

Distribution, life history and fishery of plaice (*Pleuronectes platessa*) and lemon sole (*Microstomus kitt*) in Faroese waters

Útbreiðsla, lívfrøði og fiskiskapur eftir reyðsprøku og tungu undir Føroyum

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Abstract

This project collected and analysed new fishery and biological data for plaice (*Pleuronectes platessa*) and lemon sole (*Microstomus kitt*) in Faroese waters, together with existing datasets, to address longstanding knowledge gaps in the biology and stock status of these two commercially exploited flatfish species. Data from commercial catches, annual demersal trawl surveys, and biological sampling programmes were integrated to investigate growth, maturity, reproductive biology, spatial distribution, and abundance trends.

Spatial patterns in commercial and survey catches were examined to characterise the distribution of both species across Faroese waters and identify areas of relatively high abundance, including potential spawning areas.

Length- and age-based analyses were used to estimate growth parameters and maturity ogives for both species. Biological samples from surveys and commercial landings were used to examine spatial and seasonal patterns in gonad development, including the occurrence of spawning individuals. Length distributions and gonad development stages were analysed by gender throughout the year. These analyses provided new information on the seasonal and spatial distribution of reproductive stages in Faroese waters.

Fishery-independent catch-per-unit-effort (CPUE) indices were derived from spring- and summer demersal trawl surveys and incorporated into state-space assessment models (SAM) covering 2016–2024. Although only weakly related to commercial landings, the survey indices provided complementary information on relative abundance and stock dynamics. The assessments integrated catch-at-age, stock weights-at-age, maturity-at-age, and survey age compositions.

Assessment results indicated contrasting stock trajectories between the two species. Spawning-stock biomass of plaice declined throughout the assessment period and reached its lowest estimated level in 2024, accompanied by low recruitment and a moderate increase in fishing mortality. In contrast, lemon sole spawning-stock biomass and total stock biomass fluctuated over the assessment period without a sustained decline, while fishing mortality increased until 2020 before subsequently declining. Recruitment estimates showed considerable uncertainty for both species, particularly in recent years.

The study provides updated biological parameters and the first stock assessments for both species in Faroese waters, providing a basis for future monitoring, assessment development, and management of these stocks.

Úrtak

Henda verkætlan hevur innsavnað og greinað vinnuligt og lívfrøðiligt taltifar av reyðsprøku (*Pleuronectes platessa*) og tungu (*Microstomus kitt*) í føroyskum sjógvi fyri at bota um manglandi vitan um lívfrøði og stovnsstøðu hjá hesum báðum vinnuliga týðningarmiklu flatfiskasløgunum. Taltifar frá vinnuligari veiðu, herundir sýnistøku av landingum, og frá árligu botntrols yvirlitskanningum vórðu samantvinnaðar fyri at kanna vøkstur, kynsbúning, gýting, útbreiðslu og broytingar í nøgd.

Mynstur í vinnuligari veiðu og í veiðuni frá yvirlitstrolingunum vórðu kannað fyri at lýsa útbreiðsluna av báðum sløgunum í føroyskum sjógvi og eyðmerkja øki við lutfalsliga høgari mongdum, íroknað møgulig gýtingarøki.

Greiningar av longdar- og aldursdátum vórðu framdar fyri at meta um vakstrarparametrar og kynsbúning hjá báðum sløgum. Lívfrøðilig sýni frá bæði kanningum og vinnuligari veiðu vórðu nýtt til at kanna árstíðar- og útbreiðslumynstur av búningini av rognum og sili, herundir gýtandi fiski. Longdarbýtið og kynsbúningarstig vórðu greinað gjøgnum árið og býtt eftir kyni. Hesar greiningar geva nýggja vitan um árstíðarútbreiðsluna av gýtingar- og búningarstigum í føroyskum sjógvi.

Vinnuliga óheft veiðu-uppá-roynd indeks (CPUE) vórðu roknað fyri vár- og summaryvirlitstrolingarnar og brúkt í aldursbaseraðu stovnsmetingum (SAM) fyri tíðarskeiðið 2016–2024. Hóast veikt samband við vinnuligari veiðu góvu hesi indeks virðismikla og stuðlandi kunning um lutfalsliga nøgd og stovnsmenning.

Stovnsmetingarnar vístu ymiska gongd hjá teimum báðum sløgum. Gýtingarstovnurin hjá reyðsprøku minkaði gjøgnum tíðarskeiðið í stovnsmetingini og varð mettur at vera á lægsta støði í 2024, samstundis sum tilgongdin var lág og fiskideyðin lutfalsliga høgur. Hjá tungu sveiggjaðu gýtingarstovnurin og heildarstovnurin gjøgnum tíðarskeiðið uttan eina støðuga minking, meðan fiskideyðin vaks fram til 2020 og síðani minkaði. Metingin av tilgongd vísti munandi óvissu.

Verkætlanin gevur dagfórdar lívfrøðiligar parametrar og tær fyrstu stovnsmetingarnar fyri bæði reyðsprøku og tungu í føroyskum sjógvi og styrkir sostatt grundarlagið undir framtíðar eftirlit, stovnsmetingum og fyrisiting av hesum stovnum.

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Summary of results

Distribution: Plaice and lemon sole are both widely distributed across the Faroe Plateau and also occur on the Faroe Bank. Plaice is generally most abundant in relatively shallow areas of the Plateau, with spring survey catches more concentrated in western and northern areas and a broader distribution during the summer survey. Lemon sole is distributed more widely across the Plateau, with relatively high densities in eastern and north-western areas and around Vágahavið. Different length groups of both species showed considerable spatial overlap, although smaller plaice tended to occur in shallower water.

Growth and age: Both species showed strong relationships between length and weight. Growth in plaice was approximately isometric, whereas lemon sole showed slightly positive allometric growth. Females generally attained greater lengths than males, with gender differences becoming increasingly apparent among older fish. Both species were represented by a broad range of ages in the survey and commercial samples. Plaice were observed up to 18 years of age and lemon sole up to 20 years, although most individuals were considerably younger. Commercial catches generally contained a greater proportion of larger and older fish than the scientific surveys.

Maturity: Plaice matured at relatively small sizes and young ages. The estimated length at which 50% of the fish were mature (L_{50}) was approximately 31 cm for both genders, while the estimated age at 50% maturity (A_{50}) was approximately 2 years. Females matured somewhat later than males, with estimated A_{50} values of approximately 2.3 and 1.8 years, respectively.

Lemon sole also matured relatively early, but with a pronounced difference between genders. The estimated A_{50} was 2.6 years for the combined data, compared with 3.1 years for females and 1.3 years for males. The estimate for males was more sensitive to the available observations of young fish and should therefore be interpreted with greater caution.

For both species, the estimated maturity-at-age schedules indicate earlier maturation than generally reported for neighbouring stocks, whereas maturity-at-length is more comparable. The reasons for this discrepancy remain uncertain and warrant further investigation. The maturity analyses provided the basis for the maturity-at-age ogives used as biological input in the stock assessments.

Spawning: The spawning season of plaice extends from February to May, with some differences in spawning timing between genders. Spawning activity occurs across a relatively broad area of the Faroe Plateau rather than at a single, clearly defined spawning ground. Nevertheless, spawning fish were concentrated mainly in the northern, northwestern (Mýlingsgrunninum) and western (Vágahavinum) shelf areas, while only isolated spawning individuals were observed in the eastern areas. This indicates a preference for the northern and western parts of the Plateau during spawning, although additional observations are required to determine how consistent this spatial pattern is between years.

Like plaice, lemon sole did not appear to form dense or spatially confined spawning aggregations. Spawning individuals were distributed broadly across the Faroe Plateau, indicating a diffuse and widespread spawning pattern rather than distinct spawning grounds. Most samples from the Faroe Bank lacked maturity-stage information, preventing a reliable assessment of spawning activity in that area.

Young fish and recruitment: Lemon sole juveniles are regularly recorded during the annual 0-group survey and occur widely across the Faroe Plateau and on the Faroe Bank. On the Plateau, their distribution overlaps areas where mature and spawning adults occur. Abundance indices were generally low from the beginning of the time series in 1983 until around 2010 but have subsequently

become more variable, with particularly high indices recorded in 2019 and 2025. The relationship between 0-group abundance and subsequent recruitment to the fishery is, however, not straightforward. Young plaice are also recorded during the 0-group survey, but reliable identification is difficult because small plaice can be confused with common dab. The historical 0-group series for plaice was therefore not considered sufficiently reliable for quantitative analysis and was used only descriptively. Improved identification of young plaice would increase the value of the survey for future recruitment monitoring.

Feeding: Plaice and lemon sole differ in their main prey despite overlapping spatially across much of the Faroe Plateau. Plaice feed predominantly on benthic molluscs, whereas polychaetes constitute an important component of the diet of lemon sole. These differences indicate that the two flatfish species exploit partly different benthic food resources.

Fishery: Plaice and lemon sole are caught in Faroese demersal fisheries, both as target species and as part of mixed catches. Commercial catches generally consisted of larger and older fish than those sampled in the scientific surveys, reflecting differences in gear selectivity and the areas exploited by the fishery. Biological sampling of commercial landings showed that the catches of both species comprised several age classes rather than being dominated by a single cohort. These samples provided the catch-at-age information required for the stock assessments; however, consistent age-composition data are currently available only from 2016 onwards, restricting the assessment period for both stocks.

Stock assessment – plaice: An age-based stock assessment was developed for Faroese plaice using SAM and data from commercial catches and the annual scientific demersal surveys. The assessment indicates a marked decline in spawning stock biomass during the latter part of the assessment period. Spawning stock biomass increased from approximately 1,540 tonnes in 2016 to around 2,100 tonnes in 2018, before declining to approximately 920 tonnes in 2024. Total stock biomass followed a similar pattern. Recruitment at age 3 also declined over much of the assessment period, from approximately 346 thousand fish in 2016 to 122 thousand in 2023, with an estimated 161 thousand recruits in 2024. At the same time, fishing mortality increased from approximately 0.24 in 2016 to around 0.32–0.36 during recent years. The assessment therefore indicates that the recent decline in plaice biomass has occurred alongside relatively weak recruitment and increased fishing mortality compared with the beginning of the assessment period. Estimates of the most recent recruitment are uncertain and should be interpreted cautiously.

Stock assessment – lemon sole: An age-based SAM assessment was also developed for Faroese lemon sole. In contrast to plaice, spawning stock biomass fluctuated during the assessment period without showing the same sustained decline. Spawning stock biomass was approximately 1,120 tonnes in 2016, increased to around 1,390 tonnes in 2019 and was estimated at approximately 1,200 tonnes in 2024. Total stock biomass was at a similar or slightly higher level at the end of the assessment period than at its beginning. Fishing mortality increased from approximately 0.34 in 2016 to a maximum of around 0.46 in 2020 and was approximately 0.41 in 2024. Recruitment varied considerably between years and estimates, particularly for the most recent cohorts, were associated with substantial uncertainty. The assessment nevertheless indicates a comparatively stable biomass trajectory for lemon sole over the period covered.

Overall: The project has substantially increased the biological and assessment information available for plaice and lemon sole in Faroese waters. Updated information on distribution, growth, age structure, maturity, spawning, early life stages and feeding was compiled, and the biological information was used to update the species information for plaice and lemon sole published on FAMRI's website. The maturity analyses provided new estimates of maturity-at-age and maturity-at-

length, while the spatial and seasonal analyses identified differences in spawning patterns between the two species. These results, together with commercial catch data and fishery-independent survey indices, provided the basis for developing the first age-based stock assessments for Faroese plaice and lemon sole.

The assessments show contrasting developments in the two stocks over the period from 2016 onwards, with a substantial decline in plaice spawning stock biomass and relatively weak recent recruitment, while lemon sole biomass has fluctuated without a comparable sustained decline. However, the relatively short assessment period and uncertainty in recent recruitment limit conclusions regarding longer-term stock dynamics and the development of management reference points. The present work therefore provides a foundation for continued monitoring and further development of the assessments, including extension of the time series, development of fishery-dependent abundance indices and improved recruitment monitoring, thereby strengthening the information available to support future management of both stocks.

1. Introduction

Plaice (*Pleuronectes platessa*) and lemon sole (*Microstomus kitt*) are demersal flatfish species distributed across North Atlantic shelf areas, including Iceland, the Norwegian coast, the North Sea, and British waters (Mouritsen, 2007). Plaice also extend in southern Greenland and range as far south as Morocco, including parts of the north-western Mediterranean Sea towards Genoa, Italy (Mouritsen, 2007).

Historical fisheries for plaice and lemon sole in Faroese waters date back to the early 1900s, with most early records derived from Scottish and British archives (Jákupsstovu, 2004), as trawl vessels from these nations were responsible for the majority of these catches. Following the extension of the Exclusive Economic Zone (EEZ) to 200 nautical miles in 1977, Faroese trawlers progressively assumed control of the fishery, which has been almost exclusively Faroese since approximately 1980 (Figure 1.1 and Figure 1.2).

Landings of both species have fluctuated considerably through time, ranging from approximately 600 to less than 50 tonnes for plaice and from approximately 2000 to less than 50 tonnes for lemon sole (Figure 1.1 and Figure 1.2). Both species are primarily harvested by the same demersal trawl fleet, using the same gear, fishing grounds, and seasonal fishing patterns. As a result, fishing effort, including vessel activity and fishing days, is largely shared.

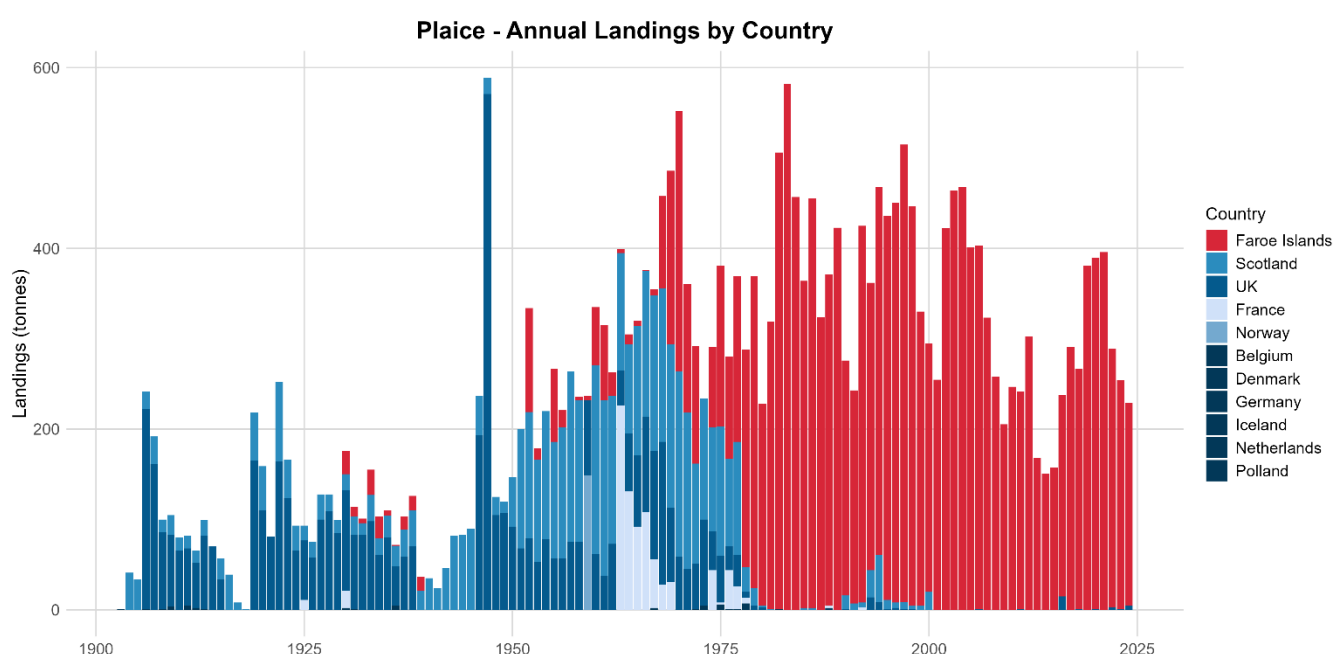


Figure 1.1 – Total landings of plaice in Faroese waters by reporting country from 1903 to the present, illustrating long-term trends in the commercial exploitation of the stock.

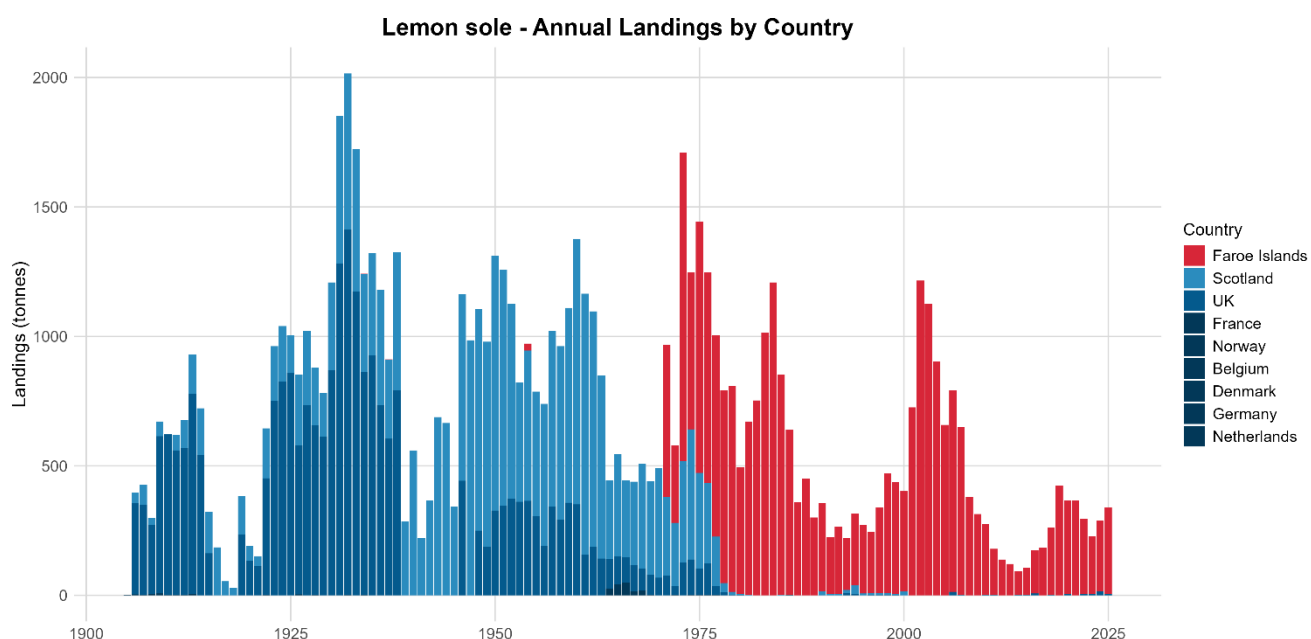


Figure 1.2 – Total landings of lemon sole in Faroese waters by reporting country from 1905 to the present, illustrating long-term trends in the commercial exploitation of the stock.

Despite the long history of exploitation, there is currently no modern or comprehensive description of the biological characteristics of either species in Faroese waters. Key aspects of their life history, including spawning period, spawning grounds, recruitment processes and stock status, remain poorly understood. Information from neighbouring regions indicates that plaice typically spawn between February and March, whereas lemon sole spawn over a broader period from May to October (De Haes, 2024; Richards, 2006). However, the applicability of these patterns to Faroese waters remains uncertain.

Evidence nevertheless suggests that both species maintain populations on the Faroe Shelf. Fry of plaice and lemon sole are regularly captured during the annual 0-group pelagic trawl surveys conducted by the Faroe Marine Research Institute on the Faroe Shelf and Faroe Bank. These surveys provide a time series dating back to 1983 and include abundance indices and length measurements of 0-group fish of both species. The consistent occurrence of young-of-the-year fish suggests that recruitment occurs regularly within Faroese waters, although the precise spawning grounds and the extent of connectivity with neighbouring areas have not yet been established.

Following settlement, plaice juveniles typically occupy shallow coastal habitats, including fjords and bays with sandy or silty substrates, particularly near river mouths (Pihl & Van der Veer, 1992; Wennhage et al., 2007). Lemon sole, in contrast, settle across a broader depth range, from shallow waters to approximately 150 m depth (Rae, 1939). Available evidence further suggests differences in movement behaviour between the species, with plaice generally exhibiting wider-ranging movements and lemon sole displaying greater site fidelity (Jennings et al., 1993).

Several lines of evidence indicate limited connectivity between Faroese populations and neighbouring stocks. Tagging studies of Icelandic plaice have demonstrated strong geographic fidelity to spawning and feeding grounds, with individuals typically returning to the same areas in successive years, suggesting limited large-scale exchange among geographically separated populations (Solmundsson et al., 2005).

Genetic analyses similarly indicate that Faroese and Icelandic plaice populations are distinct from continental European stocks (Hoarau et al., 2004; Le Moan et al., 2021). Taken together, the available evidence suggests that plaice and lemon sole on the Faroe Shelf constitute relatively discrete, locally sustained populations associated primarily with depths shallower than 200 m. Nevertheless, important aspects of their biology and population dynamics remain unresolved and warrant further investigation.

Neither plaice nor lemon sole in Faroese waters has previously been subject to a stock assessment using a modern integrated assessment framework. Existing knowledge of plaice growth and distribution is largely based on surveys conducted more than a century ago (Jensen et al., 1935; Strubberg, 1918), while comparable information for lemon sole is primarily based on studies conducted in the 1930s (Rae, 1939, 1947, 1951). In recent years, research at the Faroe Marine Research Institute has focused on other priority species, resulting in limited contemporary investigation of flatfish populations, including plaice and lemon sole.

Despite these knowledge gaps, substantial fishery-dependent, fishery-independent, and biological datasets have accumulated over recent decades. Integrating these complementary data sources requires an analytical framework capable of jointly estimating population dynamics while accounting for observation error and natural variability in stock processes.

The present study compiles and analyses available historical, survey, fishery, and biological information for plaice and lemon sole in Faroese waters, including newly collected biological data. The original project proposal included an investigation of spatial variation in growth and feeding ecology; however, as the funding awarded did not cover the full cost of the proposed project, this component was reduced in scope. Growth and feeding were nevertheless examined using the biological data collected and compiled during the project. The study focuses particularly on improving knowledge of maturity and spawning patterns and integrates the available biological and fisheries information to provide the first quantitative age-based stock assessments of plaice and lemon sole in Faroese waters.

2. Data and data analysis

Effective stock assessment relies on the integration of multiple data sources that differ in both quantity and biological resolution. At the broadest level, commercial fisheries provide large volumes of data, including catch, effort, and size composition, forming an important empirical foundation for most assessments. However, these data often provide limited information on complete age distribution and biological detail, as fish are typically processed (e.g. gutted) prior to landing, preventing the routine collection of information on gender, maturity, and reproductive status. To address these limitations, fishery-dependent data are complemented by fishery-independent observations obtained from dedicated research surveys, which provide standardised sampling of population structure and biological parameters. The combination of high-volume commercial data and high-resolution survey data underpins modern stock assessment approaches, allowing for more robust estimation of population dynamics and stock status (Figure 2.1).

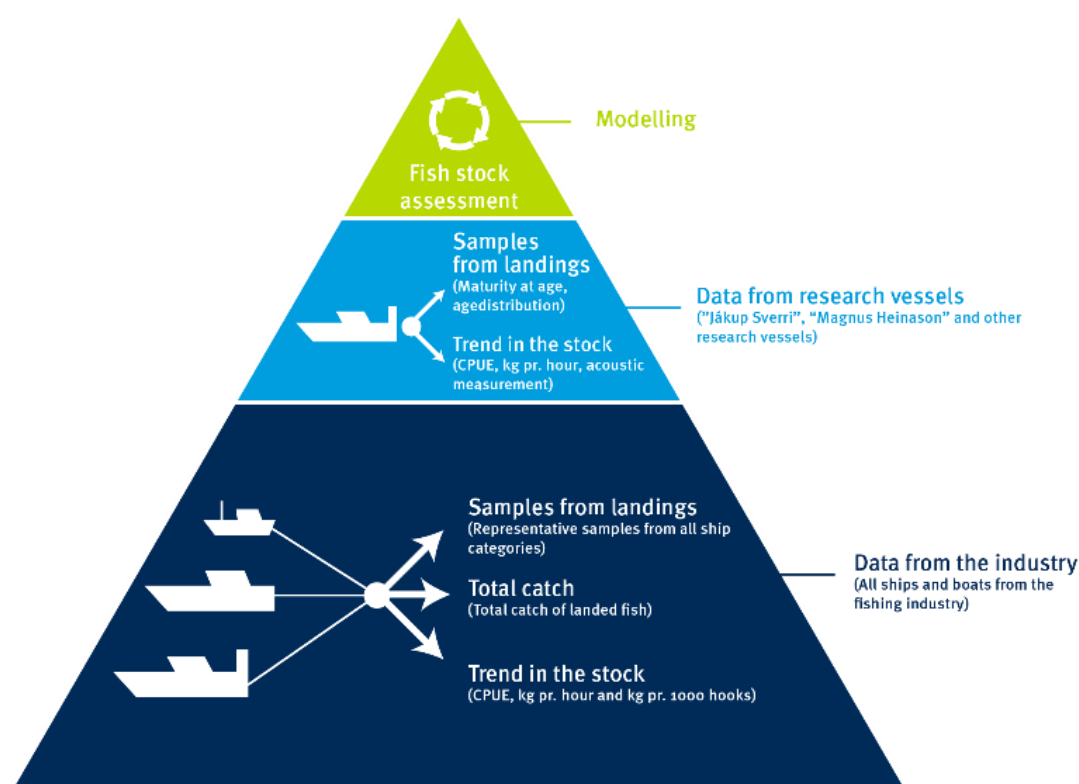


Figure 2.1 – Data hierarchy used in stock assessments (in Sjóvarmál, 2017). Commercial fisheries provide most observations but limited biological detail. Research surveys provide complementary biological information. Both data sources are combined in stock assessment analyses.

2.1 Fishery-dependant data

2.1.1 Fishery logbooks

Fishery logbook data available to Faroe Marine Research Institute (FAMRI) have historically been limited in both spatial and temporal coverage, comprising a small subset of the fleet over restricted time periods. Consequently, these data were deemed unsuitable for the development of a robust Catch-per-unit-effort (CPUE) index for plaice and lemon sole, due to concerns regarding representativeness and statistical reliability. Nonetheless, the available logbook records were utilised descriptively to characterise fishing grounds Figure 4.1 and supplementary information in Section 0.

Recently, FAMRI has obtained access to a comprehensive logbook dataset covering the commercial fleet. These data are currently subject to validation procedures, including cross-database consistency checks and error reconciliation. A continuation project of present study, initiated in late 2025 and funded by Fiskivinnugransking, aims to evaluate the integration of these data into data-limited stock assessment frameworks for plaice and lemon sole. Addition to weight-graded biological data (Joensen & Ofstad, 2025), particular emphasis will be placed on the development of standardised CPUE indices and their potential role in reducing reliance on resource-intensive age-structured or age-aggregated state-space assessment models, such as that applied in the present study. The project is ongoing through 2026¹.

2.1.2 Catch and landing sampling

Data dating back to 2016 for plaice and lemon sole from landing inspections were retrieved from FAMRI's database. Addition to time, position and depth at placement of catch, the data also included length measurements, gutted weights and age samples of the catch. In 2023 increased sampling focus was enforced on landing inspections of both plaice and lemon sole, where total lengths (mm), rounded weights (grams), gutted weights (grams), gonad weights (grams), gender, maturity stage (see section 2.3.3) and age were sampled and recorded. This focused sampling in 2023 compromises approx. half of aged data, and two thirds of length and gutted weight data of combined biological datasets per specie. An overview of the sampling is presented in Annex 1 and 2.

2.2 Fishery-independent data

2.2.1 Annual demersal trawl surveys

Data for plaice and lemon sole were extracted from the annual demersal overview trawl surveys conducted on the Faroe Plateau and Faroe Bank in spring (1994–2024) and summer (1996–2024) (Figure 2.2). For each trawl station, information on sampling location (position and depth) and survey timing was available, together with biological measurements of sampled fish, including total length (mm), round weight (g), gender, maturity stage (see section 2.3.3), and, where available, age. Survey catches were standardised to swept area and used to derive indices of abundance, biomass, and population structure for both species (Magnussen, 2002; Steingrund & Ofstad, 2010).

During the annual demersal trawl surveys conducted in 2021-2023 additional sampling of plaice and lemon sole was undertaken to support the present study. This enhanced sampling programme increased sample sizes and included detailed biological examinations of subsamples of plaice and lemon sole, comprising gender, maturity stages, measurements of gutted weight, liver weight, gonad weight and stomach content examination as well as increased otolith sampling. In addition, photographs of gonads were collected to develop a visual guide illustrating maturity stages 1-7 for both genders of each species – see Annex 6 and 7. An overview of the sampling effort and biological data collected is provided in Annexes 3-4.

Detailed descriptions of the demersal trawl survey design, sampling procedures, and protocols are provided in (Magnussen, 2002; Steingrund & Ofstad, 2010), while the additional biological sampling procedures implemented for this study are described in Annex 5.

¹ Link to project details: <https://www.hav.fo/verkaetlan/hvussu-kunnu-skipsdagbokur-og-innvigingartol-brukast-i-stovnsmeting-av-reydsproku-og-tungu/>

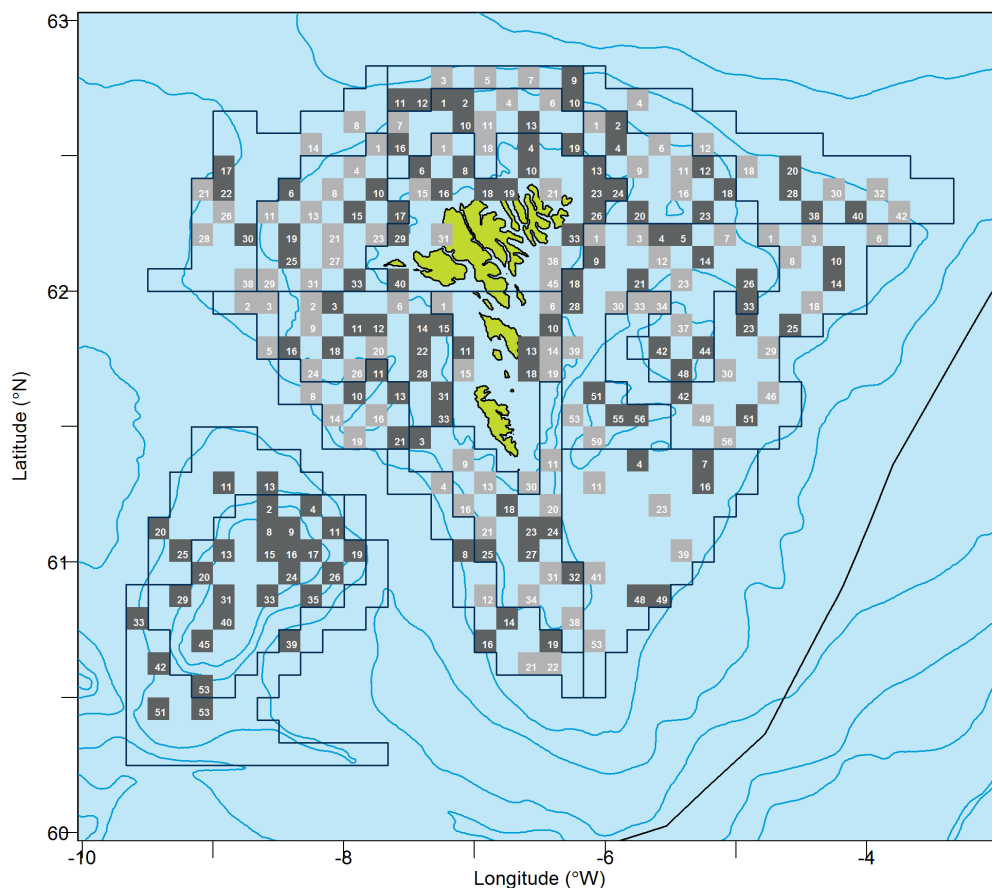


Figure 2.2 – Overview of survey design in the annual demersal trawl survey. The summer survey plan includes all 200 stations, whilst spring survey includes the dark grey. In spring 2021, additional trawl stations were conducted as part of calibration efforts between two vessels. Data from both vessels were included in the analyses.

2.2.2 Annual 0-group survey data

FAMRI has conducted annual 0-group surveys on the Faroe Plateau and Faroe Bank since 1983 using pelagic trawl (Figure 2.3). Catches are recorded, and subsamples are analysed with species identification, enumeration, and length measurements to the nearest millimetre. Although the surveys primarily target cod (*Gadus morhua*) year-class strength, by-catch species, including plaice and lemon sole, are also recorded (Gaard & Reinert, 2002).

0-group by-catch data were screened for suitability prior to inclusion in the present analyses due to known taxonomic uncertainty in early-life stages of flatfish. In particular, young of the year plaice and common dab (*Limanda limanda*) exhibit substantial morphological overlap, resulting in inconsistent species identification throughout the time series. For this project, plaice 0-group data were therefore considered unsuitable for quantitative analysis as potential misidentification could not be excluded. In contrast, lemon sole young of the year have been reliably identified throughout the survey data and occurred over a broad size range, potentially indicating an extended spawning period.

Consequently, 0-group survey data were not included in any quantitative analyses presented in this study. However, selected spatial distribution maps and time-series indices are presented descriptively to provide context on the occurrence and distribution of early life stages. These observations should be interpreted with caution, particularly for plaice, where species misidentification may influence the observed patterns.

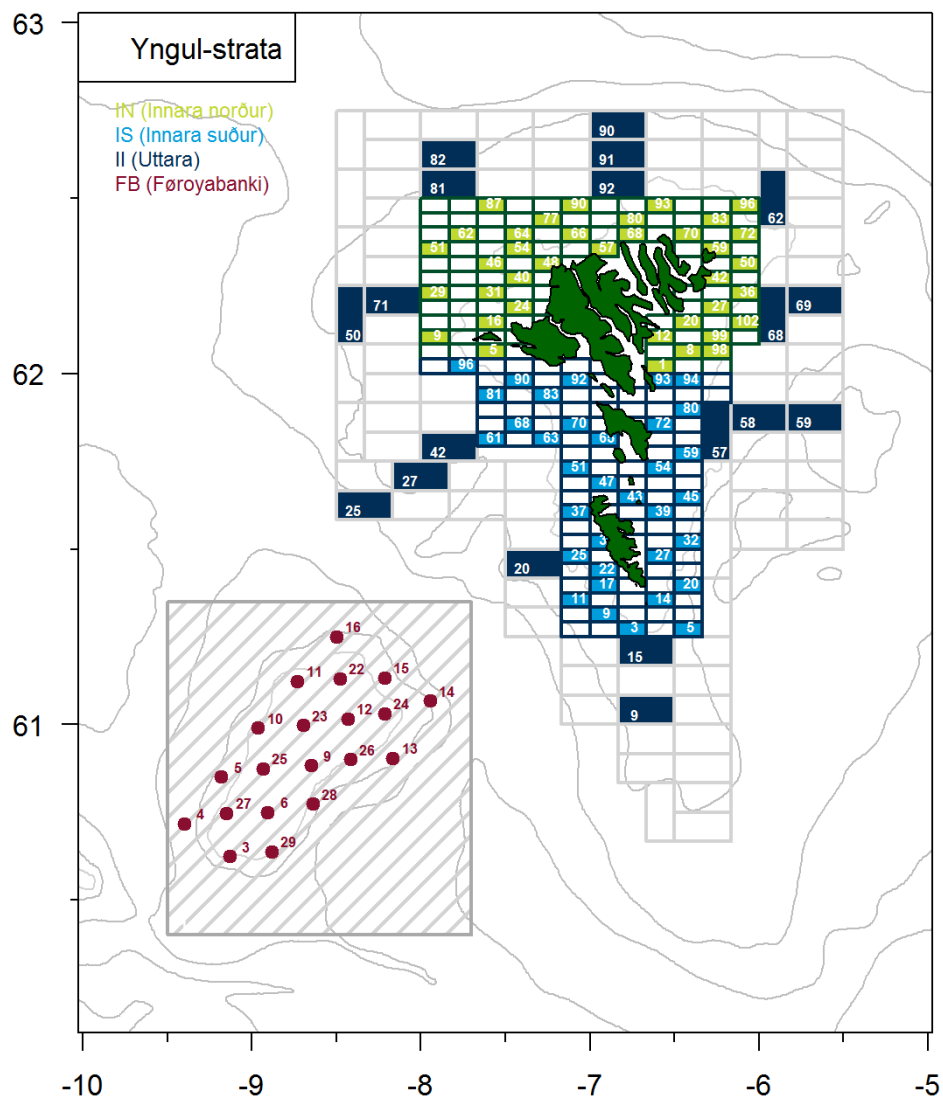


Figure 2.3 – Overview of survey design in the annual 0-group survey. The survey stations on the Faroe Plateau are distinguished into three states of rectangles – green: inner shelf north; light blue: inner shore south; dark blue outer shelf. The survey stations on the Faroe Bank are shown by red points representing start trawling positions.

2.3 Biological sampling and analysis

2.3.1 Growth and age determination

Ages of plaice and lemon sole were determined from growth increments in whole otoliths (Figure 2.4). Age readings were conducted following standardised ICES protocols for fish age estimation and established procedures for flatfish otolith interpretation, supported by cross-institutional calibration exercises to ensure consistency between readers and minimise potential reader bias (Adrian-Schütte et al., 2022; Vitale et al., 2019). Where applicable, repeat readings and reconciliation of discrepancies were used to improve precision and agreement in age determination.

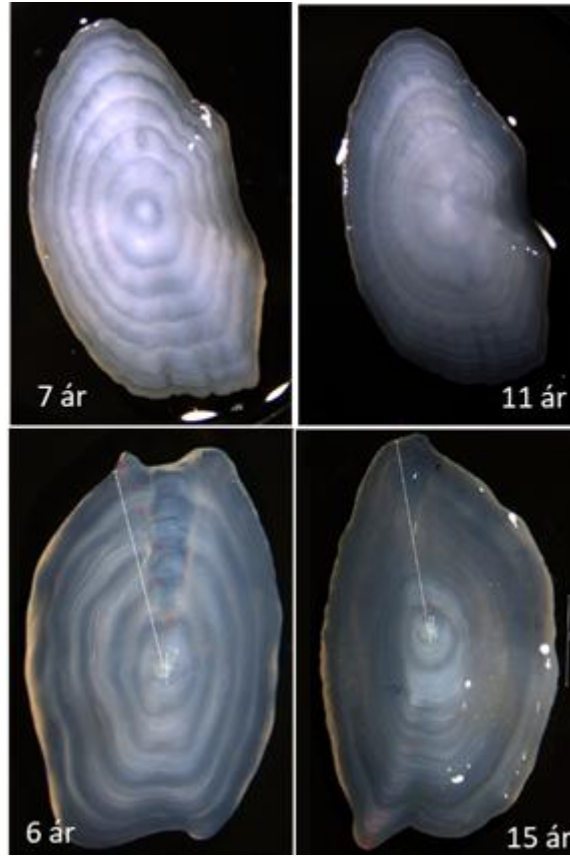


Figure 2.4 - Otoliths of plaice (top) and lemon sole (bottom), illustrating age-related growth increments. Younger individuals are shown on the left and older individuals on the right. ár = years.

Growth was described using the Von Bertalanffy Growth Function, fitted to the observed length-at-age data derived from aged plaice and lemon soles. Ages were linked to corresponding length measurements obtained from both survey and commercial sampling.

The model is expressed as:

$$L_t = L_{\infty}(1 - e^{-K(t-t_0)})$$

where L_t is the expected length at age t , L_{∞} is the asymptotic length, K is the growth coefficient describing the rate at which the asymptotic length is approached, and t_0 is the theoretical age at which length equals zero. The fitted model describes the growth trajectory of individual fish in the populations and provides parameter estimates that can be compared with those from other areas and studies.

Length–weight relationships were modelled using the power function:

$$W = aL^b$$

where W is weight (g), L is total length (mm), a is the intercept, and b is the allometric growth coefficient. Parameters were estimated using linear regression in log-transformed space.

2.3.1.1 Standardised body weight

To ensure consistency across observations, a standardised body weight (W_{body}) was defined. Where round weight was available, it was used directly. For individuals lacking round weight, body weight was estimated from gutted weight using a multiplicative conversion:

$$W_{\text{body},i} = W_{\text{gutted},i} \times R,$$

where $R = E(W_{\text{round}}/W_{\text{gutted}})$ is the mean ratio calculated from individuals with both measurements. This approach assumes a proportional relationship between round and gutted weight with a constant scaling factor across individuals.

2.3.1.2 Hepatosomatic Index

The hepatosomatic index (HSI) was calculated for individuals with available liver weight measurements as an indicator of energy reserves. HSI was defined as:

$$\text{HSI}_i = \frac{W_{\text{liver},i}}{W_{\text{body},i}} \times 100,$$

where $W_{\text{liver},i}$ is liver weight and $W_{\text{body},i}$ is standardised body weight for individual i (see section 2.3.1.1). Analyses were restricted to individuals with non-missing liver weight and body weight estimates.

2.3.2 Age-length keys

Age-length keys (ALKs) were constructed using paired observations of fish length and age per year. Within defined length intervals, ALKs estimates the probability of an individual belonging to a given age class. These keys were then applied to the corresponding length-frequency data to convert observed size distributions into age compositions. Age-disaggregated indices for the assessments are available only from 2016 onwards, as age readings are not conducted prior to this.

The resulting compositions were used to derive annual catch-at-age matrices for plaice and lemon sole, following standard procedures applied at the FAMRI (Eliassen et al., 2021). Catch-at-age data were stratified by year and relevant fleet components (commercial and survey).

Plus-group definitions were evaluated for both species to ensure robust representation of older age classes while minimising the influence of sparse observations. A range of candidate plus-groups was tested for each year. For each option, the proportion of total catch represented by the aggregated older ages was calculated in both numbers and weight. These summaries were used to assess the influence of alternative plus-group thresholds on the representation of older fish and the contribution of sparse observations to the catch-at-age structure. The selected plus-group for each species was subsequently applied in the construction of final catch-at-age matrices. The selected thresholds are presented in Section 3.9 (plaice) and Section 4.9 (lemon sole).

2.3.3 Gender and maturity data

Prior to sampling, existing maturity staging approaches for plaice and for lemon sole were reviewed. No standardised maturity key is consistently applied across North Atlantic shelf areas. A seven-stage maturity scale routinely used in demersal trawl surveys by the Faroe Marine Research Institute (FAMRI) was therefore adopted for both plaice and lemon sole. This standardised maturity classification ensured consistency across sampling platforms and observers.

The species-specific maturity keys were developed in 2020 based on gonad development, incorporating descriptive criteria and photographic references across maturity stages (Annex 6 and 7). Maturity stages were defined as: (1) immature, (2) early developing, (3) mid developing, (4) late developing, (5) mature, (6) spawning, and (7) resting.

To investigate the maturity ogive, gender distribution and potential spawning sites, sample data was compiled from both commercial landing inspections and from the demersal trawl surveys. The combined dataset comprised 1 601 plaice (837 females and 764 male) and 2 671 lemon sole (1 758 female and 913 male) (Annex 1-4).

2.3.3.1 Maturity Ogive

Maturity-at-age was modelled using a logistic maturity ogive within a binomial generalised linear modelling (GLM) framework. For an individual of age a , the probability of being mature, $p(a)$, was described as:

$$p(a) = \frac{1}{1 + \exp[-k(a - A_{50})]}$$

where A_{50} is the age at which 50% of individuals are mature and k is the slope parameter describing the rate of transition from immature to mature. The model was fitted assuming a binomial error structure with a logit link function. Maturity stage was treated as a binary response (immature = 0, mature = 1).

To evaluate the consistency between age- and length-based maturity estimates, a crosswalk analysis between A_{50} and L_{50} was performed using gender-specific von Bertalanffy growth functions (VBGFs). Growth trajectories were fitted to age–length observations using non-linear least squares estimation of the von Bertalanffy model parameters (L_{∞} , k , and t_0). The fitted growth functions were subsequently used to predict expected lengths at A_{50} and expected ages at L_{50} , thereby enabling direct comparison between empirical maturity ogives derived independently from age- and length-based analyses. Uncertainty in the growth trajectories was quantified using covariance-derived simulations of the VBGF parameters, from which 95% confidence intervals were generated around the predicted growth curves.

To stabilise estimation at younger ages, fictive immature observations (maturity stage 1) were added to the dataset at ages 0 and 1 for both genders of both species. These records were included solely to constrain the lower tail of the ogive, reflecting the biological expectation of immaturity at these ages, and do not represent observed biological data. Sensitivity analyses confirmed that these constraints only affected the lower tail of the ogive and did not influence estimated maturity at intermediate and older ages.

Alternative fitting formulations, including individual-level models and age-aggregated binomial models, produced identical maturity ogives, indicating that parameter estimates were robust to differences in age sampling structure.

2.3.3.2 Gonadosomatic index

Gonadosomatic index (GSI) was calculated for individuals with available gonad weight measurements as:

$$GSI_i = \frac{W_{\text{gonad},i}}{W_{\text{body},i}} \times 100,$$

where $W_{\text{gonad},i}$ is gonad weight and $W_{\text{body},i}$ is total body weight for individual i as described in Section 2.3.1.1. Analyses were restricted to individuals with non-missing gonad weight and body weight estimates.

2.3.4 Stomach content analysis

Stomach content sampling was conducted on a reduced scale relative to the original study design. Samples were collected opportunistically during the annual demersal spring and summer surveys between 2021 and 2023, whilst no stomach samples were obtained from commercial catches. Consequently, the available material represents only a limited subset of the spatial, temporal, and size distributions sampled during the broader study.

Stomachs were dissected and prey items identified to lowest practical taxonomic level. Prey length was measured using a vernier caliper and recorded to the nearest millimetre, while prey weight was recorded in grams with a precision of 1 g.

Given the restricted sample size and coverage, stomach content data were used primarily to provide a descriptive overview of prey composition. The data were not considered sufficient for quantitative analyses of feeding ecology, dietary variation, or seasonal feeding dynamics.

2.4 Data management and storage

Biological data from plaice and lemon sole collected from commercial landings and research surveys were processed according to FAMRI sampling protocols using dedicated MATLAB-based applications developed for institutional use. These tools are used for data recording during both harbour-based sampling and at-sea survey sampling.

All biological records are stored in institutional databases: *Unnur* (samples) and *Magnus* (research surveys). Fish length was measured in millimetres and recorded to the nearest 0.5 mm (rounded down). Weight was recorded in grams with a precision of 0.1 g. Stomach content data were collected using dedicated MATLAB-based software developed for diet composition analyses and are archived in the *Unnur* database.

2.5 Analytical framework and software

Analyses were based on the integration of fishery-dependent and fishery-independent data, with the two data sources combined where appropriate to provide sufficient spatial, temporal, and biological coverage. The combined dataset was used for most life-history analyses, including growth, length–weight relationships, age–length relationships, gender and maturity, and spatial distribution by length group. Where analyses required a specific data source or sampling design, fishery and survey data were analysed separately.

For analyses of spatial distribution by length class, fishery-dependent and fishery-independent observations were combined. Species-specific length classes were used to examine potential size-related differences in spatial distribution. For plaice and lemon sole, respectively, the lower length

boundaries were set at 32 and 25 cm based on the maturity analysis, with subsequent individuals grouped into 10- and 5-cm length classes. The geographical position associated with each individual observation was used to visualise and compare the spatial distribution of the different length classes.

Analyses combined deterministic derivation of biological indices, probabilistic construction of age compositions using age–length keys, spatial analyses of fishery dependant and independent observations, and statistical modelling approaches for growth, maturity, and stock assessment.

All analyses were conducted using R 4.4.1 (R Core Team, 2025). Data processing and visualisation were primarily carried out using the *tidyverse* suite, including *dplyr*, *tidyr*, *ggplot2*, and *readr*. Additional packages were used for specialised tasks, including *data.table* for efficient data handling; *lubridate* for date processing; *sf* and *rnatrualearth* for spatial analyses; and *patchwork*, *cowplot*, *gridExtra*, *ggnewscale*, and *ggbreak* (Xu et al., 2021) for figure assembly and visualisation. Fisheries-specific analyses were supported using the *FSA* package.

The stock assessment analysis of both plaice and lemon sole was conducted using the State-space Assessment Model (SAM) within the stockassessment.org framework. The model integrated commercial catches, survey indices, and age-composition information to estimate annual stock biomass, recruitment, and fishing mortality while accounting for observation and process uncertainty.

3. Plaice – results and discussion

3.1 Spatial Distribution

Plaice is widely distributed across the Faroe Plateau occurring from shallow coastal grounds of depths of approximately 200 m. In contrast, plaice is only rarely encountered on the Faroe Bank. The following sections describe the spatial distribution of plaice based on fishery and survey data, providing insight into the areas where the species is most frequently observed and its distribution across the Faroese shelf.

3.1.1 Spatial distribution from fishery

The spatial pattern shown in Figure 3.1 reflects both the footprint of commercial fishing effort and the spatial limitations of the fishing gears deployed. Plaice is primarily caught as part of a mixed demersal fishery, commonly alongside but not limited to cod, haddock and lemon sole. Consequently, the distribution of catches should not be interpreted as representing a directed plaice fishery. It should be noted that the logbook records available for this study are incomplete; therefore, years without reported fishing positions should not be interpreted as an absence of plaice fishing activity, but rather as periods for which positional data were unavailable (Section 0).

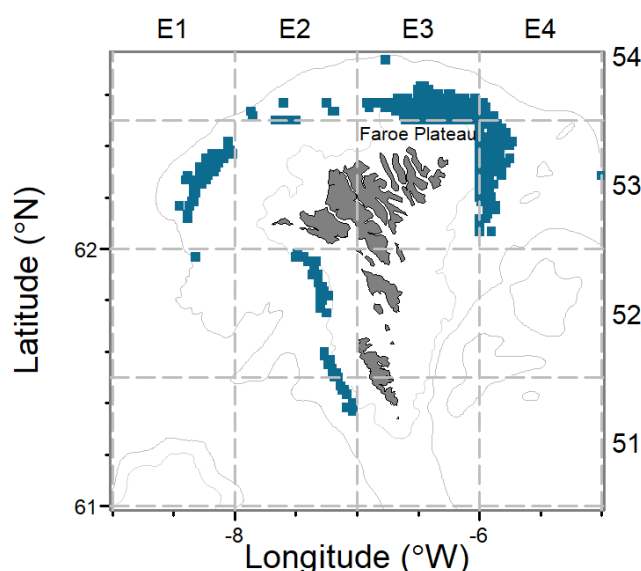


Figure 3.1 – Distribution of plaice fishery from available logbook data restricted to catches with plaice >15%.

3.1.2 Spatial distribution from spring and summer survey

The spring survey indicates a pronounced aggregation of plaice in the western and northern areas of the Faroe Plateau (Figure 3.2). This pattern is consistent with a seasonal contraction of the stock and is likely associated with pre-spawning or spawning migrations. In contrast, the summer survey shows a broader distribution across the plateau (Figure 3.2). The wider spatial extent partly reflects the greater station density of the summer series—approximately twice that of the spring survey—but also suggests a more diffuse post-spawning distribution likely to be corresponding to the stock's general feeding habitat (Gibson et al., 2015; van Keeken et al., 2007). Overall, the two surveys provide

complementary information, with the spring distribution reflecting potential spawning-related movements and the summer distribution representing the typical seasonal habitat of the stock.

Annual spatial distribution of plaice CPUE from the Faroese spring (1994–2025) and summer (1996–2025) demersal trawl surveys are presented in supplementary information Section 0.

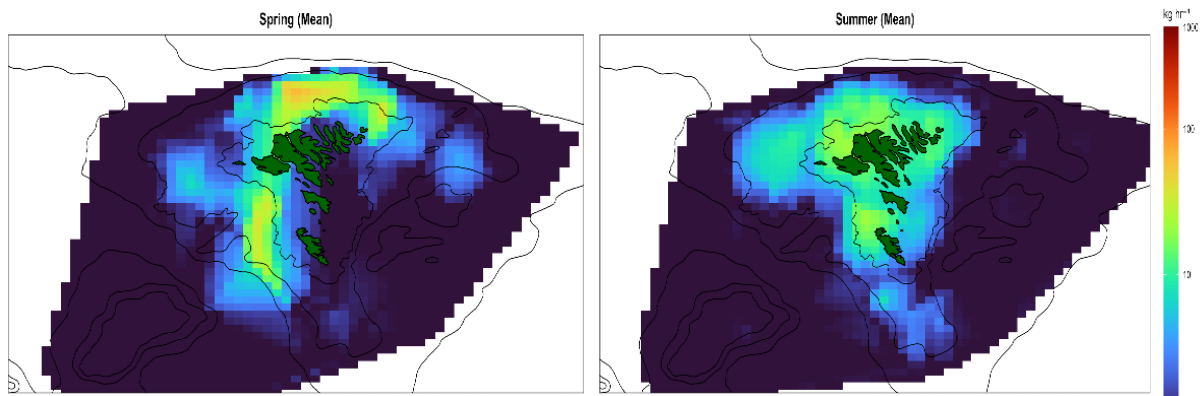


Figure 3.2 – Averaged spatial distribution of plaice CPUE (log kg/hr) from the annual demersal trawl spring survey from 1994–2025 (left) and summer survey 1996–2025 (right).

3.1.3 Spatial distribution of length groups

The spatial distribution of plaice exhibited a broadly overlapping distribution across length groups, with no clear and strong spatial segregation by size (Figure 3-3). Smaller individuals (<32 cm) appeared somewhat more concentrated in shallower areas, whereas larger individuals (≥62 cm) were more widely distributed across the study area, including both coastal and offshore locations. However, considerable overlap in the spatial distribution of different length groups was evident, particularly among intermediate size groups (32–62 cm), indicating limited spatial structuring by size.

While some weak tendencies towards ontogenetic spatial variation may be present, these patterns are not strongly pronounced in the point distribution data. This overlap suggests that factors other than size, such as environmental conditions or sampling coverage, may also play an important role in shaping the observed spatial distribution.

Plaice spatial distribution by length group and gender

5 cm length classes (cm) from combined survey and commercial data

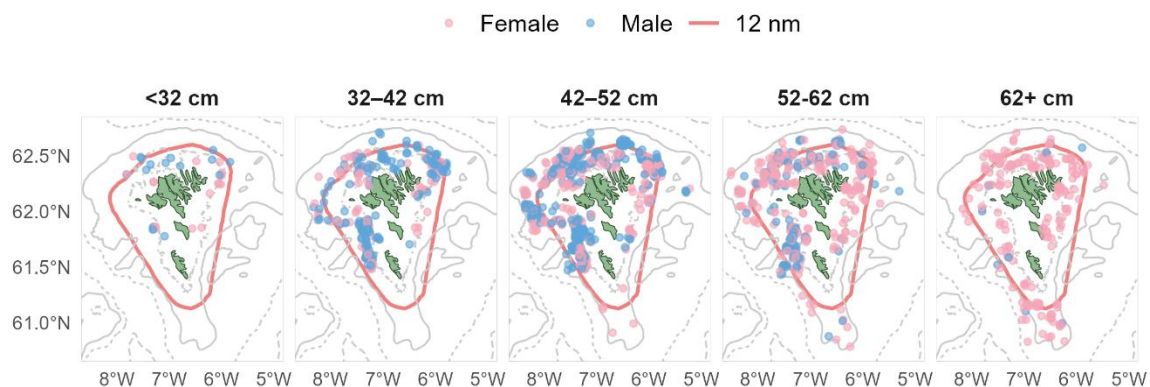


Figure 3-3. Spatial distribution of plaice segregated into length groups and separated into genders (pink: females, blue: males). Isobaths are represented by grey lines in 50 m increments. 12nm EEZ is represented in red.

3.2 Growth

3.2.1 Length - weight distribution

A strong positive relationship between length and weight was observed across the sampled size range ($W = 1.1 \times 10^{-5} L^{3.02}$; Figure 3.4), with the model explaining a high proportion of the variance in the data ($R^2 = 0.97$). The estimated exponent was close to 3, indicating approximately isometric growth, whereby weight increases proportionally with length.

The fitted relationship provided a good overall description of the data, with no evident systematic deviations, although some increase in variability in weight-at-length was observed among larger individuals. This variability likely reflects differences in condition, maturity status, and reproductive development. Overall, the results are consistent with expected growth patterns for the specie and supports the use of a fitted relationship for characterising population size–weight structure.

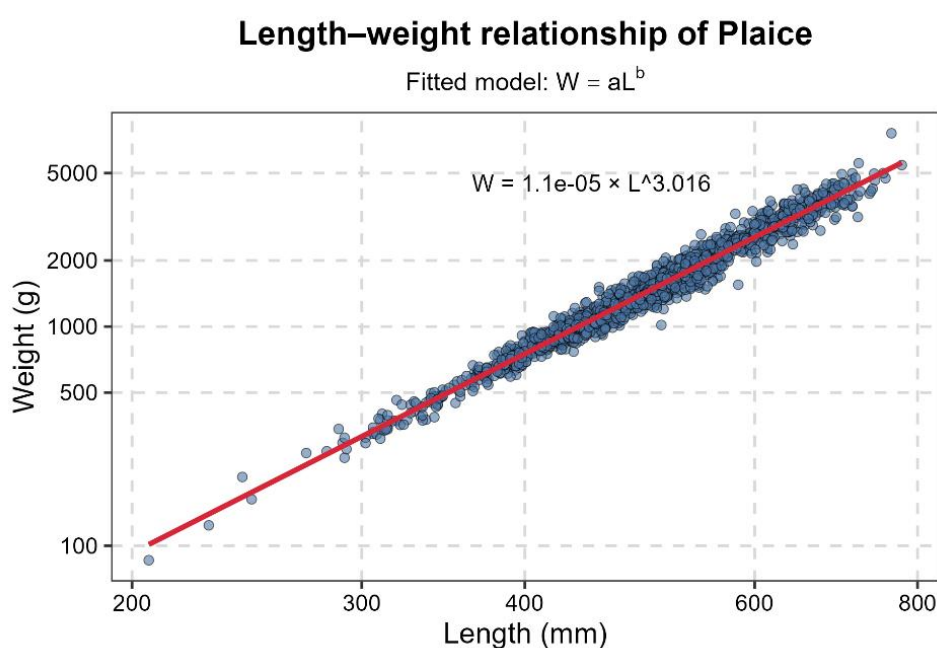


Figure 3.4 - Length–weight relationship of plaice based on combined commercial and survey samples. Points represent individual observations. The solid line shows the fitted power function ($W = aL^b$).

3.2.2 Age - length distribution

The growth of plaice on the Faroe Plateau was described using the von Bertalanffy model, with observed lengths ranging from 206 mm at age 1 to 778 mm at age 16 (Table 3.1). Growth trajectories were consistent between males and females in early ages, but females generally attained larger sizes at older ages. These growth curves provide the mechanistic link between age and length necessary for estimating maturity parameters (A_{50} and L_{50}) and for interpreting the crosswalk between age- and length-based maturity assessments.

Table 3.1 – Mean, min and max length for plaice by age and sample size.

Length-at-age summary for plaice				
Age	Sample size	Length (mm)		
		Mean	Min	Max
1	11	274.3	206	339
2	22	338.3	308	381
3	66	352.4	282	416
4	77	397.4	338	453
5	178	431.8	354	531
6	253	462.0	340	561
7	230	479.8	386	581
8	212	501.2	412	602
9	139	529.3	454	632
10	124	558.3	469	692
11	113	601.5	487	707
12	66	639.7	531	720
13	47	643.2	563	717
14	38	652.9	581	764
15	12	681.9	566	741
16	6	730.7	642	778
17	3	678.3	644	721
18	4	679.0	643	737

The age–length distribution of plaice in the commercial fishery demonstrates a strong selectivity for larger, mature individuals. Very few immature fish are present in the commercial catches, with the majority of individuals falling between 400 and 600 mm in length (Figure 3.5). In contrast, survey catches capture the full range of ages and sizes, including smaller, immature plaice. This pattern highlights that commercial catches provide limited information on recruitment and early growth, reinforcing the importance of survey data for assessing the full population structure.

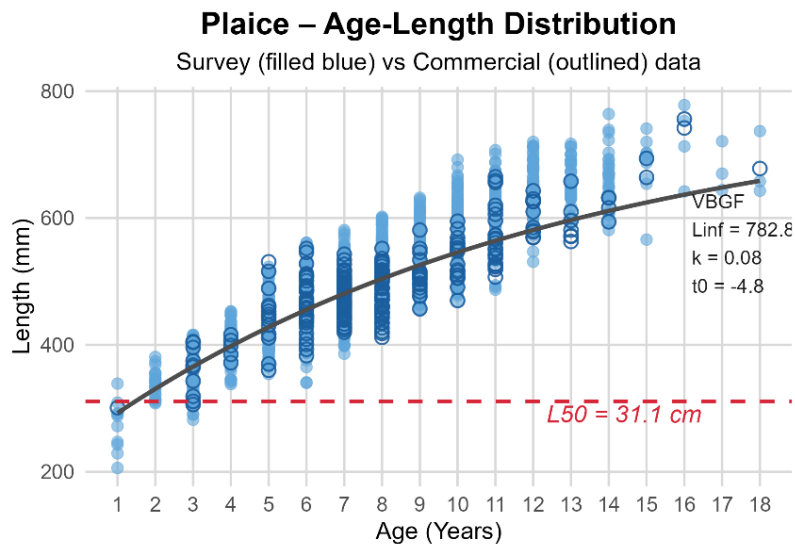


Figure 3.5 – Age-length distribution of plaice based on survey (filled blue symbols) and commercial (open dark blue symbols) samples. The solid black line represents the fitted von Bertalanffy growth function (VBGF). The stippled red horizontal line denotes the estimated length at 50% maturity (L_{50}).

The age-length distribution of plaice reveals clear differences in growth between genders (Figure 3.6). Males generally reach a plateau in length at around 550–600 mm, whereas females continue to grow for longer and typically plateau at 700–750 mm. This sexual dimorphism in growth results in larger maximum sizes for females and has implications for maturity, population structure, and fishery selectivity.

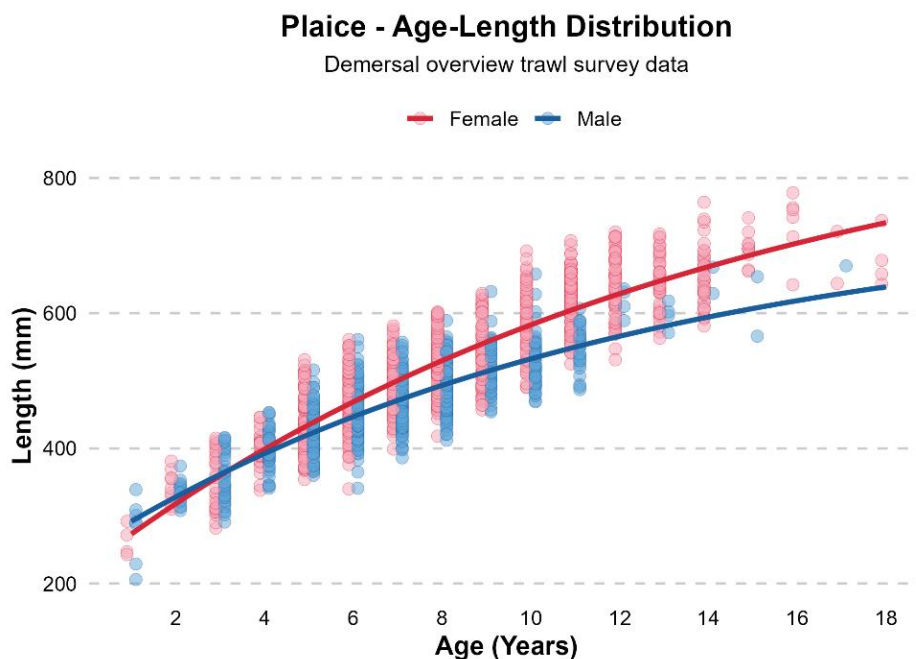


Figure 3.6 – Age-length distribution of female (pink) and male (blue) plaice from the demersal overview trawl survey. Solid lines represent gender-specific von Bertalanffy growth functions (VBGFs) fitted separately to female and male observations.

3.3 Age distribution

The age composition of plaice exhibits an approximately normal distribution from ages 1 to 14, with a tail extending to 18 years (Figure 3.7). The majority of individuals in the combined dataset fall between ages 5 and 11.

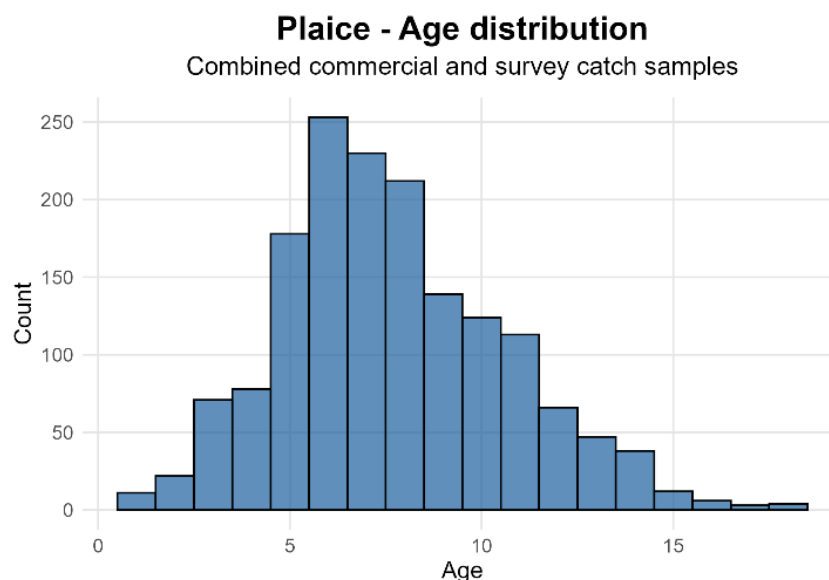


Figure 3.7 – Age distribution of plaice in the combined survey and commercial dataset, illustrating an approximately normal distribution of ages with a tail extending to older individuals.

The age distribution of plaice in the combined survey and commercial sampling indicates broadly similar numbers of males and females up to approximately age 10 (Figure 3.8). Beyond this point, females become increasingly dominant in the population, comprising more than 75% of individuals at older ages. This skewed gender ratio at higher ages is consistent with the faster growth and greater longevity of female plaice. The oldest individual observed in the dataset was female of 18 years, confirming the presence of long-lived females in the stock, even though such ages occur at low frequency.

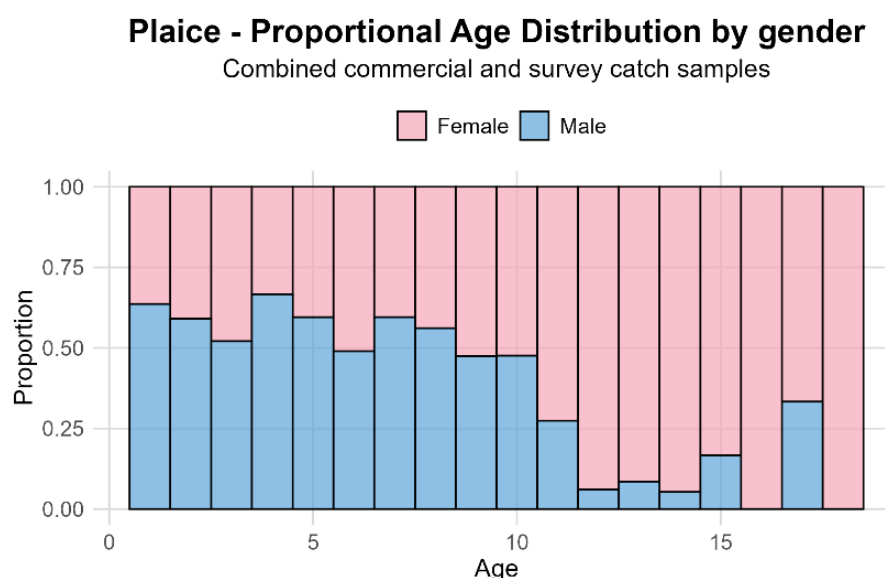


Figure 3.8 – Proportional age distribution of plaice by gender (Pink: female; Blue: male)

A comparison of age distributions from 2023 samples indicates that survey samples contain proportionally more younger fish (ages 1–6), whereas commercial catches are dominated by fish aged 6, 7 and 8 (Figure 3.9). This pattern reflects the combined effects of gear selectivity and spatial targeting in the commercial fishery, which tends to capture larger, more mature individuals, while the survey samples provide a more representative picture of the full age structure, including younger cohorts.

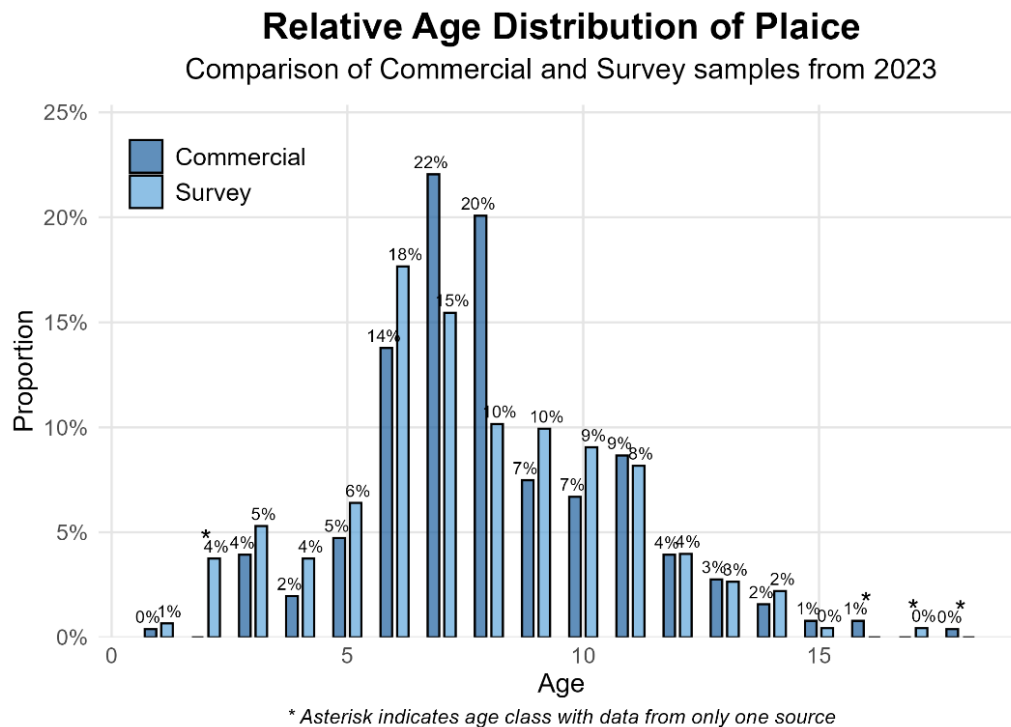


Figure 3.9 – Age distribution of plaice from survey and commercial catch samples in 2023 only.

3.4 Maturity

Maturity analyses of plaice examined maturity-at-length and maturity-at-age, the relationship between these two maturity indicators, and patterns in maturity stage and reproductive investment. Estimates of length and age at 50% maturity (L_{50} and A_{50}) were derived for the combined dataset and separately by gender. The relationship between L_{50} and A_{50} was further evaluated using the von Bertalanffy growth trajectories, while gonadosomatic index (GSI) and maturity-stage composition were examined to provide additional information on reproductive investment and seasonal reproductive patterns. The following sections present these analyses and describe the resulting patterns in greater detail.

3.4.1 Maturity ogive by length groups

Length data were grouped into 2-cm bins, and maturity was classified using a stage threshold of 2. A logistic regression model was fitted using a generalized linear model (GLM) to estimate the length at 50% maturity (L_{50}), which was calculated to be 31.3 cm for the combined dataset (Table 3.2 and Figure 3.10). The estimated L_{50} was 31.7 cm for females and 30.9 cm for males, with overlapping confidence intervals (Figure 3.11). The corresponding logistic regression parameters, including the intercept and slope estimates, standard errors, p-values, L_{50} estimates, and Akaike Information Criterion (AIC), are presented in Table 3.3.

Table 3.2 – Results of logistic regression model of plaice maturity at length (L_{50}). The table includes length bins, total number of fish, number of mature fish, observed ogive, predicted probability of maturity, and 95% confidence limits (lower and upper)

Length bin	Total fish	Mature fish	Ogive observed	Predicted prob	Lower CI	Upper CI
20	1	0	0	0.085	0.044	0.159
22	1	0	0	0.125	0.07	0.213
24	2	0	0	0.178	0.108	0.279
26	1	0	0	0.248	0.165	0.356
28	7	1	0.143	0.335	0.242	0.442
30	25	15	0.6	0.434	0.34	0.532
32	19	12	0.632	0.538	0.454	0.621
34	27	13	0.481	0.64	0.571	0.704
36	35	26	0.743	0.73	0.678	0.776
38	76	65	0.855	0.805	0.768	0.837
40	84	73	0.869	0.863	0.836	0.886
42	133	115	0.865	0.905	0.884	0.923
44	151	142	0.94	0.936	0.919	0.949
46	163	155	0.951	0.957	0.943	0.968
48	155	150	0.968	0.971	0.96	0.98
50	155	153	0.987	0.981	0.972	0.987
52	106	104	0.981	0.987	0.98	0.992
54	95	95	1	0.992	0.986	0.995
56	63	63	1	0.995	0.99	0.997
58	55	55	1	0.996	0.993	0.998
60	55	55	1	0.998	0.995	0.999
62	57	57	1	0.998	0.997	0.999
64	48	48	1	0.999	0.998	1
66	38	38	1	0.999	0.998	1
68	24	24	1	1	0.999	1
70	18	18	1	1	0.999	1
72	7	7	1	1	0.999	1
74	4	4	1	1	1	1
76	2	2	1	1	1	1

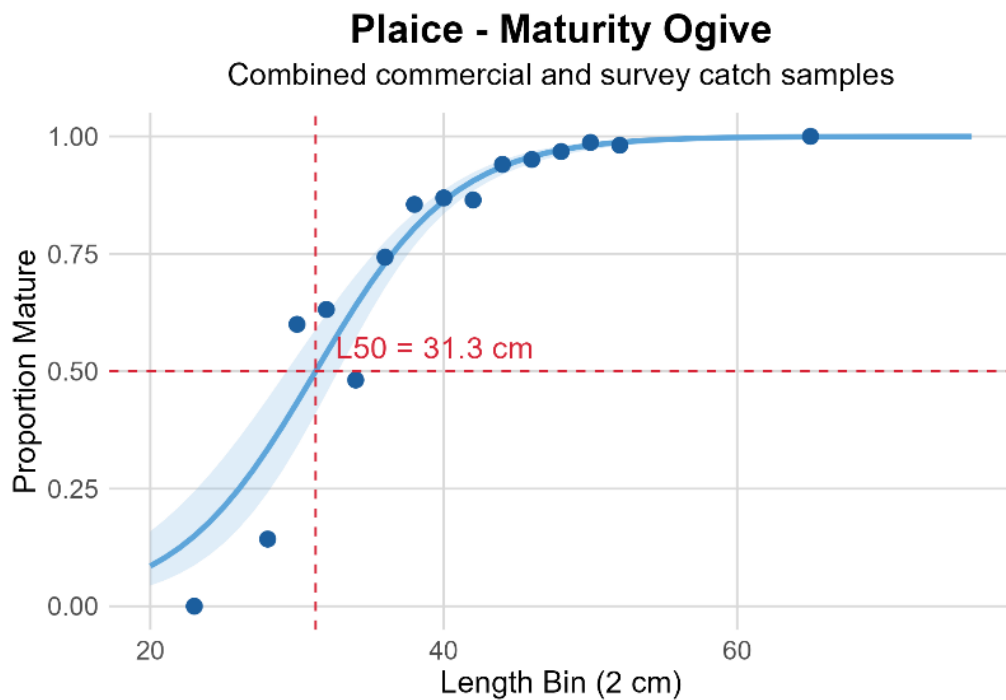


Figure 3.10 – Logistic regression model of the plaice maturity ogive. The blue line shows the fitted model, with shaded areas representing ± 1 standard deviation. Observed maturity at length is shown as dots, and stippled vertical line indicate the estimated length at 50% maturity (L_{50}).

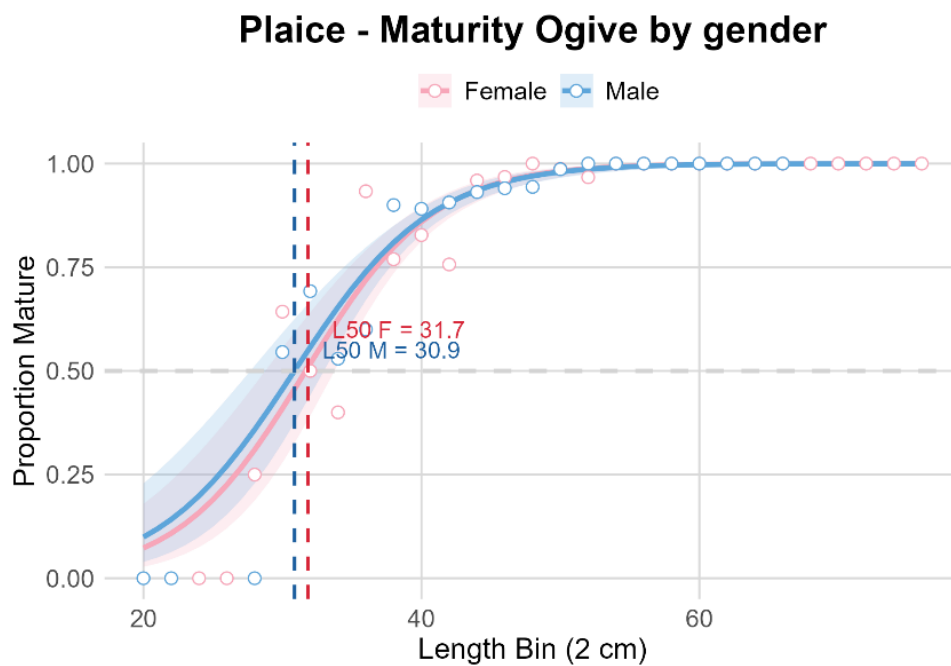


Figure 3.11 – Logistic regression models of the plaice maturity ogive by gender. Females are shown in pink/red and males in blue, with shaded areas representing ± 1 standard deviation. Observed maturity at length is shown as dots, and stippled vertical lines indicate the estimated length at 50% maturity (L_{50}) for each gender.

Table 3.3 – Logistic regression model parameters for the plaice maturity length ogive, shown for the combined dataset and separately for females and males. Parameters include the intercept estimate (Est), standard error (SE), and p-value (P), the slope estimate (Est), standard error (SE), and p-value (P), the estimated length at 50% maturity (L50), and the model Akaike Information Criterion (AIC).

Logistic Ogive Model Parameters								
Plaice length-at-maturity by gender								
Gender	Intercept (Est)	Intercept (SE)	Intercept (p)	Slope (Est)	Slope (SE)	Slope (p)	L50 (cm)	AIC
Combined	–6.58	0.70	<0.001	0.21	0.02	<0.001	31.30	613.90
Female	–6.90	1.00	<0.001	0.22	0.02	<0.001	31.70	240.60
Male	–6.27	0.98	<0.001	0.20	0.02	<0.001	30.90	377.10

3.4.2 Maturity ogive by age groups

Age data were grouped into 1-year bins, and maturity was defined using the same stage threshold of 2. A logistic regression model was fitted using a generalized linear model (GLM) to estimate the age at 50% maturity (A_{50}), which was calculated to be 2.0 years in the combined dataset (Table 3.4; Figure 3.12). The estimated A_{50} was 2.3 years for females and 1.8 years for males, with overlapping confidence intervals (Figure 3.13). The corresponding logistic regression parameters, including the intercept and slope estimates, standard errors, p-values, A_{50} estimates, and Akaike Information Criterion (AIC), are presented in

Table 3.5.

Table 3.4 – Results of logistic regression model of plaice maturity at age (A_{50}). The table includes age bins, total number of fish, number of mature fish, observed ogive, predicted probability of maturity, and 95% confidence limits (lower and upper)

Age bin	Total fish	Mature fish	Ogive observed	Predicted prob	Lower CI	Upper CI
1	11	1	0.091	0.320	0.226	0.431
2	22	8	0.364	0.479	0.386	0.573
3	71	47	0.662	0.642	0.573	0.706
4	78	65	0.833	0.778	0.736	0.815
5	178	164	0.921	0.872	0.847	0.894
6	253	232	0.917	0.930	0.913	0.945
7	230	215	0.935	0.963	0.950	0.973
8	212	206	0.972	0.981	0.971	0.987
9	139	139	1	0.990	0.983	0.994
10	124	124	1	0.995	0.991	0.997
11	113	113	1	0.997	0.995	0.999
12	66	66	1	0.999	0.997	0.999
13	47	47	1	0.999	0.998	1
14	38	38	1	1	0.999	1
15	12	12	1	1	0.999	1
16	6	6	1	1	1	1
17	3	3	1	1	1	1
18	4	4	1	1	1	1

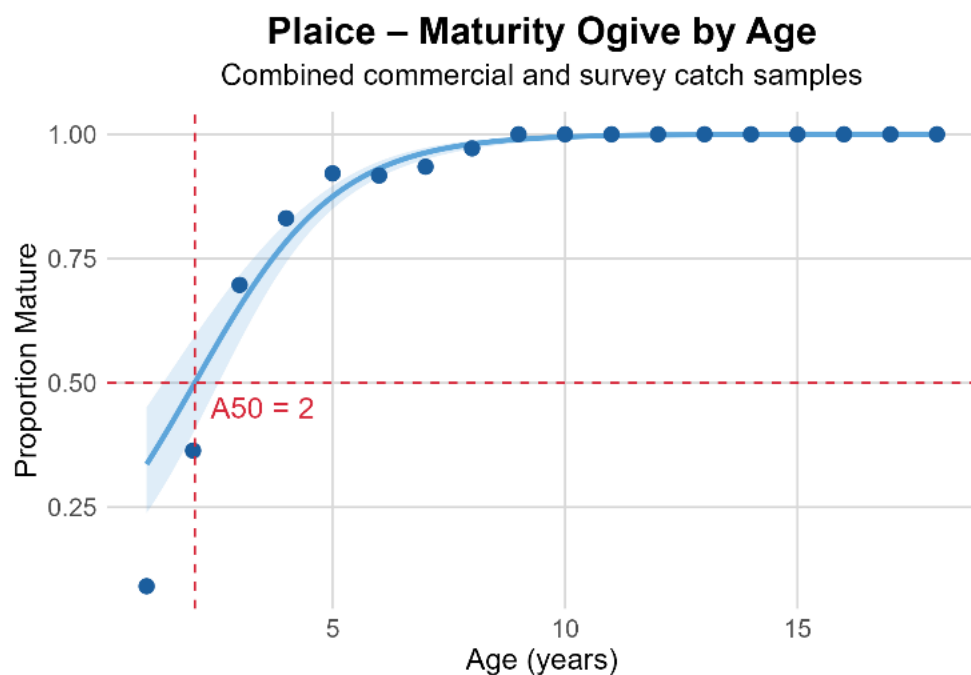


Figure 3.12 – Logistic regression model of the plaice maturity ogive by age. The blue line shows the fitted model, with shaded areas representing the 95% confidence interval. Observed maturity at age is shown as black dots. Fictive immature observations were added at age 0 to constrain the lower tail of the ogive. A_{50} is highlighted by the intersection of the 50% maturity level and the fitted ogive, with the vertical line indicating the corresponding age.

Plaice – Age-based Maturity Ogive by Gender

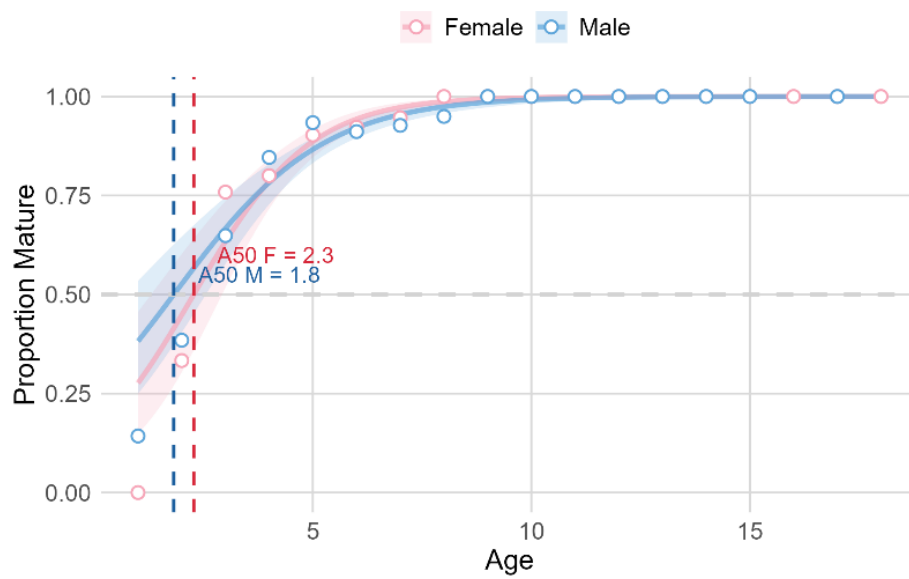


Figure 3.13 – Logistic regression models of the plaice maturity ogive by age and gender. Females are shown in pink/red and males in blue, with shaded areas representing ± 1 standard deviation. Observed maturity at age is shown as dots, and stippled vertical lines indicate the estimated age at 50% maturity (A_{50}) for each gender.

Table 3.5 – Logistic regression model parameters for the plaice maturity age-ogive, shown for the combined dataset and separately for females and males. Parameters include the intercept estimate (Est), standard error (SE), and p-value (P), the slope estimate (Est), standard error (SE), and p-value (P), the estimated length at 50% maturity (L50), and the model Akaike Information Criterion (AIC).

Logistic Age-at-Maturity Model Parameters								
Plaice age-at-maturity by gender								
Gender	Intercept (Est)	Intercept (SE)	Intercept (p)	Slope (Est)	Slope (SE)	Slope (p)	A50 (yrs)	AIC
Combined	–1.34	0.30	<0.001	0.66	0.06	<0.001	2.00	620.30
Female	–1.71	0.49	<0.001	0.75	0.10	<0.001	2.30	240.10
Male	–1.07	0.38	0.005	0.59	0.07	<0.001	1.80	381.80

Inspection of the maturity ogives indicated that the maturity-at-age schedules differed substantially from published estimates for adjacent North Atlantic plaice stocks, whereas maturity-at-length schedules were broadly consistent across regions. For example, published studies of North Sea plaice indicate later maturity-at-age than observed in the present study, with males generally becoming mature at ages 2–3 and females at ages 4–5 (Rijnsdorp, 1989), while in the Barents Sea and in Iceland, maturity is considerably delayed, often exceeding 6 years (Bromley, 2000; ICES, 2022). These age-at-maturity schedules contrast with the present findings, whereas the length-based ogives remain broadly consistent across regions. This mismatch may reflect differences in growth trajectories among populations, whereby fish can reach similar sizes at maturity despite attaining those sizes at different ages. Differences in growth may contribute to variation in age at maturity, as growth rates of North Sea plaice have varied substantially over time and among areas (Rijnsdorp & van Leeuwen, 1996).

However, differences in growth alone may not fully explain the observed discrepancy, and several features of the present dataset may also have contributed to the relatively early A_{50} estimates. These include potential age underestimation, growth-curve mismatches, and sampling effects. The aged samples may disproportionately originate from areas dominated by faster-growing cohorts, thereby producing an A-ogive skewed toward younger ages. In addition, the dataset is biased by an over-representation of spawning males, particularly evident in the spawning-season subset. As illustrated in Figure 3.16 females, by contrast, are more numerous in the resting and especially the spent stages. During the spawning season, female abundance is relatively evenly distributed across pre-spawning, spawning, and spent stages, whereas males occur predominantly in the spawning stage. These differences reflect established life-history strategies: males exhibit a more opportunistic spawning behaviour, while females allocate energy more conservatively across reproductive stages.

Sensitivity analyses examining the effects of truncating observations at full maturity ($\geq 99\%$ mature) and introducing fictive immature observations for ages 0 and 1 produced only minor changes in the estimated maturity schedules. In the combined dataset, A_{50} remained unchanged at 2.0 years. Female A_{50} decreased marginally from 2.3 to 2.2 years, while male A_{50} remained stable at 1.8 years. These results suggest that the comparatively early maturity-at-age estimates are unlikely to arise solely from uneven age representation or the predominance of mature individuals within the sampled dataset. Instead, the discrepancy between age- and length-based maturity schedules more likely reflects differences in growth dynamics, ageing uncertainty, or population-specific growth trajectories.

3.4.3 Crosswalk of L_{50} and A_{50}

The relationship between age at 50% maturity (A_{50}) and length at 50% maturity (L_{50}) for male and female plaice, integrating empirical maturity observations with von Bertalanffy growth trajectories, is presented in Figure 3.14 and Table 3.6. Solid lines show the median growth curves, while shaded ribbons represent 95% confidence intervals derived from covariance-based simulations of the growth parameters, incorporating both uncertainty and parameter correlation. Vertical dashed lines indicate the observed A_{50} values, and horizontal dotted lines show the observed L_{50} values.

Predicted lengths at A_{50} (circles) and predicted ages at L_{50} (triangles) generally overlap the observed values, demonstrating that the empirical maturity estimates are consistent with the underlying growth patterns. Minor discrepancies, where present, remain within expected uncertainty bounds, illustrating the robustness of the age- and length-based maturity assessments for both genders.

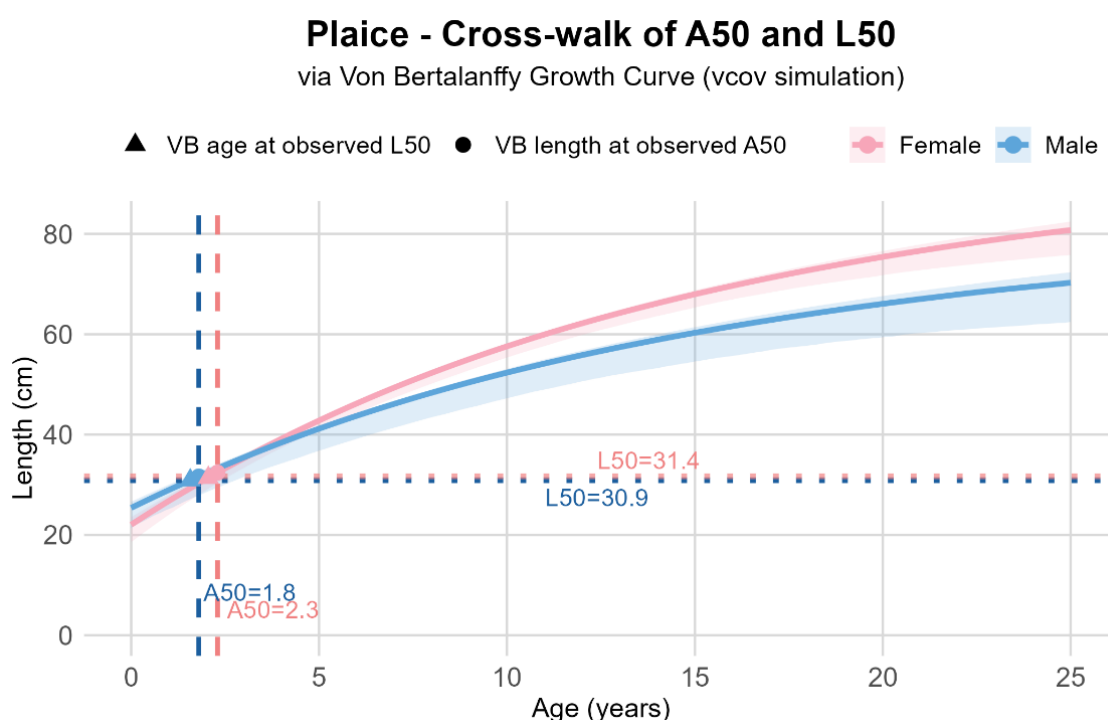


Figure 3.14 – Crosswalk of plaice age at 50% maturity (A_{50}) and length at 50% maturity (L_{50}) for males and females. Solid lines show the median von Bertalanffy growth trajectories, and shaded ribbons indicate 95% confidence intervals derived from covariance-based simulations of the growth parameters, accounting for parameter uncertainty and correlation. Vertical dashed lines mark the observed A_{50} values, and horizontal dotted lines indicate the observed L_{50} values. Points represent predicted lengths at A_{50} (circles) and predicted ages at L_{50} (triangles).

Table 3.6 – Crosswalk of plaice age- and length-at-maturity estimates by gender. The table includes observed age at 50% maturity (A_{50}) and length at 50% maturity (L_{50}), predicted length at A_{50} and predicted age at L_{50} from the von Bertalanffy growth model, and the differences between predicted and observed values (ΔL and ΔA).

Plaice Maturity Crosswalk						
Comparison of age-based (years) and length-based (cm) maturity metrics						
Gender	Observed		Predicted		Differences	
	A_{50}	L_{50}	A at L_{50}	L at A_{50}	ΔA	ΔL
Male	1.80	30.90	1.44	32.10	-0.36	1.20
Female	2.30	31.40	2.01	32.63	-0.29	1.23

The consistency between empirical maturity estimates and the underlying growth trajectories, allowing validation of A_{50} and L_{50} while highlighting minor discrepancies between age- and length-based maturity indicators for males, is demonstrated in Figure 3.15. The von Bertalanffy growth curves provide a mechanistic link between age and length, and the shaded 95% confidence intervals account for uncertainty in the fitted growth parameters. Predicted lengths at A_{50} and predicted ages at L_{50} generally overlap the observed values, confirming that the empirical maturity estimates are consistent with the growth model. Small gaps between predicted and observed values, where present, are quantified and remain within the expected uncertainty, illustrating a robustness of the maturity data. Comparable analyses for females show similar consistency, supporting the validity of length- and age-based maturity assessments across genders. The von Bertalanffy growth curves with the corresponding A_{50} - L_{50} crosswalk for both males and females is shown in Figure 3.15

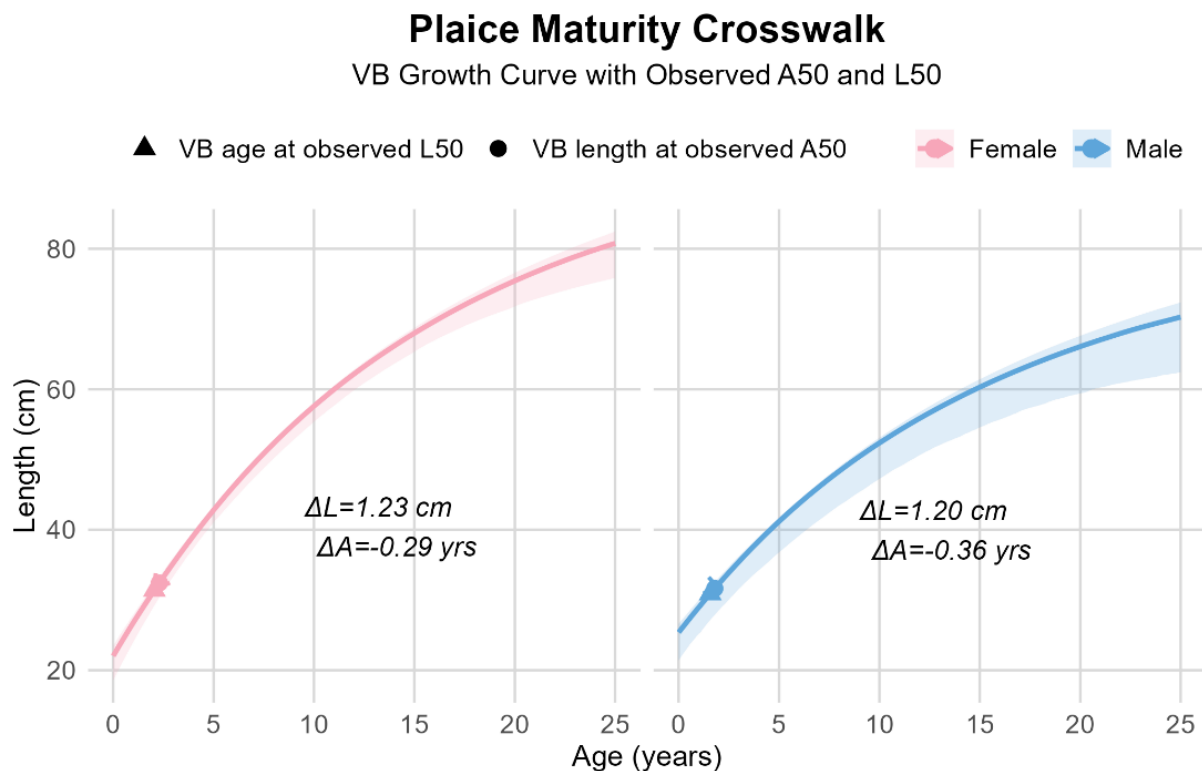


Figure 3.15 – Plaice von Bertalanffy growth curves with crosswalk of age at 50% maturity (A_{50}) and length at 50% maturity (L_{50}) for males and females. Solid lines show median growth trajectories, shaded ribbons represent 95% confidence intervals from covariance-based simulations, and points indicate predicted length at A_{50} (circles) and predicted age at L_{50} (triangles).

3.4.4 Gender and Maturity stage

Analysis of plaice by gender and maturity stage indicates that adult females are generally more abundant than males across most stages (Figure 3.16). However, during the spawning season (February–June), this pattern is reversed: male counts reach approximately 180–200 individuals, whereas females number fewer than 50. This pronounced imbalance likely reflects differences in spawning behaviour and spatial distribution, with males aggregating in spawning areas ahead of or in greater numbers than females, while females are more dispersed or progress through development over a longer period. Sampling design and timing relative to peak female spawning activity may also contribute to the observed ratios.

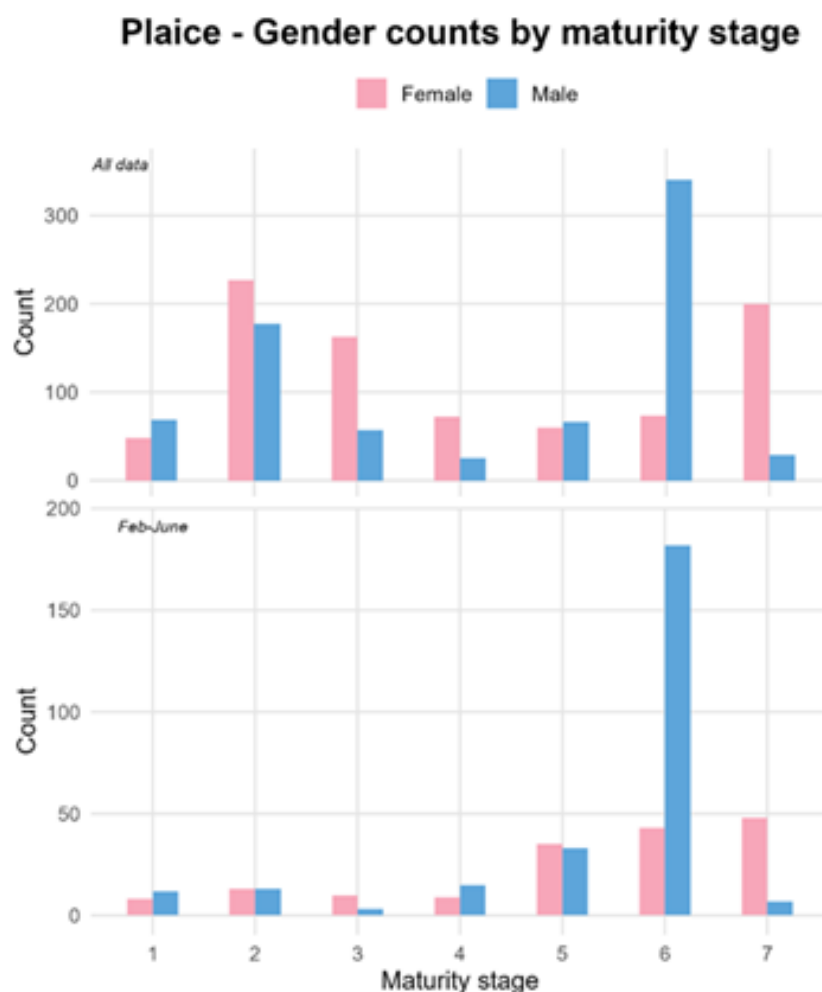


Figure 3.16 – Counts of male and female plaice by maturity stage in all data (upper) and subset including data from February to June (lower)

3.4.5 Gonads Somatic Index

Gonadosomatic index (GSI) data were available only for a subset of sampled individuals of plaice and did not reflect the full-size composition used for maturity ogive estimation. GSI observations were concentrated within intermediate and larger size classes, with relatively few smaller individuals represented in the dataset (Figure 3.17 and Figure 3.18). This pattern reflects opportunistic gonad sampling, where larger and predominantly mature fish were preferentially sampled.

The relationship between GSI and length showed substantial variability, particularly among females. Male GSI values were generally low and narrowly distributed across the observed length range, whereas females displayed considerably greater variation, including several individuals with markedly elevated GSI values. The highest GSI observations occurred almost exclusively in females within the intermediate-to-large-size classes (~500–650 mm), indicating substantial variability in reproductive investment and spawning condition among mature females.

No strong linear relationship between length and GSI was evident for either gender. Instead, GSI appeared highly variable among individuals of similar size, suggesting that reproductive condition is influenced more strongly by maturity stage and spawning timing than by body length alone.

Consequently, the observed GSI patterns primarily describe reproductive investment among mature individuals rather than maturity dynamics across the population as a whole. In contrast, the L50

estimates derived from the complete maturity dataset represent the size at onset of maturation within the stock. Direct comparisons between L50 estimates and GSI trends should therefore be interpreted cautiously, as the two metrics are derived from datasets with substantially different sampling coverage and size composition.

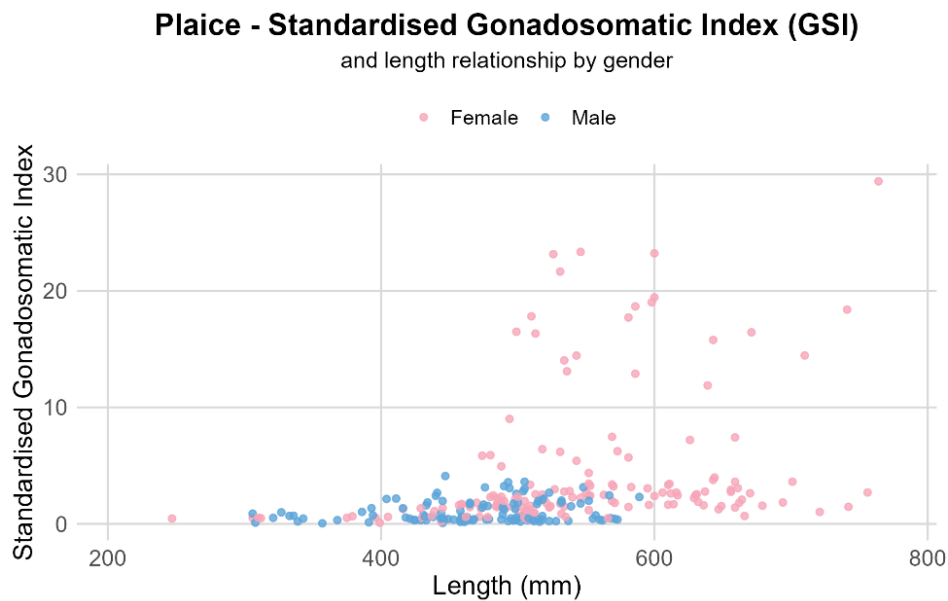


Figure 3.17 – Standardised gonadosomatic index (GSI) in relation to length (mm) for plaice, shown separately for males and females. Each point represents an individual fish. GSI values are derived from gonad weight relative to standardised body weight (round weight or estimated from gutted weight).

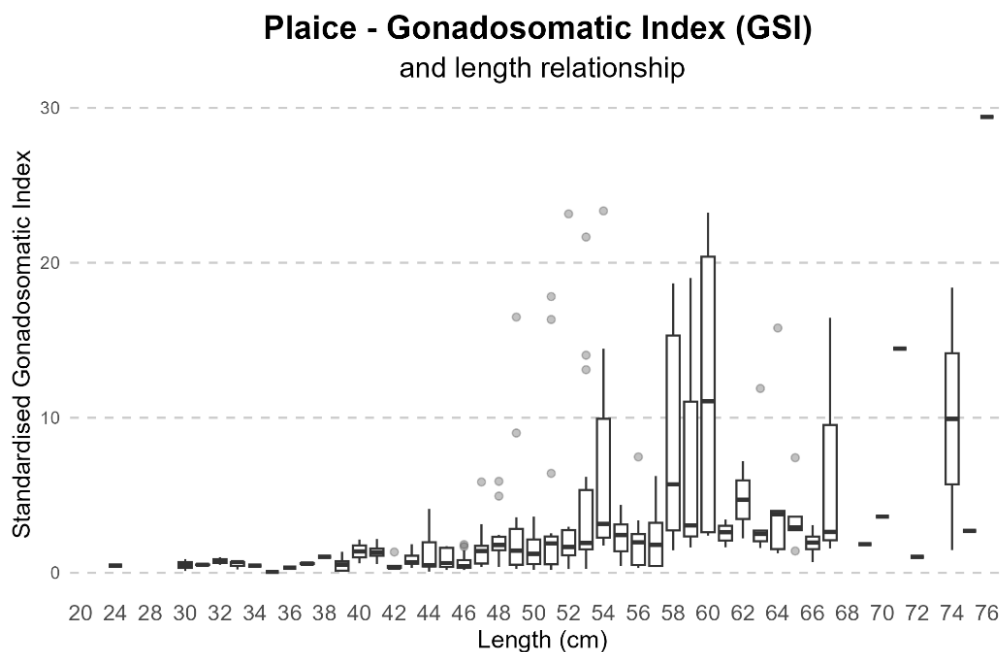


Figure 3.18 – Distribution of standardised gonadosomatic index (GSI) by length class (cm) for plaice. Boxes represent the interquartile range, with median values indicated by horizontal lines; whiskers extend to $1.5 \times$ the interquartile range, and points indicate outliers.

3.5 Phenological Distribution

The seasonal pattern of gonad maturity in plaice indicates a defined spawning season, as shown in Figure 3.19. Spawning individuals are present from February through to May (Figure 3.21), with peak gonad development differing between the genders (Figure 3.20). Females tend to mature later, with spawning-stage gonads appearing progressively across the season, whereas males with spawning gonads are observed over a longer and more continuous period (Figure 3.20). This pattern highlights the gender-specific timing of reproduction in plaice on the Faroe Plateau.

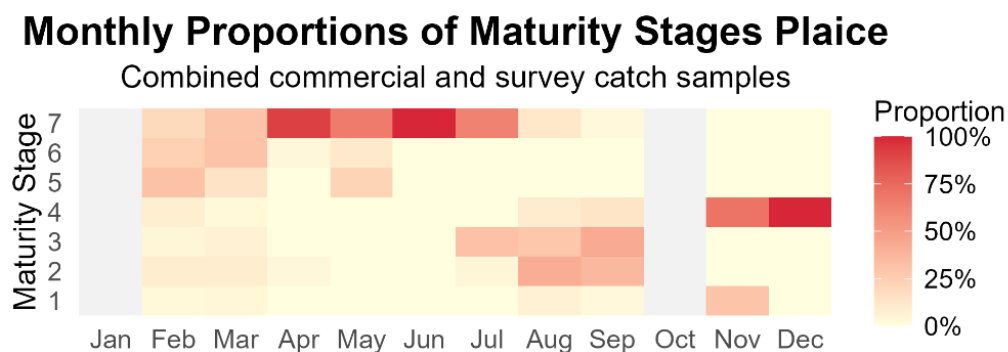


Figure 3.19 – Heat map of the monthly proportion of plaice maturity stages 1–7. Maturity data for January and October is not available.

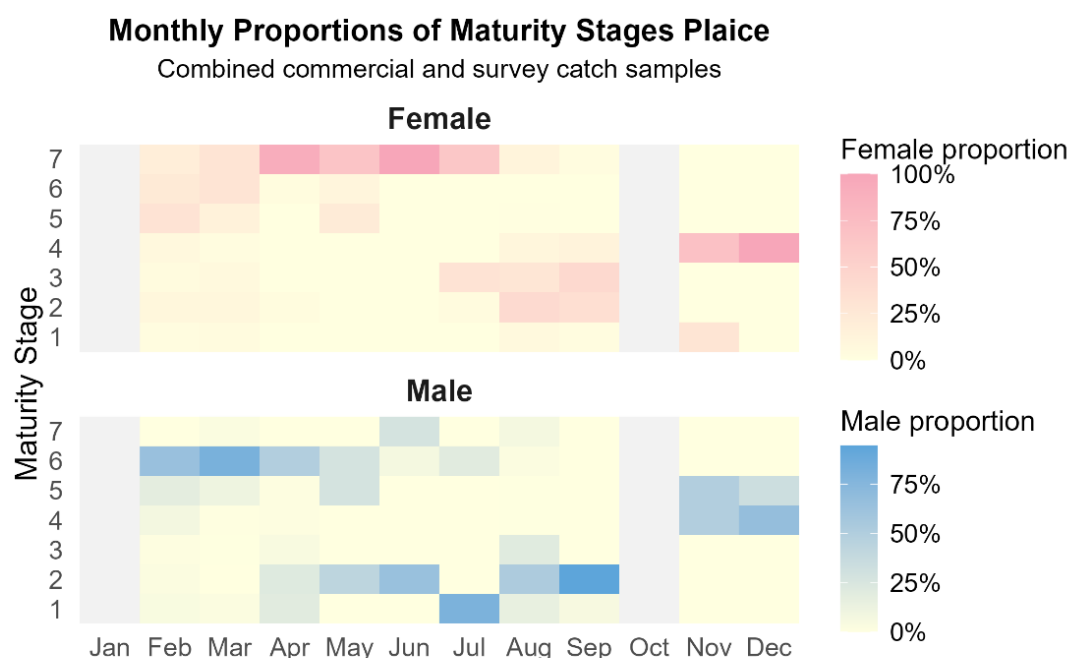


Figure 3.20 – Heat map of the monthly proportion of plaice maturity stages 1–7, separated into genders (female: upper; male: lower). Maturity data for January and October is not available.

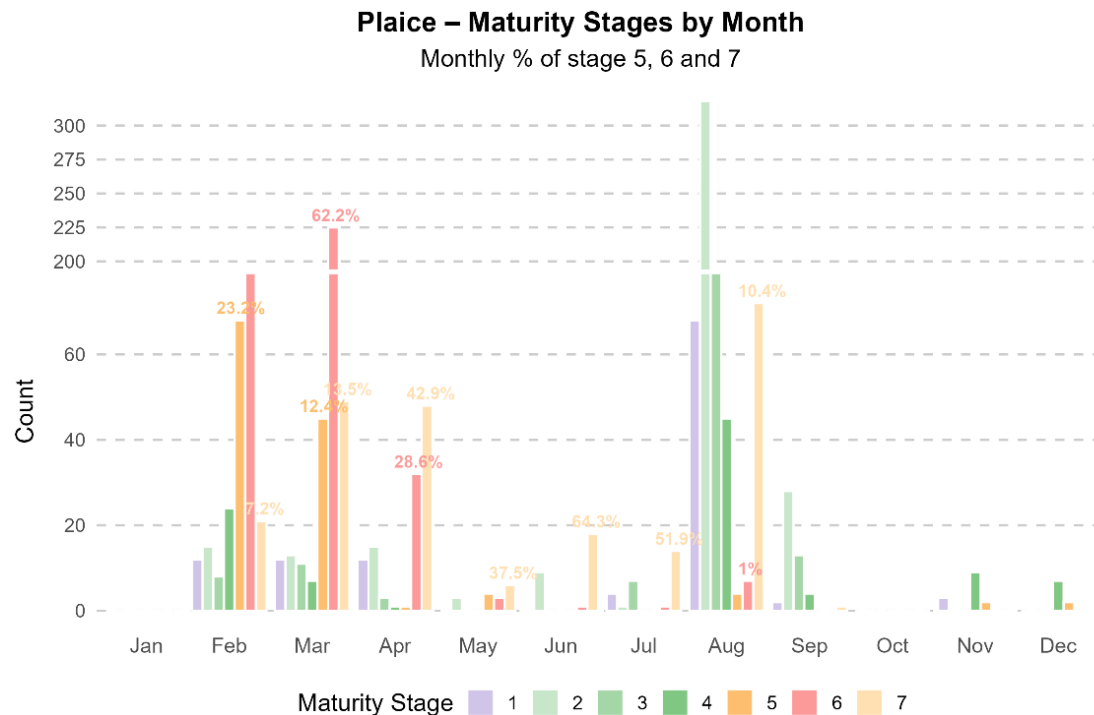


Figure 3.21 – Monthly counts of plaice maturity stages, showing the proportion (%) of stages 5, 6, and 7 only. Values are expressed as a percentage of the total observed in each month. Note the break in the y-axis to accommodate higher values in peak months (Xu et al., 2021).

3.6 Spawning- and nursery grounds

3.6.1 Spatial distribution per gender

Both genders of plaice were observed across the Faroe Plateau (Figure 3.22). Females were generally more abundant in the southern and eastern regions, whereas males were concentrated in the southwest (Vágahavið) and northeast.

Plaice spatial distribution by gender

Combined sample data from commercial catches and demersal trawl surveys

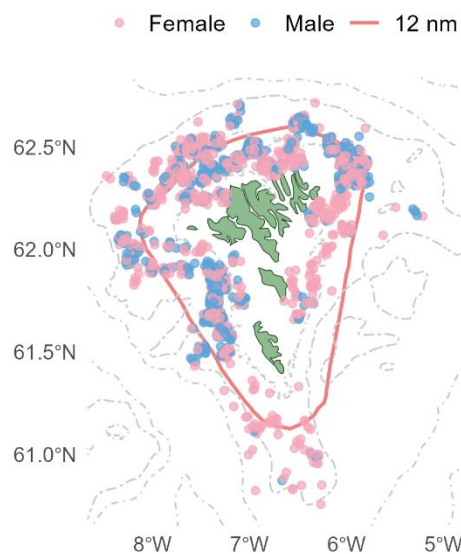


Figure 3.22 – Spatial distribution of plaice segregated into gender by combined sample data from commercial catches in 2023 and demersal overview trawl surveys from 1996 to present.

3.6.2 Spawning grounds

Unlike Faroese cod (*Gadus morhua*), plaice does not appear to form dense, spatially confined spawning aggregations on the Faroese shelf (Figure 3.23). Nevertheless, the distribution of spawning individuals (maturity stage 6) indicates a degree of spatial structuring, with spawning activity concentrated primarily in the northern, northwestern (Mýlingsgrunninum), and western (Vágahavinum) shelf areas (Figure 3.24). Although observations of spawning fish remain limited and are dispersed across the survey period, the available data suggest that reproduction is not restricted to a single spawning ground but occurs across a broader region of the shelf. The apparent concentration of spawning individuals in the northern and western shelf areas may indicate preferred spawning habitat, although additional observations would be required to determine whether these patterns are persistent between years. Overall, the available evidence suggests that plaice spawning on the Faroese shelf is relatively diffuse compared with species that form discrete spawning aggregations, while still exhibiting a clear tendency for spawning activity to occur in the northern and western shelf regions.

In contrast, the eastern fishing grounds yielded only isolated spawning individuals – one female in February and one male in June – suggesting that spawning activity in the east is rare and likely diffuse.

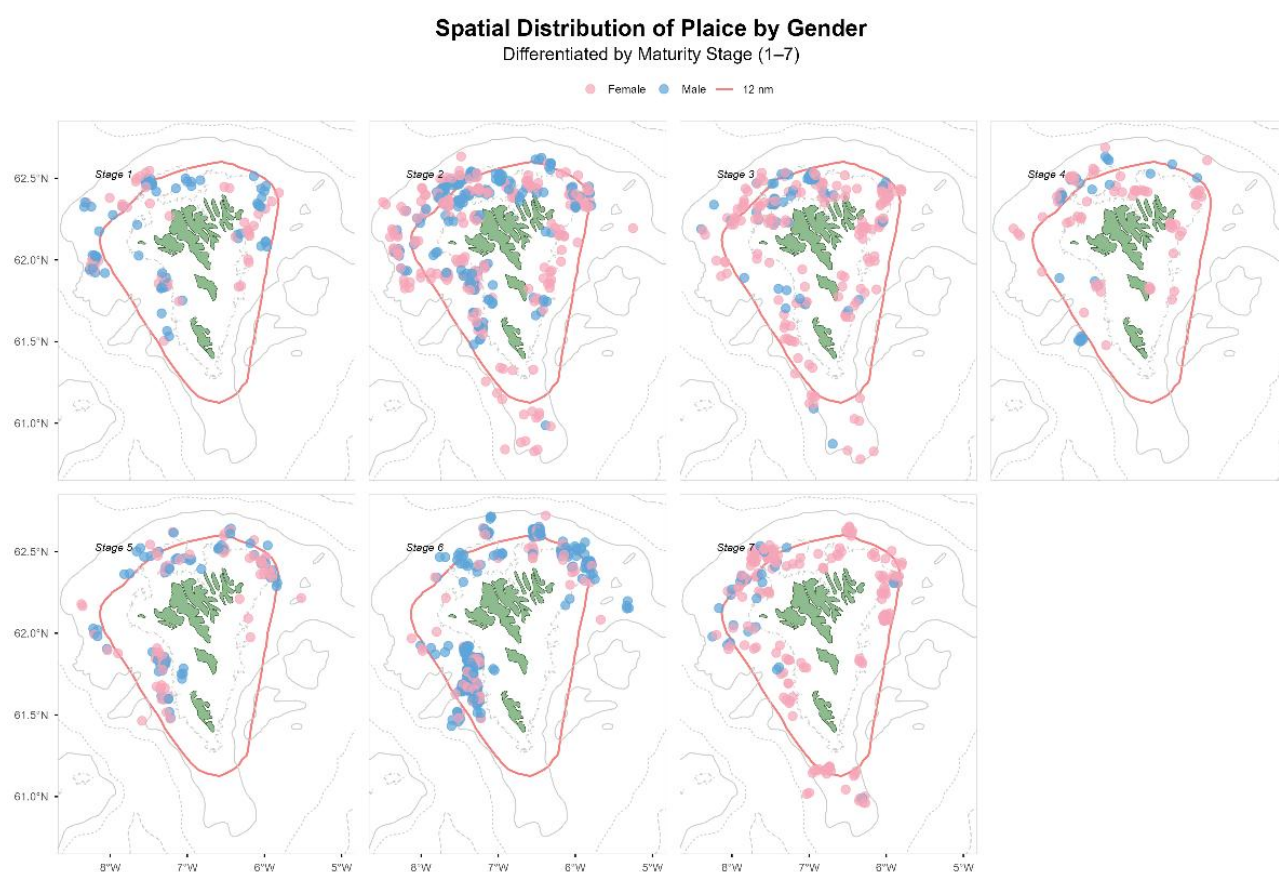


Figure 3.23 – Spatial distribution of plaice female (pink) and male (blue) differentiated by maturity stages 1 immature, 2-5 mature, 6 spawning and 7 resting.



Figure 3.24 – Spawning area of plaice.

3.6.3 Distribution of 0-group samples and index

Although 0-group observations identified as plaice were available from the annual 0-group surveys, these data should be interpreted with caution due to known difficulties in distinguishing juvenile plaice from dab (*Limanda limanda*) during early life stages. Consequently, the observations are presented only as a descriptive overview and were not used in subsequent analyses.

Observations identified as plaice were recorded across much of the Faroe Plateau and, notably, on Faroe Bank, where plaice are otherwise rarely encountered in the commercial fishery or the annual demersal trawl surveys (Figure 3.25). The corresponding 0-group index showed substantial interannual variability, including pronounced peaks in 2014 and 2015 (Figure 3.26). However, given the uncertainty surrounding species identification, these patterns should not be interpreted as definitive evidence of plaice distribution or recruitment dynamics.

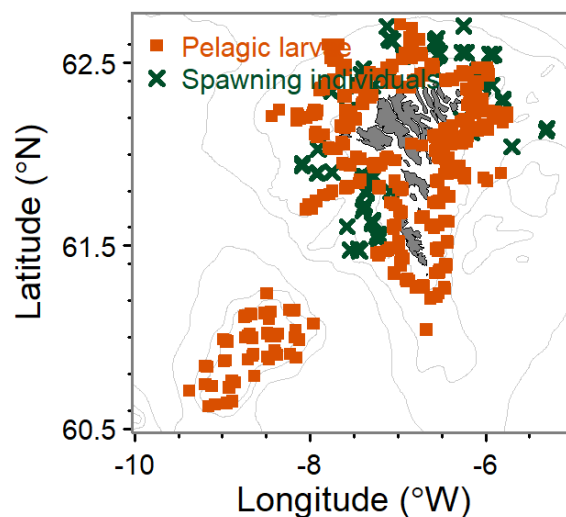


Figure 3.25 – Distribution of plaice larvae (orange squares) from 0-group surveys and locations of spawning adults (green crosses) sampled in combined spring and summer demersal trawl surveys, illustrating the spatial relationship between early life stages and spawning adults across the Faroe Plateau.

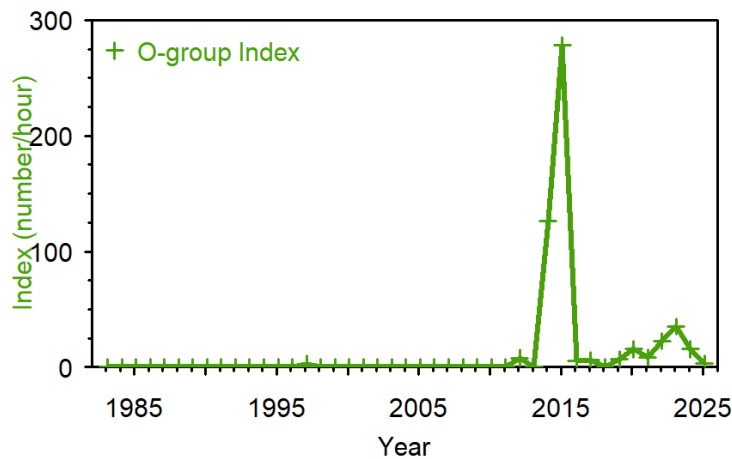


Figure 3.26 – O-group index of plaice larvae sampled in the O-group surveys from 1983 to 2025, showing interannual variation in early recruitment across the Faroe Plateau.

3.7 Liver index

The hepatosomatic index (HSI) increased generally with fish length in both female and male plaice, although considerable individual variability was observed throughout the sampled size range (Figure 3.27). This relationship was particularly evident among females, where larger individuals tended to exhibit higher HSI values than smaller fish.

Female plaice consistently displayed higher HSI values than males and exhibited a broader range of liver condition across lengths. Several females larger than 500 mm attained HSI values exceeding 1.5, with the highest values approaching 2.0. In contrast, male HSI values were generally lower and more tightly clustered, rarely exceeding 1.2. The divergence between genders became more pronounced among larger individuals, suggesting differences in energy storage and allocation.

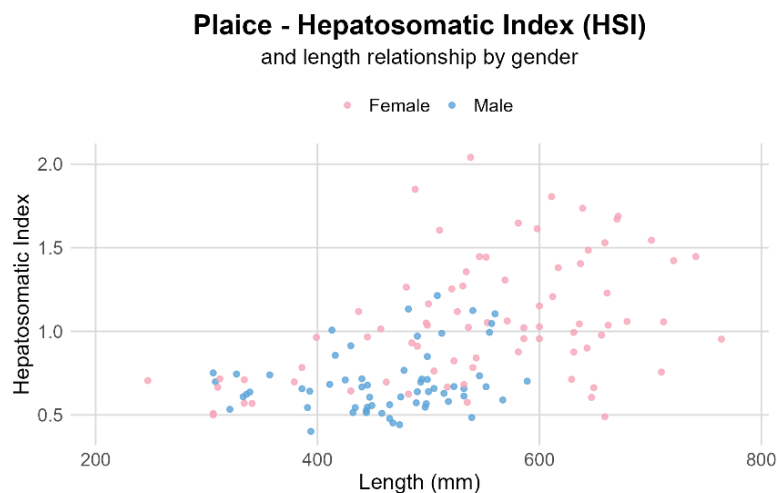


Figure 3.27 – Relationship between hepatosomatic index (HSI) and total length (mm) in female and male plaice. Each point represents an individual fish.

Monthly comparisons revealed higher HSI values during August than during February–March for both genders (Figure 3.28). Female plaice maintained higher median HSI values than males throughout the sampled periods, while August samples exhibited greater variability, particularly among females. These patterns indicate increased liver energy reserves during late summer relative to the late winter sampling period.

Overall, the HSI patterns suggest substantial variation in energetic condition within the sampled plaice population, with females exhibiting both higher liver indices and greater variability than males. However, interpretation of these patterns should be made cautiously given the limited temporal coverage of the available samples.

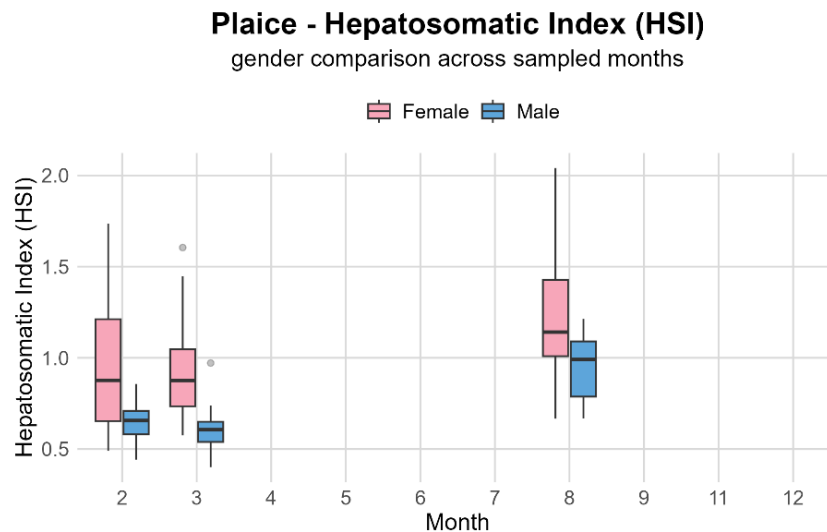


Figure 3.28 – Monthly variation in hepatosomatic index (HSI) of female and male plaice across sampled months. Boxplots show median values, interquartile ranges, and overall distribution of HSI values by gender and month.

3.8 Feeding habits

Stomach content analysis indicated that plaice fed predominantly on molluscs, which accounted for approximately three-quarters of the total stomach content weight recorded in the sampled individuals (Figure 3.29). Crustaceans, fish, and other prey categories contributed substantially smaller proportions of the diet, each comprising less than 15% of the total stomach content weight.

The available stomach samples suggest that benthic molluscs constitute an important dietary component for plaice on the Faroese shelf. However, the limited number of stomach samples and their opportunistic collection restrict the extent to which broader dietary patterns can be inferred. While the size and weight of undigested prey items were recorded, no analyses were undertaken to investigate prey selectivity, ontogenetic dietary shifts, or spatial and seasonal variation in prey composition.

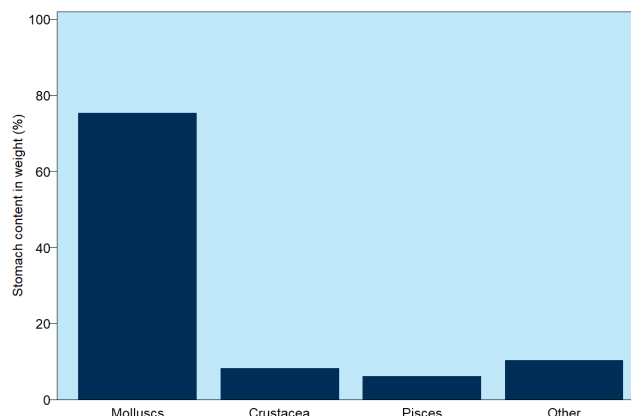


Figure 3.29 – Stomach contents of plaice expressed as %-weight for the main prey categories, illustrating the relative importance of different prey types in the diet across sampled individuals.

3.9 Stock assessment of plaice

3.9.1 Length compositions

Commercial length frequency distributions from 2016 onwards were obtained mainly from the small trawler fleet, although no length samples were taken from 2024 (Figure 3.30).

Fishery-independent length composition data were obtained from FAMRI's annual demersal fish surveys in summer (Figure 3.31) and spring (Figure 3.32).

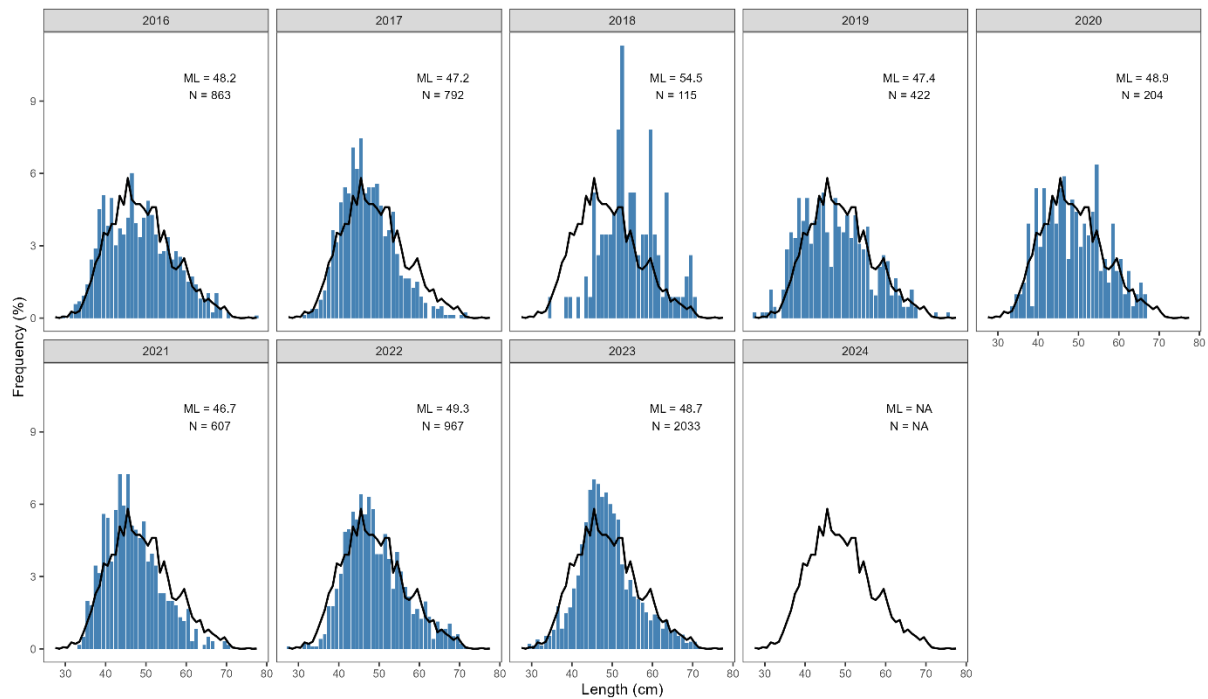


Figure 3.30 – Annual length distributions of plaice in the commercial fishery, showing interannual variation in size composition of the catches.

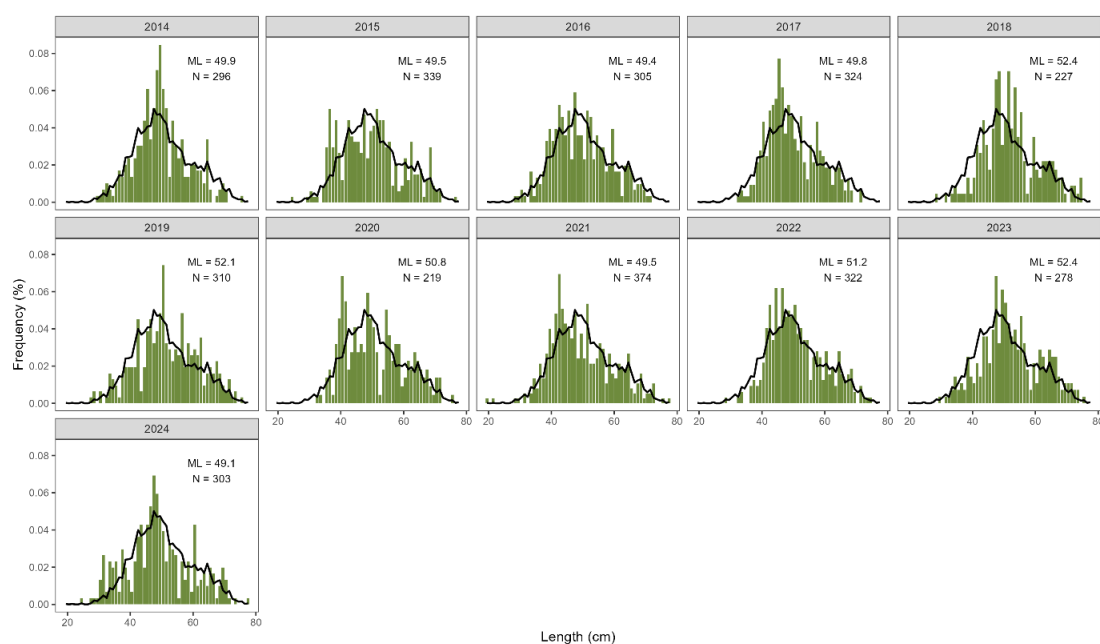


Figure 3.31 – Annual length–frequency distributions of plaice from summer demersal trawl surveys, illustrating interannual variation in the size structure of the surveyed population.

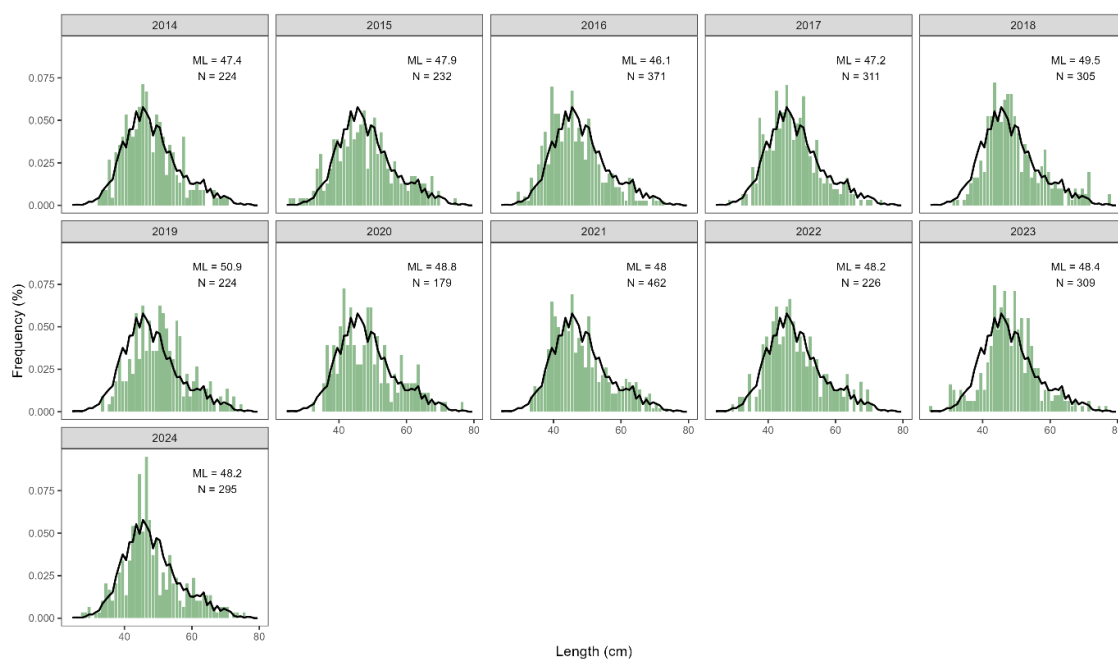


Figure 3.32 - Annual length–frequency distributions of plaice from spring demersal trawl surveys, illustrating interannual variation in the size structure of the surveyed population.

3.9.2 Catch at age

Catch-at-age estimates were generated using the ALK programme, based on age-disaggregated data from landing inspections (Figure 3.33). Due to limitations in the availability of age readings, consistent catch-at-age information is available only from 2016 onwards, with an additional isolated year (1997) that was not included in the assessment. No landing inspection samples were obtained in 2024; consequently, the age composition from 2023 was carried forward and applied to the 2024 catch.

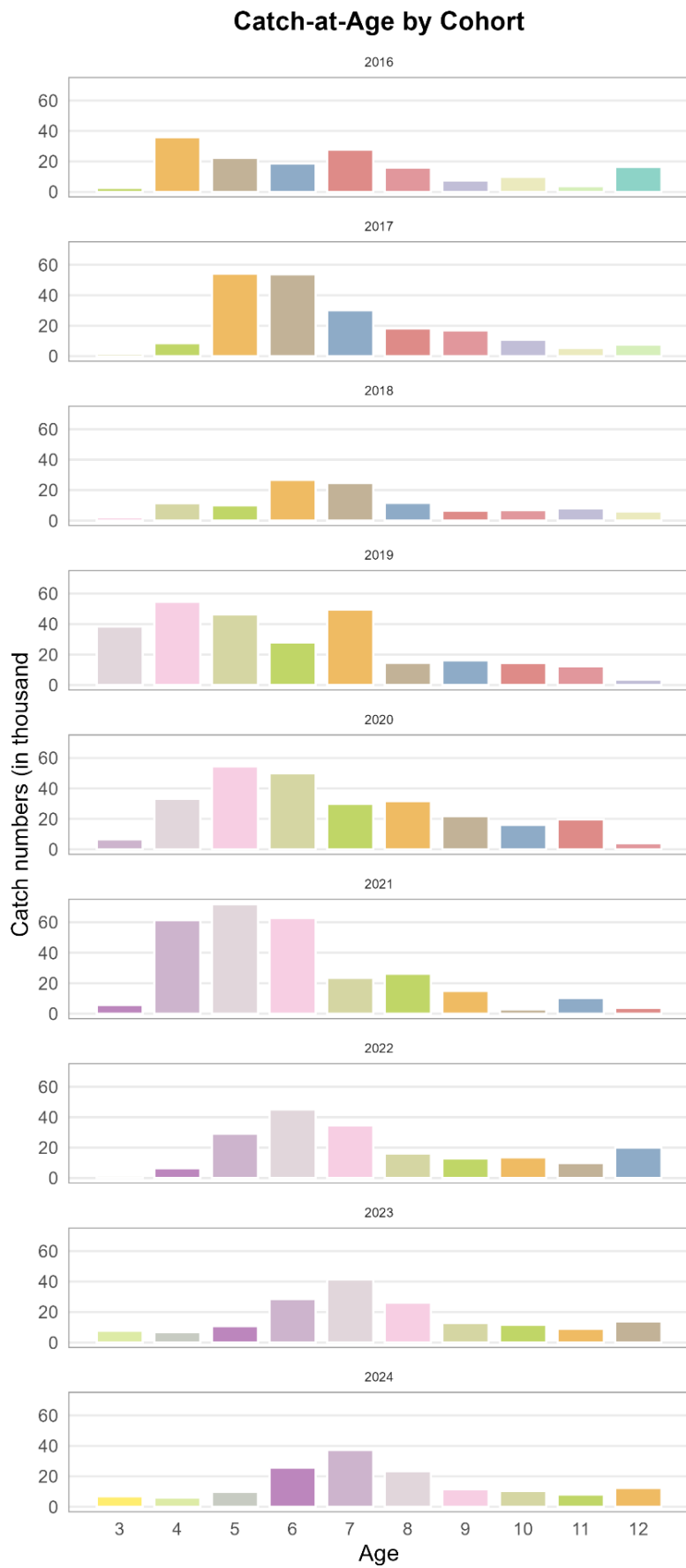


Figure 3.33 – Plaiice catch numbers at age from 2016 onwards. Cohorts are differentiated by colour.

3.9.3 Plus group

Assessment of alternative plus groups (10+, 12+, 13+, 14+, 15+) for plaice indicates that a 12+ plus group offers the most appropriate balance between maintaining age resolution and avoiding instability caused by sparse older-age observations. The catch and weight proportions show that ages 13+, 14+, and 15+ consistently represent only very small fractions of the annual catch – typically <3% for 13+, and often <1% for 14+ and 15+. These ages therefore lack sufficient sampling support to justify separate age classes. In contrast, the 12+ category captures a meaningful and consistently observed component of the older population, ranging from ~1-16% in numbers and ~3-25% weight depending on the year. Using 12+ preserves informative variation in the older age structure (especially during high-age years such as 2016 and 2018), while still aggregating the genuinely sparse tail beyond age 12. A 10+ plus group would over-aggregate and obscure this detail, whereas 13+ or higher would rely on extremely limited observations. Therefore, defining the plus group at 12+ provides the most biologically and statistically robust structure for plaice catch-at-age data.

Table 3.7 – Comparison of alternative plus group definitions for plaice catch-at-age data. The table shows the proportion of annual catch (by numbers and weight) represented by older age classes under different plus group options (10+, 12+, 13+, 14+, 15+), illustrating the trade-off between maintaining age resolution and aggregating sparse older-age observations.

Year	Catch numbers at age (%)					Calculated weights at age (%)				
	10+	12+	13+	14+	15+	10+	12+	13+	14+	15+
2016	18.63	11.07	1.86	0.93	0.63	32.71	20.80	3.28	2.07	1.42
2017	11.46	4.14	3.05	0.42	0.18	20.12	8.49	4.83	1.10	0.49
2018	18.22	15.77	7.72	0.63	0.29	28.14	24.47	11.19	1.11	0.53
2019	10.77	0.95	0.57	0.45	0.29	20.78	2.59	1.07	1.32	0.93
2020	14.88	5.42	1.35	0.12	0.00	25.30	9.62	2.54	0.25	0.00
2021	6.04	1.05	0.83	0.57	0.12	12.48	2.84	1.66	1.56	0.33
2022	22.93	0.95	0.18	4.24	2.54	37.28	2.59	0.37	8.97	5.47
2023	20.21	8.10	0.34	2.82	1.80	32.91	15.79	0.71	6.44	4.26
2024	20.21	8.10	0.34	2.82	1.80	32.91	15.79	0.71	6.44	4.26

3.9.4 Stock weight at age

Stock weight-at-age increased consistently with age, ranging from approximately 0.62 kg at age 3 to 3.22 kg at age 12 when averaged across the assessment period. Considerable interannual variation was evident, particularly among the older age groups, with 2018 showing relatively high weight-at-age values across most age groups. The weight-at-age values used for 2024 are identical to those for 2023 because no biological samples were available from 2024, and the most recent available observations were therefore carried forward. This introduces an additional source of uncertainty in the 2024 biomass estimates, particularly for age groups where weight-at-age is variable between years. Nevertheless, the overall increase in weight with age provides the basis for converting numbers-at-age to biomass in the SAM assessment.

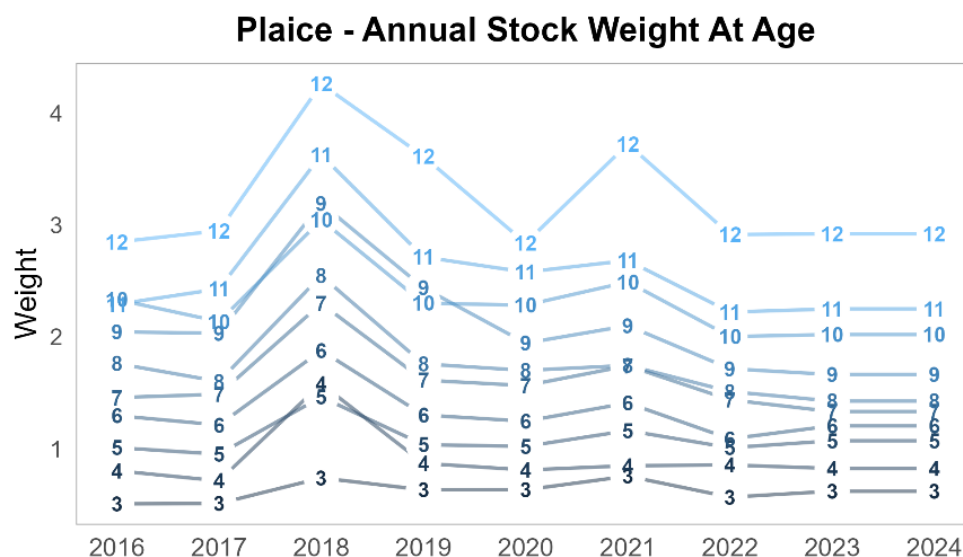


Figure 3.34 – Stock weight-at-age of plaice for ages 3–12, for the years 2016–2024, showing interannual variation in mean individual weight across the main age classes.

3.9.5 Tunings series

A catch-per-unit-effort (CPUE) index was derived for the two fishery-independent time series from the annual demersal trawl surveys conducted on the Faroe Plateau—spring (available since 1994) and summer (since 1996) (Figure 3.35). Both series exhibit interannual variability, with greater variability observed in the spring survey relative to the more stable summer series (Figure 3.36).

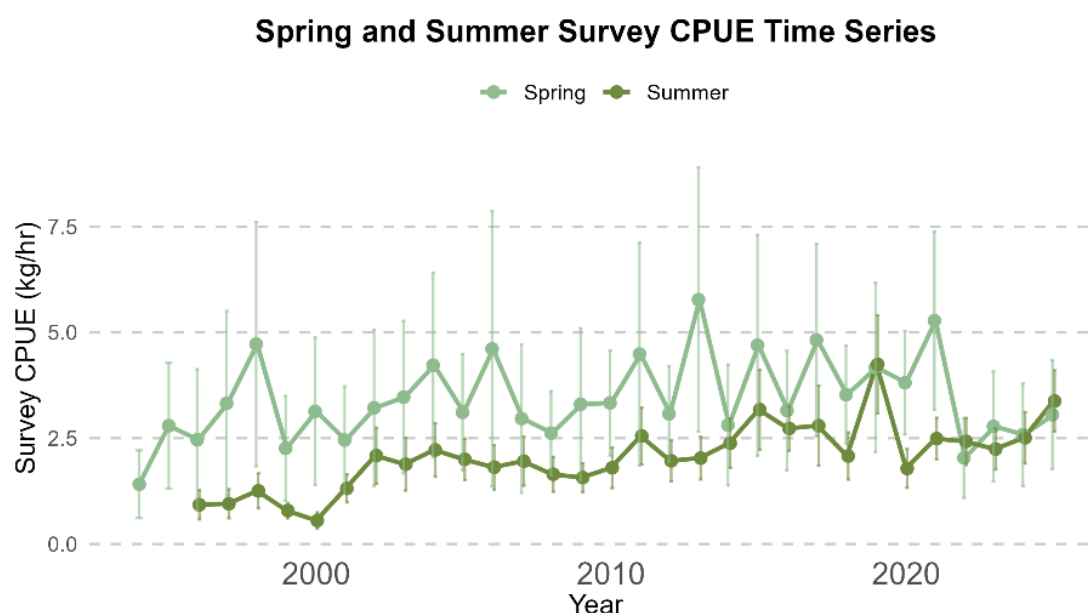


Figure 3.35 – CPUE indices of plaice from Faroese demersal trawl surveys in spring (light green) and summer (dark green). Error bars represent standard errors (SE) of the mean.

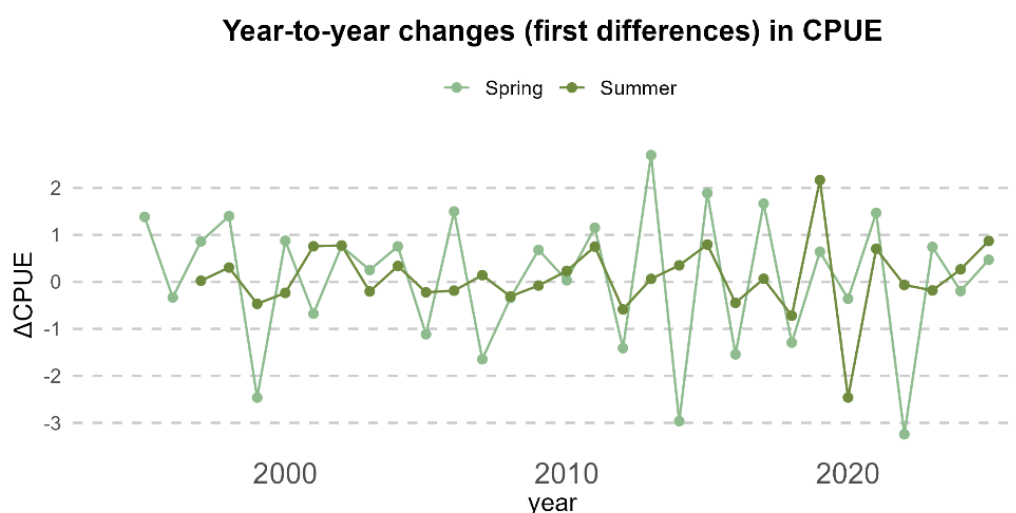


Figure 3.36 – Year-to-year changes in CPUE indices of plaice from Faroese demersal trawl surveys in spring (light green) and summer (dark green), illustrating interannual variability in relative abundance.

Standardised CPUE indices from both surveys were compared with total commercial landings of plaice to evaluate the relationship between fishery-independent indices and fishery-dependent removals (Figure 3.37). Despite differences in survey timing, spatial coverage, and fishery operations, the two surveys provide complementary indices of relative abundance suitable for use in age-structured assessment models, whereas commercial landings reflect a combination of stock abundance and fishing effort.

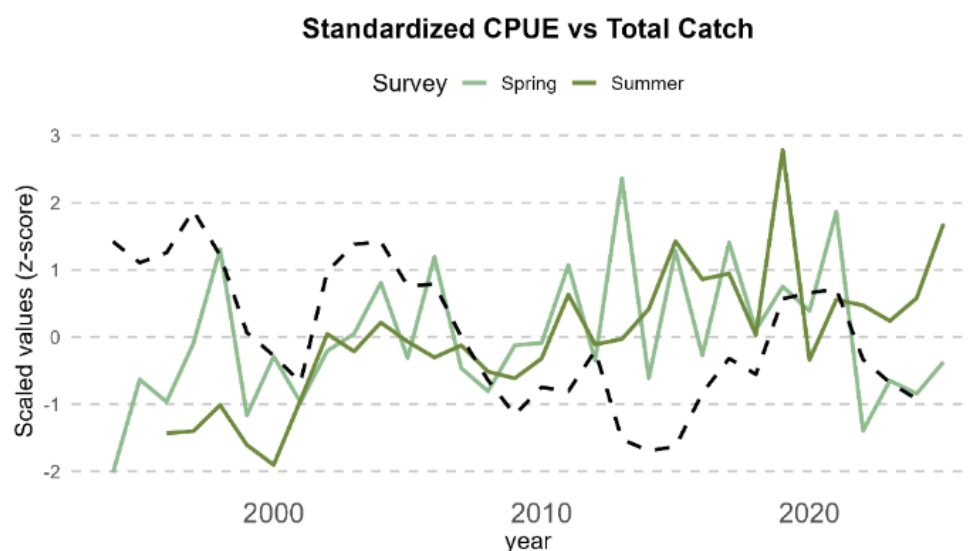


Figure 3.37 – Comparison of standardised survey CPUE from spring and summer demersal trawl surveys with total commercial catches of plaice since 1994, illustrating the relationship between fishery-independent abundance indices and reported landings.

Pearson correlation analysis indicated a weak, non-significant relationship between total annual catch and the spring survey index ($r = 0.08$, $p = 0.67$) and a weak negative relationship for the summer index ($r = -0.27$, $p = 0.16$) (Table 3.8), suggesting limited linear correspondence between survey-derived indices and commercial catches at the annual scale. This is consistent with differences in seasonal availability, fleet targeting behaviour, and survey design.

Table 3.8 – Pearson correlation between total plaice catches and CPUE from spring and summer demersal trawl surveys. The table includes the number of paired observations (n), correlation coefficient (r), t-statistic (cor_test_t), degrees of freedom (df), p-value (p), and 95% confidence intervals (lower and upper bounds).

Correlation Between Commercial Catches and Survey CPUEs							
Pearson correlation coefficients with 95% CI and p-values							
Survey	n	correlation	cor_test_t	df	p_value	conf_low	conf_high
Spring	31	-0.075	-0.4051233	29	0.688	-0.418	0.287
Summer	29	-0.270	-1.4554454	27	0.157	-0.579	0.107

The spring and summer indices showed a weak positive correlation ($r = 0.30$, $p = 0.106$), indicating partial consistency in interannual variability between the two surveys (Figure 3.38). Relationships between survey CPUE and total landings were characterised by broadly similar negative slopes for both series (Figure 3.39), with no consistent differences in modelled relationships. Uncertainty was lowest at intermediate catch levels (approximately 300 t) and increased towards the upper and lower extremes of the observed range.

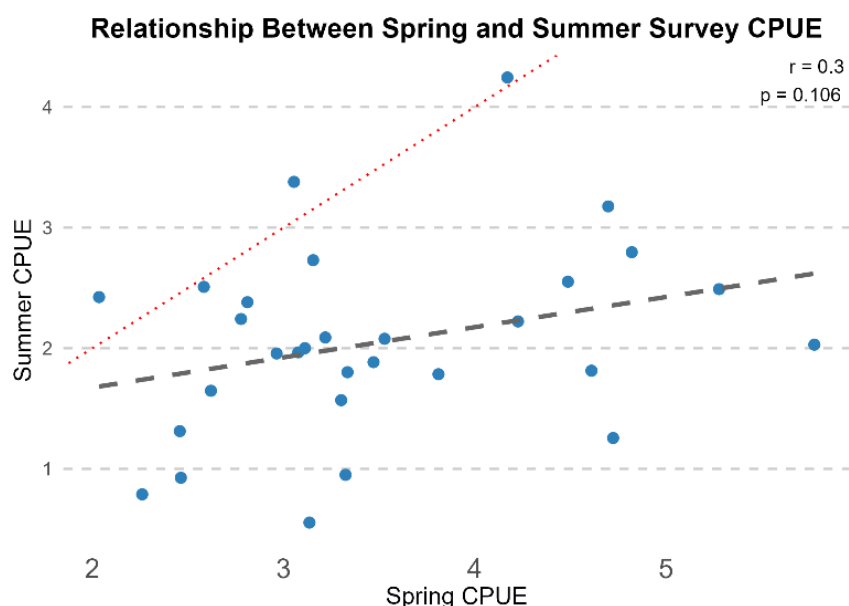


Figure 3.38 – Relationship of spring and summer CPUE of plaice. Points represent annual mean CPUE values, with the dashed grey line showing the fitted linear regression and the dotted red line representing the 1:1 relationship.

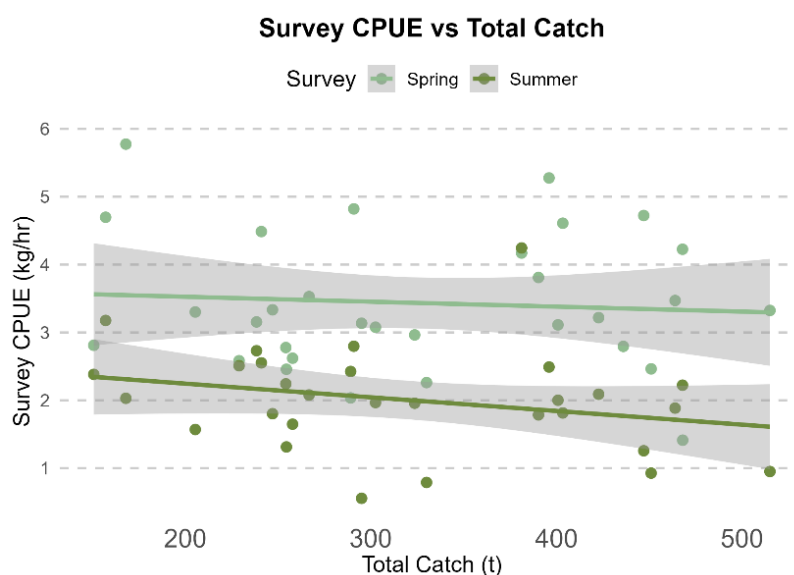


Figure 3.39 – Plaice. Relationship of total landings and survey CPUE's (spring – light green; summer – dark green). Shaded area represents the standard error.

Overall, both survey indices provide coherent but weakly associated signals of relative abundance when compared with total landings. Both series were therefore retained as tuning indices in the age-structured assessment framework.

3.9.6 SAM

The stock assessment was conducted using the State-space Assessment Model (SAM) implemented through stockassessment.org and fitted to catch numbers-at-age and two survey indices. The final assessment configuration was named Ple27_5b.

The assessment covers ages 3–12+, using annual catch-at-age data (Table 3.13) and stock weights-at-age (Table 3.14) derived from biological sampling of commercial landings from 2016 onwards. No commercial landing samples are available for 2024. Consequently, the 2023 age composition, for which extensive sampling coverage is available, was used as a proxy for 2024.

Maturity-at-age inputs were derived from the ogive analyses presented in Section 3.4 and were assumed constant throughout the assessment period (Table 3.15). Natural mortality was fixed at 0.2 for all ages and years.

The assessment was tuned using age-disaggregated abundance indices from the spring and summer demersal trawl surveys (Table 3.16 and Table 3.17), both covering ages 3–12+ from 2016 onwards.

Population dynamics were modelled on an annual time step, with numbers-at-age evolving according to fishing mortality, natural mortality, recruitment, and stochastic process error. Fishing mortality was estimated as age-specific and temporally smooth. Observation models were specified independently for each survey series, with observation errors assumed to follow a log-normal distribution.

Estimated catch, fishing mortality, recruitment and spawning stock biomass over the assessment period are shown in Figure 3.40. Estimated catch increased from approximately 240 t in 2016 to around 330 t in 2018 and remained at approximately this level through 2021, before declining to around 260 t in 2022 and 230 t in 2024 (Figure 3.40a). Mean fishing mortality over ages 6–11 ranged from 0.23 to 0.25 between 2016 and 2018, increased to 0.36 in 2020, and subsequently declined slightly and remained relatively stable at approximately 0.32–0.33 between 2021 and 2024 (Figure 3.40b).

Recruitment at age 3 increased from 346 individuals in 2016 to a peak of 409 in 2019, before declining to 122 in 2023 and increasing slightly to 161 in 2024 (Figure 3.40c). Spawning stock biomass was highest in 2018 at 2,105 t and subsequently declined, reaching its lowest estimated level of 919 t in 2024 (Figure 3.40d). Total stock biomass followed a similar trajectory, declining from a peak of 2,487 t in 2018 to 1,024 t in 2024 (Table 3.9).

Process error in numbers-at-age was initially explored using multiple variance structures. However, more complex formulations resulted in non-estimable parameters and reduced numerical stability. The final model therefore applied a single process-error variance parameter (*SdLogN*) across all ages, estimated at 0.260 (95% confidence interval: 0.184–0.369), which produced stable and well-identified parameter estimates (Table 3.12).

Observation variances (*SdLogObs*) were estimated separately among the observation groups and showed substantial differences in estimated precision. Estimated standard deviations ranged from 0.384 to 1.059 on the log scale, indicating variable levels of uncertainty among the catch and survey observations (Table 3.12). The observation variance diagnostics (Figure 3.41) showed corresponding differences in estimated precision among observation groups, ages, and fleets.

Estimated uncertainty increased in the most recent years, particularly for recruitment. The 95% confidence interval for recruitment in 2024 ranged from 73 to 355, whereas uncertainty around SSB was comparatively moderate, ranging from 666 to 1,269 t. Mean fishing mortality was also estimated with moderate uncertainty, with a 95% confidence interval of 0.214–0.489 in 2024 (Table 3.9; Figure 3.40b).

Diagnostic plots showed that the model provided generally consistent fits to the available observations. The yield-per-recruit and spawning stock biomass analysis showed the expected increase in yield and decline in SSB with increasing fishing mortality (Figure 3.42), while the recruitment–SSB relationship showed considerable scatter and no clear relationship over the assessment period (Figure 3.43). Residual diagnostics showed variation around zero without pronounced systematic patterns in either the one-observation-ahead residuals or process increments (Figure 3.44Figure 3.45). The fitted catch and survey series generally followed the observed trajectories, although deviations were evident for individual years and observations (Figure 3.46–Figure 3.48). In the leave-one-out analysis, exclusion of either survey series resulted in some changes in the estimated recruitment and SSB, particularly in recent years, but the overall declining trajectory remained similar (Figure 3.49).

Overall, the diagnostics indicate that the final model provides a statistically stable and internally consistent representation of the available data. Nevertheless, the relatively short assessment period and increasing uncertainty in recent recruitment estimates should be considered when interpreting the estimated stock trajectory.

3.9.7 SAM output figure and tables

Figure 3.40 – SAM results of plaice – a) Catch in weight (tonnes) with yearly observed total catch weight (crosses); b) Average fishing mortality for ages 5-10; c) Yearly recruitment numbers in thousand; d) spawning stock biomass numbers in thousands. Estimates from run and point wise 95% confidence intervals shown by black lines and shaded area. From www.stockassessment.org.

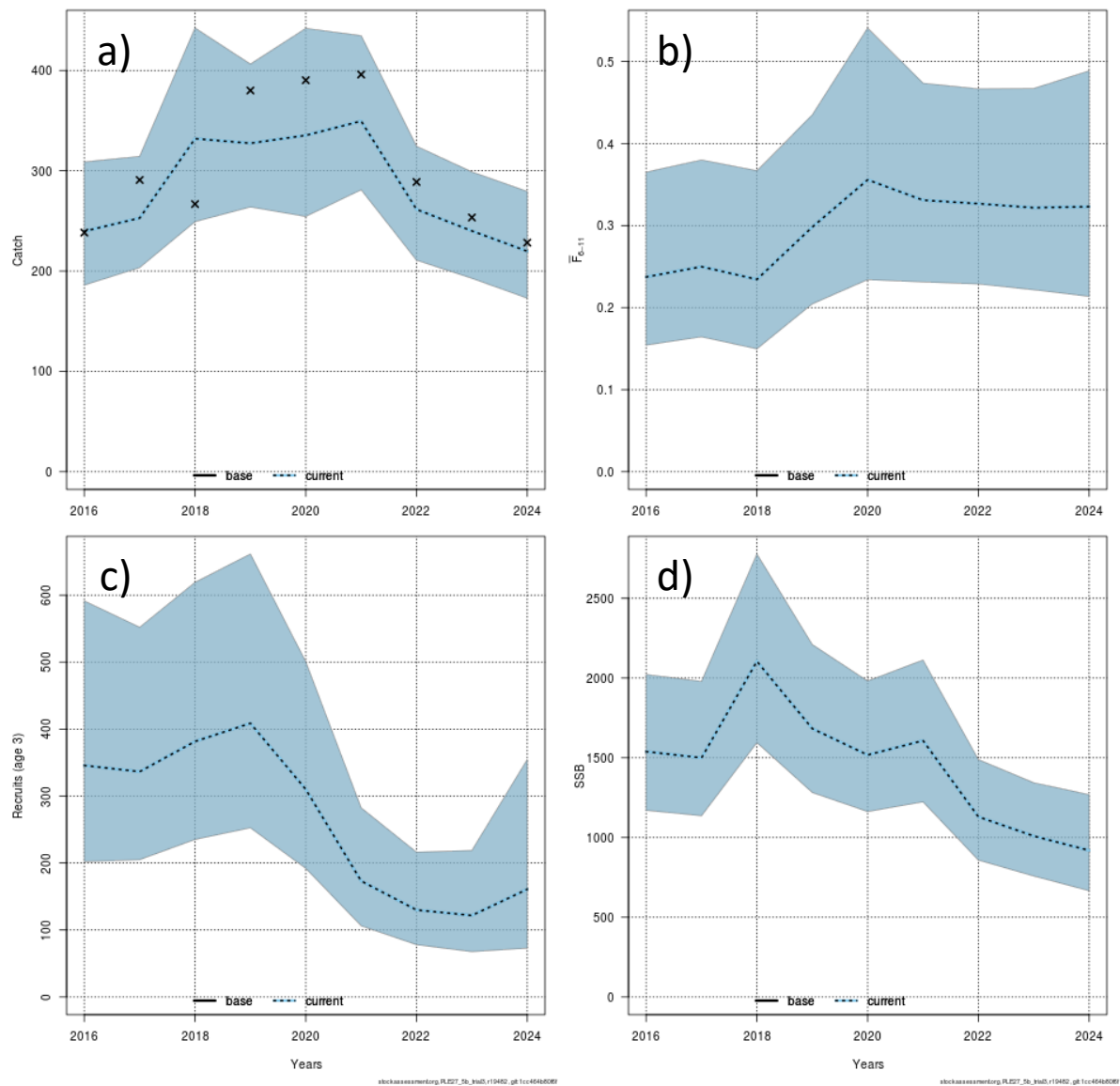


Figure 3.41 – SAM results of plaice – Standardised reciprocal variance of observations by age and fleet from the SAM plaice assessment. Black denotes commercial catch data, red the summer survey, and green the spring survey. Output generated using www.stockassessment.org.

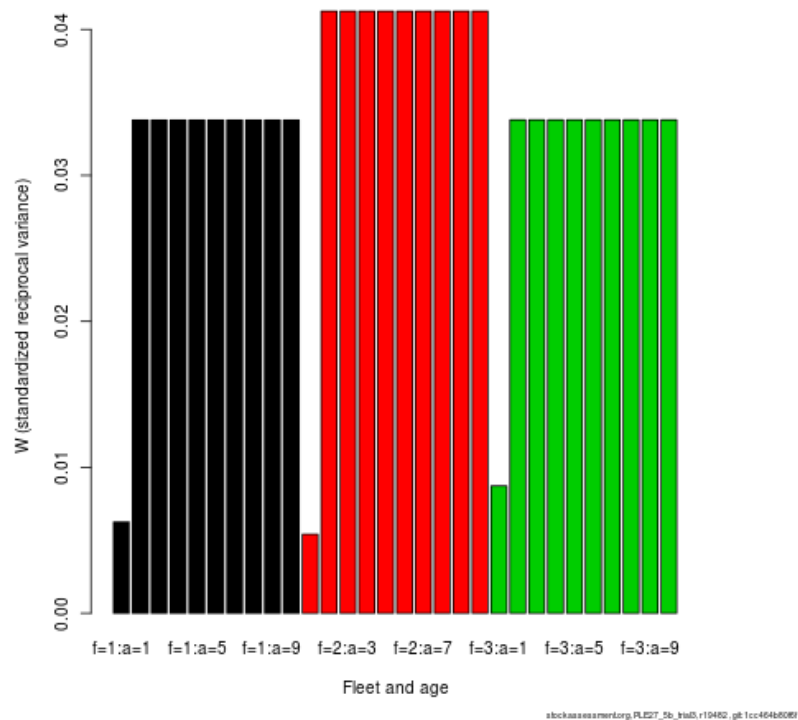


Figure 3.42 – SAM results of plaice – Yield per recruit (solid line) and spawning stock biomass (dotted line) plotted against different levels of fishing (blue, green and red lines). From www.stockassessment.org.

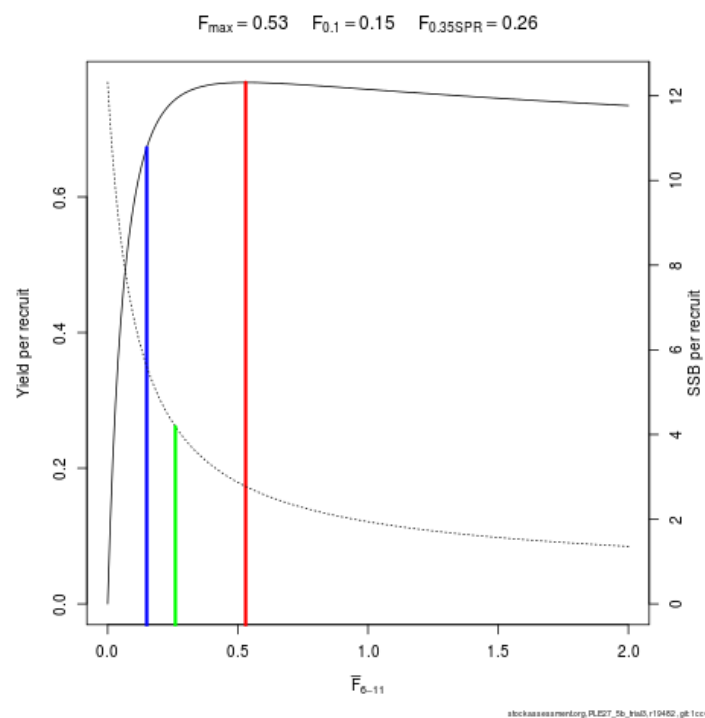


Figure 3.43 – SAM results of plaice – Estimated recruitment as a function of spawning stock biomass. From www.stockassessment.org.

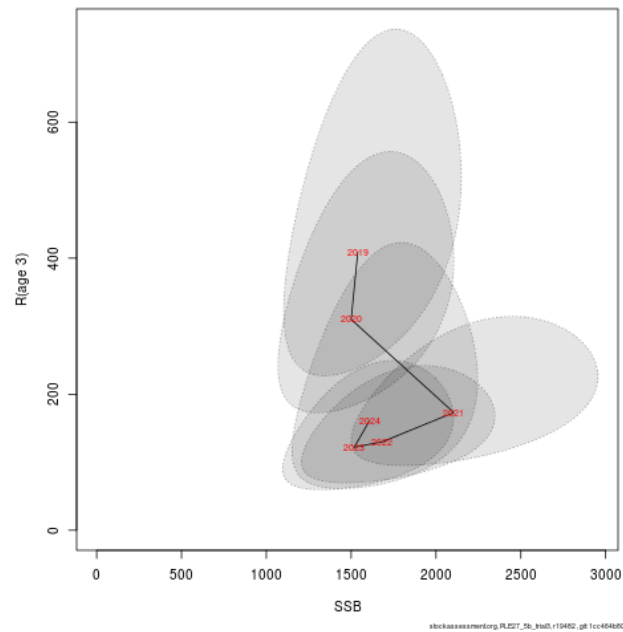


Figure 3.44 – SAM results of plaice – Standardised one-observation-ahead residuals. From www.stockassessment.org.

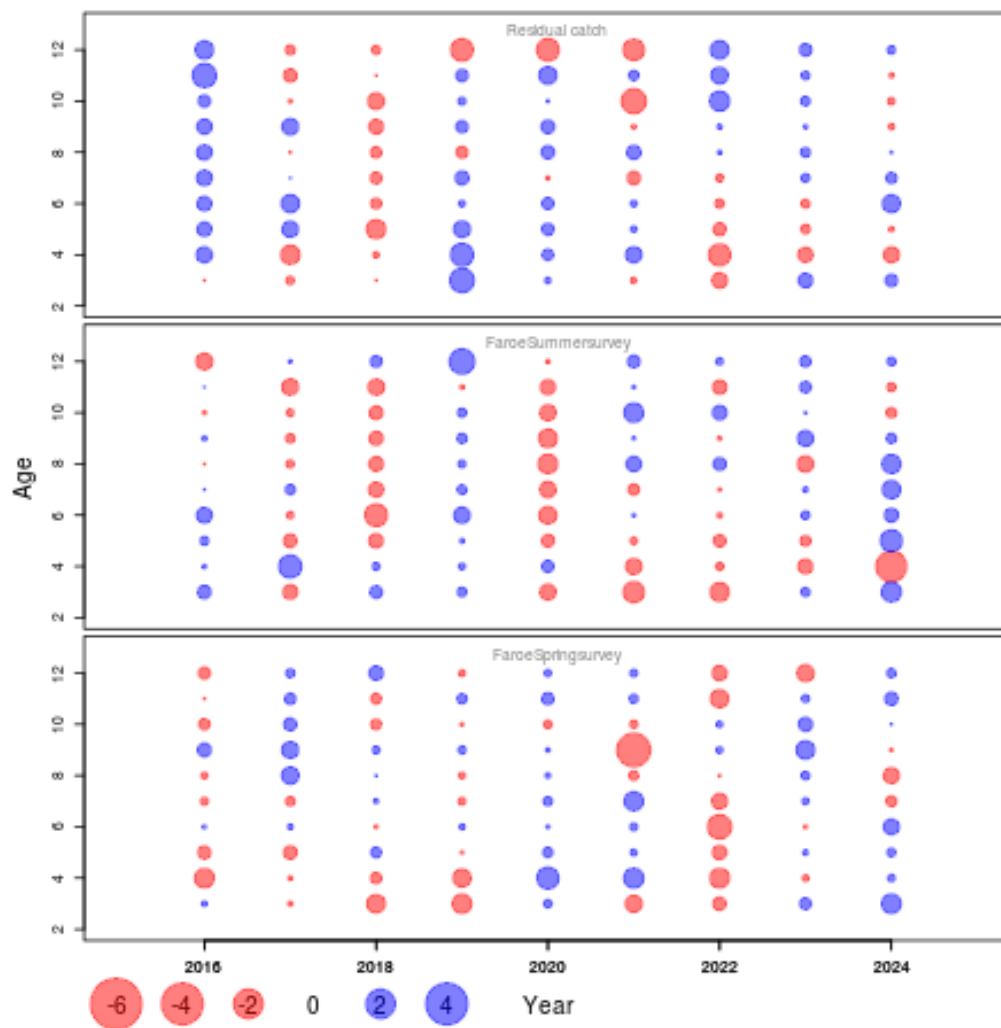


Figure 3.45 – SAM results of plaice – Standardised single-joint-sample residuals of process increments. From www.stockassessment.org.

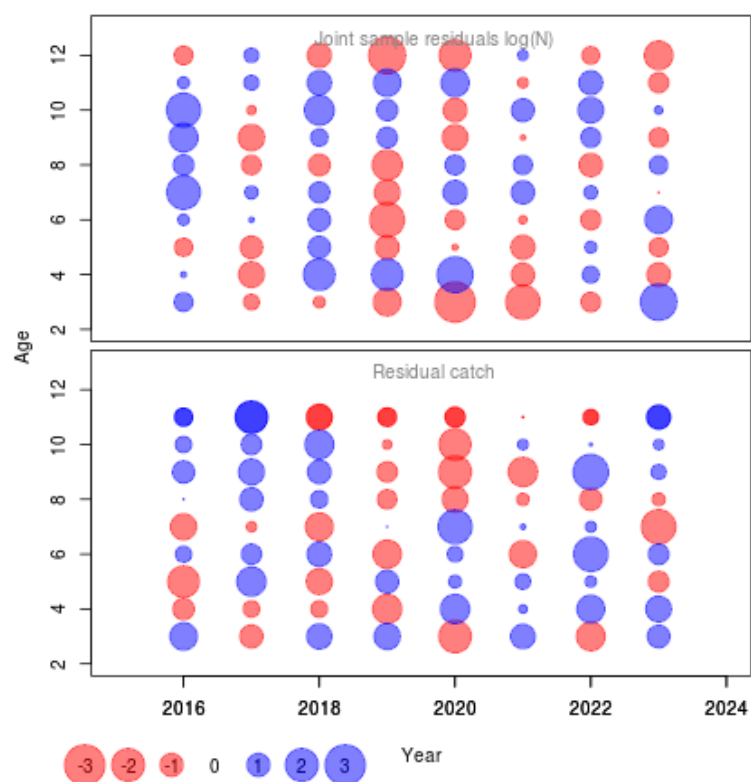


Figure 3.46 – SAM results of plaice – Total catch's fit to data – predicted line and observed points (log scale). From www.stockassessment.org.

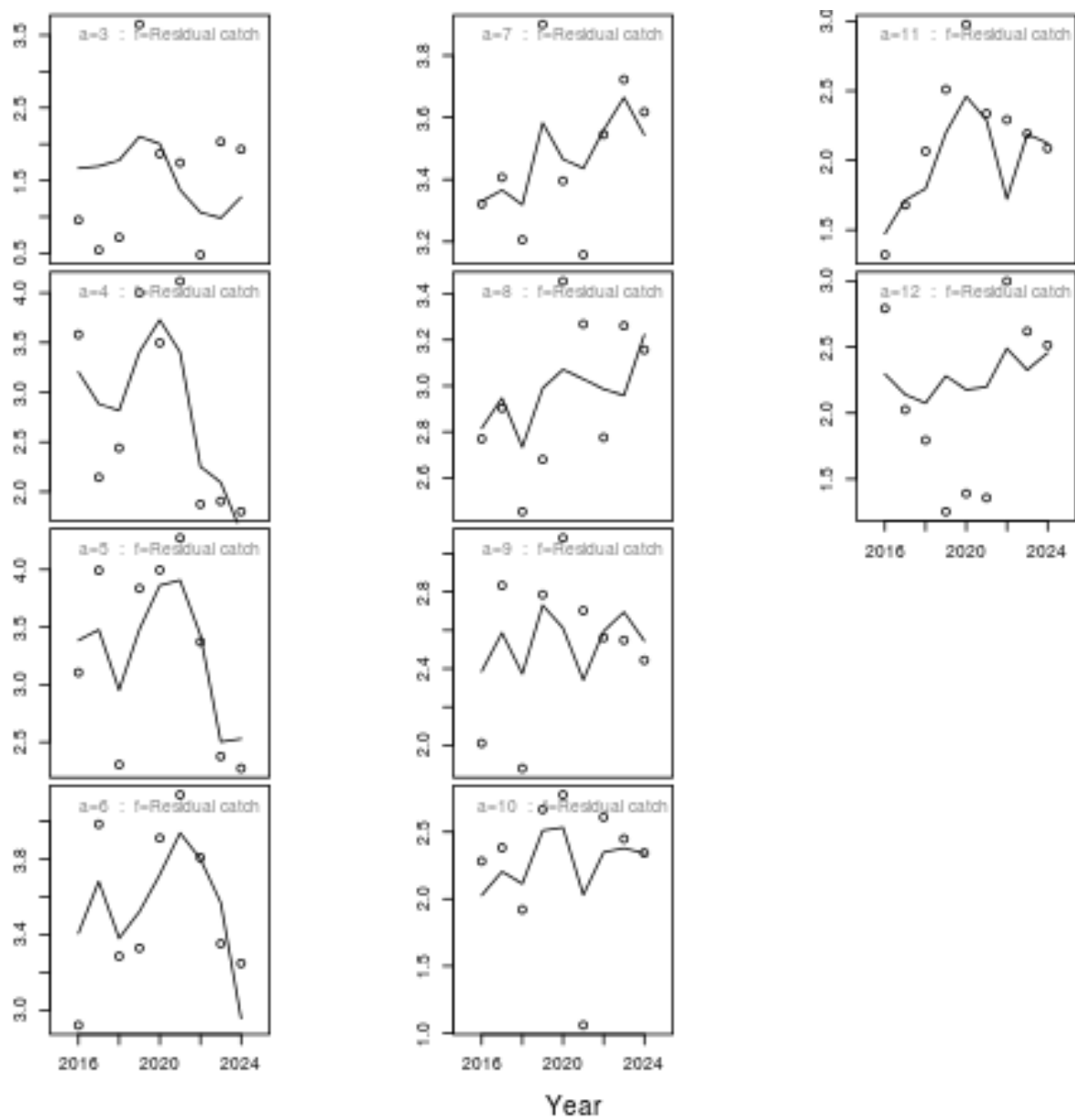


Figure 3.47 – SAM results of plaice – Summer survey's fit to data – predicted line and observed points (log scale). From www.stockassessment.org.

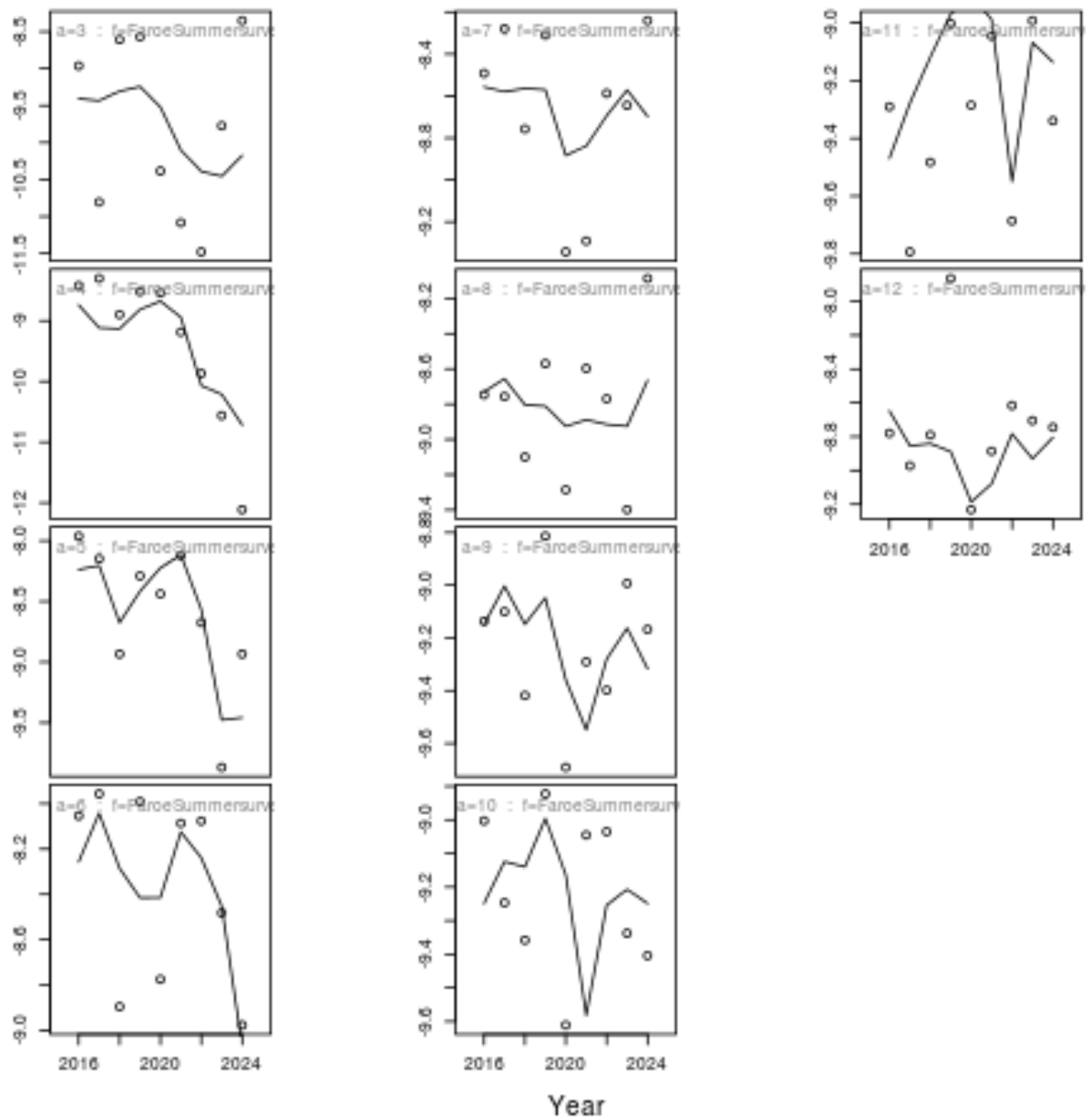


Figure 3.48 – SAM results of plaice – Spring survey's fit to data – predicted line and observed points (log scale). From www.stockassessment.org.

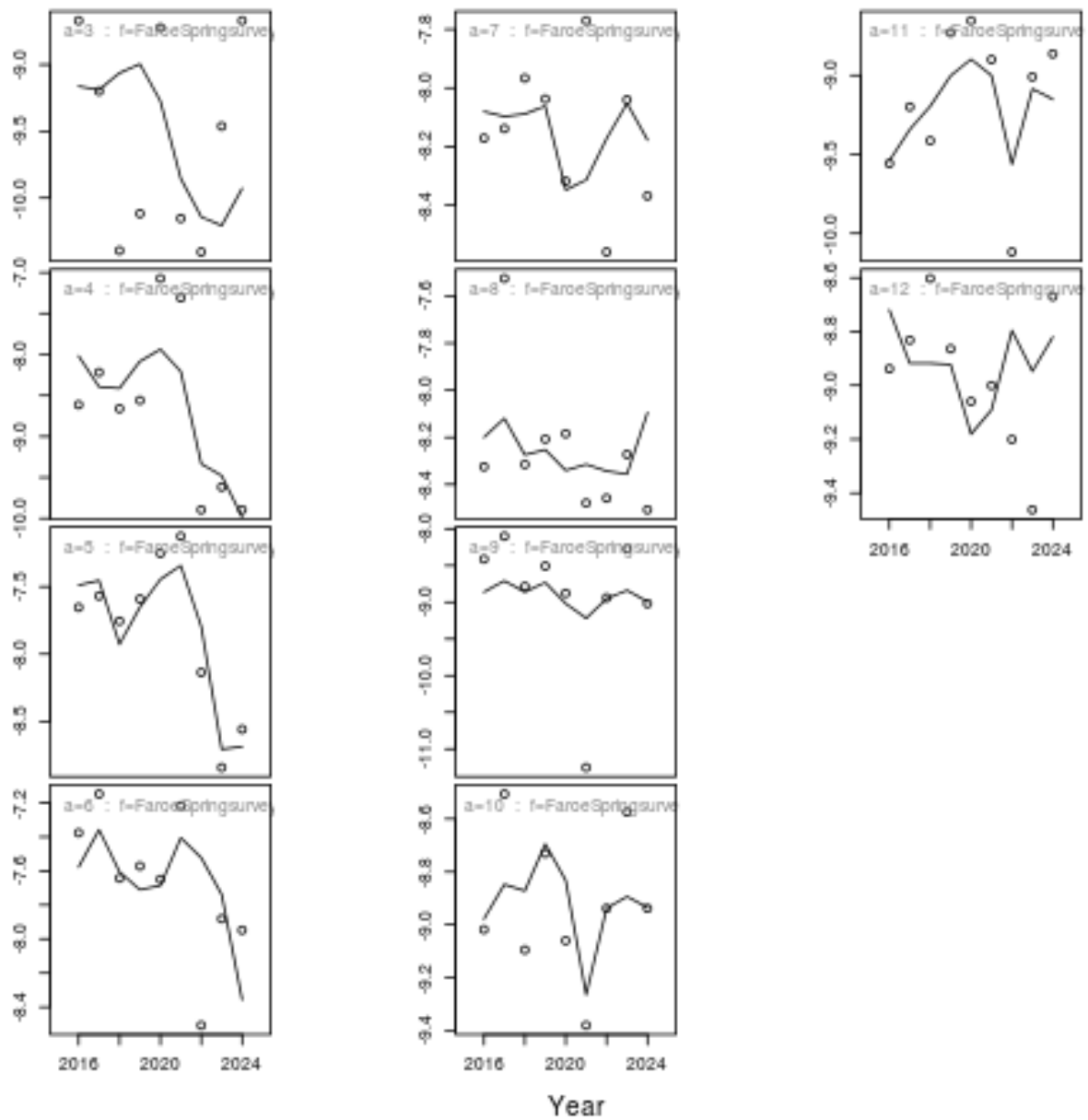


Figure 3.49 – SAM results of plaice – Leave one out run – a) Catch in weight (tonnes) with yearly observed total catch weight (crosses); b) Average fishing mortality for ages 5-10; c) Yearly recruitment numbers in thousand; d) spawning stock biomass numbers in thousands. Estimates from run and point wise 95% confidence intervals shown by black lines and shaded area, light blue is without spring survey and purple is without summer survey. From www.stockassessment.org

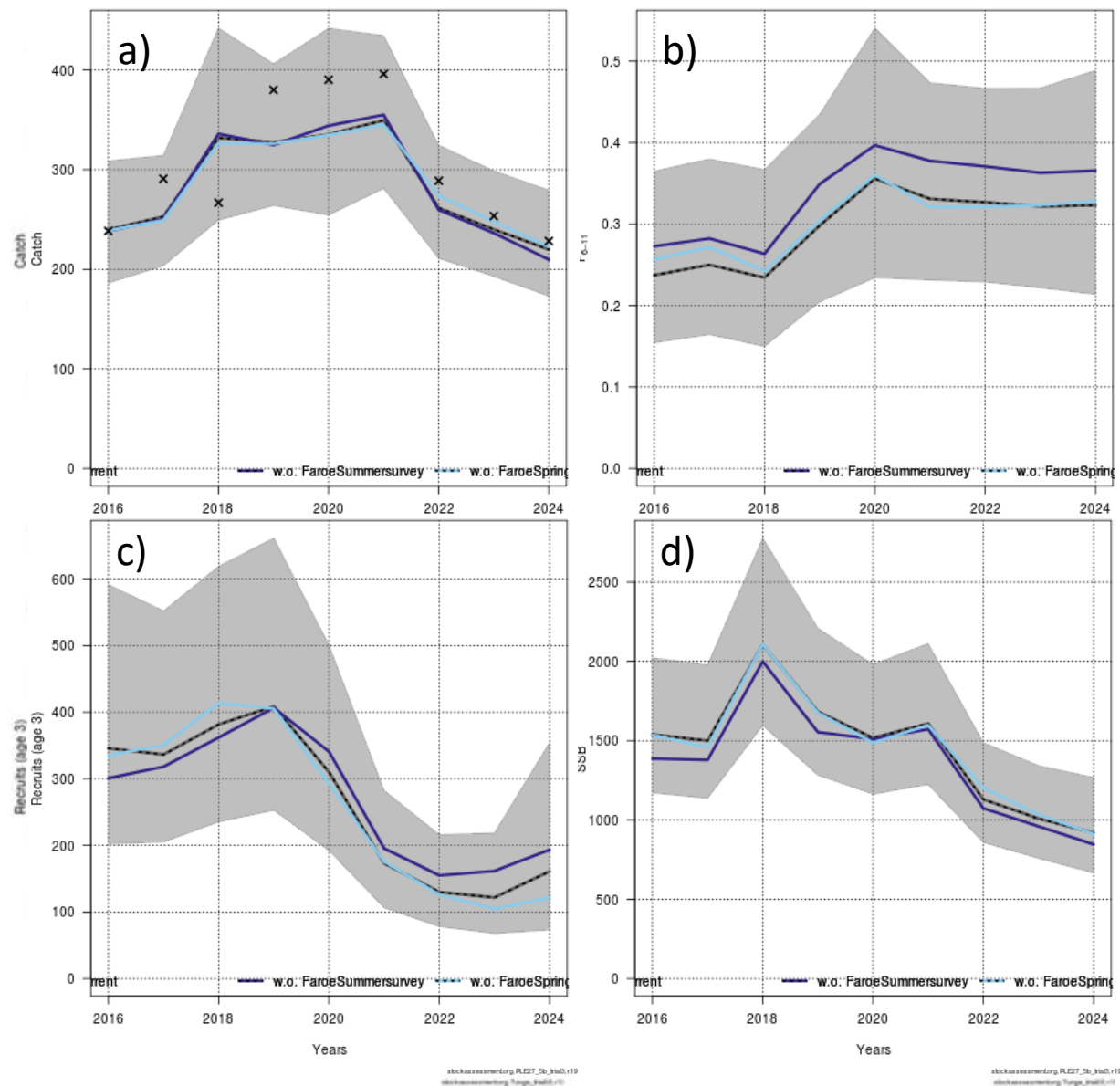


Table 3.9 – Estimated recruitment, spawning stock biomass, fishing mortality and total stock biomass for plaice, with 95% confidence intervals.

Year	R(age 3)	Low	High	SSB	Low	High	Fbar(6-11)	Low	High	TSB	Low	High
2016	346	202	591	1539	1171	2022	0.237	0.154	0.365	1826	1387	2405
2017	336	205	552	1500	1137	1979	0.250	0.164	0.380	1745	1322	2302
2018	382	235	619	2105	1596	2777	0.234	0.150	0.367	2487	1883	3286
2019	409	253	661	1683	1282	2209	0.298	0.205	0.435	1994	1516	2622
2020	310	192	501	1518	1163	1981	0.356	0.234	0.541	1822	1389	2390
2021	173	106	282	1608	1224	2113	0.331	0.231	0.474	1894	1438	2494
2022	130	78	216	1130	858	1488	0.327	0.229	0.467	1280	973	1683
2023	122	68	219	1009	758	1343	0.322	0.222	0.467	1126	849	1495
2024	161	73	355	919	666	1269	0.323	0.214	0.489	1024	743	1411

Table 3.10 – Estimated fishing mortality at age of plaice.

Year	3	4	5	6	7	8	9	10	11	12
2016	0.017	0.064	0.108	0.176	0.225	0.209	0.212	0.258	0.344	0.344
2017	0.018	0.068	0.114	0.187	0.238	0.221	0.224	0.270	0.361	0.361
2018	0.017	0.065	0.108	0.177	0.224	0.208	0.209	0.252	0.336	0.336
2019	0.022	0.084	0.140	0.228	0.288	0.266	0.266	0.319	0.422	0.422
2020	0.026	0.101	0.168	0.274	0.345	0.318	0.318	0.379	0.501	0.501
2021	0.025	0.095	0.158	0.257	0.323	0.297	0.295	0.351	0.464	0.464
2022	0.024	0.093	0.155	0.251	0.316	0.292	0.291	0.348	0.462	0.462
2023	0.024	0.092	0.152	0.247	0.311	0.287	0.287	0.343	0.456	0.456
2024	0.024	0.092	0.153	0.249	0.313	0.288	0.288	0.344	0.458	0.458

Table 3.11 – Estimated stock numbers at age of plaice.

Year	3	4	5	6	7	8	9	10	11	12
2016	346	427	311	201	149	95	61	36	16	37
2017	336	293	323	251	147	103	71	41	20	30
2018	382	288	201	195	148	88	61	40	23	30
2019	409	402	267	178	154	91	70	48	28	30
2020	310	467	330	184	118	85	54	43	32	24
2021	173	356	365	243	121	87	44	28	28	26
2022	130	115	232	216	139	84	57	38	16	35
2023	122	100	93	174	157	83	64	40	26	30
2024	161	60	95	94	138	108	55	38	24	34

3.9.8 Model configurations

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$initState
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```

3.9.9 Estimated parameters

Table 3.12 – Table of model parameters for plaice.

Parameter name	<i>par</i>	<i>sd(par)</i>	<i>exp(par)</i>	<i>Low</i>	<i>High</i>
logFpar_0	-15.126	0.403	0.000	0.000	0.000
logFpar_1	-14.632	0.217	0.000	0.000	0.000
logFpar_2	-13.784	0.208	0.000	0.000	0.000
logFpar_3	-13.314	0.205	0.000	0.000	0.000
logFpar_4	-13.278	0.209	0.000	0.000	0.000
logFpar_5	-13.014	0.217	0.000	0.000	0.000
logFpar_6	-12.989	0.230	0.000	0.000	0.000
logFpar_7	-12.524	0.257	0.000	0.000	0.000
logFpar_8	-11.875	0.332	0.000	0.000	0.000
logFpar_9	-14.966	0.338	0.000	0.000	0.000
logFpar_10	-14.021	0.220	0.000	0.000	0.000
logFpar_11	-13.165	0.208	0.000	0.000	0.000
logFpar_12	-12.798	0.202	0.000	0.000	0.000
logFpar_13	-12.990	0.203	0.000	0.000	0.000
logFpar_14	-12.663	0.210	0.000	0.000	0.000
logFpar_15	-12.882	0.220	0.000	0.000	0.000
logFpar_16	-12.457	0.239	0.000	0.000	0.000
logFpar_17	-12.194	0.284	0.000	0.000	0.000
logSdLogFsta_0	-1.779	0.581	0.169	0.053	0.539
logSdLogN_0	-1.346	0.174	0.260	0.184	0.369
logSdLogObs_0	-0.015	0.275	0.985	0.568	1.709
logSdLogObs_1	-0.859	0.112	0.424	0.339	0.530
logSdLogObs_2	0.057	0.249	1.059	0.643	1.744
logSdLogObs_3	-0.958	0.102	0.384	0.313	0.471
logSdLogObs_4	-0.181	0.260	0.834	0.496	1.404
logSdLogObs_5	-0.859	0.096	0.424	0.350	0.513
itrans_rho_0	2.468	2.992	11.800	0.030	4685.874

3.9.10 SAM input tables

Table 3.13 – Catch at age in numbers (in thousands) of plaice

Year	3	4	5	6	7	8	9	10	11	12+
2016	2.601	35.886	22.319	18.548	27.702	15.951	7.472	9.792	3.752	16.338
2017	1.721	8.538	54.213	53.787	30.176	18.233	16.999	10.824	5.366	7.579
2018	2.048	11.474	10.022	26.722	24.676	11.622	6.554	6.829	7.897	6.019
2019	38.426	54.599	46.349	27.906	49.410	14.576	16.215	14.407	12.304	3.503
2020	6.485	33.058	54.441	49.937	29.849	31.677	21.777	16.067	19.646	4.016
2021	5.716	61.387	71.857	62.835	23.521	26.282	14.922	2.884	10.348	3.885
2022	1.614	6.526	29.121	45.030	34.641	16.040	12.954	13.605	9.900	20.082
2023	7.644	6.725	10.772	28.567	41.364	26.083	12.787	11.568	8.951	13.737
2024	6.887	6.058	9.704	25.735	37.263	23.497	11.520	10.421	8.063	12.375

Table 3.14 – Stock at age in weight (in tonnes) of plaice. Same for catch weight and discard weight, since discards are presumably zero due to total discard ban within the Faroese EEZ.

Year	3	4	5	6	7	8	9	10	11	12+
2016	0.507	0.803	1.010	1.296	1.457	1.762	2.044	2.334	2.291	2.847
2017	0.510	0.713	0.951	1.212	1.487	1.601	2.033	2.137	2.429	2.949
2018	0.739	1.581	1.463	1.878	2.298	2.547	3.193	3.046	3.626	4.261
2019	0.632	0.869	1.036	1.301	1.613	1.758	2.439	2.301	2.714	3.614
2020	0.633	0.810	1.021	1.246	1.564	1.700	1.944	2.283	2.579	2.838
2021	0.755	0.848	1.162	1.409	1.742	1.745	2.100	2.491	2.683	3.724
2022	0.567	0.855	1.009	1.088	1.437	1.511	1.715	2.003	2.222	2.914
2023	0.620	0.823	1.071	1.205	1.332	1.426	1.663	2.021	2.250	2.922
2024	0.620	0.823	1.071	1.205	1.332	1.426	1.663	2.021	2.250	2.922

Table 3.15 – Maturity ogive of plaice used in SAM assessment

Age	3	4	5	6	7	8	9	10	11	12+
Ogive	0.662	0.833	0.921	0.917	0.935	0.972	1	1	1	1

Table 3.16 – Spring survey tuning index, CPUE (kg/hr) of plaice

Year	Effort	3	4	5	6	7	8	9	10	11	12+
2016	99	0.017	0.018	0.047	0.062	0.028	0.024	0.022	0.012	0.007	0.013
2017	89	0.009	0.024	0.046	0.070	0.026	0.048	0.027	0.018	0.009	0.013
2018	98	0.003	0.017	0.042	0.047	0.034	0.024	0.015	0.011	0.008	0.018
2019	99	0.004	0.019	0.050	0.051	0.032	0.027	0.020	0.016	0.016	0.014
2020	86	0.014	0.073	0.061	0.041	0.021	0.024	0.012	0.010	0.015	0.010
2021	154	0.006	0.103	0.124	0.113	0.065	0.032	0.002	0.013	0.021	0.019
2022	99	0.003	0.005	0.029	0.020	0.019	0.021	0.013	0.013	0.004	0.010
2023	90	0.007	0.006	0.013	0.034	0.029	0.023	0.023	0.017	0.011	0.007
2024	99	0.017	0.005	0.019	0.035	0.023	0.020	0.012	0.013	0.014	0.017

Table 3.17 – Summer survey tuning index, CPUE (kg/hr) of plaice

Year	Effort	3	4	5	6	7	8	9	10	11	12+
2016	195	0.025	0.043	0.068	0.062	0.04	0.031	0.021	0.024	0.018	0.030
2017	197	0.004	0.049	0.057	0.069	0.050	0.031	0.022	0.019	0.011	0.025
2018	197	0.036	0.027	0.026	0.027	0.031	0.022	0.016	0.017	0.015	0.030
2019	195	0.037	0.039	0.049	0.066	0.048	0.037	0.029	0.026	0.024	0.075
2020	194	0.006	0.038	0.042	0.030	0.017	0.018	0.012	0.013	0.018	0.019
2021	195	0.003	0.020	0.058	0.060	0.018	0.036	0.018	0.023	0.023	0.027
2022	193	0.002	0.010	0.033	0.060	0.036	0.030	0.016	0.023	0.012	0.035
2023	193	0.011	0.005	0.010	0.040	0.034	0.016	0.024	0.017	0.024	0.032
2024	182	0.043	0.001	0.024	0.023	0.048	0.056	0.019	0.015	0.016	0.029

4. Lemon sole – results and discussion

4.1 Spatial Distribution

Lemon sole is widely distributed across the Faroe Plateau occurring from shallow coastal grounds of depths of approximately 200 m. Lemon sole is also found on the Faroe Bank. The following sections describe the spatial distribution of plaice based on fishery and survey data, providing insight into the areas where the species is most frequently observed and its distribution across the Faroese shelf.

4.1.1 Spatial distribution from fishery

Lemon sole is widely distributed across the Faroe Plateau, occurring from shallow coastal grounds to deeper shelf areas of approximately 200 m. The spatial pattern shown in Figure 4.1 reflects both the footprint of commercial fishing effort and the spatial limitations of the gears deployed. It should be emphasised that the available logbook records for this project are incomplete; consequently, years without reported fishing positions must not be interpreted as an absence of lemon sole fishing activity, but rather as gaps in the positional data (supplementary information see section 0).

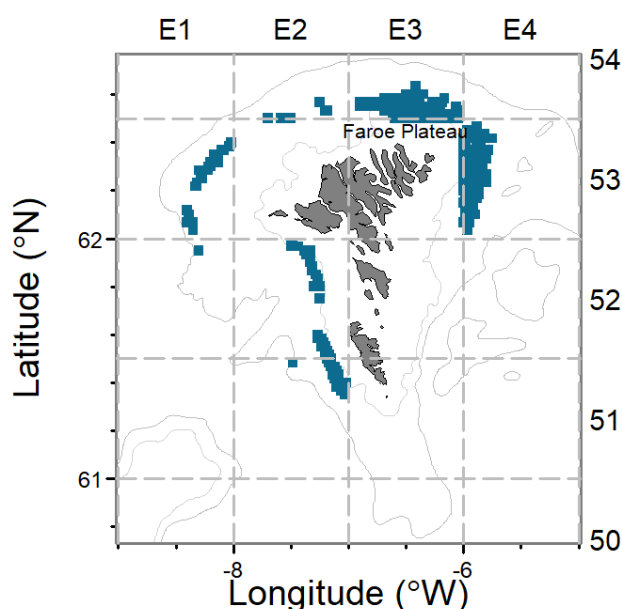


Figure 4.1 – Distribution of lemon sole fishery from available logbook data restricted to catches with lemon sole >15%.

4.1.2 Spatial distribution from spring and summer survey

The spring survey (Section 2.2.1) does not indicate a pronounced spatial aggregation of lemon sole, with the species generally occurring at low and relatively even densities across the Faroe Plateau (Figure 3.2 left). In contrast, the summer survey shows higher observed densities and a broader spatial coverage (Figure 3.2 right). However, this apparent increase in distribution and abundance is likely influenced, at least in part, by the substantially higher sampling effort in the summer series (approximately 100 additional tows compared to the spring survey), rather than reflecting a true seasonal expansion of the stock.

With in both surveys, the highest densities of lemon sole are observed in the eastern and north-western parts of the plateau, with additional occurrences adjacent to Vágahavið. The species is also found on the Faroe Bank, which contributes to its wider distribution within the Faroese EEZ. Overall, the spatial patterns suggest a relatively stable distribution of lemon sole, with no clear evidence of

migration-driven aggregation comparable to that observed in other demersal species for example plaice (Section 3.1.2). Annual spatial distribution of lemon sole CPUE from the Faroese spring (1994–2025) and summer (1996–2025) demersal trawl surveys are presented in supplementary information Section 0.

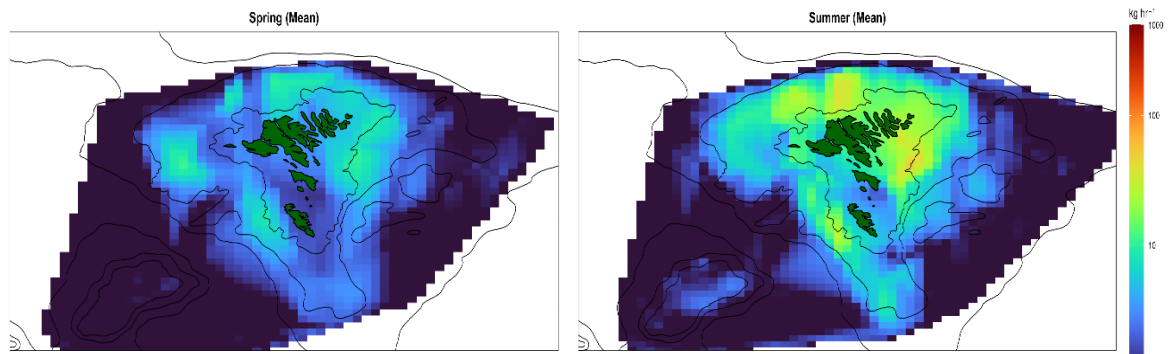


Figure 4.2 – Averaged spatial distribution of lemon sole CPUE (log kg/hr) from the annual demersal trawl spring survey from 1994–2025 (left) and summer survey 1996–2025 (right).

4.1.3 Spatial distribution of length groups

The spatial distribution of lemon sole by length groups of combined survey and commercial dataset shows broadly overlapping distributions across size classes, with no clear or strong spatial segregation by size (Figure 3-3). Individuals less than 25 cm are distributed across the general spatial range of the species, with no evident concentration in specific depth or coastal zones. Larger individuals (≥ 45 cm) are also widely distributed across the Faroe Plateau, occurring in both coastal and offshore areas. Intermediate size classes (25–45 cm) show substantial spatial overlap with both smaller and larger individuals, indicating limited spatial structuring by size.

Overall, the observed length-group distributions suggest only weak or no clear evidence of ontogenetic spatial variation. The considerable overlap among size classes indicates that factors other than size, such as environmental variability or sampling coverage, likely contribute to the observed spatial patterns.

Lemon sole spatial distribution by length group and gender

5 cm length classes (cm) from combined survey and commercial data

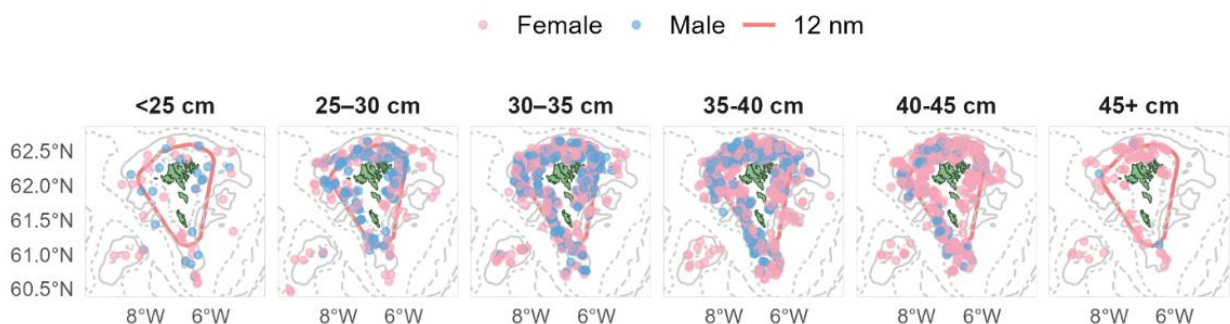


Figure 4.3 – Spatial distribution of lemon sole segregated into length groups and separated into genders (pink: females, blue: males). Isobaths are represented by grey lines in 50 m increments. 12nm EEZ is represented in red.

4.2 Growth

4.2.1 Length - weight distribution

A strong positive relationship between length and weight was observed across the sampled size range ($W = 4.2 \times 10^{-6} L^{3.12}$; Figure 3.4), with the model explaining a high proportion of the variance in the data ($R^2 = 0.96$). The estimated exponent ($b = 3.18$) indicated slight positive allometric growth, whereby weight increases at a proportionally greater rate than length.

The fitted relationship provided a good overall description of the data, with no evident systematic deviations, although some increase in variability in weight-at-length was observed among larger individuals. This variability likely reflects differences in condition, maturity status, and reproductive development. Overall, the results are consistent with expected growth patterns for the species and support the use of the fitted relationship for characterising population size–weight structure.

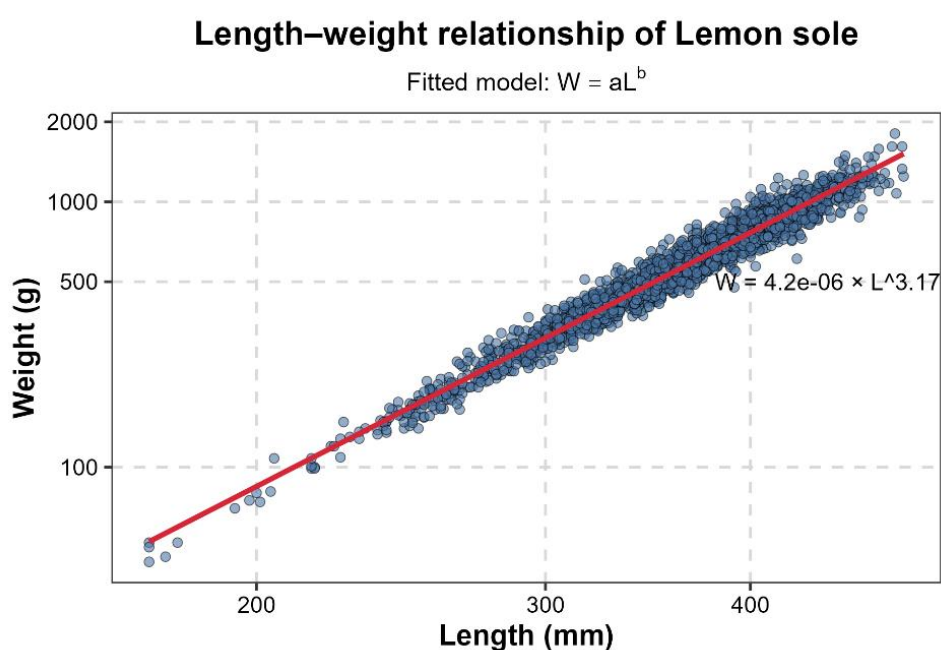


Figure 4.4 – Length–weight relationship of lemon sole based on combined commercial and survey samples. Points represent individual observations. The solid line shows the fitted power function ($W = aL^b$).

4.2.2 Age - length distribution

The growth of lemon sole in Faroese waters was described using the von Bertalanffy model with observed lengths ranging from 172 mm at age 2 to 496 mm at age 15 (Table 3.1). Growth trajectories were consistent between males and females in early ages, but females generally attained larger sizes at older ages. These growth curves provide the mechanistic link between age and length necessary for estimating maturity parameters (A_{50} and L_{50}) and for interpreting the crosswalk between age- and length-based maturity assessments.

The age–length distribution of lemon sole in the commercial fishery demonstrates a strong selectivity for larger, mature individuals. No immature fish are present in the commercial catches, with the majority of individuals falling between 350 and 450 mm in length (Figure 4.5). In contrast, survey catches capture the full range of ages and sizes, including smaller, immature lemon sole. This pattern

highlights that commercial catches provide limited information on recruitment and early growth, reinforcing the importance of survey data for assessing the full population structure.

Table 4.1 – Mean, min and max length for lemon sole by age and sample size.

Length-at-age summary for lemon sole				
Age	Sample size	Length (mm)		
		Mean	Min	Max
2	4	242.2	172	290
3	42	264.1	172	320
4	82	283.7	179	355
5	300	317.4	172	414
6	612	349.9	237	436
7	603	364.4	239	464
8	479	376.0	296	456
9	243	397.8	327	479
10	147	411.9	357	479
11	55	427.5	386	468
12	56	435.7	386	495
13	16	445.9	404	491
14	18	446.4	413	475
15	9	475.1	439	496
16	2	470.0	464	476
17	1	456.0	456	456
18	1	468.0	468	468
20	1	490.0	490	490

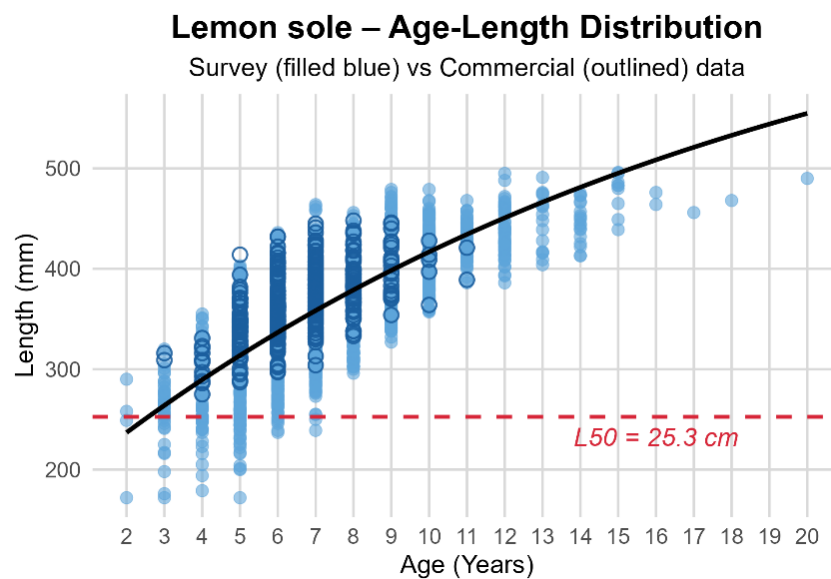


Figure 4.5 – Age-length distribution of lemon sole based on survey (filled blue symbols) and commercial (open dark blue symbols) samples. The solid black line represents the fitted von Bertalanffy growth function (VBGF). The dashed red horizontal line denotes the estimated length at 50% maturity (L_{50}).

The age-length distribution of lemon sole indicates broadly similar growth patterns between genders during the early life stages, although differences become more apparent at older ages and larger sizes (Figure 4.6). Male lemon sole generally appeared to reach an asymptotic size at around 450 mm, whereas females continued to occur at larger sizes and older ages. No males were observed beyond age 12, while females were represented across the oldest age groups in the dataset.

These patterns suggest moderate sexual dimorphism in growth and longevity, with females attaining both greater maximum size and age compared to males. Such differences may influence population age structure and maturity dynamics within the stock.

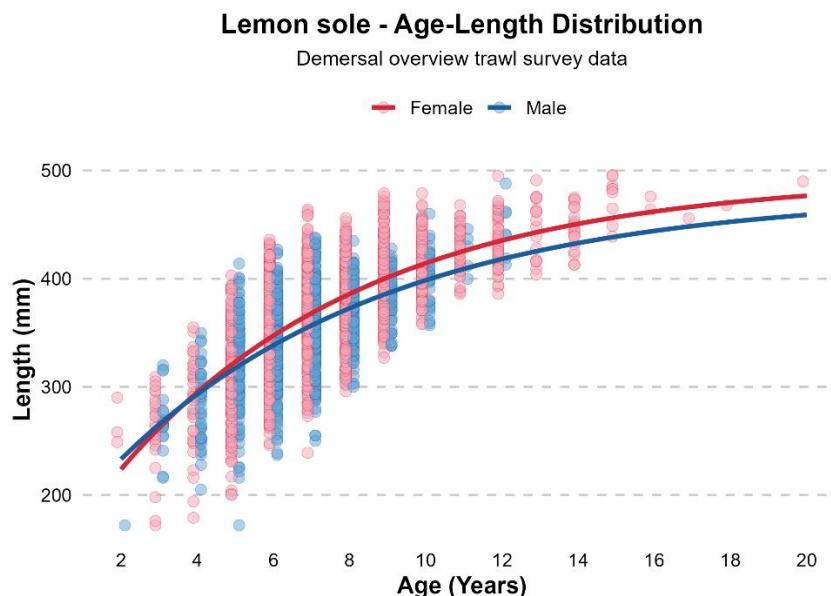


Figure 4.6 – Age-length distribution of female (pink) and male (blue) lemon sole from the demersal overview trawl survey. Solid lines represent gender-specific von Bertalanffy growth functions (VBGFs) fitted separately to female and male observations.

4.3 Age distribution

The age composition of lemon sole shows an approximately normal distribution from ages 2 to 11, with a tail extending to age 20 (Figure 4.7). Most individuals in the combined survey and commercial dataset fall between ages 5 and 8.

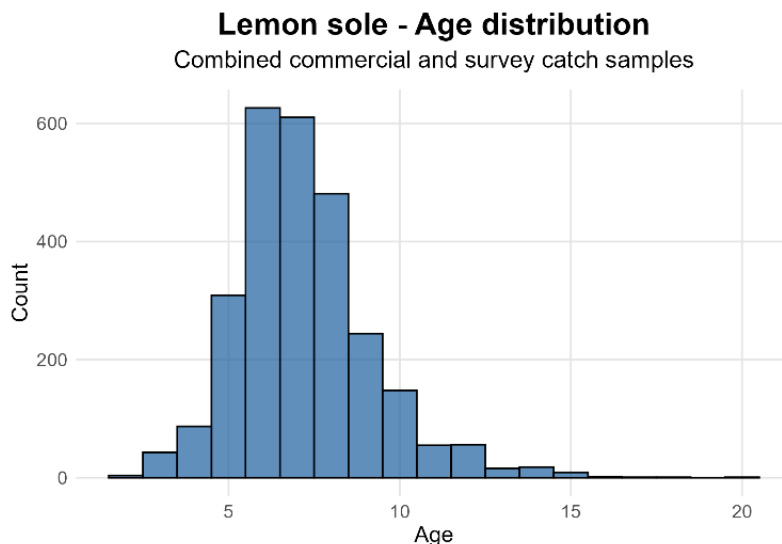


Figure 4.7 – Age distribution of lemon sole in the combined survey and commercial dataset, illustrating an approximately normal distribution of ages with a tail extending to older individuals.

The age distribution of lemon sole in the combined survey and commercial samples shows a clear dominance of females across much of the age range (Figure 4.8). Females already constitute around 75% of individuals at age 2, after which the gender ratio becomes more balanced between ages 3 and 5. From age 6 onward, females increasingly outnumber males, and by age 13 the samples consist entirely of females. This progressive shift reflects the faster growth rates and greater longevity typical of female lemon sole. The oldest individual recorded in the dataset was a 20-year-old female, indicating the presence of long-lived females in the stock, although such ages occur only rarely. Overall, the age structure highlights a strongly female-skewed population at older ages, consistent with gender-specific differences in growth and survival.

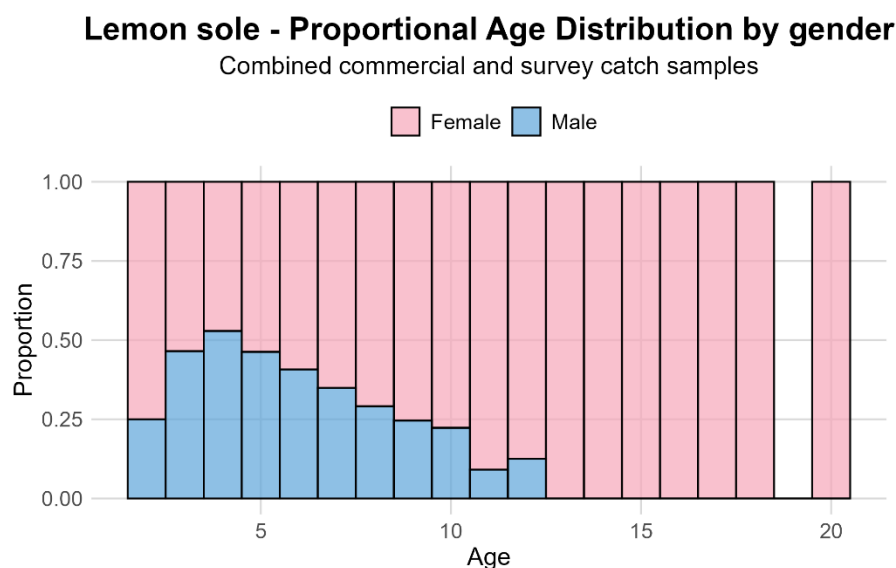


Figure 4.8 – Proportional age distribution of lemon sole by gender (female: pink; male: blue)

A comparison of age distributions from 2023 indicates clear differences between sampling sources: survey samples contain proportionally more younger fish (up to age 5), whereas commercial catches are dominated by fish aged 6 and 7 (Figure 4.9). This divergence reflects the influence of gear selectivity and spatial fishing patterns, with the commercial fishery tending to capture larger, more mature individuals, while the survey as expected provides a broader and more representative sampling of the full age structure, including younger cohorts.

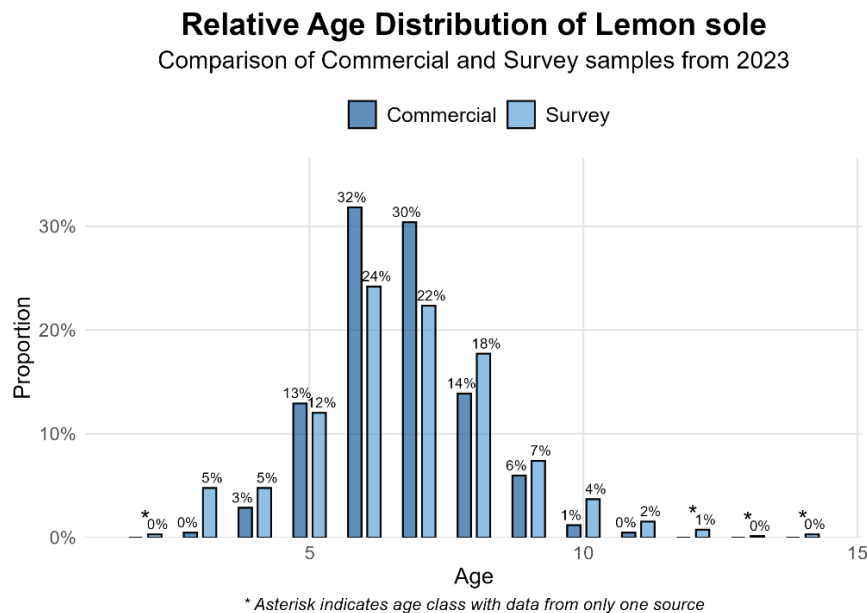


Figure 4.9 – Age distribution of lemon sole from survey and commercial catch samples in 2023 only.

4.4 Maturity

Maturity analyses of lemon sole examined maturity-at-length and maturity-at-age, the relationship between these two maturity indicators, and patterns in maturity stage and reproductive investment. Estimates of length and age at 50% maturity (L_{50} and A_{50}) were derived for the combined dataset and separately by gender. The relationship between L_{50} and A_{50} was further evaluated using the von Bertalanffy growth trajectories, while gonadosomatic index (GSI) and maturity-stage composition were examined to provide additional information on reproductive investment and seasonal reproductive patterns. The following sections present these analyses and describe the resulting patterns in greater detail.

4.4.1 Maturity ogive by length groups

Length data were grouped into 2-cm bins, and maturity was classified using a stage threshold of 2. A logistic regression model was fitted using a generalized linear model (GLM) to estimate the length at 50% maturity (L_{50}), which was calculated to be 25.3 cm for the combined dataset (Table 4.2 and Figure 4.10). The estimated L_{50} was 25.8 cm for females and 24.4 cm for males, with limited overlap in the confidence intervals (Figure 4.11). The corresponding logistic regression parameters, including the intercept and slope estimates, standard errors, p-values, L_{50} estimates, and Akaike Information Criterion (AIC), are presented in Table 4.3.

Table 4.2 – Results of logistic regression model of lemon sole maturity at length (L_{50}). The table includes length bins, total number of fish, number of mature fish, observed ogive, predicted probability of maturity, and 95% confidence limits (lower and upper)

<i>Length bin</i>	<i>Total fish</i>	<i>Mature fish</i>	<i>Ogive observed</i>	<i>Predicted prob</i>	<i>Lower CI</i>	<i>Upper CI</i>
16	5	1	0.2	0.047	0.028	0.078
18	2	2	1	0.086	0.056	0.131
20	9	3	0.333	0.154	0.109	0.213
22	15	4	0.267	0.258	0.2	0.327
24	57	22	0.386	0.4	0.337	0.467
26	83	56	0.675	0.561	0.508	0.613
28	129	81	0.628	0.71	0.674	0.745
30	219	170	0.776	0.825	0.801	0.846
32	267	242	0.906	0.9	0.884	0.914
34	423	398	0.941	0.945	0.934	0.955
36	423	415	0.981	0.971	0.962	0.977
38	409	404	0.988	0.985	0.979	0.989
40	318	318	1	0.992	0.988	0.994
42	213	212	0.995	0.996	0.993	0.997
44	86	86	1	0.998	0.996	0.999
46	43	43	1	0.999	0.998	0.999
48	10	10	1	0.999	0.999	1

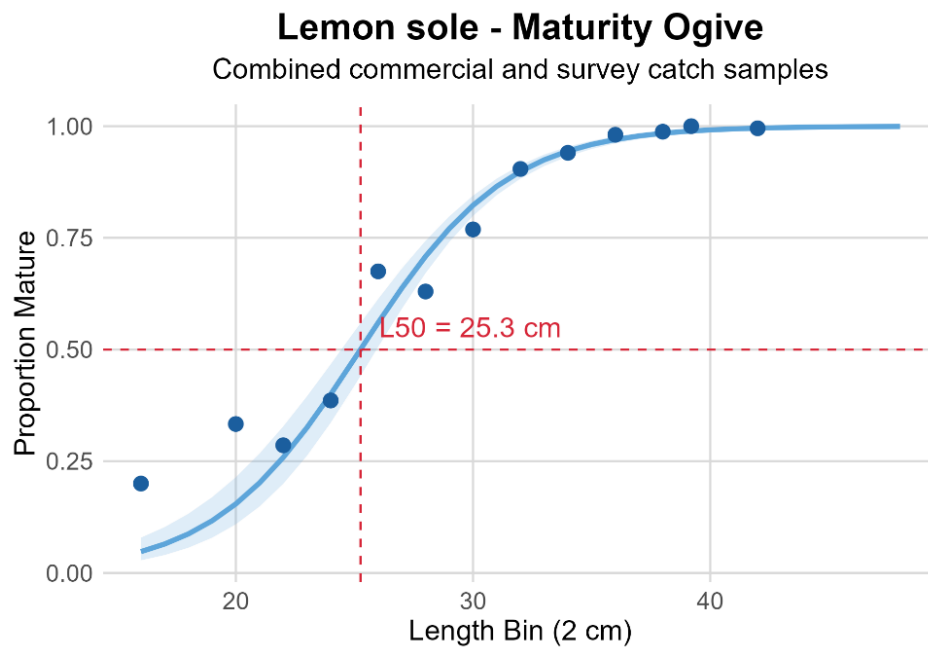


Figure 4.10 – Logistic regression model of the lemon sole maturity ogive. The blue line shows the fitted model, with shaded areas representing ± 1 standard deviation. Observed maturity at length is shown as dots, and stippled vertical line indicate the estimated length at 50% maturity (L_{50}).

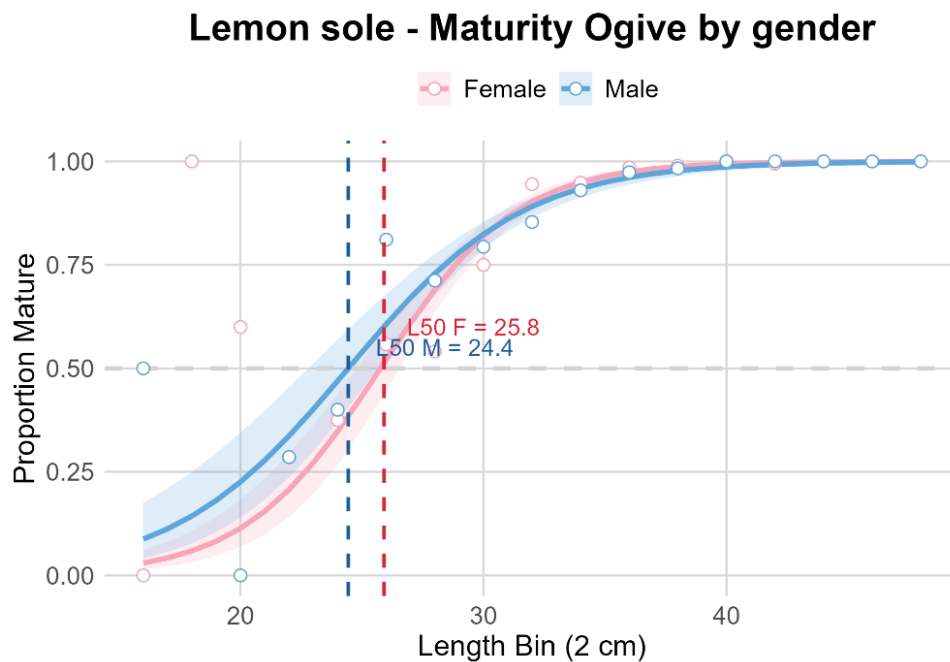


Figure 4.11– Logistic regression models of the lemon sole maturity ogive by gender. Females are shown in pink/red and males in blue, with shaded areas representing ± 1 standard deviation. Observed maturity at length is shown as dots, and stippled vertical lines indicate the estimated length at 50% maturity (L_{50}) for each gender.

Table 4.3 – Logistic regression model parameters for the lemon sole maturity length ogive, shown for the combined dataset and separately for females and males. Parameters include the intercept estimate (Est), standard error (SE), and p-value (P), the slope estimate (Est), standard error (SE), and p-value (P), the estimated length at 50% maturity (L_{50}), and the model Akaike Information Criterion (AIC).

Logistic Ogive Model Parameters								
Lemon sole length-at-maturity by gender								
Gender	Intercept (Est)	Intercept (SE)	Intercept (p)	Slope (Est)	Slope (SE)	Slope (p)	L_{50} (cm)	AIC
Combined	-8.21	0.56	<0.001	0.32	0.02	<0.001	25.20	1,156.80
Female	-9.16	0.77	<0.001	0.36	0.02	<0.001	25.70	627.90
Male	-6.91	0.83	<0.001	0.28	0.03	<0.001	24.50	528.80

4.4.2 Maturity ogive by age groups

Age data were grouped into 1-year bins, and maturity was defined again using the stage threshold of 2. A logistic regression model was fitted using a generalized linear model (GLM) to estimate the age at 50% maturity (A_{50}), which was calculated to be 2.6 years in the combined dataset (Table 4.4; Figure 4.12). The estimated A_{50} was higher for females (3.1 years) than for males (1.3 years) (Figure 4.13). The corresponding logistic regression parameters, including the intercept and slope estimates, standard errors, p-values, A_{50} estimates, and Akaike Information Criterion (AIC), are presented in Table 4.3.

Table 4.4 – Results of logistic regression model of lemon sole maturity at age (A_{50}). The table includes age bins, total number of fish, number of mature fish, observed ogive, predicted probability of maturity, and 95% confidence limits (lower and upper)

Age bin	Total fish	Mature fish	Ogive observed	Predicted prob	Lower CI	Upper CI
2	4	1	0.25	0.411	0.32	0.51
3	42	28	0.667	0.559	0.482	0.634
4	82	55	0.671	0.698	0.647	0.744
5	300	242	0.807	0.807	0.781	0.831
6	612	546	0.892	0.884	0.869	0.897
7	603	554	0.919	0.933	0.921	0.943
8	479	455	0.95	0.962	0.952	0.97
9	243	243	1	0.979	0.971	0.984
10	147	147	1	0.988	0.982	0.992
11	55	55	1	0.993	0.989	0.996
12	56	56	1	0.996	0.993	0.998
13	16	16	1	0.998	0.996	0.999
14	18	18	1	0.999	0.998	0.999
15	9	9	1	0.999	0.999	1
16	2	2	1	1	0.999	1
17	1	1	1	1	0.999	1
18	1	1	1	1	1	1
20	1	1	1	1	1	1

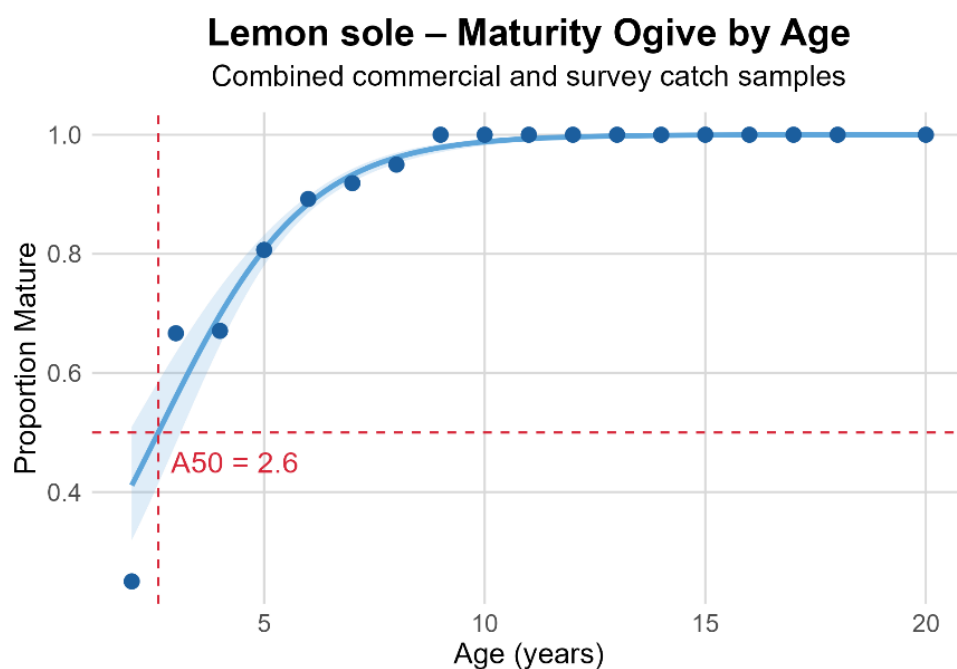


Figure 4.12– Logistic regression model of the lemon sole maturity ogive by age. The blue line shows the fitted model, with shaded areas representing ± 1 standard deviation. Observed maturity at age is shown as dots, and the stippled vertical line indicates the estimated age at 50% maturity (A_{50}).

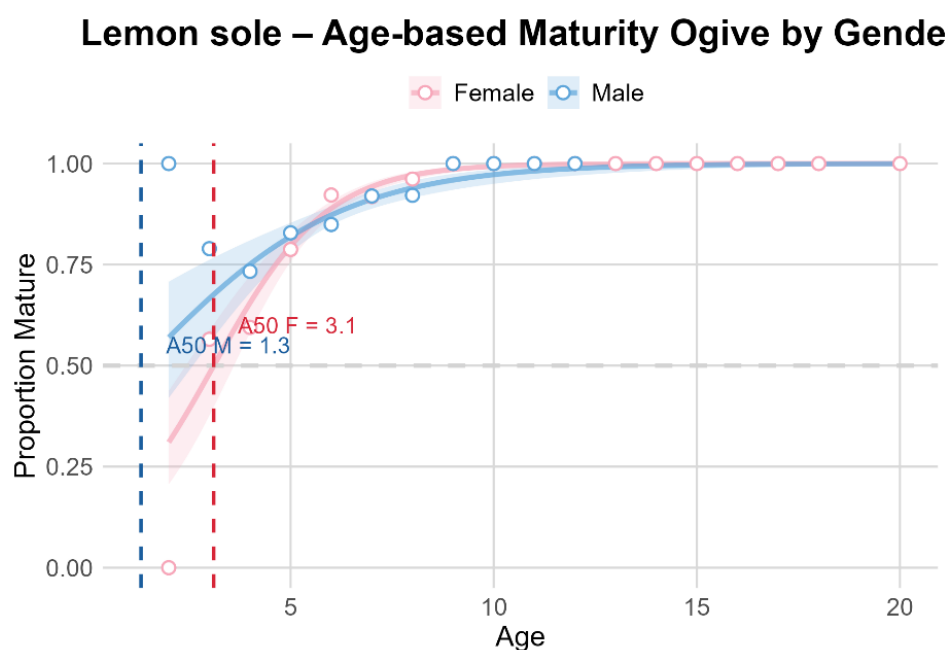


Figure 4.13– Logistic regression models of the lemon sole maturity ogive by age and gender. Females are shown in pink/red and males in blue, with shaded areas representing ± 1 standard deviation. Observed maturity at age is shown as dots, and stippled vertical lines indicate the estimated age at 50% maturity (A_{50}) for each gender.

Table 4.5 – Logistic regression model parameters for the plaice maturity age-ogive, shown for the combined dataset and separately for females and males. Parameters include the intercept estimate (Est), standard error (SE), and p-value (P), the slope estimate (Est), standard error (SE), and p-value (P), the estimated length at 50% maturity (L50), and the model Akaike Information Criterion (AIC).

Logistic Age-at-Maturity Model Parameters								
Lemon sole age-at-maturity by gender								
Gender	Intercept (Est)	Intercept (SE)	Intercept (p)	Slope (Est)	Slope (SE)	Slope (p)	A50 (yrs)	AIC
Combined	-1.55	0.30	<0.001	0.60	0.05	<0.001	2.60	1,431.30
Female	-2.24	0.41	<0.001	0.72	0.07	<0.001	3.10	799.80
Male	-0.54	0.45	0.228	0.41	0.07	<0.001	1.30	625.10

The maturity-at-age ogive estimated for Faroese lemon sole indicates relatively early maturation, with females reaching A_{50} at 3.1 years and males at 1.3 years. These values align broadly with observations from adjacent regions of the Northeast Atlantic. For example, lemon sole on the west coast of Ireland typically matures from age 2+ (Hannan, 2002; King et al., 2006), while broader regional summaries report female and male A_{50} ranges of 4–6 years and 3–4 years, respectively. Taken together, these comparisons suggest that the Faroese stock matures at the earlier end of the species' reported maturity schedule. This pattern is consistent with findings for other flatfish, where regional variation in growth rates can drive differences between age- and length-based maturity ogives ((Grift et al., 2003; Morgan & Colbourne, 1999; Rijnsdorp, 1993). The consistency between Faroese and regional length-based ogives, despite the early age-at-maturity, therefore suggests that differences in growth dynamics may contribute more to the observed variation in maturity-at-age than differences in reproductive biology.

To assess whether the relatively early A_{50} estimates could instead be influenced by the age structure of the sampled fish, sensitivity analyses were conducted by truncating observations at full maturity ($\geq 99\%$ mature) and introducing fictive immature observations for ages 0 and 1. These analyses were intended to evaluate the influence of uneven age representation, particularly the predominance of older mature individuals and the limited number of young immature fish, especially males. The results are presented in the supplementary information Section 0.

Overall, the resulting A_{50} estimates differed only marginally from the primary model outputs, indicating that the fitted ogives were generally robust to the tested assumptions. In the combined dataset, A_{50} decreased from 2.6 to 2.5 years following truncation and inclusion of fictive immature observations, while female A_{50} similarly decreased from 3.1 to 3.0 years. Male A_{50} showed a somewhat larger shift, decreasing from 1.3 to 1.0 years. This greater sensitivity likely reflects the limited availability of young immature males in the observed dataset and the resulting influence of imposed immature observations at ages 0 and 1 on the logistic model.

The comparatively small changes in estimated maturity schedules suggest that the low age-at-maturity estimates are unlikely to arise solely from the overrepresentation of older mature fish. Instead, the results indicate that uncertainty is more strongly associated with sparse sampling of younger age classes and gender-specific differences in sample composition. Similar discrepancies between age- and length-based maturity schedules have been documented in other flatfish stocks, where variability in growth trajectories, ageing uncertainty, and uneven sampling across ontogenetic stages can influence maturity-at-age estimation more strongly than maturity-at-length estimates.

4.4.3 Crosswalk of L_{50} and A_{50}

The relationship between age at 50% maturity (A_{50}) and length at 50% maturity (L_{50}) for male and female lemon sole, integrating empirical maturity observations with von Bertalanffy growth trajectories, is presented in Figure 3.14 and Table 3.6. Median growth curves are shown as solid lines, while shaded ribbons represent 95% confidence intervals derived from covariance-based simulations of the growth parameters, thereby accounting for both parameter uncertainty and covariance structure. Vertical dashed lines indicate the observed A_{50} values, whereas horizontal dotted lines denote the corresponding observed L_{50} estimates.

Predicted lengths at A_{50} and predicted ages at L_{50} aligned closely with the empirical maturity estimates for both genders, with only minor deviations falling within the modelled uncertainty bounds. This agreement demonstrates strong internal consistency between the age- and length-based maturity ogives and indicates that the estimated growth trajectories adequately describe the transition from immature to mature individuals.

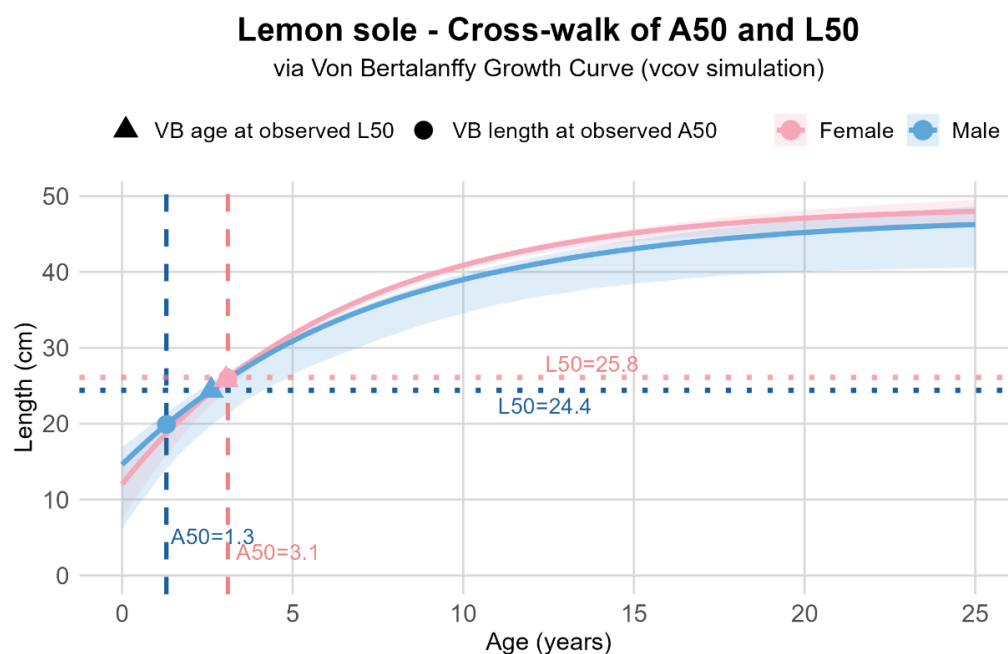


Figure 4.14 – Crosswalk of lemon sole age at 50% maturity (A_{50}) and length at 50% maturity (L_{50}) for males and females. Solid lines show the median von Bertalanffy growth trajectories, and shaded ribbons indicate 95% confidence intervals derived from covariance-based simulations of the growth parameters, accounting for parameter uncertainty and correlation. Vertical dashed lines mark the observed A_{50} values, and horizontal dotted lines indicate the observed L_{50} values. Points represent predicted lengths at A_{50} (circles) and predicted ages at L_{50} (triangles).

Table 4.6 – Crosswalk of lemon sole age- and length-at-maturity estimates by gender. The table includes observed age at 50% maturity (A_{50}) and length at 50% maturity (L_{50}), predicted length at A_{50} and predicted age at L_{50} from the von Bertalanffy growth model, and the differences between predicted and observed values (ΔL and ΔA).

Lemon sole Maturity Crosswalk						
Comparison of age-based (years) and length-based (cm) maturity metrics						
Gender	Observed		Predicted		Differences	
	A_{50}	L_{50}	A at L_{50}	L at A_{50}	ΔA	ΔL
Male	1.30	24.40	2.46	20.34	1.16	-4.06
Female	3.10	25.80	3.03	26.05	-0.07	0.25

The relationship between maturity schedules and growth dynamics, based on a direct comparison of empirical maturity estimates with the underlying von Bertalanffy growth functions, is shown in Figure 4.15. The close correspondence between observed and growth-derived maturity metrics supports the biological coherence of both the age- and length-based maturity assessments across genders. Collectively, these results suggest that the observed differences between age- and length-at-maturity are primarily attributable to variation in growth trajectories rather than inconsistencies in the maturity data themselves.

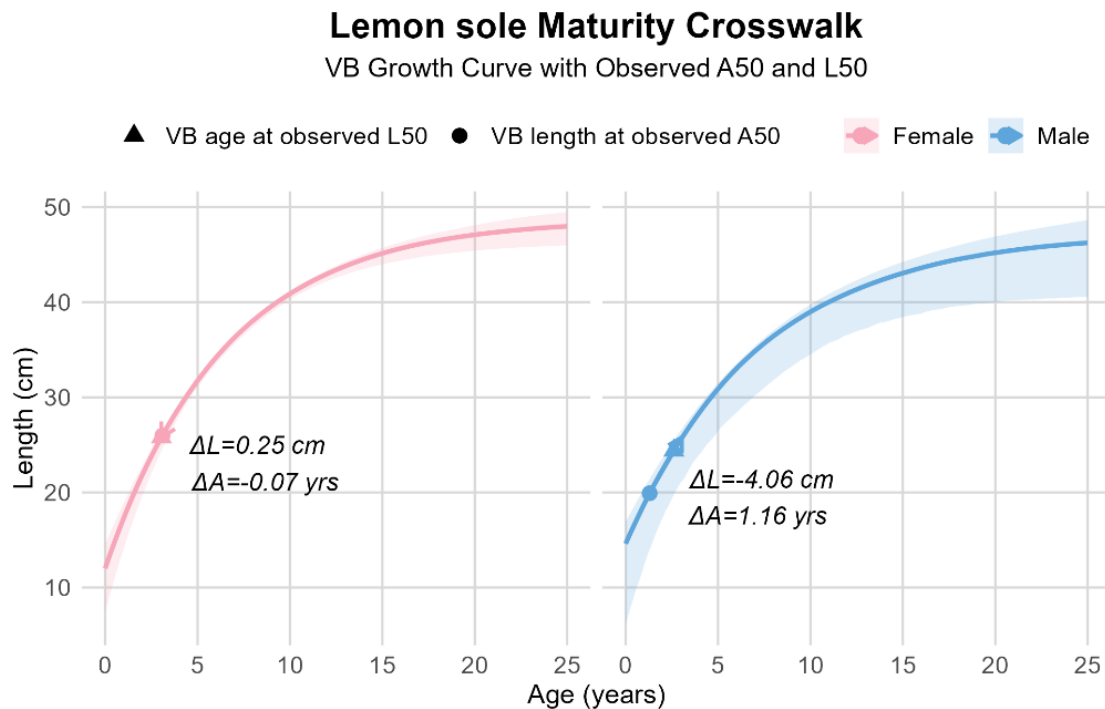


Figure 4.15 – Lemon sole von Bertalanffy growth curves with crosswalk of age at 50% maturity (A_{50}) and length at 50% maturity (L_{50}) for males and females. Solid lines show median growth trajectories, shaded ribbons represent 95% confidence intervals from covariance-based simulations, and points indicate predicted length at A_{50} (circles) and predicted age at L_{50} (triangles).

4.4.4 Gender and Maturity stage

Analysis of lemon sole by gender and maturity stage shows that females are generally more abundant than males across most stages in the combined dataset (Figure 4.16 upper panel). However, during the pre-spawning and spawning stages, this pattern shifts. In a subset of data from March to July (Figure 4.16 lower panel)—representing the likely spawning period—the majority of females were in stage 3 (developing), stage 4 (developing late stage) and stage 5 (mature pre-spawning), whereas majority of males were in stage 5 and stages 6 i.e. mature pre-spawning and spawning, respectively. Counts in all other stages were negligible. This distribution suggests that, while females dominate the population overall, males are more concentrated in advanced maturity stages during the spawning season, consistent with gender-specific timing and behaviour associated with reproduction.

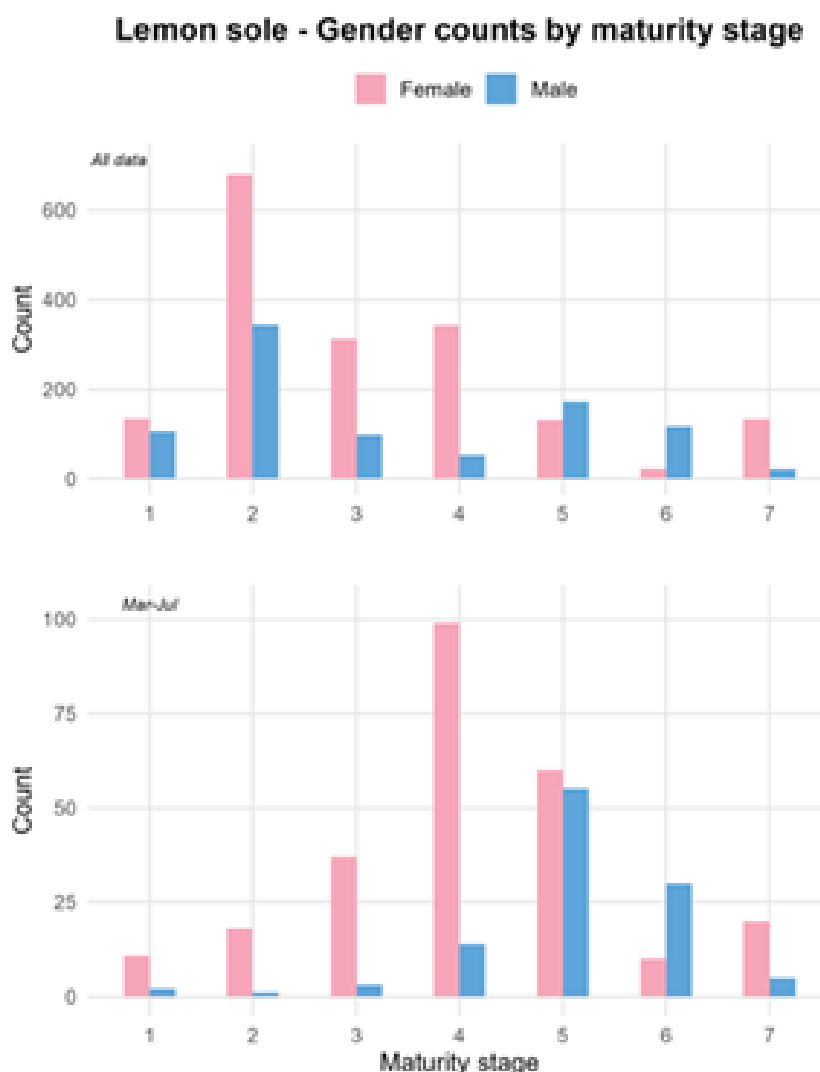


Figure 4.16 - Counts of male and female lemon sole by maturity stage in all data (upper) and subset including data from April to June (lower)

4.4.5 Gonads Somatic Index

Gonadosomatic index (GSI) data were available only for a subset of sampled individuals and did not reflect the full-size composition used for maturity ogive estimation. GSI observations were concentrated within intermediate and larger size classes, while smaller individuals were only sparsely represented (Figure 3.17 and Figure 3.18). This likely reflects opportunistic gonad sampling, where larger and predominantly mature fish were preferentially sampled.

Clear gender-specific differences in GSI were observed for lemon sole. Female individuals displayed substantially higher and more variable GSI values than males across the observed length range. The highest GSI values occurred almost exclusively in females, particularly between approximately 35 and 43 cm, indicating elevated reproductive investment associated with gonad development during maturation and spawning.

In contrast, male GSI values remained consistently low and showed comparatively little variability across lengths. While a weak positive relationship between length and GSI was apparent among females, particularly at intermediate-to-large sizes, considerable variability remained among individuals of similar length. This suggests that reproductive condition is influenced not only by body size, but also by maturity stage and spawning timing.

Consequently, the observed GSI patterns primarily describe reproductive investment among mature individuals rather than maturity dynamics across the population as a whole. In contrast, the L_{50} estimates derived from the complete maturity dataset represent the size at onset of maturation within the stock. Direct comparisons between L_{50} estimates and GSI trends should therefore be interpreted cautiously, as the two metrics are derived from datasets with substantially different sampling coverage and size composition.

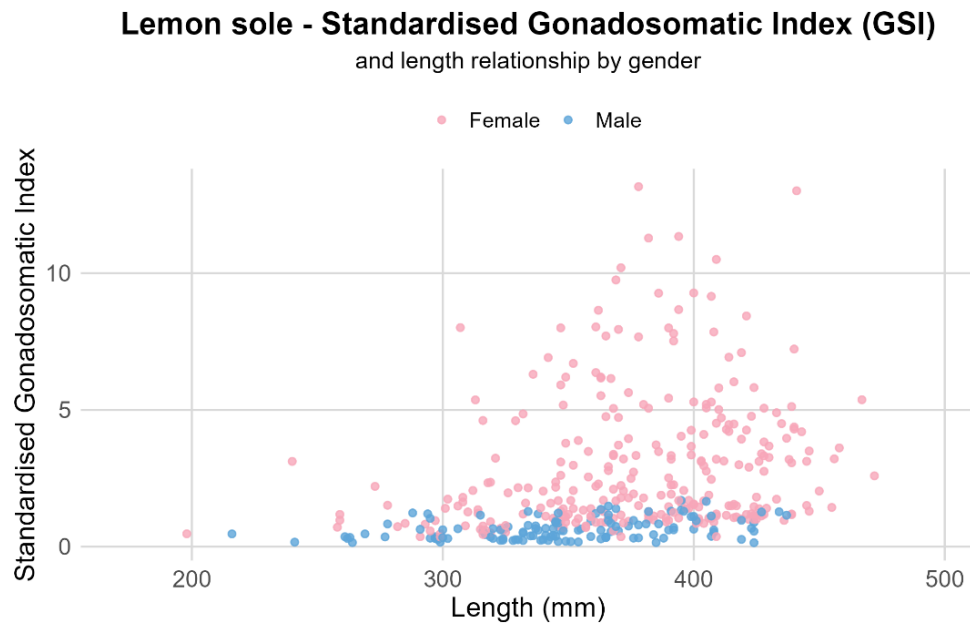


Figure 4.17 – Standardised gonadosomatic index (GSI) in relation to length (mm) for lemon sole, shown separately for males and females. Each point represents an individual fish. GSI values are derived from gonad weight relative to standardised body weight (round weight or estimated from gutted weight).

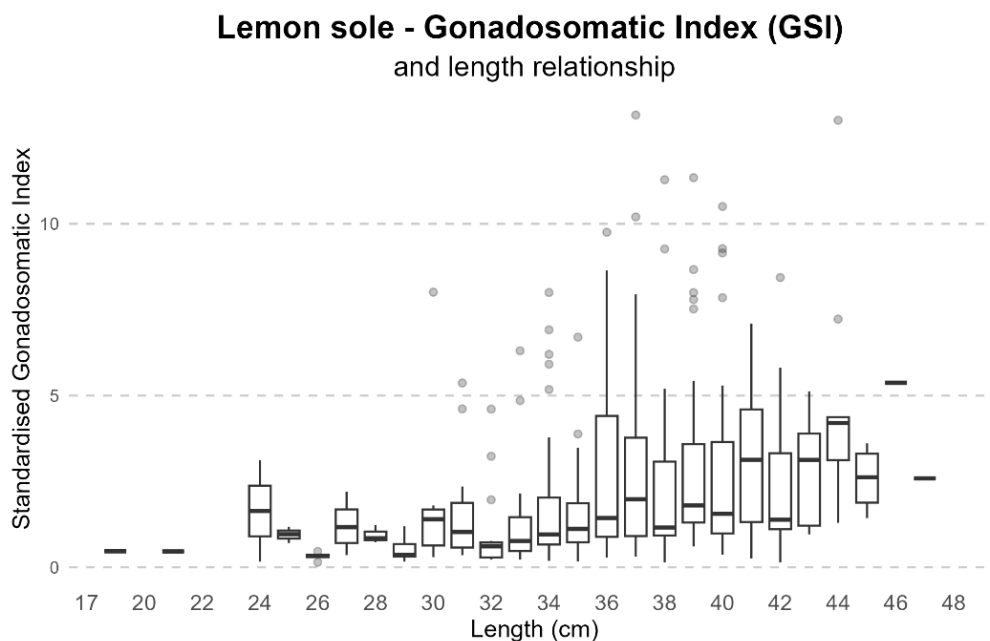


Figure 4.18 – Distribution of standardised gonadosomatic index (GSI) by length class (cm) for lemon sole. Boxes represent the interquartile range, with median values indicated by horizontal lines; whiskers extend to $1.5 \times$ the interquartile range, and points indicate outliers.

4.5 Phenological Distribution

The seasonal pattern of gonad maturity in lemon sole indicates a protracted spawning season, as shown in Figure 4.19 and Figure 4.20. Spawning individuals are present from February through to August, with peaks in gonad development occurring at different times for the two genders. Females tend to mature later, with spawning-stage gonads appearing progressively across the season, whereas males with spawning gonads are observed over a longer and more continuous period (Figure 4.21). This pattern highlights the extended and staggered reproductive timing of lemon sole on the Faroe Plateau.

Interpretation of the monthly distribution should, however, be made with caution, as sampling intensity was uneven throughout the year (Figure 4.21). The majority of maturity observations originated from research surveys conducted during February–March and August, resulting in substantially higher sample numbers during these periods relative to the intervening months. Consequently, apparent seasonal peaks in maturity-stage occurrence may partly reflect differences in sampling coverage rather than biological timing alone.

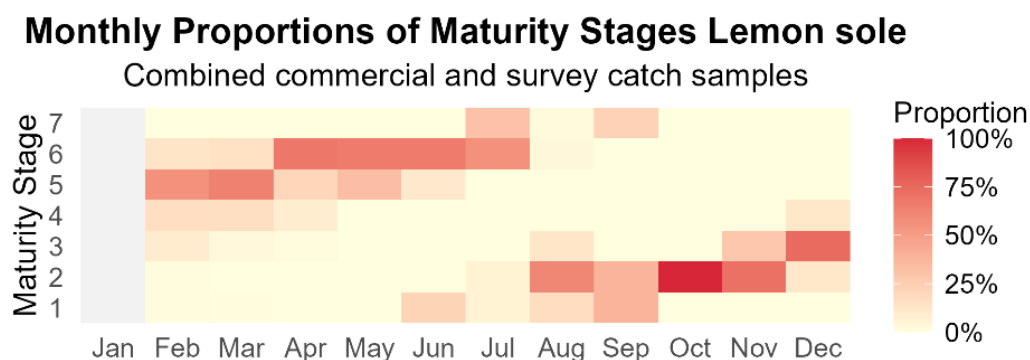


Figure 4.19 – Heat map of the monthly proportion of lemon sole maturity stages 1–7. Maturity data for January is not available.

Monthly Proportions of Maturity Stages Lemon sole

Combined commercial and survey catch samples

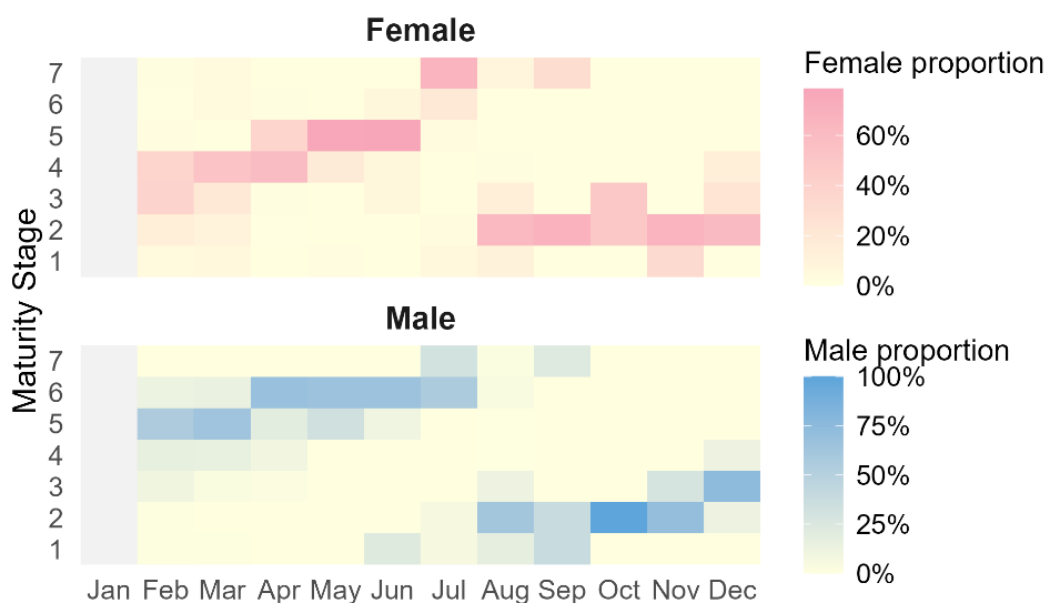


Figure 4.20 – Heat map of the monthly proportion of lemon sole maturity stages 1–7, separated into genders (female: upper; male: lower). Maturity data for January is not available.

Lemon sole – Maturity Stages by Month

Monthly % of stage 5, 6 and 7

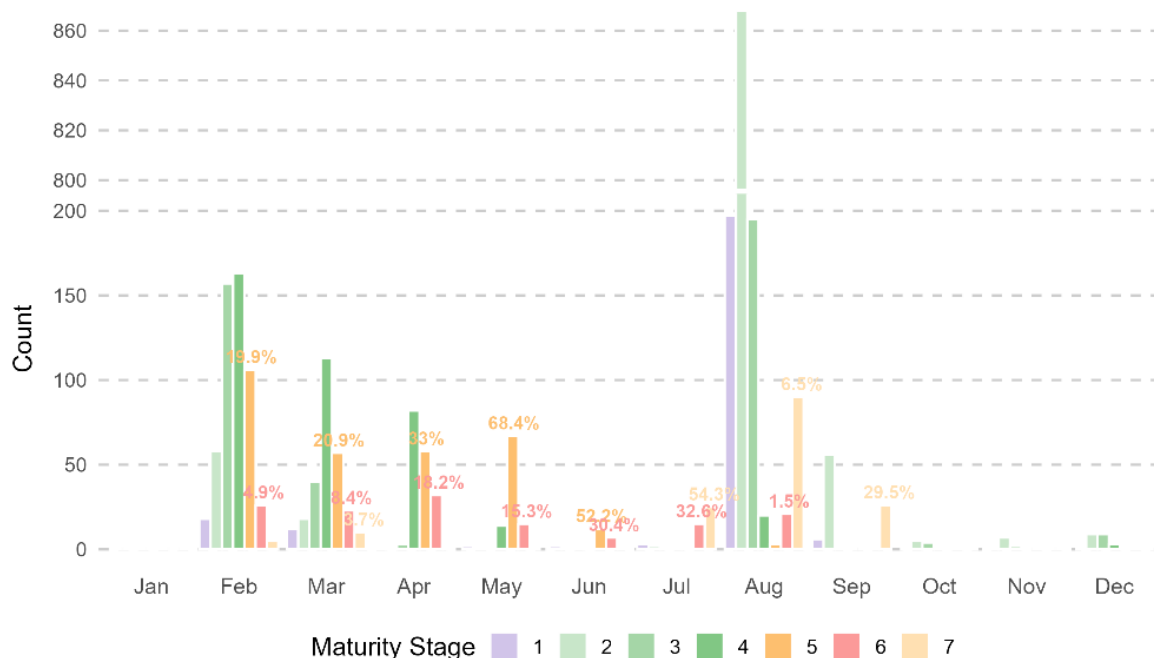


Figure 4.21 – Monthly counts of lemon sole maturity stages, showing the proportion (%) of stages 5, 6, and 7 only. Values are expressed as a percentage of the total observed in each month. Note the break in the y-axis to accommodate higher values in peak sampling months.

4.6 Spawning- and nursery grounds

4.6.1 Spatial distribution per gender

Both genders of lemon sole were observed across the Faroe Plateau and the Faroe bank (Figure 4.22). Throughout the plateau, genders were fairly evenly distributed, with a slightly higher concentration of females in the deeper eastern region and also on the Faroe Bank.

Lemon sole spatial distribution by gender
Combined sample data from commercial catches and demersal trawl surveys

● Female ● Male — 12 nm

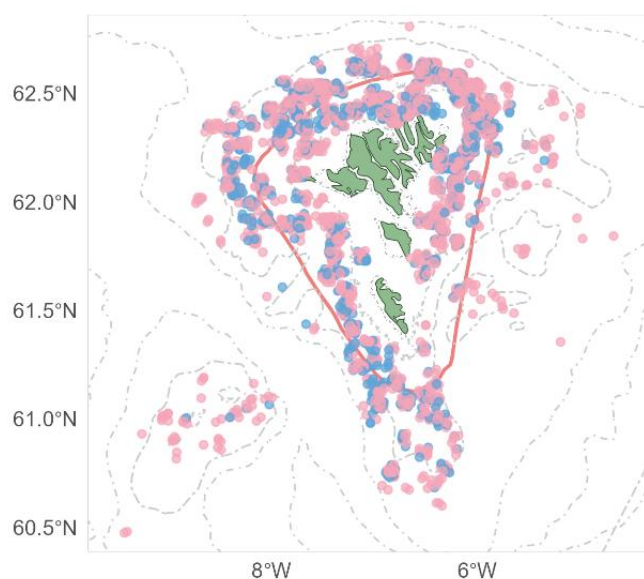


Figure 4.22 – Spatial distribution of lemon sole segregated into gender by combined sample data from commercial catches in 2023 and demersal overview trawl surveys from 1996 to present.

4.6.2 Spawning grounds

Like plaice, lemon sole does not form dense, spatially confined, or clearly defined spawning aggregations (Figure 4.23). Although data on spawning individuals are limited and phenologically dispersed, the available observations indicate that spawning occurs broadly across the Faroese shelf rather than being restricted to specific sites. Most samples from the Faroe Bank surveys lack maturity-stage information, preventing any reliable assessment of spawning activity in that area. As a result, current conclusions about the spatial extent of lemon sole spawning must rely solely on shelf data, which collectively suggest a diffuse and widespread spawning pattern (Figure 4.24).

Spatial Distribution of Lemon sole by Gender Differentiated by Maturity Stage (1–7)

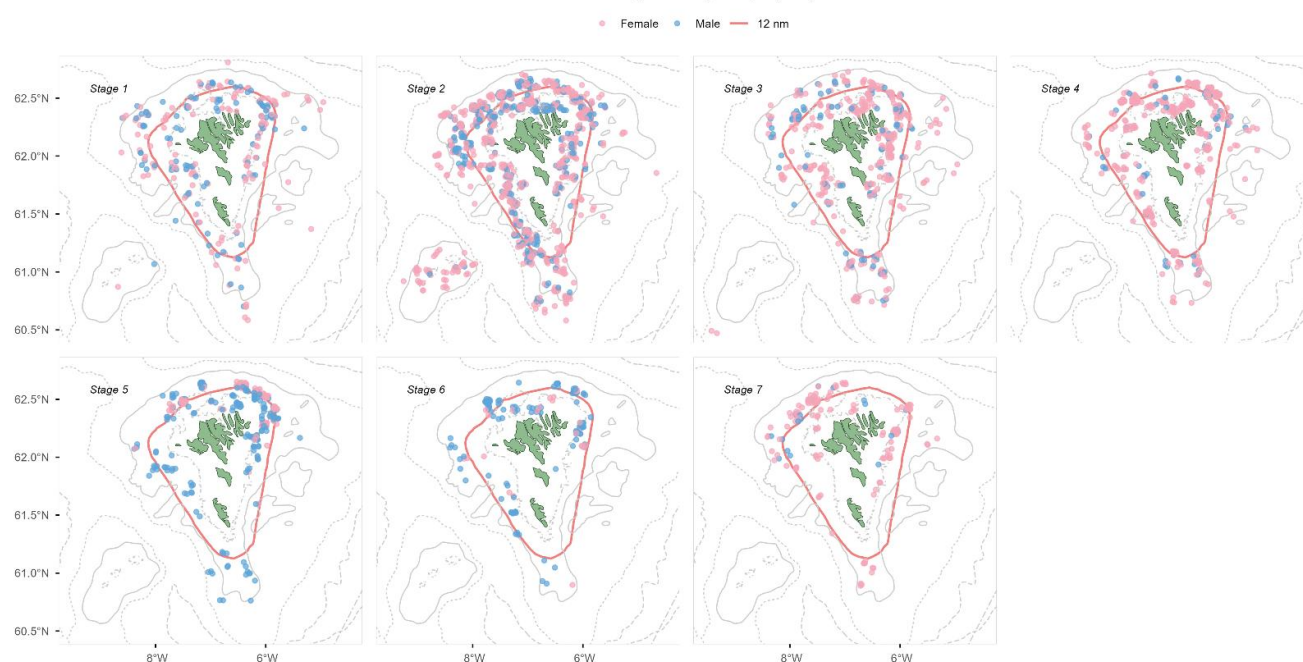


Figure 4.23 – Spatial distribution of lemon sole female (pink) and male (blue) differentiated by maturity stages 1-7.



Figure 4.24 - Spawning area of lemon sole.

4.6.3 Distribution of 0-group samples and index

The spatial distribution of lemon sole 0-group observations from the 0-group surveys showed broad coverage across the Faroe Plateau, with juvenile occurrences overlapping substantially with the distribution of spawning adults recorded in the combined survey and commercial samples (Figure 4.25). 0-group individuals were widely distributed throughout the surveyed area, indicating that early life stages are broadly dispersed across the Plateau and occur within many of the same areas occupied by mature fish during the spawning season.

The temporal development of the 0-group index demonstrated generally low recruitment levels from the beginning of the time series in 1983 until approximately 2010, with annual indices typically remaining below 25 individuals per trawling hour (Figure 4.26). From 2010 onwards, the index became more variable between years, with several periods of elevated recruitment. Particularly strong year classes were observed in 2019 and 2025, when the index exceeded 100 individuals per trawling hour. This increased interannual variability in recent years may reflect fluctuations in recruitment success, although the underlying drivers remain unclear.

The broad spatial distribution of 0-group lemon sole across the Faroe Plateau and Faroe Bank, together with the substantial spatial overlap with spawning adults on the Plateau, indicates that early life stages are widely dispersed within Faroese waters. However, the occurrence of abundant 0-group individuals on the Faroe Bank, where spawning adults were largely absent, indicates that juvenile distribution is not restricted to areas occupied by spawning fish (Figure 4.25). This pattern may reflect dispersal of early life stages from spawning areas on the Faroe Plateau, although the available observations do not allow the relative contributions of local retention and transport to be distinguished. The distribution of 0-group individuals across both the Plateau and Faroe Bank nevertheless demonstrates that Faroese shelf waters provide extensive habitat for the early life stages of lemon sole.

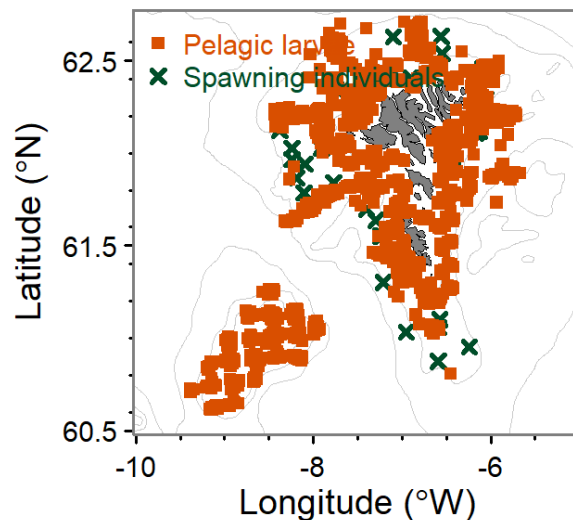


Figure 4.25 – Distribution of lemon sole larvae (orange squares) from 0-group surveys and locations of spawning adults (green crosses) sampled in combined spring and summer demersal trawl surveys, illustrating the spatial relationship between early life stages and spawning adults across the Faroe Plateau.

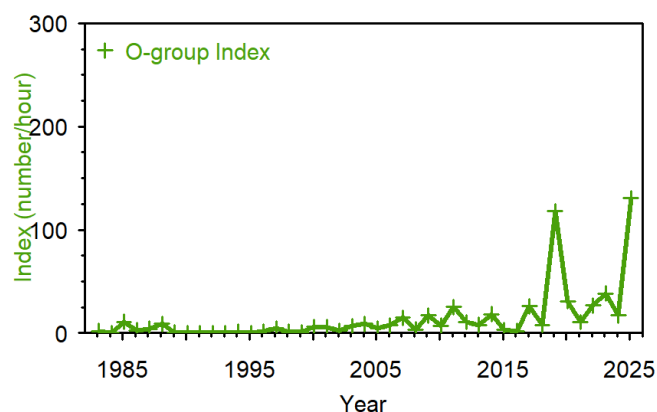


Figure 4.26 – 0-group index of lemon sole larvae sampled in the 0-group surveys from 1983 to 2025, showing interannual variation in early recruitment across the Faroe Plateau.

4.7 Hepatosomatic index

The hepatosomatic index (HSI) showed a generally positive relationship with fish length in both genders of lemon sole, although considerable individual variability was observed across the sampled size range (Figure 3.27). Most individuals exhibited HSI values between 0.5 and 1.5, with larger fish tending to display slightly elevated liver indices.

Female lemon sole displayed a broader range of HSI values and attained higher maximum values than males. Several females exceeding 400 mm in length exhibited HSI values above 1.5, whereas males were more tightly distributed around intermediate values.

No clear size-related thresholds or discontinuities were evident, indicating that liver condition varied continuously across lengths. A limited number of individuals with particularly low or high HSI values were present in both genders, potentially reflecting differences in feeding condition, reproductive stage, or seasonal energy allocation at the time of capture.

Overall, the HSI patterns indicate moderate variability in energetic condition within the sampled population, with females exhibiting greater variability than males.

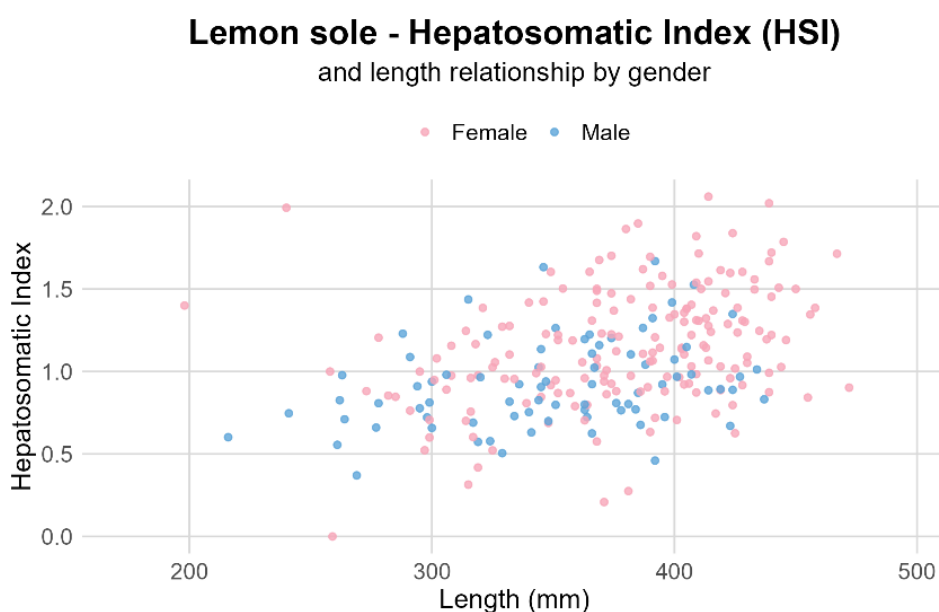


Figure 4.27 – Relationship between hepatosomatic index (HSI) and total length (mm) in female and male lemon sole. Each point represents an individual fish.

Monthly variation in hepatosomatic index (HSI) indicated differences between genders and sampling periods, although interpretation is constrained by limited temporal coverage and uneven sample sizes among months (Figure 4.28). Females generally displayed higher HSI values than males, particularly during February–March when the highest values for both genders were observed. HSI values were generally lower in August, especially among females, whereas males displayed a broader range of HSI values during this period compared with late winter samples. These patterns likely reflect seasonal variation in energy storage and allocation associated with reproductive activity and feeding conditions.

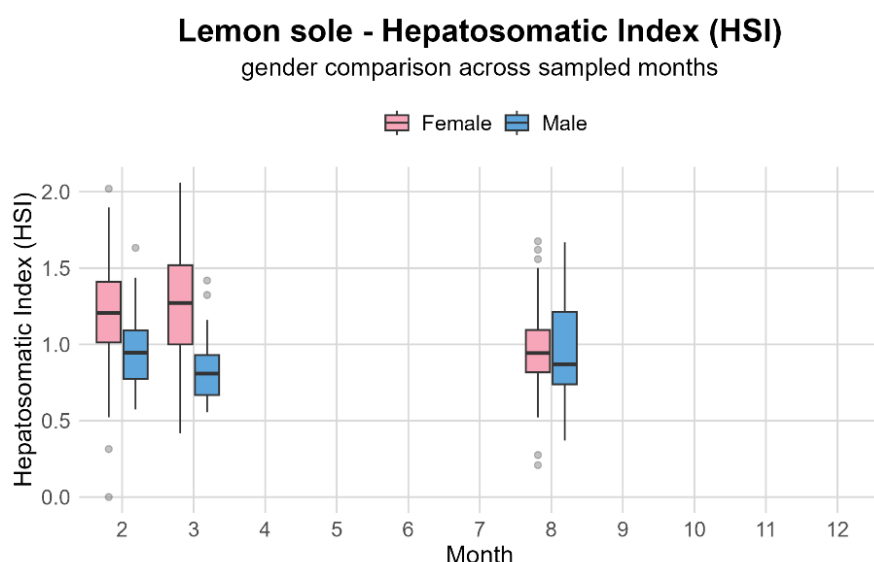


Figure 4.28 – Monthly variation in hepatosomatic index (HSI) of female and male lemon sole across sampled months. Boxplots show median values, interquartile ranges, and overall distribution of HSI values by gender and month.

4.8 Feeding habits

Stomach content analysis indicated that lemon sole fed predominantly on polychaetes, which accounted for more than 80% of the total stomach content weight recorded in the sampled individuals (Figure 4.29). Molluscs contributed a minor proportion of the diet (<10%), while other prey categories collectively accounted for approximately 10% of the total stomach content weight.

The available stomach samples suggest that benthic polychaetes constitute the primary dietary component for lemon sole on the Faroese shelf, with molluscs and other prey items playing a secondary role. However, the limited number of stomach samples and their opportunistic collection restrict the extent to which broader dietary patterns can be inferred. While the size and weight of undigested prey items were recorded, no analyses were undertaken to investigate prey selectivity, ontogenetic dietary shifts, or spatial and seasonal variation in prey composition.

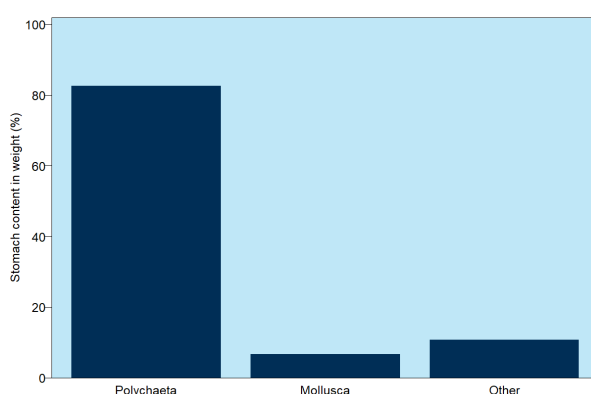


Figure 4.29 – Stomach contents of lemon sole expressed as %-weight for the main prey categories, illustrating the relative importance of different prey types in the diet across sampled individuals.

4.9 Stock assessment of lemon sole

4.9.1 Length compositions

Commercial length frequency distributions from 2016 onwards were obtained mainly from the small trawler fleet, although no length samples were taken from 2024 (Figure 4.30).

Fishery-independent length composition data were obtained from FAMRI's annual demersal fish surveys in summer (Figure 4.31) and spring (Figure 4.32).

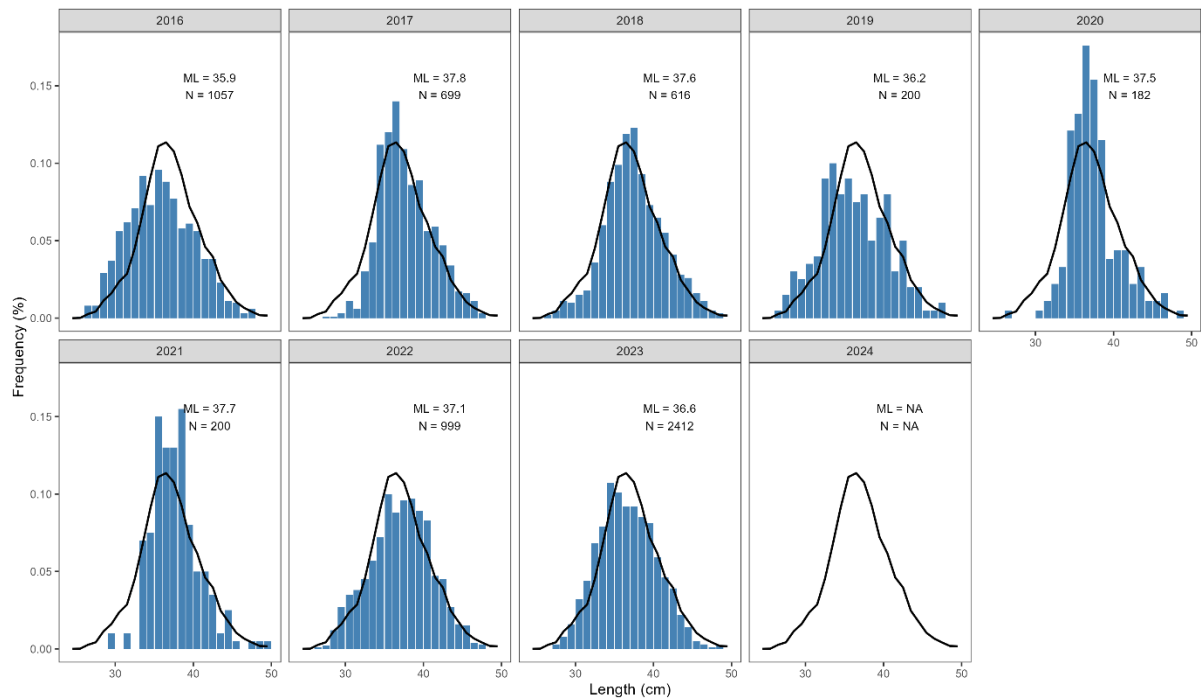


Figure 4.30 – Annual length distributions of lemon sole in the commercial fishery, showing interannual variation in size composition of the catches.

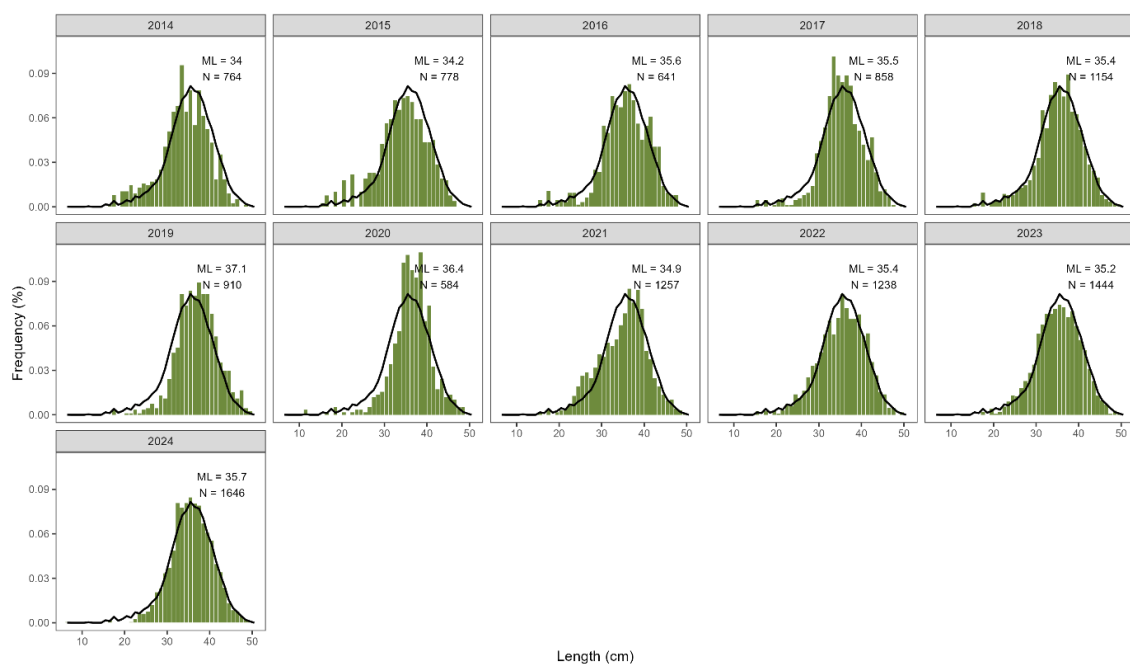


Figure 4.31 – Annual length–frequency distributions of lemon sole from summer demersal trawl surveys, illustrating interannual variation in the size structure of the surveyed population.

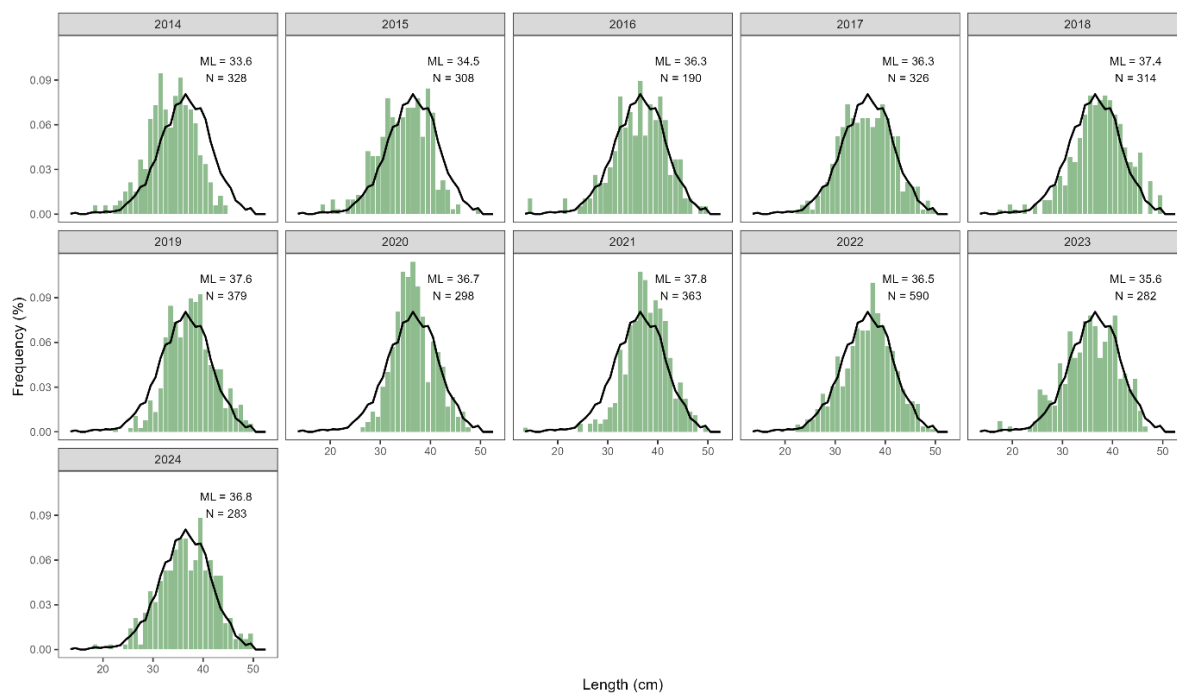


Figure 4.32 – Annual length–frequency distributions of lemon sole from spring demersal trawl surveys, illustrating interannual variation in the size structure of the surveyed population.

4.9.2 Catch at age

Catch-at-age estimates were generated using the ALK programme, based on age-disaggregated data from landing inspections (Figure 4.33). Due to limitations in the availability of otolith samples and/or age readings, consistent catch-at-age information is available only from 2016 onwards. No landing inspection samples were obtained in 2024; consequently, the age composition from 2023 was carried forward and applied to the 2024 catch. For 2018, the observed age composition was skewed, and comparison with modelled catch-at-age derived from weight-grade landing data indicated the need for adjustment. The 2018 age-disaggregated data were therefore smoothed by borrowing age-structure information from 2017 to 2019 within the ALK programme, generating a more representative age composition for that year.

4.9.3 Plus group

Evaluation of alternative plus groups (10+, 11+, 12+, 13+) indicated that a 12+ plus group provides the best balance between data resolution and stability for Lemon sole catch-at-age estimates (Table 4.7). While the 10+ and 11+ groupings concentrate a large proportion of the catch and weight into the aggregated class, they also mask substantial interannual variation in the older age structure – particularly in years such as 2017, 2018 and 2020, where ages 10 and 11 account for disproportionately high percentages compared with older ages. In contrast, the 12+ boundary retains explicit age information for the more frequently observed older ages (10 and 11), while still suitably grouping the genuinely sparse tail of the age distribution. Ages 12 and older consistently contribute only a small fraction of the total catch and weight – typically < 5% and 8% respectively – indicating that data beyond age 12 are too limited to support reliable age-specific estimation. Using 12+ therefore avoids excessive aggregation of informative ages, reduces noise associated with the very small 13+ component, and provides a more biologically and statistically appropriate representation of the population’s older age structure.

Table 4.7 – Comparison of alternative plus group definitions for lemon sole catch-at-age data. The table shows the proportion of annual catch (by numbers and weight) represented by older age classes under different plus group options (10+, 11+, 12+, 13+), illustrating the trade-off between maintaining age resolution and aggregating sparse older-age observations.

Year	Catch numbers at age (%)				Calculated weights at age (%)			
	10+	11+	12+	13+	10+	11+	12+	13+
2016	11.24	6.12	4.02	1.86	17.12	10.16	6.71	3.28
2017	17.04	9.62	7.24	3.05	24.18	14.87	11.48	4.83
2018	36.15	29.82	7.67	7.72	48.13	40.74	12.23	11.19
2019	11.56	5.40	0.93	0.57	16.37	7.33	1.78	1.07
2020	12.71	2.47	5.18	1.35	18.55	3.85	8.66	2.54
2021	4.48	2.28	0.94	0.83	7.11	3.98	1.86	1.66
2022	4.04	1.26	0.24	0.18	6.94	2.24	0.50	0.37
2023	3.17	1.49	0.65	0.34	4.97	2.79	1.26	0.71
2024	3.17	1.49	0.65	0.34	4.97	2.79	1.26	0.71

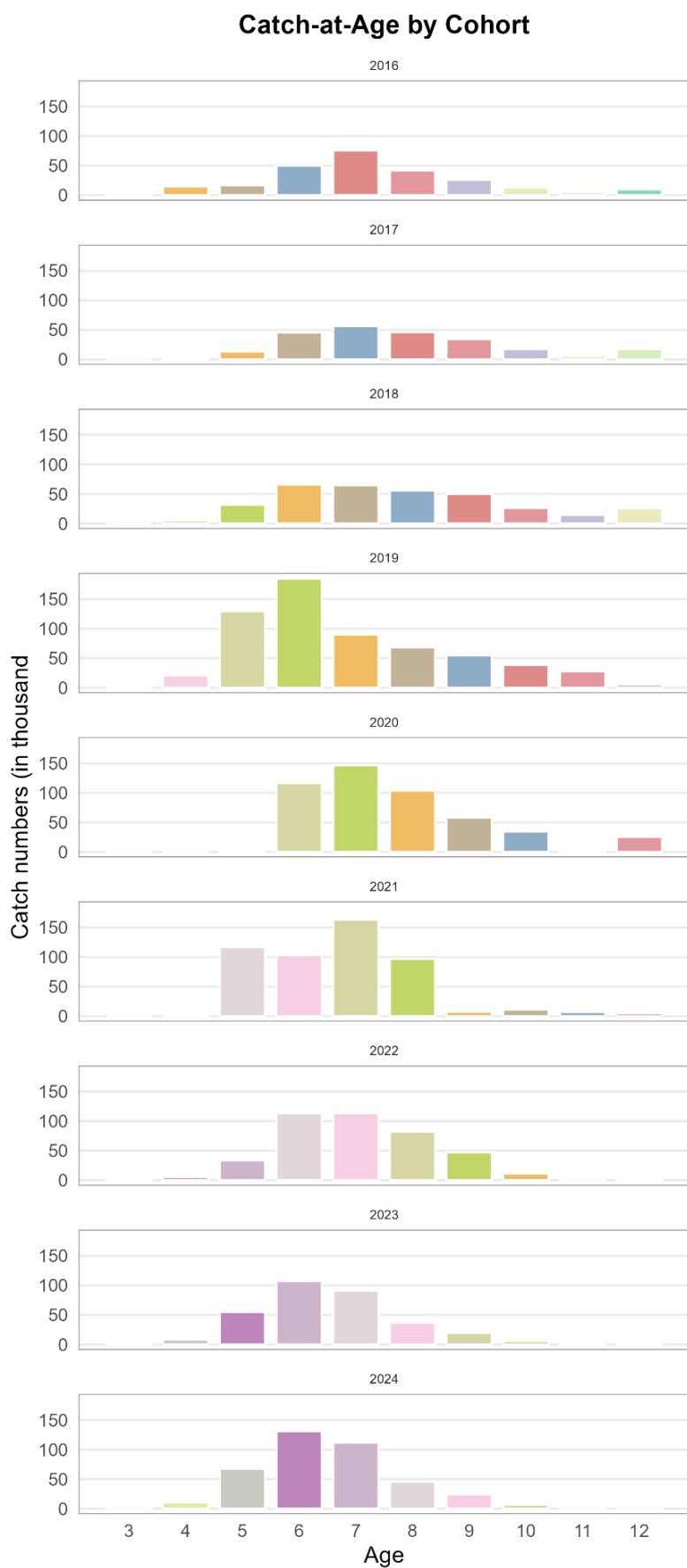


Figure 4.33 – Lemon sole catch numbers at age from 2016 onwards. Cohorts are differentiated by colour.

4.9.4 Stock weight at age

Stock weights estimated in the ALK program contained missing values for age 3 during 2017–2021 and for age 4 in 2020. In statistical catch-at-age models such as SAM, complete weight-at-age matrices are required because biomass and predicted catch calculations depend directly on annual abundance-at-age and corresponding stock weights. Missing values therefore prevent the model from evaluating the likelihood function correctly and can lead to model failure or non-convergence.

To ensure a complete time series, missing stock weights for ages 3 and 4 were replaced using a five-year backward mean interpolation. For each missing observation, the mean weight from the preceding five available years for the corresponding age group was calculated and inserted into the series. This approach was considered a conservative solution that maintained continuity in the weight-at-age matrix while avoiding abrupt year-to-year changes.

The interpolation procedure introduced a degree of smoothing into the affected time series, resulting in reduced interannual variability for the reconstructed years, particularly for age 3 (Figure 4.34). This is evident from the relatively stable trajectories and repeated values observed during the interpolated period. Nevertheless, the estimated values remained within the range of neighbouring observations and were considered biologically plausible.

The missing observations likely reflect limited sample sizes for these age groups in certain years. Younger age classes are often underrepresented in survey and commercial sampling due to recruitment variability, spatial distribution, and gear selectivity, which can result in insufficient observations for robust annual stock weight estimation.

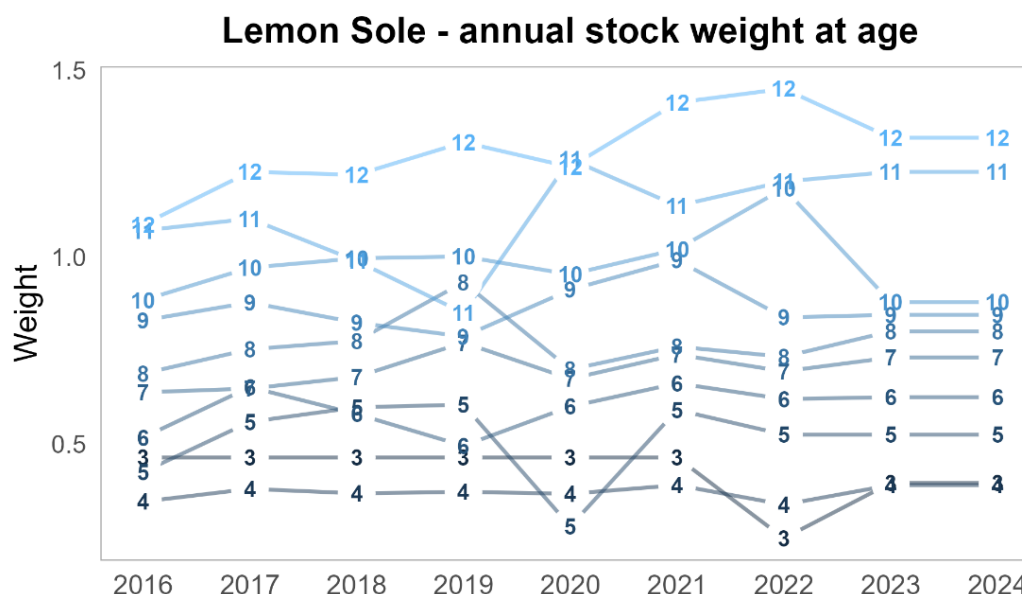


Figure 4.34 – Stock weight-at-age of lemon sole for ages 3–12, for the years 2016–2024, showing interannual variation in mean individual weight across the main age classes.

4.9.5 Tunings series

Catch-per-unit-effort (CPUE) indices were calculated from the two available fishery-independent time series derived from the annual demersal trawl surveys conducted on the Faroe Plateau in spring (since 1994) and summer (since 1996) (Figure 4.35). The resulting time series show interannual variability in

both surveys, with the spring survey exhibiting greater year-to-year fluctuation, while the summer survey displays a comparatively more stable pattern across years (Figure 4.36).

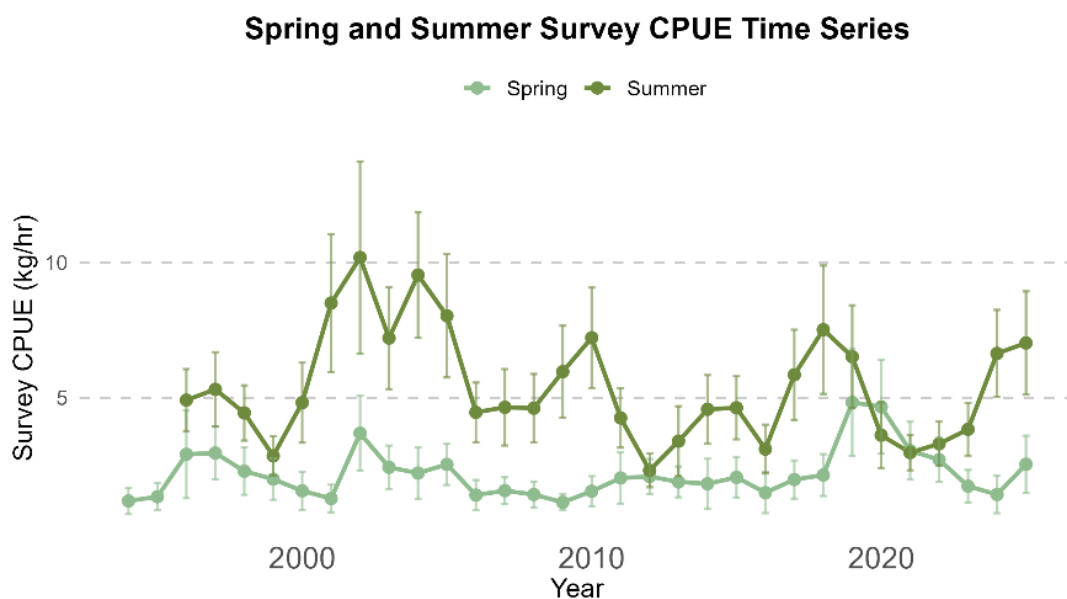


Figure 4.35 – CPUE indices of lemon sole from Faroese demersal trawl surveys in spring (light green) and summer (dark green). Error bars represent standard errors (SE) of the mean.

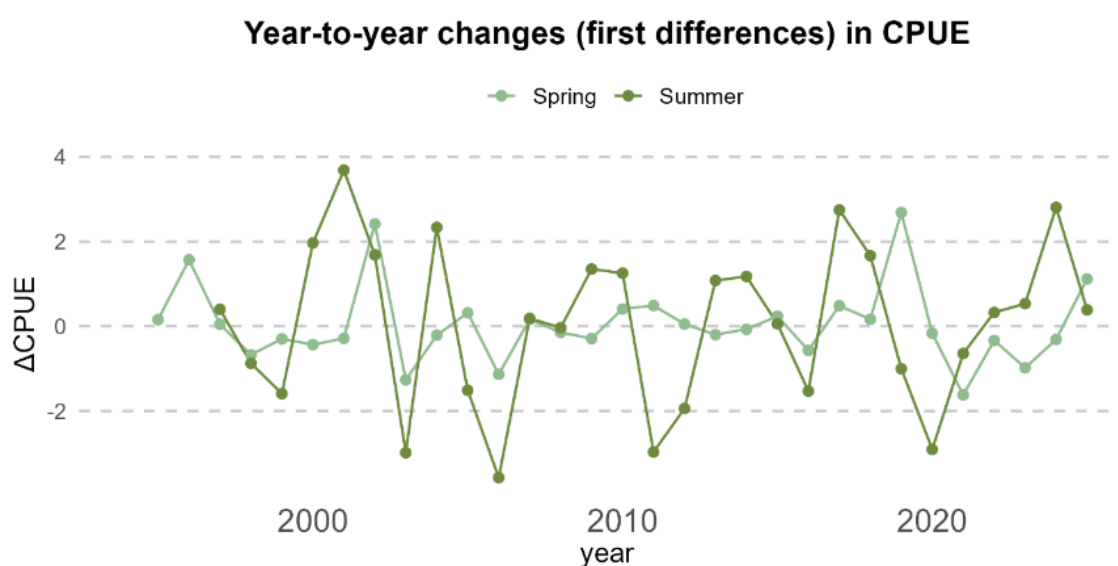


Figure 4.36 – Year-to-year changes in CPUE indices of lemon sole from Faroese demersal trawl surveys in spring (light green) and summer (dark green), illustrating interannual variability in relative abundance.

To evaluate the relationship between fishery-independent indices and fishery removals, both spring and summer CPUE series were compared with total commercial landings of lemon sole since 1994 (Figure 4.37). Both surveys exhibit variability that is only partially reflected in commercial landings, indicating that catch dynamics are influenced by factors beyond stock abundance alone, including fishing effort, fleet behaviour, and seasonal availability of the fish to the fishery. The spring survey likely reflects pre- or post-spawning aggregations, whereas the summer survey captures more dispersed feeding distributions, contributing to differences in how each index relates to fisheries data.

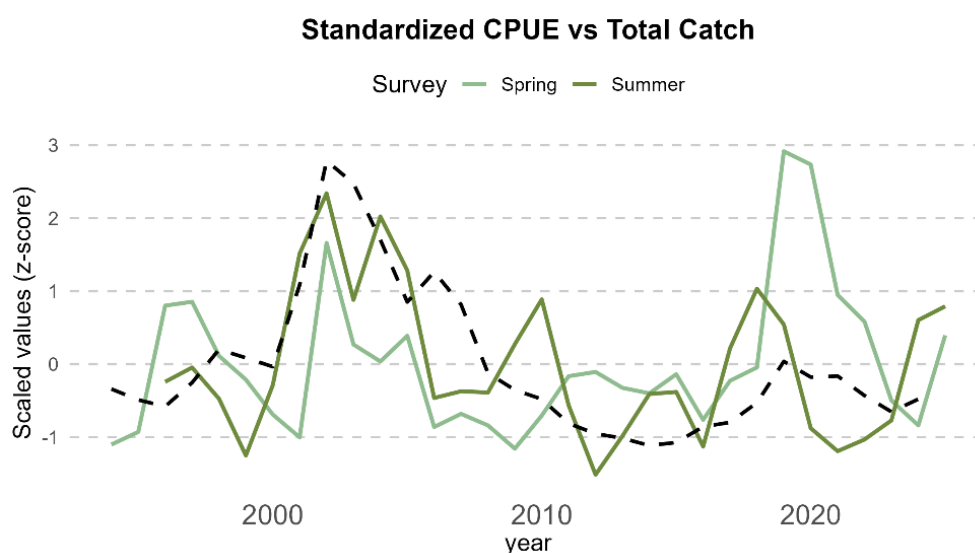


Figure 4.37 – Comparison of standardised survey CPUE from spring and summer demersal trawl surveys with total commercial catches of lemon sole since 1994, illustrating the relationship between fishery-independent abundance indices and reported landings

Despite these differences, both survey series provide useful and complementary indicators of relative abundance suitable for use in age-based stock assessment models. A Pearson correlation analysis between total annual catch and the two CPUE series showed a weak, non-significant relationship for the spring survey ($r = 0.20$, $p = 0.29$) and a stronger, significant relationship for the summer survey ($r = 0.64$, $p < 0.001$) (Table 4.8), suggesting that the summer survey is more closely aligned with commercial exploitation patterns.

Table 4.8 – Pearson correlation between total lemon sole catch and CPUE from spring and summer demersal trawl surveys. The table includes the number of paired observations (n), correlation coefficient (r), t -statistic (cor_test_t), degrees of freedom (df), p -value (p), and 95% confidence intervals (lower and upper bounds).

Correlation Between CPUE and Catch by Survey							
Pearson correlation coefficients with 95% CI and p -values							
Survey	n	correlation	cor_test_t	df	p_value	conf_low	conf_high
Spring	31	0.196	1.078384	29	0.290	-0.170	0.515
Summer	29	0.643	4.361309	27	0.000	0.362	0.817

The spring and summer survey CPUE indices showed a weak, non-significant correlation ($r = 0.09$, $p = 0.638$), indicating little evidence of consistent interannual covariance between the survey series (Figure 4.38). The differing relationships between survey CPUE and total commercial landings are illustrated in Figure 4.39. The summer survey index exhibited a clear positive relationship with total catch, whereas the spring survey showed only a weak association and substantially greater scatter around the fitted relationship. The broader confidence interval and lower slope observed for the spring survey further indicate higher interannual variability and weaker correspondence with commercial removals. In contrast, the summer survey displayed a more consistent response to changes in landings, suggesting that it may better reflect the distribution and availability of lemon sole to the fishery during the main feeding season.

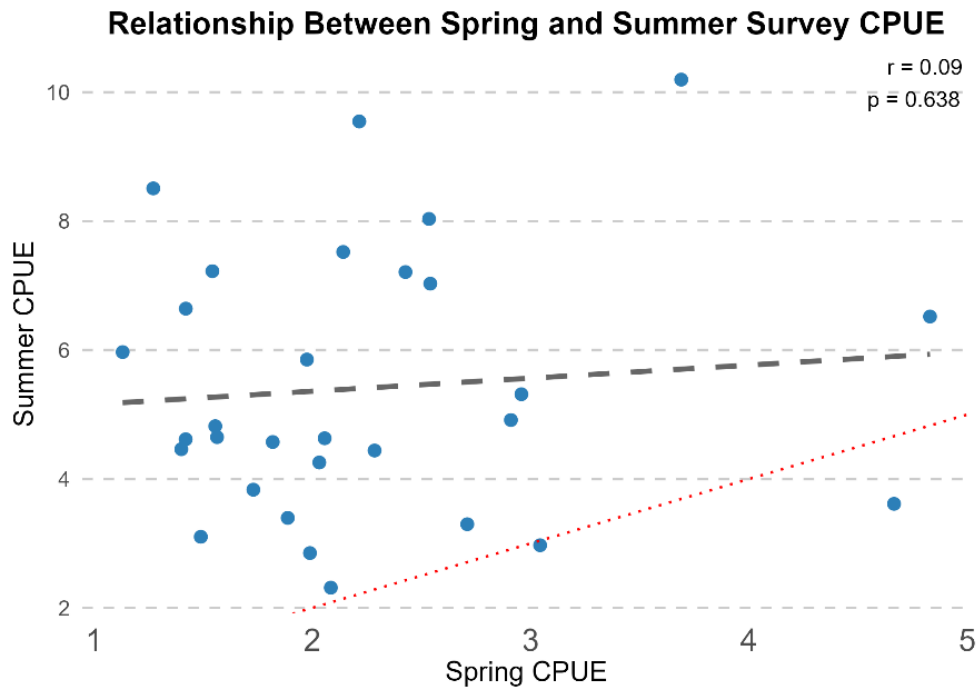


Figure 4.38 – Relationship of spring and summer CPUE of lemon sole. Points represent annual mean CPUE values, with the dashed grey line showing the fitted linear regression and the dotted red line representing the 1:1 relationship.

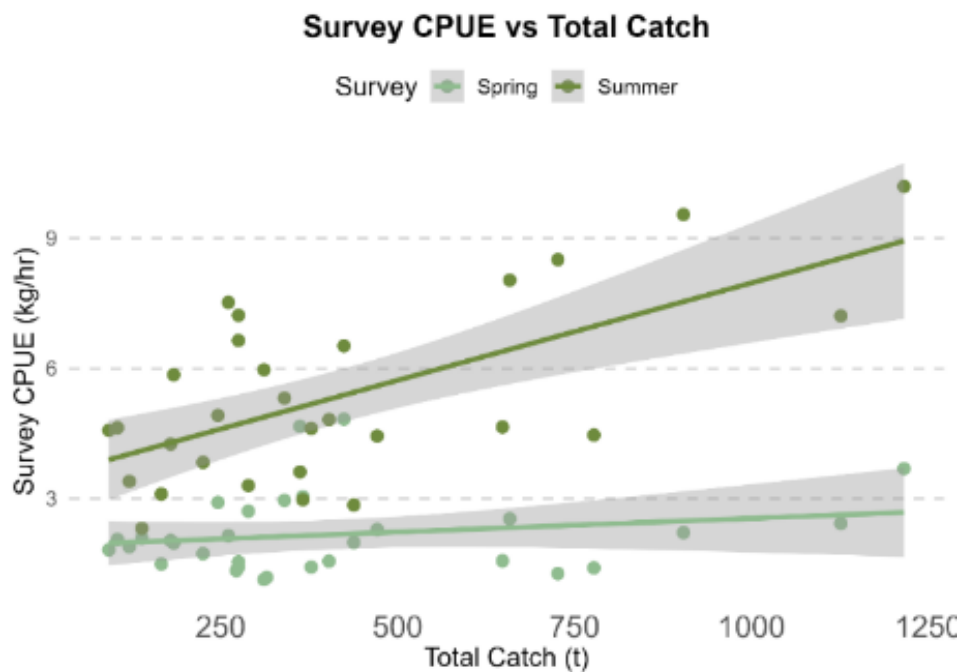


Figure 4.39 – Lemon sole. Relationship of total landings and survey CPUE's (spring – light green; summer – dark green). Shaded area represents the standard error.

In addition, the relationship between the two survey indices themselves was weak and not statistically significant ($r = 0.09$, $p = 0.638$) (Figure 4.38), indicating limited direct correspondence in annual variability between spring and summer estimates. This further supports the interpretation that the surveys capture different seasonal components of the population rather than tracking identical abundance signals.

4.9.6 SAM

The stock assessment was conducted using the State-space Assessment Model (SAM) implemented through stockassessment.org and fitted to catch numbers-at-age and two survey indices. The final assessment configuration was named Lem27_5b.

The assessment covers ages 3–12+, using annual catch-at-age data (Table 4.13) and stock weights-at-age (Table 4.14) derived from biological sampling of commercial landings from 2016 onwards. No commercial landing samples are available for 2024. Consequently, the 2023 age composition, for which extensive sampling coverage is available, was used as a proxy for 2024. In addition, the 2018 age composition was smoothed within the ALK programme by borrowing information from the surrounding years (2017–2019) to reduce skewness in the sampled age distribution (Section 0).

Maturity-at-age inputs were derived from the ogive analyses presented in Section 4.4 and were assumed constant throughout the assessment period (Table 4.15). Natural mortality was fixed at 0.2 for all ages and years.

The assessment was tuned using age-disaggregated abundance indices from the spring and summer demersal trawl surveys (Table 4.16 and Table 4.17), both covering ages 3–10+ from 2016 onwards.

Population dynamics were modelled on an annual time step, with numbers-at-age evolving according to fishing mortality, natural mortality, recruitment, and stochastic process error. Fishing mortality was estimated as age-specific and temporally smooth. Observation models were specified independently for each survey series, with observation errors assumed to follow a log-normal distribution.

Estimated catch, fishing mortality, recruitment and spawning stock biomass over the assessment period are shown in Figure 4.40. Estimated catch increased from approximately 180 t in 2016 to approximately 300 t in 2019 and remained around 300 t through 2021, before declining to approximately 250 t in 2024 (Figure 4.40a). Mean fishing mortality over ages 5–10 increased from 0.343 in 2016 to a peak of 0.462 in 2020, before declining to 0.410 in 2024 (Figure 4.40b). Recruitment at age 3 declined from 783 individuals in 2016 to a low of 684 in 2021, before increasing to 721 in 2024 (Figure 4.40c). Spawning stock biomass increased from 1,123 t in 2016 to a peak of 1,392 t in 2019, followed by a decline and subsequent fluctuations, reaching 1,195 t in 2024 (Figure 4.40d). Total stock biomass followed a similar pattern, increasing from 1,404 t in 2016 to a peak of 1,704 t in 2019, before declining and fluctuating thereafter, with an estimated 1,470 t in 2024 (Table 4.9).

Process error in numbers-at-age was initially explored using multiple variance structures. However, more complex formulations resulted in non-estimable parameters and reduced numerical stability. The final model therefore applied a single process-error variance parameter ($SdLogN$) across all ages, which produced stable and well-identified parameter estimates.

Temporal autocorrelation in survey residuals was incorporated using an $AR(1)$ correlation structure, allowing year-to-year correlation in observation errors arising from persistent variation in factors such as catchability, spatial availability, and survey conditions. The $AR(1)$ correlation coefficient (ρ) was estimable with moderate uncertainty, while separate correlation-distance parameters ($IRARdist$) were estimated for each observation group.

A sensitivity run excluding the $AR(1)$ structure resulted in a substantially poorer model fit ($\Delta AIC \approx 78$; likelihood ratio test, $p < 0.001$), providing strong statistical support for retaining temporal correlation in the final model configuration.

Model selection was based on likelihood criteria, parameter estimability, numerical stability, and biological plausibility. Simplified configurations that improved numerical stability at the expense of substantially poorer fit were rejected. The final model converged successfully without warnings, with no parameters estimated on or near parameter boundaries, finite standard errors for all estimated parameters, and a positive-definite Hessian matrix.

Estimated uncertainty in recent years was moderate. Approximate standard deviations on the log scale were 0.40 for recruitment, 0.20 for spawning stock biomass, and 0.25 for mean fishing mortality.

The estimated correlations between age groups (Figure 4.41) illustrate the correlation structure estimated for the commercial catch and the two survey fleets.

The observation variance diagnostics (Figure 4.42) showed differences in the estimated precision among observation groups, ages, and fleets.

The yield-per-recruit and spawning stock biomass analysis (Figure 4.43) showed the expected opposing responses to increasing fishing mortality, with yield increasing with fishing mortality while spawning stock biomass declined. The recruitment–SSB relationship (Figure 4.44) showed considerable scatter, with no clear relationship evident over the relatively short assessment period. This relationship should therefore be interpreted cautiously, particularly given the uncertainty associated with recent recruitment estimates.

The standardised one-observation-ahead residuals (Figure 4.45) showed variation around zero without a pronounced systematic pattern. The standardised residuals of process increments (Figure 4.46) likewise showed variation around zero, with some individual deviations but no strong systematic temporal pattern. Together, these diagnostics did not indicate major problems with the assumed process-error structure.

The model fits to total catch and the spring and summer survey series (Figure 4.47–Figure 4.49) generally followed the observed trajectories, although deviations between observed and predicted values were apparent for individual years.

The leave-one-out analysis (Figure 4.50) showed some changes in the estimated stock trajectory when either survey series was excluded, particularly in the estimates of recruitment and spawning stock biomass. However, the overall pattern of stock dynamics remained similar among the model runs, although recruitment and spawning stock biomass estimates differed in some years.

Overall, the diagnostics indicate that the final model provides a statistically stable and internally consistent representation of the available data. The strong improvement in model fit when temporal correlation was included, together with the residual and sensitivity diagnostics, supports the selected model configuration. Nevertheless, the relatively short assessment period, dependence on the survey series, and uncertainty in recent recruitment estimates should be considered when interpreting the estimated stock trajectory.

4.9.7 SAM output figure and tables

Figure 4.40 – SAM results of lemon sole – a) Catch in weight (tonnes) with yearly observed total catch weight (crosses); b) Average fishing mortality for ages 5-10; c) Yearly recruitment numbers in thousand; d) spawning stock biomass numbers in thousands. Estimates from run and point wise 95% confidence intervals shown by black lines and shaded area. From www.stockassessment.org.

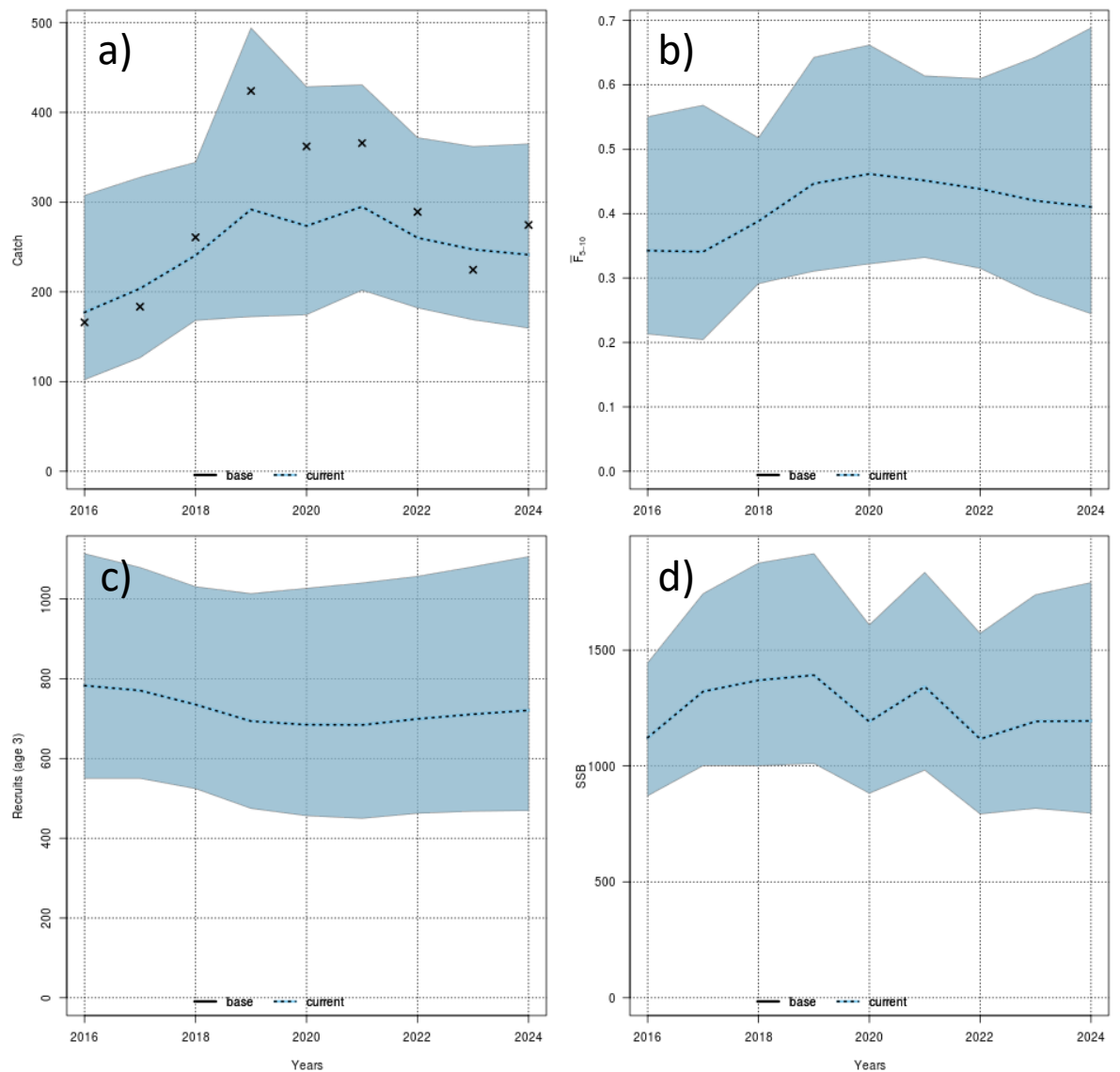
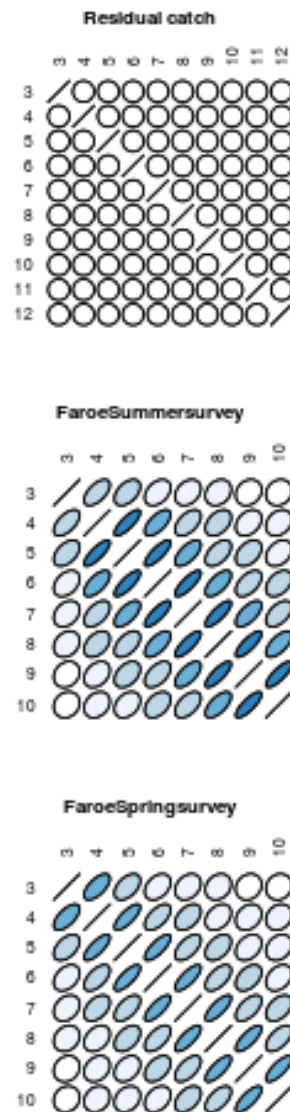


Figure 4.41 – SAM results of lemon sole – Estimated correlations between age groups for each fleet – top: catch; centre: summer survey; bottom: spring survey. From www.stockassessment.org.



stockassessment.org, Tunga_bia03, r19460, gt:1cc464b806f

Figure 4.42 – Standardised reciprocal variance of observations by age and fleet from the SAM lemon sole assessment. Black denotes commercial catch data, red the summer survey, and green the spring survey. Output generated using www.stockassessment.org.

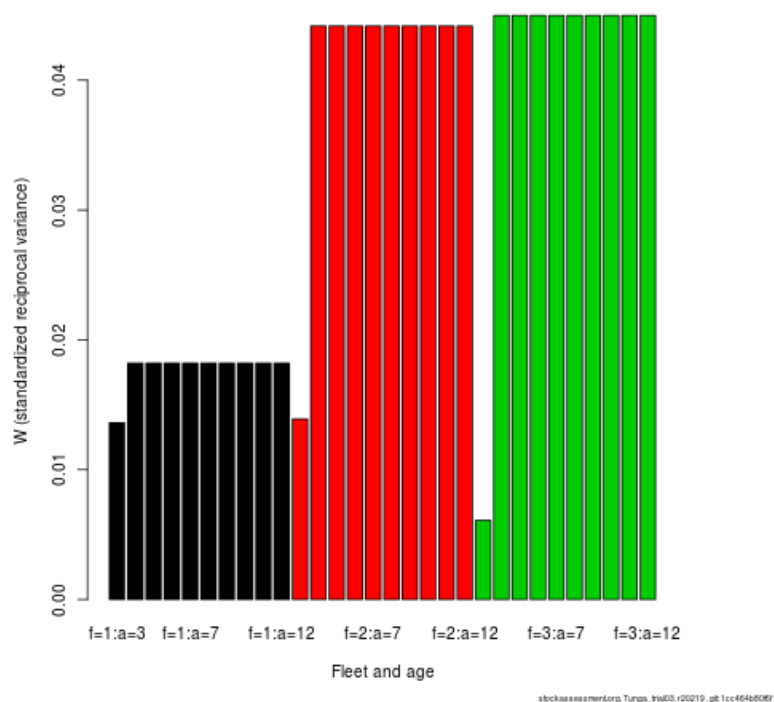


Figure 4.43 – SAM results of lemon sole – Yield per recruit (solid line) and spawning stock biomass (dotted line) plotted against different levels of fishing (blue, green and red lines). From www.stockassessment.org.

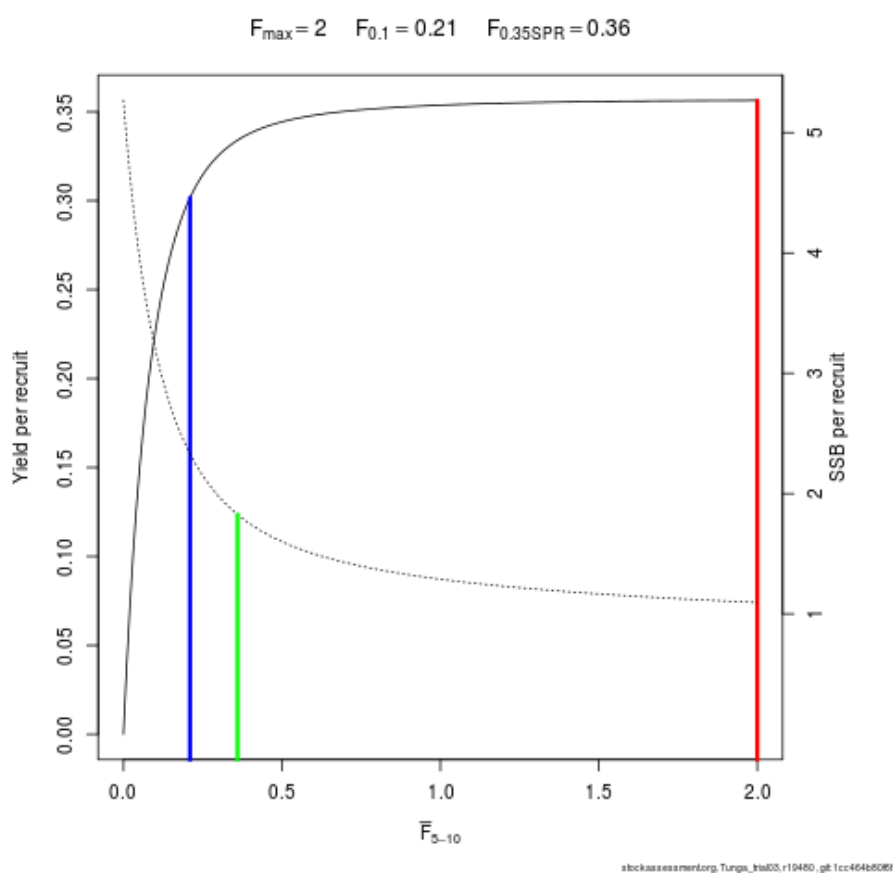


Figure 4.44 – SAM results of lemon sole – Estimated recruitment as a function of spawning stock biomass. From www.stockassessment.org.

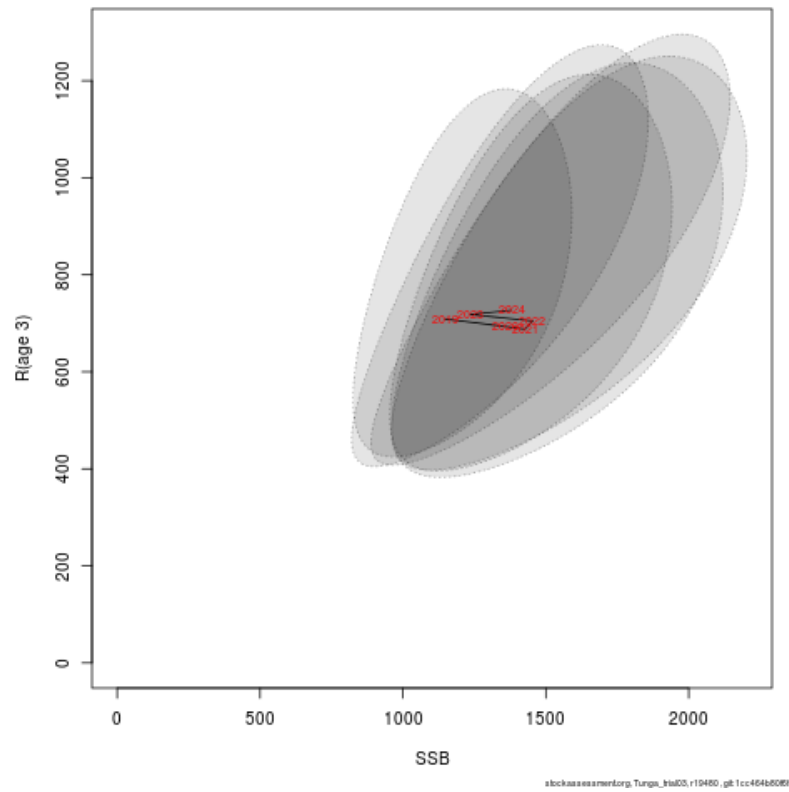


Figure 4.45 – SAM results of lemon sole – Standardised one-observation-ahead residuals. From www.stockassessment.org.

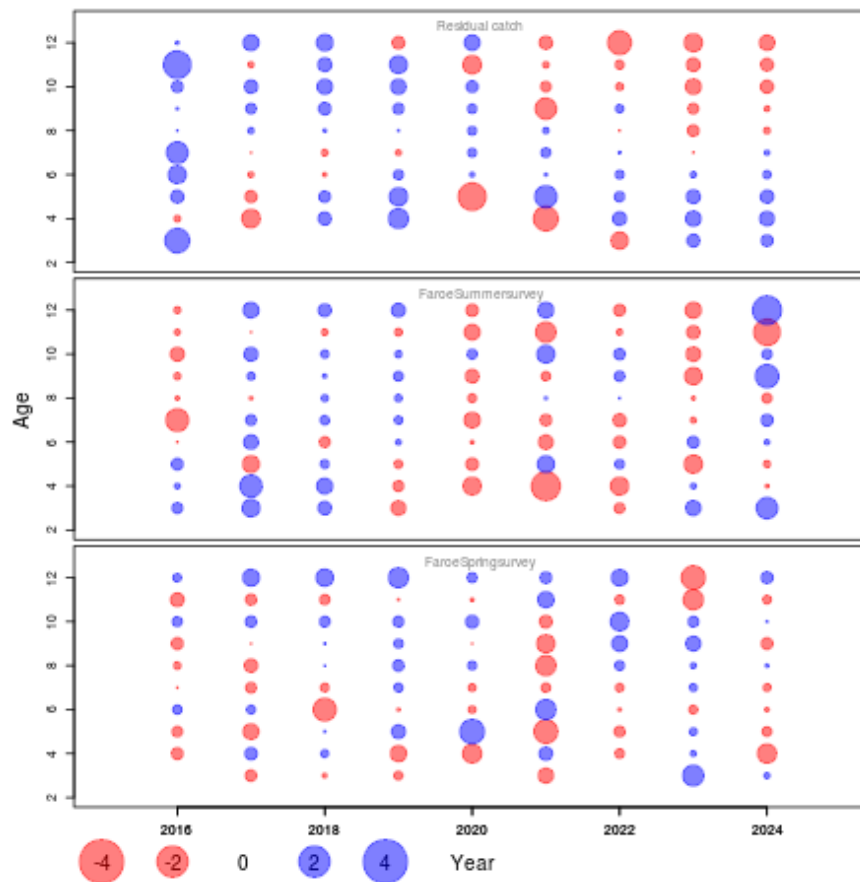


Figure 4.46 – SAM results of lemon sole – Standardised single-joint-sample residuals of process increments. From www.stockassessment.org.

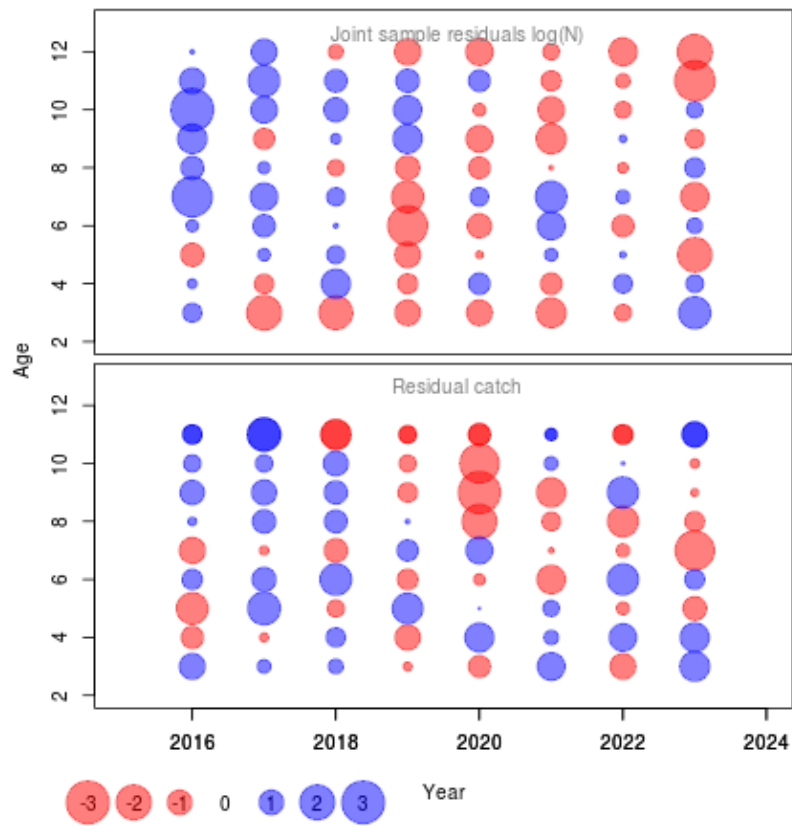


Figure 4.47 – SAM results of lemon sole – Total catch's fit to data – predicted line and observed points (log scale). From www.stockassessment.org.

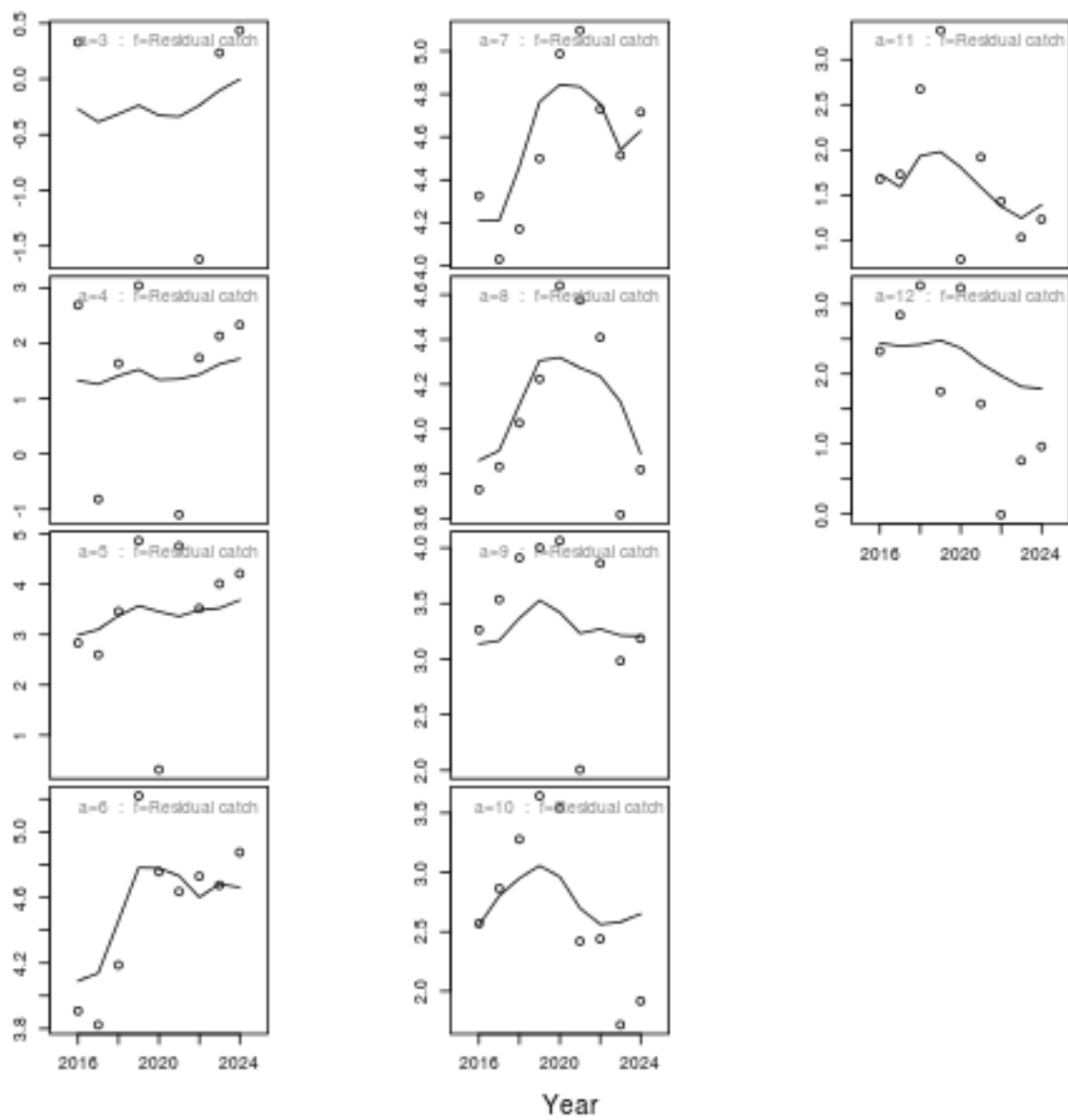


Figure 4.48 – SAM results of lemon sole – Summer survey's fit to data – predicted line and observed points (log scale). From www.stockassessment.org.

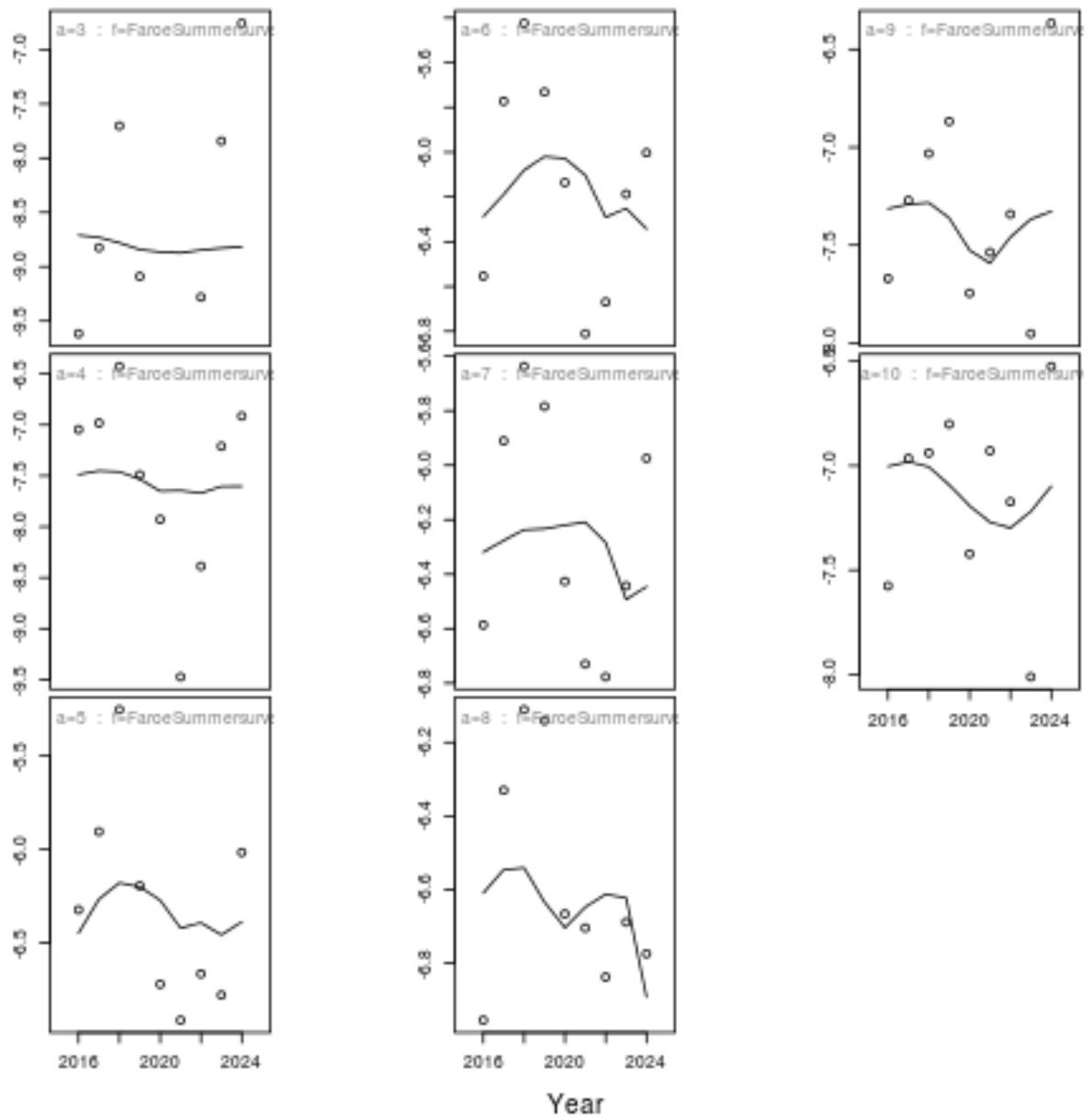


Figure 4.49 – SAM results of lemon sole – Spring survey's fit to data – predicted line and observed points (log scale). From www.stockassessment.org.

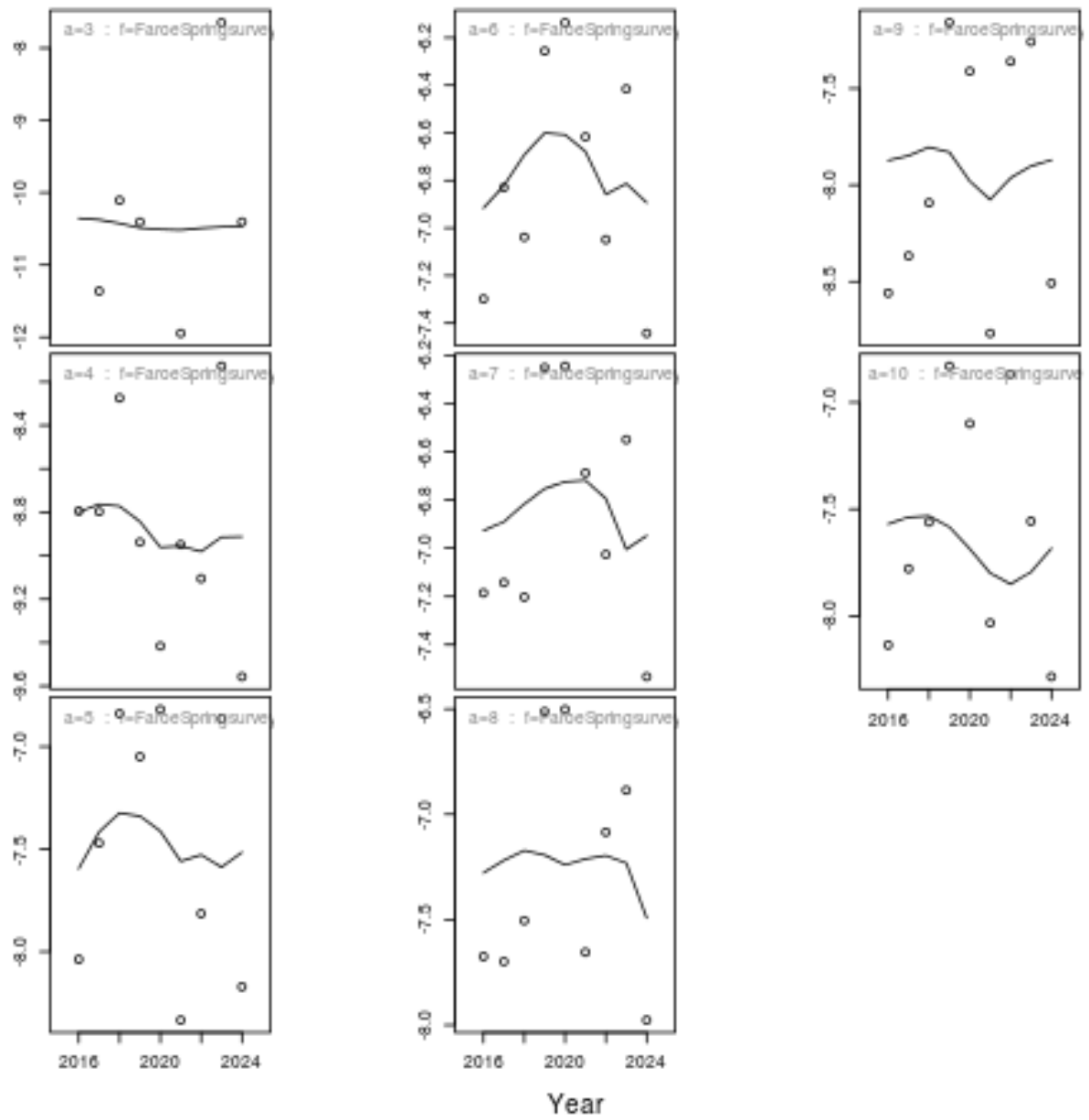


Figure 4.50 – SAM results of lemon sole – Leave one out run – a) Catch in weight (tonnes) with yearly observed total catch weight (crosses); b) Average fishing mortality for ages 5-10; c) Yearly recruitment numbers in thousand; d) spawning stock biomass numbers in thousands. Estimates from run and point wise 95% confidence intervals shown by black lines and shaded area, light blue is without spring survey and purple is without summer survey. From www.stockassessment.org

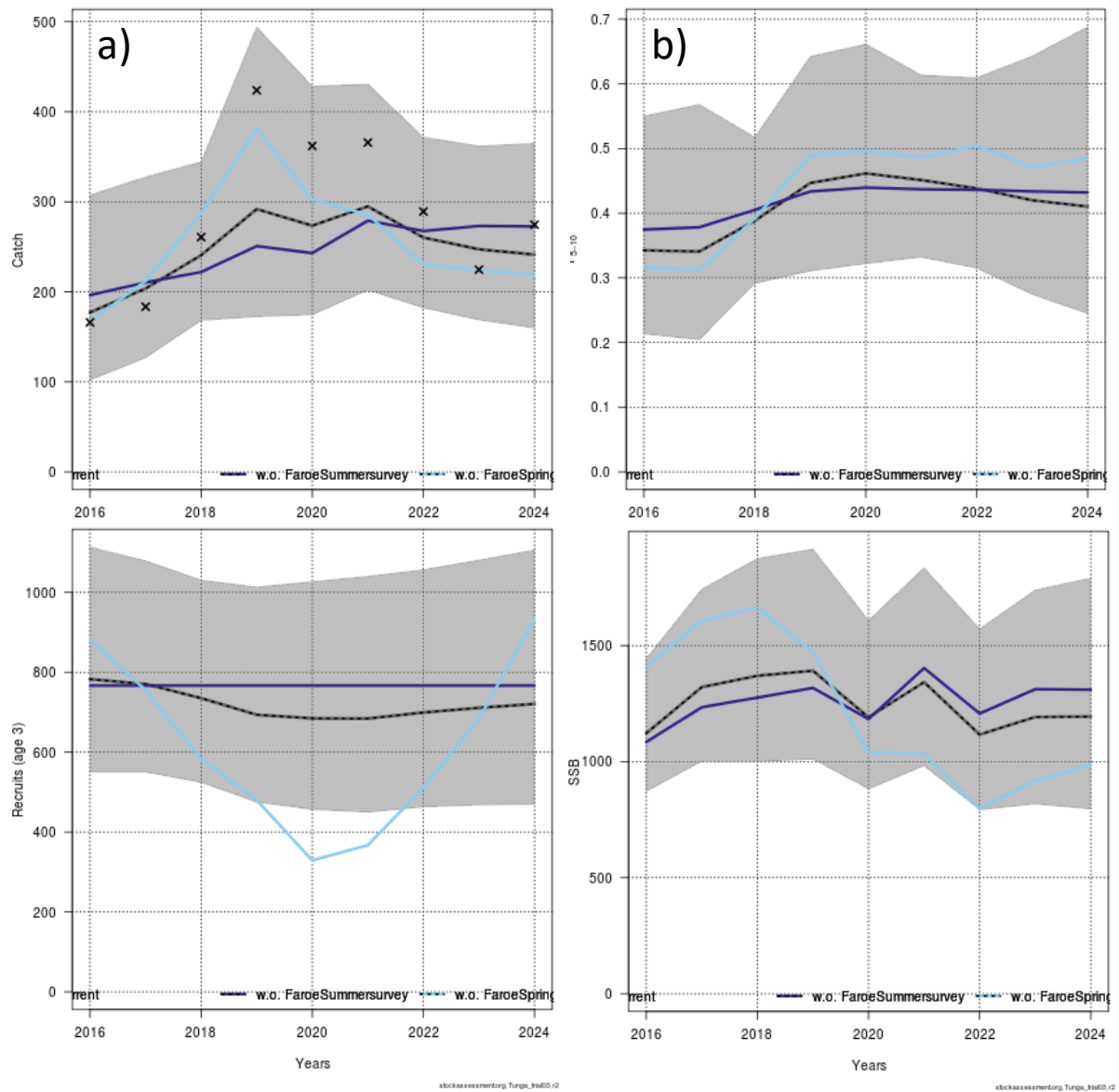


Table 4.9 – Estimated recruitment, spawning stock biomass, fishing mortality and total stock biomass for lemon sole, with 95% confidence intervals.

Year	R(age 3)	Low	High	SSB	Low	High	Fbar(5-10)	Low	High	TSB	Low	High
2016	783	551	1114	1123	872	1445	0.343	0.213	0.55	1404	1086	1815
2017	771	550	1079	1321	1002	1743	0.341	0.204	0.568	1639	1238	2170
2018	735	525	1031	1370	1001	1875	0.388	0.291	0.517	1690	1237	2308
2019	694	475	1013	1392	1011	1916	0.447	0.311	0.642	1704	1243	2335
2020	685	457	1027	1191	883	1608	0.462	0.322	0.662	1455	1074	1970
2021	684	450	1040	1343	982	1835	0.451	0.332	0.614	1639	1189	2258
2022	699	463	1057	1117	793	1572	0.438	0.315	0.609	1339	945	1898
2023	711	468	1081	1192	818	1739	0.42	0.274	0.643	1465	1002	2141
2024	721	470	1106	1195	797	1791	0.41	0.245	0.688	1470	982	2202

Table 4.10 – Estimated fishing mortality at age of lemon sole.

Year	3	4	5	6	7	8	9	10	11	12
2016	0.001	0.006	0.05	0.218	0.384	0.477	0.46	0.467	0.36	0.36
2017	0.001	0.006	0.049	0.214	0.38	0.474	0.46	0.467	0.361	0.361
2018	0.001	0.007	0.056	0.247	0.438	0.541	0.521	0.527	0.404	0.404
2019	0.001	0.008	0.065	0.288	0.512	0.629	0.594	0.593	0.449	0.449
2020	0.001	0.008	0.065	0.294	0.534	0.656	0.614	0.606	0.457	0.457
2021	0.001	0.008	0.067	0.299	0.535	0.645	0.588	0.573	0.432	0.432
2022	0.001	0.008	0.07	0.307	0.535	0.625	0.559	0.533	0.4	0.4
2023	0.001	0.008	0.073	0.31	0.527	0.596	0.519	0.495	0.369	0.369
2024	0.001	0.009	0.074	0.313	0.524	0.585	0.498	0.467	0.351	0.351

Table 4.11 – Estimated stock numbers at age of lemon sole.

Year	3	4	5	6	7	8	9	10	11	12
2016	783	690	467	366	251	137	73	44	17	37
2017	771	688	573	386	256	147	73	40	23	33
2018	735	688	598	459	269	152	79	40	21	35
2019	694	641	600	482	310	149	77	40	20	33
2020	685	571	555	490	306	161	68	37	19	29
2021	684	581	479	452	317	153	71	31	17	26
2022	699	578	500	383	287	160	68	35	15	24
2023	711	607	489	403	241	146	75	32	18	22
2024	721	608	516	391	256	121	70	39	16	24

4.9.8 Model configuration

```

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$maxAge
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$corFlag
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$keyLogFpar
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$mortalityModel
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$logNMeanAssumption
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$initState
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```

4.9.9 Estimated parameters

Table 4.12 – Table of model parameters for lemon sole.

Parameter name	<i>par</i>	<i>sd(par)</i>	<i>exp(par)</i>	<i>Low</i>	<i>High</i>
logFpar_0	-15.258	0.43	0	0	0
logFpar_1	-13.878	0.247	0	0	0
logFpar_2	-12.438	0.244	0	0	0
logFpar_3	-11.895	0.245	0	0	0
logFpar_4	-11.443	0.248	0	0	0
logFpar_5	-11.098	0.256	0	0	0
logFpar_6	-11.196	0.266	0	0	0
logFpar_7	-16.905	0.59	0	0	0
logFpar_8	-15.184	0.245	0	0	0
logFpar_9	-13.571	0.242	0	0	0
logFpar_10	-12.474	0.243	0	0	0
logFpar_11	-11.969	0.246	0	0	0
logFpar_12	-11.662	0.257	0	0	0
logFpar_13	-11.653	0.272	0	0	0
logSdLogFsta_0	-1.782	0.984	0.168	0.024	1.205
logSdLogN_0	-2.803	0.725	0.061	0.014	0.258
logSdLogObs_0	-0.008	0.423	0.992	0.426	2.311
logSdLogObs_1	-0.153	0.103	0.858	0.698	1.054
logSdLogObs_2	-0.018	0.264	0.982	0.579	1.665
logSdLogObs_3	-0.596	0.138	0.551	0.418	0.726
logSdLogObs_4	0.394	0.309	1.483	0.799	2.752
logSdLogObs_5	-0.606	0.147	0.546	0.407	0.732
transfIRARdist_0	-0.225	0.823	0.799	0.154	4.146
transfIRARdist_1	-0.423	0.378	0.655	0.307	1.396
transfIRARdist_2	-0.583	0.94	0.558	0.085	3.656
transfIRARdist_3	-0.932	0.358	0.394	0.193	0.805
itrans_rho_0	1.375	0.862	3.957	0.706	22.179

4.9.10 SAM input tables

Table 4.13 – Catch at age in numbers (in thousands) of lemon sole.

Year	3	4	5	6	7	8	9	10	11	12+
2016	1.392	14.717	17.005	49.823	75.667	41.690	26.141	13.061	5.350	10.257
2017	0.000	0.442	13.487	45.754	56.279	46.169	34.329	17.574	5.642	17.144
2018	0.000	5.119	31.875	65.906	64.815	56.084	49.948	26.548	14.481	26.137
2019	0.000	20.934	129.717	184.891	90.049	68.288	54.672	38.250	27.705	5.760
2020	0.000	0.000	1.371	116.372	146.564	103.616	58.208	34.588	2.206	25.274
2021	0.000	0.335	116.619	103.132	163.466	97.061	7.438	11.243	6.814	4.826
2022	0.198	5.665	33.782	113.253	113.377	82.236	47.478	11.475	4.194	0.991
2023	1.266	8.421	55.094	107.248	91.418	37.286	19.773	5.563	2.811	2.142
2024	1.547	10.292	67.338	131.081	111.733	45.572	24.167	6.799	3.436	2.618

Table 4.14 – Stock at age in weight (in tonnes) of lemon sole. Same for catch weight and discard weight, since discards are presumably zero due to total discard ban within the Faroese EEZ. NA produced for age 3 in 2017-2021, and for age 4 in 2020 are replaced by a 5-year prior mean.

Year	3	4	5	6	7	8	9	10	11	12+
2016	0.465	0.347	0.426	0.518	0.639	0.689	0.831	0.885	1.071	1.087
2017	0.465	0.381	0.560	0.653	0.649	0.754	0.879	0.972	1.103	1.228
2018	0.465	0.369	0.599	0.581	0.680	0.776	0.825	0.997	0.990	1.220
2019	0.465	0.373	0.606	0.496	0.772	0.933	0.788	1.002	0.851	1.307
2020	0.465	0.368	0.281	0.601	0.675	0.700	0.913	0.954	1.262	1.241
2021	0.465	0.391	0.592	0.663	0.740	0.761	0.992	1.021	1.137	1.413
2022	0.249	0.339	0.526	0.621	0.695	0.734	0.839	1.184	1.202	1.450
2023	0.397	0.391	0.526	0.626	0.732	0.802	0.846	0.880	1.228	1.319
2024	0.397	0.391	0.526	0.626	0.732	0.802	0.846	0.880	1.228	1.319

Table 4.15 – Maturity ogive of lemon sole used in SAM assessment.

Age	3	4	5	6	7	8	9	10	11	12+
Ogive	0.651	0.667	0.812	0.895	0.92	0.95	1	1	1	1

Table 4.16 – Spring survey tuning index, CPUE (kg/hr) of lemon sole.

Year	Effort	3	4	5	6	7	8	9	10	11	12+
2016	99	0.000	0.015	0.032	0.067	0.075	0.046	0.019	0.048	0.02	0.032
2017	86	0.001	0.013	0.049	0.093	0.068	0.039	0.020	0.085	0.041	0.060
2018	98	0.004	0.025	0.105	0.086	0.073	0.054	0.030	0.088	0.039	0.064
2019	99	0.003	0.013	0.086	0.190	0.191	0.147	0.077	0.104	0.042	0.071
2020	86	0.000	0.007	0.094	0.186	0.167	0.129	0.052	0.064	0.023	0.029
2021	154	0.001	0.020	0.037	0.206	0.192	0.073	0.024	0.106	0.024	0.061
2022	99	0.000	0.011	0.040	0.086	0.088	0.083	0.063	0.074	0.035	0.040
2023	44	0.021	0.013	0.046	0.072	0.063	0.045	0.031	0.030	0.016	0.018
2024	99	0.003	0.007	0.028	0.058	0.053	0.034	0.020	0.147	0.014	0.105

Table 4.17 – Summer survey tuning index, CPUE (kg/hr) of lemon sole.

Year	Effort	3	4	5	6	7	8	9	10	11	12+
2016	195	0.013	0.170	0.350	0.278	0.269	0.186	0.091	0.015	0.004	0.009
2017	197	0.029	0.183	0.537	0.613	0.534	0.351	0.137	0.015	0.007	0.014
2018	197	0.089	0.319	1.030	0.869	0.702	0.437	0.174	0.02	0.009	0.021
2019	195	0.022	0.109	0.398	0.632	0.600	0.420	0.203	0.044	0.019	0.044
2020	194	0.000	0.070	0.234	0.420	0.314	0.247	0.084	0.034	0.015	0.022
2021	195	0.000	0.015	0.194	0.215	0.233	0.239	0.104	0.012	0.013	0.026
2022	193	0.018	0.044	0.246	0.245	0.220	0.207	0.125	0.048	0.018	0.038
2023	196	0.077	0.145	0.223	0.403	0.312	0.244	0.069	0.017	0.004	0.002
2024	182	0.212	0.181	0.444	0.450	0.463	0.208	0.313	0.016	0.007	0.014

5. Conclusion

This project has substantially increased the biological and assessment information available for plaice and lemon sole in Faroese waters. Analyses of maturity and spawning provided species-specific maturity schedules and improved information on the timing and spatial distribution of spawning. Both species appear to mature relatively early compared with observations from neighbouring areas, particularly when maturity is considered in relation to age, although the estimated maturity schedules warrant further investigation. Spawning was broadly distributed across the Faroe Plateau for both species, with plaice showing a greater concentration of spawning activity in northern, northwestern and western areas, while the spawning distribution of lemon sole was more diffuse. The maturity analyses also provided the maturity-at-age ogives used as biological input to the stock assessments.

The project established the first age-based stock assessments for Faroese plaice and lemon sole, providing a quantitative basis for evaluating recent stock dynamics. The assessments indicate contrasting developments between the two species. Plaice spawning stock biomass declined substantially during the latter part of the assessment period, alongside relatively weak recruitment and fishing mortality above the level estimated at the beginning of the time series. Lemon sole biomass fluctuated over the assessment period without showing a comparable sustained decline, although recruitment was variable and estimates for recent cohorts were uncertain.

The assessments are currently limited to the period from 2016 onwards by the availability of age-composition data from commercial landings. They therefore provide information on recent stock development rather than a longer-term historical perspective, and the available time series is insufficient for establishing management reference points. Nevertheless, the assessments establish a framework for continued quantitative monitoring of both stocks and provide a basis from which the assessment models and supporting data can be further developed.

Together with the broader biological information compiled and analysed for plaice and lemon sole, and the updated species information published through FAMRI's website, the project provides a substantially improved knowledge base for these two stocks in Faroese waters. Continued development of the assessments and their supporting data should increase their value for future stock monitoring and fisheries management.

6. Recommendations

6.1 Elongating the assessment years

The current stock assessments are constrained by the availability of age-composition data from commercial landings and therefore covers only the period from 2016 onwards. Extending the assessments further back in time would provide a longer perspective on stock dynamics and increase the likelihood of capturing periods of contrasting recruitment, biomass, and fishing pressure. This would be particularly beneficial for lemon sole, where the current assessment period does not encompass pronounced historical peaks or troughs in catches, hence provides limited information on the full range of stock dynamics.

A potential approach would be to investigate the age composition of historical survey catches and assess whether these data can be used to reconstruct age distributions for earlier commercial catches. Historical survey information could potentially be combined with available catch and length data to extend the catch-at-age series beyond the current assessment period. The feasibility and uncertainty associated with such reconstruction should be evaluated before incorporation into a future assessment.

6.2 Development of fishery-dependent CPUE indices

The current age-based assessments require substantial resources for the collection, processing, and ageing of biological samples and are constrained by the relatively short period for which sufficiently detailed catch-at-age data are available. To complement the existing assessment framework, a more comprehensive fishery-dependent CPUE index is being developed from commercial fishery log-book data. This work will provide an opportunity to investigate whether routinely collected information on catch and fishing effort can provide a longer and more consistent index of relative stock abundance for plaice and lemon sole.

Development of the CPUE index should include standardisation of fishing effort while accounting for changes in vessel characteristics, fishing practices, gear, fishing location, depth, season, and other factors that may influence catchability. The resulting indices can then be evaluated against the existing survey indices and age-based assessment outputs to determine their potential value as additional abundance information.

A fishery-dependent CPUE index is not expected to replace the existing survey and biological sampling programmes. Rather, it could provide a complementary source of information that is available at higher temporal resolution and potentially over a longer historical period. This could be particularly valuable for extending the assessment time series and improving the ability of future assessments to identify longer-term changes in stock abundance and productivity.

6.3 Evaluation of landing weight-grader data

Landing weight-grader data represent another promising source of information for future assessments of plaice and lemon sole. A recent pilot study evaluating industrial weight-grader data from Faroese fish processing facilities demonstrated that these data can provide substantially larger sample sizes and improved temporal and spatial coverage compared with conventional biological sampling (Joensen & Ofstad, 2025). The study further showed that weight distributions and age estimates derived using age-weight keys were broadly comparable with those obtained from routine biological sampling, supporting the potential value of weight-grader data as a supplementary source of assessment information.

Further work is now being undertaken to evaluate the availability, consistency, and representativeness of weight-grader data of plaice and lemon sole to investigate how these data can be incorporated into future assessment models for these two species. Particular emphasis should be placed on determining how weight-grader observations of plaice and lemon sole can be linked to age through appropriate age–weight keys, and on quantifying potential differences among processing facilities, fishing areas, seasons, vessels, and size classes. The representativeness of the weight distributions should also be evaluated against conventional biological samples before their incorporation into future assessments.

Weight-grader data are unlikely to replace conventional biological sampling completely, as direct information on age, length, gender, and maturity remains essential for estimating key life-history parameters and constructing age-based assessment inputs. However, their substantially greater sample size and coverage may allow them to provide complementary information on the size and weight structure of commercial catches and potentially extend the temporal coverage of assessment data. The ongoing evaluation should therefore determine whether weight-grader data can be integrated with conventional biological sampling to improve future assessments while reducing some of the sampling constraints associated with the current age-based approach.

6.4 Recruitment monitoring and early-life-stage indicators

The analyses demonstrate substantial interannual variability in recruitment for both plaice and lemon sole, with periods of strong juvenile abundance broadly associated with subsequent increases in catches. Recent years, however, have been characterised by weaker recruitment and lower fishery yields, and the relationship between juvenile indices and subsequent catches has not been consistent for lemon sole. This suggests that recruitment indices provide valuable information on early-life-stage variability but should not be interpreted as direct predictors of future fishery yields.

Continued monitoring of 0-group abundance is therefore recommended as an important complementary indicator of recruitment conditions. Lemon sole 0-group individuals were reliably identified in the survey material and occurred across a broad area of the Faroese shelf, making the species particularly suitable for continued recruitment monitoring. For plaice, improvements in the identification and quantification of 0-group individuals would be valuable, given the greater difficulty in reliably distinguishing 0-group plaice from other flatfish in the survey material.

The combination of recruitment indices with environmental observations could provide further insight into the drivers of recruitment variability. In particular, linking juvenile abundance to temperature, hydrographic conditions, circulation, and other environmental variables could help distinguish changes in recruitment success from changes in juvenile distribution or survey availability.

6.5 Further investigations of maturity schedules

The unusually low ages at 50% maturity estimated for both species warrant further investigation. The maturity estimates were examined extensively, including assessment of potential age-reading errors, comparisons among readers thereamongst cross-institutional age-reading comparisons, providing no clear indication that systematic ageing error alone could explain the observed maturity schedules.

Several alternative explanations should therefore be considered. Differences in the size and gender composition of the biological samples may influence the estimated maturity ogives if sampling is not representative of the population. In addition, fisheries-induced changes in life-history characteristics, including potentially earlier maturation under sustained fishing pressure, could potentially contribute to the observed patterns, particularly for plaice where fishing mortality increased during the assessment period.

Future monitoring should therefore aim to maintain sufficiently broad coverage across size classes, genders, seasons, and fishing areas when collecting maturity samples. Further comparison with neighbouring stocks would also be valuable, particularly where comparable maturity-at-age and maturity-at-length data are available. Analyses combining maturity, growth, and fishing mortality could subsequently be used to investigate whether the observed maturity schedules are consistent with population-specific growth patterns or potential fisheries-induced changes in maturation.

Together, these recommended developments would complement continued biological sampling and scientific survey monitoring by extending the historical perspective, broadening the information available on stock abundance and catch composition, and reducing uncertainty in future assessments of both species.

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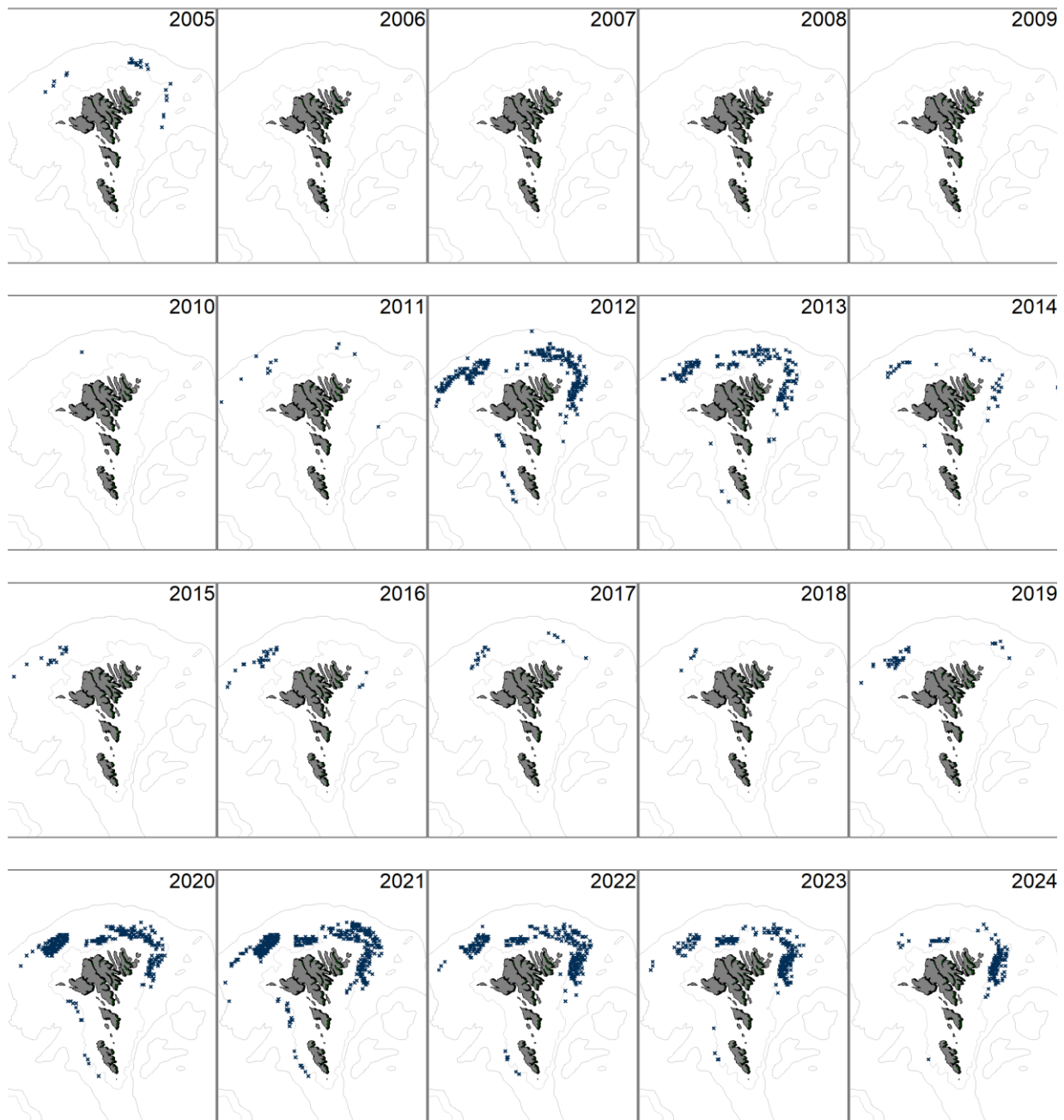
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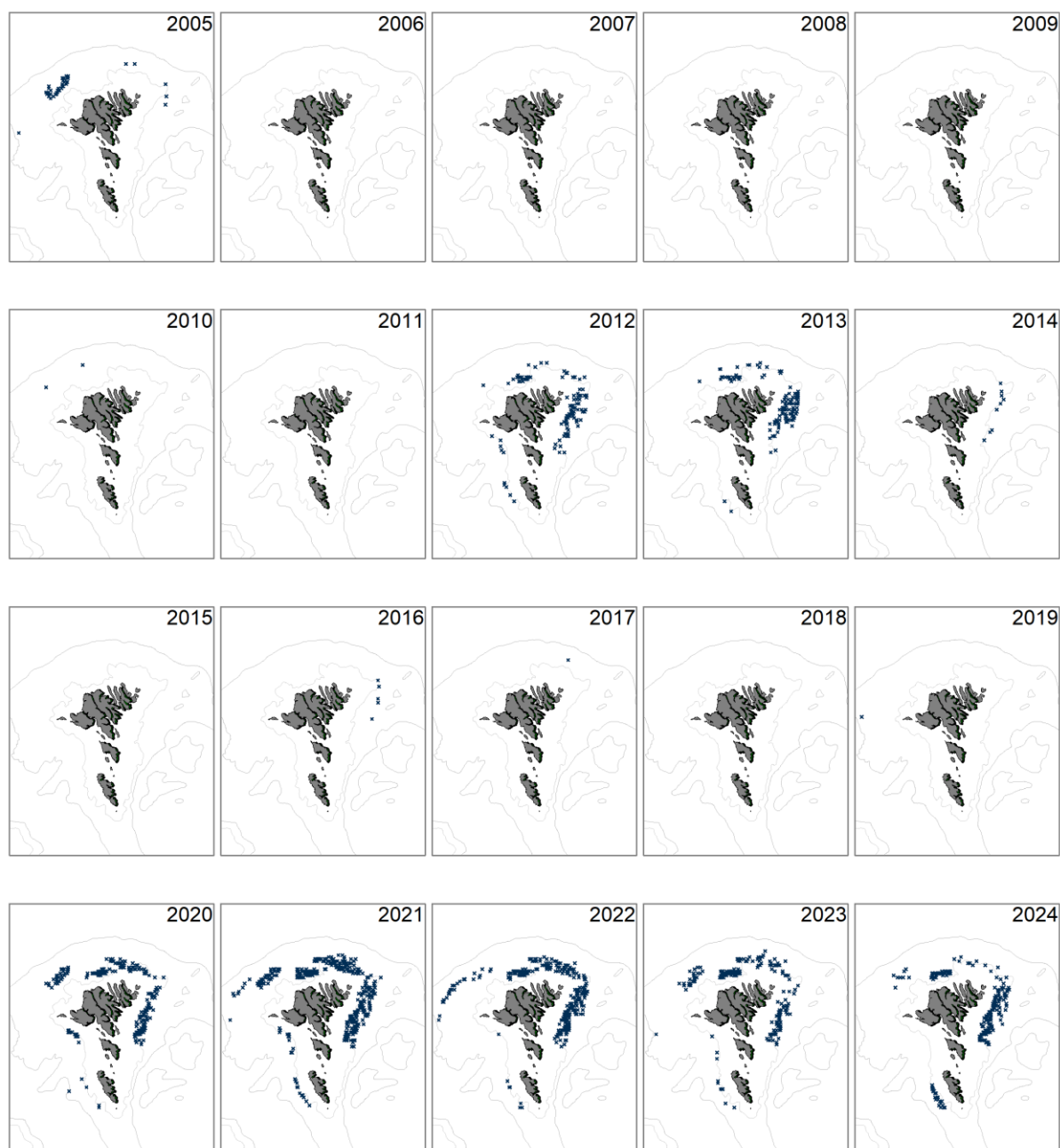
Supplementary information

Commercial logbook data

The annual spatial pattern for the years 2005 to 2024 shown in SI Figure 1 and 2 reflects both the footprint of commercial fishing effort and the spatial limitations of the gears deployed in the fishery of plaice and lemon sole, respectively. It should be emphasised that the available logbook records for this project are incomplete; consequently, years without reported fishing positions must not be interpreted as an absence of plaice fishing activity, but rather as gaps in the positional data.



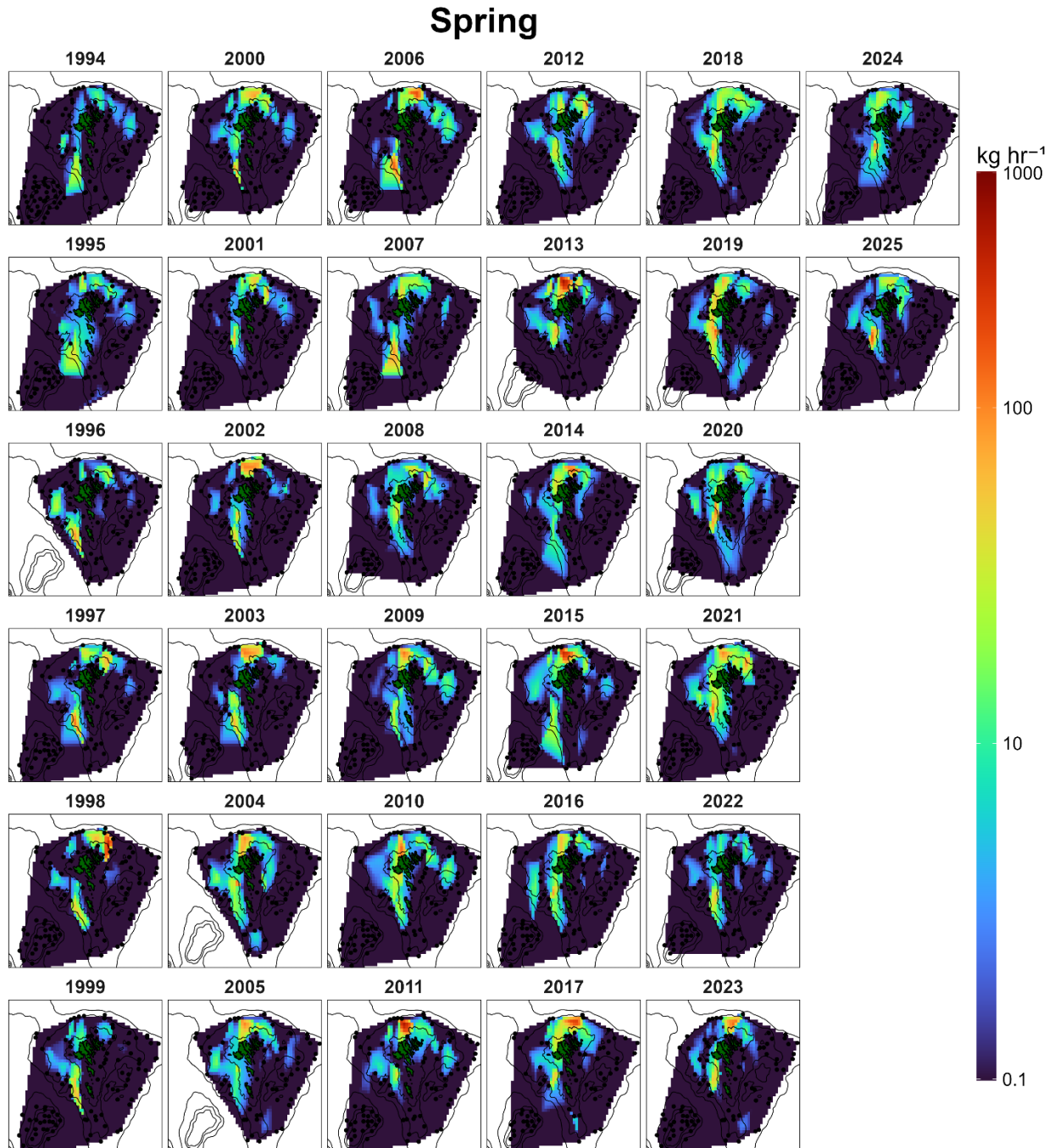
SI figure 1 - Distribution of plaice fishery from available logbook data restricted to catches with plaice <15%. 2005 to 2024.



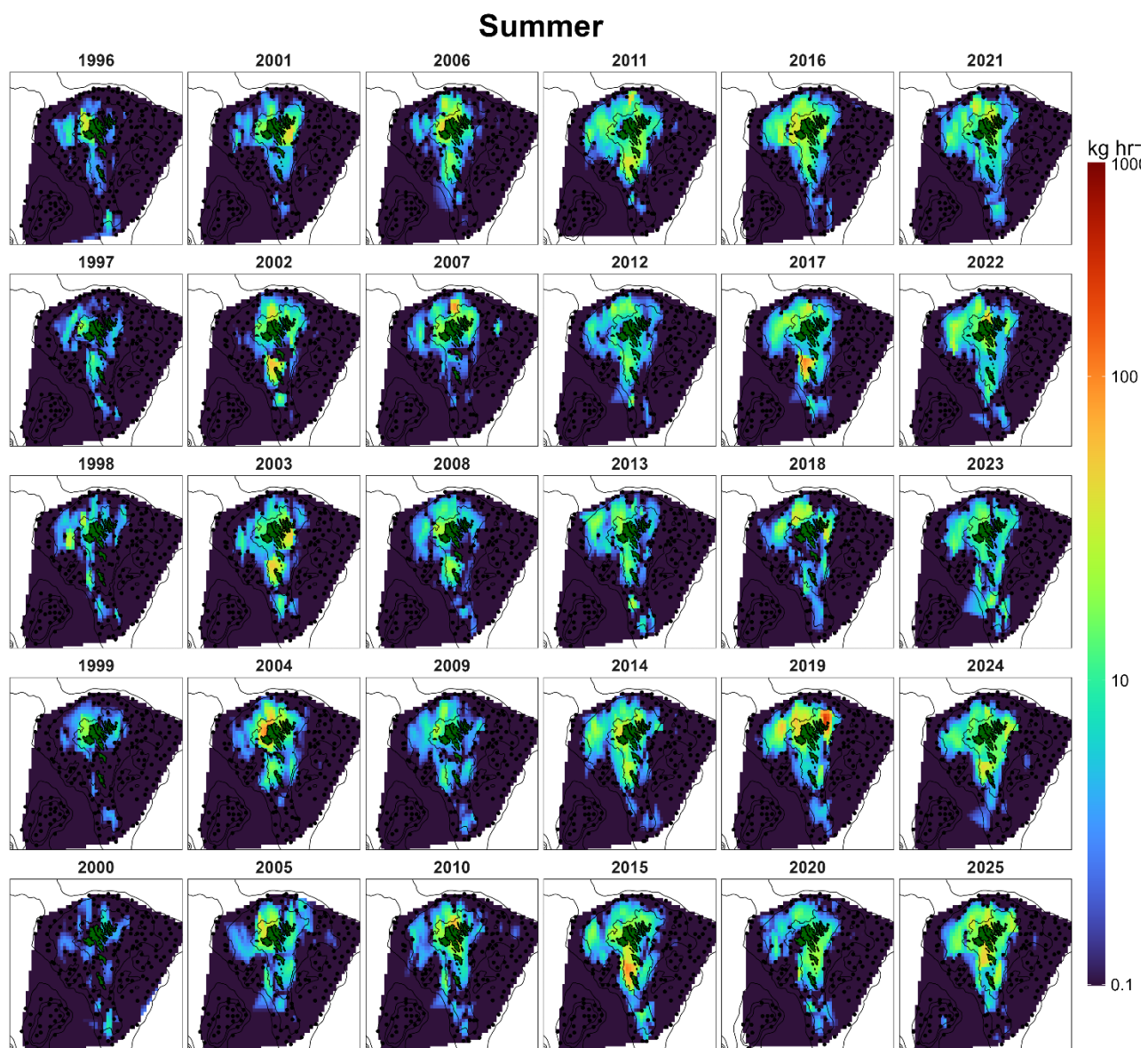
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Demersal trawl surveys

Spatial distribution of plaice (CPUE (kg/hr) from the annual demersal trawl spring and summer surveys from 1994 to 2025 show highly variable distribution throughout time. The spring survey indicates a pronounced aggregation of plaice in the western and northern areas of the Faroe Plateau (SI figure 3) compared to the summer survey (SI figure 4) that suggests a more diffuse post-spawning distribution likely to be corresponding to the stock's general feeding habitat.

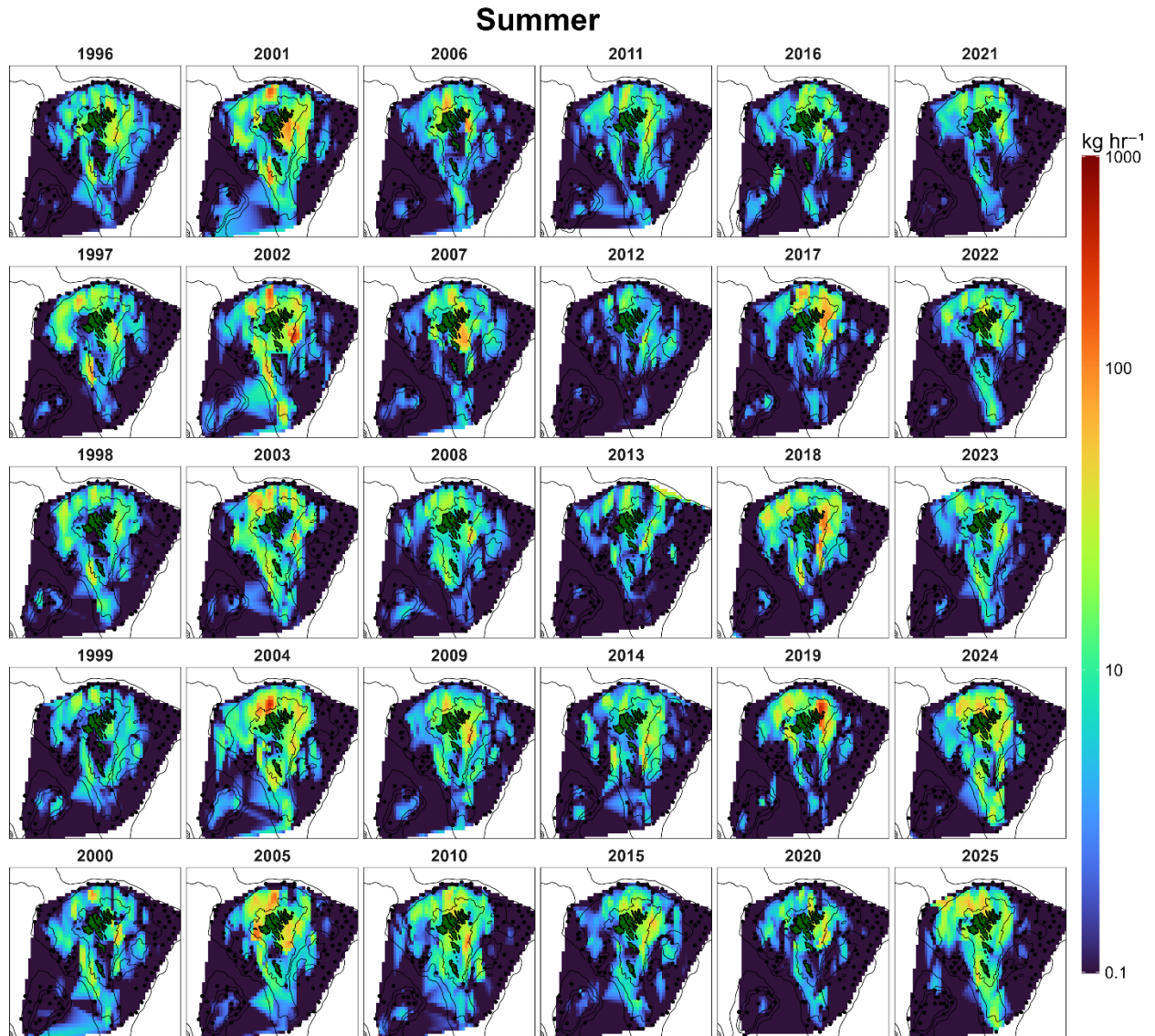


SI figure 3 - Annual Spatial distribution of plaice CPUE (kg/hr) from the annual demersal trawl spring survey from 1994 to 2025. Black points represent trawling stations with no plaice catches.



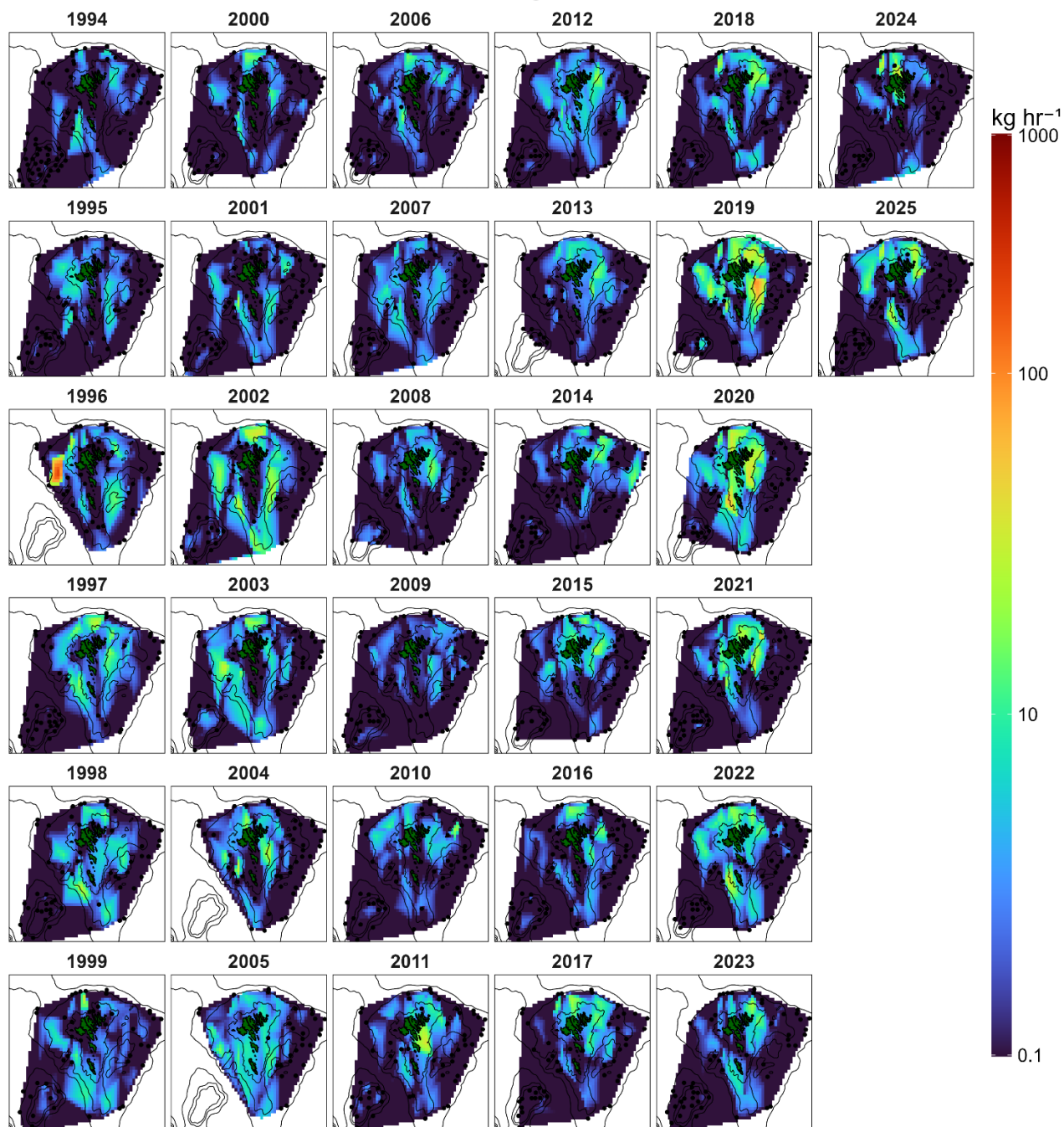
SI figure 4 - Annual Spatial distribution of plaice CPUE (kg/hr) from the annual demersal trawl summer survey from 1994 to 2025. Black points represent trawling stations with no plaice catches.

Unlike plaice, lemon sole catches do not indicate a pronounced spatial aggregation of lemon sole, with the species generally occurring at low and relatively even densities across the Faroe Plateau (SI Figure 5). In contrast, the summer survey shows higher observed densities and a broader spatial coverage (SI Figure 6). However, this apparent increase in distribution and abundance is likely influenced, at least in part, by the substantially higher sampling effort in the summer series (approximately 100 additional tows compared to the spring survey), rather than reflecting a true seasonal expansion of the stock.



SI figure 5 - Annual Spatial distribution of lemon sole CPUE (kg/hr) from the annual demersal trawl spring survey from 1994 to 2025. Black points represent trawling stations with no plaice catches.

Spring

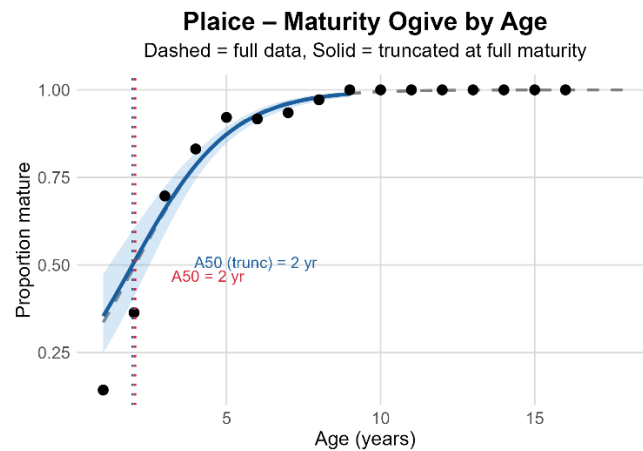


SI figure 6 - Annual Spatial distribution of lemon sole CPUE (kg/hr) from the annual demersal trawl summer survey from 1994 to 2025. Black points represent trawling stations with no plaice catches.

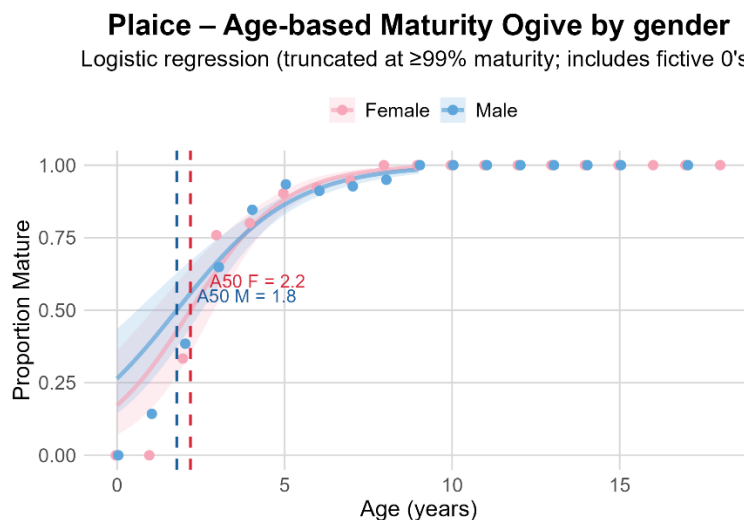
Maturity Ogive sensitivity analysis

Sensitivity analyses examining the effects of truncating observations at full maturity ($\geq 99\%$ mature) and introducing fictive immature observations for ages 0 and 1 are presented in the supplementary material. These analyses were conducted to evaluate the influence of uneven age representation, particularly the predominance of older mature individuals and the limited number of young immature fish, especially males, on the fitted maturity ogives.

Overall, for plaice, A50 remained unchanged at 2 years. Female A50 decreased marginally from 2.3 to 2.2 years, while male A50 remained stable at 1.8 years. These results suggest that the comparatively early maturity-at-age estimates are unlikely to arise solely from uneven age representation or the predominance of mature individuals within the sampled dataset. Instead, the discrepancy between age- and length-based maturity schedules more likely reflects differences in growth dynamics, ageing uncertainty, or population-specific growth trajectories.

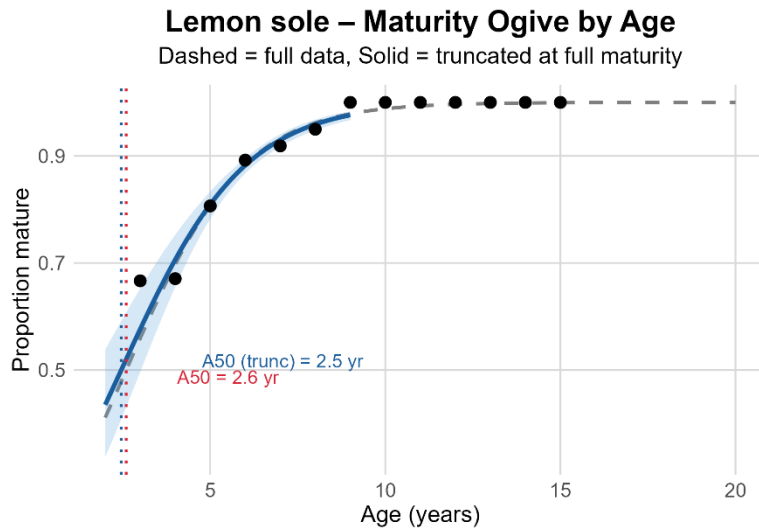


SI figure 7 – Logistic regression model of the plaice maturity ogive by age with full maturity truncated at $<99\%$ and fictive immature fish added to ages 0 and 1. The blue line shows the fitted model, with shaded areas representing ± 1 standard deviation. Observed maturity at age is shown as dots, and the stippled vertical line in red indicates the estimated age at 50% maturity (A_{50}) whilst the stippled blue line indicates the estimated age at 50% truncated maturity with the fictive immature ages.



SI figure 8 – Logistic regression models of the plaice maturity ogive by age and with full maturity truncated at $<99\%$ and fictive immature fish added to ages 0 and 1. Females are shown in pink/red and males in blue, with shaded areas representing ± 1 standard deviation. Observed maturity at age is shown as dots, and stippled vertical lines indicate the estimated age at 50% truncated maturity with the fictive immature ages ($A_{50trunc}$) for each gender.

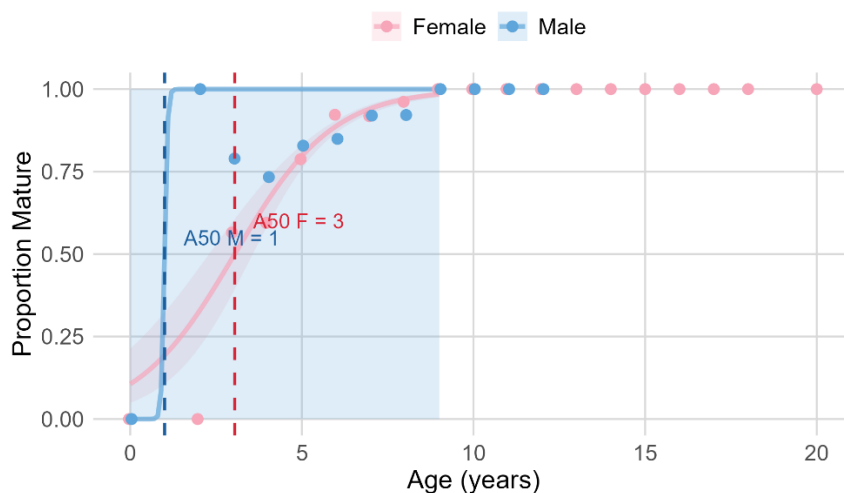
For lemon sole, the resulting A50 estimates differed only marginally from the primary model outputs, indicating that the fitted ogives were generally robust to the tested assumptions. In the combined dataset, A50 decreased from 2.6 to 2.5 years following truncation and inclusion of fictive immature observations. Female A50 estimates similarly decreased only slightly, from 3.1 to 3.0 years. Male estimates showed a somewhat larger shift, decreasing from 1.3 to 1.0 years, reflecting the limited availability of young immature males in the observed dataset and the resulting sensitivity of the logistic model to imposed immature observations at ages 0 and 1.



SI figure 9 – Logistic regression model of the lemon sole maturity ogive by age with full maturity truncated at <99% and fictive immature fish added to ages 0 and 1. The blue line shows the fitted model, with shaded areas representing ± 1 standard deviation. Observed maturity at age is shown as dots, and the stippled vertical line in red indicates the estimated age at 50% maturity (A_{50}) whilst the stippled blue line indicates the estimated age at 50% truncated maturity with the fictive immature ages.

Lemon sole – Age-based Maturity Ogive by gender

Logistic regression (truncated at $\geq 99\%$ maturity; includes fictive 0's)



SI figure 10 – Logistic regression models of the lemon sole maturity ogive by age and with full maturity truncated at <99% and fictive immature fish added to ages 0 and 1. Females are shown in pink/red and males in blue, with shaded areas representing ± 1 standard deviation. Observed maturity at age is shown as dots, and stippled vertical lines indicate the estimated age at 50% truncated maturity with the fictive immature ages ($A_{50trunc}$) for each gender.

Annexes

Annex 1 – Overview of number of plaice samples from demersal trawl surveys in spring (var) and summer (summar) on the Faroe Shelf (lg) and Faroe Bank (fb) in the years 1994 to 2024.

YEAR	SURVEY	Lengths	Round weights	Genders	Maturity stages	Ages	Gonad weights	Liver weights	Stomach analysed
1994	lg_var	121	8	0	0	0	0	0	0
1995	lg_var	187	2	0	0	0	0	0	0
1996	lg_var	186	6	0	0	0	0	0	0
1996	lg_summar	130	14	0	0	0	0	0	0
1997	lg_var	316	17	0	0	0	0	0	1
1997	lg_summar	125	43	0	0	0	0	0	0
1998	lg_var	290	161	0	0	0	0	0	0
1998	lg_summar	219	158	0	0	0	0	0	0
1999	lg_var	244	152	0	0	0	0	0	0
1999	lg_summar	120	106	5	0	0	0	0	0
2000	lg_var	296	211	0	0	0	0	0	0
2000	fb_var	1	1	0	0	0	0	0	0
2000	lg_summar	68	68	0	0	0	0	0	0
2001	lg_var	292	193	0	0	0	0	0	0
2001	lg_summar	168	146	0	0	0	0	0	0
2002	lg_var	283	155	0	0	0	0	0	0
2002	lg_summar	225	189	0	0	0	0	0	0
2003	lg_var	299	209	0	0	0	0	0	0
2003	lg_summar	237	237	0	0	0	0	0	0
2004	lg_var	407	298	0	0	0	0	0	0
2004	lg_summar	315	272	0	0	0	0	0	0
2005	lg_var	337	271	0	0	0	0	0	0
2005	lg_summar	286	267	0	0	0	0	0	0
2006	lg_var	327	307	0	0	0	0	0	0
2006	lg_summar	204	204	0	0	0	0	0	0
2007	lg_var	289	277	0	0	0	0	0	0
2007	lg_summar	213	213	0	0	0	0	0	0
2007	fb_summar	5	5	0	0	0	0	0	0
2008	lg_var	307	179	0	0	0	0	0	0
2008	lg_summar	252	193	0	0	0	0	0	0
2009	lg_var	308	305	0	0	0	0	0	0
2009	lg_summar	223	186	0	0	0	0	0	0
2010	lg_var	363	260	0	0	0	0	0	0
2010	lg_summar	197	173	0	0	0	0	0	0
2011	lg_var	245	216	0	0	0	0	0	0
2011	lg_summar	263	263	0	0	0	0	0	0
2012	lg_var	274	229	0	0	0	0	0	0
2012	lg_summar	262	262	0	0	0	0	0	0

2013	lg_var	357	331	0	0	0	0	0	0
2013	lg_summar	249	249	7	7	7	0	0	7
2014	lg_var	233	175	0	0	0	0	0	0
2014	lg_summar	296	270	0	0	0	0	0	0
2015	lg_var	245	245	0	0	0	0	0	0
2015	lg_summar	339	308	0	0	0	0	0	0
2016	lg_var	371	325	16	16	15	0	0	16
2016	lg_summar	305	293	0	0	0	0	0	0
2017	lg_var	312	275	11	11	11	0	0	11
2017	lg_summar	324	297	0	0	0	0	0	0
2018	lg_var	305	282	0	0	0	0	0	0
2018	lg_summar	227	218	0	0	0	0	0	0
2019	lg_var	224	224	0	0	0	0	0	0
2019	lg_summar	310	309	0	0	0	0	0	0
2020	lg_var	190	177	0	0	0	0	0	0
2020	lg_summar	219	219	0	0	0	0	0	0
2021	lg_var	308	307	4	4	3	0	0	8
2021	lg_summar	374	374	311	310	298	4	0	65
2022	lg_var	226	226	191	191	174	0	0	28
2022	lg_summar	322	320	277	277	74	0	0	0
2023	lg_var	309	309	309	309	281	71	77	81
2023	lg_summar	278	273	174	173	222	40	46	33
2024	lg_var	299	245	136	136	119	17	17	17
2024	lg_summar	336	334	137	137	131	0	0	0
Total		15842	13041	1578	1571	1335	132	140	267

Annex 2 – Overview of number of lemon sole samples from demersal trawl surveys in spring (var) and summer (summar) on the Faroe Shelf (lg) and Faroe Bank (fb) in the years 1994 to 2024.

YEAR	SURVEY	Round		Genders	Maturity		Gonad	Liver	Stomach
		Lengths	weights		stages	Ages			
1994	lg_var	203	12	0	0	0	0	0	0
1994	fb_var	14	2	0	0	0	0	0	0
1995	lg_var	175	2	0	0	0	0	0	0
1995	fb_var	11	2	0	0	0	0	0	0
1996	lg_var	195	6	0	0	0	0	0	0
1996	lg_summar	1353	108	0	0	0	0	0	0
1996	fb_summar	19	2	0	0	0	0	0	0
1997	lg_var	578	17	0	0	0	0	0	0
1997	fb_var	5	1	0	0	0	0	0	0
1997	lg_summar	1436	136	0	0	0	0	0	0
1997	fb_summar	17	0	0	0	0	0	0	0
1998	lg_var	369	221	0	0	0	0	0	0
1998	fb_var	11	8	0	0	0	0	0	0
1998	lg_summar	1766	880	0	0	0	0	0	0
1998	fb_summar	23	0	0	0	0	0	0	0
1999	lg_var	354	267	4	0	0	0	0	0
1999	fb_var	26	25	0	0	0	0	0	0
1999	lg_summar	906	681	0	0	0	0	0	0
1999	fb_summar	32	32	24	24	22	0	0	0
2000	lg_var	271	242	0	0	0	0	0	0
2000	fb_var	14	14	0	0	0	0	0	0
2000	lg_summar	1131	804	0	0	0	0	0	0
2000	fb_summar	12	12	0	0	0	0	0	0
2001	lg_var	231	210	0	0	0	0	0	0
2001	fb_var	16	16	0	0	0	0	0	0
2001	lg_summar	1750	891	0	0	0	0	0	0
2001	fb_summar	30	27	0	0	0	0	0	0
2002	lg_var	535	406	0	0	0	0	0	0
2002	fb_var	30	28	0	0	0	0	0	0
2002	lg_summar	1828	1139	0	0	0	0	0	0
2002	fb_summar	57	52	0	0	0	0	0	0
2003	lg_var	404	322	0	0	0	0	0	0
2003	fb_var	19	18	0	0	0	0	0	0
2003	lg_summar	1366	837	0	0	0	0	0	0
2003	fb_summar	23	23	0	0	0	0	0	0
2004	lg_var	261	260	0	0	0	0	0	0
2004	lg_summar	2318	1385	0	0	0	0	0	0
2004	fb_summar	68	61	0	0	0	0	0	0
2005	lg_var	487	477	0	0	0	0	0	0
2005	lg_summar	1343	1062	0	0	0	0	0	0
2005	fb_summar	22	22	0	0	0	0	0	0
2006	lg_var	326	297	0	0	0	0	0	0
2006	fb_var	15	15	0	0	0	0	0	0
2006	lg_summar	1172	1055	0	0	0	0	0	0
2006	fb_summar	20	19	0	0	0	0	0	0
2007	lg_var	339	337	0	0	0	0	0	0
2007	fb_var	10	10	0	0	0	0	0	0
2007	lg_summar	1009	776	0	0	0	0	0	0
2007	fb_summar	44	44	0	0	0	0	0	0

2008	lg_var	314	268	0	0	0	0	0	0
2008	fb_var	27	27	0	0	0	0	0	0
2008	lg_summar	1366	908	0	0	0	0	0	0
2008	fb_summar	45	45	0	0	0	0	0	0
2009	lg_var	221	220	0	0	0	0	0	0
2009	fb_var	9	9	0	0	0	0	0	0
2009	lg_summar	1616	935	0	0	0	0	0	0
2009	fb_summar	38	37	0	0	0	0	0	0
2010	lg_var	315	288	0	0	0	0	0	0
2010	fb_var	18	18	0	0	0	0	0	0
2010	lg_summar	1370	1105	0	0	0	0	0	5
2010	fb_summar	27	27	0	0	0	0	0	0
2011	lg_var	373	364	0	0	0	0	0	0
2011	fb_var	24	24	0	0	0	0	0	0
2011	lg_summar	1057	978	0	0	0	0	0	0
2011	fb_summar	28	28	0	0	0	0	0	0
2012	lg_var	516	465	0	0	0	0	0	0
2012	fb_var	10	10	0	0	0	0	0	0
2012	lg_summar	607	508	0	0	0	0	0	0
2012	fb_summar	15	15	0	0	0	0	0	0
2013	lg_var	498	462	5	5	5	0	0	5
2013	fb_var	3	3	0	0	0	0	0	0
2013	lg_summar	595	564	0	0	0	0	0	0
2013	fb_summar	14	14	0	0	0	0	0	0
2014	lg_var	328	295	0	0	0	0	0	0
2014	fb_var	11	11	0	0	0	0	0	0
2014	lg_summar	764	679	0	0	0	0	0	0
2014	fb_summar	23	23	0	0	0	0	0	0
2015	lg_var	308	307	0	0	0	0	0	0
2015	fb_var	9	9	0	0	0	0	0	0
2015	lg_summar	778	745	0	0	0	0	0	0
2015	fb_summar	69	62	0	0	0	0	0	0
2016	lg_var	190	190	9	9	9	0	0	9
2016	fb_var	20	20	0	0	0	0	0	0
2016	lg_summar	642	602	0	0	0	0	0	0
2016	fb_summar	30	30	0	0	0	0	0	0
2017	lg_var	326	270	5	5	2	0	0	5
2017	fb_var	6	6	0	0	0	0	0	0
2017	lg_summar	858	721	0	0	0	0	0	0
2017	fb_summar	14	14	0	0	0	0	0	0
2018	lg_var	314	296	0	0	0	0	0	0
2018	fb_var	14	14	0	0	0	0	0	0
2018	lg_summar	1155	1007	0	0	0	0	0	0
2018	fb_summar	27	27	0	0	0	0	0	0
2019	lg_var	380	374	0	0	0	0	0	0
2019	fb_var	5	5	0	0	0	0	0	0
2019	lg_summar	910	779	0	0	0	0	0	0
2019	fb_summar	10	10	0	0	0	0	0	0
2020	lg_var	333	333	0	0	0	0	0	0
2020	fb_var	8	8	0	0	0	0	0	0
2020	lg_summar	585	579	0	0	0	0	0	0
2020	fb_summar	14	14	0	0	0	0	0	0
2021	lg_var	233	233	0	0	0	0	0	0
2021	fb_var	3	3	0	0	0	0	0	0
2021	lg_summar	1257	1141	323	321	303	1	0	63
2021	fb_summar	33	33	31	31	31	0	0	8
2022	lg_var	591	575	302	302	300	0	0	63
2022	fb_var	6	6	0	0	0	0	0	0

2022	lg_summar	1239	1194	766	766	503	0	0	0
2022	fb_summar	22	22	0	0	0	0	0	0
2023	lg_var	389	389	387	387	332	156	155	159
2023	fb_var	10	10	0	0	0	0	0	0
2023	lg_summar	1445	1245	335	334	368	67	73	62
2023	fb_summar	23	23	0	0	0	0	0	0
2024	lg_var	283	258	116	116	121	33	33	31
2024	fb_var	2	2	2	2	2	0	0	0
2024	lg_summar	1915	1864	296	296	262	6	8	0
2024	fb_summar	34	34	0	0	0	0	0	0
Total		47366	35047	2605	2598	2260	263	269	410

Annex 3 – Overview of numbers of plaice samples from landings.

YEAR	LONGD	RVEKT	KVEKT	KYN	BUSTIG	ALDUR	GONADUR	LIVUR	MAGAR
2016	863	0	863	0	0	119	0	0	0
2017	792	0	792	0	0	118	0	0	0
2018	115	0	115	0	0	60	0	0	0
2019	422	0	422	0	0	119	0	0	0
2020	204	0	204	0	0	0	0	0	0
2021	607	0	607	0	0	179	0	0	0
2022	967	0	967	0	0	417	0	0	0
2023	2033	253	2017	272	266	1048	138	0	0
Total	6094	253	5987	272	266	2060	138	0	0

Annex 4 – Overview of numbers of lemon sole samples from landings.

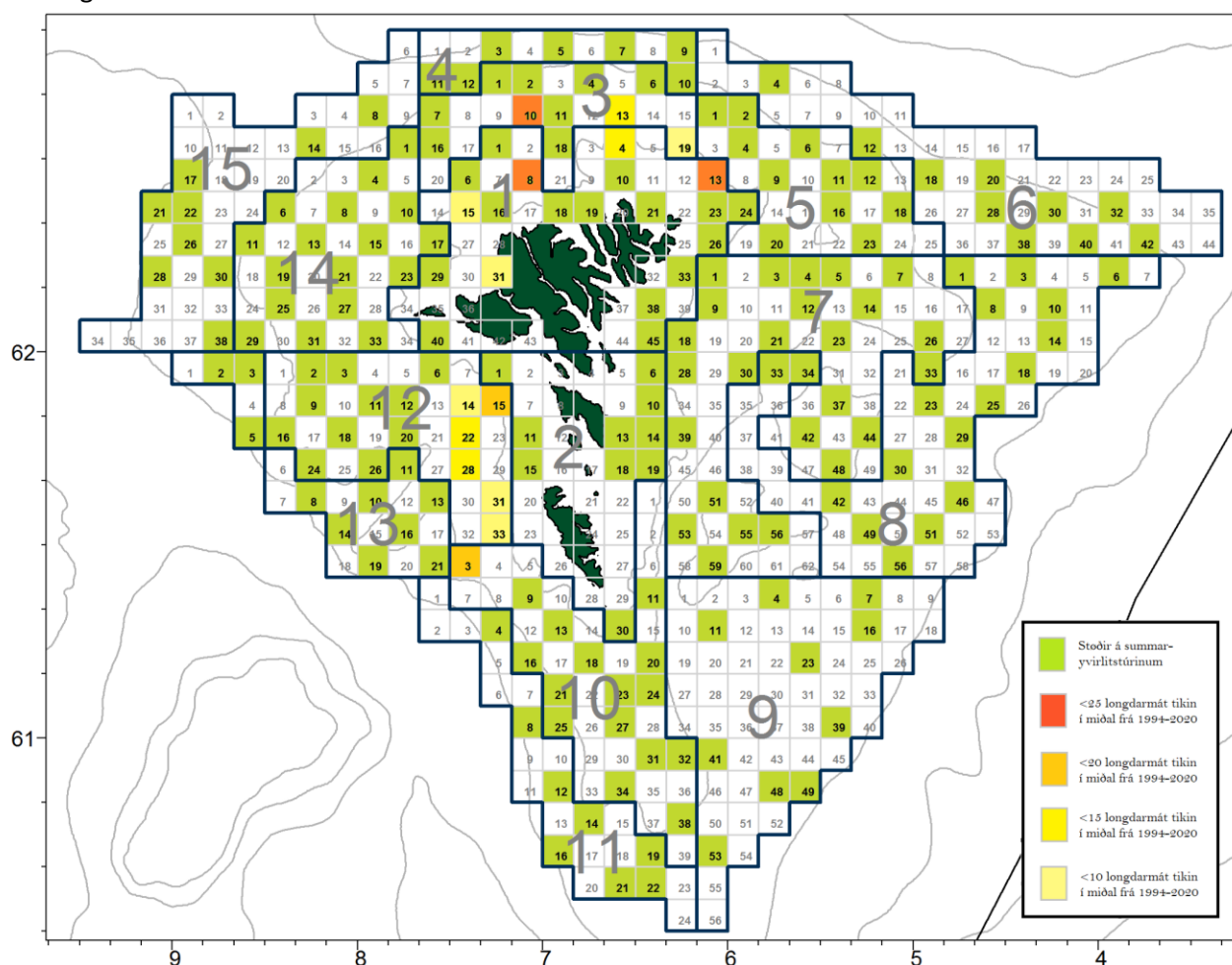
YEAR	LONGD	RVEKT	KVEKT	KYN	BUSTIG	ALDUR	GONADUR	LIVUR	MAGAR
2016	1057	0	1057	0	0	149	0	0	0
2017	699	0	699	0	0	135	0	0	0
2018	123	0	123	0	0	55	0	0	0
2019	200	0	200	0	0	60	0	0	0
2020	182	0	182	0	0	59	0	0	0
2021	200	0	200	0	0	60	0	0	0
2022	999	0	999	0	0	401	0	0	0
2023	2412	486	2315	559	537	1070	172	0	0
Total	5872	486	5775	559	537	1989	172	0	0

Prøvatøka í samband við reyðsprøku og tungu verkætlanina

Ynskiligt er at fáa **300 nytrur av tungu** og **300 nytrur av reyðsprøku** (um veiðan er so mikið), har longd (TL), vekt, kyn og búningarstig eisini vera skrásett. Hetta merkir, at neyðugt er at nytra nakrar fáa tungur og serstakliga reyðsprøkur á gott og væl hvørji støð (helst 5-10 stk har veiðan er so frætt). Harumframt er ynskiligt, at **2-4 magar** bæði av reyðsprøku og av tungu verða kannaðir per støð um dagen. Hesir fiskar slal eisini skrásetast **gonadu-, livur- og maga-vekt á fabrikkini**.

Útbreiðsla hjá reyðsprøku (*Pleuronectes platessa*)

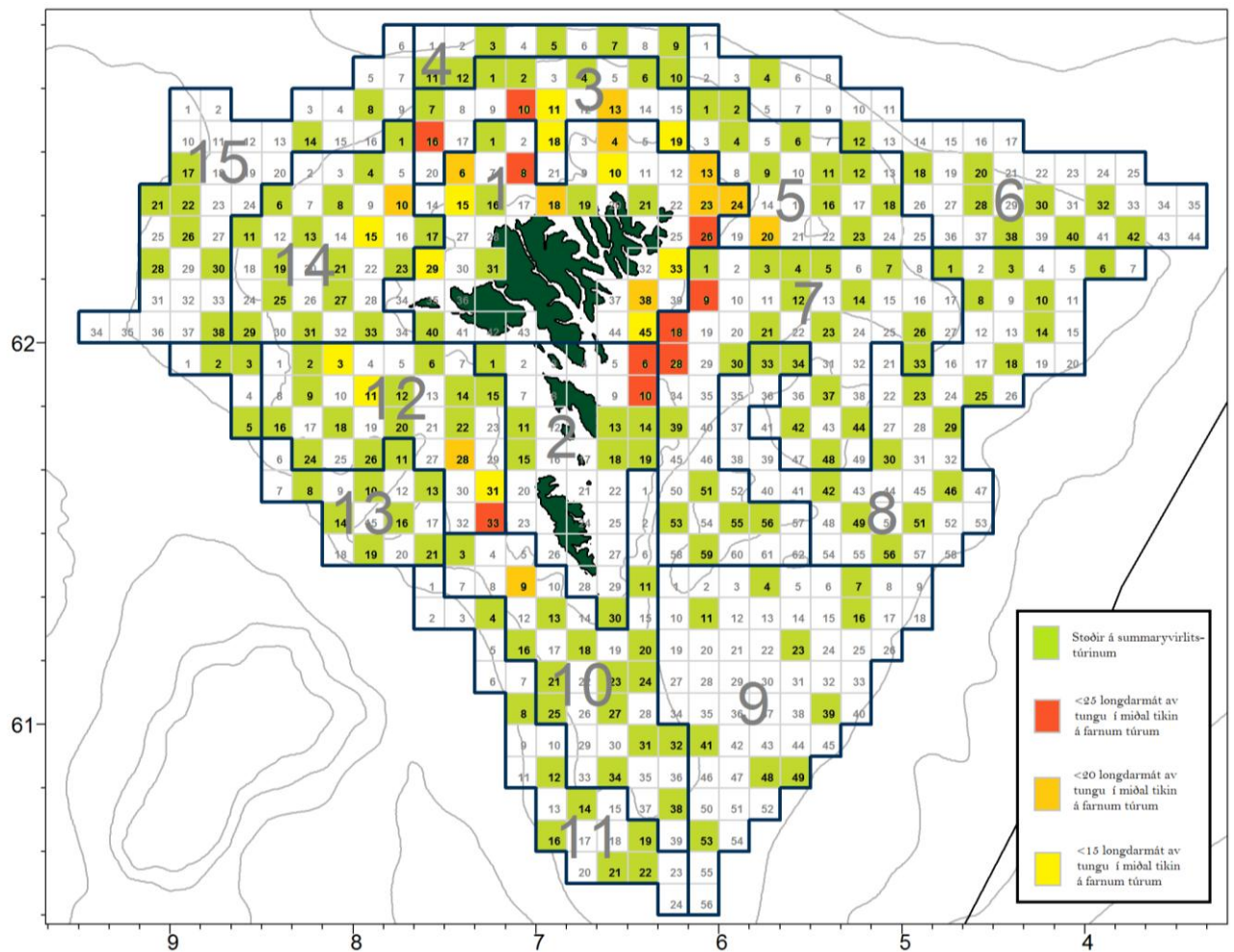
Reyðsprøka er spjodd runt um allan landgrunnin. Á summaryvirlitstrolingunum á landgunninum er síðani 1994 í miðal tikin 231 longdarmát av reyðsprøku. Á mynd 1 sæst á hvørji støð hesi flestu longdarmát eru tikin. Her kann væntast at fáa fleiri prøvar. Síðstu fimm árin er miðaltalið av longdarmátum reyðsprøkum 270 longdarmát, sum er áleið tað sama sum á várvirlitstúrinum, har 280 longdarmát í miðal eru tikin síðani 1994.



Mynd 1 - Virlit yvir støðir (litaðir puntar) á summaryvirlitstúrinum. Reyðir puntar eru støðir, har longdar-mát av reyðsprøku í miðal hava verið <25 síðani 1994, appilsingulir <20 longdarmát, gulir <15 longdarmát, ljóst gult <10 longdarmát.

Útbreiðsla hjá tungu (*Microstomus kitt*)

Tunga er eisini spjodd runt um allan landgrunnin og er eisini á Føroyabanka. Á summar-yvirlitstrolingunum á Landgrunninum er síðani 1994 í miðal tikin 1187 longdarmát av tungu. Á mynd 2 sæst á hvørji støð hesi flestu longdarmát eru tikin. Her kann væntast at fáa fleiri prøvar. Síðstu fimm árin er miðaltalið av longdarmátum tungum minkað nakað niður á 830 longdarmát í miðal. Hetta hóast CPUE ikki er nakað serliga nógv lækkað. Á summaryvirlitstrolingunum á Føroyabanka er síðani 1994 í miðal per ár tikin 29 longdarmát av tungu, og seinastu 5 árin hevur hetta talið verið 19 longdarmát. Á Føroyabanka er tunga fingin á grynra partinum uppi á bankanum í smáum nøgdnum 1-4 stk per støð.



Mynd 1 – Yvirlit yvir støðir (litaðir pundar) á summaryvirlitstúrunum. Reyðir pundar eru støðir, har longdar-mát av tungu í miðal hava verið <25 síðani 1994, appelsingulir <20 longdarmát og gulir <15 longdarmát.

Kyn og kynsbúning (sami sum hjá toski, hýsu, upsa v.m.)

Stig	Lýsing	Samband millum stiginu
1	Óbúgvinn	<pre> graph TD 1 --> 2 2 --> 3 3 --> 4 4 --> 5 5 --> 6 6 --> 7 7 --> 1 </pre>
2	Búnandi, stutt ávegis	
3	Búnandi, nakað ávegis	
4	Búnandi, væl ávegis	
5	Búgvinn	
6	Gýtandi	
7	Útgýttur/hvílandi	

Stig	Lýsing av rognafiski (1 ella F)	Lýsing av siljafiski (2 ella M)
9	Kanning gjørd, ógjørligt at staðfesta búningarstig	Kanning gjørd, ógjørligt at staðfesta búningarstig
1	Rognini eru háttað sum tveir tunnir, reydligr og gjøgnumsiktugir streingir, ið liggja beint undir ryggjageislunum. Rognkorn ikki sjónlig við berum eygum. Tað kann vera trupult at avgera kynið.	Silið, ið er háttað sum tveir tunnir streingir (ella træðrir), liggur beint undir ryggjageislunum; tað er litleyst yvir í ljósareytt og gjøgnumsiktugt. Tað kann vera trupult at avgera kynið.
2	Bert smá rognkorn, ið kunnu síggjast við lesiglasí. Longdin á rognunum umleið helvtin av longdini á búkholuni.	Silið enn háttað sum tveir nú heldur tjúkri streingir, ið kunnu vera gráhvítir yvir í ljósareyðir á liti. Longdin á silunum er umleið helvtin av longdini á búkholuni.
3	Rognini appelsingult reydligr. Rognkornini síggjast við berum eygum. Rognini fylla umleið helvtina av búkholuni.	Silið fyllir umleið helvtina av búkholuni. Liturin er hvítligur. Eingin silsevja kemur úr, um trýst verður á silið.
4	Rognini appelsingul við blóðæðrum. Rognkornini síggjast týðuliga við berum eygum sum hvít korn. Rognini fylla umleið tveir triðingar av búkholuni.	Silið meira tjúkt í tí, hvítligt við blóðæðrum. Eingin silsevja kemur úr, um trýst verður á silið. Tað fyllir umleið tveir triðingar av búkholuni.
5	Rognkornini heilt rund, og nógv eru gjøgnumsiktug. Rognini fylla búkholuna.	Silið fyllir búkholuna. Silið er hvítt á liti, og dropar av silsevju koma út, um trýst verður á tað.
6	Rennandi rogn (sjórogn). Lætt trýst á búkin fær rognkornini at spræna úr fiskinum. Nøkur fá ikki gjøgnumsiktug rognkorn kunnu vera eftir inni í rognunum	Rennandi sil. Lætt trýst á búkin fær tað hvítu silsevju at spræna út úr fiskinum.
7	Rognini posut og blóðsprongd, enn eru nøkur rognkorn eftir í rognunum, men øll eru gjøgnumsiktug. Seinni hvørvur tað blóðsprongda og posuta, og rognkorn eru tá ikki sjónlig longur.	Silini ósløtt og tóm, tó kunnu leivdir av silsevju hómast. Liturin skiftir úr grá-bláum yvir í reydligt, men er innast í streingjunum við at hvítta.

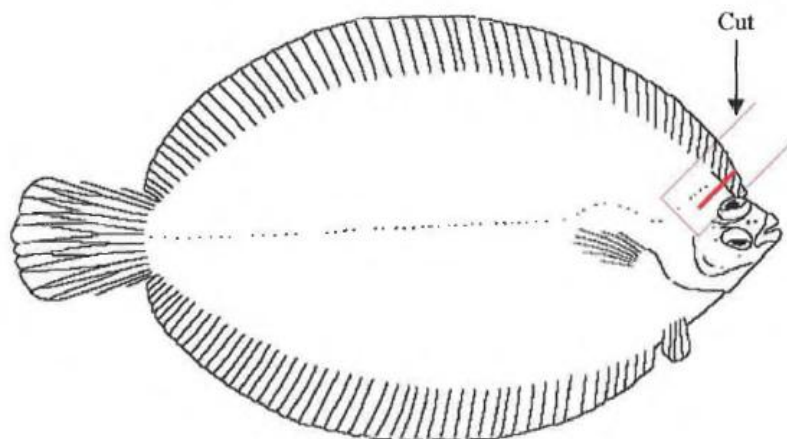
Nytrur

Nytrur úr **reyðsprøku** eru stórar, og rættuliga viðbreknar tvs brotna lætt. Harafturímóti eru nytur úr **tungu** relativt smáar. Nyturnar vera savnaðar í kláran plastbakka, og vera lisnar heilar í vatni eins og hjá t.d svartkalva. Alneyðugt er, at tær ikki torna, og tískil skal nytrubakkin fyllast við vatnið áðrenn innsavning byrjar, og **frystast**, tá hann er fullur. Yvirlit yvir hvørjar nyturnar eru (fiskaslag, støðnummur og reglunummur til tilhoyrandi “nytru-bakka-rúm”) skal klistrast á loki.

Magar

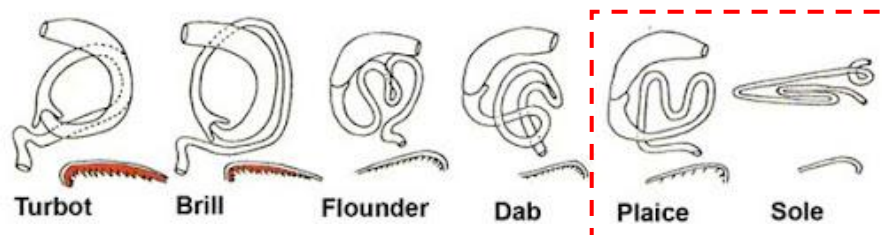
Í litteraturi um magakanningar av flatfiski er eitt sindur ymiskt hvat egenligt varð kannað. Hetta kemst av at gøgnini eru eitt vet annaleiðis (sí mynd 4). Hetta er eisini galdandi fyri tungu og reyðsprøku, har magin ikki er eins væl uppdeildir sum hjá t.d. toskafiskum av tí at skúvgøgnini ikki eru eins væl útviklaði. Umborð á JS er týðningarmikið at bert magin verður kannaður og førdur inn í magainntastingarforriti. Hetta tí at magnus databasan er bert roknað til magakanningar av magasekkinum. Tað kann tí vera trupult at klippa magan frá tarmunum, men við góðum vilja ber til at finna skúvgøgnini, har eini 2-5 útvøkstrir eru eftir magasekkin, og klippa tarmin frá á hesum stað.

Fig. 2.2.2 A lemon sole showing the point of incision of the knife into the head of the fish, in order to remove the otoliths.



Guts and gill rakers of flatfish

After de Groot



Annex 6 – Maturity stage key of plaice

REYÐSPRØKA - KVENNKYN ♀

Búningarstig



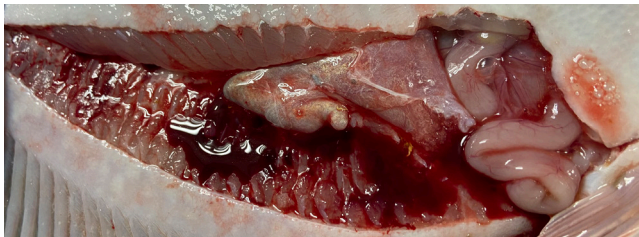
1

- Tunnir, reyðligir og gjøgnumsigtigir streingir ið liggja beint undir ryggjageislunum.
- Rognkorn **ikki sjónlig** við berum eygum.
- Tað kann vera trupult at avgera kynið.



2

- Bert smá rognkorn, ið kunnu síggjast við lesiglasí.
- Posin fyllir uml. 1/2 av búkholuni í longd.



3

- Appelsingult reyðlig rognkorn.
- Rognkornini síggjast við berum eygum.
- Fyllir uml. 1/2 av búkholuni.



4

- Rogn appelsingul við blóðæðrum.
- Síggjast **týðuliga** við berum eygum, sum hvít korn.
- Fylla uml. 2/3 av búkholuni.



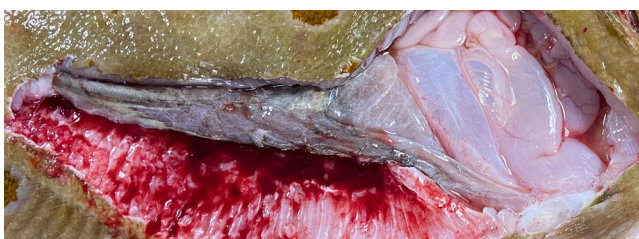
5

- Rognkornini heilt rund.
- Nógv eru gjøgnumsigtig.
- Rognini fylla búkholuna.



6

- Rennandi rogn (sjórogn).
- Lætt trýst á búkin fær rognini at spræna úr.
- Nøkur fá "ikki-gjøgnumsigtig" rognkorn kunnu vera eftir.

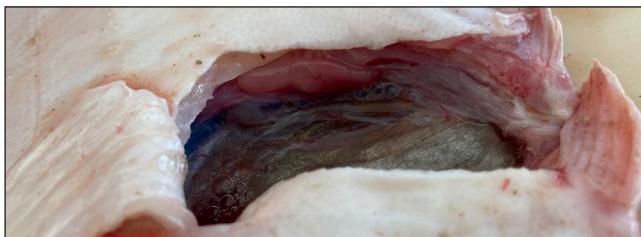


7

- Rognini posut og blóðsprongd.
- Enn eru nøkur rognkorn eftir í posanum.
- Øll rognkorn gjøgnumsigtig.
- Seinni hvørvur tað blóðsprongda og posuta og rognkorn eru tá ikki sjónlig longur.

REYÐSPRØKA - KALLKYN ♂

Búningarstig



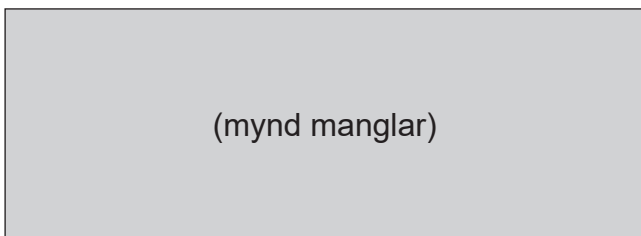
1

- Litleyst yvir í ljósareytt / gjøgnumsigtugt.
- Tunnir streingir/træðrir, ið liggja beint undir ryggjageislunum.
- Tað kann vera trupult at avgera kynið.



2

- Heldur tjúkri streingir, gráhvítir yvir í ljósareytt.
- Longd uml. 1/2 av búkholuni.



(mynd manglar)

3

- Fyllir uml. 1/2 av búkholuni.
- Hvíttligt.
- **Eingin** silsevja kemur út tá trýst verður á silið.



(mynd manglar)

4

- Meira tjúkt, hvíttligt og við blóðæðrum.
- **Eingin** silsevja kemur út tá trýst verður á silið.
- Fyllir uml. 2/3 av búkholuni.



5

- Silið fyllir búkholuna.
- Hvítt á liti.
- Dropar av silsevju koma út um man trýstir á tað.



6

- Rennandi sil.
- Lætt trýst á búkin fær silsevjuna til at spræna úr fiskinum.



7

- Silini ósløtt og tóm.
- Leivdir av silsevju kunnu hómast.
- Liturin skiftir úr grá-bláum yvir í reydligt, men er innast í streingjunum við at hvíttna.

Annex 7 – Maturity stage key of lemon sole

TUNGA - KVENNKYN ♀

Búningarstig



1

- Tunnir, reyðligir og gjøgnumsigtigir streingir ið liggja beint undir ryggjageislunum.
- Rognkorn **ikki sjónlig** við berum eygum.
- Tað kann vera trupult at avgera kynið.



2

- Bert smá rognkorn, ið kunnu síggjast við lesiglasi.
- Posin fyllir uml. 1/2 av búkholuni í longd.



3

- Appelsingult reyðlig rognkorn.
- Rognkornini síggjast við berum eygum.
- Fyllir uml. 1/2 av búkholuni.



4

- Rogn appelsingul við blóðæðrum.
- Síggjast **týðuliga** við berum eygum, sum hvít korn.
- Fylla uml. 2/3 av búkholuni.



5

- Rognkornini heilt rund.
- Nógv eru gjøgnumsigtig.
- Rognini fylla búkholuna.



6

- Rennandi rogn (sjórogn).
- Lætt trýst á búkin fær rognini at spræna úr.
- Nøkur fá "ikki-gjøgnumsigtig" rognkorn kunnu vera eftir.

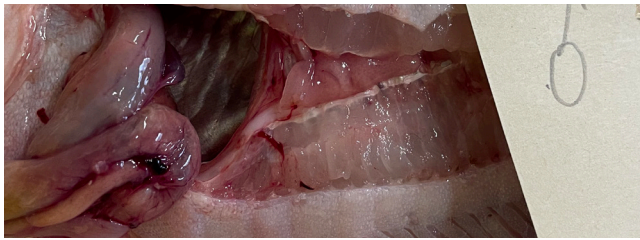


7

- Rognini posut og blóðsprongd.
- Enn eru nøkur rognkorn eftir í posanum.
- Øll rognkorn gjøgnumsigtig.
- Seinni hvørvur tað blóðsprongda og posuta og rognkorn eru tá ikki sjónlig longur.

TUNGA - KALLKYN ♂

Búningarstig



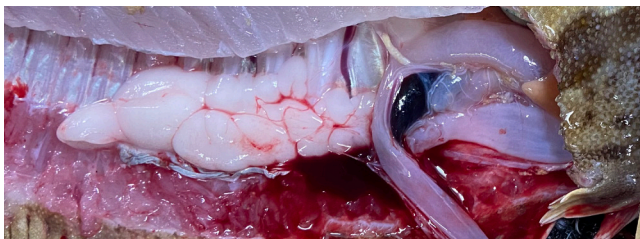
1

- Litleyst yvir í ljósareytt / gjøgnumsigugt.
- Tunnir streingir/træðrir, ið liggja beint undir ryggjageislunum.
- Tað kann vera trupult at avgera kynið.



2

- Heldur tjúkri streingir, gráhvítir yvir í ljósareytt.
- Longd uml. 1/2 av búkholuni.



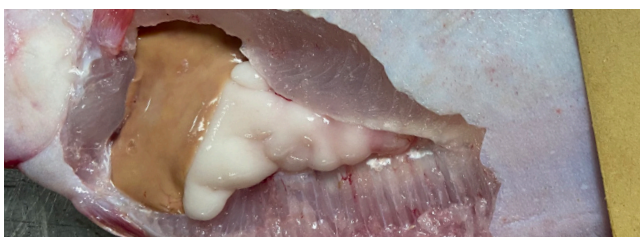
3

- Fyllir uml. 1/2 av búkholuni.
- Hvíttligt.
- **Eingin** silsevja kemur út tá trýst verður á silið.



4

- Meira tjúkt, hvíttligt og við blóðæðrum.
- **Eingin** silsevja kemur út tá trýst verður á silið.
- Fyllir uml. 2/3 av búkholuni.



5

- Silið fyllir búkholuna.
- Hvítt á liti.
- Dropar av silsevju koma út um man trýstir á tað.



6

- Rennandi sil.
- Lætt trýst á búkin fær silsevjuna til at spræna úr fiskinum.



7

- Silini ósløtt og tóm.
- Leivdir av silsevju kunnu hómast.
- Liturin skiftir úr grá-bláum yvir í reydligt, men er innast í streingjunum við at hvíttna.

Annex 8 – Fish facts information sheet from 2022 – Plaice

REYÐSPRØKA

Pleuronectes platessa

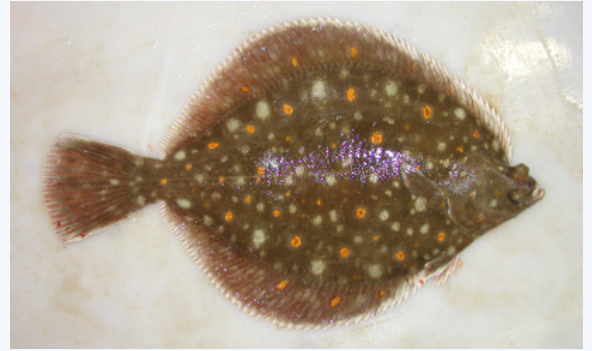
Serføroyskur fiskastovnur

Gagnfiskur

Botnfiskur

Elsta aldursgreinaða reyðsprøka undir Føroyum: 16 ár

Longsta mátaða reyðsprøka undir Føroyum: 81 cm

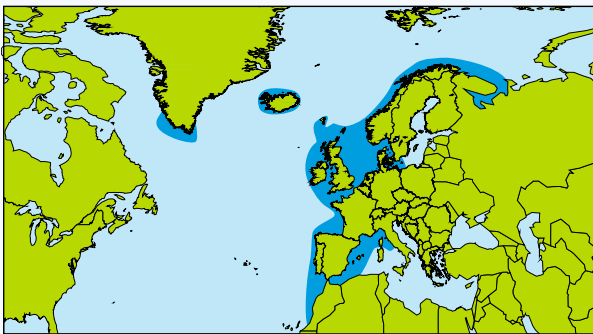


Lívfrøði

Reyðsprøka er høgravendur flatfiskur. Hon hevur eina ryggfjøður av nakkanum aftur til klingruna, eina gotfjøður frá gotinum til klingruna, rættiliga smáar ugga- og búkfjaðrar, stóran stert, eitt lítið sindur útbogin. Hon hevur pík beint aftan fyri gotið, men er annars sløtt bæði undir og omaná. Strikan fer í ein lítlan boga oman fyri ugga-fjøðurina. Millum eyguni og aftur til kápuklovan er ein týðiligur reikur við 5-7 beinknútum.

Útbreiðsla

Reyðsprøka er úr Genovavíkini til Gibraltar, frá Marokko fram við Evropa norður í Hvítahavið. Hon er í donsrum sjógvum og syðra parti av Eystarasalti. Hon er í Norðsjónum og kring Bretsku Oyggjarnar, undir Føroyum og Íslandi. Hendingaferð er hon fingin í Grønlandi (Mynd 1).



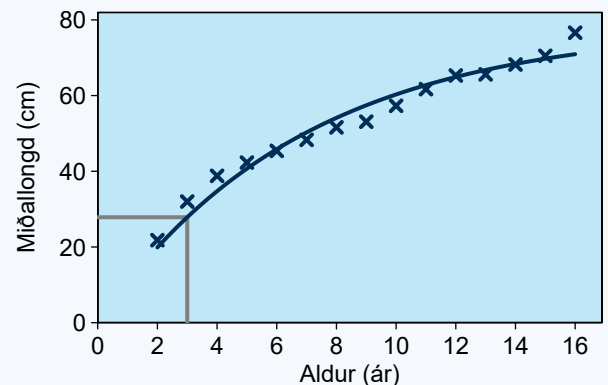
Mynd 1. Útbreiðsla av reyðsprøku.

Reyðsprøka er vanligur botnfiskur á firðum, víkum og á Landgrunninum út á 200 m dýpi. Reyðsprøka er ikki á Føroyabanka. Um stovnsuppbýtið um okkara leiðir vita vit lítið.

Vøkstur

Ársgomul er reyðsprøka umleið 6-14 cm. Tvey ára gomul er hon millum 10-33 cm, trý ára gomul 17-36 cm og fýra ára gomul 23-38 cm (Mynd 2).

Kanningar inni við land hava víst, at reyðsprøkan sama árið, sum hon er gýtt, er 3-9 cm til longdar. Ymiskt er, hvussu reyðsprøka veksur ymsastaði undir Føroyum.



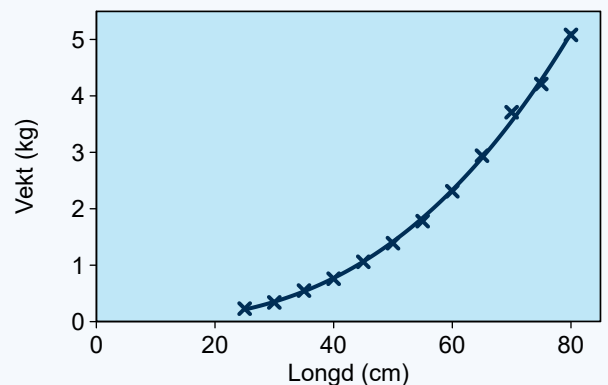
Miðallongd móti aldri, mátað frá rannsóknarskipi í 2022. Víst er, nær helvtin av reyðsprøkunum er búgvín at gýta fyrstu ferð.

Samanbórið við onnur øki veksur reyðsprøkan undir Føroyum lutfalsliga skjótt.

Aldurin hjá reyðsprøku verður staðfestur við at telja árringar í nytrunum. Nytran á reyðsprøku er lutfalsliga lítil (Mynd 3). Aldurin verður lisin av heilari nytru, sum



Mynd 3. Nytrur av 9 ára gamlari reyðsprøku



Mynd 4. Longd móti vekt mátað frá landingunum í 2015-2022.

hefur ligið á bloti í vatni í minst eitt samdøgur. Á henda hátt gerast árringarnir sjónskari og lættari at lesa.

Longd móti vekt fyri allar støddir av landaðari reyðsprøku sæst í Mynd 4. Miðalvektin á 40 cm og 60 cm langari reyðsprøku í krúvdari vekt var umleið 0,8 kg og 2 kg.

Kynsbúning

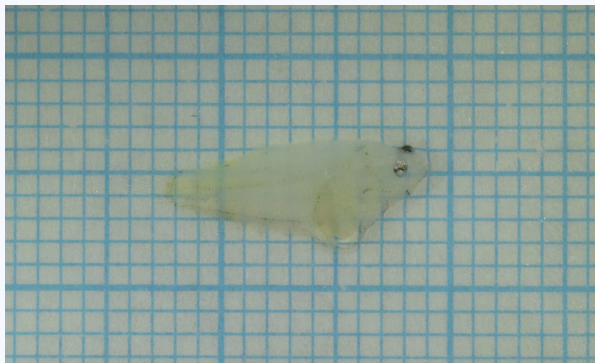
Í miðal gýtir helvtin av reyðsprøkuni fyrstu ferð umleið 3 ára gomul; tá er hon um 32 cm til longdar.

Gýting

Reyðsprøka gýtir í februar-apríl ymsa staðni á Landgrunninum á um 100 m dýpi. Eingin gýting er inni á firðunum.

Yngul og ungfiskur

Sum hjá øðrum toskafiskum so flotna tey gitnu rognkornini og eru eins og larvur og yngul (Mynd 5) at finna ovarlaga í sjónum. Í juni leitar yngulin inn á firðir og víkir og tekur til botn. Í juli-august er nógur reyðsprøkuungul at síggja á heilt grunnum vatni, har sandur ella móðrutur sandur er á botninum, serliga við áarmunnar.



Mynd 5. Reyðsprøkuungul fingin við rannsóknarskipinum Magnusi Heinasyni á yngultúri síðst í juni, har trolað varð uppi í sjónum.

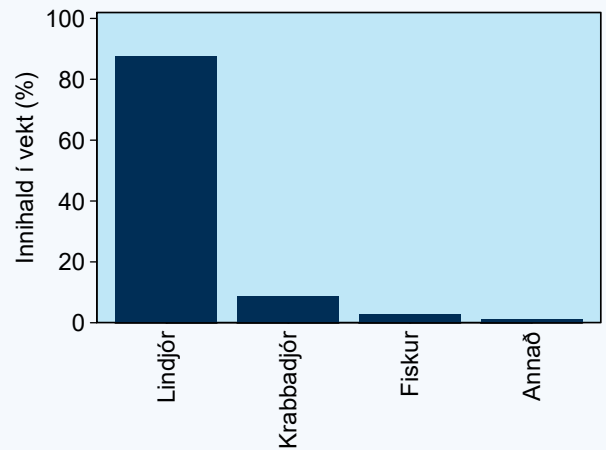
Ferðing

Reyðsprøkan heldur sær á grunnum vatni inni á firðum, víkum og sundum tey fyrstu 3 árin. Um 4 ára aldur leitar hon so út á Landgrunnin.

Merkjaroyndir undir Føroyum hava víst, at tann vaksna reyðsprøkan ferðast rættiliga víða um Landgrunnin, men um samband er við onnur havøki, er óvist. Nevnast skal í hesum sambandi, at reyðsprøkur merktar undir Íslandi eru fingnar aftur m.a. við Hetland, Norðurnoreg og í Barentshavinum heilt inn í Hvítahavið, so hon kann ferðast víða.

Føði

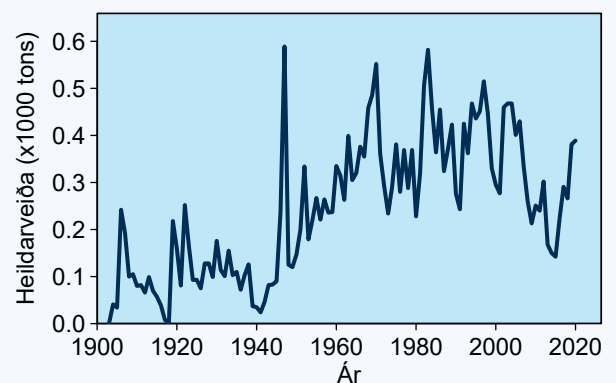
Føðin hjá vaksna reyðsprøku er serliga lindjór (Mynd 6), eitt nú ormar og tvískeljar. Av aðrari føði hjá reyðsprøku kann nevast gággukrabbar og nebbasild.



Mynd 6. Føðin í vekt í reyðsprøkumagum býtt í høvuðsbólkar árin 2013-2022.

Veidda

Heildarveiðan av reyðsprøku undir Føroyum síðani 1903 er víst á Mynd 7. Fyri seinna heimsbardaga vórðu um 100 til 200 tons fiskað um árið, men eftir bardagaárin og fram til umleið 1970 vaks veiðan stóðugt. Síðani hevur veiðan verið nøkurlunda jøvn um 300-400 tons, tó við onkrum frægari árum og onkrum slækari árum uppmillum.

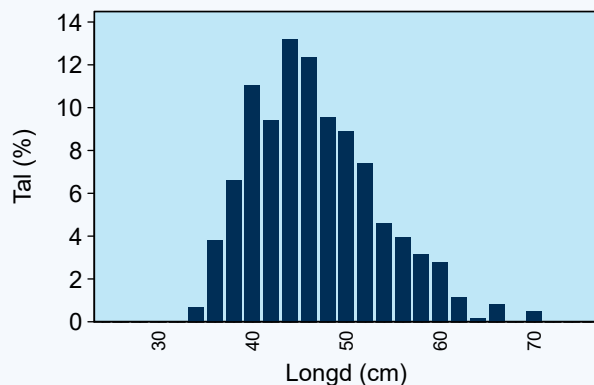


Mynd 7. Heildarveiðan av reyðsprøku undir Føroyum 1903-2022 í rundari vekt.

Í dag er tað einamest trolbátarnir í bólki 4T, sum fiska reyðsprøku við beinleiðis fiskiskapi eftir flatfiski á landleiðini um summarið. Reyðsprøka verður tó eisini fiskað sum hjálveiða hjá partrolarum, línubátum og útróðrabátum.

Longdarbýtið í reyðsprøkuveiðuni undir Føroyum í 2022 er víst á Mynd 8. Meginparturin av reyðsprøkuni í veiðuni var yvir 35 cm langur. Miðallongdin var umleið 47 cm.

Á landingarmiðstöðunum kring landið verður reyðsprøka bólkað í trýggjar stóðdarbólkar, alt eftir vekt (Talva 1).



Mynd 8. Longdarbýtið í reyðsprøkuveiðuni undir Føroyum í 2022.

Stovnsmeting

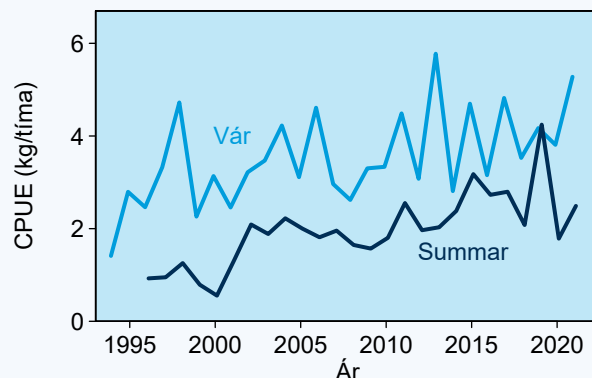
Ongin stovnsmeting verður gjørd fyri reyðsprøku við Føroyar. Tøl frá "veiðu upp á roynd" (cpue) kunnu nýtast til at geva eina ábending um, hvussu støðan er hjá

Talva 1. Umrokningartalva út frá støddarbólkum. Virðini byggja á tøl fyri árin 2014-2022. Aftasta kolonnan sigur, hvussu stórir partur av fiskinum í ymsu støddarbólkunum væntandi hevur gýtt minst einaferð.

	Kruvd vekt (kg)	Aldur (ár)	Longd (cm)	Búgvín
Stødd 1	1,0+	5-11+	41-61+	92-100%
Stødd 2	0,5-1,0	4-6	37-44	86-89%
Stødd 3	<0,5	3-5	30-36	54-92%

stovninum í føroyskum øki.

Tá Havstovan ger yvirlitstrolingar á Landgrunninum, fæst reyðsprøka sum hjáveiða. Hendan cpue-serian síðani mitt í 1990'unum vísir sum heild ein lítlan vøkstur av reyðsprøku (Mynd 9).



Mynd 9. Veiða upp á roynd av reyðsprøku á yvirlitstrolingum á Landgrunninum hjá Magnusi Heinasyni um várið (1994-2022) og um summarið (1996-2022).

Keldur

Mouritsen, R. 2007. *Fiskur undir Føroyum.*

Jákupsstovu, S. H. í, 2004. *Fiskiskapur við Føroyar í 100 ár. Úrdráttir úr hagtølum frá ICES.*

Tåning, A. V. 1943. *Fiskeri- og Havundersøgelse ved Færøerne.* Skrifter udgivet af Kommissionen for Danmarks Fiskeri- og Havundersøgelser. No. 12.

Annex 9 – Fish facts information sheet from 2022 – Lemon sole

TUNGA

Microstomus kitt

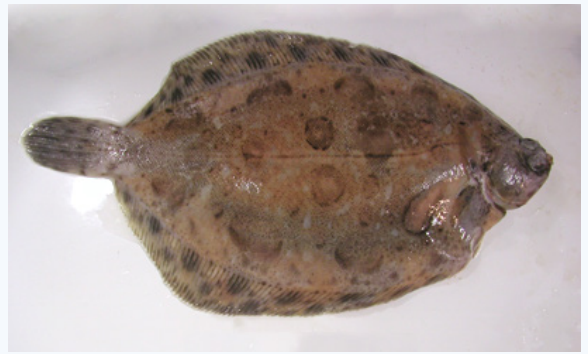
Serføroyskur fiskastovnur

Gagnfiskur

Botnfiskur

Elsta aldursgreinaða tunga undir Føroyum: 24 ár

Longsta mátaða tunga undir Føroyum: 56 cm

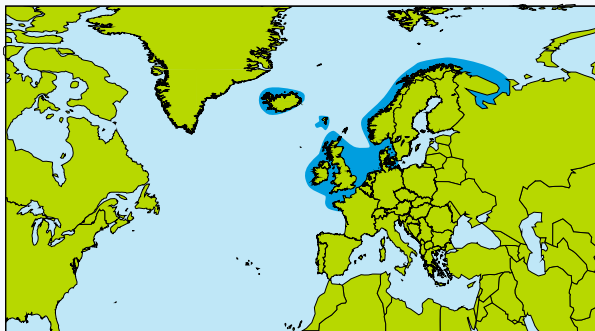


Lívfrøði

Tunga er høgravendur flatfiskur. Hon hevur eina ryggfjørður frá vinstra eyga aftur til klingruna, eina gotfjørður frá gotinum aftur til klingruna, smáar búk- og uggaðar, nógv rundaðan stert og smáar roðslur. Strikan hjá tungu er bert eitt sindur bogin yvir uggaðar. Tunga hevur sermerktan lítlan kjaft við lutfalsliga stórum granum. Kjaftklovin røkkur ikki aftur undir eygað. Tunga er slipur og smeðin fiskur.

Útbreiðsla

Tunga er undir Føroyum og Íslandi. Hon er í Hvítahavinum, vestur og suður við norsku strondini, suður í syðra part av Eystarasalti. Hon er í Norðsjónum, runt Bretsku Oyggjarnar og suður í Biskeiavíkina (Mynd 1).



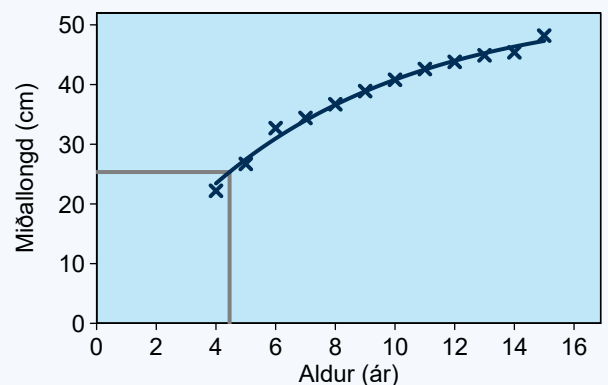
Mynd 1. Útbreiðsla av tungu.

Tunga er botnfiskur, sum best dámar harðan botn ella grovan sand. Undir Føroyum er hon frá taraskóginum og út á góðar 200 m. Hon er eisini á Føroyabanka, Ytrabanka og á Ytstabanka. Eftir trolingini á landleiðini at døma er mest til á 100-200 m dýpi eystan fyri Føroyar.

Vøkstur

Í miðal er 5 ára gomul tunga 25 cm. 10 ára gomul er hon 38 cm, og 15 ára gomul 45 cm (Mynd 2).

Ymiskt er, hvussu tunga veksur ymsastaðni undir Føroyum. Bestur tykist vøksturin at vera í útnyrðingspartinum av Landgrunninum, eisini samanborið við



Mynd 2. Miðallongd móti aldri, mátað frá rannsóknarskipi í 2022. Víst er á, nær helvtin av tungunum eru kynsbúna at gýta fyrstu ferð.

vøksturin aðrastaðni t.d. undir Íslandi og í Norðsjónum. Undir Føroyum er vøksturin minstur á Føroyabanka.

Aldurin hjá tungu verður staðfestur við at telja árringar í nytrunum. Nytran hjá tungu er lutfalsliga lítil (Mynd 3).



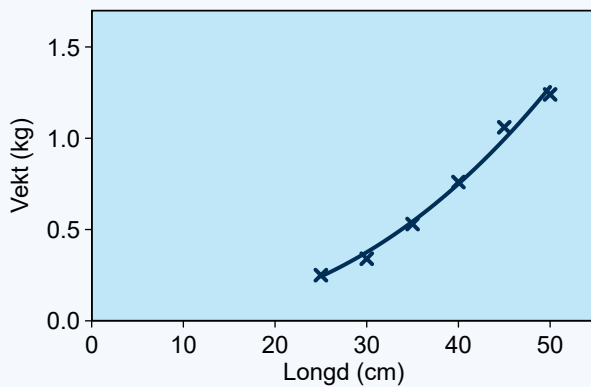
Mynd 3. Nytrur av 7 ára gamlari tungu

Tungunytran verður lisin í heilum líki av nytru, sum hevur ligið á bloti í vatni í minst eitt samdøgur. Á henda hátt gerast árringarnir sjónskari og lættari at lesa.

Longd móti vekt fyri allar støddir av landaðari tungu sæst í Mynd 4 á síðu 2. Miðalvektin á 35 cm og 50 cm langari tungu í kruvdari vekt í árunum 2015-2022 var ávíkavist umleið 0,5 kg og 1,2 kg.

Kynsbúning

Kvennfiskar kynsbúnast seinni (4-6 ár) enn kallfiskar (3-4 ár). Í miðal gýtir helvtin av tunguni fyrstu ferð umleið 4 ára gomul; tá er hon um 22 cm til longdar.



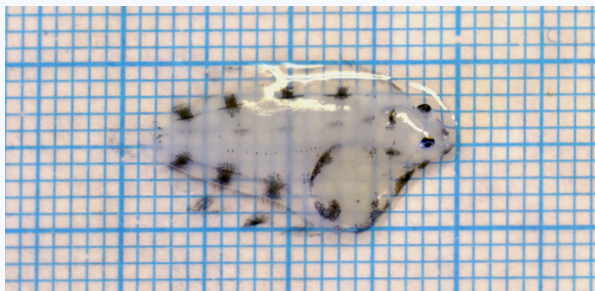
Mynd 4. Longd móti vekt mátað frá landingunum í 2015-2022.

Gýting

Gýtingartíðin er frá apríl til september, tó mest mitt um summarið, og hóast meginparturin gýtir norðanfyri, so fer gýting fram allastaðni, har tunga vanliga er.

Yngul og ungfiskur

Sum hjá øðrum toskafiskum so flotna tey gitnu rognkornini og eru at finna ovarlaga í sjónum eins og larvur og yngul (Mynd 5).



Mynd 5. Tunguyngul fingin við rannsóknarskipinum Magnusi Heinasyni á yngultúri síðst í juni, har trolað varð uppi í sjónum.

Tá yngulin er um 25 mm langur, leitar hann móti botni frá grunnum vatni og út á einar 150 m dýpi.

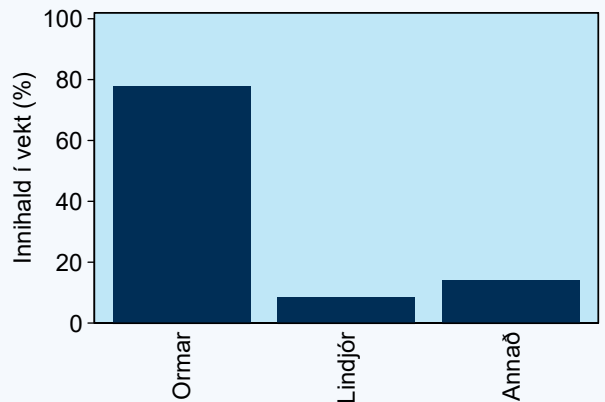
Ferðing

Tunga er stöðufastur fiskur, sum ikki ferðast víða. Merkingarroyndir undir Føroyum vóru gjørdar í 1930'unum av m.a. tungu, har ábendingar vóru um, at tungan inni á firðunum verður verandi har, men at tunga úti á Landgrunninum og bankunum kann ferðast ímóti høvuðsrákinum; tað er kring Føroyar ímóti klockuni. Bert ein einkult tunga í hesum merkingarroyndum ferðaðist tvørtur um sjóvarfalsfrontin. Óvist er, um hesar royndir eru tengdar at árligari ferðing á gýtingarøkið.

Føði

Føðin hjá tungu ber merki av, hvar tunga heldur til, og eisini hvat hon er før fyri at eta við líttla kjaftinum.

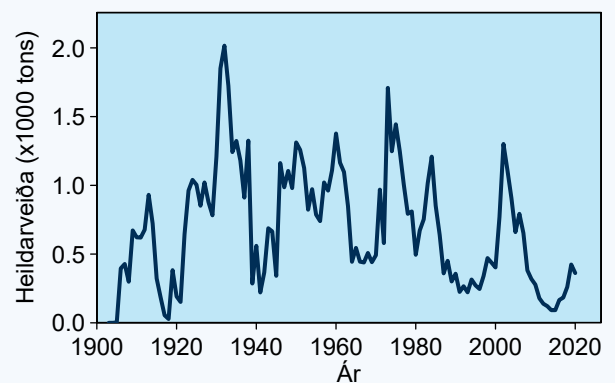
Einamest etur hon bustormar (Mynd 6), sum hon finnur millum sandkornini. Tunga etur tó eisini m.a. lítlar kræklingar, slangustjørnur og ymisk smá krabbadjór. Hildið verður, at tunga niðursetur evnaskiftið um veturin tá smáfrøgt er, og møguliga fer hon heilt í vetrardvala.



Mynd 6. Føðin í vekt í tungumagum býtt í høvuðsbólkar árin 2020-2022.

Veiða

Heildarveiðan av tungu undir Føroyum síðani 1903 er víst á Mynd 7. Við jøvnum millumbilum hevur veiðan verið um 1.000 tons, men er síðani minkað aftur. Miðalveiðan síðstu øldina hevur verið um 750 tons. Mest varð fiskað fyrst í trítíárunum, um 2.000 tons.



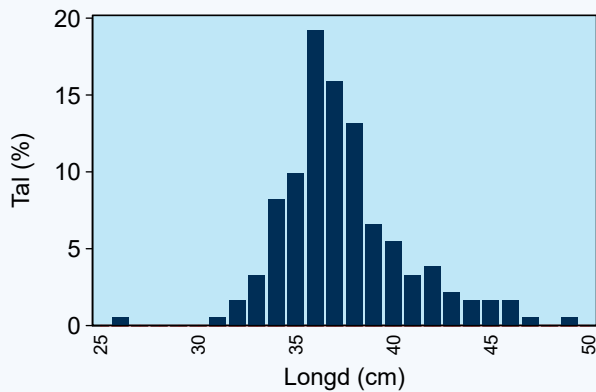
Mynd 7. Heildarveiðan av tungu undir Føroyum 1903-2022 í rundari vekt.

Einki tíðarskeið síðani fyrst í tjúguárunum hevur so lítið verið fiskað av tungu sum árin 2011-2018.

Í dag er tað einamest trolbátarnir í bólki 4T, sum fiska tungu við beinleiðis fiskiskapi eftir flatfiski á landleiðini um summarið. Tunga verður tó eisini fiskað sum hjáveiða hjá partolarunum og útróðrabátum við línu.

Longdarbýtið í tunguveiðuni undir Føroyum í 2022 er víst á Mynd 8. Meginparturin av tunguni í veiðuni var yvir 34 cm langur. Miðallongdin var umleið 36 cm.

Á landingarmiðstöðunum kring landið verður tunga bólkað í trýggjar stöddarbólkar, alt eftir vekt (Talva 1).



Mynd 8. Longdarbýtið í tunguveiðuni undir Føroyum í 2022.

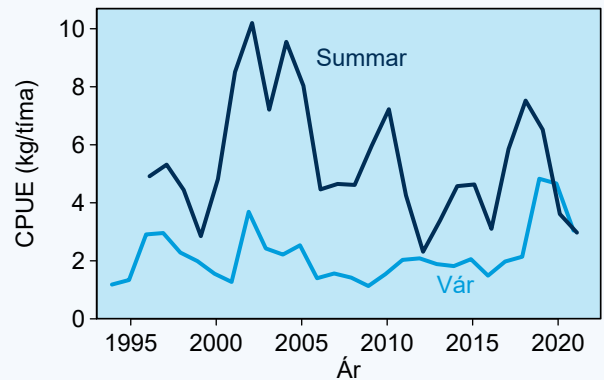
	Kruvd vekt (kg)	Aldur (ár)	Longd (cm)	Búgvín
Stødd 1	1,0+	8-12+	42-47+	95-100%
Stødd 2	0,5-1,0	6-10	35-42	75-98%
Stødd 3	<0,5	5-8	30-35	50-90%

Talva 1. Umrokningartalva út frá støddarbólkum. Virðini byggja á tøl fyri árinum 2014-2022. Aftasta kolonnan sigur, hvussu stórir partur av fiskinum í ymsu støddarbólkunum væntandi hevur gýtt minst einaferð.

Stovnsmeting

Ongin stovnsmeting verður gjørd fyri tungu við Føroyar. Tøl frá "veiðu upp á roynd" (cpue) kunnu nýtast til at geva eina ábending um, hvussu støðan er hjá stovninum í føroyskum øki.

Tá Havstovan ger yvirlitstrolingar á Landgrunninum um várið og summarið, fæst tunga sum hjáveiða. Hendan cpue-serian síðani mitt í 1990'unum vísir sum heild lítlar broytingar í stovnsstøddini (Mynd 9). Í árunum 2000-2002 var ein stórus vækstur í veiðuni, eins og í 2017-2018. Hesi árin vóru eisini sermerkt fyri aðrar fiskastovnar og vistskipanina á landgrunninum.



Mynd 9. Veiða upp á roynd av tungu á yvirlitstrolingum á Landgrunninum hjá rannsóknarskipinum hjá Havstovuni um várið (1994-2022) og um summarið (1996-2022).

Keldur

Mouritsen, R. 2007. *Fiskur undir Føroyum*
Jákupsstovu, S. H. í, 2004. *Fiskiskapur við Føroyar í 100 ár. Údráttir úr hagtølum frá ICES.*
Rae, B.B. 1965. *The Lemon Sole.* The Whitefriars Press Ltd, London.
Tåning, A. V. 1943. *Fiskeri- og Havundersøgelse ved Færøerne.* Skrifter udgivet af Kommissionen for Danmarks Fiskeri- og Havundersøgelser. No. 12.

