Shifting species assemblages in the Northeast US Continental Shelf Large Marine Ecosystem

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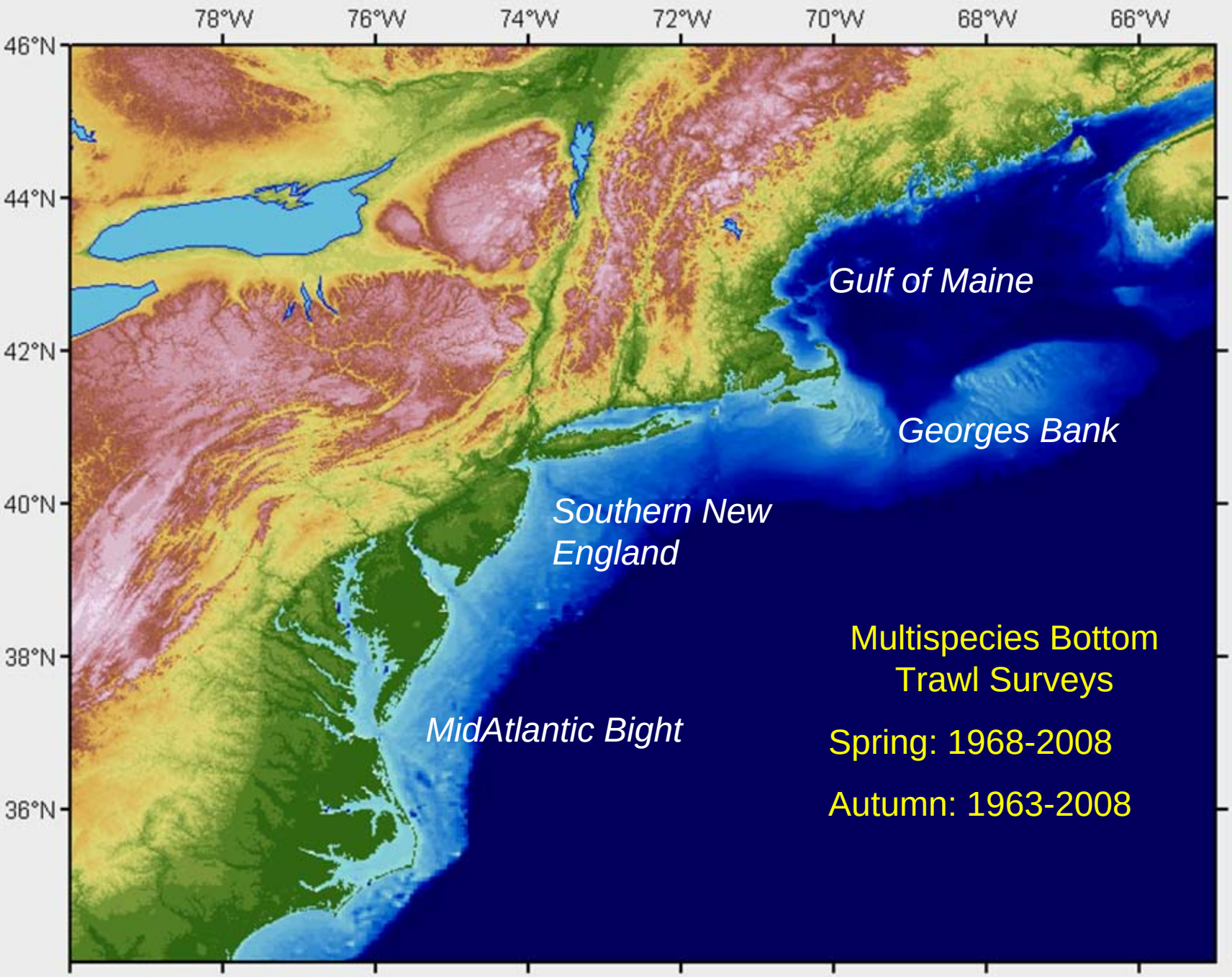
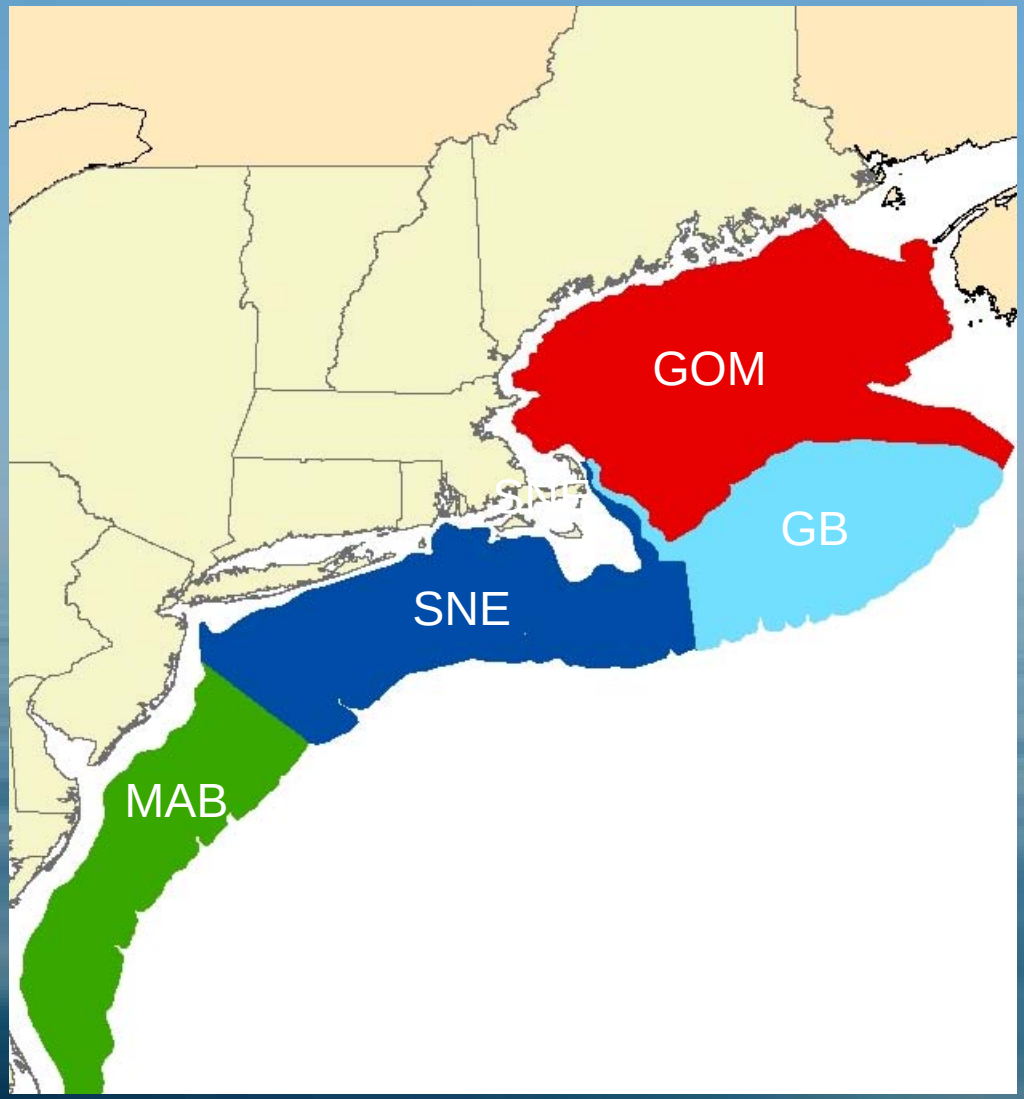

78°W
76°W
74°W
72°W
70°W
68°W
66°W
46°N
44°N
42°N
40°N
38°N
36°N
Gulf of Maine
Georges Bank
Southern New England
MidAtlantic Bight
Multispecies Bottom Trawl Surveys
Spring: 1968-2008
Autumn: 1963-2008

Background

- Shifts in spatial distribution have been observed in most fish stocks
  - Patterns, rates and mechanisms are species specific
  - Therefore, species assemblages have likely changed over time
- Many species are overfished and are under rebuilding plans
  - Some stocks have recovered while others have not
  - To understand this lack of recovery some ecosystem-level concerns have been investigated

Objectives

- Examine the temporal change in species assemblages within the historic subregions of the NES LME
- Examine how these trends correlate with fishing pressure and climate change



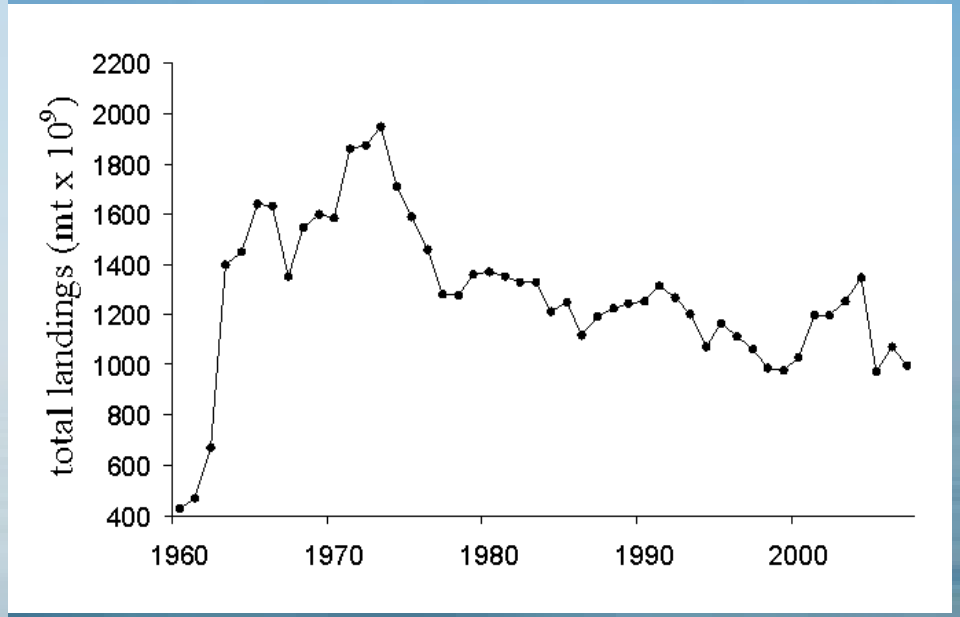
Methods

- Stratified mean biomass of top 50 species
- Nonmetric multidimensional scaling (nMDS) in PRIMER
- Converted to Bray-Curtis similarity matrix
  - Square-root transformed
- SIMPER-quantifies similarities among subregions
- BIOENV-relates drivers to species assemblages

Common Name	Scientific Name
Spiny dogfish	*Squalus acanthias*
Haddock	*Melanogrammus aeglefinus*
Atlantic cod	*Gadus morhua*
Winter skate	*Leucoraja ocellata*
Acadian redfish	*Sebastes fasciatus*
Little skate	*Leucoraja erinacea*
Silver hake	*Merluccius bilinearis*
Smooth dogfish	*Mustelus canis*
Longfin squid	*Loligo pealeii*
Butterfish	*Peprilus triacanthus*
Atlantic croaker	*Micropogonias undulatus*
White hake	*Urophycis tenuis*
Goosefish	*Lophius americanus*
Pollock	*Pollachius virens*
Spot	*Leiostomus xanthurus*
Red hake	*Urophycis chuss*
Thorny skate	*Amblyraja radiata*
Yellowtail flounder	*Limanda ferruginea*
Winter flounder	*Pseudopleuronectes americanus*
Scup	*Stenotomus chrysops*
Shortfin squid	*Illex illecebrosus*
American plaice	*Hippoglossoides platessoides*
Northern searobin	*Prionotus carolinus*
Atlantic mackerel	*Scomber scombrus*
Atlantic herring	*Clupea harengus*
Windowpane flounder	*Scophthalmus aquosus*
Ocean pout	*Zoarces americanus*
Longhorn sculpin	*Myoxocephalus octodecemspinosus*
Roughtail stingray	*Dasyatis centroura*
Weakfish	*Cynoscion regalis*
American lobster	*Homarus americanus*
Bluntnose ray	*Dasyatis say*
Horseshoe crab	*Limulus polyphemus*
Fourspot flounder	*Hippoglossina oblonga*
Bluefish	*Pomatomus saltatrix*
Spiny butterfly ray	*Gymnura altavela*
Summer flounder	*Paralichthys dentatus*
Atlantic sea scallop	*Placopecten magellanicus*
Witch flounder	*Glyptocephalus cynoglossus*
Alewife	*Alosa pseudoharengus*
Spotted hake	*Urophycis regia*
Sea raven	*Hemitripterus americanus*
Bay anchovy	*Anchoa mitchilli*
Wolffish	*Anarchichas lupus*
Bullnose ray	*Myliobatis freminvilli*
Round herring	*Etrumeus regia*
Striped anchovy	*Anchoa hepsetus*
Cusk	*Brosme brosme*
Northern Sand Lance	*Ammodytes dubius*
Clearnose Skate	*Raja eglanteria*

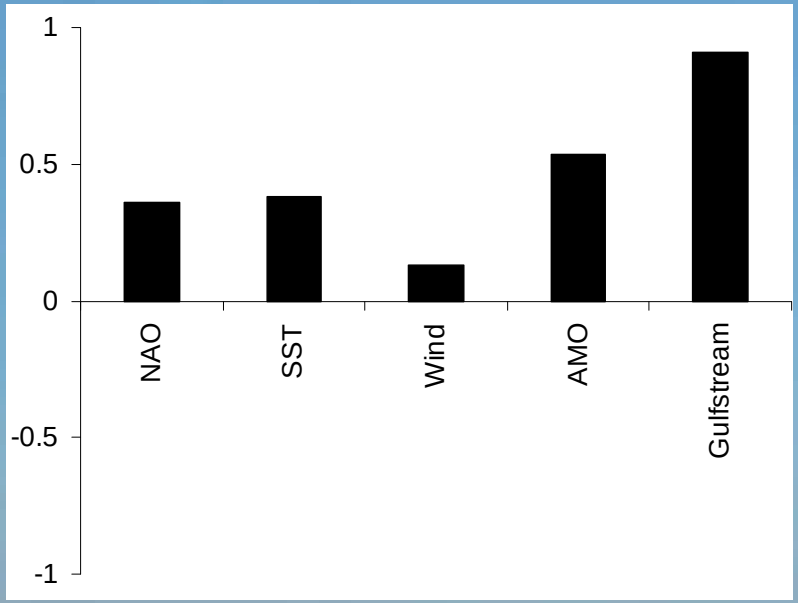
Fishing

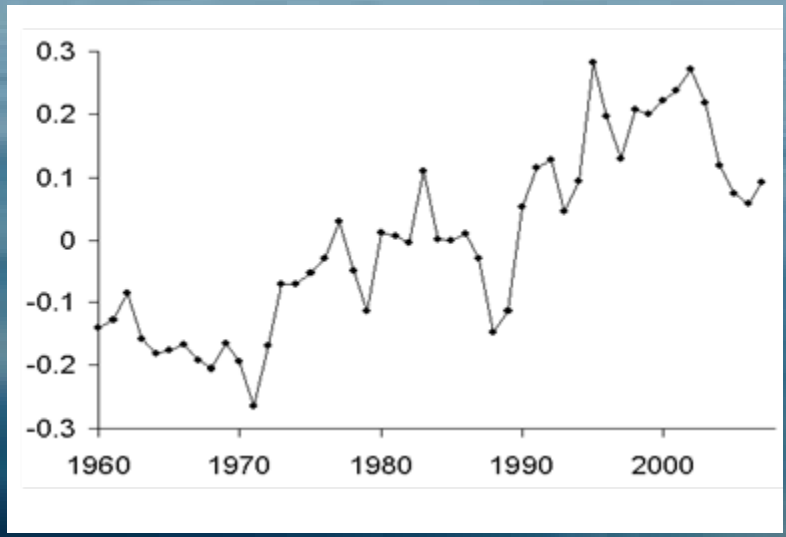
- Fishing mortality for all 50 species not available
- Total landings used as an index of fishing impact
- Landings include all groundfish, finfish, small pelagics, crustaceans, and mollusks



Broad Scale Climate

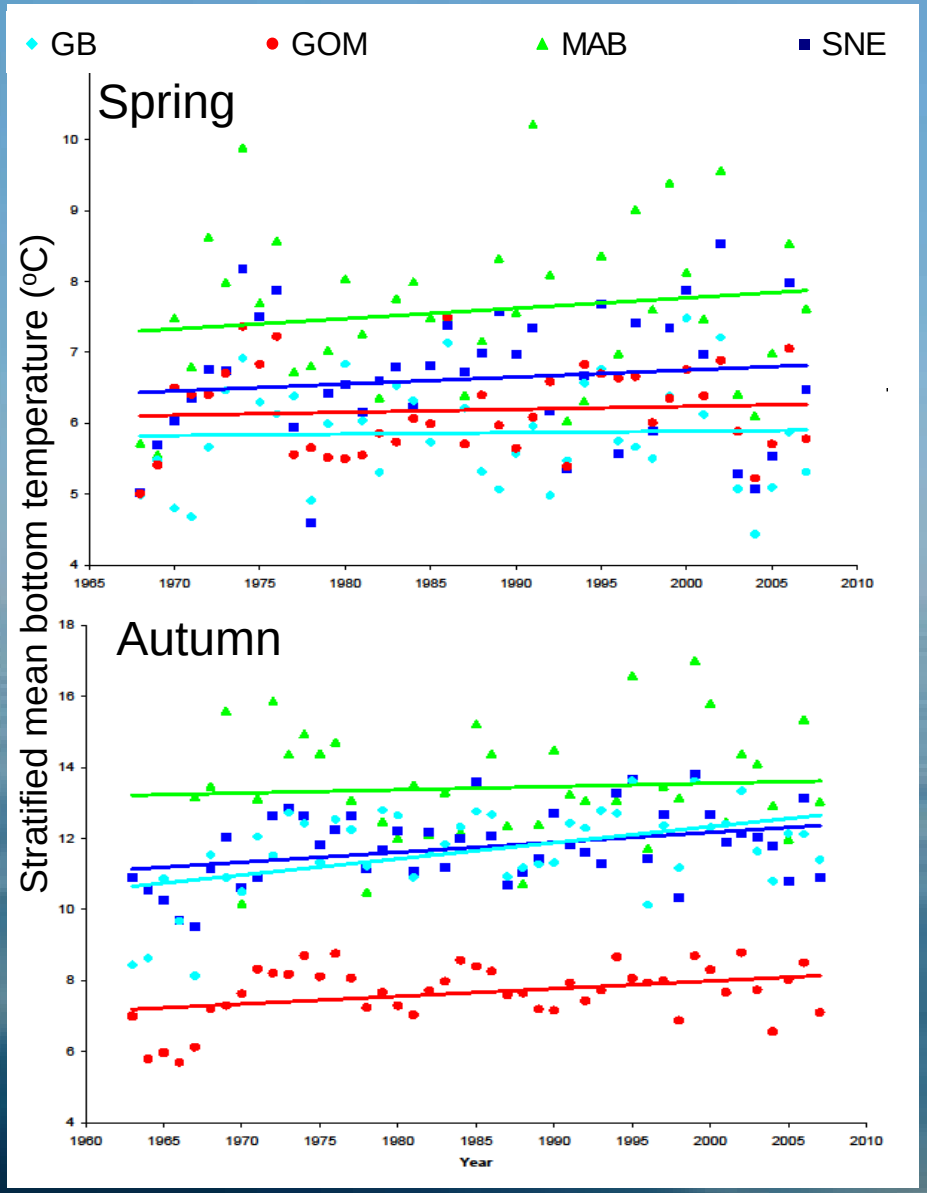
- Combined broad scale climate indices by minimum-maximum autocorrelation factor analysis (MAFA)
  - Extended Reconstructed Sea Surface Temperature (ERSST)
  - North Atlantic Oscillation (NAO)
  - Atlantic Multi-decadal Oscillation (AMO)
  - Wind stress
  - Position of the North wall of the Gulf Stream





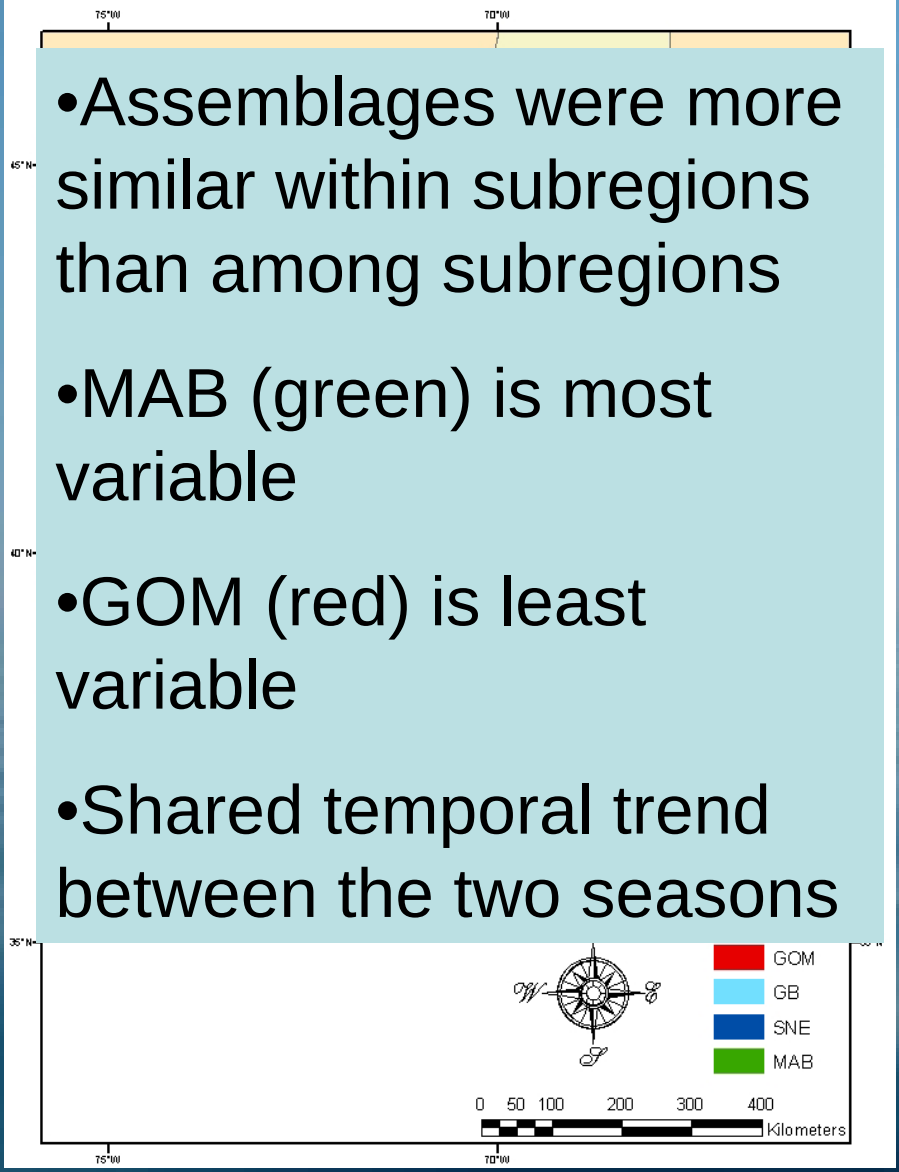
Regional Climate

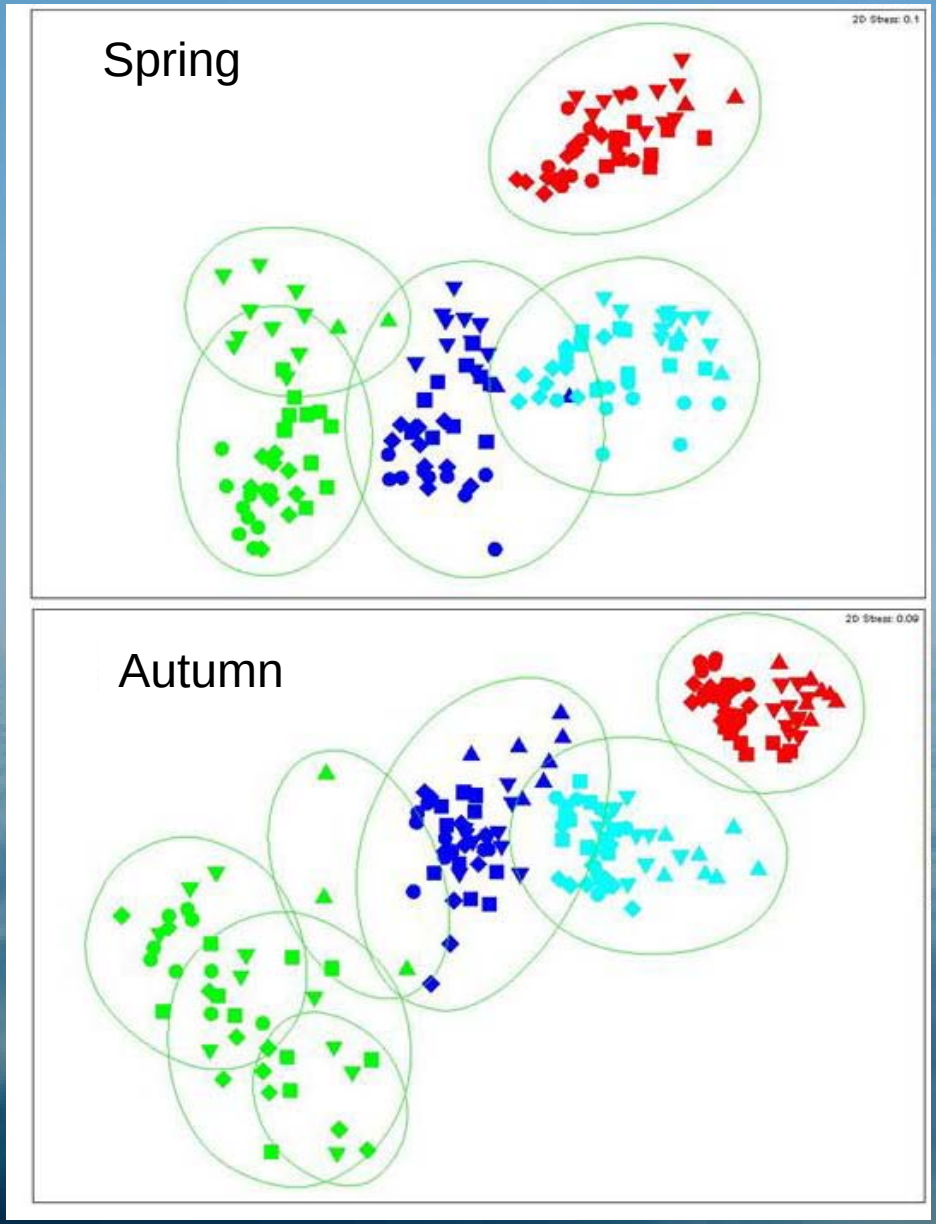
- Stratified mean bottom temperature was used to provide a snap shot of the conditions being experienced by the species assemblage at the time of collection



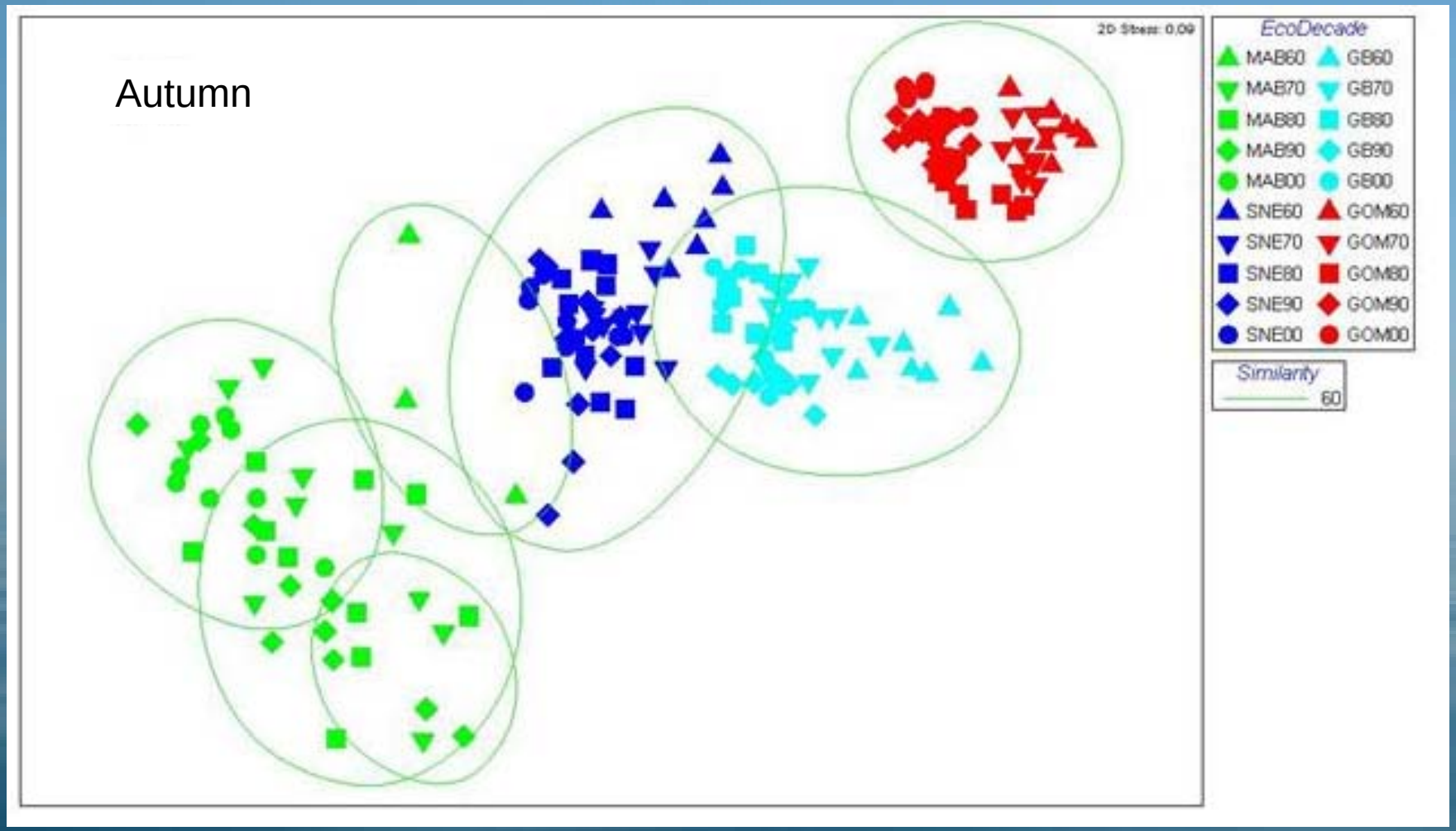
Results

- Assemblages were more similar within subregions than among subregions
- MAB (green) is most variable
- GOM (red) is least variable
- Shared temporal trend between the two seasons

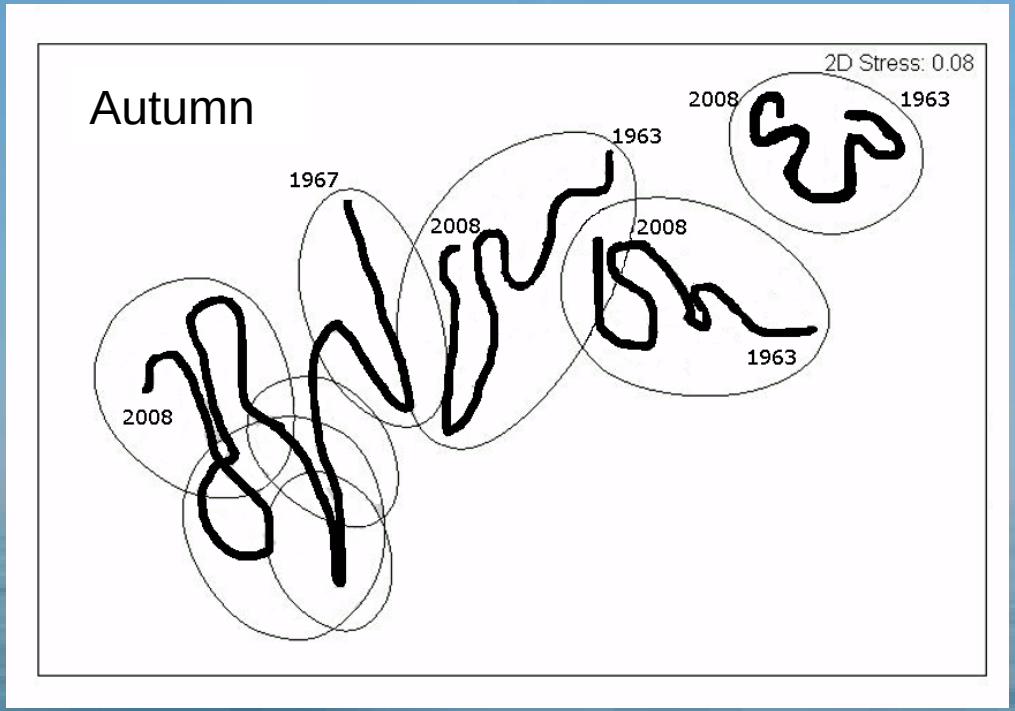




Results


Autumn
2D Stress: 0.09
EcoDecade
MAB60
MAB70
MAB80
MAB90
MAB00
SNE60
SNE70
SNE80
SNE90
SNE00
GB60
GB70
GB80
GB90
GB00
GOM60
GOM70
GOM80
GOM90
GOM00
Similarity
60

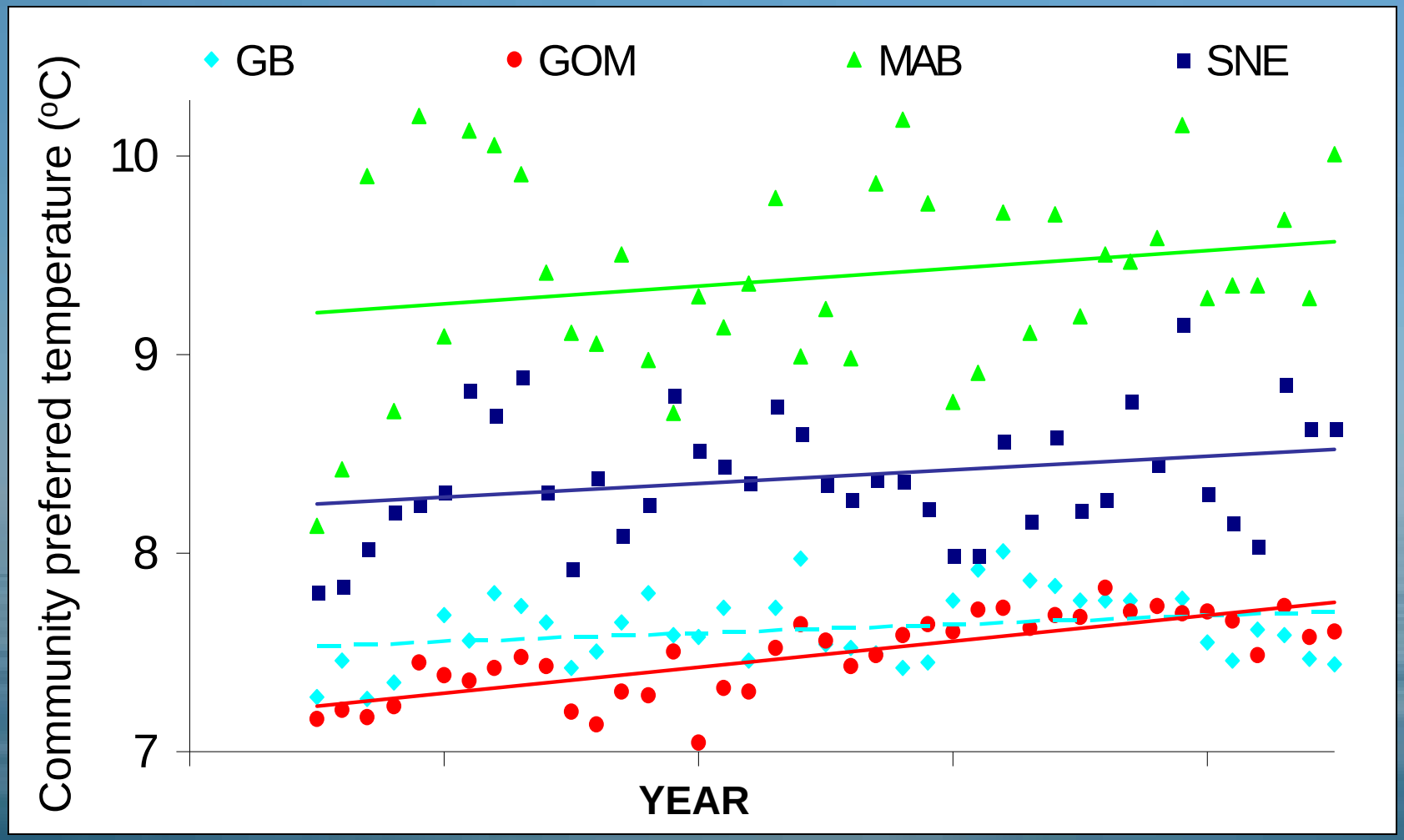
Directionality of shifts in species assemblage



SIMPER

Autumn			
	MAB to SNE	SNE to GB	GB to GOM
Time series (1963-2008)	41.31	58.71	51.18
Beginning (1968-1972)	47.77	60.29	50.50
Recent (2004-2008)	40.49	64.57	56.12
Recent N to Beginning S	52.43	65.19	54.87

Community Preferred Temperature

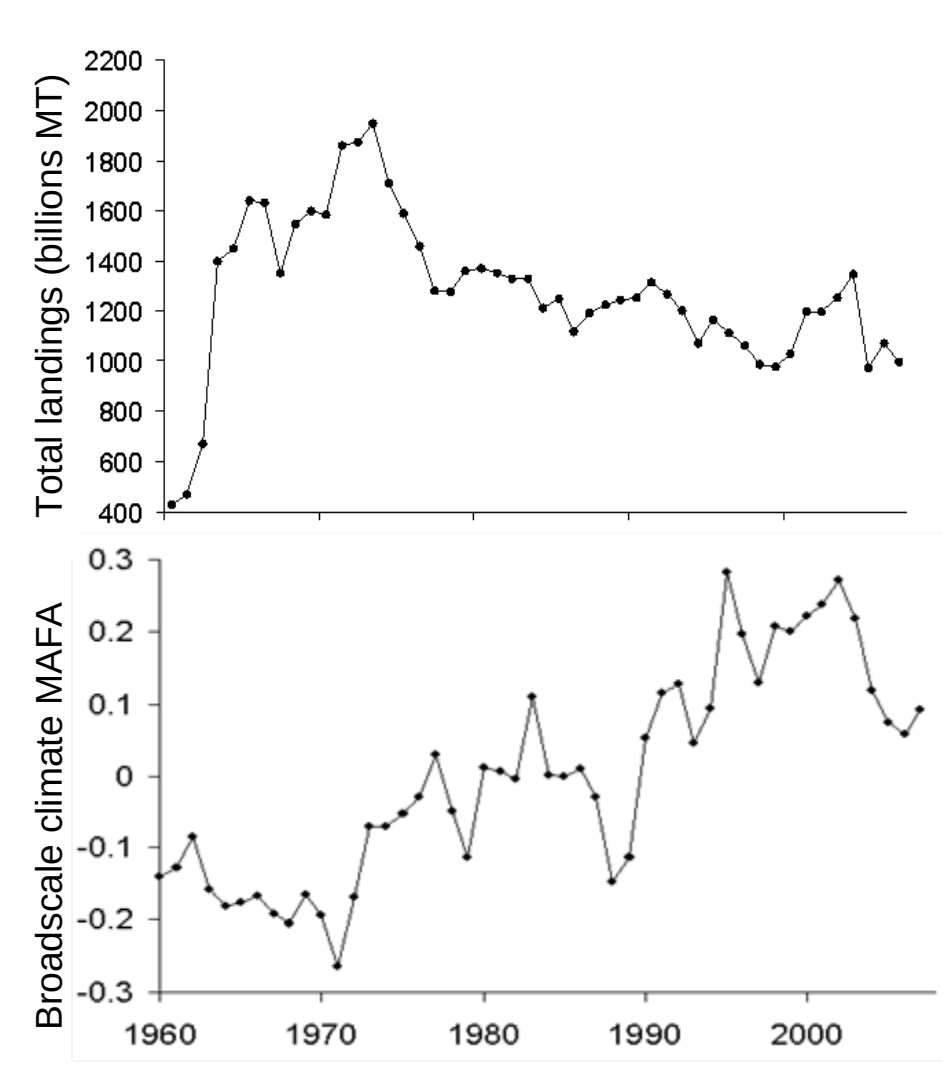


Magnitude of change over the entire time series was 0.18-1.34°C

BIO-ENV

	Spring			
	Landings	MAFA1	BT	Combination
MAB	0.526	0.369	0.044	0.534 (landings/MAFA1)
SNE	0.396	0.357	0.154	0.446 (landings/MAFA1)
GB	0.236	0.296	0.026	0.330 (landings/MAFA1)
GOM	0.394	0.451	0.050	0.492 (landings/MAFA1)
	Autumn			
	Landings	MAFA1	BT	Combination
MAB	0.084	0.287	0.201	0.369 (MAFA1/BT)
SNE	0.26	0.404	0.187	0.397 (MAFA1/BT)
GB	0.226	0.337	0.280	0.414 (all three)
GOM	0.329	0.415	0.075	0.434 (landings/MAFA1)

Fishing and climate drivers



“Southerning” of Northeast subregions

- Species assemblages in each subregion are currently more similar the historical assemblage of the adjacent southern subregion
- Poleward shifts in spatial distribution
- Increase in abundance of “warm water species”

Drivers

- Shifts are occurring due to a combination of fishing and climate
- Fishing affects relative biomass
- Climate shifts spatial distributions
- Heavy fishing at the beginning of the time series caused initial shifts
- Climatic factors have become more important as fishing pressure has decreased
- Because of combined effects, it may be difficult to reverse current trajectories

Acknowledgements

- Participants of the NEFSC multispecies bottom trawl survey
- Ecosystem Assessment Group:
  - Jason Link, Mike Fogarty
- Brian Smith for help with Primer
- NOAA Fisheries and the Environment (FATE) grant