T6.2 OCEANIC ENVIRONMENTS

Temperature and salinity are important components of the oceanic environment influencing biological productivity. Tables T6.2.1a to T6.2.1d[1] show charts of February and August temperatures and salinities in the shallow nearshore waters of Nova Scotia. The February upper-layer temperatures are at or close to freezing; the south shore of Nova Scotia and Bay of Fundy show the highest values in the region. August temperatures are highest in Northumberland Strait and become cooler southwestward from Cape Breton along the Atlantic Coast.

Traditionally there are three distinct oceanic environments that influence Nova Scotia: the Gulf of St. Lawrence, the Scotian Shelf and the Bay of Fundy–Gulf of Maine. The Nova Scotian portions of these larger areas are described in Theme Regions (Vol-

Name	District /Unit	Temperature (°C)						Salinity (‰)					
		0 m		30 m		100 m		0 m		30 m		100 m	
		Feb	Aug	Feb	Aug	Feb	Aug	Feb	Aug	Feb	Aug	Feb	Aug
Canso	911	-0.8	17.4	-0.6	6.7	0.9	1.0	31.2	29.7	31.2	31.2	32.1	32.7
Eastern Shore	911	0.7	15.4	1.0	4.8	3.8	3.6	31.2	30.7	31.3	32.0	32.9	33.1
South Shore	911	0.6	14.8	0.5	4.1	2.8	3.8	31.3	31.0	31.4	32.0	32.5	33.2
Shelburne	911	1.6	10.6	1.6	6.2	N/A	4.6	31.2	31.9	31.2	32.1	N/A	33.1
Lurcher Shoal	911	2.9	9.7	3.2	8.8	N/A	7.2	31.5	32.1	31.6	32.5	N/A	33.2
Sydney Bight	915	-1.5	17.1	-1.1	7.8	1.2	1.2	30.4	29.4	31.2	30.7	32.4	32.7

Table T6.2.1a: Average February and August temperatures and salinities at 0-, 30- and 100-m depths for Inner Scotian Shelf (District 910).[1]
N/A = not available. Salinity reported in particle salinity units (psu), or parts per thousand.

Name	District /Unit	Temperature (°C)						Salinity (‰)					
		0 m		30 m		100 m		0 m		30 m		100 m	
		Feb	Aug	Feb	Aug	Feb	Aug	Feb	Aug	Feb	Aug	Feb	Aug
Roseway Bank	921b	2.0	15.6	2.1	5.8	3.0	4.6	31.6	31.3	31.6	31.9	32.2	33.1
Middle Bank	921e	-0.1	17.3	-0.4	6.8	2.1	1.1	31.4	30.6	31.4	31.7	32.5	32.6
Misaine Bank	921g	0.8	16.7	1.1	5.6	2.5	1.0	31.7	30.3	31.8	31.4	32.4	32.6
Banquareau	921h	2.2	16.1	2.1	6.9	2.2	4.5	32.2	31.1	32.2	32.0	33.0	33.7
Georges Basin	922b	4.3	17.7	4.7	12.4	6.3	6.5	33.0	32.1	33.1	32.5	33.8	33.6
LaHave Basin	922c	1.1	15.7	1.5	4.9	3.8	4.6	31.2	31.0	31.4	32.3	33.1	33.5
Emerald Basin	922d	2.4	17.7	2.9	5.3	7.1	5.3	32.1	30.9	32.3	32.4	34.2	33.7
East Gulf of Maine	923	3.5	12.6	3.6	9.4	4.9	7.1	31.8	32.4	31.7	32.8	32.7	33.6
Roseway Channel	923	N/A	N/A	N/A	7.3	N/A	N/A	N/A	N/A	N/A	32.6	N/A	N/A
Roseway Basin	923	1.9	10.9	1.8	4.7	3.8	3.1	31.2	31.8	31.2	32.3	32.6	32.8

Table T6.2.1b: Average February and August temperatures and salinities at 0-, 30- and 100-m depths for Middle Scotian Shelf (District 920).[1]
N/A = not available

Name	District /Unit	Temperature (°C)						Salinity (‰)					
		0 m		30 m		100 m		0 m		30 m		100 m	
		Feb	Aug	Feb	Aug	Feb	Aug	Feb	Aug	Feb	Aug	Feb	Aug
E Georges Bank	931a	3.9	15.1	4.5	10.7	5.7	7.2	32.7	32.3	33.0	32.6	33.1	33.4
Georges Shoal	931a	4.4	13.9	4.9	12.4	N/A	N/A	33.1	N/A	33.4	32.5	N/A	N/A
Browns Bank	931b	3.5	14.3	3.5	7.3	8.0	8.3	32.0	31.8	32.1	32.5	34.1	34.2
Baccaro Bank	931b	2.3	14.4	3.1	7.8	4.5	4.1	31.9	31.6	32.2	32.1	32.5	33.1
LaHave Bank	931c	2.5	16.6	2.3	6.5	5.1	5.6	31.6	31.3	31.7	32.1	33.3	33.6
Emerald Bank	931d	3.4	19.1	3.7	8.1	8.1	8.9	32.4	31.2	32.5	32.9	34.4	34.7
Western Bank	931e	3.4	18.9	3.5	8.6	7.5	7.0	32.3	31.7	32.4	32.6	34.0	34.2
Sable Island Bank	931e	2.5	17.1	2.4	12.1	N/A	7.3	31.1	31.2	31.4	31.8	N/A	34.0
Banquereau	931f	2.2	16.1	2.1	6.9	2.2	4.5	32.2	31.1	32.2	32.0	33.0	33.7
NE Channel	932	3.2	15.8	1.7	12.0	6.6	8.7	32.1	32.4	32.8	32.9	33.7	34.2
Saddle	932	N/A	18.1	N/A	6.9	N/A	7.1	N/A	31.1	N/A	32.8	N/A	34.0
The Gully	932	N/A	16.8	2.3	7.0	3.6	3.6	N/A	30.8	32.1	31.7	33.0	33.3

Table T6.2.1c: Average February and August temperatures and salinities at 0-, 30- and 100-m depths in the Outer Scotian Shelf Region (District 930).[1]
N/A = not available

Name	District / Unit	Temperature (°C)						Salinity (‰)					
		0 m		30 m		100 m		0 m		30 m		100 m	
		Feb	Aug	Feb	Aug	Feb	Aug	Feb	Aug	Feb	Aug	Feb	Aug
Southern Slope	940	5.8	17.7	9.3	11.5	4.1	4.2	33.2	32.3	34.4	35.0	34.9	34.9
Central Slope	940	4.8	19.2	8.8	9.4	N/A	4.1	32.9	31.8	34.4	34.7	N/A	35.0
Northern Slope	940	4.0	18.2	6.9	7.7	3.4	4.1	32.7	31.9	34.1	34.3	35.0	35.0

Table T6.2.1d: Average February and August temperatures and salinities at 0-, 30- and 100-m depths for the Continental Slope (District 940).[1]
N/A = not available

ume 2) and the corresponding Districts and Units are indicated below.

ENVIRONMENT OF THE GULF OF ST. LAWRENCE

The Gulf of St. Lawrence (Unit 914) is an inland sea as well as a large estuary. It has been compared to the Baltic Sea in northern Europe because both hold similar quantities of water, both drain fresh water from comparable watersheds, and both have similar biological productivity. However, the Gulf of St. Lawrence exchanges ten times more ocean water than the Baltic Sea,[2] for reasons related to the larger runoff in the Gulf of St. Lawrence. Thus, while the residence time for water in the Baltic is approximately twenty years (7000 days), in the Gulf of St. Lawrence it is 200 to 500 days.

The environment in the Gulf of St. Lawrence is influenced by freshwater flow from the St. Lawrence River, by winds and air temperatures, and by flows in and out of the Strait of Belle Isle and the Cabot Strait. In the winter a two-layer water column structure exists, with a thick, cold, relatively fresh layer overlying deep, warmer water from Cabot Strait (Figure T6.2.2). The cold, upper layer, formed by cooling rather than by influxes of polar water, has temperatures of –1 to 2°C and associated salinities of 32 to 33

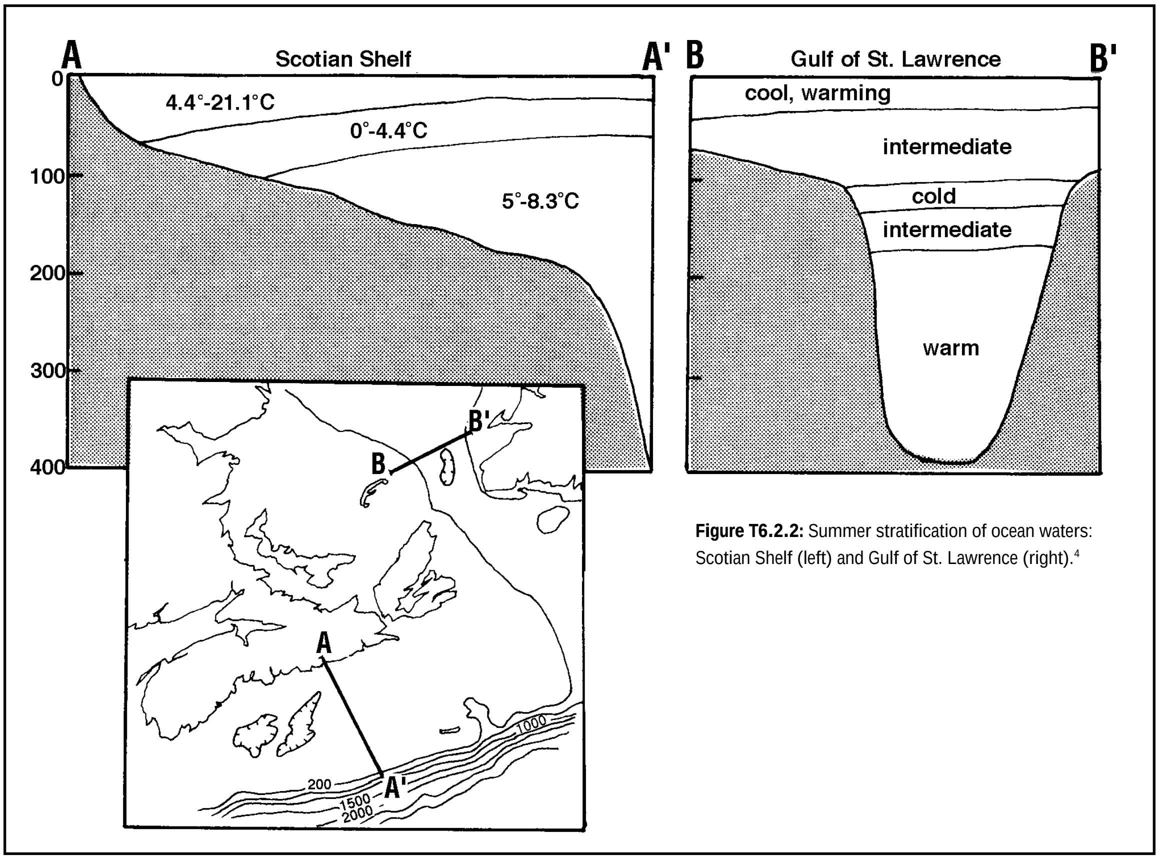

Figure T6.2.2: Summer stratification of ocean waters: Scotian Shelf (left) and Gulf of St. Lawrence (right).[4]

particle salinity units (psu), or parts per thousand. The deep "warm" layer has temperatures as high as 6°C and salinities over 34 psu. The temperature of this deep, warm layer has increased by up to 2°C between the mid-1960s and the late 1970s. Analysis indicates that the primary factor determining the variation of the deep-water properties is the variation of the oceanic waters at the mouth of the Laurentian Channel, rather than variation of freshwater runoff, as previously suggested.[3]

In the spring, a third layer—a warm, surface layer—develops on top of the cold layer. The cold layer persists at middle depths. The surface layer is approximately 20 m thick, with temperature typically around 15°C and salinity 30 psu.

In the Magdalen shallows and the Northumberland Strait, the difference between summer and winter temperatures is even more pronounced, due to summer heating of the relatively shallow water column. Summer temperatures in the Northumberland Strait are higher than on the Atlantic Coast (see Figure T6.2.2). These warm temperatures result from the combination of shallow water, stratification and relatively weak currents. The tidal range is 2 m in the Northumberland Strait, and at certain times, only one tide occurs (see Figure T6.1.4a).

In summer, the low tides that occur during the day, expose beaches and sandbars to the sun. The incoming water is warmed as it moves over these sand flats, retaining the high water temperature.

In the open Gulf, surface salinities range from 26 to 32 psu, but may be lower in bays and estuaries. As the summer progresses, the surface layer in the southwestern area of the Gulf becomes thinner and less salty, due to the arrival and influence of the spring peak of the St. Lawrence River freshwater runoff, which has been two to three months in transit. Of course, changes in wind direction and strength may alter the relative positions of the water layers, resulting in changes in temperature and salinity.

Environmental variations linked with river flow may be an important determinant of commercial fish production, especially in the spring. There is an upwelling effect of fresh water; nutrients are brought to the surface.[5] The arrival of the spring discharge from the St. Lawrence estuary significantly affects the hydrology of the area and, through the formation of fronts, may result in increased aggregation of food organisms and fish larvae.[6]

In addition to natural effects, there are significant changes in seasonal flow patterns resulting from the control of the freshwater supply by hydroelectric

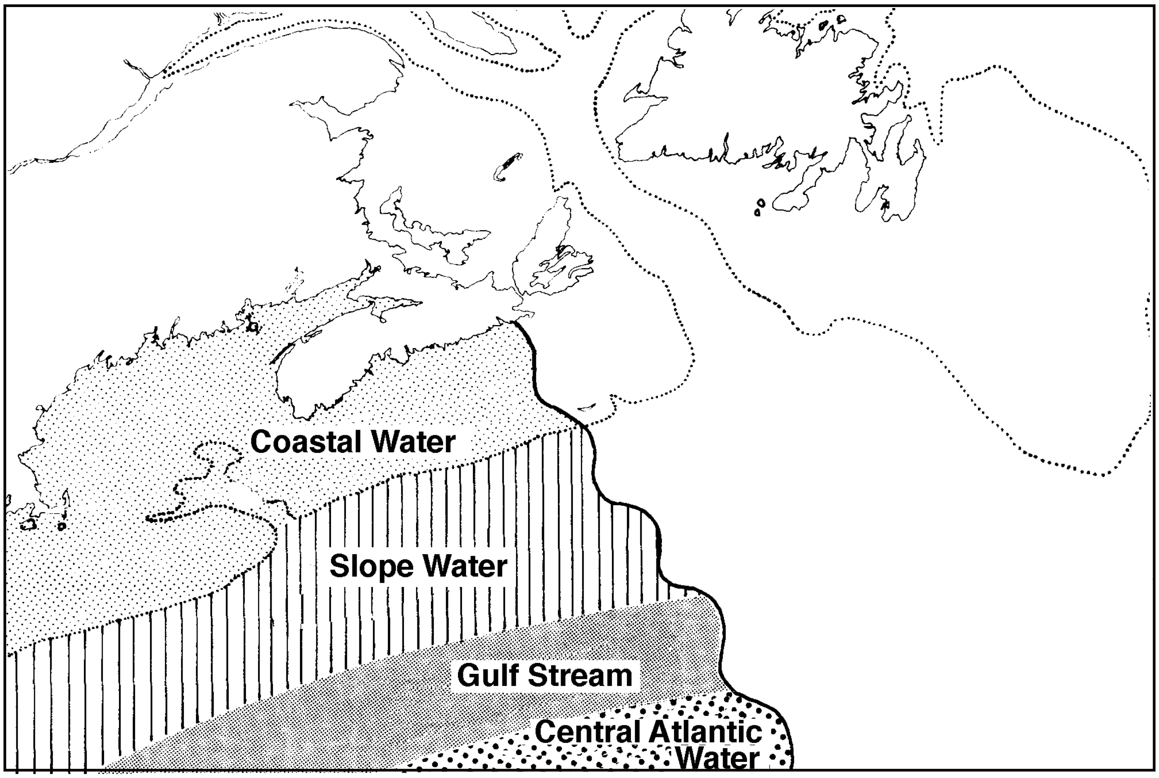

Figure T6.2.3: Classification of ocean water off the Atlantic Coast.[7]

development, principally in Quebec. The effect is to reduce greatly the biologically important spring discharge. Total productivity of the Gulf system has probably already been seriously reduced, and further hydroelectric development could further reduce productivity.[6]

ENVIRONMENT OF THE SCOTIAN SHELF

The environment of the Scotian Shelf (Units 911, 915 and Districts 920, 930) is determined largely by the circulation. Moving outward from the Atlantic Coast of Nova Scotia, four distinct bands of water are crossed, as shown in Figure T6.2.3[7]. The Scotian Shelf is normally covered by a surface layer of relatively fresh and low-density coastal water, the Nova Scotia Current. Beyond this, in the vicinity of the edge of the continental shelf and separated by a sharp front, is a band of slope water consisting of Gulf Stream water diluted approximately 20 per cent by coastal water. Beyond the slope water lies the Gulf Stream and beyond that is central Atlantic water.

On the Scotian Shelf in summer, three vertical layers of water are evident:

1. an upper, warm, “fresh” layer, typically 30 m thick, with temperatures of 5 to 20°C and salinities of less than 32 psu
2. an intermediate, cold layer, typically 100 m in thickness, with temperatures of 0 to 4°C and with salinities from 32 to 34 psu
3. a warm, saline, bottom layer, located at depths between 90 and 200 m, with temperatures between 5 and 8°C, and salinities up to 35 psu. Temperatures in the warm bottom layer may rise as high as 12°C due to incursions of slope water.

A long-term, large-scale overview of shelf sea-surface temperatures from Newfoundland to Maryland shows coherent trends for the Grand Banks, Scotian Shelf, Gulf of Maine, and the Sydney Bight. Annual averages vary coherently over a range of approximately four Celsius degrees. Increased sea-surface temperature is related to increased onshore winds.[8]

Against this background, there are many areas on the Scotian Shelf where the mixing/stratification sequence (and consequent high productivity) occurs. There are coastal upwelling areas, estuarine upwelling, banks with tidal gyres, and shelf-break fronts.

T6.2
Oceanic
Environments

ENVIRONMENT OF BAY OF FUNDY AND GULF OF MAINE

The dominant influence on the marine environment of the Bay of Fundy (Units 912, 913) is that exerted by the phenomenally large tides. The waters of the Bay of Fundy come from the Scotian Shelf as well as from the Gulf of Maine. The tidal mixing of waters with different characteristics tends to modify seasonal temperature variations and to create a water column that is fairly uniform in temperature and salinity. Ice occurs in the upper reaches of the Bay of Fundy from December to April, and ice conditions are influenced by the macro-tidal characteristics of the area. Tides influence patterns of erosion and sediment deposition in coastal areas. Tidal mixing, coupled with ample sediment sources, makes the water quite opaque, an important factor in limiting phytoplankton productivity.

The mud-flat habitat at the head of the Bay of Fundy is influenced by the large tidal extreme and seasonal occurrence of highest tides (see T6.1).

The Gulf of Maine ocean environment (parts of Unit 911 and Districts 920, 930) is determined by the environmental condition of Scotian Shelf waters and by tidal and mean currents, slope-water incursions, and atmospheric influences. In contrast to the Bay of Fundy, the tides are not so very dominant.

The intermittent incursions of relatively warm, saline slope water occurs in surface and bottom layers. The Gulf of Maine bottom water originates from slope water that enters the Gulf through the Northeast Channel. It is modified within the Gulf by vertical mixing with the near-surface waters of Scotian Shelf origin.

Analyses suggest that as much as 44 per cent of the new nitrate which enters the Gulf of Maine at depth through the Northeast Channel upwells in the eastern Gulf. This feature appears to be very important to the general biological productivity of the inner Gulf of Maine.

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Associated Topics

T3.5 Offshore Bottom Characteristics, T5.2 Nova Scotia's Climate, T6.1 Ocean Currents, T6.3 Coastal Aquatic Environments, T6.4 Estuaries, T7.1 Modifying Forces, T10.9 Algae, T11.7 Seabirds and Birds of Marine Habitats, T11.12 Marine Mammals, T11.14 Marine Fishes, T11.17 Marine Invertebrates

Associated Habitats

H1 Offshore, H2.4 Mud Flat

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1 Petrie, B., and F. Jordan (1992) *Nearshore, Shallow-water Temperature Atlas for Nova Scotia*. Cdn. Tech. Rept. Hydrog. & Ocean Sci., Department of Fisheries and Oceans, Bedford Institute of Oceanography.
2 Pocklington, R. (1983) “The Gulf of St. Lawrence and the Baltic Sea: A comparison of two organic systems.” *Mar. Chem*. 12 (2–3) 235.
3 Koutitonsky, V.G., and G.L. Bugden (1991) “The physical oceanography of the Gulf of St. Lawrence: A review with emphasis on the synoptic variability of the motion.” In *The Gulf of St. Lawrence: Small Ocean or Big Estuary?* (*Can. Spec. Publ. Fish. Aquat. Sci.* 113).
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5 Dunbar, M.J. (1980) “The Gulf of St. Lawrence: Physical constraints on biological production, Canada and the sea. I. Resources of the marine environment: East and West Coast.” *Assoc. for Can. Studies* 3 (1): 7–14.
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Additional Reading

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