Ecotypes of NE Atlantic fish species

Ellis, Engelhard & Pinnegar --- *Cefas*

- Fish faunas have numerous species, each may respond differently to climate change
- How to facilitate studying climate impacts on entire fish assemblages?
- Concept of ***ecotypes*** **---** groups of species similar in important biological characteristics
    - ***Life-history, biogeography, feeding guild, etc.***
- We classified all NE Atlantic fishes according to ecotype

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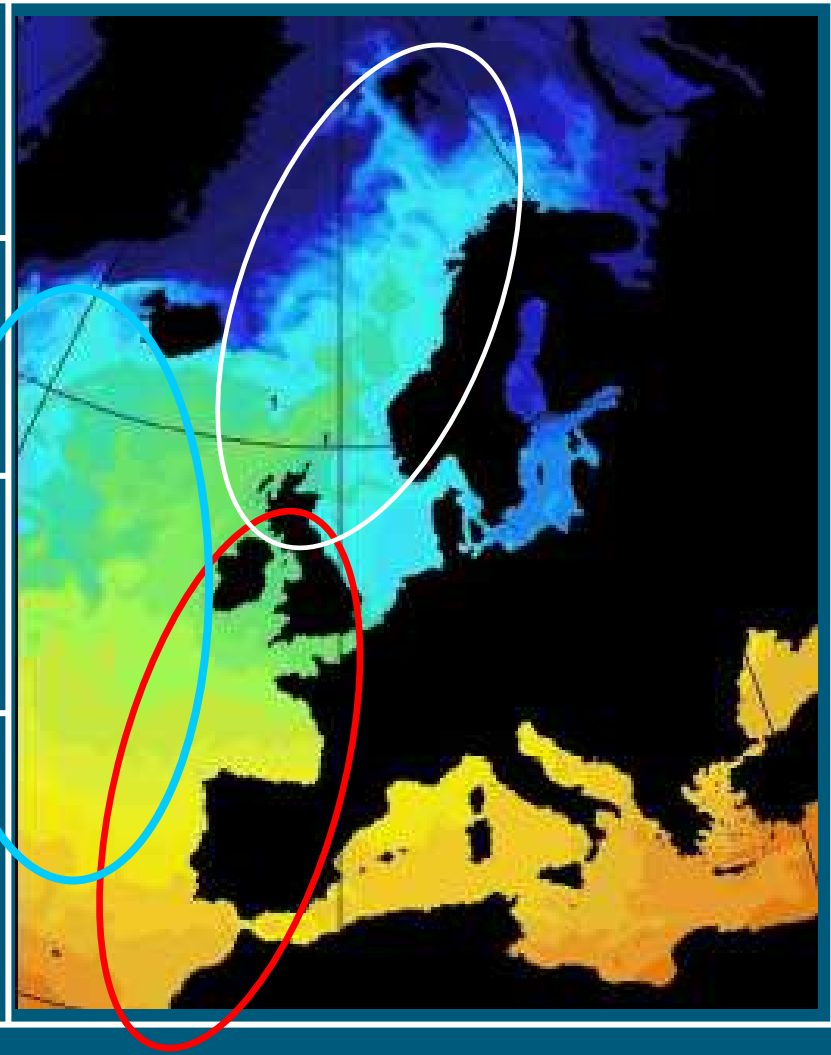
Aspects of ecotypes

(a) Biogeographical affinities

Ecotype	
Boreal	
Atlantic	
Lusitanian	



Aspects of ecotypes

(a) Biogeographical affinities

Ecotype	*Examples*
Atlantic	Eel, blue whiting, tuna, mackerel
Boreal	Spurdog, herring, cod, saithe, haddock, wolf-fish, redfish, lemon sole, halibut, witch
Lusitanian	Many rays, sardine, anchovy, whiting, hake, dory, angler, gurnards, seabass, red mullet, sole

Aspects of ecotypes

(b) Reproductive mode

Ecotype	*Examples*
Planktonic eggs	Majority, incl. many clupeids, gadoids, dory, gurnards, (horse-)mackerel, breams, mullets
Demersal eggs	Many rays, herring, many perciforms incl. sandeels, gobies and blennies
Egg brooder	Seahorses and pipefish
Nest-forming	Stickleback, wrasses
Viviparous	Many sharks and some rays, redfish, eelpout

Aspects of ecotypes

(c) Maximum body length

(d) Feeding guild and trophic level

Ecotype	*Feeding on:*
Piscivores	Preying on smaller fish (and cephalopods)
Benthivores	Variety of benthic invertebrates
Carcinophages	Specialised on crustaceans (smooth-hounds)
Planktivores	Primarily zooplankton
Herbivores	Grazing on algae
Detritivores	Ingesting sediments (e.g. grey mullets)
Ectoparasites	Feed off other fish (e.g. lampreys)

Aspects of ecotypes

(e) Habitat

Ecotype	*Examples*
Rocky intertidal	Few species almost exclusively here, e.g. blenny
Estuarine	Grey mullet, flounder, juveniles of many species
Coastal	Many species prevail in shallow coastal zones (but also occur on shelf); nursery areas for many species
Contin. shelf	Majority of North Sea fishes, demersal and small pelagic
Contin. slope	Northern North Sea and Norwegian Deep: various demersal, bathypelagic, pelagic fishes
Oceanic	NW-most North Sea: mainly epi- (0-200m) and mesopelagic (200-1000m) enter North Sea

Family	Species	Common name	Source	Biogeogr. guild	Reprod. guild	Lmax (cm)	Habitat	Habitat	Trophic level	Trophic guild
Petromyzontidae	*Lampetra fluviatilis*	River lamprey	Yang (1982)	Boreal	Fluvial spawner	45	Demersal	Coastal	4.5	Ectoparasit
Petromyzontidae	*Petromyzon marinus*	Sea lamprey	Yang (1982)	Boreal	Fluvial spawner	120	Demersal	Shelf	4.4	Ectoparasit
Myxinidae	*Myxine glutinosa*	Hagfish	Yang (1982)	Atlantic	Demersal eggs	45	Demersal	Shelf	3.5	Scavenger
Hexanchidae	*Hexanchus griseus*	Six-gilled shark	Yang (1982)	Atlantic	Viviparous	500	Bathydemersal	Slope	4.3	Piscivore
Alopiidae	*Alopias vulpinus*	Thresher shark	Yang (1982)	Atlantic	Viviparous	560	Epipelagic	Oceanic	4.5	Piscivore
Cetorhinidae	*Cetorhinus maximus*	Basking shark	Yang (1982)	Atlantic	Viviparous	980	Epipelagic	Shelf	3.2	Planktivore
Lamnidae	*Isurus oxyrinchus*	Mako shark	Yang (1982)	Atlantic	Viviparous	400	Epipelagic	Oceanic	4.5	Piscivore
Lamnidae	*Lamna nasus*	Porbeagle shark	Yang (1982)	Atlantic	Viviparous	370	Epipelagic	Shelf	4.5	Piscivore
Scyliorhinidae	*Galeus melastomus*	Blackmouthed dogfish	Yang (1982)	Lusitanian	Demersal eggs	90	Bathydemersal	Slope	4.2	Benthopiscivor
Scyliorhinidae	*Scyliorhinus canicula*	Lesser-spotted dogfish	Yang (1982)	Lusitanian	Demersal eggs	80	Demersal	Inner shelf	3.7	Benthopiscivor
Scyliorhinidae	*Scyliorhinus stellaris*	Nurse hound	Yang (1982)	Lusitanian	Demersal egg	162	Reef	Inner shelf	4.0	Piscivore
Triakidae	*Galeorhinus galeus*	Tope shark	Yang (1982)	Lusitanian	Viviparous	200	Benthopelagic	Shelf	4.2	Piscivore
Triakidae	*Mustelus asterias*	Starry smooth hound	Yang (1982)	Lusitanian	Viviparous	140	Demersal	Shelf	3.7	Carcinopha
Triakidae	*Mustelus mustelus*	Smooth hound	Yang (1982)	Lusitanian	Viviparous	150	Demersal	Shelf	3.8	Carcinopha
Carcharhinidae	*Carcharhinus longimanus*	Oceanic whitetip shark	One vagrant	Atlantic	Viviparous	350	Epipelagic	Oceanic	4.2	Piscivore
Carcharhinidae	*Prionace glauca*	Blue shark	Yang (1982)	Atlantic	Viviparous	383	Epipelagic	Oceanic	4.2	Piscivore
Sphyrnidae	*Sphyrna zygaena*	Common hammerhead	Yang (1982)	Atlantic	Viviparous	400	Epipelagic	Oceanic	4.5	Piscivore
Dalatiidae	*Dalatias licha*	Darkie charlie	Yang (1982)	Atlantic	Viviparous	180	Bathydemersal	Slope	4.2	Piscivore
Dalatiidae	*Etmopterus spinax*	Velvet belly	Yang (1982)	Atlantic	Viviparous	45	Bathydemersal	Slope	3.8	Piscivore
Dalatiidae	*Somniosus microcephalus*	Greenland shark	Yang (1982)	Boreal	Viviparous	650	Benthopelagic	Slope	4.2	Piscivore
Squalidae	*Squalus acanthias*	Spurdog	Yang (1982)	Boreal	Viviparous	105	Benthopelagic	Shelf	4.3	Piscivore
Echinorhinidae	*Echinorhinus brucus*	Bramble shark	Compagno (1984)	Atlantic	Viviparous	250	Bathydemersal	Slope	4.4	Piscivore
Squatinidae	*Squatina squatina*	Angel shark	Yang (1982)	Lusitanian	Viviparous	250	Demersal	Inner shelf	4.1	Piscivore
Torpedinidae	*Torpedo marmorata*	Marbled electric ray	Yang (1982)	Lusitanian	Viviparous	60	Demersal	Shelf	4.5	Piscivore
Torpedinidae	*Torpedo nobiliana*	Common electric ray	Yang (1982)	Lusitanian	Viviparous	180	Demersal	Shelf	4.5	Piscivore
Rajidae	*Amblyraja radiata*	Starry ray	Yang (1982)	Boreal	Demersal eggs	90	Demersal	Shelf	4.0	Piscivore
Rajidae	*Dipturus batis*	Common skate	Yang (1982)	Boreal	Demersal eggs	250	Demersal	Shelf	4.0	Piscivore
Rajidae	*Dipturus linteus*	Sailray	Laverack & Blackler (1974)	Boreal	Demersal eggs	110	Demersal	Slope	3.5	Benthivore
Rajidae	*Dipturus nidarosiensis*	Black skate	Yang (1982)	Boreal	Demersal eggs	200	Bathydemersal	Slope	3.5	Piscivore
Rajidae	*Dipturus oxyrinchus*	Long-nose skate	Yang (1982)	Lusitanian	Demersal eggs	150	Bathydemersal	Slope	3.5	Piscivore

Applying ecosystem concept

Climate change and deepening of the North Sea fish assemblage

Nick Dulvy and colleagues (Cefas, IMR)

- From 1980-2004, fish assemblage has 'deepened' by ~3.6 m decade^{-1}
- Also latitudinal response, but more heterogeneous:
  - ✓Northward shift of many ***Boreal*** species
  - ✓Southward shift of many warm-tolerant ***Lusitanian*** species
- Aggregate deepening response can be monitored as indicator of warming regional seas

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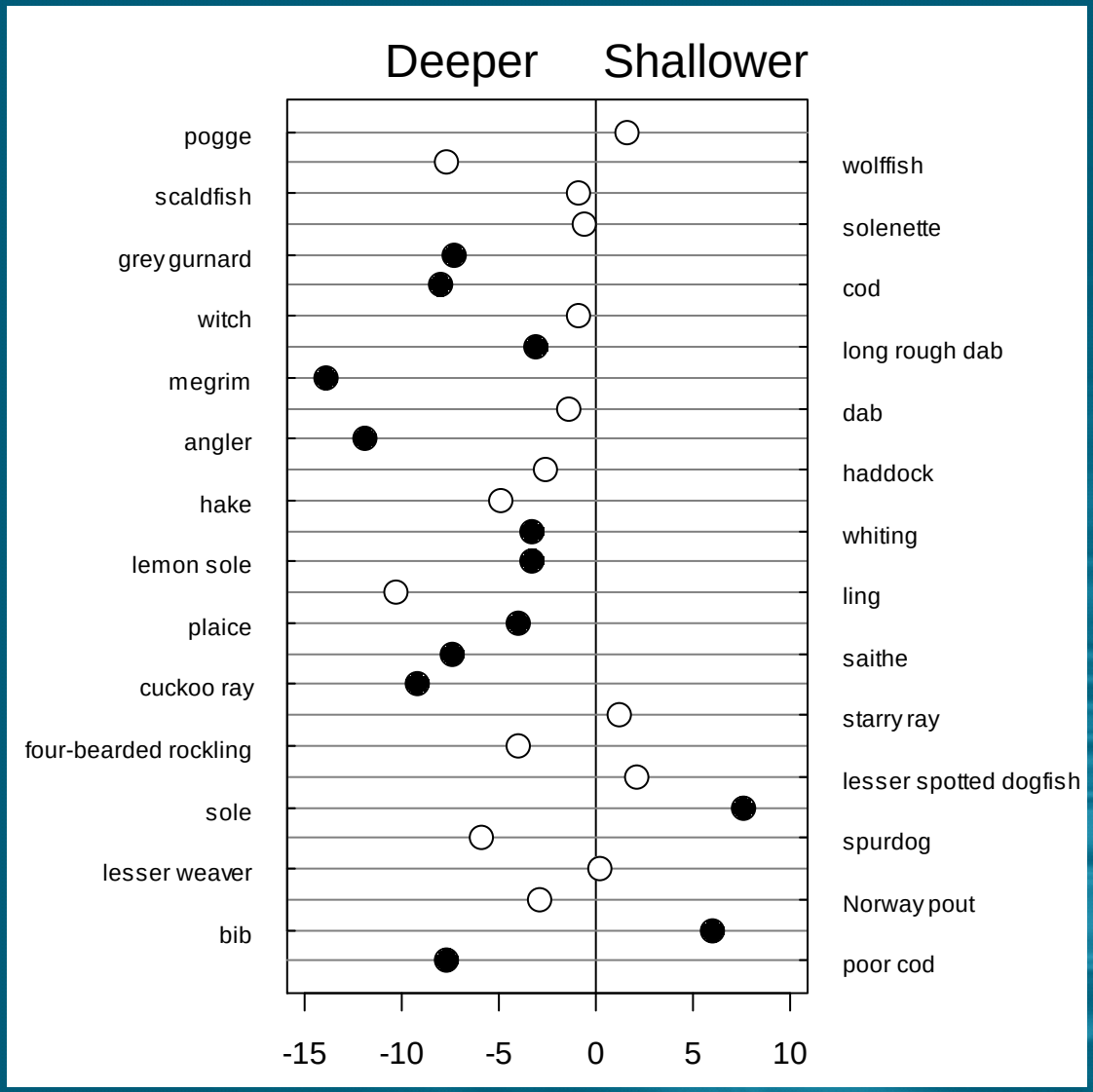
Decadal change in depth anomaly

in m decade^{-1}



Significant

Not significant

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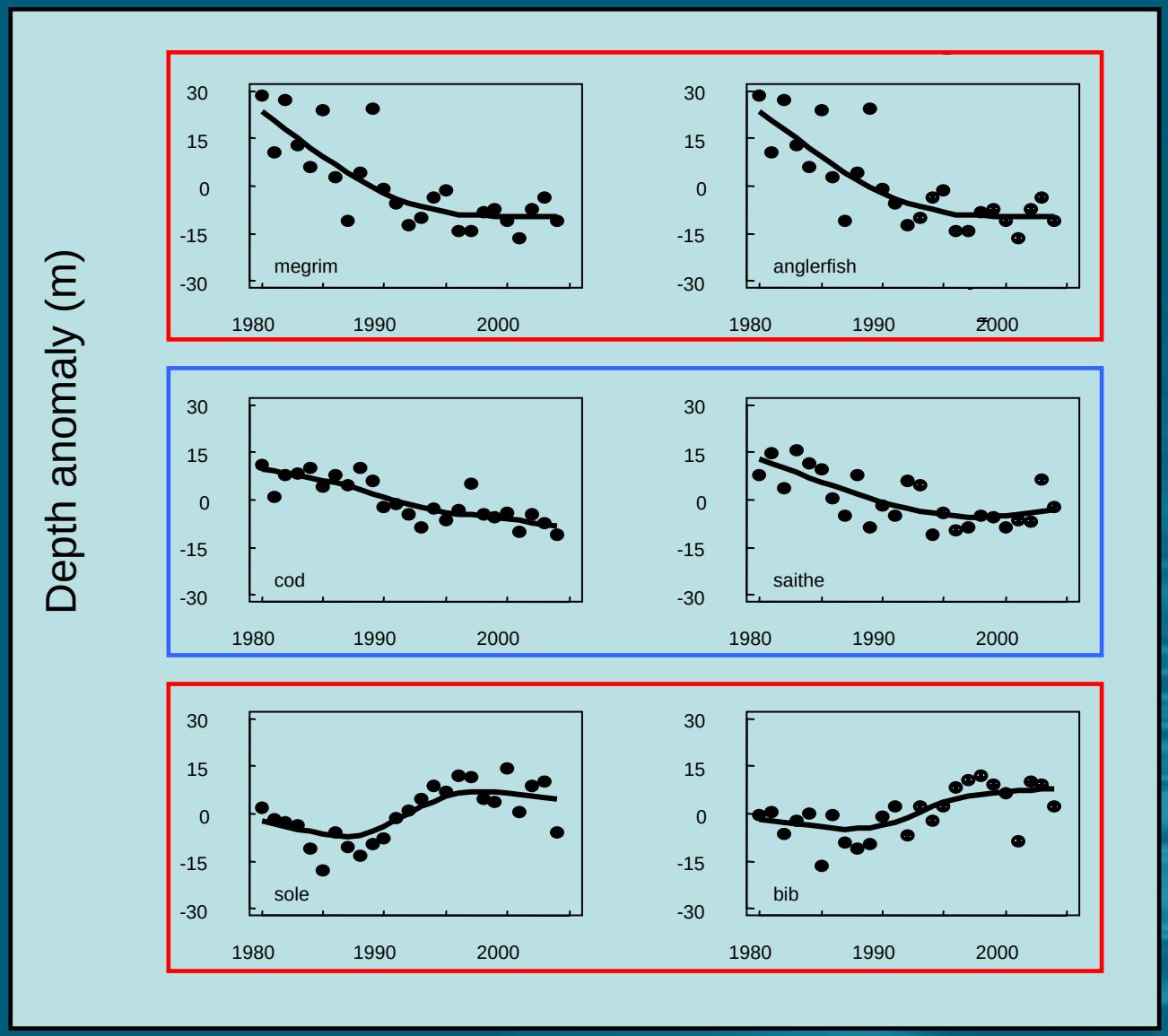
Depth anomaly: 4 boreal, 2 lusitanian species



Shelf

Shelf

Inner shelf

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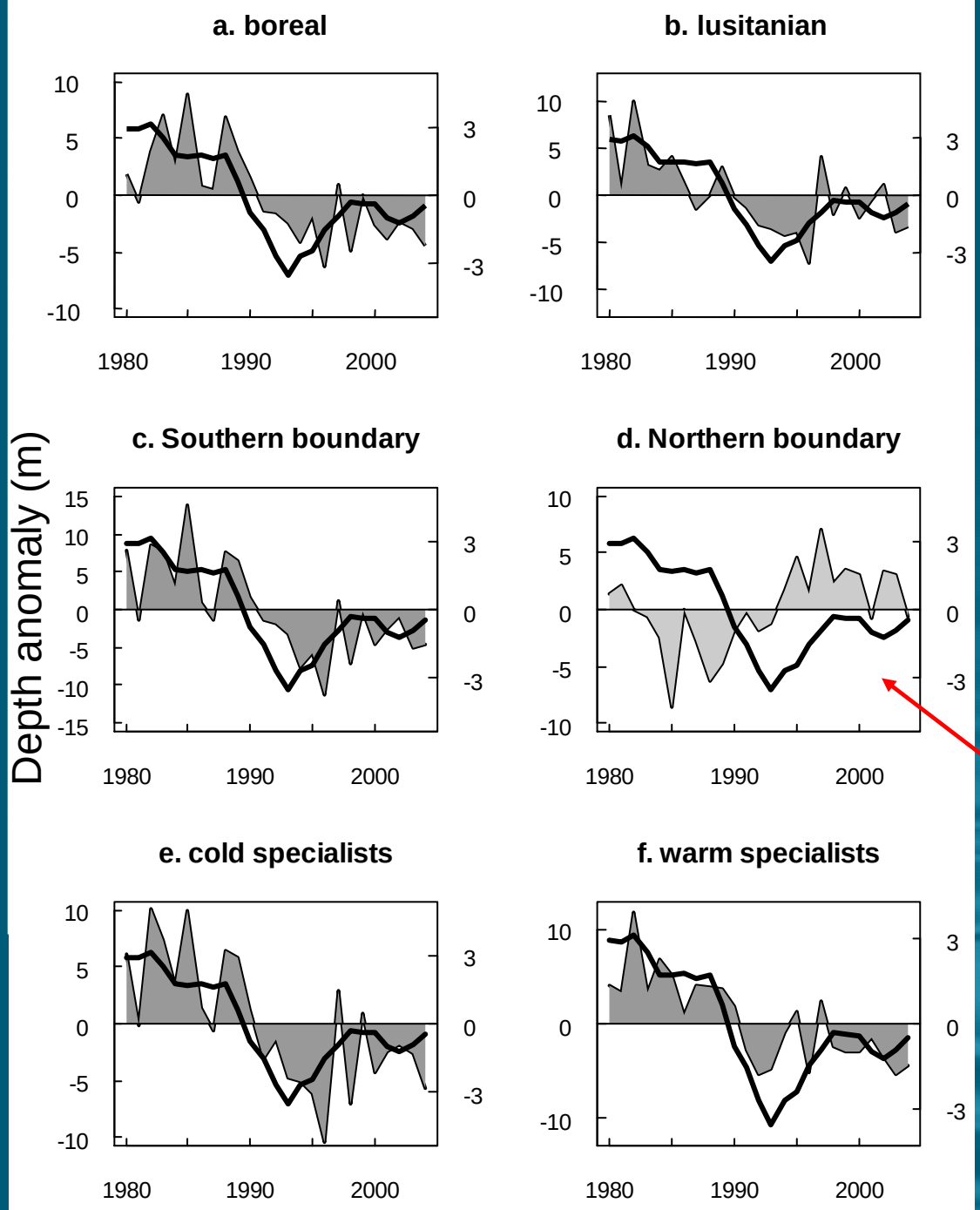
Depth change by functional group



'northern boundary' species are exception to general pattern

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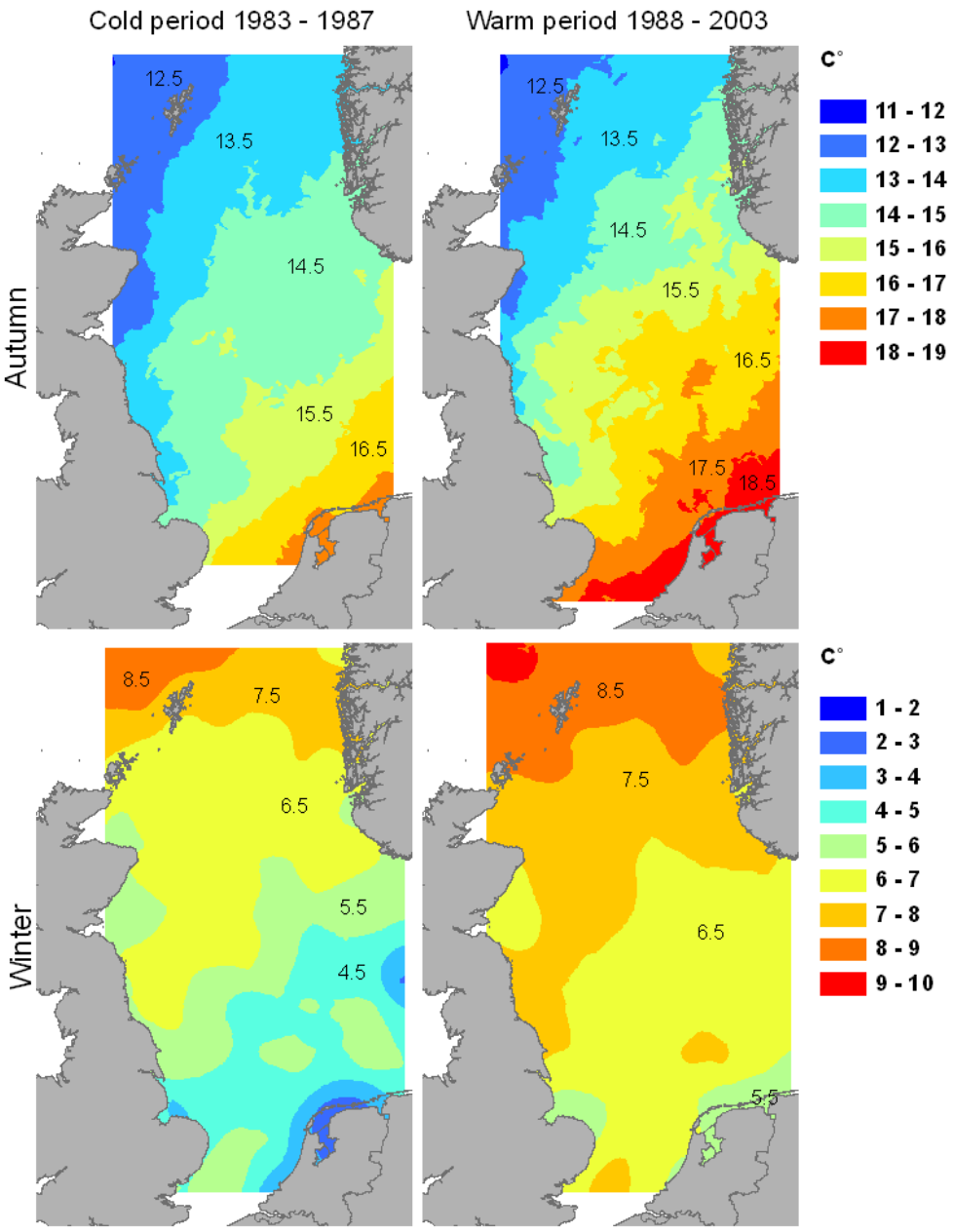

Southward shift ‘northern boundary’ ecotypes within North Sea:

- warming and increasing availability shallow habitats in southern North Sea
- increased inflow warm Atlantic water in northwestern North Sea

Cefas