Annex 11: Jack Mackerel Technical Annex

1. Introduction

1. This document and content are based on discussions and analyses conducted at the 13th SPRFMO Scientific Committee (SC) meeting in 2025. During SC13, the model was updated with new data, and subsequently accepted by the SC. Discussions at SC13 focused on the following topics:

- Review and update of datasets;
- Leave-one-out and leave-one-in analyses for CPUE indices; and
- Changes to how selectivity is treated in projections and reference point estimations.

Scientific Name and General Distribution

2. The Chilean jack mackerel (*Trachurus murphyi*, Nichols 1920) is widespread throughout the South Pacific. It is found along the shelf and oceanic waters adjacent to Ecuador, Peru, and Chile, and across the South Pacific along the Subtropical Convergence Zone in what has been described as the "jack mackerel belt" that goes from the coast of Chile to New Zealand within a 35° to 50° S variable band across the South Pacific.

Main Management Units

3. At least five management units of *T. murphyi* associated to distinct fisheries are identified in the SE Pacific: the Ecuadorian fishery, which is managed as part of a more general pelagic fishery within the Ecuadorian EEZ; the Peruvian fishery, which is managed as part of a jack mackerel, mackerel and sardine fishery directed exclusively for direct human consumption taking place almost entirely within the Peruvian EEZ; the northern and the central-southern Chilean fisheries which are managed as separate management units, with the northern fishery being mostly within the Chilean EEZ and the central-southern Chilean fishery which straddles the Chilean EEZ and the adjacent high sea; and, the purely high sea fishery which is a multinational fishery being managed entirely within the context of the SPRFMO. At present there is no directed fishery for *T. murphyi* in the central and western South Pacific and around New Zealand, where incidental catches are very small.

Stock Structure

4. There are a number of competing stock structure hypotheses, and up to five and more separate stocks have been suggested: i) a Peruvian stock (northern stock) which is a straddling stock with respect to the high seas; ii) a Chilean stock (southern stock) which is also a straddling stock with respect to the high seas; iii) a central Pacific stock which exists solely in the high seas; iv) a southwest Pacific stock which exists solely in the high seas; v) and, a New Zealand-Australian stock which straddles the high seas and both the New Zealand and Australian EEZs. Regarding specifically the eastern and central South Pacific, the SPRFMO has identified the following four alternative stock structure working hypotheses: 1) jack mackerel caught off the coasts of Peru and Chile each constitute separate stocks which straddle the high seas; 2) jack mackerel caught off the coasts of Peru and Chile constitute a single shared stock which straddles the high seas; 3) jack mackerel

caught off the Chilean area constitute a single straddling stock extending from the coast out to about 120°W; and, 4) jack mackerel caught off the Chilean area constitute separate straddling and high seas stocks.

5. Accordingly, the Jack Mackerel Sub-group (JMSG) of the Science Working Group (SWG) of the SPRFMO at its 11th Session (SWG-11) carried out parallel assessments of the jack mackerel stock(s) in the Eastern South Pacific under the two main working hypotheses already identified. That is: jack mackerel caught off the coasts of Peru and Chile constitute a single shared stock which straddles the high seas (hypothesis 1); or that jack mackerel caught off the coasts of Peru and Chile each constitute separate stocks (the Peruvian or northern and the Chilean or southern stock) which straddle the high seas (hypothesis 2). In following up on the SWG-11 recommendations, the SPRFMO Commission at its 1st Commission Meeting requested the newly established Scientific Commission (SC) to continue the work on evaluating alternative hypotheses on jack mackerel stock population. Pending more conclusive findings on the stock population structure of jack mackerel, the 2nd Commission meeting requested the SC to continue and expand the stock assessment work under both stock hypotheses considered in the 11th SWG Meeting, and this continues to be one of the main tasks undertaken at SC13.

Fishery

6. The fishery for jack mackerel in the south-eastern Pacific is conducted by fleets from the coastal states (Chile, Peru and Ecuador), and by distant water fleets from various countries, operating beyond the EEZ of the coastal states.

7. The fishery by the coastal states is conducted by purse seiners. The largest fishery exists in Chile, where the fish are used for fish meal. In Peru, the fishery is variable from year to year. Here the fish are taken by purse seiners that also fish for other pelagic species (e.g., anchovy, mackerel, sardines). According to government regulations, the jack mackerel in Peru may only be used for human consumption. Ecuador constitutes the northern fringe of the distribution of jack mackerel. Here the fish only occur in certain years, when the local purse seiners may take substantial quantities (70,000 tons in 2011). Part of the catch is processed into fish meal but recently jack mackerel has been promoted to be used for human consumption.

8. The distant water fleets operating for jack mackerel outside the EEZs have been from a number of parties including Belize, China, Cook Islands, Cuba, European Union (Netherlands, Germany, Poland and Lithuania), Faroe Islands, Korea, Japan, Russian Federation, Ukraine and Vanuatu. These fleets consist exclusively of pelagic trawlers that freeze the catch for human consumption. In the 1980s a large fleet from Russia and other Eastern European countries operated as far west as 130° W. After the economic reforms in the communist countries around 1990, the fishery by these countries in the eastern Pacific was halted. It was not until 2003 that foreign trawlers re-appeared in the waters outside the EEZs of the coastal states.

9. The jack mackerel fishery in Chilean and offshore waters is mono-specific. In the offshore fishery, the catch consists of 90 – 98% jack mackerel, with minor bycatch of chub mackerel (*Scomber japonicus*) and Pacific bream (*Brama australis*). The available time series of jack mackerel catches in the south-eastern Pacific by Member are shown in Table 1, with the catch summarised by fleets in Figure 4 and Table 2.

Management

10. Jack mackerel were managed by coastal states beginning in the mid-1990s. National catch quotas for jack mackerel were introduced by Peru in 1995 and by Chile in 1999. Peru introduced a ban on the use of jack mackerel for fish meal in 2002. For the international waters, the first voluntary agreement to limit the number of fishing vessels was introduced in 2010. Catch limits for jack mackerel were established for the south-eastern Pacific starting from 2011.

Information on the environment in relation to the fisheries

11. Important environmental events such as the El Niño effect of 2016 affect oceanographic dynamics. During such events, the depth of the 15ºC isotherm and oxycline change significantly affecting the spatial distribution of jack mackerel and their availability in different regions (see for example the work of the Habitat Monitoring Working Group of the Scientific Committee as reported in previous meetings of the Scientific Committee). The extent that such changes affect the overall population productivity is unclear.

Reproductive Biology

12. The main spawning season happens from October to December; however, spawning has been described from July to March. Gonadosomatic index and egg surveys have been used to determine the time of spawning.

2. Data used in the assessment

Data Sets

13. A full description of data sets used for the assessment of jack mackerel is in Annex 3 of the SC Data workshop 2015. Summaries of all data available for the assessment of the fishery in the South Pacific area are provided in Table 18 and Figure 5.

Fishery Data

14. The catch data for the model represents a summation of catch values from various Members (Table 1) to form four “fleets”, which are intended to be consistent with the gear and general areas of fishing (Figure 4). The summarised catches from each of these fleets are presented in Table 2.

15. Length data are available from all major fisheries both inside and outside the EEZs. Length distributions from Chile and the older international fleet were converted into age distributions using annual Chilean age-length keys. The more recent length composition data from China were converted to age compositions by applying EU, Russian or Chilean age-length keys as compiled by quarter of the year and then aggregated (Table 3, Table 4, and Table 5). The EU and Russia provided age-length keys which were used to convert EU length distribution data to age. For Peruvian and Ecuadorian fisheries, length frequency data (Table 6) were used directly and fit within the model according to the specified growth curve.

16. In the benchmark workshop prior to SC10 (SCW14), a new Chilean ageing method was included into the assessment. This resulted in revisions to age composition data for both Chilean fleets, as well as the offshore fleet for older years. In addition, several biological variables (weight, maturity,

natural mortality) were re-estimated and updated. Some detail on the revisions to the historical data and the validation approach can be found in the SCW11 report.

17. In the benchmark workshop SCW14, it was further agreed that a protocol should be developed to include self-sampling data from the Offshore fleet into the assessment. As introduced in meeting documents SC10-JM03 and SC10-JM04, the protocol stipulates that length-distributions from quarters that are not sampled in the observer program but that are covered in the self-sampling, will be included into the assessment. This meant that, beginning in 2021, self-sampling data were included in the assessment data.

18. Several CPUE data series are used in the model, with changes in methodology to calculate the series introduced during SC4, SC6, SC7, SC9 and SC10. Since 2022 (SC10), all CPUE series include a factor that compensates for efficiency increases of fishing operations as estimated in global effort analysis (e.g., Rousseau et al. (2019)). The details for each series are outlined below.

19. For the Chilean purse seiner fleet in the southern-central area, a “Generalized Linear Model” (GLM; McCullagh & Nelder (1989)) approach has been used to standardise the CPUE. Here trip-based CPUE has been modelled as a linear combination of explanatory variables, with the goal of estimating a year-effect that is proportional to jack mackerel biomass. Factors in the GLM included year, quarter, zone, and vessel hold capacity. Effort units were computed as the number of days spent fishing by each vessel. This CPUE series was revised during SC4 to exclude trips with no jack mackerel catches. This was preferred because it better reflected changes in management over time (particularly the introduction of vessel-level quotas starting in 2000). To account for changes in fleet behaviour arising from the changes in management, the revised CPUE series from the GLM was modelled with a catchability change in year 2000. An overall increase of technical efficiency of 1% per year has been included for this fleet since SC10. In SC11 and SC12, alternative efficiency factors in the form of time blocks were proposed as a result of interviews with fishers (SC11-JM06, SC12-JM02). It was noted that inclusion of these proposed time blocks should be explored in a benchmark assessment.

20. Prior to the 2018 assessment (SC6), Peru presented a CPUE abundance index derived from the industrial purse seine fleet. This fishery has a strong focus on anchoveta and other stocks such as chub mackerel (*Scomber japonicus*) and bonito (*Sarda chiliensis*). With increasing catch rates in those fisheries, the focus on jack mackerel shifted, and the CPUE index was deemed to be no longer indicative of jack mackerel biomass. This resulted in a lack of CPUE data between 2015 and 2017. Thus, for the 2018 (SC6) assessment, CPUE indicators were calculated based on artisanal and small-scale fleets. These fleets are and have been targeting jack mackerel on a regular basis, operating at a closer distance to the coast than the industrial fleets. Historical data on catch by haul capacity for the artisanal fleets were recovered beginning in 2000. A Generalised Additive Model (GAM), in which the dependent variable (catch per trip) is gamma-distributed using a log-link function, was applied by removing the operational (holding capacity) and temporal effects (year, month). The GAM combined data from both artisanal and industrial fleets, although concerns were raised about the accuracy of the historical data (e.g., from missing fleet identifiers) and thus there is a need for continued development. In addition, an overall increase of technical efficiency of 1% per year has been included for the entire time series, beginning in SC10.

21. Up to the 2017 assessment (SC5), the European Union CPUE index (un-standardised), the Russian CPUE index (un-standardised) and the Chinese CPUE index (standardised with a GLM) were included as separate indices of exploitable biomass for the offshore fleet. However, it was noted

that these fleets shared similar temporal and spatial dynamics and the European Union and Russian data were incorporated into a combined standardised offshore CPUE index in 2018 (SC6), with the Chinese CPUE kept separate. In 2019 (SC7), haul-by-haul data of China, EU, Korea, Vanuatu, and Russia were combined and standardised into a single Offshore CPUE time series (SC7-JM06_rev1). The standardisation procedure followed what had previously been done during SCW6. A GAM was fit to catch data with an offset of log(effort) assuming a negative binomial distribution. Vessel, month of the year, year, and El Niño effect (sea surface temperature anomaly) were taken as linear effects while two-dimensional smoothers were applied to correct for spatial effects. In SC9, the vessel explanatory variable was replaced by vessel contracting party, which resulted in CPUE indices that were similar in trend (SC9-JM02). Note that the start year of the various offshore CPUE indices has varied over time. Originally, when the European Union CPUE index was separate from the Chinese and Russian CPUE indices (SC5), the index began in 2003. In SC6, when the Russian CPUE data was incorporated into the combined Offshore index, this index was taken as beginning in 2006. From 2019 (SC7), the combined Offshore CPUE index has been included in the stock assessment as an index for the period from 2008 to the present. In addition, an overall increase of technical efficiency of 2.5% per year has been included in the time series, beginning in SC10.

22. In all standardised CPUE series (Table 7), no explicit correction for search time has been incorporated. In some products, such as the offshore CPUE, effort in weeks is taken rather than effort by day (of positive registrations) to account for searching time. However, the inability to consistently define and accurately measure searching time remains an issue.

23. In SCW14, advances in fishing technological efficiency (also termed “effort creep”) were explicitly incorporated in the CPUE standardization process. As mentioned previously, annual effort creep value of 2.5% was thus applied to CPUE for the offshore fleet (details in SCW14-WD01). Preliminary evaluations of technological advances in the Chilean fleet were conducted in SC11-JM06 and SC12-JM07, but have not been formally included in the assessment. For Peru, no formal evaluations of technological advances have been conducted. As such, an interim level of 1% efficiency improvement was applied to the CPUE time series from Chile and from Peru. It was agreed that further analyses would be required to understand the model reaction to the effort creep factor and noted that at this stage this factor does not appear to have an important effect on model results. SCW14 further recommended specific studies to evaluate the potential efficiency improvements for these fleets, including the technical equipment (e.g., those under consideration by the SPRFMO Scientific Committee’s Habitat Monitoring Working Group), and any other factors that could influence effective fishing effort.

24. During SC12, it was noted that updating the preliminary CPUE values from the previous year to the finalised values had a significant impact on the perception of the stock. This was likely due to the fact that the CPUE values for the current year only reflected the dynamics for the first half of the assessment year. Consequently, they may not be reflective of the abundance trends of that year. Subsequent assessments have down-weighted the CPUE value of the current year by a factor of 2 (i.e., CV is multiplied by 2).

25. The lack of a defined protocol for CPUE standardisation was noted during SCW14. Development of CPUE standardisation guidelines has thus been identified as a priority to improve the quality of the assessment.

Fisheries Independent Data

26. The Chilean jack mackerel research programme has included surveys using hydro-acoustics and the daily egg production method (DEPM). Acoustic estimates have been used as relative abundance indices. For the northern region (N-Chile), data on acoustic biomass and numbers, and weights at age are available from 1984-1988, 1991, and 2006-2021. For the central-southern regions, these data are available from 1997 to 2009. The survey resumed in 2020, resulting in data points for 2020, 2022, and 2023. Preliminary analyses during SC11 led to the recommendation of further investigation during the next benchmark assessment, prior to including these updated data in the assessment. In previous jack mackerel assessments, the acoustic survey in northern Chile was assigned the same selection-at-age curve as the northern Chile fishing fleet. However, given that the survey age composition data indicate that it catches younger ages than the fishing fleet, the SC6 considered it more appropriate to assign the survey its own selectivity.

27. Egg surveys (using DEPM) were conducted on an annual basis from 1999 to 2008 along the central zone of the Chilean coast in order to assess the biomass of the spawning stock. In addition, there are estimates of abundance and numbers-at-age for the central-southern regions based on DEPM for the years 2001, 2003, 2004, 2005, 2006, 2008. Egg survey results have been used as relative abundance indices in the models. Age composition data from the acoustic and DEPM Chilean surveys are shown in Table 8, Table 9, and Table 10. The DEPM age composition has not been updated with the new ageing criteria.

28. In SC10, as mentioned previously, changes were made to the Chilean ageing methods. These resulted in updated historical age composition data for both Chilean surveys and the commercial catches.

29. The Peruvian jack mackerel research programme includes egg and larvae surveys and hydro-acoustic stock assessment surveys. Results of these egg and larvae surveys provide information on the spatial and temporal variability of jack mackerel larvae along the Peruvian coast beginning in 1966. Acoustic biomass estimates of jack mackerel were available beginning in 1983. As these surveys had Peruvian anchoveta as the target species, the data only covered the first 80 miles, and eventually 100 miles from the coast. Corrections to compensate for this partial coverage of acoustic biomass estimates of jack mackerel were made using an environmental index describing the potential habitat of this species based on available monthly data on SST, Sea Surface Salinity (SSS), water masses (WM), oxycline depth (OD) and chlorophyll (CHL). An alternative acoustic index for Peru was presented at SC3. This was constructed using backscatter information without converting the information to biomass estimates using length-frequency data. This method was proposed to address the reduced quality of the available length-frequency data in recent years. This alternative series was included in the jack mackerel assessment in SC4, thus replacing the Peruvian acoustic series used in previous assessments. The last value provided for this series corresponds to 2013. The El Niño conditions in 2014 and 2015 affected the distribution of jack mackerel making them more dispersed and outside the area covered by the anchovy survey. Further work is needed to standardise and analyse the survey data to develop a reasonable index from the later data. The index has been retained in the current assessment and extends from 1985 to 2013.

30. Acoustic surveys, to estimate the biomass and distribution of jack mackerel, have also been conducted along the Chilean coast, inside and outside of the EEZ, using scientific vessels. Additionally, comprehensive acoustic surveys have been conducted from the Chilean commercial fleet, although they are not currently used in the assessment model. The time series of available

acoustic estimates extends from 1984 to present day (intermittently, depending on the area). All abundance indices (fishery CPUE and survey) series used in the model are presented in Table 7.

Biological Parameters

31. The maturity-at-age for jack mackerel in Chile was estimated by Leal et al. (2012) and has been updated by applying the new ageing criteria (SCW14-WD04) to the otoliths and histological maturity data collected between September 2011 and January 2012. Overall, the changes caused by the new aging criteria led to the understanding of a faster-growing species that is earlier to mature. Maturity-at-length was consistently observed with L_{50} at about 22-23 cm fork length (FL). The maturity-at-age values, for the single/Southern stock and those for the far north stock, are shown in Table 11.

32. To fit the length composition data from the far north fleet, a growth curve was used to convert age compositions predicted by the model to predicted lengths, with the conversion occurring within the model. The values for the von Bertalanffy growth parameters are given in Table 12. It was noted in SC10 that the growth parameters reflected fish Total Length, whereas the data were in Fork Length. The parameters were since corrected. Ageing imprecision was previously acknowledged using an age-error matrix, as shown in Table 13. However, because this matrix is based on expert judgement instead of empirical data, the discussions during SC4 led to selecting the final assessment model with this ageing error option turned off.

33. Mean weight-at-age is required for all fishing fleets and biomass indices in order to relate biomass quantities to the underlying model estimates of jack mackerel abundance (in numbers). The four weight-at-age matrices for the fishing fleets correspond to: Fleet 1 (northern Chile), Fleet 2 (south-central Chile), Fleet 3 (the far north fleet) and Fleet 4 (the offshore trawl fleet). These values are shown in Table 14, Table 15, Table 16, and Table 17. Historically, missing weight-at-age data were replaced with data from the previous year. In SCW14, it was recommended that those missing data be replaced with appropriate fleet-specific mean values from the previous five years instead. This procedure was adopted in SC11.

34. For the Chilean fleets, the mean weight-at-age was calculated by year by taking the mean length-at-age in the catch and a length-weight relationship derived for the year. Before SC3, the same weight-at-age matrix was used for the Northern Chilean Fleet (Fleet 1) and the Southern Chilean Fleet (Fleet 2). Beginning in SC3, a weight-at-age matrix specific for Northern Chile was applied. The method used two information sources: the length-age keys and the parameters of the weight-at-length relationship from IFOP's monitoring programme of the Chilean fisheries. The information was separated into two zones which correspond to fishing areas (and acoustic surveys) that occur in Chile. Annual weight-at-length relationship was fitted to the data by each fleet independently, and these relationships were applied to mean length-at-age within each zone, resulting in the weights-at-ages seen in Table 14 and Table 15. The information covers the period 1974-2025; for earlier years the weight-at-age from 1974 was used.

35. For the far north fleet, biological sampling data were collected by length and converted post-hoc to weights-at-age. Weight-length parameters for the von Bertalanffy weight-length curve (Bertalanffy, 1957) were estimated annually from these biological sampling data. The calculated weight-length parameters were then converted to weight-at-age by applying a mean length-at-age vector, calculated using a fixed (non-annually-varying) von Bertalanffy growth curve ($L_\infty = 80.77$, $t_0 = -0.356$, $k = 0.155$, $L_0 = 15.31$). These growth parameters are different from the ones used in the

assessment Table 12, as they are based on Total Length, whereas the assessment uses parameters based on Fork Length. A procedure was developed (and adopted in SC11) to convert the mean length-at-age vector to a mean weight-at-age vector for the given year Table 16. This procedure was designed to better reflect the dynamics of the far north fishery, and to match the assessment model used for the Peruvian Area of National Jurisdiction (ANJ). Prior to SC11, the far north fleet weights-at-age for 2015-2022 were fixed at historical mean values.

36. The weights-at-age for the offshore fleet were derived from EU and Russian age-length keys as well as age-length keys from the south-central Chilean fleet. The EU and Russia reported both age, length, and weight data, allowing for weight-at-age to be reported for their catches based on observer programme data compiled in 2019. For China, Vanuatu and Korea, length-weight information is transformed using quarter-specific age-length keys. For most countries in this fleet, weight-at-length information is available. In some years, however, including 2018, weight-at-length data from the Chinese fleet were missing, which resulted in the use of the length-weight relationship from the south-central Chilean fleet. As of SCW14, due to the update in the Chilean ageing criteria, these weight-at-age data were updated for the time series beginning in 2015 (Table 17).

37. In SCW14, the Natural Mortality Tool was used to derive values of M range from roughly 0.1 to 0.35 with a mode at 0.28. The L_∞ was assumed to be 80.4cm, k was assumed at 0.16 and t_0 at –0.356. The value of 0.28 was used for the assessment beginning in SC10. The estimated M values are assumed to be the same for all ages and all years within the given stock (Table 12).

3. The Assessment Model

38. A statistical catch-at-age model was used to evaluate the jack mackerel stocks. The JJM ("Joint Jack Mackerel Model") is implemented in AD Model Builder (ADMB) and considers different types of data types. The available data on the jack mackerel fishery in the South Pacific area begin from 1970 to the present year, and are described in Table 18 and Figure 5, as mentioned previously.

39. The JJM model is an explicitly age-structured model that uses a forward projection approach and maximum likelihood estimation to solve for model parameters. The operational population dynamics model is defined by the standard catch equation with various modifications such as those described by D. Fournier & Archibald (1982), Hilborn & Walters (1992), and Schnute & Richards (1995). This model was adopted as the assessment method in 2010 after several technical meetings.

40. A full description and user guide describing the population dynamics and the computational aspects of the model can be found in SC12-JM08. It includes, among other things, details on the mathematical model equations and the practical application of the model (i.e., software installation and running the model).

JJM Developments

41. Since its adoption, the JJM model has been improved by participating scientists. The most notable changes have been options to include length composition data (and specifying or estimating growth) and the capability to estimate natural mortality by age and time (although this capability is not used). The model is flexible and permits the use of catch information either at age or size for any fleet, and explicitly incorporates regime shifts in population productivity.

42. The model consists of several components, (i) the dynamics of the stock; (ii) the fishery dynamics; (ii) observation models for the data; and (v) the procedure used for parameter estimation (including uncertainties).

43. A JM modelling workshop was held from 7/8 – 9/10 June 2022, attended by 33 people, with the aim of building capacity for utilization of the existing JJM model but also identifying several ways in which it could be improved to enhance transparency and ease of use. These ideas were subsequently fed into the JM Benchmark Workshop in July (SCW14).

Stock dynamics

44. Recruitment is assumed to occur in January while the spawning season is assumed to be an instantaneous process occurring in mid-November. The population's age composition considers individuals from 1 to 12+ years old. In all cases a stochastic Beverton-Holt relationship (Beverton & Holt (1957)) between stock and recruitment is included. Each cohort survives an age-specific mortality composed of fishing mortalities at-age by fleet and natural mortality (assumed to be constant over time and age). The model is not spatially-explicit, although the fisheries operate in geographically distinct areas. The initial population is based on an equilibrium condition and occurs in 1958 (12 years prior to the model start in 1970).

Fishery dynamics

45. The interaction of the fisheries with the population occurs through fishing mortality. Fishing mortality is assumed to be a composite of several processes – selectivity (by fleet), which describes the age-specific pattern of fishing mortality; catchability, which scales fishing effort to fishing mortality; and effort deviations, which are a random effect in the fishing effort − fishing mortality relationship. The selectivity pattern is non-parametric and assumed to be fishery-specific and time-variant. Catchability is specific to each individual abundance index. The model includes temporal variation in both fishery and index selectivity patterns at the annual and regime scales, depending on the index and the stock structure hypothesis. More detail is included in the subsequent section.

Observation models for the data

46. There are four data components that contribute to the log-likelihood function: the total catch data, the age-frequency data, the length-frequency data and the abundance indices.

47. The probability distributions for the age and length-frequency proportions are assumed to be approximated by multinomial distributions. Sample size is specified to be gear-specific but mostly constant over years. For the total catch by fishery (4) and the abundance indices (7), a log-normal assumption has been assumed with constant CV; the CV for the fisheries being 0.05 whereas the CV for the abundance indices depends on the index. Beginning in 2018, as discussed in SC4 and agreed upon in SCW6, the Francis T1.8 weighting method (Francis (2011)) is used to assign weighted sample sizes for age-frequency data. The data weights were updated during the JM 2022 benchmark (SCW14).

Parameter estimation

48. The model parameters Table 19 are estimated by maximising the log-likelihoods of the data plus the log of the probability density functions of the priors and smoothing penalties specified in the model. Estimation was conducted in a series of phases, the first of which used arbitrary starting

values for most parameters. The model has been implemented and compiled in ADMB and its characteristics can be consulted in D. A. Fournier et al. (2012).

Stock Structure Hypotheses

49. As mentioned in the introduction, during SWG11, two types of population structure were evaluated, and this was continued for subsequent evaluations. Beginning in 2020 (SC8), models under the single-stock hypothesis carry “h1” in front of the model number, models under the two-stock hypotheses carry “h2” in front of the model number. Some of the differences in the two models, mainly in the treatment of the data, selectivity, and recruitment, are described later in the Annex.

Model Details

50. Parameters estimated conditionally are listed in Table 19. The most numerous of these involve estimates of annual and age-specific components of fishing mortality for each year and for each of the four fisheries identified in the model. Parameters describing population numbers at age 1 in each year (and years prior to 1970 to estimate the initial population numbers at ages 1-12+) were the second most numerous type of parameter.

51. Equations and specifications for the assessment model are given in Table 20 and Table 21. Table 22 contains the initial variance assumptions for the indices and the age and length compositions.

Selectivity patterns

52. The treatment of selectivity patterns and how they are shared among fisheries and indices are given in Table 23 for the single-stock hypothesis (hypothesis 1), and Table 24 and Table 25 for the two stocks under the two-stock model configurations (hypothesis 2). Selectivity for the Far North fleet was specified with a regime shift in 2002 under the two-stock hypothesis, while annual variations beginning in 1981 were specified for the same fleet under the single-stock hypothesis. A growth function within the model was specified to convert model-predicted age compositions to length compositions, in order to fit the model to the length composition data (Table 12).

Management Quantities

53. Equilibrium-based management quantities are estimated within the jjm model. The model estimates values of Maximum Sustainable Yield (MSY) and the fishing mortality rate that produces it (F_{MSY}) using a Newton-Raphson minimization routine. F_{MSY} is the rate of fishing mortality that maximises long-term catch while still allowing recruitment to sustain the population. MSY is the expected long-term catch under F_{MSY}, and biomass at MSY (B_{MSY}) is defined as the long-term expected spawning biomass when the stock is fished at F_{MSY}.

54. The management quantities are estimated by projecting catches given fleet-specific relative catch allocations and weights-at-ages in the terminal year, and (beginning in SC13) selectivity patterns averaged over the most recent 15 years. Prior to SC13, estimations were done using terminal year selectivity for each fleet, which resulted in large annual fluctuations of the reference points. To improve the stability of the estimates and to better reflect fishery dynamics in the long-term, a 15-year rolling average of selectivity patterns was adopted in 2025. As such, the management quantities in assessment year 2025 were estimated using selectivity patterns averaged over 2010-

2024. The SC13 accepted these improvements and noted they should be re-examined at the forthcoming benchmark evaluation.

55. Between 2013 and 2021, a provisional B_{MSY} level of 5.5 million tons was instated based on analyses executed at SC03. In SCW14, the provisional management reference point for B_{MSY} was revised to a ten-year average of the model-estimated B_{MSY}. A limit reference point B_{lim} (where B refers to spawning biomass) for the single-stock hypothesis was also developed during SCW14. B_{lim} was defined as the spawning biomass level below which recruitment would likely be impaired. As such, there should be no fishing when the current spawning biomass is estimated to be below B_{lim}. For jack mackerel, B_{lim} was computed from the lowest ratio of historical spawning biomass relative to the most-recently-estimated unfished spawning biomass. In SCW14, this ratio was estimated to be 8% of the unfished spawning biomass.

Description of Model Explorations

56. The assessment analyses developed during SC13 were considered an update. The main explorations involved incrementally adding new data components relative to the model and data adopted from SC12. As in past assessments, these are labelled "h1_0.x" and "h2_0.x", where **h1** and **h2** represent the stock structure hypothesis and **x** represents the number when a component was added (Table 26).

57. The rationale for the main updates and data revisions occurring through model configurations 0.00 to 0.10 has been explained in the "Data used in the assessment" section, earlier in this Annex.

58. Thereafter, Model 0.10 was renamed as Model 1.00. with an updated control file to reflect changes in selectivity for the current year, as was done in previous years.

59. Due to conflicting trends in the indices of abundance, the working group and SC proposed conducting sets of model sensitivities during the early part of the meeting. This entailed two types of analyses for the four main indices of abundance— the three CPUE indices and the Acoustic North survey index. One type, termed "leave one in" (LOI; models 1.01-1.04), and the other "leave one out" (LOO; models 1.06-1.09). For the LOO, this involved running the base model four times, with each index omitted in turn. For the LOI analysis, three of the four indices were removed, and the model run with only one of the four indices at a time. This was based on findings on how each CPUE time series varied annually, due to updates outside of the stock assessment.

60. In each assessment year, each CPUE time series is updated with new data, with the occasional update to standardisation methods. This results in changes to each index over time, often smoothing out the variance in trends. For example, comparing the standardised Chilean CPUE series across assessment years shows a broadly consistent long-term decline from the late 1980s through about 2010. Earlier assessments (2019–2021) showed steep drops in the early 2000s and strong rebounds after 2015. However, the most recent assessments (2023–2025) produce a more muted mid-2010s trough and a flatter recovery Figure 1. The newest runs also cluster more tightly in recent years, reflecting updated standardization and added data that reduce retrospective spread. The changes of the index between assessment years largely impact the amplitude of dips and peaks, not the overall trajectory, which remains a decline followed by partial recovery.

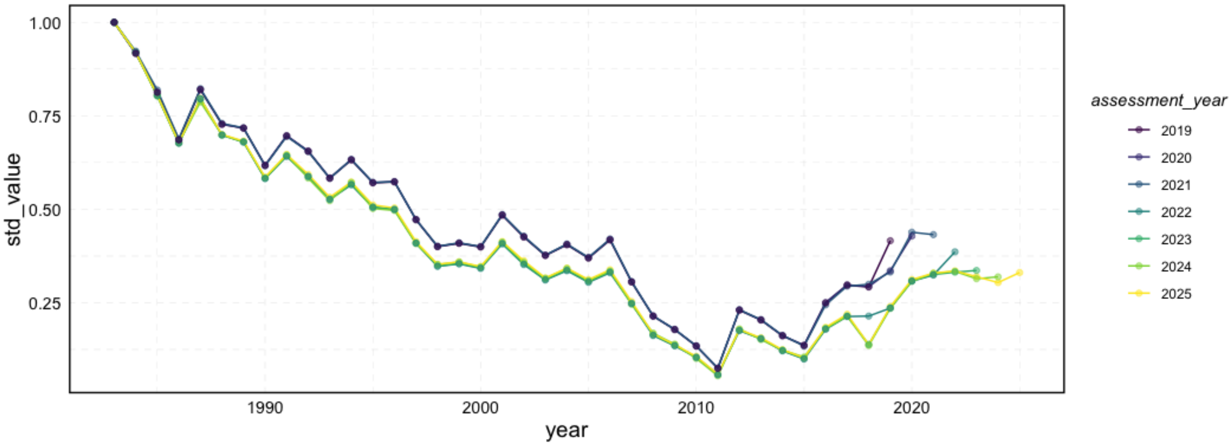

Figure 1: Time series of CPUE estimates for the South-Central Chile fleet, relative to the first value of the time series. Each line represents the index used in a given assessment year.

61. Comparisons of the Peruvian CPUE series shows a broadly consistent pattern across assessments up to about 2018, showing modest year-to-year variation and a relatively flat trend Figure 2. The sharp rise beginning around 2018 appears in all assessment years, but the height and persistence of the peak differ: earlier assessments (2019–2021) show a steeper surge and higher maxima, while later assessments (2023–2025) smooth the peak slightly and shift the recent decline. The latest assessment shows a more pronounced drop in 2024–2025, reflecting added data and revised standardization. Despite these revisions, the core signal—a stable period followed by a rapid multi-year increase—remains unchanged.

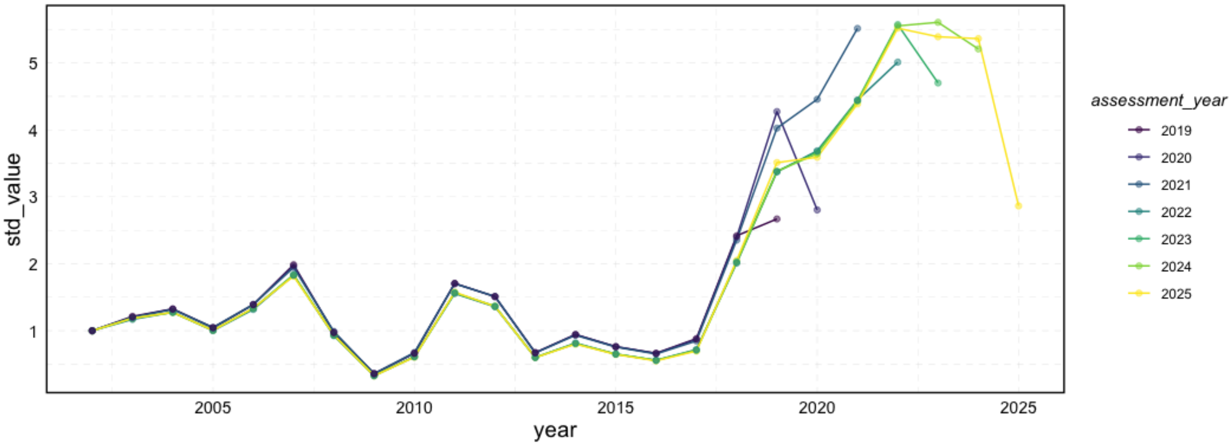

Figure 2: Time series of CPUE estimates for the Peruvian fleet, relative to the first value of the time series. Each line represents the index used in a given assessment year.

62. For the offshore CPUE, the series is tightly aligned across assessments through roughly 2018, showing the same mid-2010s dip and gradual rise. Differences emerge once the series climbs after 2018: the 2021 assessment shows a sharper early increase, while the 2024 run produces a pronounced spike in 2021–2022 that is absent or muted in the other years Figure 3. Significantly, the 2025 assessment series shifts the recent pattern downward, producing a lower peak and a steeper drop at the end of the series. Despite these revisions, the broad pattern—a trough around

2012–2014 followed by a sustained increase—remains consistent across assessments but shows a dramatic decrease through to 2025.

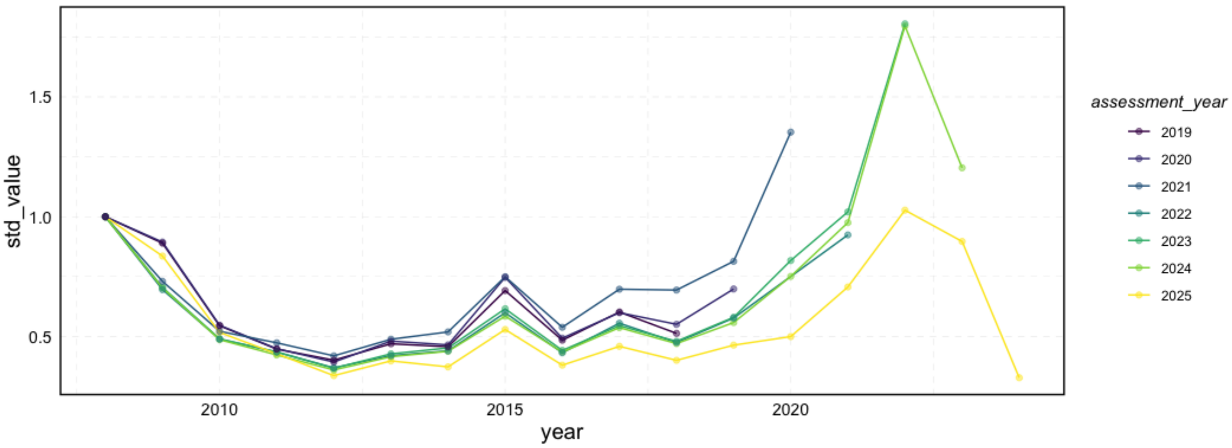

Figure 3: Time series of CPUE estimates for the Offshore fleet, relative to the first value of the time series. Each line represents the index used in a given assessment year.

63. The assessment model fit to recent data was poor, particularly for the SC Chile and the offshore fleets. Efforts were made to improve the fit, namely by 1) allowing for additional flexibility in selectivity patterns for those fleets in 2025 (Models 1.10 and 1.11), and 2) increasing the weight of the age composition data from those fleets in 2025 (Model 1.12). Age composition data from the current assessment year are typically downweighted by a factor of 0.1 relative to previous years, as those data are often incomplete for that year at the time of the assessment. For Model 1.12, the 2025 age composition for SC Chile and the Offshore fleets were increased by a factor of 5 (i.e., the weights were decreased by a factor of 0.5 relative to data from the previous years).

64. The data from the early years (pre-2000) of the Chile Acoustic North survey still had an impact on the historical perception of the stock. The survey process has also changed since 2000. As such, a sensitivity analysis was conducted downweighting those data from those earlier years (Model 1.13). Based on discussions with Chilean scientists most familiar with this survey, the final model omitting these earlier years was considered appropriate for this year’s assessment (the model results for stock status was insensitive to these data being included). As noted in SC12, the mean weights-at-age for the fleets need to be reviewed at the next benchmark assessment. This year, the assumptions used were the same as from the SC12 model.

65. Mean weights-at-age for older fish (ages 9-12+) in the FarNorth fleet had not historically been updated in the assessment, using instead a short-term (five-year) historical mean beginning in 2013. This led to much higher weights for older fish than those for the other fishing fleets. A sensitivity analysis was conducted using the fleet-specific mean weight-at-age over the entire time series for those older fish beginning in 2013, instead of using a rolling five-year average (Model 1.14).

66. The final model used the Francis weights agreed upon by SCW14 for the multinomial age composition sample sizes, and these weights were not updated in this assessment update. Also, the model took a precautionary approach to assessment and advice. It assumed low steepness (h=0.65) and used a low recruitment regime estimated from 2001-2015, similar to assessments prior to SC5. Recruitment used in the forecast was taken directly from the assessment.

67. Beginning in SC9, efforts have been made to increase the reproducibility and transparency of the assessment process. A centralised repository for data submissions was created on Teams to facilitate ease of access. R scripts were developed to document the assessment update process. These scripts included code to 1) read in, analyse, and raise catch at age/length data, 2) incrementally update data files for the bridging exercise from the previous year's assessment to the new assessment, 3) update model files for model sensitivity runs, 4) conduct projections with the final model, and 5) create an HTML document for result presentation. Scripts for processing the data (1) are found in the jjmData repository, whereas the assessment scripts can be found on the jjm repository, in the assessment/R folder.

4. Results

68. Results from incrementally updating the data and the model (Models 0.00 to 1.00) indicated a generally increasing trend in biomass for recent years. For the single-stock hypothesis, updating the offshore CPUE and the Chilean CPUE indices (Models h1_0.04 and h1_0.08) had the largest impact on the biomass estimates in recent years, resulting in decrease in the rate of biomass increase. This decrease in the slope of the increase in biomass was also seen for the south stock in the two-stock hypothesis (Models h2_0.04 and h2_0.08). Updating the Peruvian CPUE and the Chile Acoustic North survey data, however, reversed that trend and increased the rate of biomass increase in the single-stock and the southern stock under the two-stock hypothesis (Models 0.09 and 0.10). The biomass of the north stock showed a slight decrease in recent years, showing similar trends to the previous year.

69. The LOI analysis (Models 1.01 - 1.05), as mentioned previously, involved runs where three indices of abundance were removed, leaving one in. It was found that both indices from the north (Peruvian CPUE and Chile Acoustic North survey) had a positive impact on the biomass whereas the southern indices (Central-South Chile CPUE and Offshore CPUE) had a negative impact on biomass perception.

70. The LOO analysis (Models 1.06 - 1.09) involved runs where only one index of abundance was removed, leaving the other three in. Similarly to the previous analysis, removing either the South-Central Chile CPUE or the Offshore CPUE (Models 1.06 and 1.07) resulted in an increase in biomass perception beginning in the late 2000s. The removal of the Chilean CPUE index had the largest impact on biomass perception. Removing the Peruvian CPUE or the Acoustic North survey (Models 1.08 and 1.09) resulted in similar decreases in biomass perception.

71. Incorporating flexibility in selectivity patterns (Models 1.10 and 1.11) while increasing the weights of age composition data (Model 1.12) for the SC Chile and the Offshore fleets in 2025 allowed for the increased selection of younger fish in the two fisheries. These changes improved model fit to the Chile CPUE index data and age composition data for both fleets in 2025. They also resulted in reduced rates of biomass increase beginning in the late 2010s, for the single stock and the south stock under the two-stock hypothesis.

72. Downweighting the early years of the Chile Acoustic North survey data (Model 1.13) resulted in increased biomass estimates prior to 1990, and lower biomass estimates in recent years. Updating the historical weight at age for the Far North fleet (Model 1.14) had negligible impact on stock perception.

73. It was decided that the final model for SC13 was to be Model 1.14. This model incorporates 1) data updated to 2025, 2) flexibility in selectivity patterns for the SC Chile and Offshore fleets in 2025, and 3) increased confidence (decreased CV) for the 2025 age composition data from the same fleets. The early years of Chile acoustic north survey data were downweighted, and the changes in Peruvian weight at age for older fish were corrected. Overall, the stock (or stocks; depending on the stock structure hypothesis used) shows continued increasing trends in biomass, albeit at lower rates than those of last year. Recruitment estimates in more recent years were smoothed, while estimates of fishing mortality increased.

74. An analytical retrospective analysis involves running the model multiple times, each time removing the final year of data (for five years). The retrospective analysis shows that Model h1_1.14 tended to slightly under-estimate SSB, with a Mohn's rho of -0.03 (Figure 6). Recruitment tended to also be under-estimated, with a Mohn's rho of -0.3 (Figure 7). The negative bias in recruitment is likely due to the fact that recruitment in recent years has been very high, with less data to inform recruitment estimates in the final year. This results in recruitment in the final year reverting to a longer-term mean. Model h2_1.14 showed a tendency to over-estimate SSB for for both the north and south stocks (Mohn's rho of 0.15 and 0.24 respectively; Figure 8). The model also tended to under-estimate recruitment for the south (Mohn's rho of -0.23), with an inverse but somewhat worse pattern for the north stock (Mohn's rho of 0.41; Figure 9).

75. A historical retrospective analysis was also conducted as an alternative to the analytical retrospective analysis. This analysis compares quantities derived from assessments previously adopted by the SC, indicating year-to-year changes in estimates of stock trends and reference points. This analysis was only conducted on Model h1_1.14 (raw values for biomass found in Table 27; graphically visualised in Figure 10 and Figure 11). The results showed an overall higher fishing mortality rate along with a slower rate of increase in biomass than estimated in previous years. The trends in the CPUE and age composition data were likely driving this change. Recruitment estimates appear mostly in line with those of previous models, similar to SC11 and SC12. Overall, the trends appear consistent over time (Figure 10).

76. Another interesting comparison to make is that of the management reference points (biomass (B) at maximum sustainable yield (MSY) and fishing mortality (F) at MSY; B_{MSY} and F_{MSY} respectively) estimated within the model over the years. Previously, updates to the ageing methodology in 2022 likely led to a change in the perception of stock biomass, likely resulting in an increase in the estimate of B_{MSY}. In 2025, updates to the estimation methods for MSY were adopted (refer above to the Management Quantities section), resulting in lower estimates of MSY. The updates to the data and model for 2025 resulted a slight increase in the model estimates of B_{MSY} and F_{MSY} relative to the SC12 model (Figure 11). It is worth noting that these are management quantities estimated annually from the final model, not necessarily the same quantities used in management. The B_{MSY} used for management takes an average of the annual B_{MSY} estimated from the model over the most recent ten years. The stock has consistently been estimated as rebuilt since 2018, and not subject to overfishing since 2013, relative to the dynamically-estimated MSY reference points.

77. Fishery mean weights-at-age assumed for all models are shown in Figure 12, and those for the surveys are shown in Figure 13. Estimates of numbers-at-age from Model h1_1.14 are given in Table 28, and Model h2_1.14 results are in Table 29 (southern stock) and Table 30 (northern stock). Both models show similarly good fits to the fishery composition data (Figure 14, Figure 15, Figure 16, Figure 17, Figure 20, Figure 21, Figure 18, and Figure 19). The single stock model predicted more older fish than were found in 2025 for the south-central Chile, while both models

predicted more older fish than were found in 2024 and 2025 for the offshore trawl fleet (Figure 16,Figure 17, Figure 18 and Figure 19). Both models also fit the length compositions from the far north fleet well, although the data showed more fish in the plus group for 2024 than the model predicted (Figure 20 and Figure 21). The fits to age composition data from the surveys are given in Figure 22, Figure 23, Figure 24, Figure 25, Figure 26, and Figure 27. Both models appear to fit those data relatively well. Models h1_1.14 and h2_1.14 fit the indices similarly well (Figure 28 (h1), Figure 29 (h2 south), and Figure 30 (h2 north)); relative abundance estimates remained within the uncertainty bounds of the data. Neither model was able to fit well to the Offshore CPUE index in 2024, however. Both models show an increasing estimate of mean fishery age over the last decade across the three fleets for which age composition data were available, although there was a decrease in the Offshore fleet in 2025 (Figure 31 and Figure 32). This increase is less pronounced in the survey (Figure 33 and Figure 34), where only the Chile acoustic north survey has age composition data after 2010. The single-stock model predicted the increasing mean length for the far north fleet relatively well (Figure 35). The two-stock model, on the other hand, consistently under-estimated the mean length for that fishery after 2020 (Figure 36). Selectivity estimates for the fishery and indices are shown over time in Figure 37, Figure 38, Figure 39, and Figure 40.

78. For SC13, B_{MSY} was estimated to be approximately 9.1 million t under the single-stock hypothesis (h1_1.14), and 7.53 and 0.17 million t for the south and far north stocks respectively under the two-stock hypothesis (h2_1.14).

79. A summary of the time series stock status (spawning biomass, F, recruitment, total biomass) for the single-stock hypothesis (h1_1.14) is shown in Figure 41. It is noted that the biomass has been steadily increasing over the last decade, and is now above the B_{MSY} management reference point. Currently, the biomass is estimated to be around 52% of what is estimated to have occurred had there been no fishing (Figure 42).

80. Under the two-stock hypothesis (h2_1.14), conditions of the jack mackerel stock in its entire distribution range in the southeast Pacific show a continued recovery since the time-series low in 2010. It is noted that under the two-stock model, the southern stock shows an increasing trend in biomass over the last decade (Figure 43), while the northern stock only shows an increase in biomass beginning in the middle of the last decade, with a decrease in the last three years (Figure 44). The southern stock showed similar results to that of the single-stock hypothesis, although SSB was estimated slightly higher under the former scenario. Estimates of exploitation rate for the northern stock were comparable to recent years, remaining at relatively low levels. Figure 45 and Figure 46 show the current total biomass to be approximately 49% and 55% of unfished total biomass for the southern and the far north stocks respectively.

81. Estimated annual fishing mortality rates (combined fleets) were high starting in about 1992 across the entire jack mackerel population, but have declined in the past years, regardless of stock structure hypothesis or designation Figure 41, Figure 43, and Figure 44). Similarly, fishing mortality rates at age showed a decline in fishing pressure, after the mid-1990s, with the biggest changes occurring in older fish (Table 31, Table 32, and Table 33). Time series of quantities derived by Model h1_1.14 are presented in Table 34, whereas those of Model h2_1.14 are in Table 35 (southern stock) and Table 36 (far north stock).

82. Short, medium and long-term projections for the stock(s) under different fishing mortalities are found under Table 37 (h1_1.14) and Table 38 (h2_1.14). Prior to SC13, selectivity-at-age patterns were fixed at the final year values for each fleet. It was noted that selectivity patterns across all

fleets in recent years had shifted to favour older fish, which would also have impacted the estimated reference points. Beginning in SC13 (2025), a rolling average of the selectivity patterns for the previous three years were used. For example, for assessment year 2025, the projections used selectivity patterns for each fleet averaged over 2022-2024. As the data for the assessment year are typically not complete, current year selectivity patterns are not used for the projections.

83. During SC11 and SC12, the risk tables were expanded to include additional fishing scenarios, by projecting using a fishing mortality rate that was calculated to provide the present year's Total Allowable Catch (TAC) in the next year. For example, the scenario $F_{TAC2024}$ would produce a catch of 1,242 kt (which was the 2024 catch advice) in 2025, based on selectivity patterns from 2021-2023. Subsequent years in the projection would be subject to the same fishing mortality rate and selectivity patterns. Other scenarios included multipliers on that fishing mortality rate.

84. In the risk tables, comparisons to B_{MSY} are based on an average of B_{MSY} over the past 10 years, as specified at SWG14, which gives a larger B_{MSY} value than recent annually-estimated values of B_{MSY}. Additionally, recruitment has increased in recent years to about the long-term average mean, based on a recruitment curve estimated from 2000 to 2022 for the southern/single stock. However, the recruitment curve estimated from the period of low recruitment (2001 - 2015) was used for projections. The validity of these assumptions and their impacts on resultant reference points and management advice remain a topic for further investigation.

5. Management Advice

85. New data and indicators on the status of the jack mackerel stock suggest that conditions evaluated in detail from the last update assessment are relatively unchanged. The population trend is estimated to be increasing. The indications of stock improvement (higher abundance observed in the acoustic survey in the northern part of Chile, better catch rates apparent in all fisheries for which data are available, and increase in average age in the Chilean fisheries) drive the increase.

86. Historical fishing mortality rates and patterns relative to the provisional biomass target are shown in Figure 41 for Model h1_1.14. Near-term spawning biomass is expected to increase from 15.2 million t in 2025 to 16.6 million t in 2026 (with approximate 90% confidence bounds of 12.7 – 21.7 t). Under the two-stock hypothesis, historical fishing mortality rates and patterns relative to the biomass targets estimated by Model h2_1.14 are shown in Figure 43 and Figure 44. Near-term spawning biomass is expected to increase from the 2025 estimate of 10.5 million t to 11.9 million t in 2026 for the southern stock (with approximate 90% confidence bounds of 8.48 – 16.6 million t), and decrease from 0.937 million t to 0.93 million t for the far north stock (with approximate 90% confidence bounds of 0.61 – 1.42 million t).

87. As was the case last year, the stock is estimated to be in the third tier of the harvest control rule (as defined in the SCW14 report, para 62.d). Within the third tier of the harvest control rule, catches should be limited to a fishing mortality rate based on F_{MSY}, which would be expected to result in catches in 2025 of 4,997 kt. This expected catch is more than four times the current catch levels, and likely due to inflated F_{MSY} estimates from strong selection on older fish. However, in line with the adopted harvest control rule (SCW14; para 62.d), catch advice (and TACs) cannot exceed a 15% increase from the advice in the previous year. However, the SC13 lacked consensus and provided two recommendations for setting the TAC throughout the range of jack mackerel:

- that the 2026 TAC be at or below 1,642.2 kt, (15% increase over the 2025 SC catch advice)

- that the 2026 TAC be at or below 1,785.4 kt, (15% increase over 2025 TAC).

88. This advice is independent from alternative stock structure hypotheses.

89. Projections show a high likelihood of the biomass being above B_{MSY} in 2026, even under the most conservative recruitment productivity scenario evaluated (h1_1.14.ls and h2_1.14.ls; Table 37 and Table 38). A re-evaluation of the rebuilding plan is recommended to analyse sustainable exploitation rates of the rebuilt jack mackerel stock.

6. Assessment Issues

90. Based on results from the 2022 benchmark workshop, assessment plans for the next benchmark should be developed several months prior. Doing so will allow data coordinators to configure alternatives and conduct a careful evaluation of all available information to best guide the Commission. One of the higher priority items for consideration continues to be the catch-at-age estimates (based on age-determinations being conducted from different labs) and mean body weights at age assumed in the model. Another priority for consideration is the development of guidelines for standardisation of CPUE indices and the collection of relevant data. In particular, evaluations of efficiency improvements for the Peruvian and Chilean fishing fleets were noted. Results of the data weighting and the retrospective pattern analysis also warrant further investigation.

91. The issue of evaluating sensitivities to the early fishery age composition data was raised. The SC noted that this might be a fruitful avenue for investigation in subsequent assessments, particularly since these data (pre-1990) are less well-documented. Residual patterns in the age composition for the North Chilean fleet remain unresolved, and warrant further investigation as well.

92. The validity of the assumptions used in model projections and the sensitivity of the results to those assumptions, both to estimate reference points and to conduct the risk analyses, require further research. In particular, the assumptions on selectivity patterns and recruitment regimes are likely to have a large impact on the management outcomes.

93. The need for a closer evaluation comparing the performance of the model under the single-stock and two-stock hypotheses was noted, likely conducted using simulation and MSE.

94. In SC13, a list of high priority topics were identified for additional investigation in the next benchmark workshop:

- Acoustic biomass in the north area, with emphasis on age composition and biological sampling.
- CPUE index standardisation approaches (sdmTMB or INLA)
- Consider spatio-temporal models combining fleets. For example, tinyVAST (spatio temporal model) has capabilities to consider different data types so may provide a way to combine datasets from different fleets and regions.
- Comprehensive analysis of the different CPUE indices and acoustic biomass estimates including a review S-C and N Chile; this should include an evaluation of sampling levels and expansion protocols
- Consider impact of bycatch in jack mackerel fisheries
- Peruvian potentials? Vessels of opportunity?
- Projection year scenarios, namely
- Long- and shorter-term productivity periods
- Steepness value assumptions
- Selectivity aspects and assumptions
- F-scenarios (relative Fs, Fmsy, etc)
- Possibly converting the assessment into updated software (e.g., RTMB) or using an alternative platform

7. References

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8. Tables

Table 1: Sources and values of catch (t) compiled for the four fleets used for the assessment (note that data for 2024 are preliminary, and 2025 are predictions; continued on next page).

	Fleet 1	Fleet 2	Fleet 3					
Year	CHL	CHL	COK	CUB	ECU	PER	RUS	Total
1970	101,685.00	10,309.0				4,711		116,705
1971	143,454.00	14,988.0				9,189		167,631
1972	64,457.00	22,546.0				18,782		105,785
1973	83,204.00	38,391.0				42,781		164,376
1974	164,762.00	28,750.0				129,211		322,723
1975	207,327.00	53,878.0				37,899		299,104
1976	257,698.00	84,571.0				54,154		396,458
1977	226,234.00	114,572.0				504,992		848,071
1978	398,414.00	188,267.0				386,793	0	1,024,764
1979	344,051.00	253,460.0		6,281		151,591	175,938	1,301,611
1980	288,809.00	273,453.0		38,841		123,380	252,078	1,316,363
1981	474,817.00	586,092.0		35,783		37,875	371,981	1,944,670
1982	789,912.00	704,771.0		9,589		50,013	84,122	2,371,611
1983	301,934.00	563,338.0		2,096		76,825	31,769	1,870,262
1984	727,000.00	699,301.0		560		184,333	15,781	2,686,902
1985	511,150.00	945,839.0		1,067		87,466	26,089	2,370,934
1986	55,210.00	1,129,107.0		66		49,863	1,100	2,072,848
1987	313,310.00	1,456,727.0		0		46,304	0	2,679,764
1988	325,462.00	1,812,793.0		5,676		118,076	120,476	3,245,699
1989	338,600.00	2,051,517.0		3,386	0	140,720	137,033	3,547,077
1990	323,089.00	2,148,786.0		6,904	4,144	191,139	168,636	3,714,757
1991	346,245.00	2,674,267.0		1,703	45,313	136,337	30,094	3,777,618
1992	304,243.00	2,907,817.0		0	15,022	96,660	0	3,361,674
1993	379,467.00	2,856,777.0			2,673	130,681		3,369,598
1994	222,254.00	3,819,193.0			36,575	196,771		4,274,793
1995	230,177.00	4,174,016.0			174,393	376,600		4,955,186
1996	278,439.00	3,604,887.0			56,782	438,736		4,378,844
1997	104,198.00	2,812,866.0			30,302	649,751		3,597,117
1998	30,273.00	1,582,639.0			25,900	386,946		2,025,758
1999	55,654.00	1,164,035.0			19,072	184,679		1,423,447
2000	118,734.00	1,115,565.0			7,122	296,579		1,540,318
2001	248,097.00	1,401,836.0			133,969	723,733		2,527,725
2002	108,727.00	1,410,266.0			604	154,219		1,750,077
2003	143,277.00	1,278,019.0			0	217,734		1,797,229
2004	158,656.00	1,292,943.0			0	187,369		1,934,411
2005	165,626.00	1,264,808.0			0	80,663		1,754,673
2006	155,256.00	1,224,685.0			0	277,568		2,020,136
2007	172,701.00	1,130,083.0	7		927	254,426		1,996,975
2008	167,258.00	728,850.0	0		0	169,537		1,472,631
2009	134,022.00	700,905.0	0		1,934	74,694		1,283,473
2010	169,012.00	295,796.0	0		4,613	17,559		726,573
2011	30,825.00	216,470.0	0		69,373	256,566		634,125
2012	13,256.00	214,204.0	0		77	187,292		454,747
2013	16,361.00	214,999.0	0		3,563	79,441		355,540
2014	18,219.00	254,295.0			9	79,191		415,367
2015	34,886.00	250,327.0			289	23,036		395,210
2016	24,657.00	295,160.0			0	15,121		389,101
2017	35,002.00	311,863.0			54	10,094		406,125
2018	11,551.00	415,149.0			23	58,356		527,538
2019	11,875.00	432,447.0				139,811		635,569
2020	44,155.00	517,665.0				158,880		725,945
2021	61,359.00	567,267.0				118,096		802,040
2022	72,795.00	655,157.0			5	159,604		961,598
2023	80,466.00	736,292.0			3	222,284		1,134,379
2024	105,308.75	977,040.2			30	217,212		1,330,070
2025	94,340.63	1,068,425.0			75	208,000		1,384,404

Table 1: Sources and values of catch (t) compiled for the four fleets used for the assessment (note that data for 2024 are preliminary, and 2025 are predictions; continued).

						Fleet 4						
Year	BLZ	CHN	CUB	EUC	FRO	JPN	KOR	PER	RUS	UKR	VUT	Total
1970												116,705
1971												167,631
1972												105,785
1973												164,376
1974												322,723
1975												299,104
1976						35						396,458
1977						2,273						848,071
1978						1,667	403		49,220			1,024,764
1979			12,719	1,180		120			356,271			1,301,611
1980			45,130	1,780					292,892			1,316,363
1981			38,444			29			399,649			1,944,670
1982			74,292	7,136					651,776			2,371,611
1983			52,779	39,943		1,694			799,884			1,870,262
1984			33,448	80,129		3,871			942,479			2,686,902
1985			31,191			5,229			762,903			2,370,934
1986			46,767			6,835			783,900			2,072,848
1987			35,980			8,815			818,628			2,679,764
1988			38,533			6,871			817,812			3,245,699
1989			21,100			701			854,020			3,547,077
1990			34,293			157			837,609			3,714,757
1991			29,125						514,534			3,777,618
1992			3,196						32,000	2,736		3,361,674
1993									0			3,369,598
1994									0			4,274,793
1995									0			4,955,186
1996									0			4,378,844
1997									0			3,597,117
1998									0			2,025,758
1999						7			0			1,423,447
2000		2,318							0			1,540,318
2001		20,090							0			2,527,725
2002		76,261							0			1,750,077
2003		94,690					2,010		7,540		53,959	1,797,229
2004		131,020					7,438		62,300		94,685	1,934,411
2005	867	143,000		6,187			9,126		7,040		77,356	1,754,673
2006	481	160,000		62,137			10,474		0		129,535	2,020,136
2007	12,585	140,582		123,523	38,700		10,940		0		112,501	1,996,975
2008	15,245	143,182		108,174	22,919		12,600		4,800		100,066	1,472,631
2009	5,681	117,963		111,921	20,213	0	13,759	13,326	9,113		79,942	1,283,473
2010	2,240	63,606		67,497	11,643	0	8,183	40,516	0		45,908	726,573
2011	0	32,862	8	2,248	0		9,253	674	8,229		7,617	634,125
2012		13,012	0	0	0	0	5,492	5,346	0		16,068	454,747
2013		8,329		10,101	0		5,267	2,670			14,809	355,540
2014		21,155		20,539			4,078	2,557			15,324	415,367
2015		29,180		27,955			5,749	0	2,561		21,227	395,210
2016		20,208		11,962			6,430	0	0		15,563	389,101
2017		16,802		27,887			1,235	0	3,188			406,125
2018		24,366		9,691			3,717	0	4,685			527,538
2019		22,699		11,870			7,444	0	9,423			635,569
2020				0				0	5,245			725,945
2021				43,167					12,151			802,040
2022				44,594					29,443			961,598
2023				52,590					42,744			1,134,379
2024				16,571			1,798		12,110			1,330,070
2025				11,055				2,508				1,384,404

Table 2: Input catch (kilo tonnes) by fleet (combined) for the stock assessment model. Note that data for 2024 and 2025 are preliminary.

Year	Fleet 1	Fleet 2	Fleet 3	Fleet 4
1970	101.69	10.31	4.71	1.00
1971	143.45	14.99	9.19	1.00
1972	64.46	22.55	18.78	5.50
1973	83.20	38.39	42.78	1.00
1974	164.76	28.75	129.21	1.00
1975	207.33	53.88	37.90	1.00
1976	257.70	84.57	54.15	1.04
1977	226.23	114.57	504.99	2.27
1978	398.41	188.27	386.79	51.29
1979	344.05	253.46	333.81	370.29
1980	288.81	273.45	414.30	339.80
1981	474.82	586.09	445.64	438.12
1982	789.91	704.77	143.72	733.20
1983	301.93	563.34	110.69	894.30
1984	727.00	699.30	200.67	1,059.93
1985	511.15	945.84	114.62	799.32
1986	55.21	1,129.11	51.03	837.50
1987	313.31	1,456.73	46.30	863.42
1988	325.46	1,812.79	244.23	863.22
1989	338.60	2,051.52	316.25	875.82
1990	323.09	2,148.79	370.82	872.06
1991	346.25	2,674.27	213.45	543.66
1992	304.24	2,907.82	111.68	37.93
1993	379.47	2,856.78	133.35	1.00
1994	222.25	3,819.19	233.35	1.00
1995	230.18	4,174.02	550.99	1.00
1996	278.44	3,604.89	495.52	1.00
1997	104.20	2,812.87	680.05	1.00
1998	30.27	1,582.64	412.85	1.00
1999	55.65	1,164.04	203.75	1.01
2000	118.73	1,115.57	303.70	2.32
2001	248.10	1,401.84	857.74	20.09
2002	108.73	1,410.27	154.82	76.26
2003	143.28	1,278.02	217.73	158.20
2004	158.66	1,292.94	187.37	295.44
2005	165.63	1,264.81	80.66	243.58
2006	155.26	1,224.69	277.57	362.63
2007	172.70	1,130.08	255.36	438.83
2008	167.26	728.85	169.54	406.99
2009	134.02	700.90	76.63	371.92
2010	169.01	295.80	22.17	239.59
2011	30.82	216.47	326.39	60.89
2012	13.26	214.20	187.40	39.92
2013	16.36	215.00	80.59	41.18
2014	18.22	254.29	74.53	63.65
2015	34.89	250.33	22.45	86.67
2016	24.66	295.16	15.09	54.16
2017	35.00	311.86	8.87	49.11
2018	11.55	415.15	57.16	42.46
2019	11.88	432.45	135.78	51.44
2020	44.16	517.66	140.12	4.74
2021	61.36	567.27	123.64	55.30
2022	72.80	655.16	159.61	73.87
2023	68.05	740.20	222.29	95.33
2024	105.31	977.04	217.24	30.48
2025	94.34	1,068.42	208.07	13.56

Table 3: Input catch at age for Fleet 1. Units are relative value (they are normalized to sum to 100 for each year in the model).

	Age group (years)											
Year	1	2	3	4	5	6	7	8	9	10	11	12
1980	0	5	14	24	31	22	4	0	0	0	0	0
1981	1	7	13	21	33	19	5	1	0	0	0	0
1982	0	15	15	21	26	16	6	1	0	0	0	0
1983	1	9	17	27	28	15	3	0	0	0	0	0
1984	2	34	12	14	18	16	4	0	0	0	0	0
1985	1	18	26	30	18	5	1	0	0	0	0	0
1986	8	11	9	18	32	18	5	0	0	0	0	0
1987	15	68	11	3	2	1	0	0	0	0	0	0
1988	1	17	54	26	2	0	0	0	0	0	0	0
1989	0	9	42	39	8	1	0	0	0	0	0	0
1990	9	3	28	49	10	1	0	0	0	0	0	0
1991	11	33	8	18	24	6	1	0	0	0	0	0
1992	11	30	21	21	12	5	1	0	0	0	0	0
1993	15	72	8	4	1	0	0	0	0	0	0	0
1994	27	32	25	13	2	1	0	0	0	0	0	0
1995	5	69	18	6	2	0	0	0	0	0	0	0
1996	29	57	11	3	0	0	0	0	0	0	0	0
1997	36	60	3	0	0	0	0	0	0	0	0	0
1998	8	79	11	3	0	0	0	0	0	0	0	0
1999	9	84	5	2	0	0	0	0	0	0	0	0
2000	36	47	16	1	0	0	0	0	0	0	0	0
2001	51	48	1	0	0	0	0	0	0	0	0	0
2002	21	58	17	3	1	0	0	0	0	0	0	0
2003	21	72	4	2	1	0	0	0	0	0	0	0
2004	13	63	23	1	0	0	0	0	0	0	0	0
2005	40	44	11	4	1	0	0	0	0	0	0	0
2006	8	83	6	2	1	0	0	0	0	0	0	0
2007	12	69	13	3	2	0	0	0	0	0	0	0
2008	56	27	9	7	1	0	0	0	0	0	0	0
2009	20	68	4	8	0	0	0	0	0	0	0	0
2010	9	74	13	3	1	0	0	0	0	0	0	0
2011	77	20	2	1	0	0	0	0	0	0	0	0
2012	34	58	7	0	0	0	0	0	0	0	0	0
2013	31	66	1	1	1	0	0	0	0	0	0	0
2014	59	40	2	0	0	0	0	0	0	0	0	0
2015	14	60	15	6	4	1	0	0	0	0	0	0
2016	10	20	13	19	19	7	10	1	0	0	0	0
2017	31	61	6	1	1	0	0	0	0	0	0	0
2018	100	0	0	0	0	0	0	0	0	0	0	0
2019	20	19	9	14	13	6	7	4	3	3	1	2
2020	0	27	25	23	15	8	2	0	0	0	0	0
2021	18	3	4	14	22	18	12	7	3	1	1	0
2022	2	1	1	11	26	29	19	6	3	1	0	0
2023	9	2	6	8	16	25	18	10	4	1	2	0
2024	0	1	10	14	13	19	21	14	7	1	0	0
2025	0	2	10	10	23	13	12	17	10	3	0	0

Table 4: Input catch at age for Fleet 2. Units are relative value (they are normalized to sum to 100 for each year in the model).

	Age group (years)											
Year	1	2	3	4	5	6	7	8	9	10	11	12
1980	2	23	40	26	8	1	0	0	0	0	0	0
1981	2	20	32	31	12	3	0	0	0	0	0	0
1982	2	27	37	25	8	1	0	0	0	0	0	0
1983	15	28	24	20	11	2	0	0	0	0	0	0
1984	7	50	8	14	12	6	2	0	0	0	0	0
1985	3	27	26	20	17	7	2	0	0	0	0	0
1986	4	11	24	27	21	12	2	0	0	0	0	0
1987	8	46	7	10	17	10	2	0	0	0	0	0
1988	12	38	29	7	8	6	1	0	0	0	0	0
1989	1	12	42	30	9	5	2	0	0	0	0	0
1990	0	1	6	26	33	18	12	3	0	0	0	0
1991	1	3	0	6	27	29	18	10	4	1	0	0
1992	1	7	6	6	8	21	22	16	9	4	0	0
1993	1	16	17	14	12	10	14	12	4	1	0	0
1994	0	6	17	18	13	11	17	13	4	1	0	0
1995	1	19	17	22	20	8	7	4	1	0	0	0
1996	4	22	19	17	15	10	6	3	1	0	0	0
1997	8	42	21	10	6	5	5	2	1	1	0	0
1998	9	58	14	6	3	3	4	2	1	0	0	0
1999	20	52	15	6	2	1	1	1	1	0	0	0
2000	10	49	24	10	3	1	1	1	1	0	0	0
2001	6	41	28	12	4	2	2	2	1	1	1	0
2002	7	34	23	16	6	4	3	2	2	2	1	0
2003	4	31	28	21	8	3	2	2	1	1	0	0
2004	2	22	29	26	11	5	3	2	1	0	0	0
2005	2	8	20	33	19	9	5	2	1	1	0	0
2006	1	6	9	20	25	14	11	7	3	2	1	1
2007	0	13	17	11	15	15	12	9	4	2	1	1
2008	3	1	6	22	20	16	11	9	5	3	2	2
2009	2	15	2	19	21	16	10	7	4	2	1	1
2010	1	32	20	10	11	6	9	6	2	1	1	0
2011	2	11	14	36	11	8	13	2	1	0	0	0
2012	0	8	25	27	29	7	3	1	0	0	0	0
2013	2	18	31	33	14	2	0	0	0	0	0	0
2014	1	13	24	26	21	12	3	1	0	0	0	0
2015	10	45	14	10	10	7	3	1	0	0	0	0
2016	0	23	26	22	14	8	4	2	1	0	0	0
2017	3	21	16	16	16	11	7	4	3	1	0	1
2018	2	18	24	20	17	9	5	3	1	1	1	0
2019	0	9	17	22	24	14	8	4	1	0	0	0
2020	0	9	10	15	22	20	14	8	3	0	1	0
2021	0	4	15	18	24	18	11	6	2	1	0	0
2022	0	1	5	17	24	23	16	9	3	2	0	0
2023	0	2	9	17	23	23	15	7	3	1	0	0
2024	0	3	10	20	23	19	15	6	2	1	0	0
2025	0	0	10	27	30	17	10	4	1	0	0	0

Table 5: Input catch at age for Fleet 4. Units are relative value (they are normalized to sum to 100 for each year in the model).

	Age group (years)											
Year	1	2	3	4	5	6	7	8	9	10	11	12
2015	17	26	10	7	11	11	8	5	3	1	1	0
2016	6	14	17	25	22	7	3	2	1	1	0	0
2017	65	14	12	5	2	1	1	0	0	0	0	0
2018	15	21	7	12	18	15	8	3	1	0	0	0
2019	19	32	8	8	8	8	8	6	2	0	1	0
2020	14	53	24	4	1	1	1	0	0	0	0	0
2021	6	21	50	13	7	2	0	0	0	0	0	0
2022	1	67	8	7	10	3	2	1	1	0	0	0
2023	0	14	32	37	7	4	2	2	1	0	0	0
2024	1	10	24	36	20	6	2	0	0	0	0	0
2025	13	79	3	2	2	1	0	0	0	0	0	0

Table 6: Input catch at length for Fleet 3. Units are relative value (they are normalized to sum to 100 for each year in the model.

	Total length (cm)																																							
Year	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
1980	1	2	2	2	3	2	5	3	2	1	0	0	0	1	1	1	0	0	1	3	3	5	8	12	11	9	7	5	3	2	1	1	1	1	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	9	11	9	10	10	9	8	7	6	4	3	3	2	2	2	1	0	0	0	0	0	0
1982	0	0	1	3	6	6	6	5	4	5	6	4	1	0	0	0	0	0	0	1	1	4	8	12	9	6	3	2	2	2	1	1	0	0	0	0	0	0	0	0	0
1983	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	2	3	7	15	18	15	13	7	5	3	2	1	1	1	1	0	0	0	0	0	0	0
1984	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	4	6	8	8	8	11	11	10	8	6	4	3	2	1	1	1	1	1	0	1	0	0	0	0
1985	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3	4	5	7	7	8	8	7	7	7	7	6	5	3	3	2	2	2	1	2	1	0
1986	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	1	2	4	7	10	13	12	12	8	6	5	3	3	2	2	2	1	1	1	0
1987	0	0	0	0	0	0	0	1	0	0	1	1	1	2	2	4	5	8	11	12	10	8	5	3	2	3	4	4	3	2	2	2	1	1	1	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	4	7	9	10	9	7	5	4	3	3	3	3	3	2	2	2	3	3	2	3	3	2	2	1	1	0
1989	0	0	0	0	0	0	0	0	0	0	0	1	7	10	5	6	4	3	2	2	2	3	4	6	8	8	8	6	4	3	1	1	1	1	1	1	1	1	0	0	0
1990	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	3	5	6	7	9	12	13	10	8	6	4	3	3	2	1	1	0	0	0	0
1991	0	0	0	0	0	0	0	0	0	0	0	0	0	2	4	2	1	1	1	2	2	3	4	5	5	7	8	8	8	7	6	4	3	3	2	2	2	2	1	1	1
1992	0	0	0	0	0	0	0	0	0	0	1	2	1	1	1	1	1	1	1	2	3	4	7	9	12	11	8	6	6	5	5	4	3	2	1	1	0	0	0	0	0
1993	0	0	0	0	0	0	0	0	0	1	2	2	3	4	6	9	12	9	7	6	5	5	6	5	5	5	4	2	1	1	0	0	0	0	0	0	0	0	0	0	0
1994	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	2	3	3	5	11	14	11	8	6	4	3	3	3	3	2	3	2	2	2	1	1	1	1	0
1995	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	2	2	3	4	5	6	7	8	9	11	12	10	6	3	2	2	1	1	1	1	0	0	0	0	0	0
1996	0	0	0	0	0	0	0	0	0	1	2	2	2	3	5	6	6	6	6	7	9	8	6	6	5	4	4	3	3	2	1	1	0	0	0	0	0	0	0	0	0
1997	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3	7	11	10	5	4	8	14	16	8	4	3	1	1	1	0	0	0	0	0	0	0	0	0	0	0
1998	0	0	0	0	0	0	0	0	1	2	4	3	2	4	7	16	20	14	8	4	3	2	2	2	2	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
1999	0	0	0	0	0	1	1	1	1	1	1	1	2	3	5	7	12	13	16	15	8	5	3	2	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	0	0	4	8	7	5	4	4	10	8	7	8	12	11	7	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0	0	0	1	2	1	1	2	4	7	10	12	16	16	14	9	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	1	0	0	0	0	0	0	1	1	1	0	0	1	3	9	16	19	19	14	7	3	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	1	1	2	5	7	8	6	5	6	9	10	7	5	4	3	4	5	5	3	2	1	0	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	6	7	9	12	13	11	8	8	7	5	3	2	1	0	0	0	0	0	0	0	0
2005	0	0	1	1	1	0	0	1	3	6	8	8	10	10	6	3	1	1	1	1	1	0	0	0	0	0	0	0	2	5	9	9	5	3	2	1	0	0	0	0	0
2006	0	0	0	0	0	0	0	0	0	0	2	3	6	8	7	8	8	8	7	8	8	8	7	5	3	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2007	0	0	0	0	0	0	0	0	0	0	0	0	0	1	5	9	8	5	6	4	3	6	10	12	11	8	6	3	1	1	0	0	0	0	0	0	0	0	0	0	0
2008	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	3	10	18	21	17	10	6	3	2	1	2	1	1	0	0	0	0	0	0	0	0	0
2009	1	1	1	1	0	0	0	0	0	0	1	4	4	4	2	2	1	0	1	1	0	0	0	0	0	1	2	5	11	19	20	11	5	1	0	0	0	0	0	0	0
2010	0	0	0	0	0	0	0	0	0	0	2	0	2	25	49	18	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2011	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	8	18	23	24	18	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2012	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	2	15	32	27	14	6	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2013	0	0	0	0	0	0	0	0	0	0	1	1	1	0	1	2	2	4	4	11	8	5	2	0	1	1	1	3	12	20	15	4	1	0	0	0	0	0	0	0	0
2014	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2	2	5	20	31	19	8	3	2	2	1	1	0	0	0	0	0	0	0	0	0	0
2015	0	0	0	0	0	0	0	0	0	0	1	1	3	10	13	12	14	14	9	5	4	4	3	2	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
2016	0	0	0	0	0	0	0	0	0	0	0	1	2	5	6	6	7	8	7	8	8	8	8	7	6	5	3	2	1	0	0	0	0	0	0	0	0	0	0	0	0
2017	0	0	0	0	0	0	1	2	3	4	5	6	8	8	7	7	8	8	7	5	5	3	3	3	3	2	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0
2018	0	0	0	0	0	0	0	0	1	1	1	1	2	3	7	11	15	18	15	7	5	4	3	2	2	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
2019	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	2	3	5	8	12	16	17	13	8	5	3	2	1	1	0	0	0	0	0	0	0	0	0	0	0
2020	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	2	3	4	6	9	13	16	15	11	7	4	2	1	1	0	0	0	0	0	0	0	0	0
2021	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	3	5	6	8	9	9	12	11	11	8	6	3	2	1	1	0	0	0
2022	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	3	4	4	5	6	7	8	7	7	6	6	6	6	6	5	4	3	2	1	1	1
2023	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	3	5	6	6	5	4	3	4	4	5	5	5	5	5	5	5	5	4	4	3	5
2024	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	3	4	5	5	6	5	6	7	7	6	6	5	4	4	4	16
2025	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	2	2	3	4	6	8	9	11	12	10	8	5	3	5

Table 7: Abundance index values used within the assessment model.

Year	Chile (1)	Chile (2)	Chile (3)	Chile (4)	Peru(2)	Peru(3)	Offshore
1983			0.82110				
1984		99.0	0.75490				
1985		324.0	0.66160		94.320		
1986		123.0	0.55670		108.100		
1987		213.0	0.65400		109.800		
1988		134.0	0.57480		114.200		
1989			0.56030		157.400		
1990			0.48110		229.800		
1991		242.0	0.53100		231.700		
1992			0.48710		180.400		
1993			0.43690		145.700		
1994			0.47040		95.250		
1995			0.42000		54.260		
1996			0.41350		29.970		
1997	3,530		0.33960		31.660		
1998	3,200		0.28970		43.990		
1999	4,100		0.29510	5,724	52.680		
2000	5,600		0.28490	4,688	105.800		
2001	5,950		0.33970	5,627	131.600		
2002	3,700		0.29750		96.660	4.035	
2003	2,640		0.25980	1,388	67.470	4.790	
2004	2,640		0.28140	3,287	51.850	5.144	
2005	4,110		0.25620	1,043	75.170	4.057	
2006	3,192	112.0	0.27770	3,283	111.300	5.400	
2007	3,140	275.0	0.20800	626	79.750	7.320	
2008	487	259.0	0.13670	1,935	24.250	3.773	1,304.0
2009	328	18.0	0.11320			1.319	1,090.0
2010		440.0	0.08741		7.247	2.444	674.4
2011		432.0	0.04841		35.280	6.361	558.4
2012		230.0	0.14620		50.330	5.500	439.6
2013		144.0	0.12830		64.500	2.418	519.6
2014		87.0	0.10210			3.230	487.1
2015		459.0	0.08431			2.604	690.6
2016		587.2	0.15120			2.221	496.4
2017		610.5	0.18000			2.809	598.7
2018		374.1	0.11350			8.269	522.8
2019		1,487.0	0.19680			14.170	605.3
2020		1,728.0	0.25620			14.490	651.9
2021		1,870.0	0.27030			17.700	921.8
2022			0.27510			22.260	1,340.0
2023		2,502.0	0.26260			21.750	1,169.0
2024		2,788.0	0.24960			21.630	428.1
2025		3,059.0	0.27150			11.560	

Legend:

- Chile (1): Acoustic survey for south-central zone in Chile
- Chile (2): Acoustic survey for northern zone in Chile
- Chile (3): Chilean south-central fishery CPUE for Fleet 1
- Chile (4): Daily Egg Production Method
- Peru(1): Peruvian acoustic survey in Fleet 3
- Peru(2): Peruvian fishery CPUE in Fleet 3
- Offshore: Combined CPUE for China, EU, South Korea, Russia, and Vanuatu in Fleet 4

Table 8: Input catch at age for acoustic surveys in southern Chile. Units are relative value (they are normalized to sum to 100 for each year in the model).

	Age group (years)											
Year	1	2	3	4	5	6	7	8	9	10	11	12
2001	1	56	10	17	6	4	2	1	1	1	0	0
2002	2	45	27	13	5	5	2	1	0	0	0	0
2003	1	29	32	22	7	4	2	1	1	1	0	0
2004	1	13	19	25	17	10	9	4	1	0	0	0
2005	1	12	20	41	16	5	2	1	1	0	0	0
2006	0	0	13	34	32	8	6	4	2	1	0	0
2007	0	0	2	14	19	21	18	13	8	2	2	1
2008	0	0	0	12	33	25	13	9	4	2	1	2
2009	0	0	0	0	1	30	24	16	17	6	3	3

Table 9: Input catch at age for acoustic surveys in northern Chile. Units are relative value (they are normalized to sum to 100 for each year in the model).

	Age group (years)											
Year	1	2	3	4	5	6	7	8	9	10	11	12
2006	30	69	1	0	0	0	0	0	0	0	0	0
2007	8	60	23	8	2	0	0	0	0	0	0	0
2009	68	31	1	0	0	0	0	0	0	0	0	0
2013	45	13	21	15	5	1	0	0	0	0	0	0
2014	95	2	0	1	1	0	0	0	0	0	0	0
2015	72	21	4	2	1	0	0	0	0	0	0	0
2016	73	19	4	2	1	0	0	0	0	0	0	0
2017	76	16	6	1	0	0	0	0	0	0	0	0
2018	93	5	1	0	0	0	0	0	0	0	0	0
2019	16	59	20	4	1	1	0	0	0	0	0	0
2020	23	8	25	31	11	2	0	0	0	0	0	0
2021	63	0	13	14	5	3	2	0	0	0	0	0
2023	5	18	23	22	14	11	6	1	0	0	0	0
2024	66	2	5	9	8	5	4	1	0	0	0	0
2025	62	0	8	12	11	4	2	1	0	0	0	0

Table 10: Input catch at age for DEPM surveys in southern Chile. Units are relative value (they are normalized to sum to 100 for each year in the model).

	Age group (years)											
Year	1	2	3	4	5	6	7	8	9	10	11	12
2001	0	15	36	37	6	3	2	2	1	0	0	0
2003	0	2	15	24	10	16	11	12	6	2	1	0
2004	0	2	15	35	19	9	5	7	5	2	1	0
2005	0	0	0	1	38	24	16	11	5	3	2	0
2006	0	0	0	4	20	31	24	14	5	2	1	0
2008	0	0	0	4	12	22	27	20	9	5	0	0

Table 11: Jack mackerel sexual maturity by age used in the JJM models.

Stock	1	2	3	4	5	6	7	8	9	10	11	12
Single / Southern	0.52	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Far North	0.00	0.37	0.98	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Table 12: Jack mackerel growth (von Bertalanffy) and natural mortality parameters used in JJM models.

Parameter	Single / South Stock	Far North Stock
$M(year^{-1})$	0.28	0.33
$L_\infty(cm; ForkLength)$	73.56	73.56
k	0.16	0.16
$L_0(cm)$	13.56	13.56

95. L_0 is the mean length at the recruitment age (1 yrs).

Table 13: Ageing error matrix of jack mackerel. Columns represent the observed ages, while the rows represent the true age. These data are not used in the stock assessment.

Age	1	2	3	4	5	6	7	8	9	10	11	12
1	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	0.000	0.762	0.222	0.016	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3	0.000	0.244	0.512	0.225	0.018	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4	0.000	0.022	0.229	0.499	0.229	0.021	0.000	0.000	0.000	0.000	0.000	0.000
5	0.000	0.001	0.024	0.232	0.487	0.232	0.024	0.001	0.000	0.000	0.000	0.000
6	0.000	0.000	0.001	0.027	0.234	0.475	0.234	0.027	0.001	0.000	0.000	0.000
7	0.000	0.000	0.000	0.001	0.031	0.236	0.464	0.236	0.031	0.001	0.000	0.000
8	0.000	0.000	0.000	0.000	0.001	0.034	0.238	0.454	0.238	0.034	0.001	0.000
9	0.000	0.000	0.000	0.000	0.000	0.002	0.037	0.239	0.444	0.239	0.037	0.002
10	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.041	0.240	0.434	0.240	0.043
11	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.044	0.241	0.424	0.288
12	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.047	0.242	0.708

Table 14: Input mean body mass (kg) at age over time assumed for Fleet 1.

	Age group (years)											
Year	1	2	3	4	5	6	7	8	9	10	11	12
1970	0.108	0.155	0.247	0.314	0.388	0.510	0.653	0.780	0.949	1.153	1.349	1.575
1971	0.108	0.155	0.247	0.314	0.388	0.510	0.653	0.780	0.949	1.153	1.349	1.575
1972	0.108	0.155	0.247	0.314	0.388	0.510	0.653	0.780	0.949	1.153	1.349	1.575
1973	0.108	0.155	0.247	0.314	0.388	0.510	0.653	0.780	0.949	1.153	1.349	1.575
1974	0.108	0.155	0.247	0.314	0.388	0.510	0.653	0.780	0.949	1.153	1.349	1.575
1975	0.108	0.155	0.247	0.314	0.388	0.510	0.653	0.780	0.949	1.153	1.349	1.575
1976	0.108	0.155	0.247	0.314	0.388	0.510	0.653	0.780	0.949	1.153	1.349	1.575
1977	0.108	0.155	0.247	0.314	0.388	0.510	0.653	0.780	0.949	1.153	1.349	1.575
1978	0.108	0.155	0.247	0.314	0.388	0.510	0.653	0.780	0.949	1.153	1.349	1.575
1979	0.108	0.155	0.247	0.314	0.388	0.510	0.653	0.780	0.949	1.153	1.349	1.575
1980	0.181	0.209	0.263	0.338	0.434	0.462	0.499	1.062	0.984	1.144	1.350	1.551
1981	0.205	0.235	0.287	0.353	0.424	0.500	0.601	0.735	0.984	1.144	1.350	1.551
1982	0.164	0.192	0.236	0.301	0.354	0.422	0.460	0.490	0.739	1.144	1.350	1.551
1983	0.122	0.191	0.245	0.309	0.376	0.429	0.485	0.486	0.529	1.144	1.350	1.551
1984	0.157	0.174	0.241	0.323	0.387	0.443	0.510	0.559	0.984	1.144	1.350	1.551
1985	0.209	0.206	0.275	0.344	0.406	0.482	0.553	0.595	0.984	1.144	1.350	1.551
1986	0.083	0.166	0.279	0.358	0.432	0.523	0.559	0.716	0.984	1.144	1.350	1.551
1987	0.159	0.163	0.237	0.335	0.432	0.491	0.542	0.545	0.984	1.144	1.350	1.551
1988	0.178	0.214	0.251	0.296	0.382	0.581	0.690	0.852	0.984	1.144	1.350	1.551
1989	0.137	0.194	0.252	0.297	0.354	0.496	0.579	0.547	0.701	1.144	1.350	1.551
1990	0.116	0.238	0.293	0.338	0.386	0.490	0.688	0.677	0.950	1.144	1.350	1.551
1991	0.144	0.165	0.283	0.344	0.388	0.440	0.739	0.855	0.775	1.144	1.350	1.551
1992	0.116	0.159	0.259	0.285	0.342	0.394	0.471	0.673	0.984	1.144	1.350	1.551
1993	0.133	0.130	0.258	0.334	0.379	0.432	0.520	0.638	0.815	0.935	0.960	1.551
1994	0.105	0.132	0.282	0.322	0.379	0.436	0.508	0.584	0.984	1.144	1.350	1.551
1995	0.072	0.147	0.270	0.340	0.394	0.394	0.632	0.852	0.984	1.144	1.350	1.551
1996	0.117	0.151	0.203	0.230	0.284	0.388	1.320	0.852	0.984	1.144	1.350	1.551
1997	0.162	0.150	0.225	0.291	0.425	0.556	0.704	0.852	0.984	1.144	1.350	1.551
1998	0.183	0.124	0.246	0.285	0.339	0.411	0.704	0.852	0.984	1.144	1.350	1.551
1999	0.111	0.095	0.266	0.306	0.370	0.612	0.704	0.852	0.984	1.144	1.350	1.551
2000	0.061	0.173	0.232	0.256	0.456	0.556	0.704	0.852	0.984	1.144	1.350	1.551
2001	0.117	0.116	0.208	0.289	0.400	0.556	0.704	0.852	0.984	1.144	1.350	1.551
2002	0.097	0.133	0.240	0.324	0.389	0.483	0.704	0.852	0.984	1.144	1.350	1.551
2003	0.095	0.112	0.234	0.314	0.422	0.478	0.510	0.852	0.984	1.144	1.350	1.551
2004	0.140	0.182	0.199	0.246	0.360	0.556	0.704	0.852	0.984	1.144	1.350	1.551
2005	0.084	0.134	0.223	0.265	0.294	0.660	0.739	0.852	0.984	1.144	1.350	1.551
2006	0.077	0.127	0.202	0.386	0.457	0.529	0.636	0.852	0.984	1.144	1.350	1.551
2007	0.116	0.140	0.217	0.296	0.401	0.539	0.658	0.852	0.984	1.144	1.350	1.551
2008	0.053	0.100	0.246	0.290	0.389	0.592	0.629	0.761	0.984	1.144	1.350	1.551
2009	0.088	0.126	0.246	0.286	0.334	0.534	0.704	0.852	0.984	1.144	1.350	1.551
2010	0.056	0.102	0.231	0.287	0.401	0.602	0.701	0.852	0.984	1.144	1.350	1.551
2011	0.064	0.109	0.275	0.325	0.382	0.556	0.704	0.852	0.984	1.144	1.350	1.551
2012	0.047	0.179	0.252	0.349	0.361	0.556	0.704	0.852	0.984	1.144	1.350	1.551
2013	0.064	0.064	0.284	0.390	0.441	0.657	0.520	0.852	0.984	1.144	1.350	1.551
2014	0.052	0.105	0.218	0.283	0.430	0.553	0.704	0.852	0.984	1.144	1.350	1.551
2015	0.037	0.185	0.279	0.369	0.437	0.608	0.779	0.852	0.984	1.144	1.350	1.551
2016	0.164	0.175	0.233	0.294	0.366	0.499	0.718	0.860	0.658	1.144	1.350	1.551
2017	0.049	0.158	0.192	0.259	0.332	0.451	0.600	0.528	0.984	1.144	1.350	1.551
2018	0.034	0.129	0.248	0.277	0.279	0.556	0.704	0.852	0.984	1.144	1.350	1.551
2019	0.025	0.179	0.284	0.471	0.501	0.528	0.732	0.853	0.888	1.280	1.695	1.806
2020	0.068	0.211	0.242	0.303	0.397	0.474	0.770	1.066	1.351	1.568	1.350	2.294
2021	0.042	0.147	0.457	0.452	0.536	0.655	0.745	0.923	1.002	1.098	1.193	1.804
2022	0.027	0.244	0.404	0.520	0.606	0.684	0.792	0.816	1.065	1.120	1.193	2.659
2023	0.010	0.212	0.318	0.506	0.590	0.674	0.805	0.830	0.864	1.229	1.224	1.489
2024	0.135	0.243	0.306	0.375	0.507	0.686	0.842	0.972	1.055	1.252	1.314	1.489
2025	0.098	0.328	0.402	0.403	0.511	0.595	0.863	0.900	0.999	1.094	1.431	1.592

Table 15: Input mean body mass (kg) at age over time assumed for Fleet 2.

	Age group (years)										
Year	1	2	3	4	5	6	7	8	9	10	11	12
1970	0.157	0.202	0.271	0.346	0.444	0.570	0.709	0.867	1.076	1.313	1.579	1.826
1971	0.157	0.202	0.271	0.346	0.444	0.570	0.709	0.867	1.076	1.313	1.579	1.826
1972	0.157	0.202	0.271	0.346	0.444	0.570	0.709	0.867	1.076	1.313	1.579	1.826
1973	0.157	0.202	0.271	0.346	0.444	0.570	0.709	0.867	1.076	1.313	1.579	1.826
1974	0.157	0.202	0.271	0.346	0.444	0.570	0.709	0.867	1.076	1.313	1.579	1.826
1975	0.157	0.202	0.271	0.346	0.444	0.570	0.709	0.867	1.076	1.313	1.579	1.826
1976	0.157	0.202	0.271	0.346	0.444	0.570	0.709	0.867	1.076	1.313	1.579	1.826
1977	0.157	0.202	0.271	0.346	0.444	0.570	0.709	0.867	1.076	1.313	1.579	1.826
1978	0.157	0.202	0.271	0.346	0.444	0.570	0.709	0.867	1.076	1.313	1.579	1.826
1979	0.157	0.202	0.271	0.346	0.444	0.570	0.709	0.867	1.076	1.313	1.579	1.826
1980	0.203	0.201	0.237	0.275	0.328	0.375	0.504	0.861	0.995	1.159	1.397	1.534
1981	0.164	0.187	0.238	0.268	0.308	0.368	0.464	0.796	0.995	1.159	1.397	1.534
1982	0.183	0.201	0.233	0.261	0.295	0.344	0.402	0.447	0.995	1.159	1.397	1.534
1983	0.120	0.166	0.249	0.284	0.330	0.418	0.497	0.606	0.995	1.159	1.397	1.534
1984	0.151	0.148	0.243	0.289	0.342	0.421	0.499	0.567	0.995	1.159	1.397	1.534
1985	0.192	0.204	0.233	0.299	0.366	0.452	0.537	0.627	0.695	1.159	1.397	1.534
1986	0.136	0.212	0.273	0.313	0.408	0.475	0.550	0.687	1.000	1.159	1.397	1.534
1987	0.126	0.137	0.218	0.335	0.407	0.455	0.492	0.564	0.824	1.159	1.397	1.534
1988	0.182	0.197	0.221	0.340	0.444	0.490	0.539	0.801	1.108	1.159	1.397	1.534
1989	0.211	0.224	0.257	0.310	0.436	0.536	0.579	0.625	0.948	1.159	1.397	1.534
1990	0.110	0.271	0.318	0.380	0.457	0.572	0.675	0.752	0.797	1.485	1.397	1.534
1991	0.170	0.136	0.295	0.418	0.469	0.538	0.657	0.761	0.829	0.921	0.966	1.211
1992	0.147	0.186	0.230	0.296	0.470	0.545	0.605	0.712	0.844	0.968	1.334	1.534
1993	0.162	0.177	0.246	0.320	0.389	0.533	0.684	0.820	0.925	1.117	1.827	1.534
1994	0.195	0.226	0.287	0.347	0.454	0.614	0.783	0.884	1.014	1.178	1.581	1.534
1995	0.174	0.190	0.266	0.339	0.425	0.563	0.797	1.012	1.187	1.425	1.797	1.534
1996	0.189	0.193	0.281	0.362	0.512	0.704	0.954	1.182	1.356	1.445	2.008	1.534
1997	0.174	0.196	0.266	0.360	0.518	0.699	0.887	1.084	1.287	1.529	1.786	1.779
1998	0.151	0.165	0.251	0.343	0.539	0.794	1.025	1.218	1.404	1.584	1.933	2.526
1999	0.161	0.167	0.259	0.338	0.494	0.789	1.039	1.235	1.397	1.654	1.841	1.952
2000	0.188	0.199	0.262	0.357	0.486	0.801	1.058	1.159	1.310	1.454	1.656	2.052
2001	0.183	0.202	0.266	0.336	0.455	0.614	0.868	1.119	1.395	1.568	1.813	1.929
2002	0.182	0.201	0.265	0.330	0.449	0.638	0.860	1.093	1.312	1.499	1.665	2.073
2003	0.174	0.192	0.249	0.305	0.403	0.588	0.786	1.026	1.261	1.504	1.734	1.861
2004	0.195	0.204	0.259	0.311	0.396	0.520	0.685	0.857	1.065	1.395	1.517	1.772
2005	0.083	0.234	0.280	0.318	0.396	0.506	0.642	0.751	0.920	1.160	1.324	1.606
2006	0.114	0.186	0.289	0.349	0.413	0.512	0.618	0.760	0.938	1.041	1.312	1.725
2007	0.124	0.187	0.230	0.333	0.431	0.513	0.625	0.777	0.909	1.056	1.228	1.542
2008	0.033	0.215	0.287	0.336	0.421	0.525	0.620	0.726	0.880	1.016	1.160	1.479
2009	0.138	0.139	0.273	0.346	0.418	0.539	0.624	0.759	0.892	1.007	1.138	1.398
2010	0.095	0.182	0.236	0.321	0.414	0.539	0.651	0.796	1.056	1.374	1.560	1.778
2011	0.198	0.202	0.296	0.360	0.478	0.640	0.806	1.025	1.261	1.450	1.874	1.981
2012	0.201	0.213	0.297	0.349	0.491	0.650	0.827	1.062	0.968	1.835	2.222	2.796
2013	0.218	0.245	0.312	0.381	0.448	0.580	0.714	0.926	1.292	1.751	2.082	2.512
2014	0.192	0.265	0.418	0.544	0.643	0.785	0.913	1.002	1.345	1.592	2.407	2.971
2015	0.214	0.214	0.282	0.480	0.610	0.746	0.884	0.990	1.049	1.239	1.130	1.483
2016	0.236	0.258	0.316	0.377	0.483	0.584	0.791	0.872	1.132	1.284	1.544	2.045
2017	0.182	0.226	0.295	0.368	0.444	0.549	0.676	0.922	1.096	1.391	1.741	1.583
2018	0.105	0.241	0.304	0.376	0.493	0.594	0.771	0.922	1.342	1.627	1.792	2.549
2019	0.019	0.268	0.305	0.393	0.482	0.578	0.683	0.759	0.888	1.339	1.978	2.906
2020	0.062	0.230	0.302	0.424	0.560	0.686	0.813	1.014	1.204	1.366	1.408	2.801
2021	0.231	0.272	0.318	0.405	0.562	0.695	0.809	0.956	1.115	1.404	1.484	1.693
2022	0.025	0.355	0.437	0.560	0.690	0.806	0.925	1.057	1.231	1.128	1.415	1.620
2023	0.196	0.275	0.404	0.511	0.613	0.736	0.935	1.057	1.244	1.368	1.540	2.128
2024	0.196	0.325	0.349	0.416	0.505	0.608	0.800	0.941	1.182	1.311	1.483	1.895
2025	0.142	0.184	0.405	0.433	0.488	0.545	0.660	0.846	1.112	1.301	1.709	1.756

Table 16: Input mean body mass (kg) at age over time assumed for Fleet 3.

	Age group (years)											
Year	1	2	3	4	5	6	7	8	9	10	11	12
1970	0.045	0.171	0.377	0.642	0.945	1.265	1.587	1.900	2.196	2.470	2.721	2.946
1971	0.045	0.171	0.377	0.643	0.946	1.266	1.588	1.902	2.198	2.472	2.723	2.949
1972	0.030	0.130	0.306	0.548	0.835	1.148	1.470	1.789	2.095	2.382	2.647	2.887
1973	0.037	0.147	0.330	0.568	0.842	1.134	1.430	1.718	1.991	2.246	2.478	2.688
1974	0.038	0.147	0.326	0.558	0.825	1.108	1.393	1.671	1.934	2.178	2.402	2.603
1975	0.034	0.136	0.310	0.540	0.808	1.095	1.387	1.674	1.946	2.201	2.434	2.645
1976	0.044	0.160	0.340	0.567	0.822	1.087	1.351	1.606	1.845	2.065	2.266	2.446
1977	0.032	0.130	0.294	0.510	0.760	1.028	1.300	1.566	1.818	2.054	2.270	2.465
1978	0.032	0.129	0.295	0.516	0.774	1.050	1.332	1.608	1.872	2.117	2.343	2.547
1979	0.036	0.138	0.304	0.518	0.762	1.020	1.280	1.532	1.770	1.991	2.193	2.375
1980	0.036	0.136	0.298	0.506	0.743	0.994	1.245	1.490	1.721	1.934	2.130	2.306
1981	0.041	0.148	0.314	0.524	0.758	1.003	1.247	1.481	1.702	1.905	2.089	2.255
1982	0.039	0.144	0.309	0.519	0.755	1.002	1.249	1.488	1.712	1.920	2.108	2.278
1983	0.042	0.138	0.280	0.451	0.638	0.828	1.014	1.191	1.356	1.507	1.643	1.764
1984	0.044	0.156	0.328	0.541	0.778	1.024	1.267	1.501	1.719	1.921	2.103	2.267
1985	0.040	0.149	0.322	0.541	0.789	1.048	1.308	1.558	1.794	2.012	2.211	2.389
1986	0.042	0.151	0.323	0.539	0.781	1.033	1.285	1.527	1.755	1.965	2.156	2.327
1987	0.034	0.132	0.294	0.504	0.745	1.001	1.260	1.512	1.751	1.973	2.176	2.359
1988	0.038	0.145	0.315	0.533	0.780	1.041	1.302	1.554	1.793	2.013	2.215	2.396
1989	0.044	0.158	0.337	0.561	0.812	1.074	1.334	1.585	1.821	2.038	2.236	2.413
1990	0.042	0.150	0.320	0.532	0.769	1.017	1.263	1.499	1.722	1.927	2.113	2.280
1991	0.039	0.142	0.305	0.511	0.743	0.985	1.227	1.461	1.680	1.883	2.068	2.234
1992	0.040	0.148	0.318	0.534	0.776	1.031	1.286	1.531	1.763	1.976	2.171	2.346
1993	0.039	0.147	0.323	0.549	0.807	1.080	1.354	1.620	1.871	2.104	2.317	2.508
1994	0.036	0.147	0.335	0.584	0.874	1.186	1.503	1.813	2.109	2.385	2.638	2.867
1995	0.038	0.146	0.318	0.540	0.792	1.058	1.325	1.583	1.827	2.053	2.260	2.446
1996	0.038	0.145	0.317	0.537	0.788	1.053	1.318	1.576	1.820	2.045	2.251	2.436
1997	0.045	0.152	0.312	0.506	0.720	0.940	1.155	1.361	1.553	1.729	1.889	2.031
1998	0.040	0.140	0.294	0.483	0.693	0.911	1.126	1.333	1.526	1.703	1.864	2.008
1999	0.037	0.146	0.324	0.557	0.824	1.107	1.394	1.673	1.938	2.183	2.408	2.611
2000	0.035	0.145	0.336	0.592	0.893	1.218	1.550	1.877	2.189	2.481	2.750	2.994
2001	0.033	0.139	0.324	0.572	0.864	1.180	1.504	1.822	2.127	2.412	2.674	2.912
2002	0.036	0.145	0.330	0.576	0.861	1.167	1.478	1.783	2.074	2.344	2.593	2.817
2003	0.040	0.154	0.341	0.584	0.862	1.157	1.454	1.743	2.017	2.272	2.504	2.714
2004	0.038	0.149	0.333	0.574	0.852	1.148	1.447	1.740	2.017	2.275	2.511	2.724
2005	0.037	0.150	0.341	0.595	0.890	1.206	1.527	1.842	2.142	2.422	2.678	2.911
2006	0.038	0.152	0.347	0.606	0.907	1.230	1.558	1.880	2.187	2.473	2.735	2.973
2007	0.038	0.149	0.335	0.579	0.861	1.161	1.465	1.762	2.044	2.306	2.546	2.763
2008	0.036	0.146	0.334	0.585	0.876	1.190	1.510	1.823	2.122	2.400	2.656	2.888
2009	0.038	0.150	0.337	0.582	0.865	1.167	1.474	1.773	2.057	2.321	2.563	2.782
2010	0.039	0.150	0.332	0.567	0.837	1.123	1.411	1.691	1.956	2.203	2.428	2.631
2011	0.031	0.143	0.351	0.644	1.000	1.395	1.806	2.217	2.614	2.990	3.337	3.655
2012	0.032	0.145	0.349	0.632	0.971	1.344	1.731	2.115	2.485	2.834	3.156	3.449
2013	0.030	0.136	0.329	0.600	0.928	1.291	1.671	2.052	1.922	2.165	2.387	2.588
2014	0.029	0.137	0.339	0.625	0.976	1.368	1.781	2.196	1.922	2.165	2.387	2.588
2015	0.033	0.140	0.328	0.584	0.889	1.223	1.568	1.910	1.922	2.165	2.387	2.588
2016	0.037	0.143	0.320	0.553	0.821	1.109	1.402	1.689	1.922	2.165	2.387	2.588
2017	0.029	0.132	0.318	0.578	0.892	1.240	1.602	1.966	1.922	2.165	2.387	2.588
2018	0.031	0.136	0.326	0.591	0.910	1.262	1.628	1.995	1.922	2.165	2.387	2.588
2019	0.030	0.134	0.322	0.586	0.904	1.256	1.623	1.991	1.922	2.165	2.387	2.588
2020	0.029	0.131	0.319	0.584	0.905	1.262	1.637	2.012	1.922	2.165	2.387	2.588
2021	0.031	0.134	0.315	0.564	0.861	1.186	1.523	1.858	1.922	2.165	2.387	2.588
2022	0.032	0.135	0.315	0.559	0.847	1.162	1.486	1.808	1.922	2.165	2.387	2.588
2023	0.034	0.137	0.311	0.540	0.808	1.096	1.390	1.680	1.922	2.165	2.387	2.588
2024	0.038	0.145	0.323	0.553	0.820	1.104	1.392	1.674	1.922	2.165	2.387	2.588
2025	0.037	0.147	0.330	0.573	0.854	1.156	1.465	1.768	1.922	2.165	2.387	2.588

Table 17: Input mean body mass (kg) at age over time assumed for Fleet 4.

Age group (years)										
1	2	3	4	5	6	7	8	9	10	11
0.157	0.223	0.329	0.429	0.613	0.741	0.835	0.935	1.049	1.145	1.308
0.157	0.223	0.329	0.429	0.613	0.741	0.835	0.935	1.049	1.145	1.308
0.157	0.223	0.329	0.429	0.613	0.741	0.835	0.935	1.049	1.145	1.308
0.157	0.223	0.329	0.429	0.613	0.741	0.835	0.935	1.049	1.145	1.308
0.157	0.223	0.329	0.429	0.613	0.741	0.835	0.935	1.049	1.145	1.308
0.157	0.223	0.329	0.429	0.613	0.741	0.835	0.935	1.049	1.145	1.308
0.157	0.223	0.329	0.429	0.613	0.741	0.835	0.935	1.049	1.145	1.308
0.157	0.223	0.329	0.429	0.613	0.741	0.835	0.935	1.049	1.145	1.308
0.157	0.223	0.329	0.429	0.613	0.741	0.835	0.935	1.049	1.145	1.308
0.157	0.223	0.329	0.429	0.613	0.741	0.835	0.935	1.049	1.145	1.308
0.157	0.223	0.329	0.429	0.613	0.741	0.835	0.935	1.049	1.145	1.308
0.157	0.223	0.329	0.429	0.613	0.741	0.835	0.935	1.049	1.145	1.308
0.157	0.223	0.329	0.429	0.613	0.741	0.835	0.935	1.049	1.145	1.308
0.157	0.223	0.329	0.429	0.613	0.741	0.835	0.935	1.049	1.145	1.308
0.157	0.223	0.329	0.429	0.613	0.741	0.835	0.935	1.049	1.145	1.308
0.157	0.223	0.329	0.429	0.613	0.741	0.835	0.935	1.049	1.145	1.308
0.157	0.223	0.329	0.429	0.613	0.741	0.835	0.935	1.049	1.145	1.308
0.157	0.223	0.329	0.429	0.613	0.741	0.835	0.935	1.049	1.145	1.308
0.157	0.223	0.329	0.429	0.613	0.741	0.835	0.935	1.049	1.145	1.308
0.157	0.223	0.329	0.429	0.613	0.741	0.835	0.935	1.049	1.145	1.308
0.157	0.223	0.329	0.429	0.613	0.741	0.835	0.935	1.049	1.145	1.308
0.157	0.223	0.329	0.429	0.613	0.741	0.835	0.935	1.049	1.145	1.308
0.157	0.223	0.329	0.429	0.613	0.741	0.835	0.935	1.049	1.145	1.308
0.157	0.223	0.329	0.429	0.613	0.741	0.835	0.935	1.049	1.145	1.308
0.157	0.223	0.329	0.429	0.613	0.741	0.835	0.935	1.049	1.145	1.308
0.157	0.223	0.329	0.429	0.613	0.741	0.835	0.935	1.049	1.145	1.308
0.157	0.223	0.329	0.429	0.613	0.741	0.835	0.935	1.049	1.145	1.308
0.157	0.223	0.329	0.429	0.613	0.741	0.835	0.935	1.049	1.145	1.308
0.157	0.223	0.329	0.429	0.613	0.741	0.835	0.935	1.049	1.145	1.308
0.157	0.223	0.329	0.429	0.613	0.741	0.835	0.935	1.049	1.145	1.308
0.157	0.223	0.329	0.429	0.613	0.741	0.835	0.935	1.049	1.145	1.308
0.157	0.223	0.329	0.429	0.613	0.741	0.835	0.935	1.049	1.145	1.308
0.157	0.223	0.329	0.429	0.613	0.741	0.835	0.935	1.049	1.145	1.308
0.157	0.223	0.329	0.429	0.613	0.741	0.835	0.935	1.049	1.145	1.308
0.157	0.223	0.329	0.429	0.613	0.741	0.835	0.935	1.049	1.145	1.308
0.157	0.223	0.329	0.429	0.613	0.741	0.835	0.935	1.049	1.145	1.308
0.157	0.223	0.329	0.429	0.613	0.741	0.835	0.935	1.049	1.145	1.308
0.157	0.223	0.329	0.429	0.613	0.741	0.835	0.935	1.049	1.145	1.308
0.157	0.223	0.329	0.429	0.613	0.741	0.835	0.935	1.049	1.145	1.308
0.157	0.223	0.329	0.429	0.613	0.741	0.835	0.935	1.049	1.145	1.308
0.157	0.223	0.329	0.429	0.613	0.741	0.835	0.935	1.049	1.145	1.308
0.157	0.223	0.329	0.429	0.613	0.741	0.835	0.935	1.049	1.145	1.308
0.157	0.223	0.329	0.429	0.613	0.741	0.835	0.935	1.049	1.145	1.308
0.157	0.223	0.329	0.429	0.613	0.741	0.835	0.935	1.049	1.145	1.308
0.157	0.223	0.329	0.429	0.613	0.741	0.835	0.935	1.049	1.145	1.308
0.228	0.248	0.295	0.434	0.655	0.818	0.933	1.098	1.214	1.326	1.270
0.311	0.383	0.399	0.428	0.481	0.610	0.837	0.883	0.985	1.094	1.535
0.059	0.192	0.470	0.549	0.659	0.703	0.739	0.922	0.962	1.094	1.359
0.066	0.146	0.305	0.388	0.507	0.606	0.649	0.634	0.778	0.868	1.051
0.127	0.136	0.244	0.510	0.790	0.927	1.040	1.042	1.128	1.263	1.249
0.152	0.234	0.259	0.265	0.588	0.778	0.811	1.029	1.228	1.226	1.382
0.103	0.204	0.251	0.277	0.279	0.343	0.544	0.670	0.617	0.966	1.032
0.154	0.141	0.218	0.251	0.278	0.544	0.785	0.933	1.090	1.252	1.362
0.151	0.187	0.211	0.224	0.310	0.397	0.513	0.653	0.758	0.821	0.912
0.209	0.228	0.272	0.310	0.349	0.405	0.470	0.482	0.561	0.977	1.297
0.059	0.131	0.263	0.379	0.420	0.460	0.473	0.492	0.851	1.049	1.197

Table 18: Years and types of information used in the JJM assessment models.

Fleet	Catch-at-age	Catch-at-length	Landings	CPUE	Acoustic	DEPM
1) North Chile purse seine	1980-2025	-	1970-2025	-	Index: 1984-1988; 1991; 2006-2021, 2023-2025; Age comps: 2006-2007, 2009; 2013-2021, 2023-2025	-
2) South-central Chile purse seine	1980-2025	-	1970-2025	1983-2025	Index: 1997-2009; Age comps: 2001-2009	Index: 1999-2001; 2003-2008; Age comps: 2001; 2003-2006, 2008
3) FarNorth	-	1980-2025	1970-2025	2002-2025	1985-2008; 2010-2013	-
4) International trawl off Chile	2015-2025	2015-2025*	1970-2025	China, EU, Korea, Russia, & Vanuatu (2008-2024)	-	-

96. (*) Converted to age using age-length keys of central-southern area off Chile, the EU, and Russia.

Table 19: Symbols and definitions used for model equations.

General Definitions	Symbol/Value	Use in Catch at Age Model
Year index:	i = {1970, …, 2025}	
Fleets (f) and surveys (s)	f, s	Identification of information source
Age index	j = {1, 2, …, 12+}	
Length index	l = {10, 11, …, 50+}	
Mean length at age	L_j	
Variation coefficient of the length at age	CV	
Mean weight in year i by age j	$W_{i,j}$	
Maximum age beyond which selectivity is constant	Maxage	
Instantaneous Natural Mortality	M	Constant over all ages
Proportion females mature at age j	P_j	
Ageing error matrix	T	
Proportion of length at age j	Γ	
Sample size for proportion in year i	T_i	Scales multinomial assumption about estimates of proportion at age
Survey catchability coefficient	q^s	Prior distribution lognormal$\left(\mu_s^q\right), \sigma_q^2$
Stock-recruitment parameters	R_0	Unfished equilibrium recruitment
	h	Stock-recruitment steepness
	σ_R^2	Recruitment variance
Unfished biomass	ϕ	Spawning biomass per recruit when there is no fishing
Estimated parameters		$R_0, h, \epsilon(\#), \mu^f, \mu^s, M, \eta^s, \eta^f, q^s(\#)$

97. **Note**: The number of selectivity parameters estimated depends on the model configuration.

Table 20: Variables and equations describing implementation of the Joint Jack Mackerel assessment model (JJM).

Eq	Description	Symbol/Constraints	Key Equation(s)
1)	Survey abundance index (s) by year. The symbol Δ^s represents the fraction of the year when the survey occurs.	I_i^s	$I_i^s = q^s \sum_{j=1}^{12} N_{ij}\, W_{ij} S_j^s e^{-\Delta^S Z_{ij}}$
2)	Catch biomass by fleet (f=1,2,3,4), year(i) and age(j)/length(l)	$\hat{C}_{il}, \hat{C}_{ij}, \hat{Y}_i$	$\hat{C}_{f,j} = N_{ij} F_{fi,j} Z_{fi,j} (1 - e^{-Z_{fi,j}})$
			$\hat{Y}_i = \sum_{j=1}^{12+} \hat{C}_{f,i,j}\, w_{i,j}$
	(transformation from age to length composition. Fleet 3, FarNorth)		$\hat{C}_{il} = \Gamma \hat{C}_{ij}$
			$\Gamma_{l,j} = \int_j^{j+1} e^{-\frac{1}{2\sigma_j^2}(l - L_j)^2}\, dl$ $L_j = L_\infty (1 - e^{-k}) + e^{-k} L_{j-1}$ $\sigma_j = CV \cdot L_j$
3)	Proportion at age j, in year i for fishery f	p_{ij}^f	$p_{ij}^f = \frac{\hat{C}_{ij}^f}{\sum_j \hat{C}_{ij}^f}$
	Proportion at age j, in year i for survey s	p_{ij}^s	$p_{ij}^s = \frac{N_{ij} S_j^s e^{-\Delta^s Z_{ij}}}{\sum_j N_{ij}\, S_j^s e^{-\Delta^s Z_{ij}}}$
	Proportion at length l in year i	p_{il}	$p_{il} = \frac{C_{il}}{\sum_{l=50}^{l=10} C_{il}}$
4)	Initial numbers at age, $j = 1$	$N_{1970,j}$	$N_{1970,j} = e^{\mu R \tau_1}$
5)		$1 < j < 11$	$N_{1970,j} = e^{\mu R \tau_1} \prod_{j=1}^{10} e^{-M}$
6)	Subsequent years ($i > 1970$)	$j = 12+$	$N_{1970,12+} = N_{1970,11} e^{-M} (1 - e^{-M})^{-1}$
7)	$j = 1$		$N_{i,1} = e^{\mu R + \epsilon_i}$
8)	$1 < j < 11$		$N_{i,j} = N_{i-1,j-1} e^{-Z_{i-1,j-1}}$
9)	$j = 12+$		$N_{i,12+} = N_{i-1,11} e^{-Z_{i-1,11}} + N_{i-1,12} e^{-Z_{i-1,12}}$
10)	Year effect and individuals at age 1 and $j = 1958,\ldots,2016$	$\epsilon_i,\ i = 1958,\ldots,2016$	$\sum_{i=1958}^{2016} \epsilon_i = 0 \quad N_{i,1} = e^{\mu R + \epsilon_i}$
11)	Index catchability	μ^s, μ^f	$q_i^s = e^{\mu^s}, q_i^f = e^{\mu^f}$
	Mean effect		$S_j^s = e^{\eta_j^s}\ \ S_j^s = \eta_j^s = 0$ for $j \leq$ maxage $S_j^s = \eta_{maxage}^s$ for $j >$ maxage
	Age effect		$F_{ij}^f = e^{\mu^f + \eta_j^f + \phi_i}$
12)	Instantaneous fishing mortality	μ^f	
13)	Mean fishing effect	μ^f	
14)	Annual effect of fishing mortality in year i	$\phi_i, \sum_{i=1970}^{2016} \phi_i = 0$	ϕ_i
15)	Age effect of fishing (regularized) in year; time variation allowed	$\eta_f, \sum_{i=1958}^{2016} \eta_f = 0$	$S_{ij}^f = e^{\eta_f}$ for $j \leq$ maxage; $S_{ij}^f = e^{\eta_{\text{maxage}}}$ for $j >$ maxage
16)	Natural Mortality	M	fixed
17)	Total mortality	$Z_{ij} = \sum_f F_{ij}^f + M$	
18)	Spawning biomass (note spawning taken to occur at mid of November)	B_i	$B_i = \sum_{j=2}^{12} N_j\, e^{\frac{10.5}{12} z_j W_{ij} p_j}$
19)	Recruits (Beverton-Holt form) at age 1	$\hat{R}_i$	$\hat{R}_i = \frac{\alpha B_i}{\beta + B_i}\ \ \alpha = \frac{4hR_0}{5h-1}, \beta = \frac{B_0(1-h)}{5h-1}$ where $h = 0.8\ \ B_0 = R_0\phi,\ \phi = \sum_{j=1}^{12} e^{-M(j-1)}\, W_j p_j + \frac{e^{-12M} W_{12} P_{12}}{1-e^{-M}}$

Table 21: Specification of objective function that is minimised (i.e., the penalised negative of the log-likelihood).

Likelihood / Penalty Component	Description / Notes	Key Equation(s)	
21)	Abundance indices	$L_1 = 0.5\sum_{s}\frac{1}{cv_s^2}\sum_{i}\log\left(\frac{l_i}{\hat{l}_i}\right)^2$	Surveys / CPUE indexes
22)	Prior on smoothness for selectivities	$L_2 = \sum_{i=1}^{12}\lambda_2\sum_{j=1}^{12}\left(\eta_{j+2}+\eta_j - 2\eta_{j+1}\right)^2$	Smoothness (second differencing) Note: $i \neq f$ for survey and fishery selectivity
23)	Prior on recruitment regularity	$L_3 = \lambda_3\sum_{i=1958}^{2016} e^{e_i}$	Influences estimates where data are lacking (e.g., if no signal of recruitment strength is available, then the recruitment estimate will converge to median value). $\lambda_3 = 0.5\frac{\sigma_R^2}{\sigma_R}$
24)	Catch biomass likelihood	$L_4 = 0.5\sum_{f}\frac{1}{cv_f^2}\sum_{i=1970}^{2016}\log\left(\frac{y_i}{\hat{y}_f}\right)^2$	Fit to catch biomass in each year
25)	Proportion at age/length likelihood	$L_5 = -\sum_{v,i,j}P_{v,i,j}\log\left(\hat{P}_{v,i,j}\right)$	Proportions for survey and fishery age composition observations $P_{i,j}$ are the catch-at-age/length proportions
26)	Dome-shaped selectivity	$L_6 = \lambda_4\sum_{j=6}^{12}\left(\ln S_j - \ln S_{j-1}\right)^2$	Relaxed in final phases of estimation $S_{j-1} > S_j$
27)	Fishing mortality regularity	F values constrained between 0 and 5	Relaxed in final phases of estimation
28)	Recruitment curve fit	$L_7 = \lambda_5\sum_{j=1970}^{2013}\log\left(\frac{N_{1j}}{\hat{R}_i}\right)^2$	Conditioning on stock-recruitment curve over period 1970-2013 $\lambda_5 = 0.5\frac{\sigma_R^2}{\sigma_R}$
29)	Priors or assumptions	R_0 non-informative	$\sigma_R = 0.6$
30)	Overall objective function to be minimized	$\hat{L} = \sum_{k}L_k$	

Table 22: Coefficients of variation and sample sizes used in likelihood functions, with adjustments based on calculated Francis weights. Initial sample sizes are in parentheses.

Abundance Index	CV	Catch Biomass Likelihood	CV
Acoustic CS-Chile	0.20	N-Chile	0.05
Acoustic N-Chile	0.30	CS-Chile	0.05
CPUE – Chile	0.20	Farnorth	0.05
DEPM – Chile	0.50	Offshore	0.05
Acoustic –Peru	0.20		
CPUE – Peru	0.20		
CPUE – Offshore	0.20		
Smoothness for Selectivities (Indices)	**Λ**	**Proportion at Age Likelihood (Indices)**	**n**
Acoustic CS-Chile	100	Acoustic CS-Chile	6.8 (150)
Acoustic N-Chile	100	Acoustic N-Chile	12.4 (150)
CPUE – Chile	100	DEPM – Chile	1
CPUE – Offshore	100		
Smoothness for Selectivities (Fleets)	**λ**	**Proportion at Age (or Length) Likelihood**	n
N -Chile	1	N-Chile	23.9 (100)
CS-Chile	25	CS-Chile	64.3 (250)
Farnorth	12.5	Farnorth (length)	30
Offshore	12.5	Offshore	12.6 (150)
Recruitment Regularity	**λ**	**Stock – Recruitment Curve Fit**	**CV**
	1.4		0.6

Table 23: Description of JJM model components and how selectivity was treated under the single-stock hypothesis.

Item	Description	Selectivity assumption
Fisheries		
1)	Chilean northern area fishery	Estimated from age composition data. Annual variations were considered since 1984
2)	Chilean central and southern area fishery	Estimated from age composition data. Annual variations were considered since 1984.
3)	Peruvian and Ecuadorian area fishery	Estimated from length composition data (converted to age inside the model). Annual variations were considered since 1981.
4)	Offshore trawl fishery	Estimated from age composition data. Annual variations were considered since 1980. Additional flexibility in selectivity was allowed for 2021 to reflect a change in the fishing pattern.
Index series		
5)	Acoustic survey in central and southern Chile	Estimated from age composition data. Two time-blocks were considered 1970-2004; 2005-2009.
6)	Acoustic survey in northern Chile	Estimated from age composition data 2006-2016. Selectivity changes were implemented in 2012 and 2016
7)	Central and southern fishery CPUE	Assumed to be the same as 2)
8)	Egg production survey	Estimated from age composition data 2001, 2003-2006, 2008. Two time-blocks were considered around 2003.
9)	Acoustic survey in Peru	Assumed to be the same as 3)
10)	Peruvian fishery CPUE	Assumed to be the same as 3)
11)	Offshore fleet (Vanuatu, Russia, Korea, EU & China) CPUE	Assumed to be the same as 4)

Table 24: Description of JJM model components and how selectivity was treated (two-stock hypothesis; southern stock).

Item	Description	Selectivity assumption
Fisheries		
1)	Chilean northern area fishery	Estimated from age composition data. Annual variations were considered since 1984
2)	Chilean central and southern area fishery	Estimated from age composition data. Annual variations were considered since 1984.
3)	Offshore trawl fishery	Estimated from age composition data. Annual variations were considered since 1980. Additional flexibility in selectivity was allowed for 2021 to reflect a change in the fishing pattern.
Index series		
4)	Acoustic survey in central and southern Chile	Estimated from age composition data. Two time-blocks were considered 1970-2004; 2005-2009.
5)	Acoustic survey in northern Chile	Estimated from age composition data. Selectivity changes were implemented in 2012 and 2016.
6)	Central and southern fishery CPUE	Assumed to be the same as 2)
7)	Egg production survey	Estimated from age composition data. Two time-blocks were considered 1970-2002; 2003-2008.
8)	Offshore fleet (China, EU, Korea, Russia, Vanuatu) CPUE	Assumed to be the same as 3)

Table 25: Description of JJM model components and how selectivity was treated (two-stock hypothesis; far north stock).

Item	Description	Selectivity assumption
Fisheries		
1)	Peruvian and Ecuadorian area fishery	Selectivity in the model under the two-stock hypothesis was estimated from length composition data (converted to age inside the model). Two regimes were considered – before and after 2002. This is a different assumption from the single-stock hypothesis, which has annual variations in selectivity between 1981 and 2025.
Index series		
2)	Acoustic survey in Peru	Assumed to be the same as in fishery 1)
3)	Peruvian fishery CPUE	Assumed to be the same as in fishery 1)

Table 26: Systematic model progression from the 2024 assessment data to the agreed revised datasets for 2025. Note that the data file names corresponding to each model follow the same naming convention, but with the stock-structure hypothesis denoted as h1 for the single-stock and h2 for the two-stock (e.g., 0.01.dat with h1_0.01.ctl and h2_0.01.ctl).

Model	Description
Models 0.x	Data introductions
0.00	Exact 2024 (single stock h1 and two-stock h2) model and data set (model 1.07) from SC12.
0.01	As 0.00 but with revised catches through 2024 (currently still estimates)
0.02	As 0.01 but with updated 2024 fishery age composition data for N_Chile, SC_Chile, and Offshore_Trawl, and updated 2024 fishery length composition data for FarNorth
0.03	As 0.02 but with updated 2024 weight at age data for all fisheries and their associated CPUE indices
0.04	As 0.03 but replaced offshore CPUE up to 2024
0.05	As 0.04 but with 2025 catch projections
0.06	As 0.05 but with updated 2025 fishery age composition data for N_Chile, SC_Chile, and Offshore_Trawl, and updated 2025 fishery length composition data for FarNorth
0.07	As 0.06 but with updated 2025 weight at age data for N_Chile, SC_Chile, and FarNorth fleets, and for their associated CPUE indices
0.08	As 0.07 but replaced SC_Chile_CPUE index (traditional absolute scaled CPUE by trip)
0.09	As 0.08 but replaced Peru_CPUE index
0.10	As 0.09 but updated 2025 AcousN index, with associated age composition and weight at age
Models 1.x	Updated Model and Sensitivities
1.00	As 0.10 but with updated model (selectivity changes, recruitment) to 2025; 0.10 data file
Leave one in analysis	
1.01	As 1.00 but with downweighted Chile AcousN, Offshore CPUE, and Peru CPUE
1.02	As 1.00 but with downweighted Chile AcousN, Chile CPUE, and Peru CPUE
1.03	As 1.00 but with downweighted Chile CPUE, Offshore CPUE, and Chile AcousN
1.04	As 1.00 but with downweighted Chile CPUE, Offshore CPUE, and Peru CPUE
1.05	As 1.00 but with downweighted Chile CPUE, Offshore CPUE, Peru CPUE, and pre-2000 AcousN
Leave one out analysis	
1.06	As 1.00 but with downweighted Chile CPUE
1.07	As 1.00 but with downweighted Offshore CPUE
1.08	As 1.00 but with downweighted Peru CPUE
1.09	As 1.00 but with downweighted Chile AcousN
Regularly scheduled sensitivities	
1.10	As 1.00 but with selectivity change implemented for 2025 Offshore fishery
1.11	As 1.10 but with selectivity change implemented for 2025 SC Chile fishery
1.12	As 1.11 but with increased weight for 2025 age compositions in the offshore and SC Chile fishery
1.13	As 1.12 but with downweighted early years (pre-2000) of AcousN
1.14	As 1.13 but with updates to historical weight at age for the FarNorth fleet
Models 1.xx.yy	Base Model Projections
1.xx.ls	As 1.xx but low steepness and short recruitment time series (2001-2015)

Table 27: Spawning biomass of jack mackerel (base model under the single-stock hypothesis) estimated in previous SPRFMO SC meetings.

Year	SC1	SC2	SC3	SC4	SC5	SC6	SC7	SC8	SC9	SC10	SC11	SC12	SC13
1970	8761	6726	10082	9770	9928	10319	10289	10629	11383	14378	14403	14627	15472
1971	8112	6384	9164	8872	9037	10015	9964	10214	10979	13372	13368	13517	14391
1972	7818	6173	8527	8289	8457	9854	9783	9964	10731	12456	12431	12521	13411
1973	7726	6015	8042	7911	8079	9756	9666	9794	10521	11541	11499	11543	12436
1974	7676	5910	7673	7633	7800	9646	9538	9625	10249	10560	10505	10514	11402
1975	7763	5894	7446	7511	7675	9604	9480	9534	9984	9742	9675	9651	10540
1976	8141	6075	7454	7638	7799	9752	9610	9638	9822	9136	9057	9005	9889
1977	8810	6589	7808	8027	8186	10112	9948	9955	9808	8711	8623	8547	9410
1978	9551	7151	8224	8445	8603	10458	10267	10256	9810	8562	8469	8374	9206
1979	10188	7613	8553	8810	8965	10717	10497	10473	9832	8470	8374	8265	9061
1980	10854	8276	9085	9349	9494	11124	10881	10847	10069	8560	8464	8346	9079
1981	11170	8521	9213	9561	9693	11174	10920	10878	9982	8423	8325	8200	8858
1982	10806	8122	8679	9137	9252	10513	10263	10217	9192	8033	7933	7798	8397
1983	11092	8503	8926	9487	9578	10584	10358	10310	9344	9078	8976	8835	9377
1984	11122	8635	8942	9653	9722	10502	10310	10264	9434	9507	9404	9257	9737
1985	11554	9342	9557	10297	10351	10869	10721	10679	10077	10080	9980	9833	10252
1986	13159	11355	11531	11890	11936	12177	12075	12039	11772	13579	13487	13348	13835
1987	14919	13284	13459	13371	13411	13402	13344	13314	13297	18078	17988	17857	18422
1988	15496	13716	13894	13801	13830	13717	13702	13679	13828	19862	19768	19641	20188
1989	15050	13082	13256	13389	13406	13455	13472	13454	13502	18745	18646	18524	19005
1990	14228	12207	12371	12701	12699	13076	13116	13101	13136	17271	17171	17052	17486
1991	13098	11032	11197	11792	11763	12408	12466	12455	12537	16133	16034	15921	16284
1992	11909	9856	10018	10772	10716	11542	11610	11602	11763	15260	15170	15068	15293
1993	10802	8942	9082	9800	9722	10658	10726	10720	10743	13700	13621	13534	13662
1994	9271	7518	7634	8165	8070	9061	9127	9123	9074	11132	11064	10991	11048
1995	7154	5448	5532	5901	5794	6696	6761	6758	6666	8161	8100	8035	8051
1996	5819	3820	3862	4174	4073	4775	4832	4831	4740	6003	5942	5877	5866
1997	4950	2990	2965	3254	3181	3609	3655	3657	3564	4719	4645	4567	4528
1998	4985	3158	3074	3539	3498	3677	3724	3730	3573	4814	4718	4613	4518
1999	5668	3937	3795	4475	4457	4434	4499	4511	4278	5956	5839	5701	5494
2000	6671	5018	4834	5616	5624	5463	5556	5574	5312	7308	7182	7021	6672
2001	7481	5892	5690	6368	6404	6172	6298	6323	6095	7759	7642	7476	6977
2002	8083	6699	6544	7010	7073	6805	6965	6997	6770	8442	8342	8181	7547
2003	8201	6952	6848	7274	7349	7080	7270	7309	7078	8463	8373	8218	7500
2004	7641	6564	6475	6908	6979	6725	6935	6980	6751	7815	7725	7572	6817
2005	6708	5763	5676	6159	6225	5997	6213	6262	6056	7188	7095	6946	6159
2006	5486	4682	4595	5102	5160	4979	5195	5248	5061	6049	5957	5820	5059
2007	4119	3430	3324	3846	3890	3754	3973	4029	3857	4241	4157	4036	3333
2008	3067	2545	2382	2890	2915	2779	2998	3055	2926	2986	2904	2801	2245
2009	2130	1850	1598	2070	2074	1893	2103	2159	2076	2465	2363	2268	1851
2010	1709	1647	1291	1775	1758	1538	1728	1778	1703	2413	2277	2172	1813
2011	1855	1861	1382	1868	1832	1667	1817	1855	1782	2373	2203	2085	1731
2012	2304	2115	1552	2065	2015	1980	2068	2090	2038	2458	2257	2126	1752
2013	3085	2383	1814	2308	2248	2339	2362	2370	2348	2659	2433	2285	1870
2014		2738	2222	2667	2572	2725	2687	2691	2719	3127	2873	2694	2191
2015		3206	2720	3273	3103	3176	3019	3042	3107	3767	3504	3285	2629
2016			3174	4116	3885	3606	3390	3456	3567	4857	4615	4358	3375
2017					5294	4097	3915	4047	4190	6867	6685	6439	4840
2018						4777	4821	5078	5264	9747	9730	9599	7145
2019							6188	6673	6956	12041	12534	12630	9474
2020								8273	8740	12802	14060	14538	11169
2021									9960	13547	15454	16259	12906
2022										14289	16482	17498	14336
2023											16400	17577	14691
2024												17738	14745
2025													15183

Table 28: Estimated begin-year numbers at age (Model h1_1.14; single-stock hypothesis).

	Age group (years)											
Year	1	2	3	4	5	6	7	8	9	10	11	12
1970	6,240	5,051	4,128	3,367	2,725	2,188	1,746	1,383	1,087	848	657	2,829
1971	5,809	4,715	3,811	3,106	2,518	2,014	1,608	1,299	1,037	817	638	2,623
1972	5,354	4,388	3,554	2,861	2,310	1,838	1,458	1,187	970	778	613	2,447
1973	4,788	4,044	3,308	2,668	2,132	1,709	1,357	1,087	890	729	585	2,302
1974	4,861	3,615	3,042	2,469	1,966	1,559	1,248	1,005	813	668	547	2,166
1975	6,248	3,666	2,711	2,244	1,767	1,389	1,098	906	743	605	497	2,021
1976	7,589	4,714	2,747	2,003	1,616	1,230	955	786	666	552	450	1,871
1977	11,065	5,719	3,515	2,004	1,407	1,084	813	669	571	491	407	1,711
1978	13,766	8,273	4,181	2,382	1,197	867	689	555	474	411	353	1,524
1979	14,203	10,286	6,000	2,802	1,395	671	485	436	378	332	288	1,315
1980	14,662	10,568	7,401	3,991	1,641	773	366	292	277	245	215	1,041
1981	17,007	10,900	7,587	4,897	2,329	933	440	225	187	180	159	817
1982	19,751	12,574	7,572	4,633	2,566	1,147	458	243	133	113	109	591
1983	27,754	14,439	8,478	4,466	2,244	980	400	198	120	68	58	360
1984	20,910	20,252	9,946	5,308	2,472	1,129	468	199	100	60	35	213
1985	25,128	15,016	13,171	6,116	2,765	975	384	181	85	44	27	110
1986	56,722	18,246	10,138	8,276	3,365	1,239	397	170	86	42	22	67
1987	52,513	41,556	12,905	6,718	5,061	1,777	586	201	89	45	22	46
1988	25,753	38,212	28,290	8,599	4,194	2,683	811	279	99	43	21	32
1989	15,215	18,609	26,089	18,433	5,447	2,494	1,446	406	131	43	17	21
1990	17,338	11,068	12,961	16,703	11,352	3,333	1,448	764	189	52	15	13
1991	22,583	12,613	7,865	8,780	10,515	6,789	1,867	744	362	77	18	10
1992	25,049	16,465	8,916	5,389	5,685	6,255	3,588	851	292	126	24	9
1993	14,423	18,513	11,683	6,052	3,495	3,533	3,377	1,512	240	67	32	9
1994	15,671	10,524	12,512	7,593	3,753	2,074	1,985	1,575	469	54	16	10
1995	14,686	11,450	7,145	7,767	4,360	1,988	988	704	396	96	11	5
1996	14,811	10,579	6,757	3,484	3,348	1,722	758	283	144	61	13	2
1997	17,092	10,278	5,572	2,695	1,273	1,221	593	214	63	25	9	2
1998	16,373	11,882	4,449	1,648	899	488	441	169	48	11	4	2
1999	20,580	11,632	5,660	1,799	767	462	243	192	63	15	3	2
2000	19,446	14,684	6,565	3,024	1,031	465	278	135	95	27	6	2
2001	19,467	13,994	8,959	3,571	1,799	651	294	167	74	46	12	3
2002	17,658	13,532	7,960	3,963	1,877	1,048	381	161	82	31	17	6
2003	10,820	12,667	8,561	4,637	2,253	1,103	613	207	77	33	11	8
2004	9,641	7,599	7,861	5,031	2,636	1,330	656	343	102	32	12	7
2005	10,531	6,639	4,636	4,511	2,770	1,506	770	360	171	44	12	7
2006	6,550	7,149	4,147	2,718	2,385	1,483	837	413	179	76	17	7
2007	2,390	4,270	4,162	2,287	1,401	1,117	715	385	178	74	30	10
2008	6,600	1,343	2,170	1,998	1,107	622	437	255	124	58	25	14
2009	9,614	3,450	617	1,010	888	465	245	158	83	41	21	14
2010	5,209	5,745	1,703	293	357	266	130	63	35	21	12	11
2011	3,739	3,168	2,984	895	137	146	106	41	21	14	9	10
2012	3,255	2,598	2,121	1,489	446	63	67	44	19	10	7	10
2013	3,526	2,382	1,828	1,267	812	219	33	38	26	11	6	10
2014	5,741	2,583	1,660	1,162	733	489	135	20	23	15	7	10
2015	5,946	4,213	1,819	1,072	712	450	304	83	12	13	8	9
2016	10,274	4,393	2,906	1,220	704	448	277	184	47	6	6	8
2017	17,061	7,690	3,163	1,987	793	439	274	168	107	26	3	8
2018	23,663	12,741	5,607	2,235	1,344	497	260	156	92	56	13	6
2019	19,857	17,754	9,434	3,970	1,521	859	298	145	82	46	27	9
2020	15,522	14,948	13,250	6,783	2,752	978	517	166	76	43	24	19
2021	20,867	11,705	11,210	9,789	4,848	1,872	601	289	87	41	23	23
2022	12,261	15,720	8,762	8,278	7,081	3,389	1,229	358	158	46	21	24
2023	8,126	9,238	11,750	6,487	6,001	5,036	2,342	802	215	87	23	22
2024	14,175	6,119	6,903	8,646	4,645	4,211	3,517	1,606	520	122	39	20
2025	17,018	10,690	4,588	5,083	6,175	3,179	2,884	2,421	1,070	300	44	21

Table 29: Estimated begin-year numbers at age (Model h2_1.14; two-stock hypothesis; southern stock).

Age group (years)										
1	2	3	4	5	6	7	8	9	10	11
6,811	5,458	4,405	3,537	2,816	2,225	1,747	1,364	1,058	816	627
6,381	5,146	4,116	3,311	2,641	2,077	1,637	1,302	1,024	796	614
5,930	4,820	3,876	3,085	2,456	1,923	1,508	1,212	974	769	598
5,301	4,480	3,632	2,910	2,302	1,819	1,424	1,127	910	733	579
5,232	4,004	3,370	2,716	2,158	1,690	1,335	1,059	845	684	551
6,651	3,950	3,008	2,511	1,994	1,545	1,207	979	789	633	512
8,013	5,019	2,957	2,223	1,816	1,395	1,078	874	725	588	472
10,355	6,042	3,737	2,159	1,574	1,231	943	768	641	537	436
12,882	7,804	4,486	2,713	1,519	1,064	833	672	563	475	398
13,247	9,685	5,724	3,165	1,808	936	654	561	477	407	343
13,460	9,918	7,044	3,985	2,080	1,107	568	425	377	322	275
14,685	10,076	7,205	4,901	2,637	1,311	696	376	287	255	218
16,034	10,917	7,064	4,653	2,909	1,474	742	428	239	184	164
27,348	11,788	7,382	4,229	2,406	1,288	646	381	236	134	103
22,950	20,075	8,140	4,684	2,463	1,317	693	356	207	126	72
24,228	16,602	13,191	5,120	2,561	1,060	526	307	165	97	59
56,716	17,655	11,317	8,392	2,865	1,183	468	253	154	83	49
51,125	41,612	12,522	7,579	5,204	1,515	572	244	134	81	44
22,853	37,213	28,378	8,406	4,797	2,801	702	281	123	67	39
13,167	16,501	25,466	18,783	5,458	2,931	1,545	360	136	56	29
17,638	9,576	11,514	16,467	11,850	3,414	1,734	831	172	57	21
21,715	12,842	6,822	7,874	10,676	7,266	1,949	911	405	74	22
23,363	15,839	9,095	4,709	5,203	6,486	3,943	914	374	151	26
14,058	17,248	11,228	6,210	3,093	3,268	3,593	1,750	280	97	45
14,347	10,238	11,623	7,384	3,923	1,859	1,864	1,750	603	74	27
11,284	10,450	6,934	7,317	4,362	2,133	902	688	492	147	18
13,071	8,082	6,098	3,608	3,445	1,850	871	283	162	94	25
14,006	8,974	4,066	2,655	1,509	1,412	716	284	75	35	18
14,133	9,677	3,847	1,557	1,132	690	608	254	81	17	7
15,464	10,029	4,688	1,984	867	662	391	310	113	31	6
17,468	10,943	5,607	2,733	1,223	557	423	236	169	53	12
18,006	12,520	6,588	3,335	1,722	806	367	268	137	86	23
16,870	12,512	7,363	3,718	1,984	1,084	506	218	142	61	32
11,334	12,100	7,932	4,459	2,206	1,217	664	291	110	59	20
7,045	7,961	7,600	4,819	2,640	1,353	754	391	151	47	20
8,159	4,809	4,904	4,498	2,741	1,552	807	430	201	65	16
5,566	5,437	2,948	2,901	2,428	1,494	878	441	216	88	24
2,761	3,543	3,137	1,743	1,572	1,185	743	414	192	87	33
6,991	1,488	1,750	1,646	912	730	483	275	135	61	28
5,876	3,538	697	904	796	403	302	182	92	44	21
4,063	3,157	1,678	345	343	248	118	81	42	23	13
3,429	2,194	1,351	835	161	142	99	37	25	15	9
3,218	2,323	1,483	885	469	79	67	41	17	13	8
3,655	2,339	1,643	981	518	234	42	37	24	10	8
5,646	2,663	1,627	1,070	583	304	141	26	23	14	6
5,656	4,123	1,880	1,100	684	353	182	85	15	13	8
7,263	4,159	2,837	1,281	729	427	211	106	47	8	6
9,733	5,417	2,980	1,948	836	453	257	123	59	25	4
14,321	7,217	3,901	2,091	1,310	520	264	142	65	30	13
12,504	10,703	5,308	2,762	1,415	830	309	144	71	31	14
10,145	9,398	7,965	3,855	1,909	895	492	169	74	36	16
16,075	7,645	7,033	5,885	2,759	1,262	530	265	86	39	20
10,952	12,098	5,703	5,150	4,223	1,862	778	295	137	44	20
7,307	8,245	9,015	4,202	3,713	2,943	1,213	465	162	72	22
12,704	5,500	6,150	6,610	2,990	2,564	1,970	768	271	84	32
15,029	9,579	4,120	4,516	4,681	1,983	1,661	1,248	452	134	30

Table 30: Estimated begin-year numbers at age (Model h2_1.14; two-stock hypothesis; northern stock).

											Age group (year	
Year	1	2	3	4	5	6	7	8	9	10	11	1
1970	1,604	1,011	746	548	403	295	215	157	114	82	60	18
1971	1,563	1,153	727	535	392	289	212	155	113	82	59	17
1972	1,510	1,124	829	520	380	280	207	152	111	81	59	16
1973	1,460	1,085	807	589	363	270	200	148	109	80	58	16
1974	1,467	1,050	779	566	396	254	192	143	106	78	57	15
1975	1,480	1,054	749	517	327	261	176	135	101	75	55	15
1976	1,504	1,064	756	525	347	229	185	126	96	72	53	14
1977	2,437	1,081	762	525	343	240	162	132	90	69	51	14
1978	1,976	1,746	742	340	102	146	140	102	83	56	43	12
1979	1,612	1,415	1,192	312	56	41	83	87	63	52	35	10
1980	1,152	1,155	971	531	60	24	24	52	55	40	33	8
1981	1,687	825	782	379	71	22	13	14	32	33	24	7
1982	1,937	1,203	534	191	14	16	10	7	8	17	18	5
1983	1,091	1,389	830	249	42	6	9	6	4	5	11	4
1984	524	783	974	463	90	23	4	6	4	3	3	3
1985	1,324	376	549	539	163	49	15	3	4	3	2	2
1986	2,154	951	267	346	271	102	33	10	2	3	2	2
1987	3,053	1,548	679	179	206	181	71	23	7	1	2	1
1988	2,090	2,194	1,105	453	105	136	126	50	16	5	1	1
1989	1,365	1,500	1,535	600	151	56	87	84	33	11	3	
1990	751	980	1,051	846	208	81	36	58	56	22	7	
1991	1,429	539	684	558	265	108	51	24	38	37	15	1
1992	1,762	1,026	379	391	214	149	70	35	16	26	25	1
1993	1,374	1,266	727	236	190	132	100	48	24	11	18	2
1994	1,861	987	893	433	101	111	87	68	33	16	7	3
1995	4,266	1,336	691	494	151	55	71	58	46	22	11	2
1996	2,356	3,044	868	176	20	35	25	39	32	25	12	2
1997	2,773	1,671	1,827	97	1	2	11	11	17	14	11	1
1998	1,950	1,953	909	74	0	0	0	4	3	5	4	
1999	5,264	1,352	861	4	0	0	0	0	1	1	1	
2000	2,108	3,749	857	169	0	0	0	0	0	0	0	
2001	1,438	1,504	2,420	203	6	0	0	0	0	0	0	
2002	1,062	1,011	802	80	0	0	0	0	0	0	0	
2003	286	761	643	287	22	0	0	0	0	0	0	
2004	1,884	205	481	221	73	7	0	0	0	0	0	
2005	1,601	1,349	128	160	54	22	3	0	0	0	0	
2006	886	1,148	902	61	65	24	13	2	0	0	0	
2007	146	633	687	228	10	14	10	7	1	0	0	
2008	237	104	375	163	35	2	6	5	3	1	0	
2009	2,548	169	62	89	25	7	1	3	3	2	0	
2010	938	1,820	98	13	11	5	3	0	1	1	1	
2011	445	674	1,250	55	7	6	3	2	0	1	1	
2012	314	318	391	267	7	1	2	1	1	0	0	
2013	280	225	196	117	56	2	1	1	1	0	0	
2014	456	200	146	81	39	22	1	0	1	0	0	
2015	431	327	128	54	23	13	11	1	0	0	0	
2016	1,684	310	226	74	29	13	8	7	0	0	0	
2017	3,713	1,210	219	146	46	18	9	6	5	0	0	
2018	2,748	2,669	864	151	100	32	13	6	4	4	0	
2019	1,590	1,975	1,880	553	92	63	21	9	4	3	2	
2020	1,921	1,142	1,386	1,181	329	57	42	15	6	3	2	
2021	1,034	1,380	808	908	745	213	39	29	10	4	2	
2022	518	743	979	537	584	490	147	27	21	7	3	
2023	722	372	523	628	329	370	331	102	19	14	5	
2024	1,040	519	258	307	339	188	237	224	69	13	10	
2025	1,126	747	355	141	150	179	116	157	148	46	9	1

Table 31: *Estimated total fishing mortality at age (Model h1_1.14; single-stock hypothesis).*

					Age group (years)					
1	2	3	4	5	6	7	8	9	10	11
0.000	0.002	0.004	0.010	0.023	0.028	0.016	0.008	0.005	0.005	0.005
0.001	0.003	0.007	0.016	0.035	0.043	0.024	0.012	0.007	0.007	0.007
0.001	0.003	0.007	0.014	0.021	0.023	0.014	0.008	0.005	0.005	0.005
0.001	0.005	0.013	0.025	0.033	0.034	0.020	0.011	0.008	0.007	0.007
0.002	0.008	0.024	0.055	0.068	0.071	0.040	0.022	0.015	0.015	0.015
0.002	0.009	0.023	0.049	0.082	0.094	0.054	0.027	0.017	0.017	0.017
0.003	0.014	0.035	0.073	0.119	0.134	0.077	0.039	0.026	0.025	0.025
0.011	0.033	0.109	0.235	0.203	0.173	0.102	0.064	0.050	0.049	0.049
0.011	0.041	0.120	0.255	0.298	0.302	0.178	0.105	0.078	0.076	0.076
0.016	0.049	0.128	0.255	0.311	0.326	0.226	0.171	0.153	0.151	0.151
0.016	0.051	0.133	0.259	0.285	0.284	0.206	0.166	0.154	0.151	0.151
0.022	0.084	0.213	0.366	0.428	0.431	0.312	0.247	0.226	0.221	0.221
0.033	0.114	0.248	0.445	0.682	0.773	0.558	0.431	0.390	0.384	0.384
0.035	0.093	0.188	0.311	0.407	0.458	0.416	0.402	0.402	0.397	0.397
0.051	0.150	0.206	0.372	0.650	0.799	0.674	0.575	0.538	0.533	0.533
0.040	0.113	0.185	0.317	0.522	0.619	0.533	0.459	0.431	0.429	0.429
0.031	0.066	0.132	0.212	0.359	0.469	0.403	0.368	0.365	0.372	0.372
0.038	0.105	0.126	0.191	0.355	0.505	0.461	0.431	0.446	0.477	0.477
0.045	0.102	0.148	0.177	0.240	0.338	0.411	0.475	0.559	0.642	0.642
0.038	0.082	0.166	0.205	0.211	0.264	0.358	0.484	0.637	0.774	0.774
0.038	0.062	0.110	0.183	0.234	0.299	0.386	0.466	0.617	0.772	0.772
0.036	0.067	0.098	0.155	0.239	0.358	0.506	0.653	0.778	0.877	0.877
0.022	0.063	0.107	0.153	0.196	0.337	0.584	0.987	1.201	1.074	1.074
0.035	0.112	0.151	0.198	0.242	0.297	0.483	0.891	1.214	1.169	1.169
0.034	0.107	0.197	0.275	0.356	0.462	0.756	1.100	1.305	1.331	1.331
0.048	0.247	0.438	0.562	0.649	0.684	0.968	1.309	1.594	1.735	1.735
0.085	0.361	0.639	0.727	0.729	0.786	0.984	1.225	1.453	1.580	1.580
0.084	0.557	0.938	0.818	0.679	0.738	0.972	1.218	1.446	1.570	1.570
0.062	0.462	0.625	0.485	0.386	0.418	0.554	0.713	0.875	0.990	0.990
0.058	0.292	0.347	0.277	0.221	0.229	0.303	0.420	0.563	0.686	0.686
0.049	0.214	0.329	0.239	0.180	0.179	0.230	0.322	0.441	0.558	0.558
0.084	0.284	0.536	0.363	0.261	0.257	0.324	0.436	0.581	0.711	0.711
0.052	0.178	0.260	0.285	0.252	0.256	0.330	0.461	0.622	0.758	0.758
0.073	0.197	0.252	0.285	0.247	0.240	0.302	0.426	0.590	0.736	0.736
0.093	0.214	0.275	0.317	0.280	0.267	0.320	0.417	0.566	0.722	0.722
0.107	0.191	0.254	0.357	0.344	0.308	0.343	0.419	0.525	0.658	0.658
0.148	0.261	0.315	0.383	0.479	0.450	0.495	0.559	0.608	0.640	0.640
0.296	0.397	0.454	0.446	0.531	0.659	0.749	0.855	0.843	0.795	0.795
0.369	0.498	0.484	0.531	0.587	0.652	0.738	0.846	0.838	0.745	0.745
0.235	0.426	0.464	0.759	0.926	0.995	1.073	1.215	1.094	0.908	0.908
0.217	0.375	0.363	0.481	0.617	0.637	0.880	0.846	0.680	0.567	0.567
0.084	0.121	0.415	0.417	0.505	0.500	0.605	0.477	0.398	0.351	0.351
0.032	0.072	0.235	0.327	0.431	0.346	0.295	0.255	0.239	0.235	0.235
0.031	0.081	0.173	0.267	0.226	0.206	0.214	0.224	0.241	0.259	0.259
0.029	0.071	0.157	0.210	0.207	0.197	0.206	0.245	0.290	0.328	0.328
0.023	0.091	0.120	0.141	0.184	0.205	0.220	0.281	0.372	0.438	0.438
0.010	0.049	0.100	0.151	0.192	0.211	0.223	0.266	0.331	0.381	0.381
0.012	0.036	0.067	0.111	0.188	0.244	0.281	0.323	0.367	0.383	0.383
0.007	0.021	0.065	0.105	0.167	0.231	0.301	0.367	0.405	0.441	0.441
0.004	0.013	0.050	0.087	0.161	0.228	0.305	0.364	0.368	0.366	0.366
0.002	0.008	0.023	0.056	0.105	0.208	0.302	0.363	0.353	0.339	0.339
0.003	0.010	0.023	0.044	0.078	0.140	0.239	0.323	0.366	0.398	0.398
0.003	0.011	0.021	0.042	0.061	0.089	0.147	0.230	0.313	0.423	0.423
0.004	0.011	0.027	0.054	0.074	0.079	0.097	0.153	0.284	0.533	0.533
0.002	0.008	0.026	0.057	0.099	0.099	0.093	0.126	0.270	0.752	0.752
0.002	0.007	0.032	0.091	0.113	0.105	0.080	0.084	0.170	0.589	0.589

Table 32: Estimated total fishing mortality at age (Model h2_1.14; two-stock hypothesis; southern stock).

Age group (years)										
1	2	3	4	5	6	7	8	9	10	11
0.000	0.002	0.006	0.012	0.025	0.027	0.014	0.007	0.004	0.004	0.004
0.001	0.003	0.008	0.019	0.037	0.040	0.021	0.010	0.006	0.006	0.006
0.000	0.003	0.007	0.012	0.020	0.021	0.011	0.006	0.004	0.004	0.004
0.001	0.005	0.011	0.019	0.029	0.029	0.016	0.008	0.005	0.005	0.005
0.001	0.006	0.014	0.029	0.054	0.057	0.030	0.015	0.009	0.009	0.009
0.002	0.010	0.023	0.044	0.077	0.080	0.042	0.021	0.014	0.013	0.013
0.002	0.015	0.035	0.065	0.109	0.111	0.059	0.030	0.019	0.019	0.019
0.003	0.018	0.041	0.072	0.112	0.111	0.060	0.031	0.021	0.020	0.020
0.005	0.030	0.069	0.126	0.204	0.208	0.115	0.063	0.045	0.045	0.045
0.009	0.038	0.082	0.140	0.211	0.219	0.150	0.119	0.112	0.112	0.112
0.010	0.040	0.083	0.133	0.182	0.184	0.133	0.112	0.110	0.109	0.109
0.016	0.075	0.157	0.242	0.302	0.289	0.206	0.171	0.165	0.163	0.163
0.028	0.111	0.233	0.380	0.534	0.545	0.387	0.318	0.304	0.301	0.301
0.029	0.090	0.175	0.261	0.323	0.339	0.316	0.328	0.343	0.341	0.341
0.044	0.140	0.184	0.324	0.563	0.638	0.534	0.489	0.481	0.480	0.480
0.036	0.103	0.172	0.300	0.492	0.539	0.453	0.413	0.407	0.407	0.407
0.030	0.064	0.121	0.198	0.357	0.446	0.371	0.351	0.360	0.366	0.366
0.038	0.103	0.119	0.177	0.339	0.489	0.433	0.402	0.417	0.440	0.440
0.046	0.099	0.133	0.152	0.213	0.315	0.389	0.442	0.508	0.569	0.569
0.039	0.080	0.156	0.181	0.189	0.245	0.340	0.457	0.584	0.685	0.685
0.037	0.059	0.100	0.153	0.209	0.281	0.364	0.440	0.571	0.683	0.683
0.036	0.065	0.091	0.134	0.218	0.331	0.477	0.610	0.708	0.766	0.766
0.023	0.064	0.102	0.140	0.185	0.311	0.532	0.903	1.065	0.920	0.920
0.037	0.115	0.139	0.179	0.229	0.281	0.439	0.786	1.053	0.990	0.990
0.037	0.110	0.183	0.246	0.329	0.443	0.717	0.989	1.129	1.138	1.138
0.054	0.259	0.373	0.473	0.578	0.616	0.880	1.165	1.377	1.488	1.488
0.096	0.407	0.552	0.592	0.612	0.669	0.840	1.054	1.251	1.372	1.372
0.090	0.567	0.680	0.572	0.502	0.563	0.758	0.976	1.198	1.340	1.340
0.063	0.445	0.382	0.306	0.257	0.289	0.394	0.530	0.693	0.834	0.834
0.066	0.301	0.260	0.204	0.162	0.167	0.225	0.325	0.471	0.626	0.626
0.053	0.227	0.240	0.182	0.137	0.138	0.179	0.266	0.400	0.569	0.569
0.084	0.251	0.292	0.239	0.183	0.185	0.241	0.352	0.525	0.720	0.720
0.052	0.176	0.222	0.242	0.209	0.210	0.275	0.408	0.605	0.813	0.813
0.073	0.185	0.218	0.244	0.209	0.198	0.249	0.374	0.571	0.786	0.786
0.102	0.205	0.245	0.284	0.251	0.237	0.283	0.384	0.563	0.784	0.784
0.126	0.209	0.245	0.337	0.327	0.290	0.325	0.409	0.546	0.736	0.736
0.172	0.270	0.245	0.333	0.437	0.419	0.470	0.549	0.631	0.706	0.706
0.338	0.425	0.365	0.368	0.487	0.617	0.714	0.838	0.865	0.858	0.858
0.401	0.478	0.381	0.447	0.536	0.603	0.694	0.813	0.834	0.771	0.771
0.341	0.466	0.424	0.688	0.886	0.945	1.041	1.191	1.100	0.943	0.943
0.336	0.569	0.418	0.480	0.604	0.634	0.897	0.877	0.723	0.619	0.619
0.109	0.112	0.143	0.296	0.435	0.474	0.610	0.483	0.396	0.351	0.351
0.039	0.066	0.132	0.256	0.416	0.340	0.296	0.256	0.237	0.231	0.231
0.037	0.083	0.149	0.240	0.254	0.223	0.225	0.229	0.241	0.253	0.253
0.034	0.068	0.111	0.167	0.223	0.234	0.227	0.257	0.291	0.319	0.319
0.028	0.094	0.103	0.132	0.191	0.235	0.260	0.309	0.380	0.429	0.429
0.013	0.053	0.096	0.147	0.195	0.229	0.255	0.300	0.345	0.374	0.374
0.019	0.048	0.074	0.117	0.195	0.260	0.313	0.365	0.400	0.394	0.394
0.011	0.027	0.065	0.111	0.177	0.242	0.325	0.409	0.449	0.460	0.460
0.006	0.015	0.040	0.089	0.178	0.243	0.323	0.390	0.390	0.373	0.373
0.003	0.010	0.023	0.055	0.134	0.245	0.337	0.391	0.369	0.337	0.337
0.004	0.013	0.032	0.052	0.113	0.204	0.307	0.382	0.396	0.393	0.393
0.004	0.014	0.025	0.047	0.081	0.148	0.235	0.315	0.364	0.411	0.411
0.004	0.013	0.030	0.060	0.090	0.121	0.178	0.258	0.378	0.524	0.524
0.002	0.009	0.029	0.065	0.131	0.154	0.177	0.249	0.426	0.754	0.754
0.002	0.008	0.036	0.106	0.147	0.170	0.156	0.172	0.308	0.684	0.684

Table 33: Estimated total fishing mortality at age (Model h2_1.14; two-stock hypothesis; far north stock).

Age group (years)										
1	2	3	4	5	6	7	8	9	10	11
0.000	0.000	0.002	0.007	0.003	0.001	0.001	0.001	0.001	0.001	0.001
0.000	0.000	0.005	0.013	0.005	0.002	0.001	0.001	0.001	0.001	0.001
0.000	0.001	0.011	0.031	0.012	0.005	0.003	0.003	0.003	0.003	0.003
0.000	0.002	0.025	0.067	0.027	0.011	0.007	0.007	0.007	0.007	0.007
0.001	0.008	0.080	0.220	0.087	0.035	0.022	0.022	0.022	0.022	0.022
0.000	0.002	0.025	0.069	0.027	0.011	0.007	0.007	0.007	0.007	0.007
0.000	0.003	0.035	0.096	0.038	0.015	0.010	0.010	0.010	0.010	0.010
0.003	0.046	0.477	1.309	0.520	0.209	0.132	0.132	0.132	0.132	0.132
0.004	0.052	0.537	1.473	0.585	0.236	0.148	0.148	0.148	0.148	0.148
0.003	0.046	0.478	1.312	0.521	0.210	0.132	0.132	0.132	0.132	0.132
0.004	0.059	0.612	1.678	0.667	0.268	0.169	0.169	0.169	0.169	0.169
0.008	0.105	1.078	2.955	1.174	0.473	0.297	0.297	0.297	0.297	0.297
0.003	0.042	0.431	1.182	0.470	0.189	0.119	0.119	0.119	0.119	0.119
0.002	0.025	0.253	0.693	0.275	0.111	0.070	0.070	0.070	0.070	0.070
0.002	0.025	0.261	0.715	0.284	0.114	0.072	0.072	0.072	0.072	0.072
0.001	0.013	0.130	0.357	0.142	0.057	0.036	0.036	0.036	0.036	0.036
0.000	0.007	0.069	0.190	0.075	0.030	0.019	0.019	0.019	0.019	0.019
0.001	0.007	0.075	0.205	0.082	0.033	0.021	0.021	0.021	0.021	0.021
0.002	0.027	0.280	0.767	0.305	0.123	0.077	0.077	0.077	0.077	0.077
0.002	0.026	0.266	0.730	0.290	0.117	0.073	0.073	0.073	0.073	0.073
0.002	0.029	0.303	0.830	0.330	0.133	0.083	0.083	0.083	0.083	0.083
0.002	0.022	0.229	0.627	0.249	0.100	0.063	0.063	0.063	0.063	0.063
0.001	0.014	0.142	0.390	0.155	0.062	0.039	0.039	0.039	0.039	0.039
0.001	0.018	0.189	0.518	0.206	0.083	0.052	0.052	0.052	0.052	0.052
0.002	0.026	0.263	0.720	0.286	0.115	0.072	0.072	0.072	0.072	0.072
0.007	0.101	1.041	2.855	1.134	0.457	0.287	0.287	0.287	0.287	0.287
0.013	0.181	1.858	5.094	2.024	0.815	0.512	0.512	0.512	0.512	0.512
0.021	0.279	2.873	7.880	3.132	1.261	0.792	0.792	0.792	0.792	0.792
0.036	0.489	5.027	13.787	5.479	2.206	1.385	1.385	1.385	1.385	1.385
0.009	0.126	1.298	3.559	1.415	0.569	0.358	0.358	0.358	0.358	0.358
0.008	0.108	1.111	3.046	1.210	0.487	0.306	0.306	0.306	0.306	0.306
0.022	0.299	3.074	8.432	3.351	1.349	0.847	0.847	0.847	0.847	0.847
0.004	0.123	0.699	0.983	0.783	0.385	0.210	0.210	0.210	0.210	0.210
0.004	0.129	0.736	1.034	0.824	0.406	0.221	0.221	0.221	0.221	0.221
0.004	0.135	0.771	1.084	0.864	0.425	0.231	0.231	0.231	0.231	0.231
0.002	0.072	0.411	0.577	0.460	0.226	0.123	0.123	0.123	0.123	0.123
0.006	0.184	1.046	1.470	1.172	0.577	0.313	0.313	0.313	0.313	0.313
0.006	0.194	1.106	1.554	1.238	0.610	0.331	0.331	0.331	0.331	0.331
0.006	0.195	1.112	1.562	1.245	0.613	0.333	0.333	0.333	0.333	0.333
0.006	0.215	1.221	1.716	1.368	0.673	0.366	0.366	0.366	0.366	0.366
0.001	0.046	0.260	0.365	0.291	0.143	0.078	0.078	0.078	0.078	0.078
0.006	0.214	1.215	1.708	1.361	0.670	0.364	0.364	0.364	0.364	0.364
0.005	0.155	0.880	1.237	0.985	0.485	0.264	0.264	0.264	0.264	0.264
0.003	0.097	0.553	0.777	0.619	0.305	0.166	0.166	0.166	0.166	0.166
0.004	0.116	0.660	0.928	0.740	0.364	0.198	0.198	0.198	0.198	0.198
0.001	0.039	0.223	0.313	0.249	0.123	0.067	0.067	0.067	0.067	0.067
0.001	0.018	0.104	0.146	0.117	0.057	0.031	0.031	0.031	0.031	0.031
0.000	0.007	0.037	0.052	0.042	0.020	0.011	0.011	0.011	0.011	0.011
0.001	0.020	0.116	0.163	0.130	0.064	0.035	0.035	0.035	0.035	0.035
0.001	0.024	0.135	0.189	0.151	0.074	0.040	0.040	0.040	0.040	0.040
0.000	0.016	0.093	0.131	0.104	0.051	0.028	0.028	0.028	0.028	0.028
0.000	0.014	0.079	0.111	0.088	0.043	0.024	0.024	0.024	0.024	0.024
0.001	0.020	0.114	0.160	0.128	0.063	0.034	0.034	0.034	0.034	0.034
0.001	0.036	0.204	0.287	0.229	0.113	0.061	0.061	0.061	0.061	0.061
0.001	0.048	0.276	0.388	0.309	0.152	0.083	0.083	0.083	0.083	0.083
0.002	0.063	0.358	0.503	0.401	0.197	0.107	0.107	0.107	0.107	0.107

Table 34: Summary of results for Model h1_1.14 (single-stock hypothesis). Note that MSY values are a function of time-varying selectivity and average weight.

Year	Landings ('000 t)	SSB ('000 t)	Recruitment (age 1, millions)	Fishing Mortality (mean over ages 1-12)	F_MSY	SSB_MSY ('000 t)
1970	118	15,472	6,240	0.01	0.19	7,943
1971	169	14,391	5,809	0.01	0.19	7,915
1972	111	13,411	5,354	0.01	0.18	7,924
1973	165	12,436	4,788	0.01	0.17	7,845
1974	324	11,402	4,861	0.03	0.17	7,827
1975	300	10,540	6,248	0.03	0.18	7,880
1976	397	9,889	7,589	0.05	0.18	7,824
1977	848	9,410	11,065	0.09	0.14	9,100
1978	1,025	9,206	13,766	0.13	0.17	7,965
1979	1,302	9,061	14,203	0.17	0.19	8,126
1980	1,316	9,079	14,662	0.17	0.19	8,124
1981	1,945	8,858	17,007	0.25	0.19	8,101
1982	2,372	8,397	19,751	0.40	0.20	8,194
1983	1,870	9,377	27,754	0.33	0.21	8,519
1984	2,687	9,737	20,910	0.47	0.22	8,426
1985	2,371	10,252	25,128	0.38	0.22	8,275
1986	2,073	13,835	56,722	0.29	0.24	8,375
1987	2,680	18,422	52,513	0.34	0.24	8,599
1988	3,246	20,188	25,753	0.37	0.27	8,935
1989	3,582	19,005	15,215	0.40	0.31	8,774
1990	3,715	17,486	17,338	0.39	0.34	8,679
1991	3,778	16,284	22,583	0.46	0.41	8,175
1992	3,362	15,293	25,049	0.57	0.43	9,055
1993	3,371	13,662	14,423	0.59	0.32	10,054
1994	4,276	11,048	15,671	0.72	0.33	9,307
1995	4,956	8,051	14,686	0.98	0.25	9,701
1996	4,380	5,866	14,811	0.98	0.22	9,404
1997	3,598	4,528	17,092	1.01	0.20	9,189
1998	2,027	4,518	16,373	0.63	0.18	9,868
1999	1,424	5,494	20,580	0.40	0.19	9,729
2000	1,540	6,672	19,446	0.32	0.19	9,429
2001	2,528	6,977	19,467	0.44	0.18	9,385
2002	1,750	7,547	17,658	0.41	0.22	9,835
2003	1,797	7,500	10,820	0.40	0.21	9,843
2004	1,934	6,817	9,641	0.41	0.21	9,175
2005	1,755	6,159	10,531	0.40	0.21	8,879
2006	2,020	5,059	6,550	0.47	0.20	8,618
2007	1,997	3,333	2,390	0.63	0.19	8,417
2008	1,473	2,245	6,600	0.65	0.18	8,482
2009	1,283	1,851	9,614	0.83	0.20	8,274
2010	727	1,813	5,209	0.57	0.18	8,848
2011	635	1,731	3,739	0.38	0.18	8,517
2012	455	1,752	3,255	0.24	0.18	8,615
2013	353	1,870	3,526	0.20	0.18	8,997
2014	411	2,191	5,741	0.22	0.21	9,062
2015	394	2,629	5,946	0.25	0.27	8,554
2016	389	3,375	10,274	0.22	0.27	8,772
2017	405	4,840	17,061	0.23	0.28	9,247
2018	526	7,145	23,663	0.25	0.27	10,133
2019	632	9,474	19,857	0.22	0.34	9,029
2020	707	11,169	15,522	0.20	0.39	9,230
2021	808	12,906	20,867	0.20	0.51	8,907
2022	961	14,336	12,261	0.18	0.61	8,669
2023	1,126	14,691	8,126	0.20	0.57	9,241
2024	1,330	14,745	14,175	0.25	0.72	8,990
2025	1,384	15,183	17,018	0.20	0.54	8,788

Table 35: Summary of results for Model h2_1.14 (two-stock hypothesis; south stock). Note that MSY values are a function of time-varying selectivity and average weight.

Year	Landings ('000 t)	SSB ('000 t)	Recruitment (age 1, millions)	Fishing Mortality (mean over ages 1-12)	F_MSY	SSB_MSY ('000 t)
1970	113	14,971	6,811	0.01	0.18	6,436
1971	159	14,156	6,381	0.01	0.18	6,433
1972	93	13,405	5,930	0.01	0.17	6,402
1973	123	12,632	5,301	0.01	0.17	6,339
1974	195	11,800	5,232	0.02	0.18	6,403
1975	262	11,064	6,651	0.03	0.17	6,376
1976	343	10,512	8,013	0.04	0.17	6,362
1977	343	10,293	10,355	0.04	0.17	6,341
1978	638	10,226	12,882	0.08	0.17	6,418
1979	968	10,124	13,247	0.12	0.19	6,721
1980	902	10,190	13,460	0.11	0.19	6,724
1981	1,499	9,922	14,685	0.18	0.18	6,665
1982	2,228	9,022	16,034	0.31	0.19	6,686
1983	1,760	9,664	27,348	0.27	0.21	7,023
1984	2,486	10,151	22,950	0.40	0.21	6,993
1985	2,256	10,708	24,228	0.34	0.22	6,810
1986	2,022	14,189	56,716	0.28	0.24	6,873
1987	2,633	18,659	51,125	0.32	0.24	7,027
1988	3,001	20,273	22,853	0.33	0.27	7,291
1989	3,266	18,951	13,167	0.36	0.30	7,171
1990	3,344	17,549	17,638	0.36	0.33	7,102
1991	3,564	16,446	21,715	0.41	0.39	6,718
1992	3,250	15,313	23,363	0.51	0.39	7,489
1993	3,237	13,581	14,058	0.52	0.30	8,198
1994	4,042	10,944	14,347	0.63	0.31	7,603
1995	4,405	7,935	11,284	0.85	0.24	7,955
1996	3,884	5,736	13,071	0.85	0.21	7,674
1997	2,918	4,559	14,006	0.83	0.20	7,581
1998	1,614	4,594	14,133	0.49	0.18	8,241
1999	1,221	5,241	15,464	0.34	0.19	8,041
2000	1,237	6,187	17,468	0.29	0.20	7,859
2001	1,670	6,900	18,006	0.38	0.20	8,052
2002	1,595	7,523	16,870	0.40	0.22	8,209
2003	1,580	7,614	11,334	0.39	0.21	8,241
2004	1,747	6,870	7,045	0.41	0.22	7,589
2005	1,674	5,905	8,159	0.42	0.21	7,320
2006	1,743	4,732	5,566	0.47	0.20	7,151
2007	1,742	3,164	2,761	0.63	0.20	6,943
2008	1,303	2,240	6,991	0.62	0.18	6,984
2009	1,207	1,602	5,876	0.83	0.20	6,779
2010	704	1,290	4,063	0.62	0.16	7,186
2011	308	1,330	3,429	0.34	0.19	7,337
2012	267	1,483	3,218	0.23	0.18	7,327
2013	273	1,676	3,655	0.20	0.18	7,405
2014	336	2,041	5,646	0.21	0.22	7,385
2015	372	2,477	5,656	0.25	0.27	6,954
2016	374	3,001	7,263	0.23	0.27	7,086
2017	396	3,742	9,733	0.25	0.27	7,530
2018	469	4,928	14,321	0.27	0.27	8,339
2019	496	6,226	12,504	0.23	0.31	7,627
2020	567	7,182	10,145	0.21	0.34	7,816
2021	684	8,313	16,075	0.22	0.41	7,378
2022	802	9,419	10,952	0.21	0.50	7,092
2023	904	9,787	7,307	0.23	0.48	7,638
2024	1,113	9,945	12,704	0.29	0.57	7,574
2025	1,176	10,475	15,029	0.26	0.50	7,188

Table 36: Summary of results for Model h2_1.14 (two-stock hypothesis; far north stock). Note that MSY values are a function of time-varying selectivity and average weight.

Year	Landings ('000 t)	SSB ('000 t)	Recruitment (age 1, millions)	Fishing Mortality (mean over ages 1-12)	F_MSY	SSB_MSY ('000 t)
1970	5	2,165	1,604	0.00	0.12	809
1971	9	2,119	1,563	0.00	0.12	809
1972	19	2,089	1,510	0.01	0.12	822
1973	43	2,047	1,460	0.01	0.12	812
1974	129	1,939	1,467	0.05	0.12	810
1975	38	1,880	1,480	0.01	0.12	815
1976	54	1,837	1,504	0.02	0.12	803
1977	505	1,436	2,437	0.28	0.12	814
1978	387	1,105	1,976	0.31	0.12	816
1979	334	939	1,612	0.28	0.12	809
1980	414	704	1,152	0.36	0.12	808
1981	446	415	1,687	0.63	0.12	803
1982	144	368	1,937	0.25	0.12	804
1983	111	444	1,091	0.15	0.12	794
1984	201	499	524	0.15	0.12	800
1985	115	527	1,324	0.08	0.12	805
1986	51	572	2,154	0.04	0.12	803
1987	46	707	3,053	0.04	0.12	810
1988	244	810	2,090	0.16	0.12	807
1989	316	902	1,365	0.16	0.12	802
1990	371	837	751	0.18	0.12	802
1991	213	766	1,429	0.13	0.12	804
1992	112	744	1,762	0.08	0.12	804
1993	133	779	1,374	0.11	0.12	808
1994	233	775	1,861	0.15	0.12	815
1995	551	480	4,266	0.61	0.12	807
1996	496	328	2,356	1.09	0.12	807
1997	680	166	2,773	1.68	0.12	796
1998	413	74	1,950	2.94	0.12	799
1999	204	133	5,264	0.76	0.27	148
2000	304	240	2,108	0.65	0.27	153
2001	858	103	1,438	1.80	0.27	154
2002	155	167	1,062	0.35	0.26	169
2003	218	178	286	0.37	0.27	164
2004	187	139	1,884	0.39	0.27	166
2005	81	162	1,601	0.21	0.26	169
2006	278	188	886	0.53	0.26	169
2007	255	147	146	0.56	0.27	167
2008	170	86	237	0.56	0.26	170
2009	77	39	2,548	0.62	0.27	167
2010	22	115	938	0.13	0.27	164
2011	326	159	445	0.61	0.25	184
2012	187	112	314	0.44	0.25	180
2013	81	94	280	0.28	0.25	176
2014	75	77	456	0.33	0.25	178
2015	22	94	431	0.11	0.26	172
2016	15	139	1,684	0.05	0.27	166
2017	9	231	3,713	0.02	0.25	177
2018	57	475	2,748	0.06	0.26	175
2019	136	849	1,590	0.07	0.25	176
2020	140	1,138	1,921	0.05	0.25	178
2021	124	1,320	1,034	0.04	0.26	174
2022	160	1,419	518	0.06	0.26	172
2023	222	1,324	722	0.10	0.26	168
2024	217	1,126	1,040	0.14	0.27	165
2025	208	937	1,126	0.18	0.27	166

Table 37: Summary results for the short, medium, and long-term predictions for Model h1_1.14.ls (single-stock hypothesis, low steepness, short time series). Note that B in all cases represents thousands of tonnes of spawning stock biomass, P represents probability as a percentage, and BMSY is taken as the average BMSY estimated over the last ten years.

Multiplier of F_{2025}	B_{2027}	P(B_{2027} > B_{MSY}) %	B_{2031}	P(B_{2031} > B_{MSY}) %	B_{2035}	P(B_{2035} > B_{MSY}) %	Catch 2026 (kt)	Catch 2027 (kt)
0	17086	100	18158	100	17829	98	0	0
0.75	14684	99	12489	87	11234	73	1292	1446
1	14056	99	11511	80	10272	64	1673	1766
1.25	13494	97	10733	72	9524	55	2032	2031
FMSY	12952	97	10048	64	8876	47	2395	2266
ADV2025	14439	99	11583	81	10318	65	1428	1679
ADV2025 x15	14083	99	10984	75	9741	58	1642	1874
TAC2025 x1.15	13851	98	10613	71	9388	54	1785	1997

Table 38: Summary results for the short, medium, and long-term predictions for Model h2_1.14.ls (two-stock hypothesis, low steepness, short time series). Note that B in all cases represents thousands of tonnes of spawning stock biomass, P represents probability as a percentage, and BMSY is taken as the average BMSY estimated over the last ten years.

South Stock

Multiplier of F_{2025}	B_{2027}	P(B_{2027} > B_{MSY}) %	B_{2031}	P(B_{2031} > B_{MSY}) %	B_{2035}	P(B_{2035} > B_{MSY}) %	Catch 2026 (kt)	Catch 2027 (kt)
0	12964	99	15192	100	15695	98	0	0
0.75	10980	95	9975	82	9137	71	1010	1092
1	10471	92	9095	73	8246	60	1303	1326
1.25	10018	89	8401	64	7569	51	1579	1517
FMSY	10132	92	8569	68	7731	53	1508	1471
ADV2025	10632	93	9059	73	8190	60	1213	1337
ADV2025 x15	10322	91	8520	66	7659	52	1395	1489
TAC2025 x1.15	10119	89	8189	61	7338	47	1517	1584

North stock

Multiplier of F_{2025}	B_{2027}	P(B_{2027} > B_{MSY}) %	B_{2031}	P(B_{2031} > B_{MSY}) %	B_{2035}	P(B_{2035} > B_{MSY}) %	Catch 2026 (kt)	Catch 2027 (kt)
0	977	100	1015	100	1011	100	0	0
0.75	751	100	468	99	386	96	140	147
1	692	100	373	95	292	88	181	179
1.25	640	100	301	89	226	74	219	206
FMSY	599	100	252	89	183	59	251	225
ADV2025	646	99	309	87	233	73	215	203
ADV2025 x15	605	99	258	78	188	57	247	222
TAC2025 x1.15	578	99	230	71	164	46	268	234

9. Figures

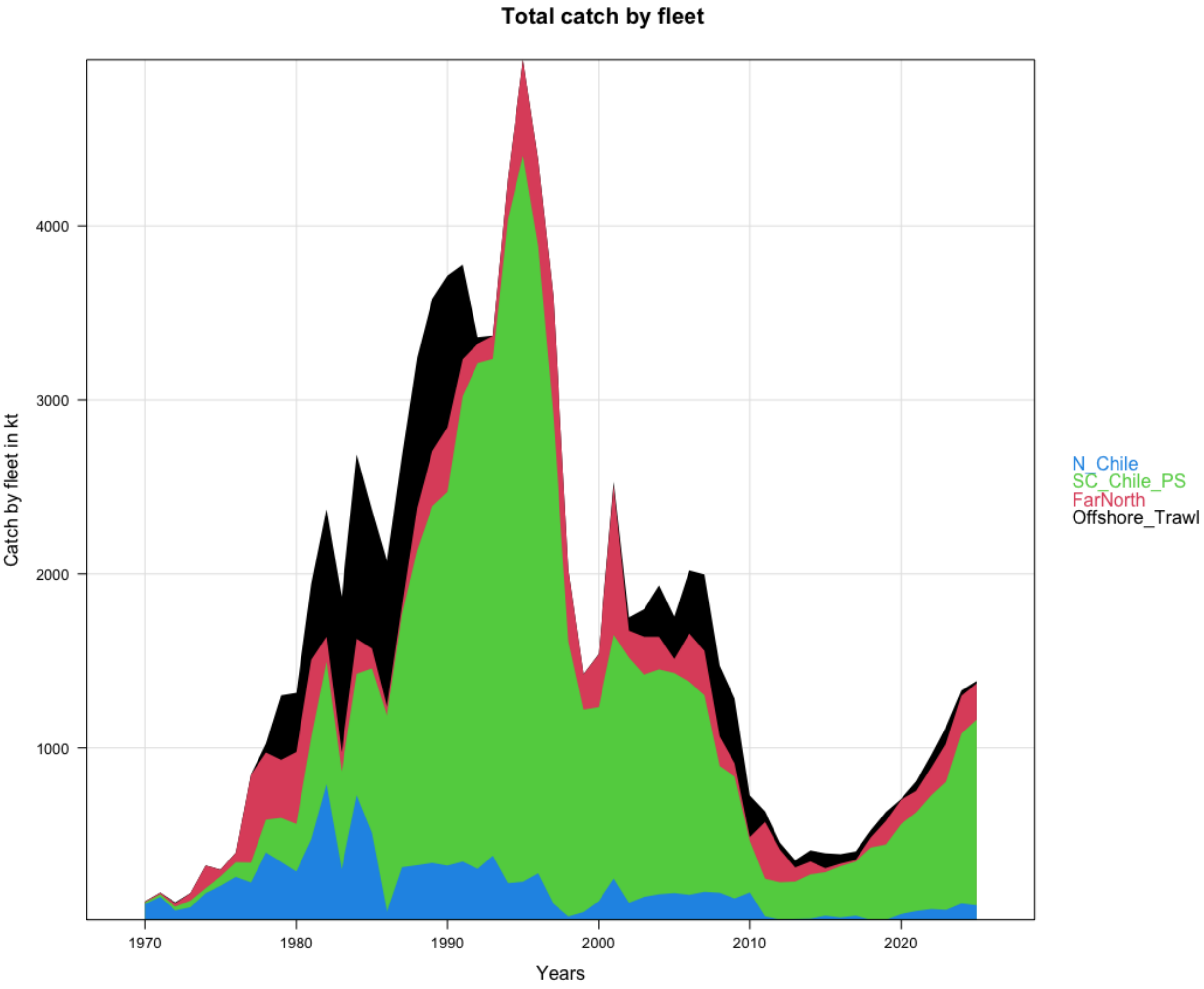

Figure 4: Catch of jack mackerel by fleet. Blue is the northern Chilean fleet, green is the south-central Chilean fleet, red is the far north fleet, and black is the offshore trawl fleet.

Figure 5: Years and types of information used in the jack mackerel assessment models.

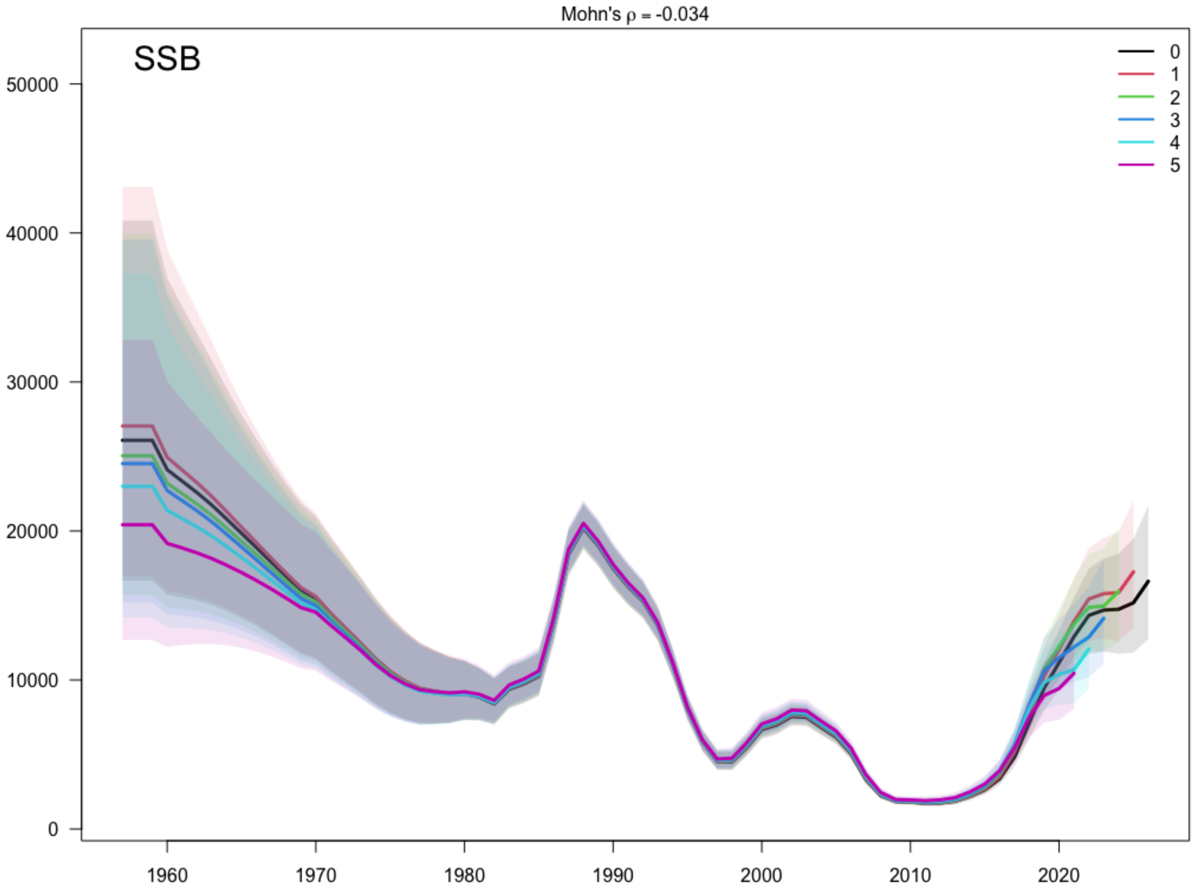

Figure 6: Model retrospective of spawning biomass from 5 separate model runs, based on Model h1_1.14 (single-stock hypothesis).

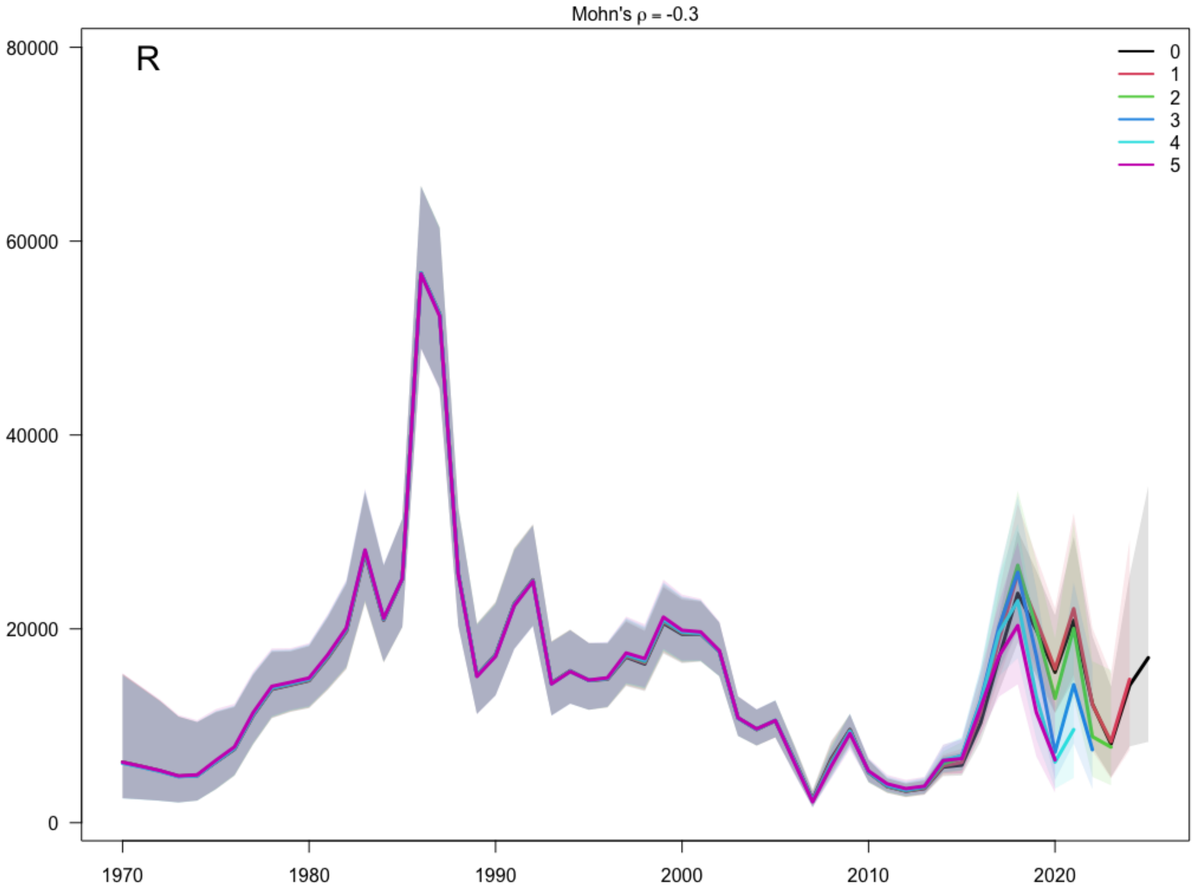

Figure 7: Model retrospective of recruitment from 5 separate model runs, based on Model h1_1.14 (single-stock hypothesis).

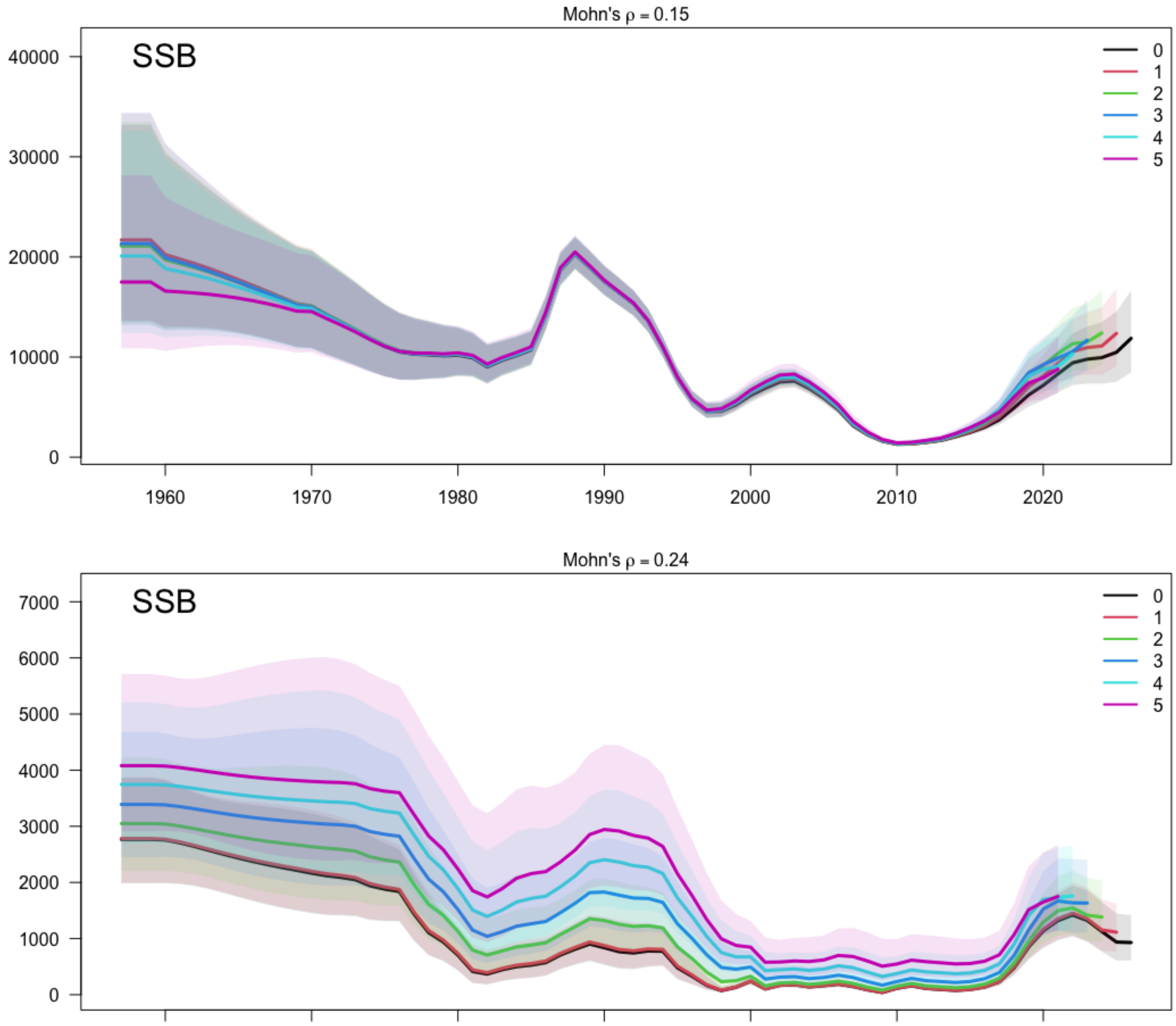

Figure 8: Model retrospective of spawning biomass from 5 separate model runs for the southern stock (top) and far north stock (bottom), based on Model h2_1.14 (two-stock hypothesis).

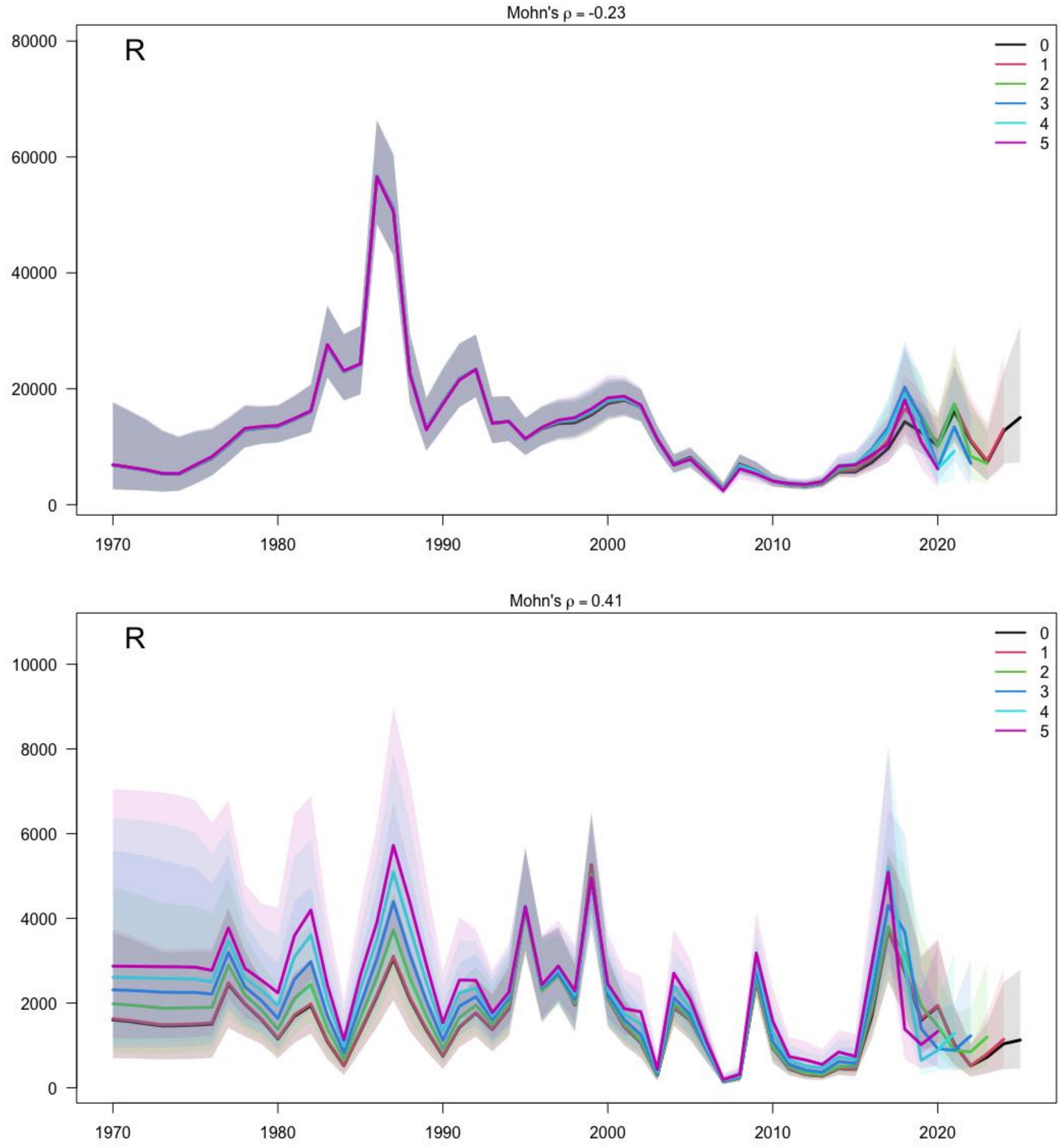

Figure 9: Model retrospective of southern stock recruitment from 5 separate model runs for the southern stock (top) and far north stock (bottom), based on Model h2_1.14 (two-stock hypothesis).

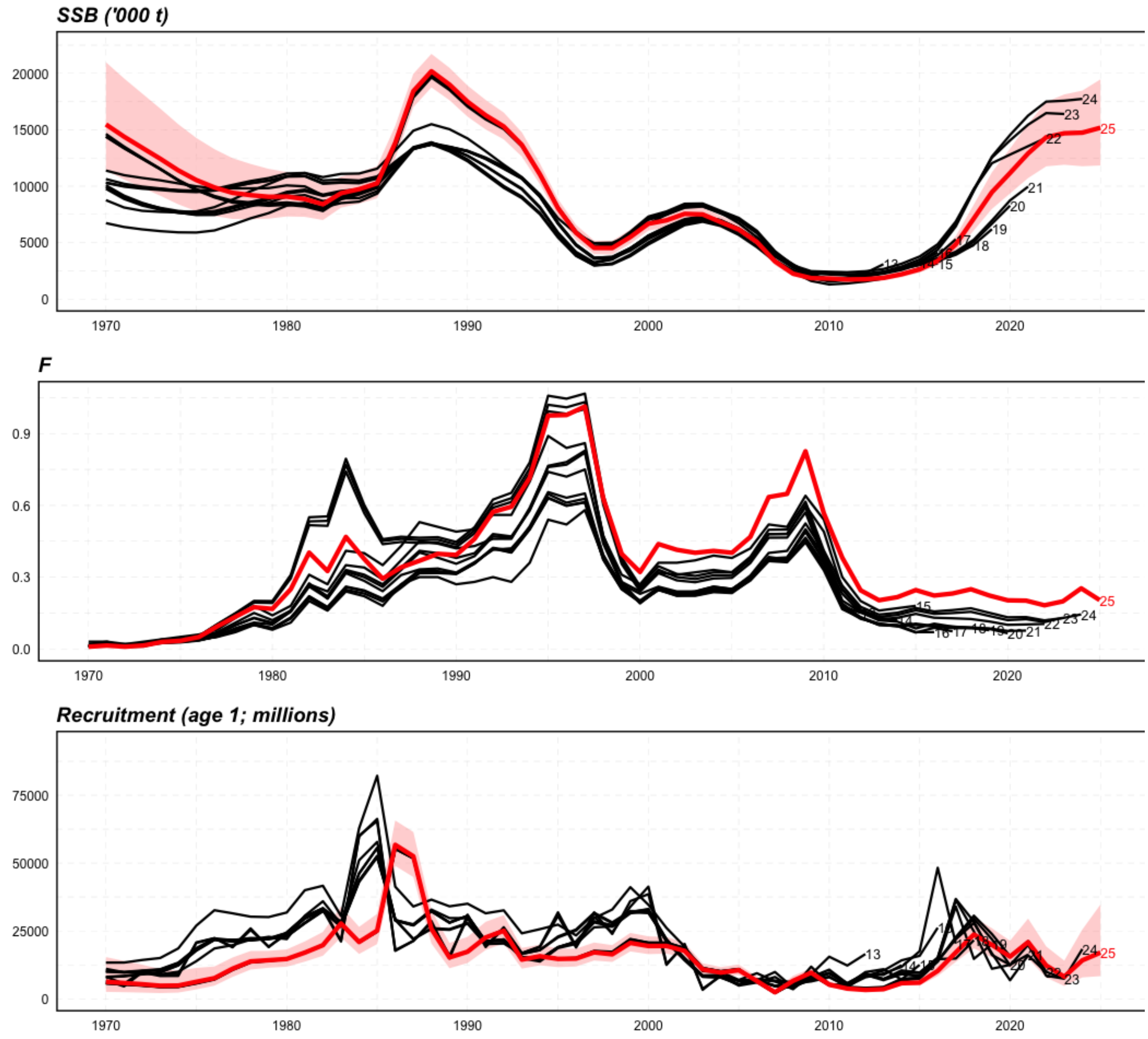

Figure 10: Historical retrospective of spawning stock biomass, fishing mortality, and recruitment estimated from Model h1_1.14 (single-stock hypothesis), as estimated and used for advice from SPFRMO Scientific Committees 2013-2025

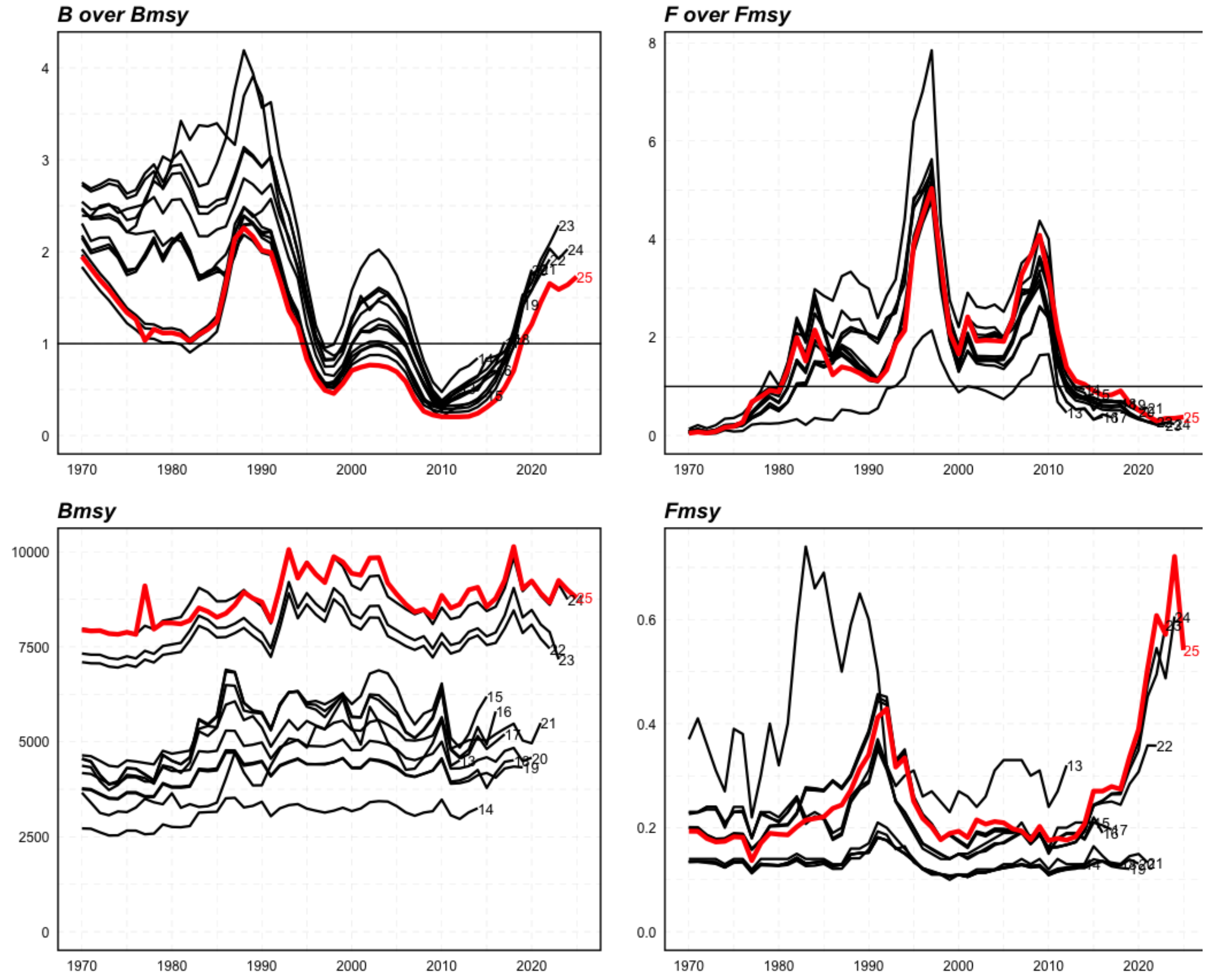

Figure 11: Historical retrospective of management reference points estimated from Model h1_1.14 (single-stock hypothesis), as estimated and used for advice from past (and present) SPRFMO Scientific Committees.

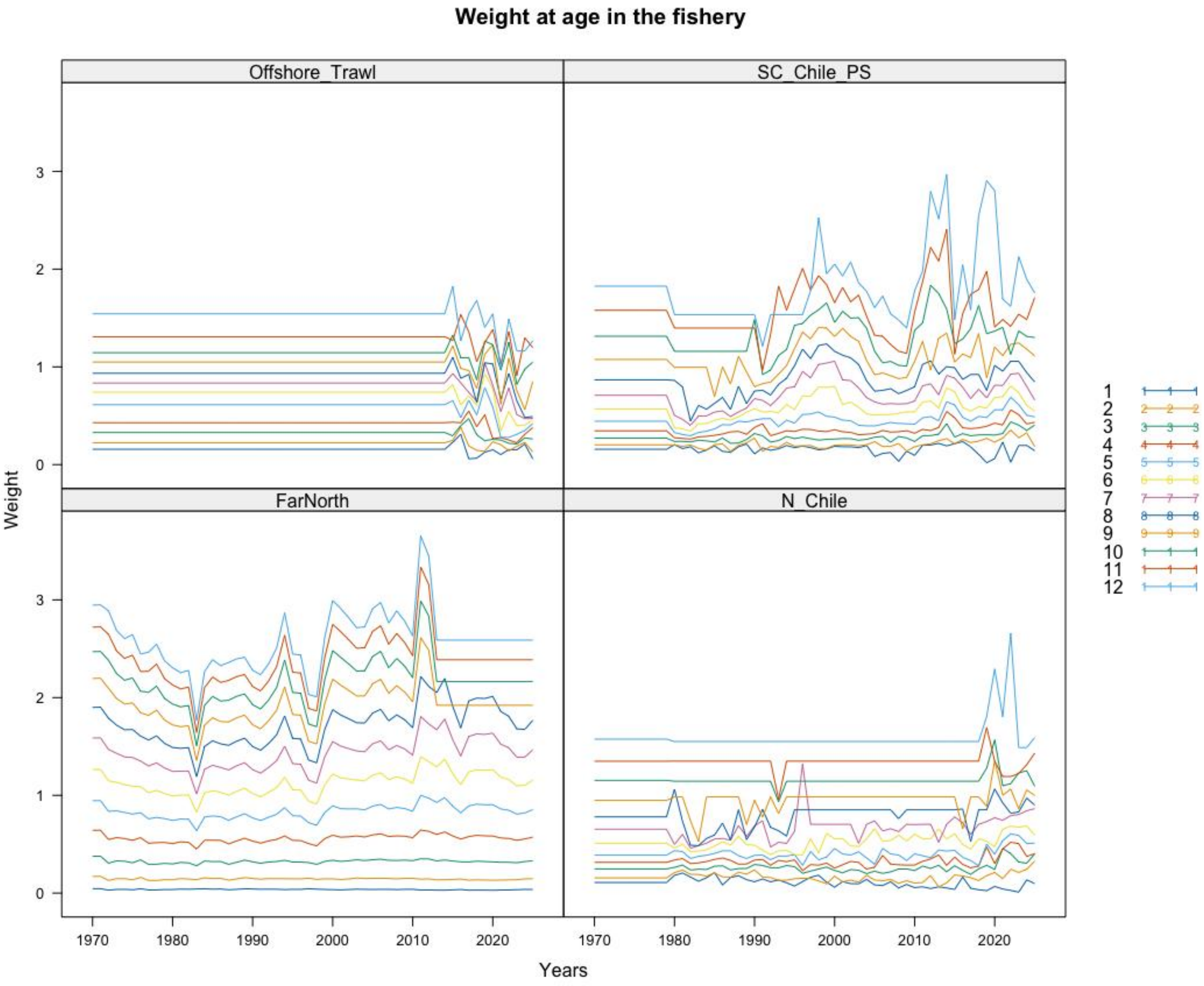

Figure 12: Mean weights-at-age (kg) over time used for the fisheries in the JJM models. Each line represents an age from 1 to 12.

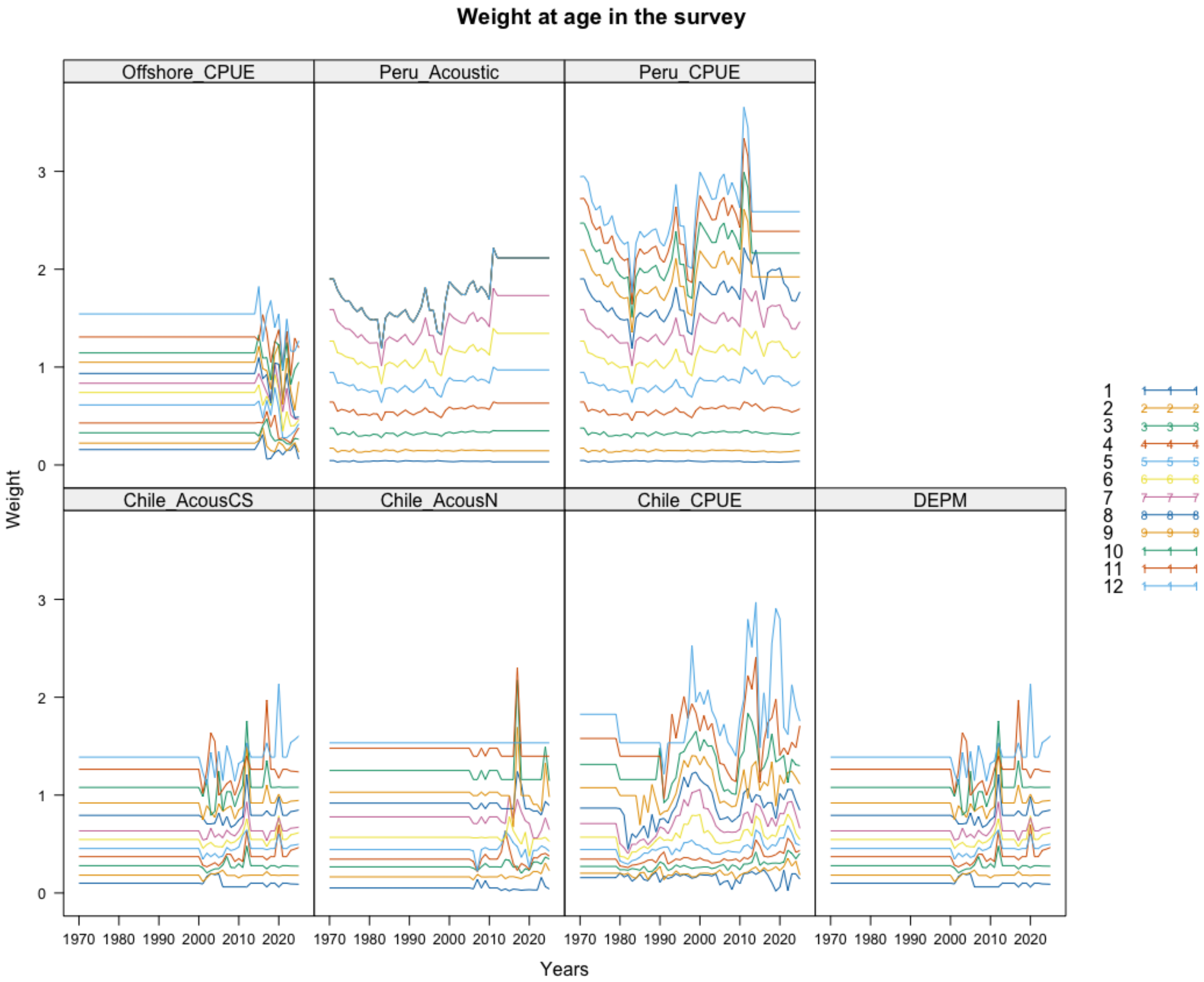

Figure 13: Mean weights-at-age (kg) over time used for the surveys in the JJM models. Each line represents an age from 1 to 12.

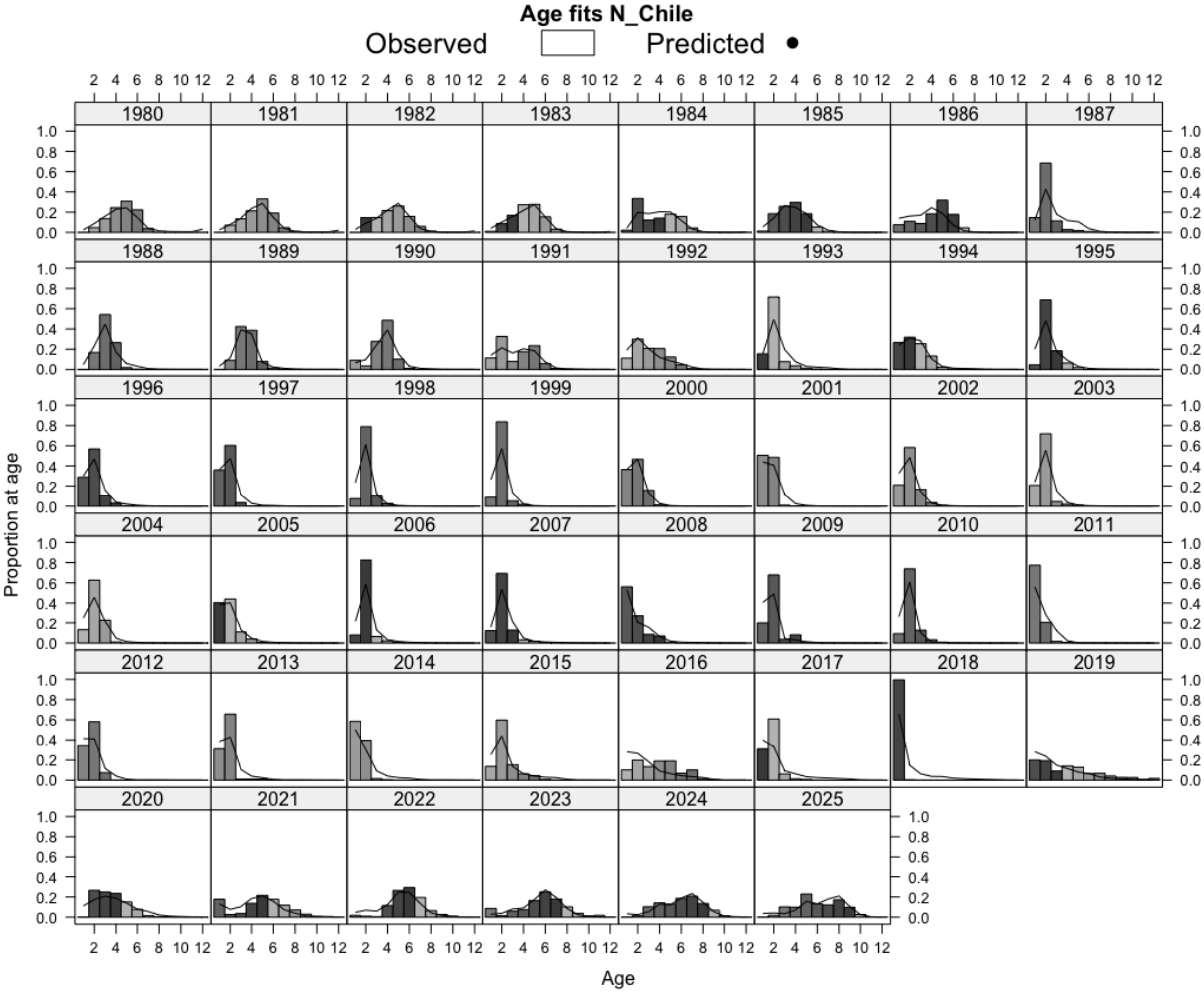

Figure 14: Model h1_1.14 (single-stock hypothesis) fit to the age compositions for the Chilean northern zone fishery (Fleet 1). Bars represent the observed data and lines represent the model predictions.

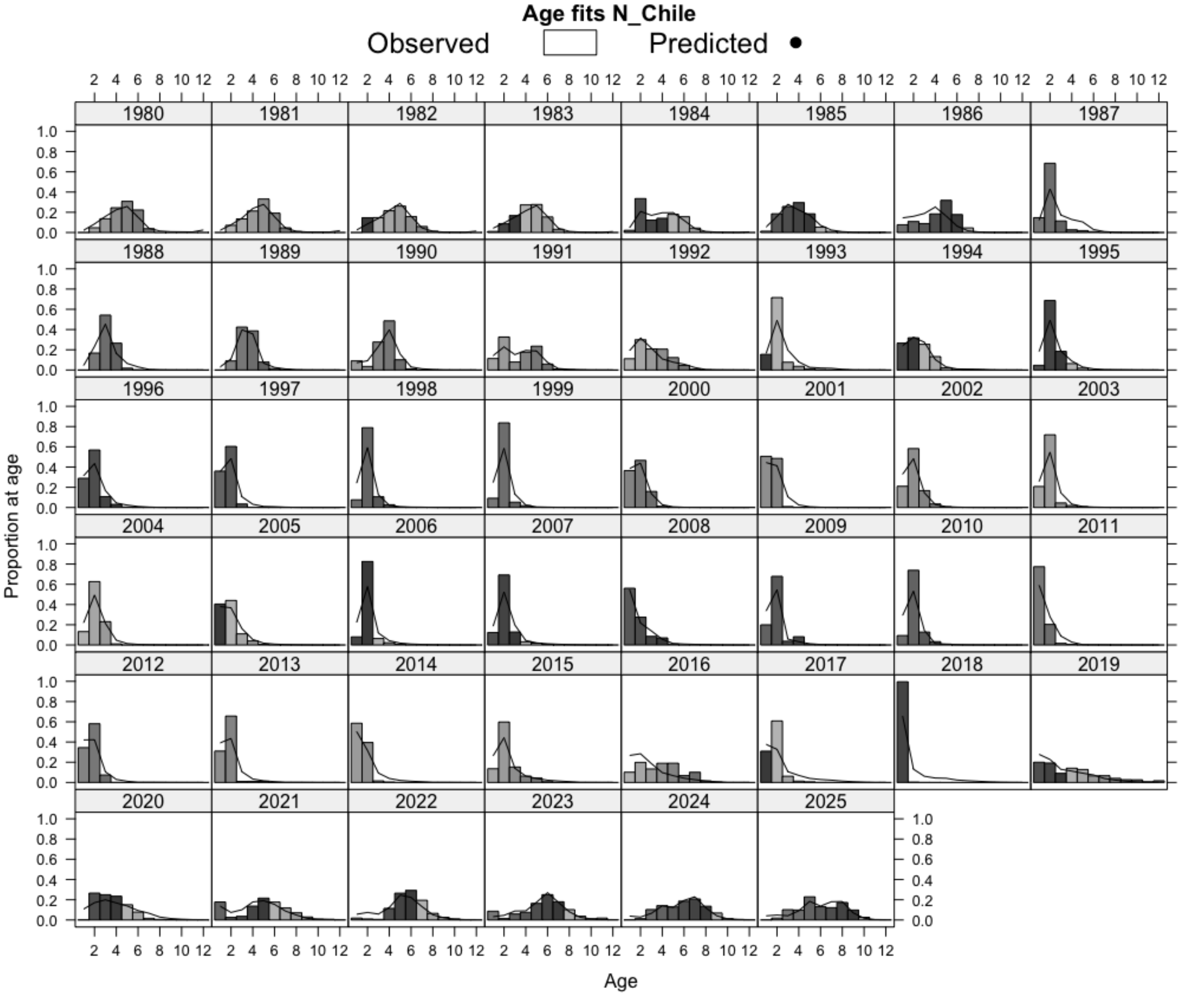

Figure 15: Model h2_1.14 (two-stock hypothesis) fit to the age compositions for the Chilean northern zone fishery (Fleet 1). Bars represent the observed data and lines represent the model predictions.

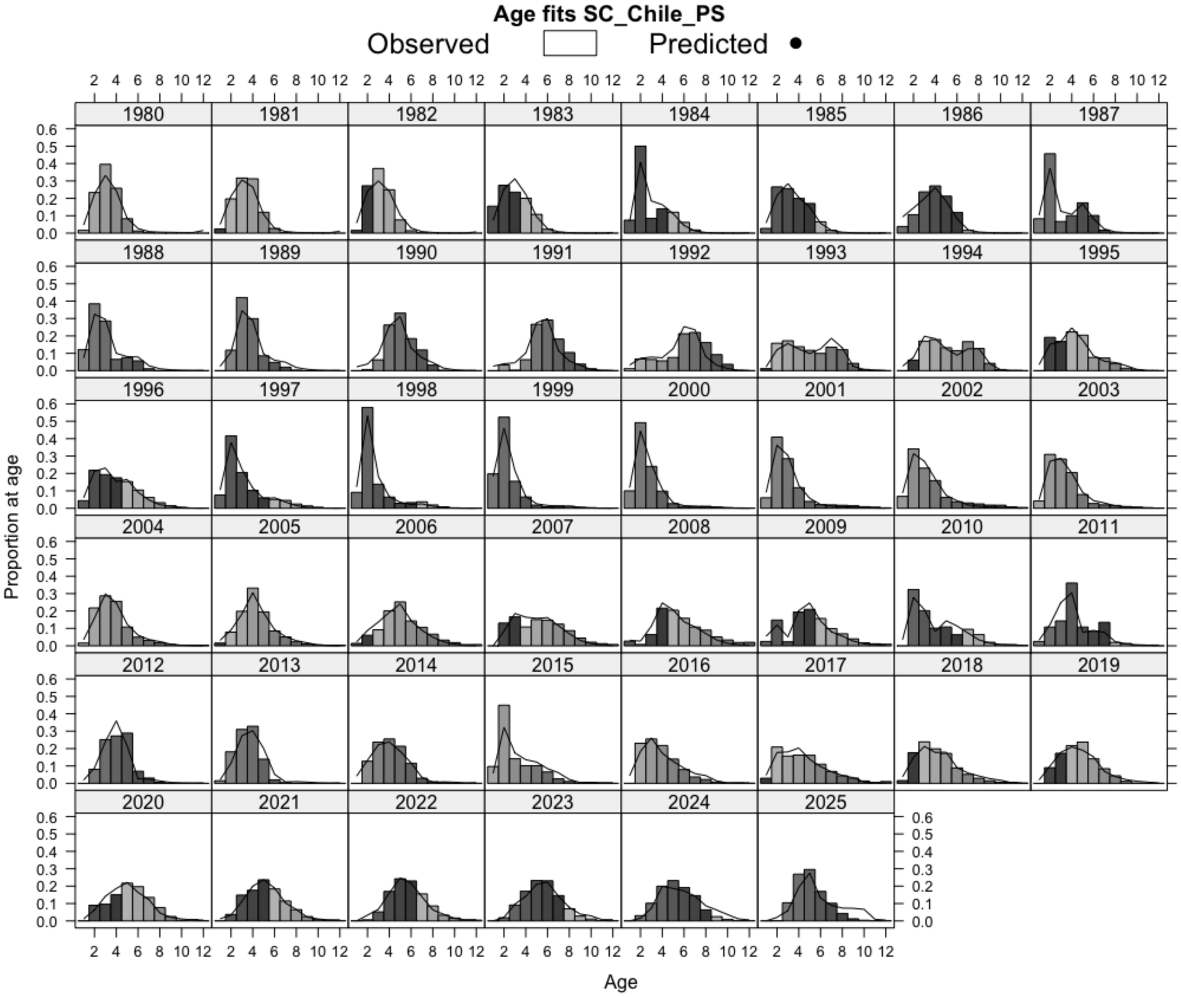

Figure 16: Model h1_1.14 (single-stock hypothesis) fit to the age compositions for the South-Central Chilean purse seine fishery (Fleet 2). Bars represent the observed data and lines represent the model predictions.

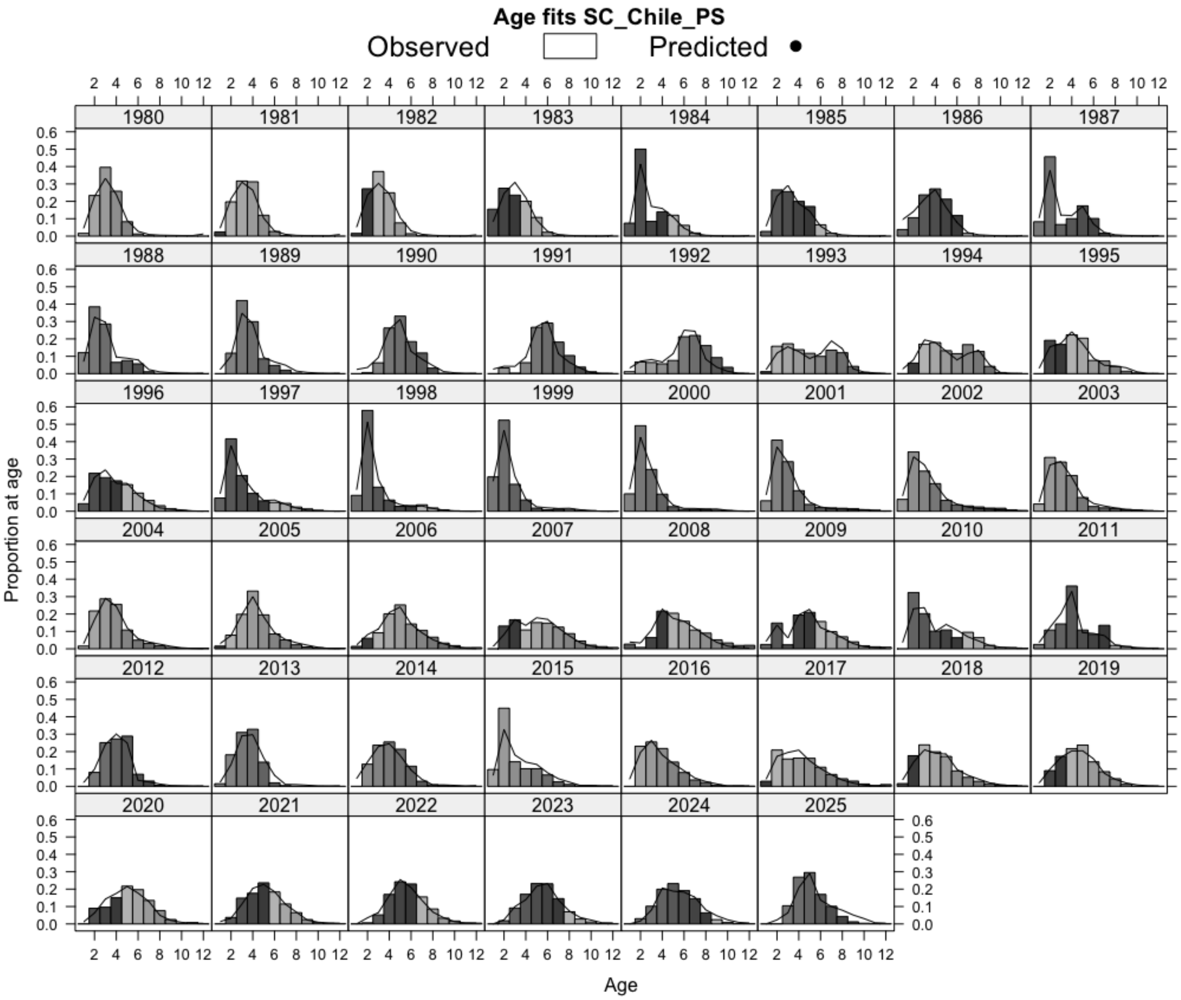

Figure 17: Model h2_1.14 (two-stock hypothesis) fit to the age compositions for the South-Central Chilean purse seine fishery (Fleet 2). Bars represent the observed data and lines represent the model predictions.

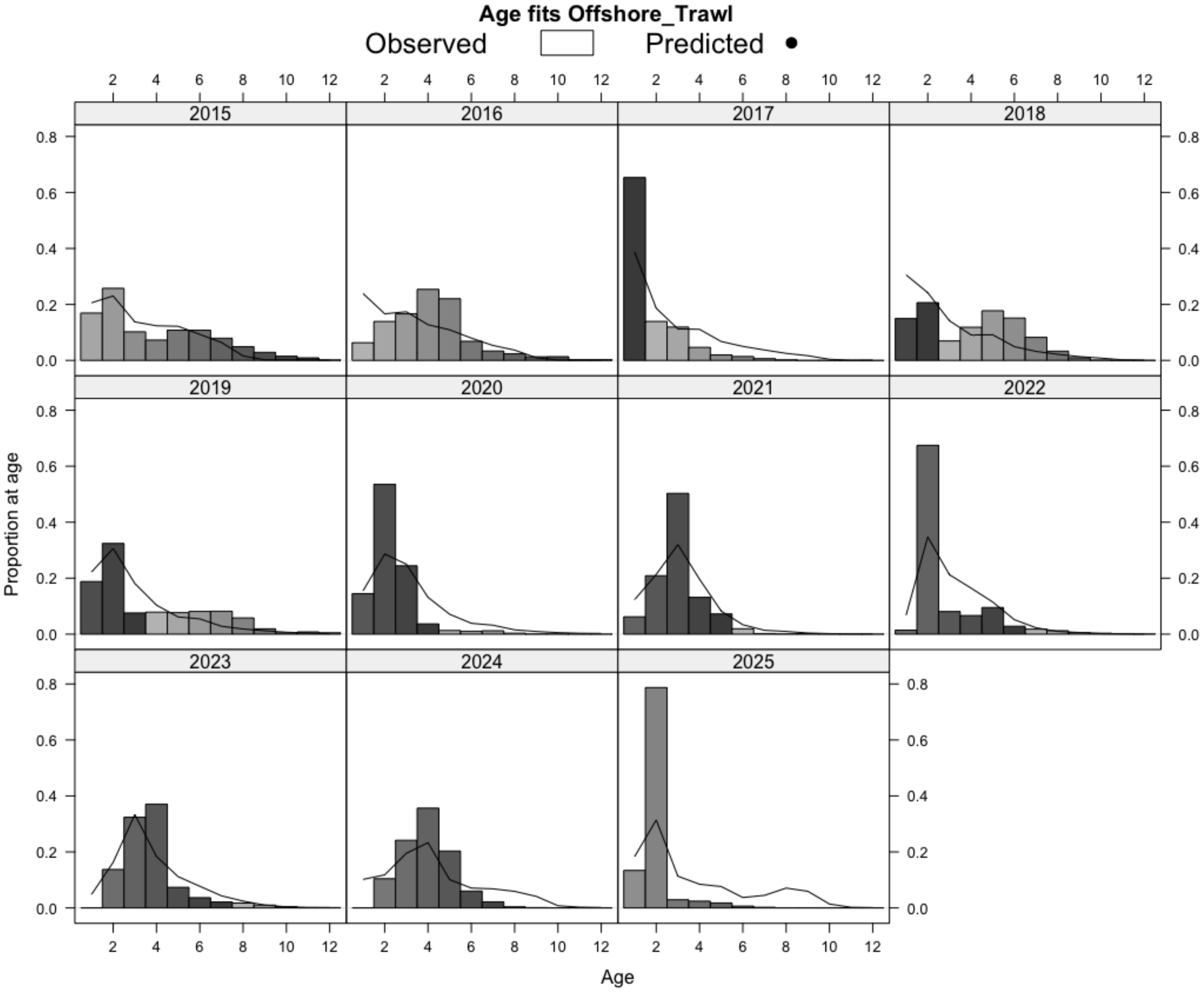

Figure 18: Model h1_1.14 (single-stock hypothesis) fit to the age compositions for the offshore trawl fishery (Fleet 4). Bars represent the observed data and lines represent the model predictions.

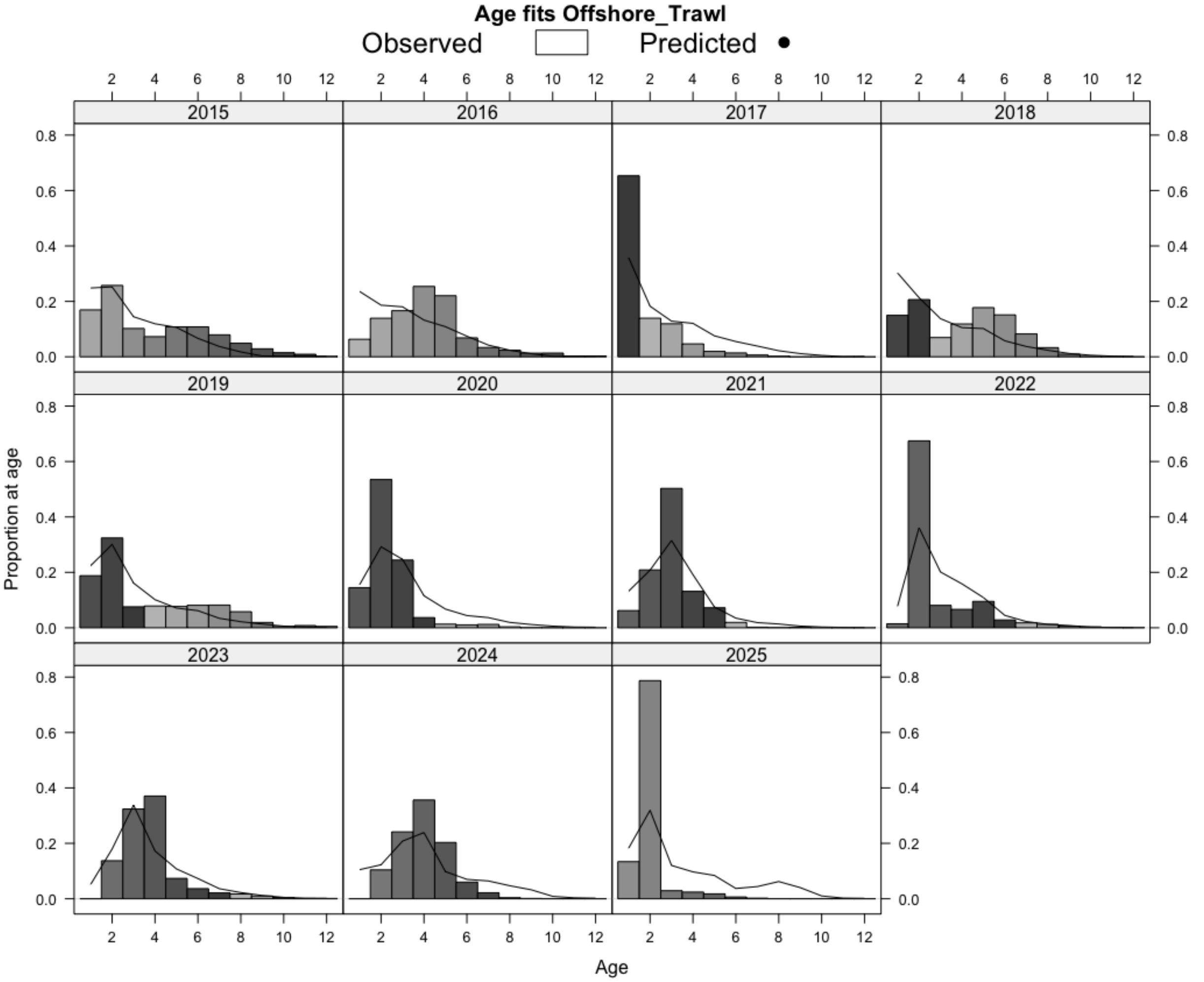

Figure 19: Model h2_1.14 (two-stock hypothesis) fit to the age compositions for the offshore trawl fishery (Fleet 4). Bars represent the observed data and lines represent the model predictions.

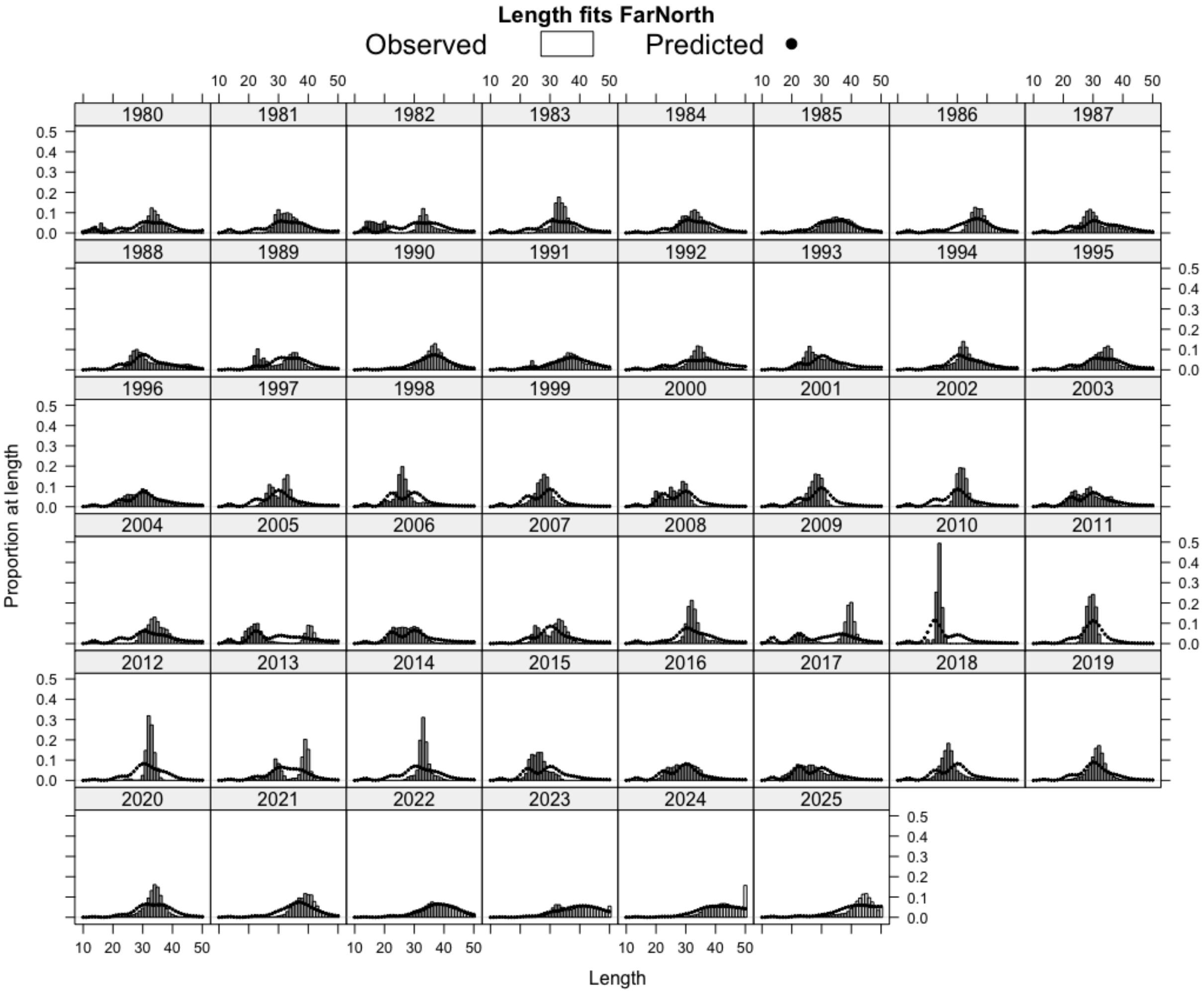

Figure 20: Model h1_1.14 (single-stock hypothesis) fit to the length compositions for the far north fishery (Fleet 3). Bars represent the observed data and lines represent the model predictions.

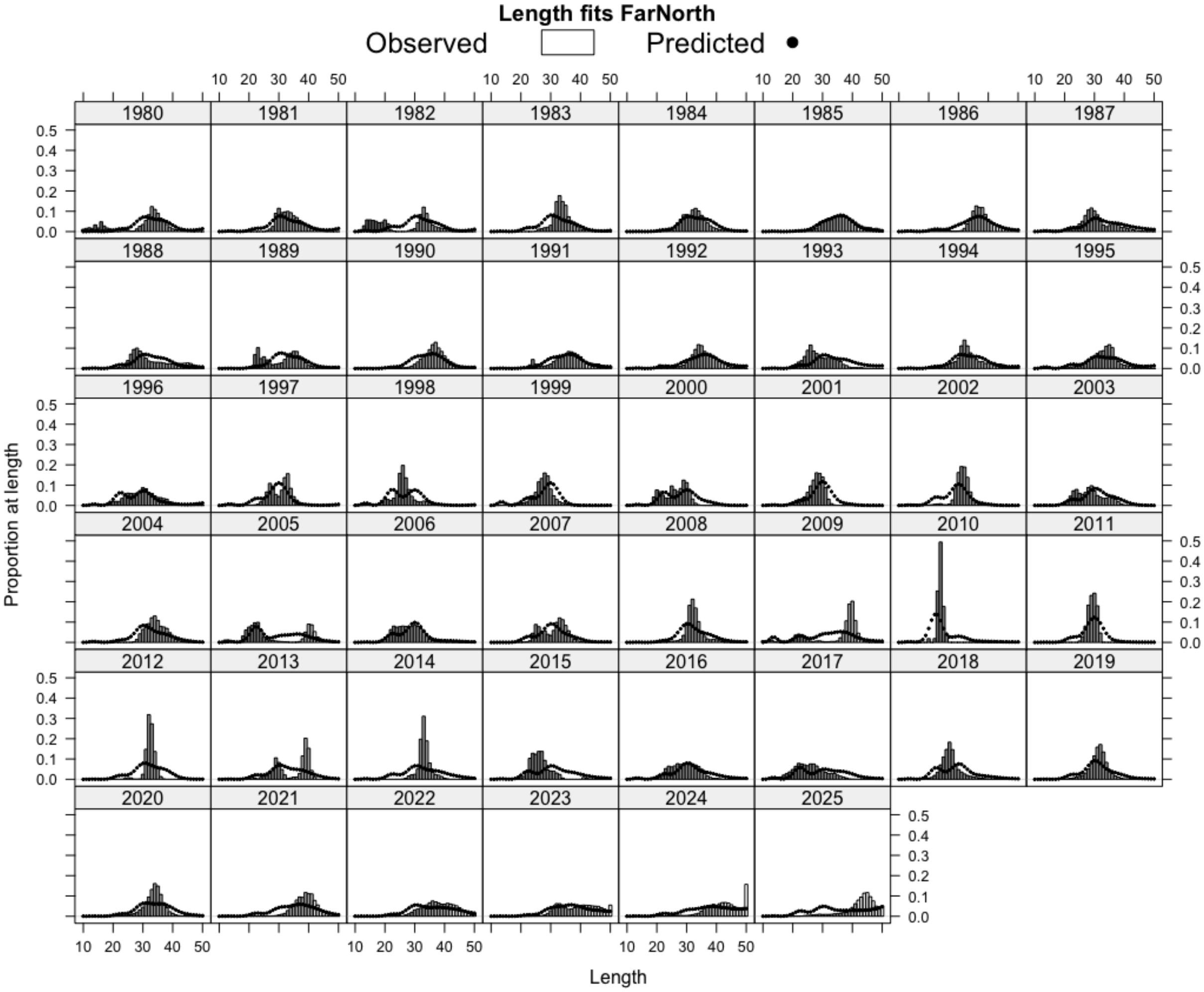

Figure 21: Model h2_1.14 (two-stock hypothesis) fit to the length compositions for the far north fishery (Fleet 3). Bars represent the observed data and lines represent the model predictions.

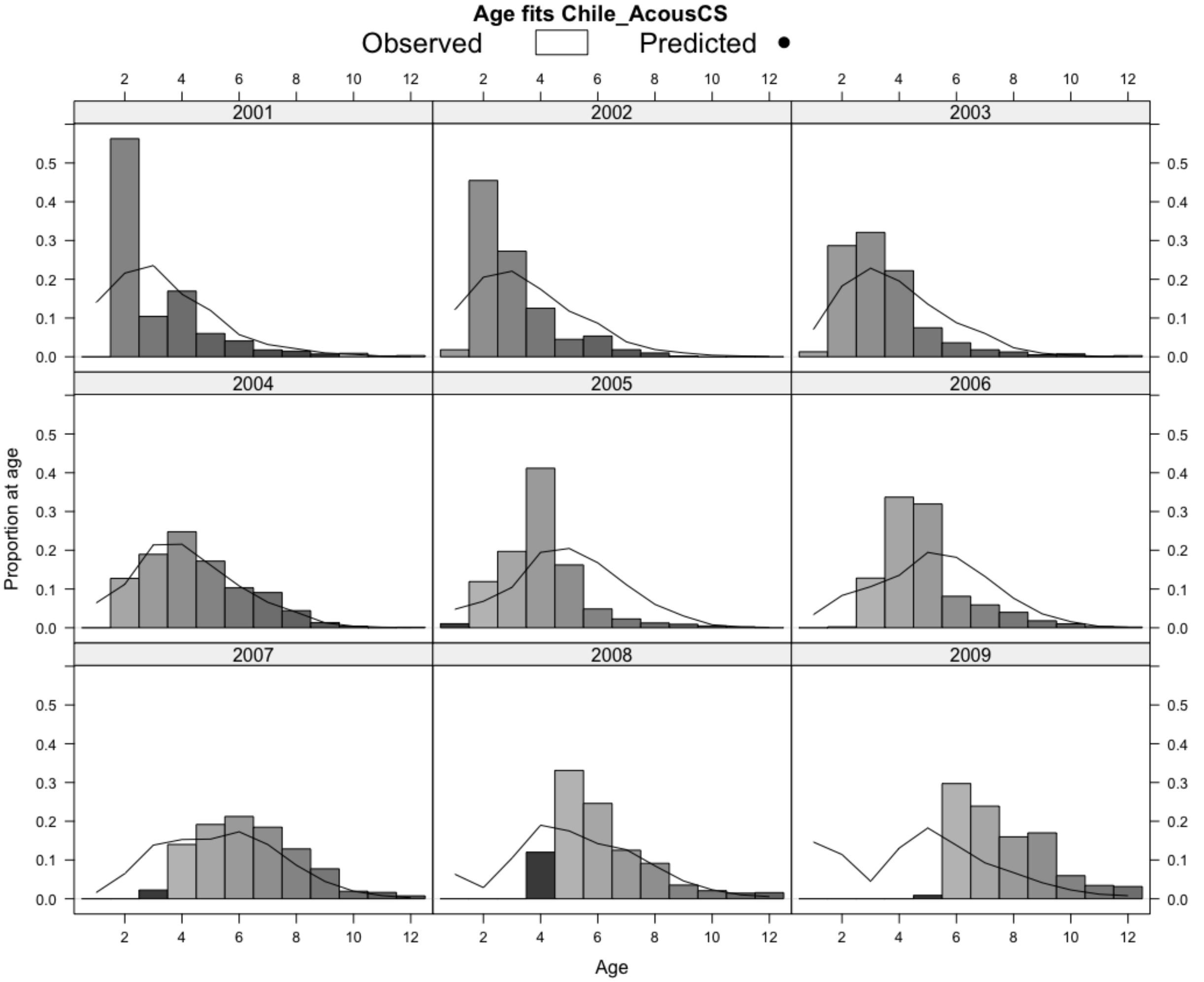

Figure 22: Model h1_1.14 (single-stock hypothesis) fit to the age compositions for the South-Central Acoustic survey. Bars represent the observed data and lines represent the model predictions.

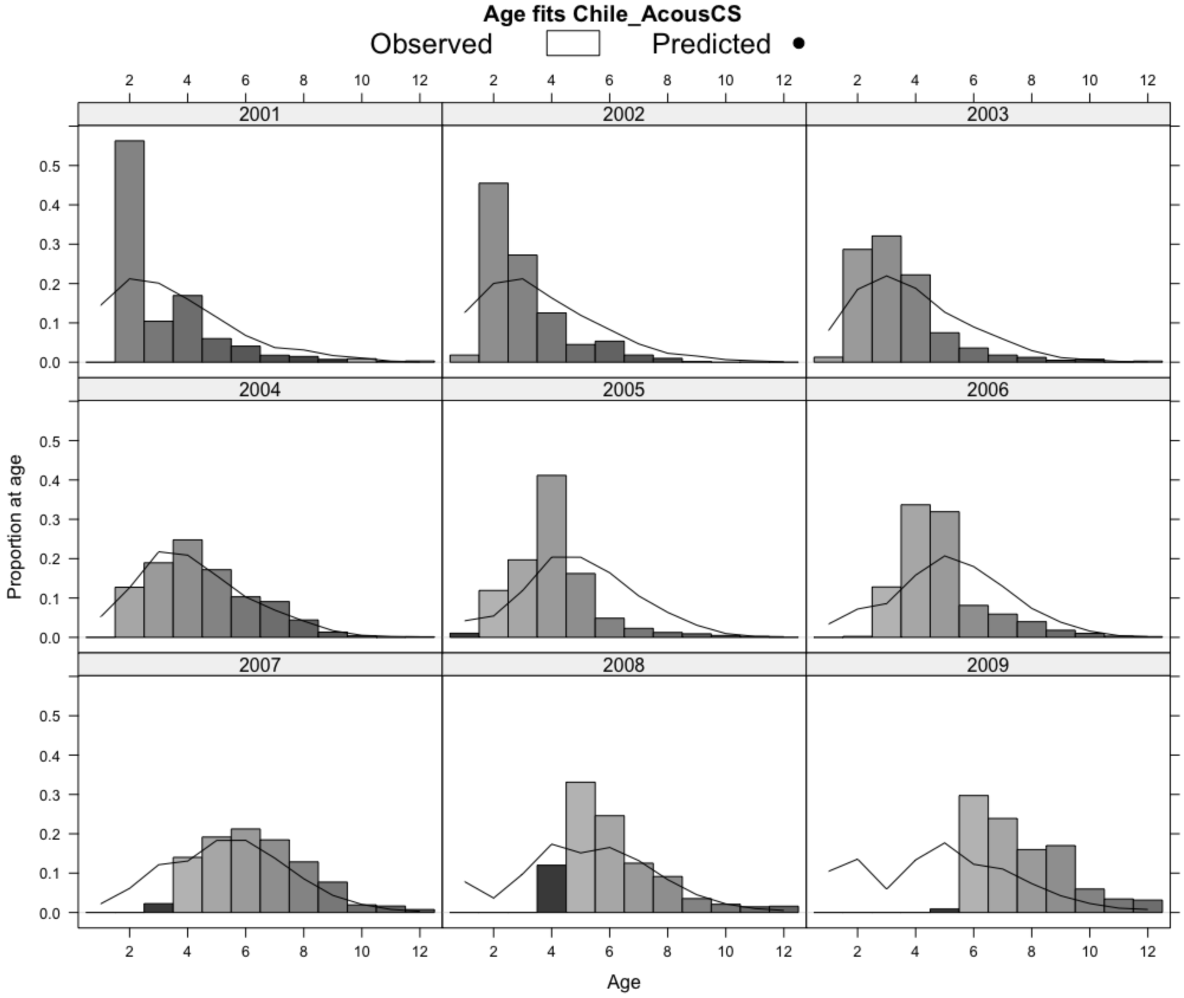

Figure 23: Model h2_1.14 (two-stock hypothesis) fit to the age compositions for the South-Central Acoustic survey. Bars represent the observed data and lines represent the model predictions.

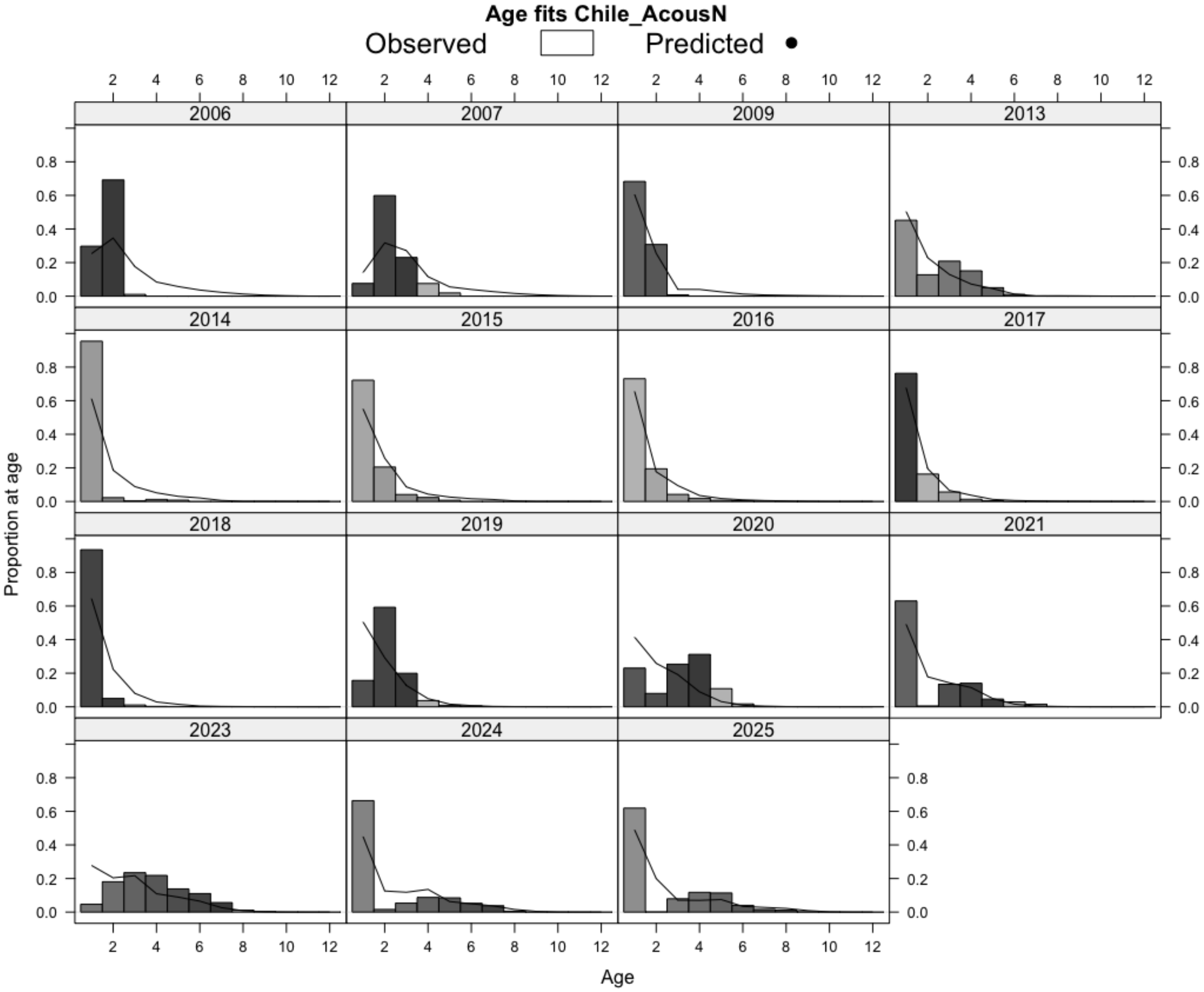

Figure 24: Model h1_1.14 (single-stock hypothesis) fit to the age compositions for the North Chilean acoustic survey. Bars represent the observed data and lines represent the model predictions.

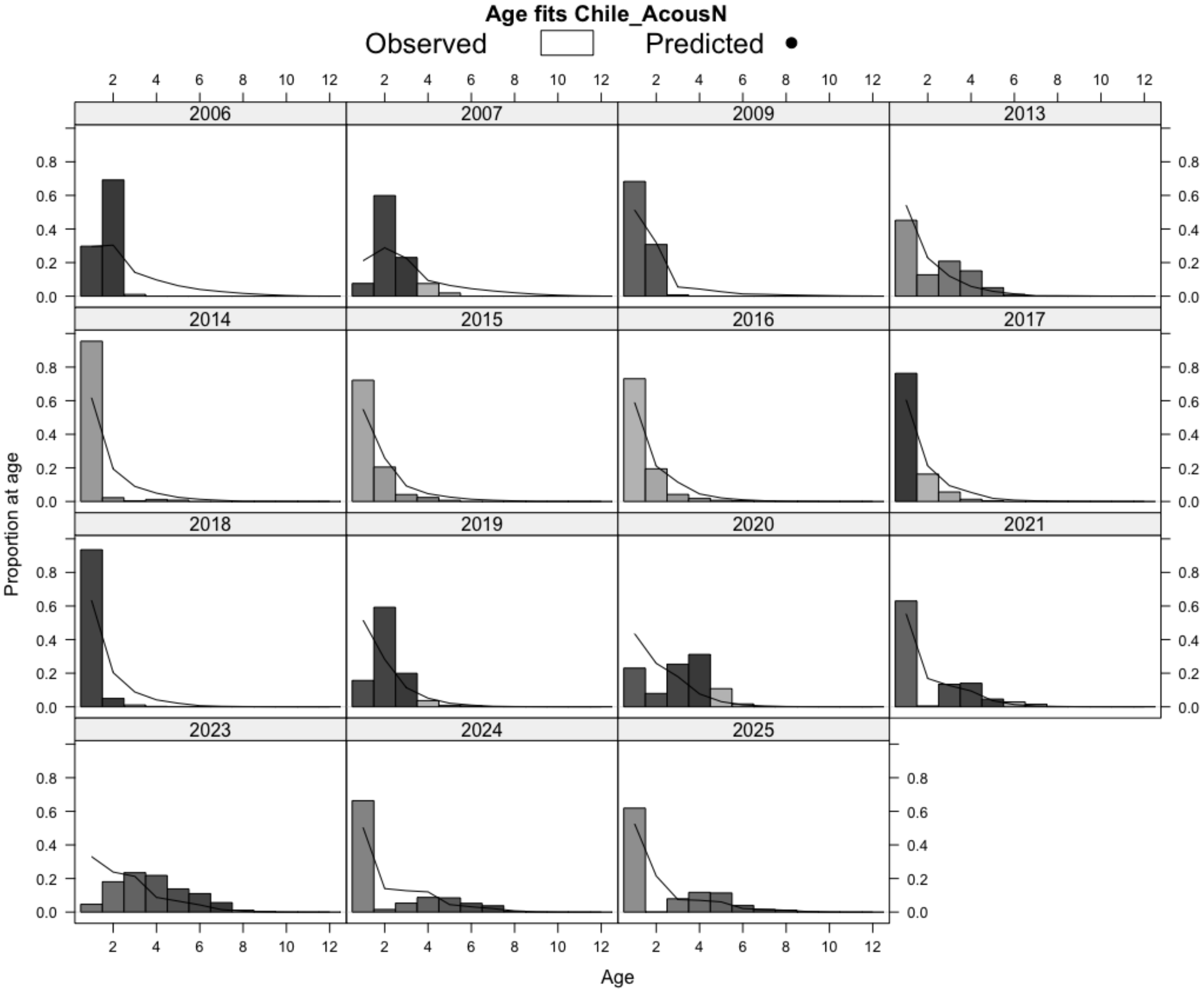

Figure 25: Model h2_1.14 (two-stock hypothesis) fit to the age compositions for the North Chilean acoustic survey. Bars represent the observed data and lines represent the model predictions.

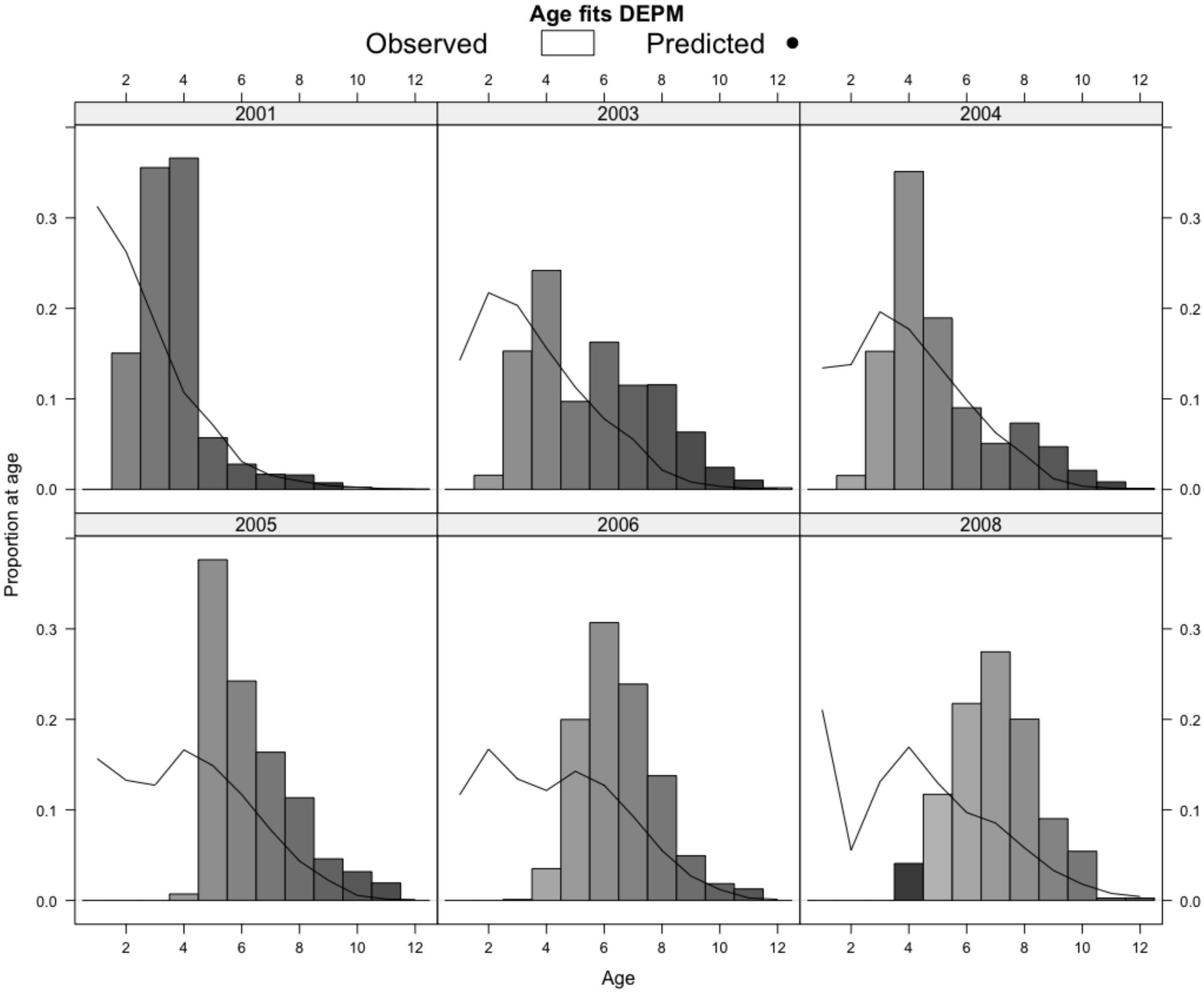

Figure 26: Model h1_1.14 (single-stock hypothesis) fit to the age compositions for the Daily Egg Production Method (DEPM) survey. Bars represent the observed data and lines represent the model predictions.

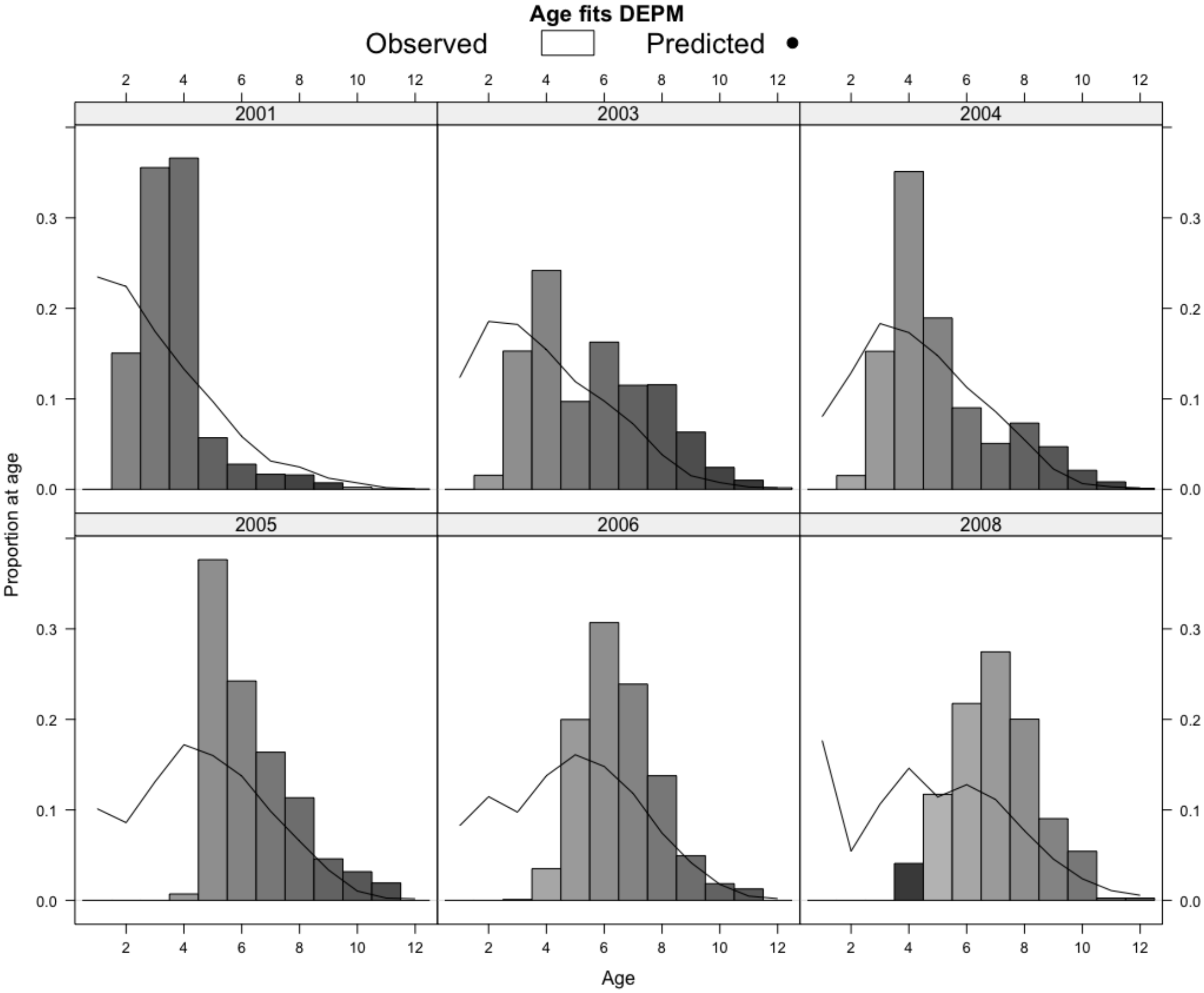

Figure 27: Model h2_1.14 (two-stock hypothesis) fit to the age compositions for the Daily Egg Production Method (DEPM) survey. Bars represent the observed data and lines represent the model predictions.

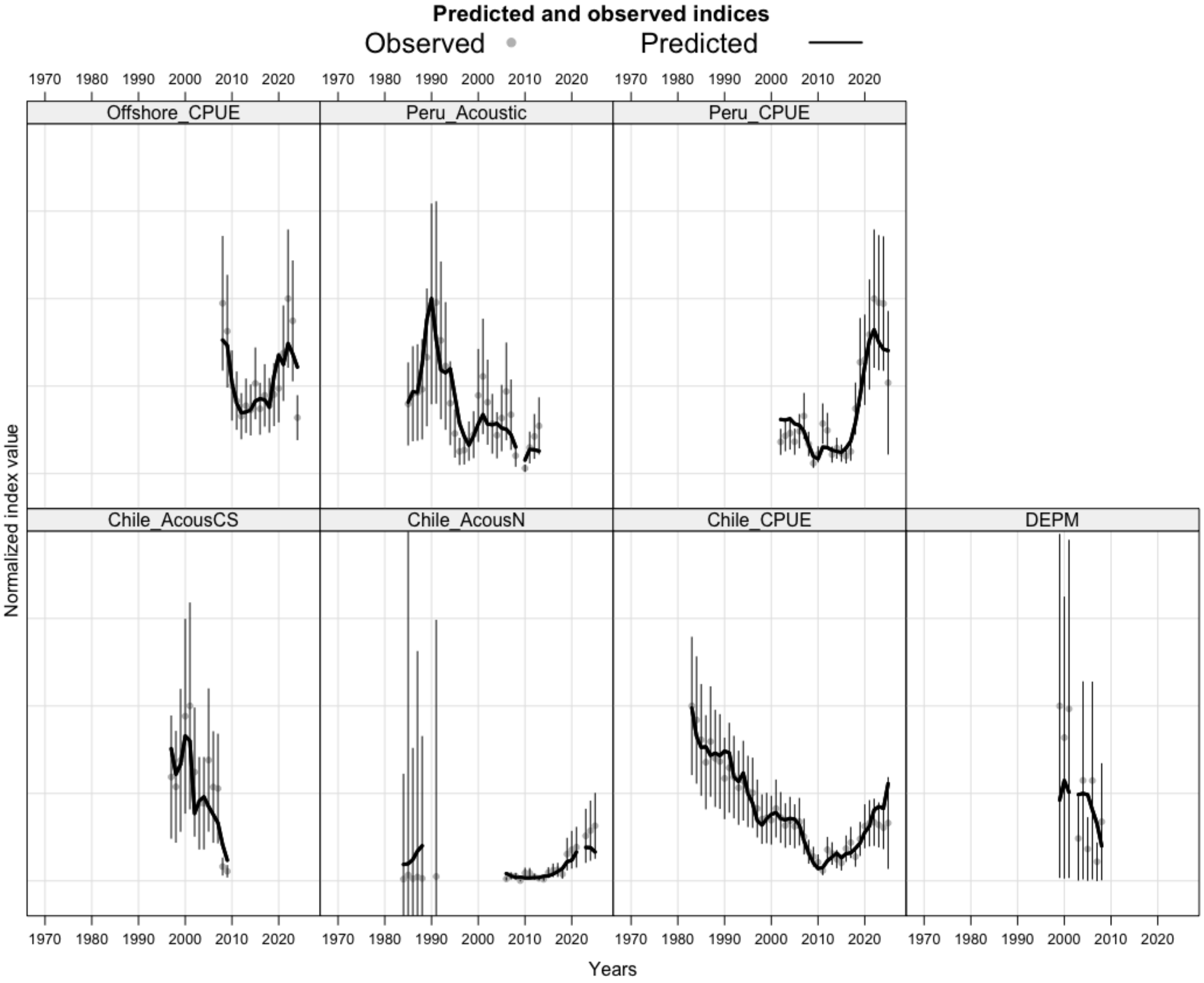

Figure 28: Model h1_1.14 (single-stock hypothesis) fit to different indices. Vertical bars represent 2 standard deviations around the observations.

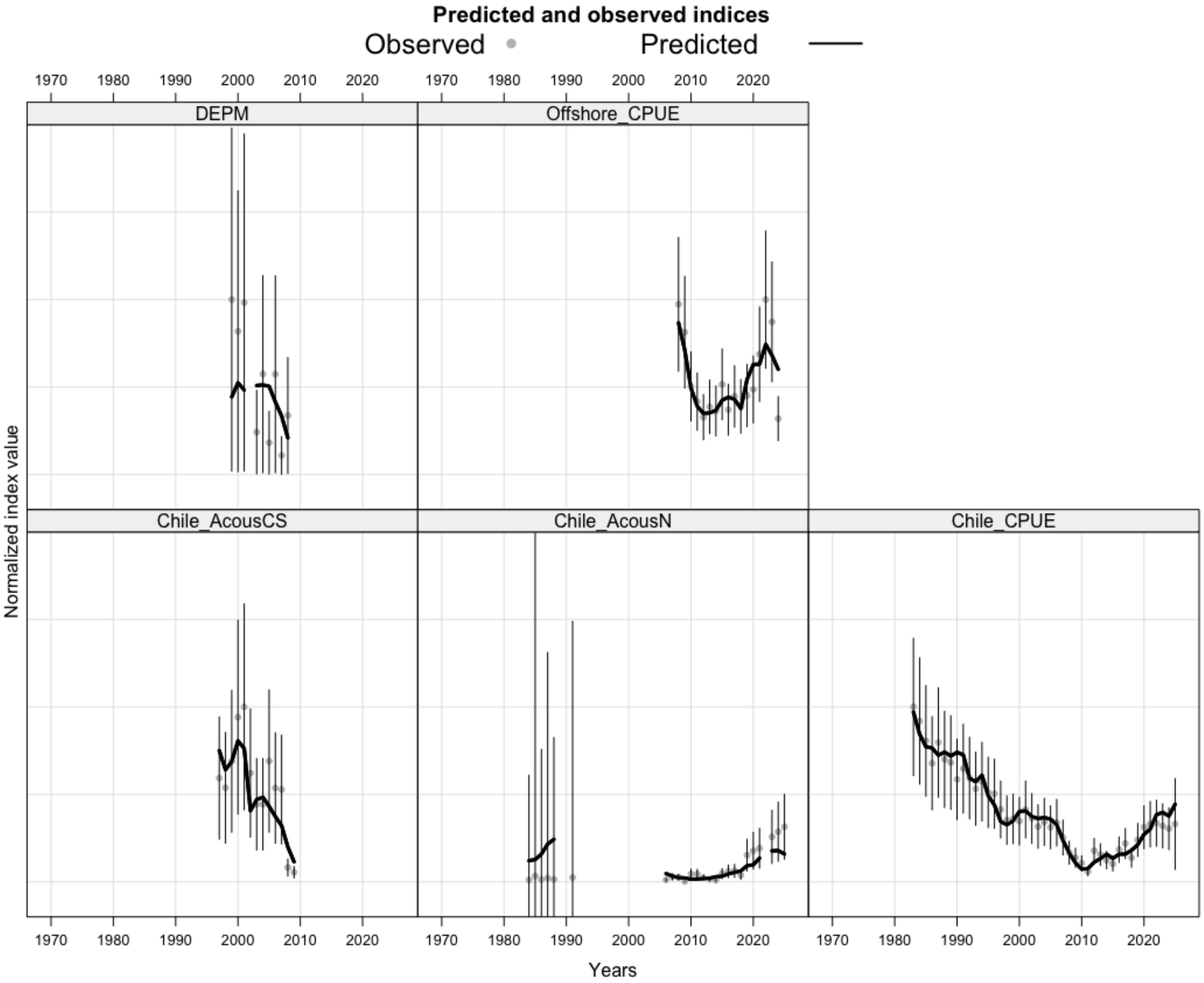

Figure 29: Model h2_1.14 (two-stock hypothesis) fit to indices for the south stock. Vertical bars represent 2 standard deviations around the observations.

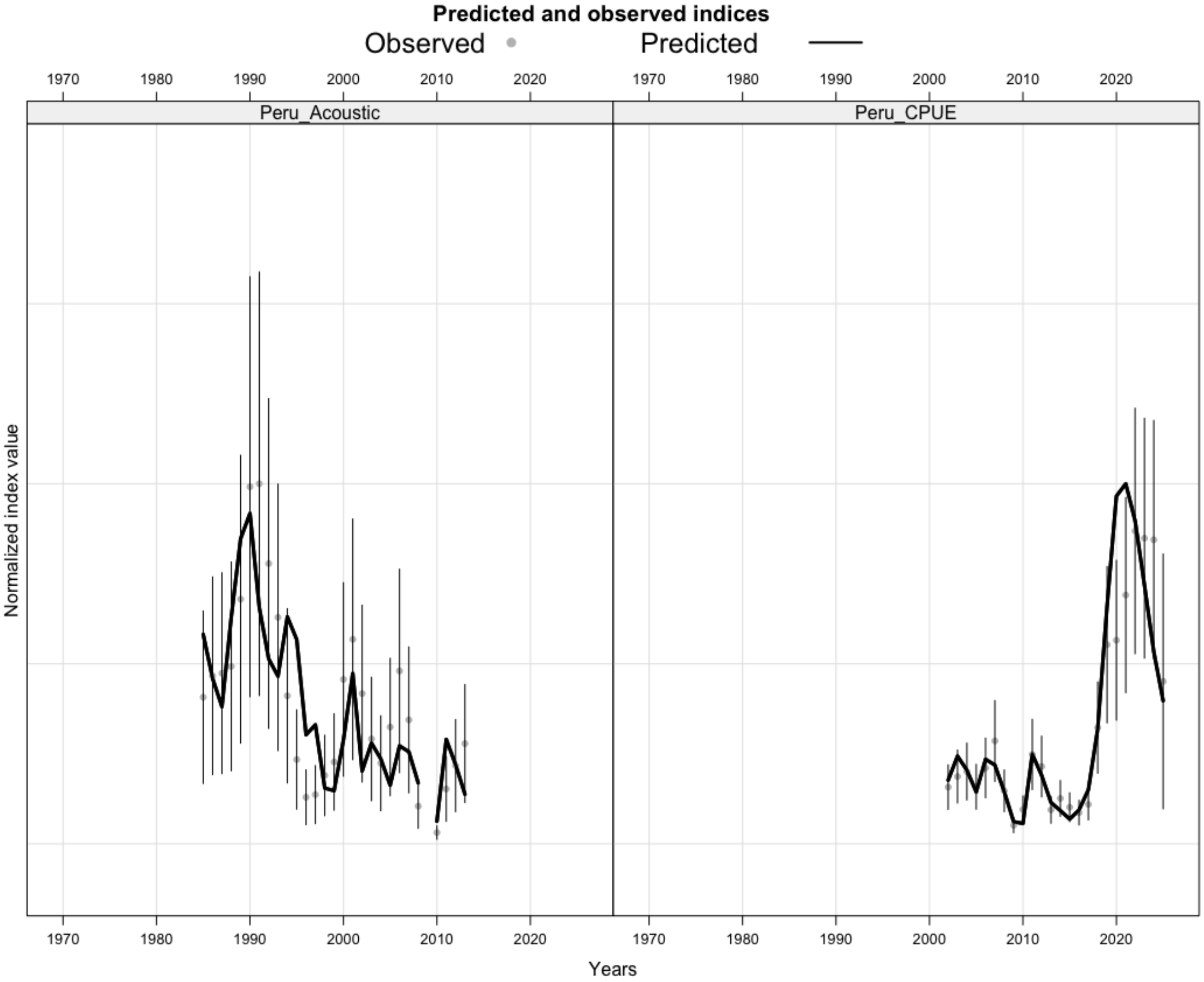

Figure 30: Model h2_1.14 (two-stock hypothesis) fit to indices for the north stock. Vertical bars represent 2 standard deviations around the observations.

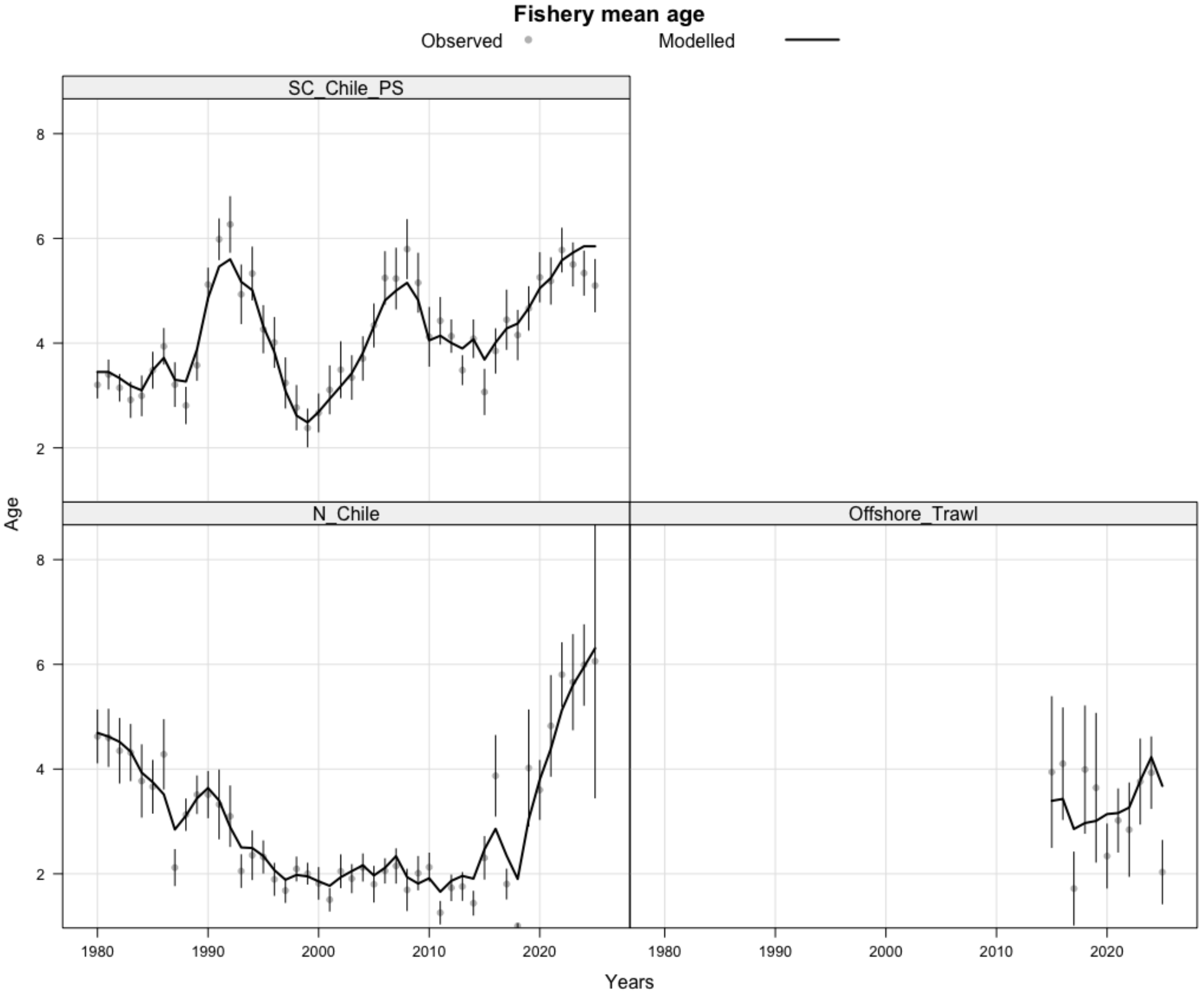

Figure 31: Mean age by year and fishery. Line represents the Model h1_1.14 (single-stock hypothesis) predictions and dots observed values with implied input error bars.

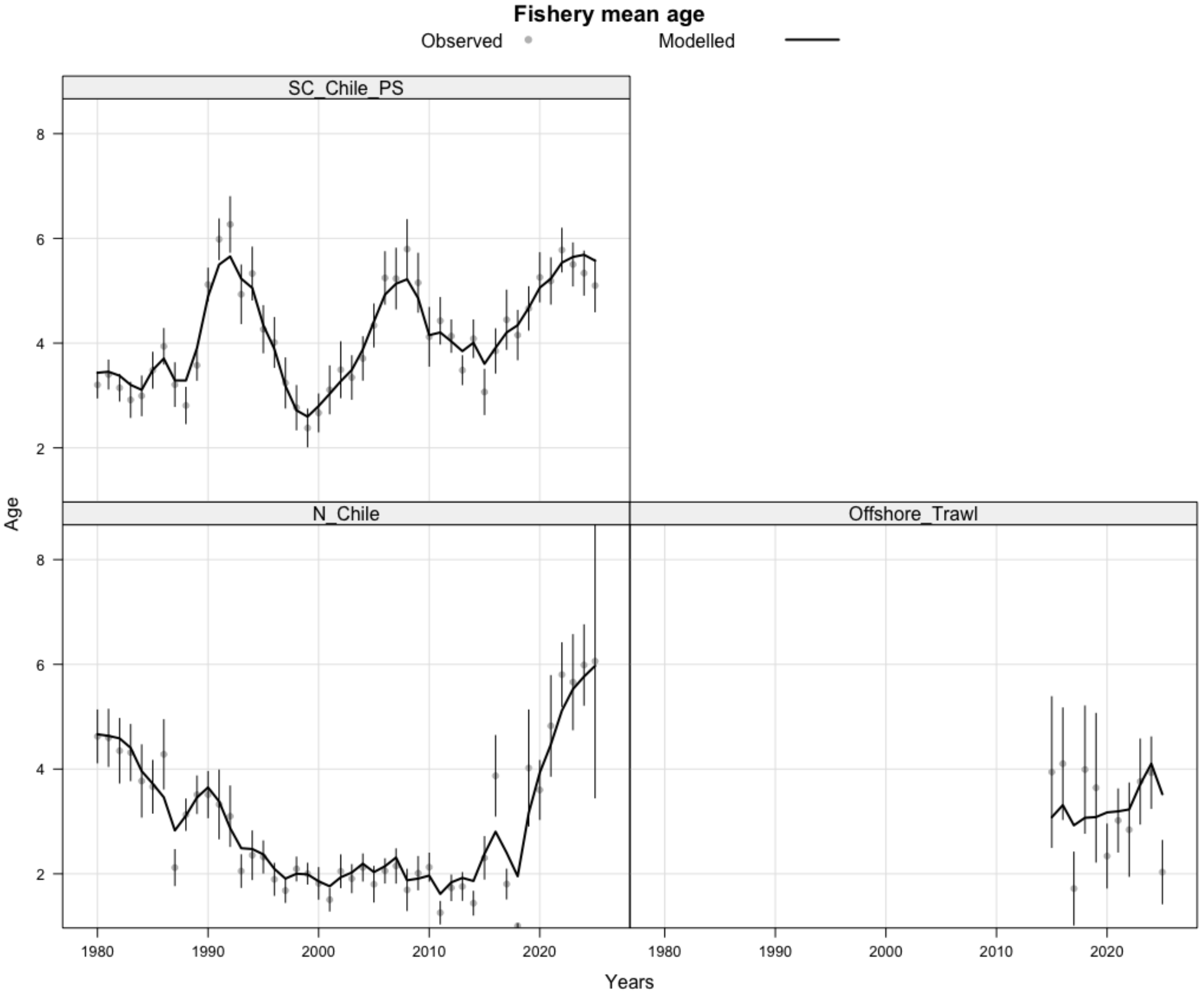

Figure 32: Mean age by year and fishery. Line represents the Model h2_1.14 (two-stock hypothesis) predictions and dots observed values with implied input error bars.

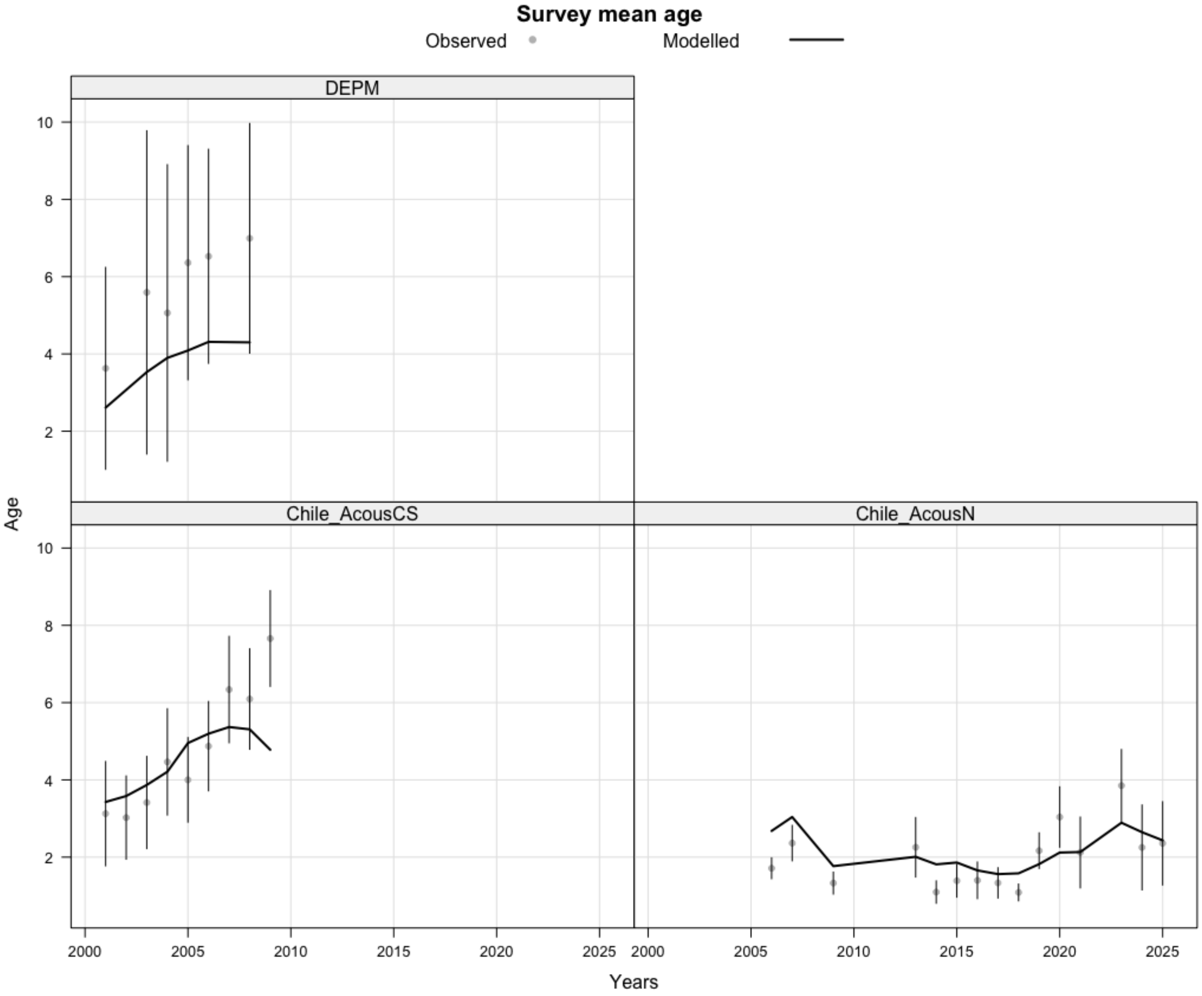

Figure 33: Mean age by year and survey. Line represents the Model h1_1.14 (single-stock hypothesis) predictions and dots observed values with implied input error bars.

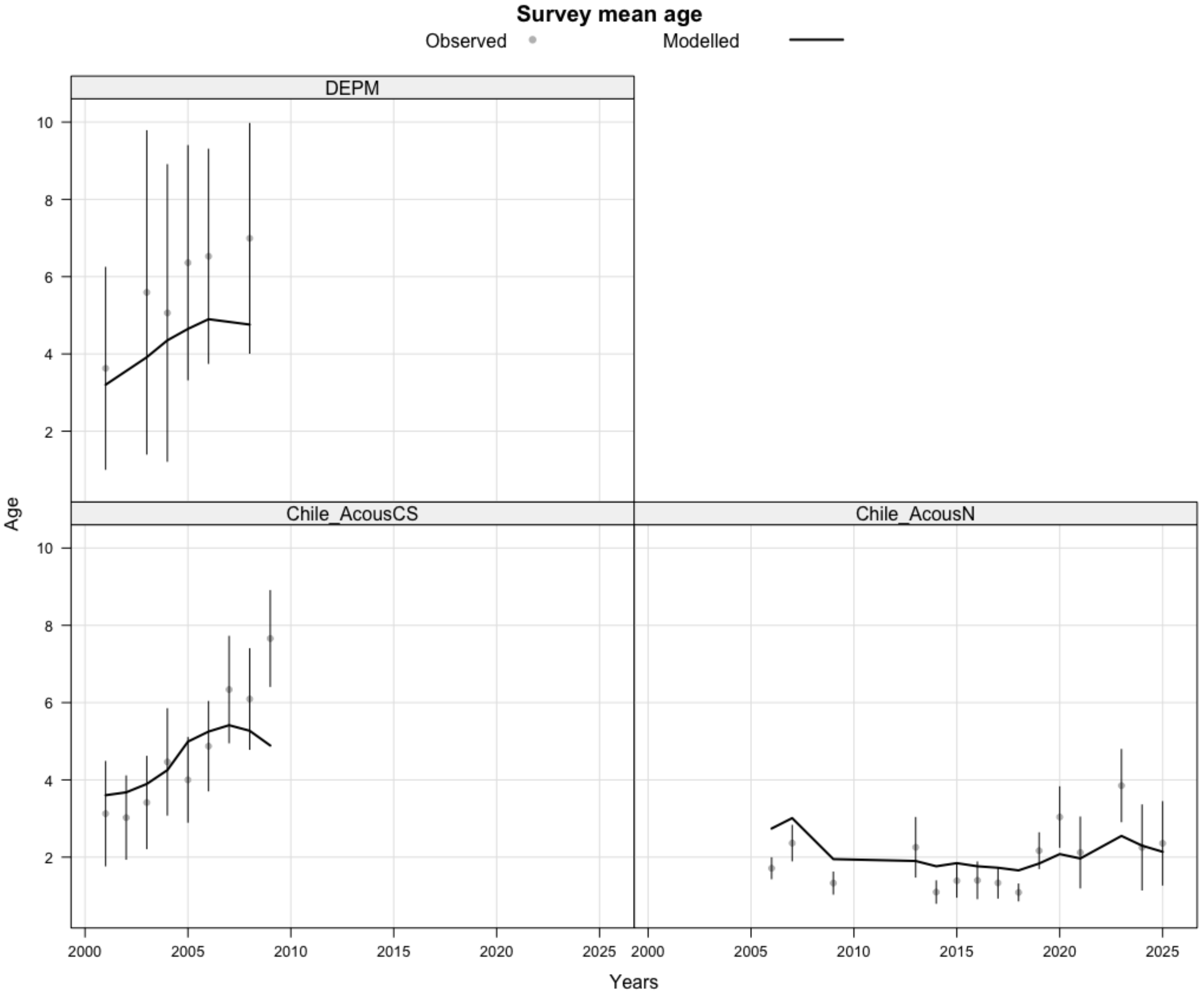

Figure 34: Mean age by year and survey. Line represents the Model h2_1.14 (two-stock hypothesis) predictions and dots observed values with implied input error bars.

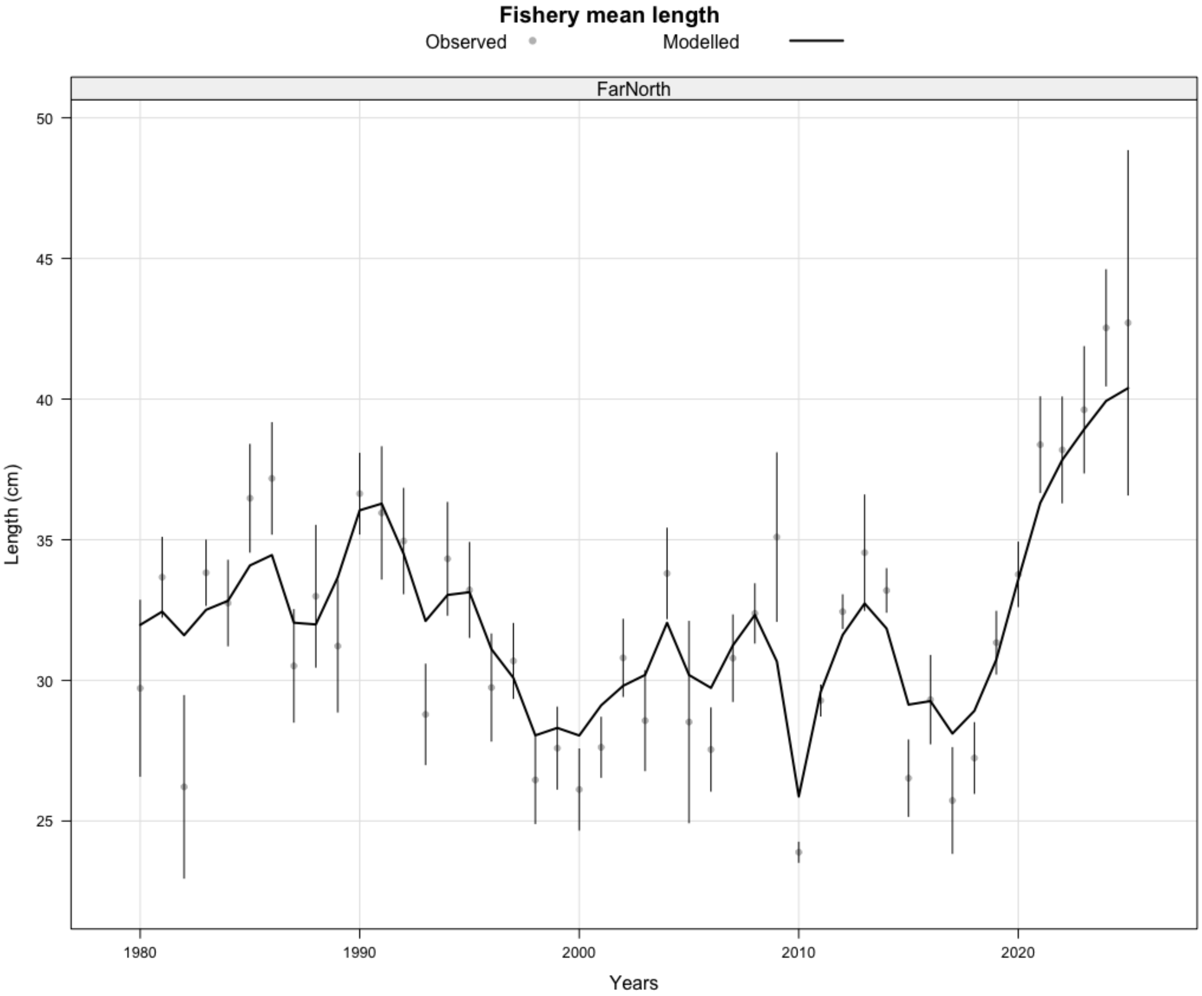

Figure 35: Mean length by year in Fleet 3 (Far North). Line represents the Model h1_1.14 (single-stock hypothesis) predictions and dots observed values with implied input error bars.

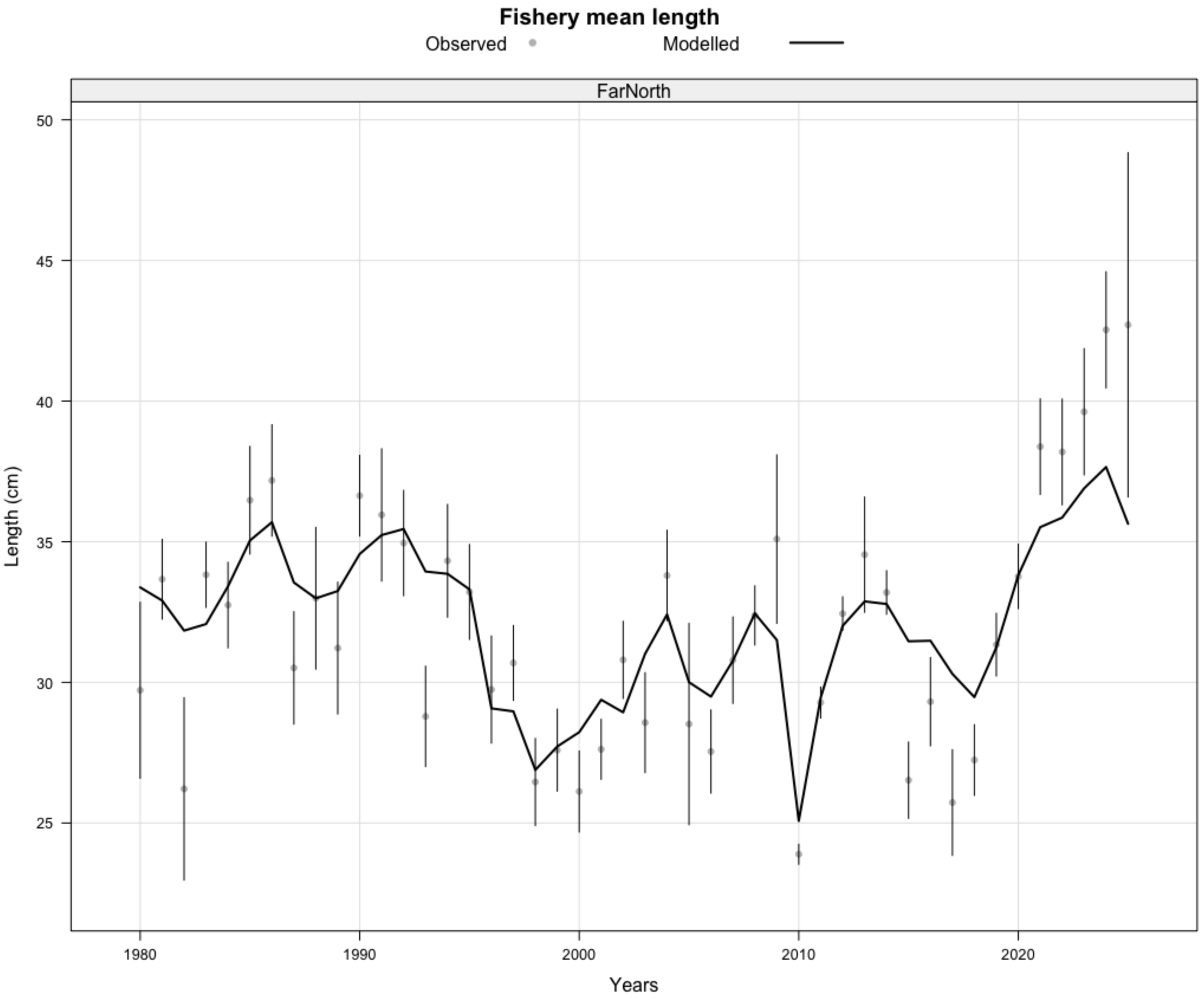

Figure 36: Mean length by year in Fleet 3 (Far North). Line represents the Model h2_1.14 (two-stock hypothesis) predictions and dots observed values with implied input error bars.

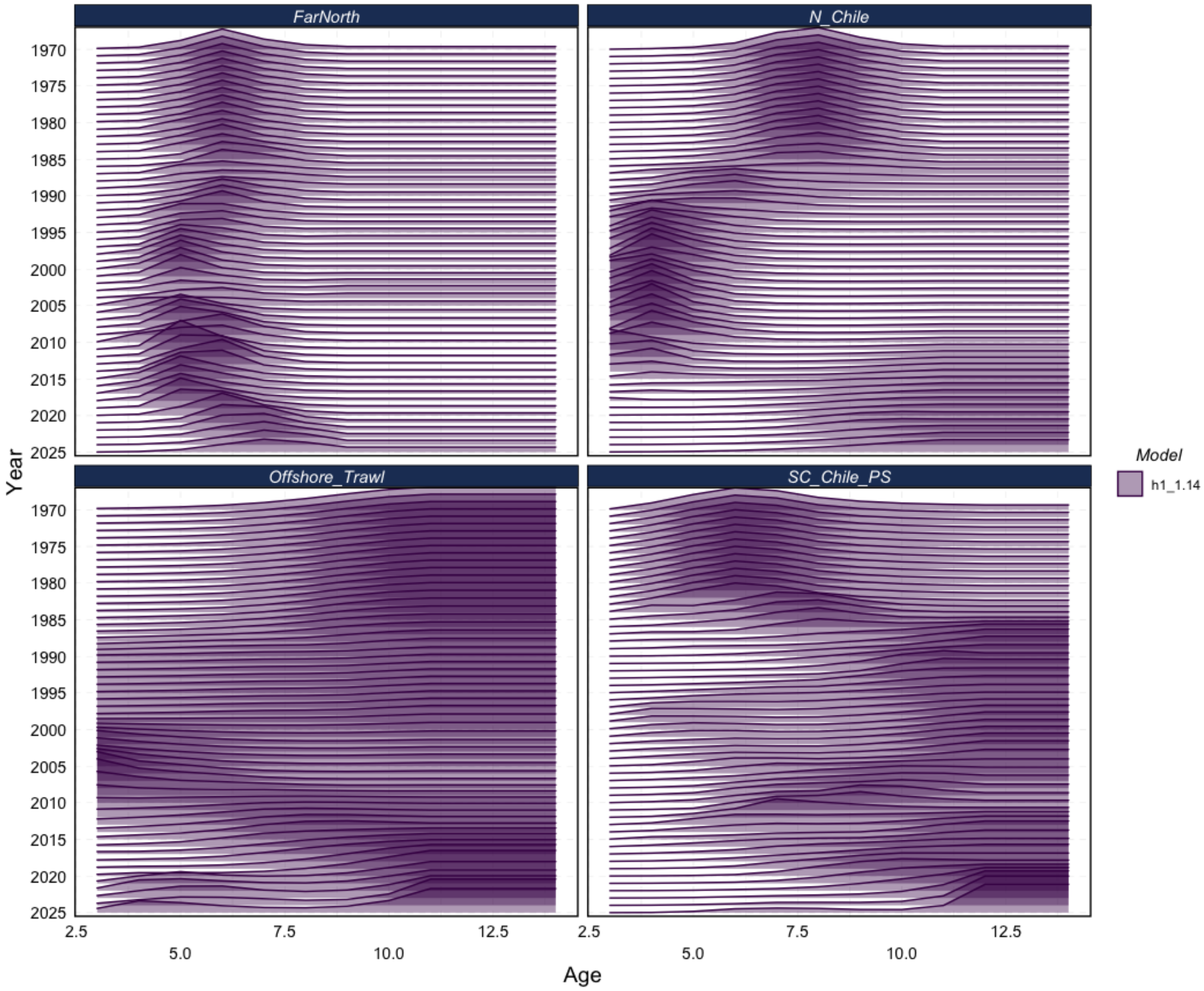

Figure 37: Estimates of selectivity by fishery over time for Model h1_1.14 (single-stock hypothesis).

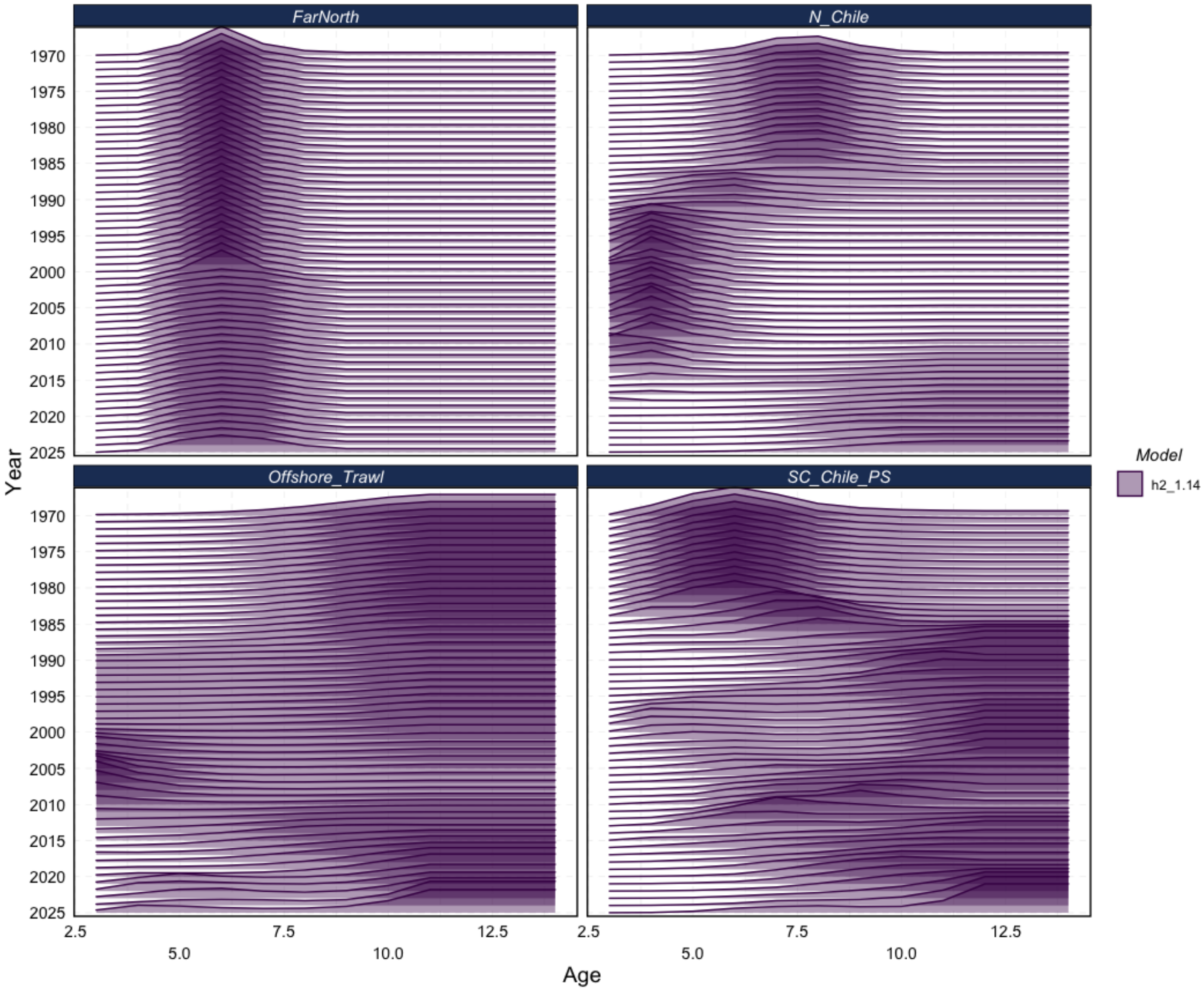

Figure 38: Estimates of selectivity by fishery over time for Model h2_1.14 (two-stock hypothesis).

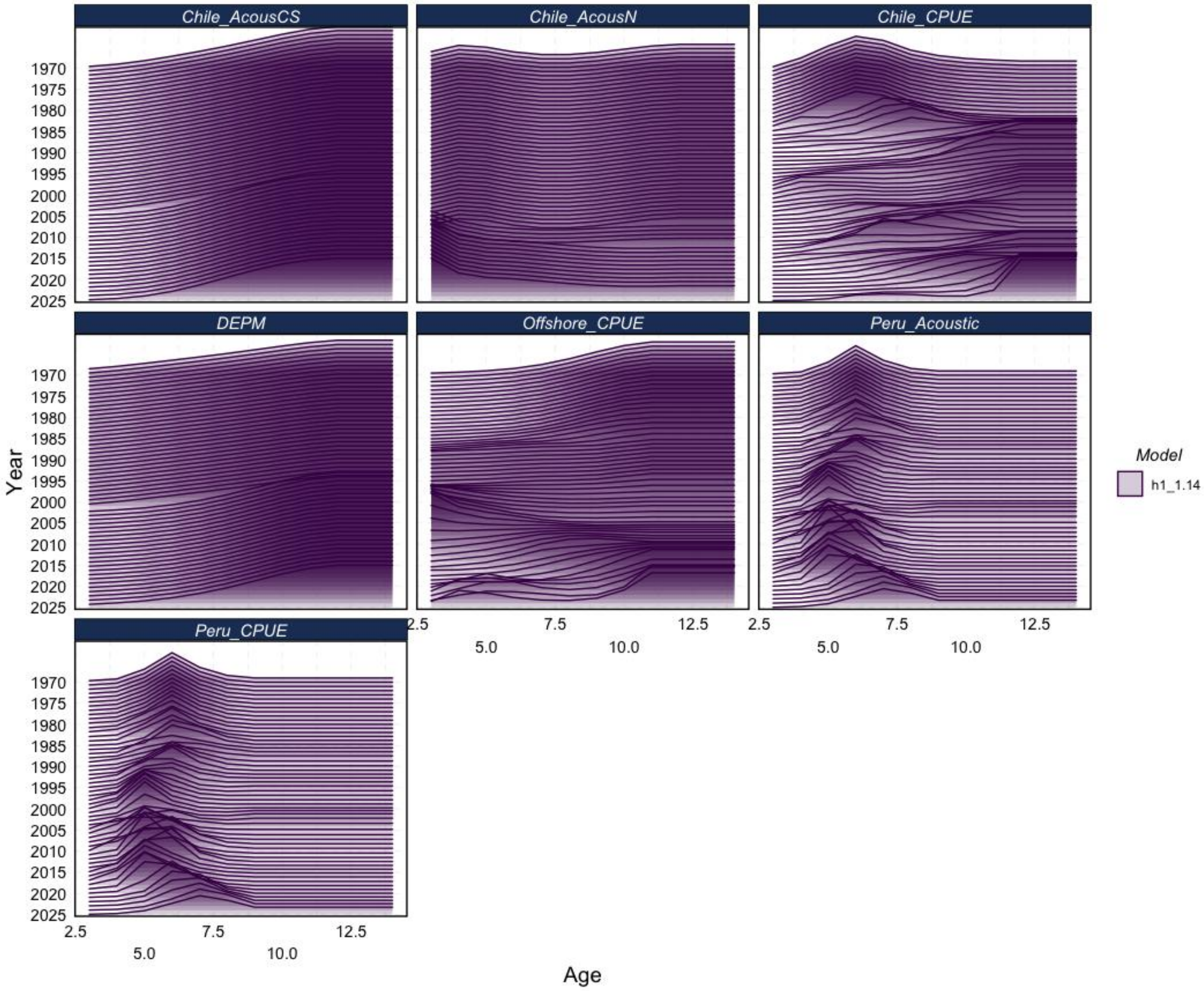

Figure 39: Estimates of selectivity by survey over time for Model h1_1.14 (single-stock hypothesis).

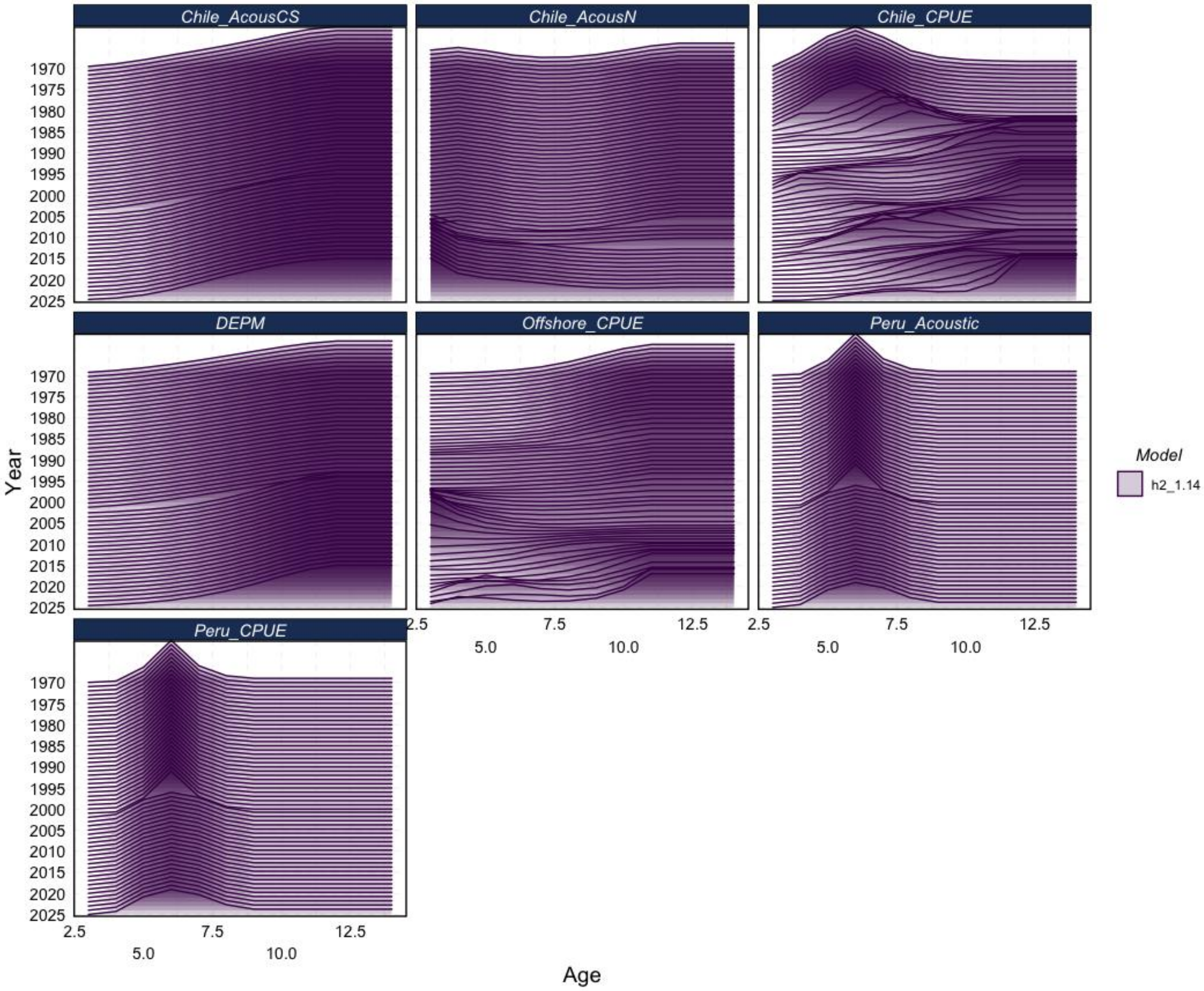

Figure 40: Estimates of selectivity by survey over time for Model h2_1.14 (two-stock hypothesis).

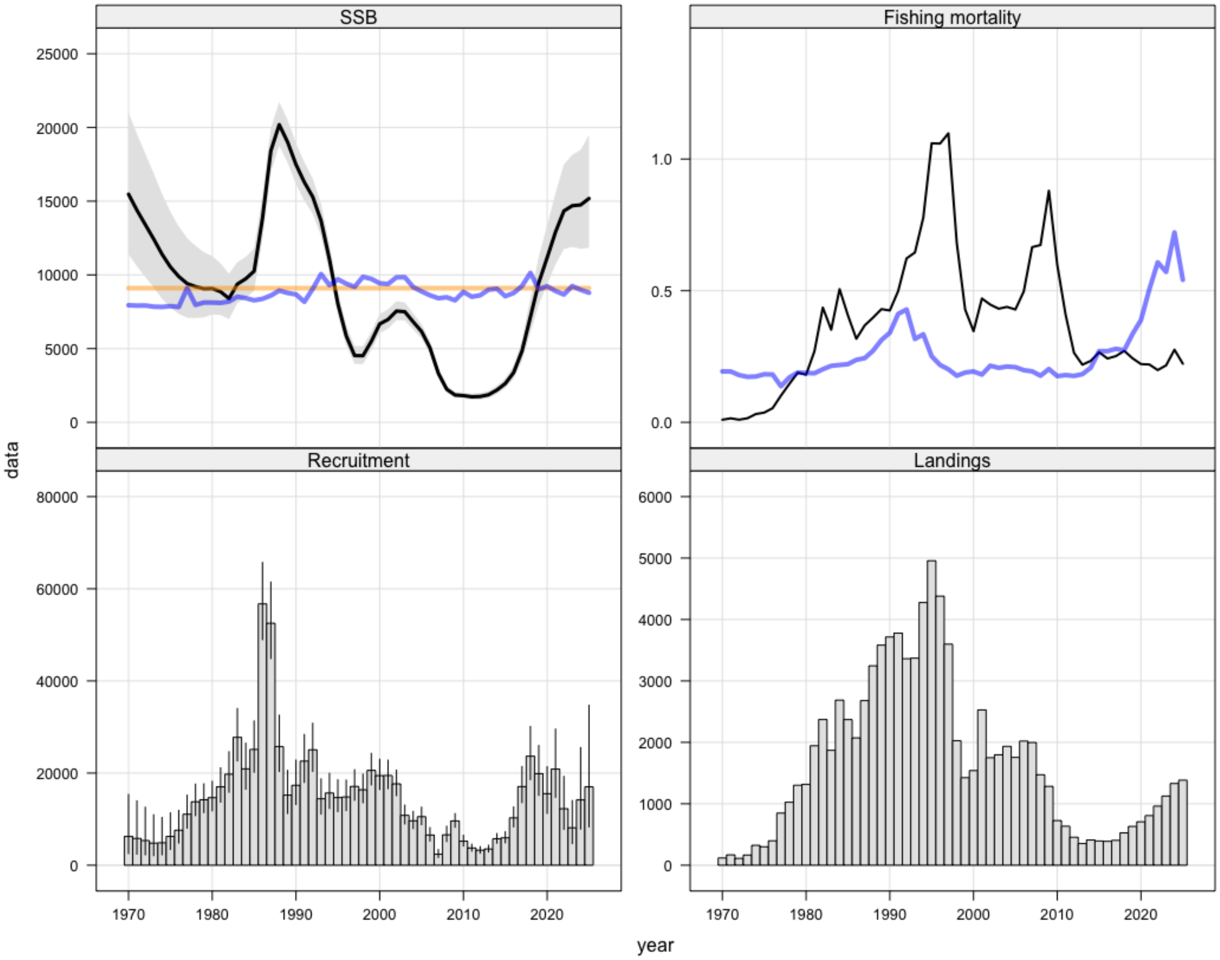

Figure 41: Model h1_1.14 (single-stock hypothesis) summary estimates over time showing spawning biomass (kt; top left), recruitment at age 1 (millions; lower left), total fishing mortality (top right), and total catch (kt; bottom right). Blue lines represent dynamic estimates of B_{MSY} (upper left) and dynamic estimates of F_{MSY} (upper right). The orange line represents the average B_{MSY} over the most recent ten years.

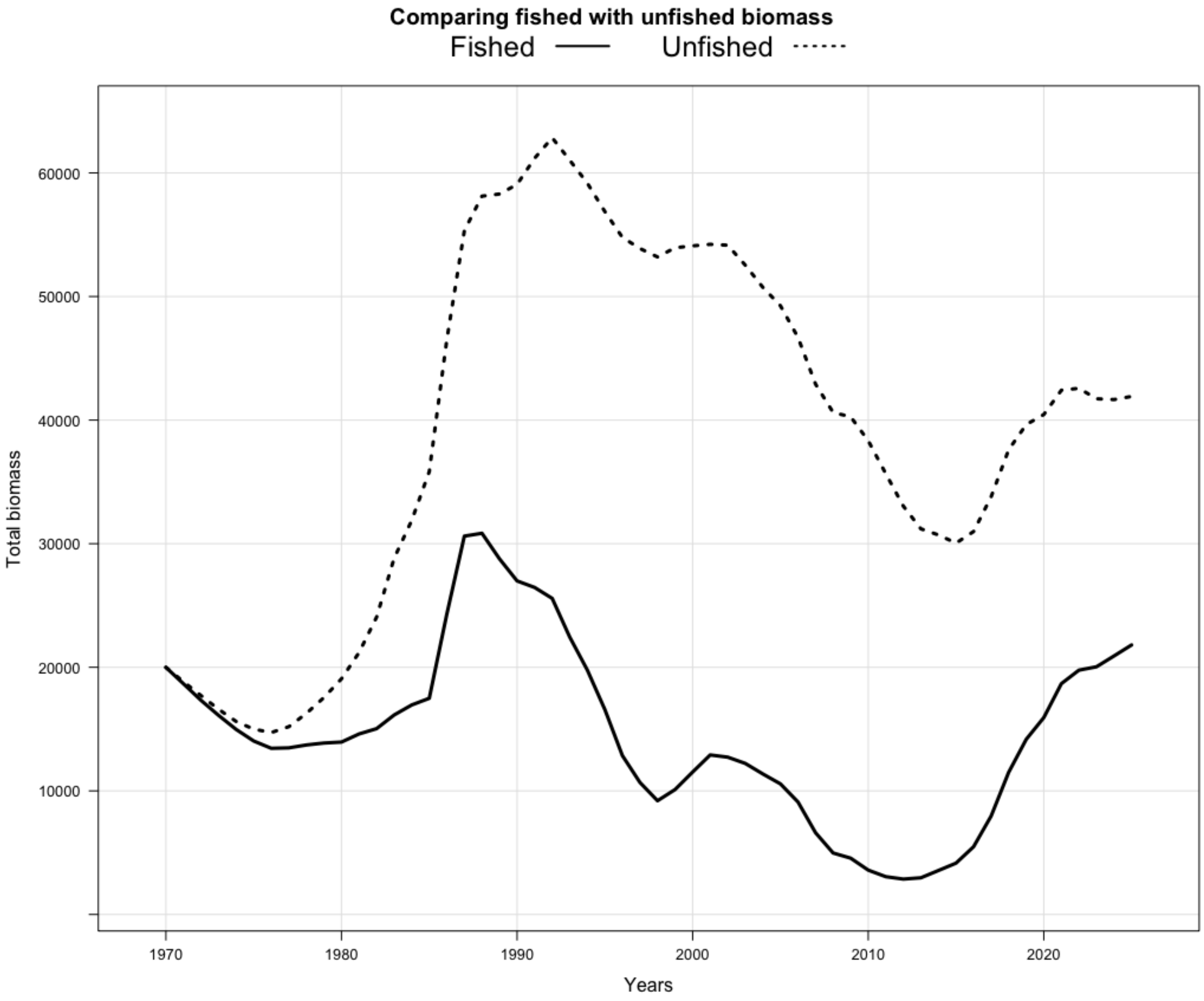

Figure 42: Model h1_1.14 (single-stock hypothesis) results for the estimated total biomass (solid line) and the estimated total biomass that would have occurred if no fishing had taken place (dotted line), beginning in 1970. This year, the ratio of total biomass to total biomass without fishing is 0.52.

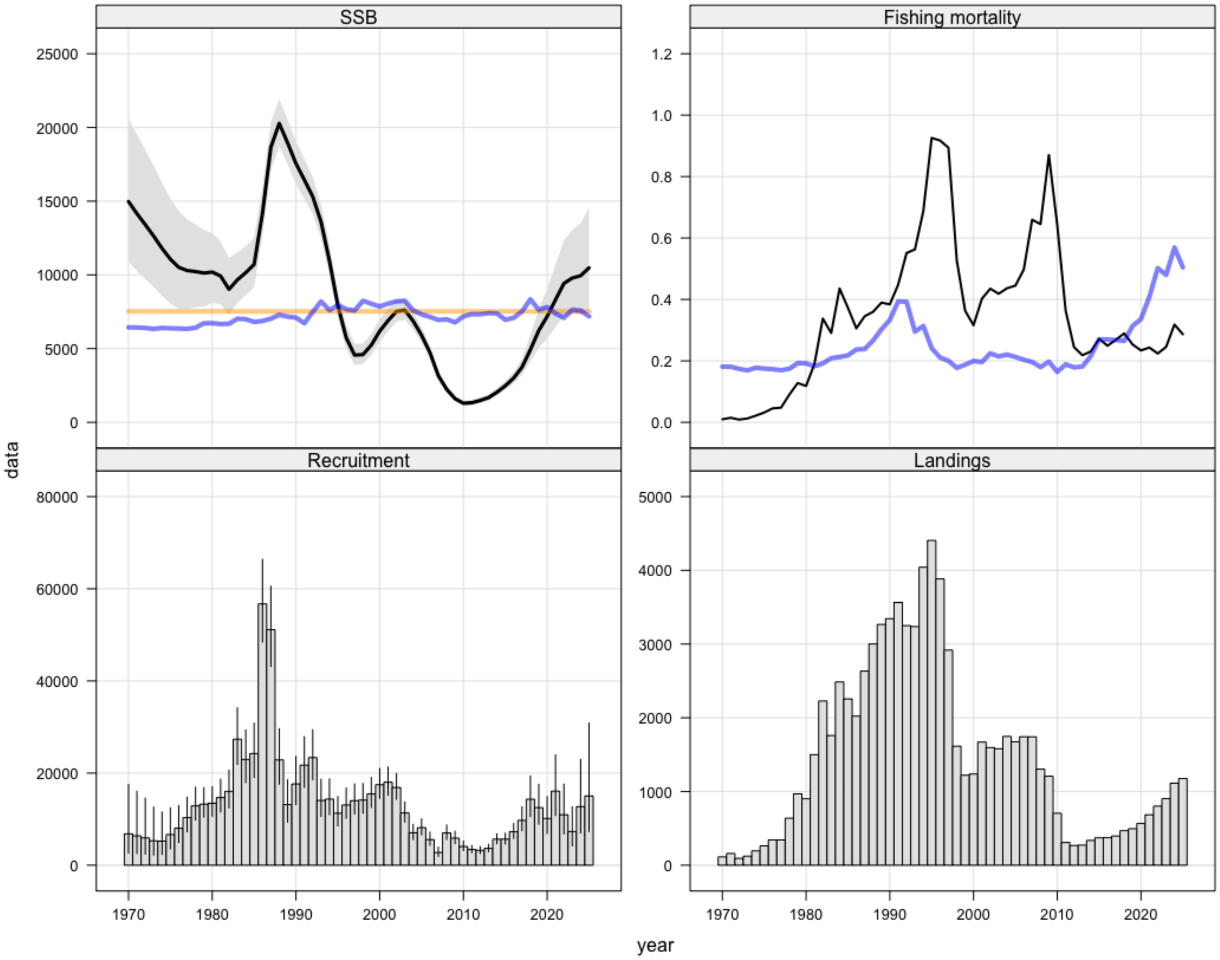

Figure 43: Model h2_1.14 (two-stock hypothesis) summary estimates over time showing spawning biomass (kt; top left), recruitment at age 1 (millions; lower left), total fishing mortality (top right), and total catch (kt; bottom right) for the south stock. Blue lines represent dynamic estimates of B_{MSY} (upper left) and of F_{MSY} (upper right). The orange line represents the average B_{MSY} over the most recent ten years.

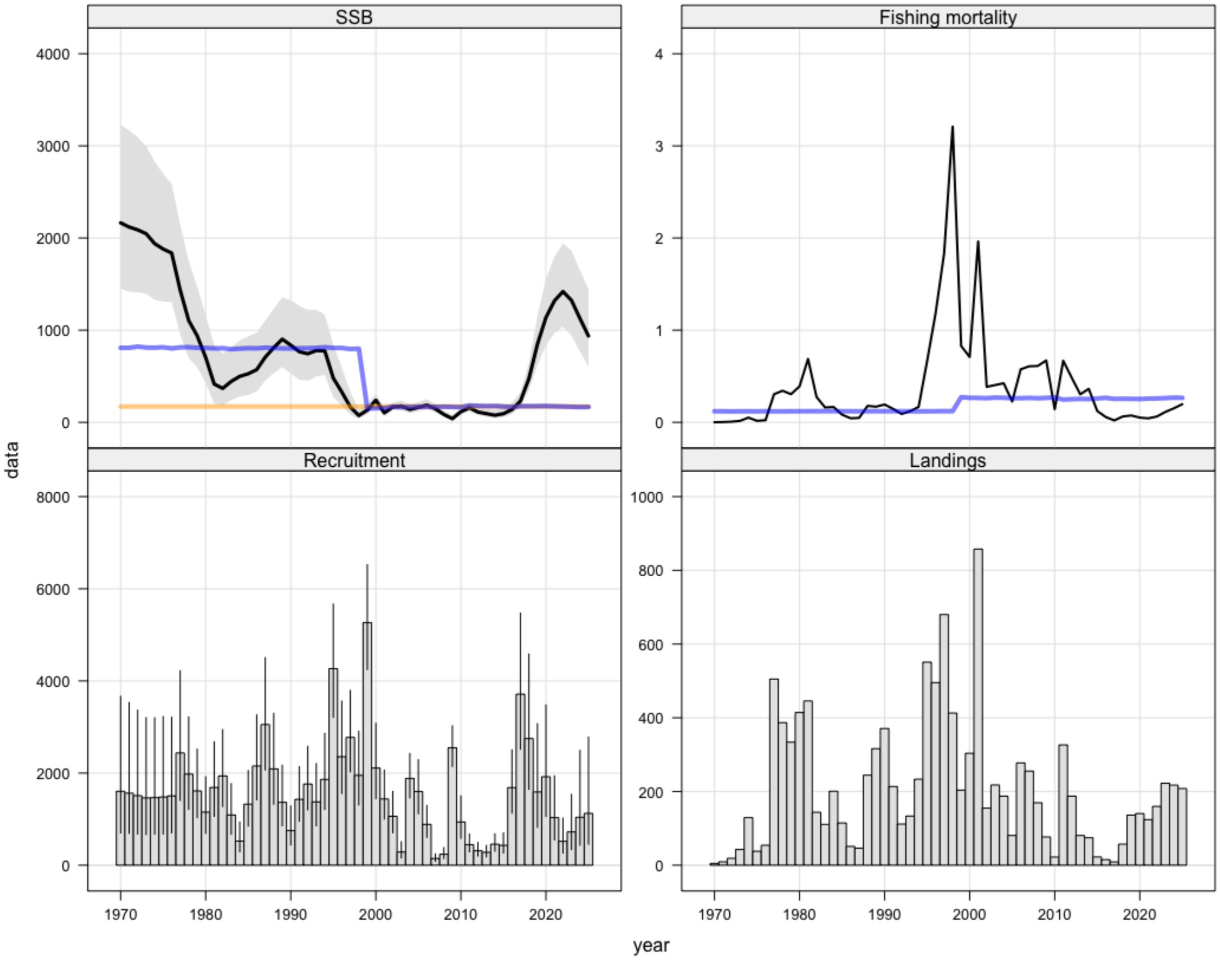

Figure 44: Model h2_1.14 (two-stock hypothesis) summary estimates over time showing spawning biomass (kt; top left), recruitment at age 1 (millions; lower left), total fishing mortality (top right), and total catch (kt; bottom right) for the far north stock. Blue lines represent dynamic estimates of B_{MSY} (upper left) and of F_{MSY} (upper right). The orange line represents the average B_{MSY} over the most recent ten years.

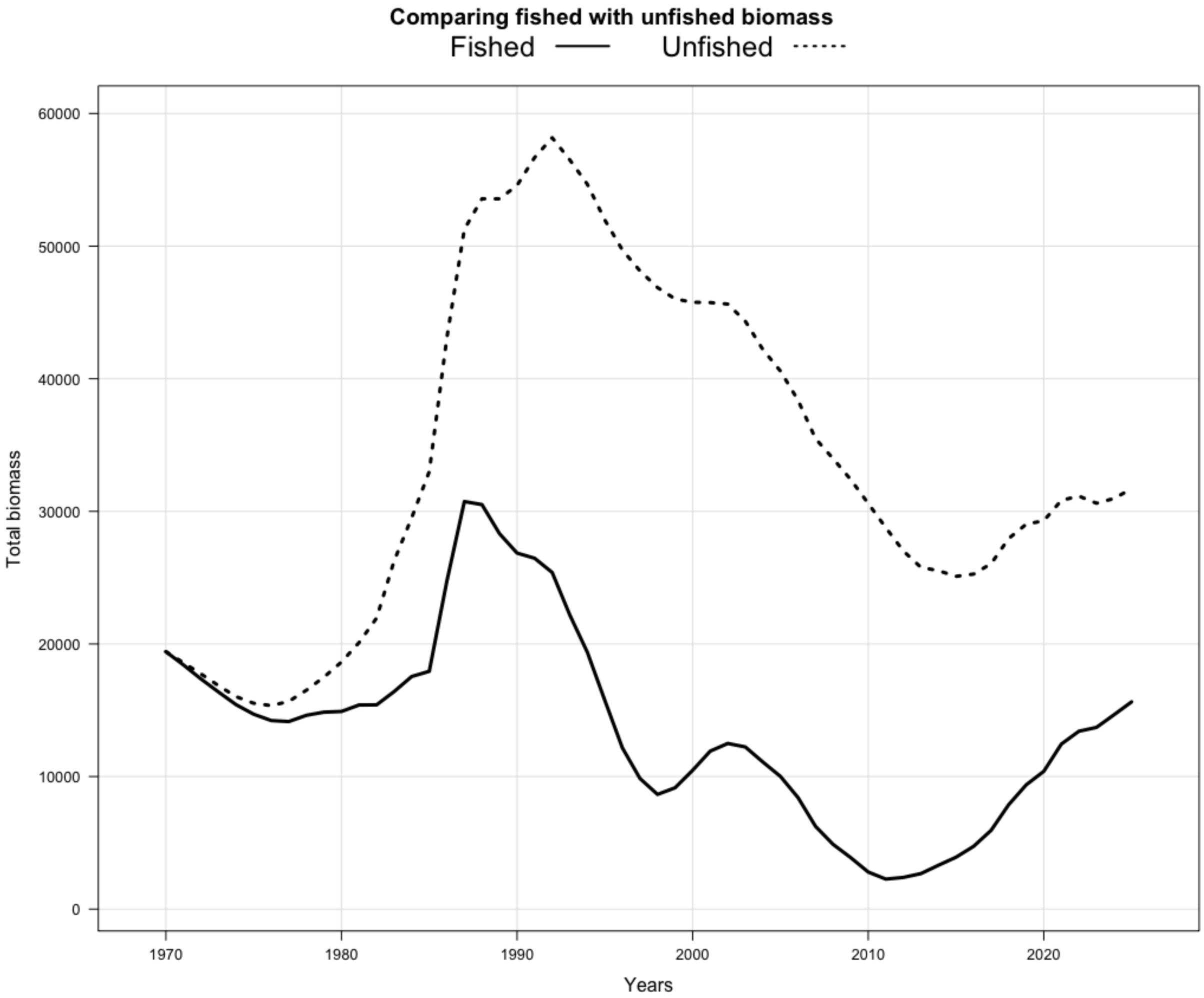

Figure 45: Model h2_1.14 (two-stock hypothesis) results for the estimated total biomass (solid line) and the estimated total biomass that would have occurred if no fishing had taken place (dotted line) for the south stock, beginning in 1970. This year, the ratio of total biomass to total biomass without fishing is 0.49.

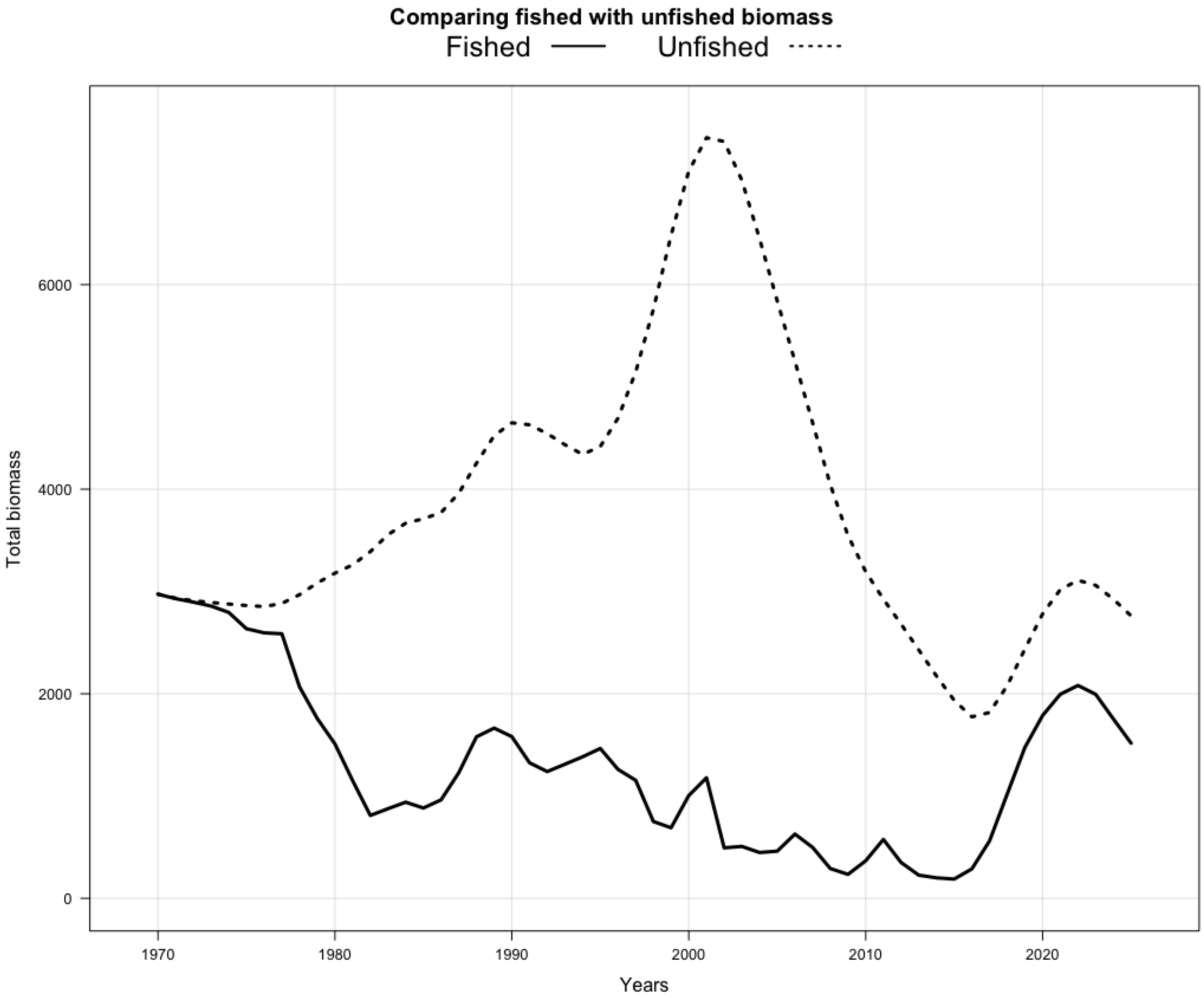

Figure 46: Model h2_1.14 (two-stock hypothesis) results for the estimated total biomass (solid line) and the estimated total biomass that would have occurred if no fishing had taken place (dotted line) for the far north stock, beginning in 1970. This year, the ratio of total biomass to total biomass without fishing is 0.55.