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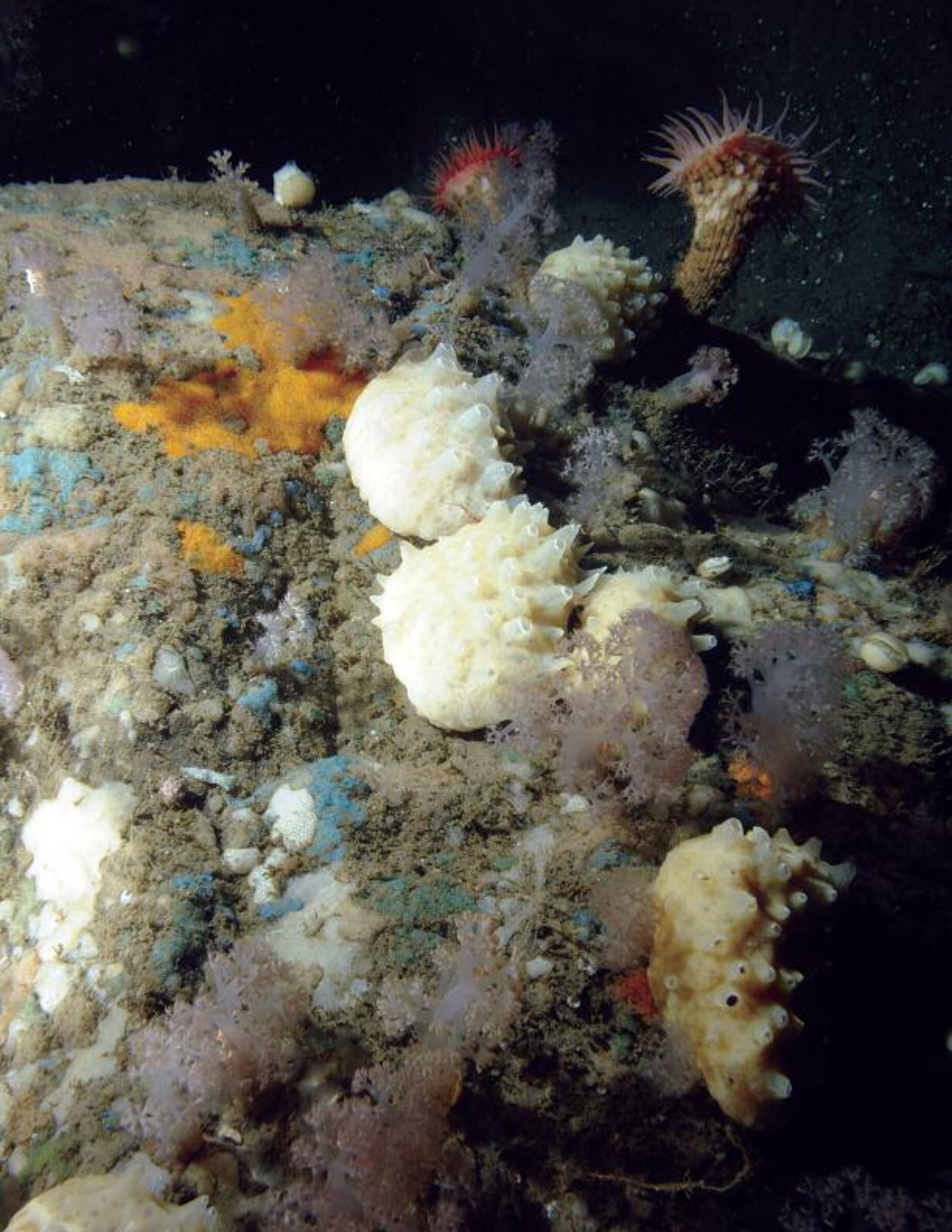
An Ocean of Diversity

The Seabeds of the Canadian Scotian Shelf and Bay of Fundy



From above the waves, the expansive ocean waters off Nova Scotia and New Brunswick conceal the many different landscapes, habitats and ecological communities that lie beneath. As the glaciers retreated they left a complex system of shallow banks, steep-walled canyons, deep basins, patches of bare rock and boulders. WWF-Canada and Fisheries and Oceans Canada have worked with respected scientists to create a new map of seabed (or ocean bottom) features of the region. This new map will be used to help guide the design of a network of marine protected areas (MPAs) in the Scotian Shelf and Bay of Fundy regions.

Mapping seabed features

Marine animals and ecosystems are difficult to survey, and we do not have complete, continuous maps of the distribution of species and communities in our region — in fact, new species are still being discovered. But species are adapted to particular physical characteristics of their habitat, such as the levels of light reaching the seafloor, the range of water temperature, and the type of seafloor, from bedrock to sand to mud. This relationship allows us to use readily-available information about physical characteristics to create a more comprehensive picture of the different habitat types — and therefore ecological communities — that can be found in the region. This is the approach taken in the development of the Seabed Features map.

Marine geologist Gordon Fader brought together scientific studies, high resolution seabed mapping, and his own extensive knowledge of the region to define areas based on their shape (morphology) and the geological history that formed them. Morphological and geological characteristics are the most enduring aspects of the offshore regions and in general, are altered only over very long timescales through major environmental changes such as glaciations and periods of significant sea-level lowering. They also convey information about bathymetry, sediment texture, and habitat complexity.

The Seabed Feature map is a *hierarchical classification*, where distinctions are made between features at both fine and coarse scales. Each region is further subdivided into individual morphologic elements based on bathymetry and on the geologic history of its bedrock and surficial material.

By mapping out these seabed features, we can begin to develop a picture of the distribution of the different kinds of habitats, species and ecological communities that make up the marine ecosystems of the Scotian Shelf and Bay of Fundy. This information can in turn be used to help make sound decisions about conservation and sustainable development.

What is biogeographic representation?

MPAs are a useful tool for protecting special places that stand out for their uniqueness or importance. But an MPA network, when well designed, can achieve more than protecting one or two small sites. MPA networks that include representative examples of the full range of biodiversity in the region can preserve and enhance the health of the entire ecosystem, boosting productivity and sustainability in the long term. This kind of network design — called biogeographic representation — can also facilitate recovery and guard against the loss of species and habitats, even if we don't yet have a full scientific understanding of their distribution. An MPA network that adheres to this design principle stands the greatest chance of effectively protecting the marine ecosystem.

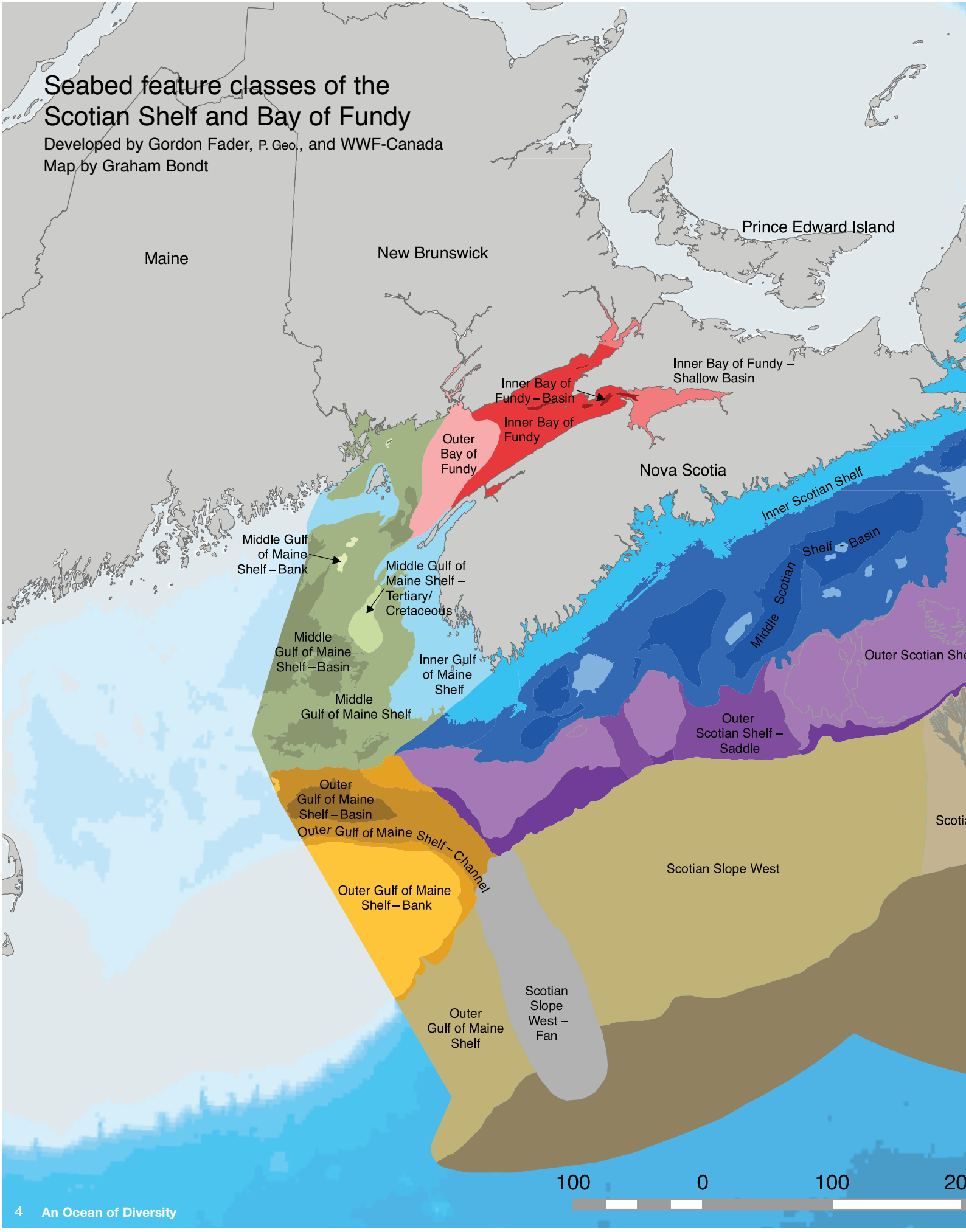
The Scotian Shelf and Bay of Fundy MPA network will be based, in part, on this principle. This approach reflects the best scientific advice, as well as international commitments such as the Convention on Biological Diversity.

The Scotian Shelf and Bay of Fundy MPA network plan

Fisheries and Oceans Canada, with other government agencies and the input of stakeholders, is leading the development of a coordinated MPA network plan for the Scotian Shelf and the Bay of Fundy. In addition to biogeographic representation, the plan will include distinctive and significant areas in a design that is ecologically connected and viable. It will also be informed by socioeconomic design principles to help ensure that the network benefits ocean resource users. This booklet is one of several information products that will be available to help stakeholders understand the scientific basis of the network design. For more information or to find out about opportunities to get involved in the planning process, contact the Oceans and Coastal Management Division of Fisheries and Oceans Canada at the Bedford Institute of Oceanography (see back cover for contact information).

Seabed feature classes

AREA	SUB-AREA
Laurentian Channel	Laurentian Channel
Scotian Slope	Scotian Slope East
	Scotian Slope East – Laurentian Fan
	Scotian Slope East – Canyons
	Scotian Slope East – Gully Fan
	Scotian Slope West
	Scotian Slope West – Fan
Scotian Rise	Scotian Rise
	Scotian Rise – Debris Flow
Outer Scotian Shelf	Outer Scotian Shelf
	Outer Scotian Shelf – Bank
	Outer Scotian Shelf – Saddles
Middle Scotian Shelf	Middle Scotian Shelf
	Middle Scotian Shelf – Banks
	Middle Scotian Shelf – Basins
Inner Scotian Shelf	Inner Scotian Shelf
Outer Gulf of Maine Shelf	Outer Gulf of Maine Shelf
	Outer Gulf of Maine Shelf – Banks
	Outer Gulf of Maine Shelf – Basins
	Outer Gulf of Maine Shelf – Channel
Middle Gulf of Maine Shelf	Middle Gulf of Maine Shelf
	Middle Gulf of Maine Shelf – Basins
	Middle Gulf of Maine Shelf – Banks
	Middle Gulf of Maine Shelf – Tertiary/Cretaceous
Inner Gulf of Maine Shelf	Inner Gulf of Maine Shelf
Outer Bay of Fundy	Outer Bay of Fundy
Inner Bay of Fundy	Inner Bay of Fundy
	Inner Bay of Fundy – Basins
	Inner Bay of Fundy – Shallow Basins


Seabed feature classes of the
Scotian Shelf and Bay of Fundy
Developed by Gordon Fader, P. Geo., and WWF-Canada
Map by Graham Bondt
Maine
New Brunswick
Prince Edward Island
Nova Scotia
Inner Bay of Fundy – Shallow Basin
Inner Bay of Fundy – Basin
Inner Bay of Fundy
Outer Bay of Fundy
Inner Scotian Shelf
Middle Scotian Shelf – Basin
Outer Scotian She
Middle Gulf of Maine Shelf – Bank
Middle Gulf of Maine Shelf – Tertiary/ Cretaceous
Middle Gulf of Maine Shelf – Basin
Inner Gulf of Maine Shelf
Middle Gulf of Maine Shelf
Outer Scotian Shelf – Saddle
Outer Gulf of Maine Shelf – Basin
Outer Gulf of Maine Shelf – Channel
Outer Gulf of Maine Shelf – Bank
Scotian Slope West
Scotian Slope West – Fan
Outer Gulf of Maine Shelf
100
0
100
20

Projection: UTM Zone 20N Datum: NAD 83
Digital Bathymetry: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Geophysical Data Center, 2006. 2-minute Gridded Global Relief Data (ETOPO2v2)

Laurentian Channel

The Laurentian Channel is a deep, linear trough that developed from a former river valley subsequently eroded by glacial ice. The Channel allows for incursions of nutrient-rich water from the Atlantic Ocean into the Gulf of St. Lawrence.

At the mouth of the Laurentian Channel the seabed is mainly sandy mud, while the flanks of the channel are covered in old iceberg furrows lined with gravel. The many tracks and burrows indicate abundant marine life living in the sediment. Krill can be exceptionally dense in the water column. Seapens, cup corals and anemones can be abundant in places in the centre of the Channel, while witch flounder and redfish are found in concentrations along the edge. Concentrations of Lophelia coral have been discovered here as well, and likely provide a refuge for juvenile fish.

An anemone on a muddy seafloor
Photo: Fisheries and Oceans Canada

Scotian Slope East

Beyond the edge of the Scotian Shelf (about 200m depth) the seabed slopes away rapidly from the relative flatness of the adjacent shelf. Both dramatic exposed sedimentary bedrock cliffs and areas of slumping sediments can be found. Between the canyons the seabed is crisscrossed by furrows and pits created by icebergs that grounded there in the past. It continues to erode, creating a natural disturbance regime that may enhance biological diversity.

Deep water mixes with surface water at the edge of the shelf to create the right conditions for abundant phytoplankton (the tiny water-column plant life that forms the base of the marine food web). This makes the slope a prime stopover for migrating species like large whales, porbeagle and Greenland sharks, swordfish, tuna, seabirds and leatherback turtles — many of which are globally endangered. Fish that occur in this area range from shallow-shelf to deep-ocean species, including halibut, which overwinter on the Slope, as do many seabirds.

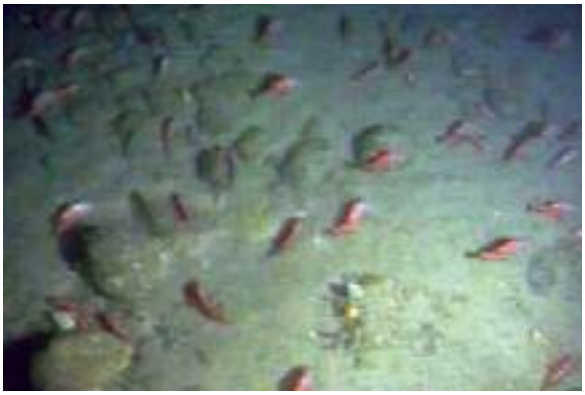
Abundant krill near the seafloor
Photo: Fisheries and Oceans Canada

Scotian Slope East

Laurentian Fan

Beyond the Laurentian Channel, down the adjacent slope, the Laurentian Fan is a delta-like feature that is the largest of its kind on the continental rise off eastern Canada. Two major valleys originate from an area of gullies on the upper slope and terminate at depths of 4500 – 5200m, where they swing easterly and open onto a sandy lobe on the abyssal plain.

Life teems in some places on the gravely sediments of the Fan, where unique 'cold seep' communities of clams, snails, crabs and feathery polychaete worms have adapted to the conditions by developing an ability to derive energy from the available carbon and sulphide seeping out of the sediment instead of sunlight. These communities have probably flourished since 1929, when a major earthquake rocked the seafloor in this area and created new surfaces to be colonised.



Redfish
Photo: Fisheries and Oceans Canada

Scotian Slope East

Canyons

Submarine canyons occur along the outer edges of the Scotian Shelf and extend down the Scotian Slope. They are narrow, deep, and steep-sided. The largest canyons of the eastern area — including the well-known Gully, Shortland, and Haldimand canyons, are carved into the shelf edge and act as channels for transport of sand.

The Canyons of the Scotian Slope are sites of high biological diversity. They are topographically complex and contain more surface area and a greater variety of habitats compared with those of the surrounding shelf. They also represent a transition from the outer shelf to the deep ocean. For these reasons, they are home to a high diversity of fish species; the deep, slow-moving waters along the canyon walls are ideal conditions for delicate, rigid gorgonian corals; and species such as squid may be one of the attractions for foragers such as the endangered northern bottlenose whale.

Deep sea coral in The Gully
Photo: Fisheries and Oceans Canada

Scotian Slope East

Gully Fan

The canyons of the Scotian Slope East were created by erosion, and today they still function as conduits for the transport of sediments from the constantly eroding shelf. These sediments travel down the slope and out to the far reaches of the Rise.

Ecologically, this is an area of transition between the rough, complex slope environments and the deep, flat Atlantic abyssal plains. As with other deep-water areas off the shelf, the ocean floor here is dark, and species depend upon food that falls in from the water column above. Sea pens, solitary cup corals, and 'sea lilies' reach out into the slight current to gather nutrients. Sea spiders scuttle across the ocean floor, and anglerfish, batfish and blue hake swim slowly near the bottom as they search for prey. The world's largest known single celled protozoan, called a xenophyophore, is also an important part of the ecosystem here.

Seapens on a muddy seafloor
Photo: Fisheries and Oceans Canada

Scotian Slope West

To the west of the saddle between Western and Emerald Banks (west of 62°W), the gradient of the Slope is more gentle and the seabed is relatively smooth, with fewer canyons and a less dynamic seabed than the Scotian Slope East. A few shallow gullies reach to depths of 500m. This is an area of low, gentle hills and valleys sloping toward the Scotian Rise and abyssal plain.

Like the eastern part of the Scotian Slope, this area is exceptionally productive and hosts many large fish and whales during times of feeding and migration. It is also important for over wintering shelf species, especially the commercially-important offshore lobster.

Anemone and redfish
Photo: Fisheries and Oceans Canada

Scotian Slope West

Fan

A tongue of glacially derived sediment spills out from the mouth of the Northeast Channel into deeper water. Although smaller in scale, this fan is similar in form to the Laurentian Fan to the east. Like the rest of the Slope, this area is fully-oceanic in nature: light penetrates only a fraction of the way into the deep water column, and species on the seabed must rely primarily on falling detritus and particulate matter for food. Invertebrates, including soft corals and sponges, grow on the seafloor and redfish are often found amongst them. Waters near the surface are generally warmer and more productive than those to the east, and phytoplankton, the base of the food web, grows more quickly and abundantly, providing food for a diversity of fishes and whales.

Seafloor invertebrates on the fan of the Northeast Channel
Photo: Fisheries and Oceans Canada

Scotian Rise

Glacial erosion, sea level rise and fall, and modern-day erosion have deposited sediments in a wide swath seaward of the continental slope. This area is called the Scotian Rise. Deep currents, along with smaller currents called eddies that peel off from the Gulf Stream, continue to rework the sand and mud here, sometimes in strong events called 'benthic storms,' disturbing the seabed but also bringing fresh nutrients to the ecosystem. This has led to a unique mix of deep-ocean species and species adapted to more dynamic, high-energy environments. Exceptionally high densities of bacteria and feathery polychaete worms are found here, along with bivalve shellfish and other species that burrow into the mud to avoid being swept away.

Seapens, characteristic of the deep waters of the Scotian Rise
Photo: Fisheries and Oceans Canada

Scotian Rise

Debris Flow

In this area on the far eastern edge of the Scotian Rise, large masses of muddy debris have shifted and settled into sheets of sediment with thick centres and wispy edges. These mudflows, found in water deeper than 750m, mix with sediment that continues to funnel down from the canyons on the slope above. The result is a complex of smooth, muddy material that is 220km wide and extends 200km down slope.

This deep-water ecosystem bears the characteristics of the open ocean, where the only food arrives from what phytoplankton grows near the surface. Largely intercepted by zooplankton, large pelagic fish, and whales, only a portion of this food source reaches the ocean floor to support the sessile invertebrates and unusual, often semitransparent crustaceans and fish that make a living in the darkness.

Outer Scotian Shelf

Surrounding the large banks and saddles of the Outer Scotian Shelf are deeper-water lowlands that feed the canyons and slope with sediment. Here on the outer margins of the shelf, water masses collide to form a 'frontal zone' that shifts from year to year, and off-shelf water masses make periodic incursions to the middle shelf through these lowlands between the banks.

Frontal zones are marked by high productivity, and they are also places where species tend to be deposited after long rides on 'conveyor belt' currents like the Gulf Stream: masses of the seaweed *Sargassum* can be found floating in the area occasionally, and short-finned squid arrive along the outer edge of the Scotian Shelf in June. The squid move in through the lowlands with the water masses to spread over the Shelf later in the summer, and then migrate southwest. Their young return the following year by the same process. On the seafloor below, corals and other invertebrates lend structure to habitats that are home to groundfish and crustaceans.

Invertebrates on the Scotian Shelf seafloor
Photo: Fisheries and Oceans Canada

Outer Scotian Shelf

Banks

The Outer Scotian Shelf is dominated by many large banks that are covered with sand and gravel. Shell beds and boulders also occur in patches. Storms and currents constantly shape the tops of the banks, forming the sand into a wide variety of ridges, waves and ripples.

Cold slope waters mix with the waters at the edges of the banks, supplying nutrients and promoting phytoplankton growth. This plant material reaches the shallow seabed and provides food for the animals that thrive there, especially filter-feeders and grazers. Scallops, surf clams, quahogs and sand dollars are abundant in finer sediments. Horse mussels, brittlestars, lobster and toad crab are found anchored to or hiding in the rockier spots.

The offshore banks are important feeding, spawning and growth areas for fish such as cod, haddock, pollock and silver hake. Gyres that circle some of the banks help to keep eggs and very young fish in the region while they drift with the currents. This area is also home to Sable Island, known for a huge population of grey seals and sharks that gather in the surrounding waters to prey upon them.

Sand dollars on Sable Island Bank
Photo: Fisheries and Oceans Canada

Outer Scotian Shelf

Saddles

Saddles are slightly deeper-water areas that occur between the banks of the Outer Scotian Shelf and exhibit a gentle relief. Saddles are present between Emerald Bank, LaHave Bank and Browns Bank. They occur at depths of less than 200m and are covered by sand that contains minor clay, silt, and frequently gravel. Most of the saddles are crossed by gentle ridges of till in the subsurface, indicating that saddles were once occupied by glacial ice streams. Saddles form an entrance to the basins of the Middle Scotian Shelf for water masses, typically the warmer, deeper slope water from the shelf edge. Primary (phytoplankton) productivity in the water over the saddles is similar to that of the adjacent shelves.

Fish, anemone and shell hash on a sand/gravel bottom
Photo: Fisheries and Oceans Canada

Middle Scotian Shelf

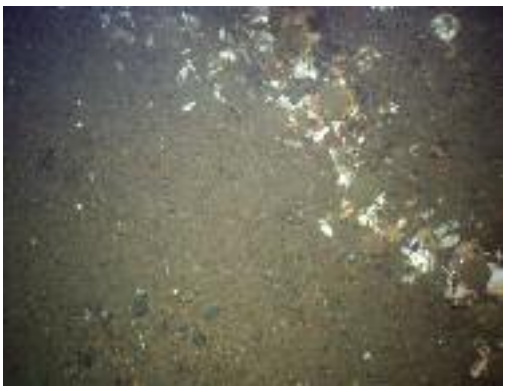
The Middle Scotian Shelf extends the length of the Shelf, grading from a narrow strip of rough bedrock in the west to a wide, complex network of valleys, ridges and small gravel-covered banks in the east. This highly diverse topography of steep slopes and deep areas creates a large number of habitat types and a variety of surfaces on which different species can be found. To the east, near St. Anns Basin, is an area recognised by fishermen and scientists for its complex topography, nicknamed "The Noodles." Deeply incised channel networks provide unique natural refugia for a high diversity of fish — some of them rare in the region — and invertebrates like sponges, shrimp and snow crab. Fishermen have long reported finding hard Lophelia corals in this area. Nearby are the deep holes of Canso, also important for snow crab.

Pollock over a sandy seafloor
Photo: Fisheries and Oceans Canada

Banks

The Middle Scotian Shelf includes a scattering of banks that, while generally underlain by bedrock and glacial till, vary in shape and surface material. Roseway and Sambro banks are steep-sided, flat-topped mesas, while Middle, Canso and Misaine present more gradually sloping margins. The surface of Misaine Bank on the northeast end of the Scotian Shelf is extensively incised by channels created by the melting ice sheet. Other banktops were leveled when rising and falling sea levels exposed and eroded them.

The larger, sandier banks, like Canso, Middle and Misaine, are home to sand dollars, amphipods and sand lance, an important forage fish. Larger bivalves like quahogs and surfclam, and scallops are found as the substrate becomes coarser, and the most gravelly areas favour horse mussel, brittle star, lobster and crab. Some of the earliest records of mollusks in this region were brought from Sambro Bank by local Halifax fishermen in the 1860s.



Sand, gravel and shell hash on a Scotian Shelf bank
Photo: Fisheries and Oceans Canada

Basins

A series of large open basins span the middle of the Scotian Shelf, forming an extended trough that runs parallel to the Atlantic coast of Nova Scotia. These basins have been filled and smoothed first by glaciers and, more recently, by deposition of clay. Boulder covered till ridges protrude through the mud in places, and crater-shaped depressions known as pockmarks are found where natural gas bubbles through the sediments to the surface.

Storms often force warmer, deeper slope water from the shelf edge through the saddles and into the basins. This brings periodic influxes of nutrients, which help to sustain phytoplankton in areas otherwise too deep for plant growth. Dense zooplankton (tiny water-column animals) and krill provide food for red and silver hake and witch flounder, while mud-loving species like heart urchin and mud star live on the seafloor. To the east, the Basins are the prime habitat of snow crabs and shrimp, while North Atlantic right whales find plentiful food in the western basins. In the middle of Emerald Basin is "The Patch," a rocky area that is the only known habitat for a population of glass sponges known as "Russian Hats."

Seafloor in Emerald Basin
Photo: Fisheries and Oceans Canada

Russian Hats (glass sponges) in "The Patch"
Photo: Fisheries and Oceans Canada

Inner Scotian Shelf

The Inner Scotian Shelf borders the mainland and extends, on average, 25kms from shore, where it dips gently seaward to the basins of the Middle Scotian Shelf in water depths of 70 – 100m. The Inner Shelf can be considered a submarine extension of Nova Scotian coastal areas, with the characteristic high relief of roughly eroded bedrock, swept clean of sediment by sea level changes and modern waves and tides. Conditions change rapidly over short distances and the distribution of bedrock, sand, and gravel is patchy, creating a high surface relief and a variety of habitats.

Exposed bedrock areas are ideal for seaweeds like kelp, knotted wrack and rockweed that form a dense carpet along the coast. Below the tideline, underwater kelp forests are habitat for many invertebrate species and refugia for small fish. Encrusting coralline algae cover rock surfaces in the shallower areas, and eelgrass beds and tidal marshes are found in sheltered bays. The complex distribution of fish, birds, and marine mammals reflects long-established movement patterns and stock distributions. In the southwest part of the region, herring flourish in areas of upwelling, and local stocks of halibut are found off Cape Sable Island where the currents are strong. Bottom invertebrates include horse mussel, sea cucumbers, sea stars, amphipods, barnacles, crabs, scallops, urchins, and significant populations of lobsters.

Seafloor near Country Harbour
Photo: Fisheries and Oceans Canada

Coraline algae encrusting boulders in the rocky nearshore zone
Photo: Robert Rangeley

Searaven
Photo: © Strong/Buzeta

Outer Gulf of Maine Shelf

The banks and basins of the Outer Gulf of Maine are set into a complex shelf seabed — in the Canadian portion of the region, this habitat includes Georges Bank, Georges Basin and the northern part of the Northeast Channel. It also contains seaward facing canyons and steep slopes that form a transition from the bank areas to the channel and/or slope. The complex coarse-sediment seafloor, warm water and high productivity of the area provides shelter, food and colonization space for a rich and diverse food web, including many important commercial fish and invertebrate species.

A seafloor on the Gulf of Maine Shelf
Photo: Fisheries and Oceans Canada

Outer Gulf of Maine Shelf

Bank

Georges Bank is a very large oval-shaped bank underlain by sandstone bedrock. Sea levels at the end of the last glaciation were low enough that Georges Bank was connected to the mainland in the west, explaining the discovery of tree trunks and even mastodon remains. Georges Bank presents a gently southeast-sloping, sandy and gravely surface, and the northern region is rougher with coarse gravel and boulders. Strong currents and large waves from storms shape the sand into dynamic bedforms (waves, ripples and ridges) that in some areas are as shallow as 4m.

The gravel areas to the north harbour dense colonies of tubeworms. Their structures provide a home for many other species. Fast currents sweep fresh nutrients and oxygen across the gravely surfaces, fanning and feeding fish eggs and young and making this an exceptionally important area for the health of many fisheries. The Georges Bank scallop stock is the largest in the world.

A crab and corals on the gravel seafloor of Georges Bank
Photo: Fisheries and Oceans Canada

Outer Gulf of Maine Shelf

Basin

North of Georges Bank lies Georges Basin, a deep, elliptically-shaped depression oriented east–west. The seabed here is generally smooth, except for a local high near the centre where bedrock protrudes. Glacial till is exposed on the northern and western flanks of the Basin, where it is covered by sand, pebbles and cobbles. These patches provide a unique colonization environment for hard-substrate benthic organisms, like corals, sponges, anemones, in an otherwise flat, muddy area. Deeper areas of Georges Basin are muddy in the west and sandier in the east as a result of strong currents that have winnowed the seabed.

Brittlestars and scallops in Georges Basin
Photo: Fisheries and Oceans Canada

Outer Gulf of Maine Shelf

Channel

The Northeast Channel is the largest and deepest entrance to the Gulf of Maine from the open Atlantic Ocean. The channel crosses the outer continental shelf as a breach between Georges and Browns Banks, connecting with the basins of the Gulf of Maine at depths between 200 and 300m. Strong tidal currents flow through the channel and form megaripples and sand waves, even at great depths. Glacial till, formed of a complex mixture of clay, silt, sand, gravel and boulders, covers large areas of the floor of the Northeast Channel, particularly toward the mouth.

Large gorgonian and fan-shaped corals live on boulders on the flanks of old iceberg furrows, forming the densest-known aggregations in the region. Juvenile redfish and shrimp are found amongst them. Nearer the surface, an area above a region known locally as the “Hell Hole” is known for aggregations of whales, swordfish and other pelagic (water-column) animals which are attracted to the abundant food available in this highly productive area.

Fish and corals in the Northeast Channel
Photo: Fisheries and Oceans Canada

Middle Gulf of Maine Shelf

This region comprises the Northern Central Shelf zone, which includes a number of small basins, some of which are oriented southwest–northeast. Depths in these basins can reach 220m water depth. The northern part of this region near the inner shelf zone consists of sand, silt, and clay at the seabed, extending to approximately 100m depth. This area is known as a rich, productive ecosystem that supports major fisheries for groundfish, scallops and lobster.

A lobster in a depression it has excavated
Photo:
© Strong/Buzeta

Middle Gulf of Maine Shelf

Basin

Among the series of basins in the Middle Gulf of Maine Shelf, Jordan Basin is the largest on the Canadian side. The seabed here is covered in a thin layer of clay and silt, likely sourced from rivers and glacial sediments that were transported out of the Bay of Fundy. Crowell Basin and Tusket Basin are similar smaller basins, although Crowell contains occasional outcrops of glacial till poking through the muddy sediments.

Submersible studies conducted in 2005 led to the discovery of a unique feature in Jordan Basin: a series of isolated rock pinnacles that poke through the muddy sediments, called the "Rock Garden," that support a diverse community of bottom-dwelling organisms, dominated by sponges and sea anemones. Surrounding these pinnacles are dense masses of krill, providing food for many species of fish and whales.

Seafloor in Crowell Basin
Photo: Fisheries and Oceans Canada

Seafloor in Jordan Basin
Photo: Fisheries and Oceans Canada

Middle Gulf of Maine Shelf

Banks

The Grand Manan Banks lie to the southwest of Grand Manan Island, near the entrance to the Bay of Fundy. The small banks are each about 12km long, and are defined by the 90m contour, ranging to shallow depths of less than 55m. These Middle Gulf of Maine Shelf banks consist of hard and resistant rocks, mainly covered by modified glacial till as well as some muddy sand and gravel. Eroded iceberg furrows occur on the flanks of the banks and exhibit less erosion further away from the banks.

Herring and other forage species are seasonally plentiful in these shallower waters, attracting seabirds, whales and dolphins, and basking sharks are sometimes seen resting near the surface. This area marks the northern extent for many warmer-water species of the Gulf of Maine.

Scallops and seastars on a pebble/cobble seafloor
Photo: Robert Rangeley

Middle Gulf of Maine Shelf

Tertiary/Cretaceous

The Middle Gulf of Maine Shelf Tertiary/Cretaceous region is comprised of shallow banks and unusual channelized topography that developed on Tertiary/Cretaceous bedrock outliers. The banks are erosional remnants from a much more extensive distribution of these coastal plain rocks through the Gulf of Maine. The softer bedrock provides the foundation for unique seabed morphology of shallow flat-topped banks and deeper adjacent channelized regions. The ecosystem is similar to that of the surrounding features, and supports economically important fisheries.

An example of a tertiary muddy seafloor
Photo: NOAA

Inner Gulf of Maine Shelf

On the Canadian side, the Inner Gulf of Maine Shelf extends off the shore of southwest Nova Scotia. This area is very wide and broad in the south, but shallows and narrows in the north (from 110m water depth in the southern area north of Browns Bank to 55m water depth near the entrance to the Bay of Fundy). It is a region of coarse, irregular seabed rock covered mainly by gravel and sand. Hundreds of parallel ridges of bouldery till give the seabed a 'washboard' appearance and provide a rich habitat for what is likely the densest lobster population in the world.

A lobster in a rocky habitat
Photo:
© Strong/Buzeta

This area of exceptionally high, seasonally consistent productivity (both for phytoplankton and seaweed) stands out in the region and creates ideal nursery conditions for haddock, herring, and other fish and invertebrates. It is also well known as a staging area for migratory birds.

Outer Bay of Fundy

The bottom of the outer Bay of Fundy is blanketed by thick till made up of angular gravel and shaped into furrows by ancient icebergs. A few local deposits of glaciomarine mud lie scattered across the till surface, including a large deposit east of Grand Manan. Several unusual large tapering ridges — likely sub-glacial eskers — project seaward from the Nova Scotia shoreline for more than 5km. Exposed bedrock and a coarse sand-and-gravel substrate occur in the nearshore regions. Tidal circulation, freshwater runoff from the land, and the presence of an oceanographic front come together to make this an area of cool, nutrient-rich, well-mixed water.

Dense rockweed is found along the shoreline and kelp grows in deeper areas. The abundant food attracts large populations of herbivorous and detritus-feeding animals, which in turn support species nearer the top of the food chain. The nearshore waters are known for scallop, lobster and herring, while witch flounder are abundant in deeper areas. Burrowing worms and tube-builders are common in silt-clay bottoms towards the outer portion on the New Brunswick side. Red hake spawn in Passamaquoddy Bay, and concentrations of Atlantic halibut are known around Grand Manan. The Outer Bay of Fundy is a feeding ground for endangered North Atlantic right whales during the summer months.

Anemones and other invertebrates on a Bay of Fundy rocky seafloor
Photo:
© Strong/Buzeta

Inner Bay of Fundy

The inner the Bay of Fundy occurs to the northwest of a line extending from Digby Gut to Cape Spencer across the Bay. The seabed consists of thin gravel lags formed over thick glaciomarine sediments. Overlying the glaciomarine muddy sediments and gravel are fields of large and small sand waves. The large sandwaves on this surface focus and intensify the currents around them, forming scoured depressions on the seabed, which are still eroding and releasing red mud from the subsurface clay that gives the Bay of Fundy its distinctive colour. This area is unique for a series of linear horse mussel mounds called "bioherms." They extend above the seabed up to 4m and can be over many km in length.

Rockweed harvesting on the rocky shore of the Bay of Fundy
Photo: Robert Rangeley

Herring take cover amongst seaweeds near the shore of the Bay of Fundy
Photo: Robert Rangeley

Basins

Near the head of the Bay of Fundy are several small, elongate depressions that formed in narrowing restrictions by current scour, Minas Passage for example. Ecological communities here may be similar to those of the rest of the inner Bay, but the deep basins serve as refugia, allowing some fish species to avoid predators. The scoured depressions can extend to over 130m in depth and are floored with exposed bedrock and gravel. The currents in this region are up to 12 knots and the tidal range increases to 16m in Minas Basin at the head of the Bay of Fundy. The deep water and strong currents make it challenging to study the seabed of these high-energy scoured areas.

Inner Bay of Fundy

Shallow Basin

Cobequid Bay, Minas Basin and Chignecto Bay are shallow inner regions of the Bay of Fundy known worldwide for their birding opportunities. The birds visit these places because of the rich tidal and subtidal ecosystems that provide the food they need to continue on their long migrations.

The high tidal range, coastal erosion, and sediments deposited by rivers have led to the formation of extensive mud flats fringed by salt marshes. Beyond the subtidal zone are patches of bedrock, sand, gravel and mud. Waters are warmer and more turbid here than elsewhere in the Bay of Fundy, although ice occurs in the upper reaches of these estuaries from December to April and transports large quantities of sediment as it breaks up and moves in the strong currents. Only small patches of seabed lend themselves to the growth of large seaweeds, so most plant production comes from microscopic algae growing on the surface of mud flats, and from salt marsh grasses. Fish, including several flatfish, migrate into the bays and streams for feeding and reproduction, and more than 40 different species remain throughout the year. The mud flats are home to invertebrates, including worms, clams, snails and crustaceans attracting vast flocks of birds.

Mudflats in Shepody Bay at low tide
Photo: Ashley Sprague

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This booklet is a summary of a more detailed technical report, and is supplemented with information drawn from publications by Fisheries and Oceans Canada and the Nova Scotia Museum of Natural History. For a copy of the full technical seabed feature report, contact:

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