Climate-Related Ecosystem Variability and Its Potential Effects on Management of Atlantic Cod and Haddock on Georges Bank

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INTRODUCTION

We seek to understand the role of a changing ocean environment in controlling the important uppermost trophic level within the Georges Bank (GB) ecosystem through an analysis of oceanographic and fish recruitment data. Results from earlier studies show strong relationships between year-to-year and decadal changes in the physical and biological characteristics of the GB ecosystem (1), including co-variating regime shifts in salinity, zooplankton community structure, and first year survival of haddock (Melanogrammus aeglefinus) and cod (Gadus morhua) populations (Fig. 2). Earlier studies identified at least two different regimes on GB that contain different zooplankton communities that had a significant impact on recruitment of haddock and cod. Specifically, we are working to provide and evaluate realistic tools based upon existing linkages between easily-observable hydrographic parameters, including salinity and the position of the shelf-slope front (SSF), measured within waters located off the eastern seaboard of the US and Canada and observed recruitment success of haddock and cod. Furthermore, this work is unique in that we are examining the additional effect of “out-of-phase” management, due to delays in management in recognizing given shifts in biomass between GB haddock and cod, due at least in part to the changing ocean environment caused by a strong regime shift that began during the early 1990s.

DATA & METHODS

Raw, monthly-mean SSF latitudinal positions along 26 longitude tracks were inter-annual monthly anomalies by removal of SSF seasonal variability through subtraction of a 20-year (1973-1992) long-term mean (Bisagni et al., 2006). Inter-annual variability (IAY) of the SSF position at each longitude was then computed as the annual mean of all monthly SSF position anomalies for each year over the 29-year period after converting values along each longitude line to a distance anomaly. Despite some missing data located largely east of 60° W, a longitude-time plot reveals westward-propagating, alternating bands of offshore (late-1970s, late-1980s, late-1990s) and onshore (early-1980s, early-1990s, early-2000s) annual mean SSF anomaly values, exhibiting a period of approximately 10 years (Fig. 3). SSF anomalies appear to be highly correlated with both shelf water volume and salinity anomalies within the Middle Atlantic Bight region (Fig. 4). If this relationship holds true over the larger domain located between the Tails of the Grand Banks and Cape Hatteras (Fig. 5), such data might be used in the predictive sense, providing “early warning” of approaching regime shifts originating from the north. We believe strongly that once the sensitivity analysis of the SSF position on both shelf-wide hydrographic changes and ecosystem variability is completed, observations of the SSF position over appropriate time scales (from months to years) will prove to be an easily measurable and useful indicator of cod and haddock recruitment on GB.

FUTURE WORK

The decadal-scale biological variability on Georges Bank, identified by Mountain and Kane (2010), connecting changes in local water properties, zooplankton community structure, and first year survival of the haddock and cod stocks, will be reanalyzed in relation to the analyses of regional-scale physical variability described above, both for the satellite-derived SSF positional data and in situ salinity data. Of particular interest will be identifying the time lags and temporal averaging needed to highlight the relationships between the propagating SSF and salinity signals, and the local biological changes. Once the time lags are determined between the physical and biological signals, the added effect of these data on fisheries regulations will be assessed and estimates of the errors due to lack of consideration of such regime shifts will be made.

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REFERENCES