

Recruitment variability of the Gulf of Riga herring stock: a long-term perspective



BIOR

INSTITUTE OF FOOD SAFETY, ANIMAL HEALTH
AND ENVIRONMENT

*Theme B - Integrating ecosystem
aspects with single-species fisheries
management advice*

15.09.2026

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Ivars Putnis



15-18 September
Brest, France

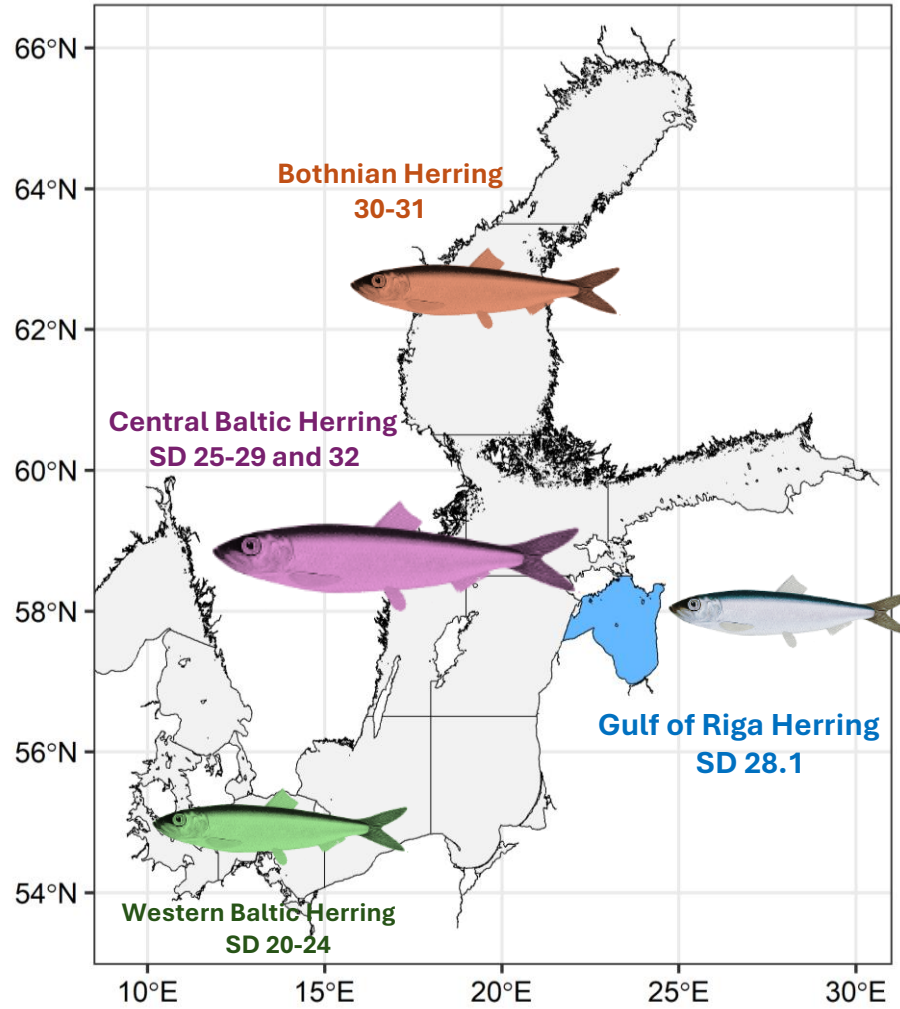


**ZIVJU
FONDS**



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Gulf of Riga herring compared to other stocks in the Baltic Sea



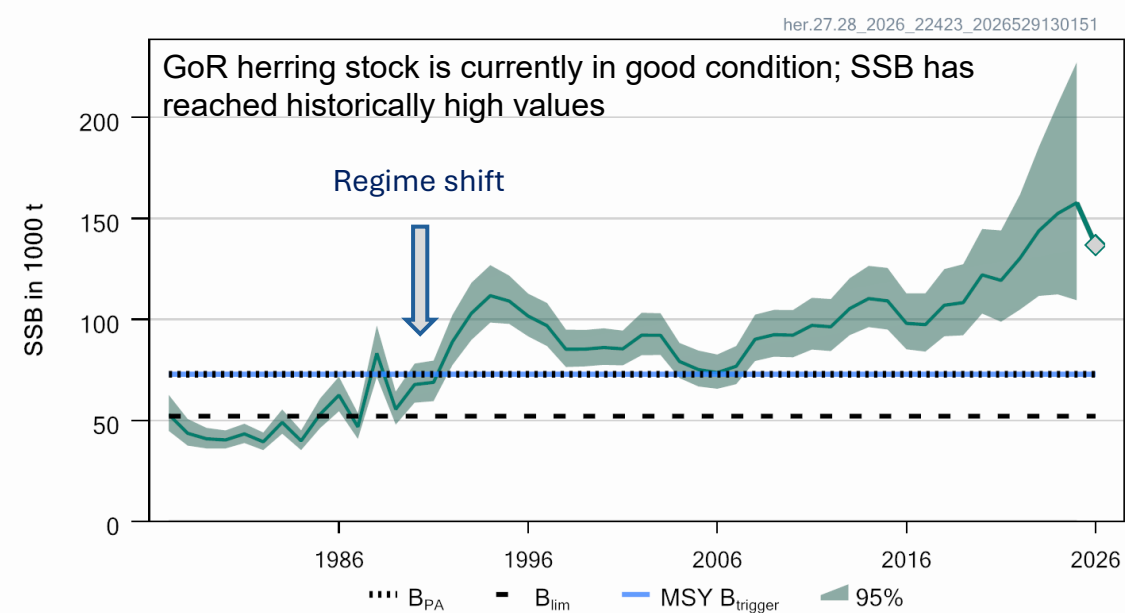
Overarching Goal

Maintain intraspecific diversity alongside sustainable fisheries management by recognizing local stock units in the Baltic Sea

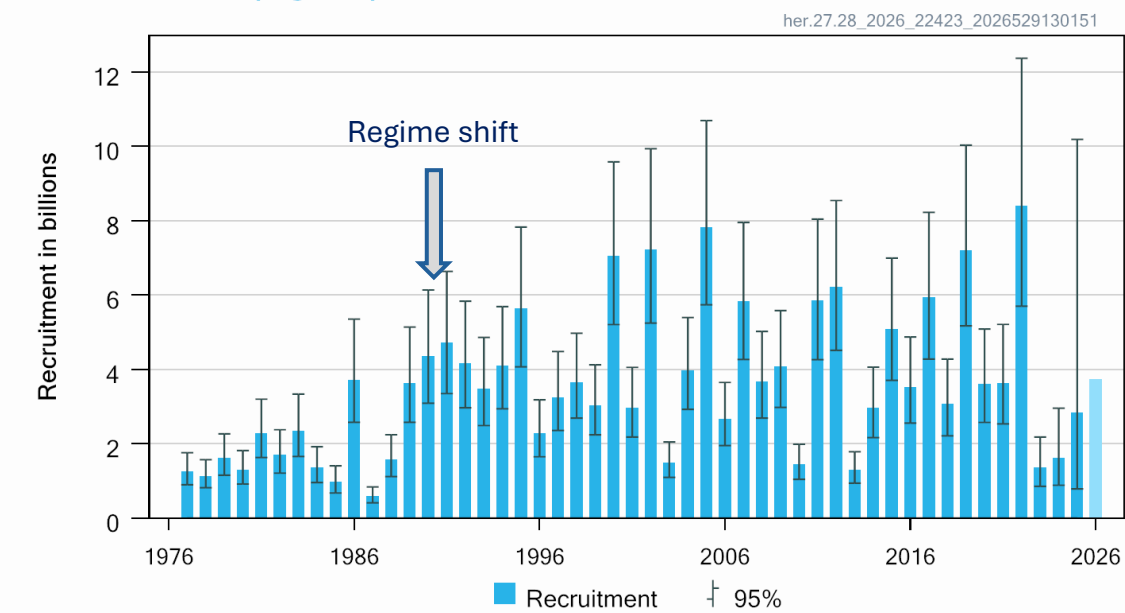
- Baltic herring can be broadly divided into “open-sea” and “gulf” populations. GoR herring remain in the gulf year-round, while CBH herring undertake longer migrations and often spawn in the gulf
- Since 1994, GoR herring has been managed and assessed as a separate stock due to its distinct biology and localized habitat
- GoR herring is slow-growing, with one of the smallest mean lengths and weights at age, matures at a young age, mainly dominated by spring spawners
- GoR herring stock is currently in good condition and contrasts with several other Baltic herring stocks (*ICES Advice 2026*)

SSB

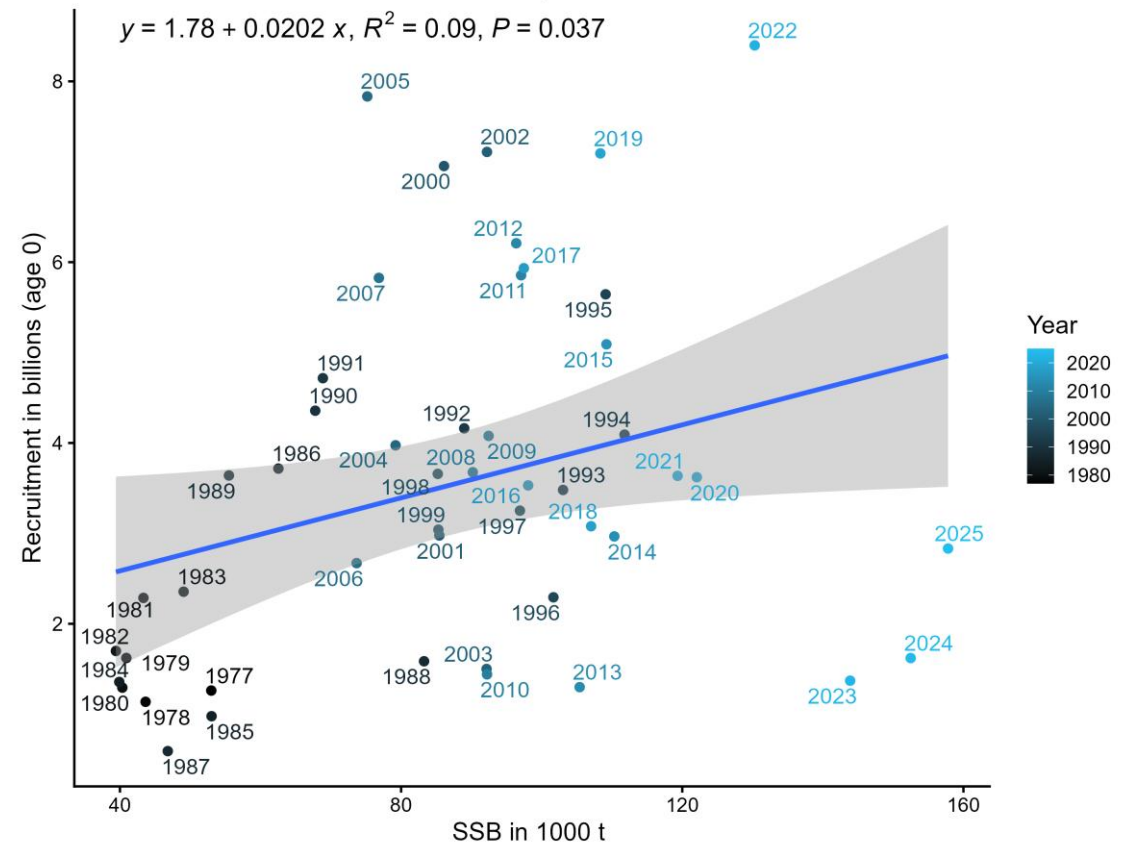
Spawning stock biomass



Recruitment (age 0)



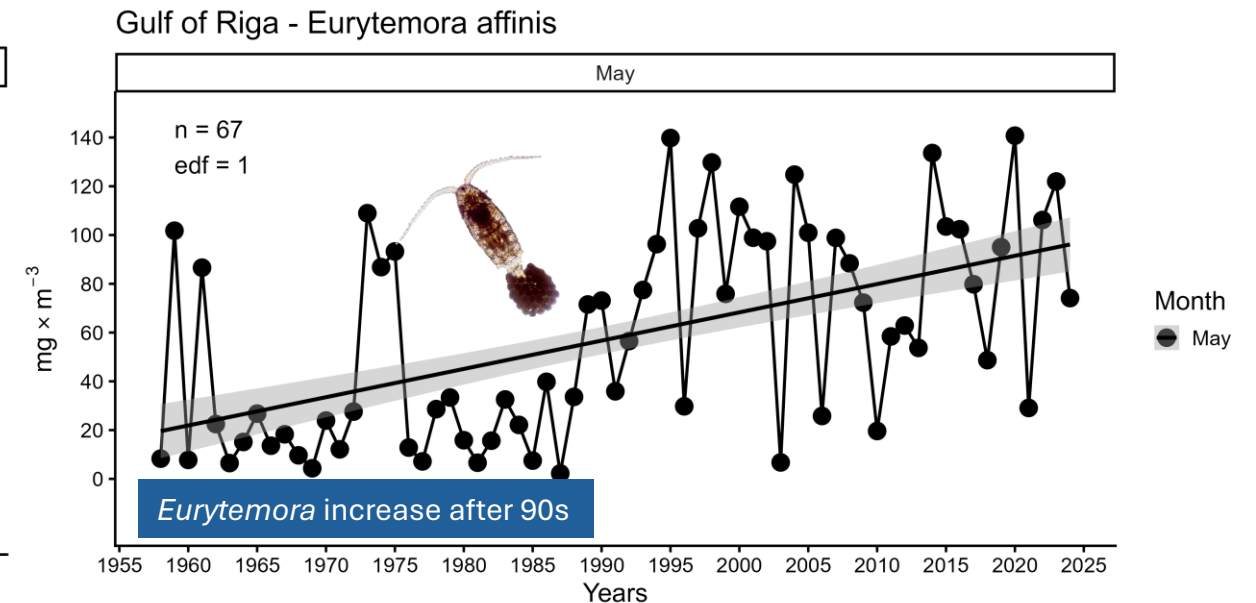
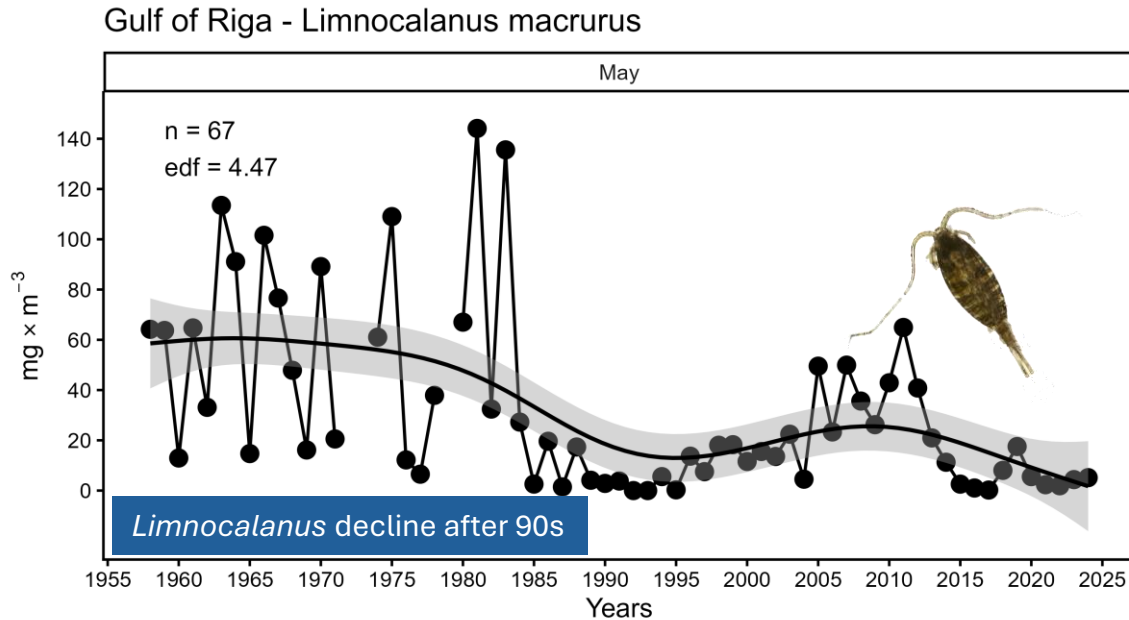
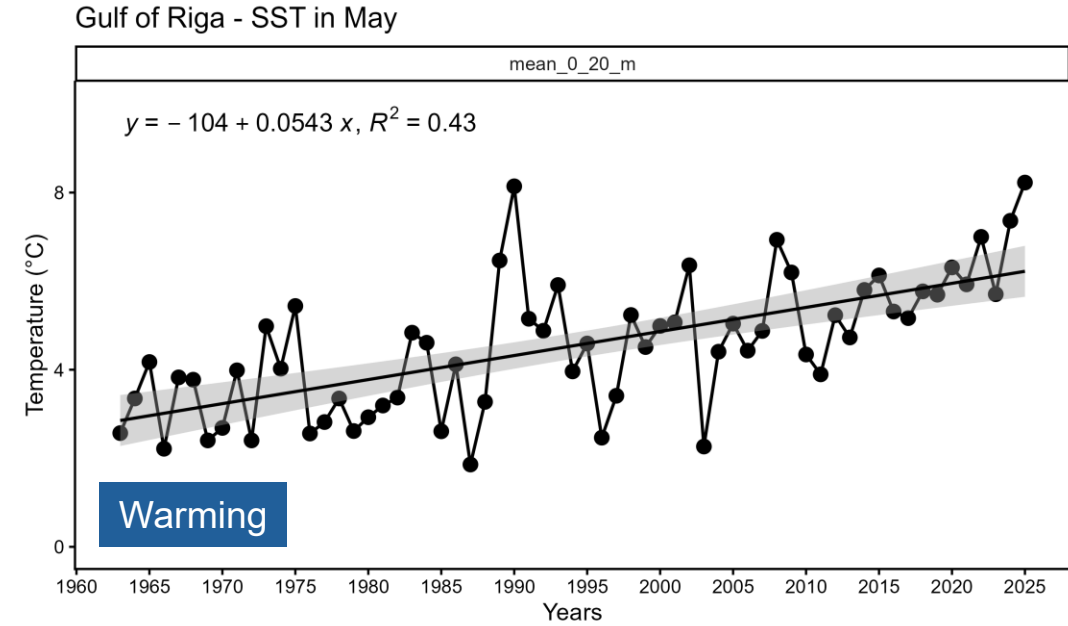
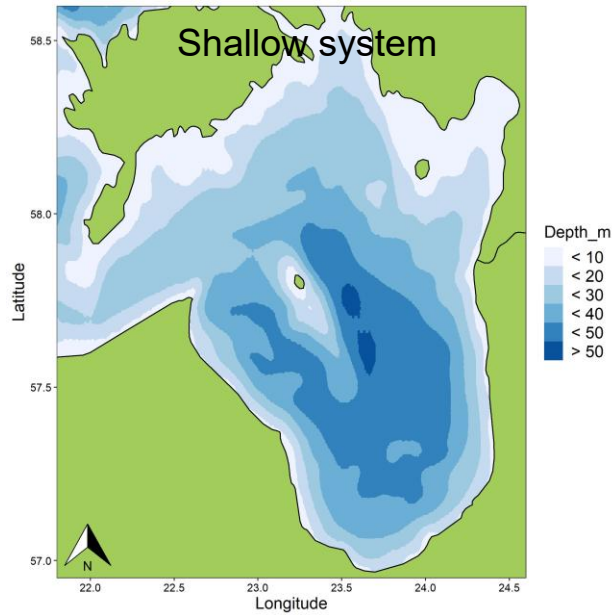
GoR - Stock-recruitment relationship

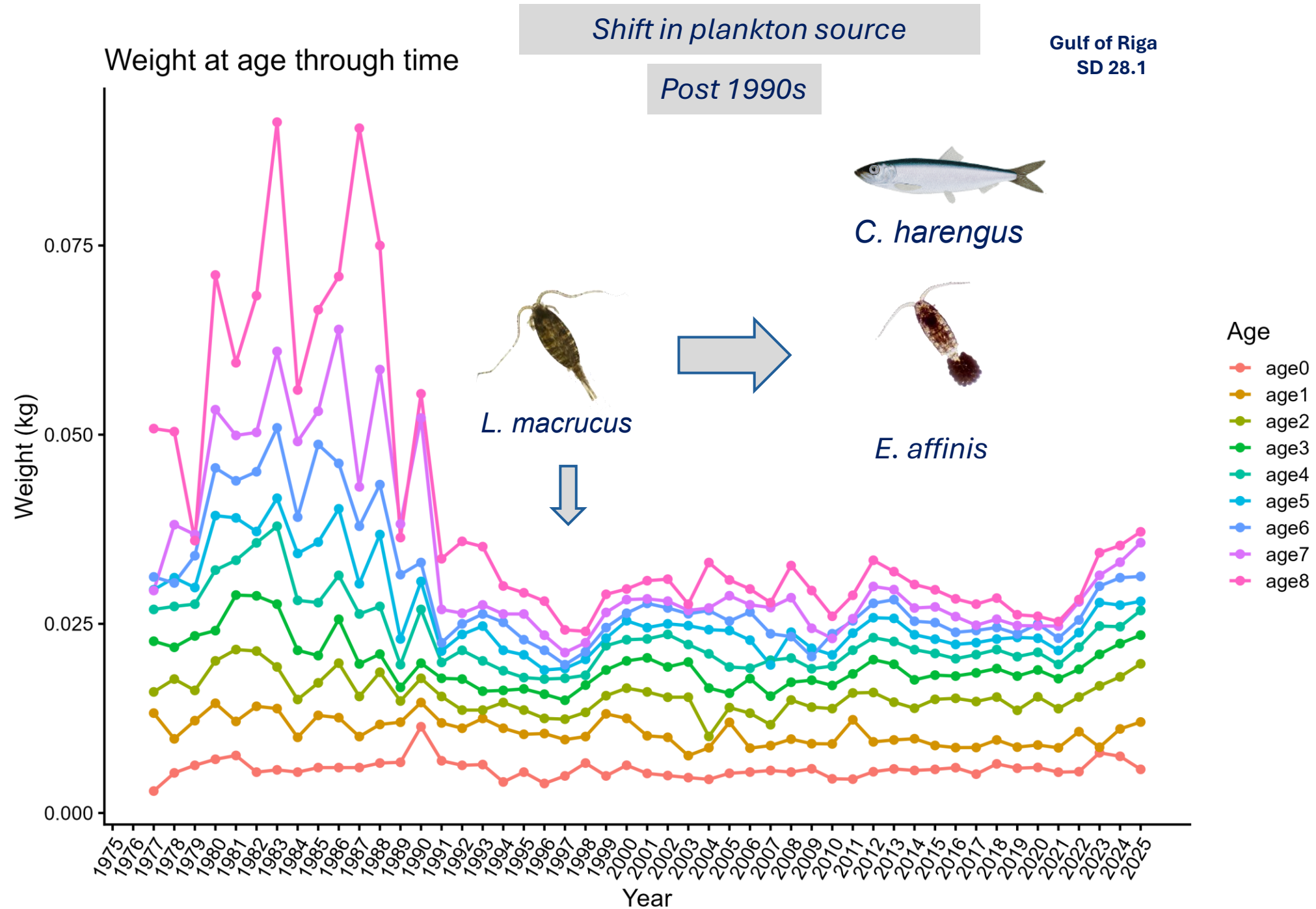


SSB alone is a weak predictor of recruitment variability

What factors drive Gulf of Riga herring recruitment variability?

The Gulf of Riga ecosystem has undergone major long-term changes



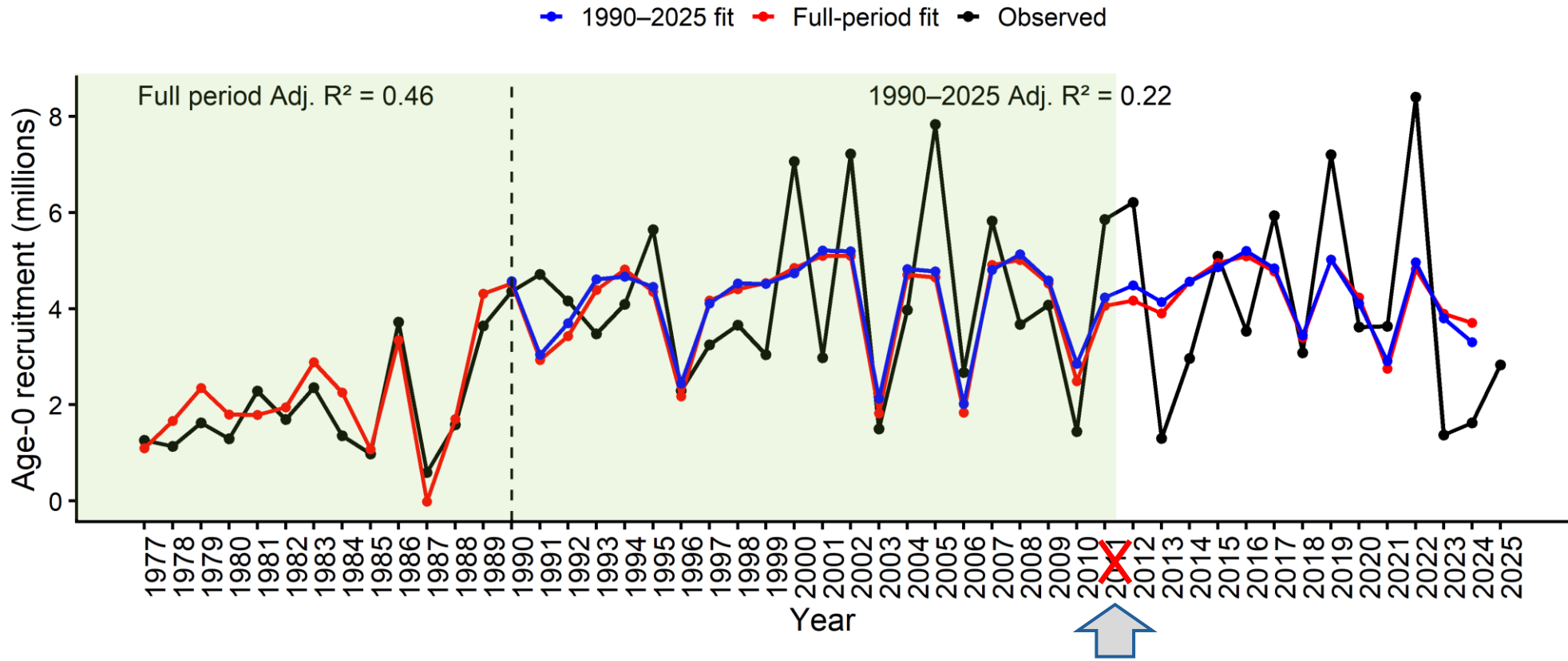




Does the historical recruitment relationship persist after 1990?

$$\text{Age0_rec} = s(\textit{Eurytemora affinis} \text{ May}) + s(T_{0-20\text{ m}} \text{ May}) + \varepsilon$$

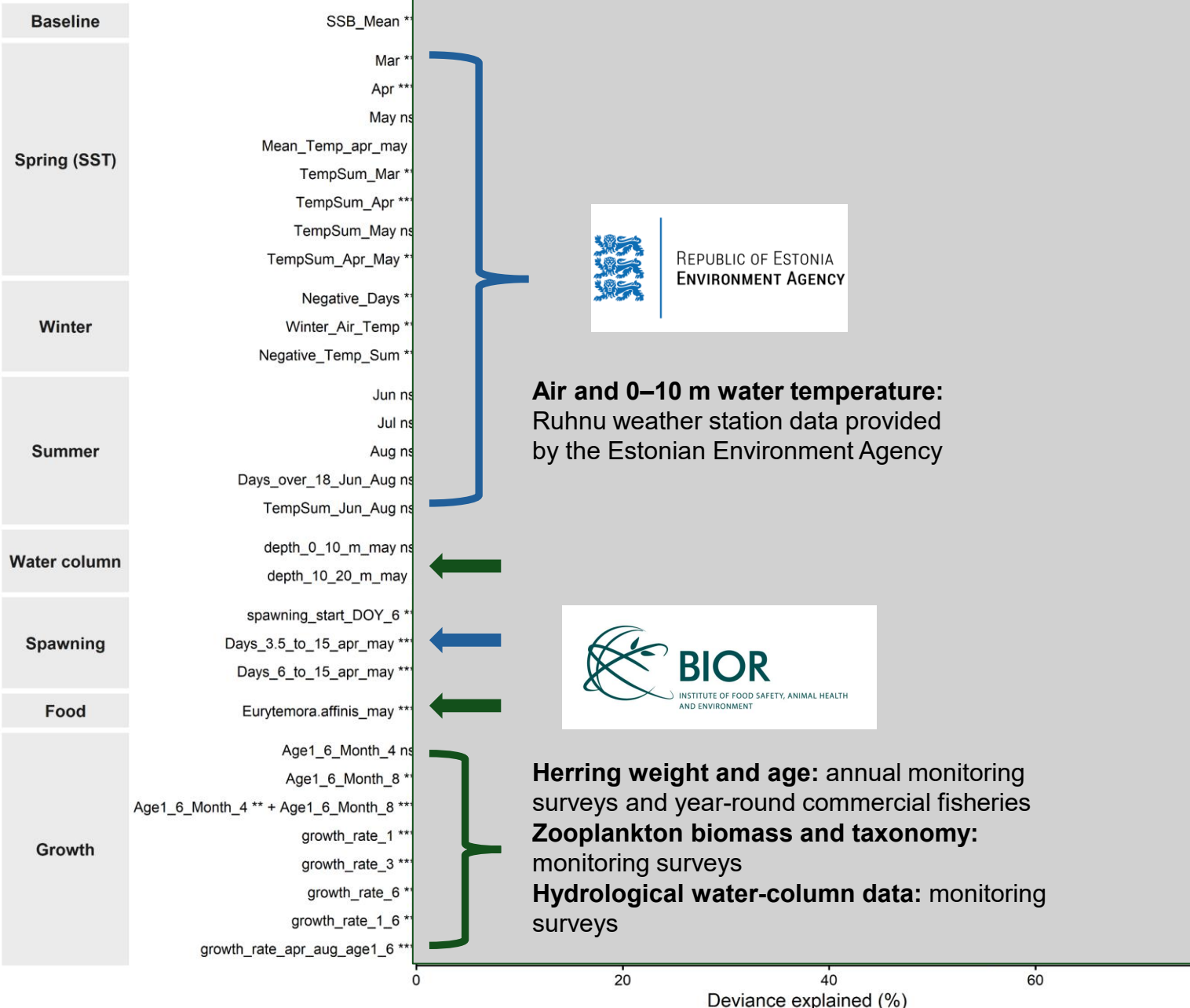
GAM, Gaussian, REML, k = 4



These variables are no longer used in the ICES short-term recruitment forecast

For short-term forecast is now used the geometric mean of recruitment beginning in 1989 trough data year -1

Materials and Methods



TOOLS:

Generalized additive models (GAMs)

with forward selection were applied to assess biological and environmental variables explaining herring recruitment age-0 variability, based on Akaike's information criterion (AIC), adjusted R^2 , deviance explained, and p-values.

SELECTION OF VARIABLES:

Variables in GAM models were selected and calculated according to previous studies (e.g., *TempSum*, *Negative_Temp_Sum* and spawning *Days 6-15 C in apr-may*) ; Kornilovs 2006, Raid et al. 2010 & 2023, Arula et al. 2014, Livdane et al. 2016, Ojaveer et al. 2021.

Growth rate:

mean herring total weight at age in each month

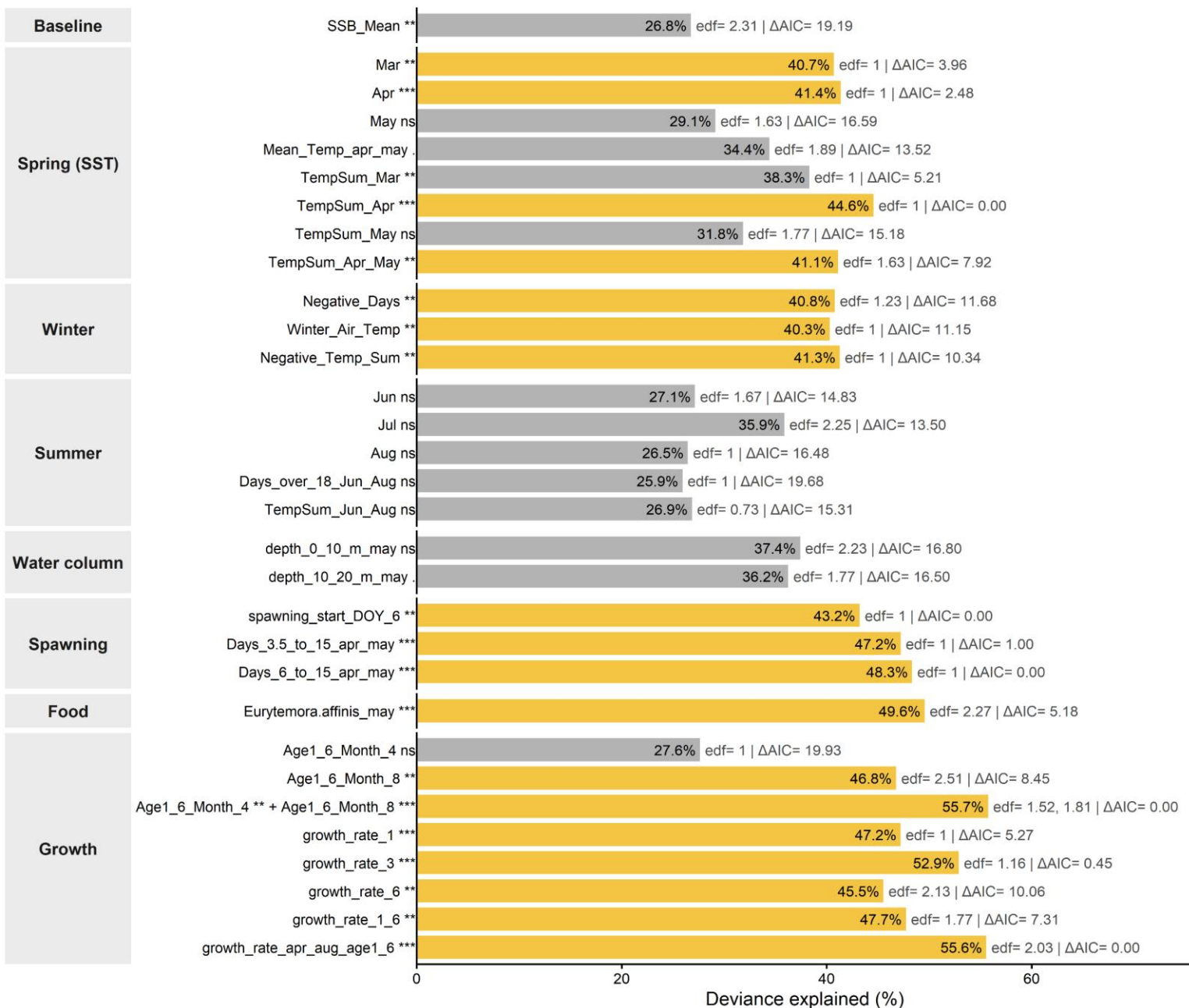
Results & Discussion



GAM recruitment models

Period: 1977–2025

■ >40% ■ ≤40%



What factors drive Gulf of Riga herring recruitment variability through time?

1977-2025 – recruitment

SSB

(26.8%)

Spring & Winter conditions, Spawning period, Growth conditions, Mass changes

TempSum_Apr (44.6%)

Days_6_to_15_mar_apr_may (48.3%)

Eurytemora affinis May (49.6%)

Age1_6_Month_4 + Age1_6_Month_8 (55.7%)

Growth_rate_apr_aug_age1_6 (55.6%)

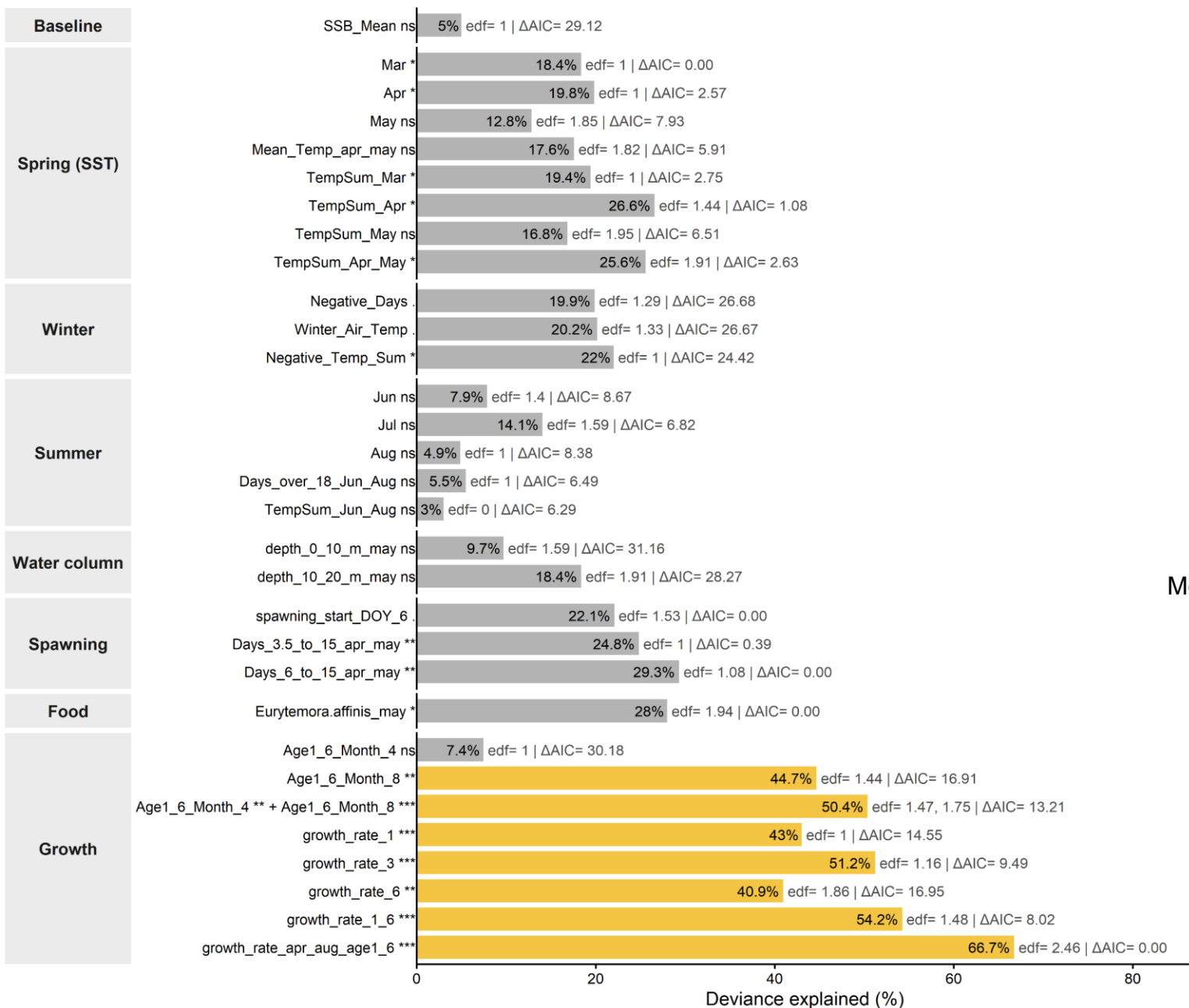
Model selection is based on dev. expl. and $\Delta AIC = 0$ (best fit)

Kornilovs 2006, Raid et al. 2010 & 2023, Arula et al. 2014, Livdane et al. 2016, Ojaveer et al. 2021

GAM recruitment models

Period: 1990–2025

■ >40% ■ ≤40%



What factors drive Gulf of Riga herring recruitment variability after the regime shift in 90s?

Post-1990 - recruitment SSB (5%)

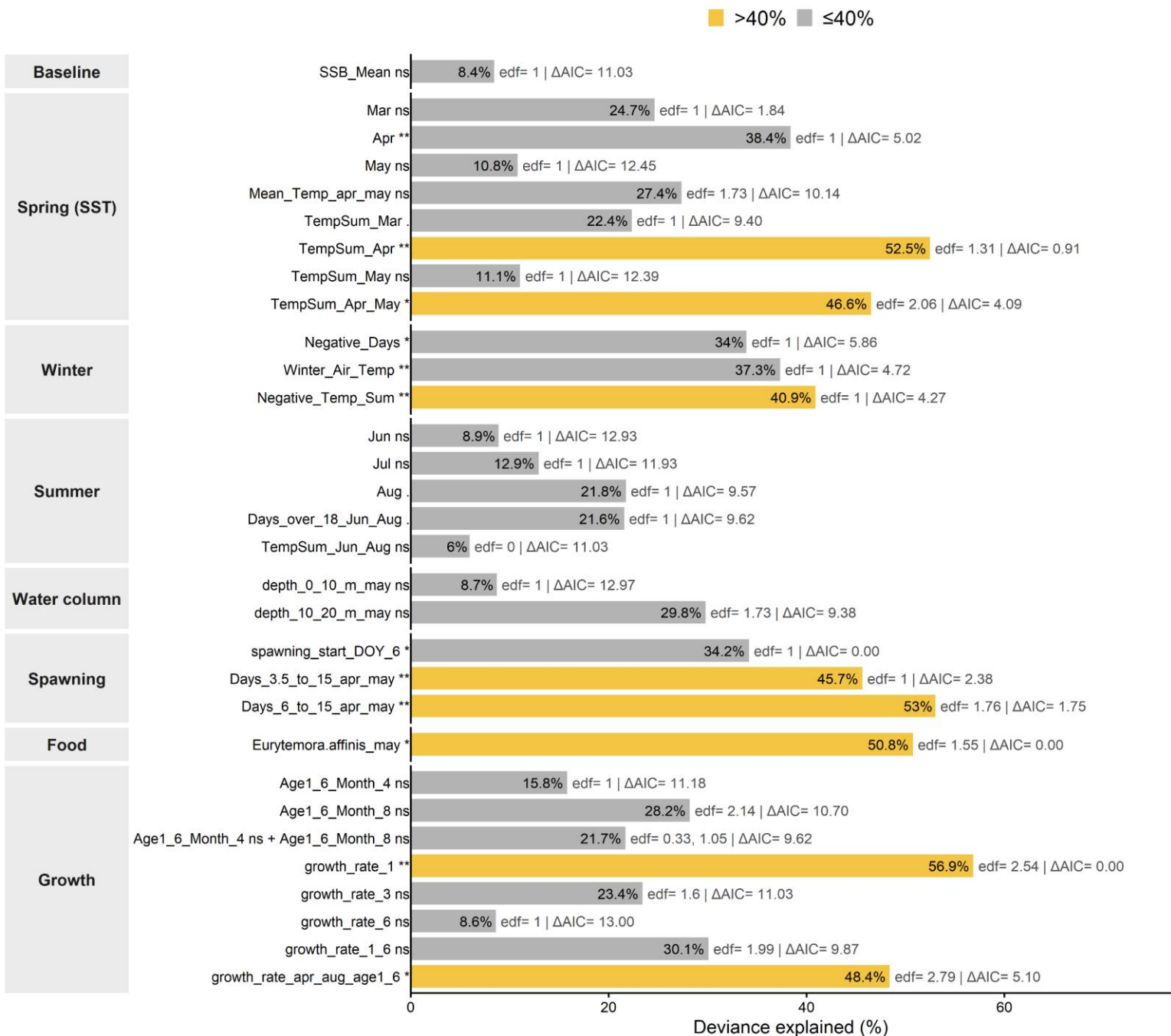
Growth conditions
Environmental and Biological variables are weak

growth_rate_apr_aug_age1_6 (66.7%)

Model selection is based on dev. expl. and ΔAIC = 0 (best fit)

Kornilovs 2006, Raid et al. 2010 & 2023, Arula et al. 2014, Livdane et al. 2016, Ojaveer et al. 2021

GAM recruitment models
Period: 1990–2025 Reduced Recruitment Years (under mean = 4.16 bil)



Do recruitment relationships persist when exceptionally strong year classes are excluded?

Post 1990 - high recruitment years removed

SSB (12.7%)

Spring conditions, Spawning period, Food availability, and Growth of younger herring (age 1)

TempSum_Apr (52.5%)

Days_6_to_15_apr_may (53.0 %)

E. affinis May (50.8%)

growth_rate_1 (56.9%)

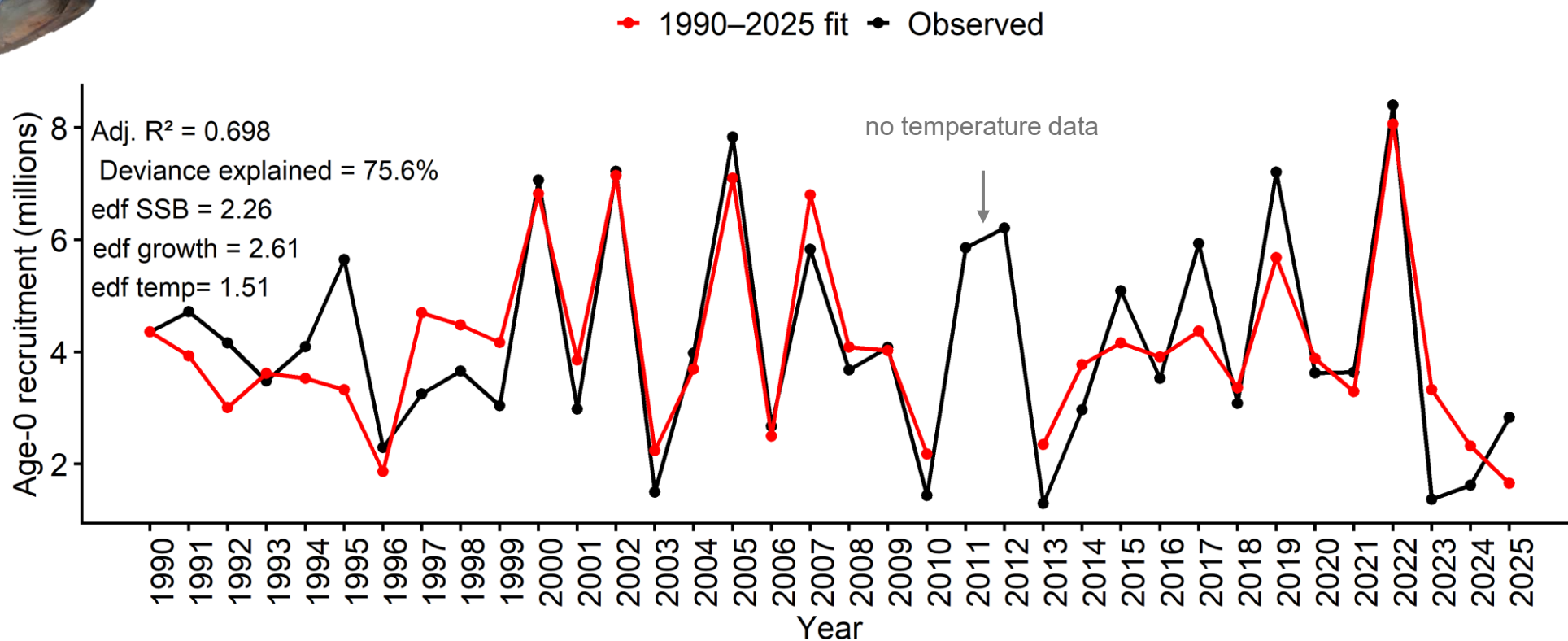
growth_rate_apr_aug_age1_6 (48.4%)

Model selection is based on dev. expl. and ΔAIC = 0 (best fit)

Kornilovs 2006, Raid et al. 2010 & 2023, Arula et al. 2014, Livdane et al. 2016, Ojaveer et al. 2021



Best
combined
model



$$\text{age0_rec} = s(\text{SSB}) + s(\text{Growth rate}_{\text{Age 1–6, Apr–Aug}}) + \varepsilon$$

dev. expl = 66.7%

$$\text{age0_rec} = s(\text{SSB}) + s(\text{Growth rate}_{\text{Age 1–6, Apr–Aug}}) + s(\text{TempSum_Apr}) + \varepsilon$$

dev. expl = 75.6%

GAM, Gaussian, REML, k = 4

Conclusions

- The factors associated with recruitment variability changed following the 1990s ecosystem regime shift
- Favorable growth condition of age 1–6 (Apr-Aug) herring are associated with stronger year classes, suggesting that herring growth acts as an integrated indicator of ecosystem conditions rather than a direct driver of recruitment
- As juvenile and older herring share similar prey resources, herring growth is likely to reflect common feeding, competition, and ecosystem conditions that also influence juvenile survival of age-0
- Combining SSB, herring growth, and spring temperature explained 75.6% of historical recruitment variability, providing a promising basis for testing ecosystem-informed recruitment forecasts

Thank you for your attention!

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Certificate of attendance

ICES Annual Science Conference 2026 at Le Quartz - National Stage, Brest in France, 15-18 September

This certificate is given to

Elvita EGLITE

for attendance at the ICES Annual Science Conference 2026 at Le Quartz - National Stage, Brest in France, 15-18 September.

Best regards

A handwritten signature in black ink, appearing to read 'A. Davies'.

Anna Davies
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Conference and Training Coordinator
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MICROPLASTIC OCCURRENCE IN THE GASTROINTESTINAL TRACTS OF KEY FISH SPECIES FROM THE BALTIC SEA AND GULF OF RIGA

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¹ Institute of Food Safety, Animal Health and Environment “BIOR”, Lejupes iela 3, Riga, LV-1076, Latvia

² Latvian Institute of Aquatic Ecology, Voleru street 4, Riga, LV-1007, Latvia



Take Home message

382

fish analysed

173

particles identified

91.9%

fibres

68.8%

most common particle size 0.1–1 mm

Microplastics occurred in all three species, but load varied by species - not consistently by fish age or sampling location

STUDY DESIGN

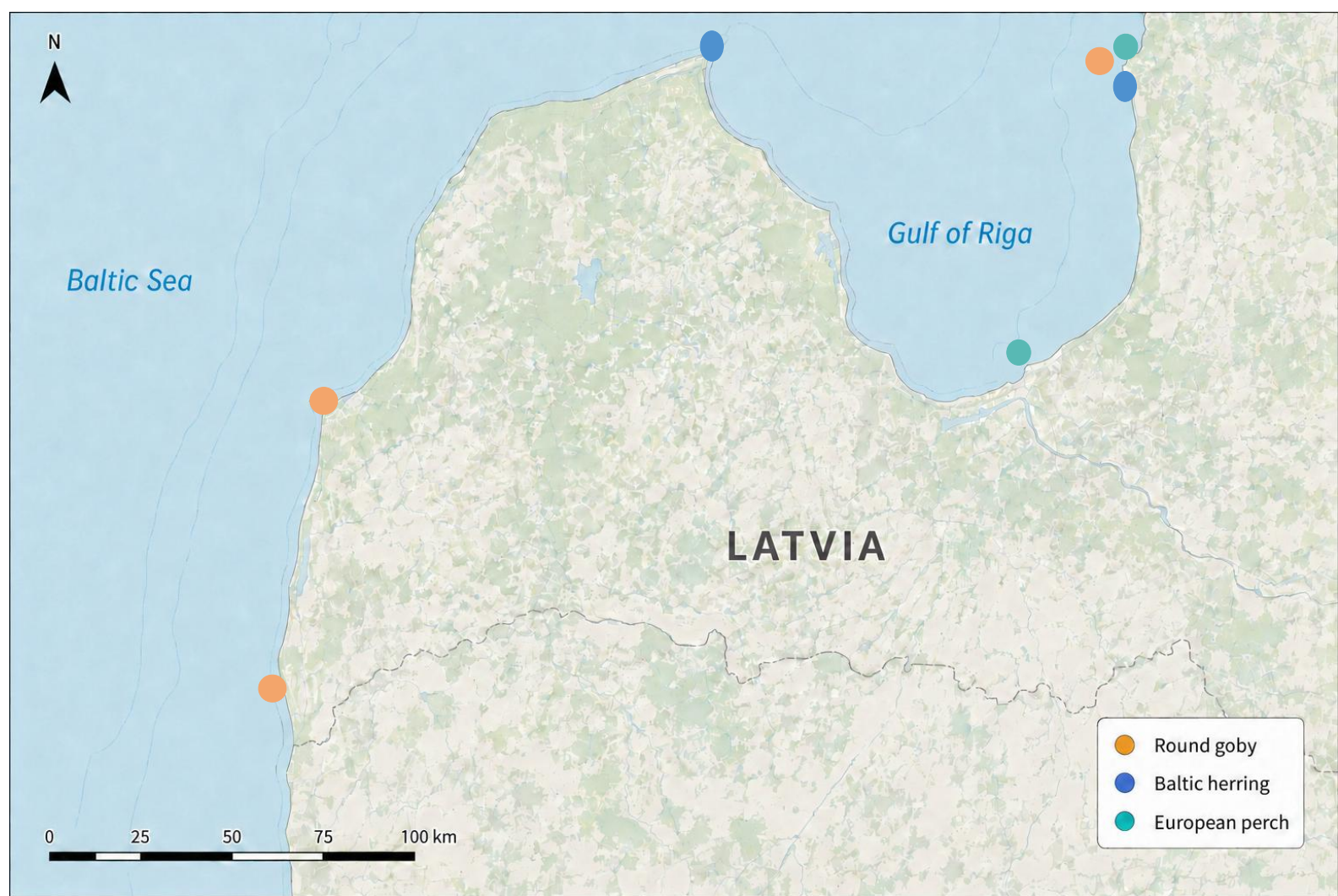
Three ecologically distinct fish species were used

Baltic herring n = 156
Clupea harengus membras · pelagic planktivore

Round goby n = 126
Neogobius melanostomus · predatory benthivore

European perch n = 100
Perca fluviatilis · benthopelagic predator

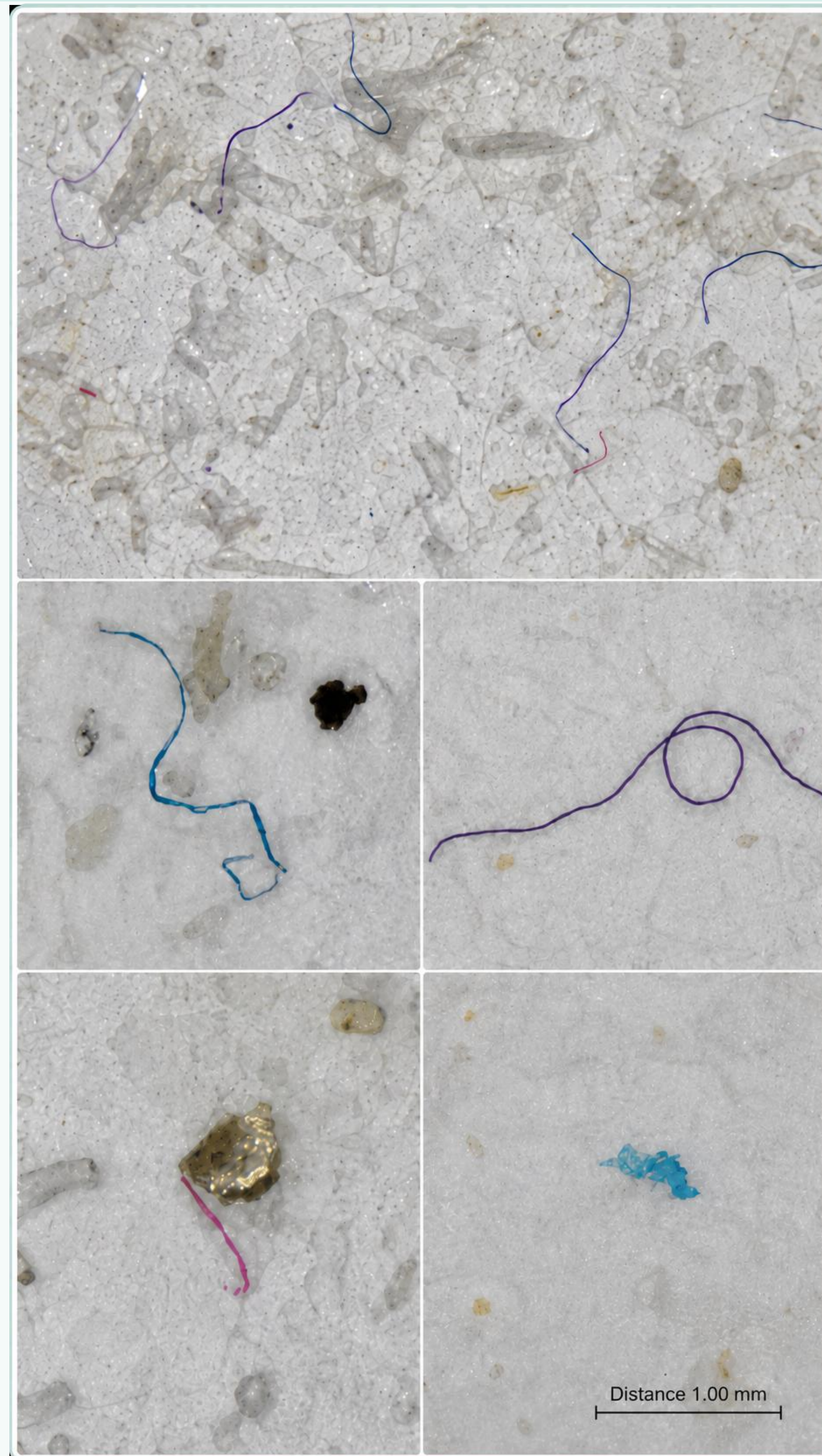
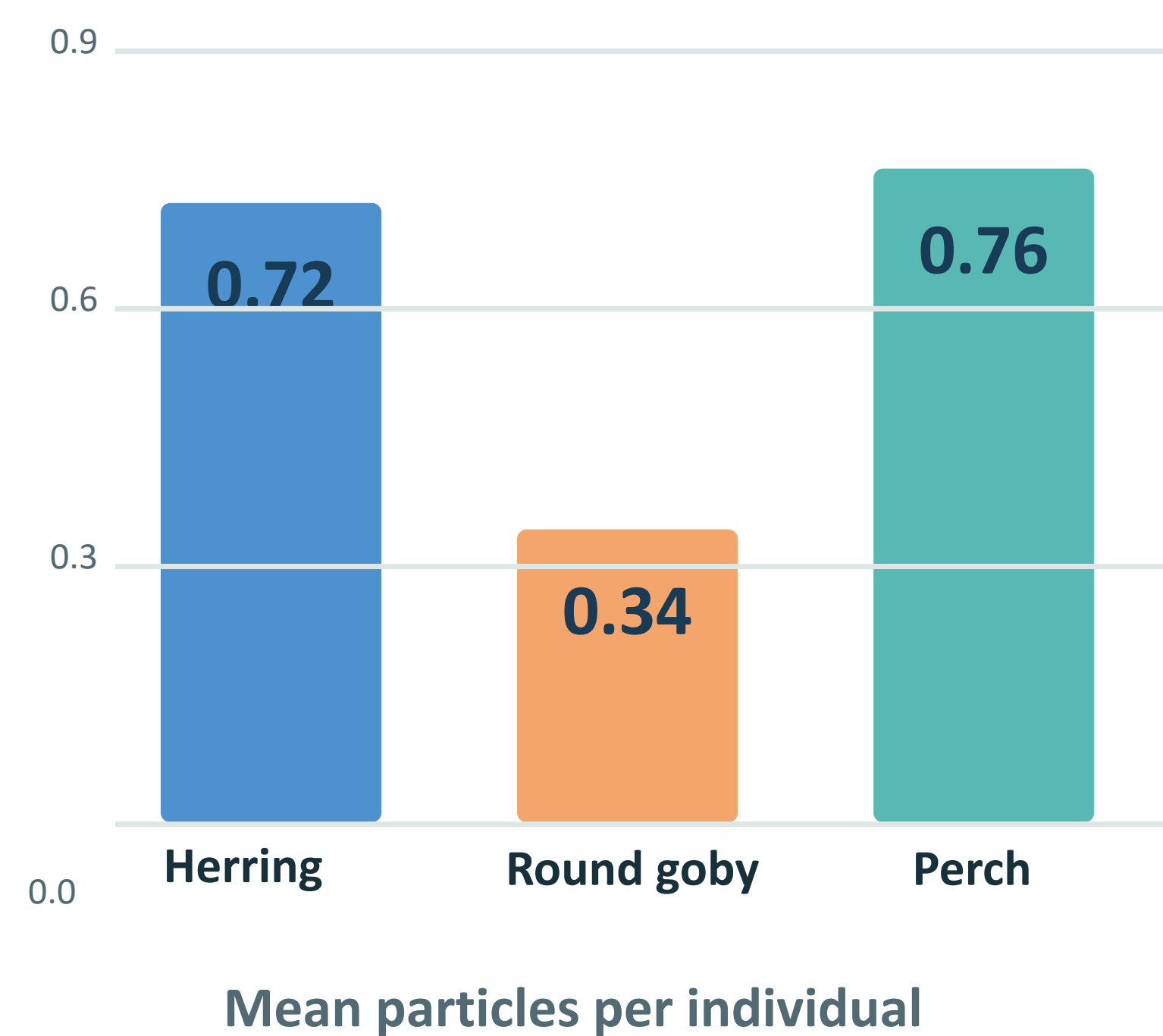
STUDY SITE



LABORATORY WORKFLOW

- 1 Entire gastrointestinal tract removed
- 2 10% NaOH · 1:3 · 24 h · 50°C · 100 rpm
- 3 30% H₂O₂ · 1:1 · 48 h · 50°C · 100 rpm
- 4 Visual microscopy; ATR-FTIR where applicable

QC Blanks + recovery tests with 100 µm PS beads



INTERPRETATION

SPECIES MATTERED

Statistically significant differences in the mean microplastic concentration per individual were found among the fish species ($p < 0.05$). A significant difference was observed between round goby, a predatory benthivore, and herring, a planktivore ($p = 0.047$). However, no statistically significant differences were found between round goby and perch, or between perch and herring.

AGE DID NOT

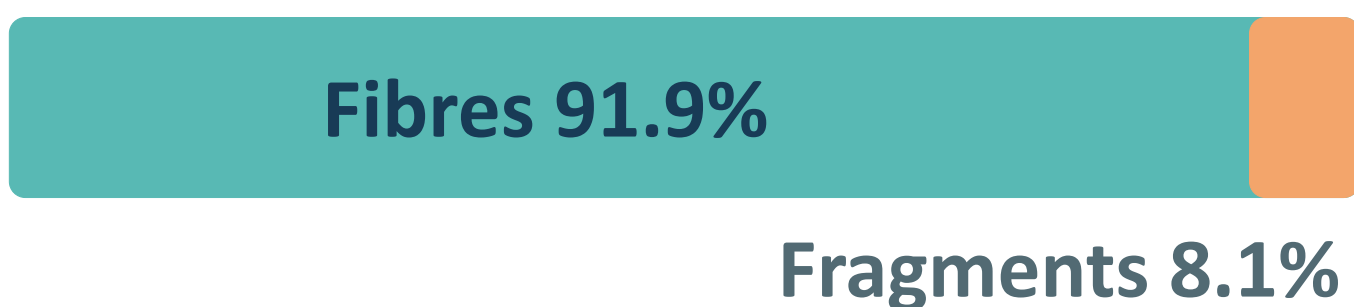
No significant differences were detected among age groups and no consistent increase with fish age was observed.

LOCATION

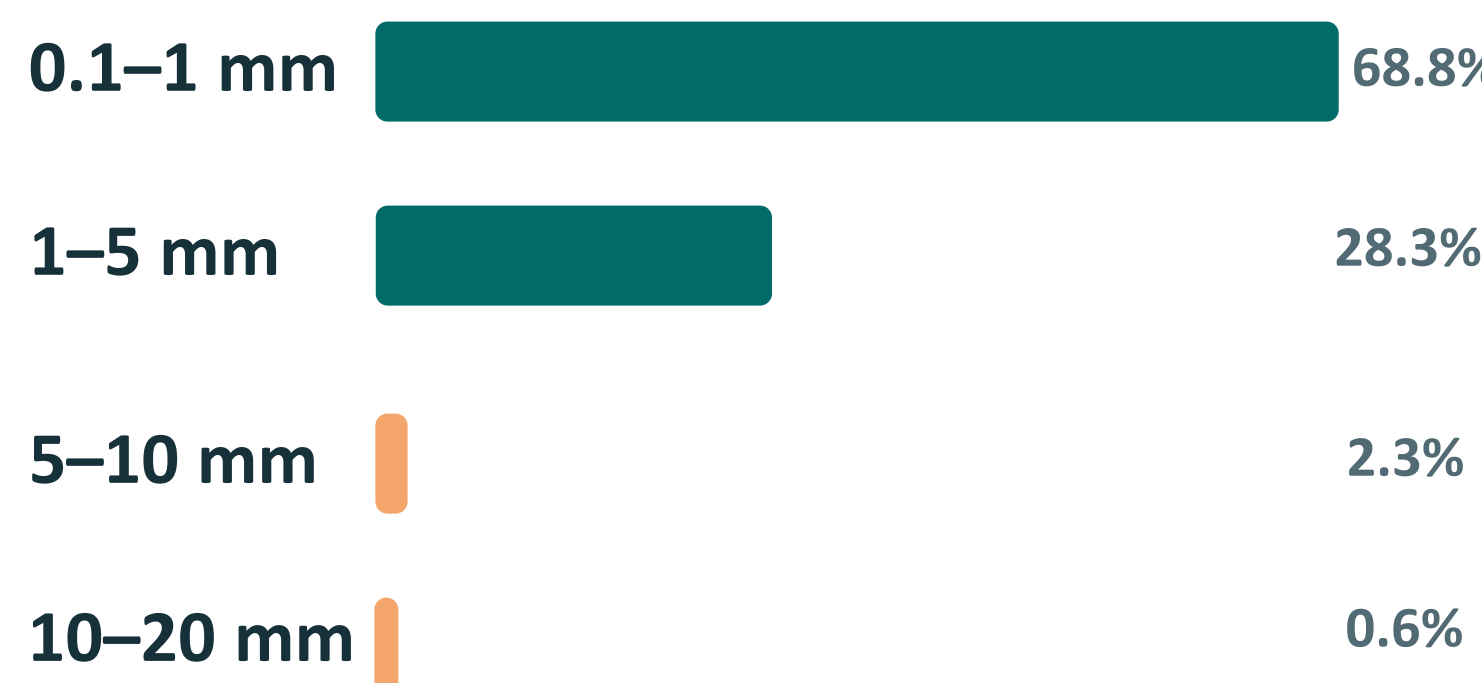
Higher concentration of microplastics was detected in Riga gulf compared to open Baltic Sea (not statistically).

PARTICLE PROFILE

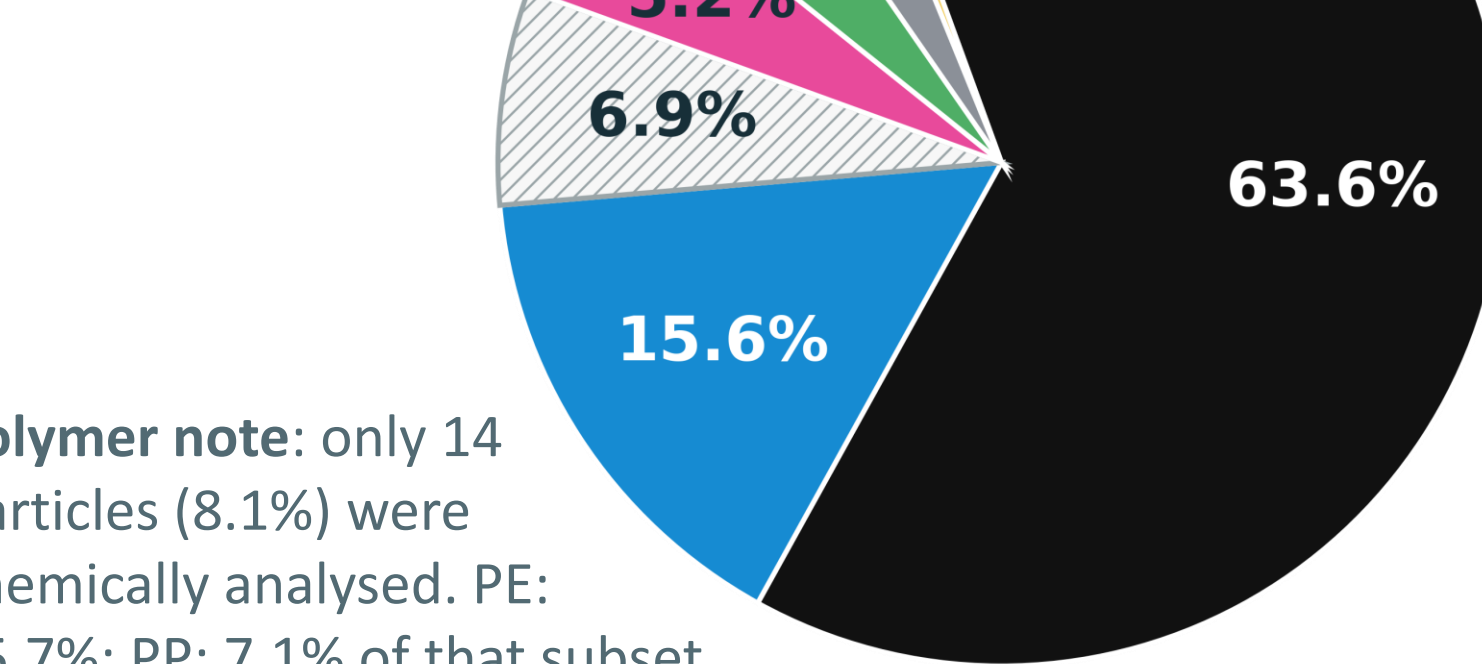
TYPE



SIZE DISTRIBUTION



COLOUR



Polymer note: only 14 particles (8.1%) were chemically analysed. PE: 35.7%; PP: 7.1% of that subset

CONCLUSIONS

The comparatively low microplastic concentration in round goby suggests species-specific feeding strategy impact.

Older and larger individuals are not necessarily predisposed to higher microplastic contamination in the gastrointestinal tract. This finding is relevant in the context of food production, where larger individuals may be preferentially used, including in public kitchens.

BASELINE, NOT RISK ESTIMATE

These results document exposure in gastrointestinal tracts, they do not quantify consumer exposure from edible fish tissue.

Correspondence

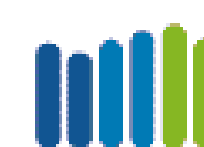
Inta Dimante-Deimantovica

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BLUE ECONOMY

RoundGoby