FINAL

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ANNEX 10

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International Scientific Committee for Tuna
and Tuna-Like Species in the North Pacific Ocean
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UPDATED SENSITIVITY ANALYSIS THROUGH 2018 OF BLUE SHARK IN THE NORTH PACIFIC OCEAN

REPORT OF THE SHARK WORKING GROUP

July 2020

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EXECUTIVE SUMMARY

This document presents the results of the updated stock assessment of blue shark (*Prionace glauca*) (BSH) in the North Pacific Ocean (NPO), The North Pacific Blue Shark (NPBSH), conducted by the International Scientific Committee for Tuna and Tuna-like Species in the NPO (ISC) by the Shark Working Group (SHARKWG) using a fully integrated size-structured model (SS; Stock Synthesis). The last benchmark stock assessment was conducted in 2017. The ISC plenary meeting in 2019 accepted the proposal of the ISC SHARKWG, which enabled us to change the benchmark assessment period from every 3 years to every 5 years; however, as a condition, an updated stock assessment was required to be conducted every 5 years (between benchmark assessments) using the future projection with an updated annual catch data. Annual catch data were updated through 2018 and the stock status and future trajectories were assessed using the future projection of SS with the same parameterization of the SS reference case in 2017, without estimating the parameters, except for unfished recruitment (R_0) and recruitment deviations.

STOCK IDENTIFICATION AND DISTRIBUTION

The BSH is widely distributed throughout the temperate and tropical waters of the Pacific Ocean. The ISC SHARKWG recognizes two stocks in the North and South Pacific, respectively, based on biological and fishery evidence. Relatively few BSH are encountered in the tropical equatorial waters separating the two stocks. Tagging data demonstrated long-distance movements with a high degree of mixing of BSH across the NPO, although there is evidence of spatial and temporal structure by size and sex.

CATCH HISTORY

Catch records for NPBSH are limited, and where lacking, have been estimated using statistical models and information from a combination of historical landing data, fishery logbooks, observer records, and research surveys. In these analyses, the estimated NPBSH catch data refer to total dead removals, which include retained catch and dead discards. Estimated catch data in the NPO date back to 1971, although longline and driftnet fisheries targeting tunas and billfish earlier in the 20th century likely caught NPBSH. The nations catching the most BSH in the NPO include Japan, Chinese Taipei, Mexico, and the USA, which account for more than 90% of the estimated catch. Estimated catches of NPBSH were highest from 1976 to 1989, with a peak estimated catch of approximately 88,000 mt in 1981. Over the past decade, BSH estimated catches in the NPO have shown a gradual decline from ~52,000 mt in 2005 to an average of ~32,000 mt annually in 2016–2018 (**Figure 1E**). Although a variety of fishing gear can catch BSH, most are caught in longline fisheries.

DATA AND ASSESSMENT

The input data in SS were used in the previous assessment in 2017, except for the updated annual catch data for 2016–2018. Annual catch estimates were derived for a variety of fisheries by nation. Catch and size composition data were grouped into 18 fisheries for the period from 1971 to 2015 and from 1971 to 2018, respectively. Standardized of catch-per-unit-effort (CPUE) from the Japanese shallow longline fleet that operated out of Hokkaido and Tohoku ports for the periods 1976-1993 and 1994-2015 were used as measures of relative population abundance in the reference case assessment.

Stock projections of biomass and catch of NPBSH from 2019 to 2028 were conducted assuming alternative constant-F harvest scenarios (F_{MSY}, $F_{2012\text{-}2014}$, $F_{2015\text{-}2017}$, $F_{20\%\mathrm{plus}}$, $F_{20\%\mathrm{minus}}$). Status-quo

F was based on the average over the past 3 years (2015–2017). All the parameters of the SS were fixed except for R_0 and the recruitment deviations.

STATUS OF STOCK

Stock status is reported in relation to maximum sustainable yield (MSY). Benchmark results are shown based on the female spawning stock biomass (*SB*). Female *SB* in 2018 (SB_{2018}) was 65% higher than that for the MSY and estimated as 285,385 mt (**Table 1E**; **Figure 2E**). Annual fishing mortality (*F*) in 2018 (F_{2018}) was estimated to be well below the F_{MSY} at approximately 29% of the F_{MSY}. (**Table 1E**, **Figure 3E**). The reference run produced terminal conditions that were predominantly in the green quadrant (not overfished and overfishing not occurring) of the Kobe plot (**Figure 4E**).

CONSERVATION INFORMATION

Target and limit reference points have not yet been established for pelagic sharks in the Pacific Ocean by either the Western and Central Pacific Fisheries Commission (WCPFC) or the Inter American Tropical Tuna Commission (IATTC). Stock status of the NPBSH is reported in relation to MSY-based reference points.

Future projections under different *F* harvest policies (F_{MSY}, $F_{2012\text{-}2014}$, $F_{2015\text{-}2017}$, $F_{20\%plus}$, $F_{20\%minus}$) show that the median NPBSH biomass will likely remain above SB_{MSY} in the foreseeable future, except for the harvest policy of F_{MSY} (**Table 2**; **Figure 2**).
Improvements in the monitoring of NPBSH catches and discards, through carefully designed observer programs and species-specific logbooks, as well as continued research into the fisheries, biology, and ecology of blue sharks in the NPO, are recommended.

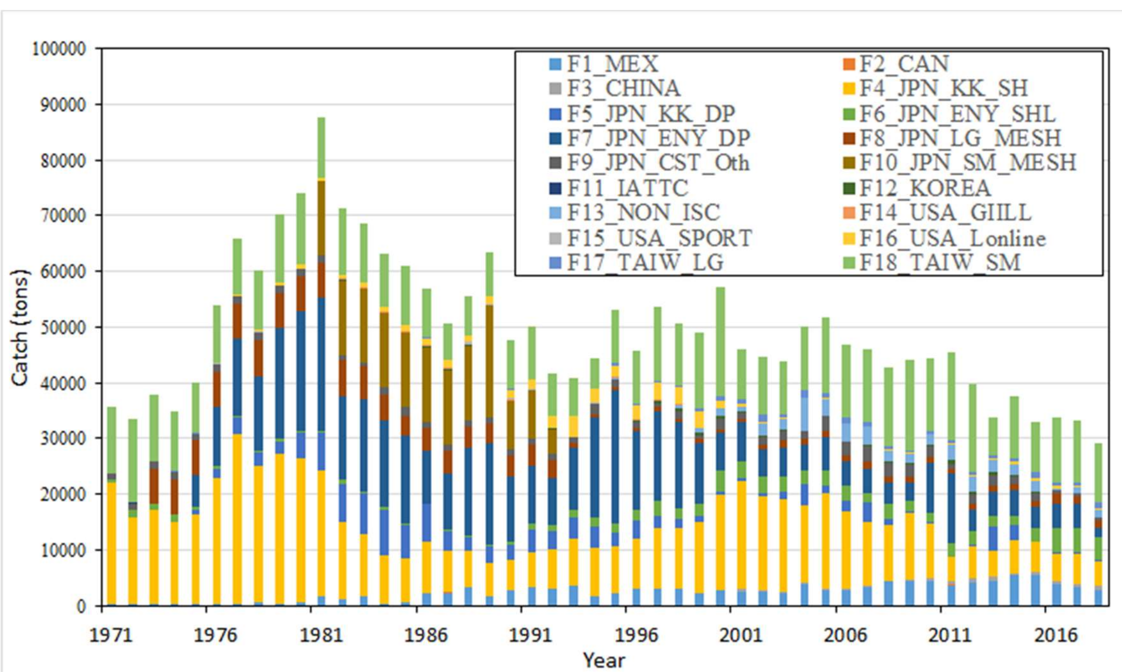

Figure 1E. Annual catch of the blue shark in the North Pacific Ocean by fleets used in the updated stock assessment from 1971 to 2018.

Table 1E. Estimates of key management quantities for the North Pacific blue shark stock assessment reference case model in 2017 and 2020.

Management quantities	Reference case in 2017	Reference case in 2020
SSB_{1971}	293,537	293,459
SSB_{2015}	291,205	290,234
SSB_{2018}		285,385
SSB_{MSY}	170,251	173,207
SSB_0	348,947	348,854
F_{MSY}	0.35	0.39
SSB_{2015}/SSB_{MSY}	1.71	1.68
SSB_{2018}/SSB_{MSY}		1.65
SSB_{2015}/SSB_0	0.83	0.83
SSB_{2018}/SSB_0		0.82
$F_{2012\text{-}2014}/F_{MSY}$	0.38	0.35
$F_{2015\text{-}2017}/F_{MSY}$		0.29
MSY	79,142	78,366

Table 2E. Estimates of key management quantities in the forecast for the North Pacific blue shark updated stock assessment.

Management quantities	$F_{2012\text{-}2014}$	$F_{2015\text{-}2017}$	$F_{20\%plus}$	$F_{20\%minus}$	F_{MSY}
SSB_{2028}	317,593	327,485	319,028	330,616	259,727
SSB_{2028}/SSB_{MSY}	1.83	1.89	1.84	1.91	1.50
SSB_{2028}/SSB_0	0.91	0.94	0.91	0.95	0.74

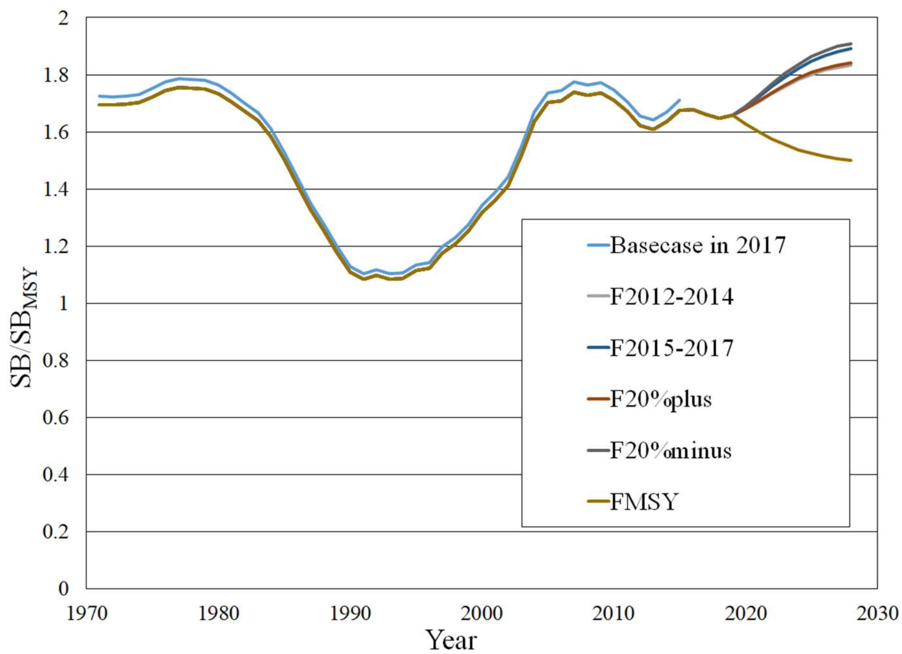

Figure 2E. Estimates of annual female spawning biomass (*SB*; in metric tons) and the projected trajectory for alternative harvest strategies. The value of one denotes the estimate of *SB* at the MSY (SB_{MSY}).

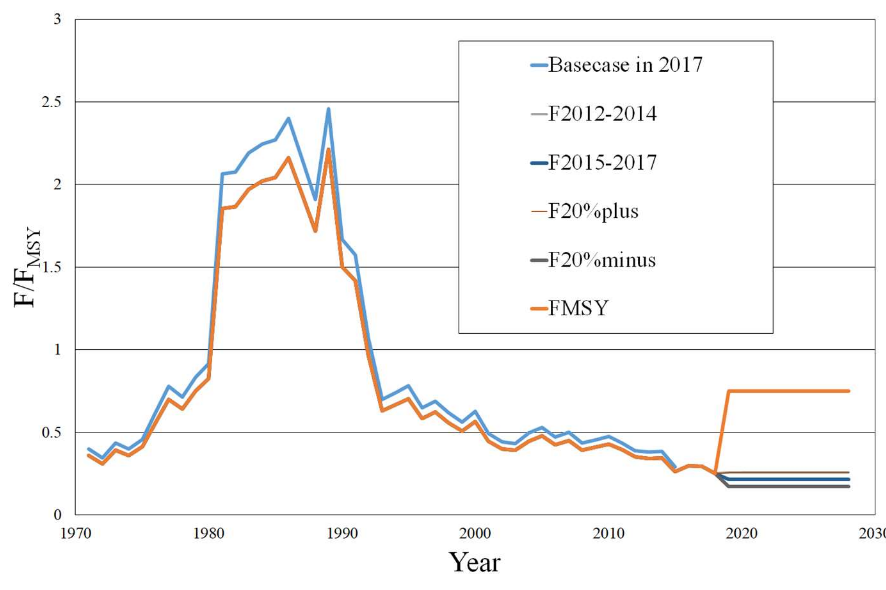

Figure 3E. Estimates of annual fishing mortality (sum of *F*'s across all fishing fleets) and the projected trajectory for alternative harvest strategies. The value of one denotes the estimate of *F* at the MSY (F_{MSY}).

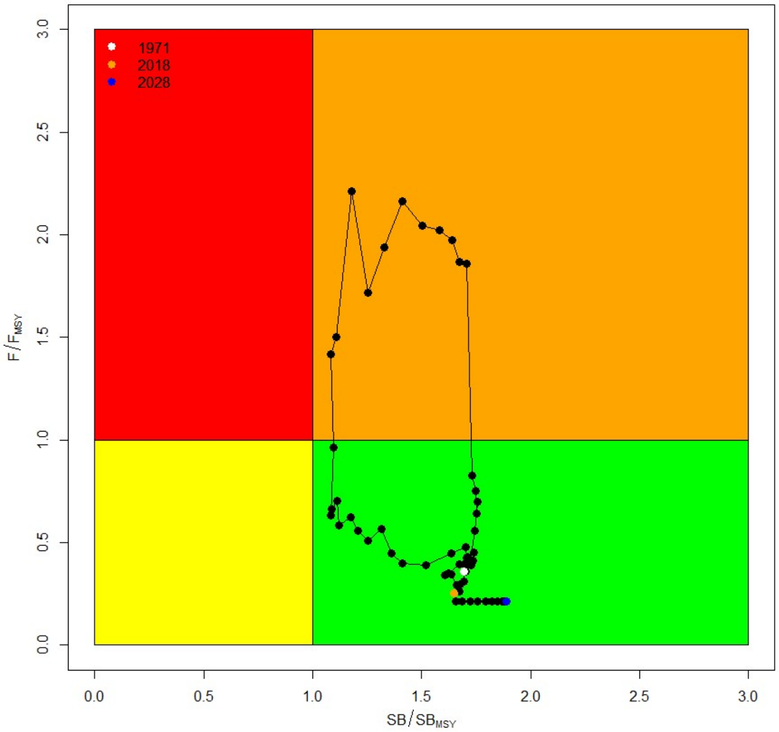

Figure 4E. Kobe plot of the trends in estimates of relative fishing mortality (*F*) and female spawning biomass (*SB*) of the North Pacific blue shark 1971-2028 for the reference case of Stock Synthesis model.

2 INTRODUCTION

Blue shark (*Prionace glauca*) (BSH) is considered a highly migratory species (HMS) under the United Nations Convention on the Law of the Sea (ANNEX I)[1]. It is a commonly occurring species found primarily in the photic zone of temperature and tropical waters worldwide. BSH populations are impacted by many fisheries as both a target and non-target component of catches, and their flesh is commonly consumed.

Historically, BSHs were caught as bycatch in fisheries targeting other species, primarily high seas tuna and swordfish fisheries. However, as new processing techniques have developed, it has led to new markets, particularly in Asia (Clarke et al., 2007) and Mexico (Sosa-Nishizaki et al., 2002). As a result of new food products, such as surimi, fishing fleets have probably been targeting BSH for at least a decade. Up through the 1980s, shark catch was only loosely monitored and often aggregated as "shark" in vessel logbooks and landings receipts but starting in the 1990s, conservation concerns about fisheries bycatch motivated the development and expansion of fishery observer programs and better record keeping.

To address uncertainty about the conservation status of high seas shark stocks in the North Pacific Ocean (NPO), the International Scientific Committee for Tuna and Tuna-like Species (ISC) created a Shark Working Group (SHARKWG or WG) in 2011 to begin compiling the necessary information to conduct stock assessments (ISC, 2011). The SHARKWG conducted its first assessment of BSH in the NPO, North Pacific blue shark (NPBSH) in 2013 (ISC, 2013), and followed up with an update in 2014 to address requests from the Western and Central Pacific Fisheries Commission (WCPFC) regarding the former assessment (ISC, 2014). Upon adoption of the 2014 assessment, the ISC and WCPFC concluded that the stock was well above B_{MSY} and fishing mortality was below F_{MSY} as of 2011, and had been since the mid-1990s. The 2014 assessment was conducted using both a fully integrated size-structured assessment model and a surplus production model. The surplus production model was the primary assessment model from which stock status conclusions were drawn because of the uncertainty about the quality of size composition data available at the time, and the need to conduct more biological research on the stock-recruitment relationship. The SHARKWG did not fully examine the size data and explored fishery definitions and selectivities. Additionally, because of a lack of understanding regarding the low fecundity stock-recruitment relationship (LFSR) and its application to NPBSH, there was an incomplete specification for the model with respect to stock-recruitment relationships. Thus, the primary objective when moving forward from that assessment was to improve data and model fitting and conduct biological research to support the development of a more defensible size-structured assessment using a fully integrated model in 2017 (ISC, 2017). The 2017 assessment was primarily conducted using a fully integrated size-structured assessment model. Time-series data updated through 2015 (catch, relative abundance, and sex-specific length composition from multiple fisheries), new biological information, and research into the parameterization of an LFSR were available and enabled the development of an improved size-structured model. SHARKWG also conducted a series of models using a Bayesian Surplus Production (BSP) model to facilitate comparison with the 2014 assessment. Based on the

[1] United Nations Convention of the Law of the Sea as of 10 December 1982.

http://www.un.org/depts/los/convention_agreements/texts/unclos/UNCLOS-TOC.htm assessments in 2017, the ISC and WCPFC concluded that the stock biomass (*B*) in 2015 was well above biomass at the maximum sustainable yield (B_{MSY}) and fishing mortality (*F*) was below F_{MSY} in the last three years from 2013 to 2015, and had been since the mid-1990s.

ISC SHARKWG has been conducting the benchmark stock assessment for BSH and the shortfin mako shark (*Isurus oxyrinchus*) in the NPO every 3 years. At the ISC plenary meeting in July 2019, in Chinese Taipei, some member countries (Japan, Taiwan, and the USA) of the ISC SHARKWG proposed to change the stock assessment cycle of these species from 3 to 5 years (ISC, 2019). The motivation for the 5-year cycle was a recommendation that was first proposed by the WCPFC. The proposal was accepted by the ISC plenary under the condition that an updated stock assessment for both species should be conducted between the benchmark assessments. All the member countries of ISC SHARKWG agreed with the proposals by the end of the webinar in November 2019. ISC SHARKWG also conducted an updated stock assessment every 5 years using the future projections with updates for the annual catch data in recent years.

This report presents the results of the ISC SHARKWG's updated stock assessment of NPBSH using the function of future projection of SS with the updated catch data from 2016–2018 and the same parameterization of the SS reference case in 2017 without estimating the parameters, except for unfished recruitment (R_0) and recruitment deviations to assess the current stock status and future trajectories of spawning stock biomass (*SB*) for the next 10 years until 2028.

3 BACKGROUND

BSH relative abundance is highest in temperate pelagic zones and decreases in neritic and warmer tropical waters, as well as in cooler waters at latitudes higher than approximately 50 degrees. The BSHs in the Eastern Pacific Ocean (EPO) spend most of their time in the mixed layer, with forays as deep as 400 m while occupying temperatures predominantly from 14–27 °C (Weng et al., 2005). In the southwest Pacific Ocean, they have been shown a similar preference for surface waters but with occasional dives over 980 m, while occupying comparable water temperatures to those in the EPO (Stevens et al., 2010). Within the NPO, males and females smaller than 50 cm in precaudal length (PCL) co-occur on the parturition grounds between approximately 35 and 40°N. The habitat for subadults diverges between subadult females (35 and 50°N) and males (30 and 40°N) at approximately 100–150 cm PCL. Subadult sharks occur in the lower latitudes, and adult habitat is believed to be more southerly with mating thought to occur in pelagic waters between 20–30°N (Nakano, 1994).

3.1 Biology

3.1.1 Stock Structure

Within the Pacific Ocean, BSHs are found in both hemispheres, with no genetic evidence in distinct hemispheric populations (King et al., 2015; Taguchi et al., 2015). However, their abundance is low in the tropics, and mark-recapture data have not documented movements across the equator (Sippel et al., 2011; Stevens et al., 2010; Weng et al., 2005). The SHARKWG concurs that current evidence justifies the consideration of two distinct populations in the northern and southern hemisphere for stock assessment purposes.

3.1.2 Reproduction

Sex-specific length-frequency data suggests mating occurs in middle latitudes (20-30°N) and pupping occurs between 35-45°N in the western Pacific Ocean and 25–50°N in the EPO (Sippel et al., 2016). Mating scars and fertilized eggs suggest that mating occurs from June to August (Suda, 1953), and this is corroborated by monthly changes in the observed gonadosomatic index (GSI) and maximum ova diameter according to Nakano (1994) and Fujinami et al. (2017). Litter size ranging from 15–112 (mean 35.5) has been observed in the western NPO (Fujinami et al., 2017) and was larger than that ranging from 1–62 (mean 25.6) reported previously in the NPO (Nakano, 1994). Fujinami et al. (2017) also estimated an annual cycle of female reproduction, with the potential for a small percentage of females to reproduce less frequently, although prior research indicated a biennial cycle (Joung et al., 2011). Different gestation estimates range from 9–12 months (Cailliet and Bedford, 1983) and 11–12 months (Nakano, 1994; Fujinami et al., 2017). Overall, BSHs are considered to be highly productive relative to other pelagic sharks based on their maturation time and fecundity (Cortés, 2002; Smith et al., 1998).

3.1.3 Growth

Pups are born at an estimated 40–50 cm fork length (FL; ~36 cm PCL) (Joung et al., 2011; Fujinami et al., 2017), and adults reach a maximum length of 380 cm total length (TL) (Hart , 1973). Fifty percent of females are considered mature at 156.6 cm PCL (Fujinami et al., 2017), at around 5–6 years old (Yokoi et al., 2017; Fujinami et al., 2019) and the size and age at 50% maturity for males is 161 cm PCL and approximately 6 years old, respectively (Cailliet and Bedford, 1983; Fujinami et al., 2017; Nakano, 1994; Yokoi et al., 2017; Fujinami et al., 2019). Growth models for BSH in the NPO have been estimated by the SHARKWG (Joung et al., 2011; Yokoi et al., 2017; Fujinami et al., 2019) and others (Cailliet and Bedford, 1983; Tanaka et al., 1990; Nakano, 1994; Blanco-Parra et al., 2008). Factors including sample size and aging techniques varied across the earlier attempts, but recent efforts by the SHARKWG focus on corroborating age readings across studies, standardizing aging techniques, increasing sample sizes, and collecting samples across a wider geographic range.

3.2 Fisheries

The primary source of BSH fishing mortality is oceanic longline fisheries targeting swordfish and tuna, including mostly shallow-set longline fisheries in temperate waters, and deep-set longline fisheries in more tropical areas. Sharks are targeted less often than tunas and swordfish, although new Asian shark markets have been developing for over a decade and shark are a common bycatch in these fisheries (Clarke et al., 2013). BSH bycatch is often discarded at sea, and the survivorship of those released depends on the condition of the released animals and environmental conditions. Factors including conditions at release, including capture methods, capture duration before fishing gear is retrieved, animal size, and handling at the boat affect survivorship of discards (FAO, 2017), although post-release mortality of BSHs released alive from longline fisheries is reported to be low in the central Pacific Ocean (Musyl et al., 2011). A recent study of the Canadian pelagic longline fishery also showed that more than 85% of BSHs survive after being hooked by a longline, and the estimate of the post-release mortality rate based on pop-off tagging was 9.8% (Campana et al., 2016).

3.3 Previous Stock Assessments

The SHARKWG conducted three stock assessments in the past. The first assessment was conducted using only a BSP model, which was not adopted for management and subsequently updated (ISC, 2013). Prior to these assessments, Kleiber et al. (2009) assessed the stock using data from the WCPFC (excluding the EPO) with a BSP model and a catch-at-length model. The second assessment was conducted using two different assessment models: a BSP model, and a catch-at-length analysis using SS (ISC, 2014). Most recently, an assessment was conducted using the SS (ISC, 2017). The main differences between the 2017 assessment and the 2014 assessment are: 1) use of SS with a thorough examination of the size composition data and the relative weighting of CPUE and composition data; 2) improved life history information, such as growth and reproductive biology, and their contribution to productivity assumptions; 3) improved understanding and parameterization of the LFSR; 4) catch, CPUE, and size time series updated through 2015; and 5) a suite of model diagnostics, including implementation of an age-structured production model implemented in SS. The 2017 assessment was the second assessment of the population using data from the entire NPO and was accepted as the best available information on NPBSH status and adopted for management.

4 DATA

4.1 Spatial Stratification

This assessment assumes a single stock in the NPO, north of the equator (**Figure 1**).

4.2 Temporal Stratification

An annual (January 1– December 31) time-series of fishery data for 1971-2015 was used for the assessment.

4.3 Definition of Fisheries

The SHARKWG estimated catches of many fisheries from different nations and member sources to understand the nature of fishing mortality. Eighteen different fisheries were defined (**Table A1**, **Figure 2**).

4.4 Catch Data

Catches (metric tons) were provided by ISC member nations and cooperating partners (**Figure 3**, **Table 1**). As in the previous assessments, the highest catches came from Japan, Taiwan, and Mexico. The primary sources of catch were from longline and drift gillnet fisheries, with smaller catches estimated from purse seine, trap, troll, trawl, and recreational fisheries (**Figure 3**). Catches were comprised of total dead removals, which included landings and discard mortalities.

4.4.1 Japan

Japan (JPN) provided estimated catch for four sectors of their longline fisheries categorized by vessel tonnage and gear configurations (F4_JPN_KK_SH; F5_JPN_KK_DP; F6_JPN_ENY_SHL; F7_JPN_ENY_DP). Offshore (Kinkai; KK) and distant-water (Enyo; ENY) longline was categorized as vessels collecting between 20 and 120 mt and larger than 120 mt, respectively, and these two-longline catches were further categorized as shallow-set (SH) and deep-set (DP), based on the gear configuration (number of hooks between floats; HBF, shallow-set - HBF < 7, and deep-set - HBF > 6). Because the landings of sharks were frequently underestimated because of the lower catches and the proportion discarded compared to that of teleost species, such as tunas and billfish, total catches, including retained and discard/released catches, were estimated using a product of the yearly standardized CPUE and fishing effort.

The estimates were separated into two time-series (1976–1993 and 1994–2015) because species disaggregated shark catch data were only available after 1993. In the estimation of the CPUE for the early period, the season-area-specific ratio of BSH catch to the total shark catch was assumed to be the same for the period before 1994 as that after 1993. The former CPUE (1976–1993) was estimated by Hiraoka et al. (2013a) and the latter CPUE (1994–2015) was estimated by Kai and Shiozaki (2016). The former and latter catches were converted into biomass using the mean weight by season and area (Hiraoka et al., 2013a). The estimation methods and estimated catch amount can be found in Kai et al. (2014) and Kai (2016), respectively.

To conduct the updated stock assessment for NPBSH, the Japanese annual catches for BSH caught by longline fisheries in the last 3 years (2016–2018) were updated by Kai (2019) using almost the same methods as those used in the previous analysis for the latter periods (1994–2015).

Japan also provided two driftnet catch time series (F8_JPN_LG_MESH; F10_JPN_SM_MESH) and catches for a miscellaneous coastal fishery (F9_JPN_CST_Oth). Prior to the United Nations moratorium on high seas, large-scale, pelagic drift net fisheries, implemented on 31 December 1992, Japanese high seas drift net fisheries in the NPO consisted of a large mesh fishery (F8_JPN_LG_MESH) targeting striped marlin and later albacore, and a small mesh fishery (F10_JPN_SM_MESH) targeting flying squid. The small mesh fishery was closed after December 1992, but Japan's large mesh driftnet fishery continued to operate within Japan's exclusive economic zone. Japanese large mesh driftnet and coastal catches (coastal and other longline, set-net, bait fishing, others; F9_JPN_CST_Oth) were updated from 1994 to 2014 (Kai and Yano, 2016). Most of the Japanese shark catch data were reported in species with an aggregated form as "sharks," thus, the ratios of the catch of BSH to all sharks by fishing gear were calculated using available species-specific landings data, and used to estimate the catch of BSH. The Japanese coastal fishery catches before 1994 were provided by Yokawa (2012) and Kimoto et al. (2012).

To conduct the updated stock assessment for NPBSH, the Japanese annual catches for BSH caught by coastal fisheries in the last 3 years (2015–2017) were updated by Kai and Yano (2019) using the same methods as those used in the previous analysis. The annual catch by coastal fisheries in 2017 was tentatively used as that in 2018.

4.4.2 Taiwan

Small-scale longline catches in Taiwan were updated in Liu et al. (2016). The large-scale longline catch was estimated in two areas (0–25°N of the equator and northwards of 25°) using catch rates multiplied by effort in the two separate areas (Tsai and Liu, 2016).

To conduct the updated stock assessment for NPBSH, the Taiwan annual small-scale longline catches for BSH from 2016 to 2018 were updated using the landings from three fishing markets (Nanfanao, Tongkong, and Chengkun). Taiwan's annual large-scale longline catches for BSH from 2004 to 2018 were estimated using the same methods as those used in the previous analyses, and the catches in the last 3 years (2016–2018) were updated (Tsai and Liu, 2019).

4.4.3 Republic of Korea

The Korean annual reports for the 2010 and 2011 WCPFC SC meetings indicated that the catch of major shark species reported in logbooks included only blue and "other" sharks (reported as "porbeagle" sharks, but have since been corrected to "other" sharks, Y. Kwon pers. comm.). Observer records for 1 year showed that 65% of the catches of major shark species comprised BSH. The Korean annual report to the WCPFC in 2010 indicated that the average CPUE of BSH caught by Korean longliners was 0.07 (number/1000 hooks) based on observer data. Using the annual aggregated shark catch and effort data submitted to the ISC, and an average BSH size of 30 kg, the average size caught in a comparable Japanese longline fishery, estimated CPUE by year in the number of BSHs per 1000 hooks caught by Korean longliners ranged from 0.0 to 0.89, which is comparable to the average CPUE obtained from Korean observer data. For this assessment, the Korean BSH catch was assumed to be equal to the North Pacific species-aggregated shark catch reported to the ISC (various shark species, code SHK). Beginning in 2013, a small number of shark catches was reported as BSH, which was added to the species-aggregated shark catch for the assessment time series. Kwon et al. (2017) developed an independent estimate of the Korean longline BSH catch for the period 1973–2015. Catch estimates were derived by applying area-specific CPUE based on observer data to the Korean longline fishing effort recorded in logbooks. A careful review of the catch estimation methodologies and time series provided by Kwon et al. (2017) was not possible in time for the assessment; however, the magnitude and trends in the catch time series were quite similar to those developed by the SHARKWG.

To conduct the updated stock assessment for NPBSH, the Korean annual catches for BSH in the past 3 years (2016–2018) were updated using the catch from logbook data without any processing because reasonable information was available for the period from 2013 to 2018 (Lee et al., 2019).

4.4.4 China

China's longline species-specific catch and effort were available for 2007–2015, and effort data were available from 2001. The mean annual CPUE for 2007–2015 was applied to effort data for 2001–2006 to estimate catch for those years. It was assumed that the effort of Chinese longliners in the NPO was minimal prior to 2001.

To conduct the updated stock assessment for NPBSH, the annual catch of China for 2016–2018 was updated by the SHARKWG Chair using the average catch for 2011–2015 because the catch was not submitted.

4.4.5 Canada

BSH bycatch in Canadian fisheries was estimated from a combination of observer and logbook records from 1979–2015 for groundfish, salmon, sardine, albacore, hake, and squid fisheries (King and Surry, 2016). Minor adjustments to previous estimates were based on newly available information.

To conduct the updated stock assessment for NPBSH, the catch statistics for 2016–2018 for BSH in Canadian waters were updated using a corrected mean weight of 24.57 kg per piece (King and Surry, 2019).

4.4.6 USA

BSH catch through 2015 in US fisheries, including the Hawaii-based longline fleet, as well as the west coast drift gillnet, recreational, albacore troll fleets, and small longline fisheries were provided by Kohin et al. (2016). The estimation methods were consistent with those used in the 2014 assessment, except that the mortality rate estimate used for the Hawaii-based longline fishery was updated, and catches from the albacore troll fishery (less than 1 mt annually) had not been previously estimated.

To conduct the updated stock assessment for NPBSH, BSH catches in the last 3 years (2016–2018) were updated for the Hawaii-based longline fleet and the west coast drift gillnet, as well as recreational fisheries (e.g., private fishing boats and commercial passenger fishing vessels). The calculation of past catch for each fishery was maintained for the approaching BSH assessment update, and previous methods for catch calculation were followed in producing estimates for 2016–2018 (Kinney, 2019). Past working papers were unclear about the method used to estimate BSH catch for California and Washington recreational fishing because neither state identified BSH in its catch, but only unidentified shark. The current update used the ratio of BSH to unidentified shark caught in Oregon to establish a ratio that was then applied to the unidentified shark catch in California and Washington.

4.4.7 Mexico

Total BSH catches through 2015 were calculated from artisanal, commercial longline, and historical drift gillnet fisheries. Catches were sourced from annual fishery statistics yearbooks of SAGARPA (the Mexican fishery authority provided by INAPESCA) from five Mexican states (Baja California, Baja California Sur, Sinaloa, Nayarit, and Colima), published articles, and reports (including grey literature) (Castillo-Geniz et al., 2017; Sosa-Nishizaki and Castillo-Geniz, 2016).

To conduct the updated stock assessment for NPBSH, BSH catches in the last three years (2016–2018) were updated for the Mexican fleet using the same method as that used in the previous assessment in 2017.

4.4.8 IATTC

The IATTC (Inter American Tropical Tuna Commission) provided estimates of BSH bycatch in tuna purse seine fisheries in the north EPO. The methods were the same as for the past stock assessment (IATTC, 2013). The number of BSH caught by number during 1971–2015 was estimated from observer bycatch data and observer and logbook effort data. Some assumptions regarding the relative bycatch rates of BSHs were applied based on their temperate distribution and catch composition information. Estimates were calculated separately by set type, year, and area. Small purse seine vessels, for which there are no observer data, were assumed to have the same BSH bycatch rates by set type, year, and area, as those of large vessels. Before 1993, when shark bycatch data were not available, BSH bycatch rates assumed to be equal to the average of 1993–1995 rates were applied to the available effort information by set type, area, and year. The number of sharks was converted to mt by applying an average annual weight estimate derived from BSHs measured through the IATTC observer program.

To conduct the updated stock assessment for NPBSH, BSH bycatch in tuna purse seine fisheries in the north EPO for 2016–2018 were updated using the same method as that used in the previous assessment in 2017.

4.4.9 SPC

BSH longline catches for non-ISC member countries in the WCPFC area north of the equator were estimated from SPC (Secretariat of the Pacific Community) observer data holdings. Catches from 1995–2010 were estimated based on standardized CPUE values for each 5 × 5-degree cell multiplied by the effort reported in that cell summed on an annual basis. The non-ISC countries represented in the dataset included 12 countries, many of which likely fish only south of the equator; thus, it is believed that the NPBSH catch of non-ISC member countries represented in the WCPFC database is attributed to Federated States of Micronesia, Kiribati, Marshall Islands, Papua New Guinea, and Vanuatu. Total dead removals are assumed to be the same as longline catches. For 2011–2014, the reported effort in the NPO (publicly available Category 1 data; https://www.wcpfc.int/node/4648) was multiplied by the 2000–2010 average CPUE based on the estimated catch for non-ISC members divided by total effort data for the NPO.

To conduct the updated stock assessment for NPBSH, the annual catches of non-ISC countries (Federated States of Micronesia, Kiribati, Marshall Islands, Papua New Guinea, Palau, Solomon Islands, and Vanuatu) from 2015 to 2018 were simply summed up from the annual catches provided by SPC.

4.5 Indices of Relative Abundance

In the updated stock assessment for NPBSH, standardized CPUE from the Japanese shallow longline fleet that operated out of Hokkaido and Tohoku ports for “early” and “late” periods, 1975–1993 and 1994–2015, respectively, were used as measures of relative population abundance in the reference case assessment. The early abundance index was estimated by Hiraoka et al. (2013b) and was unchanged from that used in the 2014 and 2017 BSH assessments. The index for the late period was updated to include data from 2015 (Kai and Shiozaki, 2016). The CPUE was standardized using a generalized linear model (glm) with negative binomial error distributions. Standardization of the late index, including investigation of the effects of the 2011 Great East Japan Earthquake and the resulting tsunami, found little concern with continuing to use it as the continuous index, and there was no reason to break up the late time-series. As in the 2017 assessment, the SHARKWG considered these indices to be the best indicators of stock abundance based on their broad spatio-temporal coverage, statistical soundness of the standardization process, size and sex composition, and larger catch relative to other fisheries.

4.6 Catch-at-length

Length composition data were provided for different fisheries from Japan, Taiwan, Republic of Korea, China, the USA, and Mexico. Sex-specific data (including unknown sex) were reported in the observed measurement units (FL – fork length, TL – total length, AL – alternate length, which is the length from the leading edge of the first dorsal fin to the leading edge of the second dorsal fin), and is subsequently converted to precaudal length (PCL) using fishery specific conversion equations if available, or the following agreed-upon conversion equations.

PCL = (FL × 0.894) + 2.547
PCL = (TL × 0.748) + 1.063
PCL = (AL × 2.462702) + 12.7976

The coordinates where the samples were taken were reported when possible to investigate the spatially explicit size and sex structure. Some data were provided with exact coordinates, whereas some were summarized into spatial blocks (1° × 1°, 5° × 5°, or 20° × 10°) (Sippel et al., 2016). For the assessment, sex-specific size data were grouped by the fishery.

5 INTEGRATED MODEL DESCRIPTION

5.1 Stock Synthesis Software

For integrated modeling efforts, the SHARKWG agreed to use a length-based, age-structured, forward-simulation population model conducted using Stock Synthesis (SS), version 3.24F (Methot, 2009; Methot and Wetzel, 2013) in addition to a Bayesian State-space Surplus Production (BSSP) model to examine the NPBSH stock status (ISC, 2014 and 2017). To conduct the updated stock assessment for NPBSH, the same version of SS 3.24F was used to assess the stock status and future trajectories.

5.2 Biological Assumptions

In addition to assumptions regarding stock structure, other critical information regarding the biology of BSH necessary for the SS assessment related to sex-specific growth, natural mortality, maturity, and fecundity were assumed. The biological assumptions and parameter values used in the SS models are summarized in **Table 2**. For the updated stock assessment, biological parameters were not updated and fixed to the same values as those used in the previous assessment in 2017.

5.3 Model Structure

For the updated stock assessment, the same values of parameters as those used in the previous assessment in 2017 were used, except for the parameters of R_0 and recruitment deviations. The SS control file, BSH.ctl, which documents the fixed values and model assumptions, is included in Appendix A.

Sensitivity analyses and stock assessment model diagnostics were not conducted, but future projections were conducted after updating the catches of all fleets until 2018.

5.4 Future Projections

Future projections from 2019 to 2028 were conducted on the reference case output assuming five harvest policies (F_{MSY}, $F_{2012\text{-}2014}$, $F_{2015\text{-}2017}$, $F_{20\%plus}$, $F_{20\%minus}$):

1. F_{MSY} scenario: The relative fishing mortality rate is sustained at the MSY level.
2. Status-Quo F scenario: The fishing mortality rate is maintained between 2012 and 2014 (average F for 2012–2014).
3. Status-Quo F scenario: The fishing mortality rate is maintained at the current level between 2015 and 2017 (average F for 2015–2017).

4. High F scenario: The relative fishing mortality rate increases by 20% from the current level (average F for 2015–2017).
5. Low F scenario: The relative fishing mortality rate decreases by 20% from the current level (average F for 2015–2017).

Projections were run using the *forecast* option available in SS. For the F_{MSY} scenario, the estimated value of F_{MSY} for the reference case was used. Time horizons of the projections were set at 10 years beginning in 2019 until 2028. A deterministic recruitment was assumed after updating the recent annual catch data through 2018. The specifications of the SS model were the same as those used in the previous benchmark stock assessment in 2017. All the parameters of the SS were fixed except for R_0 and the recruitment deviations. For the forecast file, we used the selectivity from 2012 to 2014 and changed the relative F value by the status-quo scenarios. The value of 0.111666 was used as the F-multiplier of the status-quo for $F_{2015\text{-}2017}$ when $F_{20\%\text{plus}}$ and $F_{20\%\text{minus}}$ were calculated (Kai and Carvalho, 2019).

6 RESULTS

6.1 Estimated Stock Status and Other Quantities

The relative values of F (F/F_{MSY}) for the status-quo (2015–2017) were the lowest in the stock assessment periods (**Figure 4**) because of the reduction in the recent annual catch compared to that of the last three decades (**Table 1, Figure 1**). Compared to MSY-based reference points, the current spawning biomass (SB_{2018}) was 65% above SB_{MSY}, and the current fishing mortality ($F_{2015\text{-}2017}$) was 29% of F_{MSY} (**Table 3**). These results suggest that the current stock is not in an overfished state, and that overfishing does not occur (**Figure 5**). The healthy conditions of the stock status had a large influence on the results of future projections.

6.2 Future Projections

The results of the future projection under the different constant-F policies (F_{MSY}, $F_{2012\text{-}2014}$, $F_{2015\text{-}2017}$, $F_{20\%\text{plus}}$, and $F_{20\%\text{minus}}$) indicated that the SBs could continuously increase above the SB_{MSY} until 2028, except for the scenario of F_{MSY} and maintenance above 70% of the unfished level for all strategies during the forecast period (**Table 4**, **Figure 6**).

7 STOCK STATUS AND CONSERVATION CONCLUSIONS

7.1 Status of the Stock

Stock status is reported in relation to MSY. Benchmark results are shown based on the female SB. Female SB in 2018 (SB_{2018}) was 65% higher than that at the MSY and estimated to be 285,385 mt (**Table 4**; **Figure 6**). The annual F in 2018 (F_{2018}) was estimated to be well below F_{MSY} at approximately 29% of F_{MSY} (**Table 4**; **Figure 5**). The reference run produced terminal conditions that were predominantly in the green quadrant (not overfished and overfishing not occurring) of the Kobe plot (**Figure 4E**).

7.2 Conservation Information

Target and limit reference points have not yet been established for pelagic sharks in the Pacific Ocean by either the WCPFC or the IATTC. Stock status of the NPBSH is reported in relation to MSY-based reference points.

Future projections under different F harvest policies (F_{MSY}, $F_{2012-2014}$, $F_{2015-2017}$, $F_{20\%plus}$, $F_{20\%minus}$) show that median NPBSH biomass will likely remain above SB_{MSY} in the foreseeable future, except for the harvest policy of F_{MSY} (**Table 5**; **Figure 5**).

Improvements in the monitoring of BSH catch and discards through carefully designed observer programs and species-specific logbooks, as well as continued research into the fisheries, biology, and ecology of NPBSH, are recommended.

7.3 Limitations and Research Needs

7.3.1 Catch

There is substantial uncertainty in the amount of historical catches of BSH. The SHARKWG spent substantial time and effort in estimating historical catch, but more work remains to be done. In particular, two improvements were deemed important by the SHARKWG: 1) identify all fisheries that catch BSH in the North Pacific (i.e., are there any fisheries that catch BSH that may not have been identified by the SHARKWG); and 2) methods to estimate BSH catches should be improved.

7.3.2 Future Projections

For the parameter setting in the future projection, the SHARKWG had a controversial issue, whether R_0 should be fixed or estimated in the model after fixing the remaining parameters. The SHARKWG members explained why SS experts recommend estimating R_0 in the model. The main reason was that R_0 had never been fixed in future projection before because most of the future projections were conducted using the original code made by the designer of SS. The SHARKWG asked to compare the results when R_0 was fixed and only the initial F was estimated. The results showed inconsistent trajectories of SB and F during the assessment period because of the differences in the trajectories of recruitment deviations. Because it was difficult to accept the inconsistent results, the SHARKWG determined to estimate R_0 and accepted the updated stock assessment results. However, more work remains to be done to explore the best manner of future projection in the updated stock assessment.

8 ACKNOWLEDGEMENTS

Completion of the BSH updated stock assessment was a collaborative effort by the ISC Shark Working Group. Those who greatly contributed include Mikihiko Kai (SHARKWG Chair), Michael Kinney (SHARKWG Vice-Chair), Yasuko Semba (SHARKWG data manager), Felipe Carvalho, Hideki Nakano, Minoru Kanaiwa, Yuki Fujinami, Sung-Il Lee, Kwang-Ming Liu, Wen-Pei Tsai, Jacquelynne King, José Leonardo Castillo-Geniz, José Ignacio Fernández-Méndez, Javier Tovar-Avila, Luis González-Ania, Cleridy Lennert-Cody, and Peter Williams. Felipe Carvalho and Mikihiko Kai were the lead SS modelers.

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10 TABLE CAPTIONS

Table 1E. Estimates of key management quantities for the North Pacific blue shark stock assessment reference case model in 2017 and 2020

Table 2E. Estimates of key management quantities in the forecast for the North Pacific blue shark updated stock assessment.

11 FIGURES

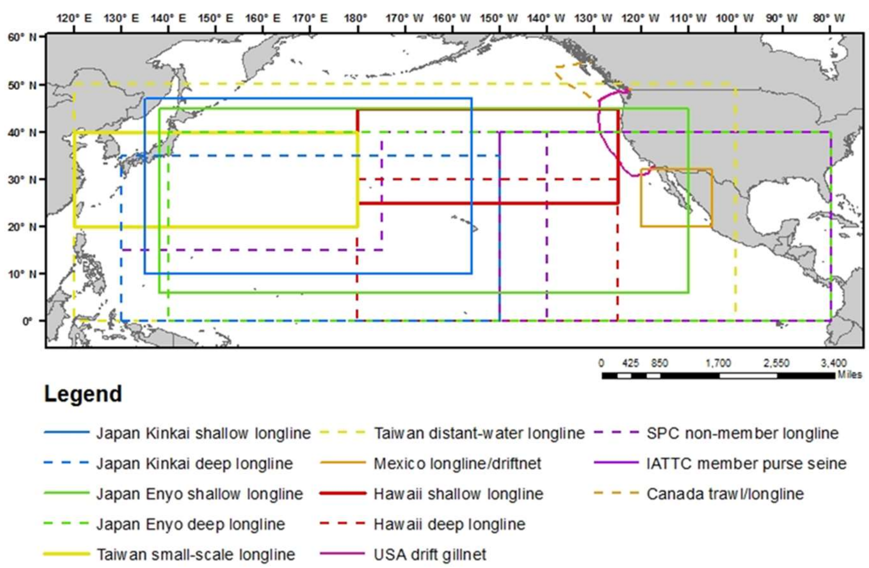

Figure 1. Blue shark (*Prionace glauca*) stock boundaries and approximate the spatial extent of the primary fisheries contributing catch for this assessment.

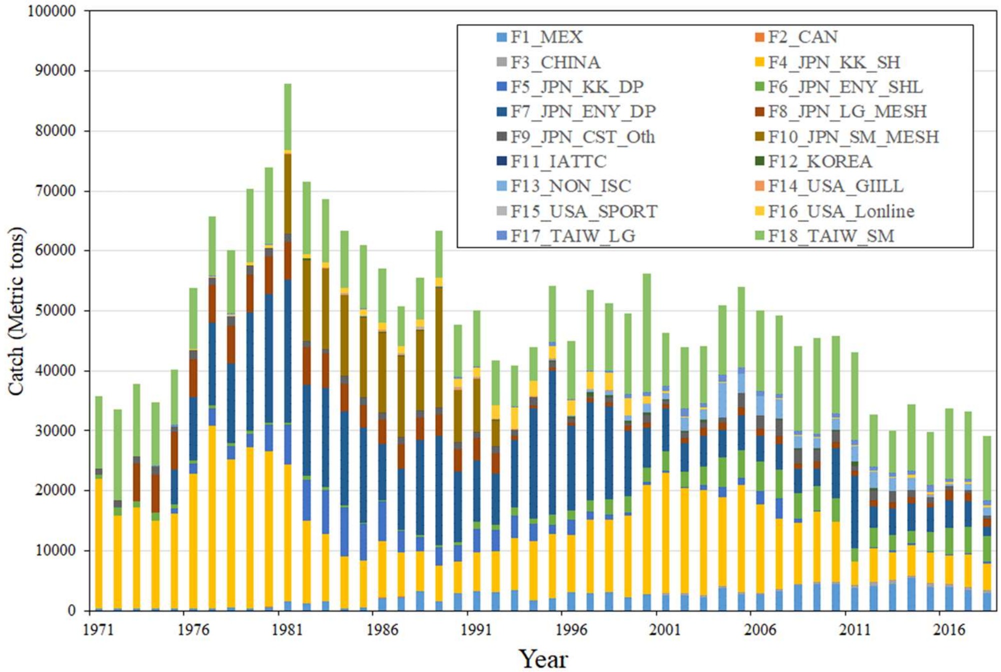

Figure 2. Catches by fishery from 1971–2015. Note: Catch in 1970 is an assumed level of catch used to derive equilibrium conditions for the reference case model.

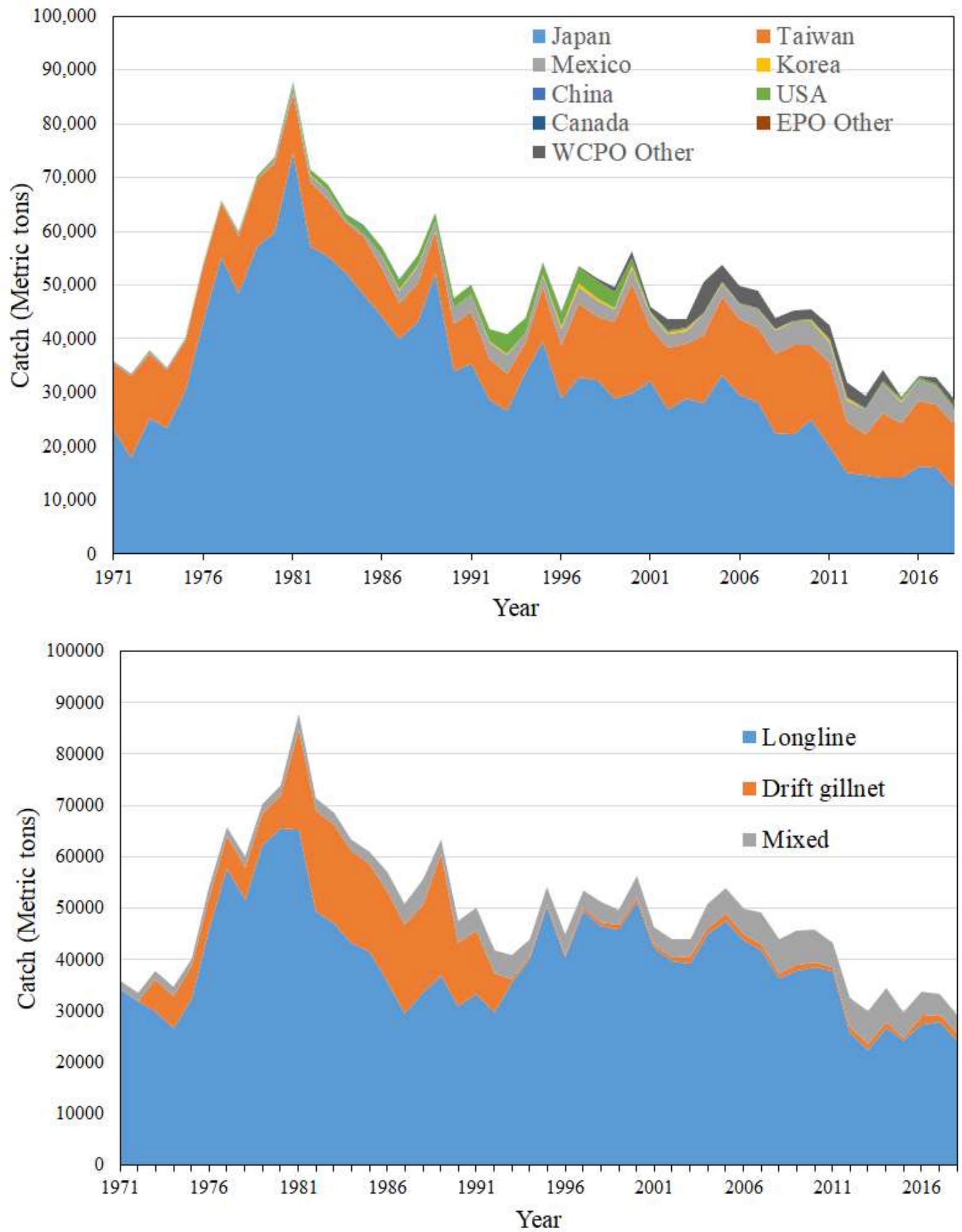

Figure 3. Total catch (total dead removals) of the North Pacific blue shark by nation or region (top panel), and by gear type (bottom panel). Note: The mixed gear category in the bottom panel includes purse seine, trap, troll, trawl, and recreational.

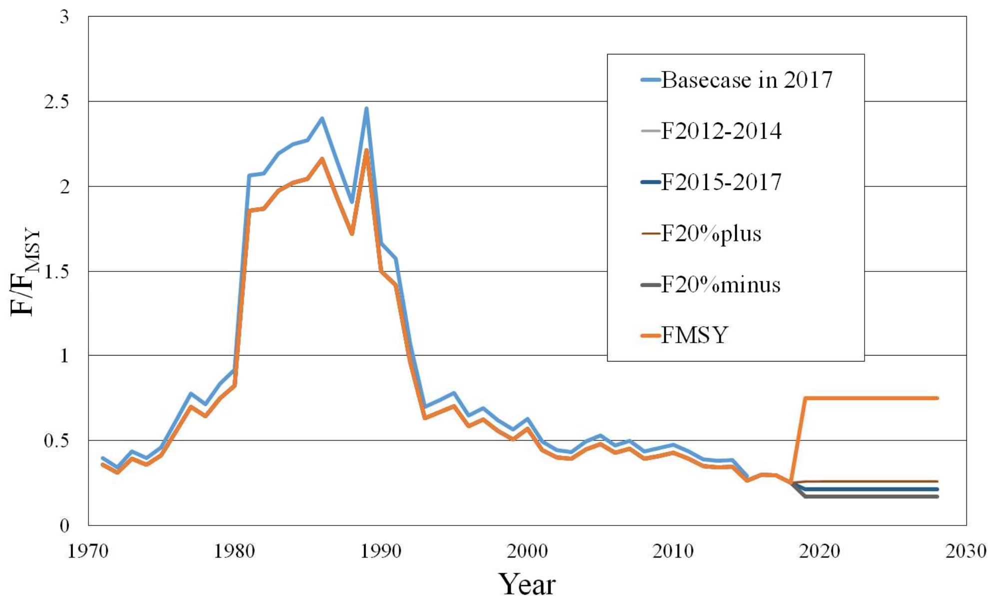

Figure 4. Estimates of annual fishing mortality (sum of *F*'s across all fishing fleets) and the projected trajectory for alternative harvest strategy. The value of one denotes the estimate of F_{MSY}.

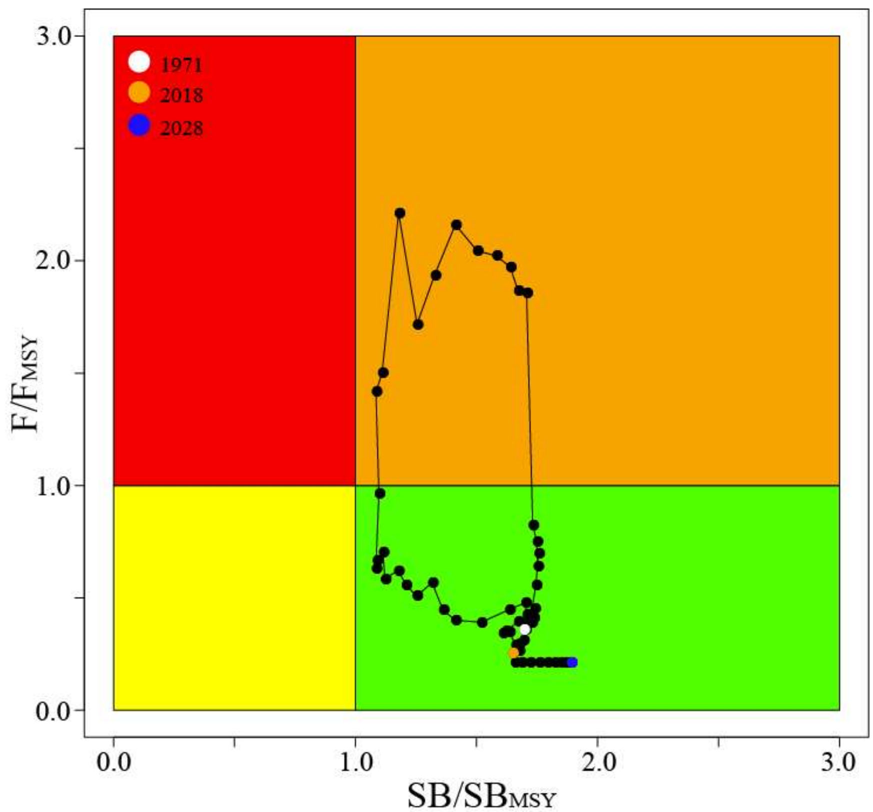

Figure 5. Kobe plot of the trends in estimates of relative fishing mortality and female spawning biomass of the North Pacific blue shark between 1971–2028 for the reference case of SS.

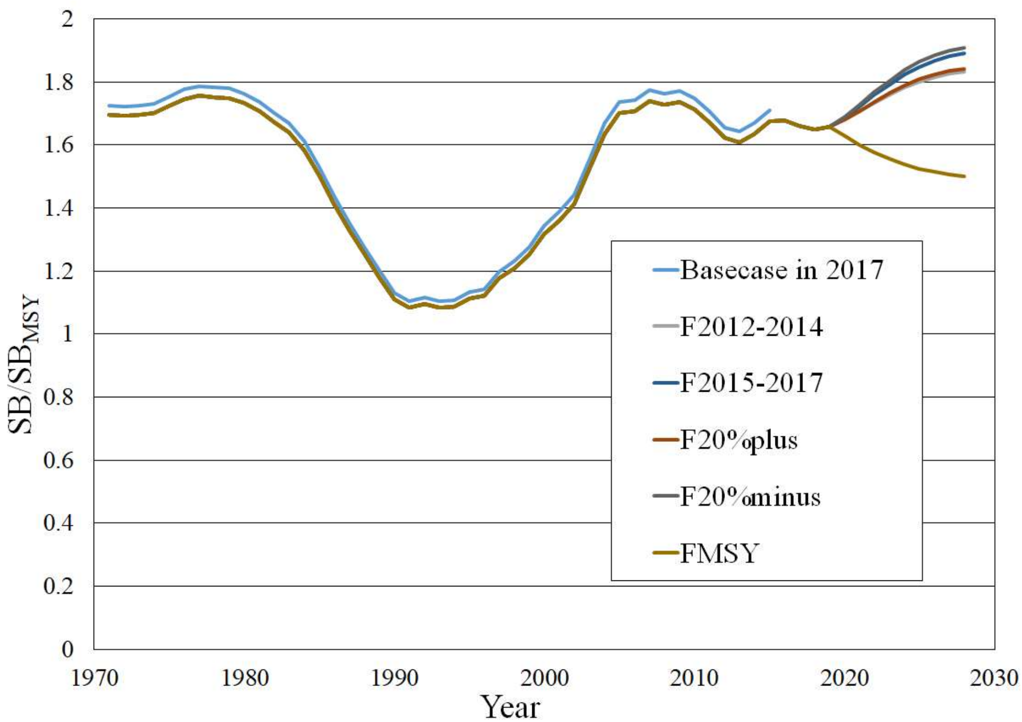

Figure 6 Estimates of annual female spawning biomass (*SB*; metric tons) and the projected trajectory for alternative harvest strategy. The value of one denotes the estimate of SB_{MSY}.

12 APPENDIX

12.1 Appendix Table

Table A1. Annual catch for 1971–2018 was used in the stock synthesis forecast.

Year	#_F1_MEX	F2_CAN	F3_CHINA	F4_JPN_KK_SH	F5_JPN_KK_DP	F6_JPN_ENY_SH	F7_JPN_ENY_DP	F8_JPN_LG_MES	F9_JPN_CST_Oth	F10_JPN_SM_ME	F11_IATTC	F12_KOREA	F13_NON_ISC	F14_USA_GILL	F15_USA_SPORT	F16_USA_Lonline	F17_TAIW_LG	F18_TAIW_SM	Total
1971	440	0	0	21604.7	0	650.8	0	0	996.4	0	7	0	0	0	30	0	5	12065	35,799
1972	440	0	0	15359	0	1416.9	0	0	1201.4	0	5	0	0	0	30	0	5	15051	33,508
1973	440	0	0	16760.9	0	1098.6	0	6296.9	1172	0	5	0.01	0	0	30	0	1	12024	37,828
1974	440	0	0	14607	0	1304.5	0	6296.9	1337.3	0	5	0.05	0	0	30	0	134	10608	34,763
1975	440	0	0	15821.8	798.5	671.1	5774.4	6296.9	913.9	0	7	4.7	0	0	33	0	200	9192	40,153
1976	374	0	0	22434.2	1819.8	494.5	10442.1	6296.9	1538.3	0	7	31.8	0	0	31	98	8	10278	53,854
1977	386	0	0	30495.3	2866.2	429.4	13790.6	6296.9	1265.1	0	6	55.5	0	0	29	196	48	9997	65,861
1978	561	0	0	24642.8	2254	456.9	13340.9	6296.9	1558.8	0	8	17.3	0	2	33	294	60	10543	60,069
1979	338	1	0	26898.2	2200	566.6	19721.5	6296.9	1509.7	0	10	0	0	5	33	428	14	12346	70,368
1980	624	11	0	25899.7	4530.5	270	21482.9	6296.9	1293.1	0	10	114.2	0	12	29	589	45	12795	74,002
1981	1593	0	0	22794.5	6641.5	378.1	23839.6	6296.9	1290.9	13331.3	9	0.3	0	55	27	587	40	10921	87,805
1982	1181	0	0	13861	6794.2	724	15146.9	6296.9	1034.4	13331.3	6	241.9	0	84	15	685	5	11998	71,405
1983	1548	25	0	11228.6	7312.6	432.7	16534	5926.8	642	13331.3	6	27.3	0	125	46	783	5	10581	68,554
1984	390	0	0	8741.6	8137.3	345.5	15544.3	4727.5	1333.1	13331.3	6	87.8	0	135	96	881	1	9508	63,265
1985	528	60	0	7846.2	6093.6	207.9	15683.9	3763.6	1387.8	13331.3	3	145.4	0	119	193	979	115	10597	61,054
1986	2128	90	0	9373.7	6603.2	143.6	9393	4081.1	1239.4	13331.3	2	95.4	0	376	43	1077	138	8910	57,025
1987	2205	159	0	7406.6	3538.8	222.9	10229.9	3990.5	1276.3	13331.3	2	158.8	0	152	181	1175	56	6673	50,758
1988	3337	0	0	6582.2	2383.7	267.5	15896.2	3707.7	1152.5	13331.3	6	139.8	0	125	346	1312	10	6956	55,553
1989	1643	0	0	5902.1	3013.9	358.5	18148.8	3707.7	1052.7	20022	5	49.5	0	128	99	1380	54	7843	63,407
1990	2865	4	0	5394.4	2717.7	484.6	11799.3	3707.7	1070.4	8758.4	3	58.2	0	299	64	1492	216	8669	47,603
1991	3197	0	0	6479.3	4007.2	1140.1	10305.7	3707.7	1053.7	8758.4	2	64.8	0	94	97	1572	230	9389	50,098
1992	3085	0	0	6902.1	3408.7	958.5	8519.6	3387.7	1099	4379.2	3	49.1	0	135	47	2146	75	7540	41,735
1993	3517	0	0	8518.4	3889.7	1340.3	11211	660.5	1047	0	3	27.8	0	105	47	3595	60	6859	40,881
1994	1758	0	0	8665.3	3857.7	1515.0	18004.9	576.9	1899.1	0	2	33.0	0	37	43	2643	12	5458	44,505
1995	2100	0	0	8679.6	2206.9	1716.7	23951.4	483.4	1439.8	0	10	103.5	161	160	50	1955	638	9462	53,117
1996	3117	1	0	8841.7	3399.5	1959.0	14109.9	474.0	1059.3	0	2	230.9	165	85	26	2475	275	9642	45,862
1997	2948	1	0	11055.8	2073.9	2821.0	16095.7	598.0	631.8	0	4	432.9	261	64	61	2895	320	13453	53,716
1998	3134	2	0	10908.7	1447.4	1959.3	15478.5	610.9	1216.6	0	2	623.2	634	105	11	2987	337	11303	50,760
1999	2261	1	0	12856.1	1019.6	2113.9	10789.6	827.6	772.2	0	1	470.8	782	54	20	2886	623	13495	48,973
2000	2719	1	0	17230.7	626.6	3652.3	6718.8	729.8	1969.7	0	2	433.0	1350	27	36	1315	684	19707	57,202

Table A1. Continued.

Year	#_F1_MEX	F2_CAN	F3_CHINA	F4_JPN_KK_SH	F5_JPN_KK_DP	F6_JPN_ENY_SH	F7_JPN_ENY_DP	F8_JPN_LG_MES	F9_JPN_CST_Oth	F10_JPN_SM_ME	F11_IATTC	F12_KOREA	F13_NON_ISC	F14_USA_GIILL	F15_USA_SPORT	F16_USA_Lonline	F17_TAIW_LG	F18_TAIW_SM	Total
2001	2587	5	340.4	19457.9	506.9	2931.8	7027.7	730.5	1083.6	0	0	162.7	944	18	13	350	984	8847	45,989
2002	2524	5	333.6	16745.8	547.8	2979.1	4930.1	767.7	1514.7	0	3	293.5	2126	12	5	256	1357	10225	44,626
2003	2307	17	305.1	16423.2	1297.1	2937.0	5029.0	1350.3	1623.9	0	1	398.8	1708	15	11	255	777	9467	43,923
2004	3781	4	282.2	14025.3	3600.8	2685.4	4536.9	1202.4	1234.2	0	1	49.6	5846	10	4	187	1189	11479	50,118
2005	2721	0	343.3	17184.4	1169.3	2863.4	5869.4	1321.2	2520.8	0	0	44.0	3081	3	3	140	915	13563	51,742
2006	2765	20	200.6	13986.9	1902.8	2680.2	4332.9	1204.1	2418.7	0	3	21.4	3111	3	4	136	884	13291	46,965
2007	3324	9	234.2	11418.8	3540.6	1741.9	4308.9	1322.6	2801.1	0	2	203.3	3153	27	5	150	818	13030	46,090
2008	4355	6	133.6	10095.0	1071.8	2544.8	3999.0	943.7	2546.7	0	3	74.6	2066	14	3	121	680	14144	42,801
2009	4423	8	297.8	11841.6	412.4	1954.7	3023.1	1207.7	2248.3	0	2	146.0	1778	5	3	114	478	16081	44,024
2010	4469	7	357.3	10018.0	204.4	1717.4	8857.0	962.5	1910.2	0	1	470.0	1808	3	3	144	334	13015	44,281
2011	3719	13	612.5	4335.5	122.1	2358.0	12492.6	764.5	933.6	0	1	952.0	2624	3	1	138	594	15,857	45,520
2012	4108	9	757.7	5798.9	284.3	2544.8	3675.3	1076.3	1595.6	0	1.9	551.0	2778	5	2.1	138	594	15,857	39,777
2013	4494	26	598.4	4807.9	4157.5	1954.7	4536.7	1103.4	1759.1	0	1.6	491.0	2131	2	1.3	265	551	6983	33,863
2014	5502	9	250.6	5972.5	2741.8	1717.4	4674.2	1059.6	1140.6	0	0.4	328.0	2059	2	1.6	392	700	11156	37,707
2015	5502	23	626.9	5312.3	57.4	2358.0	3804.8	1079.8	1498.4	0	0.3	121.0	2059	1	1.9	468	1186	8856	32,956
2016	3880	12	569.2	4841.6	166.4	4421.0	4453.3	1832.3	628.1	0	2.0	0.1	321	9.7	2.9	401.0	449	11,700	33,689
2017	3384	25	569.2	5384.7	236.3	4458.5	4152.6	1365.7	560.1	0	0.0	4.438	1062	4.5	2.5	356	431	11,309	33,306
2018	2852	46	569.2	4348.6	438.1	4168.7	1543.0	1365.7	560.1	0	0.1	2.098	1279	0.3	1.0	379	878	10,787	29,219

12.2 SS Files

North Pacific blue shark update stock assessment in 2020 using stock synthesis
ISC Shark Working Group
Mikihiko Kai* and Felipe Carvalho,
*National Research Institute of Far Seas Fisheries, Japan Fisheries Research and Education Agency
Email: Kaim@affrc.go.jp

12.2.1 SS Data File

```
#C data file created using the SS_writedat function in the R package r4ss
#C should work with SS version:
#C file write time: 2014-05-20 13:21:07
#
1971 #_styr
2018 #_endyr
1 #_nseas
12 #_months_per_seas
1 #_spawn_seas
18 #_Nfleet
10 #_Nsurveys
1 #_N_areas
F1_MEX%F2_CAN%F3_CHINA%F4_JPN_KK_SH%F5_JPN_KK_DP%F6_JPN_ENY_SHL
%F7_JPN_ENY_DP%F8_JPN_LG_MESH%F9_JPN_CST_Oth%F10_JPN_SM_MESH%F11_I
ATTC%F12_KOREA%F13_NON_ISC%F14_USA_GIILL%F15_USA_SPORT%F16_USA_Lo
nline%F17_TAIW_LG%F18_TAIW_SM%S1_HW_DP%S2_HW_SH%S3_TAIW_LG%S4_TA
IW_SM%S5_JPN_EARLY%S6_JPN_LATE%S7_JPN_RTV%S8_SPC_OBS%S9_SPC_OBS_T
ROPIC%S10_MEX #_fleetnames
-1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5
0.5#_surveytiming_in_season
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
1#_area_assignments_for_each_fishery_and_survey
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 #_units of catch:    1=bio; 2=num
0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 #_se of
log(catch) only used for init_eq_catch and for Fmethod 2 and 3
2 #_Ngenders
24 #_Nages
0 0 0 40000 0 0 0 0 0 0 0 0 0 0 0 0 0 0 #_init_equil_catch_for_each_fishery
48 #_N_lines_of_catch_to_read
  #_F1_MEX F2_CAN F3_CHINA F4_JPN_KK_SH F5_JPN_KK_DP F6_JPN_ENY_SHL
F7_JPN_ENY_DP F8_JPN_LG_MESH F9_JPN_CST_Oth F10_JPN_SM_MESH F11_IATTC
F12_KOREA F13_NON_ISC F14_USA_GIILL F15_USA_SPORT F16_USA_Lonline
F17_TAIW_LG F18_TAIW_SM year seas
Annual catches were omitted
95 #_N_cpue
  #_Fleet Units Errtype
```

#_year seas index obs se_log
CPUE data were omitted
0 #_N_discard_fleets
#_discard_units (1=same_as_catchunits(bio/num); 2=fraction; 3=numbers)
#_discard_errtype: >0 for DF of T-dist(read CV below); 0 for normal with CV; -1 for normal with se; -2 for lognormal
0 #_N_discard
0 #_N_meanbodywt
30 #_DF_for_meanbodywt_T-distribution_like
2 # length bin method: 1=use databins; 2=generate from binwidth,min,max below; 3=read vector
5 # binwidth for population size comp
05 # minimum size in the population (lower edge of first bin and size at age 0.00)
300 # maximum size in the population (lower edge of last bin)
-0.005 #_comp_tail_compression
1e-04 #_add_to_comp
0 #_combine males into females at or below this bin number
60 #_Nbins for length composition data
Length data were omitted
0 #_N_agebins
#_agebin_vector
0 #_N_ageerror_definitions
0 #_N_agecomp
0 #_Lbin_method: 1=poplenbins; 2=datalenbins; 3=lengths
0 #_combine males into females at or below this bin number
0 #_N_MeanSize_at_Age_obs
0 #_N_environ_variables
0 #_N_environ_obs
0 #_N_sizefreq_methods
0 #_do_tags
0 #_morphcomp_data
#
999

12.2.2 SS Control File

#V3.24f
#_data_and_control_files: BSH_n.dat // BSH_n.ctl
#_SS-V3.24f-safe-Win64;_08/03/2012;_Stock_Synthesis_by_Richard_Methot_(NOAA)_using_ADMB_11
1 #_N_Growth_Patterns
1 #_N_Morphs_Within_GrowthPattern
#_Cond 1 #_Morph_between/within_stdev_ratio (no read if N_morphs=1)
#_Cond 1 #vector_Morphdist_(-1_in_first_val_gives_normal_approx)
#
#_Cond 0 # N recruitment designs goes here if N_GP*nseas*area>1
#_Cond 0 # placeholder for recruitment interaction request
#_Cond 1 1 1 # example recruitment design element for GP=1, seas=1, area=1
#

#_Cond 0 # N_movement_definitions goes here if N_areas > 1
#_Cond 1.0 # first age that moves (real age at begin of season, not integer) also cond on do_migration>0
#_Cond 1 1 1 2 4 10 # example move definition for seas=1, morph=1, source=1 dest=2, age1=4, age2=10
#
3 #_Nblock_Patterns
 1 2 3 #_blocks_per_pattern
begin and end years of blocks
 2006 2015
 2001 2005 2006 2015
 2011 2011 2012 2014 2015 2015
#
0.5 #_fracfemale
3 #_natM_type:_0=1Parm; 1=N_breakpoints;_2=Lorenzen;_3=agespecific;_4=agespec_withseasinterpolate
 #_Age_natmort_by gender x growthpattern
 0.785 0.488 0.37 0.306 0.267 0.24 0.221 0.207 0.196 0.187 0.18 0.175 0.171 0.167 0.164 0.161 0.159 0.157 0.156 0.155 0.154 0.153 0.152 0.151 0.151
 0.728 0.492 0.383 0.32 0.279 0.251 0.23 0.214 0.202 0.192 0.184 0.177 0.172 0.167 0.163 0.16 0.157 0.155 0.153 0.151 0.149 0.148 0.147 0.146 0.145
2 # GrowthModel: 1=vonBert with L1&L2; 2=Richards with L1&L2; 3=age_speciific_K; 4=not implemented
1 #_Growth_Age_for_L1
20 #_Growth_Age_for_L2 (999 to use as Linf)
0 #_SD_add_to_LAA (set to 0.1 for SS2 V1.x compatibility)
0 #_CV_Growth_Pattern: 0 CV=f(LAA); 1 CV=F(A); 2 SD=F(LAA); 3 SD=F(A); 4 logSD=F(A)
1 #_maturity_option: 1=length logistic; 2=age logistic; 3=read age-maturity matrix by growth_pattern; 4=read age-fecundity; 5=read fec and wt from wtatage.ss
#_placeholder for empirical age-maturity by growth pattern
4 #_First_Mature_Age
2 #_fecundity option:(1)eggs=Wt*(a+b*Wt);(2)eggs=a*L^b;(3)eggs=a*Wt^b; (4)eggs=a+b*L; (5)eggs=a+b*W
0 #_hermaphroditism option: 0=none; 1=age-specific fxn
3 #_parameter_offset_approach (1=none, 2= M, G, CV_G as offset from female-GP1, 3=like SS2 V1.x)
1 #_env/block/dev_adjust_method (1=standard; 2=logistic transform keeps in base parm bounds; 3=standard w/ no bound check)
#
#_growth_parms
#_LO HI INIT PRIOR PR_type SD PHASE env-var use_dev dev_minyr dev_maxyr dev_stddev Block Block_Fxn
 10 120 64.4 65 0 10 -4 0 0 0 0 0.5 0 0 # L_at_Amin_Fem_GP_1
 40 410 244.6 400 0 10 -2 0 0 0 0 0.5 0 0 # L_at_Amax_Fem_GP_1
 0.1 0.25 0.147 0.15 0 0.8 -4 0 0 0 0 0.5 0 0 # VonBert_K_Fem_GP_1

```
 -10 10 1 1 0 0.8 -4 0 0 0 0 0.5 0 0 # Richards_Fem_GP_1
 0.01 1 0.25 0.0834877 0 0.8 -3 0 0 0 0 0.5 0 0 # CV_young_Fem_GP_1
 -3 3 -1.06443 0 0 0.8 -3 0 0 0 0 0.5 0 0 # CV_old_Fem_GP_1
 -3 3 0.059011 0 0 0.8 -3 0 0 0 0 0.5 0 0 # L_at_Amin_Mal_GP_1
 -3 3 0.068275 0 0 0.8 -2 0 0 0 0 0.5 0 0 # L_at_Amax_Mal_GP_1
 -3 3 -0.2 0 0 0.8 -3 0 0 0 0 0.5 0 0 # VonBert_K_Mal_GP_1
 -3 3 0 0 0 0.8 -3 0 0 0 0 0.5 0 0 # Richards_Mal_GP_1
 -3 3 0 0 0 0.8 -3 0 0 0 0 0.5 0 0 # CV_young_Mal_GP_1
 -3 3 -1.4381 0 0 0.8 -3 0 0 0 0 0.5 0 0 # CV_old_Mal_GP_1
 -3 3 5.388e-006 5.388e-006 0 0.8 -3 0 0 0 0 0.5 0 0 # Wtlen_1_Fem
 -3 3.5 3.102 3.102 0 0.8 -3 0 0 0 0 0.5 0 0 # Wtlen_2_Fem
 -3 300 156.6 55 0 0.8 -3 0 0 0 0 0.5 0 0 # Mat50%_Fem
 -3 3 -0.16 -0.16 0 0.8 -3 0 0 0 0 0.5 0 0 # Mat_slope_Fem
 -3 50 45 45 0 0.8 -3 0 0 0 0 0.5 0 0 # Eggs_scalar_Fem
 -3 3 0 0 0 0.8 -3 0 0 0 0 0.5 0 0 # Eggs_exp_len_Fem
 -3 3 3.293e-006 3.293e-006 0 0.8 -3 0 0 0 0 0.5 0 0 # Wtlen_1_Mal
 -3 3.5 3.225 3.225 0 0.8 -3 0 0 0 0 0.5 0 0 # Wtlen_2_Mal
 -4 4 0 0 -1 99 -3 0 0 0 0 0.5 0 0 # RecrDist_GP_1
 -4 4 0 0 -1 99 -3 0 0 0 0 0.5 0 0 # RecrDist_Area_1
 -4 4 4 0 -1 99 -3 0 0 0 0 0.5 0 0 # RecrDist_Seas_1
 1 1 1 1 -1 99 -3 0 0 0 0 0.5 0 0 # CohortGrowDev
#
#_Cond 0    #custom_MG-env_setup (0/1)
#_Cond -2 2 0 0 -1 99 -2 #_placeholder when no MG-environ parameters
#
#_Cond 0    #custom_MG-block_setup (0/1)
#_Cond -2 2 0 0 -1 99 -2 #_placeholder when no MG-block parameters
#_Cond No MG parm trends
#
#_seasonal_effects_on_biology_parms
 0 0 0 0 0 0 0 0 0 0 #_femwtlen1,femwtlen2,mat1,mat2,fec1,fec2,Malewtlen1,malewtlen2,L1,K
#_Cond -2 2 0 0 -1 99 -2 #_placeholder when no seasonal MG parameters
#
#_Cond -4 #_MGparm_Dev_Phase
#
#_Spawner-Recruitment
7 #_SR_function: 2=Ricker; 3=std_B-H; 4=SCAA; 5=Hockey; 6=B-H_flattop;
7=survival_3Parm
#_LO HI INIT PRIOR PR_type SD PHASE
 3 20 10.3125 9 0 10 1 # SR_LN(R0)
 0.01 1 0.391 0.5 0 0.2 -4 # SR_surv_Sfrac
 0.01 10 2 1 0 0.2 -4 # SR_surv_Beta
 0 2 0.3 0.6 0 0.8 -3 # SR_sigmaR
 -5 5 0 0 0 1 -3 # SR_envlink
 -5 5 -0.0060995 0 0 1 -1 # SR_R1_offset
 0 0 0 0 -1 99 -1 # SR_autocorr
```

```
0 #_SR_env_link
0 #_SR_env_target_0=none;1=devs;_2=R0;_3=steepness
2 #do_recdev:    0=none; 1=devvector; 2=simple deviations
1990 # first year of main recr_devs; early devs can preceed this era
2013 # last year of main recr_devs; forecast devs start in following year
1 #_recdev phase
1 # (0/1) to read 13 advanced options
 -5 #_recdev_early_start (0=none; neg value makes relative to recdev_start)
 1 #_recdev_early_phase
 0 #_forecast_recruitment phase (incl. late recr) (0 value resets to maxphase+1)
 1 #_lambda for Fcast_recr_like occurring before endyr+1
 1978.99 #_last_early_yr_nobias_adj_in_MPD
 1992.32 #_first_yr_fullbias_adj_in_MPD
 2012.46 #_last_yr_fullbias_adj_in_MPD
 2019.53 #_first_recent_yr_nobias_adj_in_MPD
 0.6094 #_max_bias_adj_in_MPD (-1 to override ramp and set biasadj=1.0 for all estimated
recdevs)
 0 #_period of cycles in recruitment (N parms read below)
 -10 #min rec_dev
 10 #max rec_dev
 0 #_read_recdevs
#_end of advanced SR options
#
#_placeholder for full parameter lines for recruitment cycles
# read specified recr devs
#_Yr Input_value
#
# all recruitment deviations
#DisplayOnly -0.113806 # Early_RecrDev_1985
#DisplayOnly -0.0520748 # Early_RecrDev_1986
#DisplayOnly 0.269481 # Early_RecrDev_1987
#DisplayOnly 0.464161 # Early_RecrDev_1988
#DisplayOnly -0.310767 # Early_RecrDev_1989
#DisplayOnly 0.142618 # Main_RecrDev_1990
#DisplayOnly 0.186807 # Main_RecrDev_1991
#DisplayOnly -0.241485 # Main_RecrDev_1992
#DisplayOnly 0.159642 # Main_RecrDev_1993
#DisplayOnly -0.174089 # Main_RecrDev_1994
#DisplayOnly 0.00490218 # Main_RecrDev_1995
#DisplayOnly 0.141229 # Main_RecrDev_1996
#DisplayOnly -0.0831216 # Main_RecrDev_1997
#DisplayOnly -0.0459126 # Main_RecrDev_1998
#DisplayOnly 0.399125 # Main_RecrDev_1999
#DisplayOnly 0.258113 # Main_RecrDev_2000
#DisplayOnly -0.02019 # Main_RecrDev_2001
#DisplayOnly -0.319415 # Main_RecrDev_2002
```

```
#DisplayOnly 0.196536 # Main_RecrDev_2003
#DisplayOnly -0.262771 # Main_RecrDev_2004
#DisplayOnly 0.0956927 # Main_RecrDev_2005
#DisplayOnly -0.302361 # Main_RecrDev_2006
#DisplayOnly -0.246038 # Main_RecrDev_2007
#DisplayOnly -0.239418 # Main_RecrDev_2008
#DisplayOnly 0.0248502 # Main_RecrDev_2009
#DisplayOnly 0.162747 # Main_RecrDev_2010
#DisplayOnly 0.137936 # Main_RecrDev_2011
#DisplayOnly -0.420244 # Main_RecrDev_2012
#DisplayOnly -0.288208 # Main_RecrDev_2013
#
#Fishing Mortality info
0.2 # F ballpark for tuning early phases
2013 # F ballpark year (neg value to disable)
3 # F_Method:    1=Pope; 2=instan. F; 3=hybrid (hybrid is recommended)
5 # max F or harvest rate, depends on F_Method
# no additional F input needed for Fmethod 1
# if Fmethod=2; read overall start F value; overall phase; N detailed inputs to read
# if Fmethod=3; read N iterations for tuning for Fmethod 3
4    # N iterations for tuning F in hybrid method (recommend 3 to 7)
#
#_initial_F_parms
#_LO HI INIT PRIOR PR_type SD PHASE
 0.1 5 0 0.01 0 99 -1 # InitF_1F1_MEX
 0.1 5 0 0.01 0 99 -1 # InitF_2F2_CAN
 0.1 5 0 0.01 0 99 -1 # InitF_3F3_CHINA
 0.001 5 0.185897 0.01 0 99 -1 # InitF_4F4_JPN_KK_SH
 0.1 5 0 0.01 0 99 -1 # InitF_5F5_JPN_KK_DP
 0.1 5 0 0.01 0 99 -1 # InitF_6F6_JPN_ENY_SHL
 0.1 5 0 0.01 0 99 -1 # InitF_7F7_JPN_ENY_DP
 0.1 5 0 0.01 0 99 -1 # InitF_8F8_JPN_LG_MESH
 0.1 5 0 0.01 0 99 -1 # InitF_9F9_JPN_CST_Oth
 0.1 5 0 0.01 0 99 -1 # InitF_10F10_JPN_SM_MESH
 0.1 5 0 0.01 0 99 -1 # InitF_11F11_IATTC
 0.1 5 0 0.01 0 99 -1 # InitF_12F12_KOREA
 0.1 5 0 0.01 0 99 -1 # InitF_13F13_NON_ISC
 0.1 5 0 0.01 0 99 -1 # InitF_14F14_USA_GIILL
 0.1 5 0 0.01 0 99 -1 # InitF_15F15_USA_SPORT
 0.1 5 0 0.01 0 99 -1 # InitF_16F16_USA_Lonline
 0.1 5 0 0.01 0 99 -1 # InitF_17F17_TAIW_LG
 0.1 5 0 0.01 0 99 -1 # InitF_18F18_TAIW_SM
#
#_Q_setup
 # Q_type options:    <0=mirror, 0=float_nobiasadj, 1=float_biasadj, 2=parm_nobiasadj,
3=parm_w_random_dev, 4=parm_w_randwalk, 5=mean_unbiased_float_assign_to_parm
```

```
#_for_env-var:_enter_index_of_the_env-var_to_be_linked
#_Den-dep   env-var   extra_se   Q_type
 0 0 0 0 # 1 F1_MEX
 0 0 0 0 # 2 F2_CAN
 0 0 0 0 # 3 F3_CHINA
 0 0 0 0 # 4 F4_JPN_KK_SH
 0 0 0 0 # 5 F5_JPN_KK_DP
 0 0 0 0 # 6 F6_JPN_ENY_SHL
 0 0 0 0 # 7 F7_JPN_ENY_DP
 0 0 0 0 # 8 F8_JPN_LG_MESH
 0 0 0 0 # 9 F9_JPN_CST_Oth
 0 0 0 0 # 10 F10_JPN_SM_MESH
 0 0 0 0 # 11 F11_IATTC
 0 0 0 0 # 12 F12_KOREA
 0 0 0 0 # 13 F13_NON_ISC
 0 0 0 0 # 14 F14_USA_GIILL
 0 0 0 0 # 15 F15_USA_SPORT
 0 0 0 0 # 16 F16_USA_Lonline
 0 0 0 0 # 17 F17_TAIW_LG
 0 0 0 0 # 18 F18_TAIW_SM
 0 0 0 0 # 19 S1_HW_DP
 0 0 0 0 # 20 S2_HW_SH
 0 0 0 0 # 21 S3_TAIW_LG
 0 0 0 0 # 22 S4_TAIW_SM
 0 0 0 0 # 23 S5_JPN_EARLY
 0 0 0 0 # 24 S6_JPN_LATE
 0 0 0 0 # 25 S7_JPN_RTV
 0 0 0 0 # 26 S8_SPC_OBS
 0 0 0 0 # 27 S9_SPC_OBS_TROPIC
 0 0 0 0 # 28 S10_MEX
#
#_Cond 0 #_If q has random component, then 0=read one parm for each fleet with random q;
1=read a parm for each year of index
#_Q_parms(if_any)
#
#_size_selex_types
#discard_options:_0=none;_1=define_retention;_2=retention&mortality;_3=all_discarded_dead
#_Pattern Discard Male Special
 24 0 4 0 # 1 F1_MEX
 5 0 0 1 # 2 F2_CAN
 24 0 4 0 # 3 F3_CHINA
 24 0 4 0 # 4 F4_JPN_KK_SH
 24 0 3 0 # 5 F5_JPN_KK_DP
 5 0 0 4 # 6 F6_JPN_ENY_SHL
 24 0 4 0 # 7 F7_JPN_ENY_DP
 24 0 4 0 # 8 F8_JPN_LG_MESH
```

```
 5 0 0 8 # 9 F9_JPN_CST_Oth
 24 0 0 0 # 10 F10_JPN_SM_MESH
 5 0 0 1 # 11 F11_IATTC
 5 0 0 3 # 12 F12_KOREA
 5 0 0 3 # 13 F13_NON_ISC
 24 0 4 0 # 14 F14_USA_GIILL
 5 0 0 14 # 15 F15_USA_SPORT
 24 0 4 0 # 16 F16_USA_Lonline
 24 0 4 0 # 17 F17_TAIW_LG
 5 0 0 17 # 18 F18_TAIW_SM
 5 0 0 16 # 19 S1_HW_DP
 5 0 0 16 # 20 S2_HW_SH
 5 0 0 17 # 21 S3_TAIW_LG
 5 0 0 18 # 22 S4_TAIW_SM
 5 0 0 4 # 23 S5_JPN_EARLY
 5 0 0 4 # 24 S6_JPN_LATE
 5 0 0 16 # 25 S7_JPN_RTV
 5 0 0 13 # 26 S8_SPC_OBS
 5 0 0 13 # 27 S9_SPC_OBS_TROPIC
 5 0 0 16 # 28 S10_MEX
#
#_age_selex_types
#_Pattern ___ Male Special
 11 0 0 0 # 1 F1_MEX
 11 0 0 0 # 2 F2_CAN
 11 0 0 0 # 3 F3_CHINA
 11 0 0 0 # 4 F4_JPN_KK_SH
 11 0 0 0 # 5 F5_JPN_KK_DP
 11 0 0 0 # 6 F6_JPN_ENY_SHL
 11 0 0 0 # 7 F7_JPN_ENY_DP
 11 0 0 0 # 8 F8_JPN_LG_MESH
 11 0 0 0 # 9 F9_JPN_CST_Oth
 11 0 0 0 # 10 F10_JPN_SM_MESH
 11 0 0 0 # 11 F11_IATTC
 11 0 0 0 # 12 F12_KOREA
 11 0 0 0 # 13 F13_NON_ISC
 11 0 0 0 # 14 F14_USA_GIILL
 11 0 0 0 # 15 F15_USA_SPORT
 11 0 0 0 # 16 F16_USA_Lonline
 11 0 0 0 # 17 F17_TAIW_LG
 11 0 0 0 # 18 F18_TAIW_SM
 11 0 0 0 # 19 S1_HW_DP
 11 0 0 0 # 20 S2_HW_SH
 11 0 0 0 # 21 S3_TAIW_LG
 11 0 0 0 # 22 S4_TAIW_SM
 11 0 0 0 # 23 S5_JPN_EARLY
```

```
 11 0 0 0 # 24 S6_JPN_LATE
 11 0 0 0 # 25 S7_JPN_RTV
 11 0 0 0 # 26 S8_SPC_OBS
 11 0 0 0 # 27 S9_SPC_OBS_TROPIC
 11 0 0 0 # 28 S10_MEX
#_LO HI INIT PRIOR PR_type SD PHASE env-var use_dev dev_minyr dev_maxyr dev_stddev Block Block_Fxn
 35 250 107.569 50 -1 0 -2 0 0 0 0 0.5 0 0 # SizeSel_1P_1_F1_MEX
 -15 15 -2.14736 0 -1 0 -4 0 0 0 0 0.5 0 0 # SizeSel_1P_2_F1_MEX
 -15 15 6.66179 0 -1 0 -4 0 0 0 0 0.5 0 0 # SizeSel_1P_3_F1_MEX
 -15 15 7.8109 0 -1 0 -4 0 0 0 0 0.5 0 0 # SizeSel_1P_4_F1_MEX
 -999 -999 -999 0 -1 0 -2 0 0 0 0 0.5 0 0 # SizeSel_1P_5_F1_MEX
 -999 -999 -999 0 -1 5 -2 0 0 0 0 0.5 0 0 # SizeSel_1P_6_F1_MEX
 -20 200 -14.3235 125 -1 50 -4 0 0 0 0 0 0 0 # SzSel_1Fem_Peak_F1_MEX
 -15 15 -0.433675 4 -1 50 -4 0 0 0 0 0 0 0 # SzSel_1Fem_Ascend_F1_MEX
 -15 15 0.0285828 4 -1 50 -4 0 0 0 0 0 0 0 # SzSel_1Fem_Descend_F1_MEX
 -15 15 0 4 -1 50 -4 0 0 0 0 0 0 0 # SzSel_1Fem_Final_F1_MEX
 -15 15 0.616069 4 -1 50 -5 0 0 0 0 0 0 0 # SzSel_1Fem_Scale_F1_MEX
 -1 200 -1 50 0 99 -2 0 0 0 0 0.5 0 0 # SizeSel_2P_1_F2_CAN
 -1 239 -1 50 0 99 -3 0 0 0 0 0.5 0 0 # SizeSel_2P_2_F2_CAN
 35 250 176.001 50 -1 0 -2 0 0 0 0 0.5 0 0 # SizeSel_3P_1_F3_CHINA
 -15 15 -11.3121 0 -1 0 -4 0 0 0 0 0.5 0 0 # SizeSel_3P_2_F3_CHINA
 -15 15 6.5661 0 -1 0 -4 0 0 0 0 0.5 0 0 # SizeSel_3P_3_F3_CHINA
 -15 15 6.73146 0 -1 0 -4 0 0 0 0 0.5 0 0 # SizeSel_3P_4_F3_CHINA
 -999 -999 -999 0 -1 0 -2 0 0 0 0 0.5 0 0 # SizeSel_3P_5_F3_CHINA
 -999 -999 -999 0 -1 5 -2 0 0 0 0 0.5 0 0 # SizeSel_3P_6_F3_CHINA
 -20 200 -15.6551 125 -1 50 -4 0 0 0 0 0 0 0 # SzSel_3Fem_Peak_F3_CHINA
 -15 15 -0.749136 4 -1 50 -4 0 0 0 0 0 0 0 # SzSel_3Fem_Ascend_F3_CHINA
 -15 15 -0.123124 4 -1 50 -4 0 0 0 0 0 0 0 # SzSel_3Fem_Descend_F3_CHINA
 -15 15 0 4 -1 50 -4 0 0 0 0 0 0 0 # SzSel_3Fem_Final_F3_CHINA
 -15 15 0.569452 4 -1 50 -5 0 0 0 0 0 0 0 # SzSel_3Fem_Scale_F3_CHINA
 35 250 149.478 50 -1 0 -2 0 0 0 0 0.5 0 0 # SizeSel_4P_1_F4_JPN_KK_SH
 -15 15 -11.2592 0 -1 0 -3 0 0 0 0 0.5 0 0 # SizeSel_4P_2_F4_JPN_KK_SH
 -15 15 6.8872 0 -1 0 -3 0 0 0 0 0.5 0 0 # SizeSel_4P_3_F4_JPN_KK_SH
 -15 15 6.91703 0 -1 0 -3 0 0 0 0 0.5 0 0 # SizeSel_4P_4_F4_JPN_KK_SH
 -999 -999 -999 0 -1 0 -3 0 0 0 0 0.5 0 0 # SizeSel_4P_5_F4_JPN_KK_SH
 -999 -999 -999 0 -1 5 -3 0 0 0 0 0.5 0 0 # SizeSel_4P_6_F4_JPN_KK_SH
 -20 200 1.00329 0 -1 50 -4 0 0 0 0 0 0 0 # SzSel_4Fem_Peak_F4_JPN_KK_SH
 -15 15 -0.423628 4 -1 50 -4 0 0 0 0 0 0 0 # SzSel_4Fem_Ascend_F4_JPN_KK_SH
 -15 15 -0.944438 4 -1 50 -4 0 0 0 0 0 0 0 # SzSel_4Fem_Descend_F4_JPN_KK_SH
 -15 15 0 4 -1 50 -4 0 0 0 0 0 0 0 # SzSel_4Fem_Final_F4_JPN_KK_SH
 -15 15 0.373 4 -1 50 -5 0 0 0 0 0 0 0 # SzSel_4Fem_Scale_F4_JPN_KK_SH
 35 250 140.929 50 -1 0 -2 0 0 0 0 0.5 0 0 # SizeSel_5P_1_F5_JPN_KK_DP
 -15 15 -10.7582 0 -1 0 -3 0 0 0 0 0.5 0 0 # SizeSel_5P_2_F5_JPN_KK_DP
 -15 15 6.02712 0 -1 0 -4 0 0 0 0 0.5 0 0 # SizeSel_5P_3_F5_JPN_KK_DP
 -15 15 4.01409 0 -1 0 -4 0 0 0 0 0.5 0 0 # SizeSel_5P_4_F5_JPN_KK_DP
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-999 -999 -999 0 -1 0 -2 0 0 0 0 0.5 0 0 # SizeSel_5P_5_F5_JPN_KK_DP
-999 -999 -999 0 -1 5 -2 0 0 0 0 0.5 0 0 # SizeSel_5P_6_F5_JPN_KK_DP
-80 200 -19.5741 125 -1 50 -4 0 0 0 0 0 0 0 # SzSel_5Male_Peak_F5_JPN_KK_DP
-15 15 -0.40707 4 -1 50 -4 0 0 0 0 0 0 0 # SzSel_5Male_Ascend_F5_JPN_KK_DP
-15 15 3.42765 4 -1 50 -4 0 0 0 0 0 0 0 # SzSel_5Male_Descend_F5_JPN_KK_DP
-15 15 0 4 -1 50 -4 0 0 0 0 0 0 0 # SzSel_5Male_Final_F5_JPN_KK_DP
-15 15 0.286519 4 -1 50 -5 0 0 0 0 0 0 0 # SzSel_5Male_Scale_F5_JPN_KK_DP
-1 200 -1 50 0 99 -2 0 0 0 0 0.5 0 0 # SizeSel_6P_1_F6_JPN_ENY_SHL
-1 239 -1 50 0 99 -3 0 0 0 0 0.5 0 0 # SizeSel_6P_2_F6_JPN_ENY_SHL
35 250 167.62 50 -1 0 -2 0 0 0 0 0.5 0 0 # SizeSel_7P_1_F7_JPN_ENY_DP
-15 15 -13.4612 0 -1 0 -4 0 0 0 0 0.5 0 0 # SizeSel_7P_2_F7_JPN_ENY_DP
-15 15 6.68388 0 -1 0 -4 0 0 0 0 0.5 0 0 # SizeSel_7P_3_F7_JPN_ENY_DP
-15 15 6.61903 0 -1 0 -4 0 0 0 0 0.5 0 0 # SizeSel_7P_4_F7_JPN_ENY_DP
-999 -999 -999 0 -1 0 -2 0 0 0 0 0.5 0 0 # SizeSel_7P_5_F7_JPN_ENY_DP
-999 -999 -999 0 -1 5 -2 0 0 0 0 0.5 0 0 # SizeSel_7P_6_F7_JPN_ENY_DP
-20 200 -10.5668 125 -1 50 -4 0 0 0 0 0 0 0 # SzSel_7Fem_Peak_F7_JPN_ENY_DP
-15 15 -0.458993 4 -1 50 -4 0 0 0 0 0 0 0 # SzSel_7Fem_Ascend_F7_JPN_ENY_DP
-15 15 -0.304803 4 -1 50 -4 0 0 0 0 0 0 0 # SzSel_7Fem_Descend_F7_JPN_ENY_DP
-15 15 0 4 -1 50 -4 0 0 0 0 0 0 0 # SzSel_7Fem_Final_F7_JPN_ENY_DP
-15 15 0.605116 4 -1 50 -5 0 0 0 0 0 0 0 # SzSel_7Fem_Scale_F7_JPN_ENY_DP
35 250 93.7113 120 -1 0 -2 0 0 0 0 0.5 3 2 # SizeSel_8P_1_F8_JPN_LG_MESH
-15 15 -11.4652 0 -1 0 -3 0 0 0 0 0.5 0 0 # SizeSel_8P_2_F8_JPN_LG_MESH
-15 15 6.98853 5 -1 0 -4 0 0 0 0 0.5 0 0 # SizeSel_8P_3_F8_JPN_LG_MESH
-15 15 7.63297 5 -1 0 -4 0 0 0 0 0.5 0 0 # SizeSel_8P_4_F8_JPN_LG_MESH
-999 -999 -999 0 -1 0 -3 0 0 0 0 0.5 0 0 # SizeSel_8P_5_F8_JPN_LG_MESH
-999 -999 -999 0 -1 5 -3 0 0 0 0 0.5 0 0 # SizeSel_8P_6_F8_JPN_LG_MESH
-20 200 199.929 125 -1 50 -4 0 0 0 0 0 3 2 # SzSel_8Fem_Peak_F8_JPN_LG_MESH
-15 15 0.43795 4 -1 50 -4 0 0 0 0 0 0 0 # SzSel_8Fem_Ascend_F8_JPN_LG_MESH
-15 15 -0.420024 4 -1 50 -4 0 0 0 0 0 0 0 # SzSel_8Fem_Descend_F8_JPN_LG_MESH
-15 15 0 4 -1 50 -4 0 0 0 0 0 0 0 # SzSel_8Fem_Final_F8_JPN_LG_MESH
-15 15 0.397245 4 -1 50 -5 0 0 0 0 0 0 0 # SzSel_8Fem_Scale_F8_JPN_LG_MESH
-1 200 -1 50 0 99 -2 0 0 0 0 0.5 0 0 # SizeSel_9P_1_F9_JPN_CST_Oth
-1 239 -1 50 0 99 -3 0 0 0 0 0.5 0 0 # SizeSel_9P_2_F9_JPN_CST_Oth
35 250 50 120 -1 0 -2 0 0 0 0 0.5 0 0 # SizeSel_10P_1_F10_JPN_SM_MESH
-15 15 -9 0 -1 0 -3 0 0 0 0 0.5 0 0 # SizeSel_10P_2_F10_JPN_SM_MESH
-15 15 5.5 5 -1 0 -4 0 0 0 0 0.5 0 0 # SizeSel_10P_3_F10_JPN_SM_MESH
-15 15 6.85 5 -1 0 -4 0 0 0 0 0.5 0 0 # SizeSel_10P_4_F10_JPN_SM_MESH
-999 -999 -999 0 -1 0 -3 0 0 0 0 0.5 0 0 # SizeSel_10P_5_F10_JPN_SM_MESH
-999 -999 -999 0 -1 4 -3 0 0 0 0 0.5 0 0 # SizeSel_10P_6_F10_JPN_SM_MESH
-1 200 -1 50 0 99 -2 0 0 0 0 0.5 0 0 # SizeSel_11P_1_F11_IATTC
-1 239 -1 50 0 99 -3 0 0 0 0 0.5 0 0 # SizeSel_11P_2_F11_IATTC
-1 200 -1 50 0 99 -2 0 0 0 0 0.5 0 0 # SizeSel_12P_1_F12_KOREA
-1 239 -1 50 0 99 -3 0 0 0 0 0.5 0 0 # SizeSel_12P_2_F12_KOREA
-1 200 -1 50 0 99 -2 0 0 0 0 0.5 0 0 # SizeSel_13P_1_F13_NON_ISC
-1 239 -1 50 0 99 -3 0 0 0 0 0.5 0 0 # SizeSel_13P_2_F13_NON_ISC
28 250 71.6705 50 -1 0 -3 0 0 0 0 0.5 2 2 # SizeSel_14P_1_F14_USA_GIILL

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-15 15 -1.79392 0 -1 0 -3 0 0 0 0 0.5 2 2 # SizeSel_14P_2_F14_USA_GIILL
-15 15 5.10038 0 -1 0 -3 0 0 0 0 0.5 2 2 # SizeSel_14P_3_F14_USA_GIILL
-15 15 8.21058 0 -1 0 -3 0 0 0 0 0.5 2 2 # SizeSel_14P_4_F14_USA_GIILL
-999 -999 -999 0 -1 0 -3 0 0 0 0 0.5 0 0 # SizeSel_14P_5_F14_USA_GIILL
-999 -999 -999 0 -1 0 -3 0 0 0 0 0.5 0 0 # SizeSel_14P_6_F14_USA_GIILL
-20 200 -1.64024 0 -1 50 -4 0 0 0 0 0 2 2 # SzSel_14Fem_Peak_F14_USA_GIILL
-15 15 0.125513 4 -1 50 -4 0 0 0 0 0 2 2 # SzSel_14Fem_Ascend_F14_USA_GIILL
-15 15 -1.15205 4 -1 50 -4 0 0 0 0 0 2 2 # SzSel_14Fem_Descend_F14_USA_GIILL
-15 15 0 4 -1 50 -4 0 0 0 0 0 2 2 # SzSel_14Fem_Final_F14_USA_GIILL
-15 15 0.761591 4 -1 50 -5 0 0 0 0 0 2 2 # SzSel_14Fem_Scale_F14_USA_GIILL
-1 200 -1 50 0 99 -2 0 0 0 0 0.5 0 0 # SizeSel_15P_1_F15_USA_SPORT
-1 239 -1 50 0 99 -3 0 0 0 0 0.5 0 0 # SizeSel_15P_2_F15_USA_SPORT
35 250 175.066 50 -1 0 -3 0 0 0 0 0.5 1 2 # SizeSel_16P_1_F16_USA_Lonline
-15 15 -12.506 0 -1 0 -3 0 0 0 0 0.5 1 2 # SizeSel_16P_2_F16_USA_Lonline
-15 15 7.12695 0 -1 0 -3 0 0 0 0 0.5 1 2 # SizeSel_16P_3_F16_USA_Lonline
-15 15 6.91078 0 -1 0 -3 0 0 0 0 0.5 1 2 # SizeSel_16P_4_F16_USA_Lonline
-999 -999 -999 0 -1 0 -3 0 0 0 0 0.5 0 0 # SizeSel_16P_5_F16_USA_Lonline
-999 -999 -999 0 -1 0 -3 0 0 0 0 0.5 0 0 # SizeSel_16P_6_F16_USA_Lonline
-80 200 -24.6289 0 -1 50 -4 0 0 0 0 0 1 2 # SzSel_16Fem_Peak_F16_USA_Lonline
-15 15 -1.744 4 -1 50 -4 0 0 0 0 0 1 2 # SzSel_16Fem_Ascend_F16_USA_Lonline
-15 15 -0.61431 4 -1 50 -4 0 0 0 0 0 1 2 # SzSel_16Fem_Descend_F16_USA_Lonline
-15 15 0 4 -1 50 -4 0 0 0 0 0 1 2 # SzSel_16Fem_Final_F16_USA_Lonline
-15 15 0.906815 4 -1 50 -5 0 0 0 0 0 1 2 # SzSel_16Fem_Scale_F16_USA_Lonline
35 250 214.514 50 -1 0 -2 0 1 2004 2014 0.6 0 0 # SizeSel_17P_1_F17_TAIW_LG
-15 15 -12.2925 0 -1 0 -3 0 0 0 0 0.5 0 0 # SizeSel_17P_2_F17_TAIW_LG
-15 15 7.27247 0 -1 0 -3 0 0 0 0 0.5 0 0 # SizeSel_17P_3_F17_TAIW_LG
-15 15 6.51858 0 -1 0 -3 0 0 0 0 0.5 0 0 # SizeSel_17P_4_F17_TAIW_LG
-999 -999 -999 0 -1 0 -3 0 0 0 0 0.5 0 0 # SizeSel_17P_5_F17_TAIW_LG
-999 -999 -999 0 -1 5 -3 0 0 0 0 0.5 0 0 # SizeSel_17P_6_F17_TAIW_LG
-80 200 -13.2409 9 -1 50 -4 0 1 2004 2014 0.6 0 0 # SzSel_17Fem_Peak_F17_TAIW_LG
-15 15 0.0214591 4 -1 50 -4 0 0 0 0 0 0 0 # SzSel_17Fem_Ascend_F17_TAIW_LG
-15 15 0.806742 4 -1 50 -4 0 0 0 0 0 0 0 # SzSel_17Fem_Descend_F17_TAIW_LG
-15 15 0 4 -1 50 -4 0 0 0 0 0 0 0 # SzSel_17Fem_Final_F17_TAIW_LG
-15 15 0.503711 4 -1 50 -5 0 0 0 0 0 0 0 # SzSel_17Fem_Scale_F17_TAIW_LG
-1 200 -1 50 0 99 -2 0 0 0 0 0.5 0 0 # SizeSel_18P_1_F18_TAIW_SM
-1 239 -1 50 0 99 -3 0 0 0 0 0.5 0 0 # SizeSel_18P_2_F18_TAIW_SM
-1 200 -1 50 0 99 -2 0 0 0 0 0.5 0 0 # SizeSel_19P_1_S1_HW_DP
-1 239 -1 50 0 99 -3 0 0 0 0 0.5 0 0 # SizeSel_19P_2_S1_HW_DP
-1 200 -1 50 0 99 -2 0 0 0 0 0.5 0 0 # SizeSel_20P_1_S2_HW_SH
-1 239 -1 50 0 99 -3 0 0 0 0 0.5 0 0 # SizeSel_20P_2_S2_HW_SH
-1 200 -1 50 0 99 -2 0 0 0 0 0.5 0 0 # SizeSel_21P_1_S3_TAIW_LG
-1 239 -1 50 0 99 -3 0 0 0 0 0.5 0 0 # SizeSel_21P_2_S3_TAIW_LG
-1 200 -1 50 0 99 -2 0 0 0 0 0.5 0 0 # SizeSel_22P_1_S4_TAIW_SM
-1 239 -1 50 0 99 -3 0 0 0 0 0.5 0 0 # SizeSel_22P_2_S4_TAIW_SM
-1 200 -1 50 0 99 -2 0 0 0 0 0.5 0 0 # SizeSel_23P_1_S5_JPN_EARLY
-1 239 -1 50 0 99 -3 0 0 0 0 0.5 0 0 # SizeSel_23P_2_S5_JPN_EARLY
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-1 200 -1 50 0 99 -2 0 0 0 0 0.5 0 0 # SizeSel_24P_1_S6_JPN_LATE
-1 239 -1 50 0 99 -3 0 0 0 0 0.5 0 0 # SizeSel_24P_2_S6_JPN_LATE
-1 200 -1 50 0 99 -2 0 0 0 0 0.5 0 0 # SizeSel_25P_1_S7_JPN_RTV
-1 239 -1 50 0 99 -3 0 0 0 0 0.5 0 0 # SizeSel_25P_2_S7_JPN_RTV
-1 200 -1 50 0 99 -2 0 0 0 0 0.5 0 0 # SizeSel_26P_1_S8_SPC_OBS
-1 239 -1 50 0 99 -3 0 0 0 0 0.5 0 0 # SizeSel_26P_2_S8_SPC_OBS
-1 200 -1 50 0 99 -2 0 0 0 0 0.5 0 0 # SizeSel_27P_1_S9_SPC_OBS_TROPIC
-1 239 -1 50 0 99 -3 0 0 0 0 0.5 0 0 # SizeSel_27P_2_S9_SPC_OBS_TROPIC
-1 200 -1 50 0 99 -2 0 0 0 0 0.5 0 0 # SizeSel_28P_1_S10_MEX
-1 239 -1 50 0 99 -3 0 0 0 0 0.5 0 0 # SizeSel_28P_2_S10_MEX
0 40 0 1 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_1P_1_F1_MEX
1 40 36 3 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_1P_2_F1_MEX
0 40 0 1 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_2P_1_F2_CAN
1 40 36 3 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_2P_2_F2_CAN
0 40 0 1 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_3P_1_F3_CHINA
1 40 36 3 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_3P_2_F3_CHINA
0 40 0 1 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_4P_1_F4_JPN_KK_SH
1 40 36 3 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_4P_2_F4_JPN_KK_SH
0 40 0 1 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_5P_1_F5_JPN_KK_DP
1 40 36 3 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_5P_2_F5_JPN_KK_DP
0 40 0 1 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_6P_1_F6_JPN_ENY_SHL
1 40 36 3 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_6P_2_F6_JPN_ENY_SHL
0 40 0 1 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_7P_1_F7_JPN_ENY_DP
1 40 36 3 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_7P_2_F7_JPN_ENY_DP
0 40 0 1 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_8P_1_F8_JPN_LG_MESH
1 40 36 3 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_8P_2_F8_JPN_LG_MESH
0 40 0 1 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_9P_1_F9_JPN_CST_Oth
1 40 36 3 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_9P_2_F9_JPN_CST_Oth
0 40 0 1 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_10P_1_F10_JPN_SM_MESH
1 40 36 3 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_10P_2_F10_JPN_SM_MESH
0 40 0 1 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_11P_1_F11_IATTC
1 40 36 3 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_11P_2_F11_IATTC
0 40 0 1 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_12P_1_F12_KOREA
1 40 36 3 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_12P_2_F12_KOREA
0 40 0 1 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_13P_1_F13_NON_ISC
1 40 36 3 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_13P_2_F13_NON_ISC
0 40 0 1 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_14P_1_F14_USA_GIILL
1 40 36 3 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_14P_2_F14_USA_GIILL
0 40 0 1 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_15P_1_F15_USA_SPORT
1 40 36 3 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_15P_2_F15_USA_SPORT
0 40 0 1 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_16P_1_F16_USA_Lonline
1 40 36 3 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_16P_2_F16_USA_Lonline
0 40 0 1 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_17P_1_F17_TAIW_LG
1 40 36 3 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_17P_2_F17_TAIW_LG
0 40 0 1 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_18P_1_F18_TAIW_SM
1 40 36 3 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_18P_2_F18_TAIW_SM
```

```
 0 40 0 1 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_19P_1_S1_HW_DP
 1 40 36 3 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_19P_2_S1_HW_DP
 0 40 0 1 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_20P_1_S2_HW_SH
 1 40 36 3 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_20P_2_S2_HW_SH
 0 40 0 1 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_21P_1_S3_TAIW_LG
 1 40 36 3 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_21P_2_S3_TAIW_LG
 0 40 0 1 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_22P_1_S4_TAIW_SM
 1 40 36 3 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_22P_2_S4_TAIW_SM
 0 40 0 1 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_23P_1_S5_JPN_EARLY
 1 40 36 3 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_23P_2_S5_JPN_EARLY
 0 40 0 1 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_24P_1_S6_JPN_LATE
 1 40 36 3 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_24P_2_S6_JPN_LATE
 0 40 0 1 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_25P_1_S7_JPN_RTV
 1 40 36 3 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_25P_2_S7_JPN_RTV
 0 40 0 1 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_26P_1_S8_SPC_OBS
 1 40 36 3 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_26P_2_S8_SPC_OBS
 0 40 0 1 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_27P_1_S9_SPC_OBS_TROPIC
 1 40 36 3 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_27P_2_S9_SPC_OBS_TROPIC
 0 40 0 1 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_28P_1_S10_MEX
 1 40 36 3 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_28P_2_S10_MEX
#_Cond 0 #_custom_sel-env_setup (0/1)
#_Cond -2 2 0 0 -1 99 -2 #_placeholder when no enviro fxns
1 #_custom_sel-blk_setup (0/1)
 35 250 124.759 120 -1 0 -4 # SizeSel_8P_1_F8_JPN_LG_MESH_BLK3repl_2011
 35 250 137.433 120 -1 0 -4 # SizeSel_8P_1_F8_JPN_LG_MESH_BLK3repl_2012
 35 250 151.591 120 -1 0 -4 # SizeSel_8P_1_F8_JPN_LG_MESH_BLK3repl_2015
 -80 200 5.59217 125 -1 50 -4 # SzSel_8Fem_Peak_F8_JPN_LG_MESH_BLK3repl_2011
 -80 200 15.5773 125 -1 50 -4 # SzSel_8Fem_Peak_F8_JPN_LG_MESH_BLK3repl_2012
 -80 200 8.88025 125 -1 50 -4 # SzSel_8Fem_Peak_F8_JPN_LG_MESH_BLK3repl_2015
 28 250 66.9647 50 -1 0 -4 # SizeSel_14P_1_F14_USA_GIILL_BLK2repl_2001
 28 250 105.604 50 -1 0 -4 # SizeSel_14P_1_F14_USA_GIILL_BLK2repl_2006
 -15 15 -2.01978 0 -1 0 -4 # SizeSel_14P_2_F14_USA_GIILL_BLK2repl_2001
 -15 15 -2.50377 0 -1 0 -4 # SizeSel_14P_2_F14_USA_GIILL_BLK2repl_2006
 -15 15 5.15917 0 -1 0 -4 # SizeSel_14P_3_F14_USA_GIILL_BLK2repl_2001
 -15 15 7.02675 0 -1 0 -4 # SizeSel_14P_3_F14_USA_GIILL_BLK2repl_2006
 -15 15 7.99046 0 -1 0 -4 # SizeSel_14P_4_F14_USA_GIILL_BLK2repl_2001
 -15 15 8.19267 0 -1 0 -4 # SizeSel_14P_4_F14_USA_GIILL_BLK2repl_2006
 -20 200 -9.05969 0 -1 50 -4 # SzSel_14Fem_Peak_F14_USA_GIILL_BLK2repl_2001
 -20 200 -13.8313 0 -1 50 -4 # SzSel_14Fem_Peak_F14_USA_GIILL_BLK2repl_2006
 -15 15 -0.671407 4 -1 50 -4 # SzSel_14Fem_Ascend_F14_USA_GIILL_BLK2repl_2001
 -15 15 -0.185976 4 -1 50 -4 # SzSel_14Fem_Ascend_F14_USA_GIILL_BLK2repl_2006
 -15 15 -0.595235 4 -1 50 -4 # SzSel_14Fem_Descend_F14_USA_GIILL_BLK2repl_2001
 -15 15 -0.764 4 -1 50 -4 # SzSel_14Fem_Descend_F14_USA_GIILL_BLK2repl_2006
 -15 15 0 4 -1 50 -4 # SzSel_14Fem_Final_F14_USA_GIILL_BLK2repl_2001
 -15 15 0 4 -1 50 -4 # SzSel_14Fem_Final_F14_USA_GIILL_BLK2repl_2006
 -15 15 0.677926 -4 -1 50 5 # SzSel_14Fem_Scale_F14_USA_GIILL_BLK2repl_2001
```

```
 -15 15 0.51735 -4 -1 50 5 # SzSel_14Fem_Scale_F14_USA_GIILL_BLK2repl_2006
 35 250 175.472 50 -1 0 -4 # SizeSel_16P_1_F16_USA_Lonline_BLK1repl_2006
 -15 15 -11.2876 0 -1 0 -4 # SizeSel_16P_2_F16_USA_Lonline_BLK1repl_2006
 -15 15 8.2585 0 -1 0 -4 # SizeSel_16P_3_F16_USA_Lonline_BLK1repl_2006
 -15 15 6.75683 0 -1 0 -4 # SizeSel_16P_4_F16_USA_Lonline_BLK1repl_2006
 -20 200 -6.63413 0 -1 50 -4 # SzSel_16Fem_Peak_F16_USA_Lonline_BLK1repl_2006
 -15 15 -0.639806 4 -1 50 -4 # SzSel_16Fem_Ascend_F16_USA_Lonline_BLK1repl_2006
 -15 15 -0.785578 4 -1 50 -4 # SzSel_16Fem_Descend_F16_USA_Lonline_BLK1repl_2006
 -15 15 0 4 -1 50 -4 # SzSel_16Fem_Final_F16_USA_Lonline_BLK1repl_2006
 -15 15 1.04134 4 -1 50 -5 # SzSel_16Fem_Scale_F16_USA_Lonline_BLK1repl_2006
#_Cond No selex parm trends
# -0.125688 # SizeSel_17P_1_F17_TAIW_LG_DEVmult_2004
# 0.186549 # SizeSel_17P_1_F17_TAIW_LG_DEVmult_2005
# -0.0178081 # SizeSel_17P_1_F17_TAIW_LG_DEVmult_2006
# -0.0719272 # SizeSel_17P_1_F17_TAIW_LG_DEVmult_2007
# -0.0176166 # SizeSel_17P_1_F17_TAIW_LG_DEVmult_2008
# -0.0643772 # SizeSel_17P_1_F17_TAIW_LG_DEVmult_2009
# -0.120168 # SizeSel_17P_1_F17_TAIW_LG_DEVmult_2010
# -0.0434036 # SizeSel_17P_1_F17_TAIW_LG_DEVmult_2011
# -0.129672 # SizeSel_17P_1_F17_TAIW_LG_DEVmult_2012
# -0.16844 # SizeSel_17P_1_F17_TAIW_LG_DEVmult_2013
# -0.138844 # SizeSel_17P_1_F17_TAIW_LG_DEVmult_2014
# -0.25647 # SzSel_17Fem_Peak_F17_TAIW_LG_DEVmult_2004
# 1.19754 # SzSel_17Fem_Peak_F17_TAIW_LG_DEVmult_2005
# -0.656942 # SzSel_17Fem_Peak_F17_TAIW_LG_DEVmult_2006
# -0.0163554 # SzSel_17Fem_Peak_F17_TAIW_LG_DEVmult_2007
# 0.0114435 # SzSel_17Fem_Peak_F17_TAIW_LG_DEVmult_2008
# 0.175519 # SzSel_17Fem_Peak_F17_TAIW_LG_DEVmult_2009
# -0.246714 # SzSel_17Fem_Peak_F17_TAIW_LG_DEVmult_2010
# -0.527916 # SzSel_17Fem_Peak_F17_TAIW_LG_DEVmult_2011
# 0.372634 # SzSel_17Fem_Peak_F17_TAIW_LG_DEVmult_2012
# -0.130654 # SzSel_17Fem_Peak_F17_TAIW_LG_DEVmult_2013
# 0.0689781 # SzSel_17Fem_Peak_F17_TAIW_LG_DEVmult_2014
6 #_selparmdev-phase
1 #_env/block/dev_adjust_method (1=standard; 2=logistic trans to keep in base parm bounds;
3=standard w/ no bound check)
#
# Tag loss and Tag reporting parameters go next
0    # TG_custom:    0=no read; 1=read if tags exist
#_Cond -6 6 1 1 2 0.01 -4 0 0 0 0 0 0 0    #_placeholder if no parameters
#
1 #_Variance_adjustments_to_input_values
#_fleet: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28
  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 #_add_to_survey_CV
  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 #_add_to_discard_stddev
  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 #_add_to_bodywt_CV
```

```
  0.49 1 1 1 0.408 1 1 1 1 1 1 1 1 1 1 0.85 1 1 1 1 1 1 1 1 1 1 1 1 #_mult_by_lencomp_N
  1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 #_mult_by_agecomp_N
  1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 #_mult_by_size-at-age_N
#
1 #_maxlambdaphase
1 #_sd_offset
#
58 # number of changes to make to default Lambdas (default value is 1.0)
# Like_comp codes:  1=surv; 2=disc; 3=mnwt; 4=length; 5=age; 6=SizeFreq; 7=sizeage;
8=catch;
# 9=init_equ_catch; 10=recrdev; 11=parm_prior; 12=parm_dev; 13=CrashPen; 14=Morphcomp;
15=Tag-comp; 16=Tag-negbin
#like_comp fleet/survey  phase  value  sizefreq_method
 1 1 1 0 1
 1 2 1 0 1
 1 3 1 0 1
 1 4 1 0 1
 1 5 1 0 1
 1 6 1 0 1
 1 7 1 0 1
 1 8 1 0 1
 1 9 1 0 1
 1 10 1 0 1
 1 11 1 0 1
 1 12 1 0 1
 1 13 1 0 1
 1 14 1 0 1
 1 15 1 0 1
 1 16 1 0 1
 1 17 1 0 1
 1 18 1 0 1
 1 19 1 0 1
 1 20 1 0 1
 1 21 1 0 1
 1 22 1 0 1
 1 23 1 1 1
 1 24 1 1 1
 1 25 1 0 1
 1 26 1 0 1
 1 27 1 0 1
 1 28 1 0 1
 4 1 1 1 0
 4 2 1 0 0
 4 3 1 1 0
 4 4 1 1 0
 4 5 1 1 0
```

```
 4 6 1 0 0
 4 7 1 1 0
 4 8 1 1 0
 4 9 1 0 0
 4 10 1 0 0
 4 11 1 0 0
 4 12 1 0 0
 4 13 1 0 0
 4 14 1 1 0
 4 15 1 0 0
 4 16 1 1 0
 4 17 1 1 0
 4 18 1 0 0
 4 19 1 0 0
 4 20 1 0 0
 4 21 1 0 0
 4 22 1 0 0
 4 23 1 0 0
 4 24 1 0 0
 4 25 1 0 0
 4 26 1 0 0
 4 27 1 0 0
 4 28 1 0 0
 9 1 1 1 0
 12 1 1 1 0
#
# lambdas (for info only; columns are phases)
#    0 #_CPUE/survey:_1
#    0 #_CPUE/survey:_2
#    0 #_CPUE/survey:_3
#    0 #_CPUE/survey:_4
#    0 #_CPUE/survey:_5
#    0 #_CPUE/survey:_6
#    0 #_CPUE/survey:_7
#    0 #_CPUE/survey:_8
#    0 #_CPUE/survey:_9
#    0 #_CPUE/survey:_10
#    0 #_CPUE/survey:_11
#    0 #_CPUE/survey:_12
#    0 #_CPUE/survey:_13
#    0 #_CPUE/survey:_14
#    0 #_CPUE/survey:_15
#    0 #_CPUE/survey:_16
#    0 #_CPUE/survey:_17
#    0 #_CPUE/survey:_18
#    0 #_CPUE/survey:_19
```

```
#    0 #_CPUE/survey:_20
#    0 #_CPUE/survey:_21
#    0 #_CPUE/survey:_22
#    1 #_CPUE/survey:_23
#    1 #_CPUE/survey:_24
#    0 #_CPUE/survey:_25
#    0 #_CPUE/survey:_26
#    0 #_CPUE/survey:_27
#    0 #_CPUE/survey:_28
#    1 #_lencomp:_1
#    0 #_lencomp:_2
#    1 #_lencomp:_3
#    1 #_lencomp:_4
#    1 #_lencomp:_5
#    0 #_lencomp:_6
#    1 #_lencomp:_7
#    1 #_lencomp:_8
#    0 #_lencomp:_9
#    0 #_lencomp:_10
#    0 #_lencomp:_11
#    0 #_lencomp:_12
#    0 #_lencomp:_13
#    1 #_lencomp:_14
#    0 #_lencomp:_15
#    1 #_lencomp:_16
#    1 #_lencomp:_17
#    0 #_lencomp:_18
#    0 #_lencomp:_19
#    0 #_lencomp:_20
#    0 #_lencomp:_21
#    0 #_lencomp:_22
#    0 #_lencomp:_23
#    0 #_lencomp:_24
#    0 #_lencomp:_25
#    0 #_lencomp:_26
#    0 #_lencomp:_27
#    0 #_lencomp:_28
#    1 #_init_equ_catch
#    1 #_recruitments
#    1 #_parameter-priors
#    1 #_parameter-dev-vectors
#    1 #_crashPenLambda
0 # (0/1) read specs for more stddev reporting
 # 0 1 -1 5 1 5 1 -1 5 # placeholder for selex type, len/age, year, N selex bins, Growth pattern, N growth ages, NatAge_area(-1 for all), NatAge_yr, N Natages
 # placeholder for vector of selex bins to be reported
```

 # placeholder for vector of growth ages to be reported
 # placeholder for vector of NatAges ages to be reported
999

12.2.3 SS Forecast File

#C generic forecast file
for all year entries except rebuilder; enter either: actual year, -999 for styr, 0 for endyr, neg number for rel. endyr
1 # Benchmarks: 0=skip; 1=calc F_spr,F_btgt,F_msy
2 # MSY: 0=none; 1= set to F(SPR); 2=calc F(MSY); 3=set to F(Btgt); 4=set to F(endyr)
0.4 # SPR target (e.g. 0.40) # old value was 0.349641857 possibly a early calc of % bio
0.4 # Biomass target (e.g. 0.40)
#_Bmark_years: beg_bio, end_bio, beg_selex, end_selex, beg_relF, end_relF (enter actual year, or values of 0 or -integer to be rel. endyr)
 0 0 0 0 2005 2013
 # 2001 2001 2001 2001 2001 2001 # after processing
1 #Bmark_relF_Basis: 1 = use year range; 2 = set relF same as forecast below
#
4 # Forecast: 0=none; 1=F(SPR); 2=F(MSY) 3=F(Btgt); 4=Ave F (uses first-last relF yrs); 5=input annual F scalar
10 # N forecast years
1 # F scalar (only used for Do_Forecast==5)
#_Fcast_years: beg_selex, end_selex, beg_relF, end_relF (enter actual year, or values of 0 or -integer to be rel. endyr)
 2015 2017 2015 2017
2001 2001 1991 2001 # after processing
1 # Control rule method (1=catch=f(SSB) west coast; 2=F=f(SSB))
0.4 # Control rule Biomass level for constant F (as frac of Bzero, e.g. 0.40)
0.1 # Control rule Biomass level for no F (as frac of Bzero, e.g. 0.10)
0.75 # Control rule target as fraction of Flimit (e.g. 0.75)
3 #_N forecast loops (1-3) (fixed at 3 for now)
3 #_First forecast loop with stochastic recruitment
0 #_Forecast loop control #3 (reserved for future bells&whistles)
0 #_Forecast loop control #4 (reserved for future bells&whistles)
0 #_Forecast loop control #5 (reserved for future bells&whistles)
0 #FirstYear for caps and allocations (should be after years with fixed inputs)
0 # stddev of log(realized catch/target catch) in forecast (set value>0.0 to cause active impl_error)
0 # Do West Coast gfish rebuilder output (0/1)
-1 # Rebuilder: first year catch could have been set to zero (Ydecl)(-1 to set to 1999)
-1 # Rebuilder: year for current age structure (Yinit) (-1 to set to endyear+1)

1 # fleet relative F: 1=use first-last alloc year; 2=read seas(row) x fleet(col) below
Note that fleet allocation is used directly as average F if Do_Forecast=4
2 # basis for fcast catch tuning and for fcast catch caps and allocation (2=deadbio; 3=retainbio; 5=deadnum; 6=retainnum)
Conditional input if relative F choice = 2

Fleet relative F: rows are seasons, columns are fleets
#_Fleet: FISHERY1
1
max totalcatch by fleet (-1 to have no max)
-1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
max totalcatch by area (-1 to have no max)
-1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
fleet assignment to allocation group (enter group ID# for each fleet, 0 for not included in an alloc group)
0
#_Conditional on >1 allocation group
allocation fraction for each of: 0 allocation groups
no allocation groups
0 # Number of forecast catch levels to input (else calc catch from forecast F)
2 # basis for input Fcast catch: 2=dead catch; 3=retained catch; 99=input Hrate(F) (units are from fleetunits; note new codes in SSV3.20)
Input fixed catch values
#Year Seas Fleet Catch(or_F)

#
999 # verify end of input

12.2.4 SS Starter File

BSH_n20.dat
BSH_n20.ctl
0 # 0=use init values in control file; 1=use ss2.par
1 # run display detail (0,1,2)
1 # detailed age-structured reports in REPORT.SSO (0,1)
0 # write detailed checkup.sso file (0,1)
0 # write parm values to ParmTrace.sso (0=no,1=good,active; 2=good,all; 3=every_iter,all_parms; 4=every,active)
0 # write to cumreport.sso (0=no,1=like&timeseries; 2=add survey fits)
0 # Include prior_like for non-estimated parameters (0,1)
1 # Use Soft Boundaries to aid convergence (0,1) (recommended)
0 # Number of bootstrap datafiles to produce
100 # Turn off estimation for parameters entering after this phase
10 # MCMC burn interval
2 # MCMC thin interval
0 # jitter initial parm value by this fraction
-1 # min yr for sdreport outputs (-1 for styr)
-2 # max yr for sdreport outputs (-1 for endyr; -2 for endyr+Nforecastyrs)
0 # N individual STD years
vector of year values
1973 1976
1e-004 # final convergence criteria (e.g. 1.0e-04)
0 # retrospective year relative to end year (e.g. -4)
0 # min age for calc of summary biomass

1 # Depletion basis: denom is: 0=skip; 1=rel X*B0; 2=rel X*Bmsy; 3=rel X*B_styr
1 # Fraction (X) for Depletion denominator (e.g. 0.4)
2 # SPR_report_basis: 0=skip; 1=(1-SPR)/(1-SPR_tgt); 2=(1-SPR)/(1-SPR_MSY); 3=(1-SPR)/(1-SPR_Btarget); 4=rawSPR
3 # F_report_units: 0=skip; 1=exploitation(Bio); 2=exploitation(Num); 3=sum(Frates)
2 # F_report_basis: 0=raw; 1=F/Fspr; 2=F/Fmsy ; 3=F/Fbtgt
999 # check value for end of file