2017 North Pacific Albacore Stock Assessment

13th Regular Session of the Northern Committee

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Busan, Republic of Korea

ISC-Albacore Working Group

Purpose

- Provide an overview of the 2017 stock assessment
    - Highlight important differences relative to 2014
- Provide stock status and conservation information
- Identify key uncertainties and challenges

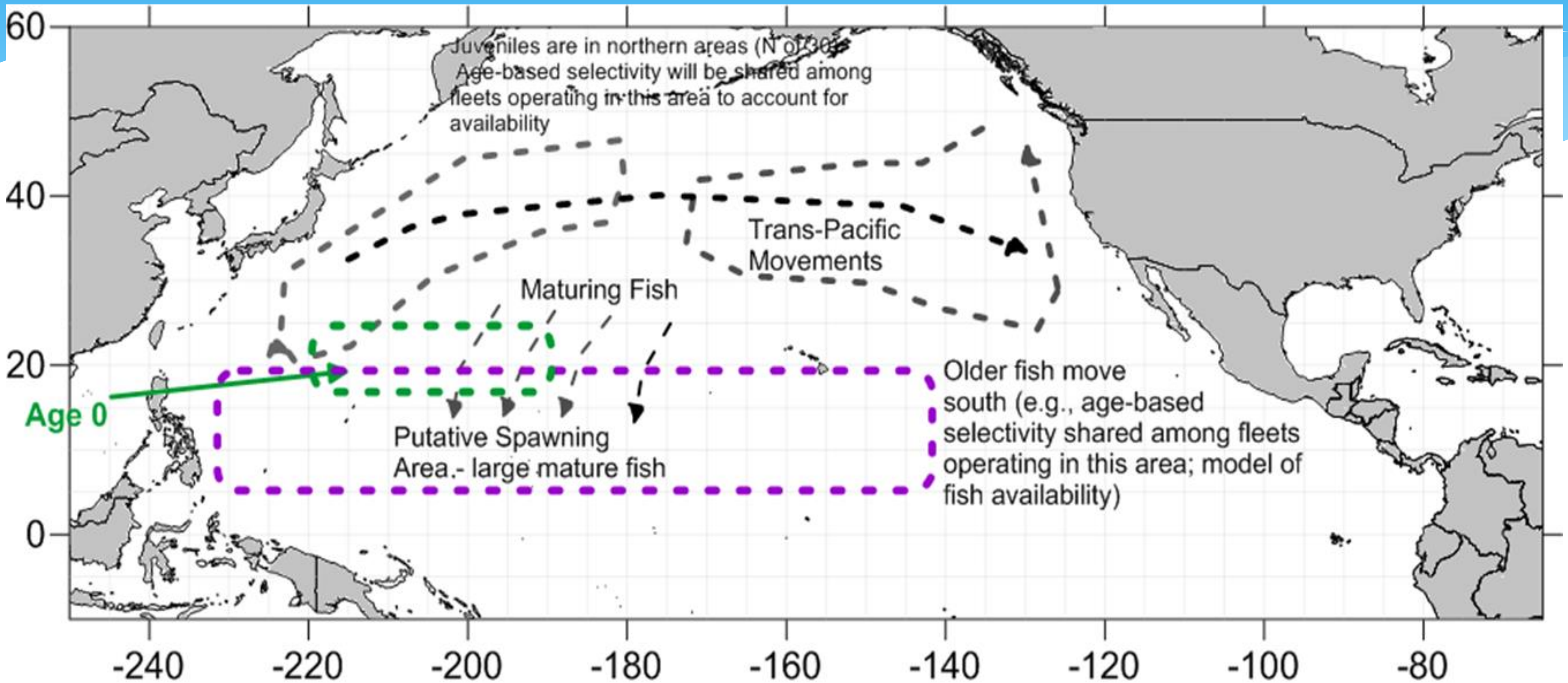
Similarities to 2014

* Integrated statistical catch-at-age model (Stock Synthesis 3.24AB)
  * Integrates catch, abundance index, & size composition data in maximum likelihood framework
* One well mixed stock on quarterly basis
* Two-sex model
* Growth parameters fixed and estimated externally for each sex (Xu et al. 2014: ISC/14/ALBWG/04)
* One spawning & recruitment period in Quarter 2 (April-June)
* Maturity: 50% age 5, 100% ≥ age 6 (Ueyanagi 1957)
* Maximum age: 15 years (Wells et al. 2013: Fish. Res. 147: 55–62)
* Quarterly W-L relationships applicable to both males & females (Watanabe et al. 2006: ISC/06/ALBWG/14)
* Beverton and Holt stock-recruit relationship; steepness (*h*) = 0.9; median of two independent estimates (Brodziak et al. 2011; Iwata et al. 2011)

Differences Relative to 2014

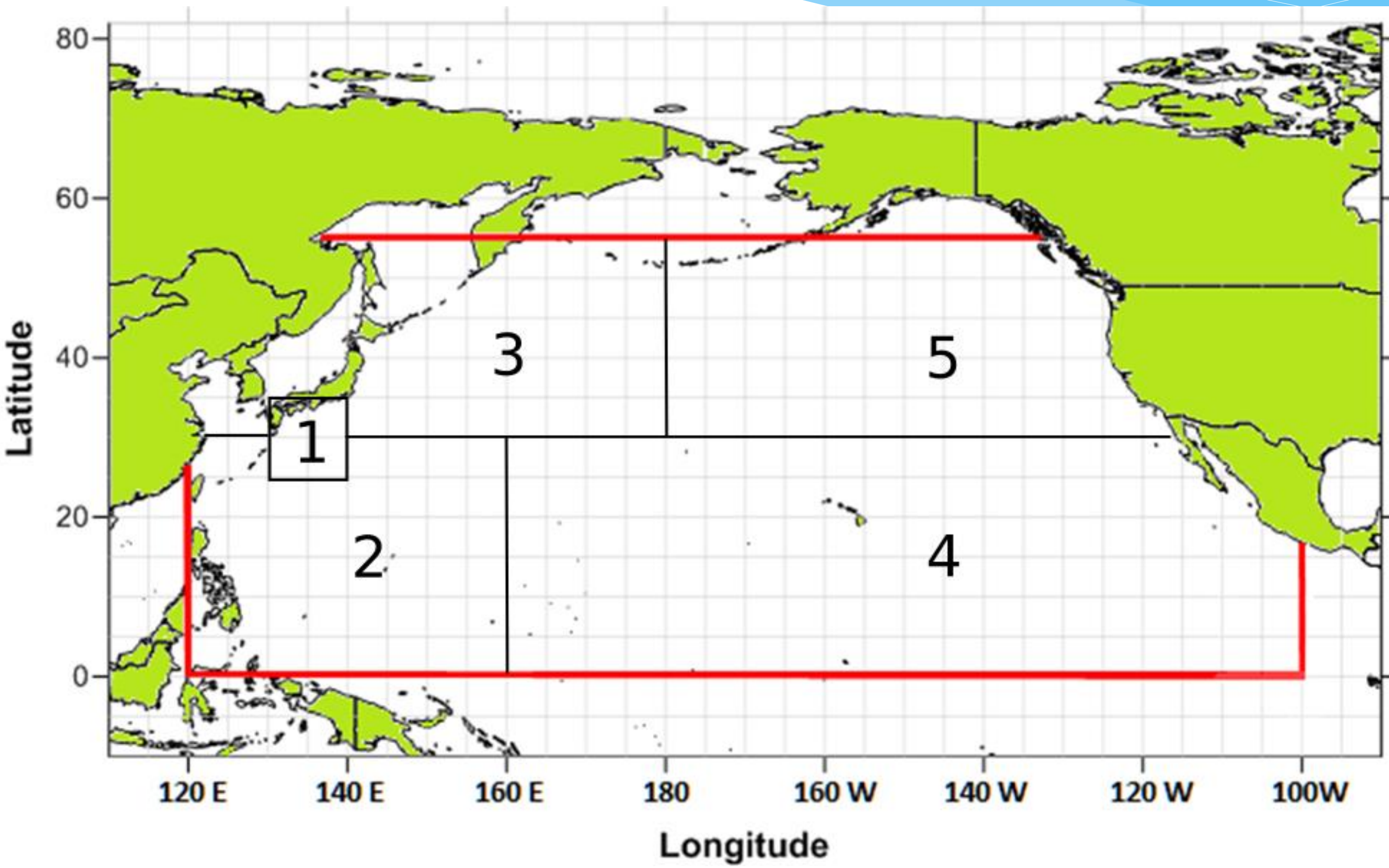
- Model time frame: 1993-2015 [1966-2012]
- Natural mortality – age-specific for ages 0-2 (Lorenzen (1996) scaling), sex specific age 3+ (0.38 yr^{-1} males, 0.48 yr^{-1} females; based on meta-analysis; Teo 2017: ISC/17/ALBWG/07) [fixed at 0.3 yr^{-1} all ages and sexes];
- Model fit to one index (Japan LL, 1996-2015, Area 2) - [four JPN LL and JPN PL indices];
- Age-based selectivity on juvenile fisheries N of 30°N (Areas 3 & 5) to model changes in availability due to movement [fleets as areas, try to capture availability through changes in selectivity];
- Dome-shaped selectivity on all fisheries (sensitivity run with asymptotic selectivity on US LL fishery – no difference); and
- Stock status evaluated relative to LRP – 20%$SSB_{current\ F=0}$ adopted by NC-WCPFC [suite of potential limit reference points]

Movements



Conceptual model of age-based movements of juveniles; consistent with tagging data from 1960s & 1970s; basis for age-based selectivity on juvenile fisheries N of 30°N

Fishing Areas



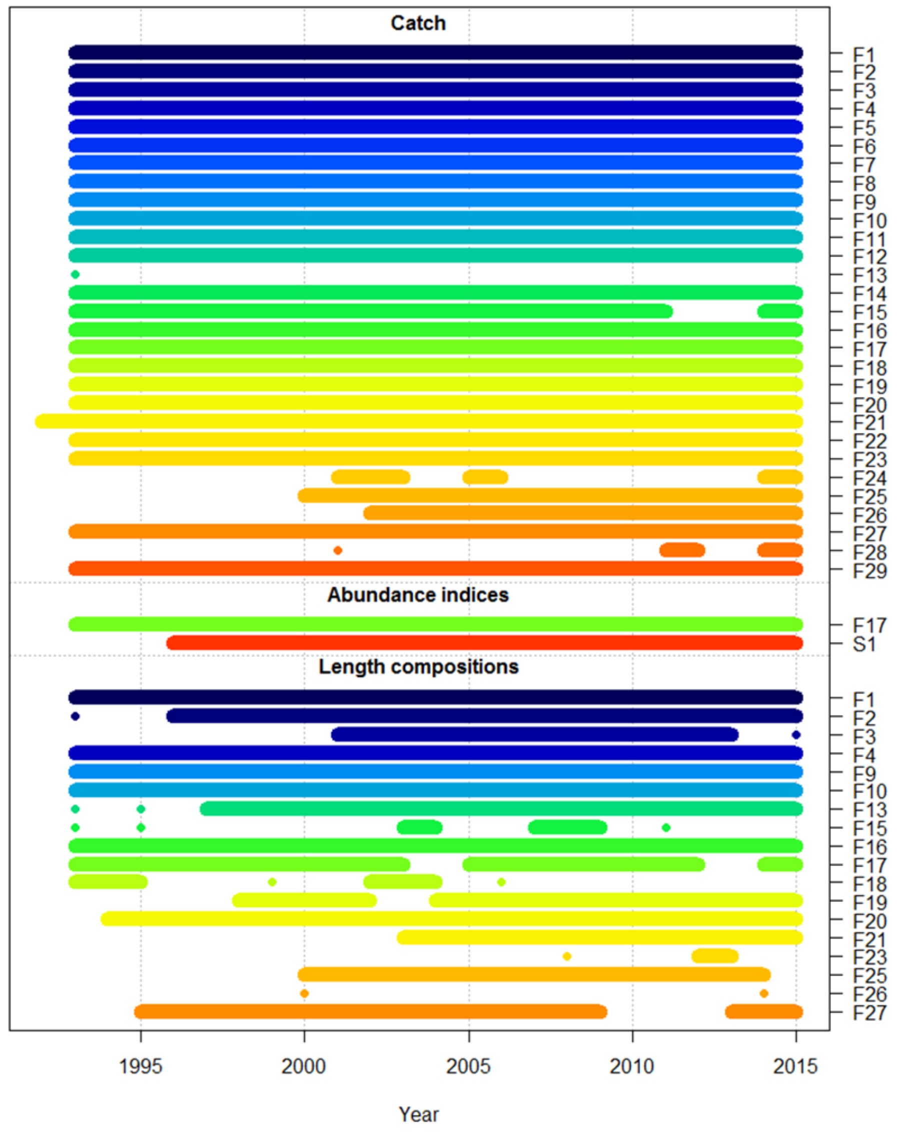
- Areas based on cluster analysis of size composition data
- 29 fisheries used in base case model – country-gear-season, area combo – homogenous size comp (& selectivity)

Data

- Catch data for 29 fisheries, 1993-2015
- 13 abundance indices developed; model fitted to adult index (JPN LL, 1996-2015); JPN PL index (F17 - 1993-2015) fitted as a sensitivity run (not shown)
- Size composition – 18 fisheries, only 15 were fitted in base case
- Sex ratio – JPN research & training vessel catches; not fitted in model; no other sex data available (genetic markers in development)

Data – Temporal Summary

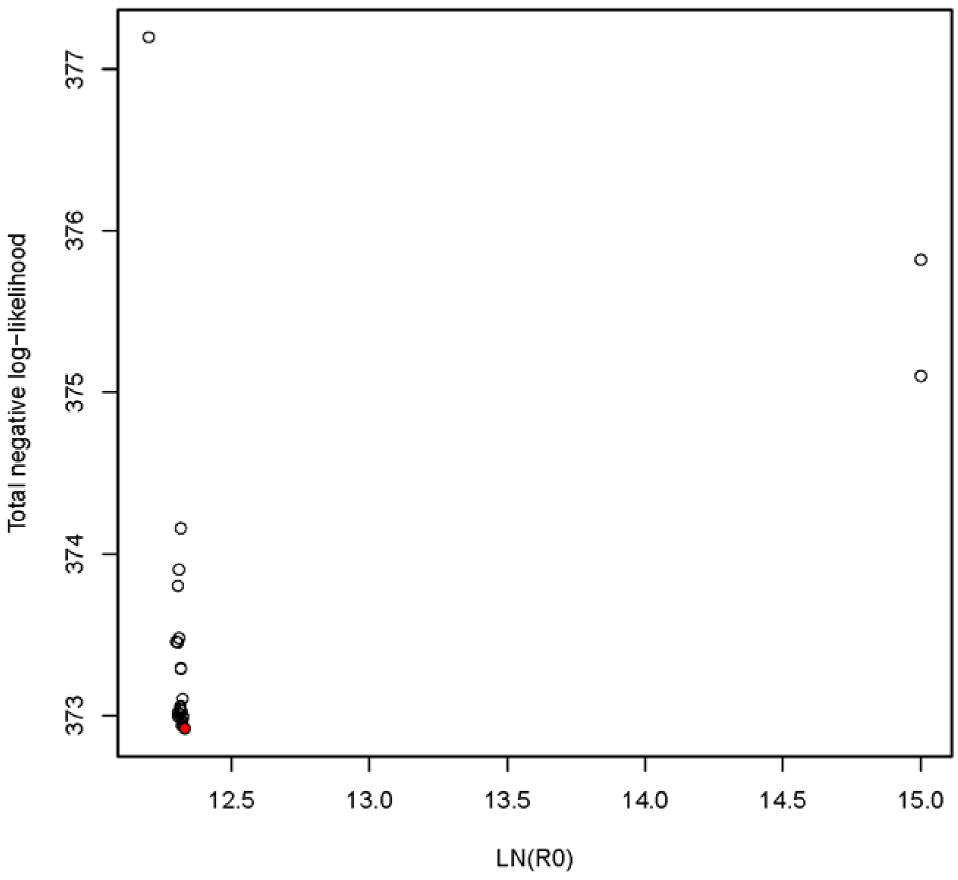
* Model time frame: 1993 to 2015
* Used catch, size composition, and CPUE data available as of 1 Jan 2016
* Most catch time series are continuous over this period; some begin well before this period
* Abundance indices are continuous through this period
* Size composition time series beginning in 1966 for 8 of 15 fisheries



Data Weighting

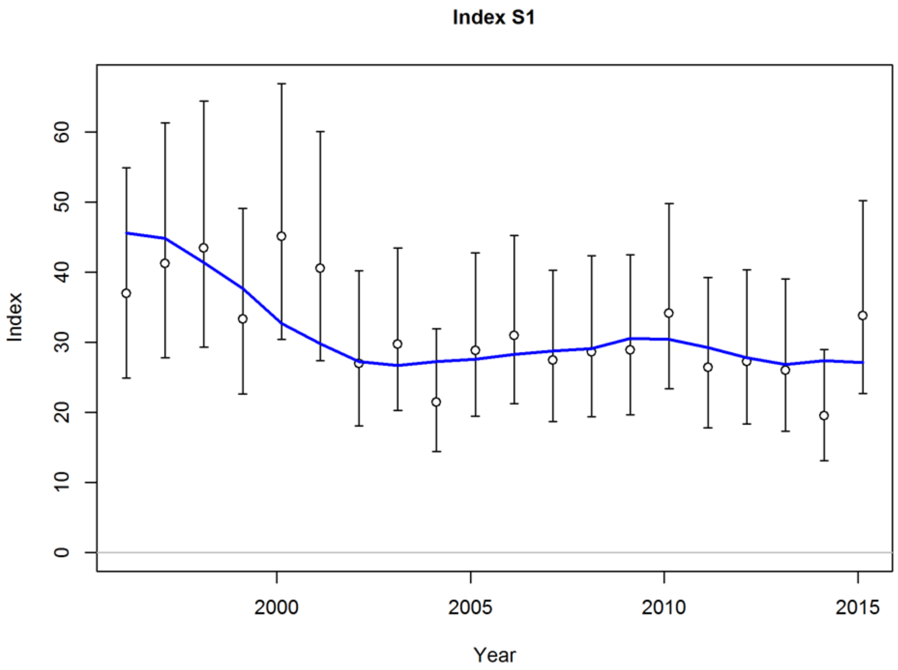
- Prioritized fit to abundance index
- Size compositions for several longline fisheries (F9, F10, F13, F19 and F20) downweighted ($\lambda = 0.1$) because degrade fit to JPN LL index
- Down-weighting resulted in model fits to the JPN LL index roughly similar to the ASPM diagnostic fit
- Effect of downweighting on model results investigated with sensitivity runs (not shown in presentation but in assessment report)

Results – Model Convergence



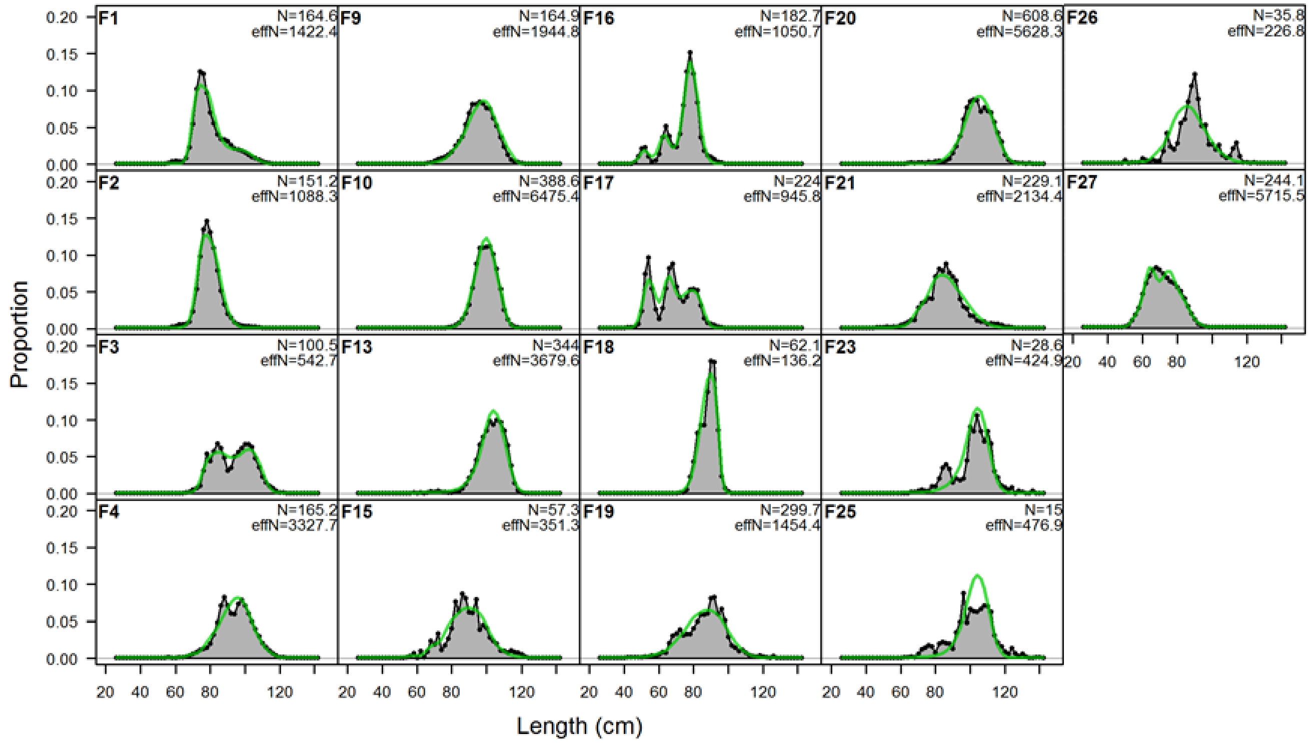
Red closed circle 2017 base case model - lowest total negative log-likelihood (-372.919) of all 50 model runs (different phasings & jitter)

Results - Primary Index Fit



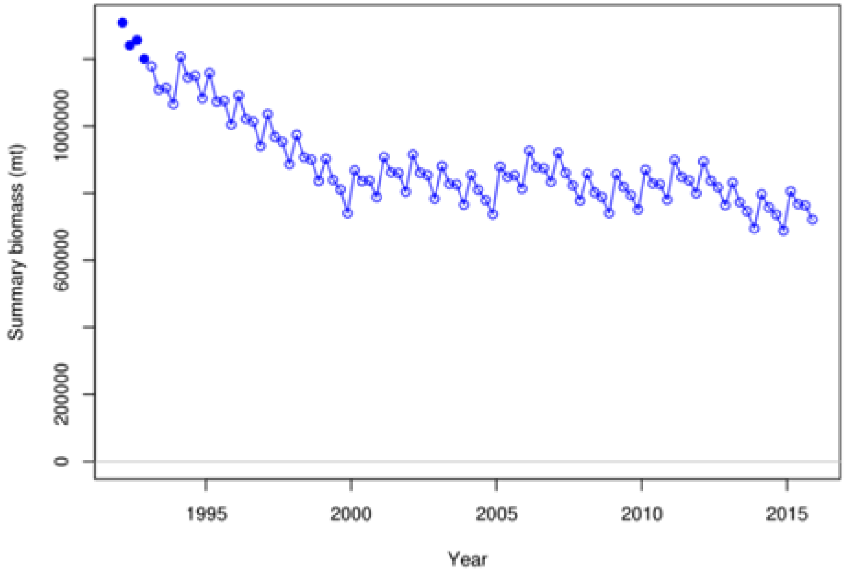
- Observed (open circles) and predicted (blue line) relative abundance.
- Error bars are the 95% confidence intervals.

Results - Size Composition Fits

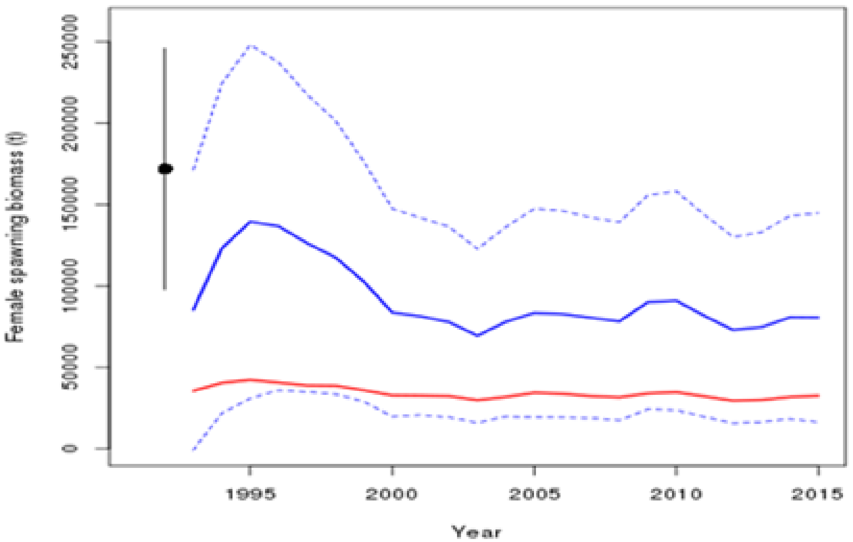


Results - Biomass

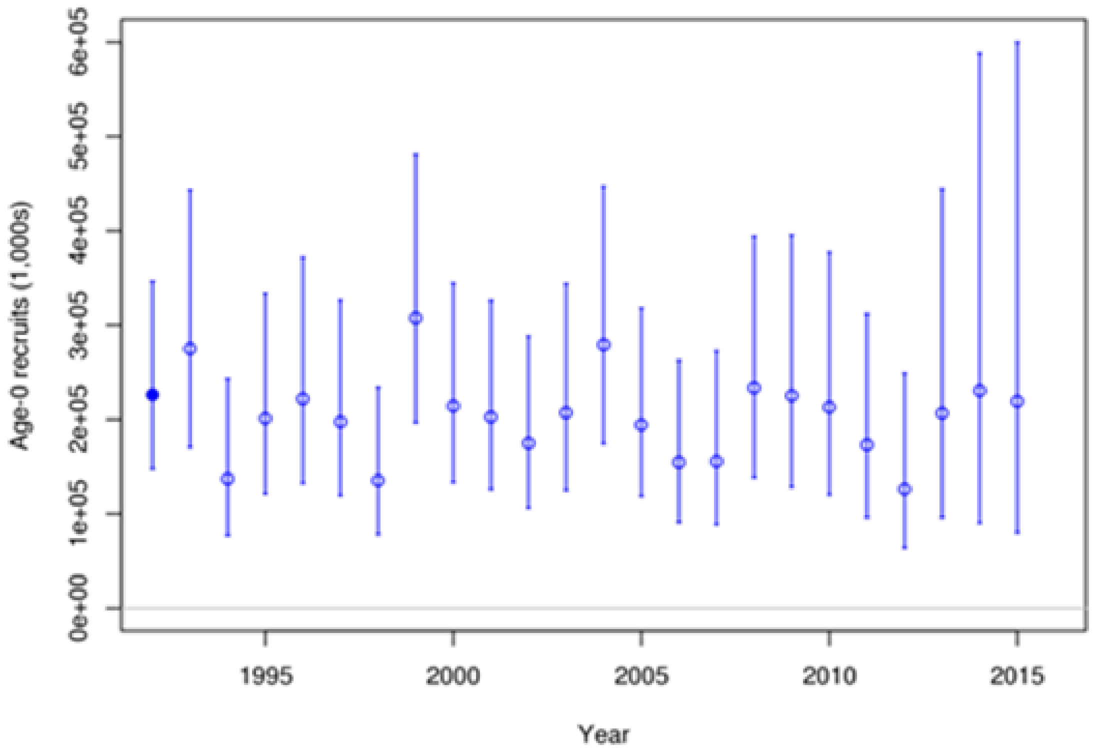
Total Biomass – 1+



Female Spawning Biomass



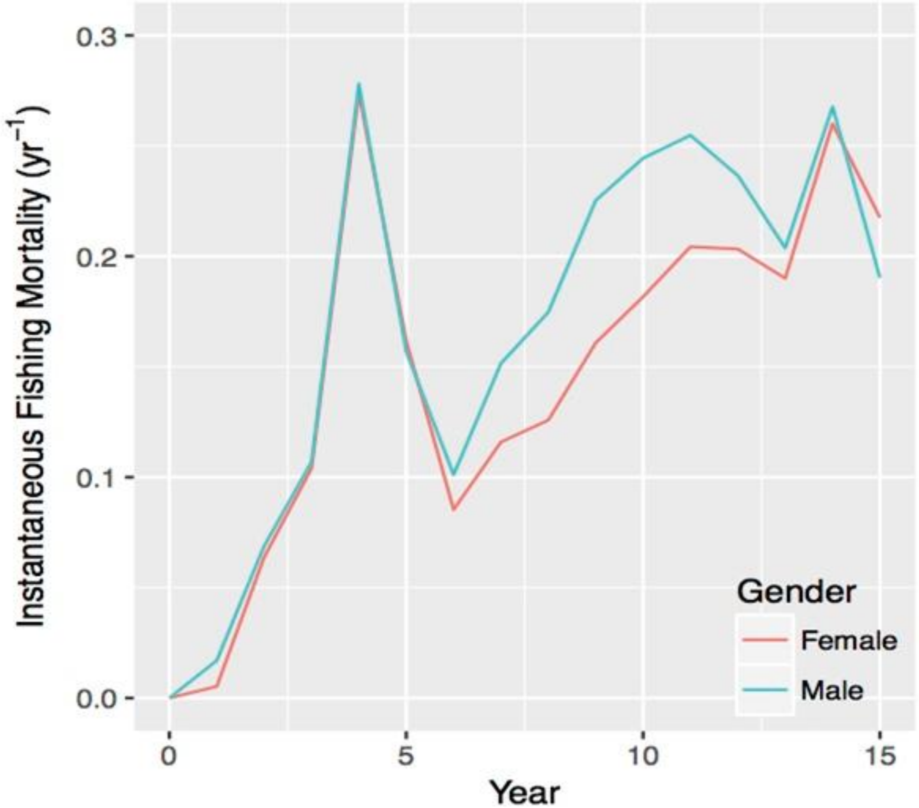
Results - Recruitment



- Average recruitment (1993 – 2015) = 201.5M fish
- Slightly below R_0 = 226.2M fish
- High uncertainty driven by high uncertainty in estimate of R_0, which largely determines the population scale.

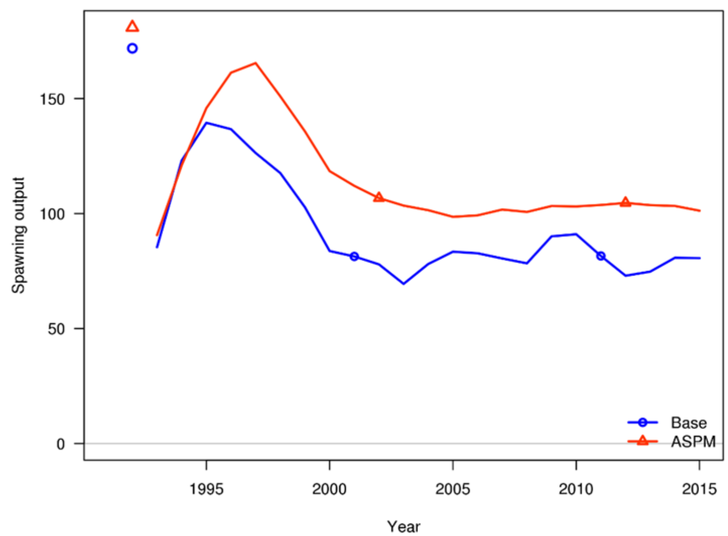
Results - Fishing Mortality

F-at-age averaged over 2012-2014

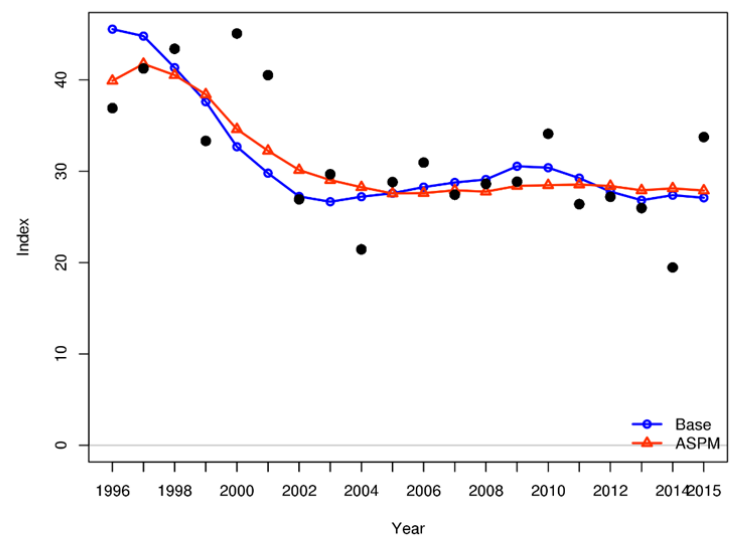


Age-structured Production Model (ASPM) Diagnostic

Estimated Female Spawning Biomass



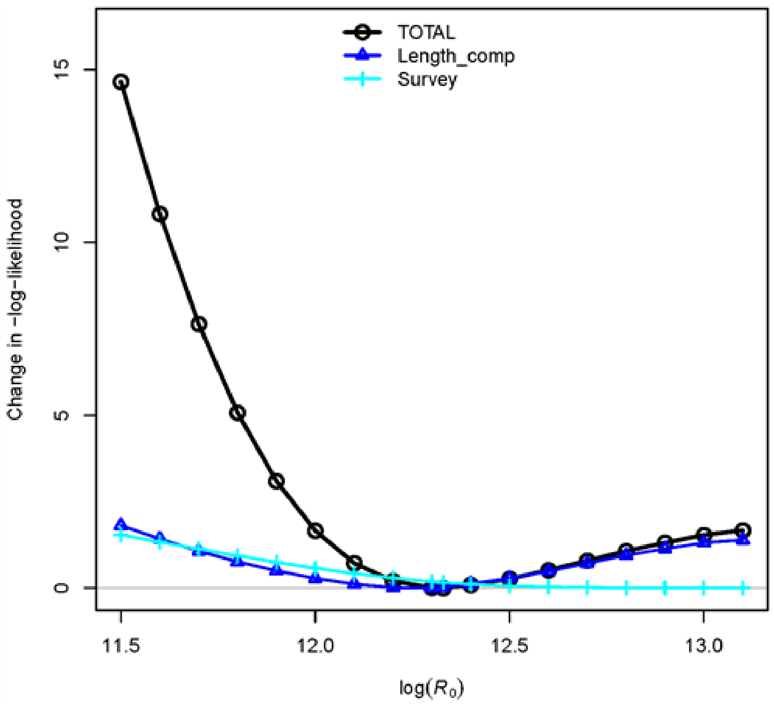
Trends in JPN LL index explained by catch & productivity parameters (growth, M, SR) – no process error (recruitment deviates)



Conclusion: (1) JPN LL index is a reasonable proxy of stock trends; and
(2) Base-case model estimates the stock production function & the effect of fishing on NPALB. Provides confidence to the data used, and is a major improvement from 2014.

Likelihood Profile on R_0 Diagnostic

- JPN LL index informative on lower limit of population scale, i.e., whether the stock is lower than LRP
- Less informative on the upper limit to the population scale
- R_0 profile of the JPN LL index shows relatively small changes in log-likelihood over the range of R_0, which means that the estimated population scale is relatively uncertain.
- Probably due to the moderate exploitation levels of this stock

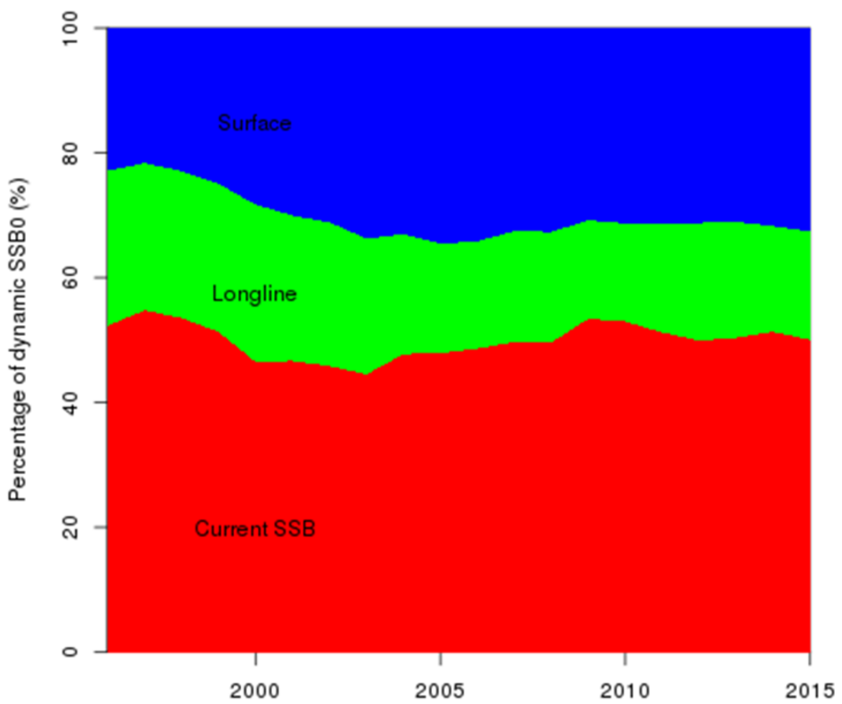


Sensitivity Analyses

	Biological assumptions
Natural mortality	Constant M of 0.3 y^{-1} for both sexes and all ages (same as 2014 assessment); Constant M of 0.48 and 0.39 y^{-1} for female and male albacore of all ages, respectively
SR steepness	h = 0.75; 0.80; and 0.85
Growth	CV of L_{inf} is fixed at higher (0.06 & 0.08) levels.
	Data inputs
Start year	1966 (same as 2014 assessment). Only the adult index from the Japanese LL Area 2, Q1 (F9) fit. Size composition data from 1966 – 1992 are not fit. Selectivity for all fisheries prior to 1993 are assumed to be the same as in 1993.
Juvenile index	Fit to the Japan pole-and-line index for F17
Size composition weighting	Down-weight size composition data of all fisheries (λ = 0.1) Natural weight all size composition data (λ = 1.0)
	Structural Assumptions
US longline asymptotic selectivity	Assume asymptotic selectivity for USA LL, Areas 2 & 4 (F20)
Equilibrium catch	Equilibrium catch of each fishery estimated as the average of 10 years during 1983 – 1992.
Bridging Analysis	Model structure follows the 2014 assessment as close as possible (start year=1966; M=0.3 y^{-1} for both sexes; down-weight all size composition data; fit to Japan pole-and-line indices)

- All runs conducted & results are in assessment report;
- In most cases, no difference in trends of SSB, depletion or fishing intensity;
- Some differences in scale, but not large differences

Fishery Impact Analysis



- Two-thirds of catch & impact related to surface fisheries, primarily pole-and-line and troll
- On average 70% of annual catch consists of juveniles.

Stock Status Information

Quantity	Base Case	$M = 0.3\ y^{-1}$	Growth CV = 0.06 for L_{inf}
MSY (t) [A]	132,072	92,027	118,836
SSB_{MSY} (t) [B]	24,770	42,098	22,351
SSB_0 (t) [B]	171,869	270,879	156,336
SSB_{2015} (t) [B]	80,618	68,169	63,719
$SSB_{2015}/20\%SSB_{current,\ F=0}$ [B]	2.47	1.31	2.15
$F_{2012\text{-}2014}/F_{MSY}$	0.61	0.89	0.68
$F_{2012\text{-}2014}/F_{0.1}$	0.58	0.90	0.65
$F_{2012\text{-}2014}/F_{10\%}$	0.56	0.81	0.63
$F_{2012\text{-}2014}/F_{20\%}$	0.63	0.91	0.71
$F_{2012\text{-}2014}/F_{30\%}$	0.72	1.04	0.81
$F_{2012\text{-}2014}/F_{40\%}$	0.85	1.21	0.96
$F_{2012\text{-}2014}/F_{50\%}$	1.01	1.47	1.16

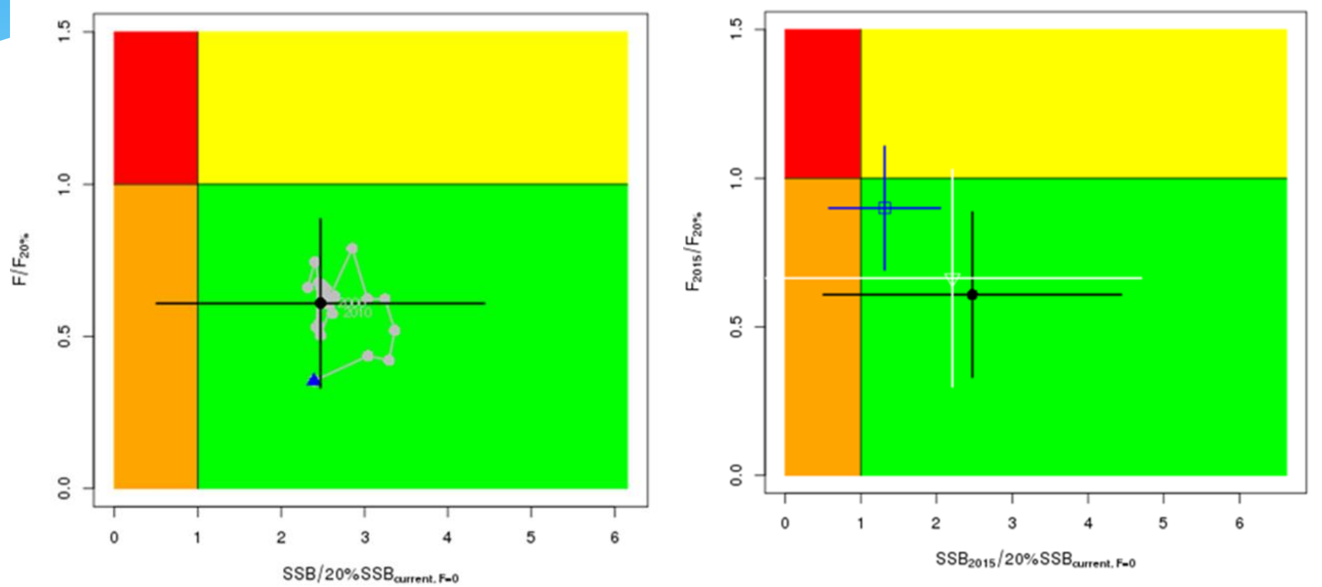
A – MSY includes male and female juvenile and adult fish

B – Spawning stock biomass (SSB) in this assessment refers to mature female biomass only.

Fishing Mortality

- Stock status is depicted in relation to the WCPFC-LRP; 20%$SSB_{current\ F=0}$) for the stock & the equivalent fishing intensity ($F_{20\%}$)
- Fishing intensity is calculated as 1-$SPR_{x\%}$.
- Fishing intensity is a measure of fishing mortality expressed as the decline in the proportion of the spawning biomass produced by each recruit relative to the unfished state. For example, a fishing intensity of 0.8 will result in a SSB of approximately 20% of SSB_0 over the long run.
- Fishing intensity is a proxy of instantaneous fishing mortality (F) & was used because there is no single representative value of F that can be calculated (recall the F-at-age plot)

Stock Status Information - 1



White – CV on L_{inf}
Blue – M
Black – 2017 base

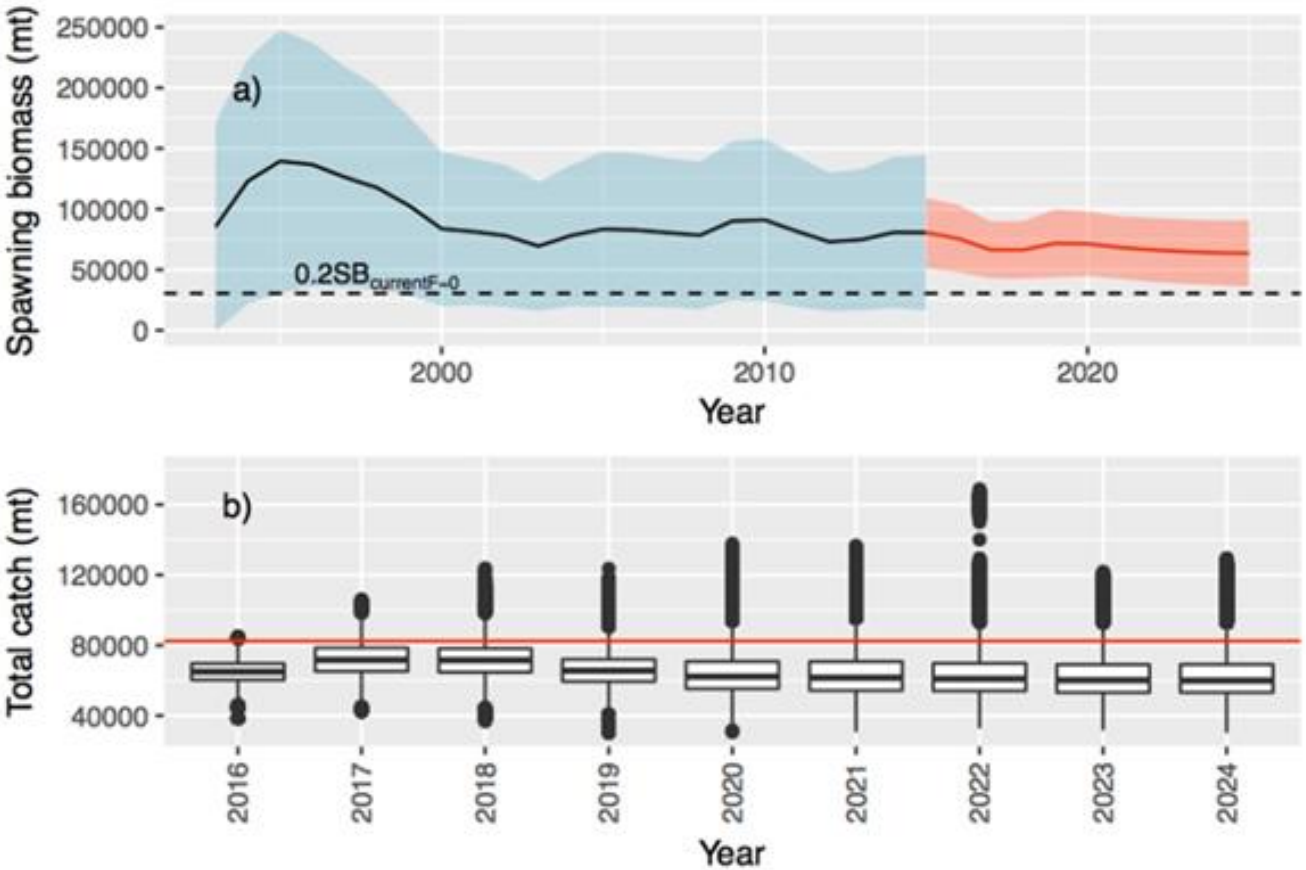
- Stock status is depicted relative to LRP; $20\%SSB_{current,\ F=0}$) adopted by NC & equivalent fishing intensity ($F_{20\%}$; calculated as 1-$SPR_{20\%}$)
- Estimated female SSB never falls below the LRP during the model time-frame (1993-2015) & does not fall below the LRP when alternative assumptions on M and growth (considered key uncertainties) are evaluated, although risk may be greater

Stock Status Information - 2

* Based on these findings, the following information on the status of the north Pacific albacore stock is provided:

1. **The stock is likely not overfished relative to the WCPFC-LRP (20%SSB $_{current\ F=0}$), and**
2. **No F-based reference points have been adopted to evaluate overfishing. Stock status was evaluated against seven potential reference points. Current fishing intensity ($F_{2012\text{-}2014}$) is below six of the seven reference points (see ratios in Table), except $F_{50\%}$**

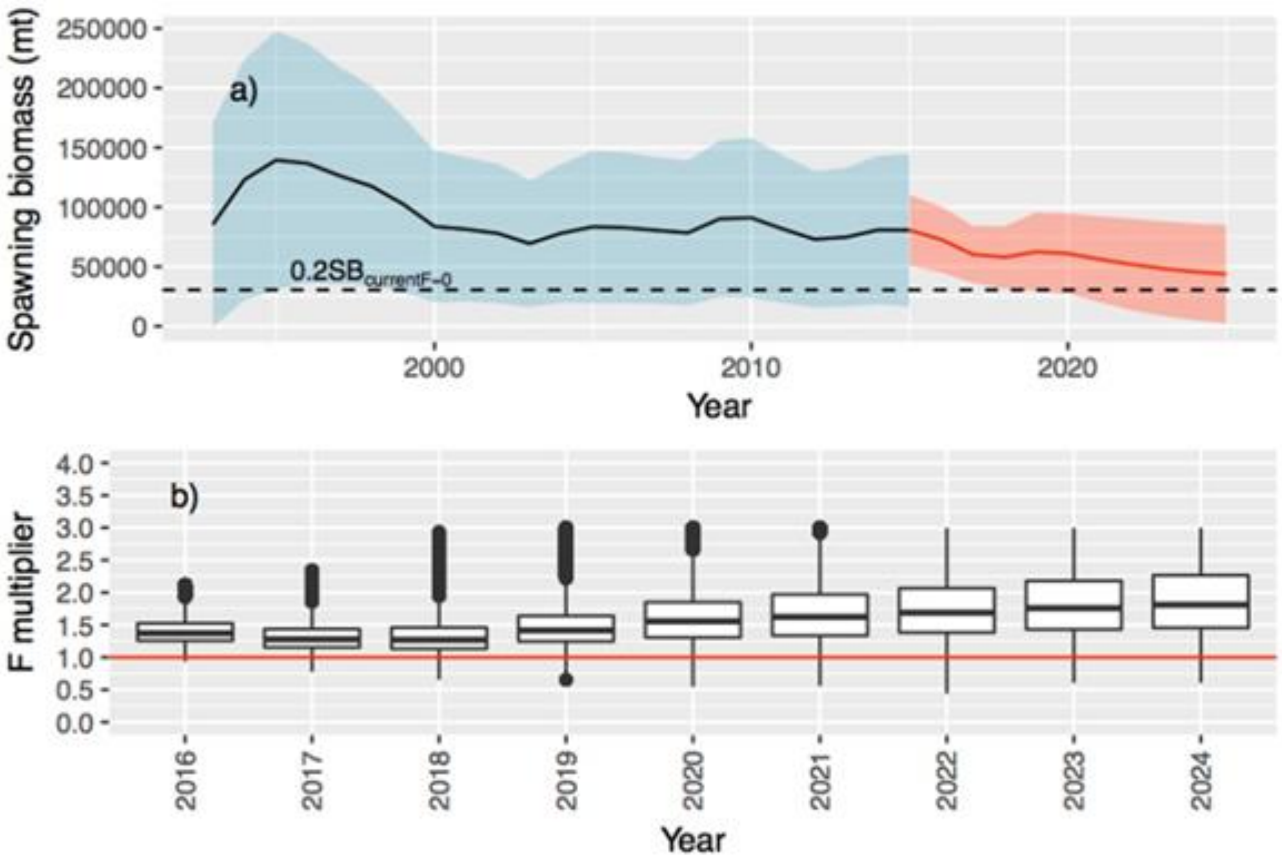
Future Projections - Constant $F_{2012\text{-}2014}$ Intensity Scenario



- Top - female SSB trajectory
- Bottom - Expected annual catch. Red line is current average catch (2010-2014 = 82,432 t).

- $P(SSB_{current}<LRP)$ is 0.2% in 2020 & <0.01% in 2025
- $P(SSB_{current}<LRP)$ may be higher due to reduced uncertainty in projections.

Future Projections - Constant Catch Scenario



- Top – Female SSB under a constant (average catch$_{2010\text{-}2014}$ = 82,432 t).
- Bottom - Projected fishing intensity relative to the current fishing intensity (2012-2014) (red line)
- P(SSBcurrent<LRP) is 3.5% in 2020 & 30% in 2025
- P(SSBcurrent<LRP) may be higher due to reduced uncertainty in projections.

Conservation Information

* Based on these findings, the following information is provided:
  * **If a constant fishing intensity ($F_{2012\text{-}2014}$) is applied to the stock, then median female spawning biomass is expected to decline 63,438 t & there is a < 0.01% probability of falling below the WCPFC-LRP by 2025. However, expected catches will be below the recent average catch level for this stock.**
  * **If a constant average catch ($C_{2010\text{-}2014}$ = 82,432 t) is removed from the stock in the future, then the decline in median female spawning biomass will be greater (to 47,491 t by 2025) than in the constant F scenario & the probability that SSB falls below the WCPFC-LRP is greater by 2025 (30%). Additionally, the estimated fishing intensity will double relative to the current level ($F_{2012\text{-}2014}$) by 2025 as spawning biomass declines.**

Key Uncertainties

* Addressing the following uncertainties will improve future stock assessments:
  1. **lack of sex-specific size data,**
  2. **uncertainty in growth and natural mortality, and**
  3. **the simplified treatment of the spatial structure of north Pacific albacore population dynamics**

* Including earlier time series (1966-1992) in the model is desirable

Acknowledgements

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  * Steve Teo –USA
  * Kevin Piner – USA
  * Hirotaka Ijima – Japan
  * Hidetada Kiyofuji –Japan
  * Daisuke Ochi - Japan
  * Osamu Sakai - Japan
  * Carolina Minte-Vera – IATTC
  * Chiee-Young Chen – TWN
  * Zane Zhang – Canada
  * Hui-hua Lee
  * David Itano– USA
  * Desiree Tommasi – USA
  * Zhe Geng - China

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  * Mark Maunder – IATTC
  * Allan Hicks– International Pacific Halibut Commission

New ALBWG Chair and Vice-Chair

Dr. Hidetada Kiyofuji - Chair

Dr. Steve Teo – Vice-Chair

2nd ISC - North Pacific Albacore Management Strategy Evaluation Meeting

* **WHEN:** October 17-19, 2017
* **WHERE:** Vancouver, Canada
* **OBJECTIVES:**
  1) Review management objectives and performance metrics previously proposed (Yokohama, May 2016),
  2) Identification of acceptable level of risk for each objective,
  3) Develop preliminary set of candidate reference points and harvest control rules for testing, and
  4) Review the work plan and timeline for conducting management strategy evaluation

Questions?