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Linking northwest Atlantic physical oceanographic processes to the oxygen regime of the St. Lawrence Estuary

D. Gilbert (1), B. Sundby (2), C. Gobeil (3), A. Mucci (4), G.-H. Tremblay (1)

(1) Maurice Lamontagne Institute, Fisheries and Oceans Canada, P.O. Box 1000, Mont-Joli, Quebec, G5H 3Z4, Canada, (2) Institut des Sciences de la Mer de Rimouski, 310 Allee des Ursulines, Rimouski, Quebec, G5L 3A1, Canada, (3) Institut National de la Recherche Scientifique, Centre Eau, Terre et Environnement, 490 rue de la Couronne, Quebec, G1K 9A9, Canada, (4) Department of Earth and Planetary Sciences, McGill University, 3450 University Street, Montreal, Quebec, H3A 2A7, Canada

Two major ocean currents dominate the general circulation of the northwest Atlantic. The northeastward flowing warm and salty Gulf Stream and the southwestward flowing cold and fresh Labrador Current nearly collide at the Tail of the Grand Banks where they come within less than 250 km of each other. This is an area of intense horizontal mixing where large contrasts in temperature and salinity on surfaces of equal density can lead to cabbeling and frontogenesis. On the 27.10 kg m-3 potential density surface, Labrador Current Water (LCW) and North Atlantic Central Water (NACW) differ in temperature, salinity and oxygen saturation by 10°C, 1.5 psu and 30 % respectively and can produce waters up to 0.17 kg m-3 denser than the parent water types due to cabbeling.

The region comprised between Cape Hatteras to the west, the Tail of the Grand Banks to the east, the Gulf Stream to the south and the 200 m isobath to the north, may be characterized by two main water masses: the Slope Water and Shelf Water. The temperature-salinity-oxygen properties of the Slope Water strongly depend on the relative proportions of LCW and NACW. When the proportion of LCW is high, the Slope Water will be relatively cold, fresh and oxygen rich. On the other hand, when the proportion of LCW is low, the Slope Water will be relatively warm, salty and oxygen poor. Since the proportions of LCW and NACW in the Slope Water region undergo interannual, interdecadal and longer timescale variations, the temperature, salinity and

oxygen concentration of the Slope Water will vary in time. These variations get transmitted to the Gulf of St. Lawrence through the mouth of the Laurentian Channel at the edge of the continental shelf. We quantify the implications of such changes in deep ocean water mass properties on the oxygen regime of the St. Lawrence Estuary. Dissolved oxygen concentrations in the bottom waters of the Lower St. Lawrence Estuary decreased from 125 μmol L-1 in the 1930s to an average value of 65 μmol L-1 for the 1984-2003 period. A concurrent 1.65°C warming of the bottom water suggests that about two thirds of the oxygen loss is due to a progressively decreasing proportion of oxygen-rich LCW in the water mass entering the Gulf of St. Lawrence from the Northwest Atlantic Ocean. The remaining third of the oxygen loss may have been caused by anthropogenic stresses affecting the local organic carbon budget.