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A LARVAL INDEX FOR GEORGES BANK YELLOWTAIL FLOUNDER WITH COMPARISONS OF RELATIVE LARVAL PRODUCTION BETWEEN YELLOWTAIL FLOUNDER STOCK AREAS

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ABSTRACT

The distribution and abundance of larval yellowtail flounder on Georges Bank and in Southern New England are presented for the years 1996-2012. Southern New England yellowtail flounder larval production was much lower than Georges Bank yellowtail flounder larval production early in the time series. However, in 2006 Georges Bank yellowtail flounder larval production dropped substantially, whereas Southern New England production started to rise near the end of the time series. The result was higher larval production in southern New England versus on Georges Bank in recent years.

INTRODUCTION

Ichthyoplankton (egg and larval fish) surveys have a long history of use in developing fisheries-independent indices of abundance, particularly for species that are difficult to assess using other methodologies. Since 1971, five different Northeast Fisheries Science Center programs have sampled ichthyoplankton along the northeast U.S. continental shelf. We developed an analytical technique that combines data from these various programs to calculate indices of larval abundance. This technique was first applied to the Georges Bank spawning component of Atlantic herring, and subsequently to a number of other stocks (sandlance, Atlantic mackerel, pollock, silver hake, summer flounder, SNE yellowtail). Here we discuss the application of this methodology to both the Georges Bank and Southern New England/Mid Atlantic Bight population of yellowtail flounder (*Limanda ferruginea*). More detail and background on the general approach is available in Richardson et al. (2010). The intent of this analysis is to address two questions. What is the trend in larval production of Georges Bank yellowtail flounder since 1995? What is the trend in the relative magnitude of Georges Bank versus Southern New England yellowtail larval production over the past decade?

ICHTHYOPLANKTON SAMPLING METHODS

The focus of this working paper is on larval yellowtail flounder abundance data from two multi-year sampling programs, GLOBEC (1995-1999) and EcoMon (1999-present). Details of each sampling program are available in Richardson et al. (2010**).**

All plankton tows used a 61-cm bongo net that was fished from the surface to within 5 m of the bottom or to a maximum depth of 200 m. Since 1995, a paired 333-µm mesh bongo net was used, with ichthyoplankton processed from a single net. Prior to 1995, the bongo net included both a 333-µm and 505-µm mesh net, with samples from the wider mesh net processed for ichthyoplankton. A calibration study with approximately 700 tows was performed during the switch over from the 505-µm mesh net to the 333-µm mesh net (Johnson and Morse 1994). However length specific calibration coefficients for this species were not calculated in that study. For this reason we focused on developing larval indices for just 1995-present. Efforts are ongoing to collect additional paired 505 µm/333 µm samples when time is available on EcoMon surveys in order to develop length-specific calibration factors.

Initial processing of most samples occurred at the Morski Instytut Rybacki in Szczecin, Poland. All larval fish were removed from samples, identified to the lowest possible taxonomic level, and measured to the nearest 0.1 mm interval. A subsample of 50 individuals was measured in those samples containing >50 individuals of one taxon.

LARVAL YELLOWTAIL FLOUNDER DISTRIBUTION

Plots of larval yellowtail flounder distribution in three-year time blocks are presented in Figure 1 and 2 for the May/June time period of spawning.

LARVAL INDEX DEVELOPMENT

The NEFSC ECOMON survey is targeted to cover the entire Northeast U.S. continental shelf six times per year. Two of these surveys are piggy-backed on the NEFSC bottom trawl survey. The four dedicated surveys occur in January/February, May, August, and November. However, ship time cutbacks combined with delays due to weather or mechanical issues have resulted in reduced coverage during certain seasons in certain years. If coverage is insufficient on a survey it is not possible to calculate a larval index value for that year. Coverage was deemed to be insufficient if the May/June cruise did not comprehensively sample the strata set defining the stock. For southern New England yellowtail flounder we defined a set of strata corresponding to NEFSC trawl strata 69-76 and 1-12 (for the ichthyoplankton sampling certain offshore and inshore trawl strata are combined). We used these designated strata to determine which ichthyoplankton surveys comprehensively covered the yellowtail flounder spawning area. For the Georges Bank stock of yellowtail flounder we used the ECOMON strata corresponding to the trawl strata 13-22 (Figure 3).

Calculation of larval index

Details of the analytical approach, and the underlying rationale, are available in Richardson et al. (2010). Briefly, the larval index methodology was designed to account for three factors that have a prominent influence on the abundance of larvae sampled on any one survey: larval mortality, the seasonality of spawning and the timing of sampling. The premise of the approach is that the abundance of an age-class of larvae can be estimated based on the age of those larvae, the year of sampling and the day of year of sampling. This requires a set of parameters and equations describing the seasonality of hatching and mortality rate of larvae (to estimate the relative abundance of larvae at any day of year/age combination). Parameters are also required for the annual larval index (to convert relative abundances to absolute abundances). The annual larval index corresponds to the annual production of a specific age-class of larvae (age-0). All of the parameters are estimated simultaneously using a non-linear least squares methodology. The input data is in the format of stratified mean abundance at age, year, and day of year. Age is estimated from length using data from Rabe and Brown (2000).

LARVAL INDEX RESULTS

Seasonality of spawning

Peak egg hatching for yellowtail flounder occurs in mid-May in southern New England a few weeks later in early June for the Georges Bank population (Figure 4).

Larval Index

The Georges Bank and Southern New England stock area covers 39,369 and 92,756 km^2 respectively. Typically the larval index is calculated as a measure of annual larval production per 10 m^2. To make the estimates comparable between the two stock areas we scaled the numbers up to an estimate of annual larval production for the stock area. These values are reported in Table 1 and Figure 5.

During the early 2000s yellowtail flounder larval production was estimated to be 4-8 fold higher on Georges Bank versus in Southern New England. In 2006 the Georges Bank larval production dropped off sharply. Around 2007 Southern New England larval production started to rise. This concurrent drop in larval production in one stock and rise in another resulted in Southern New England larval production exceeding Georges Bank larval production by a factor of 3-5 by the end of the time series.

LITERATURE CITED

Johnson, D.L. and Morse, W.W. 1994. Net Extrusion of Larval Fish: Correction Factors for 0.333 mm versus 0.505 mm Mesh Bongo Nets. NAFO Sci. Coun. Studies, 20: 85–92.

Richardson DE, Hare JA, Overholtz WJ, Johnson DL. In press. Development of long-term larval indices for Atlantic herring (*Clupea harengus*) on the northeast U.S. continental shelf. ICES Journal of Marine Science (available at: http://icesjms.oxfordjournals.org/cgi/content/abstract/fsp276)

Table 1. Annual larval production (10^9) estimates for the Georges Bank and Southern New England stocks of yellowtail flounder.

Year	SNE	GB
1996	-	880
1997	-	21,407
1998	-	14,183
1999	-	13,762
2000	941	6,242
2001	3,376	3,016
2002	1,784	9,065
2003	-	10,124
2004	1,250	18,638
2005	1,029	10,260
2006	1,183	90
2007	901	204
2008	2,234	1,051
2009	1,587	435
2010	3,386	1,287
2011	5,479	457
2012	-	289

Figure 1. Distribution of yellowtail flounder larvae May/June during the MARMAP period from 1977-1987.

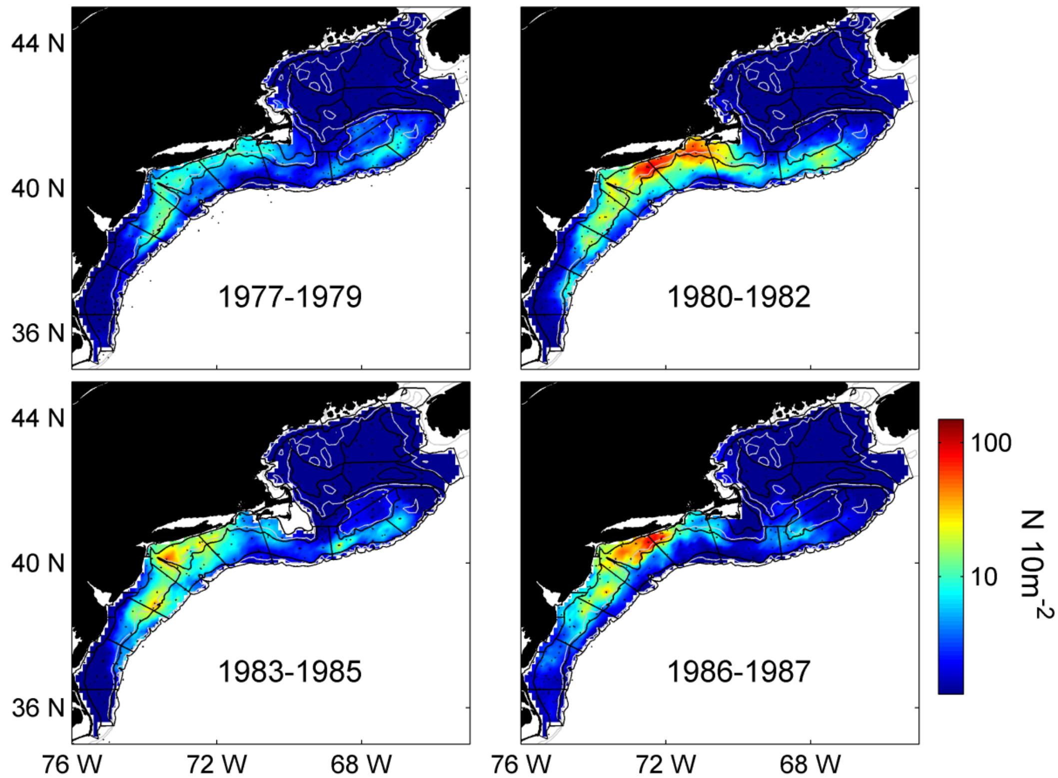

Figure 2. Distribution of yellowtail flounder larvae May/June during GLOBEC and ECOMON. Note the scale of larval abundance post-1995 is not comparable to the scale pre-1995 due to a reduction in the plankton mesh size.

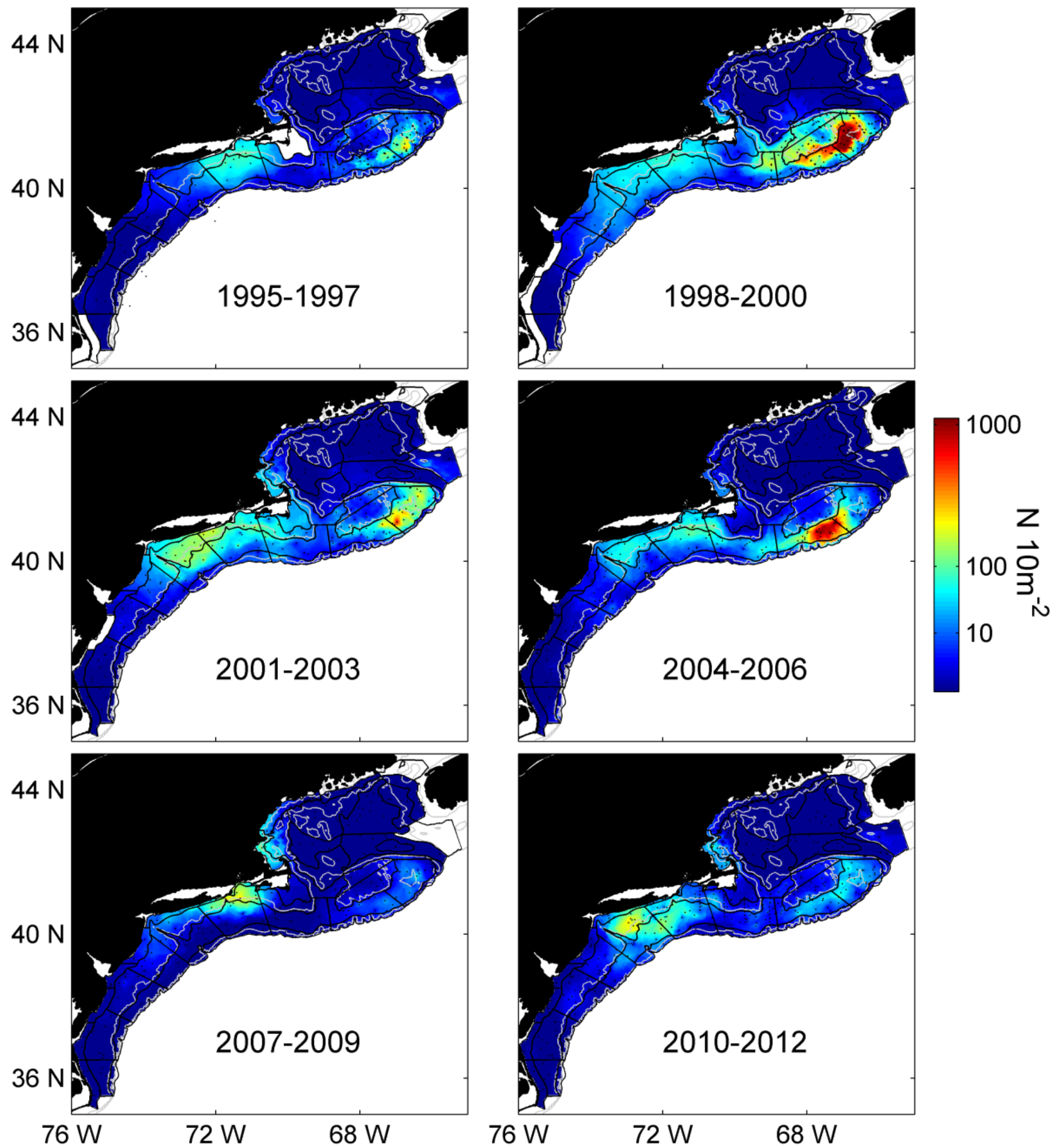

Figure 3. Map of Ichthyoplankton strata used in calculating the larval indices for Southern New England yellowtail flounder (blue) and Georges Bank yellowtail flounder (red).

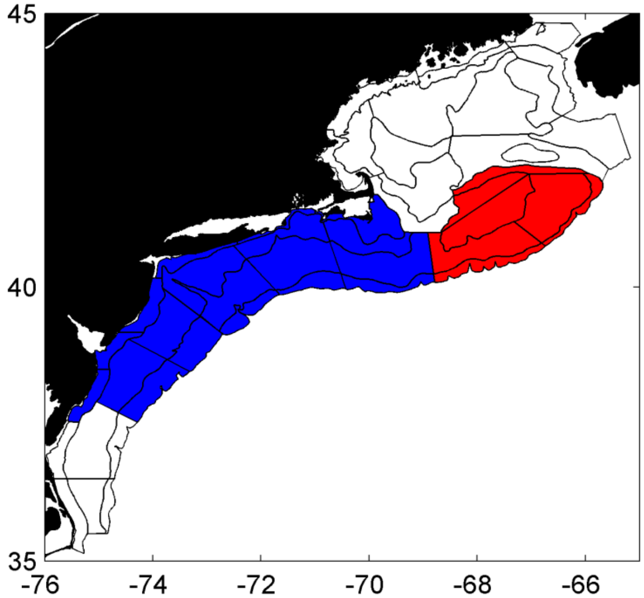

Figure 4. Calculated seasonality of egg-hatching for the yellowtail flounder population in Southern New England (black line) and on Georges Bank (Grey line).

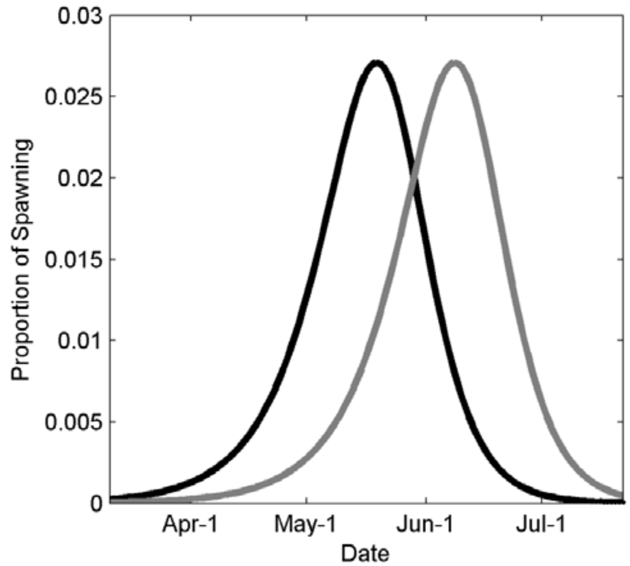

Figure 5. Larval indices for the Southern New England and Georges Bank stocks of yellowtail flounder with 3-year moving averages included