Northumberland IFCA
Inshore Fisheries and Conservation Authority

Aln Estuary Fish Survey Report (2015 - 2025)

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Contents

Summary 1
Introduction 3
Methods 3
Study Site 3
Survey Methodology 4
Results 6
Aln Survey (2025) 6
Species & Sampling Abundances 6
Mean Length 7
Aln Surveys (2015-2025) 8
Species Diversity 8
Fish Abundance 9
Species Length 11
Spatial & Temporal Species Variances 11
Salinity and Temperature 13
Discussion 15
Species Diversity & Abundances 15
Species Spatial and Temporal Trends 16
References 19

Figures

Figure 1 | Main Map: Aln Estuary MCZ EUNIS L3 habitat classification & 2025 sample sites. 5
Figure 2 | Measuring & identifying fish during the 2025 Aln Estuary survey. 5
Figure 3 | The relative abundance of the recorded species in the 2025 Aln Estuary surveys. 6
Figure 4 | The spatial abundance of the recorded species in the 2025 Aln Estuary surveys. 6
Figure 5 | Annual Shannon Diversity and Evenness Index scores for the Aln Estuary surveys 8
Figure 6 | 2015 – 2025 abundances for most dominant speciesl 9
Figure 7 | 2015 – 2025 abundances for other commercially important species. 10
Figure 8 | Volinplot displaying Spatial & temporal species variance of catch composition 2015 – 2025 12
Figure 9 | Salinity & Temperature measurements 14
Figure 10 | Spearman correlation scatterplots displaying temperature and salinity associations 15

Tables

Table 1 | Total catch, mean length, and size at maturity for commercially important species 7
Table 2 | Total catch and mean length for the non-commercially important species 7
Table 3 | Bray- Curtis Index showing the species population similarity. 11
Table 4 | Salinity and temperature measurements recorded at each sampling site 13

Annex

Annex I: Length frequency graphs 22
Annex II: Distribution & seasonality of most dominant species 24
Annex III: Life history strategies & fishery exploitation of dominant species 26
Annex IV: Transparent underside of one of the juvenile plaice recorded in the Aln Estuary Spring 2023 survey 28

Summary

The aim of the biannual Aln Estuary fish survey is to understand the fish species present in the estuary and the role it plays as an important spawning and nursery ground for North Sea fish species. The surveys identify the species present, collect biometric data, and quantify the abundances of fish communities at specific survey sites. These data are compared with previous years to assess the significance of the site as a nursery area and to monitor temporal change. Additional information on the physio-chemical properties of the estuary, for temperature and salinity, is also collected. The fish surveys follow the Environment Agency's Transitional and Coastal Monitoring (TrAC) method. Over the ten-year period, 8,959 fish have been identified, of which 5,649 (63%) biometric measurements have been taken.

Key results for the 2025 survey are:

- 680 fish were caught, including 11 commercial species and one non-commercial species identified to genus level.
- European seabass was recorded for the first time at the mouth of the estuary during the Spring survey.
- Of the 419 commercial fish measured, 81% were below their respective size of maturity (SOM).
- Salinity levels were higher than average across all sampling sites during the Spring survey.
- 2025 temperatures were the highest recorded in the survey to date, reaching 16°C in Autumn.

Key findings over all surveys (2015 – 2025) are:

- 25 species have been recorded in the Aln Estuary to date, 16 of which are commercially important.
- The lesser sandeel, Atlantic herring, goby spp., and European flounder are the most dominant species recorded.
- The estuary's protected habitats support distinct spatial patterns in species distributions, reflecting differences in habitat preference and life-history strategy.
- 87% of commercial species measured were below their SOM, with clear seasonal juvenile development evident in Atlantic herring, flounder and plaice — highlighting the continued significance of the Aln Estuary as a nursery ground.
- Both the Species Diversity Index (±0.519) and the Evenness Index (±0.220) have remained consistent over the ten-year period, indicating a stable fish assemblage.

Acknowledgments

NIFCA would like to express their sincere appreciation to all the volunteers who have given their time to assist with data collection. Without their help, it would not have been possible to complete this survey.

Introduction

The Aln Estuary Marine Conservation Zone (MCZ) is the smallest designated MCZ in the UK, covering 38.5 hectares. Designated in 2013, the site extends from the upper tidal limit at Lesbury to the estuary mouth adjacent to Alnmouth on the Northumberland coast (Figure 1). The estuary harbour is used to anchor small pleasure and fishing boats and is a popular destination for tourists and recreational sea anglers.

The Aln Estuary MCZ encompasses a variety of habitats, including intertidal mud, sheltered muddy gravels, coastal saltmarshes, saline reedbeds, and estuarine rocky habitats (Net Gain, 2011). All designated features have a conservation objective to be maintained in favourable condition. These habitats provide important spawning and nursery areas for fish species and support migratory and over-wintering birds. Under Section 154 of the Marine and Coastal Access Act (MaCAA), NIFCA has a responsibility to manage MCZs and ensure their conservation objectives are met and furthered. Given the estuary's location, the Environment Agency (EA) also undertakes monitoring for Water Framework Directive (WFD) compliance.

The TrAC fish surveys focus on collecting juvenile abundance data to determine whether the estuary functions as an important nursery ground. According to Heupel et al. (2007), nursery grounds are characterised by: (1) greater site fidelity, (2) repeated annual use, and (3) higher juvenile abundances relative to surrounding areas. Estuary depth is another factor to consider; small fish, including juveniles, are most abundant in shallow areas, which can enhance survivorship and growth (Manderson et al., 2004). However, some predators are not restricted to deeper waters by size or behaviour (Manderson et al., 2004; Linehan et al., 2001).

NIFCA conducted a pilot juvenile/small-fish survey in May 2012 to improve understanding of the estuary prior to MCZ designation due to its potential importance for juvenile fish. Since 2015 (excluding 2020 due to the COVID-19 pandemic), NIFCA has undertaken biannual surveys—in late Spring and early Autumn—to monitor fish population dynamics. This report analyses the 2025 survey data and compares it with earlier surveys to identify emerging trends within this ecologically significant habitat.

Methods

Study Site

The study site is located within the Aln Estuary along the northeast coast of Northumberland (Figure 1). Two types of nets—seine and fyke—were deployed to encompass a 24-hour sampling regime across three locations: the mouth of the estuary, below the anchorage, and at an upstream site. These sites were selected to capture the greatest range of species, reflecting the variation in salinity and habitat types across the estuary.

Survey Methodology

Two-day surveys were conducted on 22–23 May and 2–3 September 2025 to coincide with the spring and autumn migrations of juvenile fish species (Ibbotson et al., 2013).

Sampling Nets

Seine Nets: an estuary seine net measuring 43 m in length and 4 m in depth (210/12 with 6.5 mm and 14 mm mesh sizes), fitted with floats on the head rope and no lead weights on the footrope, was deployed from the boat. The first tow line was secured ashore, after which the net was deployed in a wide arc before returning to the shore (FAO, 2013). The seine net was then pulled ashore by the survey team (Environment Agency, 2011), ensuring continuous contact between the ground rope and the estuary bed to prevent fish escaping (FAO, 2013).

Fyke Nets: Two fyke nets, consisting of interconnecting nets held open by metal rings with a one-way entrance, were used. They comprised 10 mm and 14 mm mesh, with a depth of 100 cm and a combined length of 2 × 5.3 m, connected by a 10-m centre leader net. The fyke net opening was attached to the leader, guiding fish through the mouth and into the interconnecting nets and ultimately into the cod-end. The upstream end of each fyke net was positioned first, followed by the rest of the net being lowered downstream at an approximate 30° angle. Once submerged, the nets were pulled taut using the buoy rope.

Sampling Schedule

- Day One: Fyke nets were set at mid-tide using a small boat, with locations selected to prevent exposure at low tide. Nets were left to soak for 24 hours. Seine net surveys were then carried out at the two downstream sites, with each location sampled twice.
- Day Two: Fyke nets were recovered at mid-tide, and seine netting was conducted at the upstream site

Sampling processing

For all surveys, fish were removed from the nets and placed into buckets of oxygenated water collected at each site. Species were identified to the lowest possible taxonomic level using the Environment Agency (2009) manual *“Key to the Marine and Freshwater Fishes of Britain and Ireland.”* The first 50 individuals of each species were measured from mouth to tail tip to the nearest millimetre using a fish measuring board (Figure 2). After processing, fish were returned to the estuary. For seine net sampling, fish were only returned after the second net had been set to prevent recapture.

Temperature and salinity were recorded at each site at the time of sampling using a thermometer and salinity refractometer. Although the survey has been running since 2012, usable abundance and length data are only available from 2015 onwards, and abiotic data from 2019 onwards

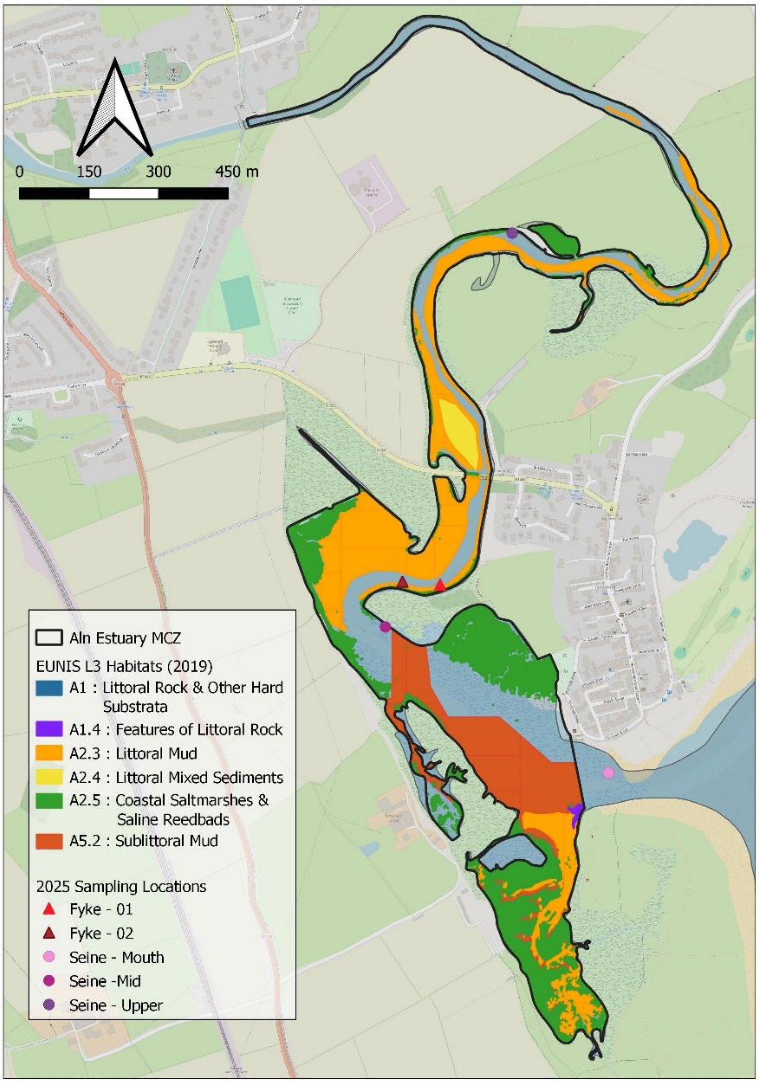


Figure 1 | *Main Map: Aln Estuary MCZ EUNIS L3 habitat classification (Pre 2022 Review) & 2025 sample sites. Map Insert: Location of Aln Estuary MCZ in NIFCA's District in the UK.*

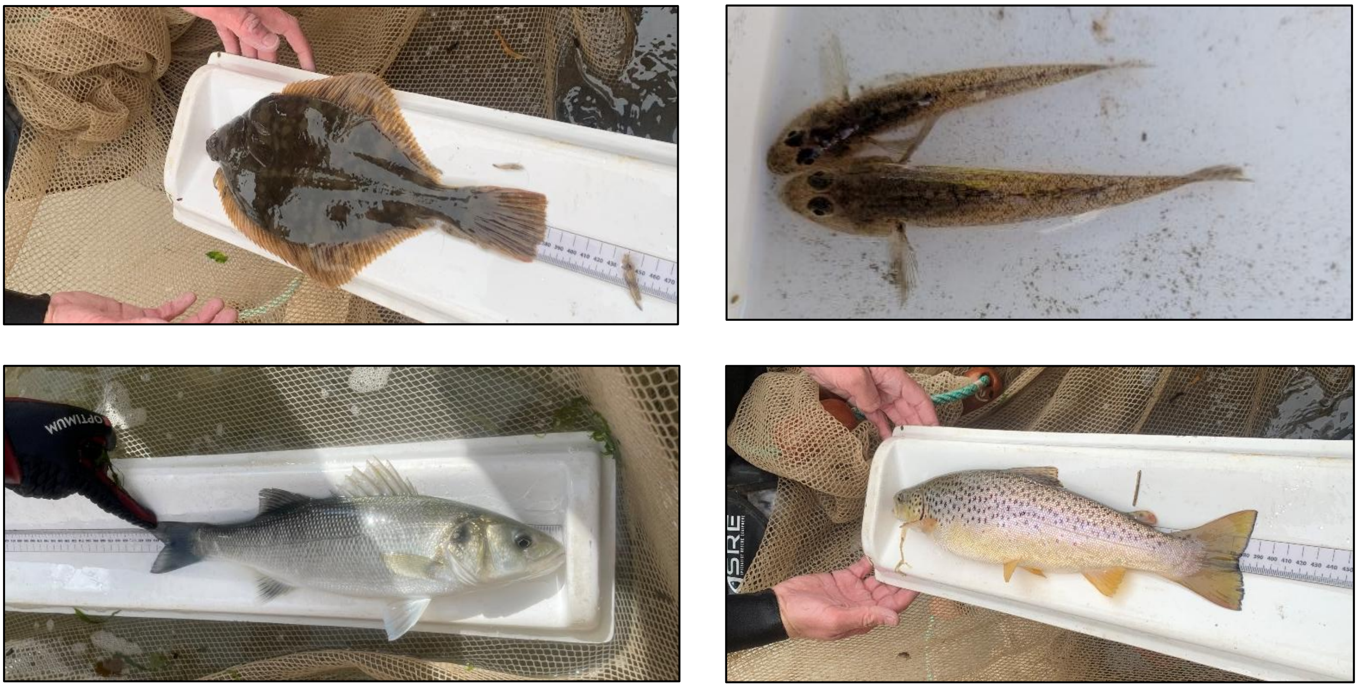


Figure 2 | *Measuring & identifying fish during the 2025 Aln Estuary survey. From top left going clockwise: flounder, goby Sp., sea trout and sea bass. Photos ©NIFCA and ©Liam Johnson*

Results

Aln Survey (2025)

A total of 680 individuals were collected and 419 individuals measured during the Aln Estuary 2025 surveys. Overall, 11 species were identified to species level, and gobies were recorded to genus level as either common goby (Pomatoschistus microps) or sand goby (Pomatoschistus minutus). Because goby identification in previous years varied between species- and genus-level classification, all goby records have been grouped to genus level to enable consistent comparative analysis across survey years.

Species & Sampling Abundances

More individuals and species were caught during the Autumn survey (*n* = 468; 11 species) compared to the Spring survey (*n* = 212; 6 species). The majority of fish were caught at the mouth sampling site (*n* = 334; 49%) (Figure 4). Six species were recorded in both surveys, and European seabass (*Dicentrarchus labrax*) was recorded for the first time in the Aln Estuary during 2025. All but one species recorded were of commercial importance, representing 79% of the overall catch composition.

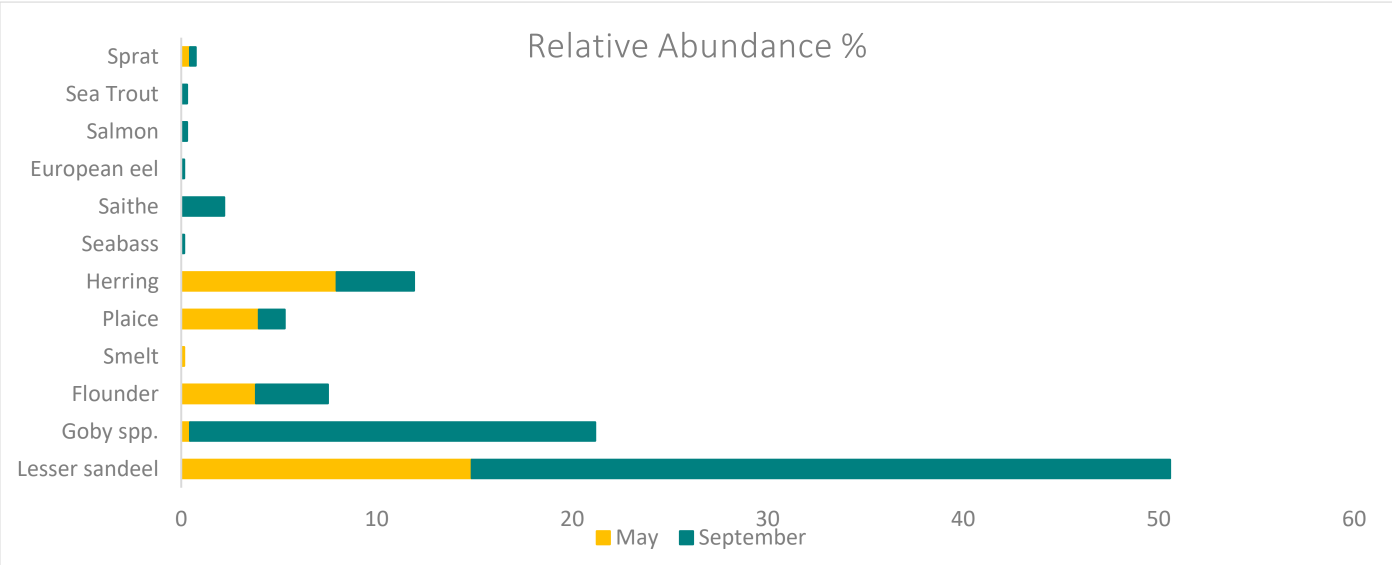


Figure 3 | The relative abundance of the recorded species in the 2025 Aln Estuary surveys.

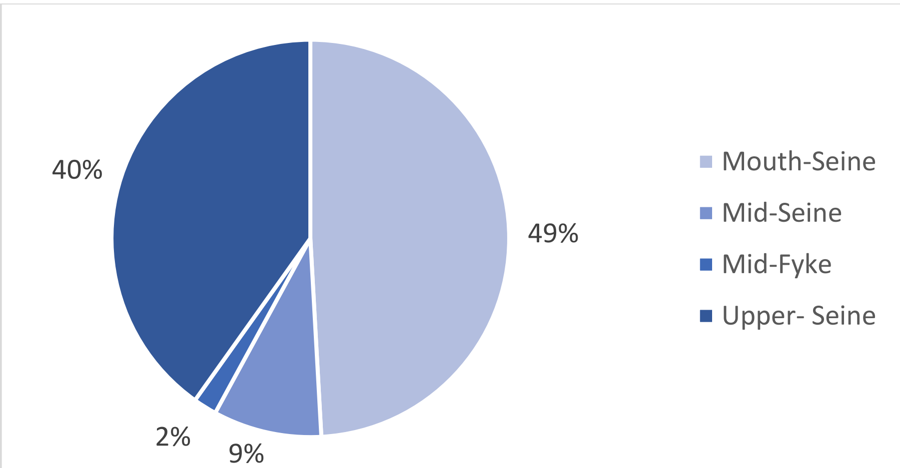


Figure 4 | The spatial abundance of the recorded species in the 2025 Aln Estuary surveys.

Mean Length

Of all commercially important fish measured in 2025 (n = 419; Table 1), 16% (n = 66) were recorded above their respective size of maturity (SOM). The remaining 84% (n = 353) were classified as juveniles, continuing the trend observed across the rolling 2015–2025 dataset, where mean lengths for all commercial species remained below SOM (Annex I), with the exception of trout and, for the first time, seabass. Although not a major target species, sand smelt has been included as a commercial species due to the presence of a small-scale fishery in specific regions of the UK. Only goby spp. represented non-commercial species recorded, with 96.5% measuring above SOM (Table 2).

Table 1 *| Total catch, mean length, and size at maturity for commercially important species from the 2025 Aln Estuary surveys. Rolling mean refers to the total mean for all individuals measured from 2015 to 2025*

Species	Number caught	Mean length (mm)	Rolling mean length (mm)	Size of maturity (mm)	Reference
Lesser sandeel (*Ammodytes tobianus*)	344	112	113	130	Froese & Pauly (2024a)
European flounder (*Platichthys flesus*)	51	119	73	110(m) – 170(f)	Skerritt (2010)
Sand Smelt (*Atherina presbyter*)	1	44	44	65(m) – 73(f)	Moreno (2005)
Plaice (*Pleuronectes platessa*)	36	53	59	350	MSEP (2014)
Atlantic herring (*Clupea harengus*)	81	60	62	175	Ellis *et al.* (2012)
European Seabass (*Dicentrarchus labrax*)	1	427	427	350(m) – 410(f)	ICES (2018)
Saithe (*Pollachius virens*)	15	163	154	554	Jennings et al. (1998)
European eel (*Anguilla anguilla*)	1	325	337	450 - 650	Froese & Pauly (2024b)
Salmon (*Salmo salar*)	2	503	207	500-800	Chaput (2012)
Sea Trout (*Salmo trutta*)	2	415	191	177 - 228	Taube (1976)
Sprat (*Sprattus sprattus*)	2	56	63	101	Froese & Pauly (2024c)
Total	536				

Table 2 *| Total catch and mean length for the non-commercially important species during the 2025 Aln Estuary surveys.*

Species	Number caught	Mean length (mm)	Rolling mean length (mm)
Goby spp. (Common/ Sand goby (*Pomatoschistus microps/ minutus*)	144	55	51
Total	144		

Aln Surveys (2015-2025)

Over ten years, 20 surveys have been carried out, consisting of 114 seine hauls and 38 fyke deployments across four sites within the Aln Estuary. In total, 8,959 fish have been caught, of which 5,438 (62%) have been measured, and 25 species have been identified, including both common and sand goby.

Species Diversity

The highest species diversity was recorded in 2015 and 2022, with 15 species (including goby spp.) identified in both years. Of these, 10 (63%) in 2015 and 11 (69%) in 2022 were commercially important species. The lowest diversity was observed in 2018, with 10 species (plus goby spp.), of which seven (64%) were commercial species. In 2025, species diversity was the second lowest recorded (12 species), similar to 2019; however, the majority—11 species (92%)—were commercially important.

To evaluate temporal changes in diversity, the Shannon Diversity Index (SDI) was calculated to compare species richness and abundance, and the Evenness Index (EI) was calculated to assess the distribution of individuals across species (Figure 5). SDI values showed low year-to-year variation, ranging from a maximum of H = 1.822 in 2021 to a minimum of H = 1.303 in 2022. In 2025, the SDI score was H = 1.441, slightly lower than the rolling average (H = 1.498).

EI values ranged from 0 to 1, with 1 representing maximum evenness. The results reflected similar temporal patterns to the SDI, with the highest EI (EH = 0.691) recorded in 2021 and the lowest (EH = 0.470) in 2022. The EI for 2025 was EH = 0.5799, slightly higher than the rolling average (EH = 0.5744), indicating the continued presence of dominant species within the estuarine fish community (see *Fish Abundance*). Both the SDI (±0.519) and EI (±0.220) have remained consistent over the ten-year period, demonstrating a stable estuarine fish community.

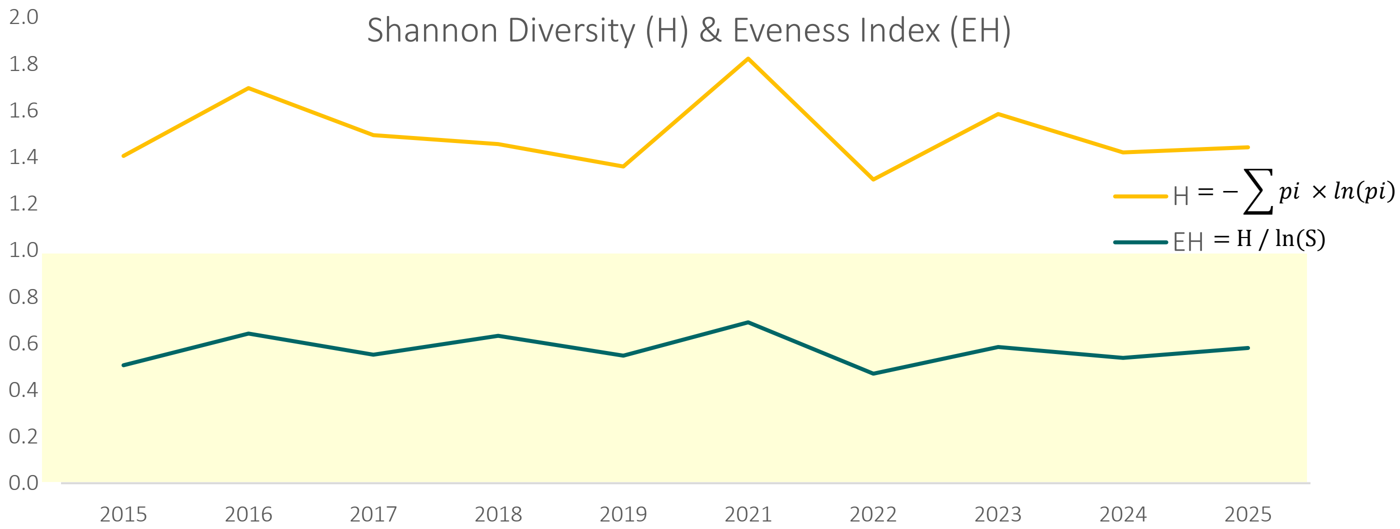


Figure 5 | Annual Shannon Diversity and Evenness Index scores for the Aln Estuary surveys. Pale yellow box represents the EH scale range on the y-axis, 0-1.

Fish Abundance

Each year, certain species dominate the catch composition. The lesser sandeel (*n* = 2,734), Atlantic herring (*n* = 2,483), and goby spp. (*n* = 1,550) together account for 76% of all individuals recorded (Figure 6). These species have been recorded in every survey year, along with European flounder (*n* = 814), saithe (*n* = 116), and European eel (*n* = 32) (Figure 7)

Six species have been recorded only once during the ten-year monitoring period: dab (2015), pipefish (2016), four-bearded rockling (2021), thick-lipped grey mullet (2022), pollock (2024), and sea bass (2025).

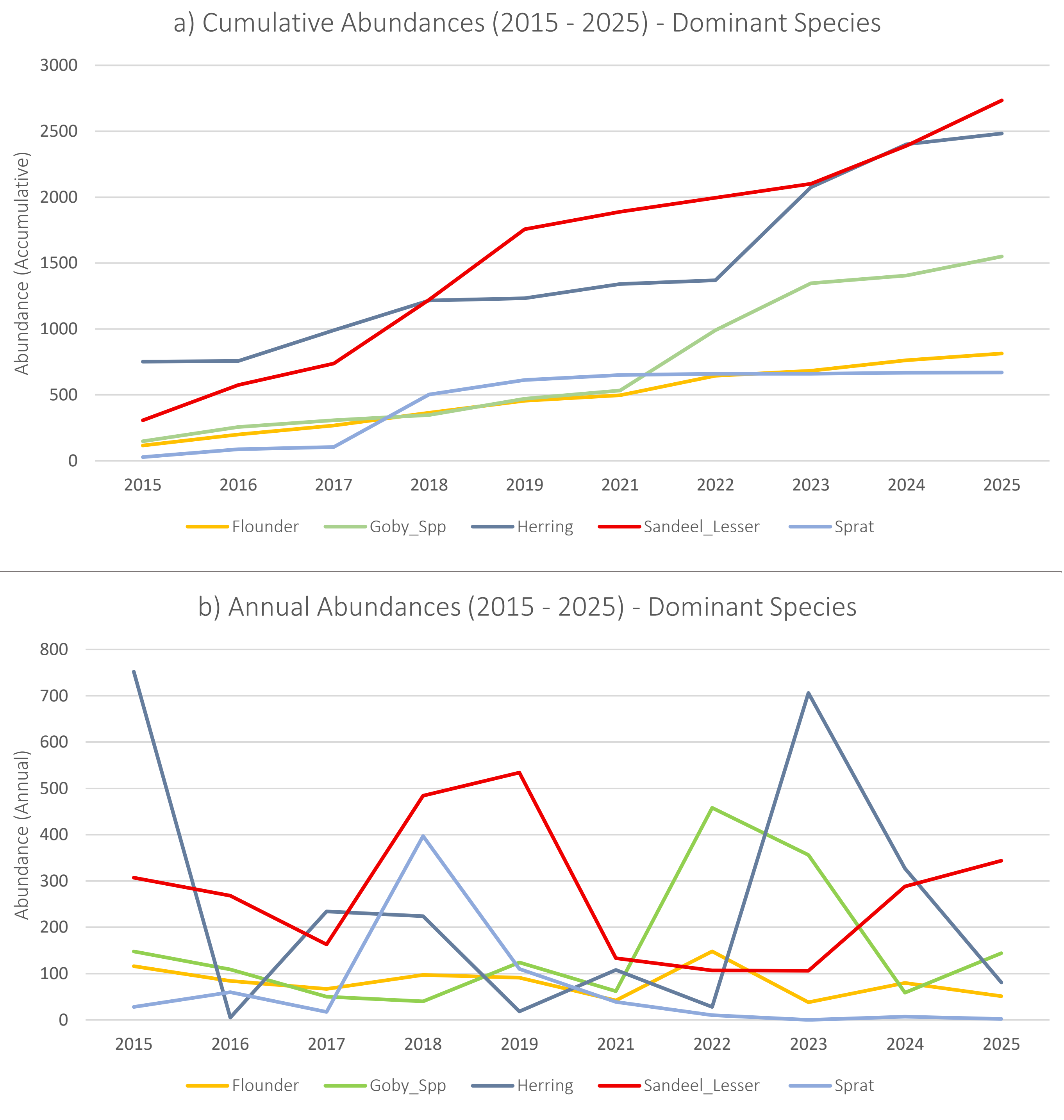


Figure 6 | 2015 – 2025 abundances for most dominant species (a) accumulative and (b) annual

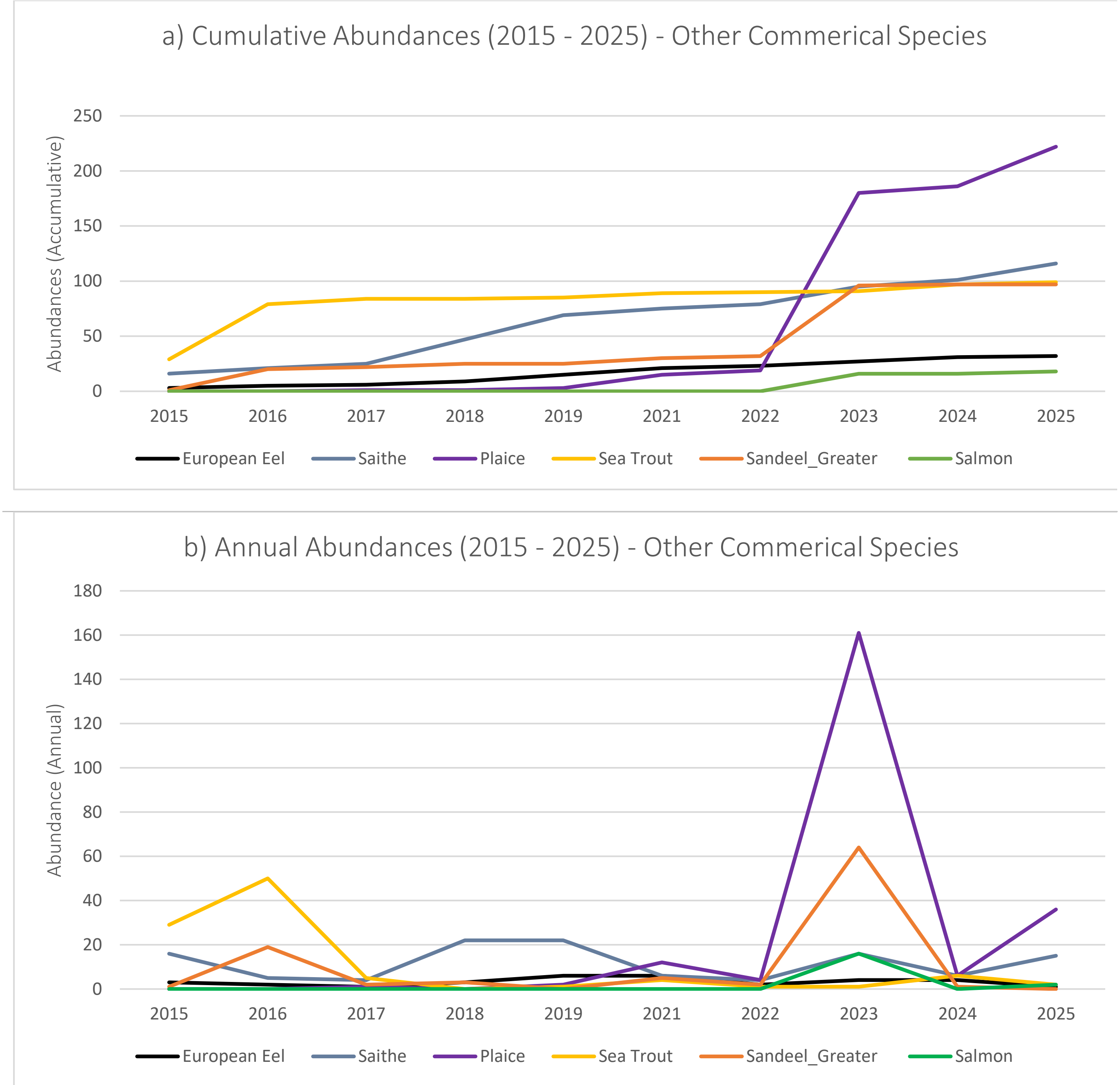


Figure 7 | *2015 – 2025 abundances for other commercially important species (a) accumulative and (b) annual.*

Bray–Curtis Index (BCI) scores provide a comparison of inter-annual species presence and absence, along with their associated abundances, between each survey year (Table 3). The 2025 catch composition was most similar to 2019 (70% similarity) and least similar to 2023 (37% similarity). Overall, the similarity percentages reveal a broad range of inter-annual variation, with the highest similarity recorded between 2017 and 2024 (80%), and the lowest between 2019 and 2023 (26%). Despite this variability, the average similarity across the ten-year period is 52.1%, indicating a moderate level of similarity between annual catch compositions.

Table 3 | Bray- Curtis Index showing the species population similarity for species composition & abundance comparison between each annual survey. Highlighted percentages represent the highest (Green) and lowest (Red) scores.

	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
2015	-	-	-	-	-	-	-	-	-	-	-
2016	53%	-	-	-	-	-	-	-	-	-	-
2017	56%	55%	-	-	-	-	-	-	-	-	-
2018	54%	50%	57%	-	-	-	-	-	-	-	-
2019	51%	71%	45%	70%	-	-	-	-	-	-	-
2020	-	-	-	-	-	-	-	-	-	-	-
2021	42%	58%	75%	44%	46%	-	-	-	-	-	-
2022	39%	48%	41%	28%	43%	-	44%	-	-	-	-
2023	70%	28%	43%	31%	26%	-	36%	38%	-	-	-
2024	71%	62%	80%	63%	55%	-	61%	38%	49%	-	-
2025	58%	69%	58%	55%	70%	-	62%	47%	37%	67%	-

Species Length

Across the ten-year surveying period, 87% of all measured individuals (*n* = 3748/4333) were classified at juveniles (Annex I). All measured Atlantic herring, plaice, and saithe were below their respective sizes of maturity, indicating that only early life-stage cohorts of these species utilise the estuary. Other species which populations recording consistently high numbers of juvenile individuals are lesser sandeels, and 78.7%, European flounder, 90% (female) 82% (male). For European eels all lengths measured between 186mm – 505mm which is indicative of eels in the yellow- stage, the longest growth stage (5- 20years) before their maturation and migration to their spawning grounds in the Sargasso Sea.

Spatial & Temporal Species Variances

Inter- and intra-seasonal, as well as site-specific, differences in species are evident for certain species (Figure 8). Temporally, larger average lengths are recorded for herring and goby spp. across all survey sites in autumn compared to spring surveys, and for flounder and plaice at the upper site. This indicates that older cohorts are present later in the year, demonstrating population development between the surveys. Spatially for the flatfish species and to a lesser extent for herring and goby spp, the upper site records the smaller (younger) individuals across the Aln Estuary.

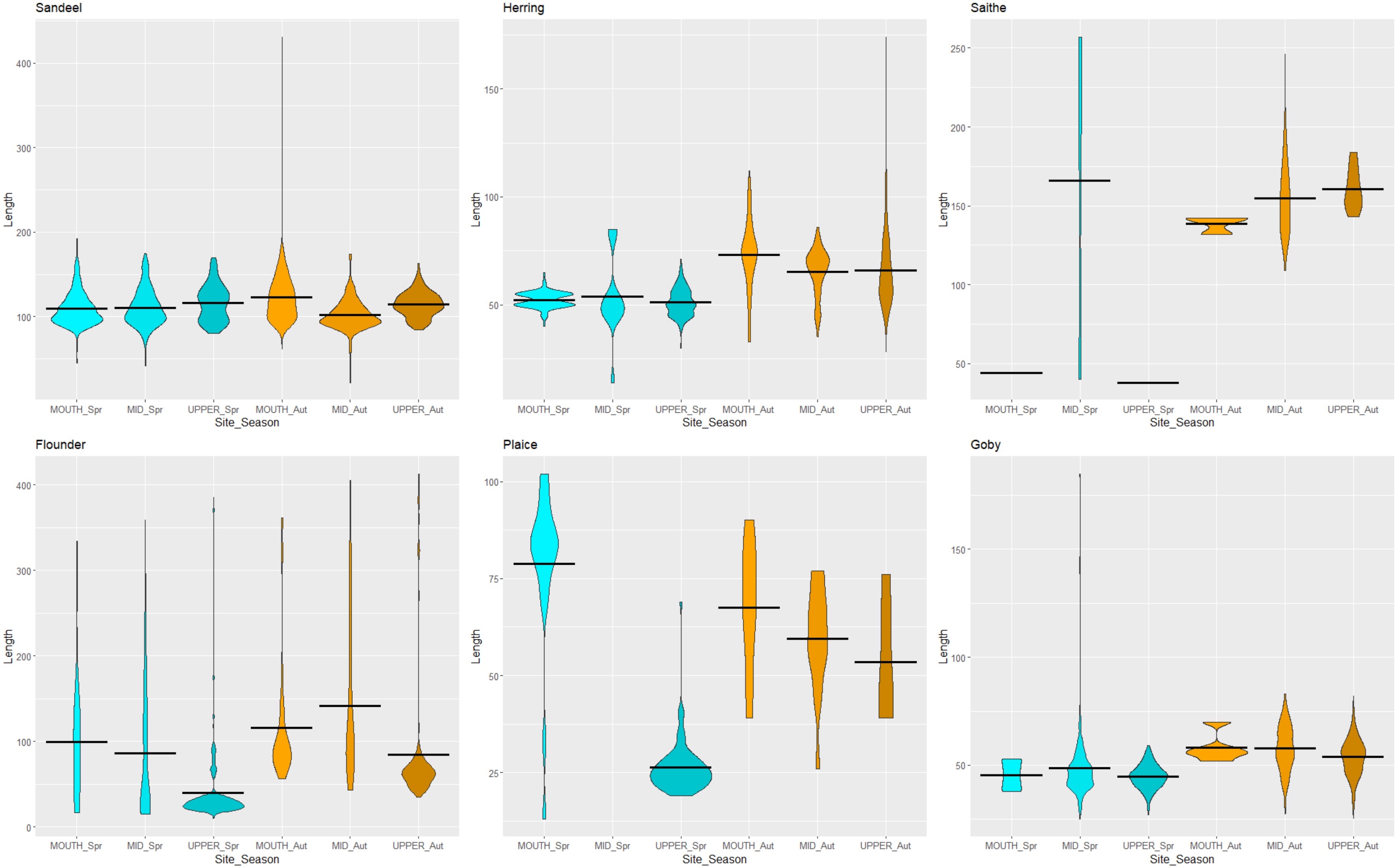


Figure 8 | Violin plot displaying Spatial & temporal species variance of catch composition 2015 – 2025

Salinity and Temperature

Temperature values (Table 4) varied slightly between sites in Spring (±1 °C) and Autumn (±2 °C), consistent with previous years (average ±1.57 °C). The highest temperature recorded during the 2025 surveys was 16 °C at two sampling sites in Autumn, which also represents the highest temperature recorded across all surveys to date. The previous maximum of 15 °C occurred in 2019, 2022, and 2023, all during Autumn surveys.

Salinity followed the expected profile, decreasing from the mouth — where marine influence is strongest — to the upper sites, which are more strongly influenced by freshwater input. However, in 2025 this gradient was less pronounced. Spring measurements showed only an 11 ppt difference between the mouth and upper site (average 17.5 ppt), representing the second-lowest salinity gradient recorded in the dataset; the lowest was 10 ppt in 2023.

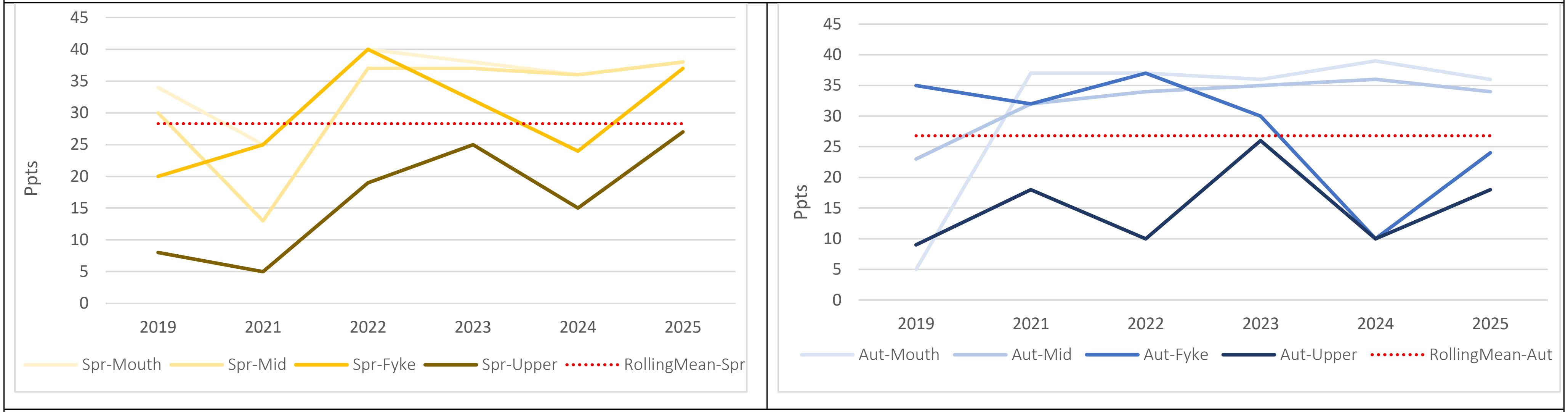
When comparing 2025 averages with the rolling mean (2019–2025), all values except Spring temperature (−0.18 °C) were higher than average. The most notable deviation was the Spring salinity average, which was +6.781 ppt above the rolling mean, followed by a smaller increase in Autumn salinity (+1.21 ppt) and Autumn temperature (+1.85 °C) (Figure 8).

Table 4 | Salinity and temperature measurements recorded at each sampling site during the 2025 Aln Estuary surveys.

	Temperature (C°)		Salinity (ppt)	
	Spring	Autumn	Spring	Autumn
Seine – mouth	12	16	38	36
Seine – mid	12	16	38	34
Fyke – mid	11	14	37	24
Seine – upper	12	15	27	18
Mean value	**11.75**	**15.25**	**35.00**	**28.00**
Rolling Mean (2019 – 2025) [1]	**11.93**	**13.40**	**28.29**	**26.79**

Using Spearman's correlation, neither temperature nor salinity recorded in the Aln Estuary showed a statistically significant influence ($p > 0.05$) on the fish assemblages (Figure 10). Temperature displayed a very weak positive correlation with total abundance ($R = 0.17$) and a very weak negative correlation with species richness ($R = –0.028$). For salinity, both abundance and species richness exhibited weak negative correlations, with correlation coefficients of $R = –0.23$ and $R = –0.32$, respectively. These results indicate that, within the range of temperatures (10–16 °C) and salinities observed in the estuary, neither variable demonstrates a strong or consistent effect on fish community structure.

SALINITY (2019 – 2025)[1]



TEMPERATURE (2019 -2025)[1]

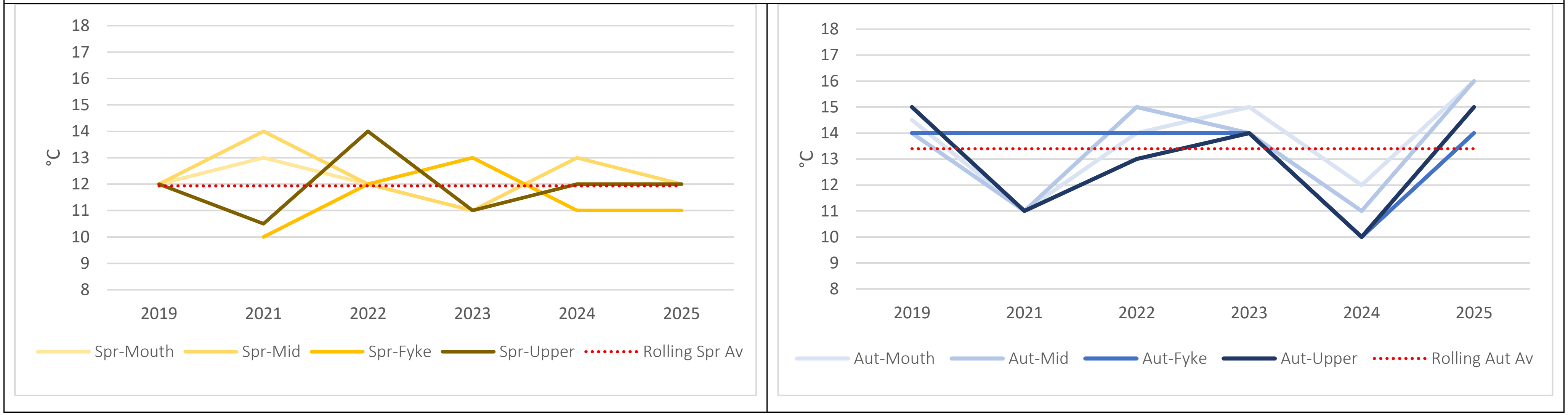


Figure 9 | Salinity & Temperature measurements taken from each sampled site per year for Spring (left) and Autumn (right) surveys.

[1] No 2020 data due to COVID pandemic

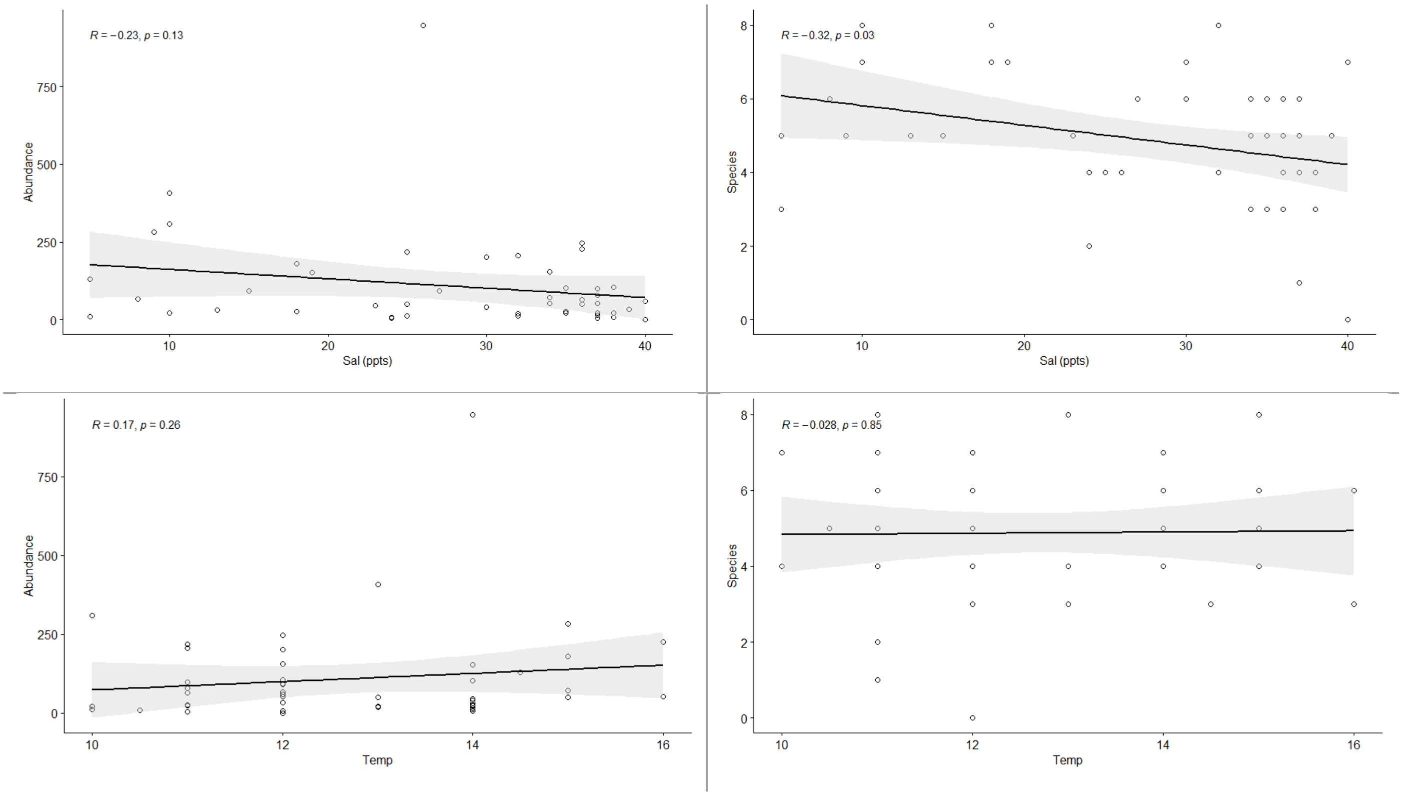


Figure 10 | Spearman correlation scatterplots displaying temperature and salinity associations with abundance and species richness from 2019-2025[2] surveys.

Discussion

Species Diversity & Abundances

Across ten years of monitoring, the Aln Estuary has demonstrated a stable fish assemblage, despite natural variability in annual abundances. Species richness has remained consistently within a narrow range (10–15 species per year), and both the Shannon Diversity Index (SDI) and Evenness Index (EI) show low inter-annual variation, indicating long-term ecological stability in the estuarine community. Dominant species including lesser sandeel, Atlantic herring, goby spp., flounder, and saithe remain consistently represented across survey years, reinforcing the estuary's role as a reliable juvenile habitat.

The 2025 survey recorded slightly lower species richness relative to the long-term average, though the proportion of commercially important species was still high. Although Bray–Curtis similarity scores indicate some variability in annual catch compositions, this degree of fluctuation is typical of estuarine fish communities and is influenced by seasonal migrations, recruitment strength, and catchability. Importantly, the dominant species have remained consistent, suggesting no directional shifts in core community structure.

[2] No 2020 data due to COVID pandemic

Species Spatial and Temporal Trends

The long-term dataset shows that three species lesser sandeel, Atlantic herring, and goby spp. account for more than three-quarters of all individuals recorded. These species, along with other regularly recorded species, exhibited clear spatial and seasonal patterns (Annex II) in 2025 that align with previously documented life-history strategies (Annex III), highlighting the importance of the estuary's habitat heterogeneity. Temporal patterns particularly seasonal differences in size distributions support the interpretation of the estuary as a nursery ground, where early life stages gradually migrate downstream as they grow.

Lesser sandeel abundance has historically peaked in spring, reflecting their emergence from winter burial (van der Kooij et al. 2008; Henriksen et al. 2024). However, in 2025, unusually high autumn abundances were observed. This contrasts with the typical onset of overwintering behaviour and may reflect the unusually warm and bright summer conditions recorded regionally. Consistently, the majority of sandeels (86.3%) were caught at the mouth and mid-estuary sites, reflecting a strong spatial preference likely driven by habitat availability (Régnier et al. 2018; Holland et al. 2005), particularly sandy sediments, which they favour for burrowing (Henriksen et al. 2024). These substrates occur at the mouth and mid-estuary sampling locations (Figure 1). The lengths of lesser sandeels remained below the size of maturity for the vast majority of individuals, reaffirming their use of the estuary as a juvenile habitat.

Juvenile Atlantic herring continue to show a strong association with the upper estuary, consistent with known preferences for muddy, saltmarsh habitats (Green et al. 2012; Stamp et al. 2022). Seasonal differences in length (spring mean = 51.7 mm; autumn mean = 67.0 mm) reflect the annual cycle of autumn-spawned cohorts (Henderson 2014). Juveniles are known to tolerate a broader salinity range than adults, with tolerance narrowing as they mature and migrate back to marine waters (Stevenson & Scott 2005). This ontogenetic shift was not evident in the Aln Estuary, with larger individuals (>100 mm) recorded at both the mouth (n = 7) and upper (n = 17) sites, suggesting that the shift may occur at a larger size nearer the onset of maturity. All individuals measured across the dataset remain below the size of maturity, underscoring the nursery role of the estuary.

Both flounder and plaice display distinct spatial structuring: the smallest individuals indicative of 0-group cohorts originating from spawning earlier in the survey year (Skerritt 2010; ICESb, no date; Wennhage et al. 2006) are consistently found at the upper site, with general increasing size downstream (Annex III). The importance of the Aln Estuary's upper habitats as an early stage for plaice can be calculated using Hjörleifsson & Pálsson (2001) growth rate of 0.6 mm day^{-1} and known lengths at metamorphosis. The juvenile plaice captured during the Spring 2023 survey, previously unidentified (Annex IV) at the upper site can be interpreted as newly settled, approximately 18–25 days prior to sampling, immediately after metamorphosis.

Goby populations remain dominated by adult individuals, reflecting a stable resident assemblage rather than a juvenile-driven population. Their widespread distribution across sites highlights their ecological plasticity within estuarine habitats (Annex III).

Although saithe and European eel occur in lower abundances, their consistent presence indicates that the estuary provides suitable resting or feeding habitat for early-stage saithe and mid- to late-stage yellow eels, or individuals at the onset of the silver-eel migration stage. Studies of saithe nursery grounds identify sandeels as an important food source for smaller juveniles around 30 cm in length (approximately two years old; Nedreaas 1987). Individuals caught in the Aln Estuary (average = 154 mm) represent an early juvenile stage between 0 and nearly 2 years old (Annex I), during which they feed mainly on zooplankton (Nedreaas 1987). Their capture, along with that of eels, almost exclusively in autumn and predominantly in fyke nets is consistent with their nocturnal and burrowing behaviour. European eels become inactive during winter, triggered by changes in photoperiod (Rohtla et al. 2022) and/or temperature (Westerberg & Sjöberg 2014), remaining dormant in mud burrows from November/December until April/May (Annex III). Saithe also rest on the seabed overnight. This demonstrates the importance of including fyke nets in the sampling methodology

Temperature and Salinity

The 2025 surveys recorded the highest temperatures and among the highest salinities in the dataset. These higher-than-average recordings were most likely driven by local climatic conditions in the preceding months. The Met Office reported that the 2025 summer was the warmest on record in the UK, with mean temperatures from June to August 1.51°C above average, and that the NE of England experienced 110–130% of typical sunshine duration during August (Met Office 2025). Prolonged sunshine and persistently high air temperatures would have increased heat absorption in water bodies, contributing to the elevated temperatures recorded during the Aln Estuary surveys. The higher 2025 salinity levels also align with wider climatic patterns. Northumberland, consistent with national trends, experienced below-average rainfall for seven consecutive months (January–July), including 50% less rainfall than average in April (EA 2025). This reduction in freshwater input is clearly reflected in the Spring salinity data, with high values and minimal variation across sites (38 – 27ppt), indicating reduced upstream river influence.

Estuarine habitats are highly varied physio-chemical environments (Whitfield & Elliott 2005) which influence fish assemblage composition and abundances. Four factors believed to be the primary drivers are salinity, temperature, turbidity (Whitfield 2021) and dissolved oxygen (Marshall & Elliott 1998). Temperature is influential for fish abundances and salinity for species richness (Marshall and Elliott 1998). No statistically significant correlations were identified between temperature or salinity and species abundance or richness. The estuary’s temperature range (10–16°C) appears insufficient to drive large biological responses. High salinities in 2025 likely reflect prolonged low rainfall in preceding months rather than ecological change.

Importantly, while abiotic conditions did not display clear immediate effects on assemblage structure, continued monitoring is essential given ongoing climate trends and their potential cumulative impacts.

Conclusions & Recommendations

The consistently high proportion of individuals below SOM across commercial species: sandeel, herring, flounder, plaice, saithe, and eel provides robust evidence that the Aln Estuary serves as a significant nursery ground. The complementary roles of shallow sandy, muddy, and saltmarsh habitats offer a stable environment and support species with markedly different life histories. The large temporal dataset strengthens confidence in these conclusions, demonstrating, recurring annual recruitment of key species, persistence of juvenile cohorts across years, and their measured development.

NIFCA surveys will continue to provide baseline counts of juvenile species at all sampling sites, contributing to long-term monitoring of commercially and recreationally valuable species. Ongoing collection of temperature and salinity data, supported by cross-referencing with online climate records and comparisons with other national fish survey conducted, will help refine understanding of environmental fluctuations, climate-related stressors, and the continued suitability and the significance of the estuary for juvenile development.

Following the successful identification of goby individuals to species level during the 2025 Autumn survey, it is recommended that a magnifying glass be added to the survey equipment list to support reliable differentiation of goby species using gill-gap morphology.

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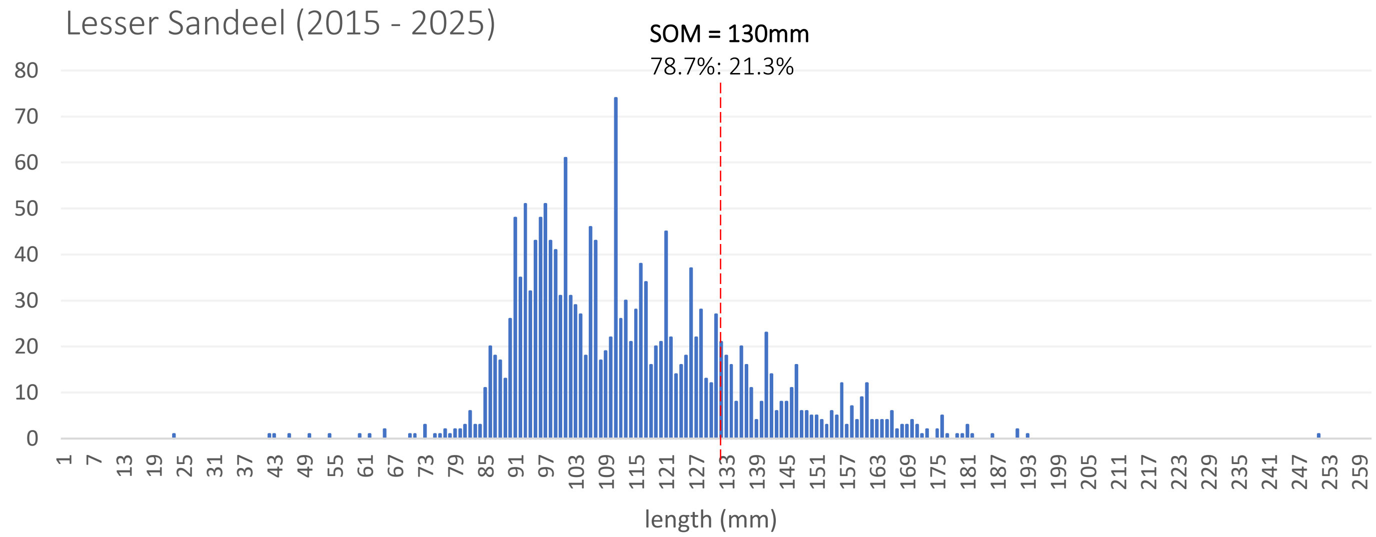
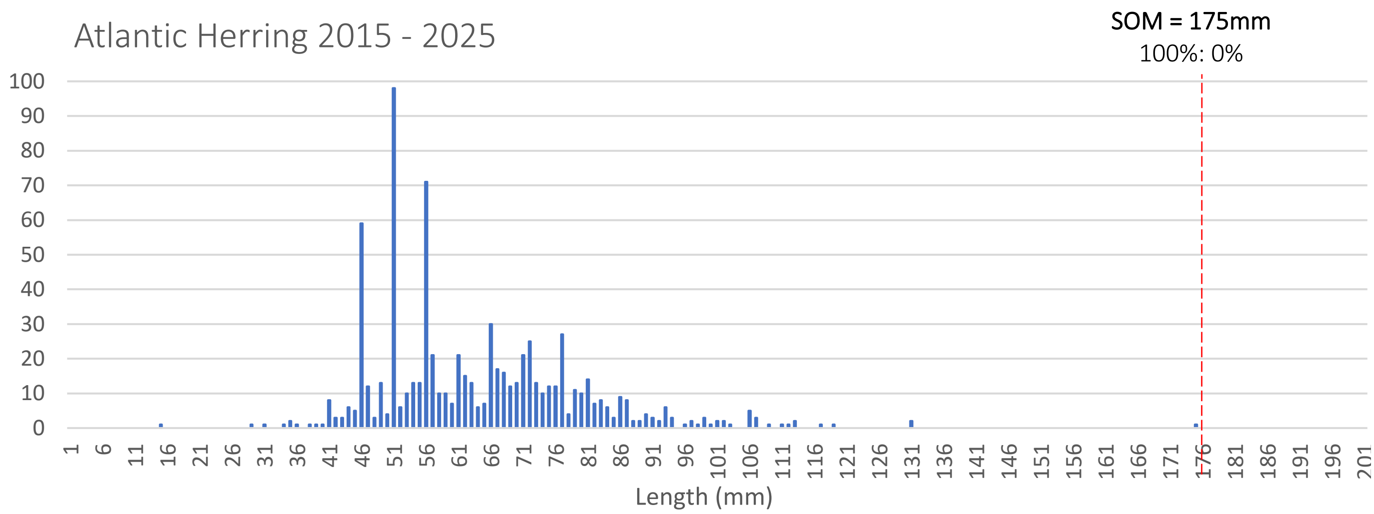
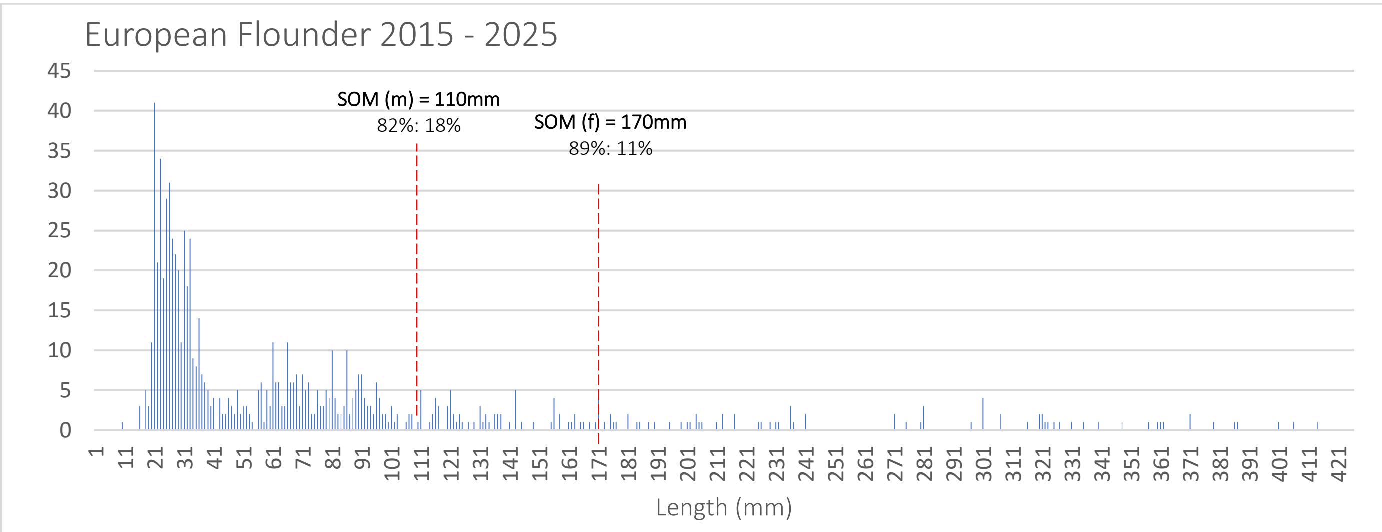
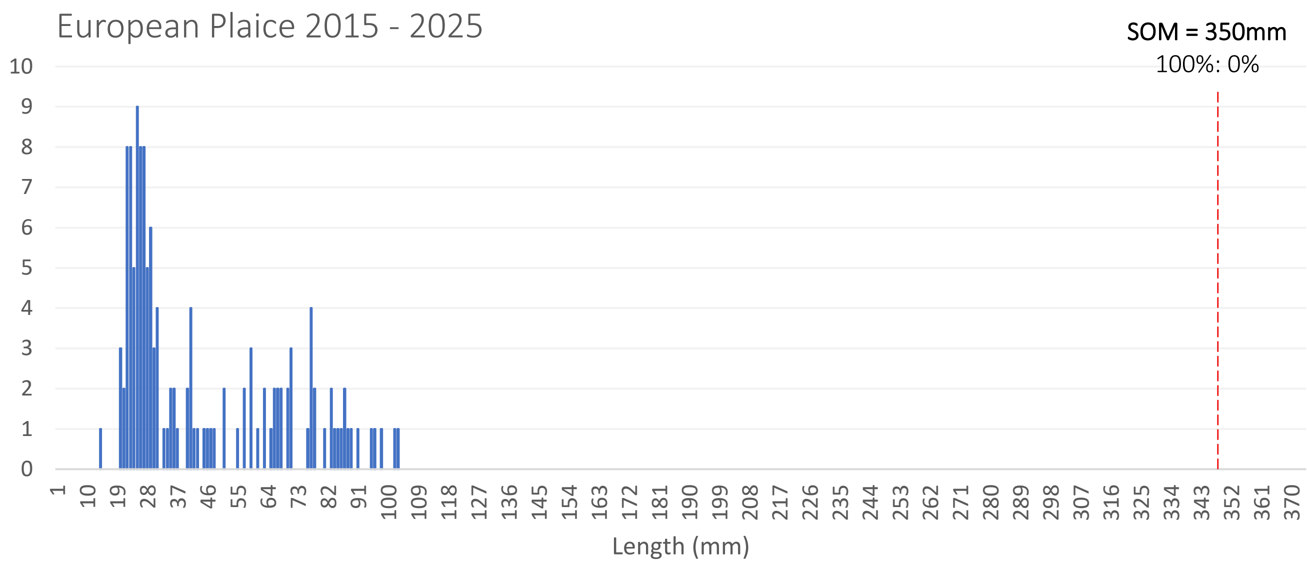
Annex I: *Length frequency graphs showing the percentage of individuals (2015 – 2025) measured above and below the species SOM (red line), for the most dominant species caught in the Aln Estuary survey.*

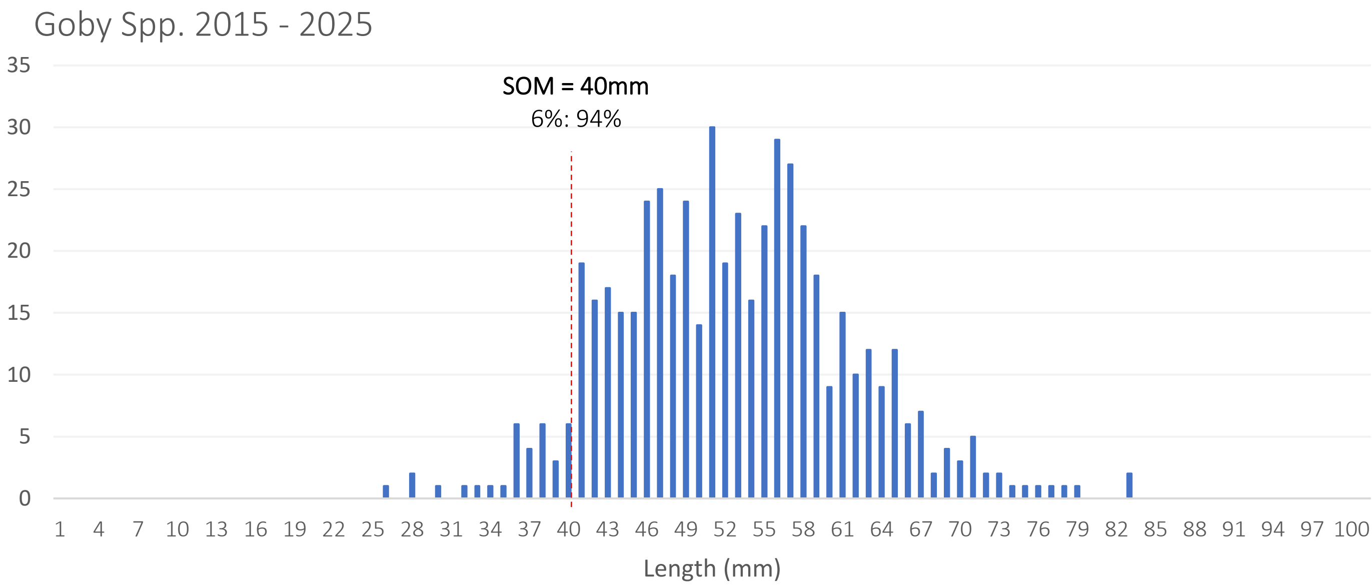




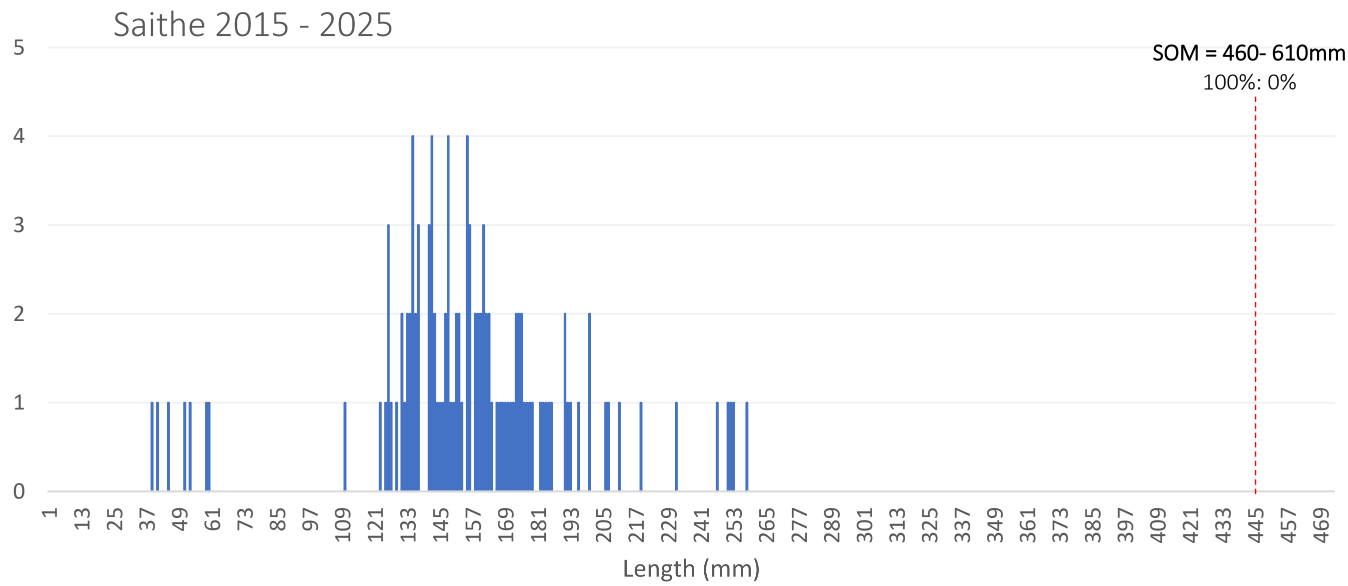




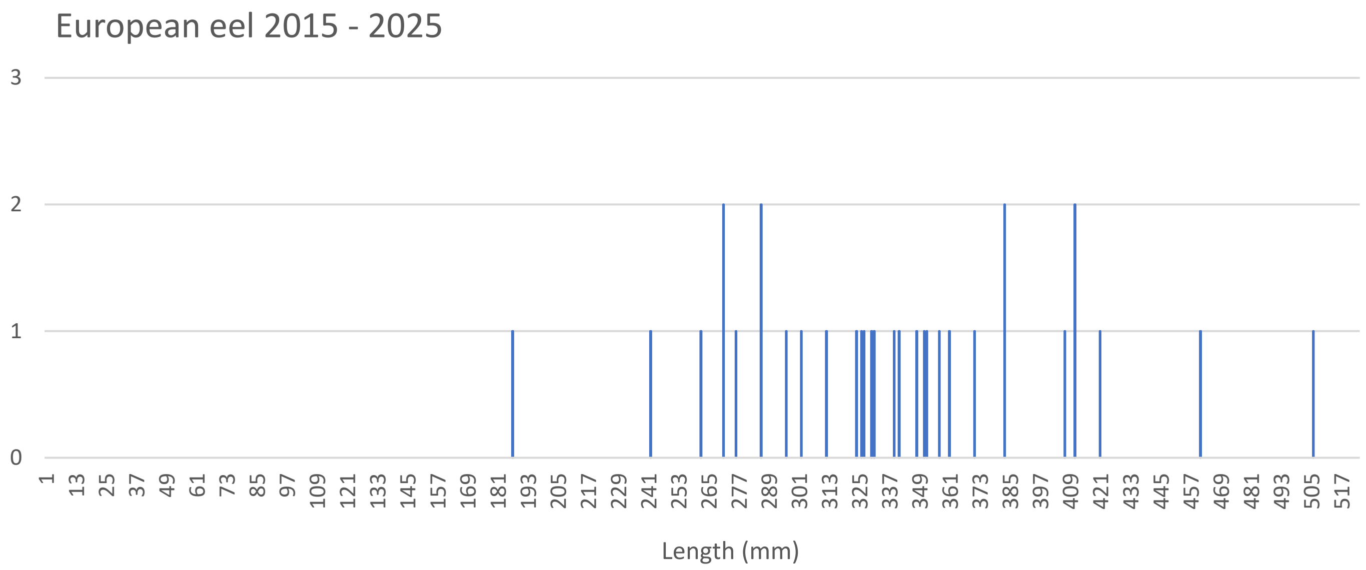
European Plaice 2015 - 2025
SOM = 350mm
100%: 0%
Length (mm)



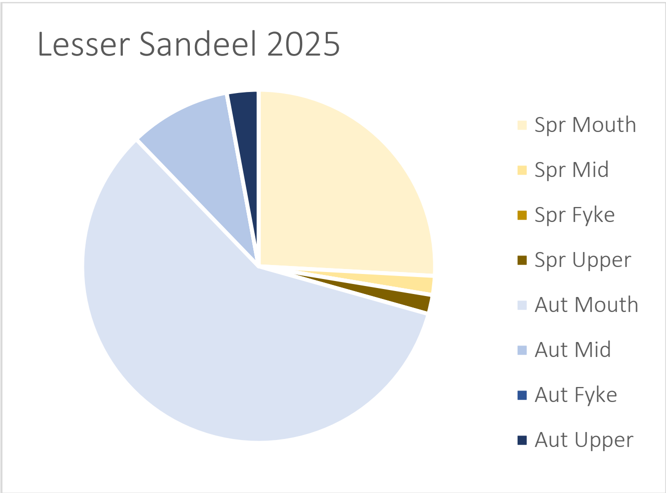
Goby Spp. 2015 - 2025
SOM = 40mm
6%: 94%
Length (mm)

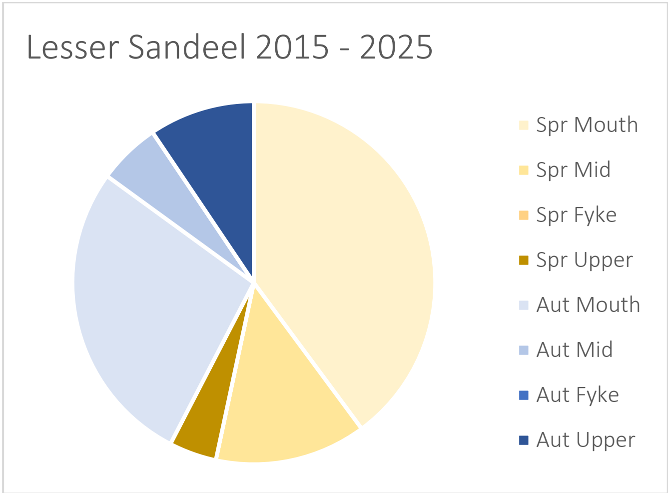


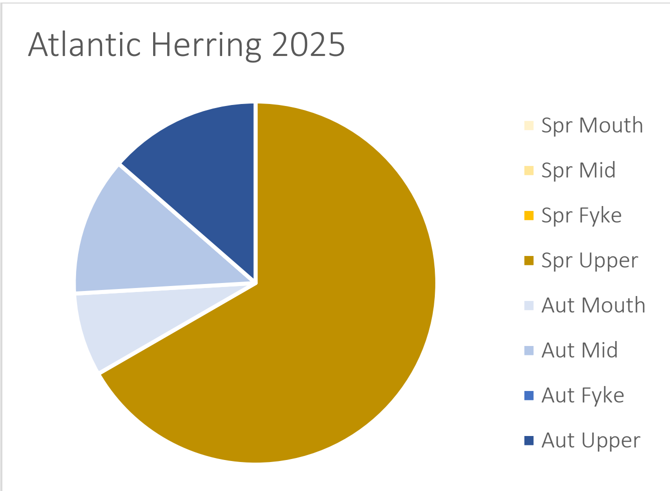
Saithe 2015 - 2025
SOM = 460- 610mm
100%: 0%
Length (mm)

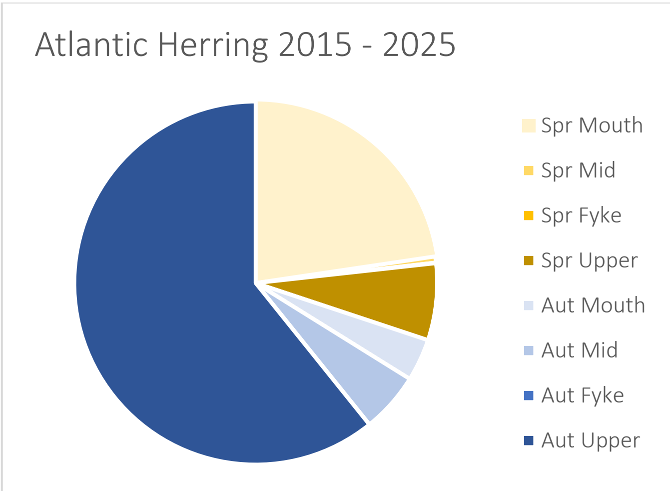


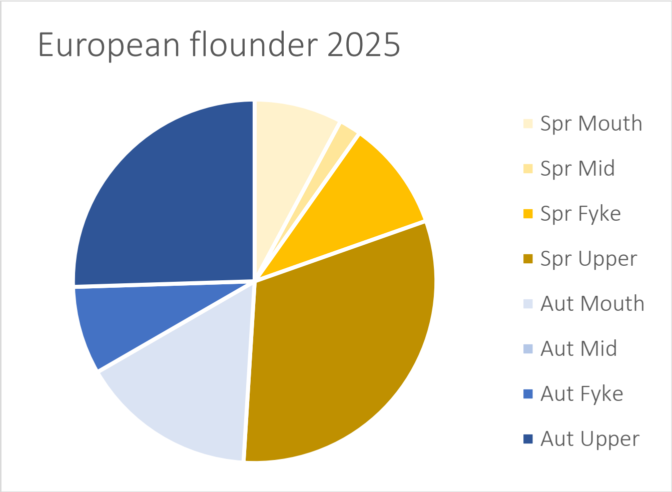
Annex II: *Distribution & seasonality of most dominant species recorded during (left) 2025 and (right) 2015 – 2025*

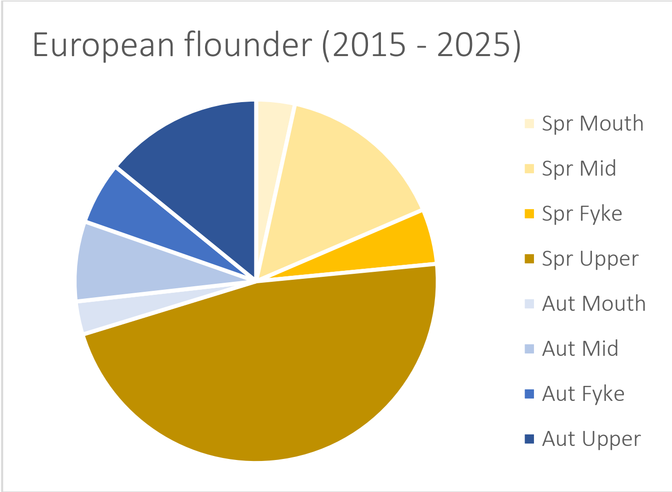


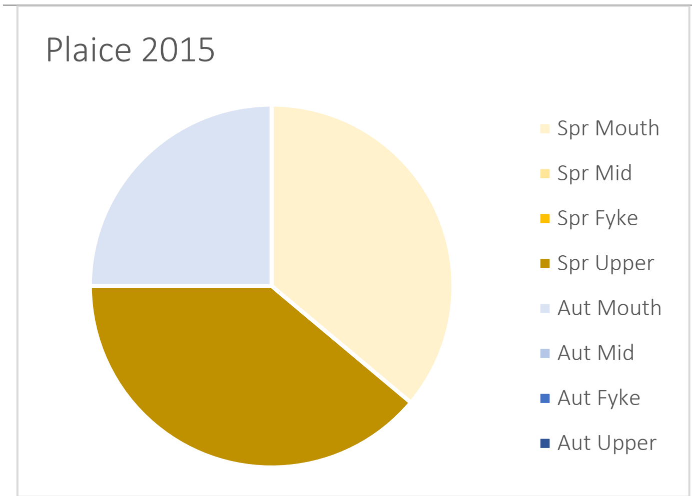


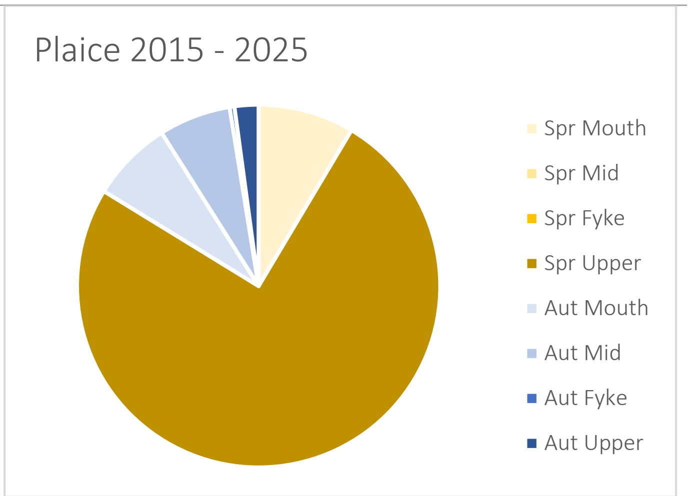


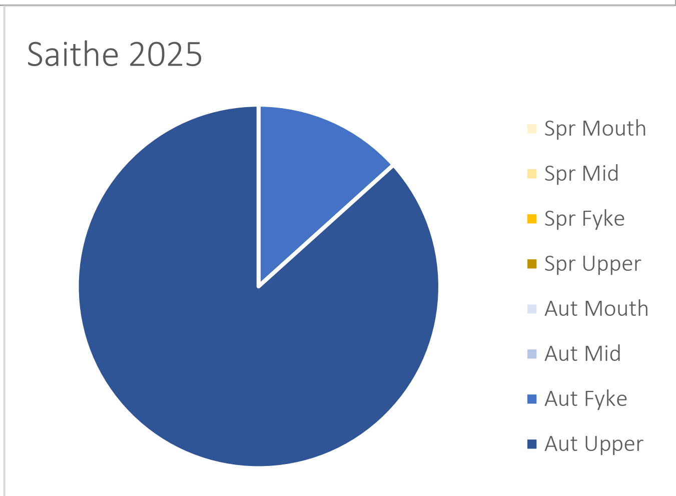


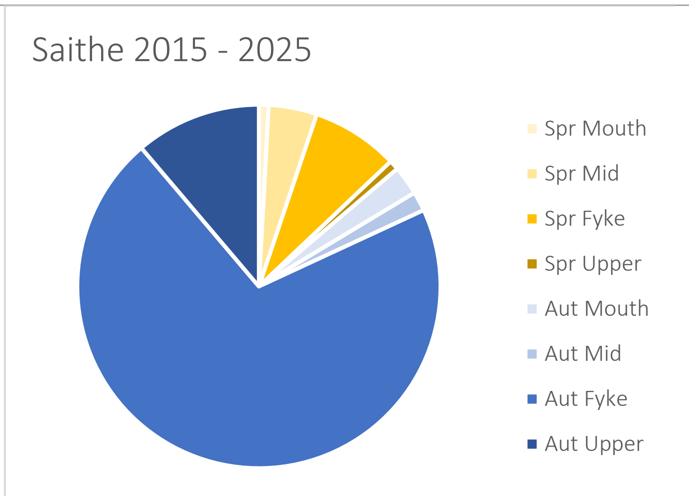

European flounder 2025
Spr Mouth
Spr Mid
Spr Fyke
Spr Upper
Aut Mouth
Aut Mid
Aut Fyke
Aut Upper


European flounder (2015 - 2025)
Spr Mouth
Spr Mid
Spr Fyke
Spr Upper
Aut Mouth
Aut Mid
Aut Fyke
Aut Upper


Plaice 2015
Spr Mouth
Spr Mid
Spr Fyke
Spr Upper
Aut Mouth
Aut Mid
Aut Fyke
Aut Upper


Plaice 2015 - 2025
Spr Mouth
Spr Mid
Spr Fyke
Spr Upper
Aut Mouth
Aut Mid
Aut Fyke
Aut Upper


Saithe 2025
Spr Mouth
Spr Mid
Spr Fyke
Spr Upper
Aut Mouth
Aut Mid
Aut Fyke
Aut Upper


Saithe 2015 - 2025
Spr Mouth
Spr Mid
Spr Fyke
Spr Upper
Aut Mouth
Aut Mid
Aut Fyke
Aut Upper

Annex III: *Life history strategies & fishery exploitation of dominant species recorded in the Aln Estuary surveys (2015 – 2025)*

Species	
Lesser Sandeel *Ammodytes tobianus*	Three sandeel species are commonly found across the North Sea: *Hyperoplus lanceolatus*, *Ammodytes tobianus*, and *Ammodytes marinus*. *A. marinus* occurs in deeper waters (20–80 m) and, prior to the prohibition on sandeel fishing within English waters in March 2024, supported a major fishery in the English sector of the North Sea. *H. lanceolatus* (greater sandeel) and *A. tobianus* (lesser sandeel) inhabit intertidal waters and both have been recorded within the Aln Estuary. Considered to be the most important forage fish species in the North Sea (Engelhard *et al.,* 2014), sandeels are a high energy mid-trophic species that transfers zooplankton energy further up the chain to piscivorous fish (e.g. mackerel, whiting, Atlantic cod) and protected species of sea birds (MCCIP 2018). Their position within the food web creates high spatial and temporal variability because their abundance can be controlled by food availability and/or predation pressure (Frederiksen et al., 2007). Sandeels favour sandy sediments (Henriksen et al. 2024), in which they burrow overnight, swimming above the substrate during daylight in a characteristic head-down posture. Following their spawning period, decreasing light levels, lower temperatures and reduced prey availability trigger, sandeels will bury themselves into the sediment for six to eight months over winter, emerging in spring to feed in the water column (van der Kooij *et al.* 2008; Henriksen *et al.* 2024).
Atlantic herring (*Clupea harengus*)	This species is a pelagic species distributed across the northwestern and northeastern Atlantic. In the North Sea, herring is both an important prey species for cod, whiting, mackerel, seabirds and marine mammals, and a commercially valuable stock (outside the NIFCA district). Historically, heavy exploitation and recruitment failures caused substantial population declines (Dickey-Collas *et al*. 2010). Today, the North Sea fishery is considered sustainably harvested within precautionary stock limits. However, the population is still viewed as declining within these limits, with recruitment failures—reported by ICES in 2025 as the lowest since the 1970s—linked to climatic factors such as sea surface temperature and reduced food availability (Payne *et al.* 2009). The North Sea Atlantic herring stock comprises four components, one of which spawns off the Northumberland coast (Coull *et al.* 1998). Atlantic herring spawn in either Spring or Autumn and North Sea herring are predominantly autumn spawners, with spawning occurring between August and October (Henderson 2014). They spawn on coarse sediment habitats at depths of 10–80 m, and once hatched, larvae drift inshore towards nursery grounds (thefishsite 2010), where they remain for up to two years before migrating offshore (ICESa, no date). By their first spring, autumn-spawned herring typically reach around 50 mm in length (Stevenson & Scott 2005)
European flounder (*Platichthys flesus*)	This fish is an important species within estuarine fish communities and is also a popular sport fish for recreational anglers. It is a bottom-dwelling flatfish commonly found within 50 m of the shore in estuaries and other low-salinity waters. Although frequently recorded in freshwater, adults return to deeper marine waters (20–50 m) to spawn between January and June. SOM is approximately 110 mm for males and 170 mm for females; however, these sizes can vary, particularly in heavily exploited populations (Skerritt 2010).
Plaice (*Pleuronectes platessa*)	Plaice is an important commercial species in the North Sea. Spawning occurs offshore throughout the region, with a key spawning area identified along the UK's east coast, from Flamborough Head to the Moray Firth (ICESb, no date). Spawning takes place from December to April (Rijnsdorp 1989), after which larvae enter a pelagic phase, drifting into coastal waters before reaching inshore nursery grounds (ICESb no date; Wennhage *et al.* 2006). Metamorphosis occurs at approximately 9–14 mm, when juveniles settle on the substrate (ICESb no date), which has been observed in Icelandic nursery grounds in late May (Hjörleifsson & Pálsson 2001). During this early 0-group stage, juveniles settle in waters as shallow as 1m, showing a strong preference for soft sediments (Wennhage *et al.* 2006) which facilitates burial

	(Gibson & Robb 2005). Older juveniles (1-group and 2-group) typically inhabit deeper coastal waters (Wennhage et al. 2006).
Common (*Pomatoschistus microps*) & **Sand** (*Pomatoschistus minutus*) **goby**	The **common** (*Pomatoschistus microps*) and the **sand goby** (*Pomatoschistus minutus*) are small, abundant species widely distributed along the UK coastline. Both occupy similar ecological niches, found in coastal waters, tide pools, lagoons, saltmarshes and estuaries, with a preference for sandy or muddy sediment substrates. They feed primarily on polychaetes and amphipods and, although not a commercially important species, they serve as a key prey species for many fish and bird predators. Gobies typically live for one to two years, with both species reaching maturity between seven and 12 months of age, at around 40 mm in length (Riley 2003; Riley 2007). Although they share the same SOM, the two species differ in maximum size: sand gobies reach <100 mm, while common gobies grow to <64 mm (Riley 2003; Riley 2007). They also have contrasting spawning periods, with sand gobies spawning in summer, June–August, and common gobies spawning in winter and early spring, February–September, (Riley 2007, Riley 2003).
Saithe (*Pollachius virens*)	A valuable commercial species is widely distributed across the North Atlantic. In the Northeast Atlantic, there are four management units, one of which is the North Sea stock (Myksvoll et al. 2021). Historically, exploitation of this species was high, causing a decline in North Sea landings during the mid-1970s. Since then, stock size has fluctuated (Saha et al. 2015) and today it is managed using the precautionary approach and TACs (ICES 2025). Recent research indicates that saithe reproductivity is decreasing, with evident suggesting environmental factors (ICES 2025), in particular rising sea temperatures (Kjesbu et al. 2021). Saithe prefer cold thermal conditions (4–15°C), and the observed deepening of their distribution in the North Sea is thought to be a response to increasing bottom temperatures (Dulvy et al. 2008). Adults migrate seasonally between deeper offshore feeding grounds and inshore shallow spawning areas from January to the end of March. Larvae develop pelagically in coastal waters before shifting to a demersal lifestyle (Reecht et al. 2020), moving offshore at around three years old (Jakobsen 1985; Nedreaas 1987; ICES 2025), roughly 40 cm in length (ICES, no date).
European eel (*Anguilla anguilla*)	Classified as Critically Endangered by the International Union for Conservation of Nature (IUCN) in 2008, after recruitment was found to have declined by approximately 95% since the 1980s (ICES 2019). The Eels (England and Wales) Regulations (2009) were introduced to support stock recovery through permitted fisheries, closed seasons, and requirements for unobstructed passage in rivers and estuaries. This species has a complex life cycle, including a prolonged period in fresh or estuarine waters as yellow eels (lasting up to 50 years), followed by the silver eel stage prior to their spawning migration to the Sargasso Sea (Westerberg et al. 2018). Recent tracking research by Wright et al. (2022) recorded slower-than-previously-estimated migration speeds, supporting an 18-month migration period (previously thought to take around six months). This extended migration aligns with the known spawning period, which begins in December, peaks in February–March and ends in May. European eels become inactive during winter, triggered by changes in the photoperiod (Rohtla et al. 2022) and/or temperature (Westerberg & Sjöberg 2014), and remain dormant in mud burrows from November/December until April/May. Lengths of European eel life stages vary widely across their distribution, influenced by latitude and population density. Reported ranges include 54–92 mm for glass eels, up to 69–1,330 mm for yellow eels, 210–1,480 mm for male silver eels, and 264–1,010 mm for females (Dekker et al. 1998).

Annex IV: *Transparent underside of one of the juvenile plaice recorded in the Aln Estuary Spring 2023 survey*