ICES CM 2014/ J:04

Before and after the climatic change: some reasons of declining impact of major salt water inflows on cod reproduction in Gotland Basin of the Baltic Sea

Elena Karasiova and Alexander Zezera
Atlantic Research Institute of Marine Fisheries and Oceanography (AtlantNIRO), 5, Dm.Donskoy St., 236022, Kaliningrad, Russia [e-mail: karasiova@rambler.ru]

Summary
During 1970s–early 80s reproduction of cod, the most abundant predator in the Baltic Sea, intensified for years of entering major salt water inflows (MBI) in Gotland Basin. After climate shift in 1988-1992 major inflows 1993 and 2003 affected insignificantly the cod spawning in that area despite a positive influence in the southern Baltic. The analysis of ambient cod reproduction conditions was carried out for some years with MBIs occurrence both before (1976-1977) and after (1994-1995, 2003-2004) the climate shift. The seasonal depth of 11psu-isohaline, oxygen content and reproductive layer thickness were estimated at standard stations BY9 and BY15. Reproductive success was evaluated via the mean cod egg abundance in Southern and Central Gotland Basins. Next prerequisites of intensive spawning were revealed in 1976-1977: entering not less than two successive inflows, the first of that renewed water in Bornholm Basin, whereupon the next one filled Gotland Basin; high level of previous salinity; coincidence of spawning seasonal dynamics and reproductive layer thickness. Reasons of spawning failure in 1994 were: a low previous salinity, 11psu-isohaline deepening and small reproductive layer. Obstacles of successful spawning in 2003-2004 were: fast oxygen depletion due to temperature rise at halocline; discrepancy of seasonal peaks of spawning (summer) and reproductive layer (spring).

Introduction
The reproduction of eastern Baltic cod, the main predator in the Baltic ecosystem, depends on the major salt water inflows (MBIs) from the Kattegat and the North Sea. However a major inflow of 1993, number 5 among advections for 1886 to 2003 (Matthäus, 2006), did not resulted in increasing of cod spawning intensity beyond bounds of Bornholm Basin. The aim of that research is to reveal reasons of different impact of MBIs on reproductive success of that population.

Materials and Methods.
The analysis of ambient cod reproduction conditions was based on calculations of the seasonal depth of 11psu-isohaline, bottom oxygen content (ml/l) and reproductive layer thickness between 11psu-isohaline and 2ml-isooxygen depth locations. These parameters were estimated at two standard stations in Southern and Central Gotland Basins: BY9 and BY15 for following years: 1976 - 1978, 1994 - 1995, 2003 - 2004. The first year in each pair was characterized with a penetration of MBI in Gotland Basin. During the next year the MBI impact could be supported by weaker inflows. The reproductive success was evaluated via the mean cod egg abundance (sp. /m^2) in Southern and Central Gotland Basins (CORE, 1998).

Results and Discussion.
The depth of 11psu-isohaline varied seasonally in range of 92.5-83m at St. BY9 and 109-86m at St. BY15 in 1976 - 1977 (Figure 1). A significant deepening of that isohaline was observed in 1994 - 1995: 120-106.7m at St. BY9 and 145-117m at St. BY15. Oxygen content oscillations in that depth were in range of 2-3 ml/l (St. BY9) and 1.5-3.5 ml/l (St. BY15) in 1976 - 1977; 1.6-4ml/l (St. BY9) and 2.3-2.9 ml/l (St. BY15) in1994 - 1995; 0.7–2.5ml/l (St. BY9) and 0.0-1.0 ml/l (St. BY15). The reproductive layer thickness varied in range of 15.5-39.5m (St. BY9) and 0-26.5m (St. BY15) in 1976 - 1977; 0.0-10.8m (St. BY9) and 0.0m (St.

BY15) in 1994 - 1995; 0.0-33.5m (St. BY9) and 0.0m (St. BY15) in 2003 - 2004, disappearing at the latter station currently.

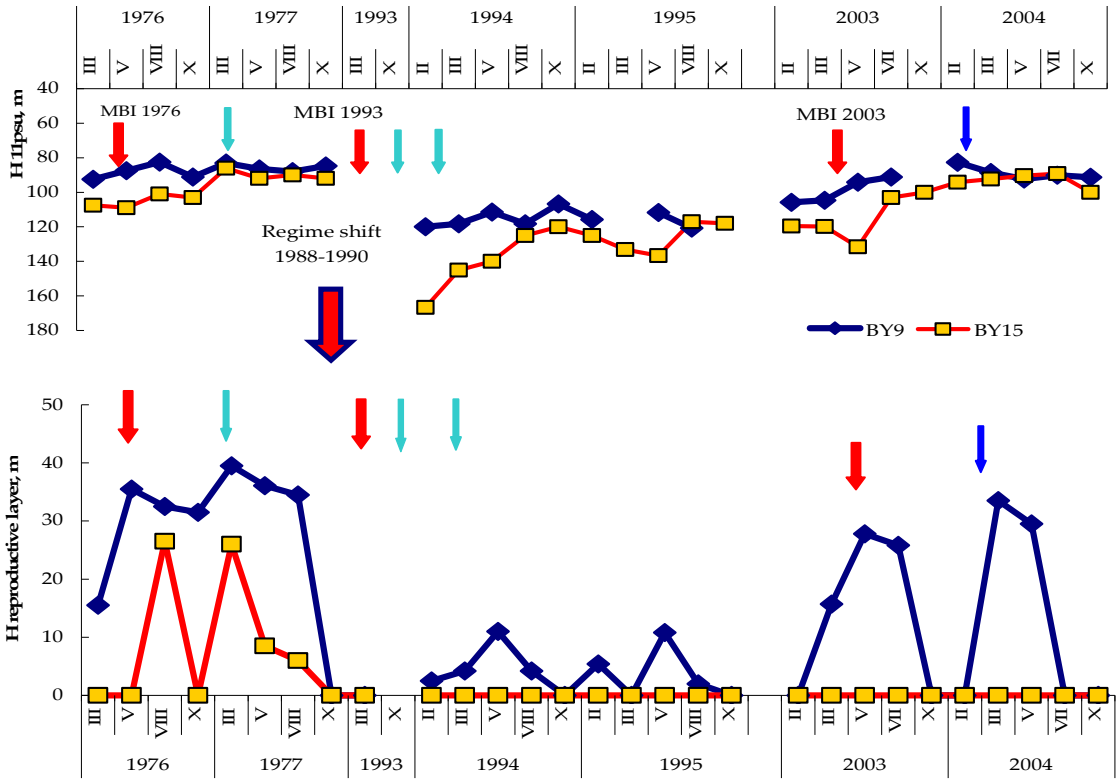

Figure 1. The depth of 11psu-isohaline and the reproductive layer thickness due to MBIs (stations BY9 and BY15).

The relative intensity (Q_{96}) of MBIs was the largest in January 1993 (34.0) and much smaller in January 1976 (25.6) and 2003 (20.3). Each of MBIs was followed by weaker inflows. It is in accordance with a conclusion that MBIs usually occur in clusters (Matthäus, 2006). As result ambient conditions for cod reproduction were improved remarkably in 1976-1977 both in Southern and Central Gotland Basins. Cod egg abundance increased significantly as compared with 1975. However after a climatic shift of late 1980s the stronger MBI 1993 did not cause a cod egg abundance increase in the Gotland Basin
Next prerequisites of intensive spawning were revealed in 1976-1977: entering not less than two successive inflows, the first of that renewed water in Bornholm Basin, whereupon the next one filled Gotland Basin; high level of previous salinity; the coincidence of seasonal dynamics of spawning and reproductive layer thickness (spring peaks in 1977). Reasons of a mass spawning cessation in above area in 1994 were: a very low previous salinity, 11psu-isohaline deepening and small reproductive layer thickness. The obstacles for successful spawning in 2003 and 2004 were: accelerating oxygen depletion due to temperature rise at halocline; discrepancy of seasonal dynamics of cod spawning (summer) and reproductive layer thickness (spring peak in 2004). The reproductive layer diminished from 33.5m in March 2004 to 0.0m in July 2004. Thus a current spawning timing shift from spring to summer and rapid oxygen depletion reduced MBI influence on cod reproductive success.

References

CORE. 1998. Mechanisms influencing long term trends in reproductive success and recruitment of Baltic cod: Implication for fisheries management (AIR2-CT94-1226), Final Report. Part I, 504p, Part II, 526p.

Matthäus W. 2006. The history of investigations of salt water inflows into the Baltic Sea – from the early beginning to recent results. Meereswiss. Berichte. Warnemünde. No 65. 74p.