Report of the Mini-symposium

Hydrographic Variability in NAFO Waters for the Decade 1991-2000 in Relation to Past Decades

by co-editors
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Introduction

As pointed out by D. B. Atkinson (Canada), who opened the Mini-symposium, ICNAF and NAFO have a long tradition of holding symposia on decadal reviews of environmental conditions in the Northwest Atlantic and their influence on fish stocks. The first was held at Rome, Italy, in 1964, which addressed the decade of 1950–59 (*ICNAF Special Publication*, No. 6, 1965). The second symposium in Dartmouth, Canada, during May 1971 focused upon the decade of 1960–69 (*ICNAF Special Publication*, No. 8, 1972). A Symposium on environmental conditions in the Newfoundland Grand Bank Area in 1972 and their effects on Fishery Trends was held in Copenhagen, Denmark, in May 1973 (*ICNAF Special Publication*, No. 10, 1975) while the decade of 1970-1979 was reviewed at Dartmouth, Canada, in September 1981 (*NAFO Scientific Council Studies*, No. 5.1982). A fourth symposium was held at NAFO headquarters in Dartmouth during September 1994 entitled *The Impact of Anomalous Oceanographic Conditions at the Beginning of the 1990s in the Northwest Atlantic on the Distribution and Behaviour of Marine Life* and included reviews of the 1980s as well as the early-1990s (*NAFO Scientific Council Studies*, No. 24. 1996). In August of 2001, ICES held a Symposium entitled *Hydrobiological Variability in the ICES Area, 1990–99* in Edinburgh, Scotland. This was in part co-sponsored by NAFO and a few NAFO scientists made presentations on some regions of the North Atlantic. It was felt by the Scientific Council of NAFO, however, that the Edinburgh Symposium did not adequately cover the NAFO Convention Area in enough detail. Therefore, during the September 2001 Scientific Council meeting in Cuba, plans were approved to conduct an overview of climate conditions in the NAFO Convention Area during the 2002 annual meeting of the Standing Committee on Fisheries Environment (STACFEN).

The Mini-symposium, on *Hydrographic Variability in NAFO Waters for the Decade 1991–2000 in Relation to Past Decades*, was therefore held at Alderney Landing, 2 Ochterloney Street, Dartmouth, Nova Scotia, Canada, on 7 June 2002. This special issue of the *Journal of the Northwest Atlantic Fisheries Science* documents the proceedings of the mini-Symposium, which was attended by 40 participants, representing Canada, Denmark (in respect of Faroe Islands and Greenland), France, Germany, Portugal, Spain, United Kingdom, Japan, Russian Federation and the United States of America. A total of eight papers were presented, seven of which appear in this issue. Below is a brief summary of the presentations. The contributions to the Mini-symposium were issed on NAFO Scientific Council research documents (SCR Docs.), and the following text refers to those SCR Docs. This publication of the Journal contains the accepted peer reviwed papers from this Mini-symposium.

Summary of Contributions

Atmospheric and sea-ice conditions in the Northwest Atlantic during the decade 1991-2000 were highlighted by Drinkwater (NAFO SCR Doc., No. 02/63, Serial No. 4675). The decadal mean of the North Atlantic Oscillation (NAO) index for the 1990s was the highest in the past 11 decades and has generally increased from the minimum in the 1960s. Mean decadal air temperatures were above their long-term means throughout the NAFO area except at West Greenland and also have been increasing since the 1960s. From Labrador to the Gulf, sea-ice severity of the 1990s was similar to that for the 1970s and 1980s but well above the 1960s. However, on the Scotian Shelf, ice area was less during the 1990s compared to the previous two decades. The decadal mean of the number of icebergs drifting along the Labrador and Newfoundland shelves was at a maximum during the 1990s. The early years of the 1990s were characterized by high NAO indices, strong northwesterly winds, and cold temperatures from the Labrador Sea to the Gulf of Maine, which resulted in extensive ice cover. During the late 1990s, the NAO rose achieving values that even exceeded those of the early years of the 1990s, however, spatial shifts in the pressure fields during the late-1990s resulted in weaker northwesterly winds, warmer temperatures in the Labrador Sea to the Gulf of Maine, and a reduction in sea-ice coverage.

Two papers were presented on climate conditions and its influence on fisheries during the 1990s decade in NAFO Subarea 1 [Buch *et al*. (*NAFO SCR. Doc*., No. 02/16, Serial No. N4617; Stein (*NAFO SCR Doc*., No. 02/8, Serial No. N4609)]. A review of the past 50 years climate conditions off West Greenland revealed large variability in the atmospheric, oceanographic and sea-ice conditions, as well as in the fish stocks. The northward extension of warm Irminger Water along the West Greenland banks and slopes showed extreme situations varying from no Irminger mode water (1992) to the northernmost extension ever of this warm water (1999). Cold polar water masses were most prevalent in 1992 and 1993 whereas warm waters such as the Irminger component of the West Greenland Current system dominated the second half of the 1990s. A positive relationship was found between water temperature and the recruitment of Atlantic cod and redfish, whereas the recruitment of shrimp and halibut increased in response to lower temperatures. Observed warming during the second half of the 1990s indicate that changes in the fish stocks may be expected.

Three papers were presented detailing climatic variability during the 1990s decade within NAFO Subareas 2 and 3 [Div. 2J and 3KL, Colbourne (*NAFO SCR Doc*. No. 02/33, Serial No. N4644); Div. 3M, Gil *et al*. (*NAFO SCR Doc*., No. 02/37, Serial No. N4648); and the central Labrador Sea, Yashayaev (*NAFO SCR Doc*. 02/51, Serial No. N4663)]. The Labrador Sea is a key location in terms of the circulation and climate change in the North Atlantic. In the 1990s, the Labrador Sea experienced the largest full-depth change ever observed in the modern instrumental oceanographic record becoming 0.6°C colder and 0.05 fresher (relative to the late-1960s), which is an equivalent of mixing an extra 6 to 7 m of fresh water into the water column. In the early-1970s and 1980s the upper layer of the Labrador Sea experienced freshening by about 0.2. However, the cold anomaly of the early-1990s was not accompanied by lower salinity and this resulted in the highest recorded density of the upper layer and the deepest convection ever observed in the Labrador Sea reaching 2300 m in 1993 and 1994. On the Newfoundland and Labrador Shelf historical data indicated that the 1950s and particularly the 1960s were the warmest decades during the latter half of the 20th century and the 1990s represent the 3rd consecutive decade with below normal temperatures. The magnitude of negative salinity anomaly on the inner Newfoundland Shelf during the 1990s was comparable to that experienced during the 'Great Salinity Anomaly' of the early-1970s. In addition, the decade of the 1990s experienced some of the most extreme variations since measurements began during the mid-1940s with temperatures ranging from record low values during 1991 to record highs during 1999. The waters on the eastern extremes of the continental shelf around the Flemish Cap region influenced by the Labrador Current experienced similar variability.

Two papers were presented on ocean climatic variability in the southern regions of the convention area, i.e. in Subareas 4 [Drinkwater *et al*. (*NAFO SCR. Doc*., No. 02/42, Serial No. N4653) and 5 and 6 Mountain (*NAFO SCR Doc*., No. 02/45, Serial No. N4656)]. Cold sub-surface waters existed throughout much of the decade in the Gulf of St. Lawrence and in the northwestern and near-shore regions of the Scotian Shelf. These cold conditions, initially established in the mid-1980s, were also observed off southern Newfoundland. The temperature trends on the Scotian Shelf and the Gulf of St. Lawrence were the result of a combination of downstream advection and *in situ* cooling, with the former appearing to be more important over the Scotian Shelf and the later in the Gulf. During 1997–98 cold Labrador Slope Water flowing along the shelf-break flooded onto the Scotian Shelf. This produced the coldest near-bottom conditions on the central and southwestern shelf in the past 30 years but was of short duration, lasting only for approximately a year. Of particular significance was the increase in the vertical stratification throughout the Scotian Shelf due primarily to the presence of low salinity surface waters during the decade of the 1990s. This potentially had important implications for marine production in the region. Further south a general freshening of the surface waters in the Gulf of Maine and of the shelf waters in the Middle Atlantic Bight was documented. An increase in the inflow to the Gulf of Maine of cool, low salinity surface water from the Scotian Shelf during the 1990s was responsible for this freshening.

In summary, the ocean climate throughout the NAFO Convention Area during the decade of the 1990s can be characterized as one of extremes, from record cold temperatures in many regions during the early years to record warm conditions towards the end of the decade. Coincident with these changes in the ocean climate, many commercially exploited marine species in NAFO waters also showed significant changes in abundance and distribution, from the collapse of many Atlantic cod populations to the substantial increases in abundance of crustacean species such as northern shrimp and snow crab. It is generally recognized that some of the changes in the fisheries were climate-induced, however it is difficult at the present time to partition the relative importance of all contributing factors, including high fishing mortality, predation and other biological effects.

In closing, we think that decadal reviews such as this one of the hydrographical conditions, provide useful reflections on the past. In the future, we hope that such reviews within NAFO can be expanded to include information on plankton and fisheries, and be able to draw stronger conclusions regarding the mechanisms responsible for the observed variability.