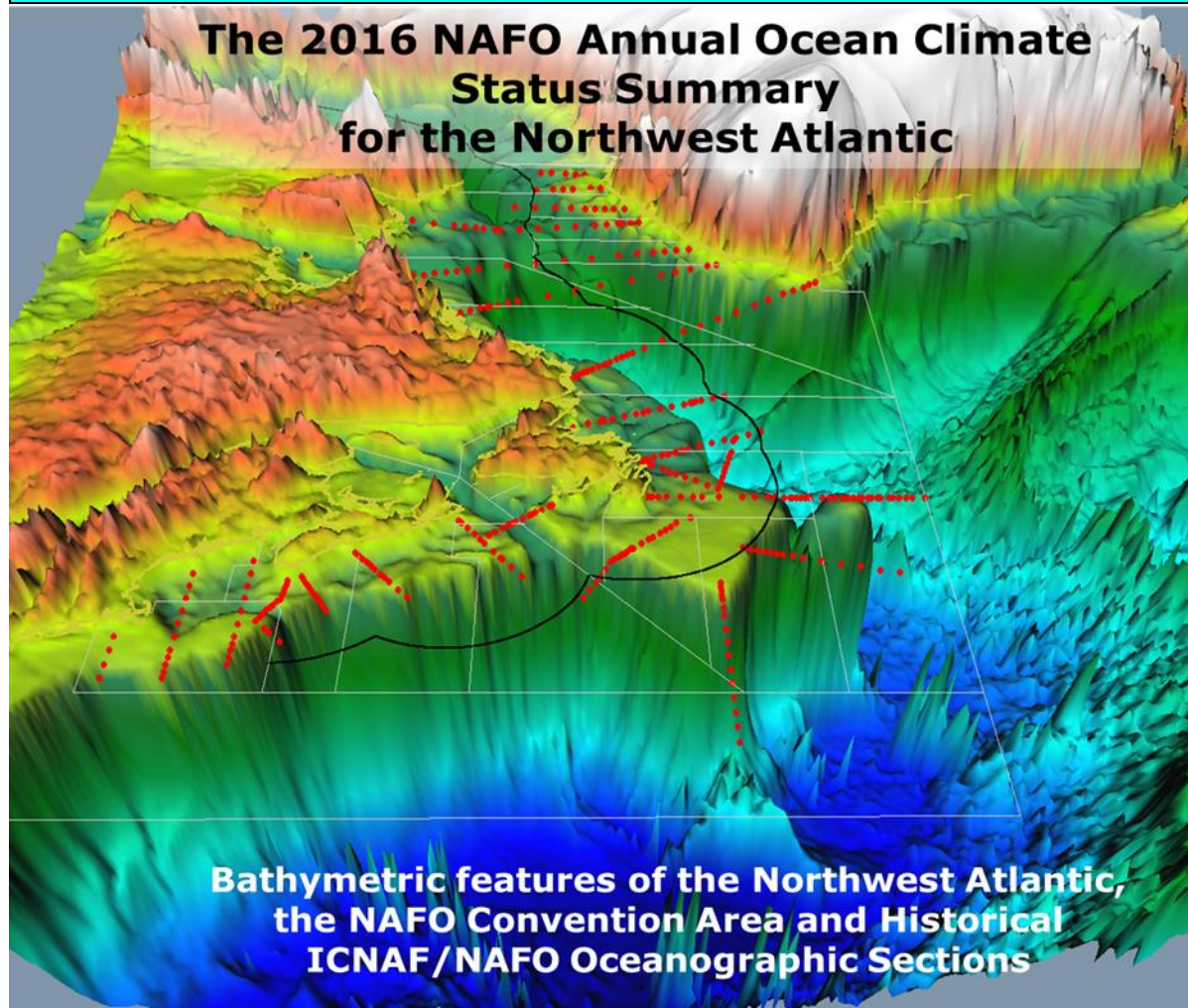


Highlights of Environmental Conditions in the NAFO Convention Area for 2016



Prepared by Scientific Council's Standing Committee on Fisheries Environment (STACFEN)

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CLIMATE HIGHLIGHTS

NAFO AREAS AND CURRENTS

GENERAL CLIMATE INDICES

**SUBAREAS 0, 1, WEST GREENLAND
LABRADOR SEA**

SUBAREA 2, LABRADOR SHELF

**SUBAREA 3, NL SHELF AND
GRAND BANKS**

SUBAREA 4, SCOTIAN SHELF

**SUB AREAS 5, 6, GEORGES BANK, GULF OF
MAINE AND MID-ATLANTIC**

METEOROLOGICAL AND ICE CONDITIONS

- The North Atlantic Oscillation index (NAO), a key indicator of climate conditions over the North Atlantic, remained in a positive phase in 2016 (+0.5 standard deviation (SD)). As a consequence, arctic air outflow in the northwest Atlantic during the winter months was lower than that in 2015 when the NAO was at a record high.
- The annual mean air temperature at Nuuk Weather Station in West Greenland was 2°C above the long term mean (1981-2010) in 2016.
- Surface air temperatures over much of the Labrador Sea were above normal, particularly during the summer and through the fall period.
- Annual air temperatures over Labrador (at Cartwright) were slightly below normal (-0.3°C) and over Newfoundland (at St. John's) they were 0.6°C above normal.
- Overall, 2016 ranked as the 5th warmest year (air temperature) in the 117 year time series for the Scotian Shelf and Gulf of Maine. Air temperature anomalies were positive at all 6 sites examined ranging from 0.8 SD above normal at Shearwater to 2 SD above normal at Yarmouth.
- Air temperatures were also warmer than average over the north eastern United States (NEUS) continental shelf, with enhanced positive anomalies in winter and fall period.
- Sea ice extent on the NL shelf increased substantially during the winter of 2014, with the first positive (higher than normal extent) anomaly observed in 16 years, it was about normal in 2015 but returned to below normal conditions in 2016.
- There were 687 icebergs detected south of 48°N on the Northern Grand Bank in 2016, slightly below the long term mean of 767.
- Ice coverage and volume on the Scotian Shelf in 2015 were above the 1981 – 2010 average, unlike the preceding four years (2010-2013) which had extremely low coverage and volume. In 2016, sea ice was almost entirely absent from the Scotian Shelf.

TEMPERATURE AND SALINITY CONDITIONS

- Average water temperatures at Fyllas Bank Station 2 (0 - 40 m depth) off West Greenland in June/July 2016 experienced a significant increase with temperatures 1.9°C higher than the long-term mean. Salinity however, was 0.45 below its long-term mean.
- Temperatures of the North Atlantic Deep Water (NADW) to the west of Greenland are monitored at 2000 m depth at Cape Desolation Station 3 were 0.1°C above the long-term mean in 2016.
- In 2016 temperature and salinity of the Irminger Sea Water in the 75-200 m layer at Cape Desolation Station 3 was 5.44°C and 34.84, which was 0.27°C and 0.08 below the long-term mean, respectively.
- The water properties between 0 - 50 m depth at Fyllas Bank Station 4 are used to monitor the variability of the fresh Polar Water component of the West Greenland current. After a temperature decrease in 2015, 2016 experienced a significant increase to levels which have not been observed since the start of the monitoring in the 1980s; with temperatures 2.12°C higher than the long-term mean. In 2016 salinity was 0.29 below its long-term mean.
- The 2016 winter convection in the Labrador Sea exceeded 2000 m making it the 4th consecutive year of increasing convection or increased production of Labrador Sea water.
- Annual sea surface temperatures (SST) were mostly below normal over the eastern Newfoundland Shelf, Flemish Cap and Grand Banks, except for St. Pierre and Green Banks where they were 0.8 SD above normal.
- The annual surface temperature anomaly at Station 27 was +0.4°C or 0.5 SD above normal.
- The annual bottom (176 m) temperature anomaly at Station 27 was -0.2°C or 0.4 SD below normal.
- The annual surface salinity anomaly at Station 27 was -0.02 or -0.1 SD below normal.
- The annual bottom (176 m) salinity anomaly at Station 27 was -0.1 or -1.4 SD below normal.

- The annual water column average (0-176 m) temperature and salinity anomaly at Station 27 was +0.3°C and -0.05 or +0.7 and -0.5 SD different from normal, respectively.
- The summer area of CIL (<0°C) water on the Grand Banks, eastern Newfoundland and southern Labrador was 26.2, 26.6 and 21.7 km² or -0.1, 0.1, -0.7 SD different from normal, respectively.
- The averaged spring bottom temperature in NAFO Div. 3P was about 3.4°C, almost 1°C (2 SD) above normal, the highest since 1984.
- The spatially averaged spring and fall bottom temperature in NAFO Divs. 3LNO was about normal at 1.5° and 1.8°C, respectively.
- The spatially averaged fall bottom temperature in 2J was 2.8°C which was 1 SD above normal.
- In 3K, the spatially averaged fall bottom temperature was 2.4°C or 0.5 SD above normal.
- A composite climate index for the NL region derived from 28 meteorological, ice and ocean temperature and salinity time series returned to slightly above normal from the 7th lowest in 67 years and the lowest since 1993 in 2015.
- During 2016, water column temperature and salinity over the Flemish Cap were mostly below normal but increased over the cold conditions of 2015. Bottom temperatures ranged from 0.2°C below normal over the shallowest areas but were above normal in deeper waters.
- SST annual anomalies on the Scotian Shelf during 2016 ranged from +0.5°C (+0.5 SD) in Cabot Strait to +1.7°C (+1.6 SD) in the Bay of Fundy.
- In 2016, the annual bottom temperatures anomalies on the Scotian Shelf in NAFO Divisions 4Vn, 4Vs, 4W, 4X were +0.9°C (+2.1 SD), +1.5°C (+2.1 SD), +1.7°C (+2.3 SD) and +1.9°C (+2.6 SD) above normal, respectively.
- In 2016, the annual temperature anomalies were +1.9°C (+3.6 SD) for Cabot Strait 200-300 m (the largest anomaly), +1.2°C (+1.9 SD) for Misaine Bank at 100 m, +1.6°C (+1.9 SD) for Emerald Basin at 250 m (a record high), +1.0°C (+1.2 SD) for Lurcher Shoals at 50 m and +1.4°C (+2.6 SD) for Georges Basin at 200 m (a record high).

- The CIL ($T < 4^{\circ}\text{C}$) volume on the Scotian Shelf in 2016 was below normal by 1.2 SD, the 9th lowest in 43 years.
- The climate index, a composite of 18 selected, normalized temperature time series on the Scotian Shelf, averaged +2.1 standard deviations (SD), making 2016 the second warmest year in the last 47 years.
- On the Northeast U.S. shelf, 2016 was characterized by warming and generally more saline conditions across the region.
- Anomalously warm winter air temperatures over the Northeastern U.S. suppressed deep convective mixing in the western Gulf of Maine, resulting in warmer intermediate water mass.
- Slope waters entering the Gulf of Maine through the Northeast Channel were anomalously warm and salty, consistent with the properties characteristic of warm slope water derived from subtropical origins.
- Summer observations indicate that water from a Gulf Stream warm core ring intruded onto the shelf in the Middle Atlantic Bight and through deep channels into the Gulf of Maine, leading to anomalous warming across the outer shelf off southern New England and in the deep basins of the Gulf of Maine.

BIOLOGICAL AND CHEMICAL CONDITIONS

- Shallow (<50m) nitrate inventories are mostly near to above normal in 2015-2016 over the southern Labrador and northeast Shelf (2J-3K) but transition to below normal throughout the Grand Bank, Gulf of St. Lawrence, and Scotian Shelf in 2016.
- The deeper (50-150m) nitrate inventories continue to remain below normal on the Grand Bank but have increased to near normal on northern transects (2J-3K). Deep inventories have generally declined over the Gulf of St. Lawrence and Scotian Shelf in Subarea 4.
- The chlorophyll *a* inventories inferred from the seasonal AZMP oceanographic surveys and fixed stations were variable throughout the Gulf of St. Lawrence and Scotian Shelf and remained below normal over the northern transects (2J to 3LNO) in 2016.
- An association between shallow and deep nitrate composite indices with the chlorophyll composite time series suggesting regulation of

phytoplankton standing stock through nitrate availability across Subareas 2-4.

- Both the magnitude and amplitude metrics of the spring bloom inferred from satellite remote sensing were mostly below the long-term climatology over Subareas 2-5 and generally consistent with the observations from the Atlantic Zone Monitoring seasonal surveys.
- Some exceptionally intense spring blooms were observed across the Labrador Sea and Gulf of St. Lawrence in 2016.
- The timing of the spring bloom demonstrated limited spatial coherence among Subareas, with later onset in the northern regions including the Labrador Sea and Greenland Shelf, near-normal on the Labrador Shelf (2H) and south to the northeast Newfoundland Shelf (3KL), with both large negative (early blooms) and positive (late blooms) anomalies throughout the Gulf of St. Lawrence, Scotian Shelf and Gulf of Maine.
- The abundance of key functional zooplankton groups dominated by copepods were generally higher in 2016 across the AZMP standard transects and fixed stations but the abundance of energy-rich *Calanus finmarchicus* was below normal throughout most of the zone.

Links to related information:

[Canadian Science Advisory Secretariat \(CSAS\)](#)

[Integrated Science Data Management \(ISDM\)](#)

[ICES Working Group Oceanic Hydrography \(WGOH\)](#)

[Atlantic Zone Monitoring Program \(AZMP\)](#)