Pacific Blue Marlin Stock Assessment Update in 2016

ISC Billfish Working Group

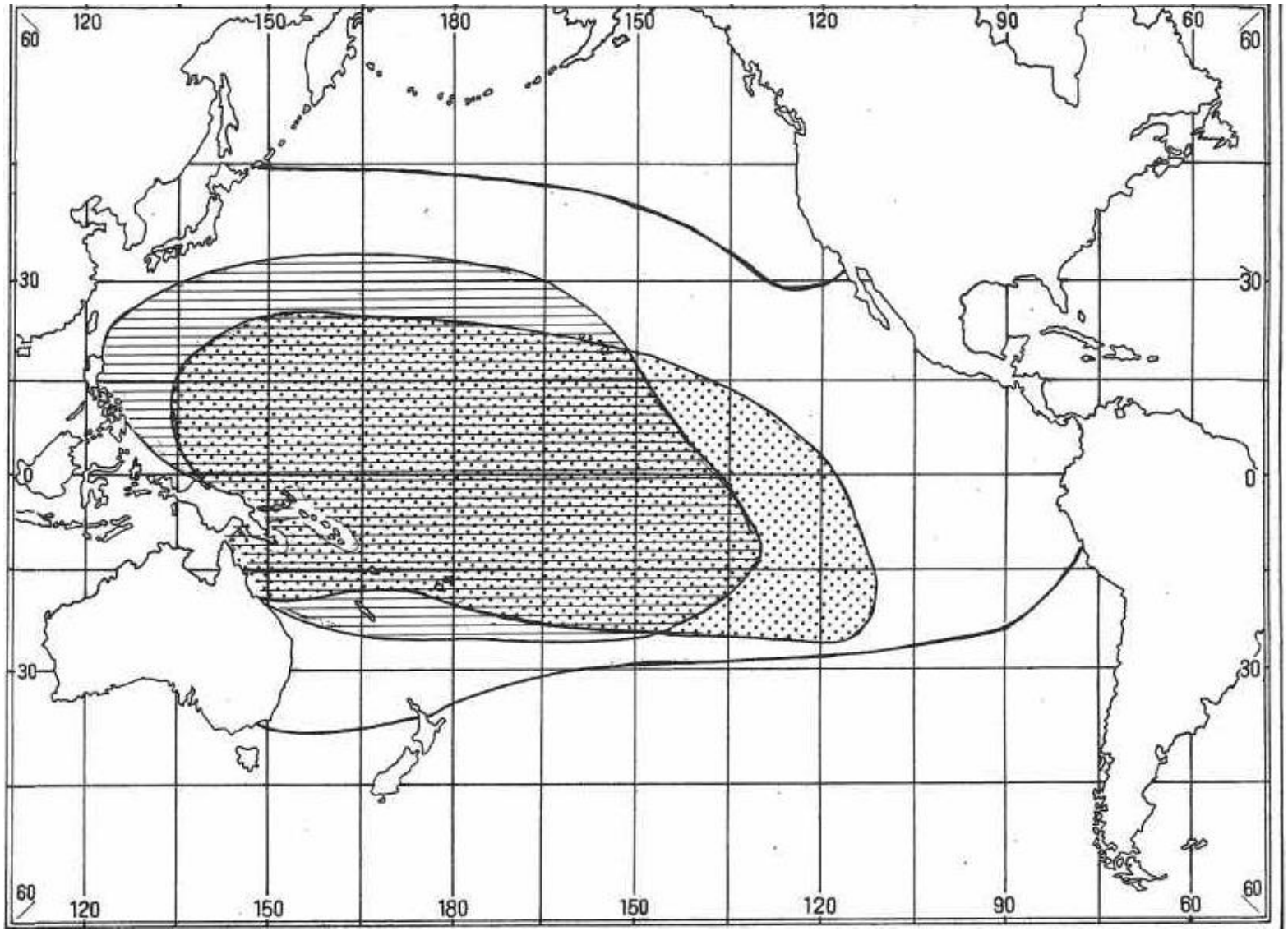
Overview

- **Overview of the 2013 Pacific Blue Marlin Stock Assessment**

- **2016 Assessment Data and Model**
  - **Blue Marlin Life History Information**
  - **Fishery Definitions and Selectivity Modeling**
  - **Updated Catch, Standardized CPUE, and Size Composition Data**
  - **Likelihood Components and Data Weighting**
  - **Base Case Model Diagnostics**

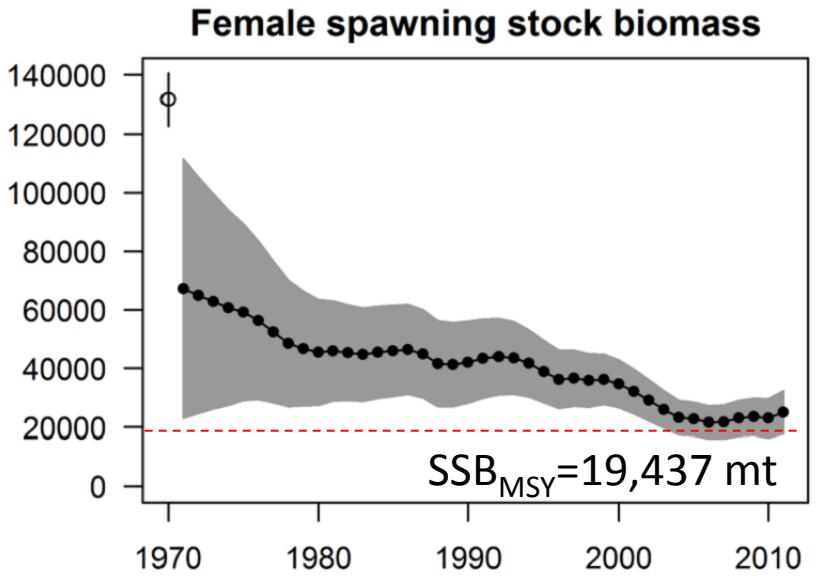
- **2016 Assessment Results**
  - **Comparison with 2013 Assessment**
  - **Stock Status**
  - **Stock Projections**

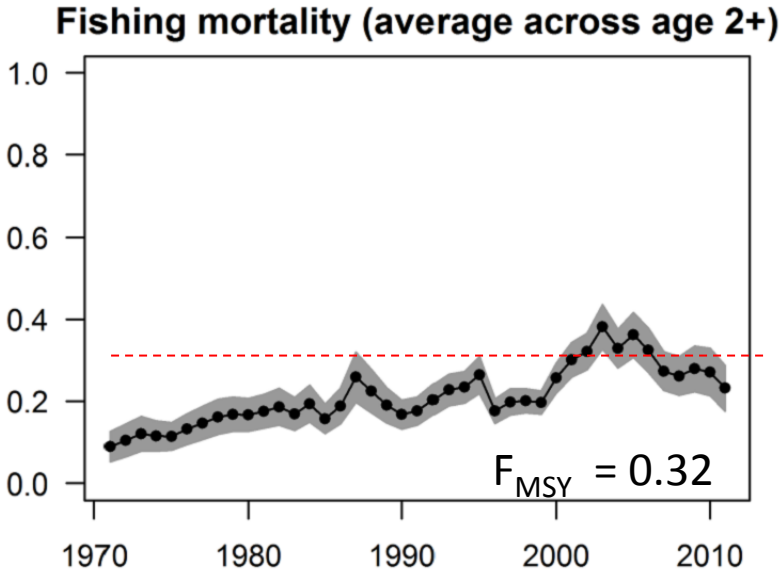
Pacific Blue Marlin Distribution



Overview of the 2013 Stock Assessment

- **2013 Stock Assessment Summary**
  - Two-sex seasonal age-structured model in SS3 (ISC 2013)
  - SSB_{2011} = 24,990 mt (29% above SSB_{MSY});
  - $F_{2009\text{-}2011}$(age 2+) = 0.36 (19% below F_{MSY})
  - **Pacific Blue Marlin Was Not Experiencing Overfishing and Was Not Overfished**



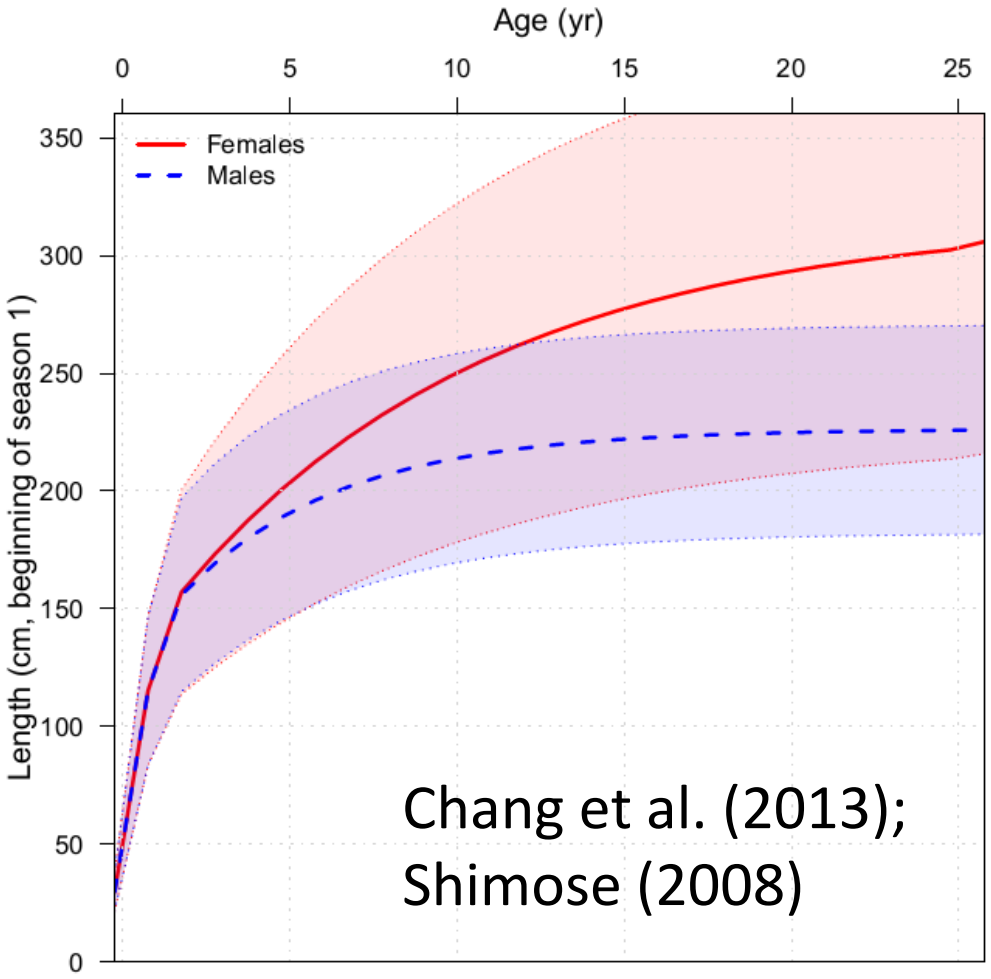


Pacific Blue Marlin 2016 Stock Assessment Update

Assessment Data and Model

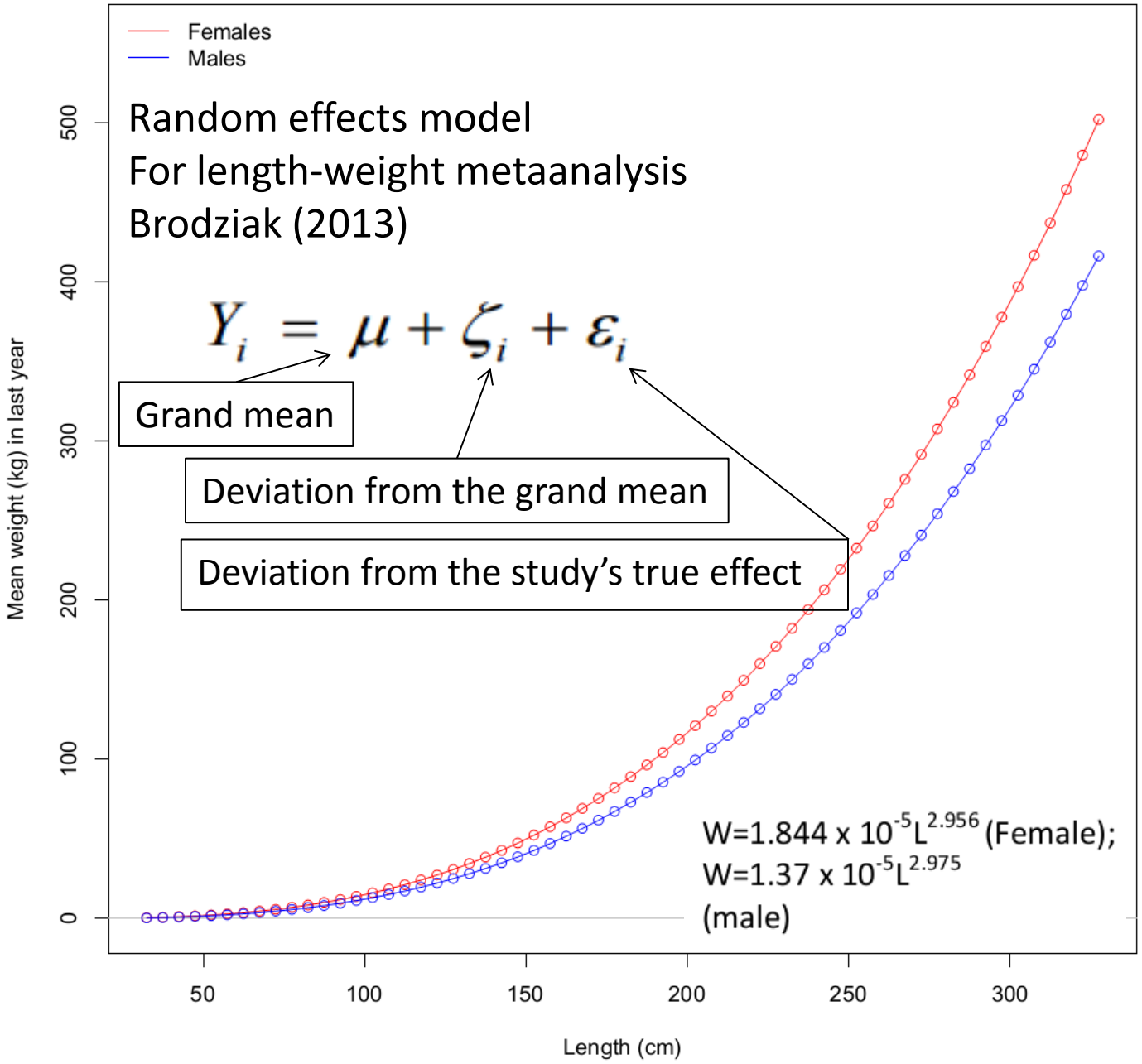
Pacific Blue Marlin Life History Information

Growth Information Used in the Stock Assessment

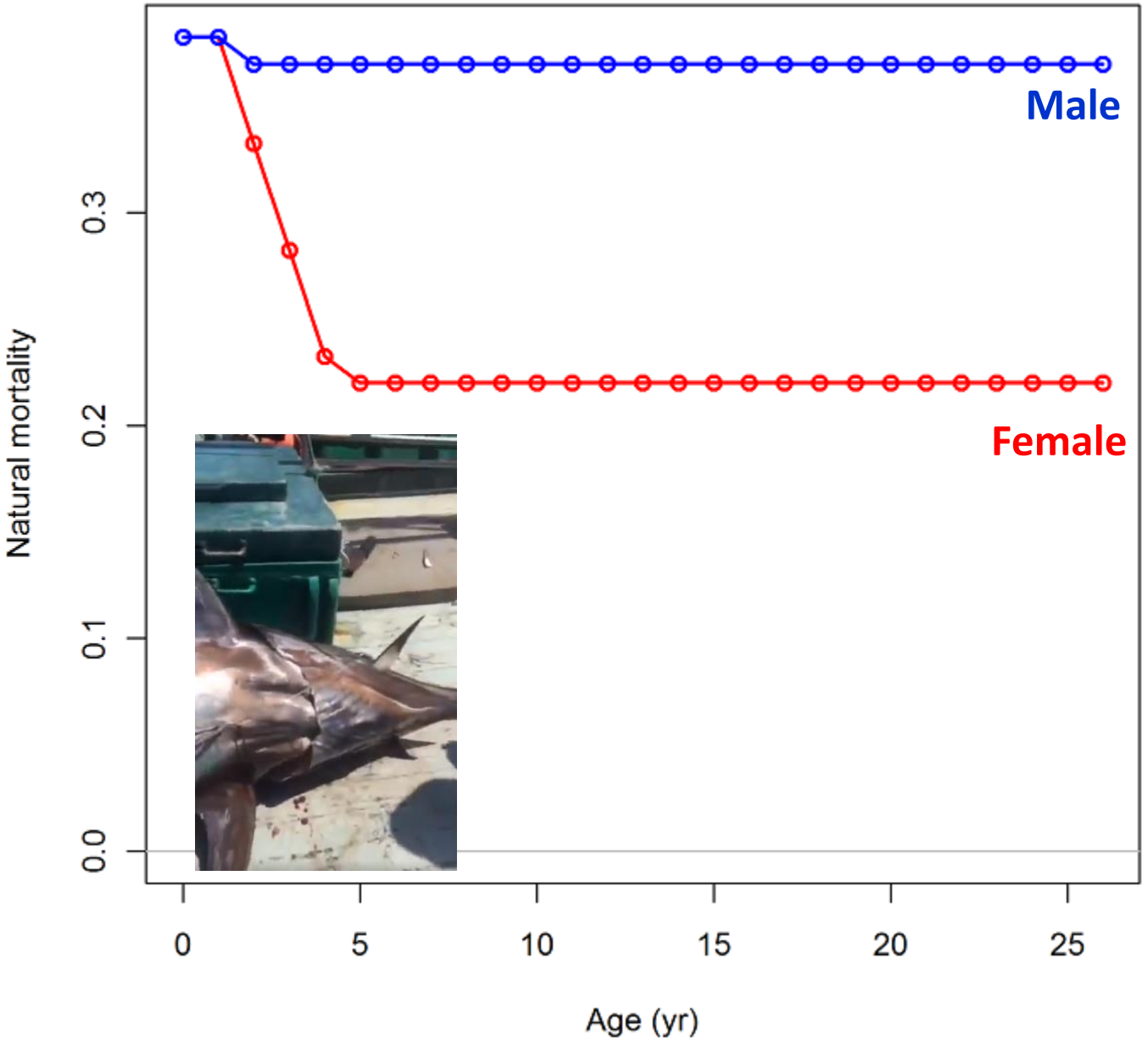


1,368-pound

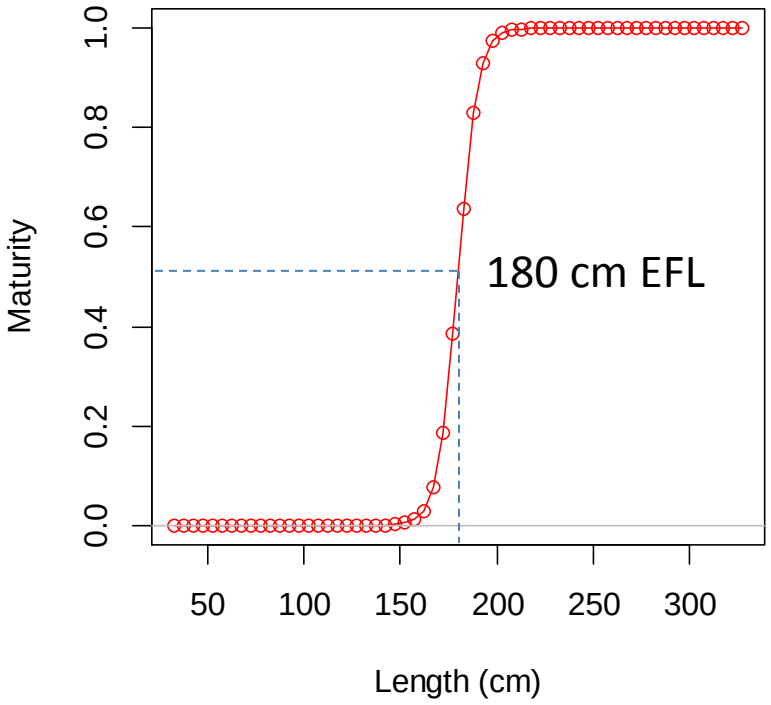
Pacific Blue Marlin Length-Weight Relationships

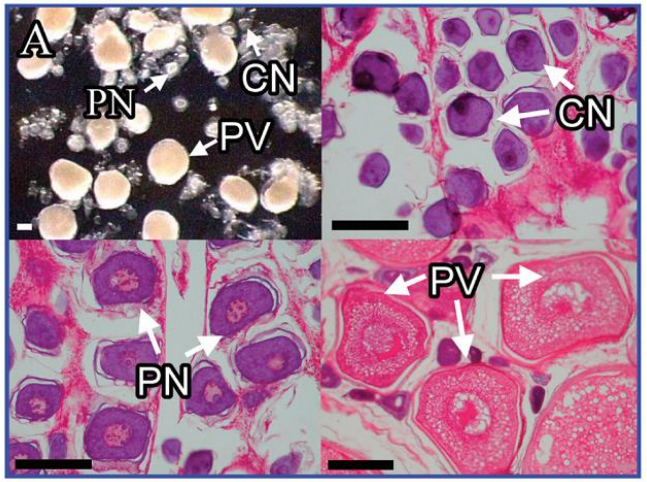


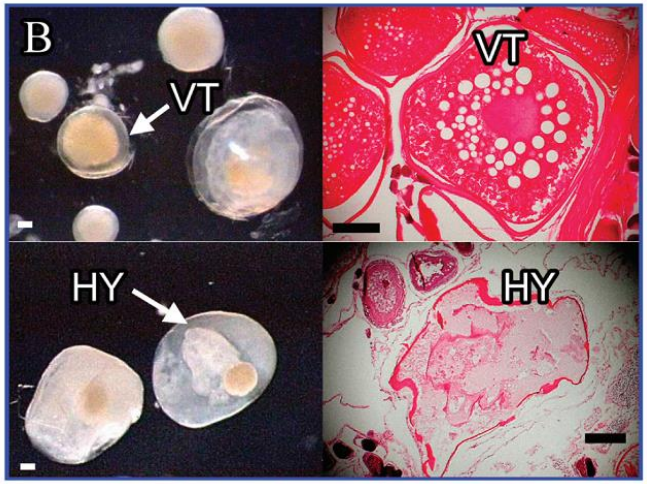
Sex-Specific Blue Marlin Natural Mortality at Age



Pacific Blue Marlin Maturity at Length







Sun et al. (2009); Shimose et al. (2009)

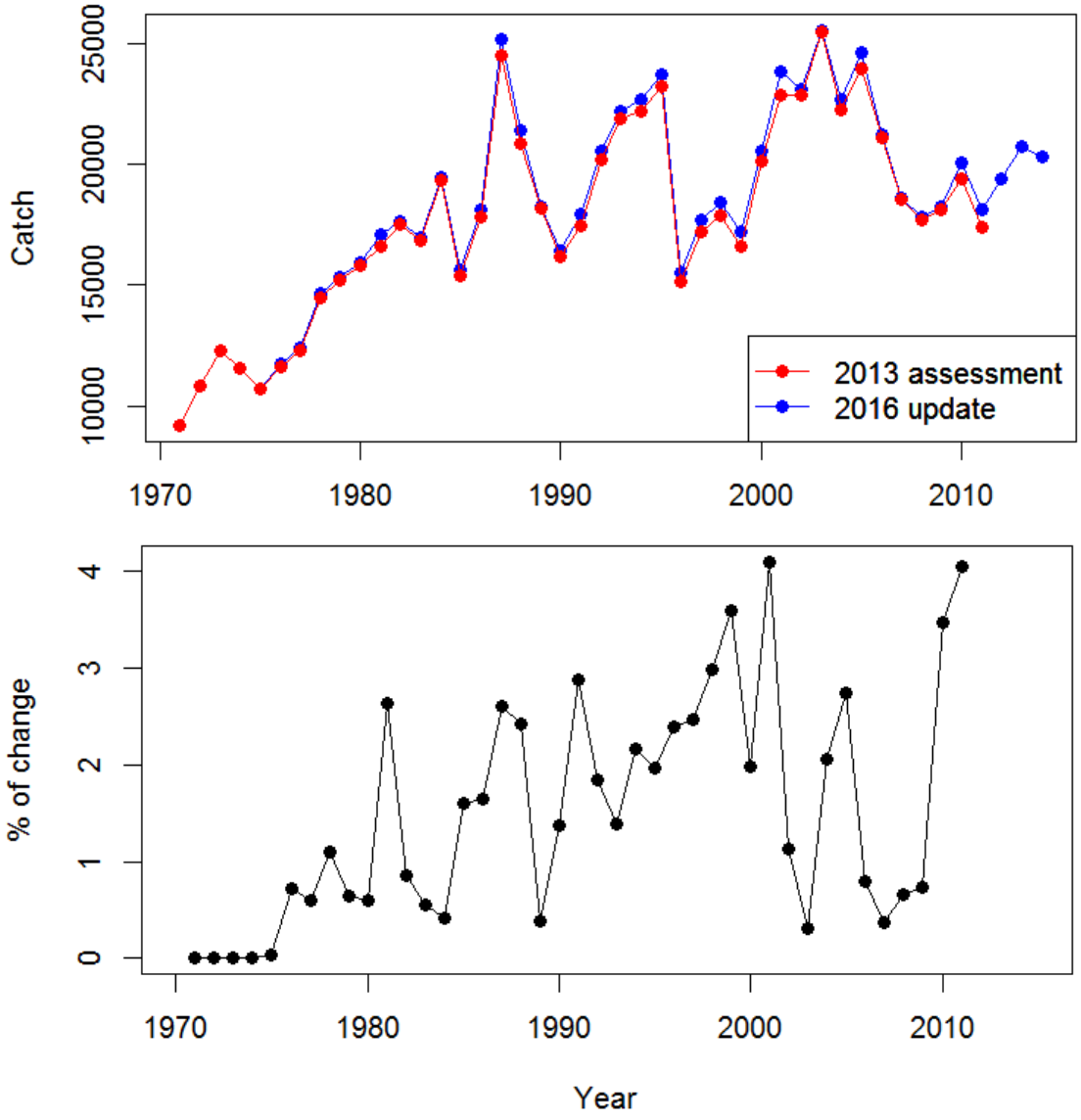
Definition of Pacific Blue Marlin Fisheries

Fishery number	Reference Code	Fishing Countries	Gear Types	Units	Source
F1	JPNEarlyLL	Japan	Offshore and distant-water longline (early period)	B	Ijima and Shiozaki (2016)
F2	JPNLateLL	Japan	Offshore and distant-water longline (late period)	B	Ijima and Shiozaki (2016)
F3	JPNCLL	Japan	Coastal longline	B	Ijima and Shiozaki (2016)
F4	JPNDRIFT	Japan	High-sea large-mesh driftnet and coastal driftnet	B	Ijima and Shiozaki (2016)
F5	JPNBait	Japan	Bait fishing	B	Ijima and Shiozaki (2016)
F6	JPNOth	Japan	Other gears	B	Ijima and Shiozaki (2016)
F7	HWLL	USA (Hawaii)	longline	B	Ito (2016)
F8	ASLL	USA (American Samoa)	longline	#	Russell Ito, pers. comm., Jan 13, 2016
F9	HWOth	USA (Hawaii)	Troll and handline	B	Ito (2016)
F10	TWNLL	Taiwan	Distant-water longline	B	NanJay Su, pers. comm., Jan 13, 2016
F11	TWNOth	Taiwan	Offshore longline, coastal longline, gillnet, harpoon, and others	B	NanJay Su, pers. comm., Jan 13, 2016
F12	OthLL	Various flags	Longline	B	Chang et al. (2016); Tagami and Wang (2016)
F13	PYFLL	French Polynesia	Longline	B	Chang et al. (2016)
F14	EPOPS	Various flags	Purse seine	#	Chang et al. (2016)
F15	WCPFCPS	Various flags	Purse seine	B	Chang et al. (2016)
F16	EPOOth	French Polynesia	Troll, handline, and harpoon	B	Chang et al. (2016)

Pacific Blue Marlin Catch Data

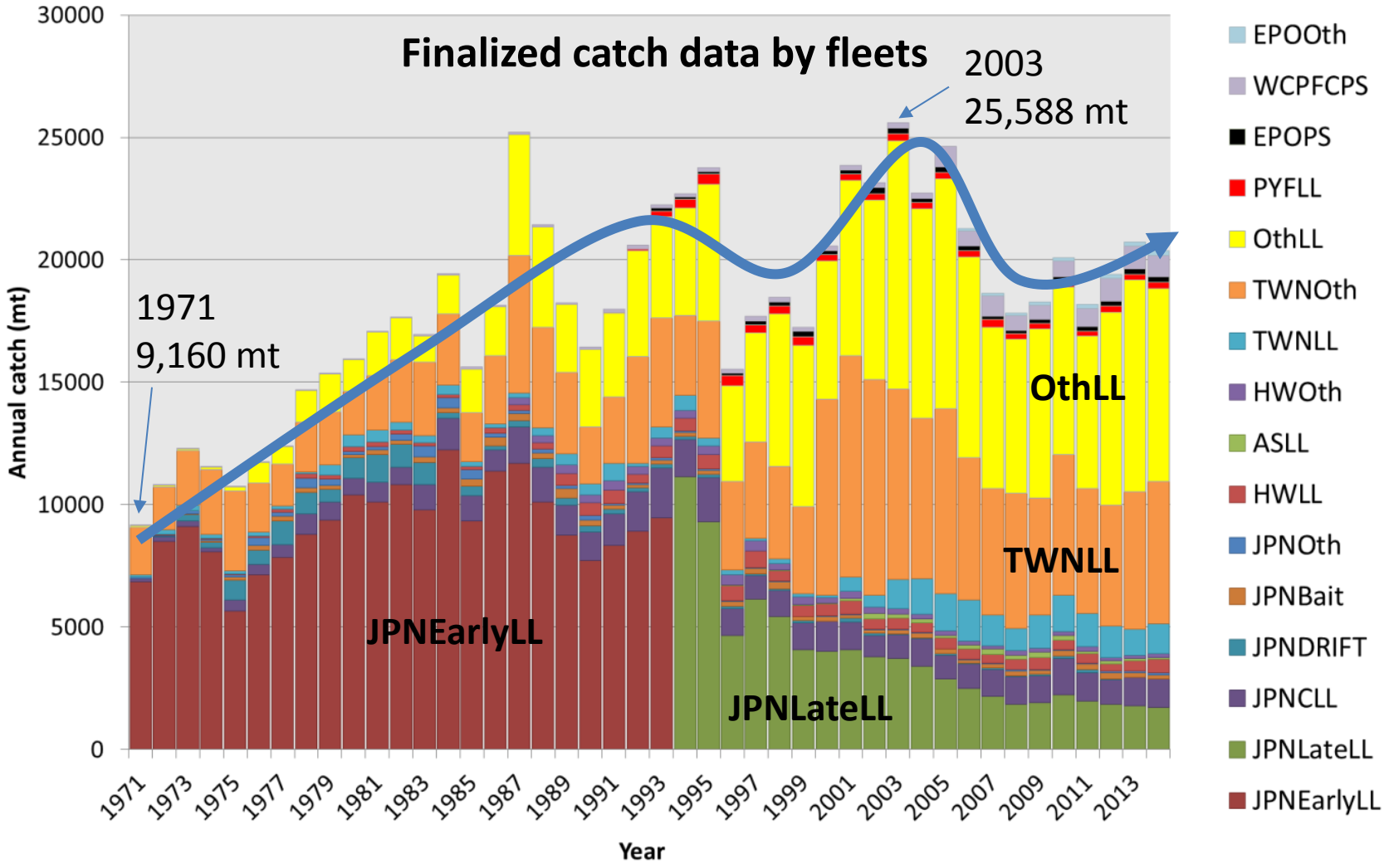
- Catches are assumed to be well reported
- Catch data for 2011 were incomplete for the 2013 assessment, and the 2016 assessment used updated catch data from 2011-2014 for all fisheries except JPNEarlyLL
- In addition, revised time series of catch prior to 2011 were used for OthLL, WCPFCPS, JPNDrift, JPNOth, ASLL, JPNCLL, PYFLL, and the EPOPS fisheries
- There were some minor differences between the catch data used in the 2013 assessment and the 2016 update

Differences in Annual Catches (mt) Between 2016 and 2013 Stock Assessments



Very similar catch patterns over time

2016 assessment included a small increase of 1.6% in the annual average catches prior to 2011 in comparison to the 2013 assessment.



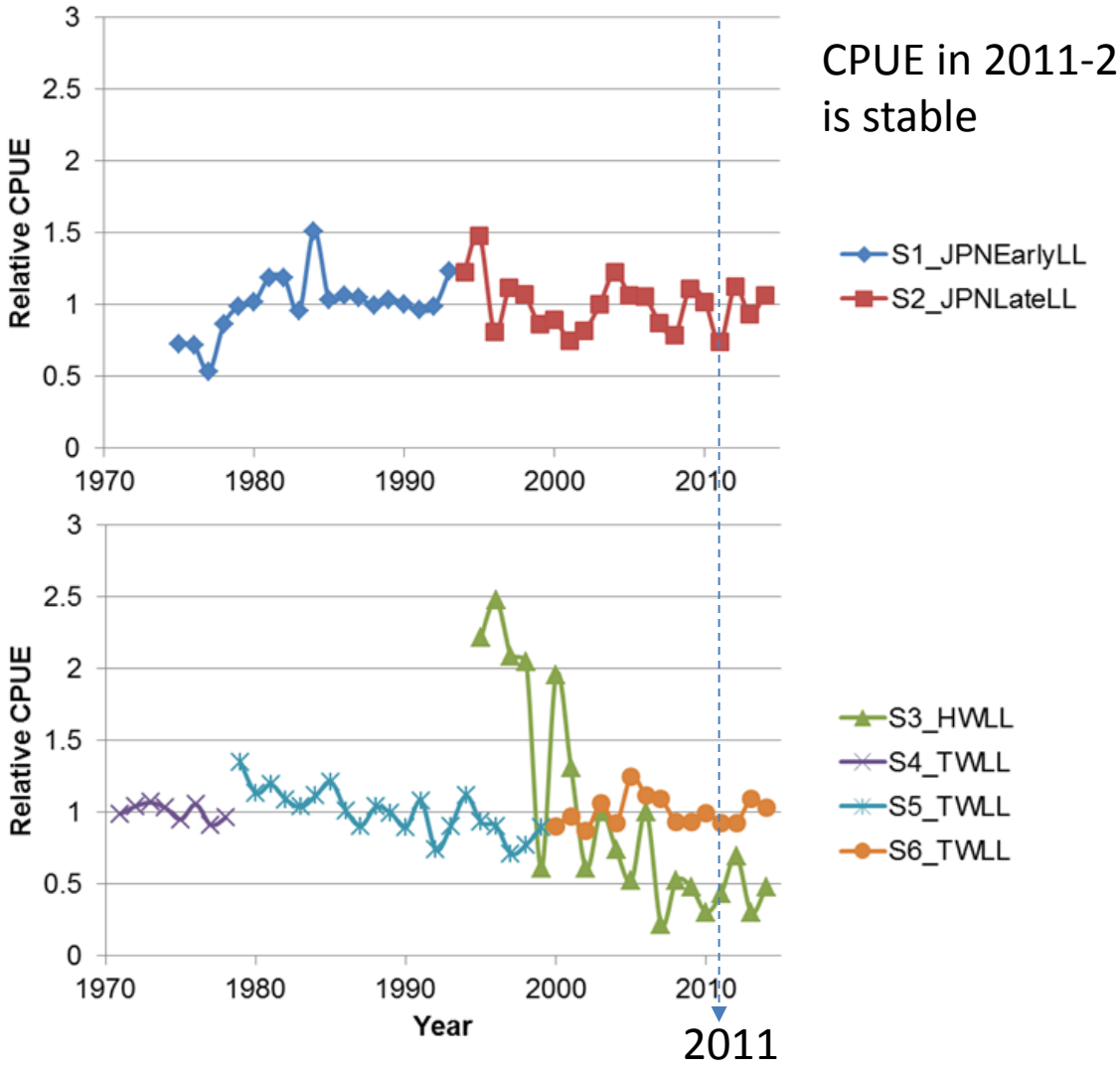
- The Japanese longline fishery took most of catch during the early period, but declined after 1995 (as JPNLateLL).
- Since reaching a maximum in 2003, catches declined and with the exception of 2010.
- The average Catch was about 19,663 metric tons during the 2011-2014) with the TWNOth and OthLL fisheries taking 27% and 39%.

Relative Abundance Indices Based on Standardized Catch-Per-Unit Effort

Reference Code	Used	Fishery Description	n	Time series	Source
S1_JPNEarlyLL (F1)	Yes	Japanese offshore and distant-water longline (early period)	19	1975-1993	Kanaiwa et al. (2013)
S2_JPNLateLL (F2)	Yes	Japanese offshore and distant-water longline (late period)	21	1994-2014	Kai et al. (2016)
S3_HWLL (F7)	No	Hawaiian longline	20	1995-2014	Carvalho et al. (2016)
S4_TWNLL (F10)	Yes	Taiwanese distant-water longline (early period)	8	1971-1978	Su et al. (2016)
S5_TWNLL (F10)	Yes	Taiwanese distant-water longline (middle period)	21	1979-1999	Su et al. (2016)
S6_TWNLL (F10)	Yes	Taiwanese distant-water longline (late period)	15	2000-2014	Su et al. (2016)

1. Japanese distant water longline

2. Taiwanese distant water longline & Hawaii longline



CPUE in 2011-2014 is stable

Abundance indies were generally stable trend over time.
However, there was an increasing trend of S1_JPNEarlyLL (1975-1984) and an apparent decreasing trend of S3_HWLL;
a minor decreasing trend of S5_TWNLL

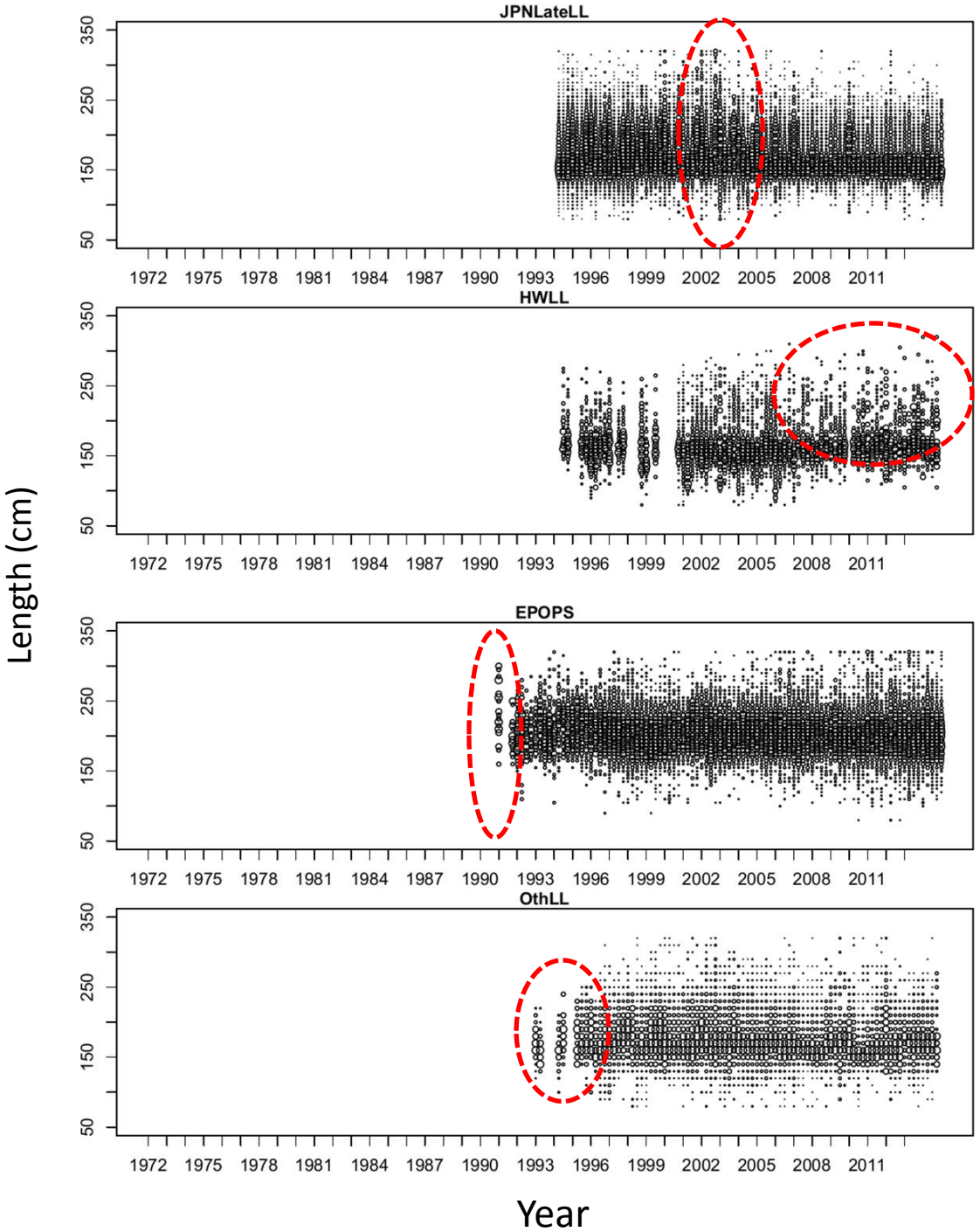
Length and Size Composition Data

Size Composition Data

Reference Code	Fleet	Fishery Description	Unit	Bin	n	Time series	Source
JPNEarlyLL	F1	Japanese offshore and distant-water longline (early period)	cm	5	92	1971-1993	Ijima and Shiozaki (2016)
JPNLateLL	F2	Japanese offshore and distant-water longline (late period)	cm	5	84	1994-2014	Ijima and Shiozaki (2016)
JPNDRIFT	F4	High-sea large-mesh driftnet and coastal driftnet	kg	Proportional to length	19	1977-1989; 1993; 1998	Ijima and Shiozaki (2016)
HWLL	F7	Hawaiian longline	cm	5	70	1994-2014	Langseth (2016)
TWNLL	F10	Taiwanese distant-water longline	cm	5	23	2005-2010	ISC (2013)
OthLL	F12	Various flags longline	cm	10	83	1992-2014	Chang et al. (2016)
PYFLL	F13	French Polynesia longline	cm	10	52	1996-2014	Chang et al. (2016)
EPOPS	F14	Various flags purse seine	cm	5	95	1990-2014	Chang et al. (2016)

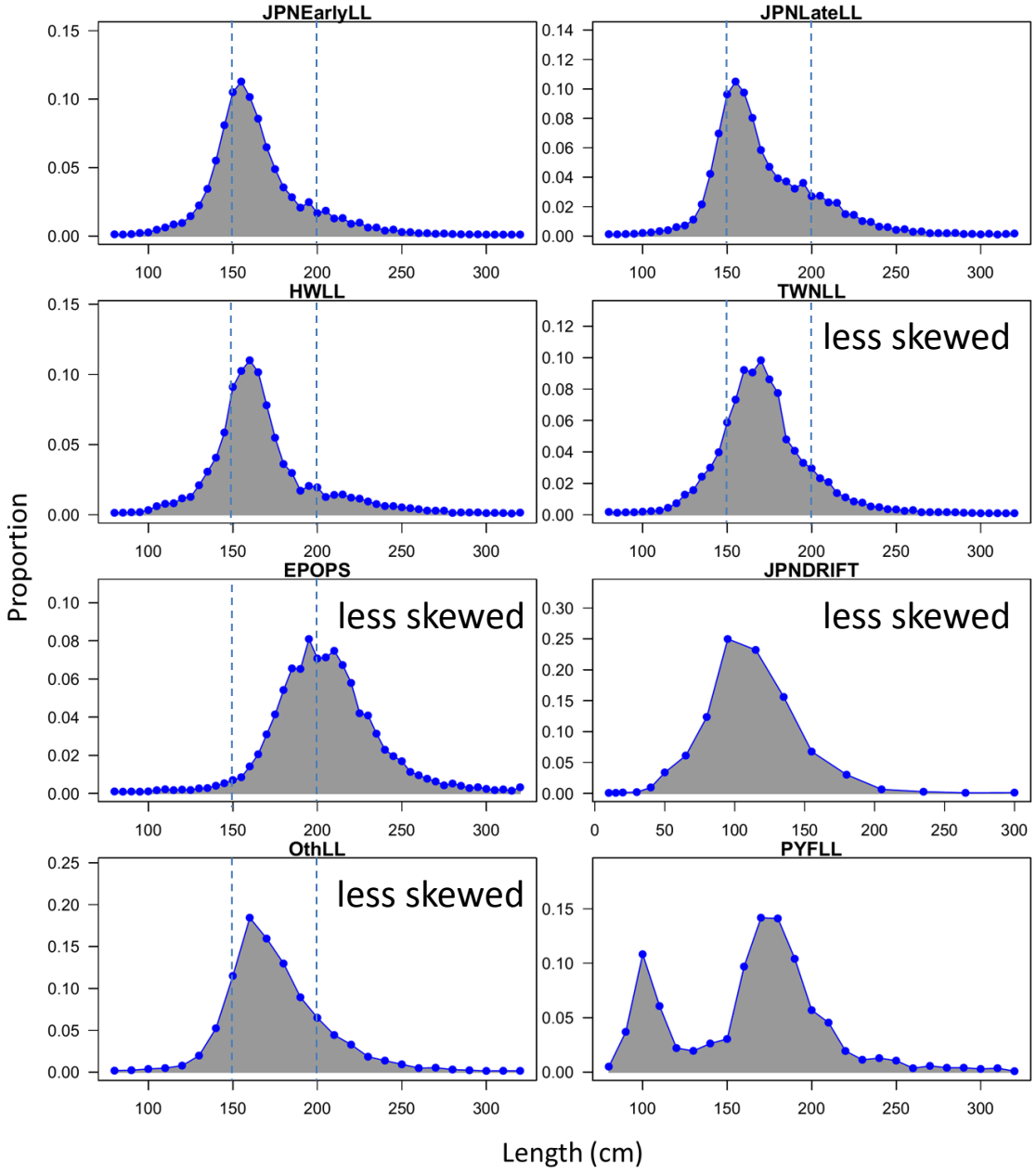
Quarterly Size Compositions

- ✓ Most of the fisheries exhibited consistent, seasonal cycles in size composition
- ✓ Some fleets had size data that varied considerably among years and seasons.

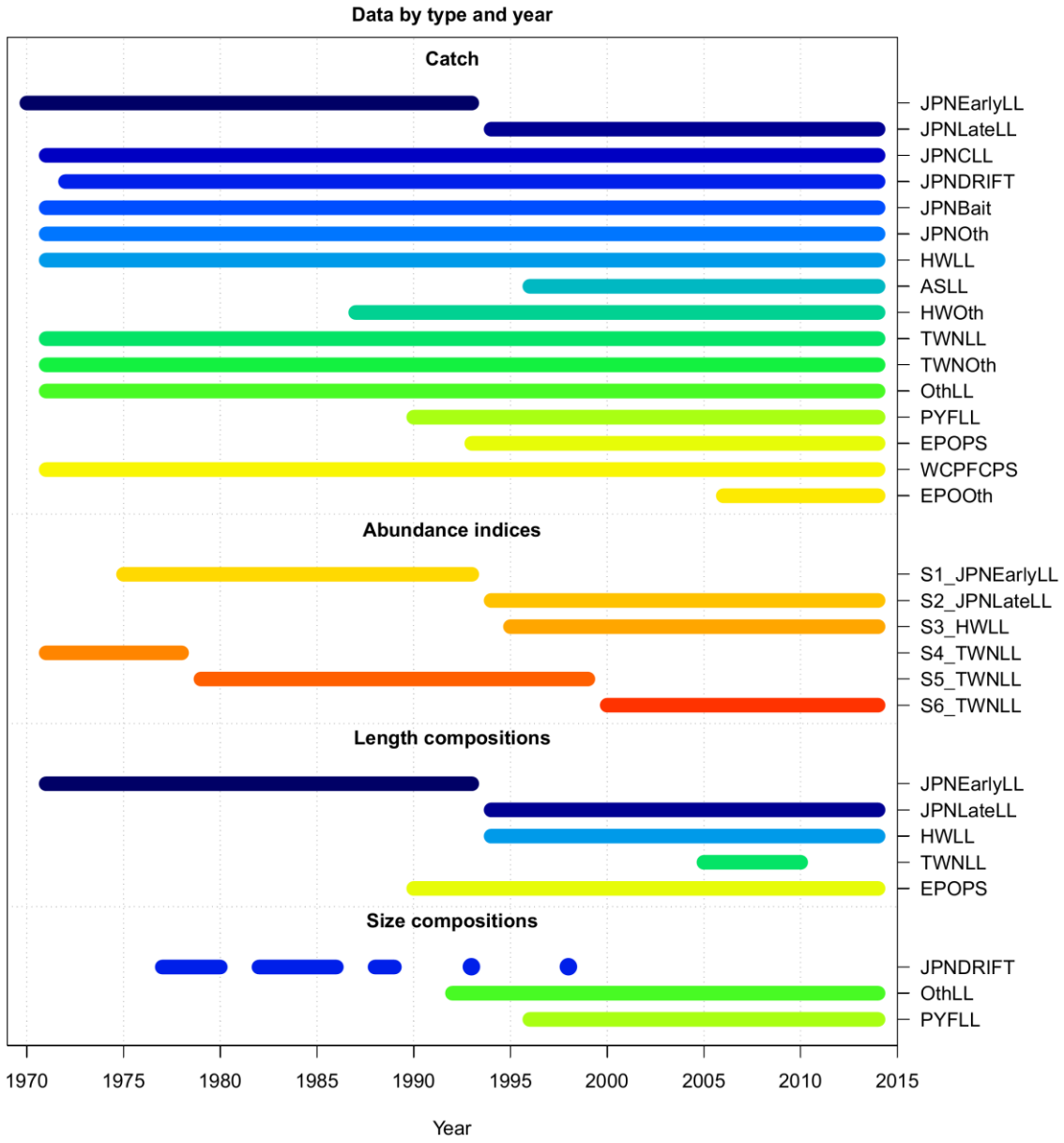


Aggregated Fits to the Length Compositions

- ✓ **JPNEarlyLL, JPNLateLL, and HWLL were skewed to lengths less than 200 cm EFL and (with a length mode at about 150 cm EFL)**
- ✓ **The TWNLL and OthLL exhibited a single mode at 160 cm EFL while the EPOPS exhibited a single mode at around 200 cm EFL (caught larger fish)**



Temporal Coverage of Catch, Abundance Index, and Size Composition Time Series



Model Description

- ✓ 2016 assessment used the same stock assessment model (Stock Synthesis, SS3) as the 2013 assessment
- ✓ Also used the same software version (Version 3.24f)
- ✓ The 2016 model structure and parameters were the same as in the 2013 assessment

Fishery-Specific Selectivity Assumptions

Mirror gear = fisheries with similar fishery selectivity patterns

Fishery number	Reference Code	Selectivity assumption	Mirror gear
F1	JPNEarlyLL	Cubic Spline (nodes=4)	
F2	JPNLateLL	Double-normal	
F3	JPNCLL	Double-normal	F2
F4	JPNDRIFT	Double-normal	
F5	JPNBait	Double-normal	F4
F6	JPNOth	Double-normal	F2
F7	HWLL	Cubic Spline (nodes=3)	
F8	ASLL	Double-normal	F7
F9	HWOth	Double-normal	F7
F10	TWNLL	Double-normal	
F11	TWNOth	Double-normal	F10
F12	OthLL	Double-normal	
F13	PYFLL	Double-normal for 1971-2002; 2003-2014	
F14	EPOPS	Double-normal	
F15	WCPFCPS	Double-normal	F14
F16	EPOOth	Double-normal	F14

Data Observation Models

Abundance Indices

- ✓ Lognormal observation errors for abundance indices
- ✓ log(SE) = sqrt(log(1+CV^2)) for the individual CPUE standardizations
- ✓ Values of log(SE) < 0.14 were rescaled to set log(SE) = 0.14

Size Composition Data

- ✓ Multinomial observation errors for size composition data
- ✓ Input effective sample size (effN) was assumed to be the number of fish measured/10 for all longline fisheries (F1, F2, F7, F10, F12, F13)
- ✓ effN was the number of fish measured for JPNDRIFT and EPOPS
- ✓ Size compositions with effN < 2.5 (< 25 for JPNDRIFT and EPOPS) were removed while size compositions with effN > 50 were set to effN=50 (as in the 2013 assessment)

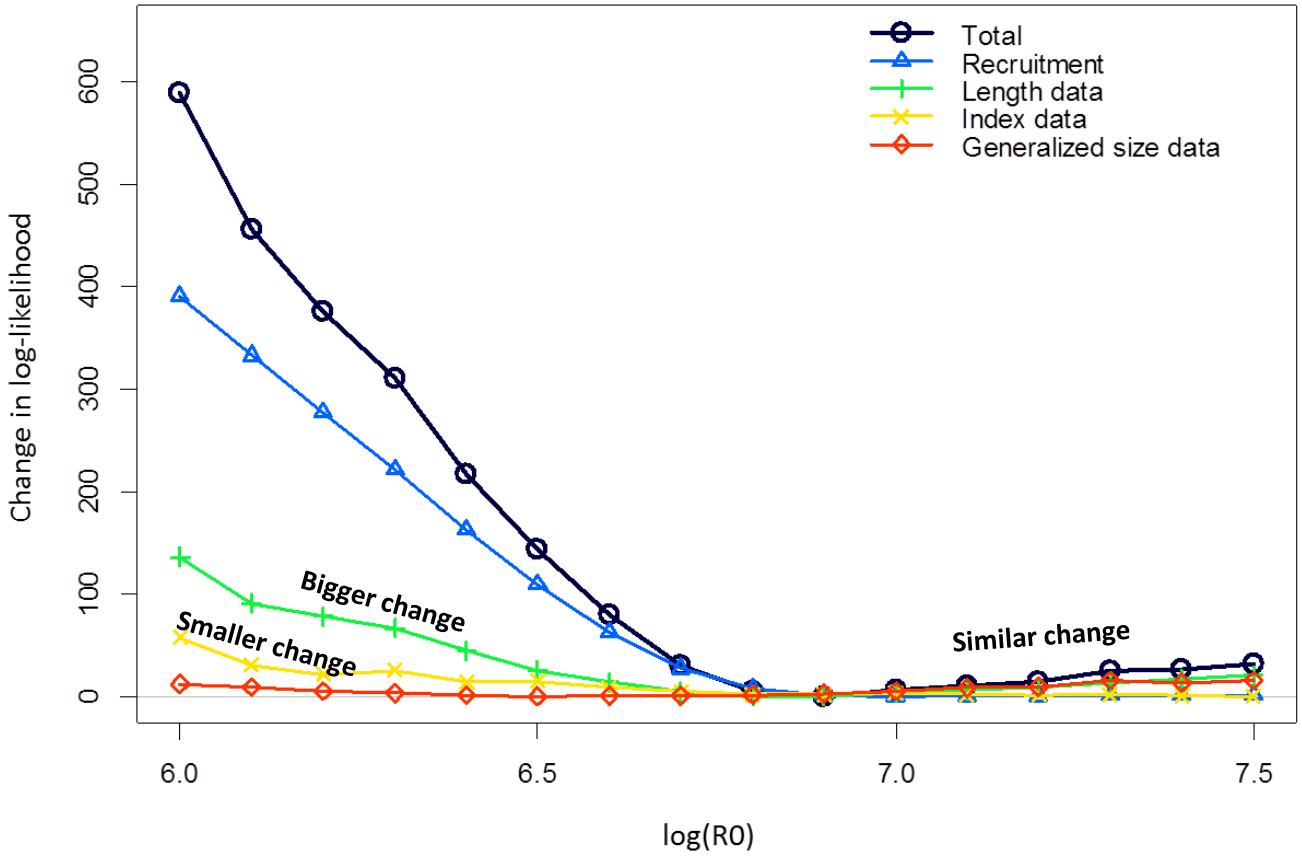
Estimation of Recruitment Deviations From Stock-Recruitment Curve

- Recruitment was estimated during 1966-2013 (with bias adjustment during 1971-2013) and used the expected recruitment value from the estimated stock-recruitment curve for 2014.

- Recruitment variability (σ_R, the standard deviation of log-recruitment) was fixed at $\sigma_R = 0.6$ and iteratively rescaled in the final model to match the expected variability of $\sigma_R = 0.28$ based on the RMSE of the recruitment deviations.

Model Diagnostics and Goodness of Fit

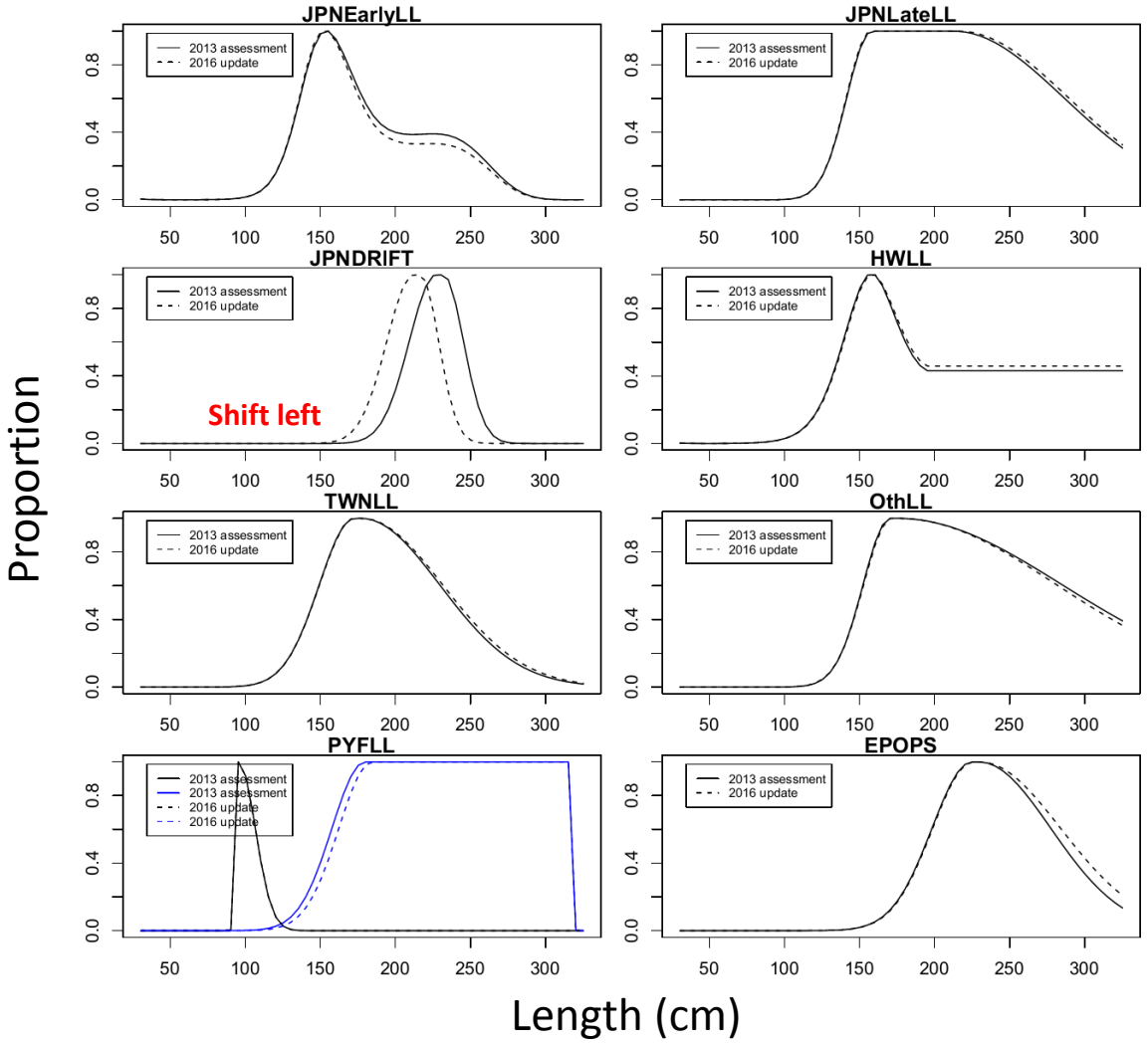
Results of Likelihood Profiles for Unfished Recruitment R0

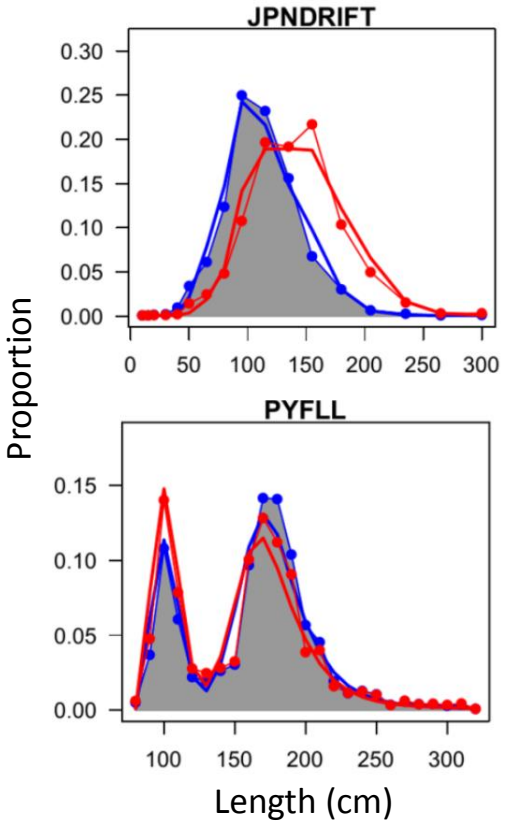


In general, the changes in negative log-likelihoods of abundance indices were small over the range of R0 compared to length data

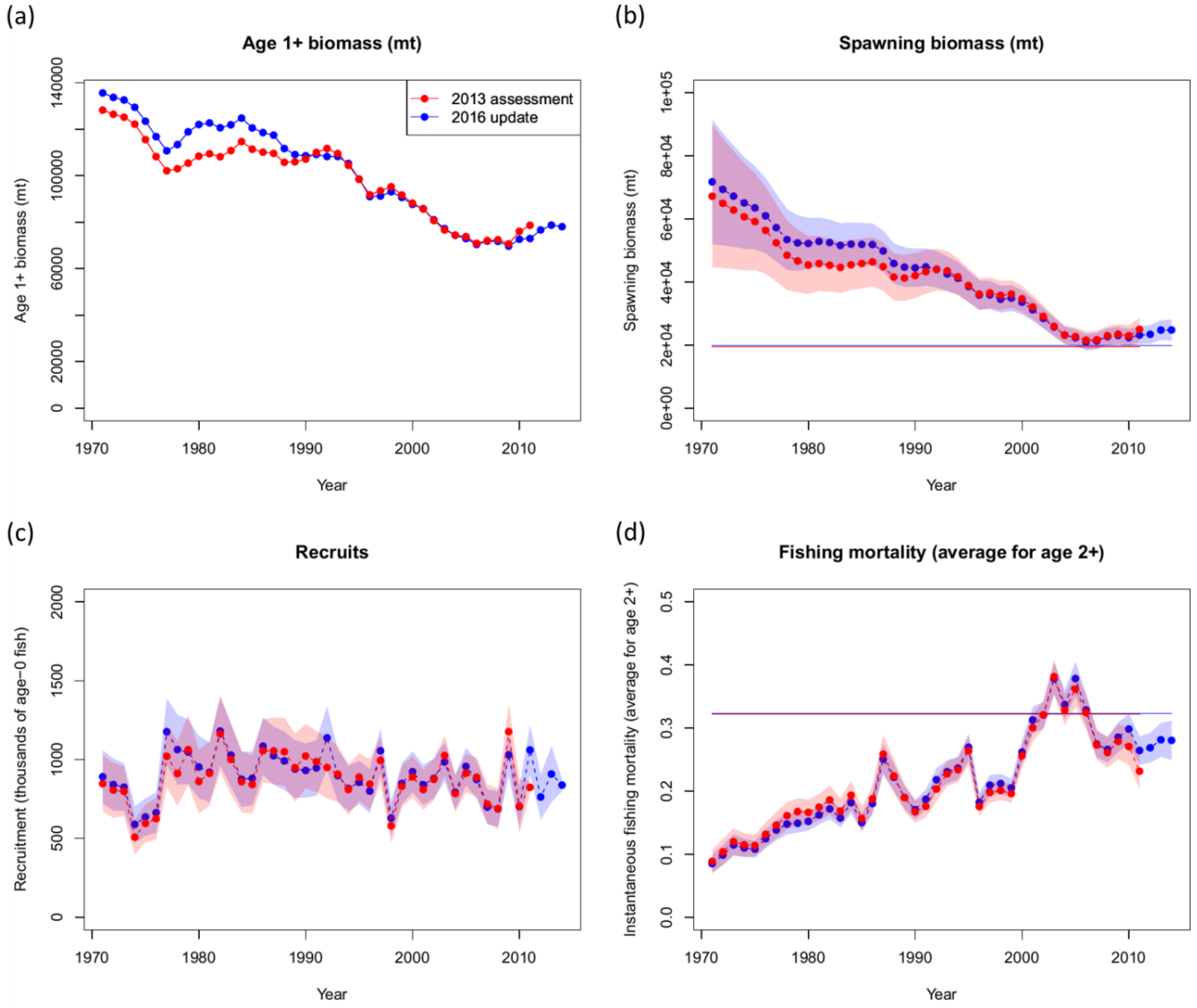
Consistency of Fishery Selectivity Estimates

- ✓ In general, 2016 and 2013 fishery selectivity estimate were consistent
- ✓ Except for a notable change for JPNDRIFT
- ✓ Also noting a minor change in selectivity during the second time block for PYFLL

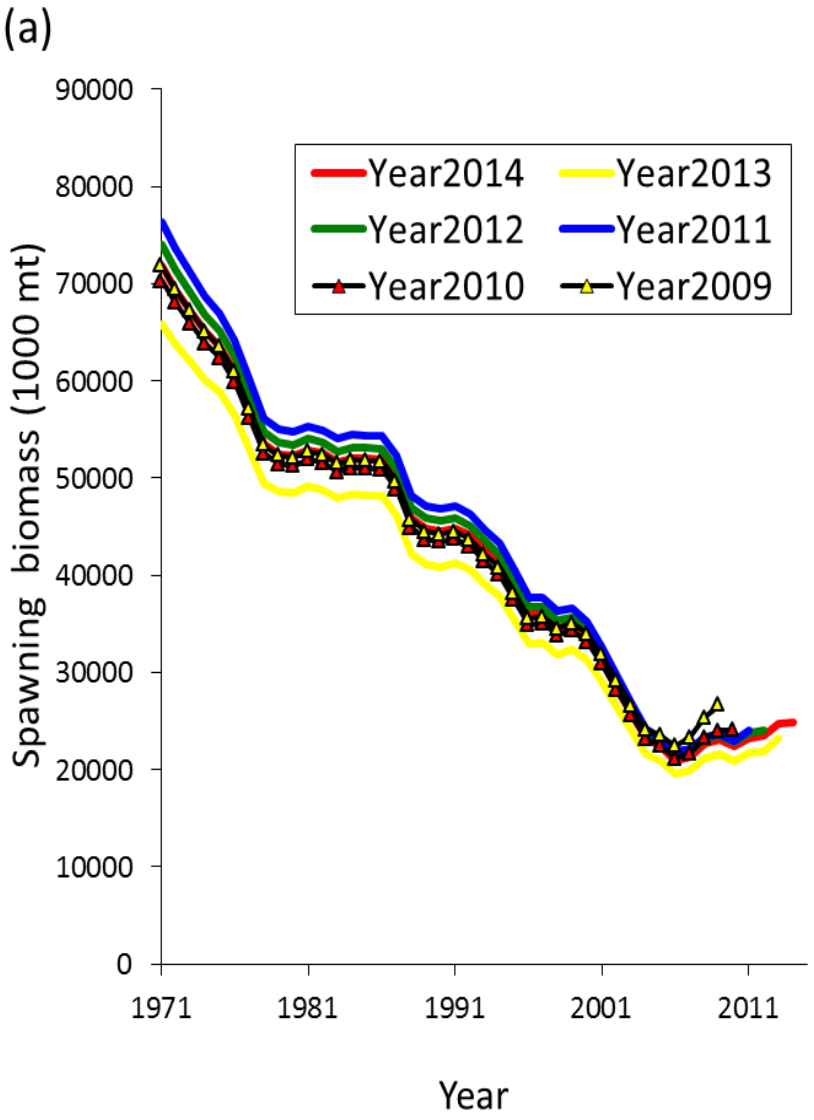


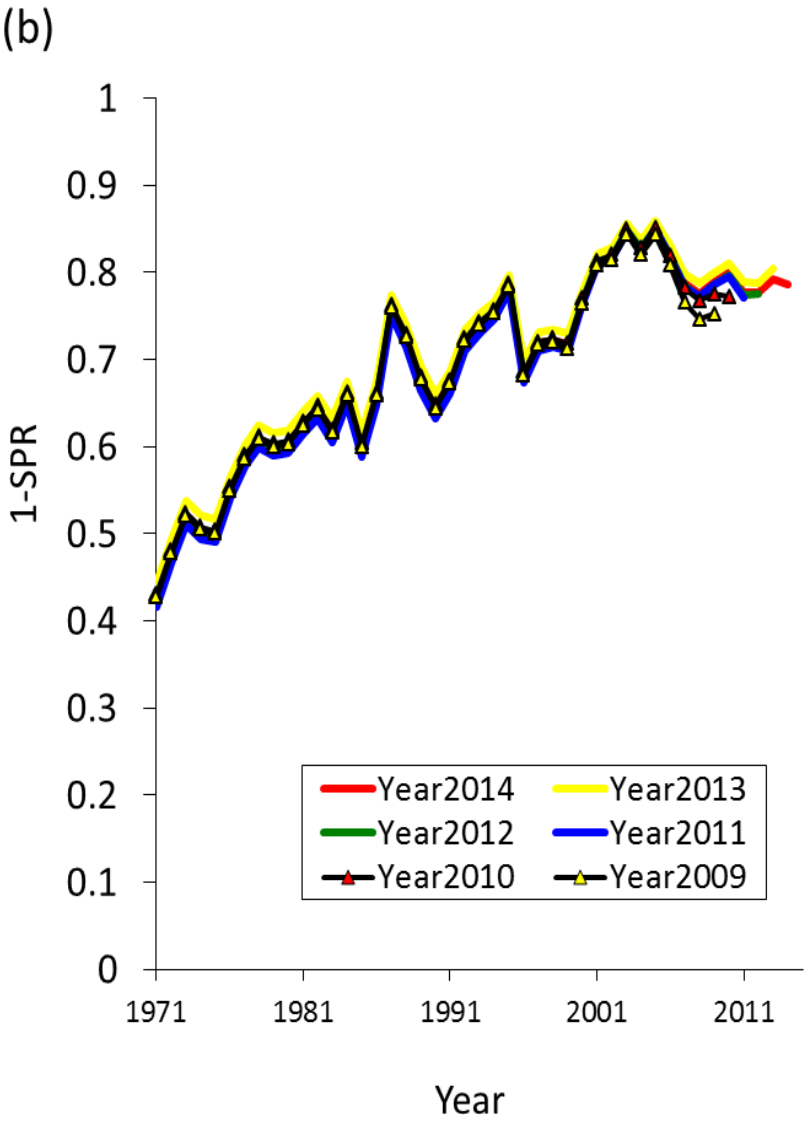


Comparisons of 2016 and 2013 Assessment Results for Pacific Blue Marlin



Pacific Blue Marlin Retrospective Analyses

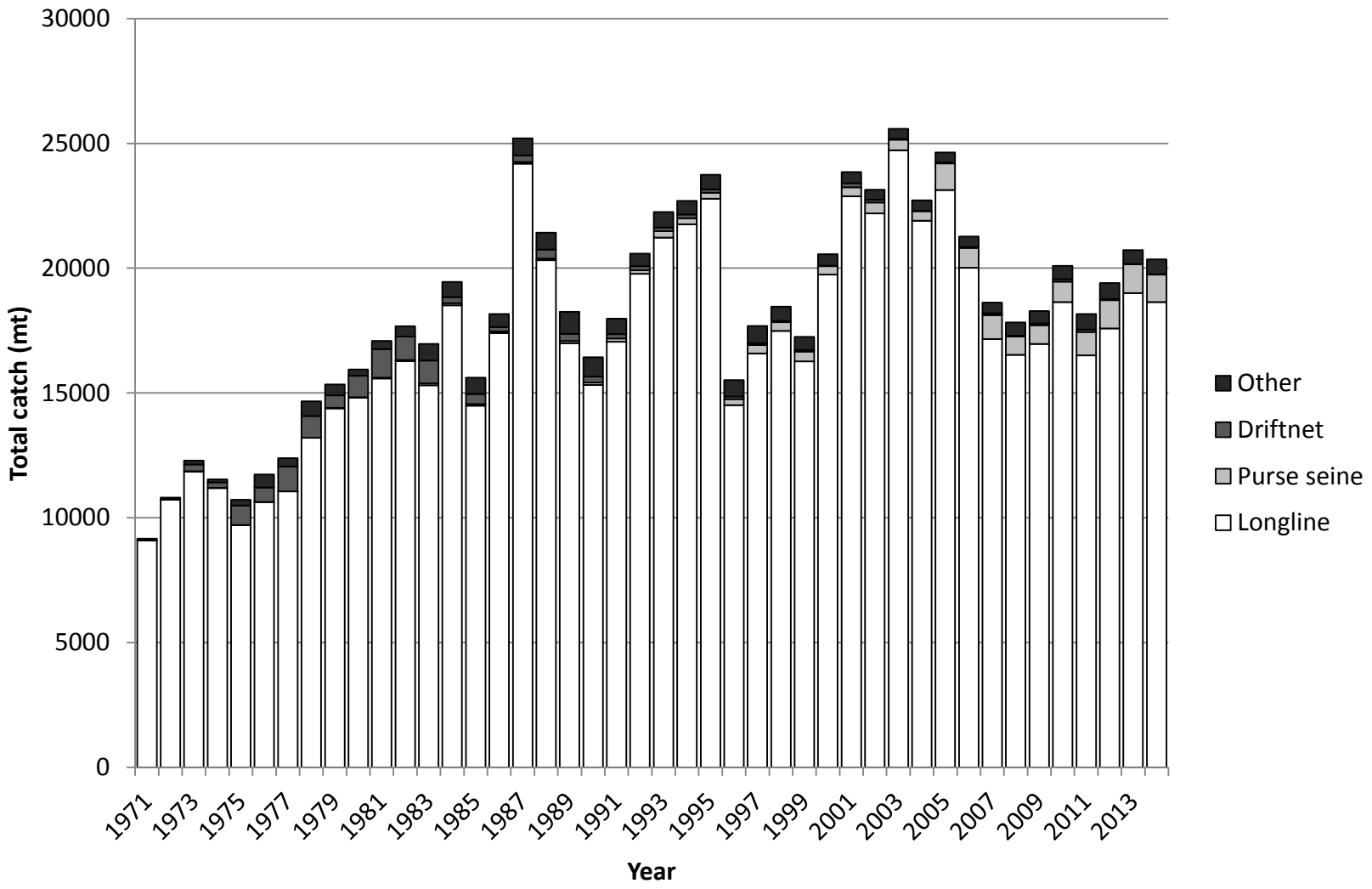




Pacific Blue Marlin 2016 Stock Assessment Update

Stock Status and Conservation Advice

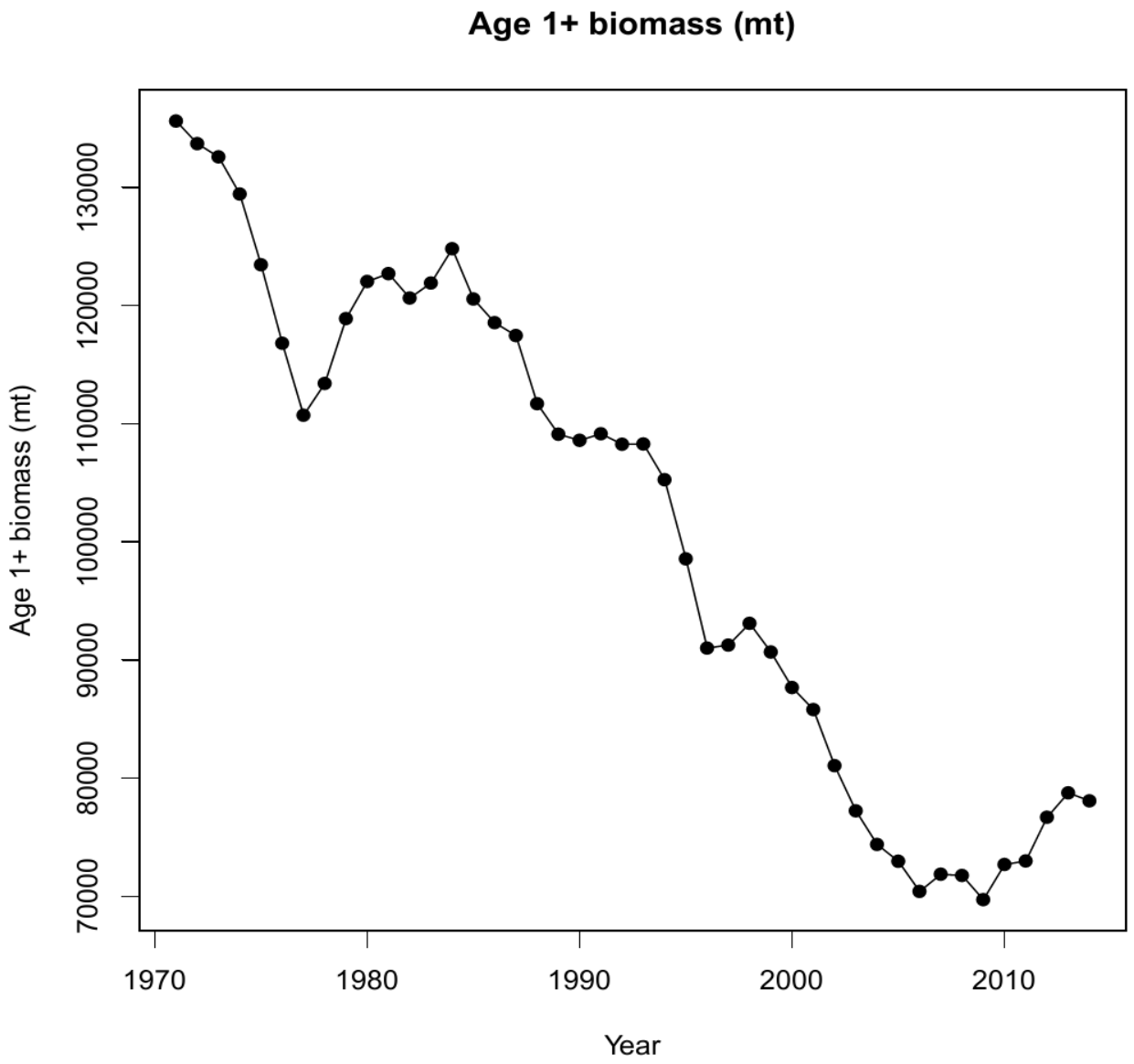
Pacific Blue Marlin Catch and Status



Pacific Blue Marlin Reference Points

Reference Point	Estimate
F_{MSY} (age 2+)	0.32
$F_{20\%}$ (age 2+)	0.30
$F_{2012\text{-}2014}$ (age 2+)	0.28
SSB_{MSY}	19,853 mt
$SSB_{20\%}$	22,727 mt
SSB_{2014}	24,809 mt
MSY	19,901 mt
$C_{2012\text{-}2014}$	20,163 mt
SPR_{MSY}	0.18
$SPR_{2012\text{-}2014}$	0.21

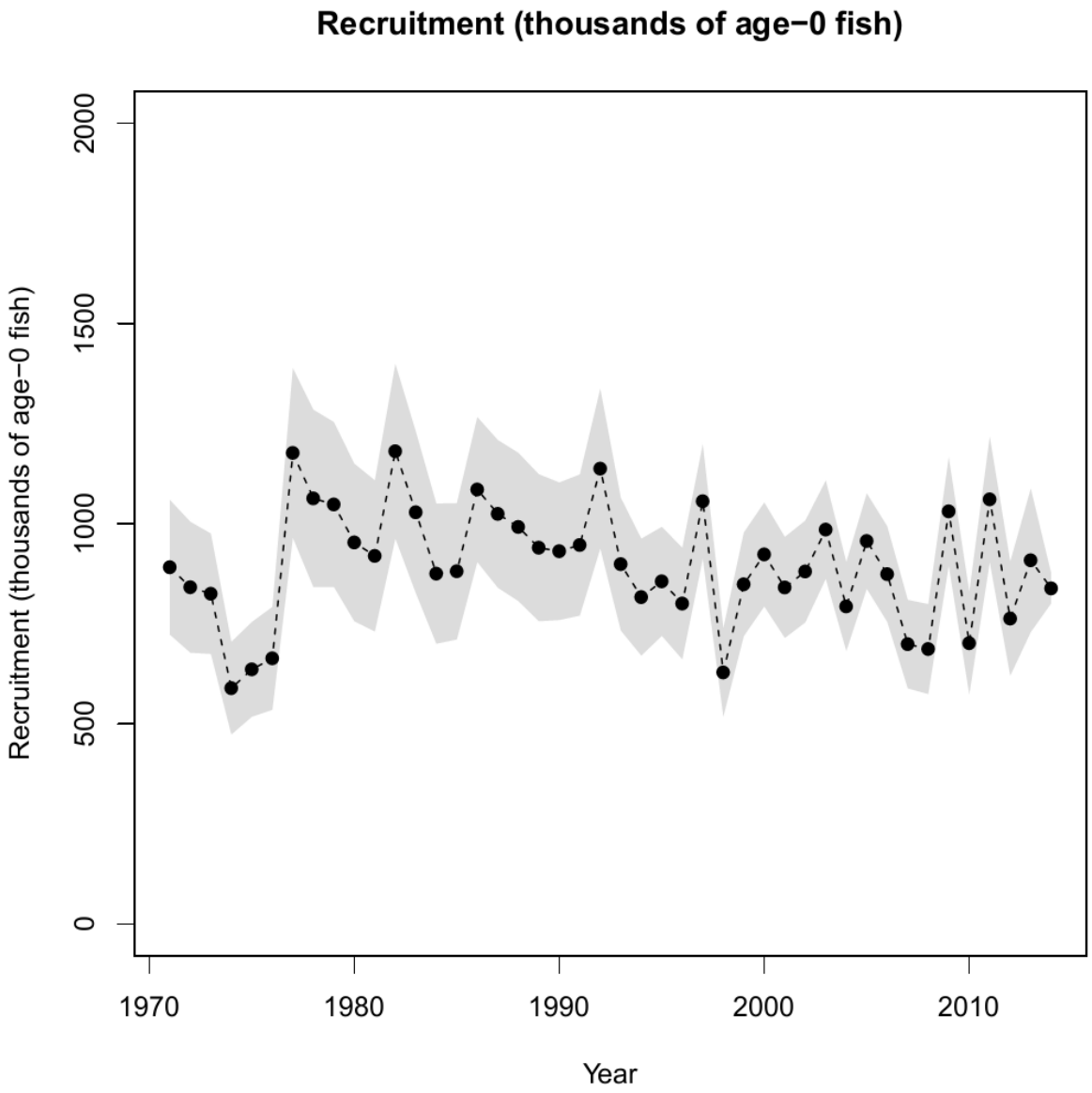
Pacific Blue Marlin Population Biomass



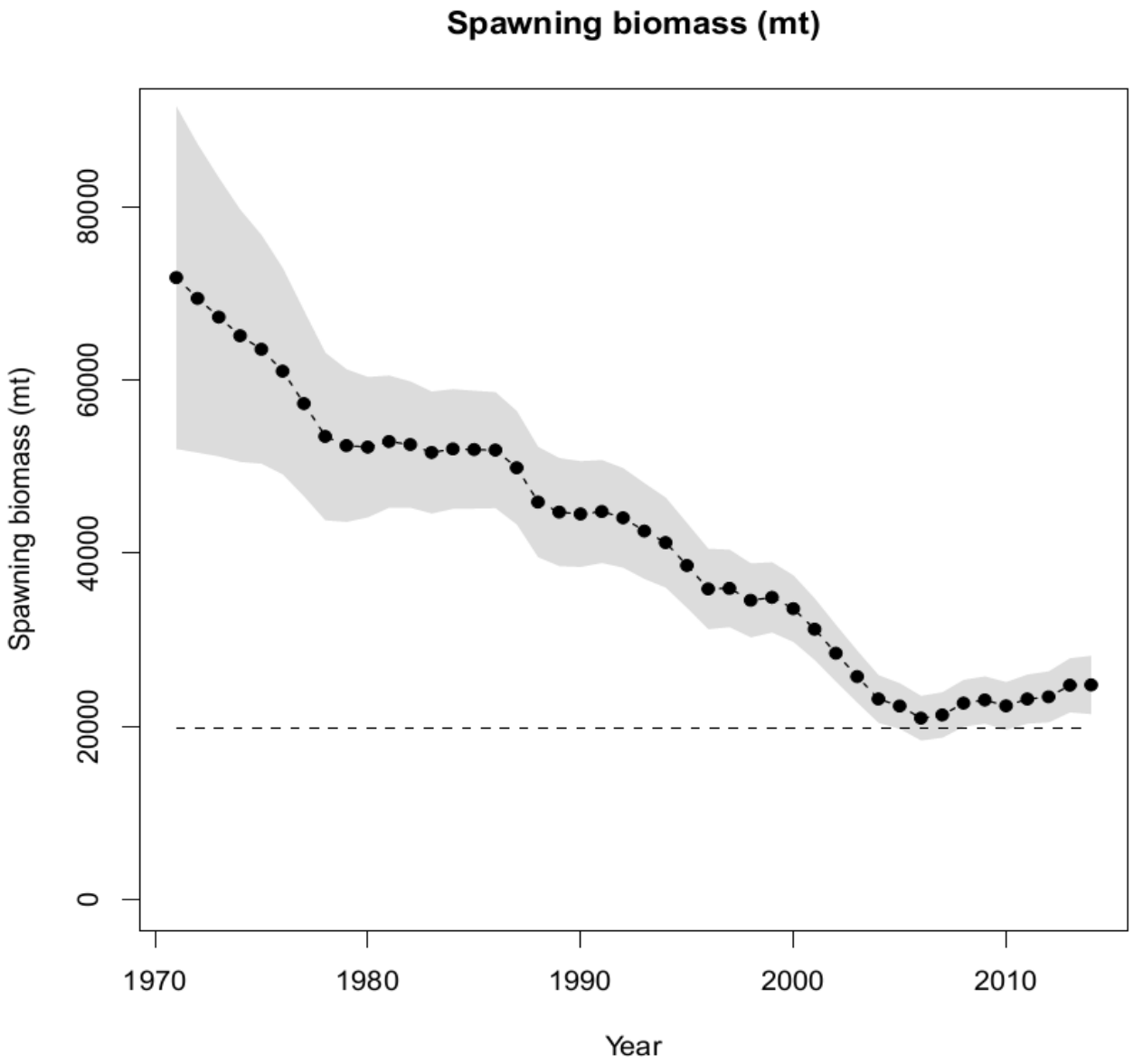
Status of Stock

- Estimates of total stock biomass show a long term decline. Population biomass (age-1 and older) averaged roughly 130,965 mt in 1971-1975, the first 5 years of the assessment time frame, and has declined by approximately 40% to 78,082 mt in 2014.

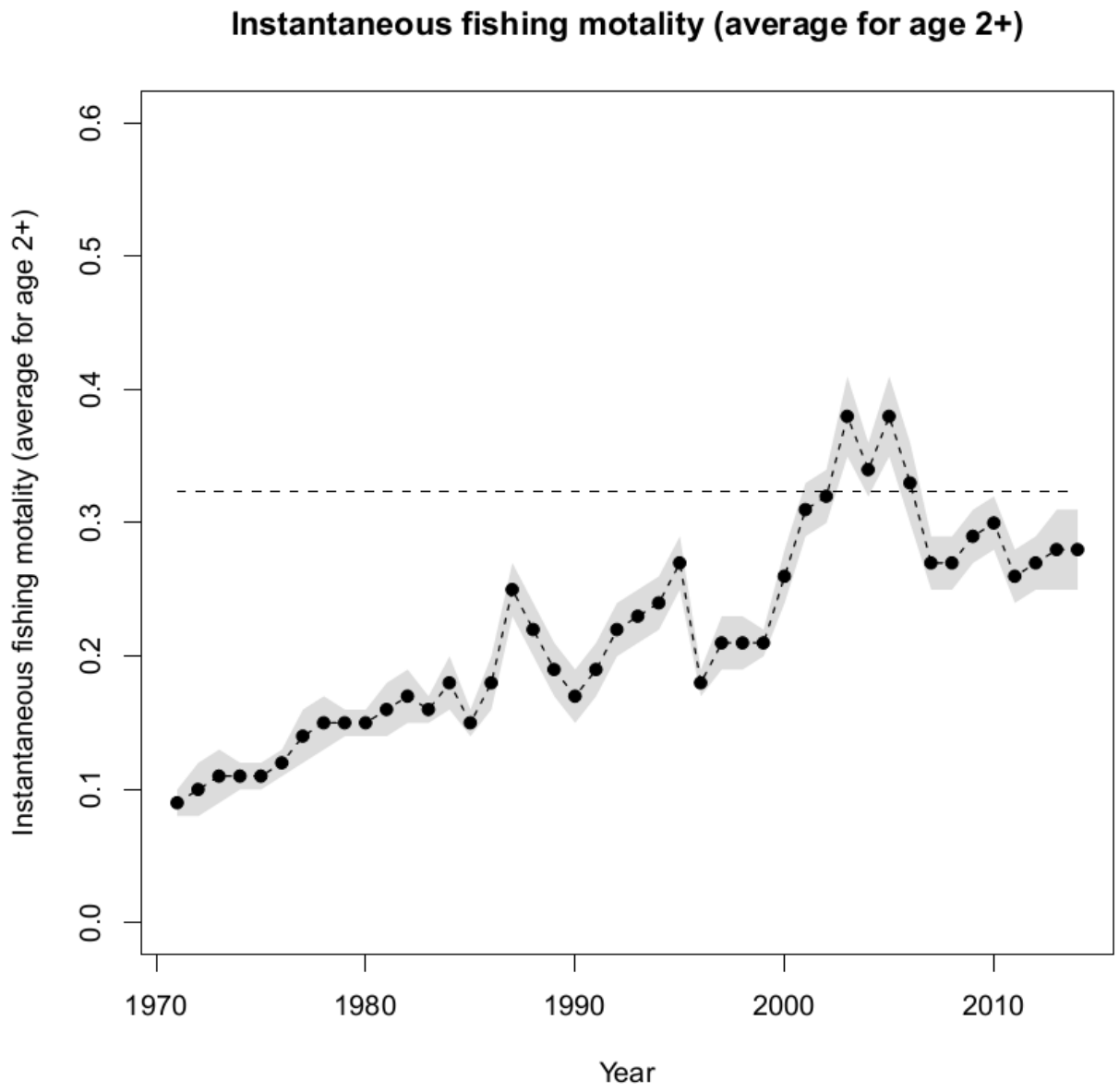
Pacific Blue Marlin Recruitment



Pacific Blue Marlin Spawning Biomass



Pacific Blue Marlin Fishing Mortality



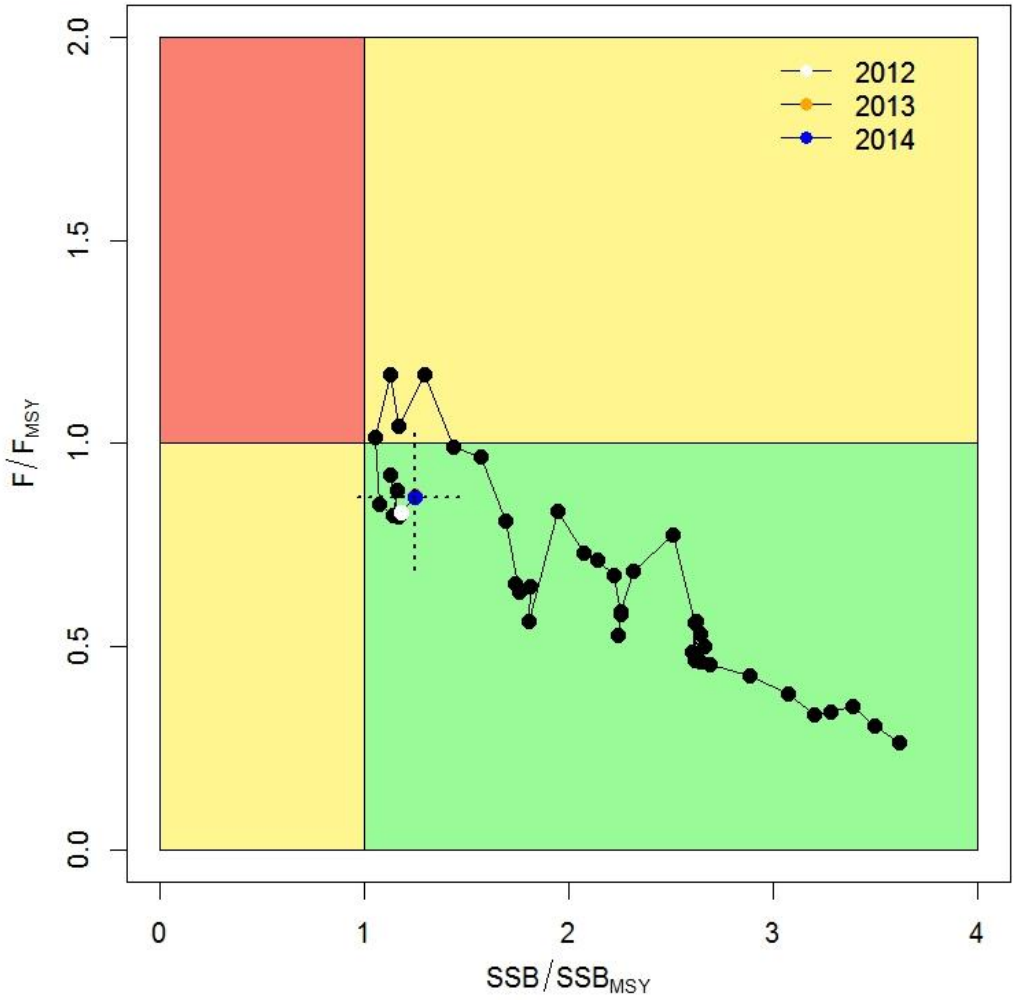
Status of Stock

- Female spawning biomass was estimated to be 24,809 mt in 2014, or about 25% above SSB_{MSY}
- Fishing mortality on the stock (average F, ages 2 and older) averaged roughly F = 0.28 during 2012-2014, or about 12% below F_{MSY}

Status of Stock

- Based on the results of this 2016 stock assessment update, the Pacific blue marlin stock is currently not overfished and is not experiencing overfishing.

Pacific Blue Marlin Kobe Plot
Relative to MSY-Based Reference Points

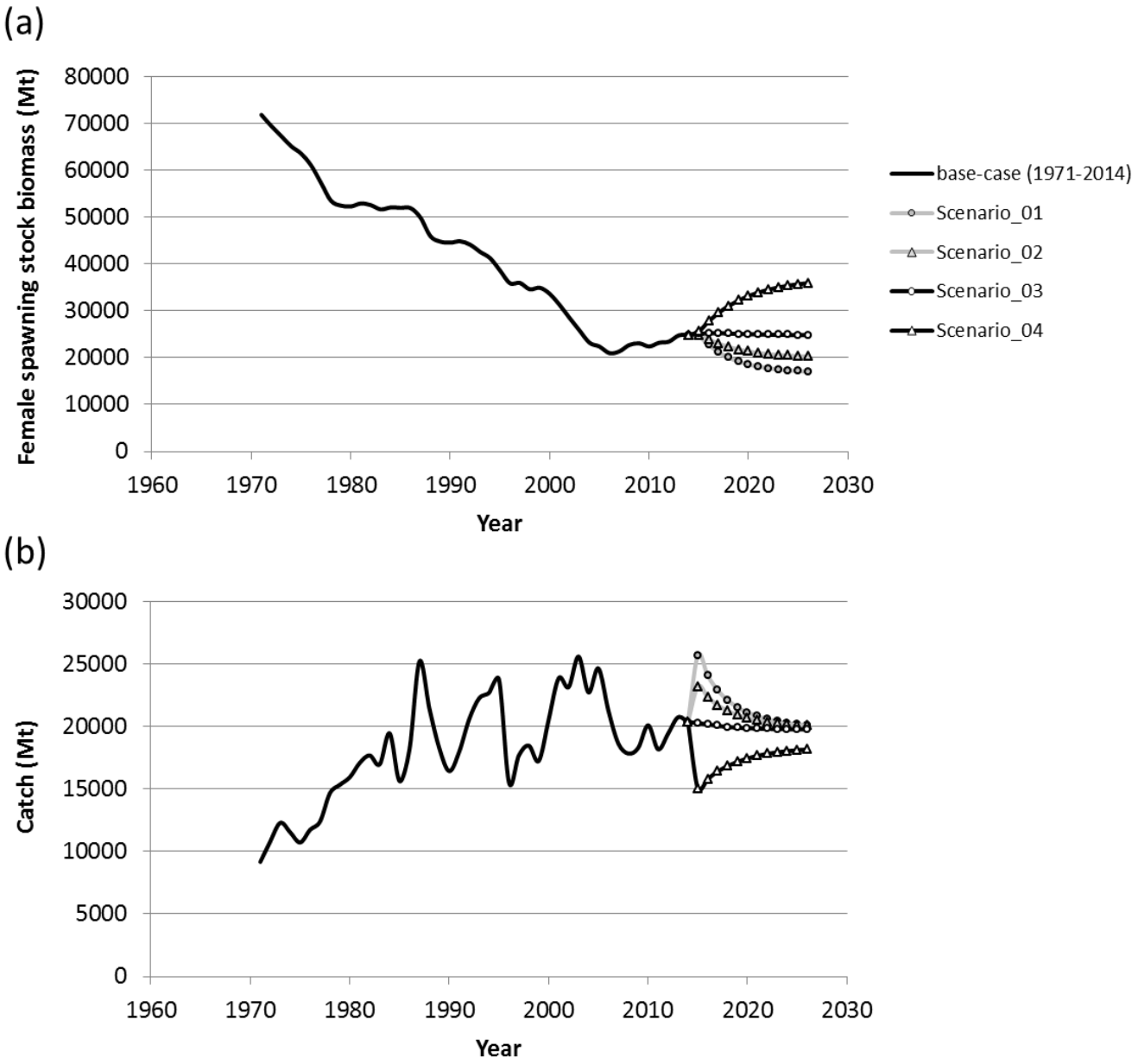


Stock Projections

- Four future harvest scenarios were analyzed:

  1. Scenario 1. $F = F_{2003\text{-}2005}$
  2. Scenario 2. $F = F_{MSY}$
  3. Scenario 3. $F = F_{2012\text{-}2014}$
  4. Scenario 4. $F = F_{30\%}$

Pacific Blue Marlin Stock Projections



Conservation Advice

- Because Pacific blue marlin is mainly caught as bycatch, direct control of the annual catch amount through the setting of a total allowable catch may be difficult.

- Since the stock is nearly full exploited, the ISC recommends that fishing mortality remain at or below current levels (2012-2014).

Pacific Blue Marlin 2016 Stock Assessment Update

The End

Pacific Blue Marlin Sensitivity Analyses