FORCES AT PLAY

Seemingly still, yet constantly in motion, your favourite beach is shaped by some surprising science

By Catherine Collins

PREVIOUS: PAUL ORENSTEIN. THIS PAGE AND OPPOSITE, RIGHT: GRANT HARDER. OPPOSITE, LEFT: ANGUS ROWE MACPHERSON

UNLIKE

the cottagers who sprawl on its surface, inert as barnacles and happy as clams, a beach is eternally restless. While it may look like the same sandy spot where you flaked and baked last summer, it is ever-changing. Today's beach is not yesterday's or tomorrow's. This magical strip between water and land is one of the most dynamic environments on the planet, endlessly reinventing itself. Whether coastal or inland, freshwater or salt, your beach is the ultimate shape-shifter.

What makes it so changeable? Waves and wind are the driving duo. Waves are most key, as they actually move beaches around, restyling them, stripping them, widening them (from front to back—that is, from water's edge to inland vegetation). But you've got to have wind to generate those waves, and you've got to have "fetch," the distance a wind travels over water, says Robin Davidson-Arnott, a coastal geomorphologist and professor emeritus in the University of Guelph's geography department. "You need a fetch of at least 80 to 100 km to create waves big enough to produce a fairly wide beach." ››

Coastal beaches such as the one at Bamfield, B.C., (inset opposite, and below) may have different characters, sights, and smells than those of inland beaches, such as Christian Island (previous pages) and Wasaga Beach (far left), both on Georgian Bay, Ont. But wherever they are, beaches are created (and destroyed) by the same forces.

BEACH BUDDY

"We love beaches to death," says Robin Tress, the coastal adaptation coordinator for the Ecology Action Centre in Halifax. By building our cottages and roads near them, she explains, we inadvertently harm them. As Geoffrey Peach, the co-founder of the Lake Huron Centre for Coastal Conservation points out, "If you damage the beach, it's going to react—and usually not in your favour." Here's how to help, not hurt:

· Accept natural erosion, don't worsen it. When cottagers block waves with seawalls to stop erosion, they actually exacerbate it by cutting off the beach from the dunes, a critical sand reserve the beach needs to rebuild itself after being stripped by storms. No walls, healthier beach.

· Let dunes do their job. By demolishing a dune for a volleyball net or a deck, you remove the buffer between storm waves and whatever is behind the dune—probably your cottage.

· Stay off the dune grass. Ten footsteps can kill one marram grass plant, a pioneer species that stabilizes a dune. Build boardwalks or designate pathways to safely circumnavigate dunes.

· Don't rake the wrack. Seaweed flotsam offers a whole mess of nutrients to beach creatures. Neat freaks, resist!

A beach can be divided into sections: the littoral zone (the near-shore area where light can penetrate the water and allow aquatic plants to grow), the foreshore (where the sand is wet), the backshore (where the sand is usually dry), and behind that, dunes.

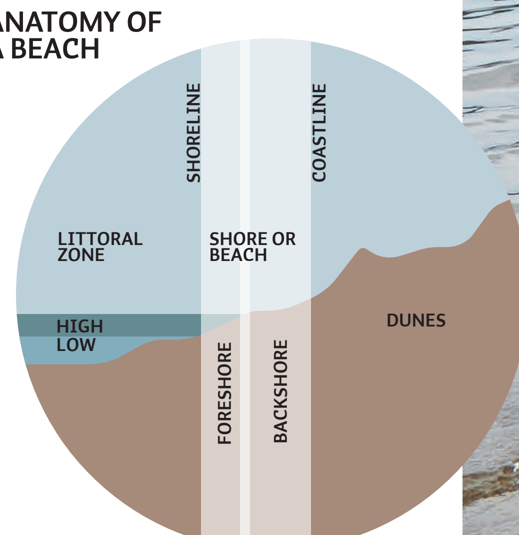
So, the smaller the lake, the shorter its fetch, the weaker its waves, and the dinkier its beaches. But that doesn't mean they aren't dynamic. "There are high-energy beaches and low-energy beaches," explains Bernard Bauer, a professor of earth and environmental sciences and geography at the University of British Columbia. Generally speaking, a Pacific Ocean beach, with a fetch all the way from Japan, is super high energy and an Atlantic Ocean beach not so much, thanks to west-to-east-moving winds called "westerlies," which drive waves straight to Pacific shores, but are typically directed offshore on the Atlantic coast. Great Lakes beaches are less energetic than Atlantic ones, and so on. Geography factors in too: a beach on an open, unsheltered coast is more energetic than a "pocket" beach protected by two headlands. And finally down to the wee crescent of sand on a little inland lake, which may look static to you but is still in the game. "Beaches are always moving," says Bauer. "Even piddly waves are moving tiny amounts of grain."

Wind moves sand too, lifting and carrying it up the beach, where it gets trapped in vegetation and builds dunes over time. (Beaches too narrow to allow this "aeolian transport" are duneless; you need at least a 10-metre stretch for wind to blow across and scoop up sand.) Dunes act as sand reservoirs for beach repair. "When a big storm surges up, it carries dune sand back to the beach," says Davidson-Arnott. "And if it's a very big storm, waves will carry sand back to the water, where it collects in sandbars." When the weather calms, gentler waves return sand to the beach, and the wind returns dry sand to the dunes. It's a vibrant cycle of destruction and renewal—erosion is natural to a beach, and usually temporary (unless we interfere).

A beach can also lose its sand, but gain another's, as more forces come into play. Longshore currents, generated by waves hitting the shore at an angle, run parallel to beaches, stealing sand from one place and depositing it downshore. This longshore "drift" of sediment sometimes accumulates into sandspits, which project into the water and can achieve some doozy lengths. At 40 km, Lake Erie's Long Point is the biggest sandspit in the country, far larger than any on our ocean coasts.

Of course, Pacific and Atlantic beaches boast serious tides (and while we're one-upping ourselves, the Bay of Fundy, on

ANATOMY OF A BEACH



THIS PAGE, EDWARD POND; OPPOSITE, PAUL ORENSTEIN

THE PLACE WHERE LAND MEETS SEA

The colour of sand varies depending on the minerals that make up the beach. The red hue of P.E.I. beaches (below, and previous pages, top left) is from iron oxide. White sand, as on these Vancouver Island, B.C. beaches, above, are ordinarily made mostly of quartz, or bits of shell. The degree of "whiteness" then depends on the amount and types of other minerals found in the sand.

OPPOSITE: TOP LEFT, GRANT HARDER; TOP RIGHT, JEREMY KORESKI; BOTTOM, STACEY VAN BERKEL

SPEAKING OF BEACHES

Fetch The distance that a wind travels over water

Wrack Organic materials that get deposited at the limit of the waves' reach

Swash Waves at their final stages, when they break onto the beach (that white fringe that moves up onto the beach with a to-and-fro motion)

Berm A flat area on a steep slope that is built up by waves and wind in the period between storms

the east coast, has the highest tides in the world, at 16 metres). Fundy aside, because tides rise and fall so gradually, most don't push a lot of sand around, but, says Bauer, if you get a storm on top of high tide, the water will reach a much higher point on the beach, with potentially more erosion and flooding. "The tide says where the wave action is going to be focused on a beach." On coastal and inland lakes, the tide hasn't got much to say at all; though a tidal force does exist, it is almost imperceptible.

These various movers and shapers change beaches, but they don't create them. You need the material to be there in the first place. Over millennia, rock is broken down into little bits of mineral, which are delivered to the shore by rivers or eroding glacial deposits, such as moraines and cliffs. This keeps the beach fed with a steady supply of sediment. (Lake Erie's plethora of eroding sand bluffs is a key reason why Long Point got—and stays—so long.) No beach's sand blend is the same as the next—the grain size, colour, and composition are as unique as a thumbprint, mirroring the beach's local geography. Little wonder there's an International Sand Collectors Society, whose members call themselves "psammophiles," or lovers of sand.

Some minerals endure eons of wear better than others—the stablest are quartz and feldspar, which dominate in beaches across the country and give their sand a whitish-grey tone. Occasionally mixed in is black magnetite, very attractive to junior scientists who think to bring a magnet to the beach. Black sand also colours some B.C. coasts in the form of leftover volcanic basalt. Maritime cottagers walk on shores glittering red with eroded sandstone, which is quartz coated with iron oxide. (After a few years of being scoured by waves, the coating can wear off and the sand turns white.) And many beaches get their sparkle from black and white mica, its flat flakes reflecting sunlight. Along with these mineral grains, which can be hundreds of millions of years old, sand has more newly arrived constituents, such as ground-up shells, only a few years old, or bits of invertebrates that washed up today. All this is under your beach towel. If you weren't a psammophile before, are you now?

Which brings us to the non-human lovers of beaches, the plants and creatures that make this tough and transient place their home. "A beach is a very extreme environment," says Judith Jones, a biologist with Winter Spider Eco-Consulting, on Ontario's Manitoulin Island. "It's hot, dry, and has high levels of light. Things blow around, and things get sandblasted."

Yet amazing survivors abound. Dune grasses, such as marram, suck silica from the sand, armouring their leaves against grit abrasion, lack of water, and *}Continued on page 116{*

IS CLIMATE CHANGE STEALING OUR SAND?

Sea levels rising worldwide—true. Less sea and coastal lake ice—true. More frequent and more severe storms—very likely. But whether climate change is causing your beach to vanish is a case of yes, no, or maybe, says Gavin Manson, a coastal geoscientist with the Geological Survey of Canada-Atlantic, part of Natural Resources Canada.

Marine beaches could be in huge trouble from rising seas, but it depends on what the Earth's crust is doing regionally. In some areas, land is rising and in others it's sinking, in response to the melting of the last ice sheet. Which means that things could go a few ways:

- Rising sea levels with sinking land = b'bye, beach. Maybe. This worst-case will play out unless a beach's sand supply (rivers, cliffs) keeps pace with rising water. If so, the beach will move landward and may be narrower, but it'll survive.
- Land rising faster than sea levels = a wider beach from front to back (yay!) and shallower shoals (boo!).
- Rising sea levels and fiercer, more frequent storms = higher waves, and more pummelling and erosion of the beach. It might re-form itself, but if it's hit again and again, it'll lose the fight. Big waves will also speed the erosion of cliffs that feed the beach; as the sand washes away and the source depletes, the beach eventually "starves." Manson (who has a cabin in inland B.C.) says, "I, for one, would not buy a cottage on top of a cliff."

Beaches on both the Atlantic and large inland lakes will feel the pain from less ice coverage (Pacific waters are too warm for ice). There'll be more frequent waves, likely bigger and stronger, causing beach and bluff erosion, plus more "scour," or loose ice scraping sand off the shore.

As well as extreme water fluctuations on our big lakes, Geoffrey Peach of the Lake Huron Centre for Coastal Conservation anticipates higher winds from warming air and water. "On open sandy beaches, this means greater wind erosion, especially where dunes have been compromised. If sand keeps rolling inland, beaches could disappear." Even small inland lakes will take a hit. Increasing storminess will bring bigger waves. Manson says, "If climate change is not affecting your lake yet, it will."

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broiling hot temperatures (40°C-50°C) in dune hollows. Growing about a metre tall, the grasses trap the sand that builds the dune. A vast, deep network of roots anchors the marram against high winds and stabilizes the dune like rebar in a building. Once steadied, the dune is more liveable for other vegetation, such as wormwood and Pitcher's thistle. "Like many beach plants, they are grey-green in colour because their leaves are covered with a layer of tiny white hairs," says Jones. "This helps to guard against drying out and sandblasting." Others have long taproots that pull up moisture and help them hang tight in shifting sand.

If there's a wetland behind a dune, some turtle species will breed, then come to the beach to lay 'em and leave 'em, letting the warm sand incubate their eggs. The piping plover, an endangered shorebird, often nests where the beach meets the foredune (the first dune facing the water), so that it's sheltered on one side but can scan the shore for predators.

One tiny hunter, the tiger beetle, hides as a larva in sandy hollows, lying in wait to chomp on passing ants and spiders. As an adult, it sprints across the beach, chasing its prey, which might seek refuge under the "wrack line"—the scraggly, smelly strand of seaweed, dead bugs, and other flotsam that lies between a beach's foreshore (the wet part) and backshore (the dry part, except when submerged by storm waves). The wrack line looks like something the waves dragged in—and it is—but to plovers, tiny crustaceans such as sand fleas, and amphibians such as the Fowler's toad, it's an all-you-can-eat buffet. Every niche on a beach is alive.

By now it should be clear that this is an awesomely active ecosystem, not a sandbox. Perpetually in motion, eternally adapting, it grows, it shrinks, it hurts, it heals, it exposes, it shelters, it shape-shifts. But for all this dynamism, it's also a place of dreamy idleness, where cottagers can kick back, maybe read a story about beaches, and contemplate infinity in a grain of sand.

Read Catherine Collins' story on dragonflies, "Beauty Is a Beast," at cottagelife.com.