Bottom trawl survey age and length composition input sample sizes for stocks assessed with statistical catch-at-age assessment models at the Alaska Fisheries Science Center

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# Abstract

At the AFSC, age and length frequency sampling from the bottom trawl surveys is used in stock assessment models in a variety of ways to inform estimates of population abundance that are subsequently used to set management quantities. The most common use of length frequency sampling is to derive estimates of the population abundance-at-length that are used in conjunction with an age-length key to estimate population estimates at age, which are then converted to age composition estimates and fit in the model (Monnahan et al. 2021, e.g., Spencer and Ianelli 2022). Length frequency samples are also used in many assessments in a conditional-age-at-length framework (Rudd et al. 2021) that both fits the length composition and enables estimation of growth internally to the assessment (e.g., McGilliard and Palsson 2017). In some cases, where age data is not available, length frequency samples which have been expanded to population abundance-at-length estimates are used directly as composition data within the assessment (e.g., McGilliard et al. 2019). Finally, recent developments have included using length frequency samples in a model-based framework to estimate length and age composition estimates (Thorson and Haltuch 2019, Ianelli et al. 2021, Thompson et al. 2021).

# Materials and Methods

## Survey data

Data collection for each AFSC groundfish survey is described in respective NOAA Technical Memorandum (EBS: Lauth et al. 2019, AI: von Szalay et al. 2017, GOA: von Szalay and Raring 2018). Length frequency protocols and recent analysis of sex-specific length frequency data are further described in Hulson et al. (2023). To facilitate age estimation, individual fish are processed at sea to record sex, length and weight and to remove sagittal otoliths that are returned the AFSC Age and Growth laboratory for age determination. Survey age sampling protocols are specific by fish species and follow 1 of 2 paradigms: 1) a stratified collection that is distributed over both the spatial frame of the stratification scheme and the expected size range of a species; or 2) a small subsample (3-6 fish, depneding on species) collected randomly per trawl. The protocol for some species has changed over the time series, which has followed a trend of transitioning from protocol 1) to protocol 2). Species within each survey that are assessed with statistical catch-at-age models were selected to be included in this analysis (Tier 3 stock assessments, Table 1). Data from AFSC bottom trawl surveys conducted in the EBS shelf (1982 to present), EBS slope (2002, 2004, 2008, 2010, 2012, and 2016), AI (1991 to present), and GOA (1990 to present) were used to estimate input sample size for each of these stock assessments in this study.

Two general categories of special cases for several stock assessments were also included in our analysis: 1) spatially-explicit assessments, and 2) assessments for species complexes. For the majority of stocks assessed at AFSC age population estimates are computed at the management area scale (e.g., the entire GOA, AI, or EBS), however, we note that there are two flatfish stock assessments that are spatially-explicit in the GOA (McGilliard and Palsson 2017, Bryan and Palsson 2021). While in the preceding equations we do not include a subscript for sub-region, population abundance-at-age can be estimated by sub-region through summing the population abundance-at-length in equation (5) across strata within the sub-region and applying equations (6) and (7) to specimen data that is subsetted to the sub-region. We have developed functions to estimate population abundance-at-age by sub-region, and by a combination of sub-regions within the GOA to allow for this flexibility in estimating population abundance-at-age. There are a handful of assessments conducted at AFSC that evaluate stocks at a complex level, where several species are included together in an assessment. There are two stock complexes at AFSC in which the species are combined and assessed within the same statistical catch-at-age model: blackspotted and rougheye rockfish in the GOA and AI (Spencer et al. 2020, Sullivan et al. 2021). Between the two management regions there are subtle differences in how the population abundance-at-age is estimated from the survey specimen data; we have developed functions that allow for these differences and estimate population abundance-at-age for these two stock complexes. In a similar case, while not assessed as a complex, over the historical bottom trawl sruvey in the GOA several species codes have been used for dusky rockfish. We have also developed a custom function that estimates population abundance-at-length and age for this case.

# CITATIONS

Ailloud, L.E., and Hoenig, J.M. 2019. A general theory of age-length keys: Combining the forward and inverse keys to estimate age composition from incomplete data. ICES Journal of Marine Science 76(6): 1515–1523.