**Equations used for purse-seine single species estimates (species: BET, YFT, and SKJ; for years 1975-1999)**

Source for equations (and most notation) and methodology: Tomlinson, P.K., Tsuji, S., and Calkins, T.P. 1992. Length-frequency estimation for yellowfin tuna (*Thunnus albacares*) caught by commercial fishing gear in the eastern Pacific Ocean. IATTC Bulletin 20 (6). <http://www.iattc.org/PDFFiles2/Bulletins/Bulletin-Vol.20-No.6.pdf>

For estimation procedures see the document: “single spp PS\_overview\_1975-1999.rtf” and the R functions in the workspace: “single spp PS\_R\_functions.RData”

**All equations assume that only one (single) species is being considered (which is in contrast to the species composition sampling methods). It is also assumed that estimates are being made for only one year at a time.**

Subscripting: *i* indexes wells, *k* indexes 1 cm bins of fish length, and *s* indexes splits within a well. The subscript *k* is only used for sample quantities that are collected per fish (*e*.*g*., length).

Catch strata are defined by: area, month and set-type x vessel size-class.

**Within-well estimates for a catch stratum** (used by R function: *well.estimates.f* )

*Non-split (non-sorted) samples* (see pages 361-362 of Tomlinson *et al*. 1992)

Estimate of the total number of fish in the *i*th well:

Estimate of the total number of fish in 1-cm length bin *k* from well *i*:

Well-level sample summaries are defined by:

where *wi* is the sum weights of measured fish in well *i* (from lengths converted to weights; see R function read.lfmmdata.f for details), is the average weight of fish (kg) in the sample (equivalently, the estimate of the average weight of a fish from well *i*), *mi* is the number of fish of measured in well *i*, *mik* is the number of fish in 1-cm length bin *k* measured from well *i*. *Wi*, the total well weight for the *i*th well is assumed known (from observer and/or logbook information).

*Split (sorted) samples*

Estimate of the weight (mt) of fish in split *s* from well *i* (*pcntis* is the percentage of total well catch that belongs to split *s* <to check with JDL if this is across well sampleno or not? Since different species of the same well got different wellsamplenos> ; it is assumed known):

< I think this equation can be deleted since Wi is known? Check with JDL>Estimate of the weight in well *i*:

Estimate of the number of fish in split *s* of well *i*:

Estimate of number of fish in well *i*:

Estimate of the number of fish in 1-cm length bin *k* of well *i* (*miks* is the number of fish in 1-cm length bin *k* measured from split *s* of well *i*):

Estimate of the average fish weight (kg) for well *i*:

**Stratum-level estimates for a catch stratum** (used by R function: *stratum.estimates.f* ; equ. (4) page 362 of Tomlinson et al. 1992)

Estimate of the number of fish in 1-cm length bin *k* for the stratum:

where *W* is the total catch for the stratum, *q* is the number of wells sampled for the stratum, is the estimate of the total number of fish in the stratum, and Is the average weight of all fish caught in the stratum.

Details of the calculations for *W* are provided in this paragraph. *W* is the *corrected* total fleet unloads for the species for the year, prorated to the catch stratum ( = corrected fleet species total x proportion CAE species-specific catch in the stratum). The proration is done with the CAE data (see R functions: read.cae.f, create.strat.flg.f, and get.strat.unloads.f). The corrected total fleet unloads for the species are calculated by the R function: get.corrected.unloads.f . The steps taken to compute the corrected total fleet unloads for each of the three tuna species are shown below (steps (iii) – (vi) are implemented by get.corrected.unloads.f):

1. get total *uncorrected* fleet unloads for each flag by species (*i*.*e*., run VB program in Miscellaneous; see file “single spp\_overview\_1975-1999.rtf”)
2. get correction factors for each flag x species (currently these are the correction factors from Pat Tomlinson in 2005, which were computed from his BSE estimates by flag for years 2000-2004; see “avg” tab in “CatchEstAdjustedDone2005.xlsx); these correction factors are the same for all years 1975-1999.
3. multiply the uncorrected unloads for each flag x species by its corresponding correction factor to produce adjusted flag x species unloads.
4. from output of (iii), compute the species proportions by flag.
5. multiply the proportions from (iv) by the total uncorrected unloads for all three species (= BET+YFT+SKJ) for each flag, to get the corrected total species unloads by flag.
6. sum the output of (v) over flags to get the corrected total species unloads for the year.

**Stock assessment ‘fishery’ estimates** (used by R function: *fishery.estimates.f*)

Estimate of the weight (mt) of catch in stock assessment ‘unit’ (= quarter x area-gear combination, Qu-Ar-Gr):

Estimate of the proportion of fish (from numbers) in 1-cm length bin *k* in stock assessment ‘unit’, **constructed using only those catch strata in *Qu*-*Ar*-*Gr* with at least the minimum number of samples (and with presence of species *i*), denoted by *cs\****:

The estimate of the proportion of fish in numbers by size above is only based on catch strata that had at least the minimum number of wells sampled (i.e., given by the parameter min.sampsize used by stratum.estimates.f).

The sums above are over months with quarter Qu, catch areas within stock assessment area Ar, and catch gears within stock assessment gear Gr (e.g., catch gears 2 and 5 make up stock assessment gear “FO”).

Currently, substitution is not done for single species estimation because the stock assessments do not use size comps from catch strata with no sample data, and the total stratum catch by species is obtained by prorating the fishery total to catch strata with proportions from the CAE.

**Some brief notes on differences between what is done above and what Pat Tomlinson probably did to estimate species catch by strata (based on conversations and emails with Pat in 2015)**

1. Because of a concern about under-reporting of bigeye tuna in the logbook data, Pat added bigeye catches from the landings data base (for Ecuadorian boats) into his version of the logbook data. Since information on the area and months of the catches is not available in the landings data base, Pat arbitrarily assigned these catches to sampling areas (area 6?) and months, based on his opinion of what was most likely. This will change the proportion of bigeye catches in the sampling strata (relative to what is in the official logbook data base), and hence the allocation of bigeye fleet catch to strata.
2. Pat’s algorithm for allocating logbook mixed-species catches to individual species may not be the same as what is currently done (as of 2015) by Bob Sarazen’s programs to generate the CAE. Per Pat, this will have the greatest effect on yellowfin and skipjack.