CHANGES IN LONGLINE SIZE-FREQUENCY DATA
AND THEIR EFFECTS ON THE STOCK ASSESSMENT MODELS FOR
YELLOWFIN AND BIGEYE TUNAS
(Document SAC-07-04a)

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Comisión Interamericana del Atún Tropical (CIAT)
Inter-American Tropical Tuna Commission (IATTC)

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Outline

- Background
- Goals
- Database update
- Model runs
- Results
- Conclusion
- Recommendations

Background

- Stock assessments using integrated statistical age-structured stock assessment models (SS3)
- Unified framework, simultaneously fit indices of abundance, size-composition giving assumptions and catches
- For yellowfin and bigeye tuna use longline catches per unit of effort as main index of abundance
- Longlines catches account for about 1/3 of bigeye tuna catches
- Size-frequency data of longline catches is a key piece of information

Background

- Traditionally the size-frequency data for the Japanese fleet to represent the longline fleets in the models.
- Japan provided the size data as length-frequencies
- A pattern was evident in these data, mainly for bigeye but to some extent for yellowfin, which consisted of smaller fish being caught prior to 1990 and larger fish after

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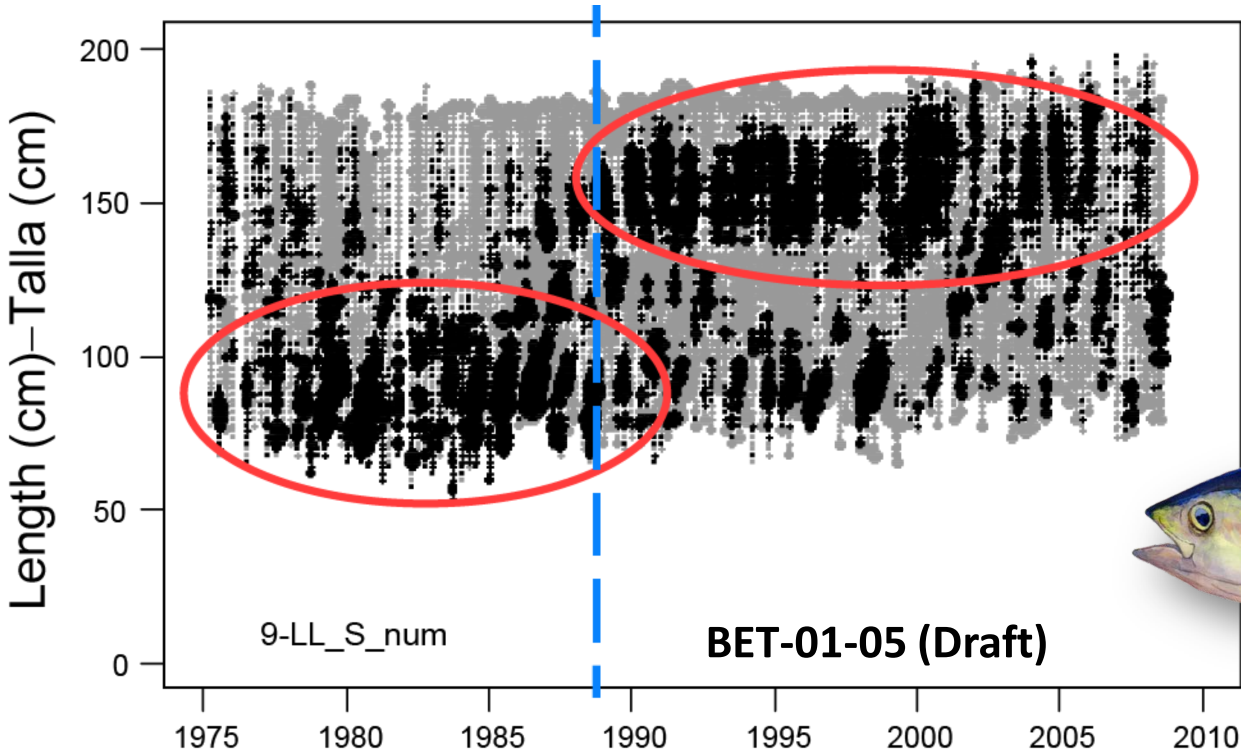
Background: prominent residual pattern



Pearson residual plots for the model fit to the length-composition data for the Southern longline fishery assumed in the 2009 base-case assessment for bigeye tuna.

From: Aires-da-Silva, A., M.N. Maunder, and C.E. Lennert-Cody. 2010. An investigation of the longline length-frequency residual pattern in the stock assessment of bigeye tuna in the eastern Pacific Ocean. IATTC. External Review of IATTC Bigeye Tuna Assessment. BET-01-05 (Draft).

Background

SAC-07-03d

Satoh, K., C.V. Minte-Vera, N.W. Vogel, A. Aires-da-Silva, C.E. Lennert-Cody, M.N. Maunder, H. Okamoto, K. Uosaki, T. Matsumoto, Y. Semba, and T. Ito. 2016. An exploration into Japanese size data of tropical tuna species because of a prominent size-frequency residual pattern in the stock assessment model. Inter-Amer. Trop. Tuna Comm., 7th Scient. Adv. Com. Meeting.

Conclusion:

- Differences in size composition between the periods pre- and post-1990 may be an artifact of the predominant methodology for size sampling and reporting of a combination:

  from commercial longlines:

  - gilled-and-gutted weight converted to fork length
  - fork length

  from training vessels:

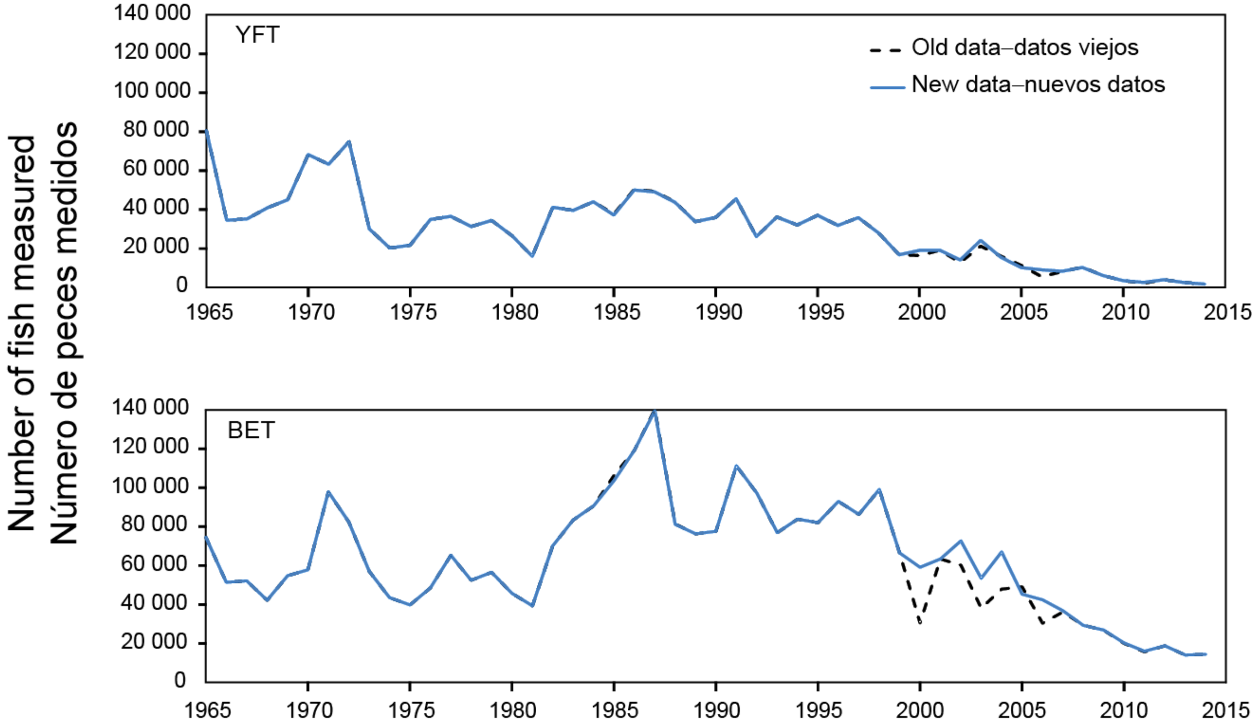
  - fork length

Fev 2016: Japan submitted the raw data by vessel category to the IATTC

Goals

- Explore the best way to incorporate the new size-frequency data into the stock assessment models for yellowfin and bigeye in the EPO
- Analyze the effect on the model estimates

Database update



Number of size measurements in the IATTC database before and after the submission of detailed data by Japan.

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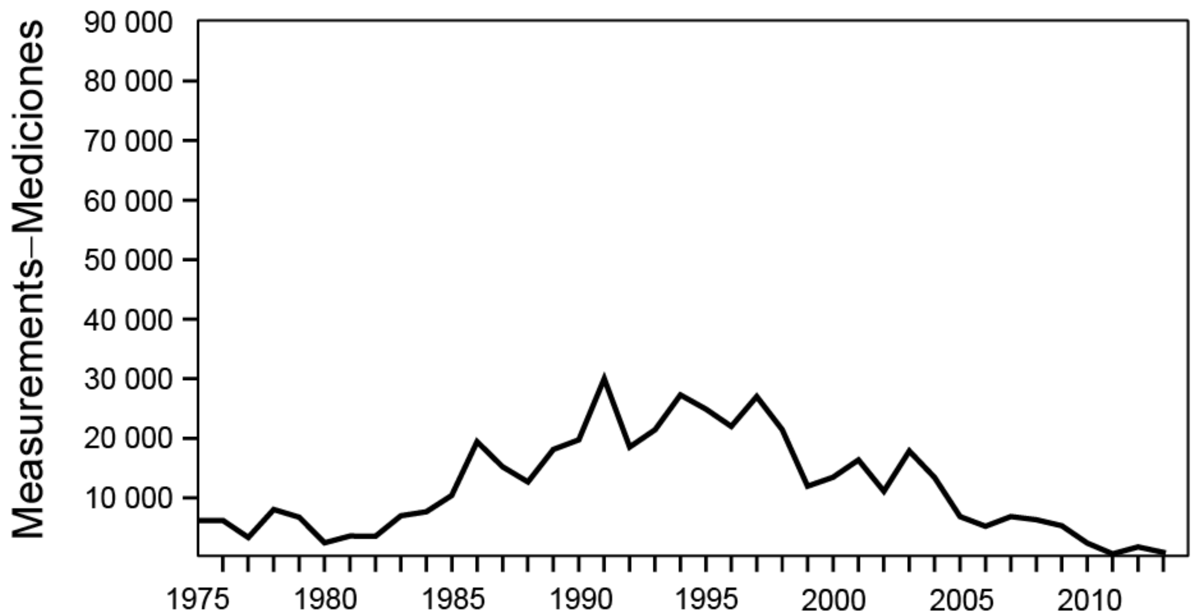
Details about the data

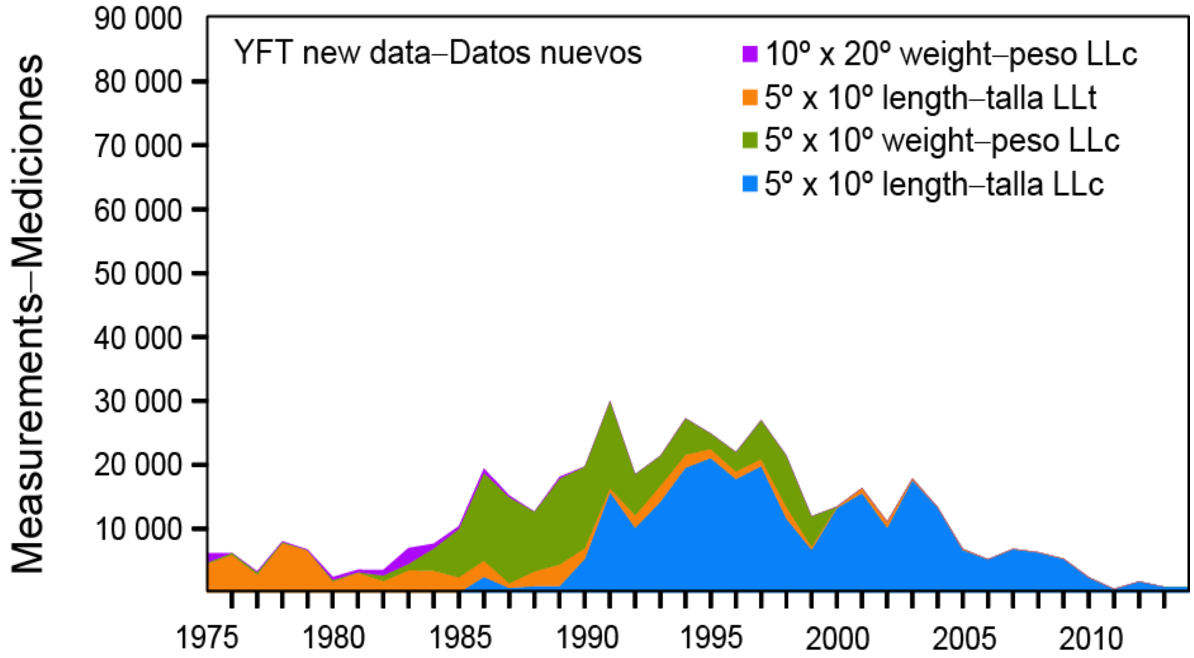
Yellowfin tuna



LLc: commercial longline vessel
LLt: longline training vessel

Details about the data

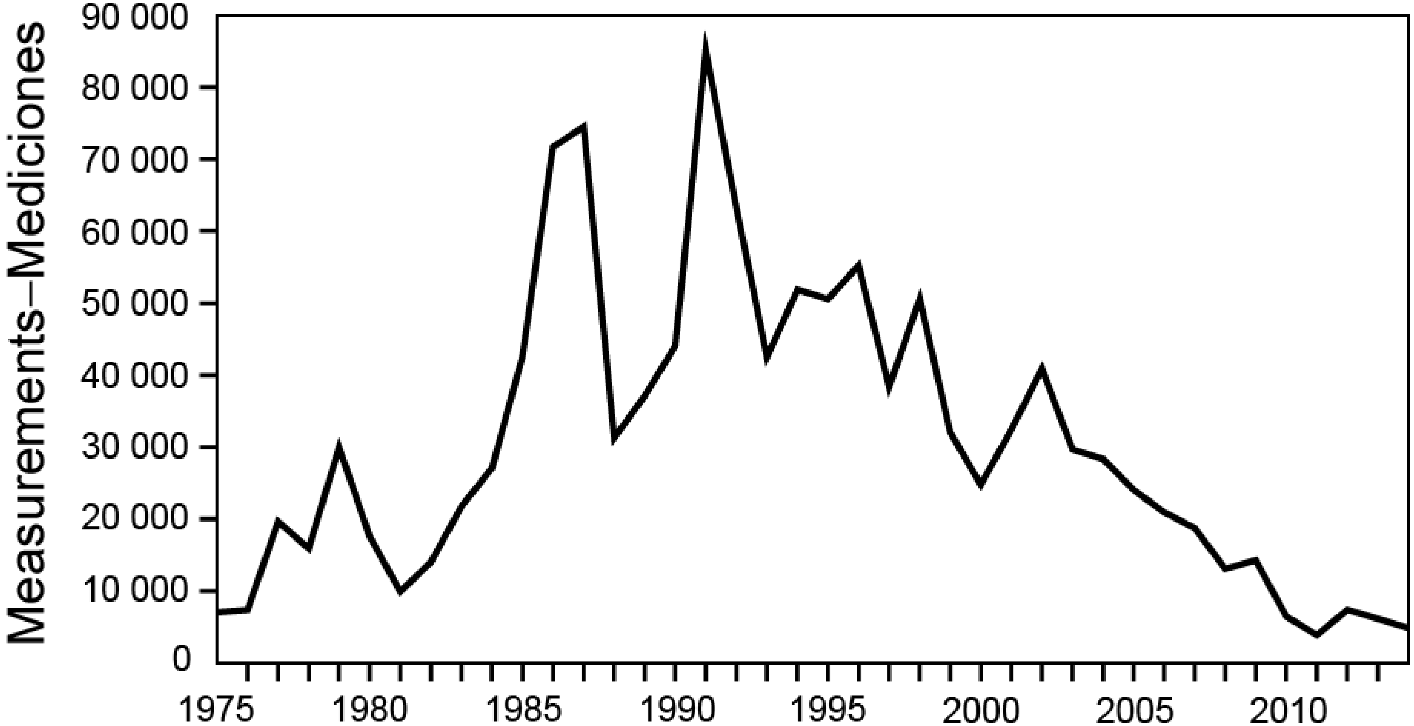
Yellowfin tuna



LLc: commercial longline vessel
LLt: longline training vessel

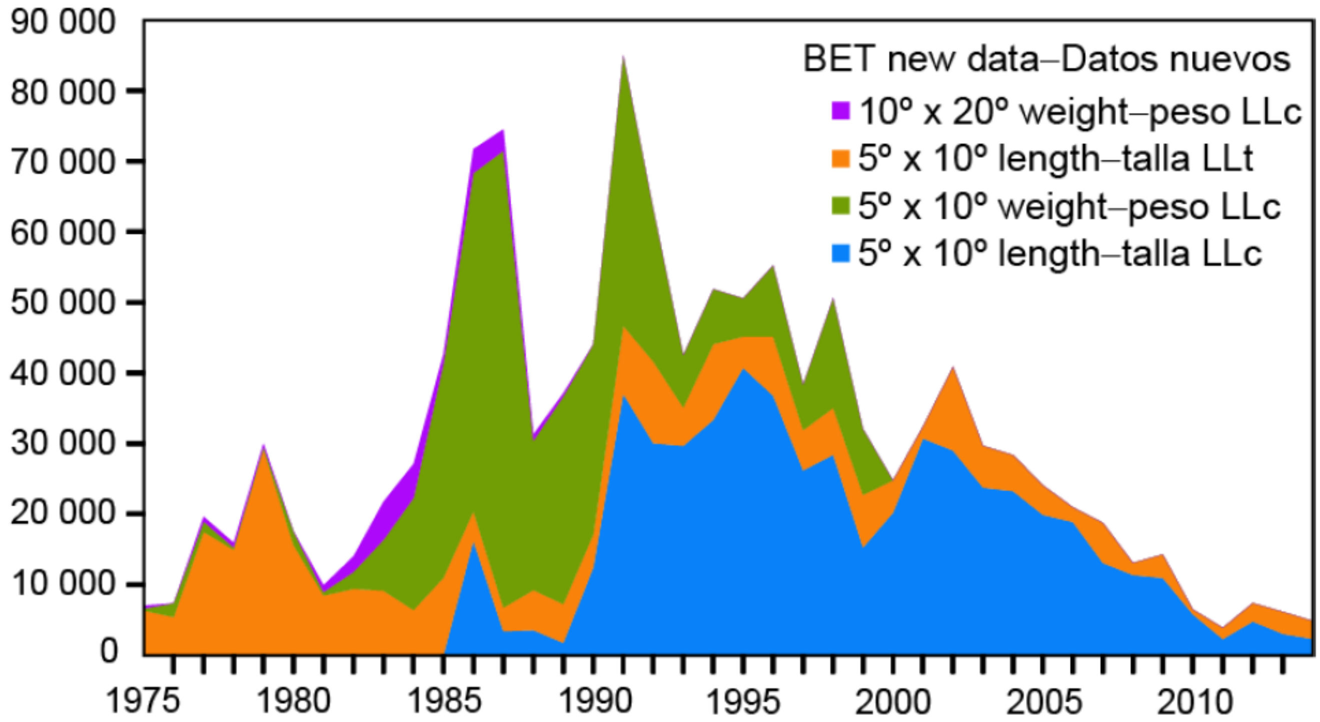
Details about the data

Bigeye tuna



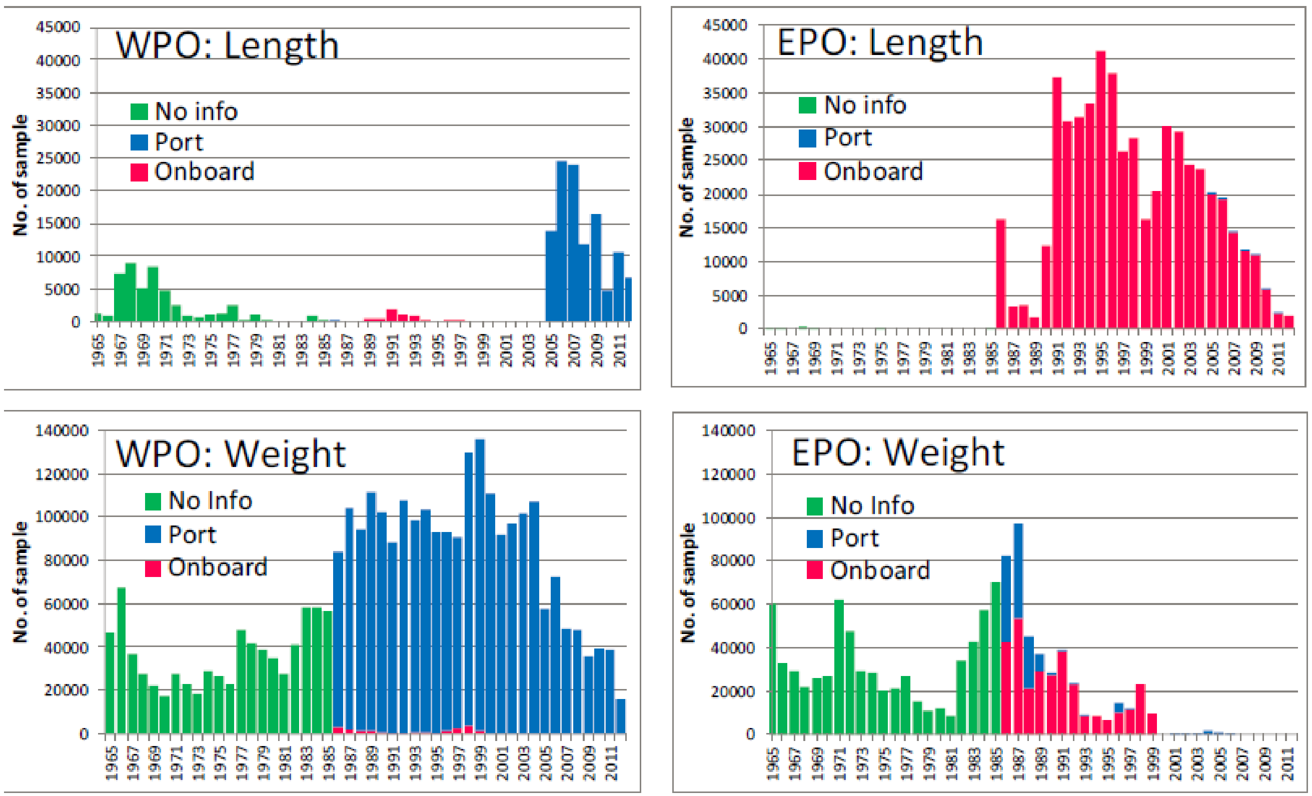
Details about the data

Bigeye tuna



Details about the data

Type of size measurement by area in the Pacific Ocean



Okamoto (2014) SAC-05 INF-D

WCPO assessments : mainly use weight-frequency data
EPO: length-frequency data dominates in recent years

Methods: data preparation

Gilled-and-gutted processing

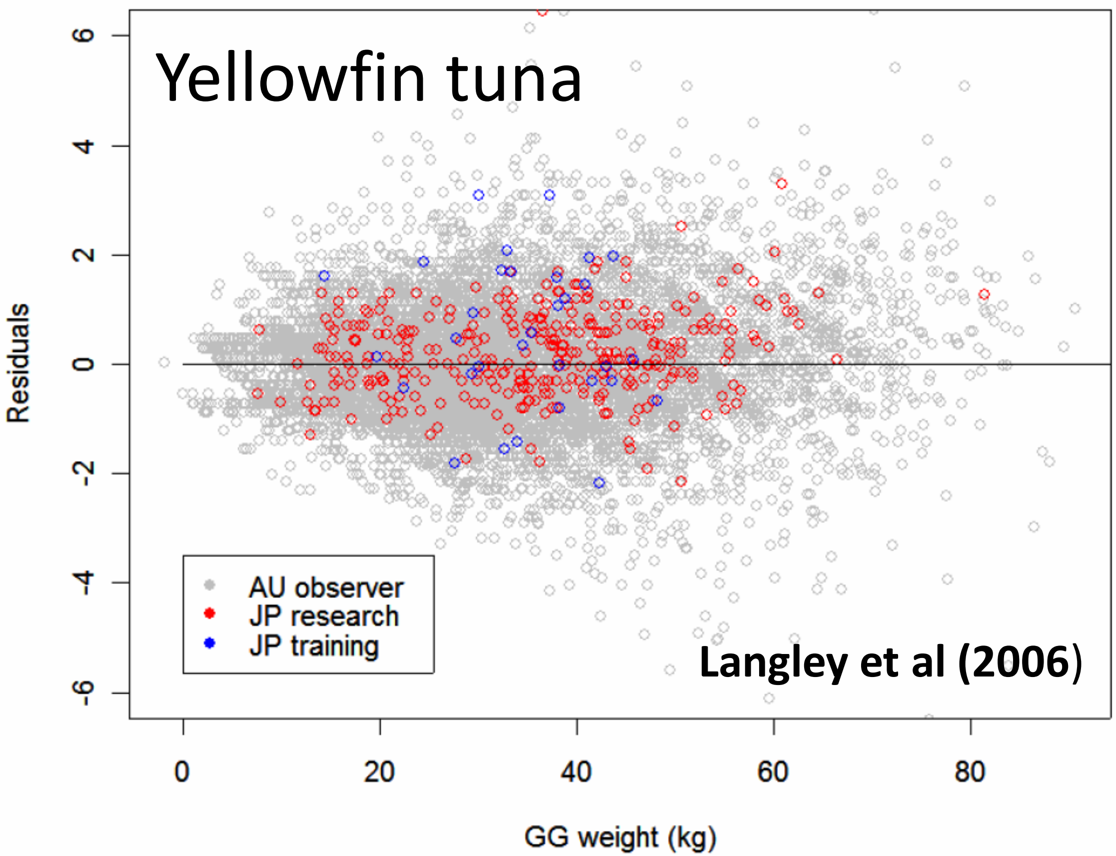
Photo credit: Peter Sharples, OFP.
Source: Langley et al (2006)

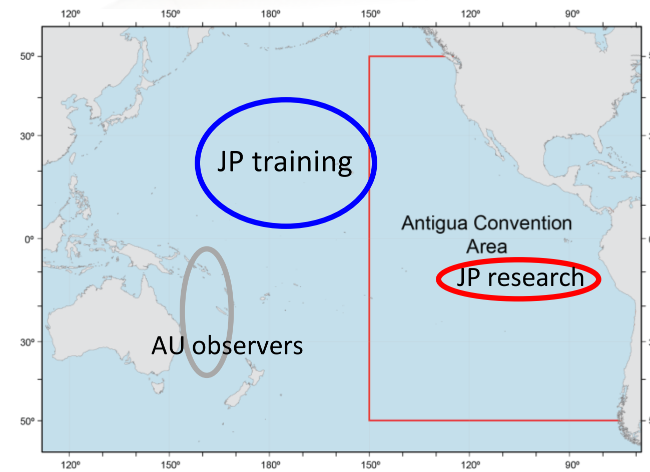
Methods: data preparation

Photo credit: Fabrice Bouyé, OFP,
Source: Langley et al (2006)

Gilled-and-gutted processing conducted by Japanese distant-water freezer vessels

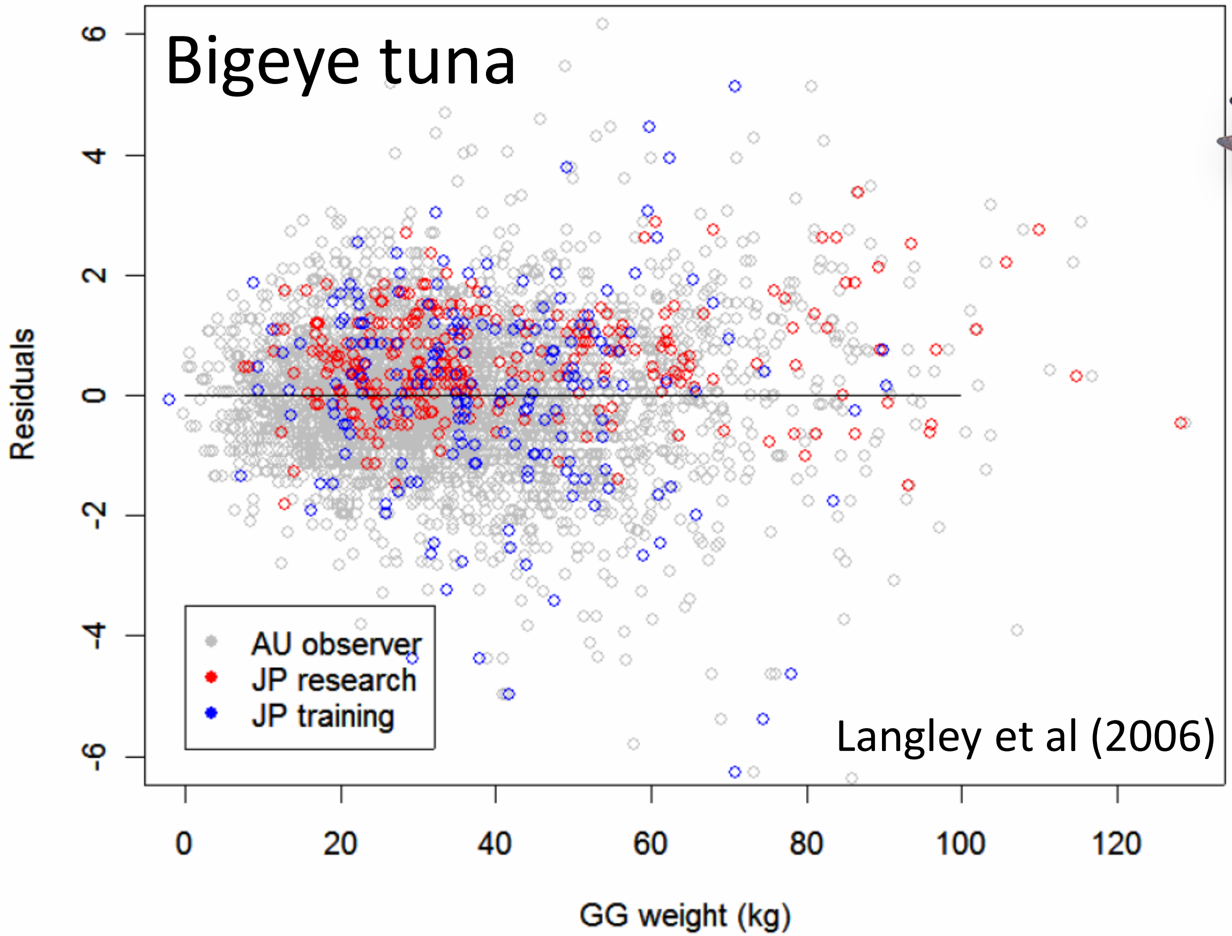
Methods: conversion factors

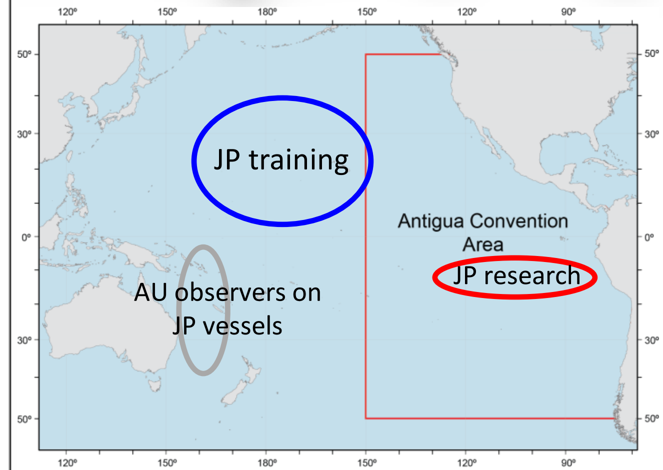




Residuals (observed - expected) of the fit between processed (GG) weight and whole weight for **yellowfin** from three datasets combined

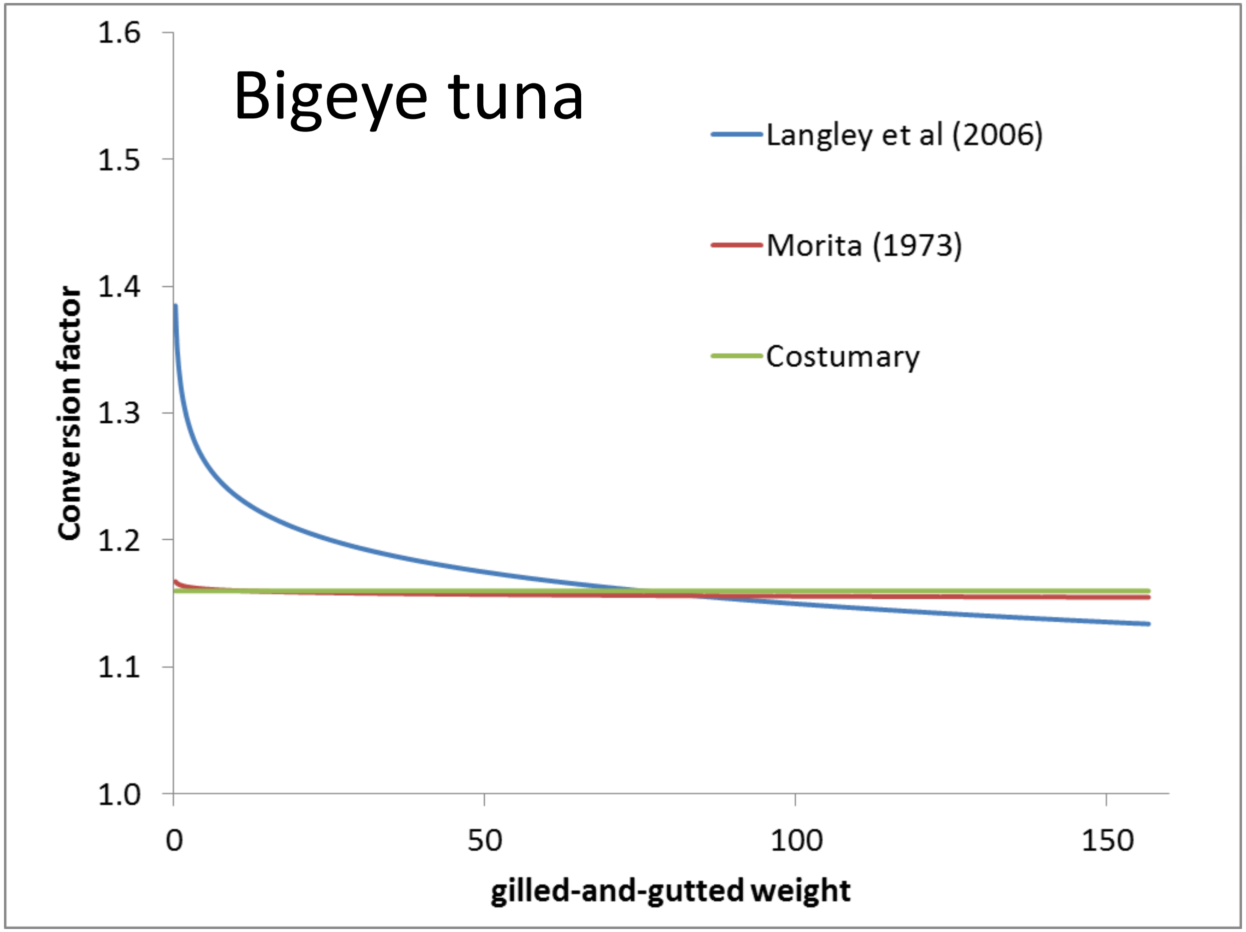
Methods: conversion factors





Residuals (observed - expected) of the fit between processed (GG) weight and whole weight for bigeye from three datasets combined

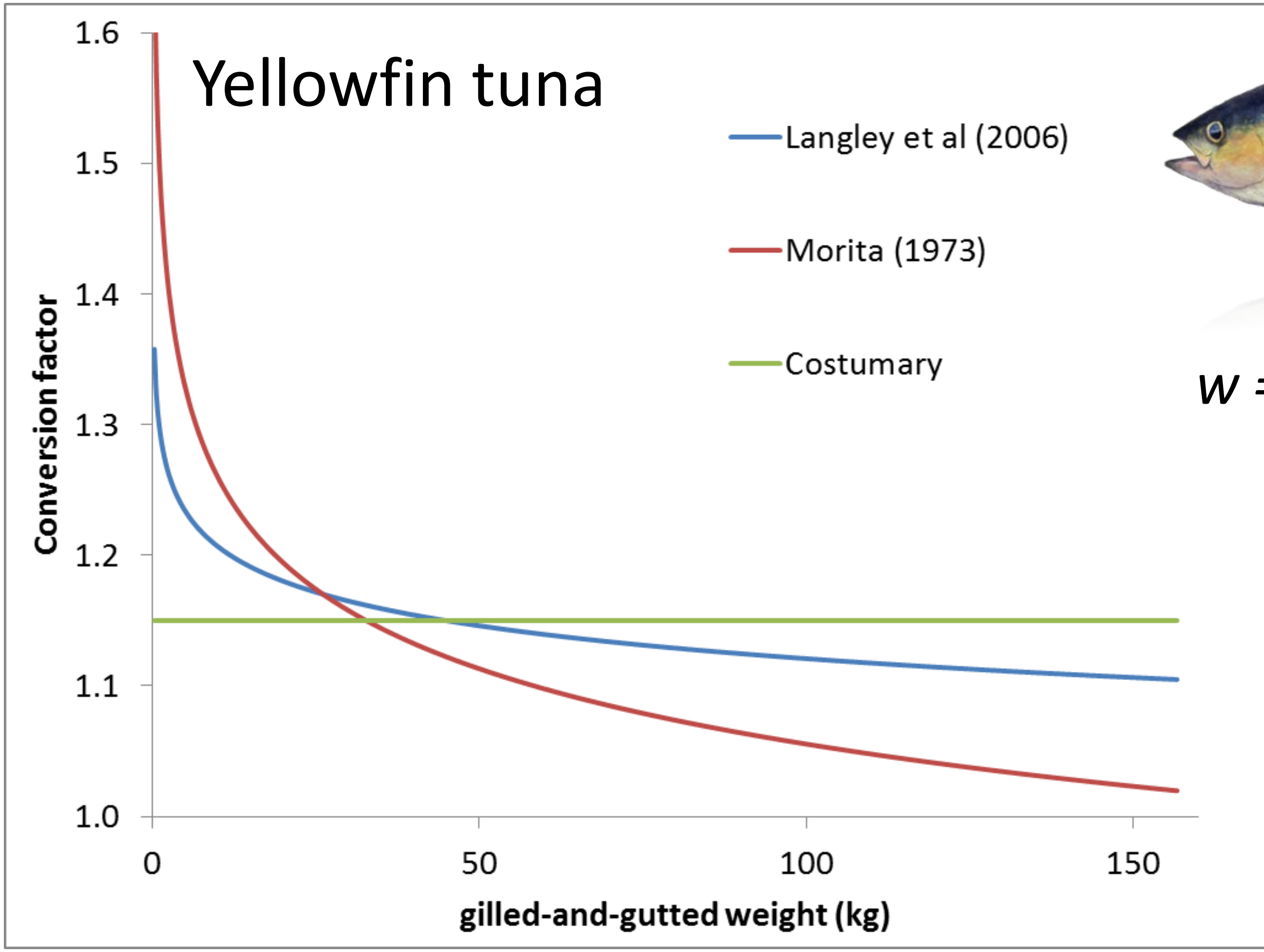
Methods: conversion factors



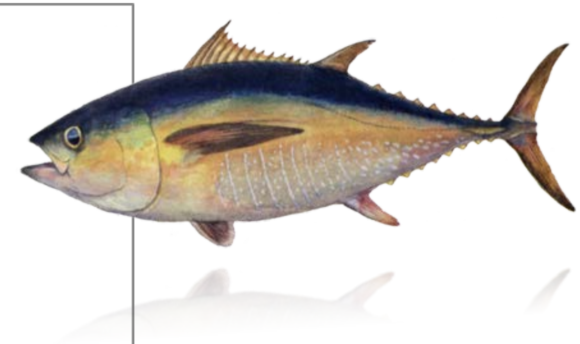
$$w = 1.3264 * GGw^{0.969}$$

Conversion factor for the whole Pacific Ocean Langley et al (2006)

Methods: conversion factors



Langley et al (2006)



$$w = 1.2988 * GGw^{0.968}$$

Conversion factor for the whole Pacific Ocean Langley et al (2006)

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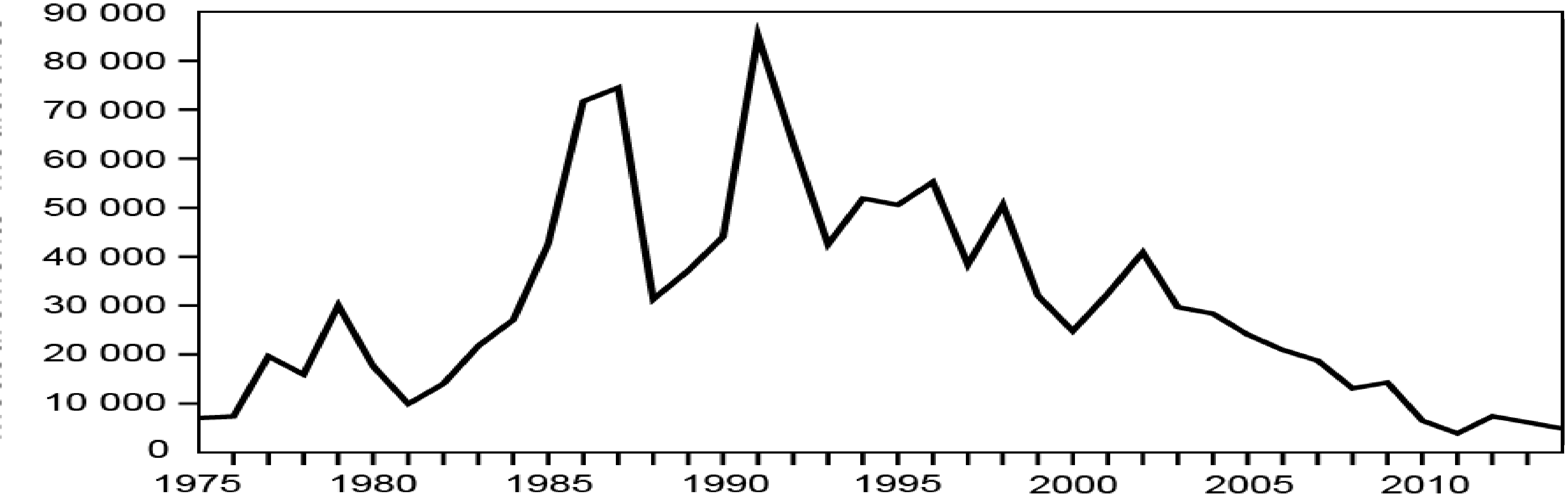
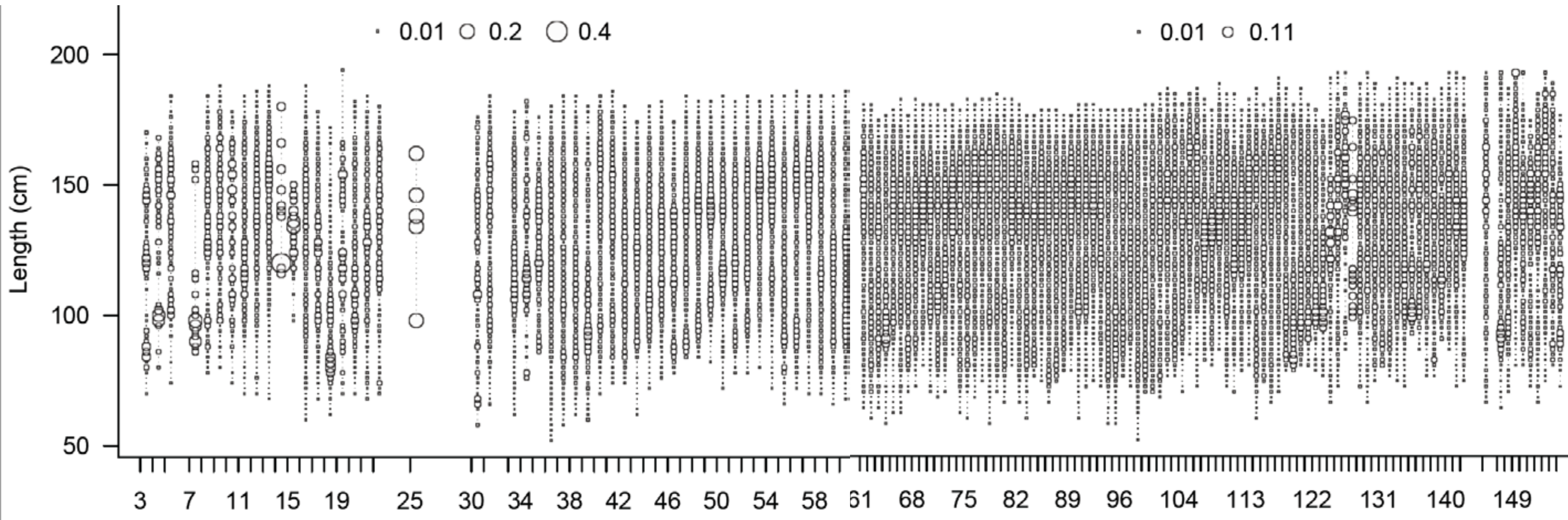
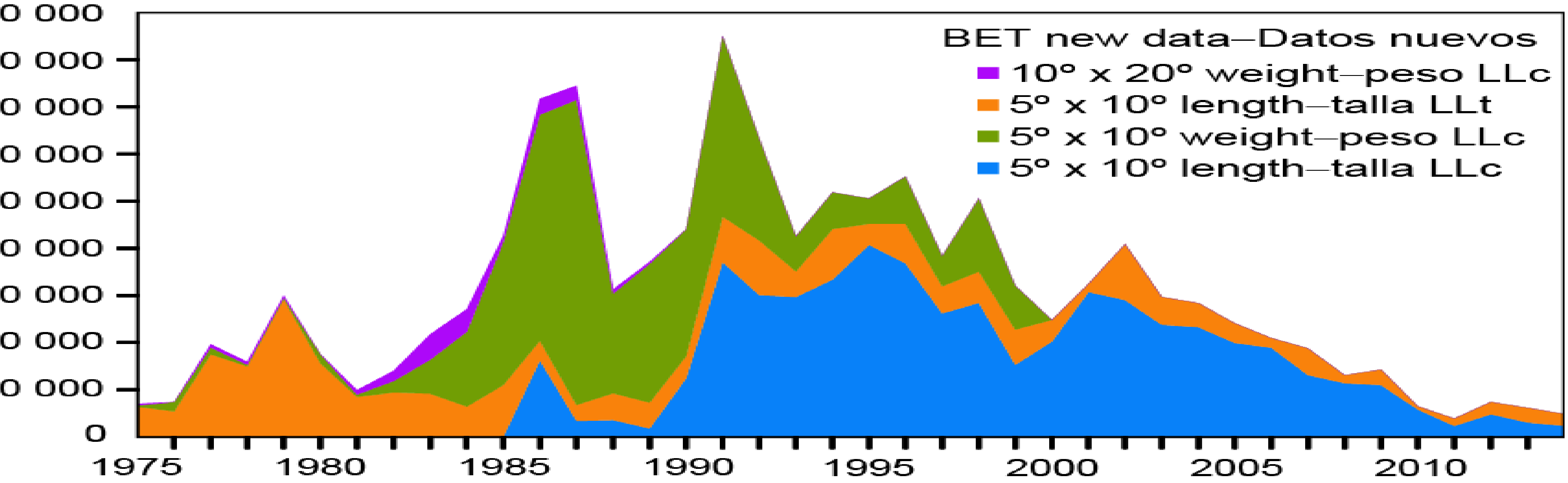
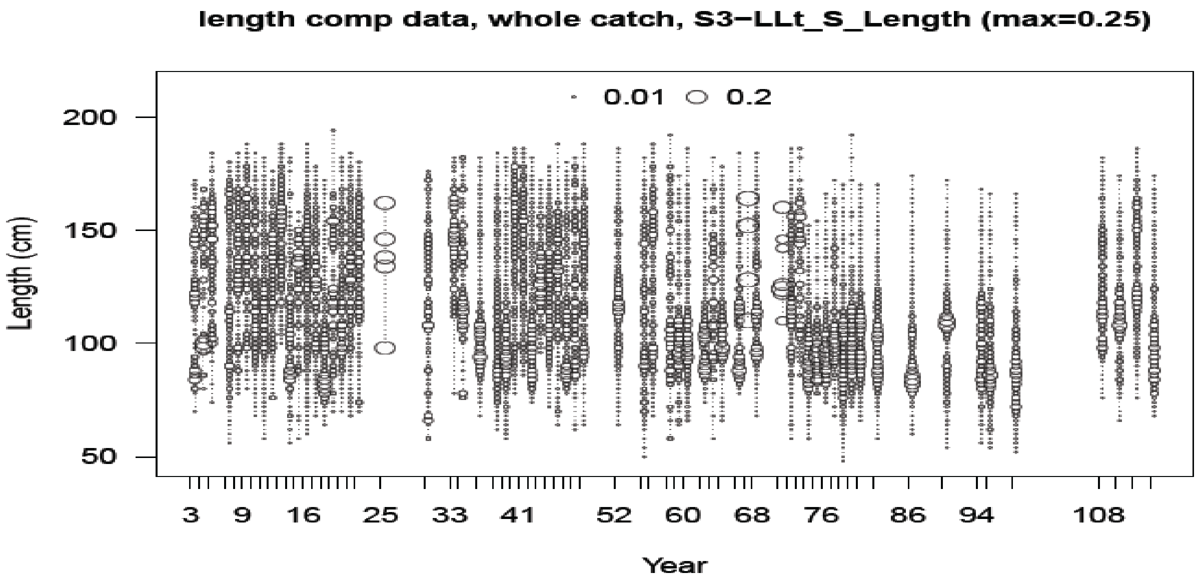
Old length-frequencies bigeye tuna





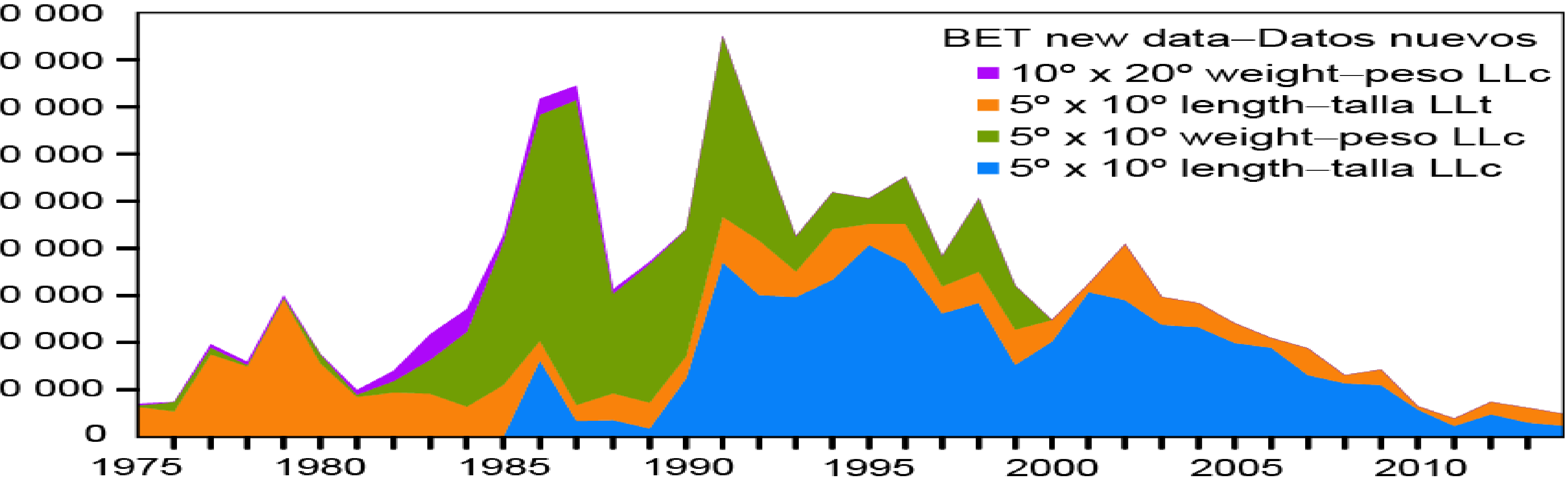
New size-frequencies bigeye tuna



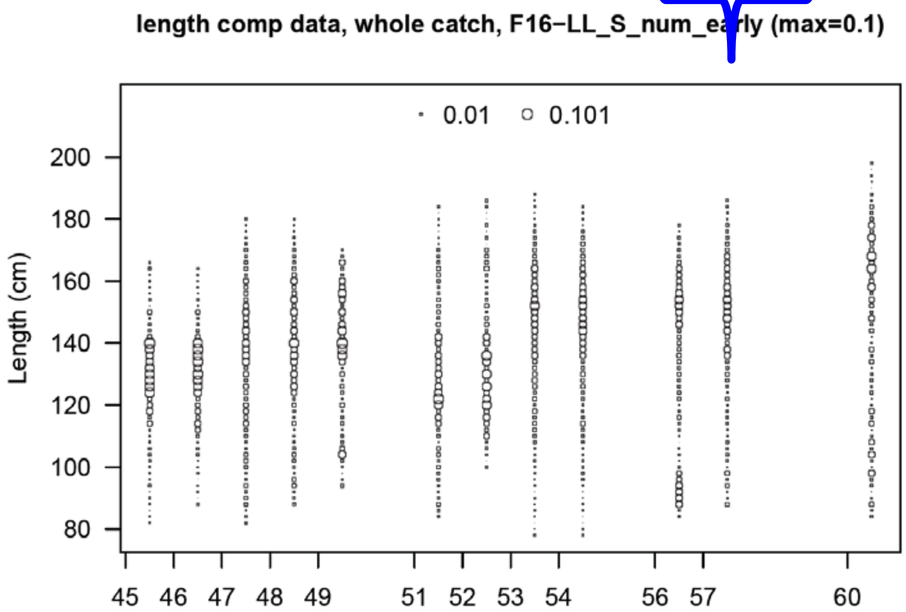


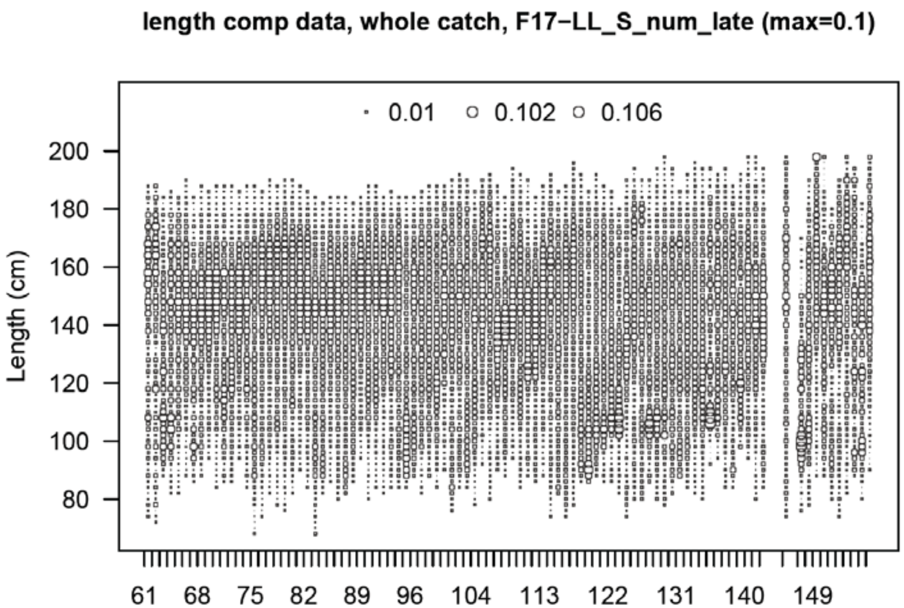
Fork length training vessels

New size-frequencies bigeye tuna

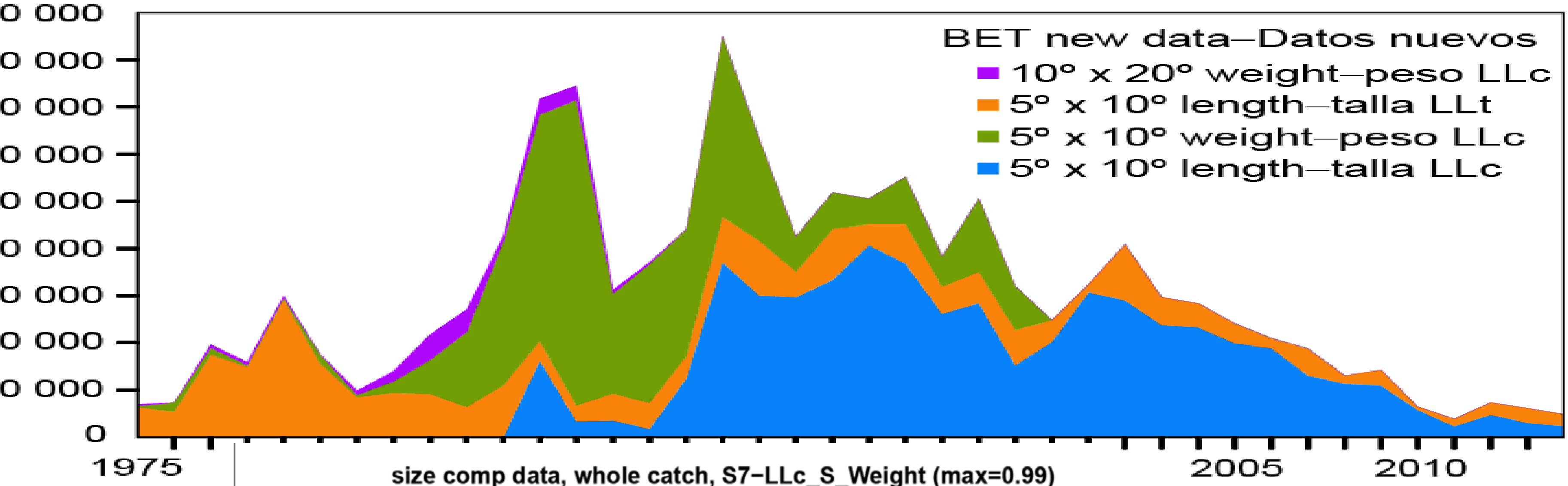


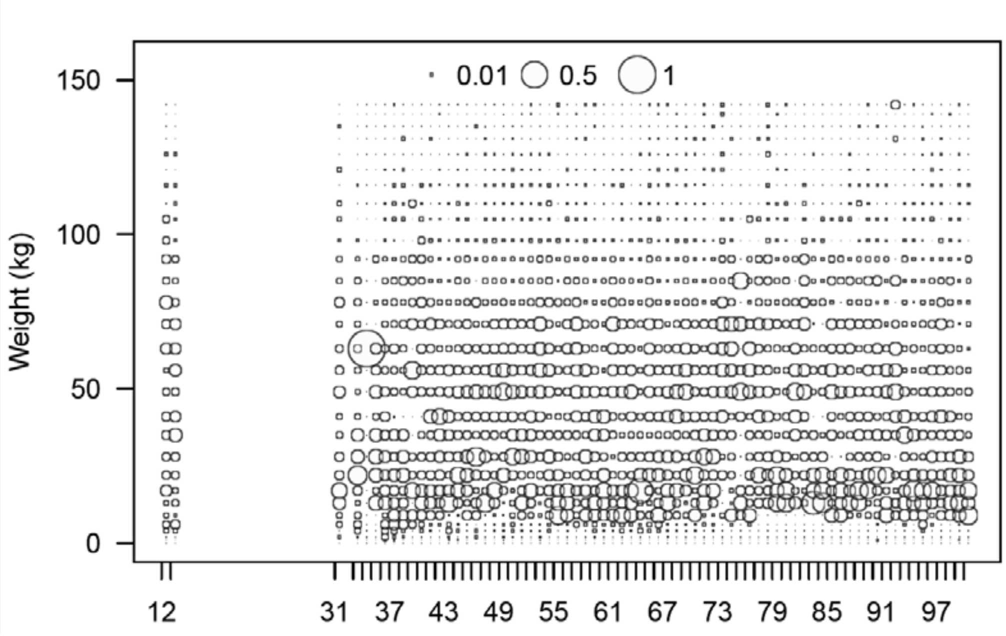
Fork length commercial vessels





New size-frequencies bigeye tuna





Gilled-and-gutted weight commercial vessels

Methods: model runs

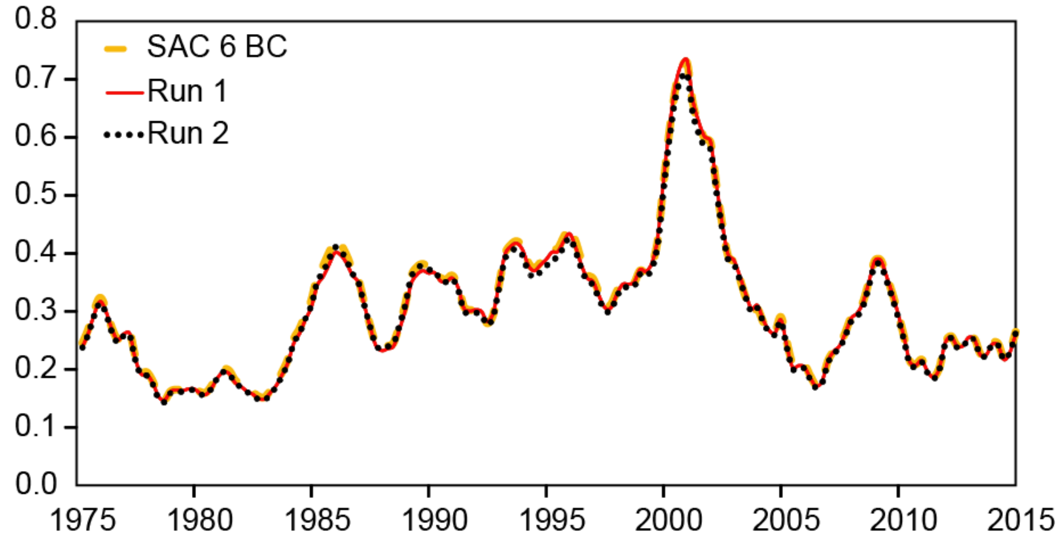
	Description	Additional changes for BET
Runs		
SAC 6 BC	Base case model for the 2015 stock assessments presented at the 6th Scientific Advisory Committee meeting (SAC 6)	
Run 1	LLc (length + GGw transformed to whole weight) + LLt (length) selectivity shared by all size-frequency data type	time blocks for selectivity and catchability
Run 2	LLc (length + GGw transformed to length) + LLt (length) selectivity shared by all size-frequency data type	time blocks for selectivity and catchability
Run 3	As Run 1, each size-frequency data type with its own selectivity	no time blocks
Run 4	= Run 1	no time blocks for BET
Run 5	As Run 4 no LLc weight	
Run 6	As Run 5 LLt length with its own selectivity	
Run 7	As Run 6 no LLt length	

Results: effect on the models that mimic the base case model

Yellowfin – Aleta amarilla

Yellowfin Aleta amarilla	SAC 6 BC	Run 1 (= Run 4)	Run 2
MSY-RMS	275,258	274,909	274,728
B_{MSY}- B_{RMS}	368,336	368,824	368,627
S_{MSY}- S_{RMS}	3,469	3,478	3,492
B_{MSY}/B_0- B_{RMS}/B_0	0.32	0.32	0.32
S_{MSY}/S_0- S_{RMS}/S_0	0.27	0.27	0.27
C_{recent}/MSY- C_{recent}/RMS	0.86	0.86	0.86
B_{recent}/B_{MSY}- B_{recent}/B_{RMS}	1.12	1.10	1.10
S_{recent}/S_{MSY}- S_{recent}/S_{RMS}	0.99	0.98	0.97
F multiplier- Multiplicador de *F*	1.11	1.10	1.08

Spawning Biomass Ratio (SBR)



Fits to size-frequency data: Runs that mimic base case SAC6

Base-case model SAC 6

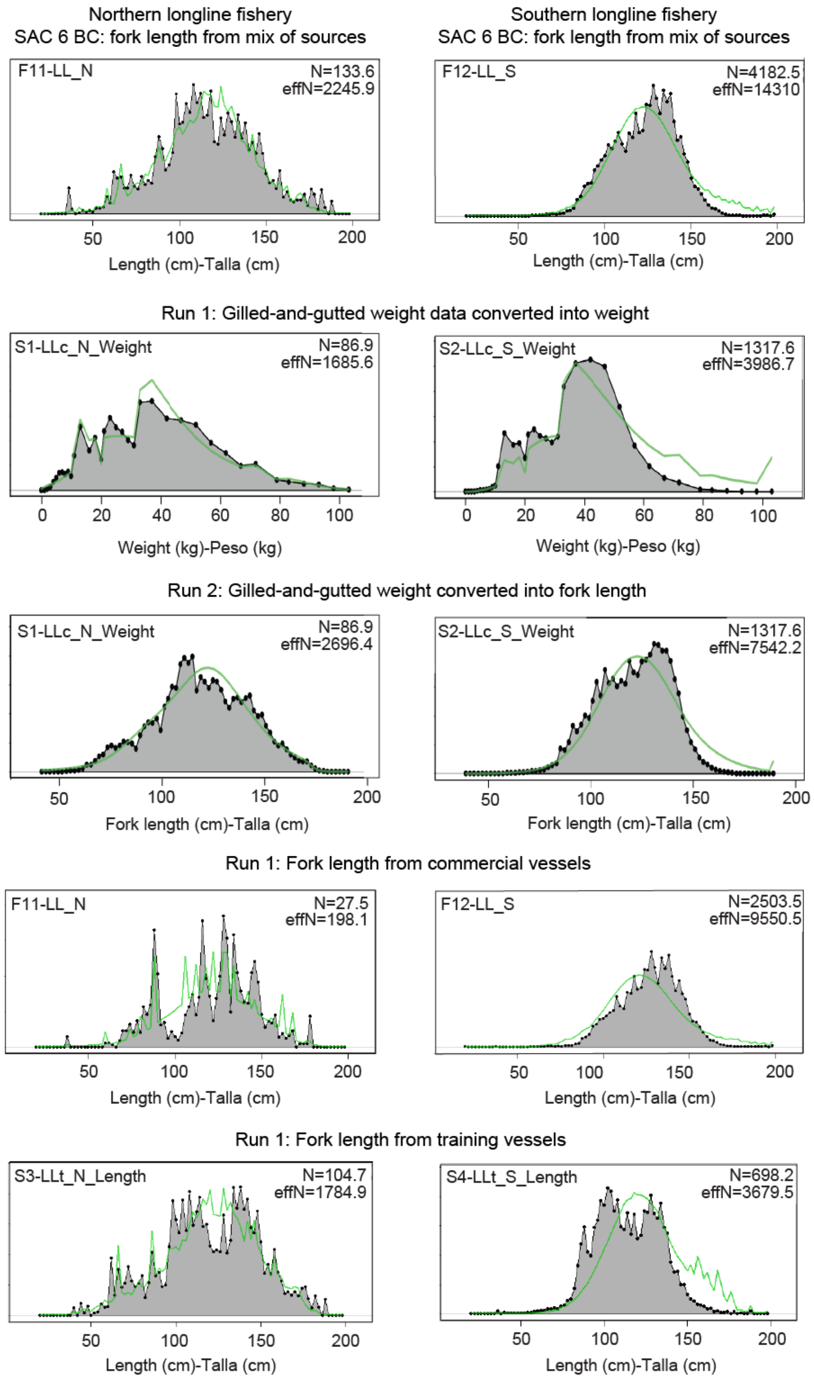
Gilled-and-gutted weight commercial vessels

Converted to weight

Converted to fork length

Fork length commercial vessels

Fork length training vessels



Yellowfin – Aleta amarilla

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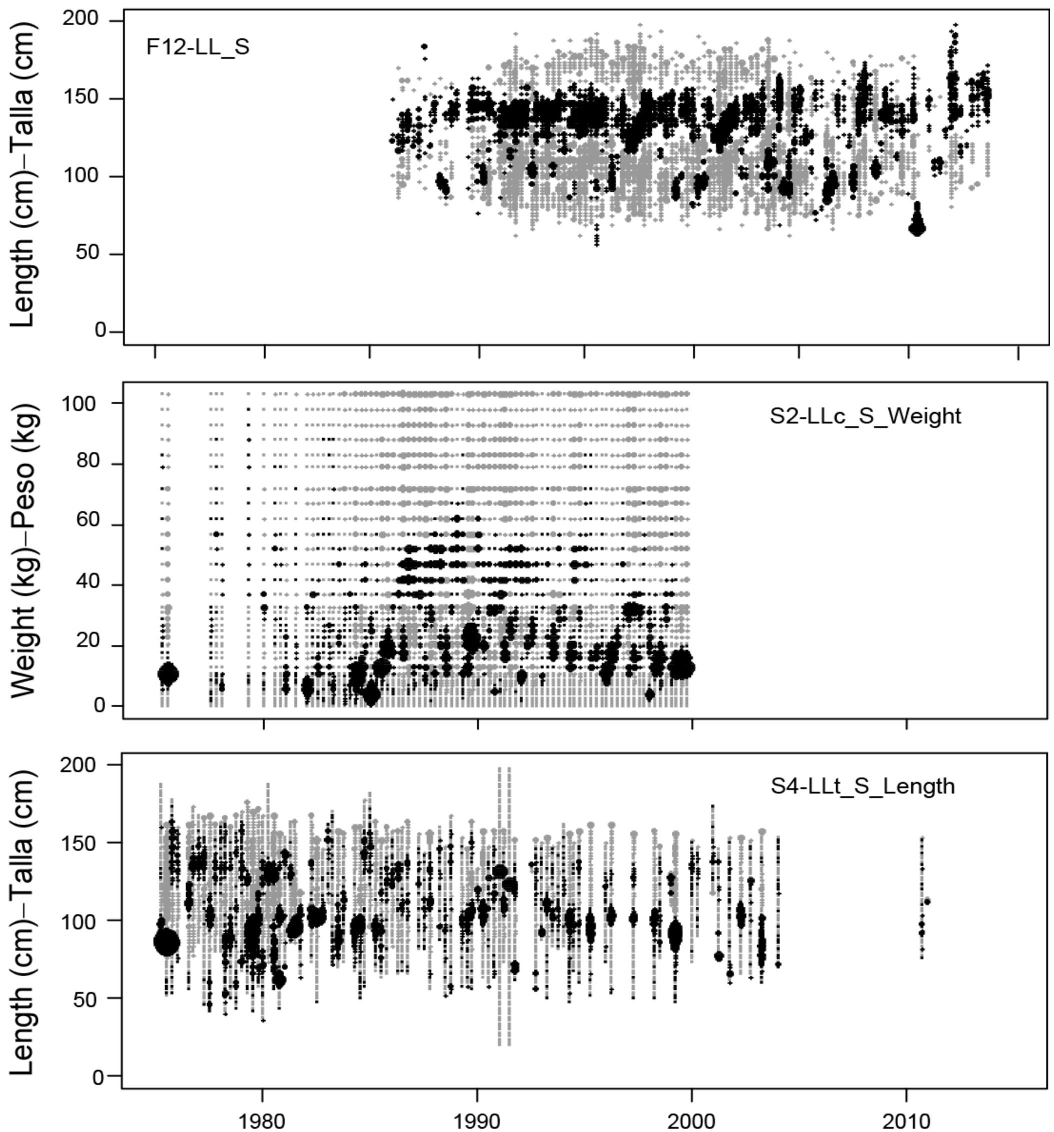
Residual patterns Run 1

Yellowfin – Aleta amarilla



Fork length commercial vessels

Gilled-and-gutted weight commercial vessels converted to weight

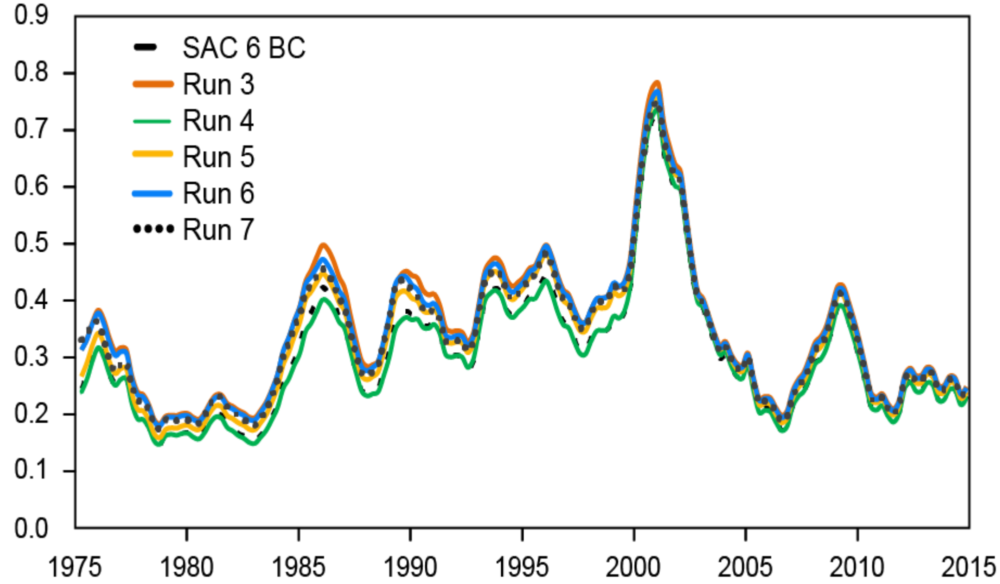
Fork length training vessels

Results: runs 3 to 7

Yellowfin – Aleta amarilla

	Description
Run 3	LLc (length + GGw transformed to whole weight) + LLt (length) each data with its own selectivity
Run 4	As Run 3 selectivity shared by all size-frequency data type
Run 5	As Run 4 no LLc weight
Run 6	As Run 5 LLt length with its own selectivity
Run 7	As Run 6 no LLt length

Spawning Biomass Ratio (SBR)



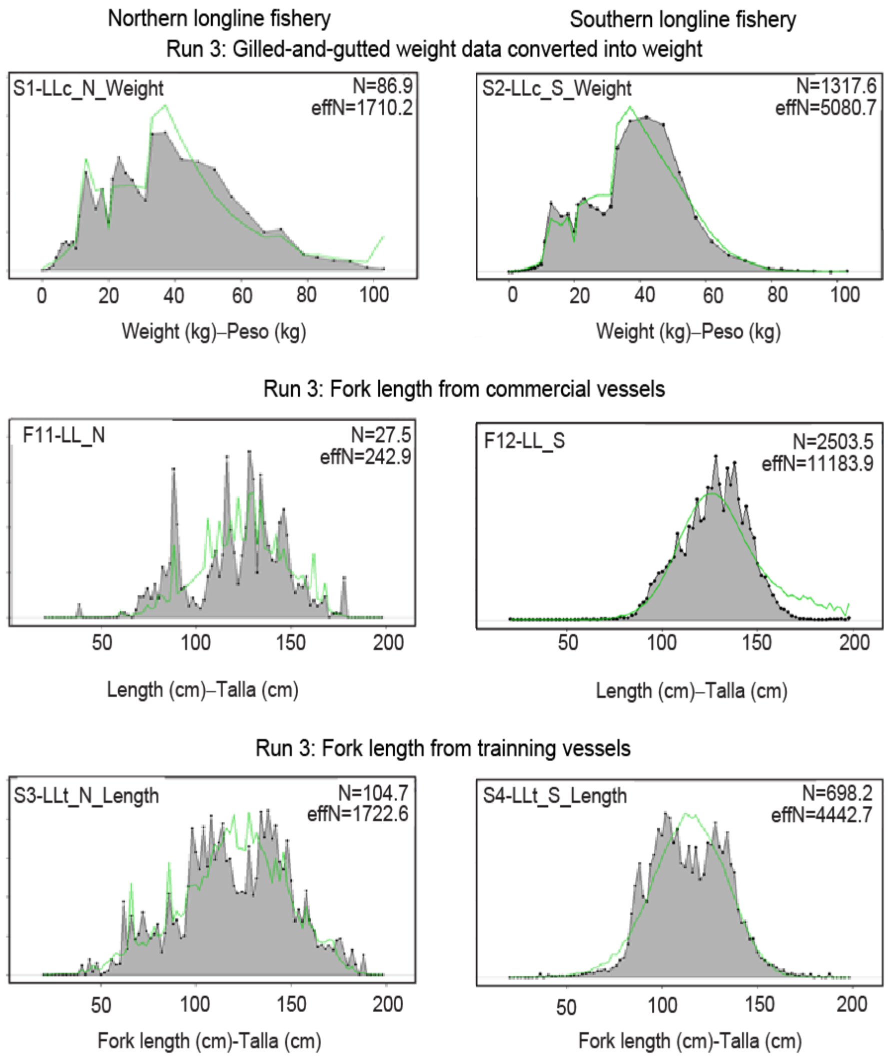
Fits to the size-frequency data

Gilled-and-gutted weight commercial vessels

Converted to weight

Fork length commercial vessels

Fork length training vessels



Run 3: each data with its own selectivity

Yellowfin – Aleta amarilla

Results: runs 3 to 7

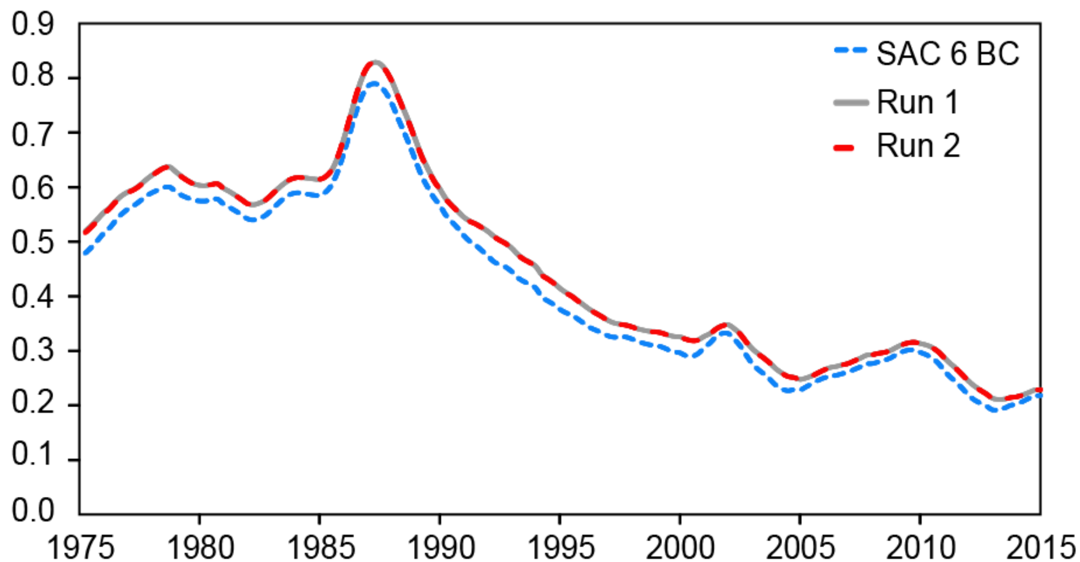
Yellowfin – Aleta amarilla

Yellowfin Aleta amarilla	SAC 6 BC	Run 1 (= Run 4)	Run 2	Run 3	Run 4	Run 5	Run 6	Run 7
MSY-RMS	275,258	274,909	274,728	284,147		279,161	282,820	281,444
B_{MSY}- B_{RMS}	368,336	368,824	368,627	381,732		374,174	380,219	376,924
S_{MSY}- S_{RMS}	3,469	3,478	3,492	3,553		3,495	3,550	3,523
B_{MSY}/B_0- B_{RMS}/B_0	0.32	0.32	0.32	0.31		0.31	0.31	0.32
S_{MSY}/S_0- S_{RMS}/S_0	0.27	0.27	0.27	0.26		0.26	0.26	0.26
C_{recent}/MSY- C_{recent}/RMS	0.86	0.86	0.86	0.84		0.85	0.84	0.85
B_{recent}/B_{MSY}- B_{recent}/B_{RMS}	1.12	1.10	1.10	1.17		1.14	1.16	1.16
S_{recent}/S_{MSY}- S_{recent}/S_{RMS}	0.99	0.98	0.97	1.09		1.04	1.07	1.06
F multiplier- Multiplicador de *F*	1.11	1.10	1.08	1.28		1.20	1.25	1.22

Results: effect on the models that mimic the base case model

Bigeye Patudo	SAC 6 BC	Run 1	Run 2
MSY-RMS	113,730	115,284	115,274
B_{MSY}- B_{RMS}	433,396	442,264	442,085
S_{MSY}- S_{RMS}	108,502	111,119	111,058
B_{MSY}/B_0- B_{RMS}/B_0	0.25	0.24	0.24
S_{MSY}/S_0- S_{RMS}/S_0	0.21	0.2	0.2
C_{recent}/MSY- C_{recent}/RMS	0.87	0.85	0.85
B_{recent}/B_{MSY}- B_{recent}/B_{RMS}	1.03	1.13	1.13
S_{recent}/S_{MSY}- S_{recent}/S_{RMS}	1.06	1.15	1.15
F multiplier- Multiplicador de *F*	1.14	1.25	1.25

Spawning Biomass Ratio (SBR)



Fits to size-frequency data: Runs that mimic base case SAC6

Base-case model SAC 6

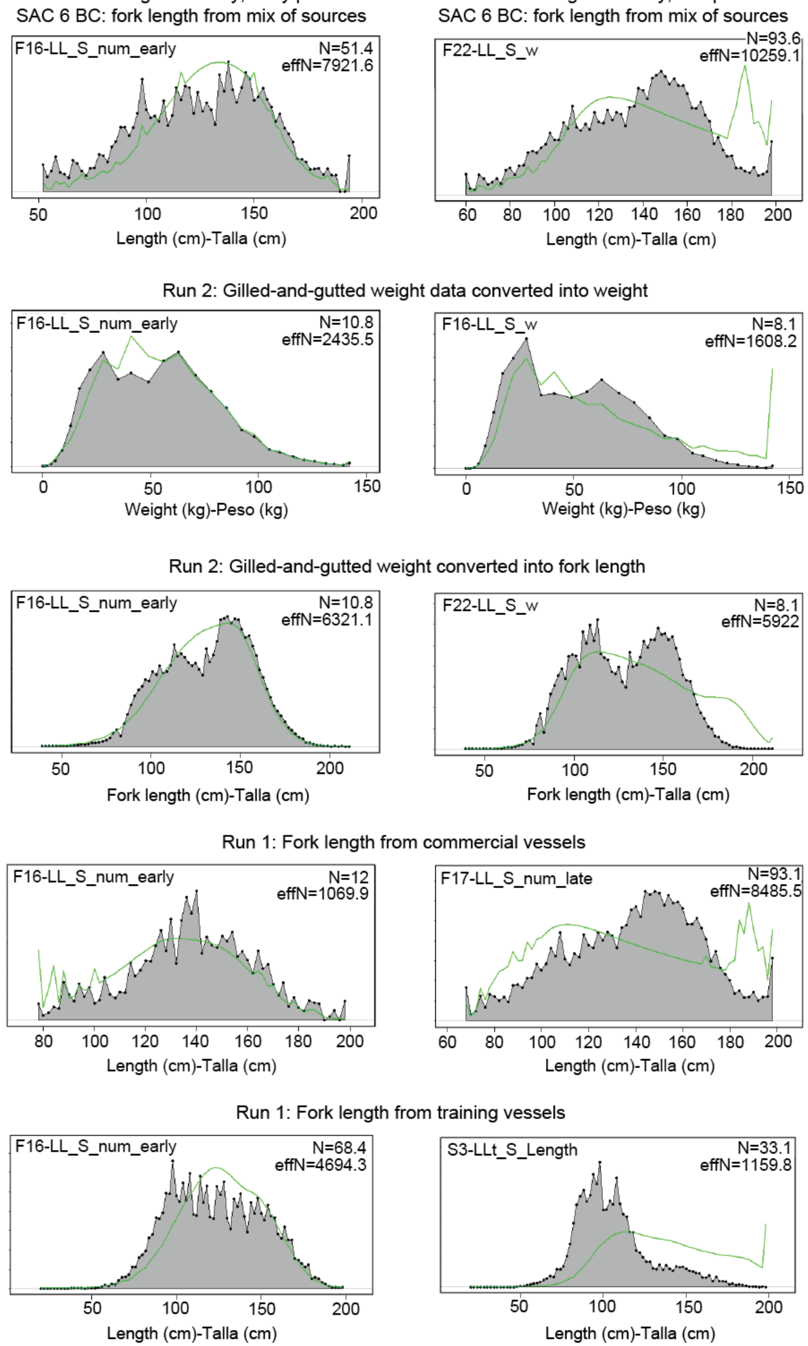
Gilled-and-gutted weight commercial vessels

Converted to weight

Converted to fork length

Fork length commercial vessels

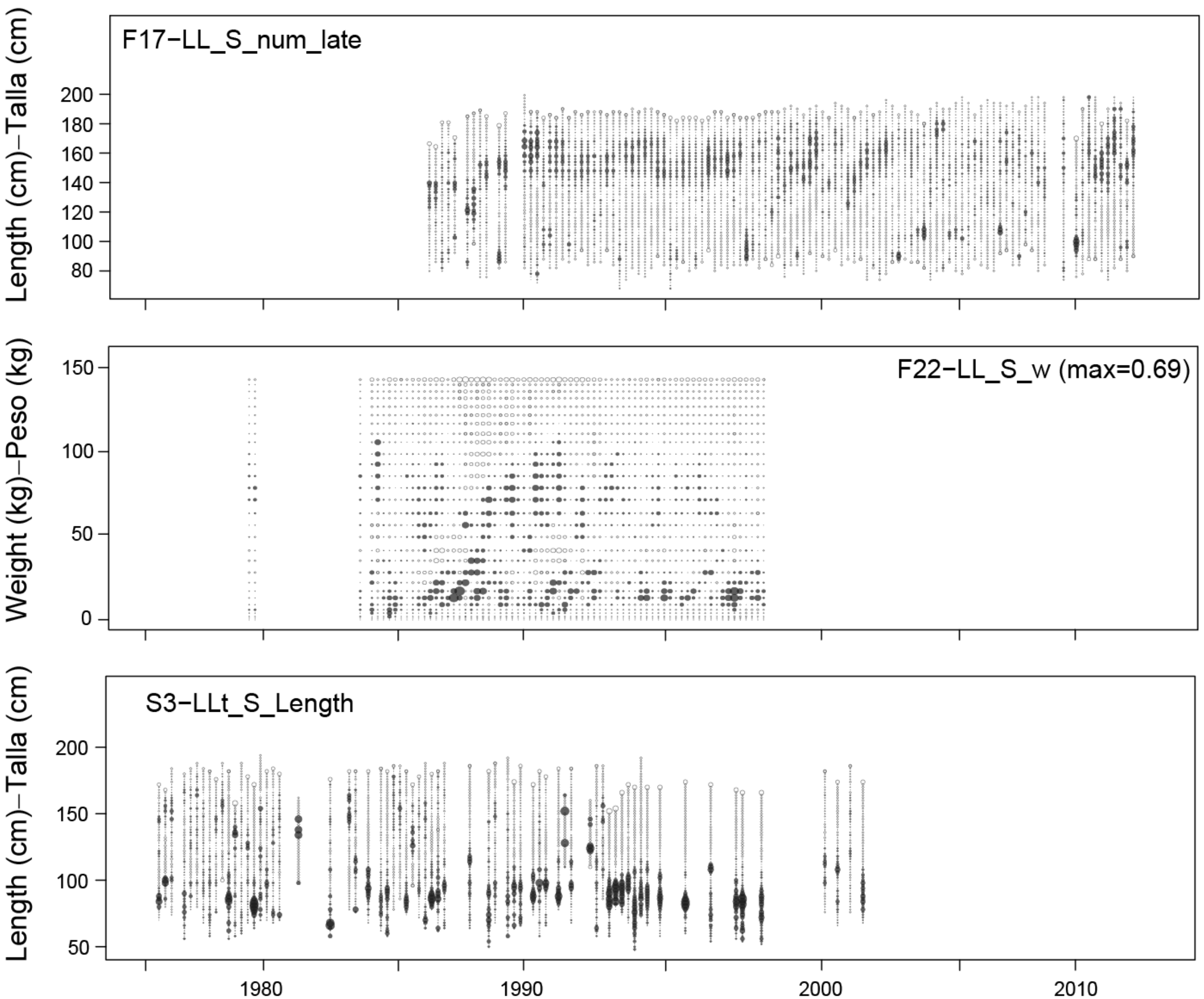
Fork length training vessels



Bigeye - Patudo

Residual patterns Run 1

Bigeye - Patudo



Fork length commercial vessels

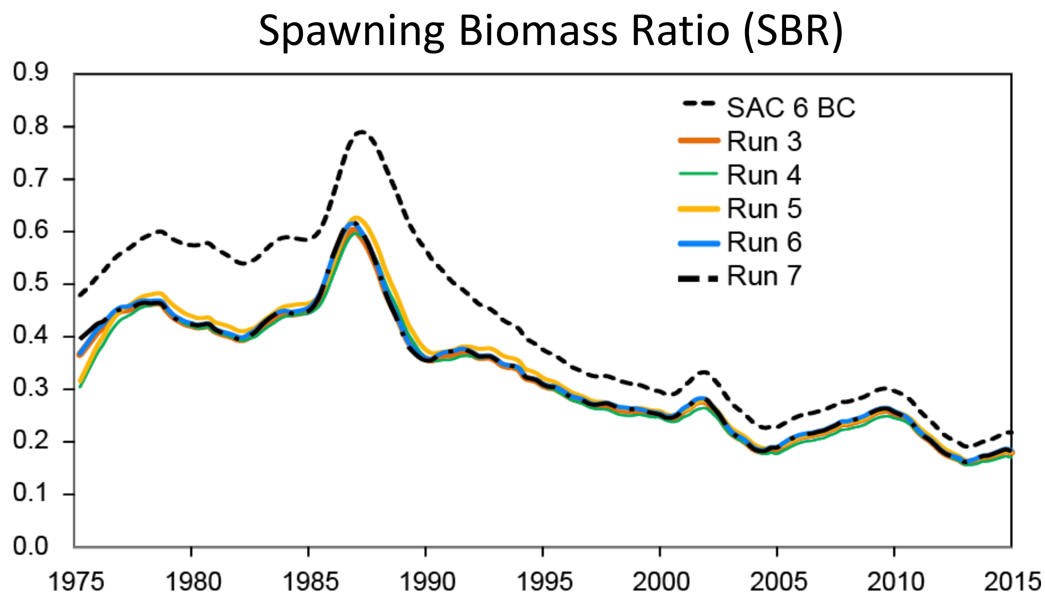
Gilled-and-gutted weight commercial vessels converted to weight

Fork length training vessels

Results: runs 3 to 7

No time blocks in CPUE catchability and selectivity

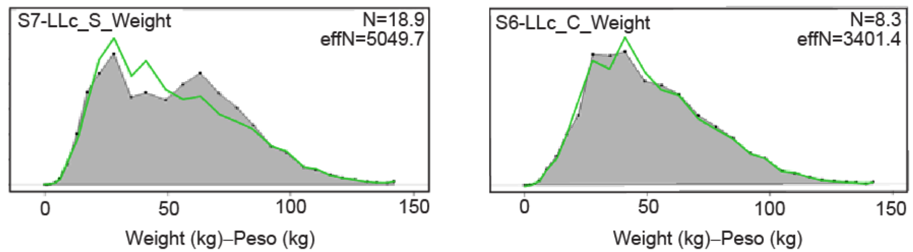
	Description
Run 3	LLc (length + GGw transformed to whole weight) + LLt (length) each data with its own selectivity
Run 4	As Run 3 selectivity shared by all size-frequency data type
Run 5	As Run 4 no LLc weight
Run 6	As Run 5 LLt length with its own selectivity
Run 7	As Run 6 no LLt length



Fits to the size-frequency data

Southern longline fishery	Central longline fishery

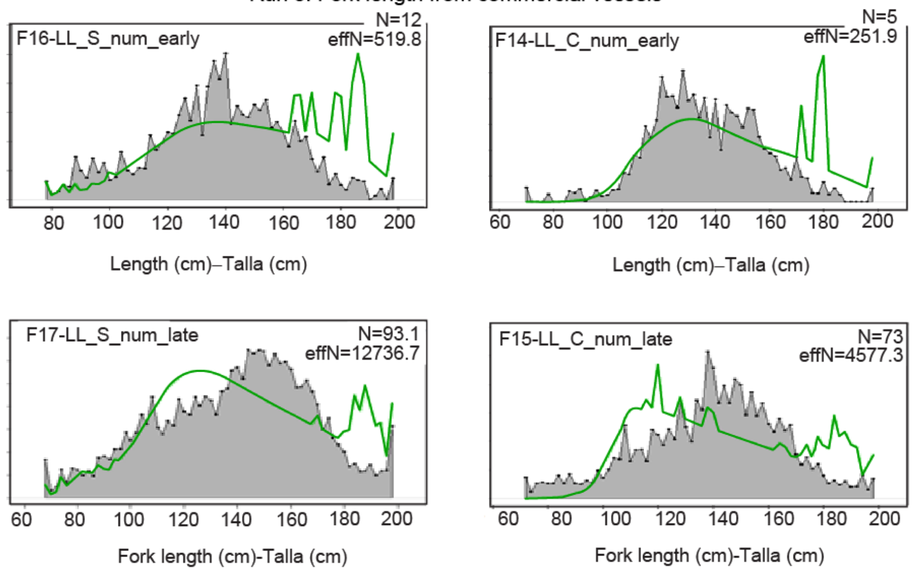
Run 3: Gilled-and-gutted weight data converted into weight



Gilled-and-gutted weight commercial vessels

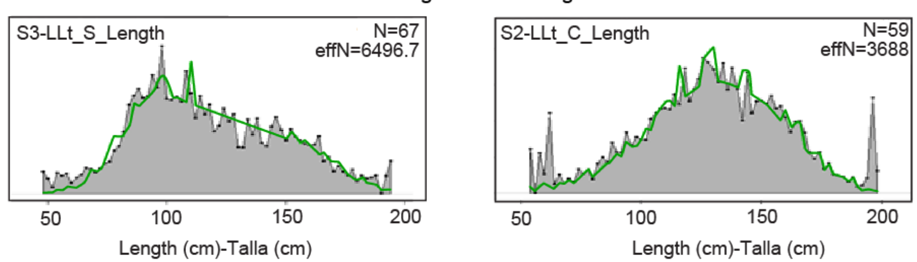
Converted to weight

Run 3: Fork length from commercial vessels



Fork length commercial vessels

Run 3: Fork length from training vessels



Fork length training vessels

Run 3: each data with its own selectivity

Bigeye - Patudo

Results: runs 3 to 7

No time blocks in CPUE catchability and selectivity

Bigeye - Patudo

Bigeye Patudo	SAC 6 BC	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6	Run 7
MSY-RMS	113,730	115,284	115,274	104,258	99,693	101,064	104,028	103,002
B_{MSY}- B_{RMS}	433,396	442,264	442,085	379,012	355,466	364,295	377,664	373,257
S_{MSY}- S_{RMS}	108,502	111,119	111,058	92,998	86,599	89,165	92,614	91,462
B_{MSY}/B_0- B_{RMS}/B_0	0.25	0.24	0.24	0.26	0.25	0.25	0.26	0.26
S_{MSY}/S_0- S_{RMS}/S_0	0.21	0.2	0.2	0.21	0.2	0.2	0.21	0.21
C_{recent}/MSY- C_{recent}/RMS	0.87	0.85	0.85	0.95	0.99	0.98	0.95	0.96
B_{recent}/B_{MSY}- B_{recent}/B_{RMS}	1.03	1.13	1.13	0.88	0.85	0.89	0.87	0.86
S_{recent}/S_{MSY}- S_{recent}/S_{RMS}	1.06	1.15	1.15	0.9	0.85	0.9	0.89	0.88
F multiplier- Multiplicador de *F*	1.14	1.25	1.25	0.94	0.91	0.95	0.94	0.92

Conclusions

- The three data types are not compatible with each other
- A conversion factor of gilled-and-gutted weight for the EPO should be developed to be able to use this data
- The training vessels length-composition data is on average smaller than the commercial vessels length-composition data, may contain useful information (*e.g*. recruitment variability)

Conclusions

Yellowfin tuna:

- The management quantities were more optimistic when the weight-frequency data were excluded or when their effect was minimized by assuming a different selectivity function for them
- **The biomass trajectories are very similar for all runs**. The largest difference was observed for the historical period (from 1975 to about 2000) for Runs 3 and 5-7, which either excluded the weight-frequency data or minimized their effects.

Bigeye tuna:

- The largest difference in management quantities was obtained when the assumption of two time periods for each longline series was replaced by **assuming one series for the whole time period with the same catchability and selectivity**
- This new assumption is justified by the fact that the **residual pattern** that motivated the inclusion of the time blocks **was likely an artifact** of the mixture of incompatible data types used to compose the longline l length frequencies that were used in the stock assessment model.

Recommendations

The size-frequency data for the longline fleets should be entered in the stock assessment models for bigeye and yellowfin as follows:

1. **Base-case model:** length-frequency of the commercial fleet, and length-frequency of the training vessel fleet treated as a survey with its own selectivity function; no time blocks on selectivity or catchability of the standardized CPUE longline series.
2. **Sensitivity model:** as for the base-case model, plus inclusion of the processed weight converted into whole weight using equations 1 or 2 . Preferably, a conversion factor specific for the EPO should be developed.
3. **Data weighting:** the weighting for the length- and weight-frequency data should be reevaluated before adopting a model to be used for management advice.

Acknowledgements

Koji Uosaki, National Research Institute of Far Seas Fisheries, and Nick Vogel, IATTC Data Collection and Database Program, for database handling and management; and Sam McKechnie and John Hampton for clarifications regarding the use of Japanese size-frequency data in the stock assessment of bigeye tuna in the Western and Central Pacific Ocean. We are specially grateful to Christine Patnode for her assistance with the figures.

Thank you