Summary of Life History and Stock Assessment Results for Pacific Blue Marlin, Western and Central North Pacific Striped Marlin, and North Pacific Swordfish

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Contents

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Abstract

The ISC Billfish Working Group (BILLWG), in its 2016-2017 work plan, agreed to update its webpage information (ISC 2016a). To that end, this working paper presents standardized figures of the best available life history information for Pacific species regularly assessed by the group and summary figures of recent stock assessment outcomes for these species (ISC 2014a, 2014b, 2015, 2016b). This document provides such figures for three species: Pacific blue marlin *(Makaira nigricans)*, North Pacific striped marlin *(Kajikia audax)*, and swordfish in the North Pacific *(Xiphias gladius)*. The latter is presented as two separate stocks, the Western and Central North Pacific (WCNP) and Eastern North Pacific (ENP) stocks of swordfish. Where possible, the billfish species' life histories are presented by sex. This working paper provides descriptions of the derivation of each figure with relevant equations and parameter sources.

Life History Figures

The following figures are intended to summarize relevant life-history information for each species in the North Pacific. Each figure is preceded by the calculations employed to generate values.

Growth

Length at age curve

Pacific Blue Marlin *(Makaira nigricans)* and North Pacific Striped Marlin *(Kajikia audax)*

For blue marlin and striped marlin, the growth curve (length at age) is based on the SS3 stock assessment model formulation of the expected length at age. This is essentially a modified von Bertalanffy curve. The SS3 curve has three parameters: the length at a minimum age a_1 denoted by L_1, the length at a maximum age a_2 denoted by L_2, and a curvature parameter k which is the Brody growth parameter for the VB curve. The SS3 growth curve can be specified by sex, and gives expected length as a function of age $L(age)$ as:

$$(1a) \quad L(age) = L_\infty + (L_1 + L_\infty)e^{-k(age-a_1)}$$

where L_∞ is calculated from L_1, L_2 and k via

$$(1b) \quad L_\infty = L_1 + \frac{L_2 - L_1}{1 - e^{-k(a_2 - a_1)}}$$

For blue marlin, the input minimum and maximum ages are $a1 = 1$ year and $a2 = 26$ years. Female growth parameters are $L_1 = 144.0$, $L_2 = 304.2$, and $k = 0.107yr^{-1}$. Male growth parameters are $L_1 = 144.0$, $L_2 = 226.0$, and $k = 0.211yr^{-1}$.

For striped marlin, the same relationships apply. However, this species is presented by pooled sexes. The input minimum and maximum ages are $a1 = 0.3$ years and $a2 = 15$ years. Growth parameters for pooled sexes are: $L_1 = 104.0$, $L_2 = 214.0$, and $k = 0.24yr^{-1}$.

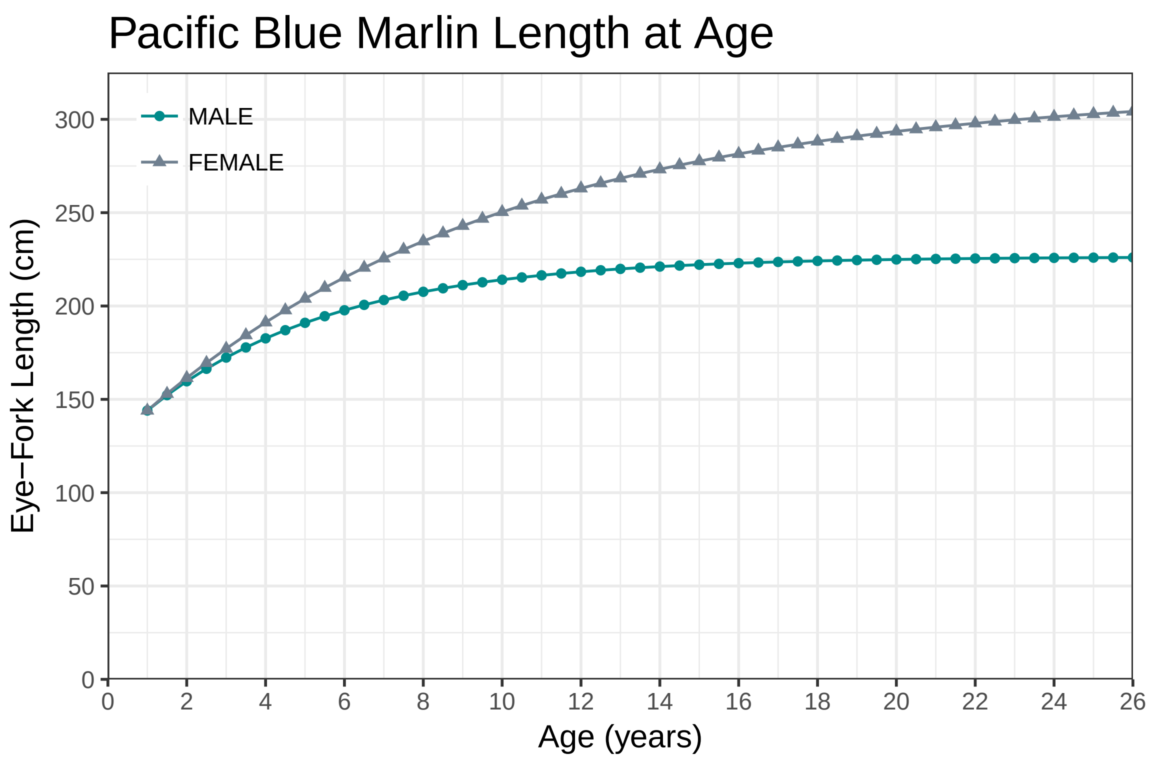


Figure 1: Males: $L(age) = 226.42 + (144.0 + 226.42)e^{-0.211(age-1)})$, Females: $L(age) = 316.05 + (144.0 + 316.05)e^{-0.107(age-1)})$ Parameters refit from Chang et al. (2013); ISC (2013)

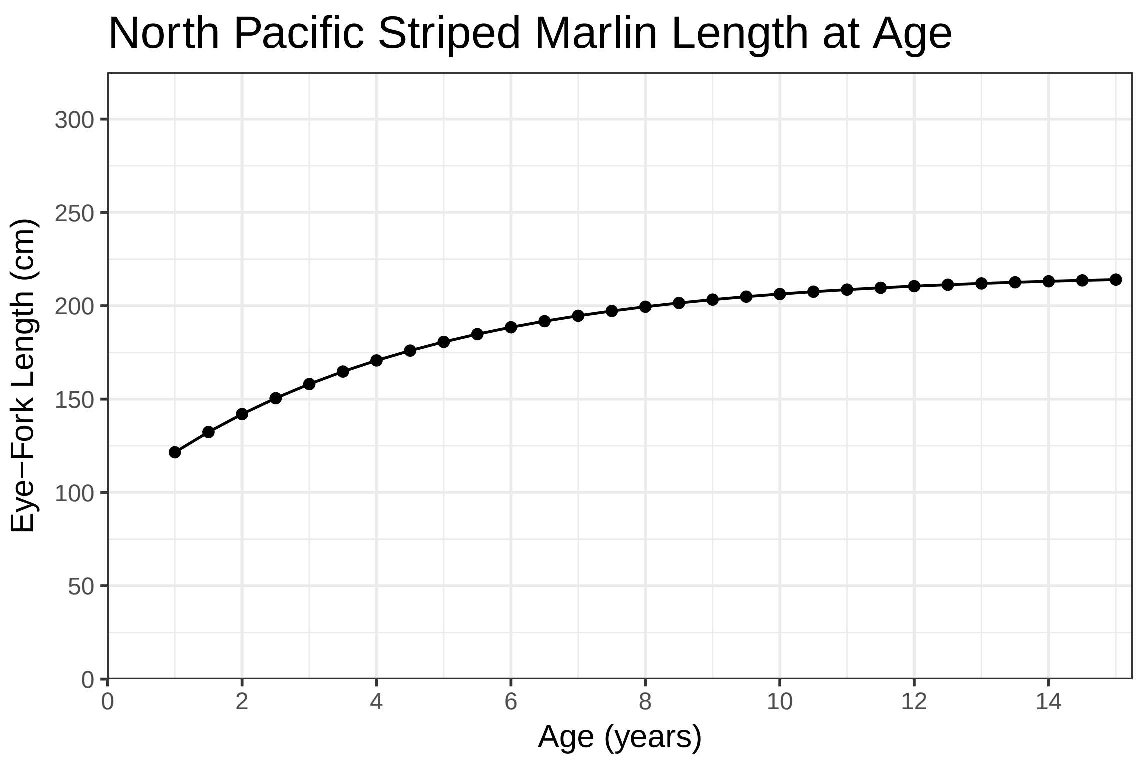


Figure 2: $L(age) = 217.3 + (104 + 214)e^{-0.24(age-0.3)})$. Parameters refit from Sun et al. (2011a) in ISC (2015).

Swordfish *(Xiphias gladius)*

For swordfish, the expected length at age is based on a standard von Bertalanffy growth curve where length in cm of EFL is a function of age $L(age)$ via the following. We display these for both sexes separately.

$$(1c) \quad L(age) = L_\infty \times (1 - e^{-k(a-t_0)})$$

For EPO swordfish, male growth parameters are $L_\infty = 273.2$, $k = 0.077$,and $t_0 = -3.2$. Female growth parameters are $L_\infty = 263.7$, $k = 0.116$, and $t_0 = -4.05$.

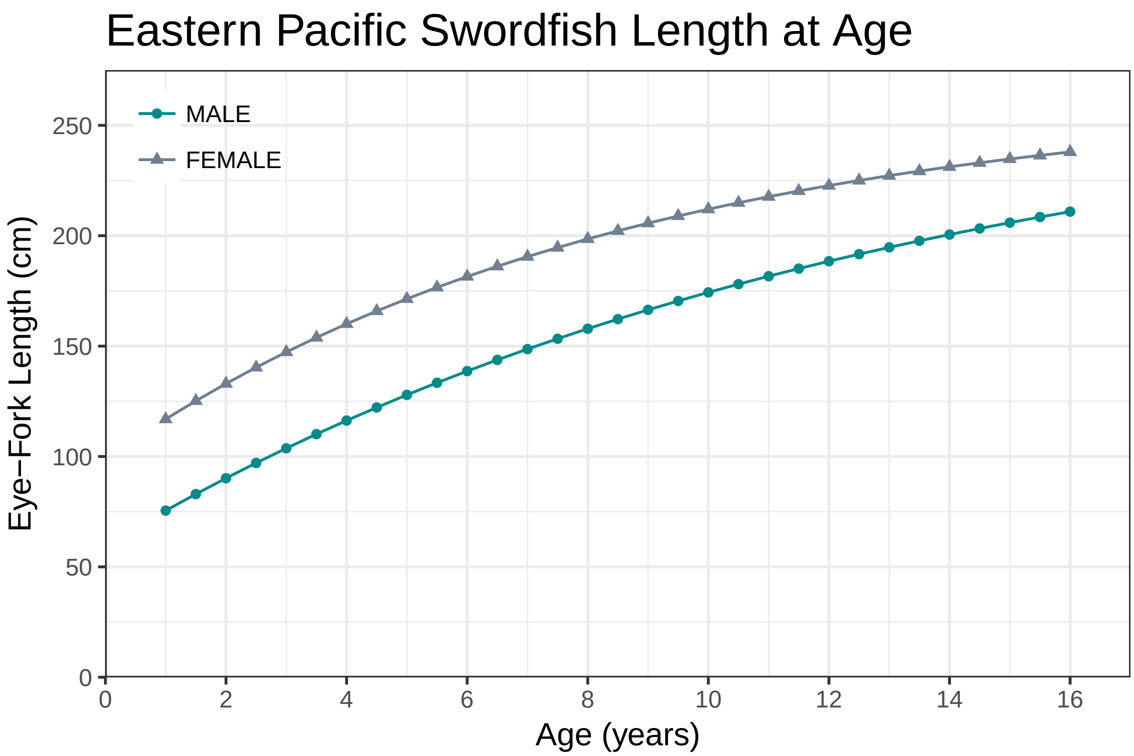


Figure 3: Males: $L(age) = 273.2 \times (1 - e^{-0.077(age+3.2)})$, Females: $L(age) = 263.7 \times (1 - e^{-0.116(age+4.05)})$ DeMartini et al (2007); Uchiyama and Humphreyes (2006), DeMartini et al (2000)

For WCNPO swordfish, male growth parameters are $L_\infty = 208.9$, $k = 0.271$, and $t_0 = -1.37$. Female growth parameters are $L_\infty = 230.5$, $k = 0.246$,and $t_0 = -1.24$. .

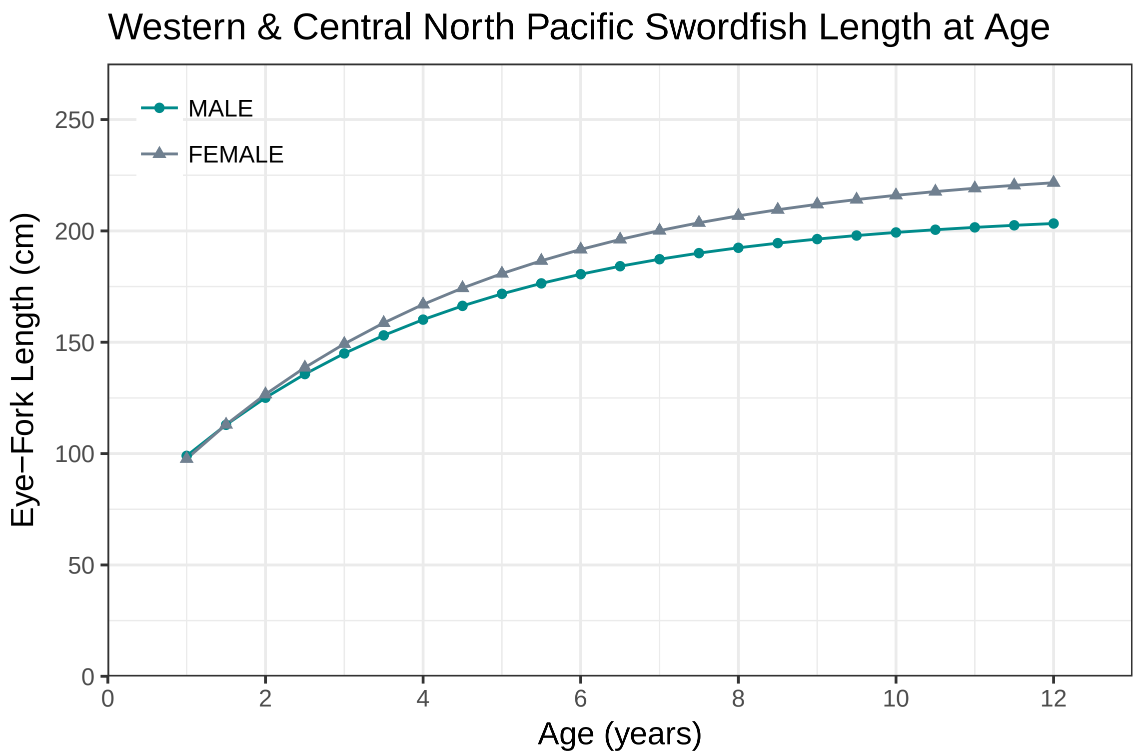


Figure 4: Males: $L(age) = 208.9 \times (1 - e^{-0.271(age+1.37)})$, Females: $L(age) = 230.5 \times (1 - e^{-0.246(age+1.24)})$ DeMartini et al (2007); Uchiyama and Humphreyes (2006), DeMartini et al (2000)

Weight at length curve

Pacific Blue Marlin *(Makaira nigricans)* and North Pacific Striped Marlin *(Kajikia audax)*

Weight at length is modeled using an allometric relationship where weight W is a power function of length L as:

$$(2) \quad W(L) = aL^b$$

where a and b are species-specific and possibly sex-specific parameters.

For blue marlin, weight (kg) at length (cm, EFL) parameters for males are$a = 1.370 \times 10^{-5}$ and $b = 2.975$; for females, $a = 1.844 \times 10^{-5}$ and $b = 2.956$.

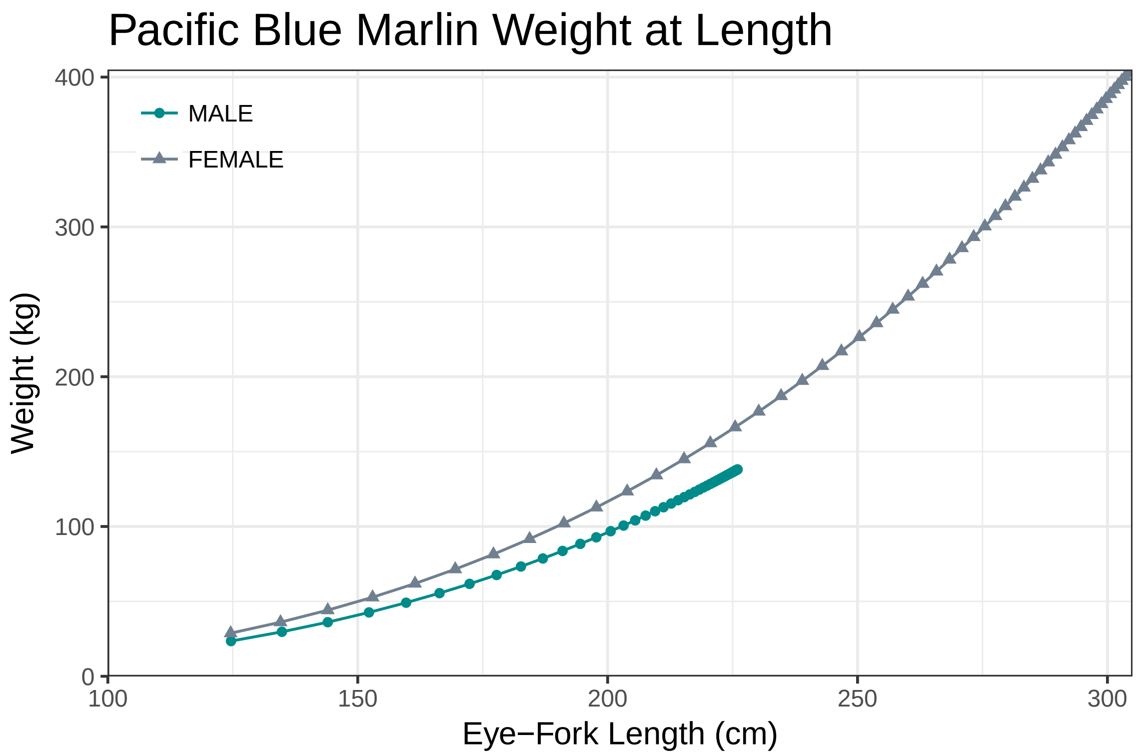


Figure 5: Males: $W(L) = 1.370 \times 10^{-5} L^{2.975}$, Females: $W(L) = 1.844 \times 10^{-5} L^{2.956}$ Parameters refit from Chang et al. (2013); Brodziak (2013)

For striped marlin, weight (kg) at length (cm, EFL) parameters for pooled sexes are $a = 4.68 \times 10^{-6}$ and $b = 3.16$.

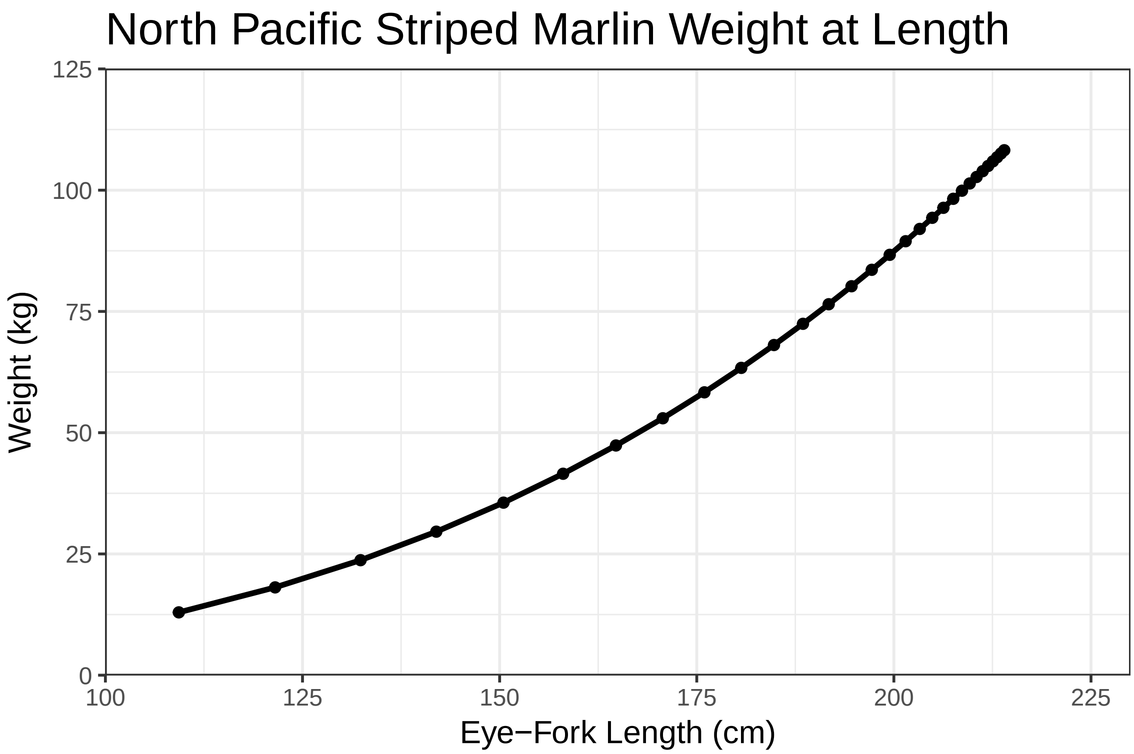


Figure 6: $W(L) = 4.68 \times 10^{-6} L^{3.16}$ Sun et al. (2011a)

Swordfish ***(Xiphias gladius)***

Weight at length is modeled using an allometric relationship where weight is a power function of length $W(L)$ as for marlin, as in Equation 2.

For EPO Swordfish, male weight (kg) at length (cm, EFL) parameters are $a = 6.60 \times 10^{-6}$ and $b = 3.19$; female weight (kg) at length (cm, EFL) parameters are $a = 1.37 \times 10^{-5}$ and $b = 3.04$.

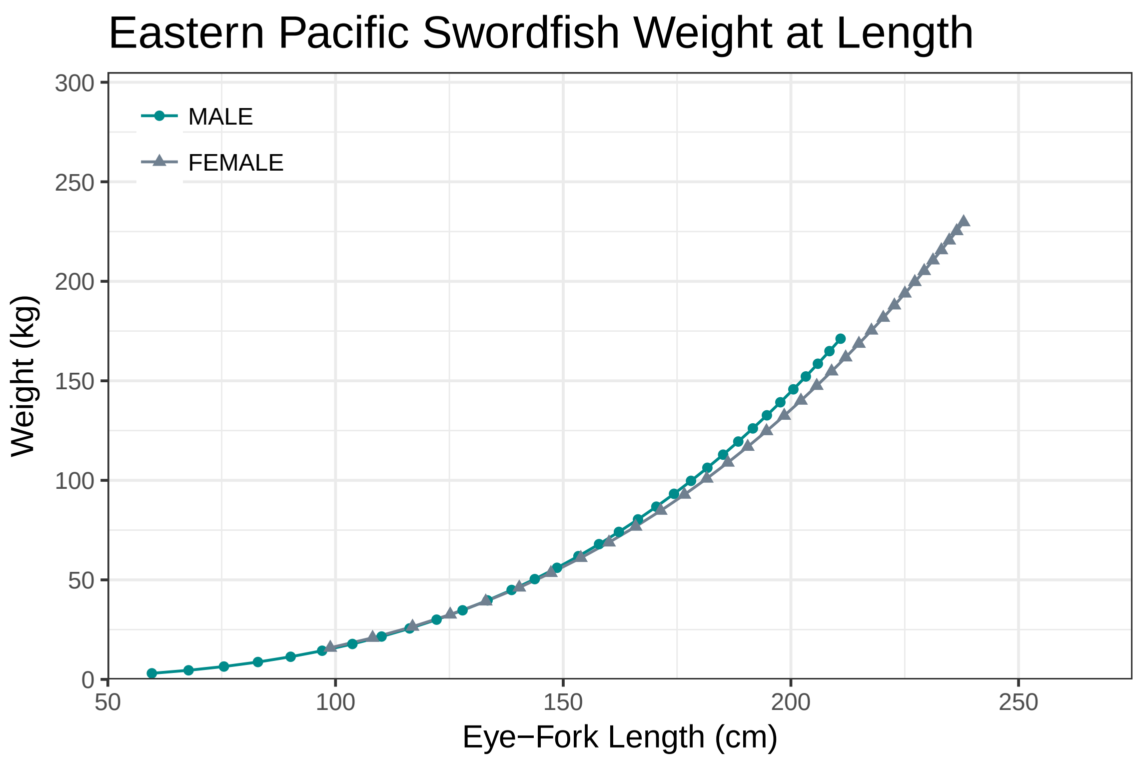


Figure 7: Males: $W(L) = 6.60 \times 10^{-6} L^{3.19}$, Females: $W(L) = 1.37 \times 10^{-5} L^{3.04}$ DeMartini et al (2007); Uchiyama and Humphreyes (2006), DeMartini et al (2000)

WCNPO Swordfish weight at lengths are shown for pooled sexes: weight (kg) at length (cm, EFL) parameters are $a = 1.299 \times 10^{-5}$ and $b = 3.0738$. Both sexes are assumed to follow the same relationship, though females obtain a higher asymptotic length than males.

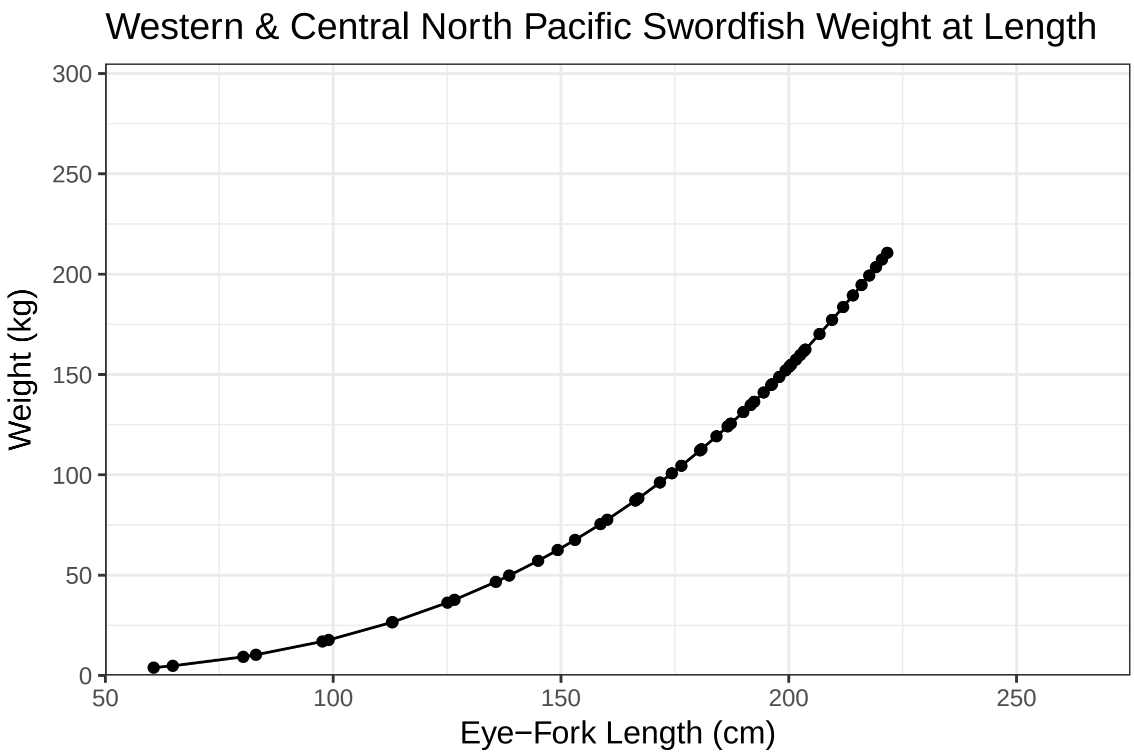


Figure 8: $W(L) = 1.299 \times 10^{-5} L^{3.0738}$ DeMartini et al (2007); Uchiyama and Humphreyes (2006), DeMartini et al (2000)

Weight at age curve

Pacific Blue Marlin *(Makaira nigricans)* and North Pacific Striped Marlin *(Kajikia audax)*

Weight at age $W(age)$ can be sex-specific, and is calculated from the species-specific length at age and weight at length as:

$$(3) \quad W(age) = a \times L(age)^b$$

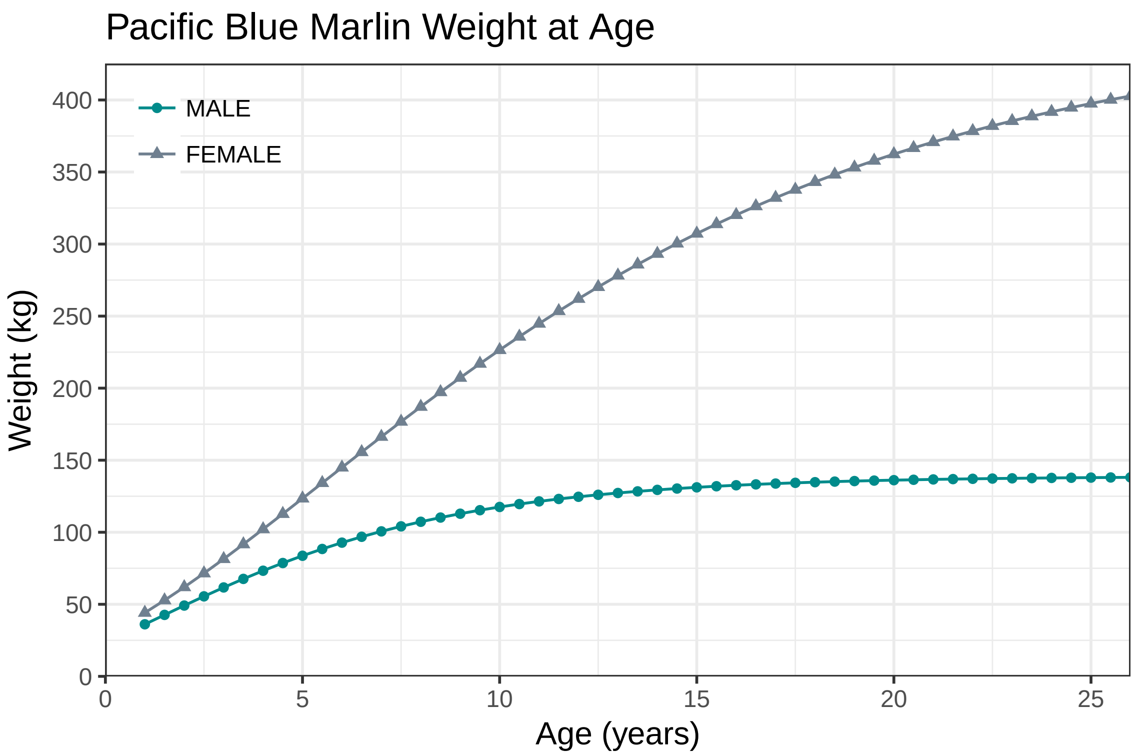


Figure 9: Males: $W(age) = 1.370 \times 10^{-5} L(age)^{2.975}$, Females: $W(L) = 1.844 \times 10^{-5} L(age)^{2.956}$

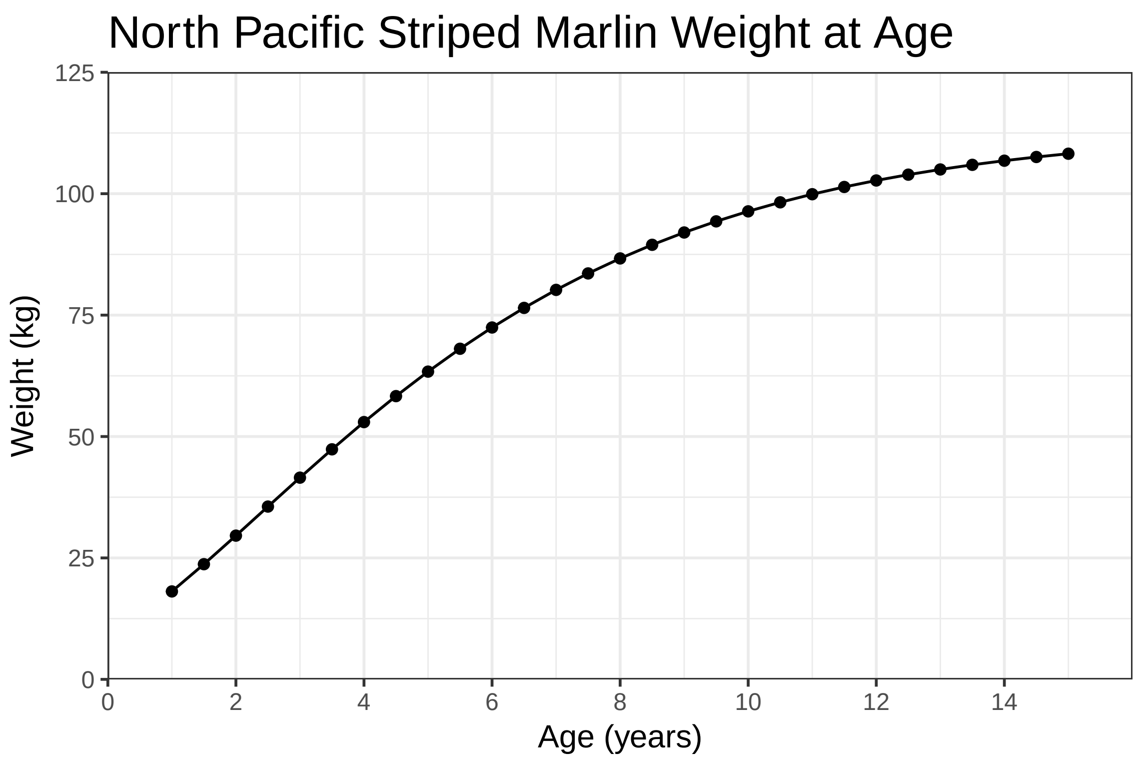


Figure 10: $W(age) = 4.68 \times 10^{-6} L(age)^{3.16}$ Sun et al. (2011a)

Swordfish *(Xiphias gladius)*

Weight at age $W(age)$ is calculated from the species-specific length at age and weight at length for either separate or pooled sexes, as in Equation 3.

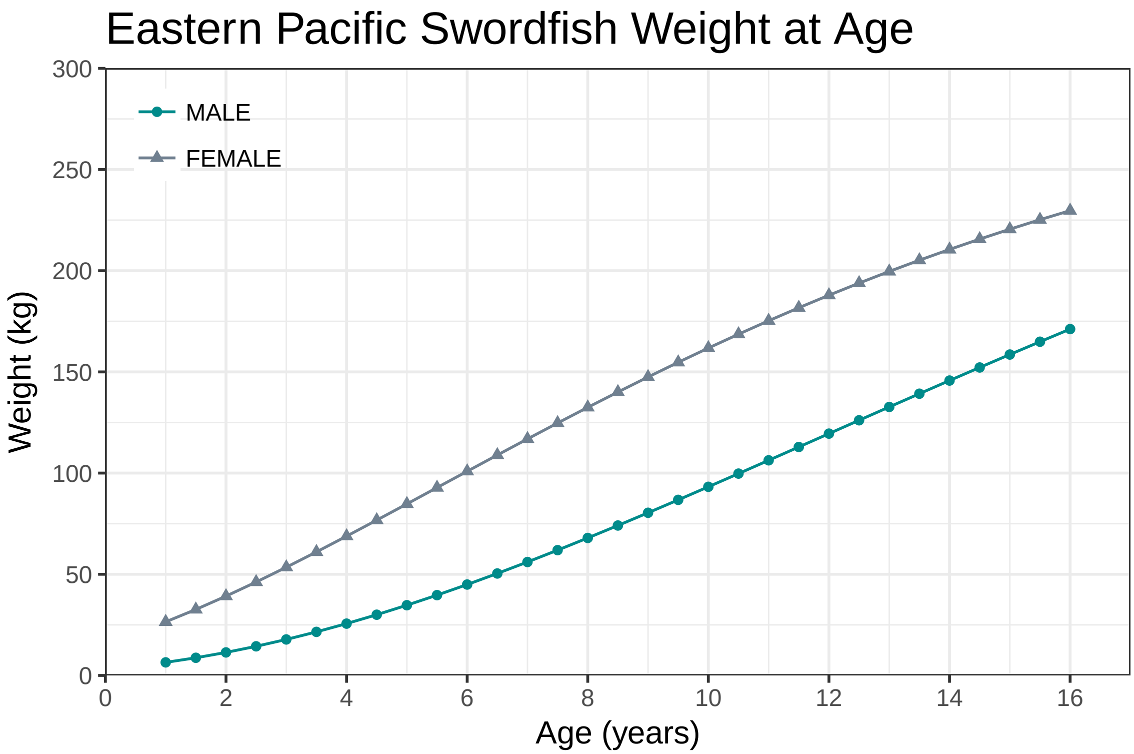


Figure 11: Males: $W(age) = 6.60 \times 10^{-6} L(age)^{3.19}$, Females: $W(age) = 1.37 \times 10^{-5} L(age)^{3.04}$ DeMartini et al (2007); Uchiyama and Humphreyes (2006), DeMartini et al (2000)

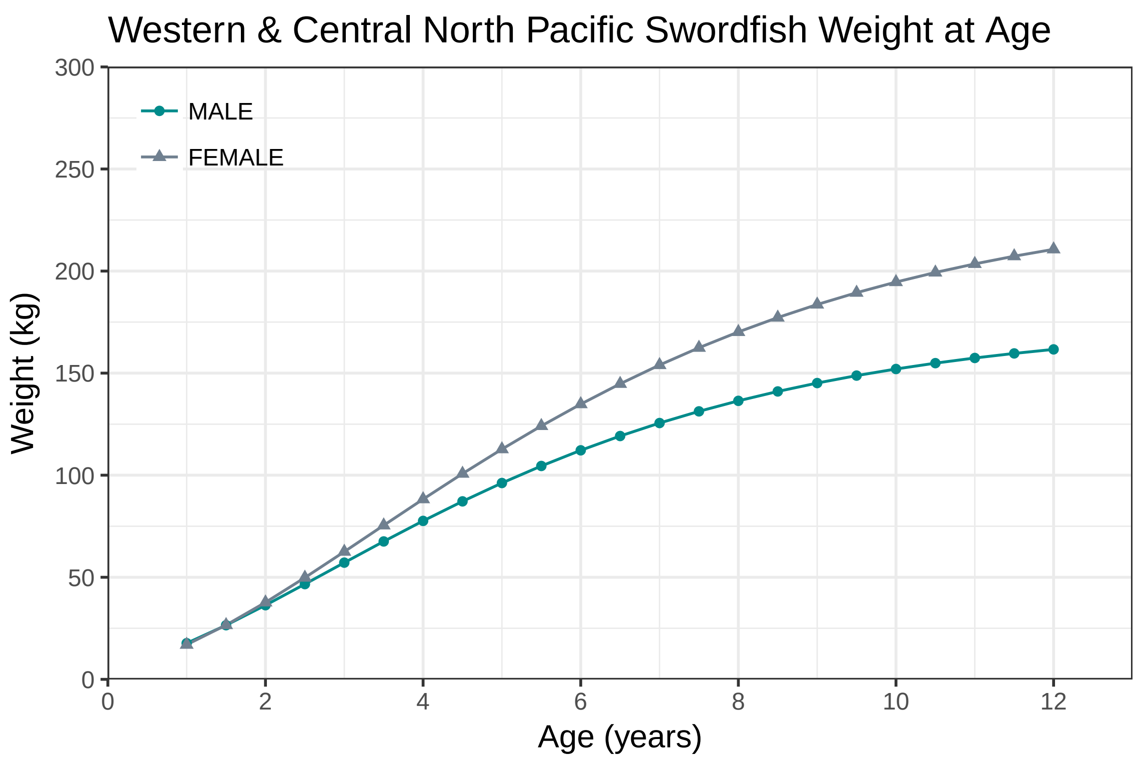


Figure 12: $W(age) = 1.299 \times 10^{-5} L(age)^{3.0738}$ DeMartini et al (2007); Uchiyama and Humphreyes (2006), DeMartini et al (2000)

Maturation and Survival

Probability of maturity at length

Pacific Blue Marlin *(Makaira nigricans)* and North Pacific Striped Marlin *(Kajikia audax)*

The probability of maturity at length $Pmature(L)$ can be sex-specific and is modeled using a logistic curve where:

$$(4a) \quad P_{mature}(L) = \frac{1}{(1+e^{\beta(L-L_{50})})}$$

and L_{50} is the length at 50% maturity and β is the slope parameter.

For blue marlin, the female maturity ogive parameters are $\beta = -0.2039$, and $L_{50} = 179.76$ (cm, EFL). For males, we used a modified version of the above equation as follows:

$$(4b) \quad P_{mature}(L) = \frac{1}{(1+e^{-log(19)\times\frac{L-L_{50}}{L_{50}-L_{95}}})}$$

Where $L_{50} = 130$ (cm, EFL), $L_{95} = 130.13$ (cm, EFL). For striped marlin, the maturity ogive parameters for pooled sexes using Equation 4a are $L_{50} = 177.0$ (cm, EFL), and $\beta = -0.064$ (Sun et al., 2011)

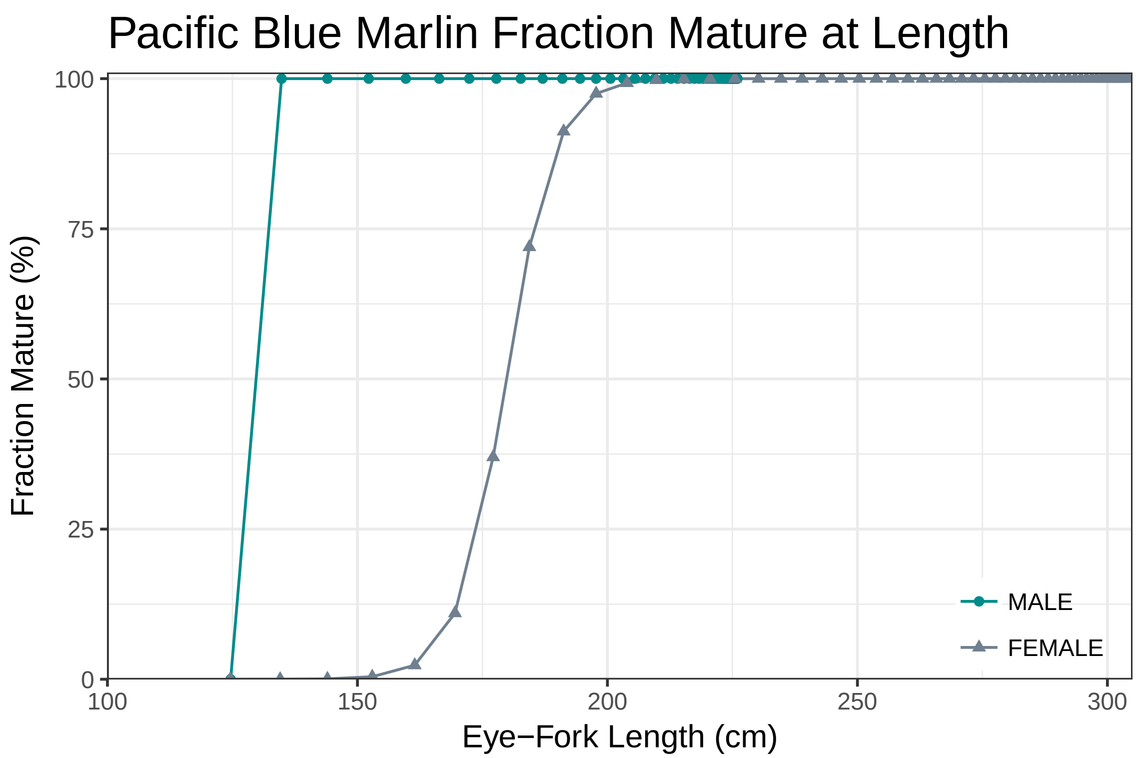


Figure 13: Males: $P_{mature}(L) = \frac{1}{(1+e^{-log(19)\times\frac{L-130}{130-130.13}})}$, Females: $P_{mature}(L) = \frac{1}{1+e^{-0.2039\times(L-179.76)})}$ Sun et al. (2009); Shimose et al. (2009)

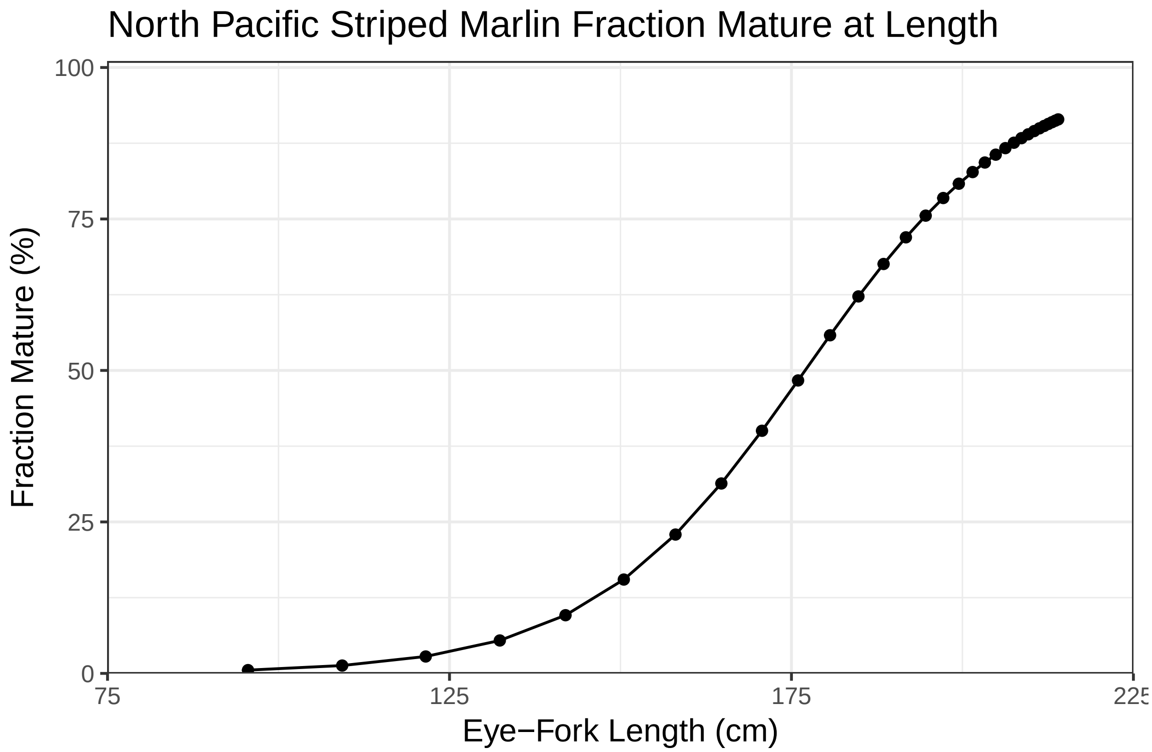


Figure 14: $P_{mature}(L) = \frac{1}{(1+e^{-0.064(L-177.0)})}$ Sun et al. (2011b)

Swordfish *(Xiphias gladius)*

The probability of maturity at length $Pmature(L)$ can be sex-specific and is modeled using a logistic curve as in Equation 4a.

For EPO Swordfish, the maturity ogive parameters for females are $\beta = -0.10$, and $L_{50} = 150.0$ (cm, EFL). The maturity ogive parameters for males are $\beta = -0.10$, and $L_{50} = 120.0$ (cm, EFL).

For WCNPO Swordfish, the maturity ogive parameters for females are $\beta = -0.103$, and $L_{50} = 143.6$ (cm, EFL). The maturity ogive parameters for males are $\beta = -0.141$, and $L_{50} = 102.0$ (cm, EFL).

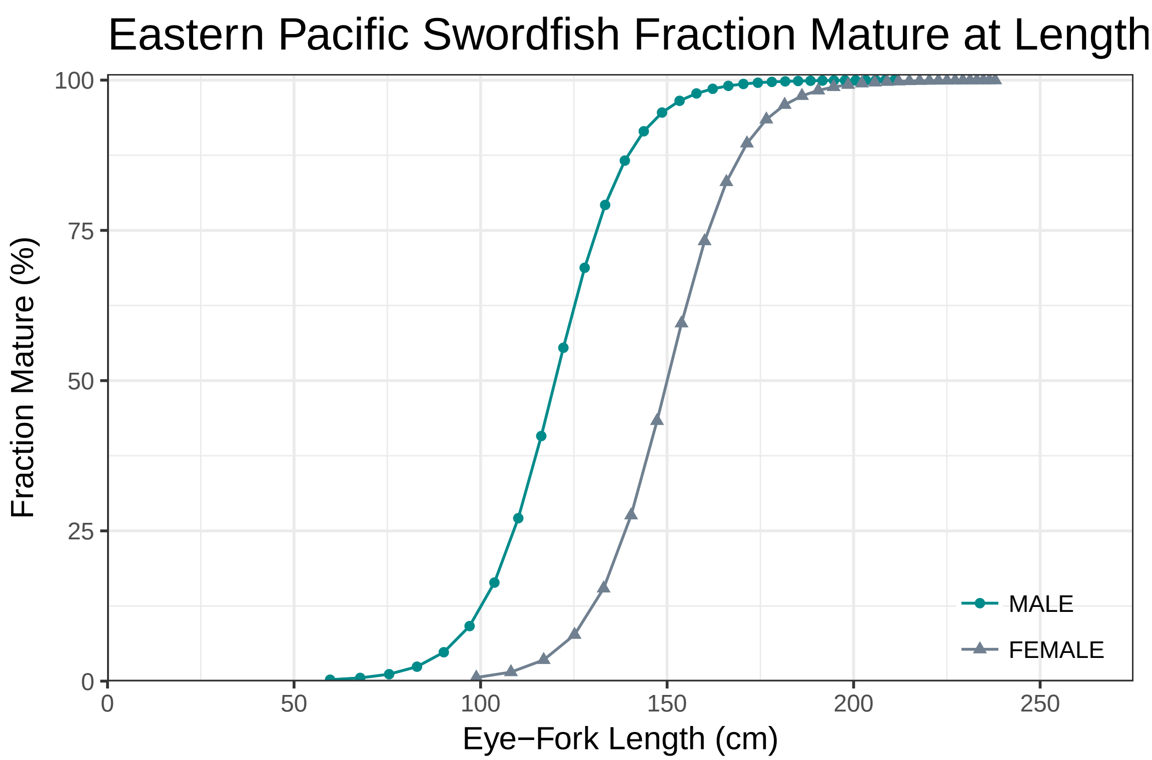


Figure 15: Males: $P_{mature}(L) = \frac{1}{(1+e^{-0.10(L-120.0)})}$, Females: $P_{mature}(L) = \frac{1}{(1+e^{-0.10(L-150.0)})}$ Pauly (1980); Hoenig (1983); Peterson and Wroblewski (1984); Hewitt and Hoenig (2005)

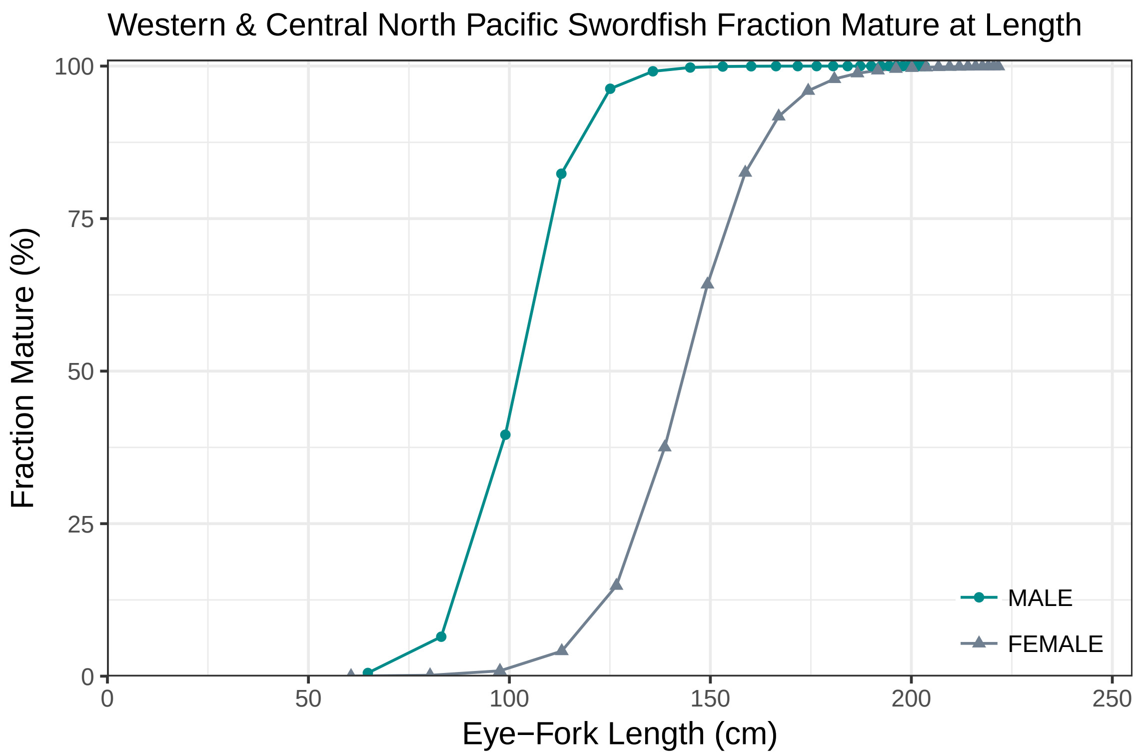


Figure 16: Males: $P_{mature}(L) = \frac{1}{(1+e^{-0.141(L-102.0)})}$, Females: $P_{mature}(L) = \frac{1}{(1+e^{-0.103(L-143.6)})}$ Pauly (1980); Hoenig (1983); Peterson and Wroblewski (1984); Hewitt and Hoenig (2005)

Natural mrtality at age

Pacific Blue Marlin *(Makaira nigricans)* and North Pacific Striped Marlin *(Kajikia audax)*

Natural mortality rates at age M_{age} can be sex-specific and are modeled as age-specific constants. We present these values at 0.5-year time steps.

For blue marlin, female natural mortality rates at age (instantaneous, yr-1) are: $M_0 = 0.42, M_1 = 0.37, M_2 = 0.32, M_3 = 0.27, M_{4+} = 0.22$. For males, $M_0 = 0.42, M_{1+} = 0.37$.

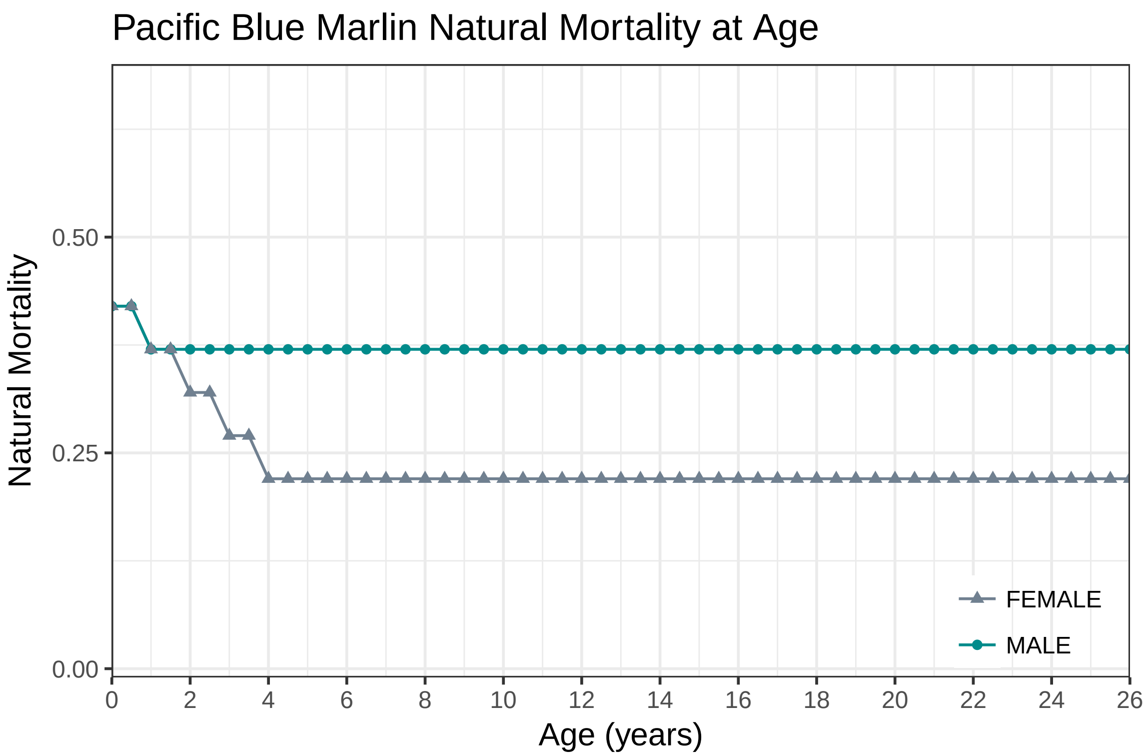


Figure 17: Female natural mortality rates at age (instantaneous, yr-1) are: $M_0 = 0.42, M_1 = 0.37, M_2 = 0.32, M_3 = 0.27, M_{4+} = 0.22$. For males, $M_0 = 0.42, M_{1+} = 0.37$ Lee and Chang (2013)

For striped marlin, natural mortality rates at age (instantaneous, yr^{-1}) for pooled sexes are: $M_0 = 0.54, M_1 = 0.47, M_2 = 0.43, M_3 = 0.40, M_{4+} = 0.38$.

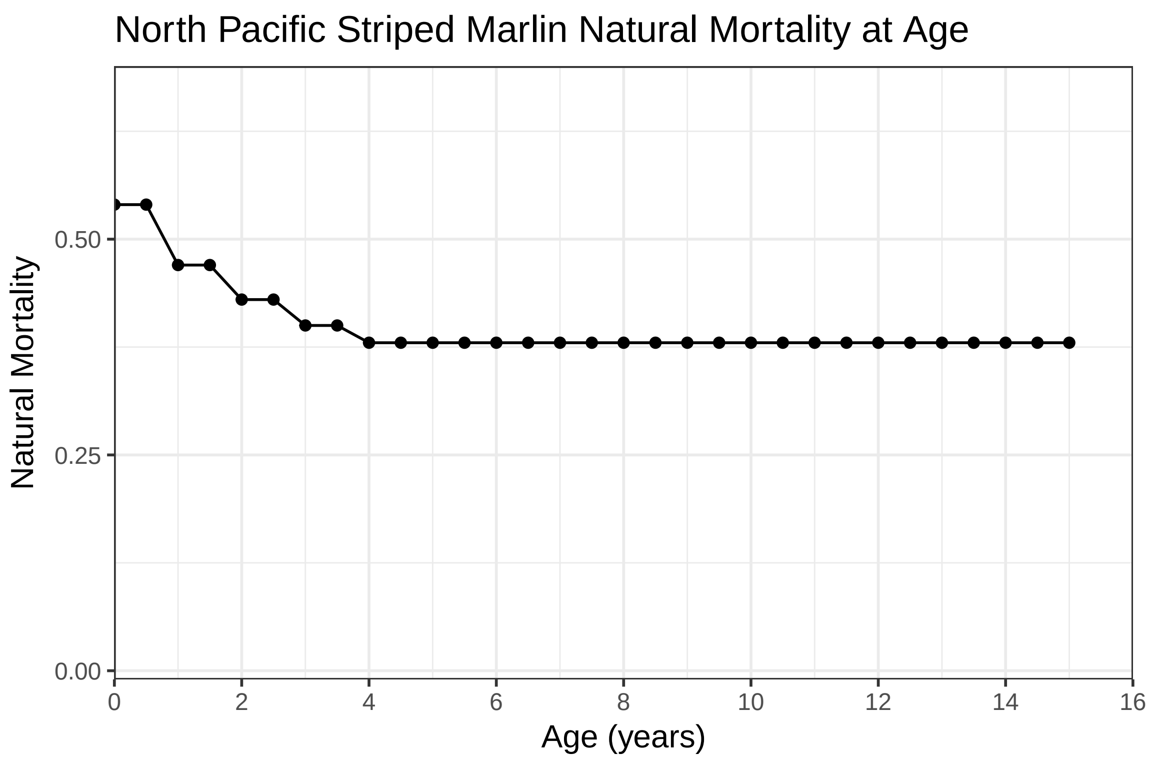


Figure 18: $M_0 = 0.54, M_1 = 0.47, M_2 = 0.43, M_3 = 0.40, M_{4+} = 0.38$. Piner and Lee (2011)

Swordfish *(Xiphias gladius)*

Natural mortality rates at age M_{age} can be sex-specific and are modeled as age-specific constants. For EPO Swordfish, female natural mortality rates at age (instantaneous, yr-1) are:

$M_0 = 0.39, M_{1-2} = 0.38, M_{3-6} = 0.37, M_{7+} = 0.36$. For males, $M_0 = 0.48, M_1 = 0.47, M_2 = 0.46, M_{3-4} = 0.45, M_{5-8} = 0.44, M_{9+} = 0.43$.

For WCNPO Swordfish, female natural mortality rates at age (instantaneous, yr-1) are: $M_0 = 0.42, M_1 = 0.37, M_2 = 0.32, M_3 = 0.27, M_{4+} = 0.22$. For males, $M_0 = 0.40, M_{1-2} = 0.38, M_{3-5} = 0.37, M_{6+} = 0.36$.

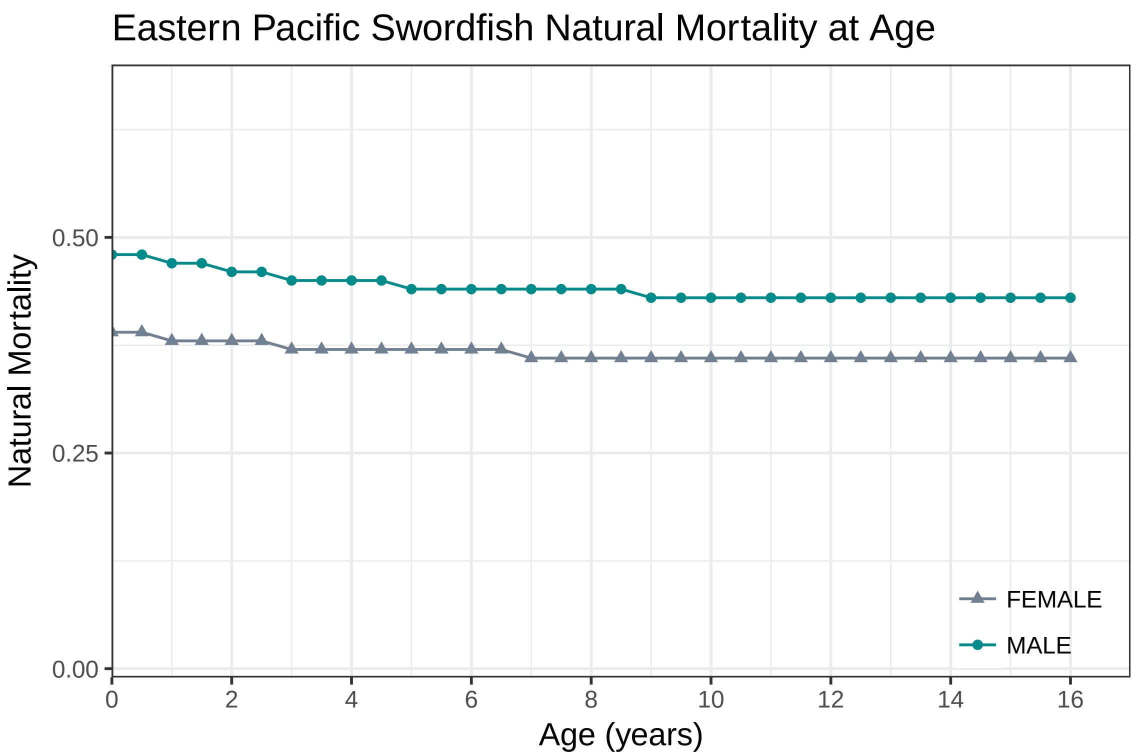


Figure 19: Female natural mortality rates at age (instantaneous, yr-1) are: $M_0 = 0.39, M_{1-2} = 0.38, M_{3-6} = 0.37, M_{7+} = 0.36$. For males, $M_0 = 0.48, M_1 = 0.47, M_2 = 0.46, M_{3-4} = 0.45, M_{5-8} = 0.44, M_{9+} = 0.43$. Chen and Watanabe (1989); Lorenzen (1996)

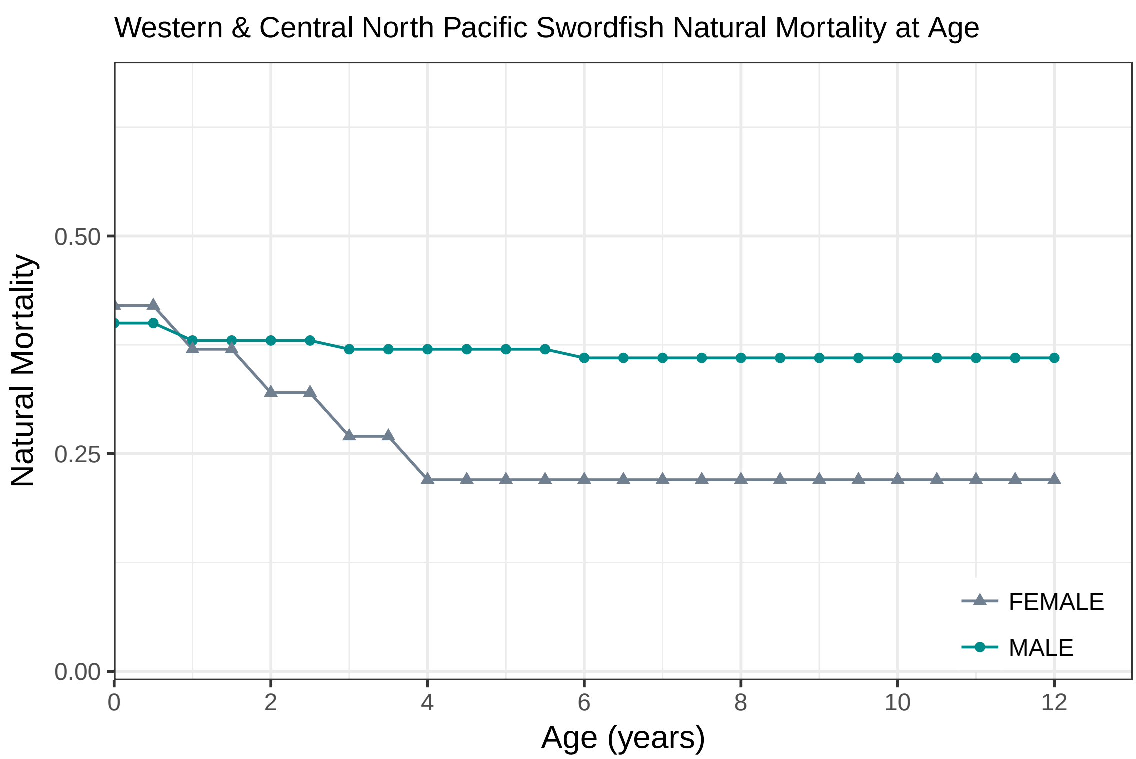


Figure 20: Female natural mortality rates at age (instantaneous, yr-1) are: $M_0 = 0.42, M_1 = 0.37, M_2 = 0.32, M_3 = 0.27, M_{4+} = 0.22$. For males, $M_0 = 0.40, M_{1-2} = 0.38, M_{3-5} = 0.37, M_{6+} = 0.36$. Chen and Watanabe (1989); Lorenzen (1996)

Unfished survival-to-age probabilities

Pacific Blue Marlin *(Makaira nigricans)* and North Pacific Striped Marlin *(Kajikia audax)*

The unfished survival to age probabilities $Psurvive(age)$ are calculated as the product of the survival at age probabilities for ages 0 to $age - 1$ using the age-specific and sometimes sex-specific natural mortality rates described above in the following:

$$(5) \quad P_{survive}(age) = \prod_{i=0}^{age-1} e^{-M_{age}(i)}$$

As a rule, the probability of survival to age 0 is expected to be 1.

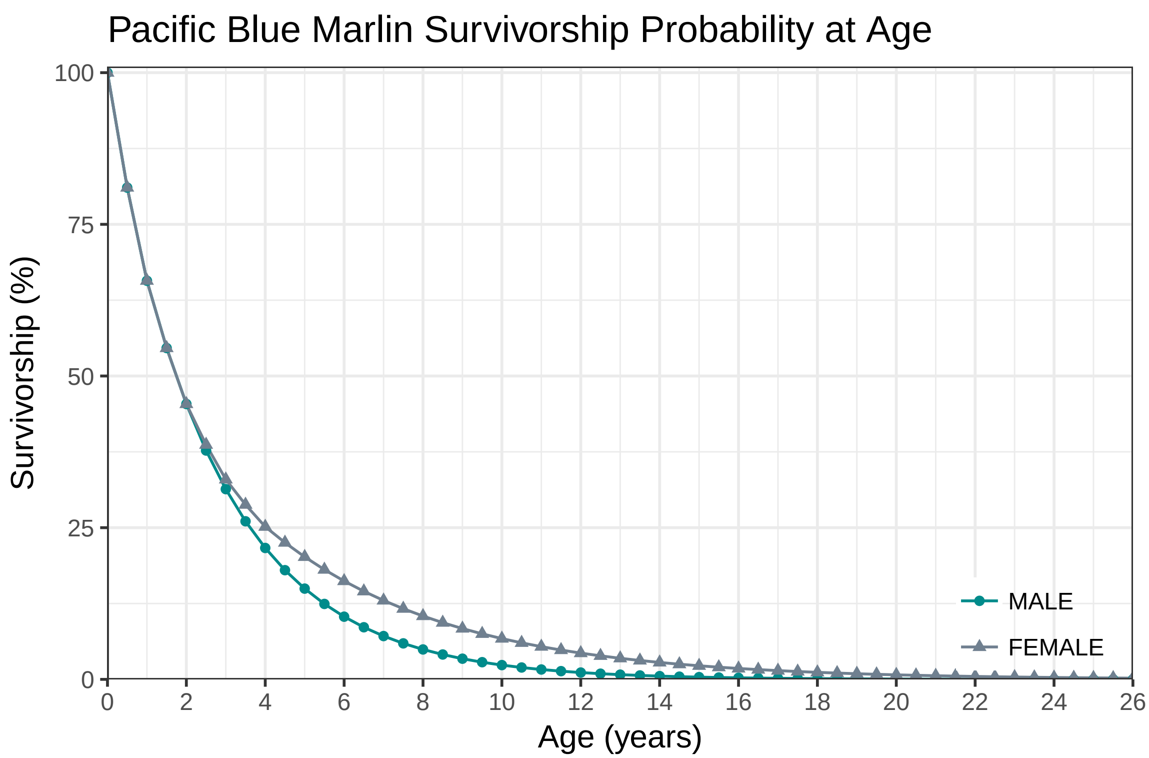


Figure 21: $P_{survive}(age) = \prod_{i=0}^{age-1} e^{-M_{age}(i)}$ Lee and Chang (2013)

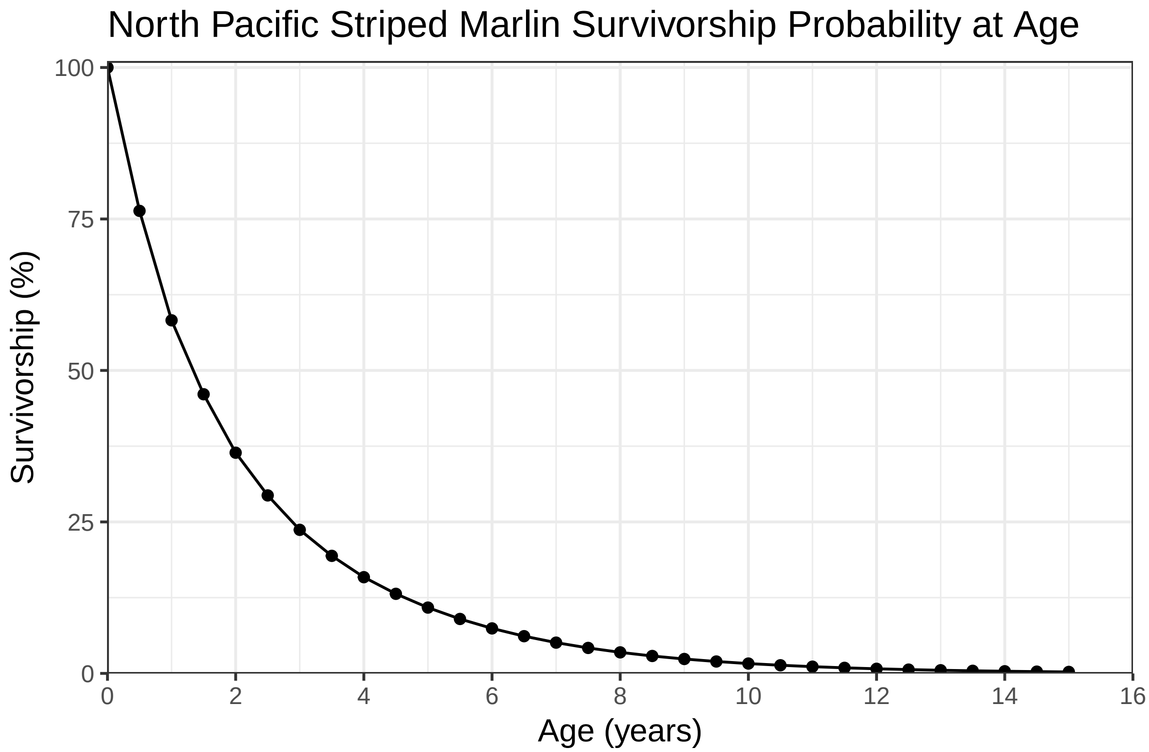


Figure 22: $P_{survive}(age) = \prod_{i=0}^{age-1} e^{-M_{age}(i)}$ Piner and Lee (2011)

Swordfish *(Xiphias gladius)*

The unfished survival to age probabilities $Psurvive(age)$ are calculated as the product of the survival at age probabilities for ages 0 to $age - 1$ using the age-specific and sometimes sex-specific natural mortality rates as in Equation 5.

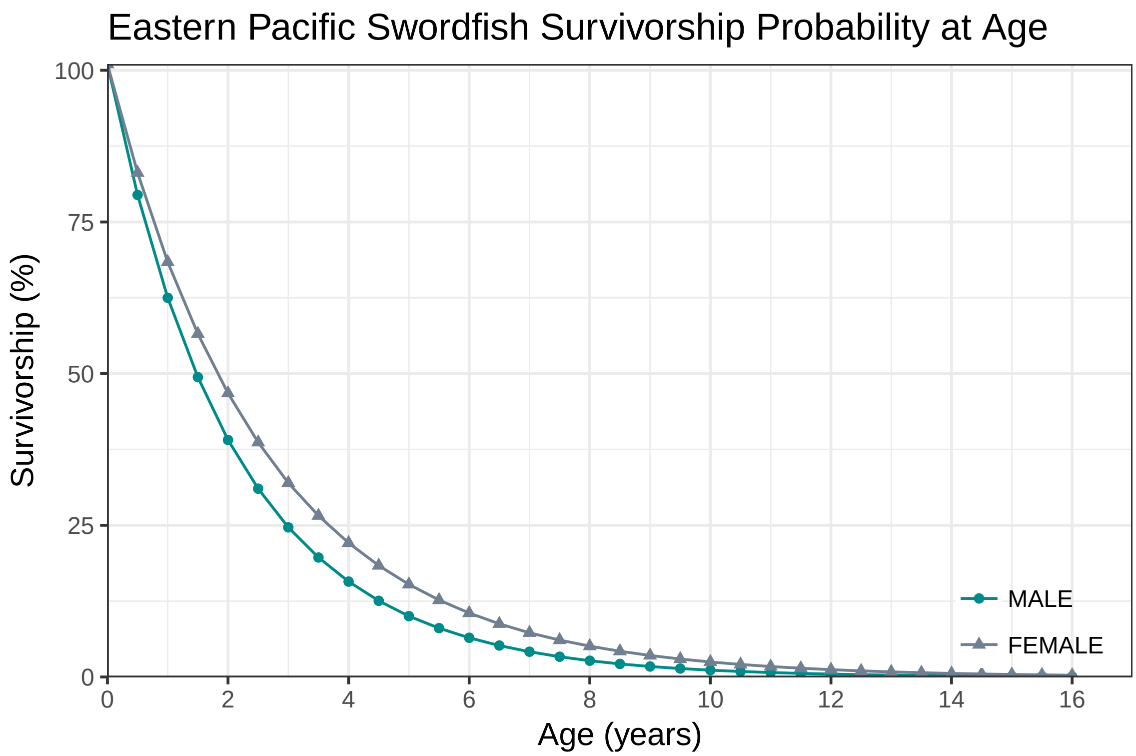


Figure 23: $P_{survive}(age) = \prod_{i=0}^{age-1} e^{-M_{age}(i)}$ Chen and Watanabe (1989); Lorenzen (1996)

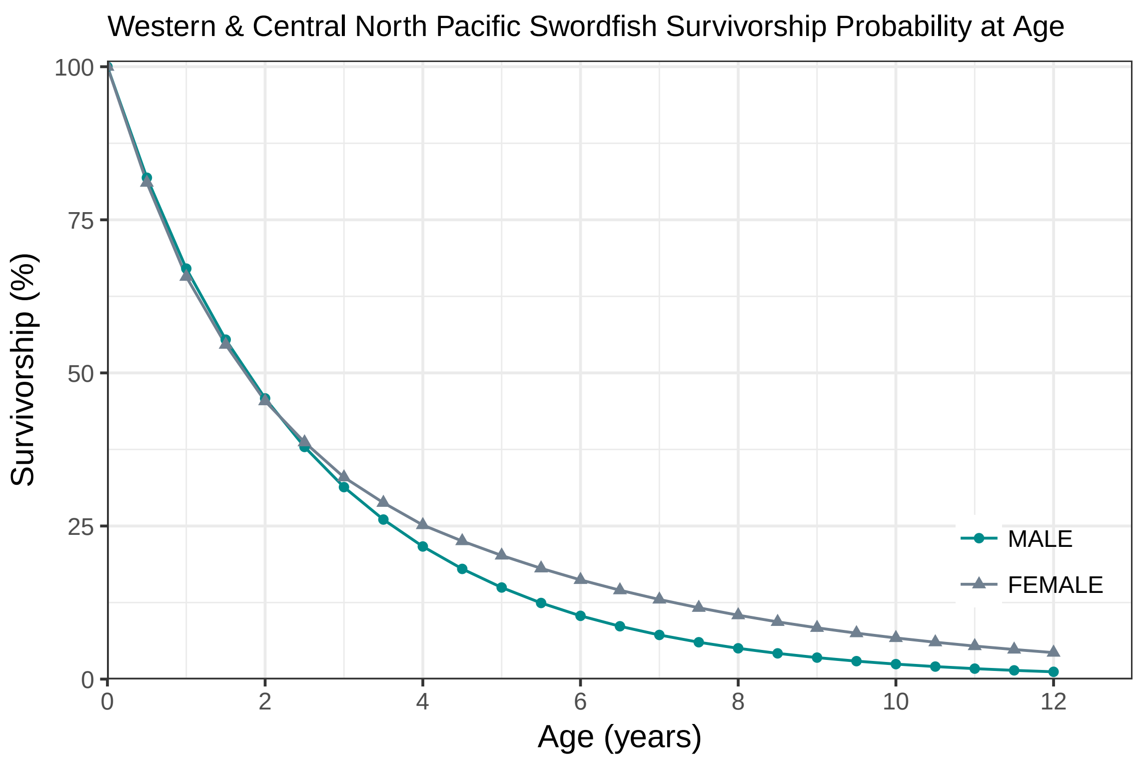


Figure 24: $P_{survive}(age) = \prod_{i=0}^{age-1} e^{-M_{age}(i)}$ Chen and Watanabe (1989); Lorenzen (1996)

Unfished cohort biomass per recruit at age

Pacific Blue Marlin *(Makaira nigricans)* and North Pacific Striped Marlin *(Kajikia audax)*

The unfished cohort biomass per recruit at age $BR_{unfished}(age)$ can be sex-specific, and is the product of the survival probability to age and the mean weight at age:

$$(6) \quad BR_{unfished}(age) = P_{survive}(age) \times W_{age}$$

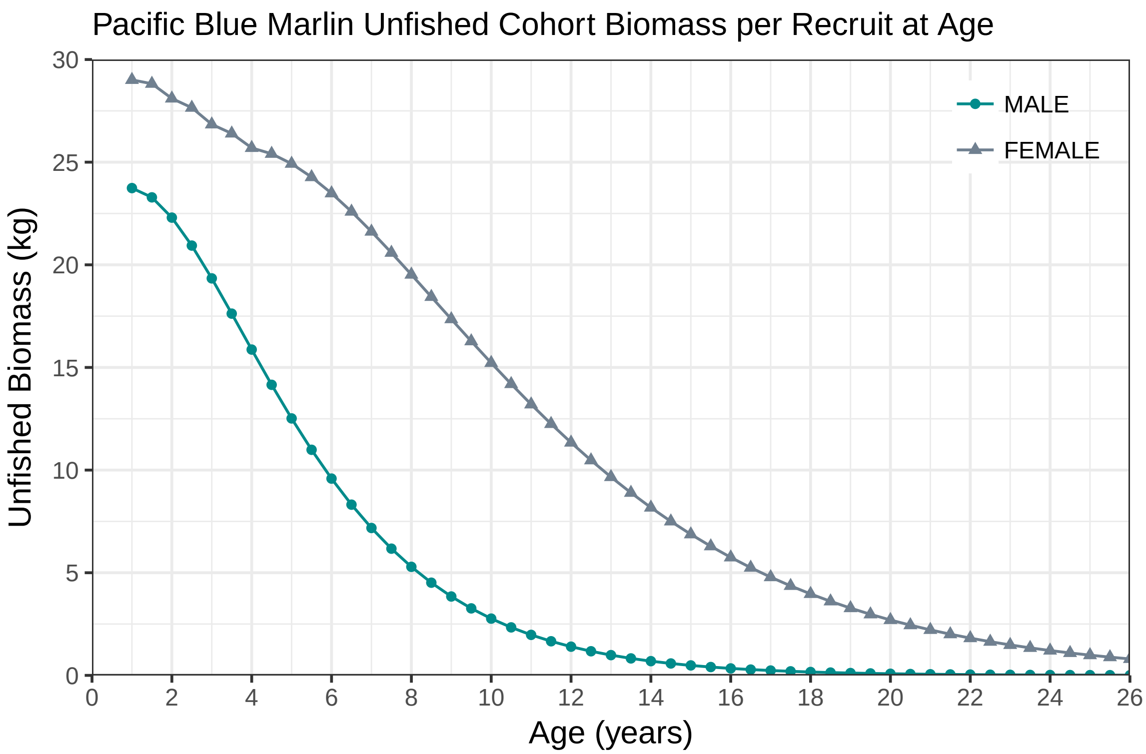


Figure 25: Brodziak (2013)

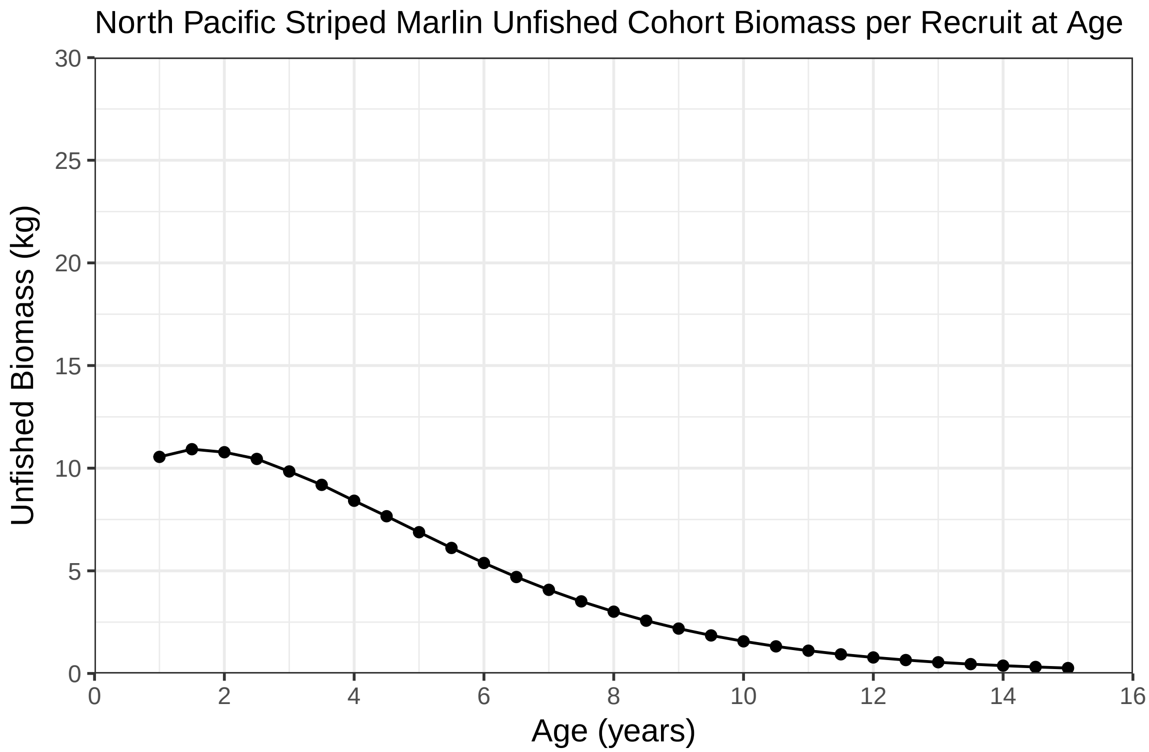


Figure 26: Sun et al. (2011a), Sun et al. (2011b)

Swordfish *(Xiphias gladius)*

The unfished survival to age probabilities $P_{survive}(age)$ are calculated as the product of the survival at age probabilities for ages 0 to age-1 using the age-specific and sometimes sex-specific natural mortality rates as in Equation 6.

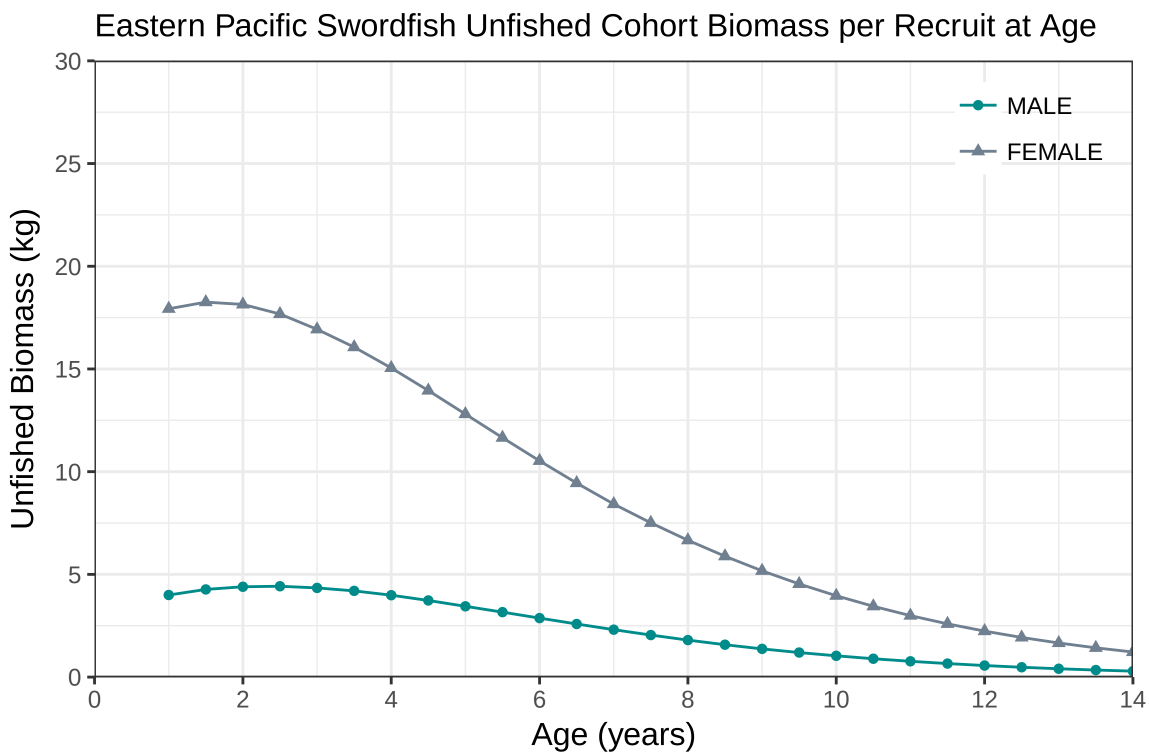


Figure 27: DeMartini et al (2007); Uchiyama and Humphreyes (2006), DeMartini et al (2000)

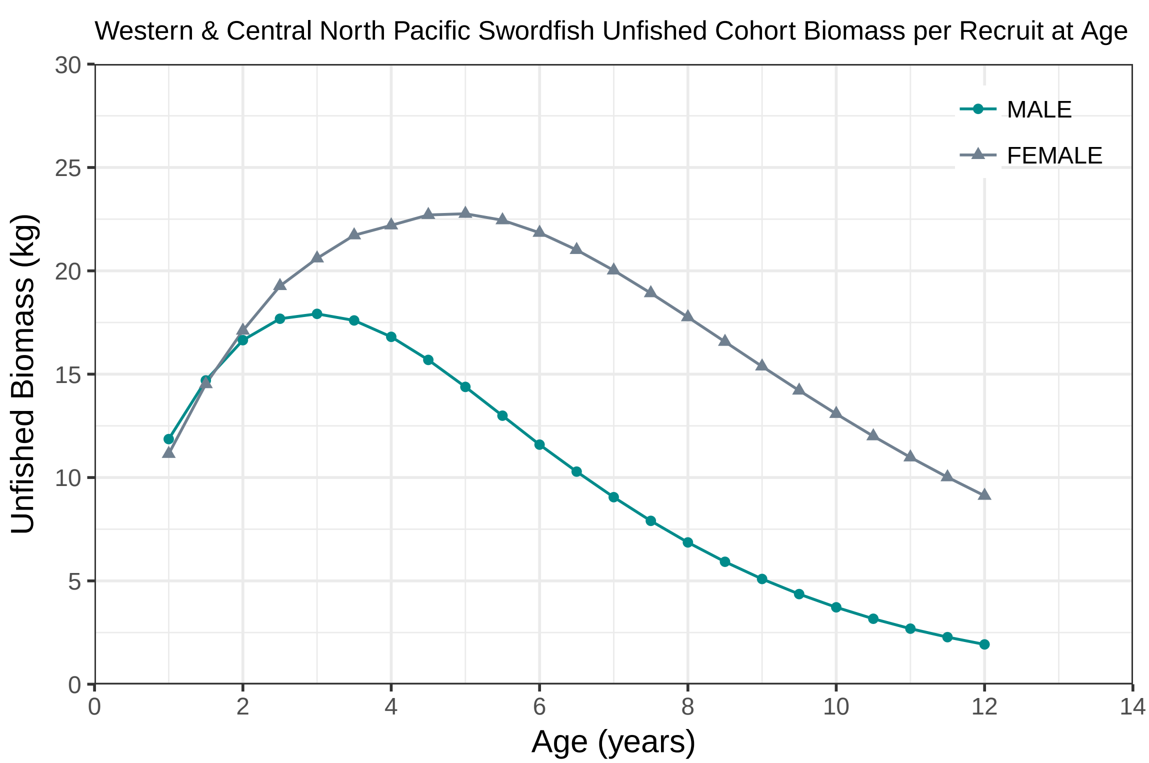


Figure 28: DeMartini et al (2007); Uchiyama and Humphreyes (2006), DeMartini et al (2000)

Unfished cohort mature biomass per recruit at age

Pacific Blue Marlin *(Makaira nigricans)* and North Pacific Striped Marlin *(Kajikia audax)*

The unfished cohort spawning biomass per recruit at age $SBR_{unfished}(age)$ can be sex-specific and is the product of the survival probability to age, the mean weight at age, and the probability of being mature at age:

$$(7) \quad SBR_{unfished}(age) = P_{survive}(age) \times W_{age} \times P_{mature}(L(age))$$

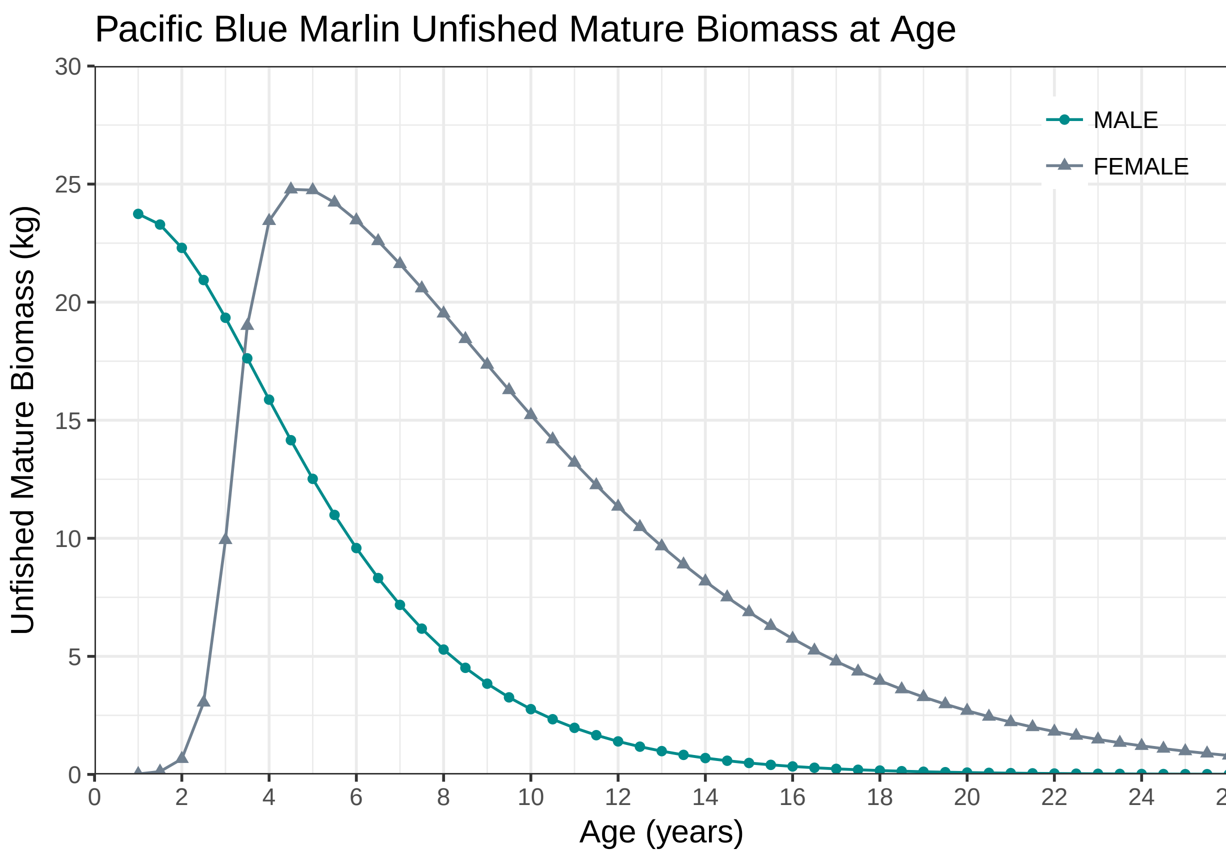


Figure 29: Sun et al. (2009); Shimose et al. (2009)

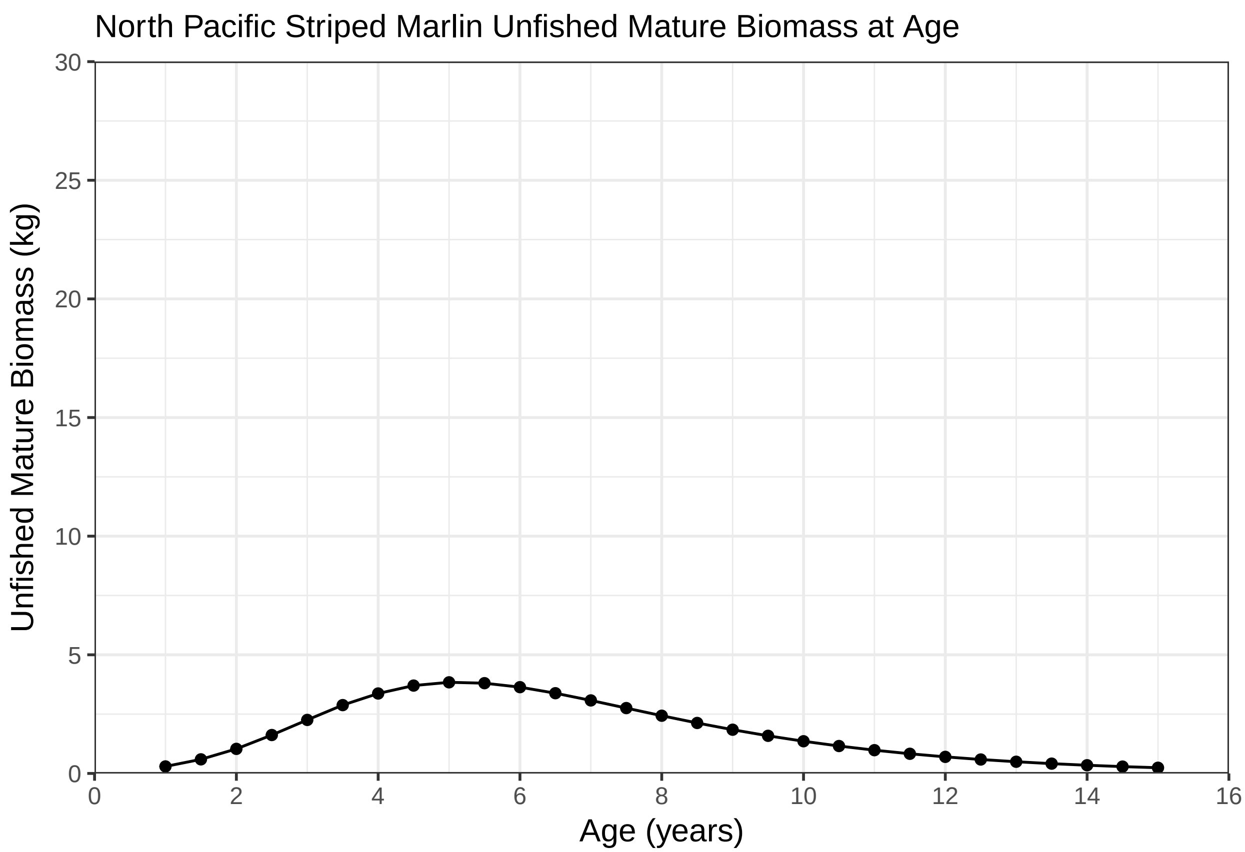


Figure 30: Sun et al. (2011a), Sun et al. (2011b)

Swordfish *(Xiphias gladius)*

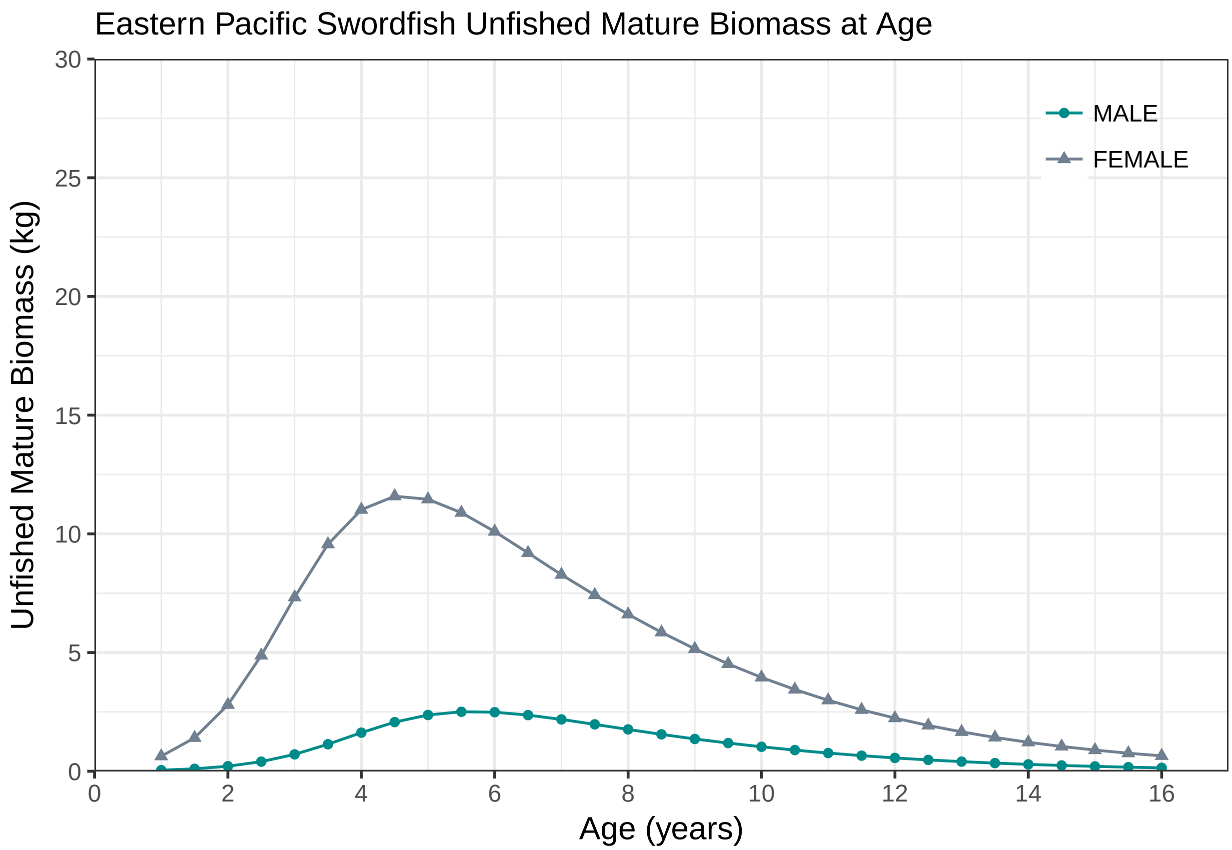


Figure 31: DeMartini et al (2007); Uchiyama and Humphreyes (2006), DeMartini et al (2000); Pauly (1980); Hoenig (1983); Peterson and Wroblewski (1984); Hewitt and Hoenig (2005)

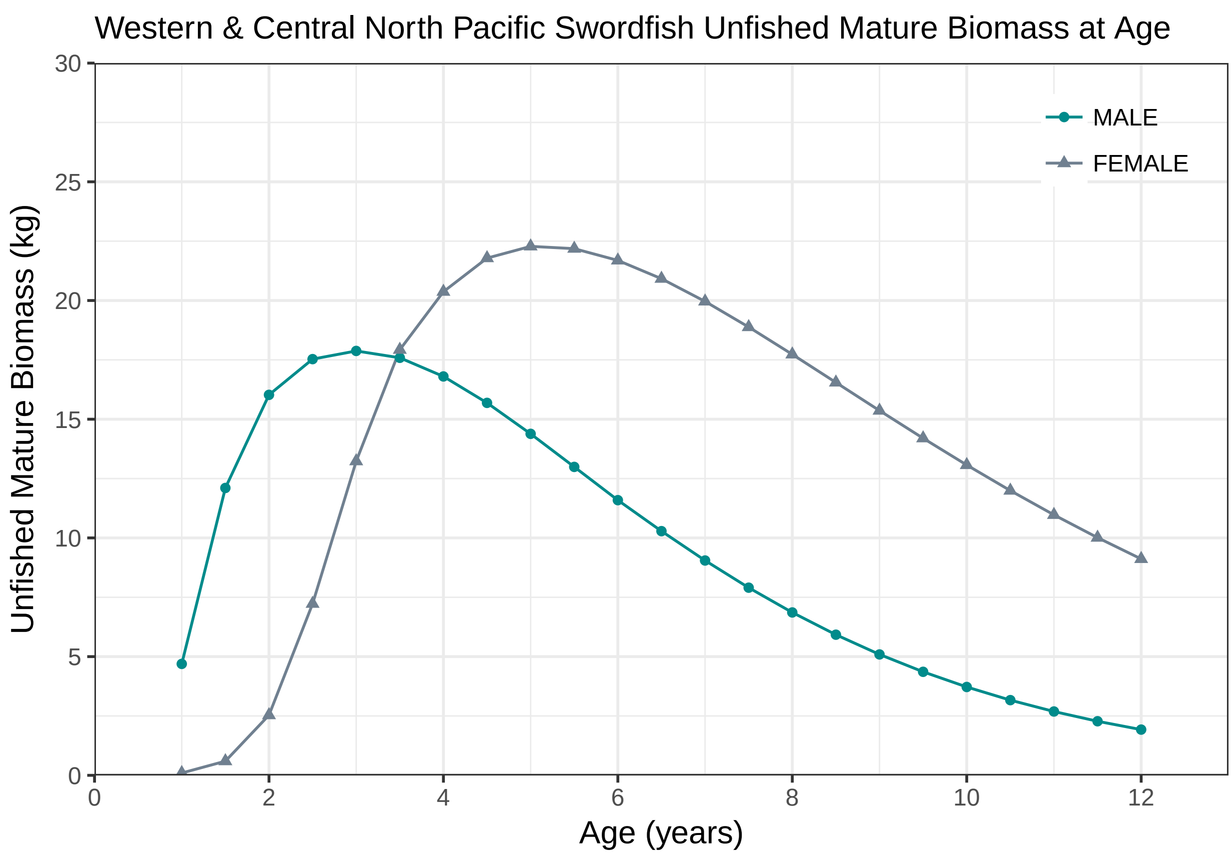


Figure 32: DeMartini et al (2007); Uchiyama and Humphreyes (2006), DeMartini et al (2000); Pauly (1980); Hoenig (1983); Peterson and Wroblewski (1984); Hewitt and Hoenig (2005)

Summaries of Stock Assessment Results

The following plots summarize stock assessment results as presented in the following:

- ISC (2016). Summary of blue marlin (Makaira nigricans) catch and size data from the Western and Central Pacific Fisheries Commission and the Inter-American Tropical Tuna Commission. Available at: ISC 2016
- ISC (2014) Stock assessment of Western and Central North Pacific Ocean swordfish (Xiphias gladius) through 2012. Honolulu, HI. Annex 9. Available at: ISC 2014 Annex 9
- ISC (2015) Stock Assessment Update for Striped Marlin (Kajikia Audax) in the Western and Central North Pacific Ocean Through 2013. Yokohama, Japan. Annex 11. Available at: ISC 2015 Annex 11.
- ISC (2016) Stock Assessment Update for Blue Marlin (Makaira nigricans) in the Pacific Ocean through 2014. Sapporo, Hokkaido, Japan. Annex 10. Available at: ISC 2016 Annex 10

Recruitment

The stock-recruitment curve provides the expected relationship between spawning biomass and the recruitment, or production of new fish (age-0) in the stock. For the blue marlin and striped marlin stocks, the stock-recruitment relationship is a based on a Beverton-Holt curve. For the Beverton-Holt curve, recruitment R is a function of spawning biomass SB and three parameters, unfished recruitment $R_{unfished}$, unfished spawning biomass $SB_{unfished}$, and steepness h, via the expression

$$(8) \quad R = f(SB) = \frac{4h \times R_{unfished} \times SB}{SB_{unfished}(1-h) + SB(5h-1)}$$

For blue marlin, the stock recruitment parameters are: $SB_{unfished} = 134513$ mt, $R_{unfished} = 977,049$ age-0 fish, and $h = 0.87$. Stock-recruitment data from 1971-2014 from the recent assessment results were also plotted. For striped marlin, the stock recruitment parameters are: $SB_{unfished} = 18928.6$ mt, $R_{unfished} = 566,211$ age-0 fish, and $h = 0.87$. Estimated stock-recruitment data from 1975-2013 from the recent assessment results were also plotted. No stock-recruitment information is provided for swordfish in the North Pacific because their most recent stock assessments did not produce stock-recruitment results.

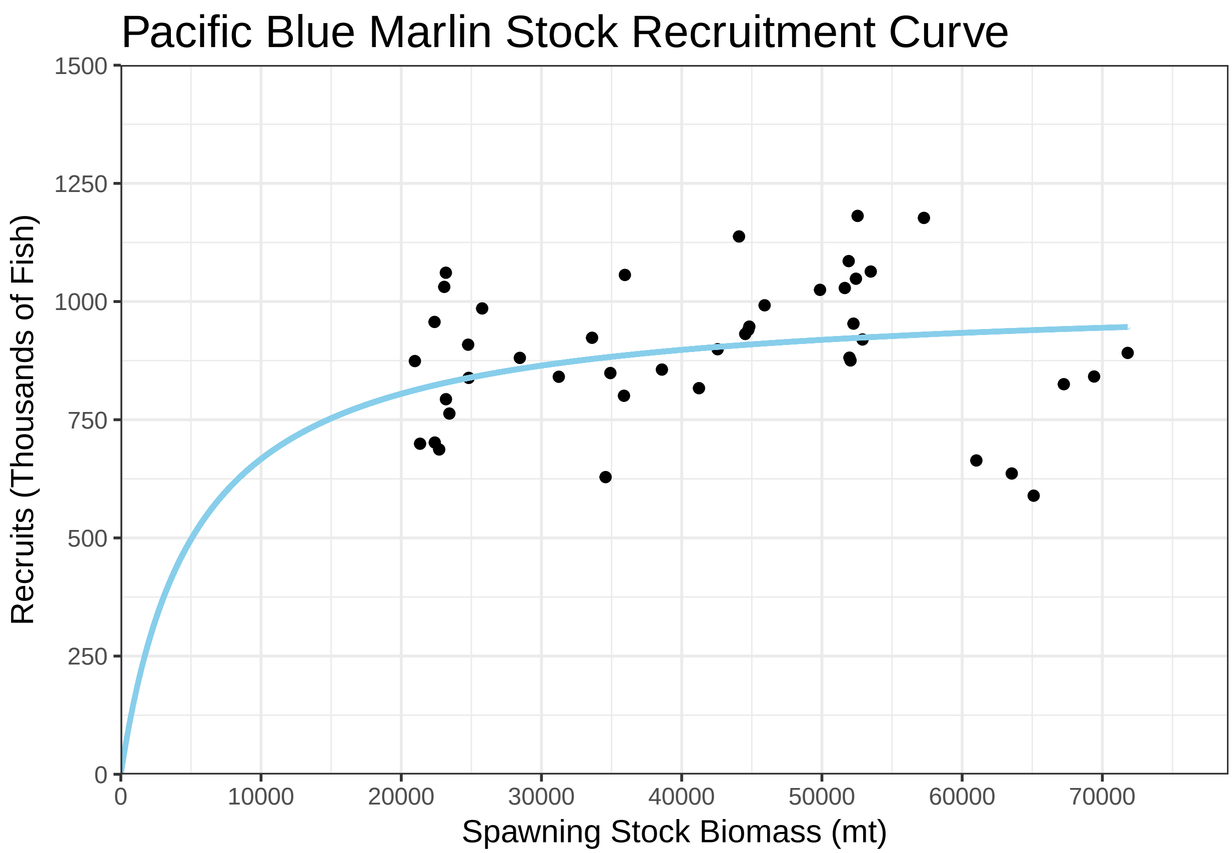


Figure 33: Brodziak and Mangel (2011); Brodziak et al. (2015)

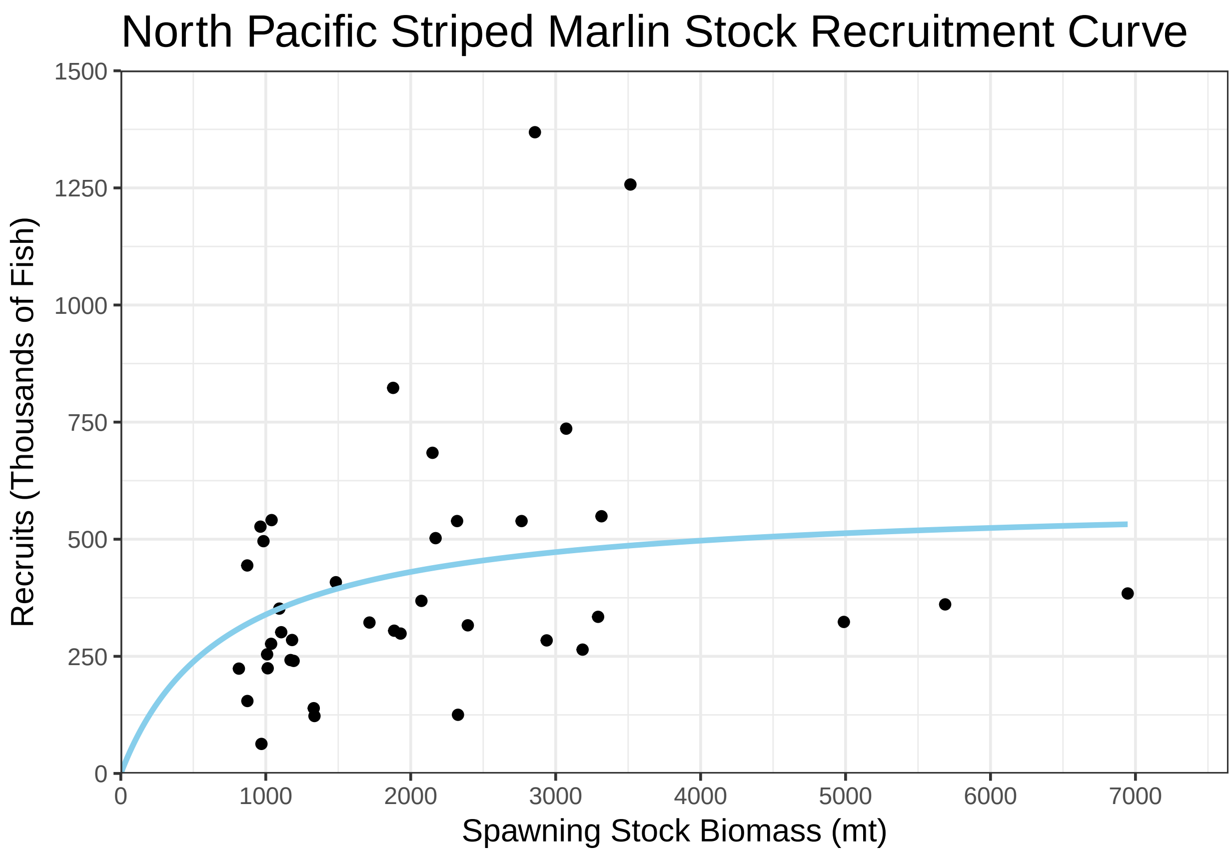


Figure 34: Brodziak and Mangel (2011); Brodziak et al. (2015)

Fishery catch biomass time series by country

For blue marlin, striped marlin, and swordfish, we collected the catch by country data from the most recent stock assessment and plotted the available time series. Dashed lines indicate MSY as estimated in each stock's most recent stock assessment.

Pacific Blue Marlin *(Makaira nigricans)* and North Pacific Striped Marlin *(Kajikia audax)*

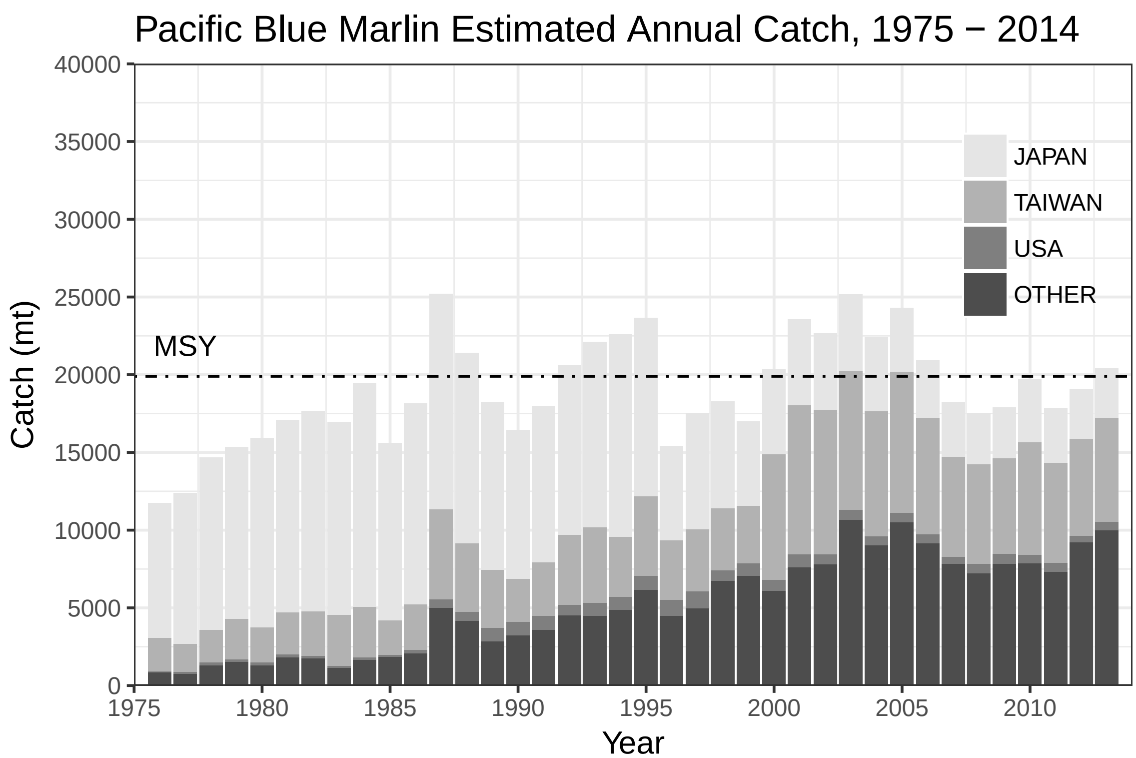


Figure 35: Countries in the 'other' category include Belize, China, Spain, Korea, and Vanuatu.

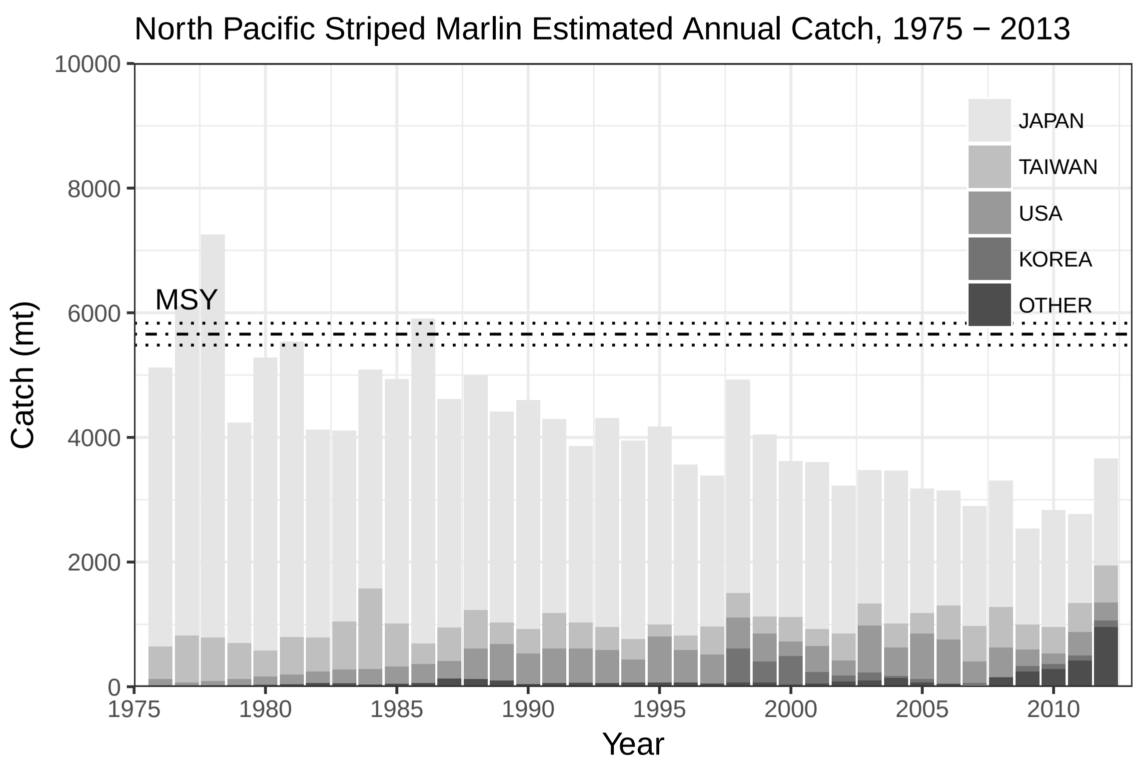


Figure 36: Countries in the 'other' category include Philippines, Indonesia, China, Vanuatu, Federated States of Micronesia, and Belize

Swordfish *(Xiphias gladius)*

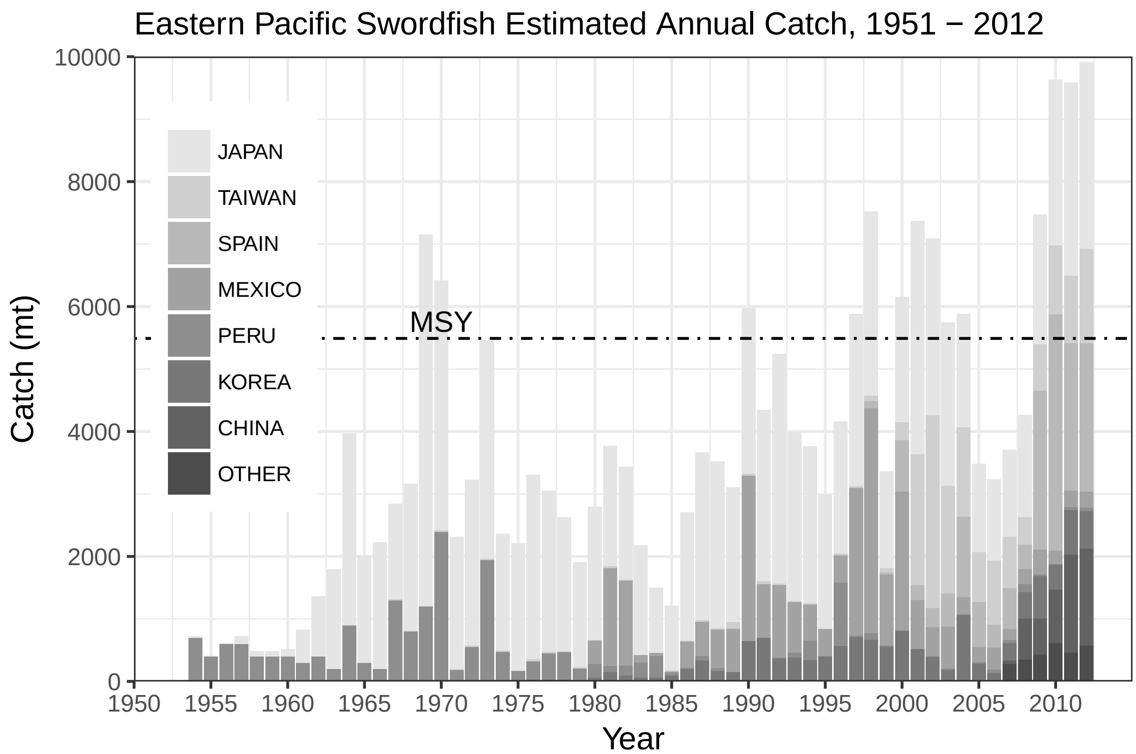


Figure 37: Countries in the 'other' category include Belize, Cook Islands, China, Spain, Fiji, Federated States of Micronesia, Kiribati, Marshall Islands, Papua New Guinea, Senegal, Tuvalu, and Vanuatu

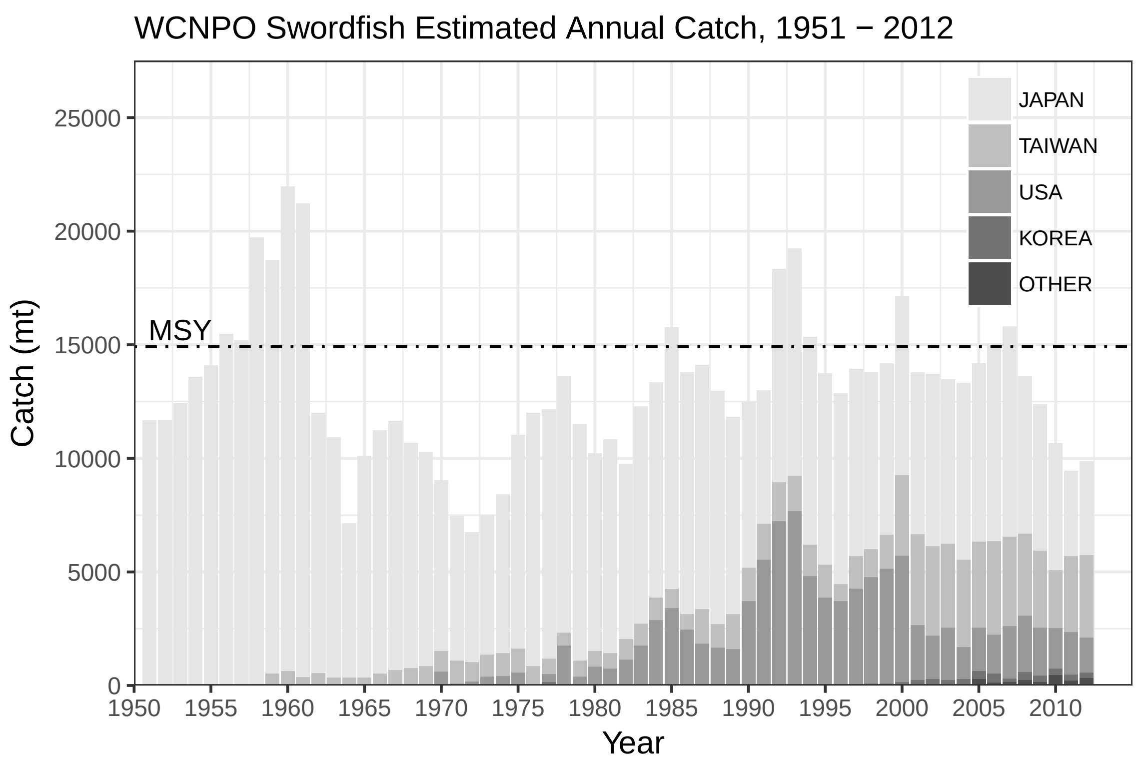
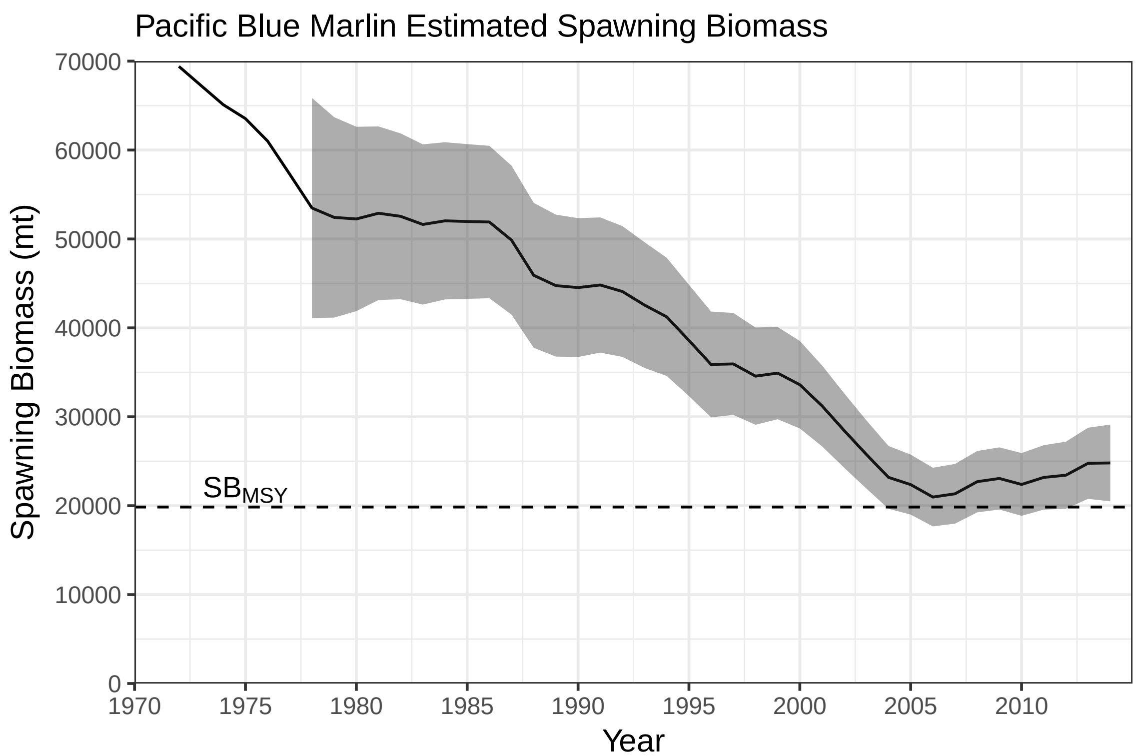


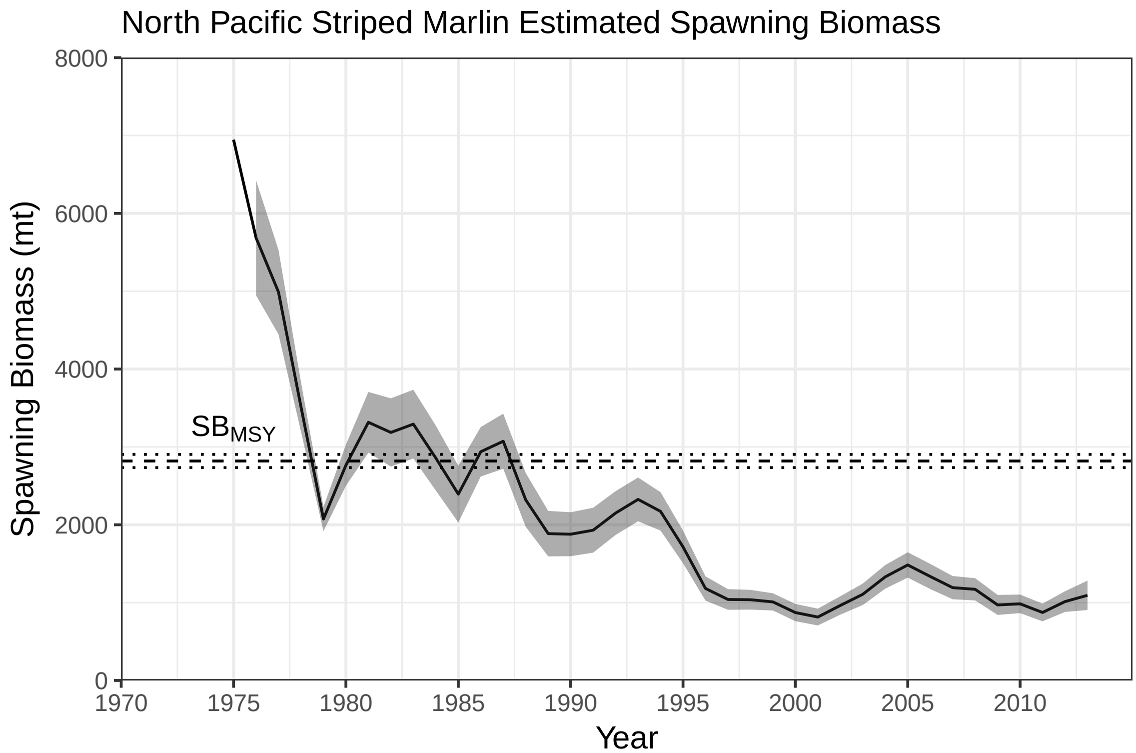
Figure 38: Countries in the 'other' category include Belize, Cook Islands, China, Spain, Fiji, Federated States of Micronesia, Kiribati, Marshall Islands, Papua New Guinea, Senegal, Tuvalu, and Vanuatu

Spawning biomass estimated time series

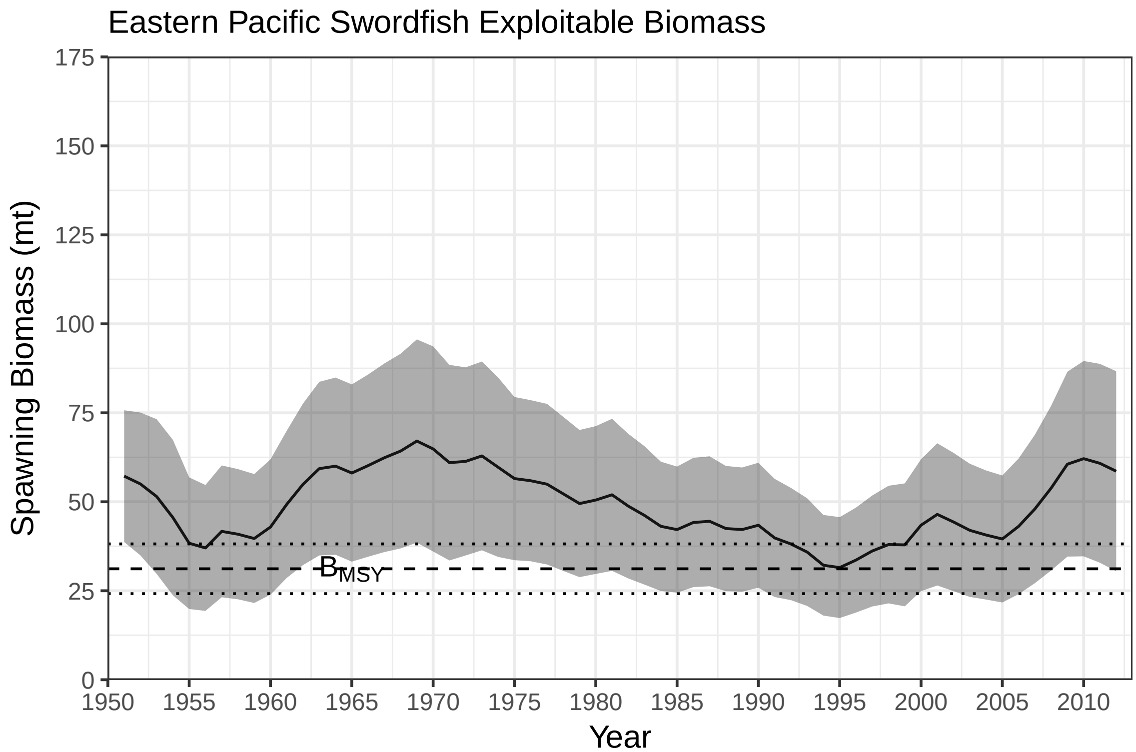
For blue and striped marlin we plotted the time series of spawning biomass estimates for each billfish stock. Dashed lines indicate the estimate of the spawning biomass to produce MSY, SB_{MSY}. For swordfish, we display estimated exploitable biomass from the most recent assessment and biomass to produce MSY, B_{MSY}. Shaded polygons surrounding estimated F_{MSY} or H_{MSY} represent 80% confidence intervals. For blue marlin, no measure of confidence surrounding the SB_{MSY} was reported. For striped marlin, dashed horizontal lines represent ± 1 standard error of SB_{MSY} For swordfish, dashed horizontal lines indicate ± 1 standard deviation of B_{MSY}.

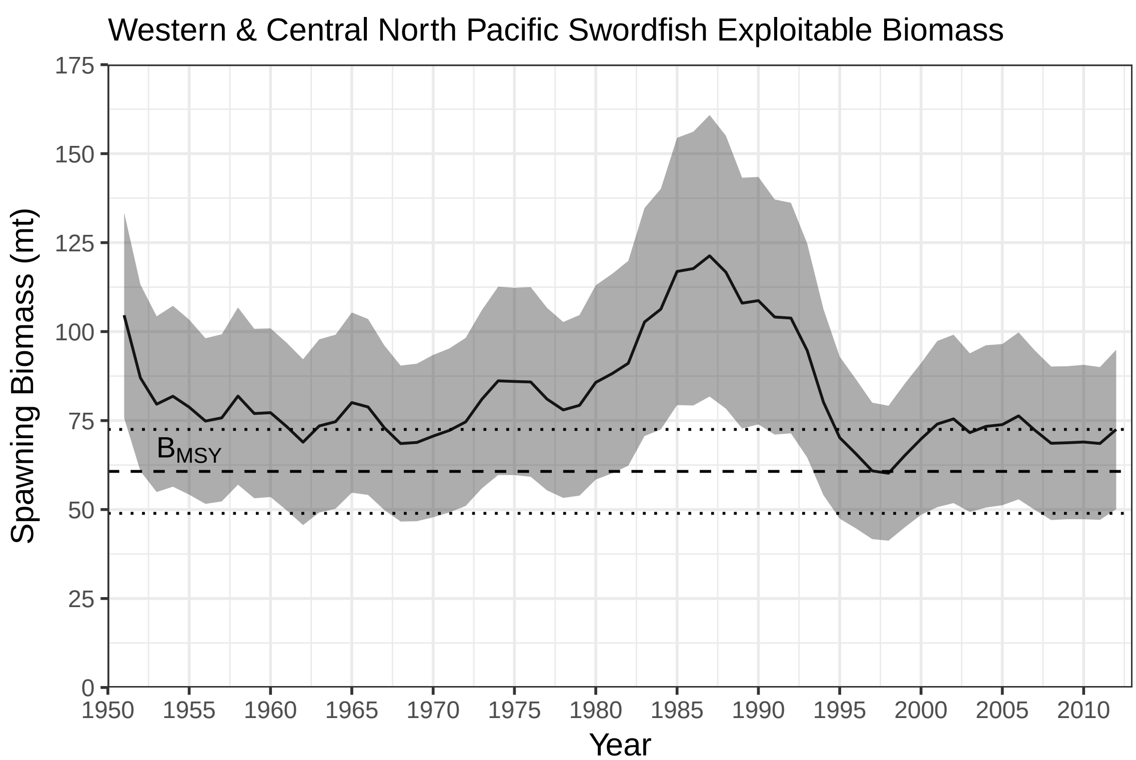
Pacific Blue Marlin *(Makaira nigricans)* and North Pacific Striped Marlin *(Kajikia audax)*




North Pacific Striped Marlin Estimated Spawning Biomass
Spawning Biomass (mt)
8000
6000
4000
2000
0
SB_{MSY}
1970
1975
1980
1985
1990
1995
2000
2005
2010
Year

Swordfish ***(Xiphias gladius)***

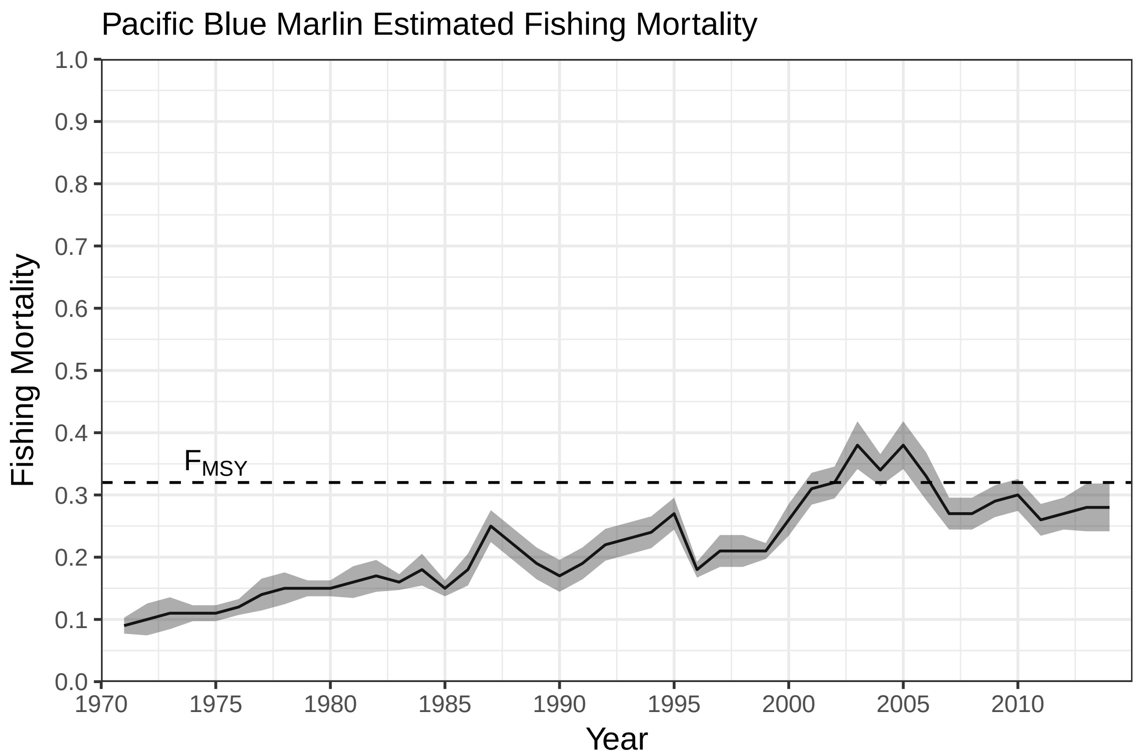


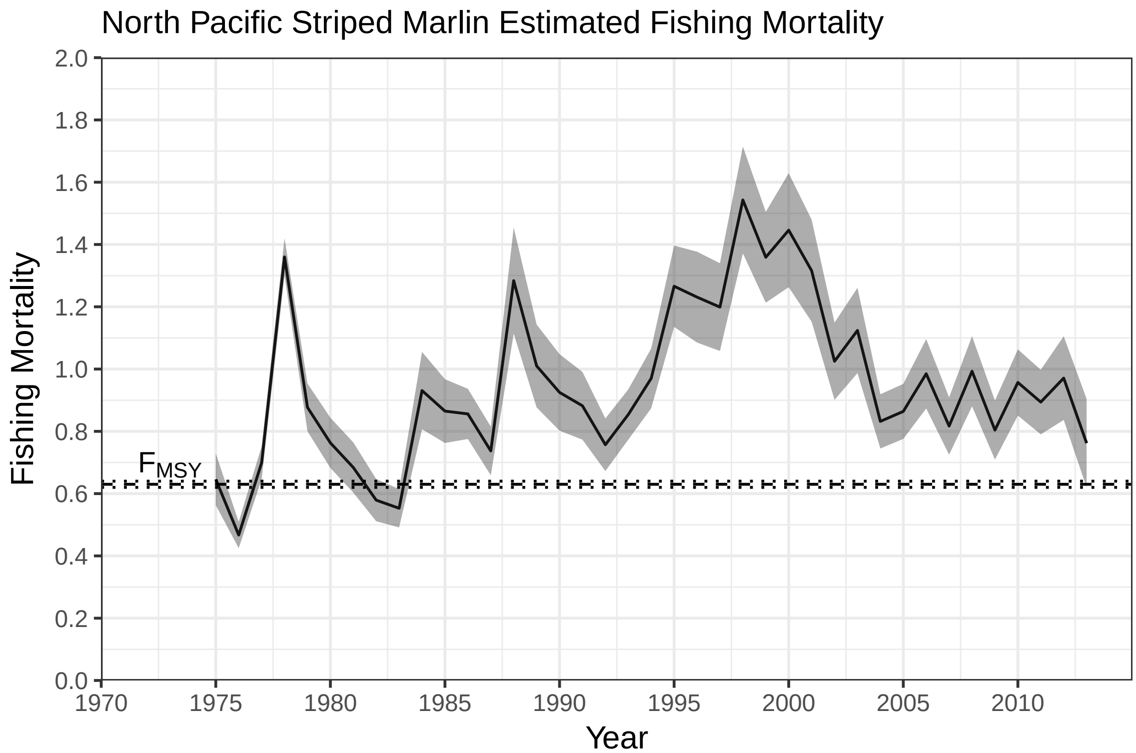


Fishing mortality rate estimated time series

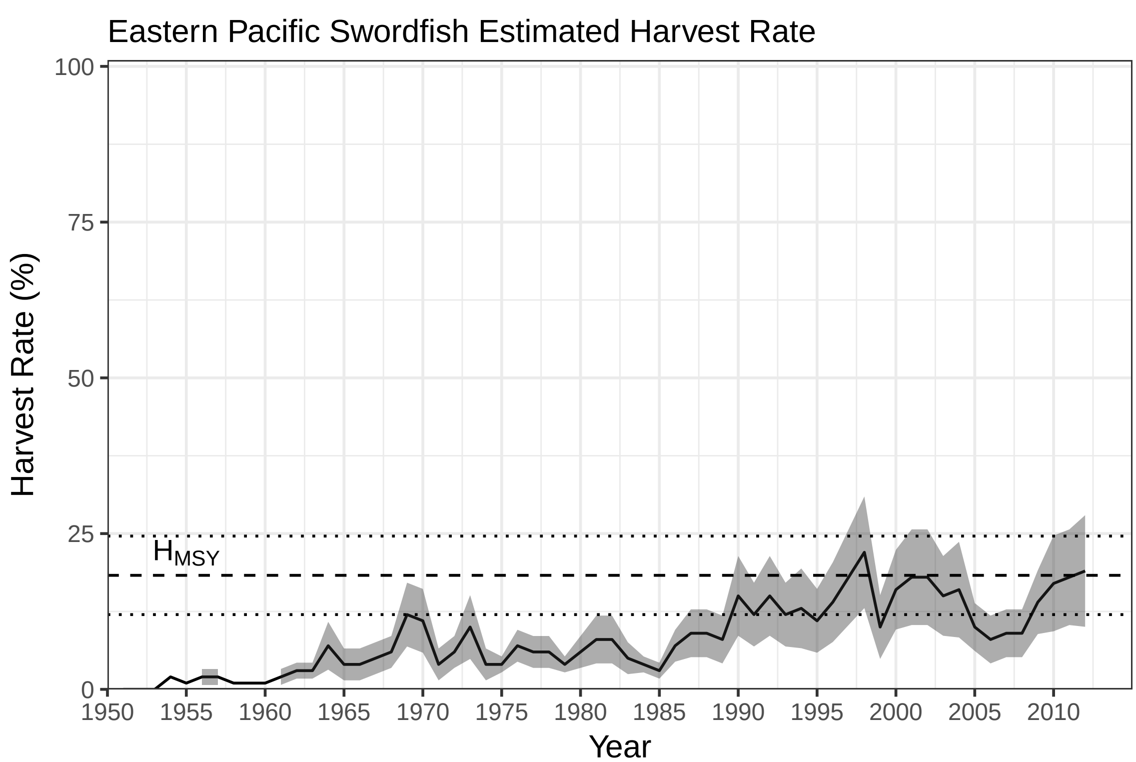
For blue marlin and striped marlin, we plotted the time series of spawning biomass estimates for each billfish stock. Dashed lines indicate the estimate of the instantaneous fishing mortality to produce MSY, F_{MSY}. For swordfish, we display the estimated annual harvest rate (annual fishing mortality); dashed lines indicate the estimate of the harvest rate to produce MSY, H_{MSY}. Shaded polygons surrounding estimated mortality represent 80% confidence intervals. For blue marlin, no measure of confidence surrounding F_{MSY} was reported. For striped marlin, dashed horizontal lines represent ± 1 standard error of F_{MSY} For swordfish, dashed horizontal lines indicate ± 1 standard deviation of H_{MSY}.

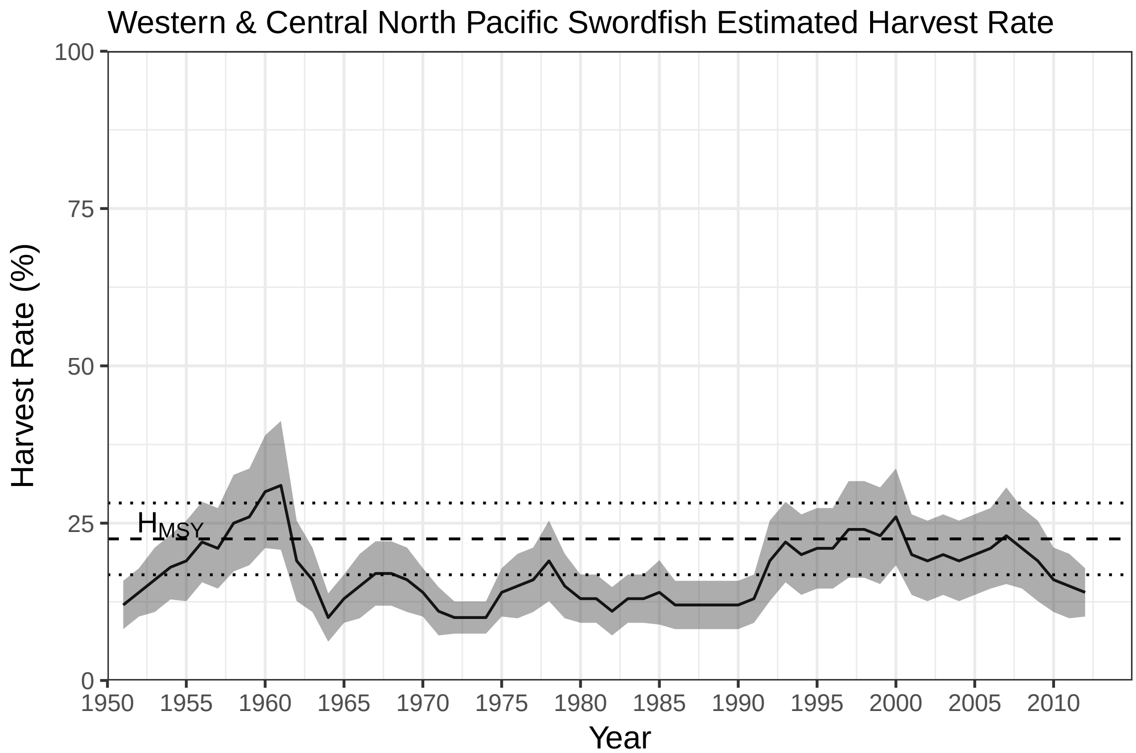
Pacific Blue Marlin *(Makaira nigricans)* and North Pacific Striped Marlin *(Kajikia audax)*





Swordfish ***(Xiphias gladius)***





Kobe plots: Stock status as relative harvest rate and relative biomass

For blue marlin, striped marlin, and swordfish, we collected the stock status time series from each of the most recent stock assessments and created Kobe plots by plotting the available time series of relative fishing mortality/harvest rate and relative biomass by year. Each stock assessment calculated fishing mortality/harvest rate and biomass relative to MSY-based reference points as a default, even though no reference points for any of these stocks have been set by managers. Evaluating against MSY-based reference points, relative harvest rates/fishing mortality rates above 1.0 indicate overfishing is occurring, and relative biomass below 1.0 indicates a stock is overfished. The following plots include start, middle, and end year labels to show time trend in stock status.

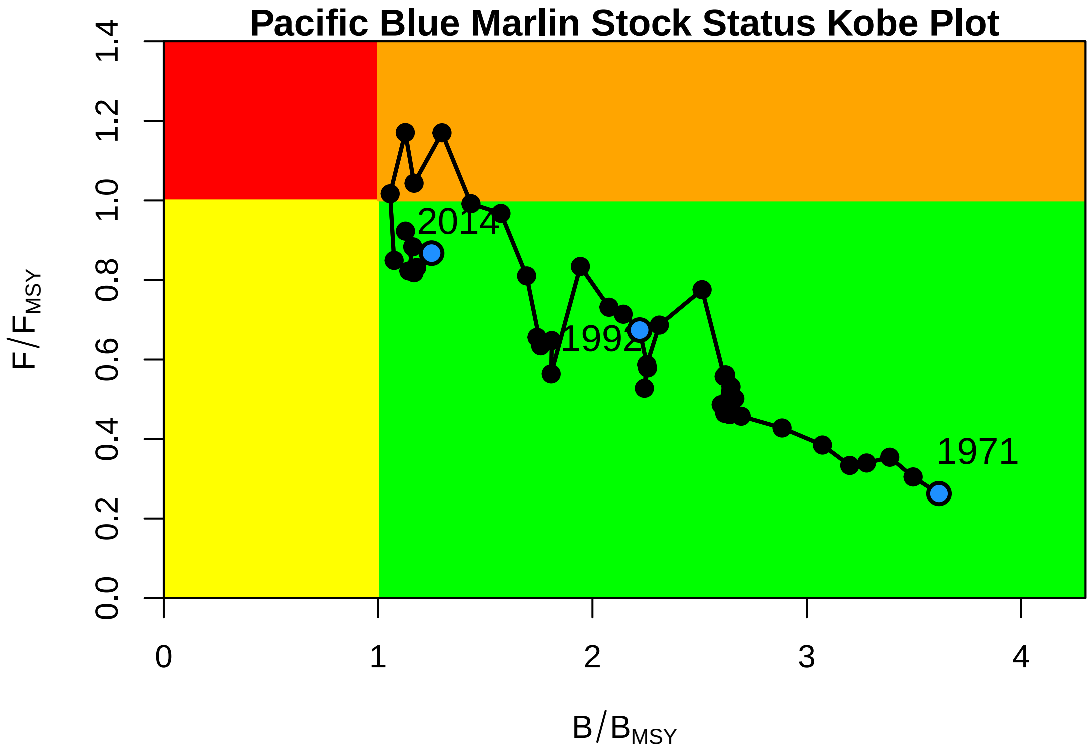


Figure 39: ISC (2016)

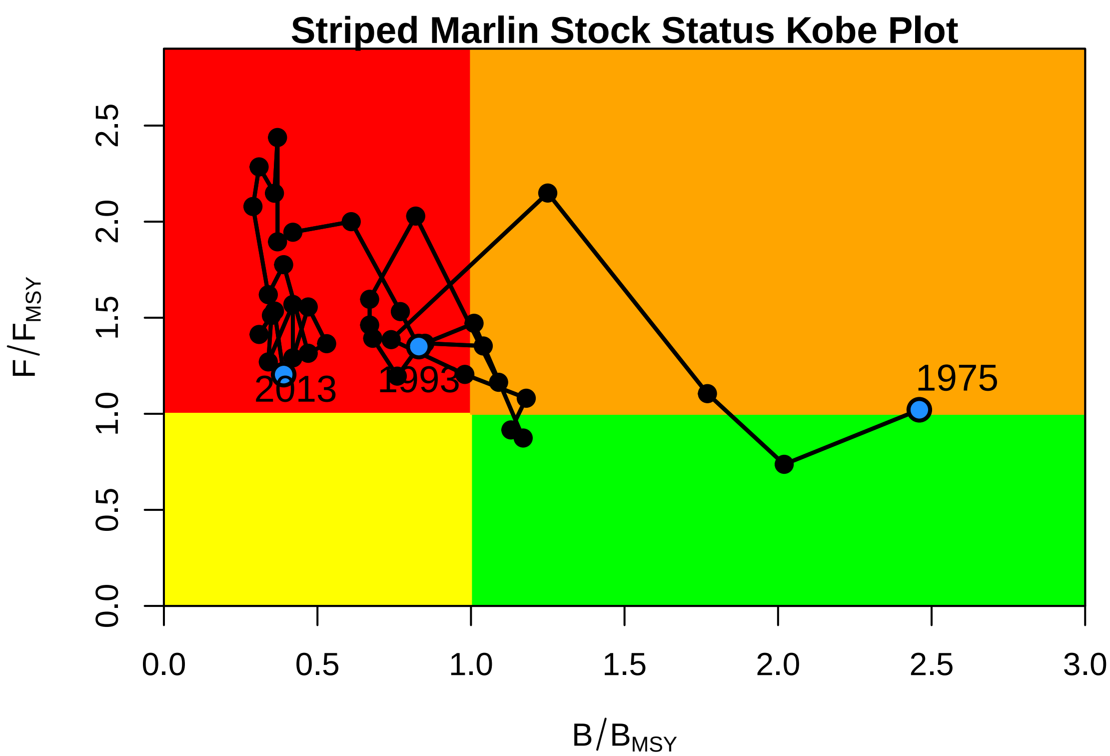


Figure 40: ISC (2015)

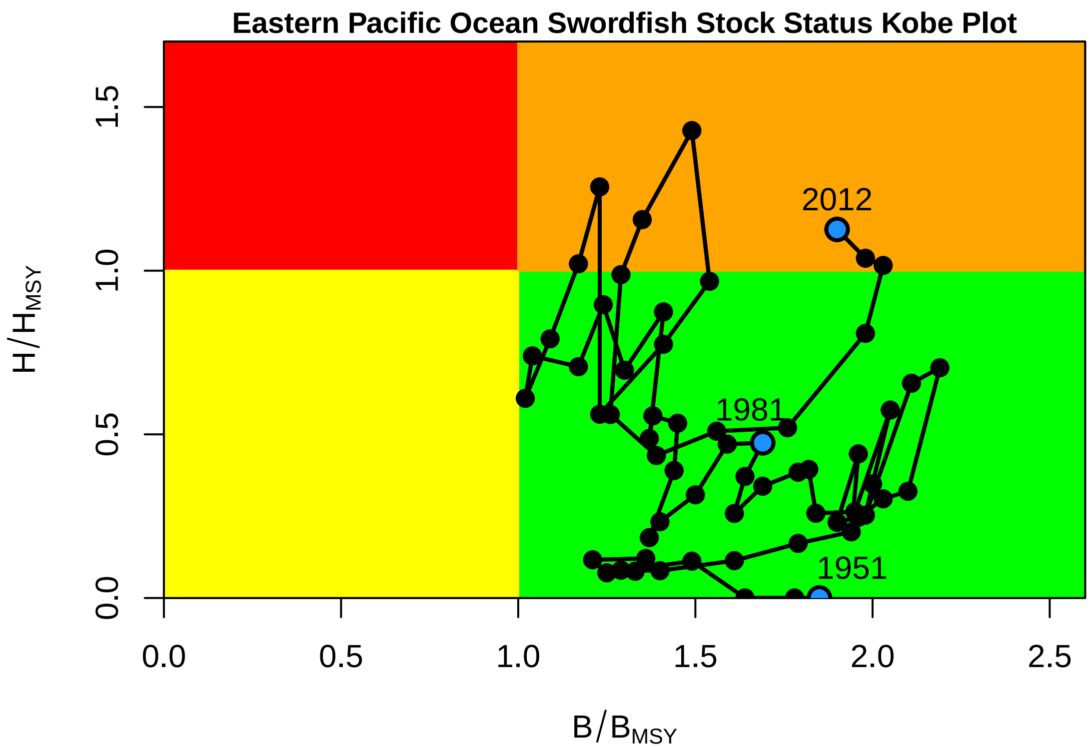


Figure 41: ISC (2014)

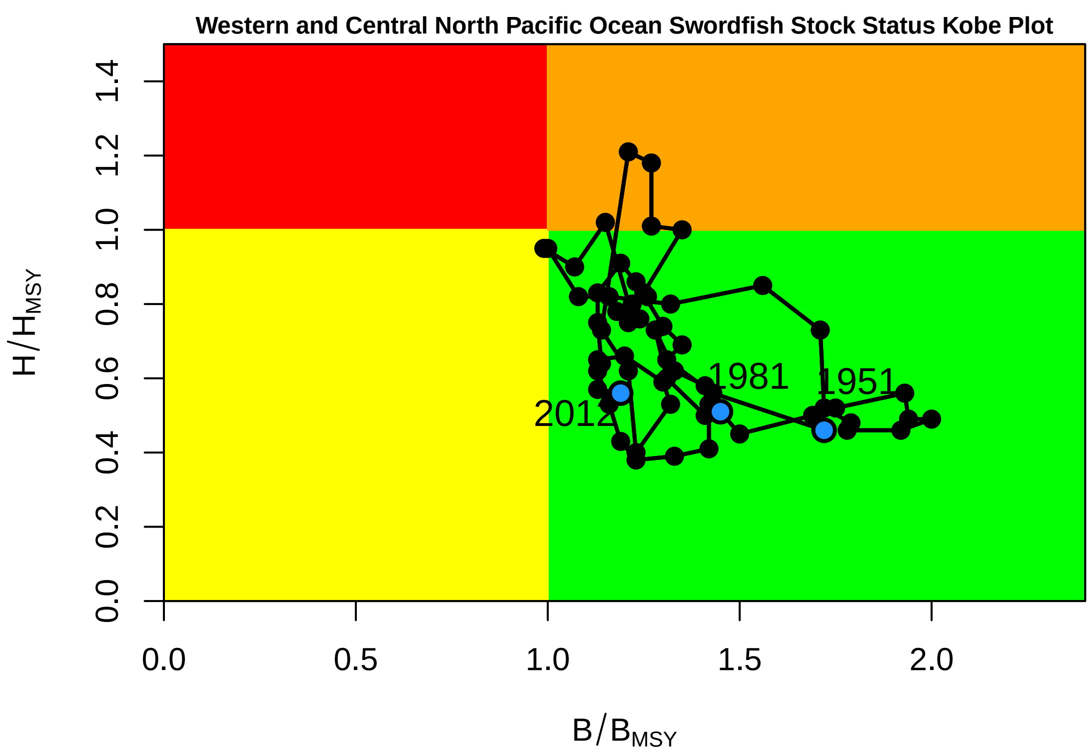


Figure 42: ISC (2014)

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