University of Essex Report from the 2025 Thames Fishing Experiment

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Introduction

Estuaries are hotspots for pollution given their link to freshwater and proximity to cities and industrial hubs. The Thames is a critical estuary for the UK, running directly through the capital city of London, whose 2020 population size was around 10 million people (Vane et al., 2022). Historically the main pollution sources in the Thames were heavy metals, PCBs and hydrocarbons (Vane et al., 2020, 2022). Today, there has been a large increase in antibiotics and pharmaceuticals, associated with large inputs from sewage. There has been considerable interest in the volumes of treated and untreated sewage entering the UK's waterways, including the Thames. In general, the human health impacts (e.g. from bacteria such as *E. coli*) have received the most attention, but there are also impacts on biota as a result of contaminants associated with urban runoff and sewage.

Stable isotopes can provide markers of pollution exposure and diet, and elevated nitrogen isotope ratios ($\delta^{15}N$) in lower trophic levels (i.e. prey to fishes such as sea bass) can be associated with sewage runoff (Loomer et al., 2015). Nitrogen isotopes in consumer tissues also tend to increase with trophic position, but we expect newly settled bass to be all eating at approximately the same trophic position, providing a potentially valuable marker of sewage exposure. Ordinarily, stable isotope studies will use soft tissues such as muscle, but these get reworked as the fish grows and ages. In contrast, eye lenses are metabolically inert and grow in sequential layers of crystallin protein (known as laminae), providing a permanent chronological record of that fish's diet history (Fig. 1A) (Quaeck-Davies et al., 2018).

European sea bass (*Dicentrarchus labrax*) is a species of high economic importance throughout its range. Bass experienced population declines in the late 2000s resulting in a number of protective measures. Sea bass typically spawn offshore, with post-spawned larvae undertaking a pelagic phase of around 2-3 months, where they drift to inshore nursery habitat such as estuaries and salt marshes (Pickett & Pawson, 1994). Juveniles occupy these nursery grounds until they reach maturity at 4-5 years old, when they recruit into the adult spawning population (Pickett & Pawson, 1994). Recent studies suggest that young sea bass show high levels of fidelity to their original settlement sites (Ryan et al., 2024), and are thereby subjected to variation in habitat quality which can strongly affect growth and condition of young fish. Maximising juvenile survival can lead to disproportionate gains in adult stock; therefore, creating optimal nursery habitats for bass should be a priority.

Previous work (Sturrock et al. unpublished) from newly settled '0-group' bass caught in the Thames and Medway in 2022-24 showed elevated $\delta^{15}N$ values in their outermost (i.e. most recently formed) eye lens laminae. The values were particularly elevated in fish sampled at upstream sites exposed to higher sewage inputs (e.g. https://experience.arcgis.com/experience/c9b8f3ba094c429aa30e0e2b6eaf43ac). We thus interpreted these data as potentially reflecting sewage effluent propagating through the food web. In preparation for this current study, we explored historical trends in bass abundance and sizes from the Thames Fishery Experiment to assess whether we would expect to catch sufficient numbers in 2025, and whether the bass being caught would likely be of the correct size range to allow us to cohort match them to the 0-group fish we sampled in 2022-24. Encouragingly, most bass caught in the

Thames Fishery Experiment in recent years were likely to have been 1-3 years old (Fig. 2) and this species has represented an increasingly large fraction of the catch (>100 fish in 2024; Fig. 3).

Our central question is whether bass exposed to high sewage levels during early life are at a survival disadvantage. To test this, we aimed to analyze eye lens isotopes from 1-3 year old bass caught in the 2025 Thames Fishery Experiment that would be cohort matched to our 0-group bass from 2022-24 (Fig. 2). We would then compare eye lens $\delta^{15}N$ values in the same innermost (equivalent to when they had recently settled in the estuary) growth layers from the different age classes of fish. If sewage effluent (and associated loadings of contaminants such as pharmaceuticals) have an adverse effect on juvenile bass survival, we would expect to see a lower fraction of fish in older age classes exhibiting high lens $\delta^{15}N$ values.

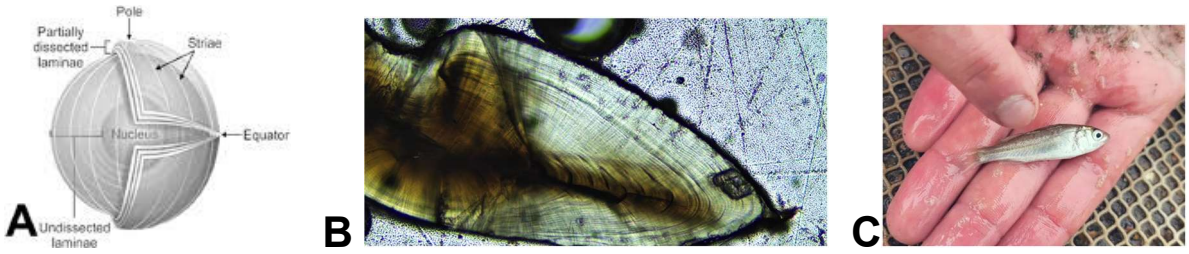


Fig. 1A Teleost eye lens showing the laminae (growth layers) and nucleus. B shows a sectioned juvenile sea bass otolith showing the daily rings used to estimate birth date and growth rate. C shows a group-0 bass caught from the Medway in September 2022.

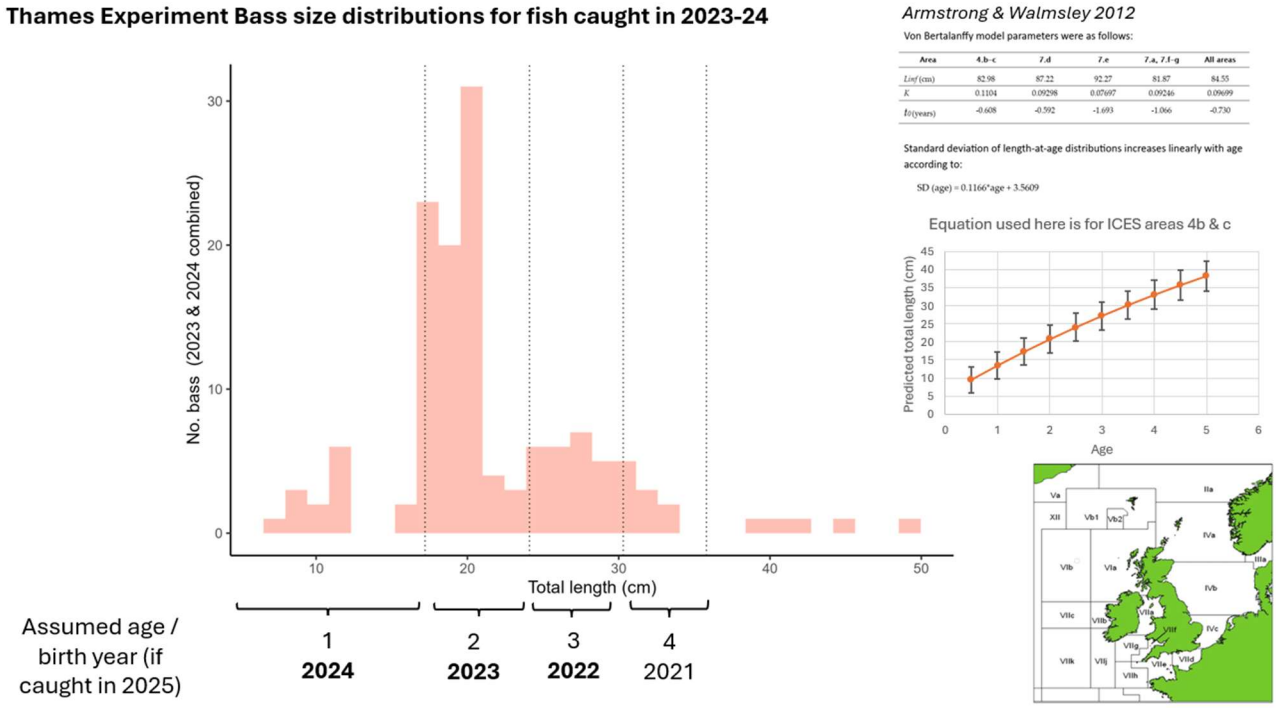


Fig. 2 Size distribution of the bass caught in the Thames Fishery Experiment in 2023-24 showing the approximate size cut offs for each age class, with the birth years in bold (2022-24) equivalent to the juvenile bass sampling previously carried out that highlighted the elevated eye lens $\delta^{15}N$ values.

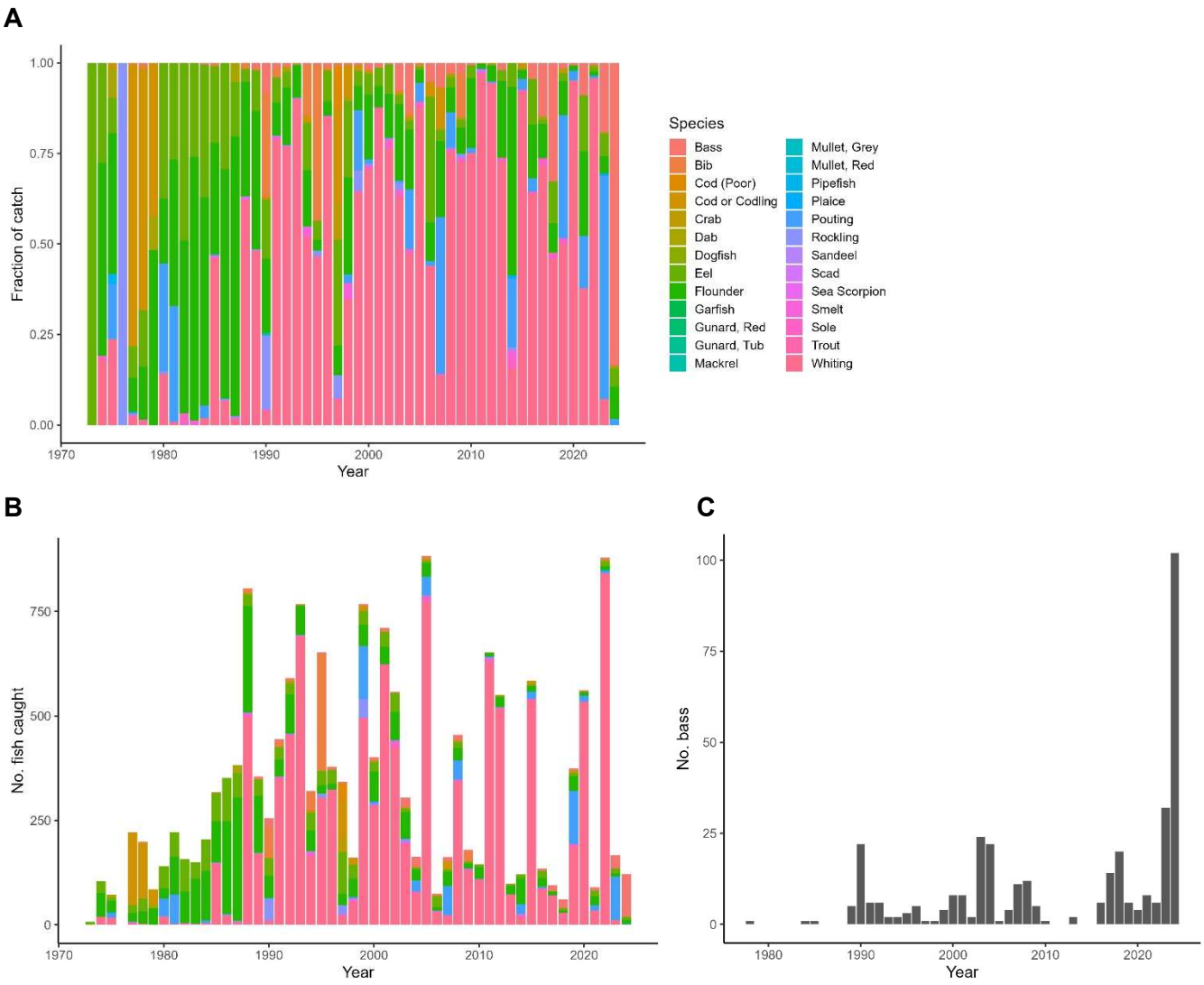


Fig. 3 Trends in species composition of the Thames Fishery Experiment through time as (A) fractions and (B) absolute numbers. Plot C shows only numbers of bass caught per year, with over 100 bass caught in 2024.

Methods

Sampling

On 4th October 2025 teams from the University of Essex, Sparsholt College and Kent & Essex IFCA set up sampling stations at the 2025 Thames Fishery Experiment Zones C and F, and spread ‘collectors’ along the full stretch of the experiment to transport bass and flounder to the sampling stations to dispatch and processing (Fig. 4). While we had been aiming for a sample size of up to 60 bass, the effects of Storm Amy resulted in only low catches. In total, 8 bass were lethally sampled for this project, and their otoliths, eyes and a muscle sample are now retained in the University of Essex Tissue Archive for potential future research.

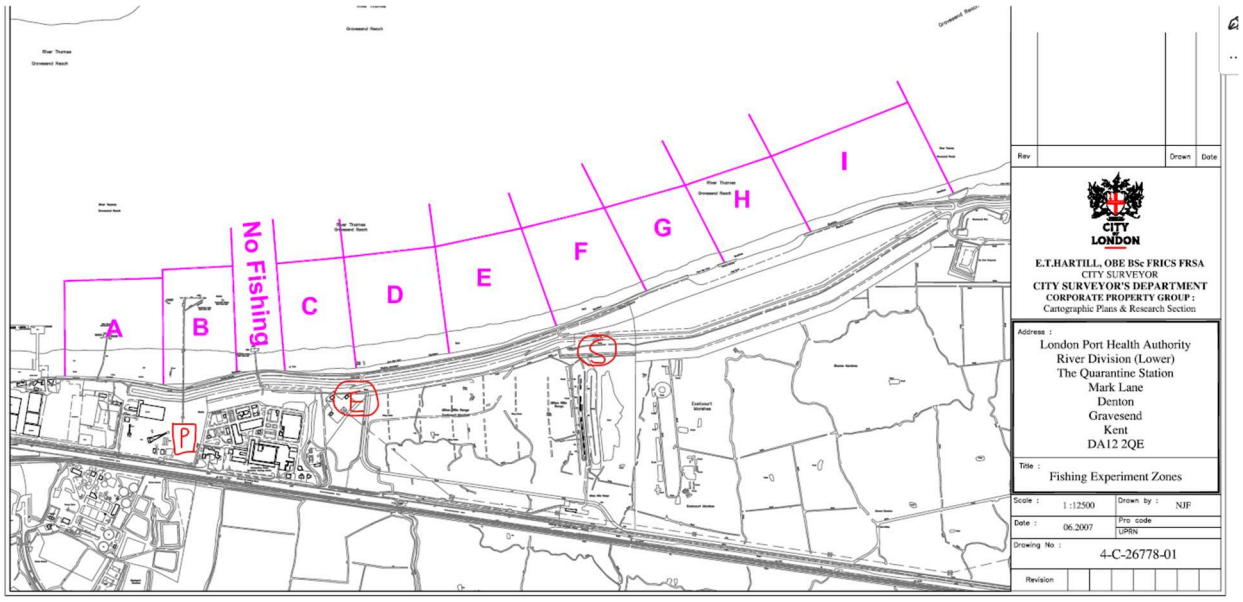


Fig. 4 Map of Thames Fishing Experiment Zones (A to I) with our sampling stations (E - Essex and S - Sparsholt).

Eye lens stable isotope analysis

The eye lens from each bass was extracted and the laminae serially sampled and the diameter re-measured after each lamina had been removed. The laminae were put into tin capsules, air dried overnight, weighed, then encapsulated and sent off for bulk carbon, nitrogen and sulphur isotope analysis. In brief, the relative abundance of carbon ($^{13}C/^{12}C$) and nitrogen ($^{15}N/^{14}N$) ($\delta^{13}C$ and $\delta^{15}N$) isotopes were measured using a Thermo Fisher Scientific (TFS; Bremen, Germany) IsoLink Elemental Analyser coupled to a TFS Delta V Plus isotope ratio mass spectrometer, using helium as the carrier gas at the National Environmental Isotope Facility (NEIF) Stable Isotope Ecology Laboratory at the Scottish Universities Environmental Research Centre (SUERC). The results of the isotopic analyses are presented in the conventional δ-notation in per mil (‰) relative to international standards calibrated to VPDB and AIR.

Results & Discussion

With such a small sample size (n=8) we would have insufficient statistical power to compare early life $\delta^{15}N$ values among age classes. As such, we analyzed full lifetime eye lens chronologies rather than only the inner laminae equivalent to our 0-group bass from our previous studies (indicated in the grey band on Fig. 5). The chronologies were interesting, showing large among-fish variation in all three isotopes, with the $\delta^{15}N$ data suggesting at least two groups that appear to have been feeding in different habitats for much of their first and second years' of life (note large differences in $\delta^{15}N$ – and also $\delta^{34}S$ - between the blue and red lines in Fig. 5 between lens diameters 1000-2200 µm). These isotopic differences became smaller later in life as presumably these groups of fish moved into a similar area prior to being sampled in the same stretch of the river in October 2025.

Future work will focus on comparing these isotopic fingerprints to our juvenile 0-group bass 'reference library' – from the Thames and other estuaries – and also analyzing element concentrations in their otoliths to identify the most likely the nursery areas, and to infer connectivity between areas. We will also return to the Fishery Experiment in 2026 to try and increase our sample sizes and tackle our main question around possible sewage impacts on juvenile bass survival and growth.

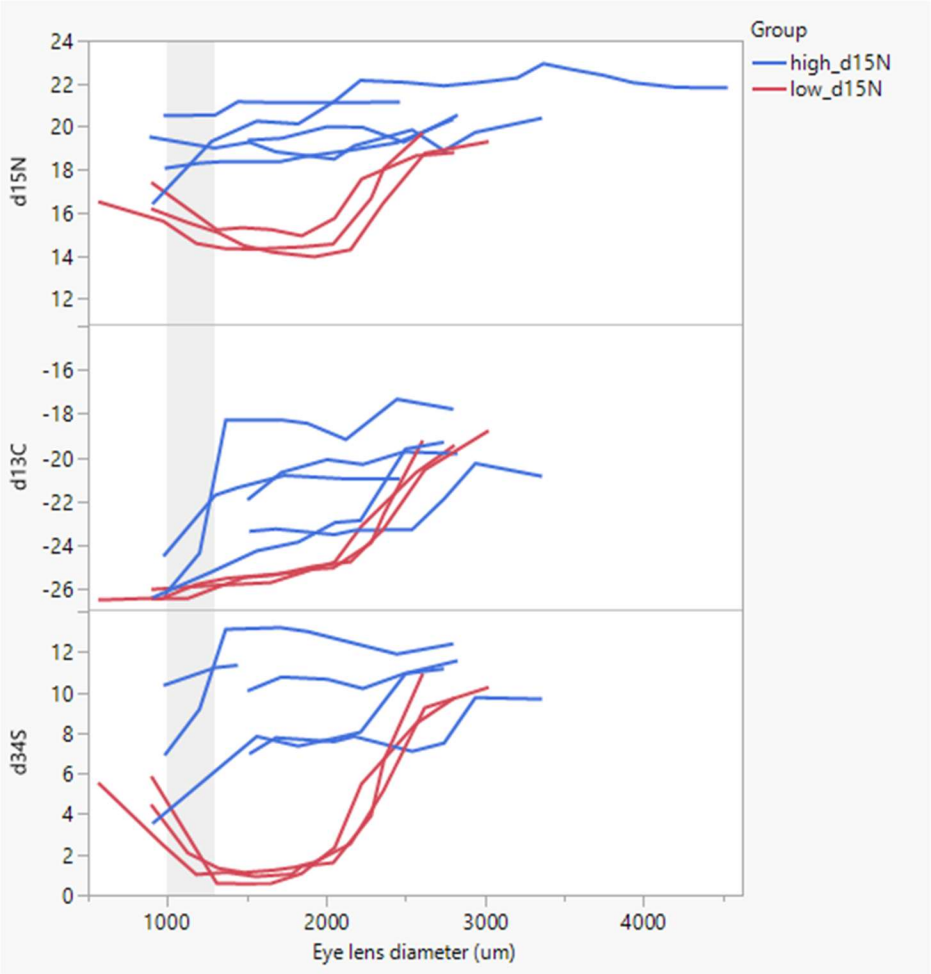


Fig. 5 Eye lens isotope chronologies for the eight bass sampled in October 2025 coloured by putative juvenile 'grouping' based on visual differences in $\delta^{15}N$. The grey bar indicates the approximate period when these fish had been newly settled in their nursery area as 0-group juveniles and thus age-equivalent to our previously-collected juvenile data from 2022-2024.

Acknowledgements

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