Seasonal resilience of temperate estuarine fish in response to climate change

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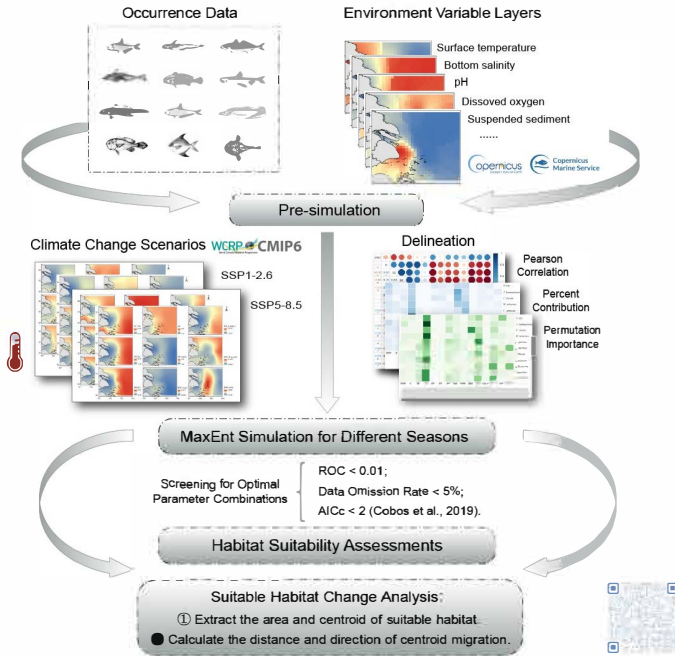
Objective

By examining the seasonal affinities of important fish populations in the Yangtze Estuary to environmental factors, this manuscript models and predicts the multidimensional habitat suitability responses (HSRs) for these populations and functional assemblages driven by climate change.

Methods

Results

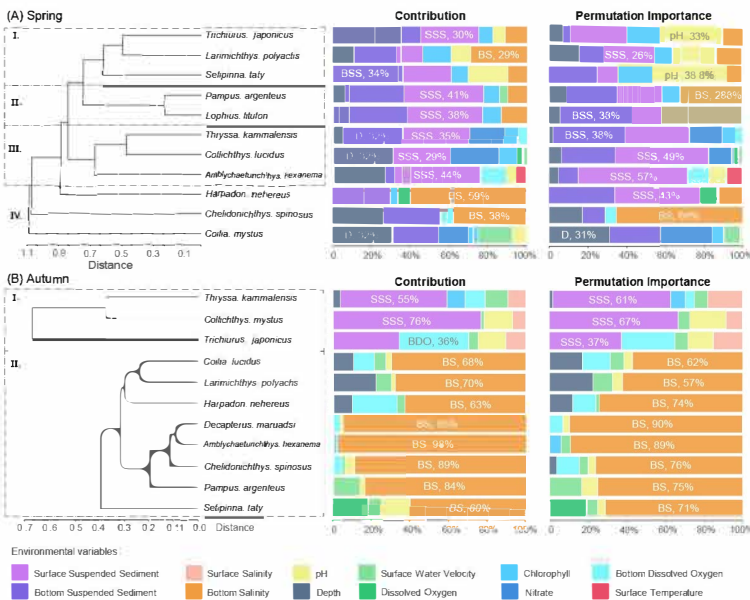### Population affinity and sensitivity to the environment:

Figure 1 The 12 fish populations are categorized into four groups in spring and two in autumn, based on environmental variable similarities in modeling. In spring, Group II abandoned climate driver pH, Group III depended on NO₃ -N, BDO, or ST, while Group IV's low similarity reflected specific environmental needs. In autumn, Group I relied on SWV and SS, while Group II preferred BS.

Three dimensions of interspecific asynchrony and seasonal resilience in habitat suitability responses for fish populations:

Table 1 Summary of future redistribution and area change in habitat suitability.

Species	Spring			Autumn		
	Redistribution	Area change		Redistribution	Area change	
		SSP1-2.6	SSP5-8.5		SSP1-2.6	SSP5-8.5
H. nehereus	☉	-100.00%	-100.00%	→	-83.75%	-87.50%
S. taty	☉	-73.77%	-100.00%	☉	-86.43%	-100.00%
C. mystus	→	-5.08%	-71.19%	✕	-87.72%	-100.00%
C. spinosus	←	25.00%	-13.39%	☉	-60.66%	-100.00%
T. japonicus	☉	-100.00%	-100.00%	←	109.15%	96.73%
L. polyactis	☉	-97.18%	-100.00%	☉	203.75%	123.73%
A. hexanema	⊡	430.00%	432.35%	✕	-32.53%	-54.22%
C. lucidus	⊡	44.35%	44.35%	✕	4.23%	-80.25%
D. maruadsi	/			⊡	-61.22%	54.08%
L. litulon	⊡	101.59%	90.48%		/	
P. argenteus	→	32.36%	24.19%	⊡	14.00%	0.50%
T. kammalensis	⊡	341.03%	341.03%	⊡	232.47%	200.00%

Note: ✕, Decentralization; ☉, Center contraction; ⊡, Center expansion; →/←, Center of gravity shift (to the open sea/estuary).
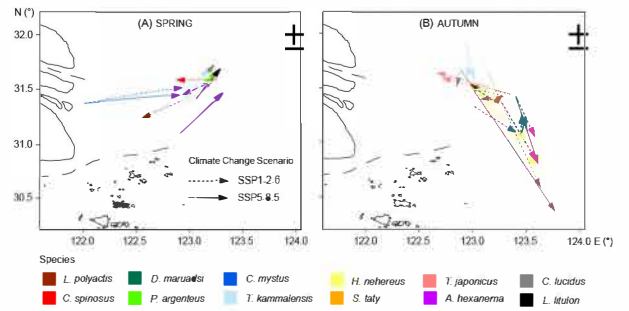

Figure 2 Migration of suitable habitat centroids for each population. Overall, seven populations may migrate towards the southeast outer sea, six of which migrated in a significantly different direction than in the spring.

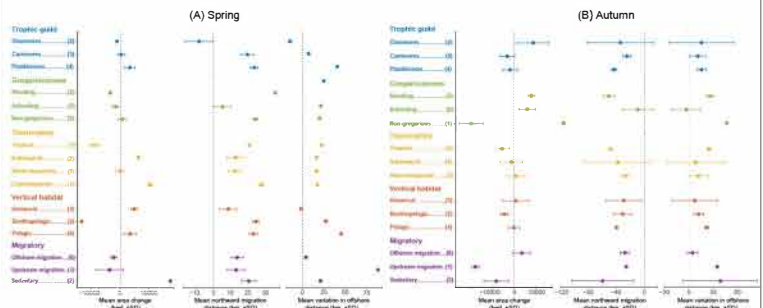### Seasonal Characteristics of Response Strategies for Functional assemblages:

Figure 3 Three mean changes in the future distribution of functional assemblages. Overall, demersal fishes alone are projected to expand suitable habitats & adapt to climate change seasonally. Anadromous, benthopelagic, & tropical fish will decline, displaying stable seasonal inadaptability. Functional assemblages exhibit contrasting spring-autumn trends in area change. Regarding migration, despite varied criteria, most show similar trends: northeast in spring, southeast in autumn.

Summary

Seasonal resilience in the multidimensional habitat suitability responses of many fish populations (5/12) and their functional assemblages (11/16) is revealed for the first time by decentralizing climate risk to seasonal scales.