2014 Stock Assessment of North Pacific Albacore Tuna

ISC ALBWG

IATTC Scientific Advisory Committee

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Acknowledgements

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  - Chiee-Young Chen – TWN
  - Steve Teo –USA
  - Kevin Piner – USA
  - Vidar Wespestad – USA
  - Yi Xu - USA
  - Keisuke Satoh – Japan
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  - Hidetada Kiyofuji –Japan
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  - Ian Stewart – International Pacific Halibut Commission

Assessment Logistics

1. Model Preparation Workshop (19-26 Mar 2013)
   - Shanghai Ocean University, Shanghai, China
2. Data Preparation Workshop (5-12 Nov 2013)
   - NRIFSF, Shimizu, Japan
3. Assessment Workshop (14-28 Apr 2014)
   - NOAA, SWFSC, La Jolla, USA
   - Model Subgroup meeting (14-18 Apr 2014)
   - Develop recommended base-case model, sensitivity analyses, & future projection scenarios
   - Develop recommendations on current stock status, future trends, and conservation.

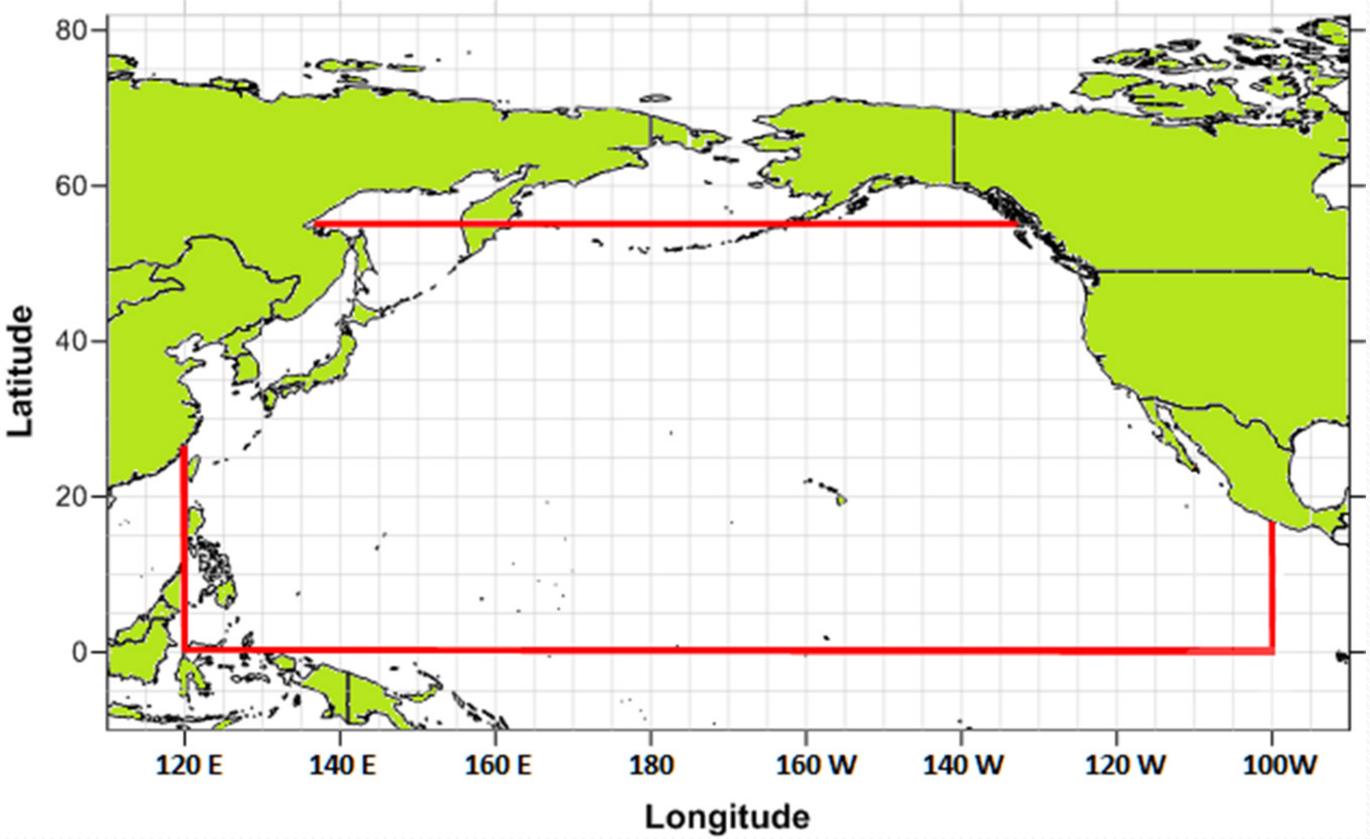
Outline

- Biology
- Data
- Model Description
  - Biological & Demographic Assumptions
  - Selectivity & Catchability
  - Data Weighting
- Results
  - Diagnostics
  - Assessment
  - Reference Points
  - Fishery Impact Analysis
  - Sensitivity Runs
  - Future Projections
- Stock Status & Conservation Advice
- Key Uncertainties & Recommendations for Future Research

Albacore Biology

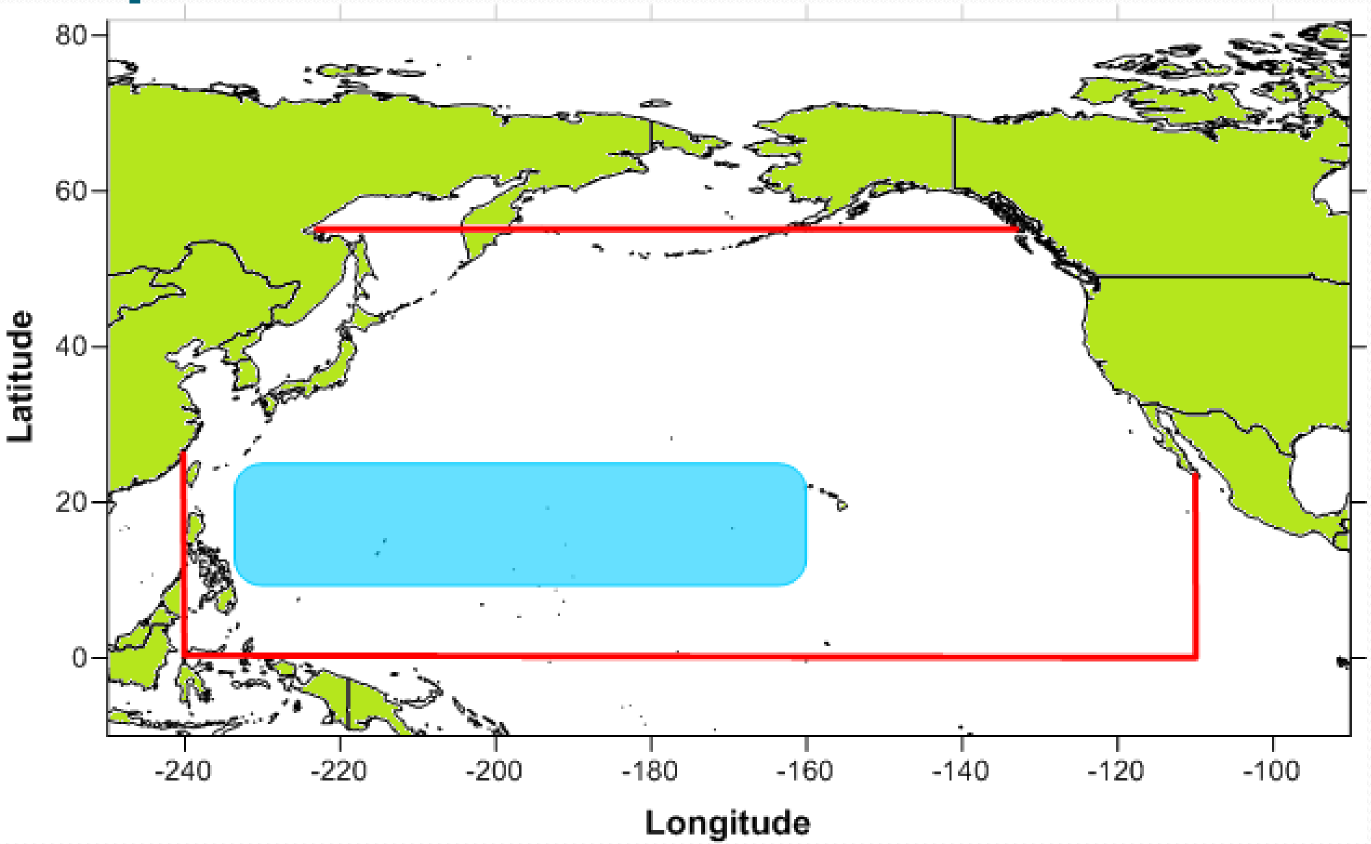
1. Stock Structure
2. Reproduction
3. Growth
4. Movements

Stock Structure



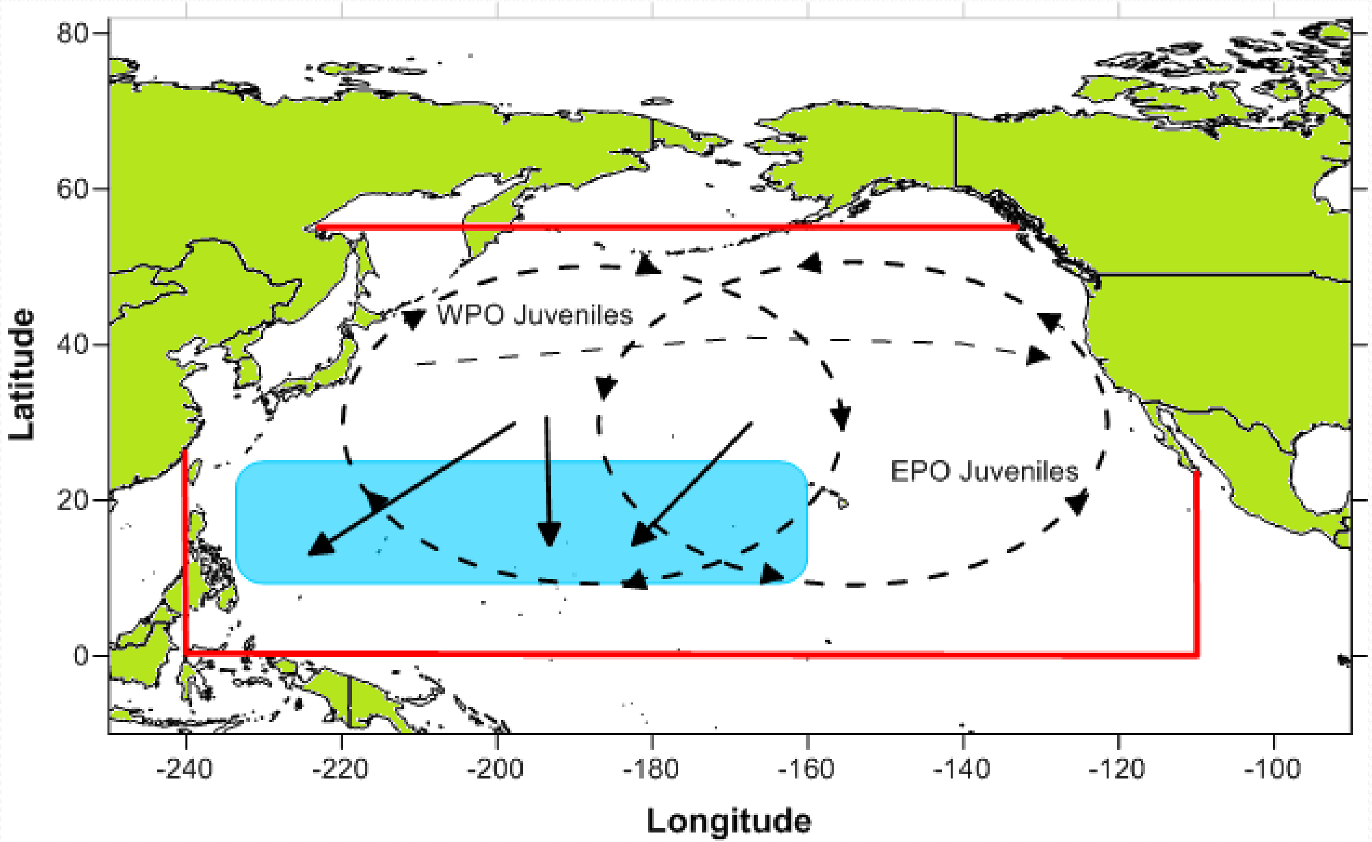
- All biological, ecological, fishery, and genetic evidence points to one stock in the north Pacific Ocean

Reproduction



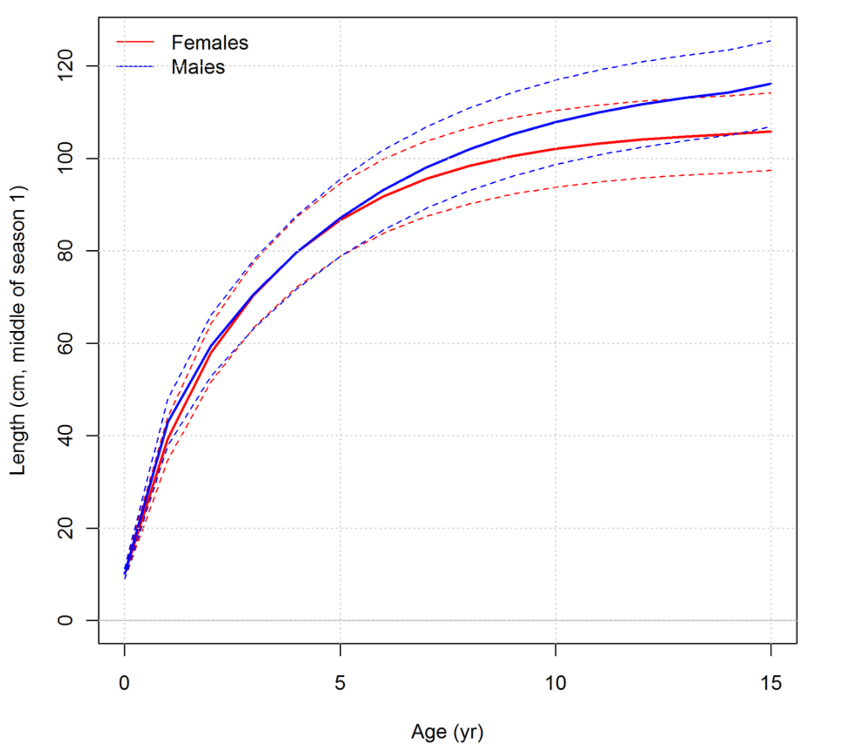
- Spawn March through September, 10-25°N
- Spawning peaks in Mar-Apr in WPO

Movements



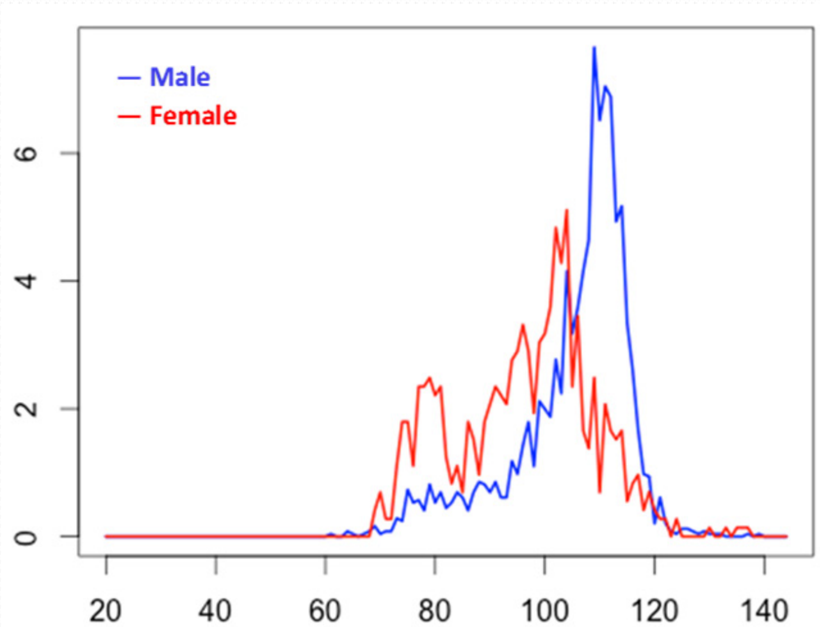
- Most movements among juveniles; EPO and WPO groups move seasonally;
- Trans-Pacific movement of juveniles west to east
- Maturing fish move to spawning area

Sex Specific Growth



- Xu et al. (2014: ISC/14/ALBWG/04) combined sex-specific data from Chen et al. (2012) & Wells et al. (2013) to estimate VBG model for each sex.
- Considered to be most representative of growth in the NPALB stock
- Base case model developed to be consistent with Xu et al. 2014 growth model
- Sensitivity runs consistent with other growth models were developed

Sex Ratio



- Japan training vessel longline catches, 1987-present
- Sex information not routinely collected in fisheries

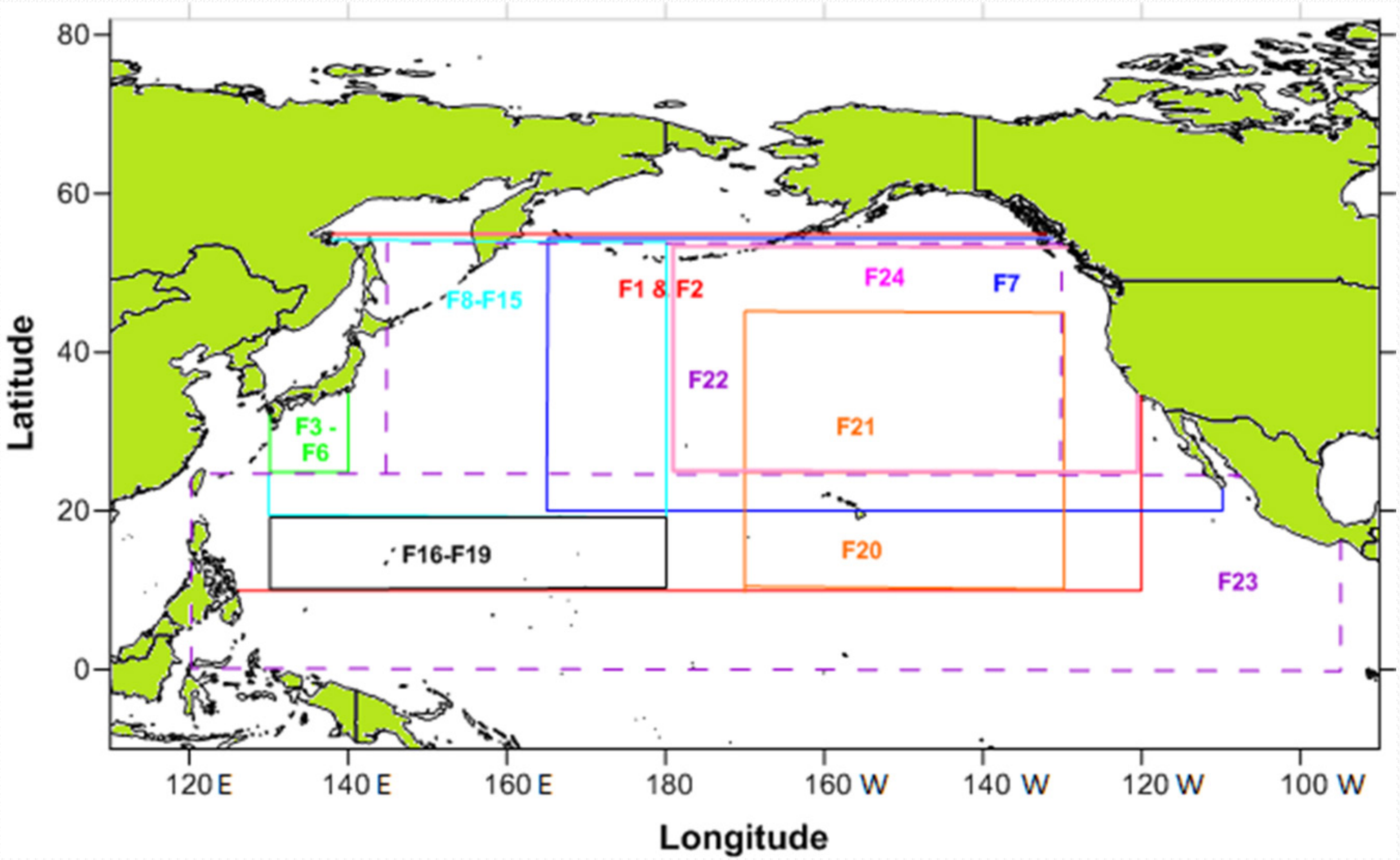
Latitude band	Sex ratio (males/females)	Sample size
10-25°N	4.78	2,288
> 25°N	1.93	1,259

- Largest fish are south of 25°N & predominately male
- Training vessel data consistent with fishery data, i.e., large fish only observed in southern areas
- JPN LL fishery spatially stratified into N of 20°N and S of 20°N as a result
- Catches in F16 and F17 (south of 20°N) are primarily large male albacore
- Sex ratio not fit; evidence supporting use of 2-sex growth model

Data

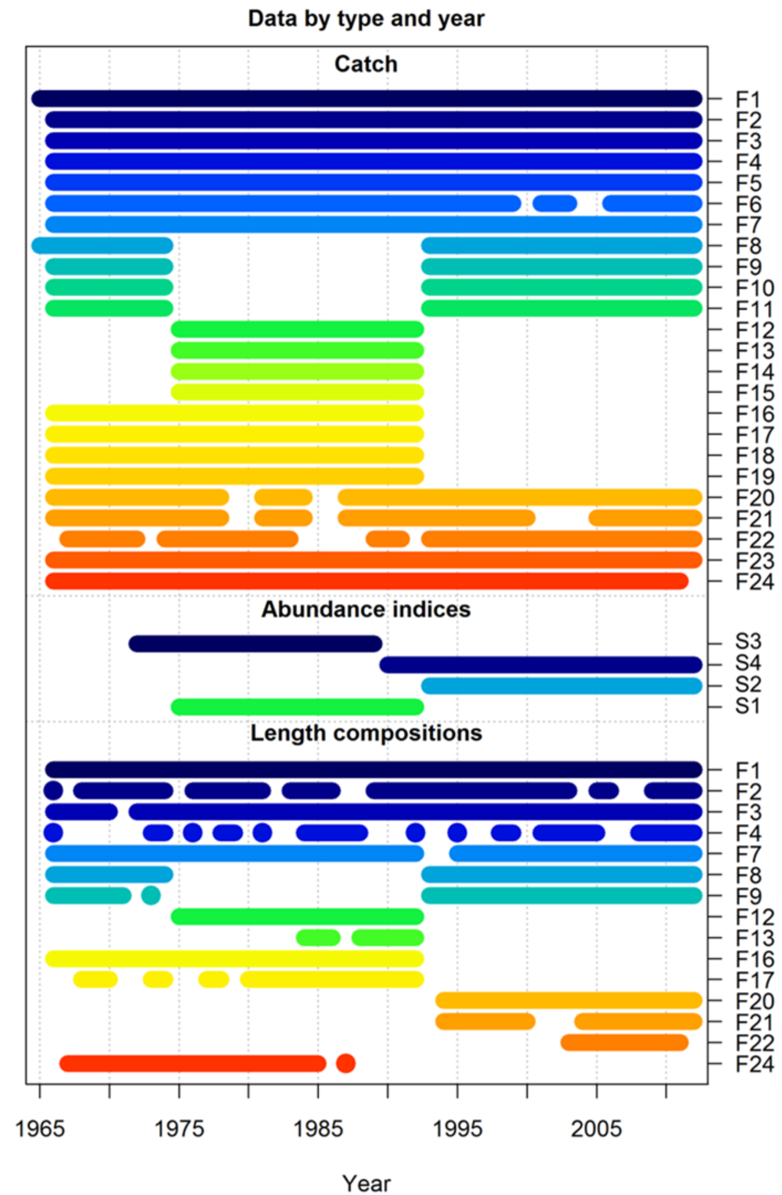
Fishery Definitions
Catch
Relative Abundance Indices
Sex Composition
Sex Ratio

Spatial Distribution of Fisheries

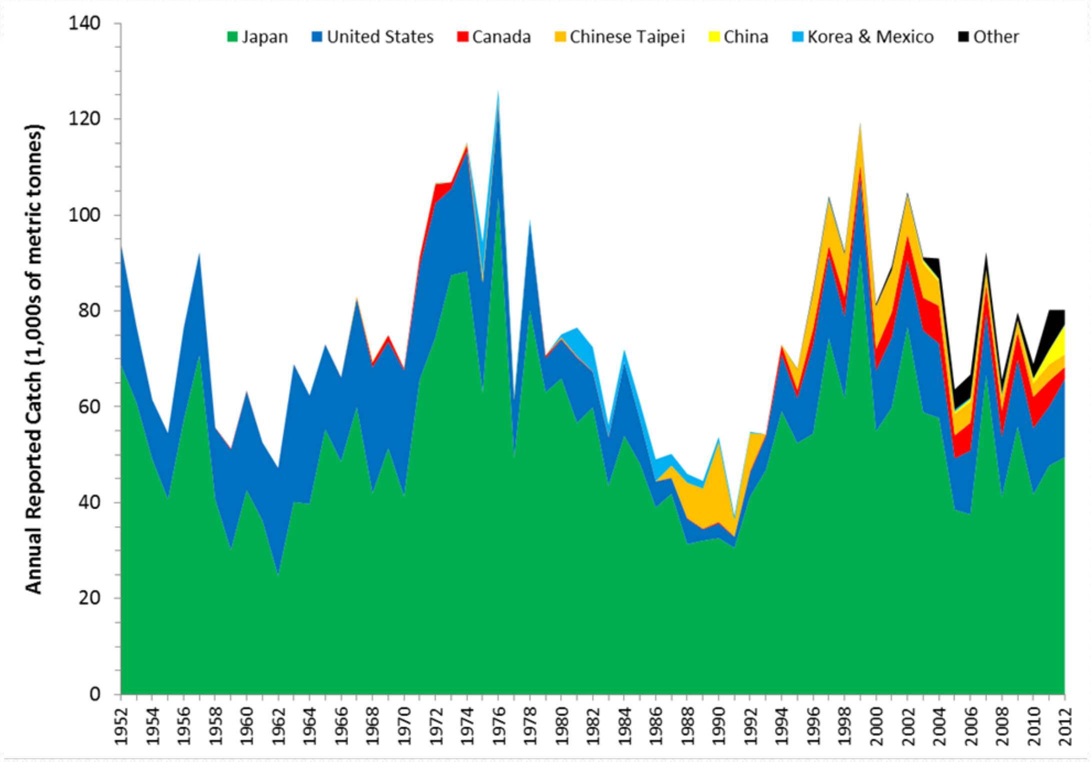


Data Time Series

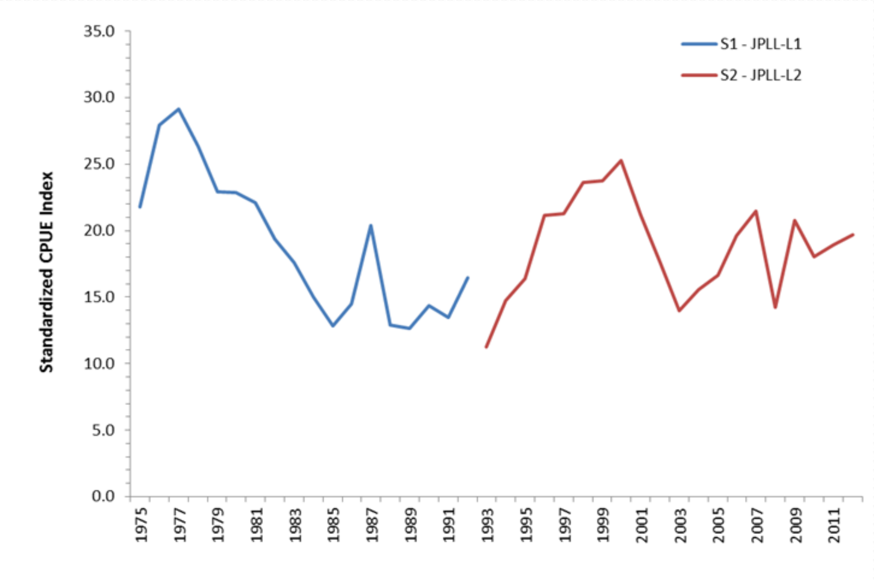
- Model time frame: 1966 to 2012
- Used data available to ALBWG as of 1 Jan 2014
- Most catch time series are continuous over this period; some begin before this period (1952)
- Abundance index time series begin in 1972 (adult) and 1975 (juvenile)
- Length composition time series beginning in 1966 for 8 of 15 fisheries
- No sex composition data



Catch History, 1952-2012



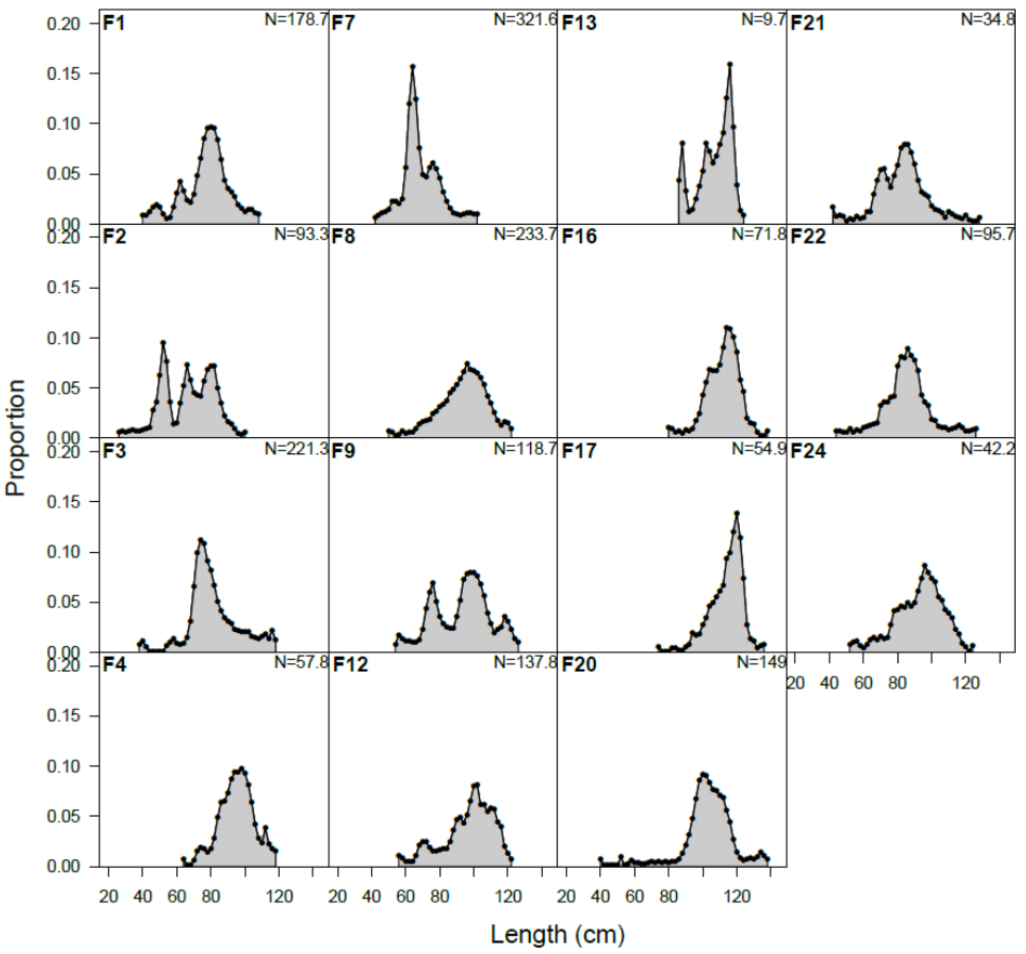
CPUE Time Series in Base Case Model



- Based on JPDW pole-&-line fleet to avoid target switching issue in offshore & coastal components
- 1972-1989: primary catch seasons Q1 & Q2
- 1990-2012: primary catch seasons Q3 & Q4
- Has largest operational area of surface fisheries so considered most representative of juvenile abundance

- Based JP LL fleet operating north of 25°N
- 1975-1992: fishery expanding N of 25°N, primarily shallow-sets & main catch seasons Q1 & Q4
- 1993-2012: fishery expanding S of 25°N, primarily deep-sets, main catch seasons Q2 & Q3
- Largest operational area & longest catch history of LL fisheries so considered most representative of adult abundance

Size Composition



- Size composition data available for 15 fisheries.
- Plots show data by fishery aggregated over sex, seasons & years
- N is the input sample size for each fishery.

Model Description

Biological & Demographic Assumptions

Selectivity & Catchability

Data Weighting

Methodology

- Sex-specific, length-based, age-structured, forward-simulating statistical catch-at-age model in Stock Synthesis Ver. 3.24f
- R-package, SSFUTURE, for projections

Key Assumptions

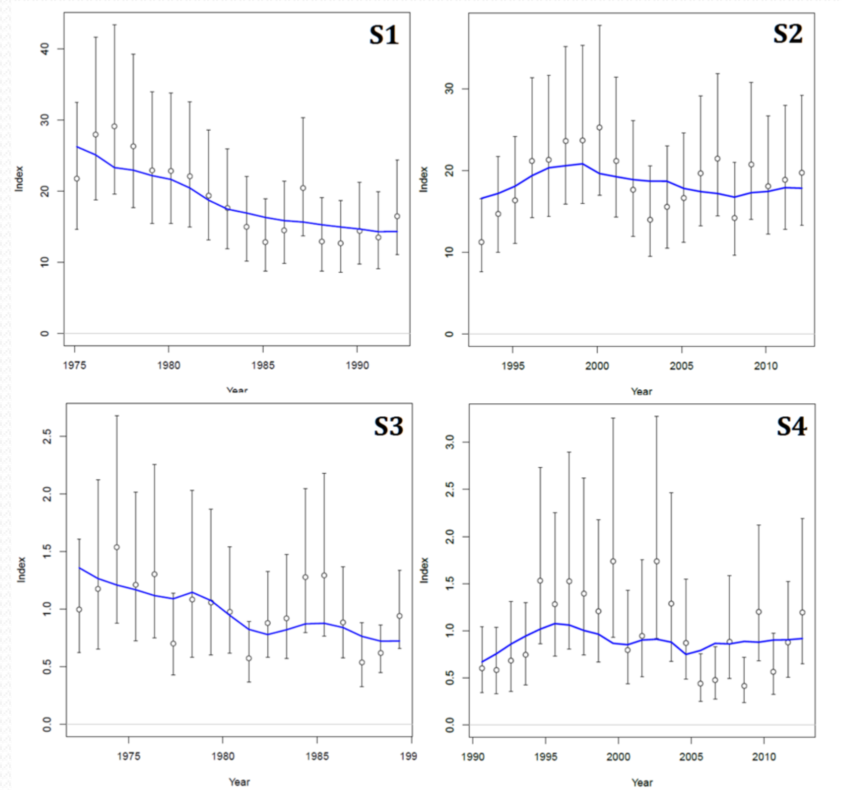
- Biological
  - One well mixed stock on quarterly basis
  - One spawning and recruitment period: Q2
  - M= 0.3 yr^{-1} for all ages
  - Maturity (Ueyanagi 1957): 50% age 5, 100% ≥ age 6
  - Maximum age: 15 years
  - Two sex growth model, fixed in the model (Xu et al. 2014)
  - Quarterly W-L relationships (Watanabe et al. 2006) assumed to be applicable to both males & females
- Stock-recruitment
  - Steepness (h) = 0.9; median of two independent estimates (Brodziak et al. 2011; Iwata et al. 2011)
- Initial Conditions
  - Init F and early recruitment freely estimated, no strong assumptions
- Data Weighting
  - Size composition data were down-weighted to produce good model fits to the abundance indices

Results

Diagnostics
Parameter Estimates
Assessment
Reference Points
Fishery Impact Analysis
Sensitivity Runs
Future Projections

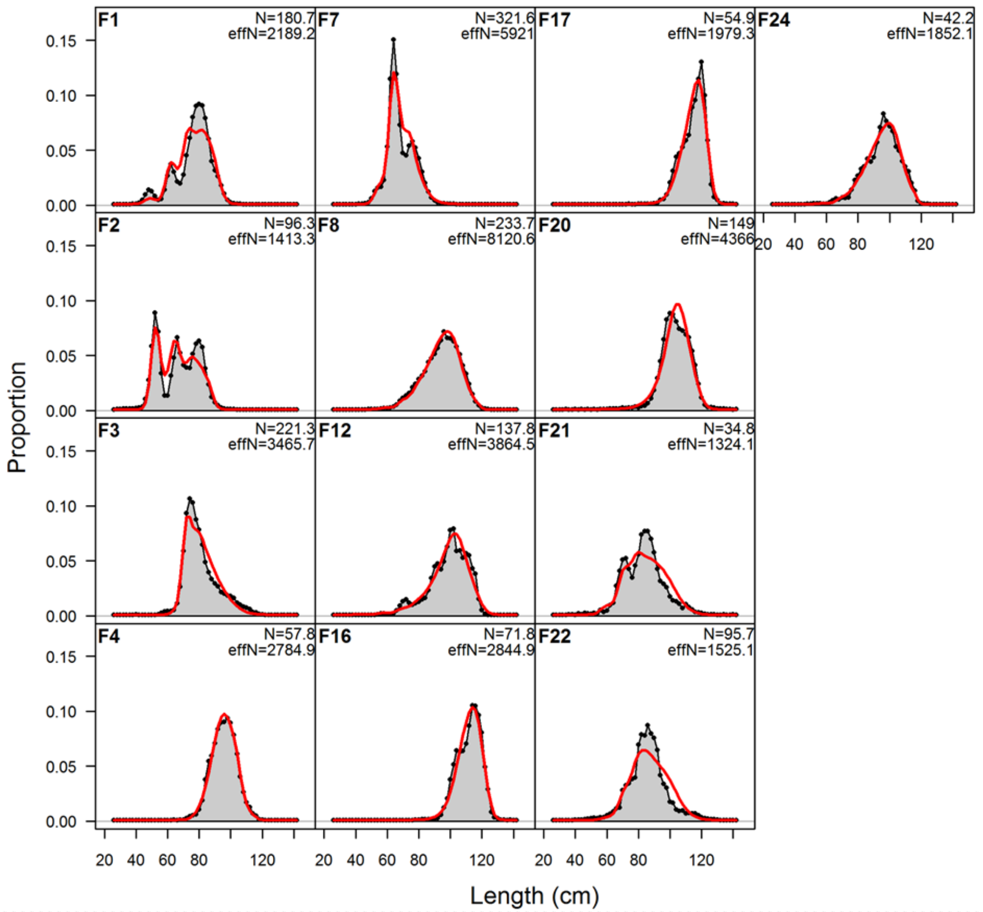
Diagnostics

- Fit to adult indices (S1 & S2) is good.
- RMSE were 0.140 & 0.169 & are less than input CV=0.2 for these indices
- S1 & S2 are primary information source for SSB trends
- Fits to the juvenile (S3 & S4) indices are poorer, but are considered consistent with the model input CVs.
- RMSE for S3 was 0.242 and input CV = 0.25.
- RMSE for S4 was 0.385, which was poorer than the sum of the mean input CV and variance adjustment (0.30).
- No increase in variance adjustment to match RMSE because ALBWG goal was to maintain a reasonably good fit as S4 is the terminal index for juvenile albacore



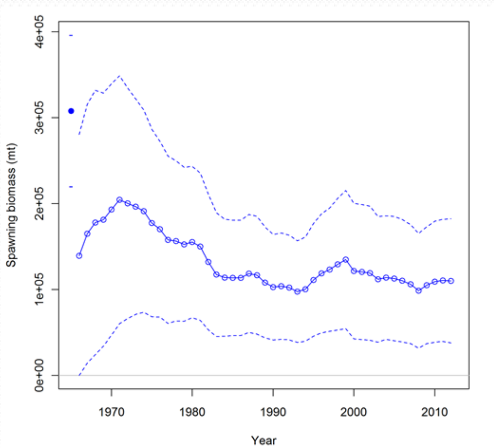
Diagnostics

- Model predicted size compositions matched observations in many fisheries
- Largest misfits occurred in juvenile fisheries (e.g., F1, F2, F3, F7), F21 (USLLs) & F22 (TWNLLa) but effects mitigated by downweighting
- Size comps of F1 & F2 highly variable both seasonally and inter-annually
- Cause may be changing fishery locations or migration patterns.
- Good fits to the size comps from fisheries catching adults (e.g., F8, F12, F16, F17, and F20) are evidence that the growth model and selectivity patterns used in base case represent the data and are consistent with each other
- No obvious patterns in Pearson residuals (not shown)

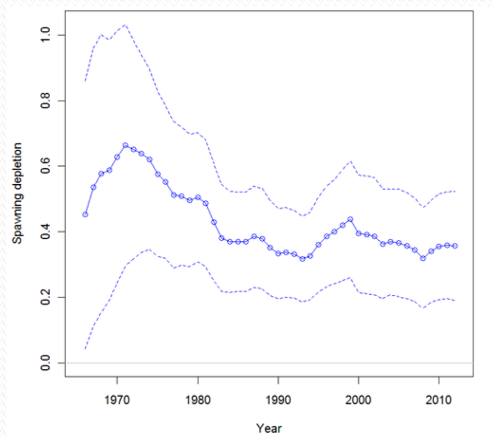


Estimated Biomass

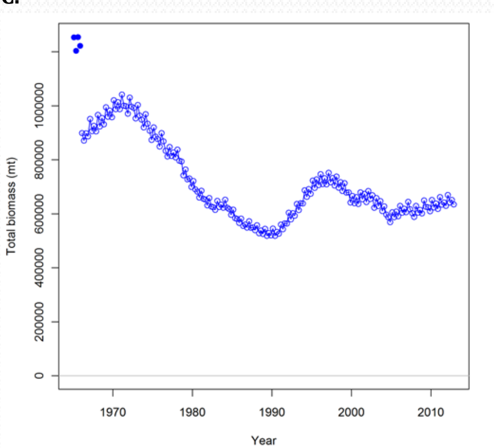
A.



B.



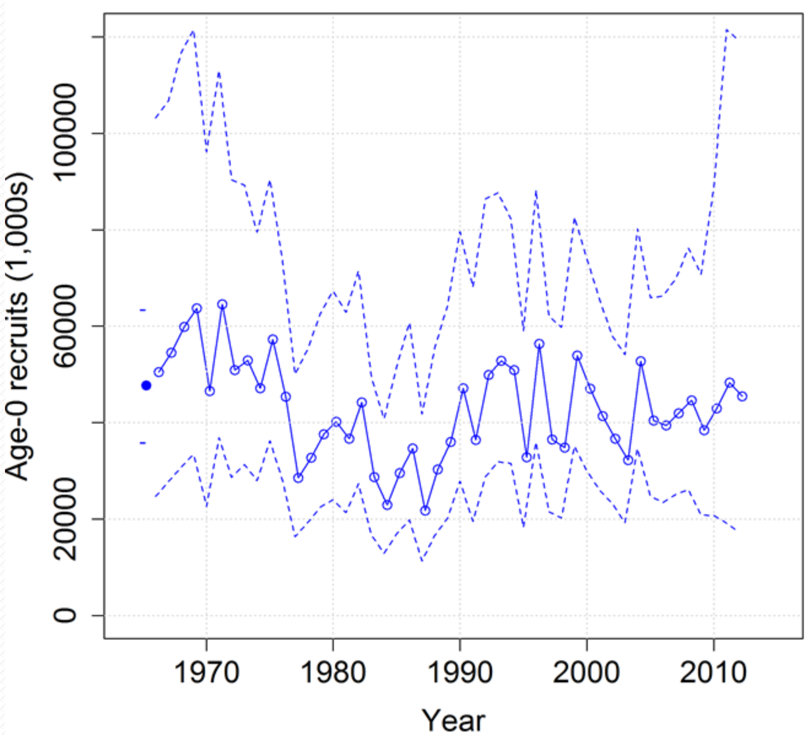
C.



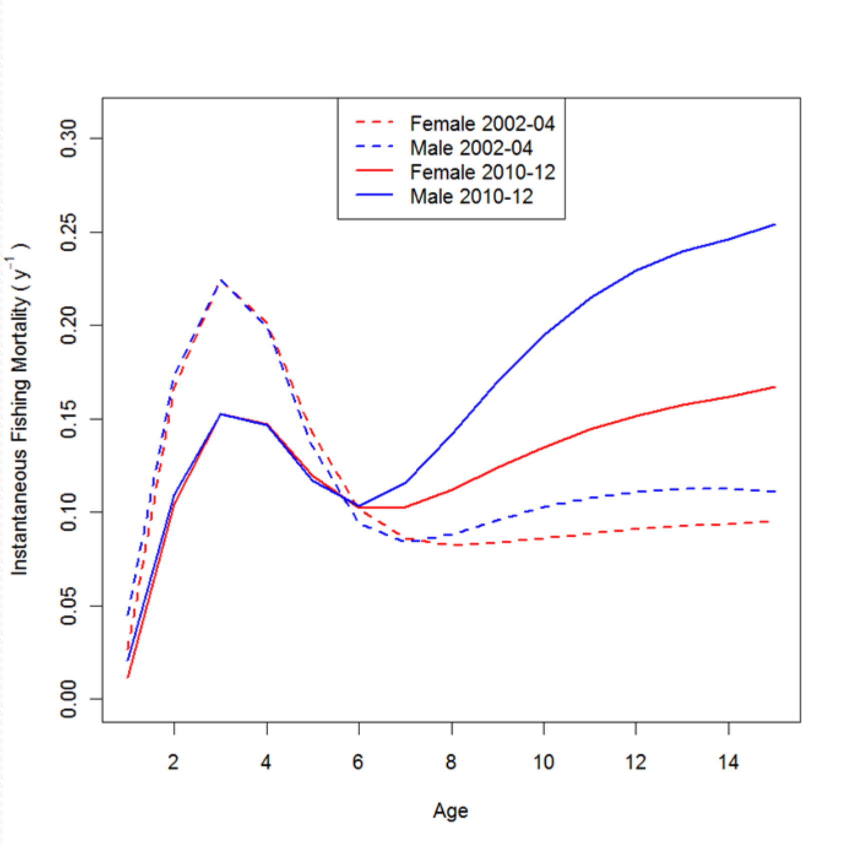
- Female SSB (A) has fluctuated between 98,000 t in 1993 and 205,000 t in 1971
- Two periods when SSB near historical lows: 1) 1989-1994, and 2) 2006-2012.
- During these periods NPALB was not in a heavily depleted state (B).
- Depletion ratio (SSB/SSB_0) has declined from 0.70 (1971) to about 0.40 (2012)
- SSB_0 was estimated to be 308,000 t; female SSB (2012) is 110,101 t
- Total biomass (age-1+; C) has ranged between 544,126 t (1989) & 1,041,570 t (1971).
- Between 2004 and 2012, total biomass has increased from 628,000 to 669,000 t.

Estimated Recruitment

- No trend in recruitment with respect to SSB
- Recruitment variability is largely driven by environmental conditions
- Estimated recruitment has fluctuated between 21.8 million fish (1987) & 65 million fish (1971)
- Average recruitment (1966 – 2010) is 42.8 million fish, which was slightly below virgin recruitment (47.7 million fish).
- Low recruitment period (1983 – 1989) averaged 29.1 million recruits
- High recruitment period (1966 – 1975) averaged 54.8 million fish.
- Recruitment about average 2005-2012, but seems to be a period of lower variability

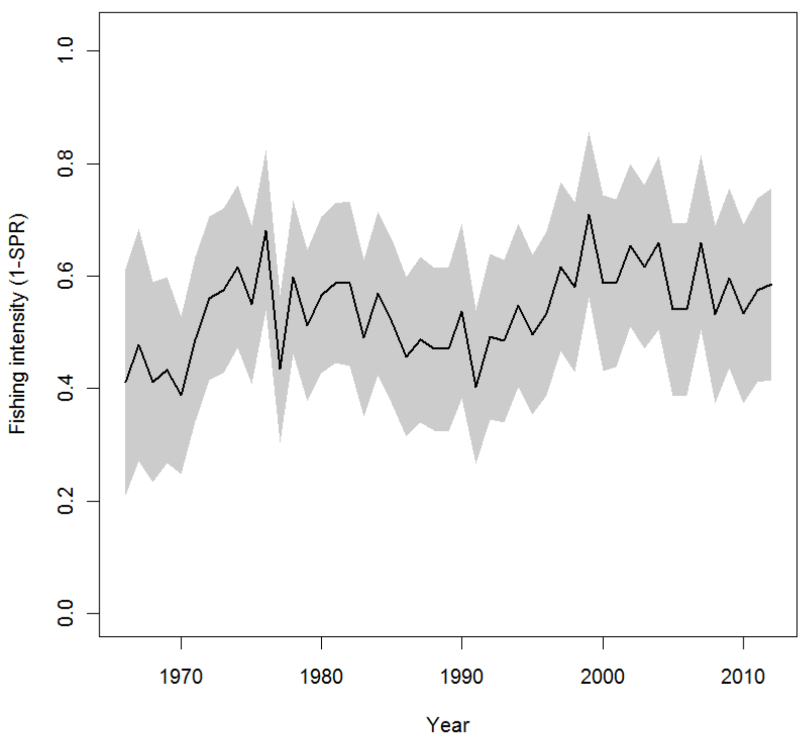


Estimated F-at-age



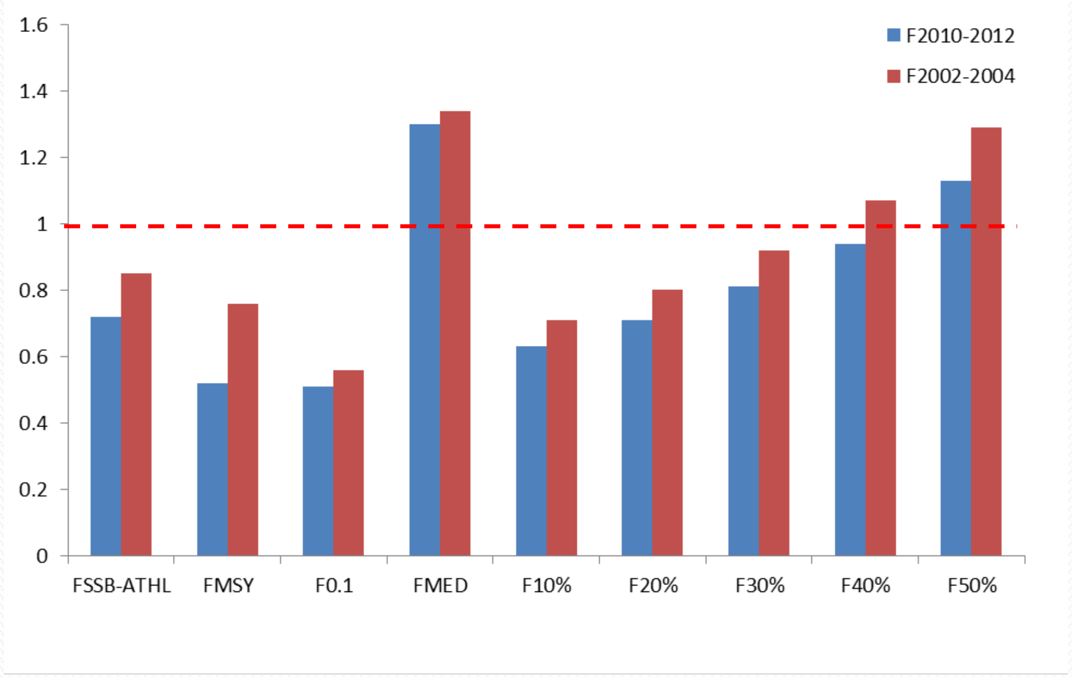
- F-at-age (2010-2012) is higher on juveniles than middle-aged fish, but adult fish have highest Fs
- F2010-2012 is consistently lower on juvenile fish than F2002-2004 (reference period for existing CMMs)
- F-at-age on adult females is lower than adult males because females do not grow as large as males & LL fisheries tend to have higher selectivity for large-sized albacore.
- High F-at-age on old mature albacore related to logistic selectivity patterns estimated for fisheries catching largest fish even though catch in these fisheries is < 1% of total catch

Estimated Fishing Intensity



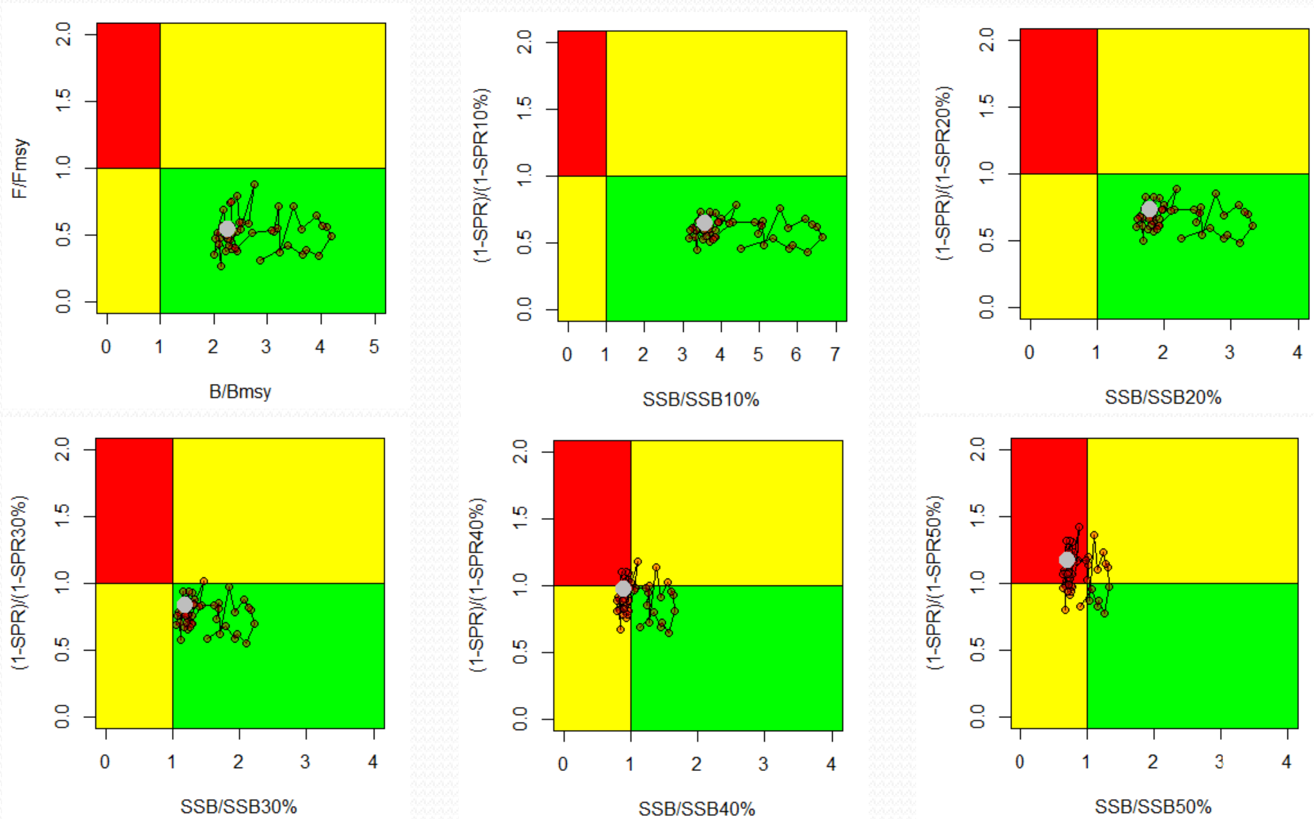
- Fishing intensity (1-SPR) has varied over time but generally declining since late 1990s

Biological Reference Points -1



- Ratio of $F_{current}/F_{RP}$
- Ratios < 1.0 are good
- F2010-2012 = $F_{current}$ in this assessment
- Ratios in this assessment are consistently < than F2002-2004

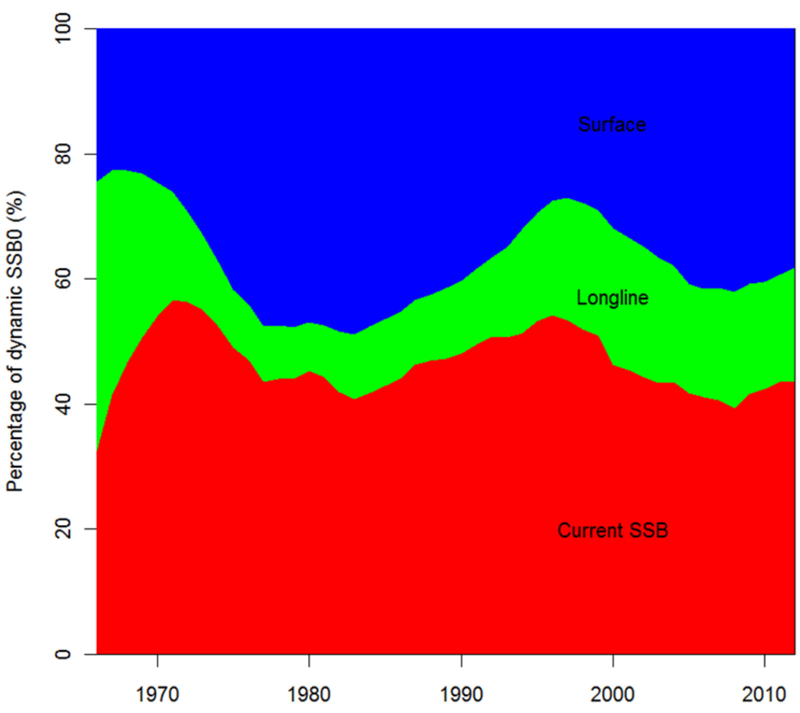
Biological Reference Points - 2



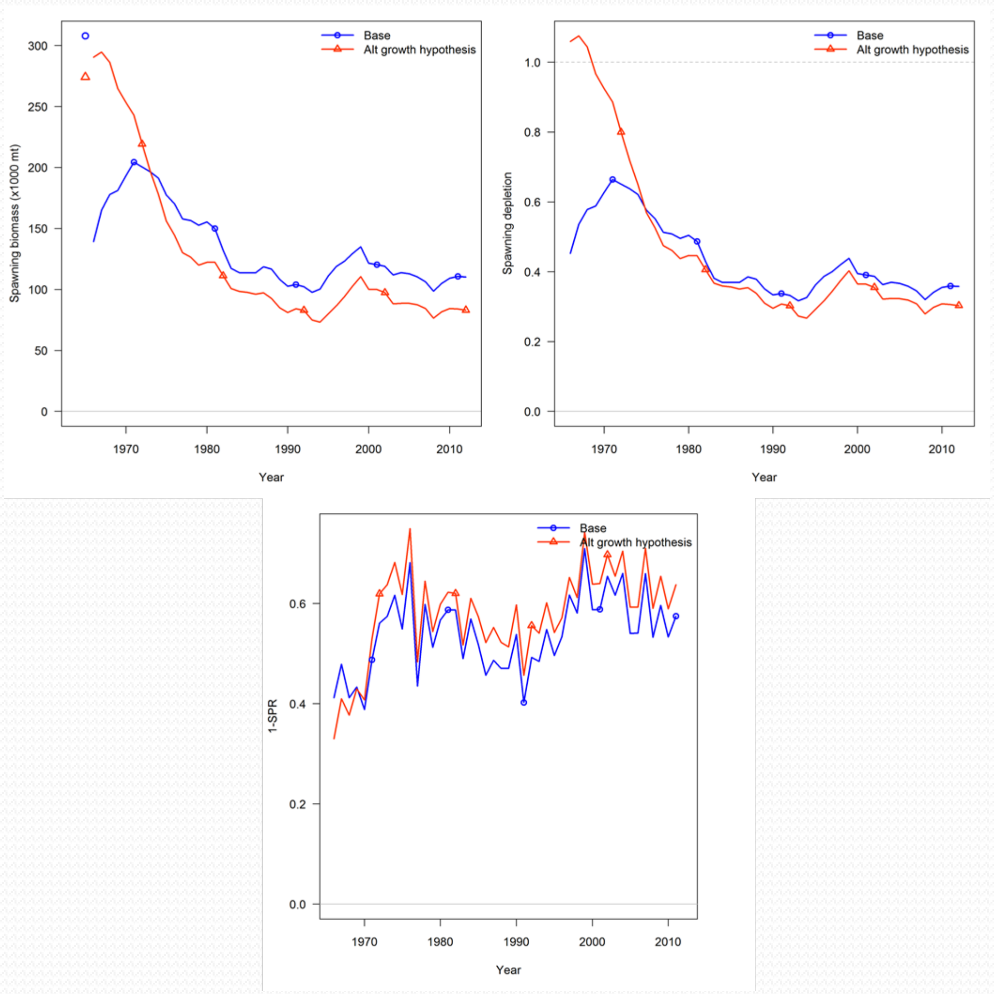
- Kobe plots are for illustrative purposes only. No RPs currently established for NPALB.
- ALBWG unsure how to illustrate $F_{SSB\text{-}ATHL}$ in Kobe plot.

Fishery Impact Analysis

- Current female SSB (red) estimated by the base case model as % of the dynamic virgin spawning biomass (SSB_o).
- Green is the portion of fishing impact attributed to longline (green) (US, Japan, Taiwan, Korea, China, and others)
- Blue is fishing impact related to surface fisheries (US, Canada, Japan). Includes primarily troll and pole-and-line gear, but also gillnet and all other gears except longline.

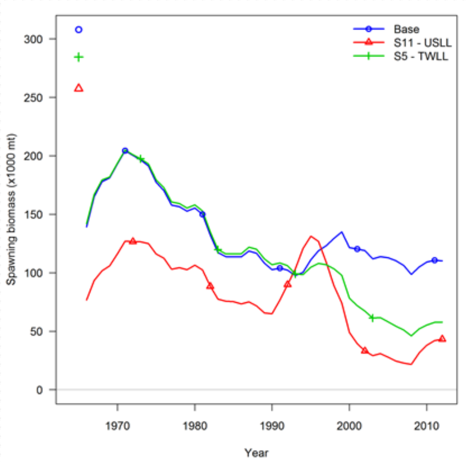


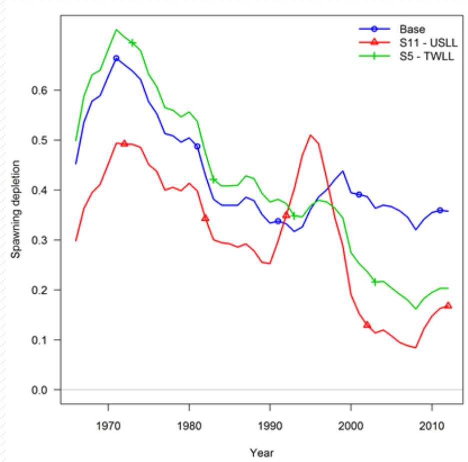
Sensitivity Runs – 1 of 2 (10 total)

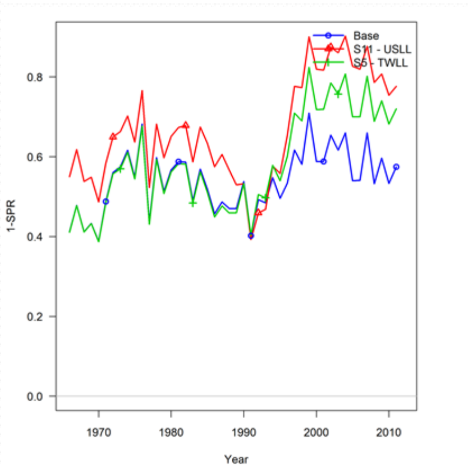


- Growth is major axis of uncertainty.
- This run uses the Chen et al. (2012) growth model (or northern growth hypothesis)
- Not used in the base case because it could not fit size composition data from LL fisheries operating south of 25°N
- The northern growth hypothesis produces similar SSB (left) and depletion (right) trajectories and scale for most of the time period
- SSB trends during the early part of the assessment, prior to start of the abundance index data differ.
- Fishing intensity (bottom) is similar

Sensitivity Runs – 2 of 2 (10 total)



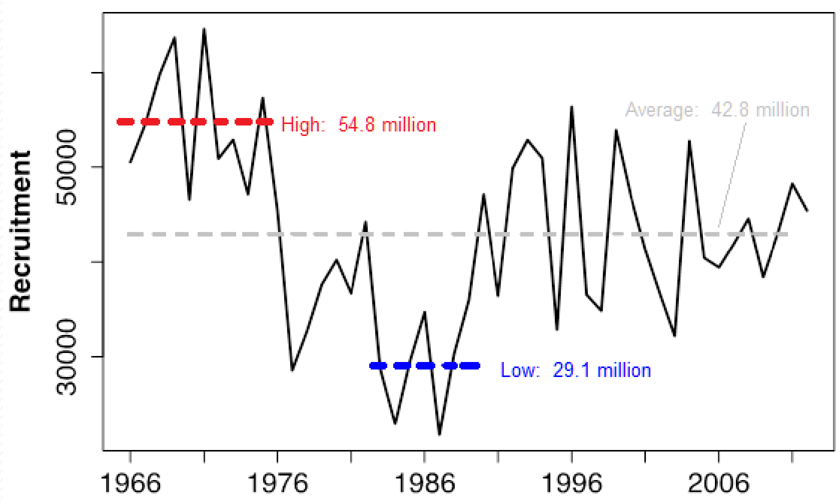




- Alternate adult indices (USALL – red; TWNLL – green) changes both trend and scale of female SSB
- USALL index (S11) begins in 1991; TWNLL index (S5) begins in 1995
- Estimated SSB trends prior to 1990 are similar to the base case model because the same early adult indices were used – divergence occurs after 1990.
- All three runs exhibit an increase in SSB during the 1990s followed by a decrease at different rates & to different levels.
- Both S5 & S11 resulted in a slightly lower estimated population scale.

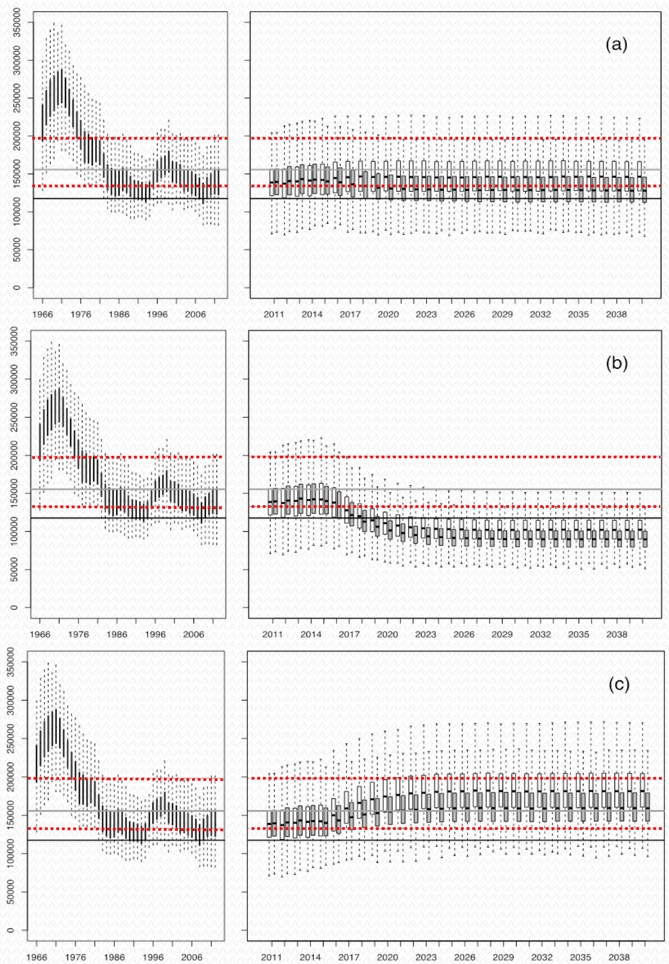
Future Projections

- Stochastic 30-yr projections :
  1. to assess effect of future harvest on stock abundance, and
  2. to estimate the probability that future SSB will fall below the SSB-ATHL threshold (the average of the ten historically lowest SSB estimates) in a 25-yr (2011-2036) projection period
- Three harvest scenarios: F2010-2012 (current F in this assessment), F2002-2004 (reference period in CMMs), & constant catch (avg 2010-2012)
- Projections start in 2011 & run to 2036 ($F_{SSB\text{-}ATHL}$) or 2041
- Used half catches assuming sex ratio in catches is 1:1



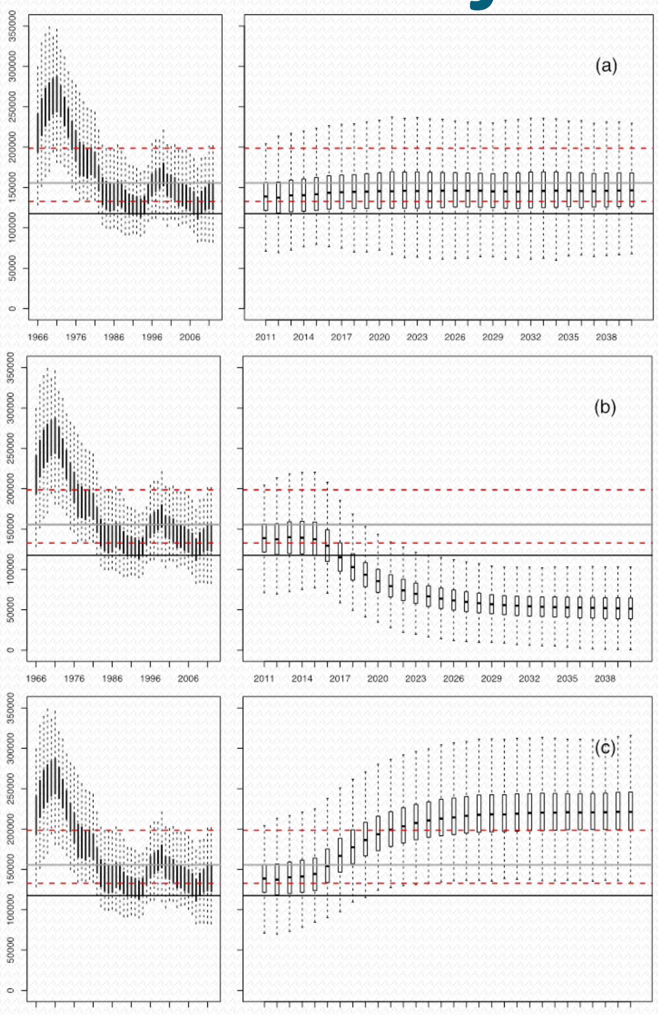
- Three recruitment scenarios: low, average, high historical.
- Recruitment resampled from historical time series

Future Projections - 1



- Avg historical recruitment
  - White box – F2010-2012
  - Grey box – F2002-2004
- Low historical recruitment
- High historical recruitment
  - Red dashed lines – 25th & 75th percentiles of historical SSB
  - Grey line – median historical SSB
  - Black line – SSB-ATHL threshold

Future Projections - 2



- Average historical recruitment
  - Constant catch averaged over 2010-2012
- Low historical recruitment
- High historical recruitment

Stock Status

- **F for 2010-2012 relative to most candidate reference points, except F_{MED} and $F_{50\%}$ are below 1.0, implying NPALB is not experiencing overfishing.**
- **Although no biomass-based reference points have been developed for this stock, there is little evidence that fishing has reduced SSB below reasonable candidate biomass-based reference points, thus the stock is not likely in an overfished condition.**

Conservation Advice

- **The North Pacific albacore stock is healthy and that current productivity is sufficient to sustain recent exploitation, assuming average historical recruitment continues.**

Key Uncertainties & Recommendations

- Key uncertainties include:
  1. lack of sex-specific size data,
  2. the absence of updated estimates of important life history parameters (M, maturity), and
  3. the simplified treatment of the spatial structure of north Pacific albacore population dynamics

- Research Recommendations:
  1. Size composition sampling should be raised to the catch so that observation error and process error can be partitioned and dealt with appropriately;
  2. All member countries are encouraged to collect sex ratio information from their fleets;
  3. Changes in sex ratio and size by depth should be investigated because the WG suspects that there is either a depth-size-sex or a spatial area-sex-size effect that is important to the population dynamics of this stock;
  4. Comprehensive sex-specific age and growth data are needed to improve understanding of growth in the north Pacific albacore stock; and
  5. The application of cubic spline functions to estimate selectivity in the assessment model should be investigated.

Questions?