PACIFIC SARDINE REBUILDING ANALYSIS BASED ON THE 2020 STOCK ASSESSMENT

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Introduction

The Pacific sardine (*Sardinops sagax caerulea*) northern subpopulation (NSP) has been managed under the PFMC's CPS-FMP since 2000. Stock assessments have been conducted to support annual management specifications since 1995. The stock underwent a rapid increase throughout the 1980s and 1990s, peaking in 2000 and again in 2005, and declining from 2006 to present low levels. The stock was declared overfished in June 2019. The following analysis, the first of its kind for Pacific sardine, evaluates harvest alternatives for the full rebuilding plan.

Overview of the 2020 benchmark stock assessment

The 2020 benchmark assessment (Kuriyama et al. 2020) was developed using Stock Synthesis (SS version 3.30.14) and included fishery and survey data collected from mid-2005 through 2019. The model was based on a July-June biological year (aka 'model year'), with two semester-based seasons per year (S1=Jul- Dec and S2=Jan-Jun). Catches and biological samples for the fisheries off ENS, SCA, and CCA were pooled into a single MexCAL fleet, for which selectivity was modeled separately in each season (S1 and S2). Catches and biological samples from OR, WA, and BC were modeled by season as a single Pacific Northwest (PNW) fleet. A single AT survey index of abundance from ongoing SWFSC surveys (2006-2019) was included in the model.

The 2020 base assessment model incorporated the following specifications:

- Sexes were combined; ages 0-8+.
- Two fisheries (MexCal and PacNW fleets), with an annual selectivity pattern for the PNW fleet and seasonal selectivity patterns (S1 and S2) for the MexCal fleet.
- MexCal fleets: domed age-based selectivity (time-varying and non-parametric [option 17 in Stock Synthesis]).
- PNW fleet: asymptotic age-based selectivity (time-varying for the inflection point).
- AT survey age compositions with effective sample sizes set to 1 per cluster (externally).
- Age compositions for the spring AT survey omitted.
- Fishery age compositions with effective sample sizes calculated by dividing the number of fish sampled by 25 (externally) and lambda weighting=1 (internally);
- Initial equilibrium ("SR regime" parameter) estimated with the 'lambda' for this parameter set to zero (no penalty contributing to total likelihood estimate).
- Natural mortality (M) estimated with a prior.
- Recruitment deviations estimated from 2005-2018.
- Virgin recruitment estimated, and total recruitment variability (σR) fixed at 1.2.
- Beverton-Holt stock-recruitment relationship with steepness fixed at h=0.3.
- Initial fishing mortality (F) estimated for the MexCal S1 fleet and assumed to be 0 for the other fleets.
- F for the 2020-1 to 2020-2 model years set to those for the 2018 (S2) and 2019 (S1) model years.
- AT survey biomass 2006-2019, partitioned into two (spring and summer) surveys, with catchability (Q) set to 1 for 2005-2014 and 0.733 for 2015-2019.
- AT survey selectivity is assumed to be uniform (fully selected) above age 1 and estimated annually for age-0.

Spawning biomass, recruitment, and stock biomass (ages 1+) time series from the 2020 benchmark stock assessment are shown in Figures 1-3, respectively.

Recent management performance

The Pacific sardine NSP underwent a decline beginning in 2006. The directed commercial fishery was closed in July 2015 when age 1+ biomass dropped below 150,000 mt 'Cutoff' threshold in the harvest guideline control rule. The stock dropped below the 50,000 mt minimum stock size threshold (MSST) in 2019 and was declared overfished in June 2019. OFLs, ABCs, ACTs, and realized landings (total and NSP) since the 2015-16 management year are provided in Table 1. Ensenada landings of NSP sardine, also included in this analysis, are provided in Table 1.

Rebuilding calculations

1. Rebuilding software: Pacific sardine rebuilding analyses were conducted using Rebuilder package version 3.12g (June 2020). Rebuilder is an age-structured population dynamics simulator that projects the population forward in time, accounting for recruitment, growth, natural mortality, and fishing mortality. It calculates the probabilities of rebuilding the stock to SB_{MSY} (rebuilt) for a given range of recruitment and fishing scenarios. Rebuilder was written by Dr. Andre Punt for conducting groundfish rebuilding analyses (Punt 2012) and recently revised to allow for projections based on Pacific sardine harvest control rules. Sardine rebuilding analyses were conducted from March through July 2020, and the SSC provided recommendations for revisions to the analysis at their June 2020 meeting. Subsequently, the SSC's CPS Subcommittee held a meeting July 15-16 to review preliminary rebuilding model results. Both the SSC and CPS Subcommittee recommendations have been incorporated in the following analyses. The Rebuild.dat file is provided in Appendix A, and the multiple parameter line file (Rebuild_samp.sso), used to set starting values and target depletion levels over a range of steepness values, is provided in Appendix B.

2. Definition of SB_0: SB_0 was estimated with Rebuilder by averaging recruitments over two ranges of model years to characterize outcomes based two states of nature. The first, '$SB_{0(2005\text{-}18)}$', was based on all estimated recruitments from the assessment model (2005-18), and the second scenario, '$SB_{0(2010\text{-}18)}$' based on a subset of years with low recruitments (2010-18). Resulting distributions of SB_0 for the two productivity scenarios are shown in Figure 4. Average SB_0 was 377,567 mt for the $SB_{0(2005\text{-}18)}$ model and 104,445 mt for the $SB_{0(2010\text{-}18)}$ model.

3. Biological data: Biological data by age were taken from Kuriyama et al. (2020). Data included natural mortality rate, weight-at-age, maturity-at-age, fecundity-at-age, selectivity-at-age, population numbers-at-age for 2019 (year declared overfished), and population numbers-at-age for the 2020. Vectors of biology-at-age are provided in Table 2. Mean generation time in this rebuilding analysis was estimated to be 3 years. In order to transition the modeled time step from seasonal (SS) to annual (Rebuilder), it was necessary to change fecundity at age zero from 0.0046 to 0.0000 (Table 2). Net spawning output-at-age is highest at age-2 (Figure 5). Natural mortality rate was ~0.584 for all ages, but this value varied slightly over the full range of profiled steepness. Steepness was profiled in SS, providing different initial numbers-at-age for 2020 based on each steepness level (see Section 5.c below).

4. Fishing mortality and selectivity: A single fleet (fishery) was modeled using selectivity and weight-at-age from the MexCal Season 2 (S2; Table 2). MexCal-S2 (Jan-Jun) best typifies the selectivity pattern for the overall MexCal fleet, and most of the northern sub-population (NSP) sardine catch is taken by this fishery at that time of year. The PNW fleet was not modeled given the low probability that sardine will be taken for live bait or incidentally in the foreseeable future.

   The MexCal fleet includes catches for both US and Mexico (Ensenada) fisheries. Mexican sardine catch was treated in two ways for these analyses: 1) as a fixed amount of catch (mt) added to the US control rule, or 2) as a fixed rate added to the US fishing rate, i.e., proportionate to the age 1+ biomass.

   For the constant Mexico catch scenarios, total catch was modeled using the ABC control rule for Pacific sardine, with addition of a constant tonnage to account for Mexico removals. We based Mexico's constant catch (6,044 mt) on the average of NSP landed in Ensenada between 2015-16 and 2018-19 (Table 1). Total catch was defined:

   Catch = ($Biomass_{age1+}$ * US Exploitation Rate * Buffer * US Distribution) + Mexico catch

   where Buffer=0.7762 (Tier 2, Pstar 0.4), US Distribution=0.87, and Mexico catch=6,044 mt per year for all fixed Mexico catch strategies.

   For the constant Mexico harvest rate scenarios, a single constant exploitation rate of 9.9% was applied as opposed to assuming a constant catch of 6,044mt. The value was calculated from stock assessment models with steepness values ranging from 0.3 to 0.8 (with intervals of 0.05). Specifically, the stock assessment model was run with a single fixed steepness value, and the season 1, age 1+ biomass values were averaged from the 2015-15 to 2018-19 management years. The assumed average NSP catch of 6,044 mt was divided by the average biomass value to calculate average exploitation rates at each steepness value. The steepness-specific exploitation rates were then averaged, weighted by relative probabilities (Table 3a) to calculate a single exploitation rate of 9.9%. Relative exploitation rates for the US and Mexico fisheries for the three harvest alternatives are shown in Table 3b.

5. Inclusion of uncertainty: Uncertainty in the rebuilding analysis was accounted for in several ways:
   a. The spawner-recruit relationship used a high σR value (1.2; from Kuriyama et al. 2020), allowing for large fluctuations in recruitment in all rebuilding projections.
   b. Uncertainty was explored by rebuilding under two different productivity states of nature (see '2. Definition of SB_0' above). Projections between the two productivity scenarios differ with respect to the level of the rebuilding target (SB_{MSY}), and the magnitude of potential recruitments generated when rebuilding to that level. In addition, each state of nature draws from a distribution of SB_0 as opposed to a single value.

c. Uncertainty in Mexico's annual NSP sardine catch was partially addressed by applying a constant harvest rate versus a constant tonnage per year (see Section 4 above). Note this does not address larger questions regarding actual stock source of Ensenada landings from year to year or general hypotheses regarding subpopulation structure of the transboundary stocks.
d. Finally, uncertainty in spawner-recruit calculations was accounted for by profiling on the Beverton-Holt steepness parameter (h). This was accomplished by first profiling h in the Stock Synthesis model to provide new starting values for the multiple parameter file (Appendix B). Steepness was profiled from 0.3 to 0.8 in 0.05 intervals. Attempts to model steepness at values lower than 0.28 resulted in runtime errors in Rebuilder, so the profile was constrained to steepness values of 0.3 and higher. For sardine, changing steepness affected the initial numbers-at age in 2020 and, to a trivial extent, natural mortality (Appendix B). Steepness was poorly estimated in Stock Synthesis, with negative log-likelihoods ranging from 91.6851 at h=0.3 to 94.2932 at h=0.8 (Figure 6). To calculate relative probabilities for constructing the multiple parameter line file (Rebuild_samp.sso; see Appendix B), the difference between the lowest and highest likelihood was calculated and the differences were normalized. Relative probabilities associated with each normalized likelihood value were calculated and multiplied by 100. Steepness of 0.3 had the highest relative probability (19/100) whereas parameters associated with steepness of 0.8 had the lowest relative probability (0/100) (Table 4, Figure 6).

6. Definition of rebuilt: Rebuilding is determined to be met when the spawning stock has a greater than 0.5 probability of rebuilding to SB_{MSY} under a given harvest scenario. Rebuilder makes this determination when the stock has reached the target depletion level (0.X*SB_0). For most groundfish stocks, target depletion is 0.4*SB_0 based on a meta-analysis of groundfish productivity. No such meta-analysis exists for Pacific sardine, so it was necessary to use Rebuilder to determine an appropriate target depletion level. This was accomplished by running the model as follows:
    a. Sardine control rule was reset to: E=0.XX, Buffer=1, Distribution=1, and Mexico catch=0.
    b. σR was set to 0.
    c. Target depletion was set to 1.0.
    d. The simulation was run, and the population rebuilt to SB_0 for F=0. SB_{MSY} was the equilibrium biomass while fishing at E_{MSY} with the above sardine control rule settings.
    e. Target depletion was then equal to SB_{MSY}/SB_0.

    Since Rebuilder samples across a range of steepness levels, and steepness and E_{MSY} are linked, it was necessary to iteratively search for an E_{MSY} corresponding to each steepness. Once E_{MSY} was found, simulations were rerun, as above, and steepness-specific target depletions were determined. The above analyses were conducted for both the high and low productivity models, and results are presented in Table 4. Estimates of E_{MSY} and target depletion were nearly identical for both scenarios. E_{MSY} ranged from 0.075 at steepness=0.3, and 0.64 at steepness=0.8. Target depletion ranges from 0.42983 for steepness=0.3 to 0.2057 for steepness=0.8. As expected, median catch and SB_{MSY} were

markedly different for the two states of nature (Table 4). While it is possible to model multiple target depletion levels in Rebuilder, the SSC's CPS Subcommittee recommended running all simulations with a single target depletion value. A single target depletion value was calculated as the average, weighted by relative probabilities (Table 4), at each steepness value. Weighted averages from the two scenarios were then averaged resulting in a single target depletion value of **0.365**. Based on this single target depletion level and average SB_0 estimates for the two states of nature, the average target *SB* rebuilding levels are:

- $SB_{0(2005\text{-}18)}$: 377,567 * 0.365 = **137,812 mt**
- $SB_{0(2010\text{-}18)}$: 104,445 * 0.365 = **38,122 mt**

7. Alternate rebuilding strategies:
   Three alternative harvest strategies were analyzed for the rebuilding plan:
   Alt 1: 'Status quo' US management.
   Alt 2: Zero US harvest.
   Alt 3: US five percent fixed harvest rate.

   For the constant Mexico catch runs, harvest strategies were:
   Alt 1: US E=0.18 (prorated by Buffer and US Distribution) + Mexico catch=6,044 mt
   Alt 2: US E=0.00 + Mexico catch 6,044 mt
   Alt 3: US E=0.05 (not prorated) + Mexico catch=6,044 mt

   For the constant Mexico harvest rate runs, strategies were:
   Alt 1: Total E=0.2202 (where US E=0.1216 and Mexico E=0.0986)
   Alt 2: Total E=0.0986 (where US E=0.0000 and Mexico E=0.0986)
   Alt 3: Total E=0.1486 (where US E=0.0500 and Mexico E=0.0986)

   The above strategies were evaluated for both productivity states of nature.

   Note that the current harvest control rules (HCRs: i.e. OFL, ABC, HG) for Pacific sardine modulate exploitation rate based on CalCOFI sea surface temperature. The Rebuilder package is unable to incorporate environmental effects, nor do reliable environmental forecasts exist for the coming decades. So, for purposes of this rebuilding analysis, the static stochastic E_{MSY}= 0.18 yr^{-1} from the recent management strategy evaluation (Hurtado and Punt 2013) was be used to project the population forward under the 'Status Quo' harvest strategy.

Results

Interpretation of the results should consider the different target biomass levels for both states of nature (see SB_0 distributions in Figure 4). The difference between these two states of nature arises from the number and magnitude of annual recruitments considered for each state of nature. Average SB_0 levels were 377,567 mt for $SB_{0(2005\text{-}18)}$ and 104,445 for $SB_{0(2010\text{-}18)}$ (Tables 4 and 5). Average target SB_{MSY} levels were 137,812 mt for $SB_{0(2005\text{-}18)}$ and 38,122 mt for $SB_{0(2010\text{-}18)}$ (Tables 4 and 5). It is important to note that individual rebuilding simulations (2,000 per run) were based on draws from the broad respective distributions of SB_0 (Figure 4), and probabilities of rebuilding were based on a corresponding range of $SB_{0.365}$ target biomass values. For the

$SB_{0(2005\text{-}18)}$ state of nature, SB_0 values ranged from 77,476 to 1,606,085 mt (Figure 4) and corresponding $SB_{0.365}$ values ranged from 28,279 to 586,221 mt. For the $SB_{0(2010\text{-}18)}$ state of nature, SB_0 values ranged from 34,849 to 455,497 mt (Figure 4) and corresponding $SB_{0.365}$ values ranged from 12,723 to 166,256 mt.

Rebuilding probabilities were examined with two metrics: 1) with respect to rebuilding to target SB_{MSY}, and 2) rebuilding to the 150,000 mt of age 1+ biomass ('Cutoff' level in the sardine harvest guideline control rule). With Total F=0, the spawning stock rebuilds above target depletion by 2029 for $SB_{0(2005\text{-}18)}$ and 2022 for $SB_{0(2010\text{-}18)}$ (Tables 6 and 7, resp.). For $SB_{0(2005\text{-}18)}$ and fixed Mexican catch (6,044 mt), the spawning stock rebuilds by 2041 with US exploitation rate=0 (US 0%) and does not rebuild with higher exploitation rates (Table 6). For $SB_{0(2005\text{-}18)}$, with fixed Mexican exploitation rate=9.9%, the spawning stock rebuilds by 2036 with US 0% and 2047 with US 5% (Table 6; Figure 7a). For $SB_{0(2010\text{-}18)}$, with fixed Mexican catch, the spawning stock rebuilds by 2023 with US 0%, or 2024 with US 5% (Table 7; Figure 7a). For $SB_{0(2010\text{-}18)}$, with fixed Mexican exploitation rate=9.9%, the stock rebuilds by 2022 with US 0%, 2023 US 5%, and 2024 US 18% (Table 7; Figure 7a). Based on these results, T_{MIN} for $SB_{0(2005\text{-}18)}$ is 2029, and T_{MAX} (2031) would be 10 years from the onset of the rebuilding plan, anticipated to be implemented by 2021 (Table 5). For the $SB_{0(2010\text{-}18)}$ state of nature, T_{MIN} is 2022 and T_{MAX} would also be 2031 (Table 5). Probabilities of rebuilding to $SB_{0.365}$ by T_{MAX} are provided for the three harvest alternatives and two states of nature in Table 5. Under the $SB_{0(2005\text{-}18)}$ scenario, none of the three harvest alternatives rebuild by T_{MAX}, whereas all three of the harvest alternatives rebuild the stock by T_{MAX} under the $SB_{0(2010\text{-}18)}$ scenario (Table 5).

With respect to 'Cutoff', the age 1+ stock rebuilds above 150,000 mt with Total F=0 by 2027 for $SB_{0(2005\text{-}18)}$ and 2037 for $SB_{0(2010\text{-}18)}$ (Tables 8 and 9, Figure 7b). For $SB_{0(2005\text{-}18)}$ and fixed Mexican catch, the stock only rebuilds above 150,000 mt by 2036 when US E=0% (Table 8; Figure 7b). For $SB_{0(2005\text{-}18)}$ and fixed Mexican exploitation, the age 1+ stock rebuilds by 2033 (US E=0%) and 2037 (US E=5%; Table 8). For $SB_{0(2010\text{-}18)}$, the stock did not rebuild above 150,000 mt under any harvest scenarios (Table 9; Figure 7b). Note, for the $SB_{0(2005\text{-}18)}$ models, the age 1+ stock rebuilds above 150,000 mt sooner than rebuilding to target SB levels.

Median spawning stock biomass (SB) was greater than 50,000 mt by 2023 with Total F=0 and 2026 with fixed rate and US 0% with the $SB_{0(2005\text{-}18)}$ scenario (Table 10; Figure 8). With Total F=0, the median spawning stock biomass exceeded 150,000 mt by 2033 (Table 10). In no other harvest scenarios did the median SSB exceed 50,000 nor 150,000 mt. In the $SB_{0(2010\text{-}18)}$ scenario, median SB exceeded 50,000 mt by 2027 (Table 11) and did not exceed 50,000 mt in any other harvest scenario (Table 11). Detailed figures including values of 5th, 25th, 50th, 75th, and 90th percentiles are included for $SB_{0(2005\text{-}18)}$ (Figure 9) and $SB_{0(2010\text{-}18)}$ (Figure 10).

The definition of rebuilding does not require the population to sustain a biomass greater than reference biomass values once that level has been attained. As a result, scenarios with fixed catch and fixed exploitation rate show SB declining through time despite probabilities of recovery remaining above 0.5 (see gray shaded values in Tables 10 and 11). In these cases, the population exceeded a particular biomass level at some point and was recorded as rebuilt.

Scenarios with fixed Mexican catches severely depleted the population, whereas scenarios with a fixed Mexican harvest rate sustained some level of catch. Median total catch values ranged from 0 to ~8,000 tons for $SB_{0(2005\text{-}18)}$ (Table 12, Figure 11) and 0 to 6,044 mt for $SB_{0(2010\text{-}18)}$ (Table 13; Figure 11). Detailed figures including 5th, 25th, 50th, 75th, and 90th percentiles are shown for $SB_{0(2005\text{-}18)}$ (Figure 12) and $SB_{0(2010\text{-}18)}$ (Figure 13). Note that the catch values in Tables 12 and 13 represent the total catch (Mexico and US combined), and do not represent US portions of that catch. US portions of the total catch can be calculated by subtracting 6,044 mt from the fixed Mexico catch columns. For the fixed Mexico rate columns, the reader should multiply the total catch by the US portions in the last column of Table 3b.

Finally, it is important to reiterate the high degree of variability in the sardine rebuilding projections and the extent to which rebuilding depends upon productivity assumptions for the two scenarios. For example, Figure 14 illustrates *SB* projections in the complete absence of fishing (US and Mexico E=0) for the two productivity scenarios. Both the large σR (1.2) and profiled range of steepness contributed to this uncertainty. The absolute magnitude of rebuilding is highly dependent upon the choice of recruitments selected to base SB_0. In the $SB_{0(2005\text{-}18)}$ scenario, more than 50% of the projections exceed the 150,000 mt threshold, whereas in the $SB_{0(2010\text{-}18)}$ scenario approximately 10% of the projections exceed that threshold (Figure 14).

Discussion

These rebuilding results are difficult to interpret as the target biomass levels and times to achieve rebuilding are strongly dependent on assumptions of the state of nature. Rebuilding above 150,000 mt with greater than 50% probability was achieved by 2037 with US (5%) and Mexico (9.9%) harvest for $SB_{0(2005\text{-}18)}$, whereas rebuilding to this level occurred by 2037 only with Total F=0 for $SB_{0(2010\text{-}18)}$.

This rebuilding analysis is limited to the available data from the current stock assessment and does not include early historic high recruitment estimates from the 1980s and 1990s or early 20th century. The analysis represents a relatively narrow time frame (15 years) relative to the number of projection years, and likely represents a limited snapshot of the long-term population fluctuations. Pacific sardine are members of the coastal pelagic species (CPS) assemblage of the northeastern Pacific Ocean, which represents an important forage base in the California Current. Pacific sardine biology is characteristic of CPS in general, including relatively small body size, short-lived, mature early, tendency to form large schools, seasonally migratory, and most importantly, highly variable recruitment success and related population abundance based primarily on oceanographic factors (environmental drivers). Further, although there is general consensus in the marine ecology community that oceanographic dynamics are likely the key drivers of year-to-year variation in recruitment and stock abundance exhibited by small pelagic fish populations (e.g., Glantz 1992; McGinn 2002; Checkley et al. 2009; NMFS 2019), detailed understanding of the relationship between specific environmental drivers and a stock's productivity is generally lacking or at the very least, refuted when evaluated over longer time periods (Bakun 1985; Walters and Collie 1988; Myers 1998; Francis 2006; Keyl and Wolff 2008; Haltuch and Punt 2011; Koslow et al. 2013; Subbey et al. 2014; Zwolinski and Demer 2019). Pacific sardine are illustrative of the challenges associated with using oceanographic data

to forecast future abundance for management purposes, given repeated research resulting in inconsistent findings of meaningful statistical correlation between the stock's recruitment success and various sea-surface temperature-related indices evaluated over time (Jacobson and MacCall 1995; McClatchie et al. 2010; Lindegren and Checkley 2013; Zwolinski and Demer 2014).

The required analysis by the Pacific Fishery Management Council for rebuilding a formally declared overfished stock is based on a population dynamics model that ultimately provides projected estimates of catch/fishing mortality and associated time periods that would be needed to allow the overfished stock to realize a specified level of abundance or 'rebuilt' (Punt 2012, PFMC 2019). An important parametrization in the rebuilding program concerns the generation of future recruitment, which represents the most critical estimates from the analysis, and the basis for determining abundance (rebuilding levels) from varying trajectories of projected fishing intensities/time periods. The inherent recruitment uncertainty exhibited by CPS likely due to environmental forcing mechanisms necessarily confounds straightforward interpretation of rebuilding programs in general for these highly variable stocks. That is, rebuilding programs for longer-lived species that are generally subject to much less variation in recruitment from year-to-year driven largely by underlying biological mechanisms (e.g., parental stock size or spawning stock biomass), such as groundfish stocks that inhabit the continental shelf/slope off the U.S. Pacific coast (e.g., Dick and MacCall 2014, Gertseva and Cope 2018), are more likely to provide meaningful results regarding levels of fishing pressure and amounts of time needed to effectively rebuild an overfished stock to desired sustainable abundance levels. Additionally, the profile on steepness may or may not be realistic for the stock over the past 15 years. Steepness would be expected to shift toward higher levels in a rebounding stock and was poorly estimated in the 2020 benchmark assessment. The median value for our steepness profile was 0.4, while meta-analysis of life history parameters predicts Clupeiformes have steepness around 0.72 (Thorson 2019).

In the above context, it is important to note that although reasonable/documented estimates of historical recruitment patterns (rebuilding scenarios) from the most recent Pacific sardine stock assessment were used here, this species' biology and substantial recruitment variation in any given year based primarily on unaccounted for environmental factors translates to increased uncertainty surrounding the generated results from the overall rebuilding analysis. Thus, the results presented here are likely to be more accurate in capturing short-term projected stock and fishery dynamics as opposed to the longer term since there is an absence of critical environmental data generally believed to be the underlying/overriding factors that influence this species' population dynamics.

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Table 1. Management quantities and landings (metric tons) since the 2015-16 management year (July-June).

	U.S. Management					
Mgmt Year	OFL	$ABC_{0.4}$	ACT	U.S. Total Landings (mt)	U.S. NSP Landings (mt)	Ensenada NSP Landings (mt)
2015-16	13,227	12,074	4,000	1,919	260	0
2016-17	23,085	19,236	5,000	1,885	601	6,936
2017-18	16,957	15,479	5,000	1,775	372	6,032
2018-19	11,324	9,436	2,500	2,282	655	11,210
2019-20	5,816	4,514	4,000	incomplete	incomplete	nd
2020-21	5,525	4,288	4,000	---	---	---
		Average for 2015-19:		1,965	472	6,044

Table 2. Rebuilding input parameters by age. Note that initial numbers-at-age and natural mortality will vary with steepness for the multiple parameter projections. In order to transition the modeled time step from seasonal (SS) to annual (Rebuilder), it was necessary to change fecundity at age zero from 0.0046 to 0.0000.

Age	Fecundity	*M*	Init N	Init N Tmin	Weight	Selectivity
0	0.0000	0.585	438996.00	580925.00	0.034	0.49003
1	0.0354	0.585	194984.00	222512.00	0.059	1.00000
2	0.0773	0.585	44087.50	46832.80	0.083	0.25724
3	0.1100	0.585	19995.00	12386.50	0.160	0.03762
4	0.1339	0.585	6617.46	47853.50	0.170	0.05343
5	0.1515	0.585	25027.30	11486.90	0.172	0.04378
6	0.1644	0.585	5931.46	5723.79	0.183	0.01445
7	0.1739	0.585	3052.62	4551.15	0.186	0.01366
8	0.1808	0.585	2481.45	1750.78	0.191	0.00306
9	0.1858	0.585	970.42	8726.19	0.195	0.00306
10	0.1939	0.585	6040.54	2171.82	0.200	0.00306

Table 3a. Respective harvest rates for U.S. and Mexico for the constant harvest rate simulations.

Steepness	Relative Probability	Assumed MX Catch (mt)	S1 Age 1+ Biomass (mt)	S1 MX Exploitation Rate
0.30	0.19	6,044	61,240	0.0987
0.35	0.17	6,044	61,219	0.0987
0.40	0.15	6,044	61,214	0.0987
0.45	0.13	6,044	61,229	0.0987
0.50	0.11	6,044	61,260	0.0987
0.55	0.09	6,044	61,307	**0.0986**
0.60	0.07	6,044	61,367	0.0985
0.65	0.05	6,044	61,436	0.0984
0.70	0.03	6,044	61,513	0.0983
0.75	0.01	6,044	61,596	0.0981
0.80	0.00	6,044	61,683	0.0980

Table 3b. Respective exploitation rates (*E*) for U.S. and Mexico for the constant harvest rate simulations.

Harvest Alternative	MX *E*	US *E*	Total *E*	US Portion
Alt 1 (US *E*=18%)	0.0986	0.1216	0.2202	0.5520
Alt 2 (US *E*=0)	0.0986	0.0000	0.0986	0.0000
Alt 3 (US *E*=5%)	0.0986	0.0500	0.1486	0.3364

Table 4. MSY references points and relative probabilities over the profiled range of steepness for two productivity states of nature. SB_0 values and the single weighted target depletion level are provided at the bottom of each table.

$SB_{0(2005\text{-}18)}$					
Steepness	E_{MSY}	Median Catch (mt)	SB_{MSY} (mt)	Target Depletion	Relative Probability
0.30	0.075	16,112	162,286	0.42983	19%
0.35	0.110	22,791	155,613	0.41213	17%
0.40	0.150	28,880	143,687	0.38057	15%
0.45	0.190	34,538	134,826	0.35710	13%
0.50	0.230	39,897	127,896	0.33870	11%
0.55	0.280	45,058	117,800	0.31200	9%
0.60	0.330	50,109	110,394	0.29240	7%
0.65	0.390	55,125	101,953	0.27000	5%
0.70	0.455	60,198	94,656	0.25070	3%
0.75	0.535	65,423	86,664	0.22950	1%
0.80	0.640	70,942	77,650	0.20570	0%
		SB_0=	**377,567**	**0.36500**	**<-Wtd Value**
		SB_{MSY}=	**137,812**		

$SB_{0(2010\text{-}18)}$					
Steepness	E_{MSY}	Median Catch (mt)	SB_{MSY} (mt)	Target Depletion	Relative Probability
0.30	0.075	4,465	44,975	0.43062	19%
0.35	0.110	6,307	43,066	0.41233	17%
0.40	0.150	7,990	39,751	0.38059	15%
0.45	0.190	9,554	37,296	0.35710	13%
0.50	0.230	11,037	35,379	0.33870	11%
0.55	0.280	12,464	32,587	0.31200	9%
0.60	0.330	13,861	30,538	0.29240	7%
0.65	0.385	15,249	28,588	0.27370	5%
0.70	0.455	16,652	26,184	0.25070	3%
0.75	0.535	18,098	23,974	0.22950	1%
0.80	0.640	19,624	21,480	0.20570	0%
		SB_0=	**104,445**	**0.36500**	**<-Wtd Value**
		SB_{MSY}=	**38,122**		

Table 5. Pacific sardine rebuilding reference points for the $SB_{0(2005\text{-}18)}$ and $SB_{0(2010\text{-}18)}$ states of nature and fixed Mexico fishing rate models. Probabilities of rebuilding to T_{MAX} are shown for the three harvest alternatives being considered in the rebuilding plan.

Parameter	$SB_{0(2005\text{-}18)}$	$SB_{0(2010\text{-}18)}$
Year declared overfished	2019	2019
Current year	2020	2020
Year 1 rebuilding plan (anticipated)	2021	2021
T_{MIN}	2029	2022
T_{MAX}	2031	2031
Alt 1 probability of rebuilding by T_{MAX}	25.8%	56.7%
Alt 2 probability of rebuilding by T_{MAX}	40.6%	69.3%
Alt 3 probability of rebuilding by T_{MAX}	33.3%	62.8%
Mean generation time	3	3
Average SB_0	377,567	104,445
Average rebuilding target ($SB_{36.5\%}$)	137,812	38,122

Table 6. Probabilities of recovery for rebuilding alternatives for $SB_{0(2005\text{-}18)}$ scenario. Mexico catch was fixed at 6,044 mt or at an exploitation rate of 9.9. Probabilities of recovery with no Mexico or US harvest is also shown. Grey shading indicates probabilities greater than 0.5.

	Fixed Mex. Catch (6,044mt)			Fixed Mex. Rate (9.9)			Total F=0
Year	**US rate=0**	**US rate=5**	**US rate=18**	**US rate=0**	**US rate=5**	**US rate=18**	
2019	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2020	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2021	0.0315	0.0300	0.0295	0.0310	0.0305	0.0295	0.0335
2022	0.0850	0.0710	0.0600	0.0760	0.0665	0.0565	0.1000
2023	0.1440	0.1200	0.0970	0.1290	0.1095	0.0915	0.1810
2024	0.1970	0.1670	0.1330	0.1805	0.1550	0.1240	0.2530
2025	0.2380	0.2040	0.1630	0.2240	0.1950	0.1510	0.3155
2026	0.2795	0.2350	0.1805	0.2620	0.2240	0.1705	0.3825
2027	0.3090	0.2575	0.2015	0.2955	0.2485	0.1920	0.4330
2028	0.3380	0.2805	0.2180	0.3280	0.2750	0.2110	0.4810
2029	0.3670	0.3045	0.2300	0.3620	0.3020	0.2315	0.5210
2030	0.3865	0.3195	0.2390	0.3870	0.3200	0.2435	0.5620
2031	0.4050	0.3315	0.2500	0.4060	0.3330	0.2580	0.6005
2032	0.4235	0.3450	0.2610	0.4285	0.3515	0.2715	0.6310
2033	0.4405	0.3610	0.2710	0.4560	0.3750	0.2850	0.6560
2034	0.4525	0.3705	0.2770	0.4765	0.3900	0.2965	0.6750
2035	0.4630	0.3780	0.2835	0.4935	0.4080	0.3065	0.7005
2036	0.4725	0.3830	0.2910	0.5090	0.4205	0.3180	0.7160
2037	0.4800	0.3895	0.2940	0.5260	0.4320	0.3275	0.7300
2038	0.4860	0.3970	0.2970	0.5370	0.4450	0.3360	0.7500
2039	0.4905	0.4050	0.3000	0.5505	0.4550	0.3425	0.7640
2040	0.4965	0.4075	0.3040	0.5620	0.4625	0.3465	0.7725
2041	0.5015	0.4095	0.3070	0.5690	0.4670	0.3530	0.7825
2042	0.5045	0.4135	0.3085	0.5800	0.4730	0.3575	0.7965
2043	0.5065	0.4150	0.3095	0.5880	0.4825	0.3650	0.8085
2044	0.5090	0.4185	0.3125	0.5940	0.4870	0.3690	0.8220
2045	0.5105	0.4195	0.3155	0.6010	0.4920	0.3765	0.8355
2046	0.5110	0.4210	0.3180	0.6075	0.4965	0.3815	0.8455
2047	0.5150	0.4240	0.3200	0.6155	0.5015	0.3860	0.8525
2048	0.5160	0.4245	0.3205	0.6225	0.5080	0.3930	0.8610
2049	0.5175	0.4245	0.3210	0.6265	0.5120	0.3960	0.8670
2050	0.5195	0.4250	0.3225	0.6315	0.5140	0.3995	0.8720

Table 7. Probabilities of recovery for rebuilding alternatives for $SB_{0(2010\text{-}18)}$ scenario. Mexico catch was fixed at 6,044 mt or at an exploitation rate of 9.9. Probabilities of recovery with no Mexico or US harvest is also shown. Grey shading indicates probabilities greater than 0.5. Rebuilding occurs earlier than in scenario $SB_{0(2005\text{-}18)}$ because the biomass target is lower for $SB_{0(2010\text{-}18)}$. See Figure 4 for the difference in SB0 target values between scenarios.

	Fixed Mex. Catch (6,044 mt)			Fixed Mex. Rate (9.9)			Total F=0
Year	**US rate=0**	**US rate=5**	**US rate=18**	**US rate=0**	**US rate=5**	**US rate=18**	
2019	0.0400	0.0400	0.0400	0.0400	0.0400	0.0400	0.0400
2020	0.3600	0.3600	0.3600	0.3600	0.3600	0.3600	0.3600
2021	0.4445	0.4340	0.4225	0.4580	0.4465	0.4295	0.4905
2022	0.4885	0.4680	0.4500	0.5150	0.4960	0.4645	0.5730
2023	0.5195	0.4940	0.4635	0.5595	0.5300	0.4915	0.6485
2024	0.5375	0.5110	0.4755	0.5940	0.5570	0.5115	0.6960
2025	0.5495	0.5215	0.4790	0.6185	0.5715	0.5250	0.7250
2026	0.5555	0.5255	0.4830	0.6360	0.5885	0.5325	0.7560
2027	0.5610	0.5285	0.4830	0.6530	0.5980	0.5410	0.7780
2028	0.5650	0.5295	0.4845	0.6645	0.6085	0.5500	0.7955
2029	0.5665	0.5315	0.4855	0.6755	0.6150	0.5575	0.8085
2030	0.5685	0.5325	0.4855	0.6855	0.6230	0.5620	0.8210
2031	0.5685	0.5330	0.4855	0.6925	0.6280	0.5665	0.8315
2032	0.5700	0.5335	0.4855	0.7005	0.6330	0.5695	0.8440
2033	0.5705	0.5335	0.4855	0.7060	0.6385	0.5725	0.8610
2034	0.5710	0.5335	0.4855	0.7125	0.6460	0.5775	0.8690
2035	0.5710	0.5335	0.4860	0.7215	0.6505	0.5785	0.8785
2036	0.5710	0.5335	0.4860	0.7320	0.6585	0.5840	0.8855
2037	0.5710	0.5335	0.4860	0.7355	0.6640	0.5865	0.8965
2038	0.5710	0.5335	0.4860	0.7395	0.6665	0.5875	0.9035
2039	0.5710	0.5335	0.4860	0.7460	0.6705	0.5885	0.9100
2040	0.5710	0.5335	0.4860	0.7505	0.6745	0.5895	0.9150
2041	0.5720	0.5335	0.4860	0.7540	0.6765	0.5900	0.9195
2042	0.5720	0.5335	0.4860	0.7590	0.6795	0.5910	0.9235
2043	0.5720	0.5335	0.4860	0.7630	0.6800	0.5910	0.9275
2044	0.5720	0.5335	0.4860	0.7670	0.6820	0.5915	0.9325
2045	0.5720	0.5335	0.4860	0.7695	0.6825	0.5930	0.9335
2046	0.5720	0.5335	0.4860	0.7715	0.6865	0.5935	0.9370
2047	0.5720	0.5335	0.4860	0.7780	0.6865	0.5935	0.9390
2048	0.5720	0.5335	0.4860	0.7815	0.6885	0.5940	0.9420
2049	0.5720	0.5335	0.4860	0.7845	0.6900	0.5945	0.9460
2050	0.5720	0.5335	0.4860	0.7855	0.6910	0.5955	0.9490

Table 8. Probabilities of recovery above 150,000 mt of age 1+ biomass for rebuilding alternatives for $SB_{0(2005\text{-}18)}$ scenario. Mexico catch was fixed at 6,044 mt or at an exploitation rate of 9.9. Probabilities of recovery with no Mexico or US harvest is also shown. Grey shading indicates probabilities greater than 0.5.

	Fixed Mex. Catch (6,044mt)			Fixed Mex. Rate (9.9)			Total F=0
Year	**US rate=0**	**US rate=5**	**US rate=18**	**US rate=0**	**US rate=5**	**US rate=18**	
2020	0	0	0	0	0	0	0
2021	0.0655	0.0635	0.0615	0.066	0.0635	0.0615	0.071
2022	0.1275	0.115	0.104	0.129	0.1125	0.1035	0.1525
2023	0.196	0.1785	0.152	0.198	0.1775	0.153	0.244
2024	0.253	0.2245	0.19	0.255	0.2255	0.1925	0.326
2025	0.2985	0.257	0.22	0.299	0.2635	0.2215	0.3995
2026	0.3335	0.2895	0.2395	0.342	0.294	0.2455	0.459
2027	0.3645	0.316	0.2585	0.3735	0.325	0.264	0.5105
2028	0.3925	0.3365	0.2725	0.4075	0.35	0.2845	0.5505
2029	0.417	0.3555	0.2865	0.44	0.3785	0.307	0.591
2030	0.432	0.368	0.2945	0.4595	0.398	0.3225	0.6275
2031	0.449	0.377	0.3005	0.48	0.4125	0.3315	0.6555
2032	0.466	0.388	0.3105	0.4995	0.4305	0.3455	0.6775
2033	0.4815	0.4005	0.3175	0.526	0.4485	0.3585	0.7015
2034	0.4865	0.4095	0.3235	0.5435	0.4655	0.371	0.7225
2035	0.4955	0.4145	0.3275	0.5585	0.48	0.3795	0.744
2036	0.504	0.4195	0.332	0.5755	0.49	0.39	0.757
2037	0.5085	0.426	0.334	0.5885	0.5025	0.3985	0.772
2038	0.515	0.4325	0.3355	0.5995	0.5135	0.4065	0.789
2039	0.5175	0.436	0.3385	0.6085	0.525	0.414	0.8
2040	0.521	0.438	0.3395	0.618	0.533	0.419	0.809
2041	0.524	0.4385	0.342	0.625	0.54	0.423	0.8185
2042	0.527	0.4425	0.343	0.634	0.545	0.4275	0.833
2043	0.5285	0.4435	0.344	0.64	0.55	0.4345	0.8425
2044	0.5285	0.4435	0.345	0.6455	0.554	0.437	0.8545
2045	0.5315	0.4445	0.3465	0.6525	0.5575	0.442	0.8645
2046	0.532	0.446	0.3475	0.657	0.5645	0.4435	0.8725
2047	0.534	0.4465	0.348	0.664	0.57	0.4465	0.8775
2048	0.5345	0.447	0.3485	0.671	0.5705	0.452	0.885
2049	0.535	0.447	0.3485	0.676	0.5745	0.455	0.89
2050	0.5355	0.4475	0.35	0.6805	0.579	0.4585	0.896

Table 9. Probabilities of recovery above 150,000 mt of age 1+ biomass for rebuilding alternatives for $SB_{0(2010\text{-}18)}$ scenario. Mexico catch was fixed at 6,044 mt or at an exploitation rate of 9.9. Probabilities of recovery with no Mexico or US harvest is also shown. Grey shading indicates probabilities greater than 0.5.

	Fixed Mex. Catch (6,044mt)			Fixed Mex. Rate (9.9)			Total F=0
Year	**US rate=0**	**US rate=5**	**US rate=18**	**US rate=0**	**US rate=5**	**US rate=18**	
2019	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2020	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2021	0.0250	0.0240	0.0220	0.0260	0.0235	0.0220	0.0280
2022	0.0410	0.0380	0.0345	0.0435	0.0380	0.0345	0.0535
2023	0.0650	0.0575	0.0505	0.0665	0.0585	0.0520	0.0935
2024	0.0895	0.0730	0.0620	0.0890	0.0740	0.0650	0.1380
2025	0.1045	0.0850	0.0700	0.1035	0.0880	0.0735	0.1715
2026	0.1225	0.0975	0.0785	0.1260	0.1030	0.0840	0.2100
2027	0.1420	0.1105	0.0880	0.1480	0.1195	0.0945	0.2410
2028	0.1550	0.1225	0.0945	0.1630	0.1330	0.1035	0.2755
2029	0.1680	0.1305	0.0980	0.1805	0.1465	0.1125	0.3105
2030	0.1765	0.1335	0.1020	0.1935	0.1535	0.1180	0.3360
2031	0.1850	0.1405	0.1055	0.2075	0.1650	0.1260	0.3580
2032	0.1940	0.1470	0.1095	0.2215	0.1765	0.1360	0.3850
2033	0.1995	0.1520	0.1110	0.2340	0.1865	0.1420	0.4170
2034	0.2095	0.1590	0.1150	0.2510	0.1975	0.1490	0.4385
2035	0.2130	0.1620	0.1155	0.2615	0.2035	0.1540	0.4635
2036	0.2205	0.1645	0.1175	0.2765	0.2135	0.1585	0.4915
2037	0.2265	0.1685	0.1185	0.2890	0.2235	0.1615	0.5065
2038	0.2305	0.1735	0.1195	0.3020	0.2370	0.1705	0.5270
2039	0.2325	0.1755	0.1215	0.3125	0.2420	0.1735	0.5470
2040	0.2345	0.1765	0.1225	0.3170	0.2470	0.1760	0.5600
2041	0.2385	0.1785	0.1230	0.3250	0.2520	0.1795	0.5685
2042	0.2425	0.1805	0.1250	0.3340	0.2610	0.1850	0.5860
2043	0.2470	0.1805	0.1255	0.3405	0.2655	0.1875	0.6030
2044	0.2485	0.1815	0.1255	0.3465	0.2700	0.1895	0.6180
2045	0.2505	0.1830	0.1260	0.3545	0.2775	0.1930	0.6335
2046	0.2520	0.1840	0.1275	0.3615	0.2830	0.1970	0.6470
2047	0.2530	0.1845	0.1280	0.3655	0.2865	0.1995	0.6640
2048	0.2550	0.1845	0.1280	0.3735	0.2925	0.2015	0.6800
2049	0.2565	0.1845	0.1285	0.3800	0.2985	0.2065	0.6910
2050	0.2585	0.1850	0.1285	0.3930	0.3060	0.2110	0.6985

Table 10. Median spawning stock biomass (mt) for rebuilding alternatives for $SB_{0(2005\text{-}18)}$ scenario. Mexico catch was fixed at 6,044 mt or at an exploitation rate of 9.9. Probabilities of recovery with no Mexico or US harvest is also shown. Gray shading indicates years in which the probability of recovery was greater than 0.5 (based on probabilities in Table 4).

	Fixed Mex. Catch (6,044mt)			Fixed Mex. Rate (9.9)			Total F=0
Year	**US rate=0**	**US rate=5**	**US rate=18**	**US rate=0**	**US rate=5**	**US rate=18**	
2019	25,879	25,879	25,879	25,879	25,879	25,879	25,879
2020	29,598	29,598	29,598	29,598	29,598	29,598	29,598
2021	33,372	31,509	28,881	35,055	33,122	30,418	38,877
2022	35,113	30,509	25,152	37,730	33,867	28,298	47,007
2023	37,177	30,269	21,784	41,633	34,991	27,326	56,350
2024	37,684	28,087	17,628	45,365	36,564	26,198	67,391
2025	39,095	26,290	13,643	47,036	35,943	23,932	76,492
2026	41,052	24,557	9,360	49,628	36,332	22,197	88,273
2027	42,838	23,165	6,360	51,792	36,591	21,372	97,579
2028	43,371	20,122	4,155	53,898	36,529	20,042	109,517
2029	46,100	18,720	2,399	56,132	36,043	18,180	119,732
2030	46,096	16,216	1,514	58,819	37,270	17,803	130,959
2031	47,985	12,522	883	60,556	36,980	17,127	140,751
2032	47,713	8,705	543	61,399	37,587	16,379	147,730
2033	48,194	5,263	287	62,813	36,351	15,597	154,344
2034	49,143	3,011	163	61,038	35,600	14,210	159,140
2035	47,250	1,808	98	63,922	35,757	13,524	163,850
2036	46,615	1,003	55	64,624	35,722	13,416	171,223
2037	45,184	593	32	65,286	35,588	13,088	179,906
2038	39,576	326	17	66,074	35,186	12,463	183,075
2039	36,632	186	9	67,704	35,571	11,879	187,576
2040	36,561	108	5	66,133	34,895	10,997	188,222
2041	38,561	62	3	65,706	33,671	9,757	187,551
2042	35,637	36	2	66,693	31,988	9,205	190,559
2043	33,449	19	1	65,268	31,210	8,744	190,788
2044	28,748	12	1	64,371	30,536	8,208	190,213
2045	29,926	6	0	64,005	29,386	7,962	192,664
2046	24,725	3	0	62,368	29,093	7,275	200,334
2047	21,019	2	0	62,426	27,685	6,660	201,381
2048	17,921	1	0	63,063	28,550	6,294	200,019
2049	15,550	1	0	62,605	28,549	5,898	201,301
2050	12,453	0	0	65,031	28,349	5,413	198,358

Table 11. Median spawning stock biomass (mt) for rebuilding alternatives for $SB_{0(2010\text{-}18)}$ scenario. Mexico catch was fixed at 6,044 mt or at an exploitation rate of 9.9. Probabilities of recovery with no Mexico or US harvest is also shown. Gray shading indicates years in which the probability of recovery was greater than 0.5 (based on probabilities in Table 5).

	Fixed Mex. Catch (6,044mt)			Fixed Mex. Rate (9.9)			Total F=0
Year	**US rate=0**	**US rate=5**	**US rate=18**	**US rate=0**	**US rate=5**	**US rate=18**	
2019	25,879	25,879	25,879	25,879	25,879	25,879	25,879
2020	29,598	29,598	29,598	29,598	29,598	29,598	29,598
2021	31,594	29,557	26,726	33,042	30,989	28,217	37,110
2022	28,916	25,000	20,100	31,639	27,859	23,149	39,706
2023	26,213	20,751	14,646	30,875	25,748	19,617	42,936
2024	22,597	16,095	9,694	29,709	23,764	16,952	44,856
2025	19,497	12,298	6,122	28,740	22,077	14,833	46,577
2026	16,558	8,445	3,771	27,835	20,590	13,182	48,217
2027	12,795	5,381	2,252	27,256	19,312	11,679	50,173
2028	9,940	3,367	1,340	26,169	18,112	10,639	51,160
2029	7,254	2,033	807	25,764	17,558	9,569	51,889
2030	4,575	1,218	465	25,467	16,768	8,953	53,379
2031	2,873	708	265	25,370	16,631	8,425	54,524
2032	1,621	445	157	24,880	15,894	7,801	55,188
2033	986	243	90	24,474	15,440	7,205	55,887
2034	556	144	50	23,665	14,347	6,364	56,050
2035	330	84	29	23,416	13,991	6,078	57,317
2036	182	47	16	23,298	13,551	5,619	58,743
2037	106	27	9	23,618	13,460	5,343	58,343
2038	62	16	6	23,822	13,352	4,970	58,573
2039	35	9	3	23,187	12,944	4,658	59,633
2040	20	5	2	22,418	12,380	4,515	59,371
2041	12	3	1	21,933	12,006	4,053	58,814
2042	6	2	1	21,896	11,721	3,646	58,824
2043	3	1	0	21,343	11,180	3,435	58,247
2044	2	1	0	21,321	10,858	3,215	59,268
2045	1	0	0	20,813	10,415	3,137	58,704
2046	1	0	0	20,479	10,065	2,780	60,412
2047	0	0	0	20,160	9,668	2,553	59,710
2048	0	0	0	20,426	9,955	2,496	59,834
2049	0	0	0	20,378	9,630	2,341	58,446
2050	0	0	0	20,008	9,445	2,109	58,442

Table 12. Median catch (mt) for rebuilding alternatives for $SB_{0(2005\text{-}18)}$ scenario. Mexico catch was fixed at 6,044 mt or at an exploitation rate of 9.9. Gray shading indicates years in which the probability of recovery was greater than 0.5 (based on probabilities in Table 4 for $SB_{0(2005\text{-}18)}$ scenario). Catch values represent the total catch (Mexico and US combined), and do not represent only US catches.

	Fixed Mex. Catch (6,044mt)			Fixed Mex. Rate (9.9)		
Year	**US rate=0**	**US rate=5**	**US rate=18**	**US rate=0**	**US rate=5**	**US rate=18**
2019	7,500	7,500	7,500	7,500	7,500	7,500
2020	6,044	7,963	10,709	3,785	5,704	8,452
2021	6,044	8,132	10,702	4,549	6,499	8,846
2022	6,044	8,117	10,105	5,026	6,738	8,296
2023	6,044	8,003	9,357	5,418	6,884	7,849
2024	6,044	7,835	8,626	5,805	6,983	7,320
2025	6,044	7,749	7,715	6,002	6,894	6,703
2026	6,044	7,609	6,914	6,251	6,840	6,167
2027	6,044	7,476	4,944	6,502	6,944	6,047
2028	6,044	7,319	3,037	6,793	6,847	5,600
2029	6,044	7,177	1,801	6,992	6,896	5,166
2030	6,044	6,954	1,191	7,426	7,084	4,978
2031	6,044	6,621	659	7,543	6,905	4,717
2032	6,044	5,755	375	7,772	6,995	4,651
2033	6,044	3,429	189	7,944	6,932	4,269
2034	6,044	2,038	119	7,671	6,661	3,912
2035	6,044	1,037	67	7,893	6,848	3,865
2036	6,044	629	40	8,137	6,597	3,801
2037	6,044	429	21	8,318	6,832	3,541
2038	6,044	191	13	8,166	6,559	3,453
2039	6,044	94	6	8,412	6,588	3,203
2040	6,044	69	3	8,306	6,570	3,124
2041	6,044	38	2	8,068	6,162	2,694
2042	6,044	21	1	8,165	6,077	2,545
2043	6,044	14	1	8,027	5,850	2,305
2044	6,044	7	0	7,914	5,839	2,331
2045	6,044	4	0	7,956	5,433	2,214
2046	6,044	3	0	7,798	5,431	1,974
2047	6,044	1	0	7,870	5,175	1,853
2048	6,044	1	0	7,831	5,392	1,721
2049	6,044	0	0	7,769	5,407	1,593
2050	6,044	0	0	8,025	5,287	1,520

Table 13. Median catch (mt) for rebuilding alternatives for $SB_{0(2010\text{-}18)}$ scenario. Mexico catch was fixed at 6,044 mt or at an exploitation rate of 9.9. Gray shading indicates years in which the probability of recovery was greater than 0.5 (based on probabilities in Table 5 for $SB_{0(2010\text{-}18)}$ scenario). Catch values represent the total catch (Mexico and US combined), and do not represent only US catches.

	Fixed Mex. Catch (6,044mt)			Fixed Mex. Rate (9.9)		
Year	**US rate=0**	**US rate=5**	**US rate=18**	**US rate=0**	**US rate=5**	**US rate=18**
2019	7,500	7,500	7,500	7,500	7,500	7,500
2020	6,044	7,963	10,709	3,785	5,704	8,452
2021	6,044	7,955	10,274	4,199	5,969	8,141
2022	6,044	7,707	9,124	4,179	5,546	6,810
2023	6,044	7,355	7,887	3,935	4,938	5,532
2024	6,044	6,983	6,514	3,672	4,394	4,538
2025	6,044	6,620	4,480	3,476	4,016	3,964
2026	6,044	6,122	2,677	3,478	3,862	3,579
2027	6,044	4,023	1,651	3,368	3,595	3,206
2028	6,044	2,498	1,008	3,223	3,393	2,844
2029	5,169	1,552	607	3,184	3,305	2,610
2030	3,422	982	349	3,143	3,156	2,480
2031	2,060	576	200	3,142	3,092	2,295
2032	1,196	336	123	3,111	2,974	2,150
2033	653	182	68	3,036	2,874	1,985
2034	462	117	42	2,876	2,664	1,724
2035	256	65	23	2,936	2,596	1,724
2036	137	35	13	2,916	2,563	1,559
2037	89	20	7	2,935	2,600	1,491
2038	43	11	4	2,864	2,459	1,352
2039	24	6	2	2,860	2,455	1,301
2040	14	3	1	2,764	2,349	1,221
2041	8	2	1	2,746	2,203	1,104
2042	5	1	0	2,744	2,185	1,003
2043	3	1	0	2,629	2,074	953
2044	1	0	0	2,569	2,030	895
2045	1	0	0	2,550	1,949	844
2046	1	0	0	2,535	1,905	740
2047	0	0	0	2,499	1,808	690
2048	0	0	0	2,509	1,803	680
2049	0	0	0	2,475	1,807	628
2050	0	0	0	2,516	1,775	577

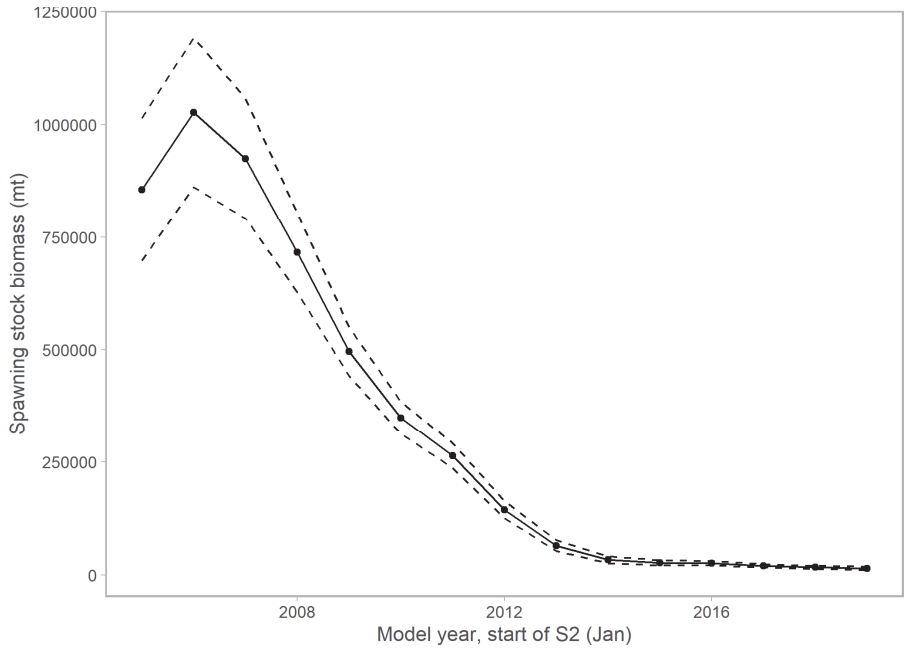

Figure 1: Spawning stock biomass time series (95% CI dashed lines) from the 2020 benchmark assessment (Kuriyama et al. 2020).

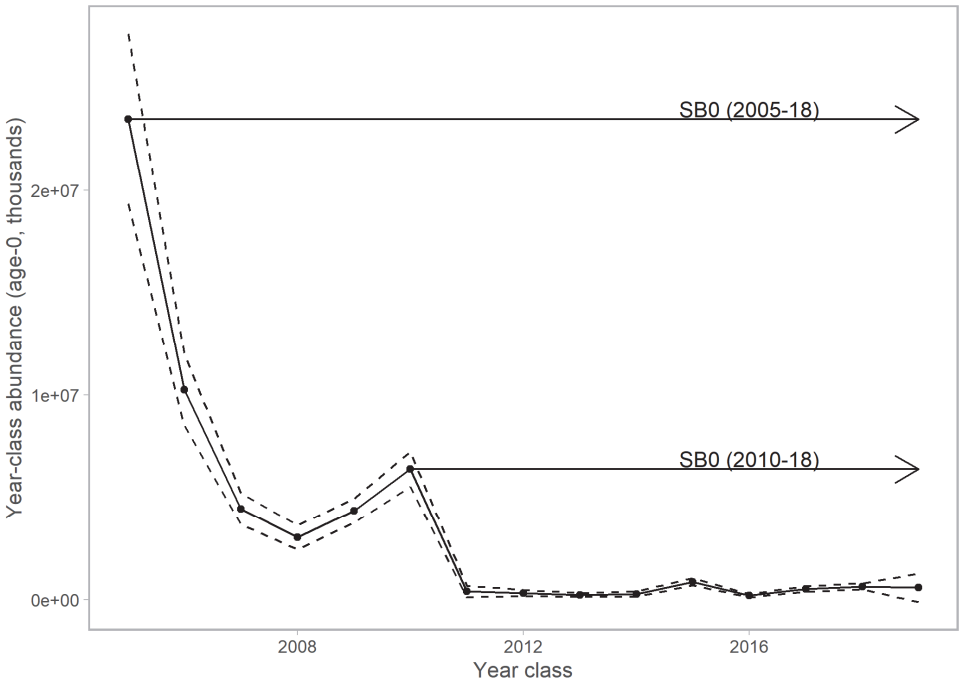

Figure 2. Estimated Pacific sardine recruitment time series from the 2020 Pacific sardine benchmark assessment (Kuriyama et al. 2020). Arrows indicate the two states of nature considered in the rebuilding analysis: SB0 sampled from 2005-18 (top arrow) and SB0 sampled from 2010-2018 (bottom arrow).

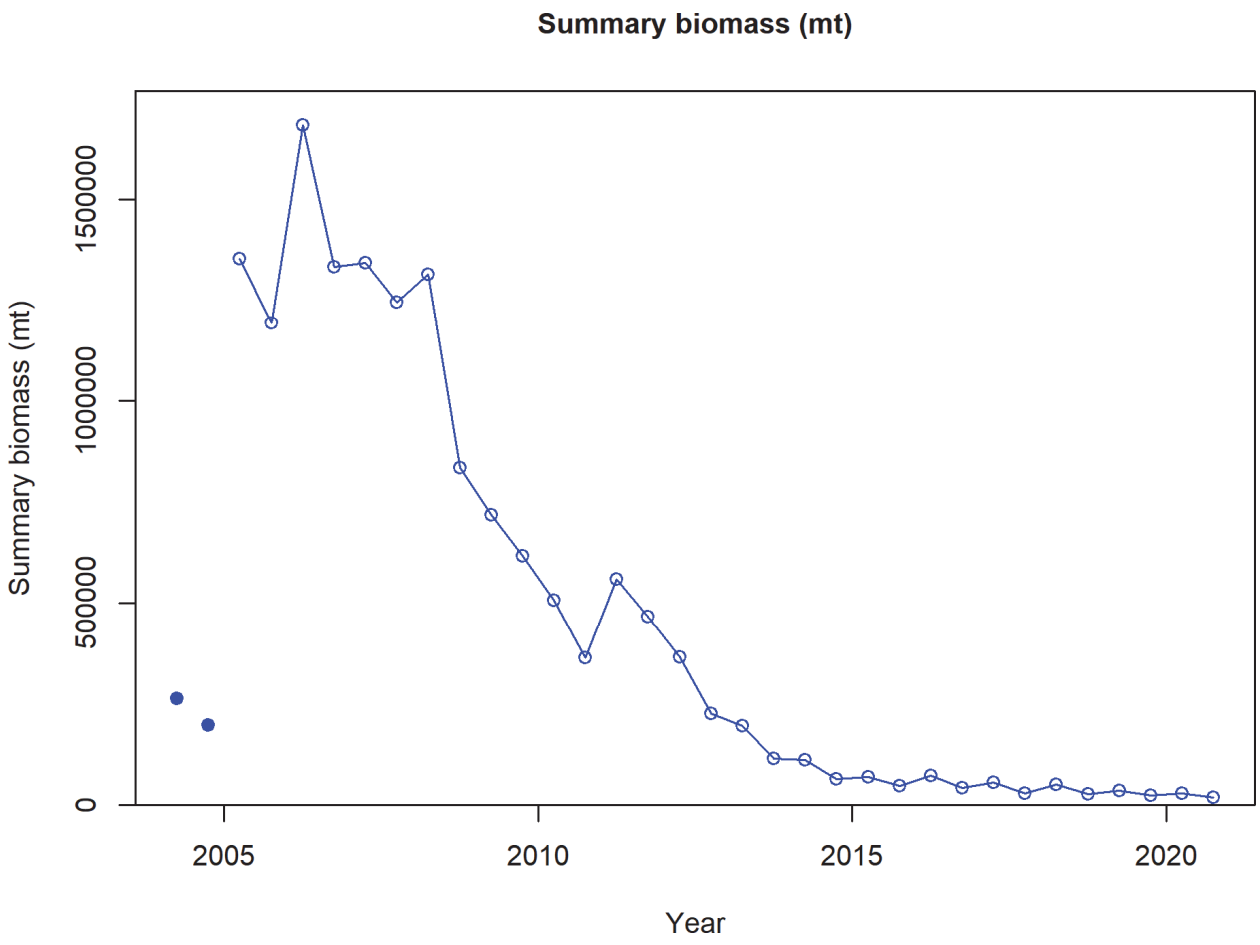

Figure 3. Estimated stock biomass (age 1+ fish; mt) time series from the 2020 benchmark assessment model (Kuriyama et al. 2020).

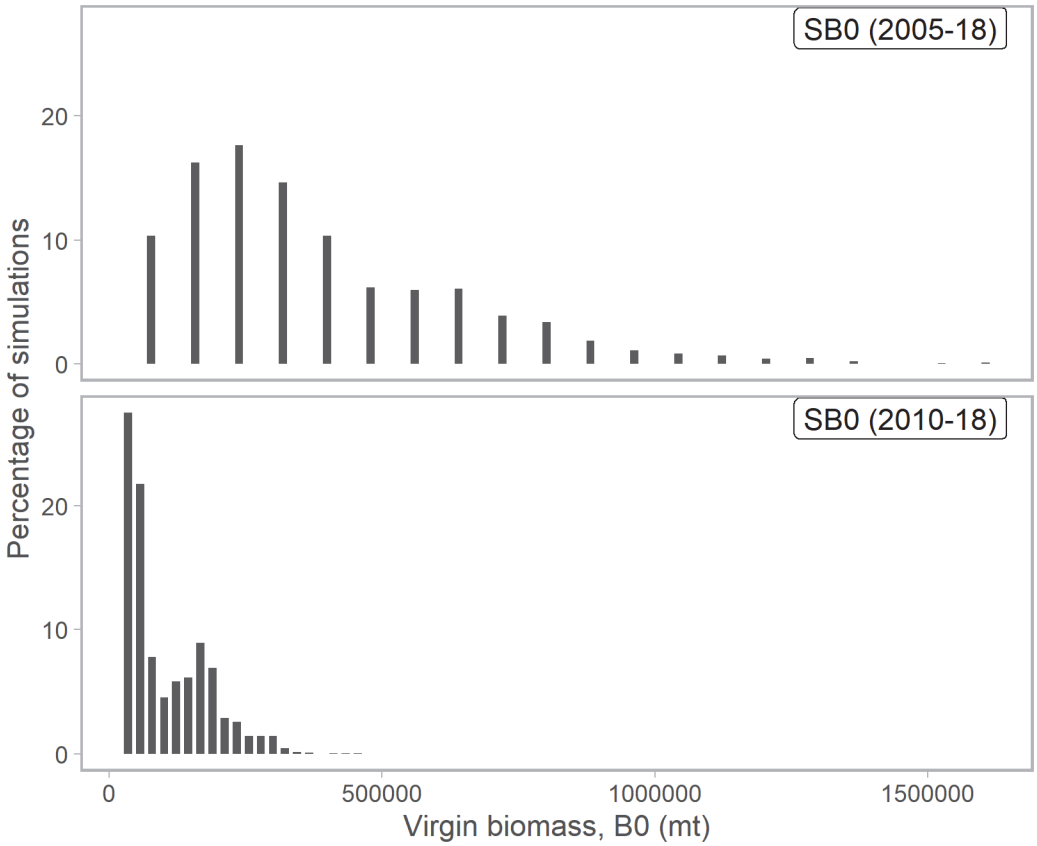

Figure 4. Virgin spawning biomass (SB_0) for the two states of nature.

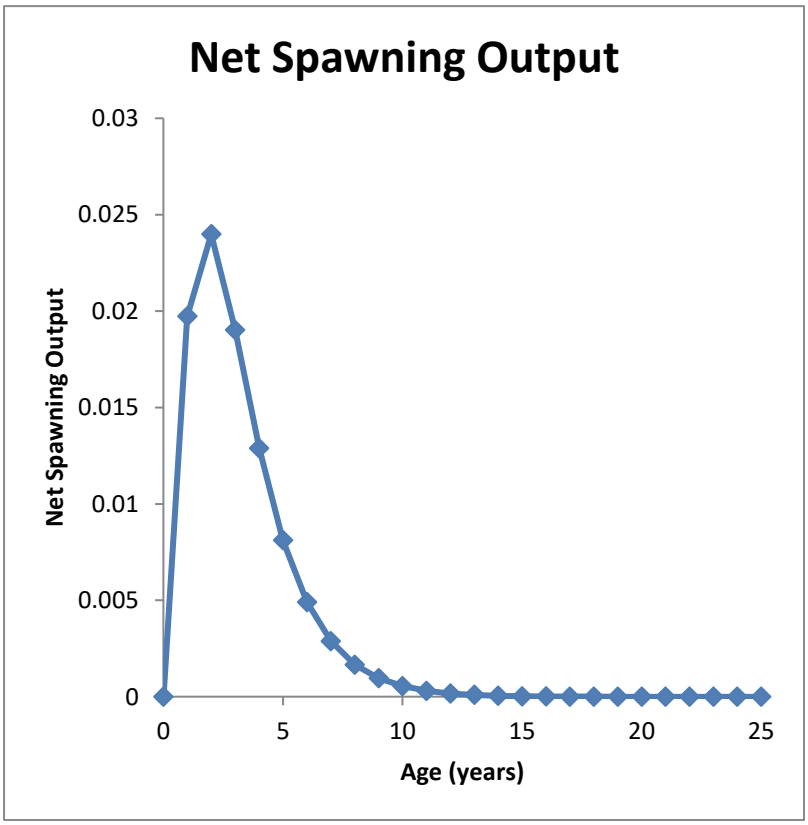

Figure 5. Pacific sardine net spawning output by age.

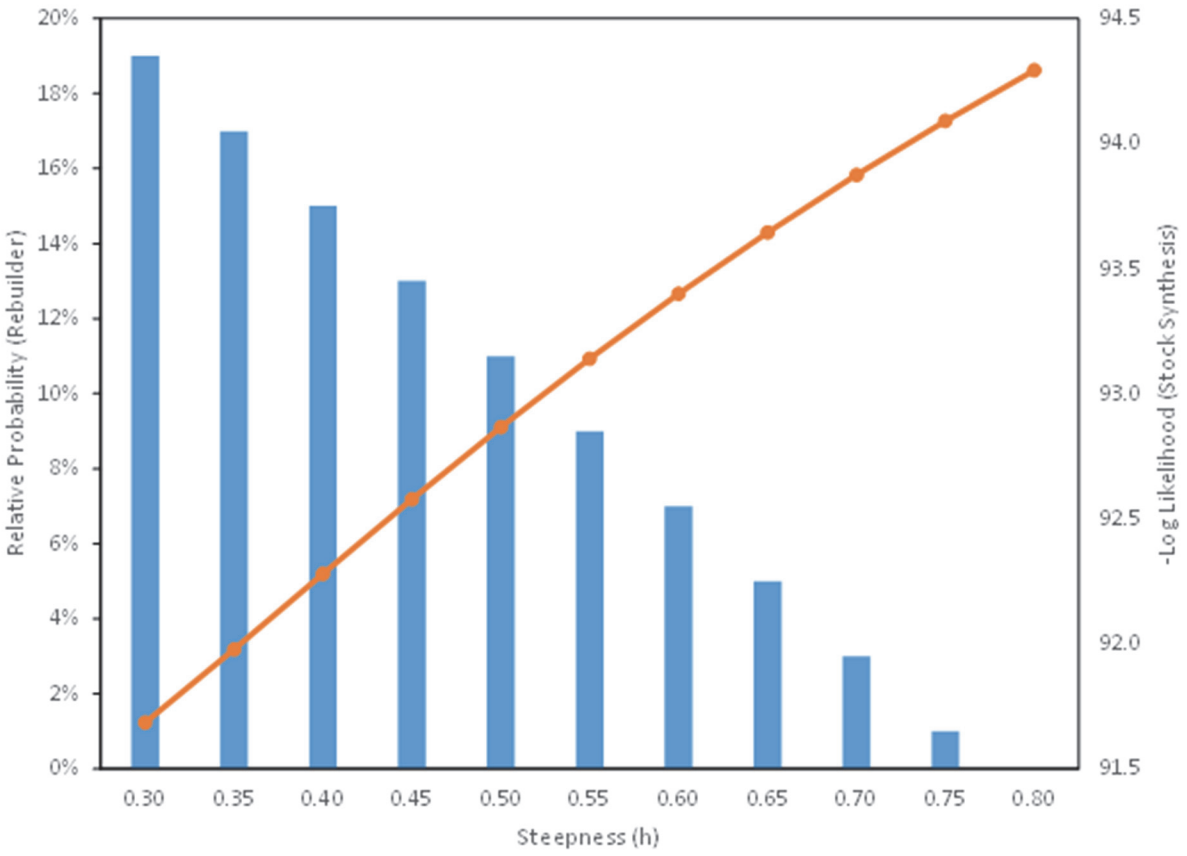

Figure 6. Relative probabilities (blue bars) for steepness levels profiled in rebuilding projections. Relative probabilities were based on negative log likelihood estimates from Stock Synthesis steepness profiles (orange line).

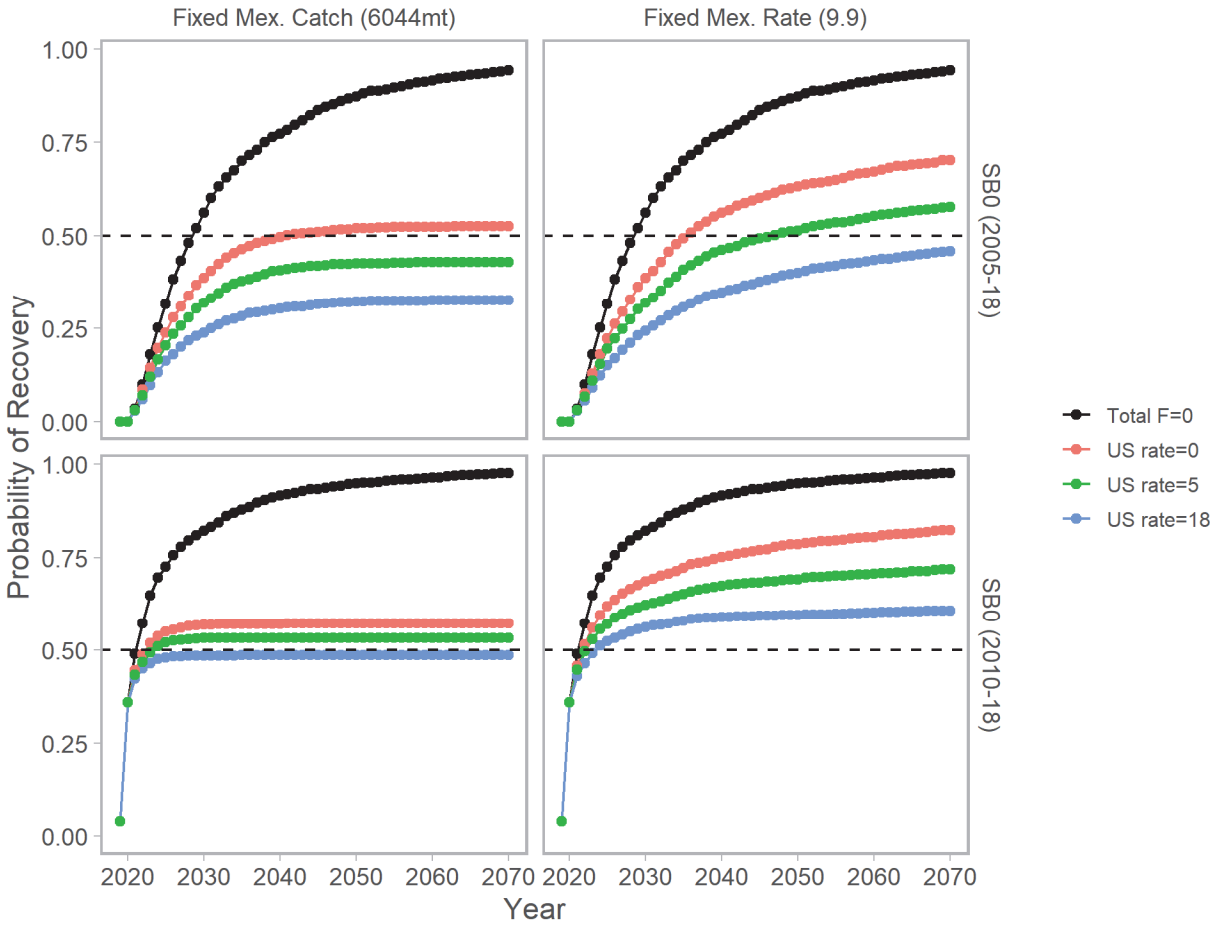

Figure 7a. Probabilities of recovery for Pacific sardine rebuilding alternatives. Panels are arranged by state of nature [$SB_{0(2005\text{-}18)}$ – top row; $SB_{0(2010\text{-}18)}$ – bottom row]. Mexico catch was fixed at 6,044 mt (left column) or assumed to have a fixed harvest rate of 9.9 (right column). The Total F=0 (black) had no harvest from Mexico nor the US. US harvest rates were 0 (red), 5 (green), and 18 (blue). The probability of recovery threshold was 0.5 (dashed black line). Note, the probability of recovery is higher with the $SB_{0(2010\text{-}18)}$ scenario because the target depletion level (as a fraction of B0; see Figure 4) is lower than that from the $SB_{0(2005\text{-}18)}$ scenario.

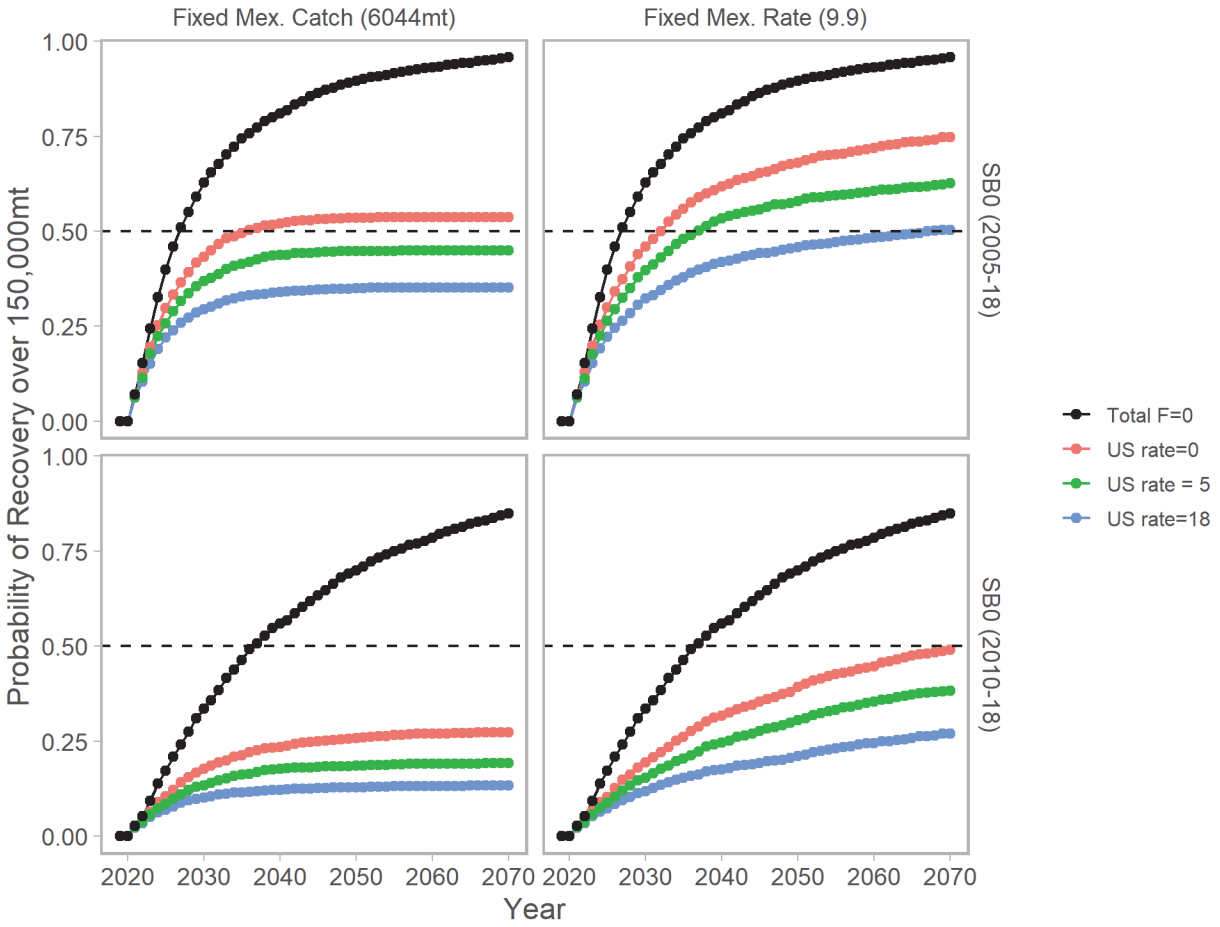

Figure 7b. Probabilities of recovery to the 150,000 mt Cutoff threshold for Pacific sardine rebuilding alternatives. Panels are arranged by state of nature [$SB_{0(2005\text{-}18)}$ – top row; $SB_{0(2010\text{-}18)}$ – bottom row]. Mexico catch was fixed at 6,044 mt (left column) or assumed to have a fixed harvest rate of 9.9 (right column). The Total F=0 (black) had no harvest from Mexico nor the US. US harvest rates were 0 (red), 5 (green), and 18 (blue). The probability of recovery threshold was 0.5 (dashed black line). Note, the probability of recovery is higher with the $SB_{0(2010\text{-}18)}$ scenario because the target depletion level (as a fraction of B0; see Figure 4) is lower than that from the $SB_{0(2005\text{-}18)}$ scenario.

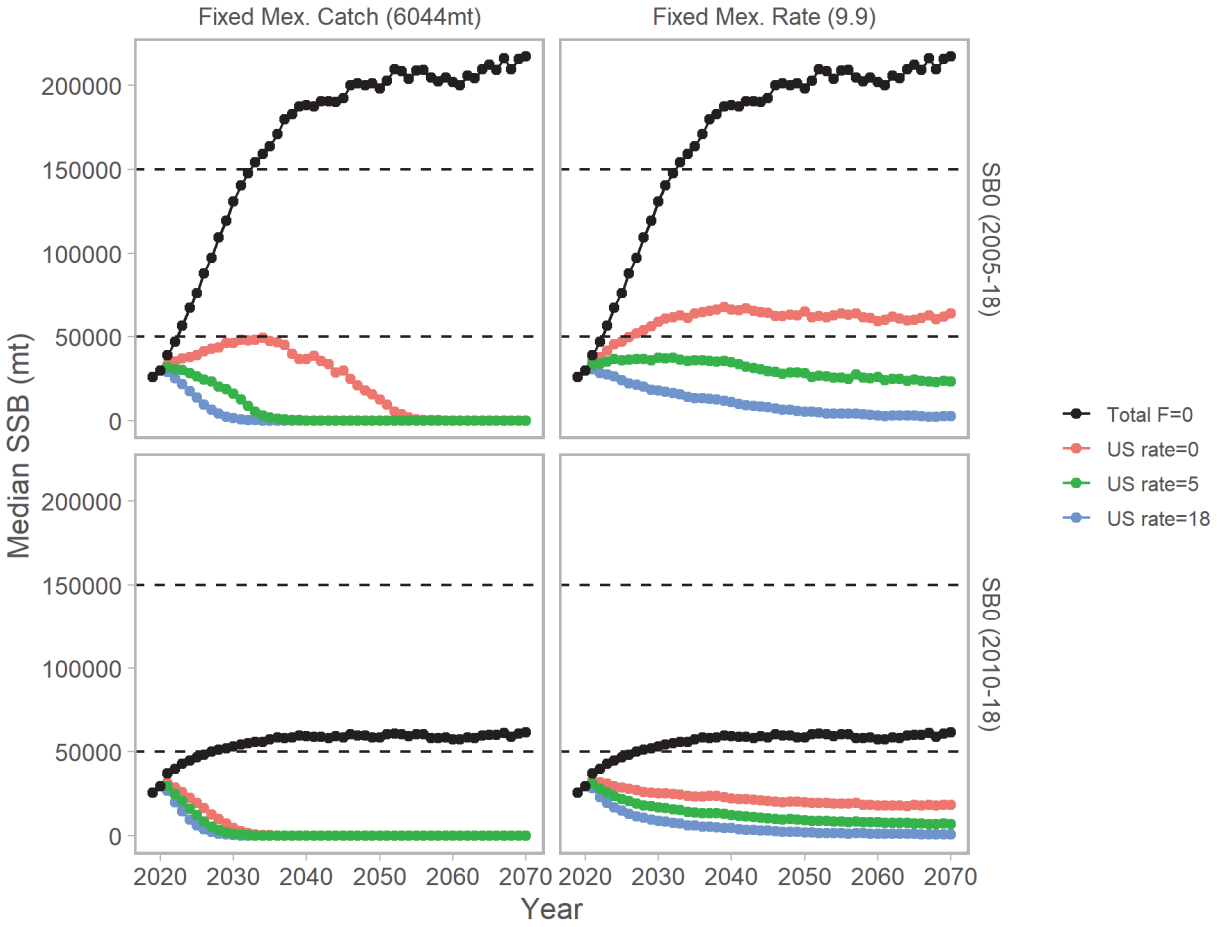

Figure 8. Median spawning stock biomass (mt) for Pacific sardine rebuilding alternatives. Panels are arranged by state of nature [$SB_{0(2005\text{-}18)}$ – top row; $SB_{0(2010\text{-}18)}$ – bottom row]. Mexico catch was fixed at 6,044 mt (left column) or assumed to have a fixed harvest rate of 9.9 (right column). The Total F=0 (black) had no harvest from Mexico nor the US. US harvest rates were 0 (red), 5 (green), and 18 (blue). The management thresholds of 50,000 mt and 150,000 mt are shown in black horizontal dashed lines. For the $SB_{0(2010\text{-}18)}$ scenario, even with Total F=0, the median SSB values do not get higher than 150,000 mt.

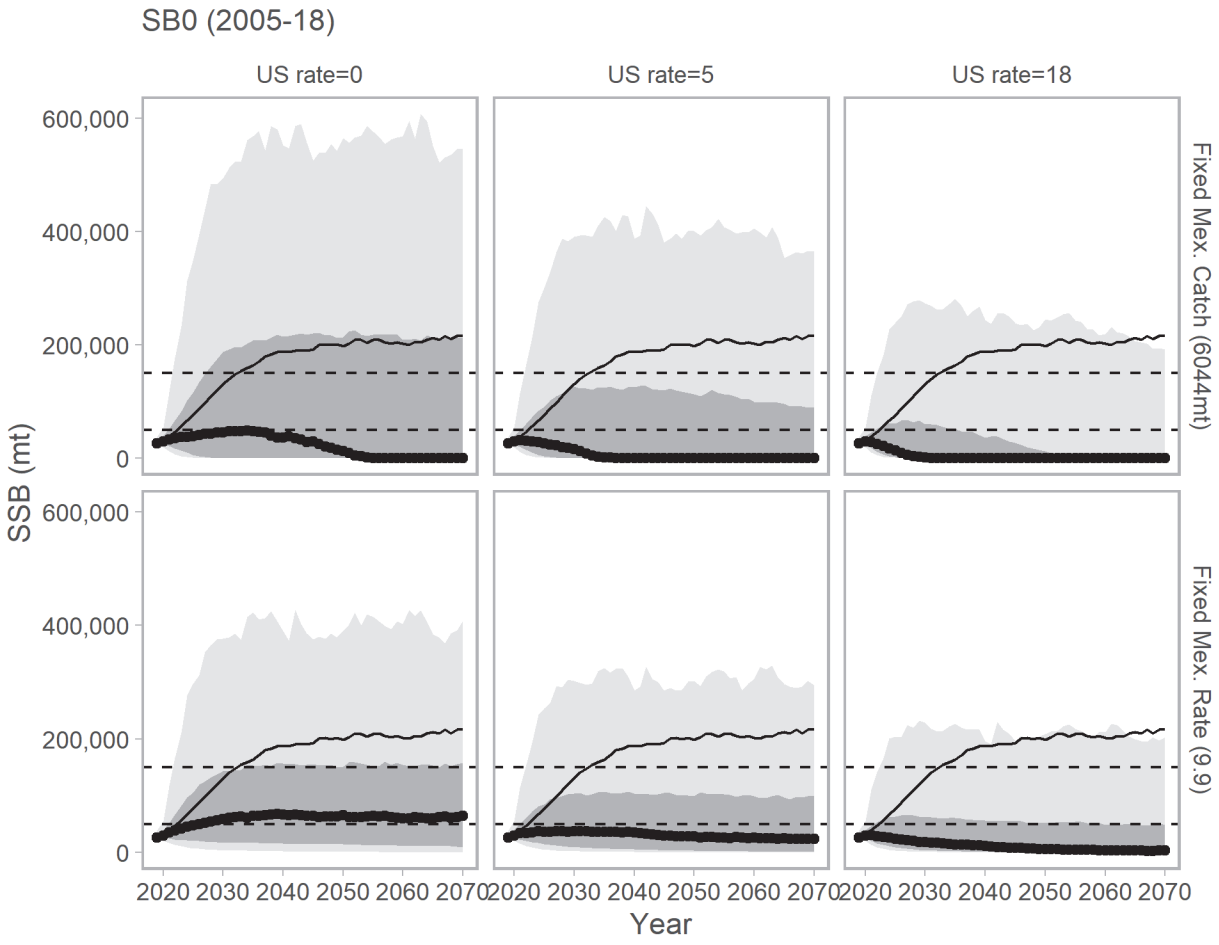

Figure 9. Projected spawning stock biomass (mt) for $SB_{0(2005\text{-}18)}$ scenario. Mexico catch was either fixed at 6,044 mt (top row) or fixed at a harvest rate of 9.9% (bottom row). US harvest rate was 0, 5, or 18% (left to right columns). Values displayed are median SSB values (black points), 25-75 percentiles (dark gray shading), and 5-95 percentiles (light gray shading). Median SSB values with total F=0 (black line), i.e. no harvest from US or Mexico, and Management thresholds at 50,000 and 150,000 mt (horizontal dashed lines) are shown in the figure.

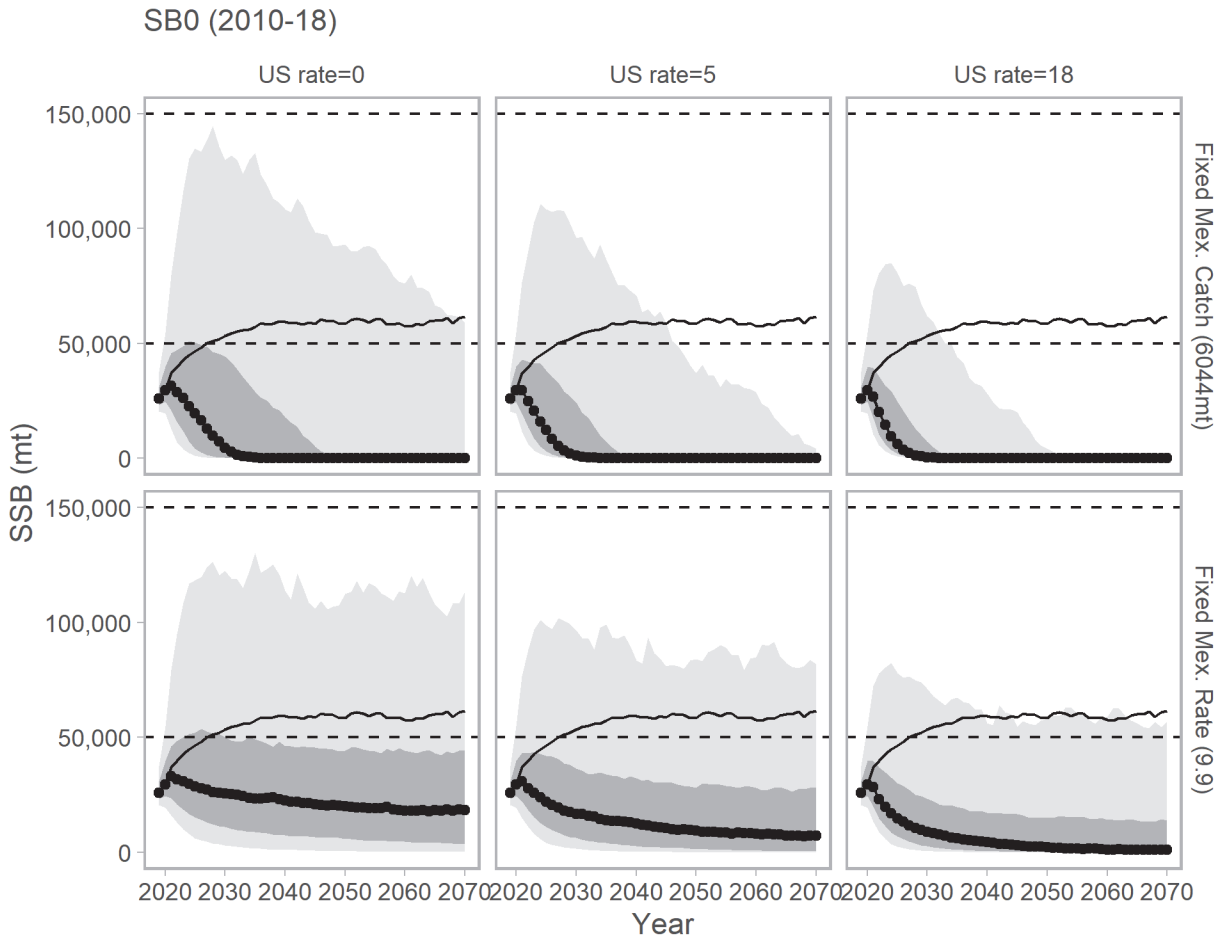

Figure 10. Projected spawning stock biomass (mt) for $SB_{0(2010\text{-}18)}$ scenario. Mexico catch was either fixed at 6,044 mt (top row) or fixed at a harvest rate of 9.9% (bottom row). US harvest rate was 0, 5, or 18% (left to right columns). Values displayed are median SSB values (black points), 25-75 percentiles (dark gray shading), and 5-95 percentiles (light gray shading). Median SSB values with total F=0 (black line), i.e. no harvest from US or Mexico, and Management thresholds at 50,000 and 150,000 mt (horizontal dashed lines) are shown in the figure.

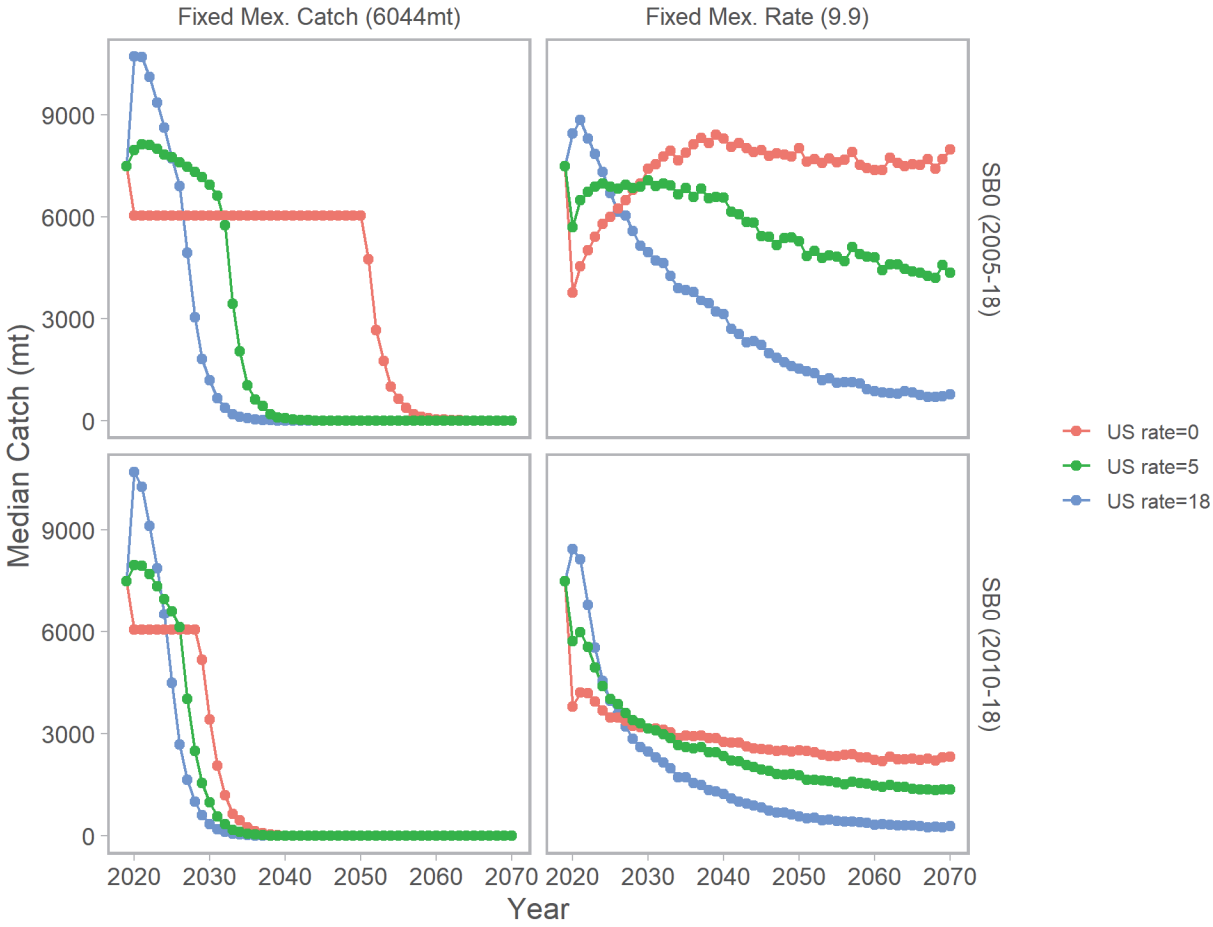

Figure 11. Median projected catch (mt) for Pacific sardine rebuilding alternatives. Panels are arranged by state of nature: $SB_{0(2005\text{-}18)}$ – top row; $SB_{0(2010\text{-}18)}$ – bottom row. Mexico catch was fixed at 6,044 mt (left column) or assumed to have a fixed harvest rate of 9.9 (right column). US harvest rates were 0 (red), 5 (green), and 18 (blue).

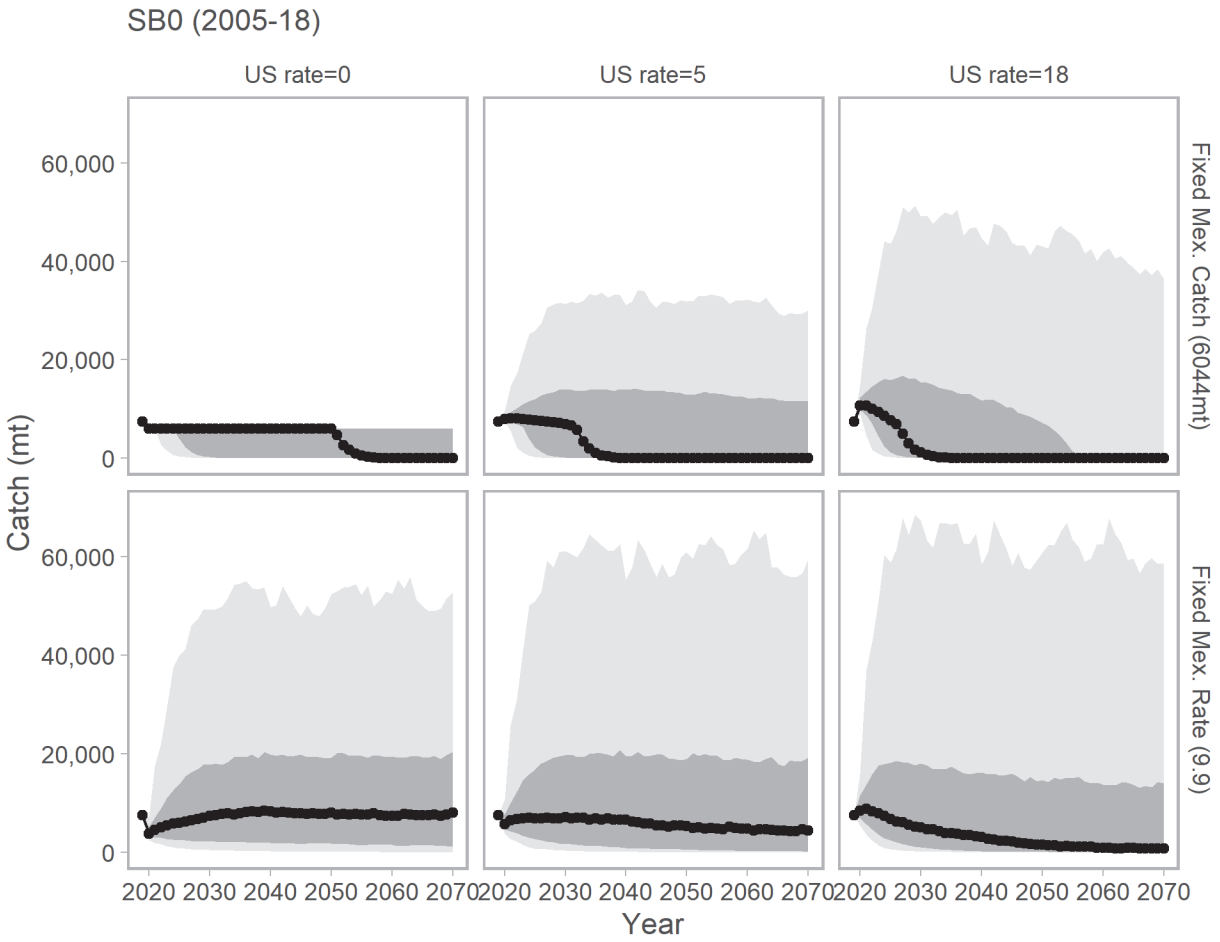

Figure 12. Projected catch (mt) for $SB_{0(2005\text{-}18)}$ scenario. Mexico catch was either fixed at 6,044 mt (top row) or fixed at a harvest rate of 9.9% (bottom row). US harvest rate was 0, 5, or 18% (left to right columns). Values displayed are median catch values (black points), 25-75 percentiles (dark gray shading), and 5-95 percentiles (light gray shading).

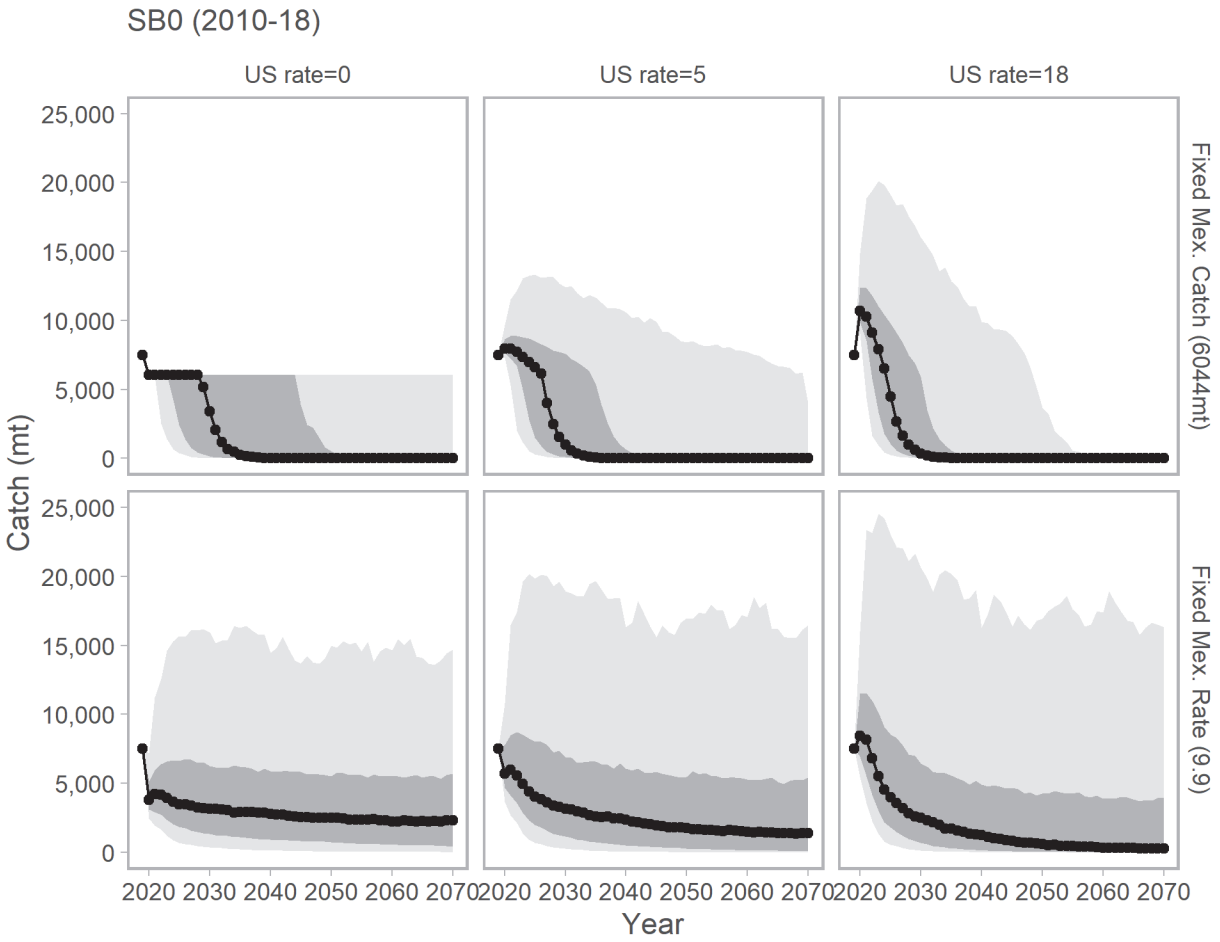

Figure 13. Projected catch (mt) for $SB_{0(2010\text{-}18)}$ scenario. Mexico catch was either fixed at 6,044 mt (top row) or fixed at a harvest rate of 9.9% (bottom row). US harvest rate was 0, 5, or 18% (left to right columns). Values displayed are median catch values (black points), 25-75 percentiles (dark gray shading), and 5-95 percentiles (light gray shading).

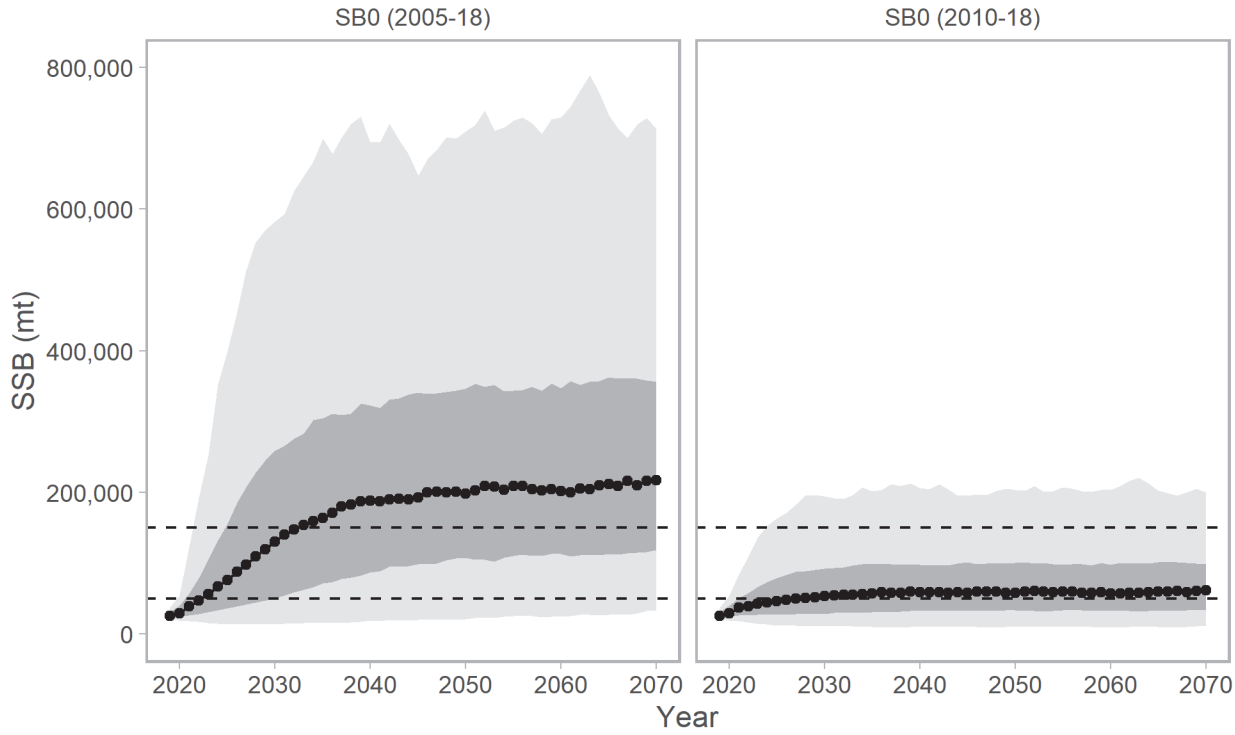

Figure 14. Projected spawning stock biomass (mt) for the $SB_{0(2005\text{-}18)}$ and $SB_{0(2010\text{-}18)}$ scenarios in the complete absence of fishing (Total E=0 for the US and Mexico). Values displayed are median SSB values (black points), 25-75 percentiles (dark gray shading), and 5-95 percentiles (light gray shading). Management thresholds at 50,000 and 150,000 mt are shown as horizontal dashed lines.

Appendix A. Rebuild.dat file for sardine rebuilding projections. The only difference between the high productivity and low productivity Rebuild.dat was the range of years selected for averaging recruitment for calculating SB0 (see input (22)).

```
# (1)Title
Sardine_2020_Rebuilding
# (2)Number of sexes
1
# (3)Age range to consider
0 10
# (4)Number of fleets
1
# (5)First year of projection (Yinit)
2019
# (6)First year the OY could have been zero
2020
# (7)Number of simulations
2000
# (8)Maximum number of years
500
# (9)Conduct projections with multiple starting values (0=No;else yes)
1
# (10)Number of parameter vectors
100
# (11)Is the maximum age a plus-group (1=Yes;2=No)
1
# (12)Generate future recruitments using historical recruitments (1)
historical recruits/spawner (2)  or a stock-recruitment (3)
3
# (13)Constant fishing mortality (1) or constant Catch (2)
1
# (14)Fishing mortality based on SPR (1) or F (2)
1
# (15)Pre-specify the year of recovery (or -1) to ignore
-1
# (16)Fecundity-at-age
# 0 1 2 3 4 5 6 7 8 9 10
0.0000 0.0354 0.0773 0.11 0.1339 0.1515 0.1644 0.1739 0.1808 0.1858 0.1939
# (17)Age specific information (females then males) weight / selectivity
#
0.0344 0.0591 0.0833 0.1601 0.17 0.1721 0.183 0.186 0.1913 0.1947 0.1995
0.490027 1 0.257237 0.0376225 0.0534343 0.0437764 0.0144477 0.0136617
0.00306224 0.00306224 0.00306224
# (18)M and current age-structure
#
0.585221 0.585221 0.585221 0.585221 0.585221 0.585221 0.585221 0.585221
0.585221 0.585221 0.585221
438996 194984 44087.5 19995 6617.46 25027.3 5931.46 3052.62 2481.45 970.423
6040.54
# (19)Age-structure at the start of year Yinit^0
580925 222512 46832.8 12386.5 47853.5 11486.9 5723.79 4551.15 1750.78 8726.19
2171.82
# (20)Year Ynit^0
2019
#  recruitment and biomass
# (21)Number of historical assessment years
```

```
16
# (22)Historical data
# year, recruitment, spawner, in B0, in R project, in R/S project
2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018
2019
1864030 23481700 10243900 4440300 3036910 4349860 6382960 400378 320608
230611 267296 874285 198698 533748 644242 580925
186412 1341469 1590355 1476111 1102498 758713 543791 424294 282412 141519
65602 41595 45097 36936 32953 27771
0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0
0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0
0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0
# (23)Number of years with pre-specified catches
1
# (24)catches for years with pre-specified catches
2019 7500
# (25)Number of future recruitments to override
1
# (26)Process for overiding (-1 for average otherwise index in data list)
2019 1 2019
# (27)Which probability to produce detailed results for (1=0.5; 2=0.6;
6=sardineHCR)
6
# (28)Steepness sigma-R, and auto-correlation
0.3 1.2 0
# (29)Target SPR rate (FMSY Proxy)
0.75
# (30)Discount rate (for cumulative catch)
0.1
# (31)Truncate the series when 0.4B0 is reached (1=Yes)
0
# (32)Set F to FMSY once 0.4B0 is reached (1=Yes)
0
# (33)Maximum possible F for projection (-1 to set to FMSY)
3
# (34)Defintion of recovery (1=now only;2=now or before)
2
# (35)Projection type (1, 2, 3, 4, 5, 11 or 12)
1
# (36)Definition of the ""40-10"" rule
10    40
# (37)Sigma Assessment Error
0.607
# (38)Pstar
0.40
# (39)Constrain catches by the ABC (1=Yes;2=No)
2
# (40)Implementation error (0=No;1=Lognormal;2=Uniform)
0
# (41)Parameters of Implementation Error
1 0.3
# (42)Calculate coefficients of variation (1=Yes)
0
# (43)Number of replicates to use
10
# (44)Random number seed
-99004
```

```
# (45)File with multiple parameter vectors
rebuild_samphi.sso
# (46)User-specific projection (1=Yes); Output replaced (1->9)
0   5
# (47)Catches and Fs (Year; 1/2 (F or C); value); Final row is -1
2020 2 7500
-1    -1    -1
# (48)Fixed catch project (1=Yes); Output replaced (1->9); Approach (-1=Read
in else 1-9)
2 8 9 -1 -1
# (48a) Special catch options (1-Yes) [CUT_OFF, Emsy, distribution, MAXCAT,
Add, replace_code]
1 0.2202 1 1 0 6
# (48b) B1Target
150000
# (49)Split of Fs
2019 1
-1    1
# (50)Five pre-specified inputs
0.5 0.6 0.7 0.8 0.9 # 200 300 400 500 600 2048 2036 2030.0 2026.7 2036
# (51)Years for which a probability of recovery is needed
2027 2028 2029 2030 2031 2032 2033 2034
# (52)Time varying weight-at-age (1=Yes;0=No)
0
# (53)File with time series of weight-at-age data
HakWght.Csv
# (54)Use bisection (0) or linear interpolation (1)
0
# (55)Target Depletion
0.365
```

Appendix B: Multiple parameter input file (Rebuild_samp.sso) used for sardine rebuilding projections.

```
#
 0.0 0.0354 0.0773 0.11 0.1339 0.1515 0.1644 0.1739 0.1808 0.1858 0.1939
#female fecundity; weighted by N in year Y_init across morphs and areas
 0.0344 0.0591 0.0833 0.1601 0.17 0.1721 0.083 0.186 0.1913 0.1947 0.1995
#bodywt for gender,fleet: 1 / 2 MexCal_S2
 0.490027 1 0.257237 0.0376225 0.0534343 0.0437764 0.0144477 0.0136617
0.00306224 0.00306224 0.00306224 #selex for gender,fleet: 1 / 2 MexCal_S2
 0.585221 0.585221 0.585221 0.585221 0.585221 0.585221 0.585221 0.585221
0.585221 0.585221 0.585221 #mean M for year Yinit: 2020 sex: 1
 438996 194984 44087.5 19995 6617.46 25027.3 5931.46 3052.62 2481.45 970.423
6040.54 #numbers for year Yinit: 2020 sex: 1
 580925 222512 46832.8 12386.5 47853.5 11486.9 5723.79 4551.15 1750.78
8726.19 2171.82 #numbers for year Ydeclare: 2019 sex: 1
#R0  2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018
2019 #years
1864030 23481700 10243900 4440300 3036910 4349860 6382960 400378 320608
230611 267296 874285 198698 533748 644242 580925 #Recruits
186412 944409 1136270 1010600 760343 508691 346715 265112 148558 69619.8
37557.4 30991.3 33300.3 27434.9 24561.4 20622.8 #SpawnBio
0.3 1.2 0 0.365 # spawn-recr steepness, sigmaR, autocorr , targetdep
#
 0.0 0.0354 0.0773 0.11 0.1339 0.1515 0.1644 0.1739 0.1808 0.1858 0.1939
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 0.0 0.0354 0.0773 0.11 0.1339 0.1515 0.1644 0.1739 0.1808 0.1858 0.1939
#female fecundity; weighted by N in year Y_init across morphs and areas
 0.0344 0.0591 0.0833 0.1601 0.17 0.1721 0.083 0.186 0.1913 0.1947 0.1995
#bodywt for gender,fleet: 1 / 2 MexCal_S2
```

```
 0.490027 1 0.257237 0.0376225 0.0534343 0.0437764 0.0144477 0.0136617
0.00306224 0.00306224 0.00306224 #selex for gender,fleet: 1 / 2 MexCal_S2
 0.585221 0.585221 0.585221 0.585221 0.585221 0.585221 0.585221 0.585221
0.585221 0.585221 0.585221 #mean M for year Yinit: 2020 sex: 1
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6040.54 #numbers for year Yinit: 2020 sex: 1
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#R0  2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018
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 0.0 0.0354 0.0773 0.11 0.1339 0.1515 0.1644 0.1739 0.1808 0.1858 0.1939
#female fecundity; weighted by N in year Y_init across morphs and areas
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#female fecundity; weighted by N in year Y_init across morphs and areas
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230611 267296 874285 198698 533748 644242 580925 #Recruits
```

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186412 944409 1136270 1010600 760343 508691 346715 265112 148558 69619.8
37557.4 30991.3 33300.3 27434.9 24561.4 20622.8 #SpawnBio
0.3 1.2 0 0.365 # spawn-recr steepness, sigmaR, autocorr , targetdep
#
 0.0 0.0354 0.0773 0.11 0.1339 0.1515 0.1644 0.1739 0.1808 0.1858 0.1939
#female fecundity; weighted by N in year Y_init across morphs and areas
 0.0344 0.0591 0.0833 0.1601 0.17 0.1721 0.083 0.186 0.1913 0.1947 0.1995
#bodywt for gender,fleet: 1 / 2 MexCal_S2
 0.490027 1 0.257237 0.0376225 0.0534343 0.0437764 0.0144477 0.0136617
0.00306224 0.00306224 0.00306224 #selex for gender,fleet: 1 / 2 MexCal_S2
 0.585221 0.585221 0.585221 0.585221 0.585221 0.585221 0.585221 0.585221
0.585221 0.585221 0.585221 #mean M for year Yinit: 2020 sex: 1
 438996 194984 44087.5 19995 6617.46 25027.3 5931.46 3052.62 2481.45 970.423
6040.54 #numbers for year Yinit: 2020 sex: 1
 580925 222512 46832.8 12386.5 47853.5 11486.9 5723.79 4551.15 1750.78
8726.19 2171.82 #numbers for year Ydeclare: 2019 sex: 1
#R0  2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018
2019 #years
1864030 23481700 10243900 4440300 3036910 4349860 6382960 400378 320608
230611 267296 874285 198698 533748 644242 580925 #Recruits
186412 944409 1136270 1010600 760343 508691 346715 265112 148558 69619.8
37557.4 30991.3 33300.3 27434.9 24561.4 20622.8 #SpawnBio
0.3 1.2 0 0.365 # spawn-recr steepness, sigmaR, autocorr , targetdep
#
 0.0 0.0354 0.0773 0.11 0.1339 0.1515 0.1644 0.1739 0.1808 0.1858 0.1939
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#bodywt for gender,fleet: 1 / 2 MexCal_S2
 0.490027 1 0.257237 0.0376225 0.0534343 0.0437764 0.0144477 0.0136617
0.00306224 0.00306224 0.00306224 #selex for gender,fleet: 1 / 2 MexCal_S2
 0.585221 0.585221 0.585221 0.585221 0.585221 0.585221 0.585221 0.585221
0.585221 0.585221 0.585221 #mean M for year Yinit: 2020 sex: 1
 438996 194984 44087.5 19995 6617.46 25027.3 5931.46 3052.62 2481.45 970.423
6040.54 #numbers for year Yinit: 2020 sex: 1
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 0.490027 1 0.257237 0.0376225 0.0534343 0.0437764 0.0144477 0.0136617
0.00306224 0.00306224 0.00306224 #selex for gender,fleet: 1 / 2 MexCal_S2
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0.585221 0.585221 0.585221 #mean M for year Yinit: 2020 sex: 1
 438996 194984 44087.5 19995 6617.46 25027.3 5931.46 3052.62 2481.45 970.423
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 0.585221 0.585221 0.585221 0.585221 0.585221 0.585221 0.585221 0.585221
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 0.585221 0.585221 0.585221 0.585221 0.585221 0.585221 0.585221 0.585221
0.585221 0.585221 0.585221 #mean M for year Yinit: 2020 sex: 1
 438996 194984 44087.5 19995 6617.46 25027.3 5931.46 3052.62 2481.45 970.423
6040.54 #numbers for year Yinit: 2020 sex: 1
 580925 222512 46832.8 12386.5 47853.5 11486.9 5723.79 4551.15 1750.78
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 0.0 0.0354 0.0773 0.11 0.1339 0.1515 0.1644 0.1739 0.1808 0.1858 0.1939
#female fecundity; weighted by N in year Y_init across morphs and areas
 0.0344 0.0591 0.0833 0.1601 0.17 0.1721 0.083 0.186 0.1913 0.1947 0.1995
#bodywt for gender,fleet: 1 / 2 MexCal_S2
 0.488545 1 0.256608 0.0374046 0.0531285 0.0434869 0.0143483 0.0135713
0.00303927 0.00303927 0.00303927 #selex for gender,fleet: 1 / 2 MexCal_S2
 0.584744 0.584744 0.584744 0.584744 0.584744 0.584744 0.584744 0.584744
0.584744 0.584744 0.584744 #mean M for year Yinit: 2020 sex: 1
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 540137 253807 50357.6 20853 6797.19 25224 6021.69 3067.65 2481.46 946.908
6029.35 #numbers for year Yinit: 2020 sex: 1
 709374 223811 47227 12654.5 47866.3 11586.4 5737.45 4540.56 1706.83 8698.09
2170 #numbers for year Ydeclare: 2019 sex: 1
#R0  2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018
2019 #years
1901660 23445000 10215200 4428990 3026940 4342540 6363040 393946 318724
230364 268743 871837 201858 534819 645658 709374 #Recruits
190450 942720 1134740 1009490 759631 508244 346375 264726 148170 69306.1
37345.9 30874.1 33239.5 27446.9 24622.7 21150.6 #SpawnBio
0.35 1.2 0 0.365 # spawn-recr steepness, sigmaR, autocorr , targetdep
#
 0.0 0.0354 0.0773 0.11 0.1339 0.1515 0.1644 0.1739 0.1808 0.1858 0.1939
#female fecundity; weighted by N in year Y_init across morphs and areas
 0.0344 0.0591 0.0833 0.1601 0.17 0.1721 0.083 0.186 0.1913 0.1947 0.1995
#bodywt for gender,fleet: 1 / 2 MexCal_S2
 0.488545 1 0.256608 0.0374046 0.0531285 0.0434869 0.0143483 0.0135713
0.00303927 0.00303927 0.00303927 #selex for gender,fleet: 1 / 2 MexCal_S2
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0.584744 0.584744 0.584744 #mean M for year Yinit: 2020 sex: 1
 540137 253807 50357.6 20853 6797.19 25224 6021.69 3067.65 2481.46 946.908
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0.00303927 0.00303927 0.00303927 #selex for gender,fleet: 1 / 2 MexCal_S2
 0.584744 0.584744 0.584744 0.584744 0.584744 0.584744 0.584744 0.584744
0.584744 0.584744 0.584744 #mean M for year Yinit: 2020 sex: 1
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 0.488545 1 0.256608 0.0374046 0.0531285 0.0434869 0.0143483 0.0135713
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 0.584744 0.584744 0.584744 0.584744 0.584744 0.584744 0.584744 0.584744
0.584744 0.584744 0.584744 #mean M for year Yinit: 2020 sex: 1
 540137 253807 50357.6 20853 6797.19 25224 6021.69 3067.65 2481.46 946.908
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 0.0 0.0354 0.0773 0.11 0.1339 0.1515 0.1644 0.1739 0.1808 0.1858 0.1939
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0.00303927 0.00303927 0.00303927 #selex for gender,fleet: 1 / 2 MexCal_S2
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0.584744 0.584744 0.584744 #mean M for year Yinit: 2020 sex: 1
 540137 253807 50357.6 20853 6797.19 25224 6021.69 3067.65 2481.46 946.908
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0.584744 0.584744 0.584744 #mean M for year Yinit: 2020 sex: 1
 540137 253807 50357.6 20853 6797.19 25224 6021.69 3067.65 2481.46 946.908
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0.584744 0.584744 0.584744 #mean M for year Yinit: 2020 sex: 1
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0.584744 0.584744 0.584744 #mean M for year Yinit: 2020 sex: 1
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1901660 23445000 10215200 4428990 3026940 4342540 6363040 393946 318724
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190450 942720 1134740 1009490 759631 508244 346375 264726 148170 69306.1
37345.9 30874.1 33239.5 27446.9 24622.7 21150.6 #SpawnBio
0.35 1.2 0 0.365 # spawn-recr steepness, sigmaR, autocorr , targetdep
#
 0.0 0.0354 0.0773 0.11 0.1339 0.1515 0.1644 0.1739 0.1808 0.1858 0.1939
#female fecundity; weighted by N in year Y_init across morphs and areas
 0.0344 0.0591 0.0833 0.1601 0.17 0.1721 0.083 0.186 0.1913 0.1947 0.1995
#bodywt for gender,fleet: 1 / 2 MexCal_S2
 0.488545 1 0.256608 0.0374046 0.0531285 0.0434869 0.0143483 0.0135713
0.00303927 0.00303927 0.00303927 #selex for gender,fleet: 1 / 2 MexCal_S2
 0.584744 0.584744 0.584744 0.584744 0.584744 0.584744 0.584744 0.584744
0.584744 0.584744 0.584744 #mean M for year Yinit: 2020 sex: 1
 540137 253807 50357.6 20853 6797.19 25224 6021.69 3067.65 2481.46 946.908
6029.35 #numbers for year Yinit: 2020 sex: 1
 709374 223811 47227 12654.5 47866.3 11586.4 5737.45 4540.56 1706.83 8698.09
2170 #numbers for year Ydeclare: 2019 sex: 1
#R0  2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018
2019 #years
1901660 23445000 10215200 4428990 3026940 4342540 6363040 393946 318724
230364 268743 871837 201858 534819 645658 709374 #Recruits
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2170 #numbers for year Ydeclare: 2019 sex: 1
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2170 #numbers for year Ydeclare: 2019 sex: 1
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2170 #numbers for year Ydeclare: 2019 sex: 1
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 0.0344 0.0591 0.0833 0.1601 0.17 0.1721 0.083 0.186 0.1913 0.1947 0.1995
#bodywt for gender,fleet: 1 / 2 MexCal_S2
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 0.487126 1 0.25616 0.0370913 0.0526866 0.043096 0.0142145 0.0134458
0.00300868 0.00300868 0.00300868 #selex for gender,fleet: 1 / 2 MexCal_S2
 0.584341 0.584341 0.584341 0.584341 0.584341 0.584341 0.584341 0.584341
0.584341 0.584341 0.584341 #mean M for year Yinit: 2020 sex: 1
 647359 313702 55665.3 21526.5 6942.53 25390.1 6090.42 3076.17 2478.38
921.271 6041.06 #numbers for year Yinit: 2020 sex: 1
 835707 224885 47541.6 12871.7 47901 11660.2 5741.96 4526.63 1659.42 8704.79
2176.53 #numbers for year Ydeclare: 2019 sex: 1
#R0  2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018
2019 #years
1877690 23416100 10192200 4420380 3019140 4337600 6352700 387178 316738
229837 269680 870159 204407 535724 646816 835707 #Recruits
188279 941409 1133610 1008700 759158 507972 346199 264560 147983 69129.9
37214.1 30796.9 33201.1 27464.6 24678.3 21659.3 #SpawnBio
0.365 1.2 0 0.365 # spawn-recr steepness, sigmaR, autocorr , targetdep
#
 0.0 0.0354 0.0773 0.11 0.1339 0.1515 0.1644 0.1739 0.1808 0.1858 0.1939
#female fecundity; weighted by N in year Y_init across morphs and areas
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#bodywt for gender,fleet: 1 / 2 MexCal_S2
 0.487126 1 0.25616 0.0370913 0.0526866 0.043096 0.0142145 0.0134458
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0.365 1.2 0 0.365 # spawn-recr steepness, sigmaR, autocorr , targetdep
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 0.0 0.0354 0.0773 0.11 0.1339 0.1515 0.1644 0.1739 0.1808 0.1858 0.1939
#female fecundity; weighted by N in year Y_init across morphs and areas
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0.365 1.2 0 0.365 # spawn-recr steepness, sigmaR, autocorr , targetdep
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 0.0 0.0354 0.0773 0.11 0.1339 0.1515 0.1644 0.1739 0.1808 0.1858 0.1939
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921.271 6041.06 #numbers for year Yinit: 2020 sex: 1
 835707 224885 47541.6 12871.7 47901 11660.2 5741.96 4526.63 1659.42 8704.79
2176.53 #numbers for year Ydeclare: 2019 sex: 1
#R0  2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018
2019 #years
1877690 23416100 10192200 4420380 3019140 4337600 6352700 387178 316738
229837 269680 870159 204407 535724 646816 835707 #Recruits
188279 941409 1133610 1008700 759158 507972 346199 264560 147983 69129.9
37214.1 30796.9 33201.1 27464.6 24678.3 21659.3 #SpawnBio
0.365 1.2 0 0.365 # spawn-recr steepness, sigmaR, autocorr , targetdep
#
 0.0 0.0354 0.0773 0.11 0.1339 0.1515 0.1644 0.1739 0.1808 0.1858 0.1939
#female fecundity; weighted by N in year Y_init across morphs and areas
 0.0344 0.0591 0.0833 0.1601 0.17 0.1721 0.083 0.186 0.1913 0.1947 0.1995
#bodywt for gender,fleet: 1 / 2 MexCal_S2
 0.487126 1 0.25616 0.0370913 0.0526866 0.043096 0.0142145 0.0134458
0.00300868 0.00300868 0.00300868 #selex for gender,fleet: 1 / 2 MexCal_S2
 0.584341 0.584341 0.584341 0.584341 0.584341 0.584341 0.584341 0.584341
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 647359 313702 55665.3 21526.5 6942.53 25390.1 6090.42 3076.17 2478.38
921.271 6041.06 #numbers for year Yinit: 2020 sex: 1
 835707 224885 47541.6 12871.7 47901 11660.2 5741.96 4526.63 1659.42 8704.79
2176.53 #numbers for year Ydeclare: 2019 sex: 1
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#R0  2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018
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 0.487126 1 0.25616 0.0370913 0.0526866 0.043096 0.0142145 0.0134458
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#female fecundity; weighted by N in year Y_init across morphs and areas
 0.0344 0.0591 0.0833 0.1601 0.17 0.1721 0.083 0.186 0.1913 0.1947 0.1995
#bodywt for gender,fleet: 1 / 2 MexCal_S2
 0.48577 1 0.255826 0.036735 0.0521844 0.0426627 0.0140661 0.013305
0.00297502 0.00297502 0.00297502 #selex for gender,fleet: 1 / 2 MexCal_S2
 0.583989 0.583989 0.583989 0.583989 0.583989 0.583989 0.583989 0.583989
0.583989 0.583989 0.583989 #mean M for year Yinit: 2020 sex: 1
 759500 373554 60182.6 22068.5 7063.02 25536.2 6144.85 3080.96 2474.26
895.762 6066.9 #numbers for year Yinit: 2020 sex: 1
 958782 225790 47798.8 13052.3 47954.2 11717.6 5741.68 4512.44 1612.5 8733.27
2187.98 #numbers for year Ydeclare: 2019 sex: 1
#R0  2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018
2019 #years
1835470 23392400 10172900 4413510 3012780 4334170 6348480 380556 314832
229188 270308 869059 206512 536495 647763 958782 #Recruits
184242 940351 1132730 1008110 758834 507807 346124 264529 147926 69047.3
37139.7 30750.7 33181.5 27488.7 24731.2 22148.7 #SpawnBio
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 0.0 0.0354 0.0773 0.11 0.1339 0.1515 0.1644 0.1739 0.1808 0.1858 0.1939
#female fecundity; weighted by N in year Y_init across morphs and areas
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 0.48577 1 0.255826 0.036735 0.0521844 0.0426627 0.0140661 0.013305
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 0.583989 0.583989 0.583989 0.583989 0.583989 0.583989 0.583989 0.583989
0.583989 0.583989 0.583989 #mean M for year Yinit: 2020 sex: 1
 759500 373554 60182.6 22068.5 7063.02 25536.2 6144.85 3080.96 2474.26
895.762 6066.9 #numbers for year Yinit: 2020 sex: 1
 958782 225790 47798.8 13052.3 47954.2 11717.6 5741.68 4512.44 1612.5 8733.27
2187.98 #numbers for year Ydeclare: 2019 sex: 1
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#R0  2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018
2019 #years
1835470 23392400 10172900 4413510 3012780 4334170 6348480 380556 314832
229188 270308 869059 206512 536495 647763 958782 #Recruits
184242 940351 1132730 1008110 758834 507807 346124 264529 147926 69047.3
37139.7 30750.7 33181.5 27488.7 24731.2 22148.7 #SpawnBio
0.45 1.2 0 0.365 # spawn-recr steepness, sigmaR, autocorr , targetdep
#
 0.0 0.0354 0.0773 0.11 0.1339 0.1515 0.1644 0.1739 0.1808 0.1858 0.1939
#female fecundity; weighted by N in year Y_init across morphs and areas
 0.0344 0.0591 0.0833 0.1601 0.17 0.1721 0.083 0.186 0.1913 0.1947 0.1995
#bodywt for gender,fleet: 1 / 2 MexCal_S2
 0.48577 1 0.255826 0.036735 0.0521844 0.0426627 0.0140661 0.013305
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0.583989 0.583989 0.583989 #mean M for year Yinit: 2020 sex: 1
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#bodywt for gender,fleet: 1 / 2 MexCal_S2
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 0.484472 1 0.255577 0.0363654 0.0516644 0.0422194 0.0139143 0.0131602
0.00294066 0.00294066 0.00294066 #selex for gender,fleet: 1 / 2 MexCal_S2
 0.583677 0.583677 0.583677 0.583677 0.583677 0.583677 0.583677 0.583677
0.583677 0.583677 0.583677 #mean M for year Yinit: 2020 sex: 1
 875251 432455 64044 22512.2 7164.61 25668.4 6189.41 3083.66 2470.04 871.194
6101.81 #numbers for year Yinit: 2020 sex: 1
1077590 226560 48013 13205 48022 11764 5739 4499 1567 8776 2202 #numbers for
year Ydeclare: 2019 sex: 1
#R0  2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018
2019 #years
1789290 23372400 10156400 4407830 3007440 4331750 6348380 374241 313075
228502 270749 868407 208279 537154 648535 1077590 #Recruits
179777 939471 1132020 1007670 758608 507711 346113 264588 147956 69030.6
37107.7 30728.9 33177.9 27518.9 24782.7 22617.7 #SpawnBio
0.5 1.2 0 0.365 # spawn-recr steepness, sigmaR, autocorr , targetdep
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#female fecundity; weighted by N in year Y_init across morphs and areas
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#bodywt for gender,fleet: 1 / 2 MexCal_S2
 0.484472 1 0.255577 0.0363654 0.0516644 0.0422194 0.0139143 0.0131602
0.00294066 0.00294066 0.00294066 #selex for gender,fleet: 1 / 2 MexCal_S2
 0.583677 0.583677 0.583677 0.583677 0.583677 0.583677 0.583677 0.583677
0.583677 0.583677 0.583677 #mean M for year Yinit: 2020 sex: 1
 875251 432455 64044 22512.2 7164.61 25668.4 6189.41 3083.66 2470.04 871.194
6101.81 #numbers for year Yinit: 2020 sex: 1
1077590 226560 48013 13205 48022 11764 5739 4499 1567 8776 2202 #numbers for
year Ydeclare: 2019 sex: 1
#R0  2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018
2019 #years
1789290 23372400 10156400 4407830 3007440 4331750 6348380 374241 313075
228502 270749 868407 208279 537154 648535 1077590 #Recruits
179777 939471 1132020 1007670 758608 507711 346113 264588 147956 69030.6
37107.7 30728.9 33177.9 27518.9 24782.7 22617.7 #SpawnBio
0.5 1.2 0 0.365 # spawn-recr steepness, sigmaR, autocorr , targetdep
#
 0.0 0.0354 0.0773 0.11 0.1339 0.1515 0.1644 0.1739 0.1808 0.1858 0.1939
#female fecundity; weighted by N in year Y_init across morphs and areas
 0.0344 0.0591 0.0833 0.1601 0.17 0.1721 0.083 0.186 0.1913 0.1947 0.1995
#bodywt for gender,fleet: 1 / 2 MexCal_S2
 0.484472 1 0.255577 0.0363654 0.0516644 0.0422194 0.0139143 0.0131602
0.00294066 0.00294066 0.00294066 #selex for gender,fleet: 1 / 2 MexCal_S2
 0.583677 0.583677 0.583677 0.583677 0.583677 0.583677 0.583677 0.583677
0.583677 0.583677 0.583677 #mean M for year Yinit: 2020 sex: 1
 875251 432455 64044 22512.2 7164.61 25668.4 6189.41 3083.66 2470.04 871.194
6101.81 #numbers for year Yinit: 2020 sex: 1
1077590 226560 48013 13205 48022 11764 5739 4499 1567 8776 2202 #numbers for
year Ydeclare: 2019 sex: 1
#R0  2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018
2019 #years
1789290 23372400 10156400 4407830 3007440 4331750 6348380 374241 313075
228502 270749 868407 208279 537154 648535 1077590 #Recruits
179777 939471 1132020 1007670 758608 507711 346113 264588 147956 69030.6
37107.7 30728.9 33177.9 27518.9 24782.7 22617.7 #SpawnBio
0.5 1.2 0 0.365 # spawn-recr steepness, sigmaR, autocorr , targetdep
#
 0.0 0.0354 0.0773 0.11 0.1339 0.1515 0.1644 0.1739 0.1808 0.1858 0.1939
#female fecundity; weighted by N in year Y_init across morphs and areas
 0.0344 0.0591 0.0833 0.1601 0.17 0.1721 0.083 0.186 0.1913 0.1947 0.1995
#bodywt for gender,fleet: 1 / 2 MexCal_S2
 0.483226 1 0.2554 0.0359994 0.0511502 0.0417846 0.0137653 0.0130174
0.00290705 0.00290705 0.00290705 #selex for gender,fleet: 1 / 2 MexCal_S2
 0.583396 0.583396 0.583396 0.583396 0.583396 0.583396 0.583396 0.583396
0.583396 0.583396 0.583396 #mean M for year Yinit: 2020 sex: 1
```

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 993250 489722 67359.1 22880.4 7251.37 25790.3 6227 3085.23 2466.15 847.832
6142.57 #numbers for year Yinit: 2020 sex: 1
1191380 227222 48193 13337 48102 11804 5736 4488 1525 8828 2219 #numbers for
year Ydeclare: 2019 sex: 1
#R0  2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018
2019 #years
1744340 23355100 10141900 4403030 3002860 4330040 6351090 368279 311487
227829 271078 868106 209777 537718 649160 1191380 #Recruits
175410 938722 1131450 1007320 758452 507664 346146 264706 148047 69061.1
37107.4 30726.4 33187.2 27554.5 24833.4 23065.1 #SpawnBio
0.55 1.2 0 0.365 # spawn-recr steepness, sigmaR, autocorr , targetdep
#
 0.0 0.0354 0.0773 0.11 0.1339 0.1515 0.1644 0.1739 0.1808 0.1858 0.1939
#female fecundity; weighted by N in year Y_init across morphs and areas
 0.0344 0.0591 0.0833 0.1601 0.17 0.1721 0.083 0.186 0.1913 0.1947 0.1995
#bodywt for gender,fleet: 1 / 2 MexCal_S2
 0.483226 1 0.2554 0.0359994 0.0511502 0.0417846 0.0137653 0.0130174
0.00290705 0.00290705 0.00290705 #selex for gender,fleet: 1 / 2 MexCal_S2
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0.583396 0.583396 0.583396 #mean M for year Yinit: 2020 sex: 1
 993250 489722 67359.1 22880.4 7251.37 25790.3 6227 3085.23 2466.15 847.832
6142.57 #numbers for year Yinit: 2020 sex: 1
1191380 227222 48193 13337 48102 11804 5736 4488 1525 8828 2219 #numbers for
year Ydeclare: 2019 sex: 1
#R0  2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018
2019 #years
1744340 23355100 10141900 4403030 3002860 4330040 6351090 368279 311487
227829 271078 868106 209777 537718 649160 1191380 #Recruits
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37107.4 30726.4 33187.2 27554.5 24833.4 23065.1 #SpawnBio
0.55 1.2 0 0.365 # spawn-recr steepness, sigmaR, autocorr , targetdep
#
 0.0 0.0354 0.0773 0.11 0.1339 0.1515 0.1644 0.1739 0.1808 0.1858 0.1939
#female fecundity; weighted by N in year Y_init across morphs and areas
 0.0344 0.0591 0.0833 0.1601 0.17 0.1721 0.083 0.186 0.1913 0.1947 0.1995
#bodywt for gender,fleet: 1 / 2 MexCal_S2
 0.483226 1 0.2554 0.0359994 0.0511502 0.0417846 0.0137653 0.0130174
0.00290705 0.00290705 0.00290705 #selex for gender,fleet: 1 / 2 MexCal_S2
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0.583396 0.583396 0.583396 #mean M for year Yinit: 2020 sex: 1
 993250 489722 67359.1 22880.4 7251.37 25790.3 6227 3085.23 2466.15 847.832
6142.57 #numbers for year Yinit: 2020 sex: 1
1191380 227222 48193 13337 48102 11804 5736 4488 1525 8828 2219 #numbers for
year Ydeclare: 2019 sex: 1
#R0  2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018
2019 #years
1744340 23355100 10141900 4403030 3002860 4330040 6351090 368279 311487
227829 271078 868106 209777 537718 649160 1191380 #Recruits
175410 938722 1131450 1007320 758452 507664 346146 264706 148047 69061.1
37107.4 30726.4 33187.2 27554.5 24833.4 23065.1 #SpawnBio
0.55 1.2 0 0.365 # spawn-recr steepness, sigmaR, autocorr , targetdep
#
 0.0 0.0354 0.0773 0.11 0.1339 0.1515 0.1644 0.1739 0.1808 0.1858 0.1939
#female fecundity; weighted by N in year Y_init across morphs and areas
 0.0344 0.0591 0.0833 0.1601 0.17 0.1721 0.083 0.186 0.1913 0.1947 0.1995
#bodywt for gender,fleet: 1 / 2 MexCal_S2
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 0.483226 1 0.2554 0.0359994 0.0511502 0.0417846 0.0137653 0.0130174
0.00290705 0.00290705 0.00290705 #selex for gender,fleet: 1 / 2 MexCal_S2
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0.583396 0.583396 0.583396 #mean M for year Yinit: 2020 sex: 1
 993250 489722 67359.1 22880.4 7251.37 25790.3 6227 3085.23 2466.15 847.832
6142.57 #numbers for year Yinit: 2020 sex: 1
1191380 227222 48193 13337 48102 11804 5736 4488 1525 8828 2219 #numbers for
year Ydeclare: 2019 sex: 1
#R0  2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018
2019 #years
1744340 23355100 10141900 4403030 3002860 4330040 6351090 368279 311487
227829 271078 868106 209777 537718 649160 1191380 #Recruits
175410 938722 1131450 1007320 758452 507664 346146 264706 148047 69061.1
37107.4 30726.4 33187.2 27554.5 24833.4 23065.1 #SpawnBio
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 0.0344 0.0591 0.0833 0.1601 0.17 0.1721 0.083 0.186 0.1913 0.1947 0.1995
#bodywt for gender,fleet: 1 / 2 MexCal_S2
 0.483226 1 0.2554 0.0359994 0.0511502 0.0417846 0.0137653 0.0130174
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0.583396 0.583396 0.583396 #mean M for year Yinit: 2020 sex: 1
 993250 489722 67359.1 22880.4 7251.37 25790.3 6227 3085.23 2466.15 847.832
6142.57 #numbers for year Yinit: 2020 sex: 1
1191380 227222 48193 13337 48102 11804 5736 4488 1525 8828 2219 #numbers for
year Ydeclare: 2019 sex: 1
#R0  2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018
2019 #years
1744340 23355100 10141900 4403030 3002860 4330040 6351090 368279 311487
227829 271078 868106 209777 537718 649160 1191380 #Recruits
175410 938722 1131450 1007320 758452 507664 346146 264706 148047 69061.1
37107.4 30726.4 33187.2 27554.5 24833.4 23065.1 #SpawnBio
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#
 0.0 0.0354 0.0773 0.11 0.1339 0.1515 0.1644 0.1739 0.1808 0.1858 0.1939
#female fecundity; weighted by N in year Y_init across morphs and areas
 0.0344 0.0591 0.0833 0.1601 0.17 0.1721 0.083 0.186 0.1913 0.1947 0.1995
#bodywt for gender,fleet: 1 / 2 MexCal_S2
 0.483226 1 0.2554 0.0359994 0.0511502 0.0417846 0.0137653 0.0130174
0.00290705 0.00290705 0.00290705 #selex for gender,fleet: 1 / 2 MexCal_S2
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0.583396 0.583396 0.583396 #mean M for year Yinit: 2020 sex: 1
 993250 489722 67359.1 22880.4 7251.37 25790.3 6227 3085.23 2466.15 847.832
6142.57 #numbers for year Yinit: 2020 sex: 1
1191380 227222 48193 13337 48102 11804 5736 4488 1525 8828 2219 #numbers for
year Ydeclare: 2019 sex: 1
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175410 938722 1131450 1007320 758452 507664 346146 264706 148047 69061.1
37107.4 30726.4 33187.2 27554.5 24833.4 23065.1 #SpawnBio
0.55 1.2 0 0.365 # spawn-recr steepness, sigmaR, autocorr , targetdep
#
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 0.0 0.0354 0.0773 0.11 0.1339 0.1515 0.1644 0.1739 0.1808 0.1858 0.1939
#female fecundity; weighted by N in year Y_init across morphs and areas
 0.0344 0.0591 0.0833 0.1601 0.17 0.1721 0.083 0.186 0.1913 0.1947 0.1995
#bodywt for gender,fleet: 1 / 2 MexCal_S2
 0.483226 1 0.2554 0.0359994 0.0511502 0.0417846 0.0137653 0.0130174
0.00290705 0.00290705 0.00290705 #selex for gender,fleet: 1 / 2 MexCal_S2
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0.583396 0.583396 0.583396 #mean M for year Yinit: 2020 sex: 1
 993250 489722 67359.1 22880.4 7251.37 25790.3 6227 3085.23 2466.15 847.832
6142.57 #numbers for year Yinit: 2020 sex: 1
1191380 227222 48193 13337 48102 11804 5736 4488 1525 8828 2219 #numbers for
year Ydeclare: 2019 sex: 1
#R0  2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018
2019 #years
1744340 23355100 10141900 4403030 3002860 4330040 6351090 368279 311487
227829 271078 868106 209777 537718 649160 1191380 #Recruits
175410 938722 1131450 1007320 758452 507664 346146 264706 148047 69061.1
37107.4 30726.4 33187.2 27554.5 24833.4 23065.1 #SpawnBio
0.55 1.2 0 0.365 # spawn-recr steepness, sigmaR, autocorr , targetdep
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 0.0 0.0354 0.0773 0.11 0.1339 0.1515 0.1644 0.1739 0.1808 0.1858 0.1939
#female fecundity; weighted by N in year Y_init across morphs and areas
 0.0344 0.0591 0.0833 0.1601 0.17 0.1721 0.083 0.186 0.1913 0.1947 0.1995
#bodywt for gender,fleet: 1 / 2 MexCal_S2
 0.483226 1 0.2554 0.0359994 0.0511502 0.0417846 0.0137653 0.0130174
0.00290705 0.00290705 0.00290705 #selex for gender,fleet: 1 / 2 MexCal_S2
 0.583396 0.583396 0.583396 0.583396 0.583396 0.583396 0.583396 0.583396
0.583396 0.583396 0.583396 #mean M for year Yinit: 2020 sex: 1
 993250 489722 67359.1 22880.4 7251.37 25790.3 6227 3085.23 2466.15 847.832
6142.57 #numbers for year Yinit: 2020 sex: 1
1191380 227222 48193 13337 48102 11804 5736 4488 1525 8828 2219 #numbers for
year Ydeclare: 2019 sex: 1
#R0  2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018
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1744340 23355100 10141900 4403030 3002860 4330040 6351090 368279 311487
227829 271078 868106 209777 537718 649160 1191380 #Recruits
175410 938722 1131450 1007320 758452 507664 346146 264706 148047 69061.1
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#
 0.0 0.0354 0.0773 0.11 0.1339 0.1515 0.1644 0.1739 0.1808 0.1858 0.1939
#female fecundity; weighted by N in year Y_init across morphs and areas
 0.0344 0.0591 0.0833 0.1601 0.17 0.1721 0.083 0.186 0.1913 0.1947 0.1995
#bodywt for gender,fleet: 1 / 2 MexCal_S2
 0.483226 1 0.2554 0.0359994 0.0511502 0.0417846 0.0137653 0.0130174
0.00290705 0.00290705 0.00290705 #selex for gender,fleet: 1 / 2 MexCal_S2
 0.583396 0.583396 0.583396 0.583396 0.583396 0.583396 0.583396 0.583396
0.583396 0.583396 0.583396 #mean M for year Yinit: 2020 sex: 1
 993250 489722 67359.1 22880.4 7251.37 25790.3 6227 3085.23 2466.15 847.832
6142.57 #numbers for year Yinit: 2020 sex: 1
1191380 227222 48193 13337 48102 11804 5736 4488 1525 8828 2219 #numbers for
year Ydeclare: 2019 sex: 1
#R0  2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018
2019 #years
1744340 23355100 10141900 4403030 3002860 4330040 6351090 368279 311487
227829 271078 868106 209777 537718 649160 1191380 #Recruits
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175410 938722 1131450 1007320 758452 507664 346146 264706 148047 69061.1
37107.4 30726.4 33187.2 27554.5 24833.4 23065.1 #SpawnBio
0.55 1.2 0 0.365 # spawn-recr steepness, sigmaR, autocorr , targetdep
#
 0.0 0.0354 0.0773 0.11 0.1339 0.1515 0.1644 0.1739 0.1808 0.1858 0.1939
#female fecundity; weighted by N in year Y_init across morphs and areas
 0.0344 0.0591 0.0833 0.1601 0.17 0.1721 0.083 0.186 0.1913 0.1947 0.1995
#bodywt for gender,fleet: 1 / 2 MexCal_S2
 0.482026 1 0.255284 0.0356464 0.0506552 0.0413681 0.0136224 0.0128801
0.00287489 0.00287489 0.00287489 #selex for gender,fleet: 1 / 2 MexCal_S2
 0.58314 0.58314 0.58314 0.58314 0.58314 0.58314 0.58314 0.58314 0.58314
0.58314 0.58314 #mean M for year Yinit: 2020 sex: 1
1112170 544890 70219 23189 7326 25904 6260 3086 2463 826 6187 #numbers for
year Yinit: 2020 sex: 1
1299710 227796 48347 13450 48192 11840 5732 4478 1484 8886 2236 #numbers for
year Ydeclare: 2019 sex: 1
#R0  2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018
2019 #years
1702480 23340100 10129100 4398880 2998860 4328840 6355740 362669 310067
227194 271345 868081 211060 538202 649661 1299710 #Recruits
171333 938074 1130970 1007050 758345 507649 346208 264866 148180 69125.2
37130.5 30738.8 33207 27594.4 24883.6 23490.1 #SpawnBio
0.6 1.2 0 0.365 # spawn-recr steepness, sigmaR, autocorr , targetdep
#
 0.0 0.0354 0.0773 0.11 0.1339 0.1515 0.1644 0.1739 0.1808 0.1858 0.1939
#female fecundity; weighted by N in year Y_init across morphs and areas
 0.0344 0.0591 0.0833 0.1601 0.17 0.1721 0.083 0.186 0.1913 0.1947 0.1995
#bodywt for gender,fleet: 1 / 2 MexCal_S2
 0.482026 1 0.255284 0.0356464 0.0506552 0.0413681 0.0136224 0.0128801
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0.58314 0.58314 #mean M for year Yinit: 2020 sex: 1
1112170 544890 70219 23189 7326 25904 6260 3086 2463 826 6187 #numbers for
year Yinit: 2020 sex: 1
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#R0  2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018
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227194 271345 868081 211060 538202 649661 1299710 #Recruits
171333 938074 1130970 1007050 758345 507649 346208 264866 148180 69125.2
37130.5 30738.8 33207 27594.4 24883.6 23490.1 #SpawnBio
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 0.0 0.0354 0.0773 0.11 0.1339 0.1515 0.1644 0.1739 0.1808 0.1858 0.1939
#female fecundity; weighted by N in year Y_init across morphs and areas
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#bodywt for gender,fleet: 1 / 2 MexCal_S2
 0.482026 1 0.255284 0.0356464 0.0506552 0.0413681 0.0136224 0.0128801
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0.58314 0.58314 #mean M for year Yinit: 2020 sex: 1
1112170 544890 70219 23189 7326 25904 6260 3086 2463 826 6187 #numbers for
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1299710 227796 48347 13450 48192 11840 5732 4478 1484 8886 2236 #numbers for
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#R0  2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018
2019 #years
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227194 271345 868081 211060 538202 649661 1299710 #Recruits
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 0.0 0.0354 0.0773 0.11 0.1339 0.1515 0.1644 0.1739 0.1808 0.1858 0.1939
#female fecundity; weighted by N in year Y_init across morphs and areas
 0.0344 0.0591 0.0833 0.1601 0.17 0.1721 0.083 0.186 0.1913 0.1947 0.1995
#bodywt for gender,fleet: 1 / 2 MexCal_S2
 0.482026 1 0.255284 0.0356464 0.0506552 0.0413681 0.0136224 0.0128801
0.00287489 0.00287489 0.00287489 #selex for gender,fleet: 1 / 2 MexCal_S2
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0.58314 0.58314 #mean M for year Yinit: 2020 sex: 1
1112170 544890 70219 23189 7326 25904 6260 3086 2463 826 6187 #numbers for
year Yinit: 2020 sex: 1
1299710 227796 48347 13450 48192 11840 5732 4478 1484 8886 2236 #numbers for
year Ydeclare: 2019 sex: 1
#R0  2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018
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1702480 23340100 10129100 4398880 2998860 4328840 6355740 362669 310067
227194 271345 868081 211060 538202 649661 1299710 #Recruits
171333 938074 1130970 1007050 758345 507649 346208 264866 148180 69125.2
37130.5 30738.8 33207 27594.4 24883.6 23490.1 #SpawnBio
0.6 1.2 0 0.365 # spawn-recr steepness, sigmaR, autocorr , targetdep
#
 0.0 0.0354 0.0773 0.11 0.1339 0.1515 0.1644 0.1739 0.1808 0.1858 0.1939
#female fecundity; weighted by N in year Y_init across morphs and areas
 0.0344 0.0591 0.0833 0.1601 0.17 0.1721 0.083 0.186 0.1913 0.1947 0.1995
#bodywt for gender,fleet: 1 / 2 MexCal_S2
 0.482026 1 0.255284 0.0356464 0.0506552 0.0413681 0.0136224 0.0128801
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year Yinit: 2020 sex: 1
1299710 227796 48347 13450 48192 11840 5732 4478 1484 8886 2236 #numbers for
year Ydeclare: 2019 sex: 1
#R0  2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018
2019 #years
1702480 23340100 10129100 4398880 2998860 4328840 6355740 362669 310067
227194 271345 868081 211060 538202 649661 1299710 #Recruits
171333 938074 1130970 1007050 758345 507649 346208 264866 148180 69125.2
37130.5 30738.8 33207 27594.4 24883.6 23490.1 #SpawnBio
0.6 1.2 0 0.365 # spawn-recr steepness, sigmaR, autocorr , targetdep
#
 0.0 0.0354 0.0773 0.11 0.1339 0.1515 0.1644 0.1739 0.1808 0.1858 0.1939
#female fecundity; weighted by N in year Y_init across morphs and areas
 0.0344 0.0591 0.0833 0.1601 0.17 0.1721 0.083 0.186 0.1913 0.1947 0.1995
#bodywt for gender,fleet: 1 / 2 MexCal_S2
 0.482026 1 0.255284 0.0356464 0.0506552 0.0413681 0.0136224 0.0128801
0.00287489 0.00287489 0.00287489 #selex for gender,fleet: 1 / 2 MexCal_S2
 0.58314 0.58314 0.58314 0.58314 0.58314 0.58314 0.58314 0.58314 0.58314
0.58314 0.58314 #mean M for year Yinit: 2020 sex: 1
```

```
1112170 544890 70219 23189 7326 25904 6260 3086 2463 826 6187 #numbers for
year Yinit: 2020 sex: 1
1299710 227796 48347 13450 48192 11840 5732 4478 1484 8886 2236 #numbers for
year Ydeclare: 2019 sex: 1
#R0  2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018
2019 #years
1702480 23340100 10129100 4398880 2998860 4328840 6355740 362669 310067
227194 271345 868081 211060 538202 649661 1299710 #Recruits
171333 938074 1130970 1007050 758345 507649 346208 264866 148180 69125.2
37130.5 30738.8 33207 27594.4 24883.6 23490.1 #SpawnBio
0.6 1.2 0 0.365 # spawn-recr steepness, sigmaR, autocorr , targetdep
#
 0.0 0.0354 0.0773 0.11 0.1339 0.1515 0.1644 0.1739 0.1808 0.1858 0.1939
#female fecundity; weighted by N in year Y_init across morphs and areas
 0.0344 0.0591 0.0833 0.1601 0.17 0.1721 0.083 0.186 0.1913 0.1947 0.1995
#bodywt for gender,fleet: 1 / 2 MexCal_S2
 0.482026 1 0.255284 0.0356464 0.0506552 0.0413681 0.0136224 0.0128801
0.00287489 0.00287489 0.00287489 #selex for gender,fleet: 1 / 2 MexCal_S2
 0.58314 0.58314 0.58314 0.58314 0.58314 0.58314 0.58314 0.58314 0.58314
0.58314 0.58314 #mean M for year Yinit: 2020 sex: 1
1112170 544890 70219 23189 7326 25904 6260 3086 2463 826 6187 #numbers for
year Yinit: 2020 sex: 1
1299710 227796 48347 13450 48192 11840 5732 4478 1484 8886 2236 #numbers for
year Ydeclare: 2019 sex: 1
#R0  2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018
2019 #years
1702480 23340100 10129100 4398880 2998860 4328840 6355740 362669 310067
227194 271345 868081 211060 538202 649661 1299710 #Recruits
171333 938074 1130970 1007050 758345 507649 346208 264866 148180 69125.2
37130.5 30738.8 33207 27594.4 24883.6 23490.1 #SpawnBio
0.6 1.2 0 0.365 # spawn-recr steepness, sigmaR, autocorr , targetdep
#
 0.0 0.0354 0.0773 0.11 0.1339 0.1515 0.1644 0.1739 0.1808 0.1858 0.1939
#female fecundity; weighted by N in year Y_init across morphs and areas
 0.0344 0.0591 0.0833 0.1601 0.17 0.1721 0.083 0.186 0.1913 0.1947 0.1995
#bodywt for gender,fleet: 1 / 2 MexCal_S2
 0.480866 1 0.255223 0.0353117 0.0501863 0.0409751 0.0134875 0.0127502
0.00284456 0.00284456 0.00284456 #selex for gender,fleet: 1 / 2 MexCal_S2
 0.582905 0.582905 0.582905 0.582905 0.582905 0.582905 0.582905 0.582905
0.582905 0.582905 0.582905 #mean M for year Yinit: 2020 sex: 1
1230790 597677 72698 23451 7391 26012 6288 3087 2460 805 6233 #numbers for
year Yinit: 2020 sex: 1
1402380 228297 48478 13550 48287 11872 5729 4469 1446 8948 2254 #numbers for
year Ydeclare: 2019 sex: 1
#R0  2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018
2019 #years
1664240 23326800 10117600 4395260 2995330 4328020 6361730 357398 308802
226608 271579 868274 212167 538617 650057 1402380 #Recruits
167605 937506 1130560 1006830 758275 507659 346291 265051 148341 69213.1
37170.8 30762.7 33235.1 27637.8 24933.2 23892.5 #SpawnBio
0.65 1.2 0 0.365 # spawn-recr steepness, sigmaR, autocorr , targetdep
#
 0.0 0.0354 0.0773 0.11 0.1339 0.1515 0.1644 0.1739 0.1808 0.1858 0.1939
#female fecundity; weighted by N in year Y_init across morphs and areas
 0.0344 0.0591 0.0833 0.1601 0.17 0.1721 0.083 0.186 0.1913 0.1947 0.1995
#bodywt for gender,fleet: 1 / 2 MexCal_S2
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 0.480866 1 0.255223 0.0353117 0.0501863 0.0409751 0.0134875 0.0127502
0.00284456 0.00284456 0.00284456 #selex for gender,fleet: 1 / 2 MexCal_S2
 0.582905 0.582905 0.582905 0.582905 0.582905 0.582905 0.582905 0.582905
0.582905 0.582905 0.582905 #mean M for year Yinit: 2020 sex: 1
1230790 597677 72698 23451 7391 26012 6288 3087 2460 805 6233 #numbers for
year Yinit: 2020 sex: 1
1402380 228297 48478 13550 48287 11872 5729 4469 1446 8948 2254 #numbers for
year Ydeclare: 2019 sex: 1
#R0  2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018
2019 #years
1664240 23326800 10117600 4395260 2995330 4328020 6361730 357398 308802
226608 271579 868274 212167 538617 650057 1402380 #Recruits
167605 937506 1130560 1006830 758275 507659 346291 265051 148341 69213.1
37170.8 30762.7 33235.1 27637.8 24933.2 23892.5 #SpawnBio
0.65 1.2 0 0.365 # spawn-recr steepness, sigmaR, autocorr , targetdep
#
 0.0 0.0354 0.0773 0.11 0.1339 0.1515 0.1644 0.1739 0.1808 0.1858 0.1939
#female fecundity; weighted by N in year Y_init across morphs and areas
 0.0344 0.0591 0.0833 0.1601 0.17 0.1721 0.083 0.186 0.1913 0.1947 0.1995
#bodywt for gender,fleet: 1 / 2 MexCal_S2
 0.480866 1 0.255223 0.0353117 0.0501863 0.0409751 0.0134875 0.0127502
0.00284456 0.00284456 0.00284456 #selex for gender,fleet: 1 / 2 MexCal_S2
 0.582905 0.582905 0.582905 0.582905 0.582905 0.582905 0.582905 0.582905
0.582905 0.582905 0.582905 #mean M for year Yinit: 2020 sex: 1
1230790 597677 72698 23451 7391 26012 6288 3087 2460 805 6233 #numbers for
year Yinit: 2020 sex: 1
1402380 228297 48478 13550 48287 11872 5729 4469 1446 8948 2254 #numbers for
year Ydeclare: 2019 sex: 1
#R0  2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018
2019 #years
1664240 23326800 10117600 4395260 2995330 4328020 6361730 357398 308802
226608 271579 868274 212167 538617 650057 1402380 #Recruits
167605 937506 1130560 1006830 758275 507659 346291 265051 148341 69213.1
37170.8 30762.7 33235.1 27637.8 24933.2 23892.5 #SpawnBio
0.65 1.2 0 0.365 # spawn-recr steepness, sigmaR, autocorr , targetdep
#
 0.0 0.0354 0.0773 0.11 0.1339 0.1515 0.1644 0.1739 0.1808 0.1858 0.1939
#female fecundity; weighted by N in year Y_init across morphs and areas
 0.0344 0.0591 0.0833 0.1601 0.17 0.1721 0.083 0.186 0.1913 0.1947 0.1995
#bodywt for gender,fleet: 1 / 2 MexCal_S2
 0.480866 1 0.255223 0.0353117 0.0501863 0.0409751 0.0134875 0.0127502
0.00284456 0.00284456 0.00284456 #selex for gender,fleet: 1 / 2 MexCal_S2
 0.582905 0.582905 0.582905 0.582905 0.582905 0.582905 0.582905 0.582905
0.582905 0.582905 0.582905 #mean M for year Yinit: 2020 sex: 1
1230790 597677 72698 23451 7391 26012 6288 3087 2460 805 6233 #numbers for
year Yinit: 2020 sex: 1
1402380 228297 48478 13550 48287 11872 5729 4469 1446 8948 2254 #numbers for
year Ydeclare: 2019 sex: 1
#R0  2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018
2019 #years
1664240 23326800 10117600 4395260 2995330 4328020 6361730 357398 308802
226608 271579 868274 212167 538617 650057 1402380 #Recruits
167605 937506 1130560 1006830 758275 507659 346291 265051 148341 69213.1
37170.8 30762.7 33235.1 27637.8 24933.2 23892.5 #SpawnBio
0.65 1.2 0 0.365 # spawn-recr steepness, sigmaR, autocorr , targetdep
#
```

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 0.0 0.0354 0.0773 0.11 0.1339 0.1515 0.1644 0.1739 0.1808 0.1858 0.1939
#female fecundity; weighted by N in year Y_init across morphs and areas
 0.0344 0.0591 0.0833 0.1601 0.17 0.1721 0.083 0.186 0.1913 0.1947 0.1995
#bodywt for gender,fleet: 1 / 2 MexCal_S2
 0.480866 1 0.255223 0.0353117 0.0501863 0.0409751 0.0134875 0.0127502
0.00284456 0.00284456 0.00284456 #selex for gender,fleet: 1 / 2 MexCal_S2
 0.582905 0.582905 0.582905 0.582905 0.582905 0.582905 0.582905 0.582905
0.582905 0.582905 0.582905 #mean M for year Yinit: 2020 sex: 1
1230790 597677 72698 23451 7391 26012 6288 3087 2460 805 6233 #numbers for
year Yinit: 2020 sex: 1
1402380 228297 48478 13550 48287 11872 5729 4469 1446 8948 2254 #numbers for
year Ydeclare: 2019 sex: 1
#R0  2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018
2019 #years
1664240 23326800 10117600 4395260 2995330 4328020 6361730 357398 308802
226608 271579 868274 212167 538617 650057 1402380 #Recruits
167605 937506 1130560 1006830 758275 507659 346291 265051 148341 69213.1
37170.8 30762.7 33235.1 27637.8 24933.2 23892.5 #SpawnBio
0.65 1.2 0 0.365 # spawn-recr steepness, sigmaR, autocorr , targetdep
#
 0.0 0.0354 0.0773 0.11 0.1339 0.1515 0.1644 0.1739 0.1808 0.1858 0.1939
#female fecundity; weighted by N in year Y_init across morphs and areas
 0.0344 0.0591 0.0833 0.1601 0.17 0.1721 0.083 0.186 0.1913 0.1947 0.1995
#bodywt for gender,fleet: 1 / 2 MexCal_S2
 0.479742 1 0.255208 0.0349976 0.0497466 0.0406077 0.0133612 0.0126284
0.00281626 0.00281626 0.00281626 #selex for gender,fleet: 1 / 2 MexCal_S2
 0.582688 0.582688 0.582688 0.582688 0.582688 0.582688 0.582688 0.582688
0.582688 0.582688 0.582688 #mean M for year Yinit: 2020 sex: 1
1348030 647950 74860 23675 7448 26114 6315 3088 2458 785 6281 #numbers for
year Yinit: 2020 sex: 1
1499390 228737 48592 13637 48387 11902 5726 4462 1410 9011 2273 #numbers for
year Ydeclare: 2019 sex: 1
#R0  2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018
2019 #years
1629630 23314900 10107100 4392040 2992180 4327470 6368590 352444 307675
226075 271799 868635 213128 538974 650365 1499390 #Recruits
164227 937001 1130210 1006660 758232 507685 346386 265254 148520 69317.2
37223.5 30795.2 33269.6 27683.6 24981.9 24272.7 #SpawnBio
0.7 1.2 0 0.365 # spawn-recr steepness, sigmaR, autocorr , targetdep
#
 0.0 0.0354 0.0773 0.11 0.1339 0.1515 0.1644 0.1739 0.1808 0.1858 0.1939
#female fecundity; weighted by N in year Y_init across morphs and areas
 0.0344 0.0591 0.0833 0.1601 0.17 0.1721 0.083 0.186 0.1913 0.1947 0.1995
#bodywt for gender,fleet: 1 / 2 MexCal_S2
 0.479742 1 0.255208 0.0349976 0.0497466 0.0406077 0.0133612 0.0126284
0.00281626 0.00281626 0.00281626 #selex for gender,fleet: 1 / 2 MexCal_S2
 0.582688 0.582688 0.582688 0.582688 0.582688 0.582688 0.582688 0.582688
0.582688 0.582688 0.582688 #mean M for year Yinit: 2020 sex: 1
1348030 647950 74860 23675 7448 26114 6315 3088 2458 785 6281 #numbers for
year Yinit: 2020 sex: 1
1499390 228737 48592 13637 48387 11902 5726 4462 1410 9011 2273 #numbers for
year Ydeclare: 2019 sex: 1
#R0  2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018
2019 #years
1629630 23314900 10107100 4392040 2992180 4327470 6368590 352444 307675
226075 271799 868635 213128 538974 650365 1499390 #Recruits
```

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164227 937001 1130210 1006660 758232 507685 346386 265254 148520 69317.2
37223.5 30795.2 33269.6 27683.6 24981.9 24272.7 #SpawnBio
0.7 1.2 0 0.365 # spawn-recr steepness, sigmaR, autocorr , targetdep
#
 0.0 0.0354 0.0773 0.11 0.1339 0.1515 0.1644 0.1739 0.1808 0.1858 0.1939
#female fecundity; weighted by N in year Y_init across morphs and areas
 0.0344 0.0591 0.0833 0.1601 0.17 0.1721 0.083 0.186 0.1913 0.1947 0.1995
#bodywt for gender,fleet: 1 / 2 MexCal_S2
 0.479742 1 0.255208 0.0349976 0.0497466 0.0406077 0.0133612 0.0126284
0.00281626 0.00281626 0.00281626 #selex for gender,fleet: 1 / 2 MexCal_S2
 0.582688 0.582688 0.582688 0.582688 0.582688 0.582688 0.582688 0.582688
0.582688 0.582688 0.582688 #mean M for year Yinit: 2020 sex: 1
1348030 647950 74860 23675 7448 26114 6315 3088 2458 785 6281 #numbers for
year Yinit: 2020 sex: 1
1499390 228737 48592 13637 48387 11902 5726 4462 1410 9011 2273 #numbers for
year Ydeclare: 2019 sex: 1
#R0  2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018
2019 #years
1629630 23314900 10107100 4392040 2992180 4327470 6368590 352444 307675
226075 271799 868635 213128 538974 650365 1499390 #Recruits
164227 937001 1130210 1006660 758232 507685 346386 265254 148520 69317.2
37223.5 30795.2 33269.6 27683.6 24981.9 24272.7 #SpawnBio
0.7 1.2 0 0.365 # spawn-recr steepness, sigmaR, autocorr , targetdep
#
 0.0 0.0354 0.0773 0.11 0.1339 0.1515 0.1644 0.1739 0.1808 0.1858 0.1939
#female fecundity; weighted by N in year Y_init across morphs and areas
 0.0344 0.0591 0.0833 0.1601 0.17 0.1721 0.083 0.186 0.1913 0.1947 0.1995
#bodywt for gender,fleet: 1 / 2 MexCal_S2
 0.478652 1 0.255233 0.0347047 0.0493371 0.0402662 0.0132437 0.012515
0.00278996 0.00278996 0.00278996 #selex for gender,fleet: 1 / 2 MexCal_S2
 0.582487 0.582487 0.582487 0.582487 0.582487 0.582487 0.582487 0.582487
0.582487 0.582487 0.582487 #mean M for year Yinit: 2020 sex: 1
1462960 695680 76755 23868 7499 26210 6339 3089 2456 767 6328 #numbers for
year Yinit: 2020 sex: 1
1590890 229125 48691 13715 48490 11930 5724 4456 1377 9075 2291 #numbers for
year Ydeclare: 2019 sex: 1
#R0  2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018
2019 #years
1598390 23304200 10097600 4389170 2989340 4327130 6376000 347786 306672
225595 272016 869126 213969 539281 650600 1590890 #Recruits
161178 936549 1129910 1006510 758208 507723 346490 265465 148710 69431.9
37284.9 30834 33308.7 27731.1 25029.8 24631.4 #SpawnBio
0.75 1.2 0 0.365 # spawn-recr steepness, sigmaR, autocorr , targetdep
```