multiple ongoing research projects are looking at issues like environmental covariates and hook saturation

# Fishery Dependent CPUE

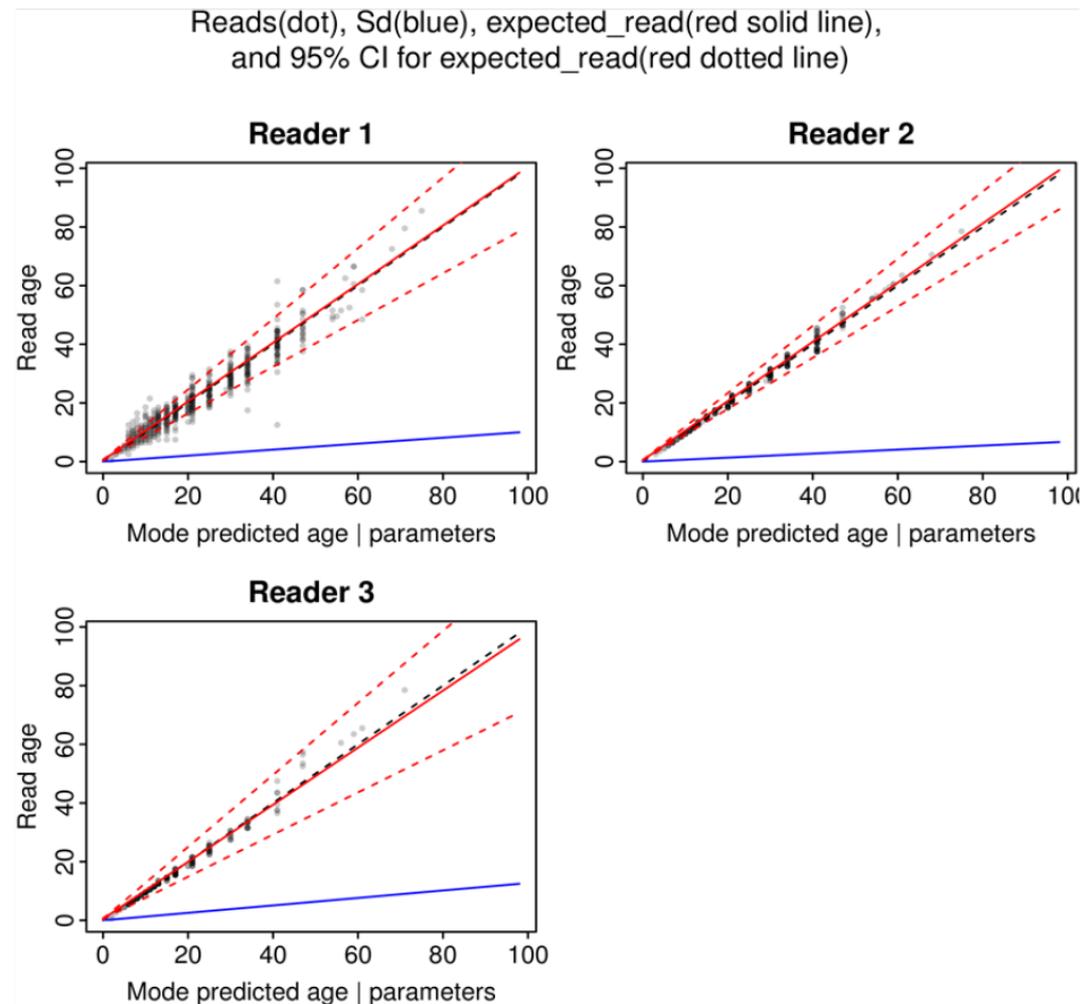
- Commercial CPUE
  - Used in Petrale Sole assessment
  - Required extensive effort to filter, standardize data
  - Not a promising approach for other species
- Recreational CPUE
  - Indices developed from 80's and 90's used in some assessments
  - Timeseries can't be extended due to extensive management changes
  - New indices being explored for nearshore species not well sampled in trawl survey (see C.3 talk)

# Composition data

- Fishery length and age data need to account for variability in sample collections relative to total catch
- Ongoing effort by Andi Stephens to develop generalized code for commercial compositions
  - So far, ~1500 lines of code, 5-page manual
  - Difficult to cover requirements associated with different fishery sectors and stocks
- Ongoing effort by Allan Hicks to develop generalized code for survey compositions
  - So far, ~1500 lines of code, R package documentation in development

# Ageing error

- State-space software developed by André Punt used to estimate ageing error matrices
- Generalized R code used for model selection
- Age readings always assumed uncertain



**Figure 33:** Ageing error figure for “late” reads (where Reader 1 is the reader of retained compositional data after 2005, and is believed *a priori* to be unbiased, while bias and imprecision are estimated separately for Readers 2-3).

Figure from Darkblotched assessment

# Estimating discards

- Recent effort by John Wallace to reanalyze early discard study
- R code developed in conjunction with Observer Program to bootstrap discard data

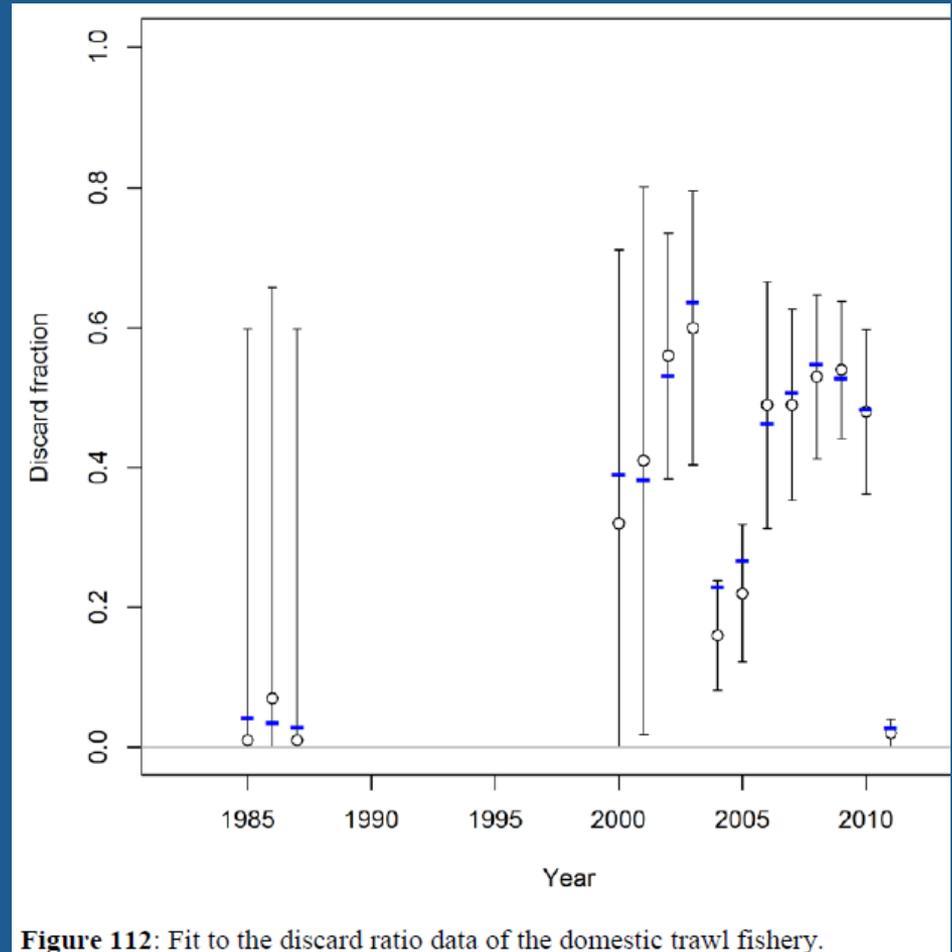


Figure 112: Fit to the discard ratio data of the domestic trawl fishery.

Figure from Darkblotched assessment

# Prior distributions for $M$ and $h$

- Natural mortality ( $M$ ) and stock-recruitment steepness ( $h$ ) are often difficult to estimate.
- Prior distributions developed from analyses of multiple stocks.
  - Hamel (in review) A method for calculating a meta-analytical prior for the natural mortality rate using multiple life-history correlates. ICES J. Mar. Sci.
  - Thorson has taken over from Dorn task of updating steepness prior described in Dorn (2002) Advice on West Coast rockfish harvest rates from Bayesian meta-analysis of stock– recruit relationships. N. Am. J. Fish. Manag. 22, 280-300.
- Difficult to know best way to use information in  $h$  prior in cases when parameter is estimated at  $h = 1$

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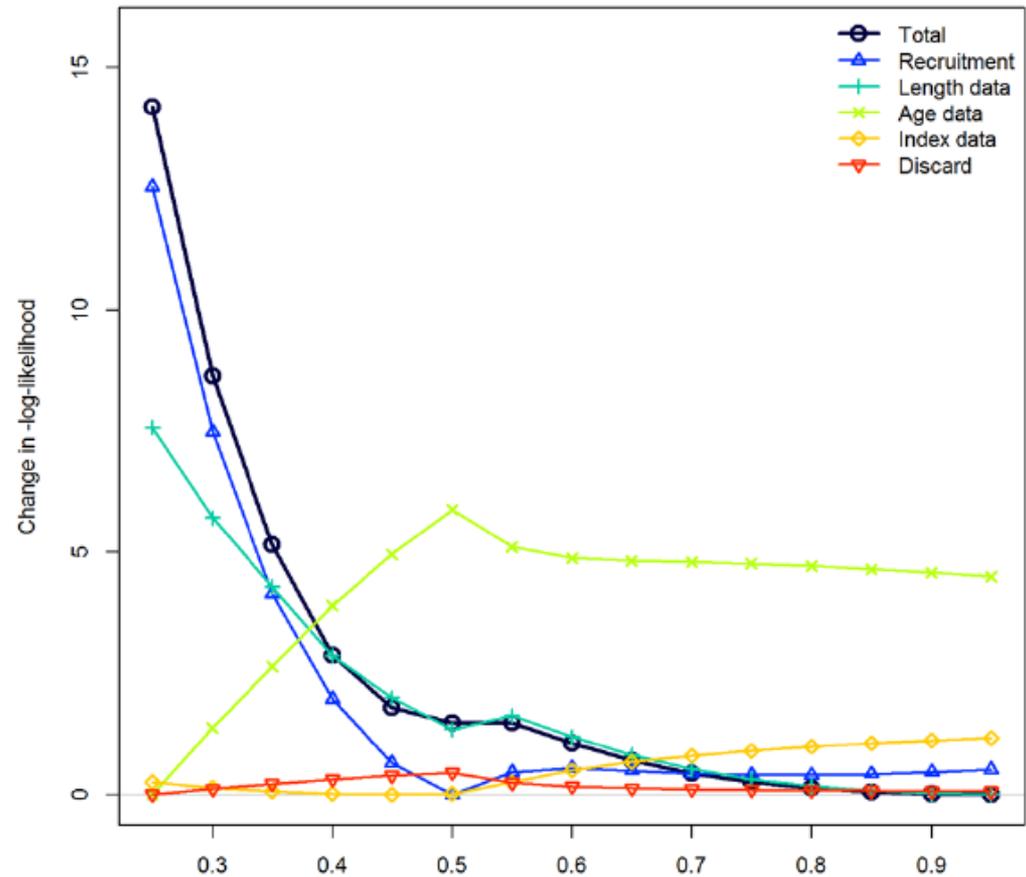


Figure 141: Negative log-likelihood profile for each data component and in total given different values of stock-recruit steepness ranging from 0.25 to 0.95 by increments of 0.05. Figure from Darkblotched assessment

- Difficult to know best way to use information in  $h$  prior in cases when parameter is estimated at  $h = 1$

# Maturity and Fecundity

- Typically estimated outside the assessment model
- Variety of modeling approaches being developed
- Fecundity often has non-linear relationship with weight for rockfish

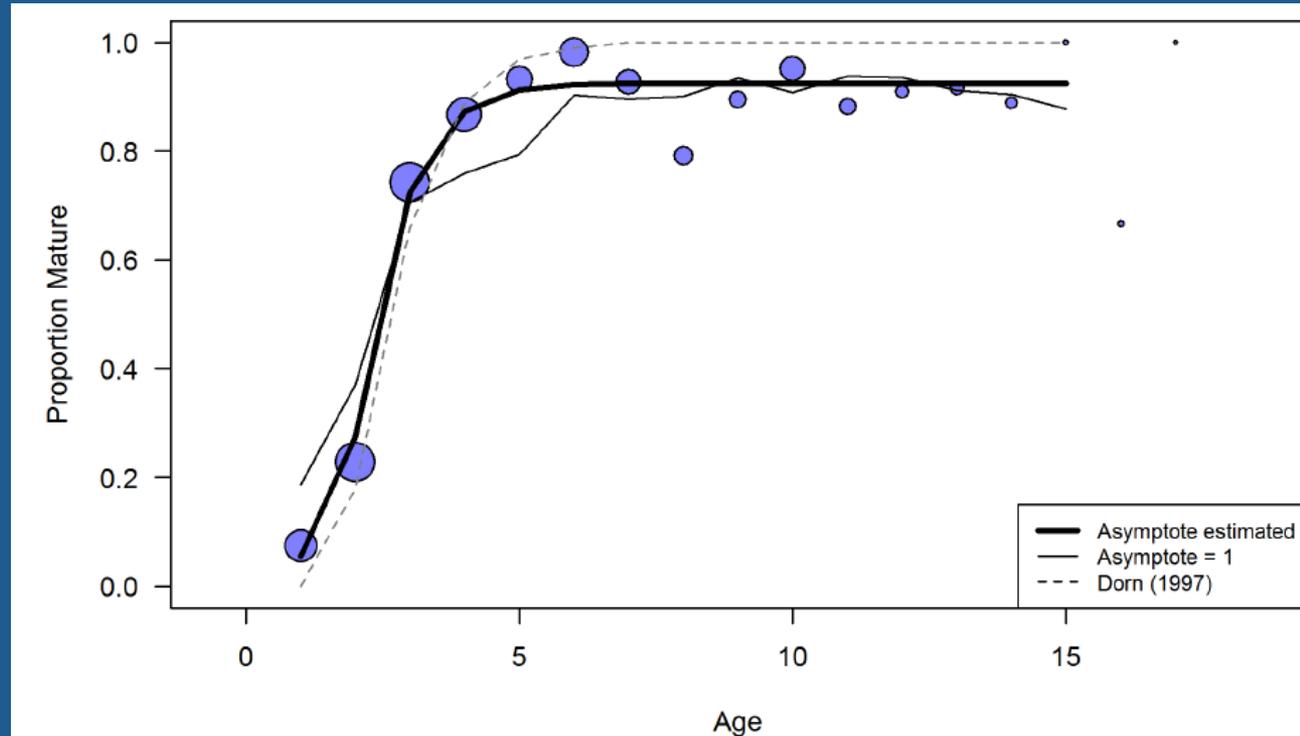


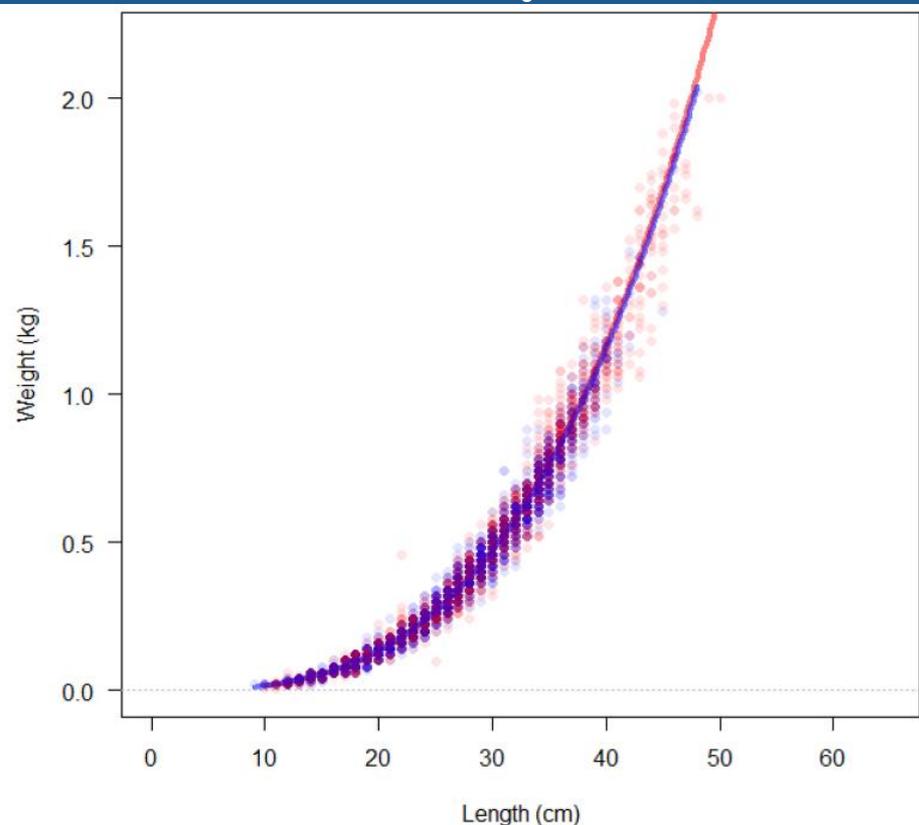
Figure 16: Proportion mature at age shown by blue circles with the area of the circle proportional to the number of observations. Maturity-at-age is shown as a dashed line from Dorn & Saunders (1997), as a thin solid line from a logistic model with an asymptote at one, and as a thick solid line from a logistic model with the asymptote estimated.

Figure from Hake assessment

# Growth

- Often estimated internally in assessment (influenced by age and length data)
- In some cases, growth curves fixed at external estimates
- Weight-length relationships estimated externally

Figure from Darkblotched assessment



**Figure 30:** Weight-length relationship for female (red) and male (blue) darkblotched rockfish used in the assessment, shown with fit to the data from the NWFSC shelf-slope survey samples (shaded points).

# r4ss

- Open source collection of R code for working with Stock Synthesis input and output
- Evolving in parallel with Stock Synthesis
- 872 changes since 2008 from 6 contributors
- Streamlines the process of model exploration, producing figures for reports
- Benefits from common assessment platform

Figure from Darkblotched assessment

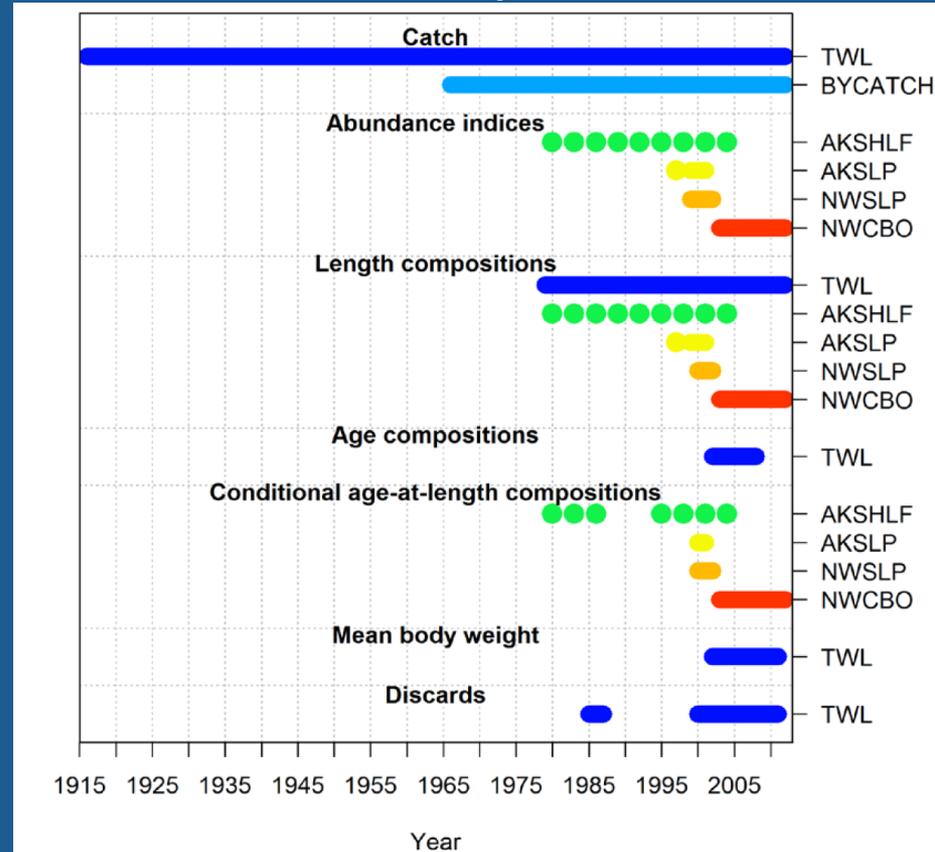


Figure 7: Summary of sources and data used in the assessment.

# Strengths, Challenges, Solutions

- Successfully producing necessary inputs to assessment models
- All assessment authors use R and can produce most inputs themselves
- Analytical tools used to produce assessment inputs are not very generalized
- Need to balance time between making existing tools easier to use and exploring new approaches
- Assessment Team working through Canary Rockfish inputs in group meetings to share ideas and discuss needs