# Regional scale trophodynamics of the N.E. Atlantic: relating the inter- and intra-decadal variability of 2000-2009 with 1960-1999

Niall McGinty, Mark Johnson, Anne Marie Power
School of Natural Sciences, Ryan Institute, NUI Galway, University Road, Galway, Ireland

## Introduction

- At the Large Marine Ecosystem (LME) scale, profound changes have been observed in phytoplankton [1] and zooplankton abundance and distribution [2]
- But there are regional scale differences in the pattern and strength of change for trophically important *Calanus spp.* [3, 4]

## Question

Is the observed regional variability species-specific or prevalent throughout trophic communities; how does regional variability compare with overall LME trends?

## Data used

| Name | Data type | Temporal coverage |
|---|---|---|
| SeaWiFS | chl-a | 1998-2009 |
| CPR | Phytoplankton & zooplankton taxa | 1960-2009 |

## Methods

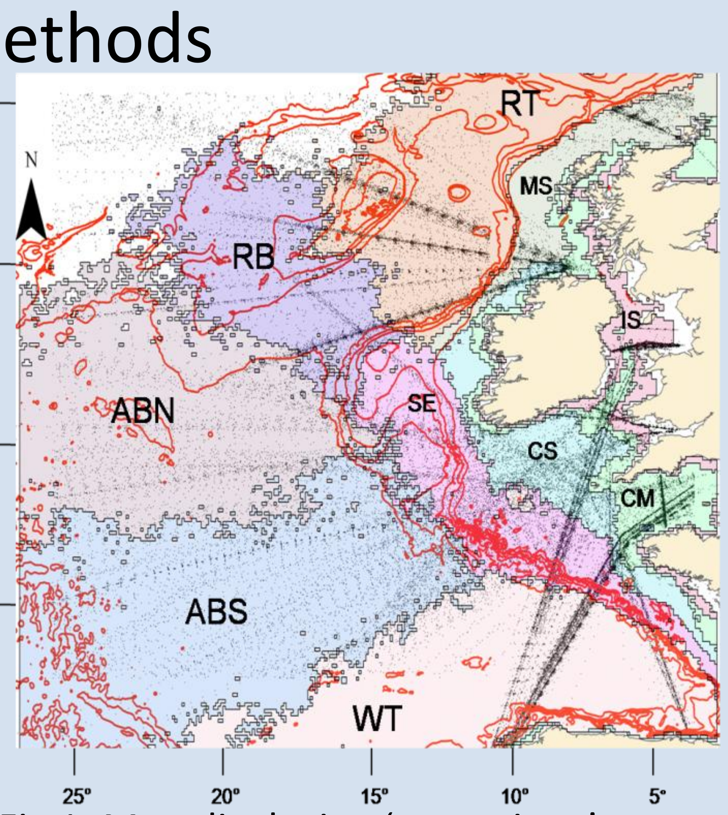


Fig 1. Map displaying 'ecoregions' based on spatio-temporal chl-a trends

- Define 'ecoregions' by clustering chl-a into areas with similar spatio-temporal trend to get ecologically meaningful partitioning
- Extract CPR samples from each 'ecoregion' [3]
- Select most dominant species from each trophic community within ecoregion
- Convert abundance to biomass and model using general additive modelling [4]
- Create multivariate control charts to investigate which years a community are beyond expected limits from a baseline [5]

## Results 2. 1960-1999 baseline

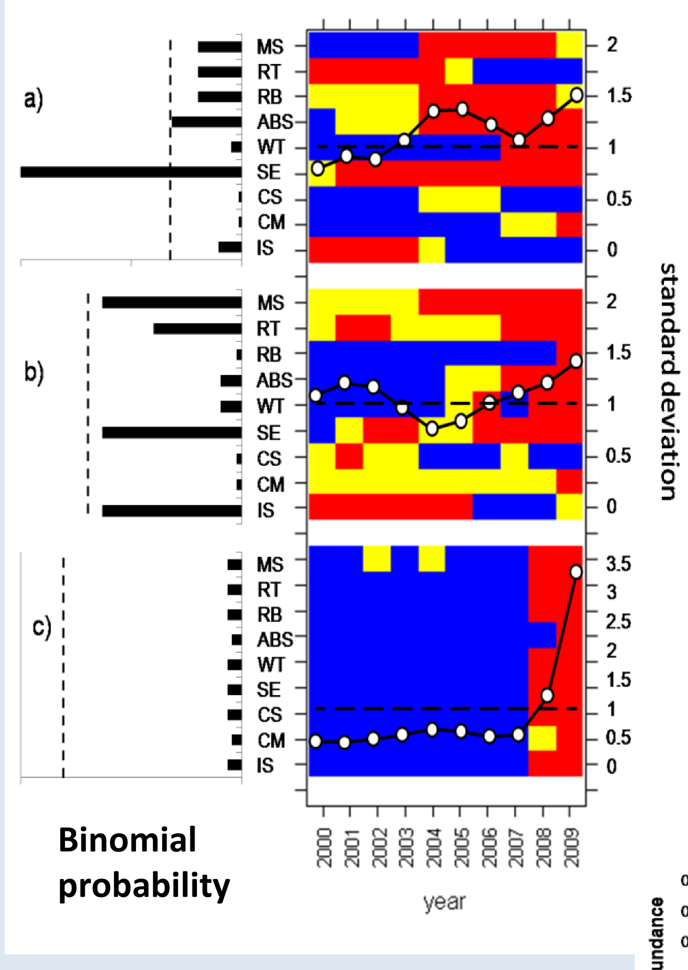


Fig 3. Multivariate control chart. Legend as Fig 2 with baseline centroid averaged between 1960-1999

- Regionally, only carnivorous zooplankton in SE were beyond expected limits
- At LME scale – higher trophic levels were beyond expected limits
- 2008 and 2009 were beyond expected limits at all trophic levels
- Comparison of years within and beyond expected limits for two baselines reveal shift in abundance pattern (Fig. 4)

a) 2000-2009 baseline
b) 1960-1999 baseline

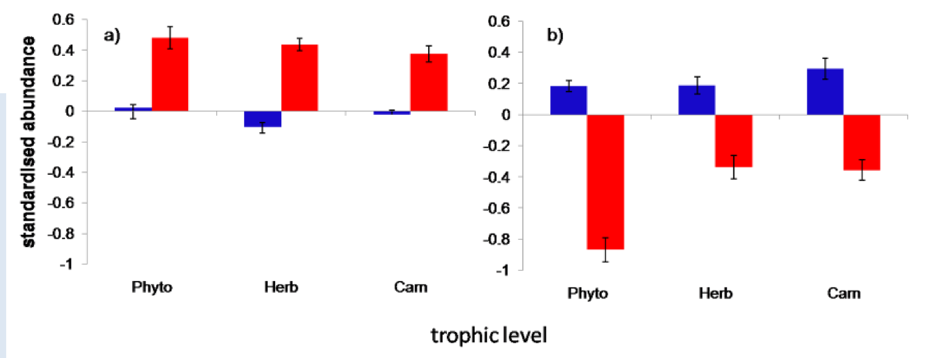


Fig 4. changes in standardised abundance between years within/beyond expected limits for the two baselines

## Results 1. 2000-2009 baseline

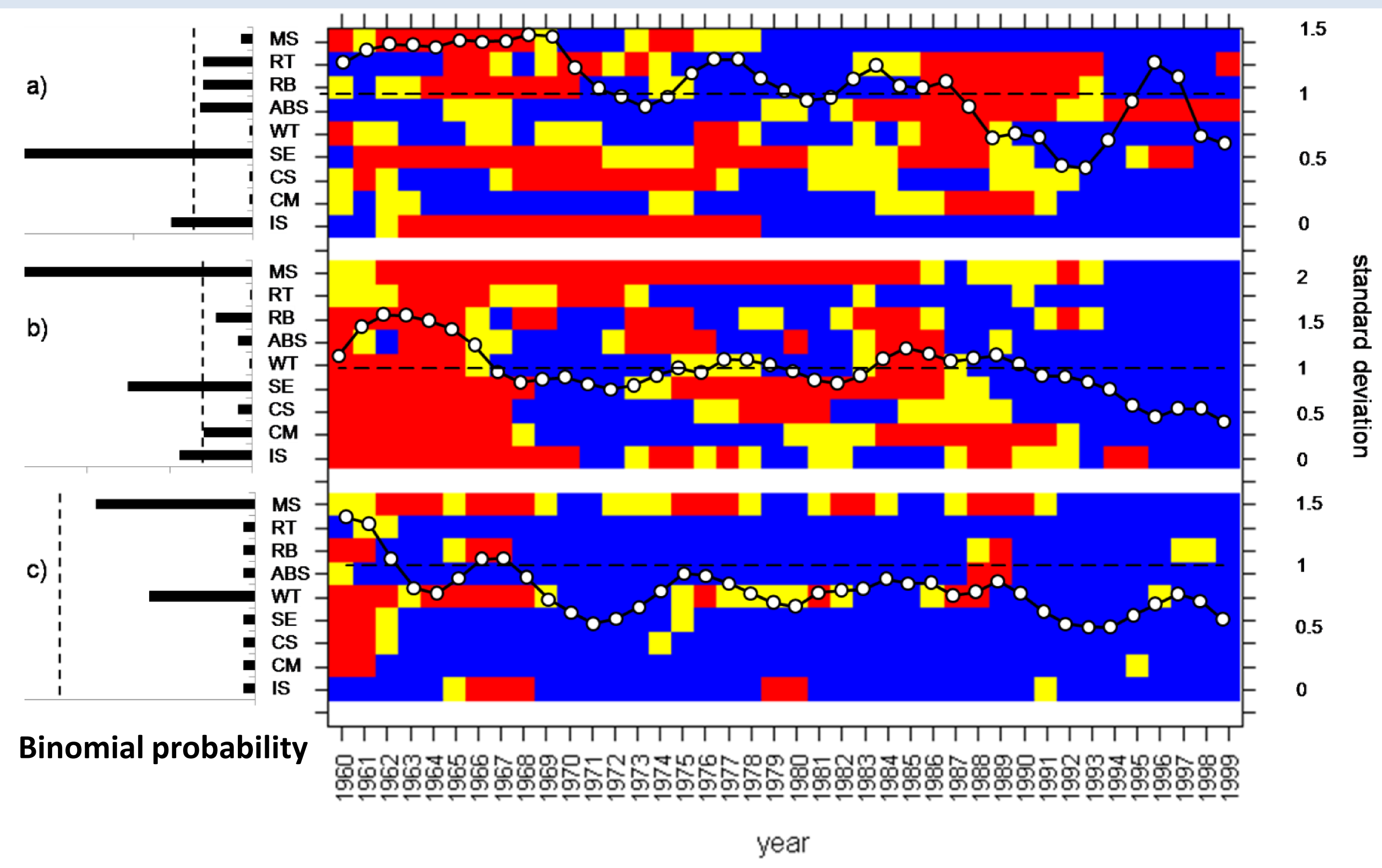


Fig 2. Multivariate control chart for each 'ecoregion'/ trophic level community using Bray-Curtis similarity. Cell colour classifies years when a community is within (Blue), >90% (yellow) or >95% (red) from baseline centroid. LME represented by trend line. Above dashed line indicates >95% from centroid. Stability of ecoregion determined by binomial probability (Bar chart: >95% if above dashed line = 0.05)

When binomial probability remains below dashed line, trophic community is "**within expected limits**"; when exceeds dashed line "**beyond expected limits**"

**Fig. 2a Carnivorous zooplankton** - large variability between ecoregions, IS and SE had significant number of years beyond expected limits between 1960-1999

**Fig. 2b Herbivorous copepods** – large variability between ecoregions, MS, SE, CM and IS had significant number of years beyond expected limits between 1960-1999

**Fig. 2c Phytoplankton** – all ecoregions were within expected limits between 1960-1999

**Overall pattern i.e. LME scale**

-phytoplankton were within expected limits
-significant number of years beyond expected limits in herbivorous copepods/carnivorous zooplankton

## Correlations across scales and trophic groups

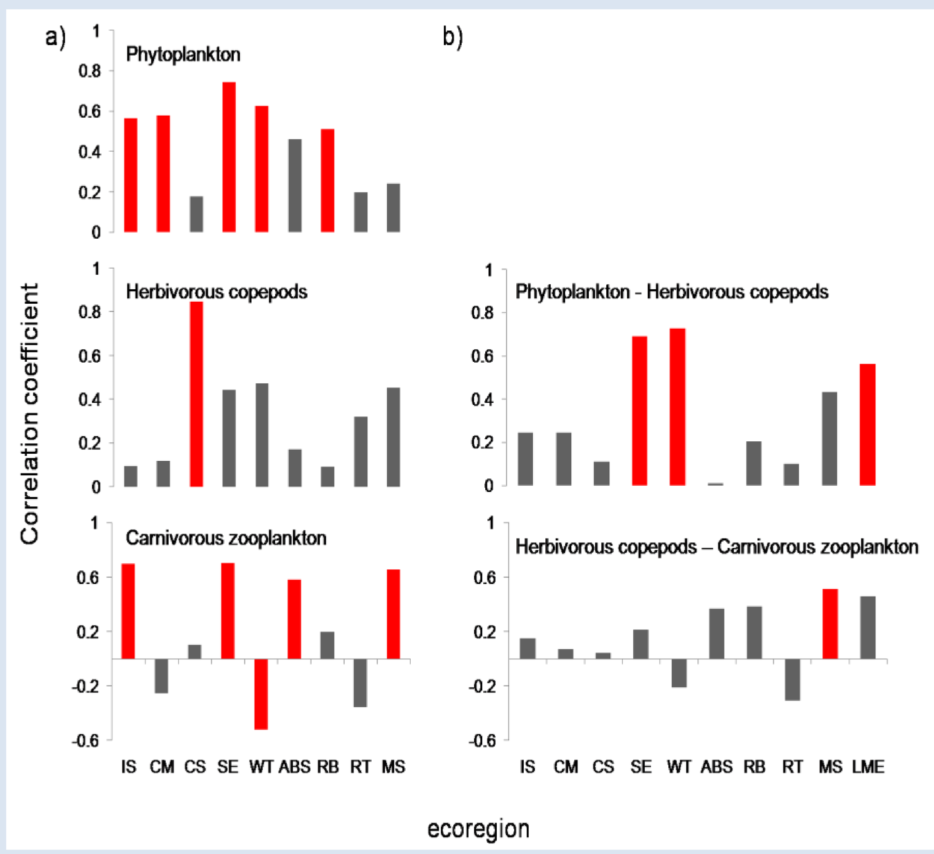


Fig 5. Correlation between LME and ecoregions for each trophic level a) and between trophic levels b). Significant correlations after autocorrelation in red

a) Correlations between LME and ecoregions reveal strong +ve correlations with phytoplankton; weakening +ve relationship for herbivorous copepods; largest variability found with carnivorous zooplankton with both +ve and –ve relationships found
b) Correlations between trophic levels reveal a weak trophic coupling across most ecoregions

## Conclusions

- There was distinct variability between regions in the trophic community patterns, in particular at higher trophic levels, suggesting variability at this scale isn't species specific but widespread through the community
- Phytoplankton have remained stable between 1960-1999 with evidence of possible large scale change in 2008 and 2009
- Correlations between ecoregions and the LME were strongest for phytoplankton with an increase in deviations from this at higher trophic levels
- The relationship between successive trophic levels was weak for most ecoregions suggesting that trophic influence on communities is operating through indirect pathways
- A shift in abundance pattern in both baselines suggest that, across all ecoregions, community biomass is in decline, with an increase in biomass loss within the last decade

1. Leterme, S.C., Edwards, M., Seuront, L., Attrill, M.J., Reid, P.C., John, A.W.G. 2005. Decadal basin-scale changes in diatoms, dinoflagellates, and phytoplankton color across the North Atlantic. Limnol. Oceanogr. 50, 1244–1253.
2. Beaugrand, G., Reid, P.C., Ibanez, F., Lindley, J.A., Edwards, M., 2002a. Reorganization of North Atlantic Marine Copepod Biodiversity and climate. Science 296, 1692–1694.
3. Beare, D.J., Gislason, A., Astthorsson, O.S., McKenzie, E., 2002. Increasing abundance of *Calanus finmarchicus* in the central and eastern North Atlantic between 1958 and 1996. J. Mar. Biol. Assoc. U. K. 82, 917–918.
4. McGinty, N., Power, A.M., and Johnson, M.P. 2011. Variation among northeast Atlantic regions in the responses of zooplankton to climate change: not all areas follow the same path. J. Exp. Mar. Biol. Eco. 400, 120-131
5. Anderson, M. A., Thompson, A.A. 2002. Multivariate Control Charts for Ecological and Environmental Monitoring. Ecol. App. 14, 1921-1935

I would also like to thank SAHFOS who continue to collect, maintain and expand on the CPR dataset and for making available this precious resource to researchers far and wide