Aquatic Environments & Wetlands

From the deepest lake zones to the edge of a salt marsh at high tide, New Brunswick's aquatic environments are extraordinary in their variety — and in the **ecological services they quietly provide.**

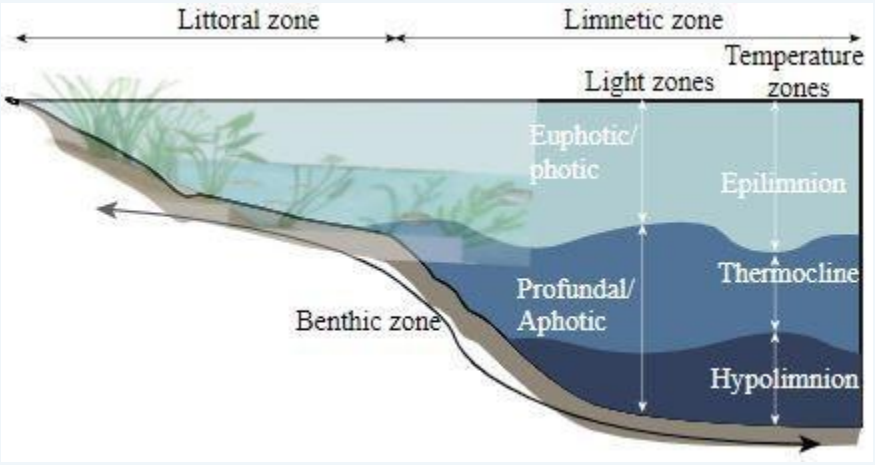
1. Lakes & ponds

Lakes and ponds are standing freshwater bodies — what ecologists call lentic systems. While we often use the terms interchangeably, ponds are generally shallower, with sunlight reaching the bottom across most of their area. Lakes are deeper, with distinct vertical zones based on light penetration, temperature, and oxygen.

Lake zones

Understanding lake zones is essential for predicting where organisms live and how energy flows through the system.

Zone	Description
Littoral zone	Shallow nearshore area where light reaches the bottom. Rich in rooted aquatic plants, invertebrates, amphibians, and juvenile fish. Highest biodiversity of any lake zone.
Limnetic zone	Open water where sunlight penetrates enough for photosynthesis. Dominated by phytoplankton and zooplankton. Supports most open-water fish species.
Profundal zone	Deep, dark water where no sunlight reaches. Cold, low-oxygen. Home to bacteria and specialized invertebrates decomposing organic matter from above.
Benthic zone	The lake bottom — sediment and organic debris. Bacteria and decomposers dominate, recycling nutrients back into the water column. The lake's digestive system.



Lake cross-section diagram.

https://www.insightsonindia.com/... /freshwater-biomes/

Lake aging: oligotrophic to eutrophic

Lakes naturally age over geological time, gradually accumulating nutrients and sediment. This process — eutrophication — changes a lake's character from clear and low-nutrient to turbid and nutrient-rich. Human activities greatly accelerate it.

Oligotrophic (young lake)	Eutrophic (old or impacted lake)
Nutrients: Low	Nutrients: High (N & P)
Water clarity: High — deep light penetration	Water clarity: Low — algae blooms
Oxygen: High throughout	Oxygen: Low in deep water
Algae: Sparse	Algae: Dense, including cyanobacteria
Fish: Cold-water species (e.g. lake trout)	Fish: Warm-water tolerant species
Littoral zone: Narrow, steep sides	Littoral zone: Wide, gently sloping

HUMAN-ACCELERATED EUTROPHICATION

Nutrient loading from agricultural runoff, lawn fertilizers, and sewage discharge can push a lake through centuries of natural aging in just decades. Excessive N and P fuel algal blooms. When algae die and decompose, bacteria consume oxygen, creating dead zones where aquatic life cannot survive. This connects directly to the 2026 focus topic: non-point source pollution.

Thermal stratification

In summer, temperate lakes develop distinct temperature layers. The warm surface layer (epilimnion) is separated from the cold bottom layer (hypolimnion) by a transition zone called the thermocline. This stratification prevents mixing, trapping oxygen in the upper layer and cutting off deep water. In fall and spring, temperatures equalize and the lake 'turns over,' mixing nutrients and oxygen throughout.

2. Rivers & streams

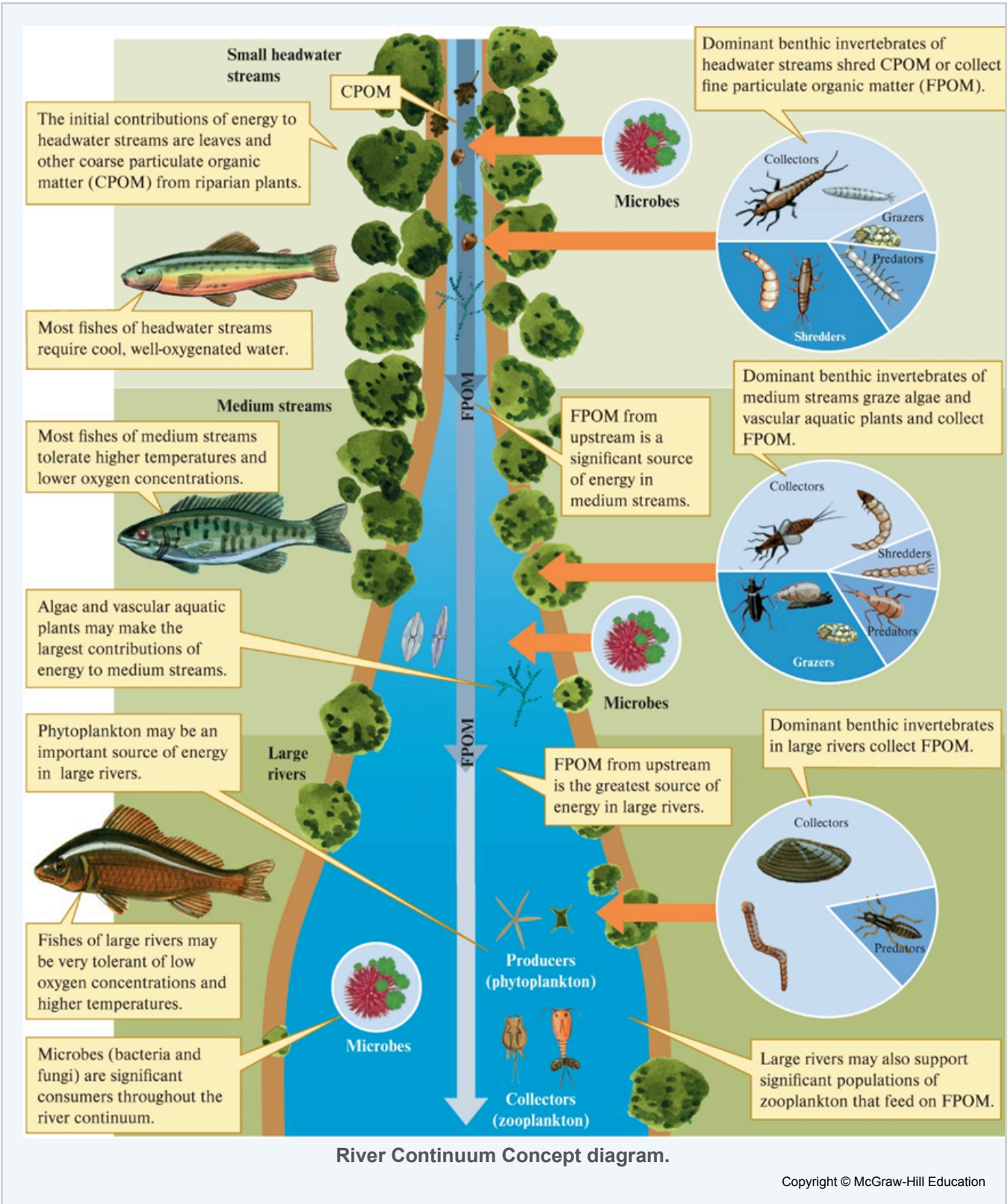
Rivers and streams are lotic systems — flowing water. Unlike lakes, they are shaped continuously by the movement of water, which influences everything from the substrate on the bottom to the species that can survive there.

Lotic (flowing) systems	Lentic (standing) systems
Oxygen: Usually high (mixing with air)	Oxygen: Stratified by depth
Temperature: Variable; shading matters	Temperature: Stratified seasonally
Nutrients: Imported from watershed (allochthonous)	Nutrients: Produced within lake (autochthonous)
Substrate: Gravel, cobble, sand — varies by gradient	Substrate: Soft sediment, accumulates over time
Organisms: Adapted to resist/use current	Organisms: Zone-adapted; plankton dominant
Energy: Leaf litter & CPOM from riparian zone	Energy: Phytoplankton, algae

The River Continuum Concept

The River Continuum Concept describes how stream ecosystems change predictably from headwaters to large rivers. Small headwater streams (orders 1-3) are heavily shaded by riparian canopy and depend on coarse particulate organic matter (CPOM) — fallen leaves, twigs, and debris — as their primary energy source. Organisms here are largely shredders and collectors.

As the stream grows wider (orders 4-6), the canopy opens, allowing more sunlight to reach the water. Algae and aquatic plants become important energy sources, and grazers increase. In large rivers (orders 7+), turbid water limits photosynthesis and fine particulate organic matter (FPOM) carried from upstream becomes the dominant energy source, with collectors dominating.



River Continuum Concept diagram.

3. Wetland types

Wetlands are ecosystems where the soil is saturated with water — either permanently or seasonally — producing conditions that support water-tolerant plants and distinctive soils. They are among the most productive and biodiverse ecosystems on Earth.

In Canada, wetlands are classified using the Canadian Wetland Classification System, which recognizes five major classes. In New Brunswick, the provincial government regulates wetlands under the Clean Water Act and the Watercourse and Wetland Alteration Regulation (WAWA), requiring permits for activities within 30 metres of any wetland.

WHAT MAKES A WETLAND?

Three conditions must be present:

(1) Water — at or near the surface for at least part of the year

(2) Hydric soils — wet, oxygen-poor soils with characteristic texture and colour

(3) Water-tolerant vegetation — plants adapted to saturated conditions (sedges, cattails, alders, sphagnum)

Inland wetland types

Type	Key features	Common NB plants
Bog	Acidic, nutrient-poor, peat-forming. Fed only by precipitation. Closed system — no groundwater inflow.	*Sphagnum moss, Labrador tea, pitcher plant, leatherleaf*
Fen	Peat-forming but connected to groundwater. More nutrients and plant diversity than bogs.	*Sedges, willows, mosses, scattered black spruce*
Marsh	Frequently or permanently flooded with mineral-rich water. Dominated by emergent vegetation.	*Cattails, bulrushes, reeds, water lilies, sedges*
Swamp	Wooded wetland with trees or shrubs in standing/seasonally flooded water. Near rivers and floodplains.	*Alder, willow, sweet gale, black ash, red maple*
Shallow water / aquatic bed	Open shallow water with submerged or floating vegetation. Transitional between open lake and marsh.	*Pondweed, bladderwort, water milfoil, water lilies*
Coastal marsh	Inundated by tidal saltwater or brackish water. ALL NB coastal wetlands = Provincially Significant.	*Cordgrass (Spartina), salt meadow rush, seaside goldenrod*

65%
of NB's salt marshes lost — mostly converted to agricultural land

$24K
ecosystem services per hectare of NB wetland per year

30 m
buffer zone required under NB's WAWA regulation

4%
of NB's total land area is currently wetland

NB REGULATION UPDATE (2020)

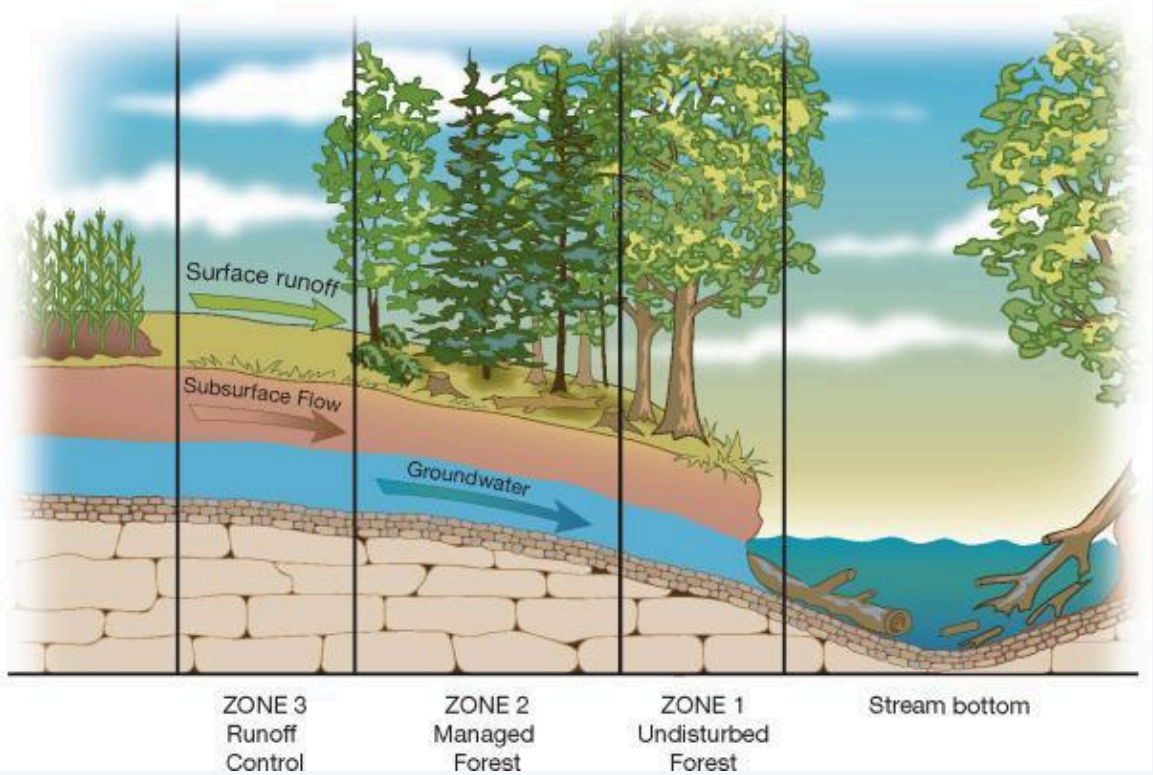
As of January 1, 2020, all wetlands are now protected based on their presence on the ground — regardless of whether they appear on a provincial map. A WAWA permit is required for any activity in or within 30 metres of a watercourse or wetland. Check the WAWA Reference Map on GeoNB for current mapping.

What wetlands do for us

Service	How it works	Why it matters
Flood control	Wetlands absorb rainfall and snowmelt, slowly releasing it — reducing peak flood flows.	*Protects downstream property and infrastructure*
Water filtration	Soils and plants trap sediments and absorb excess N & P from runoff.	*Reduces algal blooms; protects drinking water*
Groundwater recharge	Water stored in wetlands infiltrates into aquifers, maintaining baseflow in streams.	*Sustains wells and stream flow in dry periods*
Wildlife habitat	Most wildlife on Earth relies on wetlands at some point in their life cycle.	*Nesting, feeding, migration, breeding*
Carbon storage	Peatlands (bogs/fens) store vast carbon in slowly decomposing organic matter.	*Draining releases stored carbon — climate impact*
Shoreline stability	Wetland plant roots hold soil together, reducing erosion from waves and ice.	*Protects aquatic habitat and stream-bottom gravel*

4. Riparian zones

A riparian zone is the transitional band of land and vegetation directly alongside a river, stream, lake, or wetland. The word comes from the Latin *ripa*, meaning riverbank. In NB, riparian zones are protected by the Clean Water Act, requiring a **30-metre buffer zone** around all watercourses and wetlands.



Riparian zone diagram.

ScienceDirect.com

What riparian zones do

Function	How it works in practice
Stream temperature	Canopy shade keeps water cool — critical for cold-water species like salmon and brook trout. Removing riparian trees can raise stream temperature by several degrees Celsius.
Energy input (CPOM)	Leaves, twigs, and debris falling from riparian trees are the primary energy source for headwater stream food webs — feeding shredding macroinvertebrates.
Bank stabilization	Tree and shrub roots hold riverbanks together. Bare banks collapse faster, increasing turbidity and smothering fish spawning gravel.
Nutrient filtration	Vegetation absorbs excess N & P from agricultural and urban runoff before it reaches the stream — reducing algal blooms downstream.
Wildlife corridor	Deer, otters, wood turtles, and many songbirds use riparian strips to travel between habitat areas across the landscape.
Large woody debris	Trees falling into streams create pools, shelter for fish, and diverse microhabitats for macroinvertebrates.

WHY HEADWATER BUFFERS MATTER MOST

Small landowners can have outsized conservation impact. Changes to riparian zones along 1st-3rd order headwater streams have cascading effects far downstream — on water temperature, sediment loads, and food webs. Protecting these small streams is often more cost-effective than trying to fix problems in a large river.

5. Coastal & estuarine environments

Where rivers meet the sea, freshwater and saltwater mix in an estuary. Estuaries are among the most productive ecosystems on the planet — nursery grounds for fish, stopovers for migratory birds, and filters for water entering the ocean.

New Brunswick's coastline faces both the Bay of Fundy (southwest) and the Northumberland Strait / Gulf of St. Lawrence (northeast), giving the province two ecologically distinct coastal environments with very different tidal regimes.

The Bay of Fundy: a world apart

The Bay of Fundy has the highest tidal range on Earth — up to 16 metres at its upper reaches near the Minas Basin and Chignecto Bay. Twice daily, billions of tonnes of water surge in and out, exposing vast mudflats that are among the most productive feeding grounds in eastern North America.

SEMIPALMATED SANDPIPER MIGRATION — A GLOBAL SPECTACLE

Each August, up to 75% of the world's population of semipalmated sandpipers — around 1–2 million birds — stops at the Bay of Fundy during their southbound migration from Arctic breeding grounds to South America.

In just 2–3 weeks, these sparrow-sized birds nearly **double their body weight** by feeding on Corophium volutator — a tiny crustacean at densities up to 100,000 per m² in the Fundy mudflats.

They then launch a non-stop 3-day ocean flight of 3,000–4,000 km to South America. Mary's Point, NB is a designated Western Hemisphere Shorebird Reserve Network Hemispheric Site.

Salt marshes

Bay of Fundy salt marshes are characterized by two communities: low marsh (flooded frequently, dominated by saltwater cordgrass Spartina alterniflora) and high marsh (flooded less often, higher species diversity including saltmeadow rush, goose tongue, and seaside goldenrod).

Salt marshes provide 'blue carbon' storage — capturing and holding carbon in deep organic soils at rates rivalling tropical rainforests. Over 65% of NB's coastal salt marshes have been lost — primarily to historical dyking for agriculture in the upper Bay of Fundy.

Bay of Fundy salt marsh with Semipalmated Sandpipers.

Photo: D. Ross Fisher

Northumberland Strait coast

The east coast of NB faces the Gulf of St. Lawrence, with a much smaller tidal range (microtidal). Warmer, shallower water supports eelgrass beds — critical habitat for juvenile fish and waterfowl — as well as soft-bottom estuaries important for oysters and blue mussels. This coastline has experienced significant residential development pressure since the 1990s.

6. New Brunswick spotlight

Petitcodiac River — a restoration success

The Petitcodiac River was dramatically altered in 1968 when a causeway near Moncton restricted tidal flow, causing sediment buildup and loss of the famous tidal bore. Fish populations collapsed. After years of advocacy, the gates were opened in 2010 and tidal flow was restored. The tidal bore returned, fish populations began recovering, and the river is now one of Atlantic Canada's most-studied restoration case studies.

Musquash Estuary — NB's first marine protected area

Located west of Saint John, Musquash Estuary was designated Canada's first marine protected area in Atlantic Canada in 2006. It protects one of the last undisturbed estuaries on the Bay of Fundy — salt marshes, eelgrass beds, intertidal mudflats, and habitat for many Species at Risk.

Miramichi River — Atlantic salmon stronghold

The Miramichi watershed covers roughly 14,000 km² in central NB and is one of the most important Atlantic salmon rivers in the world. Its cold, clear headwater streams depend on intact riparian forest cover to maintain water temperatures within the tolerance range for salmon.

ENVIROTHON EXAM TIP

You may be asked to identify wetland types from descriptions or photos. Focus on the key distinguishing features: BOGS = acidic + closed system + sphagnum; FENS = peat + open drainage + more species; MARSHES = emergent plants + frequently flooded; SWAMPS = wooded + seasonally flooded; COASTAL MARSHES = tidal + saltwater or brackish.

7. Key terms

lentic Standing water ecosystems — lakes, ponds, wetlands.	**lotic** Flowing water ecosystems — rivers and streams.
littoral zone Shallow near-shore area of a lake where light reaches the bottom.	**limnetic zone** Open water of a lake where photosynthesis can occur.
profundal zone Deep, dark water below light penetration; cold and low-oxygen.	**thermocline** Transition layer separating warm surface water from cold deep water.
oligotrophic Low nutrient, high oxygen, clear lake — typical of young water bodies.	**eutrophic** High nutrient, often low oxygen, turbid lake — from aging or human impacts.
eutrophication Process of nutrient enrichment in a water body, accelerated by human activity.	**CPOM** Coarse Particulate Organic Matter — leaves, twigs; primary energy for headwater streams.
FPOM Fine Particulate Organic Matter — broken-down particles; dominant energy in large rivers.	**riparian zone** Transitional land and vegetation between a water body and the upland area.
hydric soil Wet, oxygen-poor soil formed under flooded or saturated conditions.	**estuary** Where freshwater from a river mixes with tidal saltwater from the ocean.
allochthonous Energy inputs originating outside the aquatic system (e.g. leaf litter from trees).	**WAWA** Watercourse and Wetland Alteration Regulation — NB's permit system near water.
blue carbon Carbon stored by coastal wetland ecosystems including salt marshes and seagrass.	**Provincially Significant Wetland** NB designation for wetlands of provincial/national importance. All coastal wetlands qualify.

8. Quick check

Test yourself before moving on. Can you answer all of these?

Quick Check — Review Questions

1. Name the four zones of a lake and describe the key characteristics of each.
2. What is the difference between an oligotrophic and a eutrophic lake? How does human activity accelerate the transition?
3. A stream's riparian trees are cleared for a new subdivision. List three specific effects on the stream ecosystem.
4. Three conditions must be present for an area to qualify as a wetland in NB. What are they?
5. How does a bog differ from a fen? What makes a marsh different from a swamp?
6. Why are NB's coastal salt marshes given maximum protection as Provincially Significant Wetlands?
7. BONUS: The semipalmated sandpiper stops in the Bay of Fundy to double its weight. What does it eat there, and why is this only possible because of the Bay of Fundy's unique tidal regime?

9. Further resources

🌐 **Nature Trust NB — Wetland Conservation** Plain-language guide to NB wetland types, functions, regulations, and the $24,000/hectare ecosystem services figure. *naturetrust.nb.ca/en/wetland-conservation*

📄 **NB Dept. of Environment — Wetlands** Official guidance on wetland identification, permitting, WAWA regulation, and the updated 2020 regulated wetland layer on GeoNB.
gnb.ca/content/gnb/en/departments/elg/environment/content/wetlands.html

🌐 **Birds Canada — Space to Roost** Explains the semipalmated sandpiper migration spectacle and how the Bay of Fundy's tidal regime makes it possible. *birdscanada.org/bird-science/space-to-roost*

📄 **Conservation Council of NB — Estuaries & Salt Marshes** Covers salt marsh loss, oyster decline, and the ecological importance of NB's east coast estuaries. *conservationcouncil.ca/estuaries-and-salt-marshes/*

▶ **Lake Stratification & Turnover — Bozeman Science** Animated explanation of epilimnion, thermocline, hypolimnion, and seasonal turnover. Under 10 minutes. *Available on YouTube*

🌐 **Canadian National Wetlands Inventory (ECCC)** Updated 2025 national database with NB wetland mapping and the Canadian Wetland Classification System.
canada.ca/en/environment-climate-change/services/wildlife-habitat/canadian-national-wetland-inventory.html

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