Summary of purse-seine data available for tropical tunas in the eastern Pacific Ocean

2nd External review of the stock assessment of yellowfin tuna in the EPO, La Jolla, California USA, 2-8 December 2019

Presentation overview

- Data sources
  - Canner/processor
  - Logbook
  - Observer
  - At-sea reports
  - Port-sampling

- Estimated quantities
  - Catch
  - Discards
  - Indices of relative abundance
  - Length composition

Data sources

- Canner/processor
  - Primary source for total fleet catch (weight)
  - Supplemented with other data sources
  - Does not include information on fishing area, set type or month/day

- Logbook
  - Set-level information:
    - Retained catch (weight)
    - Purse-seine set type
    - Date and location of fishing

Data sources

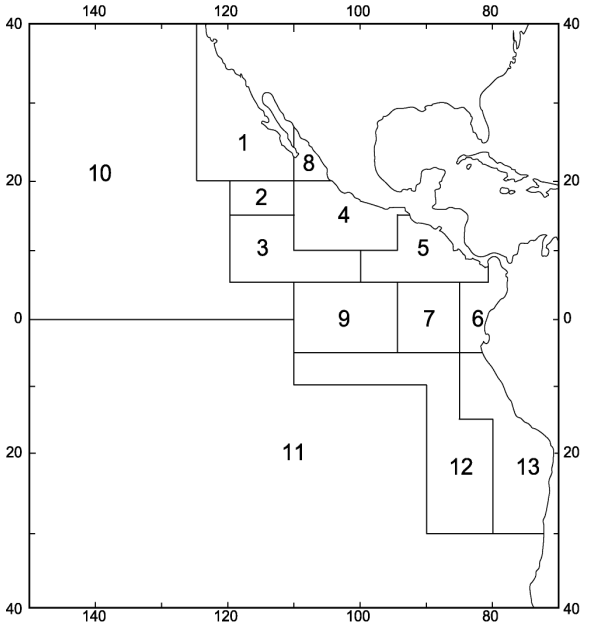
- Observer
  - Primarily large purse-seine vessels (> 363 t)
  - Coverage at or nearly 100% since 1992
  - Detailed data:
    - Vessel activities, operational information
    - Retained catch, discards (weight)
    - Fishing locations, dates, set types
- At-sea reports
  - Preliminary set-level catch (weight)
  - Includes set type, date, 5° area

Year	Total Number of Trips	Trips Sampled by the IATTC	Trips Sampled by National Programs	Combined Sampling Coverage (%)
1980	532	66	45	20.9
1981	447	60	37	21.7
1982	328	48	32	24.4
1983	248	33	0	13.3
1984	331	24	11	10.6
1985	381	47	23	18.4
1986	396	94	20	28.8
1987	473	125	80	43.3
1988	503	159	33	38.2
1989	543	194	73	49.2
1990	539	223	41	49.0
1991	425	237	26	61.9
1992	427	279	140	98.1

From Joseph 1994

Data sources

- Port-sampling
  - Two-stage sampling (vessel well; fish within a well)
  - Opportunistic, but catch in well must all be from same stratum
  - Strata: month x sampling area x set type x vessel size category
  - Well-level data:
    - Length composition (1975-1999)
      - Well sample: measurements of ~ 50 fish per species
    - Species and length composition (from 2000)
      - Counts for species composition
      - Separately, fish selected for length measurements
      - Well sample:
        - measurements of ~ 50 fish per species;
        - counts of 100+ fish for species composition.
    - Catch in the well (weight)



Estimated quantities

- Total catch
  - Estimated for sampling strata.
  - For assessment: stratum estimates summed over sampling areas and months.

  - 1975-1999
    - Catch sources: canner/processor; observer; logbook.
    - Species composition believed to be inaccurate, but no port-sampling data for species composition available.
    - Therefore, species composition adjusted based on average ratios by species computed from species composition estimates of later years (2000 - 2004).
    - Adjusted total species catch prorated to sampling strata using species stratum proportions computed from observer and logbook data.

Estimated quantities

- Total catch
  - From 2000
    - Catch (BET+SKJ+YFT) sources: canner/processor; observer; logbook
    - Observer and logbook data used to prorate BET+SKJ+YFT catch to sampling strata.
    - Port-sampling data used to estimate the species composition by stratum, considering different average weights among species $\left(\frac{w_{ij}}{m_{ij}}\right)$ and that sample species proportions $\left(\frac{n_{ij}}{n_{.j}}\right)$ are from numbers not weight:

$$\widehat{W}_i = W\left(\frac{\sum_j^q \widehat{W}_{ij}}{\sum_j^q W_j}\right) = W\left(\frac{\sum_j^q W_j\left(\frac{\left(\frac{w_{ij}}{m_{ij}}\right)\left(\frac{n_{ij}}{n_{.j}}\right)}{\sum_i^s\left(\frac{w_{ij}}{m_{ij}}\right)\left(\frac{n_{ij}}{n_{.j}}\right)}\right)}{\sum_j^q W_j}\right)$$

Estimated quantities

- Discards
  - Source: observer data, by three weight categories (since 1993).
  - Assumptions
    - Discards due to:
      - inefficiencies in fishing process that affect all sizes of fish (rotten catch; catch exceeds storage capacity);
      - size selection (assume small fish less desirable).
    - All discarded fish die.
  - Regulations since 2000 may have led to decrease in discards.

Estimated quantities

- Discards
  - By fishery and quarter (from 1993):
    - Adjust total catch estimates upwards for inefficiencies, using discard rate for medium + large fish;
    - Estimate total discards of small fish due to size sorting, using discard rate adjusted for inefficiencies.
  - Total discards of small fish:
    - Only estimated for floating-object fisheries;
    - Modelled as separate fisheries in assessment (assume different selectivities).

Estimated quantities

- Indices of relative abundance
  - Sources: 1) observer data; 2) logbook data.
  - Based on retained catch and days fished.
  - Catch data are uncorrected for species composition.
  - Large purse-seine vessels only.

  - Index is nominal catch per day fished.
  - Assessment fisheries are set type-specific.
  - However, vessels can make different types of sets in the same day/trip.
  - Thus, time spent fishing using specific set types is unknown and must be estimated.

Estimated quantities

- Indices of relative abundance
  - Estimates of days fished by set type for each year:
    - Fit model (*i*: sample area x month): $D_i = \beta_{FO} FO_i + \beta_{UA} UA_i + \beta_{DOL} DOL_i$
    - Compute estimates of days fished for *j*th year x quarter x fishery area:

$$D_{FO,j} = \hat{\beta}_{FO} FO_j$$
$$D_{UA,j} = \hat{\beta}_{UA} UA_j$$
$$D_{DOL,j} = \hat{\beta}_{DOL} DOL_j$$

where FO_j, UA_j and DOL_j are the sum over sample areas and months that correspond to fishery stratum *j* of the number of floating-object, unassociated and dolphin sets, respectively.

    - By stratum, total predicted days fished are rescaled to equal total observed days fished.
    - Index value for stratum *j* = sum of catch in stratum *j*/predicted days fished in stratum *j*

Estimated quantities

- Length composition of the catch
  - Estimates are numbers of fish in 1 cm length bins.
  - Estimated numbers at length are obtained by multiplying the well-level estimates of proportion at length, combined across sampled wells (*j*), by the estimated total catch in numbers for the species (*i*) in the stratum.

- 1975-1999

$$\widehat{N}_{ik} = \widehat{N}_i \hat{f}_{ik} = \left(\frac{W_i}{\overline{w}_{i.}}\right)\left(\frac{\sum_j^q \widehat{N}_{ijk}}{\sum_j^q \widehat{N}_{ij.}}\right)$$

- From 2000

$$\widehat{N}_{ik} = \widehat{N}_i \, \hat{f}_{ik} = (\widehat{N} \, \hat{f}_i)\left(\frac{\sum_j^q \widehat{N}_{ijk}}{\sum_j^q \widehat{N}_{ij.}}\right)$$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Estimated quantities

- Details of species composition correction for total catch, 1975-1999
  - Compute country-specific species correction factors from 2000 – 2004 estimates:
    rbar_spp = sum of cor. spp catch for years 2000-2004/sum of uncor. spp catch for years 2000-2004.
  - Correcting country-specific catch by species for year i (i = 1975, …, 1999):
    - Compute adjusted catch for each species:
      adj_spp_i= rbar_spp x uncor_catch_spp_i
    - Compute species proportion:
      p_spp_i = asj_spp_i/sum over species (adj_spp_i)
    - Corrected species estimate = p_spp_i x sum over species (uncor_catch_spp_i)
  - Corrected fleet estimate for a species for year i is the sum of country estimates.

Estimated quantities

- Discards
  - Adjusted for inefficiencies

$$C_B = landings \times \left(1 + \frac{D^o_{m\&l}}{C^o_{m\&l} - D^o_{m\&l}}\right)$$

$D^o_{m\&l} = observed\ discards\ of\ medium\ and\ large\ bigeye$

$C^o_{m\&l} = observed\ catch < capture >\ of\ medium\ and\ large\ bigeye$

  - Size selection (assuming small fish less desirable)

$$D_E = landings \times \left(\frac{D^o_s}{C^o_T - D^o_T} - \frac{D^o_{m\&l}}{C^o_{m\&l} - D^o_{m\&l}}\right)$$

$D^o_s = observed\ discards\ of\ small\ bigeye$

$C^o_T = observed\ catch\ < capture > of\ all\ bigeye$

$D^o_T = observed\ discards\ of\ all\ bigeye$

Estimated quantities

- Indices of relative abundance

The number of days fished by set type was estimated from the number of sets, using a multiple regression of total days fished against number of sets by set type (Maunder and Watters, 2001).

$$D_i = \beta_{FO} FO_i + \beta_{UA} UA_i + \beta_{DOL} DOL_i + \varepsilon_i$$

Where D is the days fished, FO is the number of floating object sets, UA is the number of unassociated sets, DOL is the number of dolphin associated sets, the betas are the coefficients of the regression and ε is normally distributed. The regression is calculated separately for each year. The data points in the regression are the sampling area-month strata, and are weighted by the days fished. The number of days fished by set type can then be estimated

$$D_{FO,j} = \beta_{FO} FO_j$$
$$D_{UA,j} = \beta_{UA} UA_j$$
$$D_{DOL,j} = \beta_{DOL} DOL_j$$

where $D_{FO,j}$ is the number of days fished on floating objects in a strata (year, quarter, and fishery) *j*.
The total predicted number of days fished from the regression will differ from the total observed number of days fished for that stratum. Therefore, we rescale the days fished to equal the observed days fished.

Estimated quantities

- Length composition
- 1975-1999

$$\hat{N}_{ik} = \hat{N}_i \hat{f}_{ik} = \left(\frac{W_i}{\overline{w}_{i.}}\right)\left(\frac{\sum_j^q \hat{N}_{ijk}}{\sum_j^q \hat{N}_{ij.}}\right) = \left(\frac{W_i}{\left(\frac{\sum_j^q W_{ij}}{\sum_j^q \left(\frac{W_{ij}}{\overline{w}_{ij}}\right)}\right)}\right)\left(\frac{\sum_j^q \hat{N}_{ijk}}{\sum_j^q \hat{N}_{ij.}}\right) = \left(\frac{W_i}{\left(\frac{\sum_j^q W_{ij}}{\sum_j^q \left(\frac{W_{ij}}{\overline{w}_{ij}}\right)}\right)}\right)\left(\frac{\sum_j^q \left(\frac{W_{ij}}{\overline{w}_{ij}}\right)\left(\frac{m_{ijk}}{m_{ij}}\right)}{\sum_j^q \left(\frac{W_{ij}}{\overline{w}_{ij}}\right)}\right)$$

- From 2000

$$\hat{N}_{ik} = \hat{N}_i\, \hat{f}_{ik} = \left(\hat{N}\, \hat{f}_i\right)\left(\frac{\sum_j^q \hat{N}_{ijk}}{\sum_j^q \hat{N}_{ij.}}\right) = \left[\left(\frac{W}{\left(\frac{\sum_j^q W_j}{\sum_j^q \hat{N}_{.j.}}\right)}\right)\left(\frac{\sum_j^q \hat{N}_{ij.}}{\sum_j^q \hat{N}_{.j.}}\right)\right]\left(\frac{\sum_j^q \hat{N}_{ijk}}{\sum_j^q \hat{N}_{ij.}}\right) = W\left(\frac{\sum_j^q W_j \left(\frac{1}{\sum_i^s \left(\frac{w_{ij}}{m_{ij}}\right)\left(\frac{n_{ij}}{n_{.j}}\right)}\right)\left(\frac{n_{ij} m_{ijk}}{n_{.j}\, m_{ij}}\right)}{\sum_j^q W_j}\right)$$

From SARM-10-09

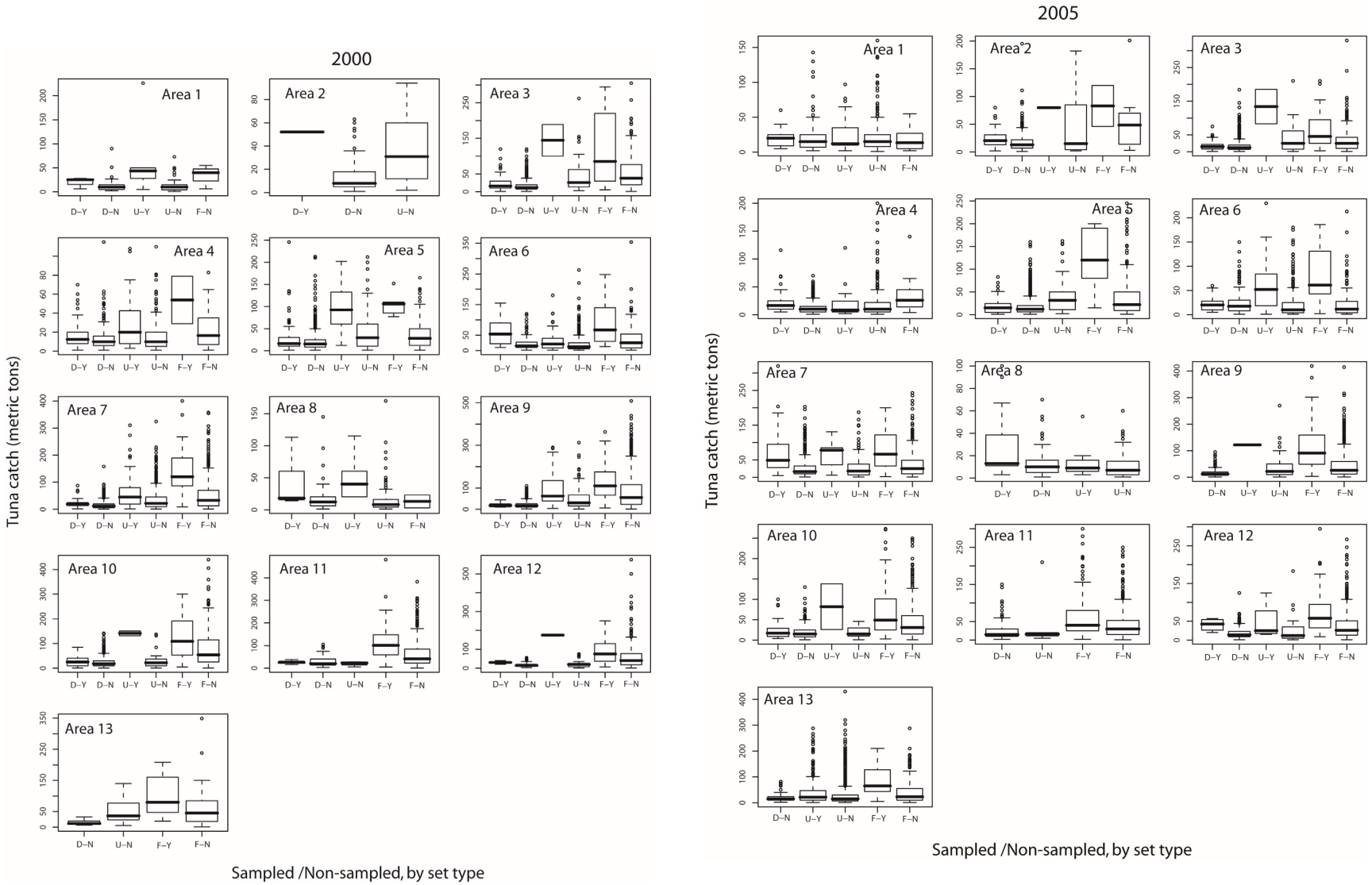


FIGURE 1. Box-and-whisker plots of tuna catch in 'sampled' and 'non-sampled' sets, by set type, for each area of years 2000 and 2005. The sum of retained catches of yellowfin, skipjack and bigeye tuna is shown on the y-axis (note that y-axis ranges differ by panel). Box labels on the x-axis are as follows: D-Y: dolphin set, sampled; D-N: dolphin set, non-sampled; U-Y: unassociated set, sampled; U-N: unassociated set, non-sampled; F-Y: floating object set, sampled; F-N: floating object set, non-sampled. Data within each area have been pooled over months for the year; each panel corresponds to a different sampling area.

From SARM-10-09

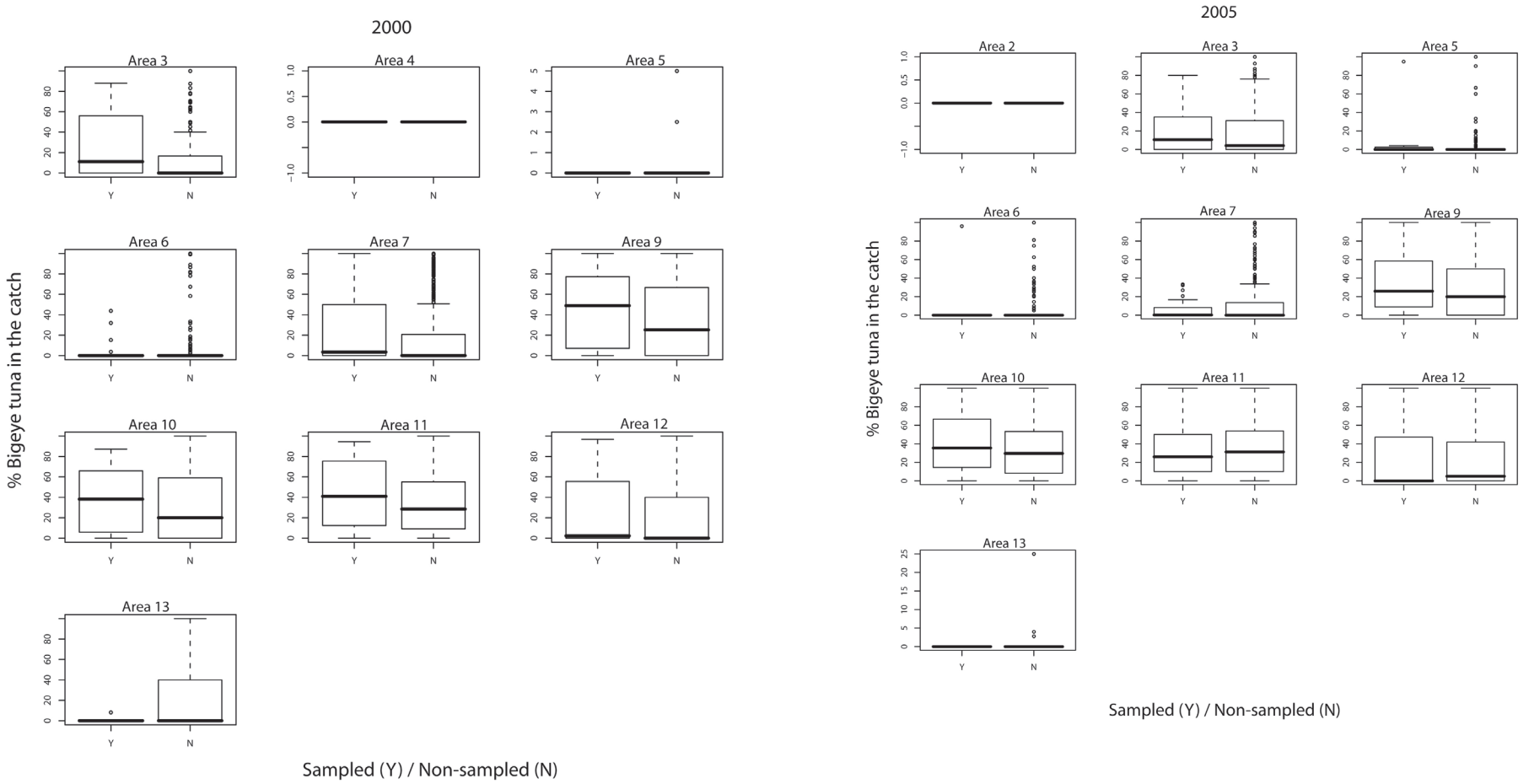


FIGURE 2. Box-and-whisker plots of the percentage of bigeye tuna in the catch of 'sampled' and 'non-sampled' sets, for each area of years 2000 and 2005. The amount of bigeye tuna divided by the sum of yellowfin, skipjack and bigeye tuna is shown on the y-axis (note that y-axis ranges differ by panel). Box labels on the x-axis are as follows: Y - sampled; N - non-sampled. Data within each area have been pooled over months for the year; each panel corresponds to a different sampling area.

From SARM-10-09

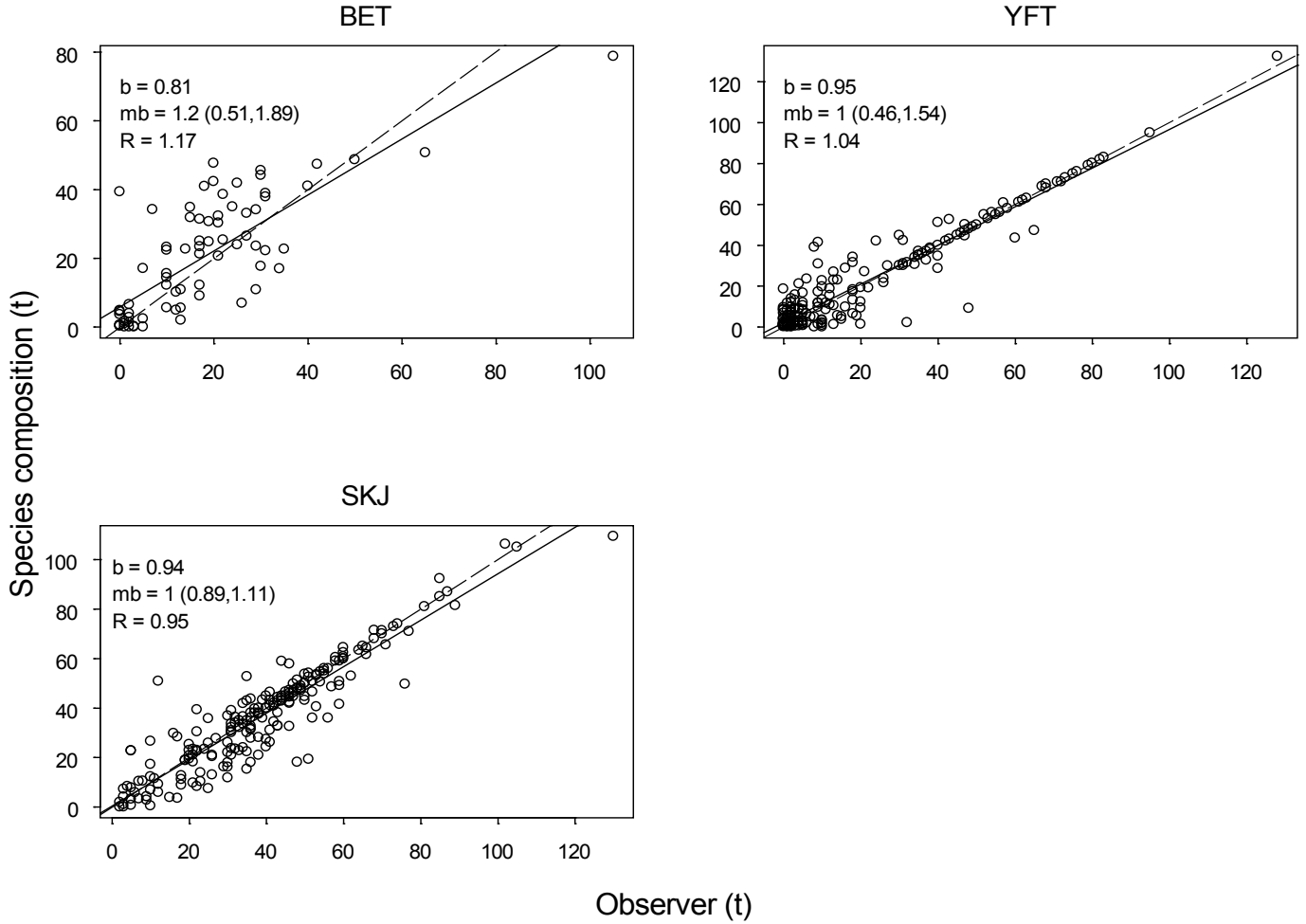
TABLE 2. Test statistics, randomization test *p*-values, and average annual differences between sampled and non-sampled sets, for the occurrence of bigeye tuna in the catch. The average difference is the sum of stratum differences divided by the number of strata. TPM is the truncated product method estimate of the global *p*-value (see text for explanation).

	Number of strata	Sum of differences in stratum means; *p*-value	Average difference (%)	Sum of differences in stratum medians; *p*-value	Average difference (%)	Sum of differences in stratum proportions; *p*-value
2000	8	52; 0.04	6.5	88; 0.03	11.0	0.58; 0.07
2001	30	-15; 0.72	-0.5	26; 0.76	0.9	0.69; 0.23
2002	25	87; 0.01	3.5	179; <0.01	7.2	0.80; 0.10
2003	21	30; 0.22	1.4	35; 0.24	1.7	1.36; <0.01
2004	7	36; 0.03	5.1	31; 0.18	4.4	0.34; 0.09
2005	15	-0.2; 0.99	-0.01	-11; 0.76	0.7	0.48; 0.16
2006	33	23; 0.56	0.7	136; 0.02	4.1	1.44; <0.01
2007	25	-4; 0.92	-0.2	74; 0.28	3.0	1.04; 0.02
	TPM *p*-value	0.13		0.04		0.01

From Suter et al. 2004

Level	Comparisons	Limitations
Well level	Observer to species composition, 2003 only	Information for 2000 – 2002 available, but not keypunched
Trip level	Observer to logbook to unloading, 1995 - 2003	Only for all trips where all data sources available
Sampling strata level	Unloading to species composition, 2000 - 2003	Unloading data must be stratified based on observer or logbook data

Figure 2: 2003 well level comparison



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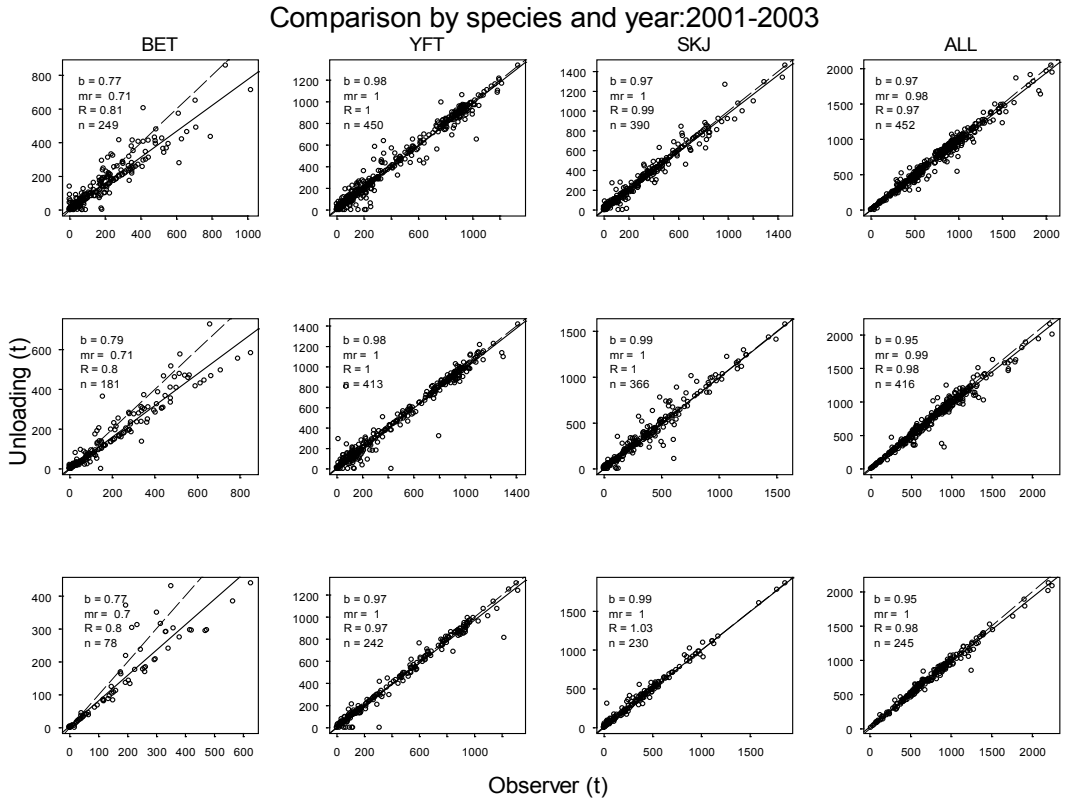

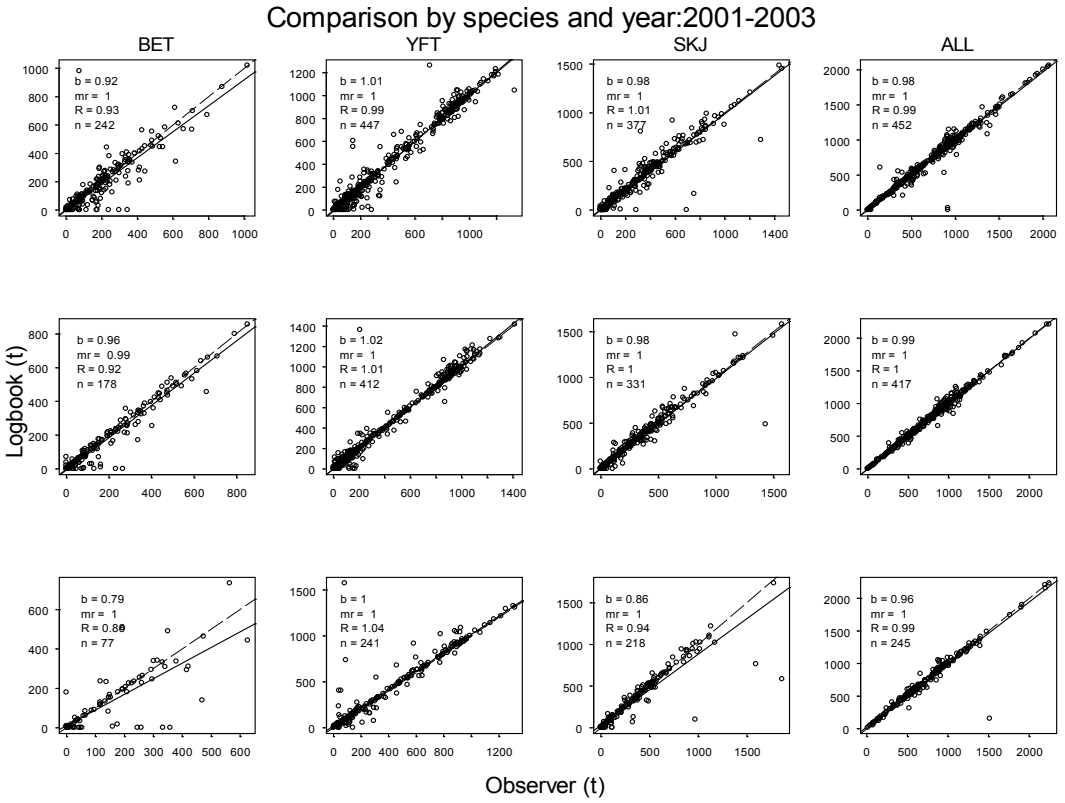

From Suter et al. 2004