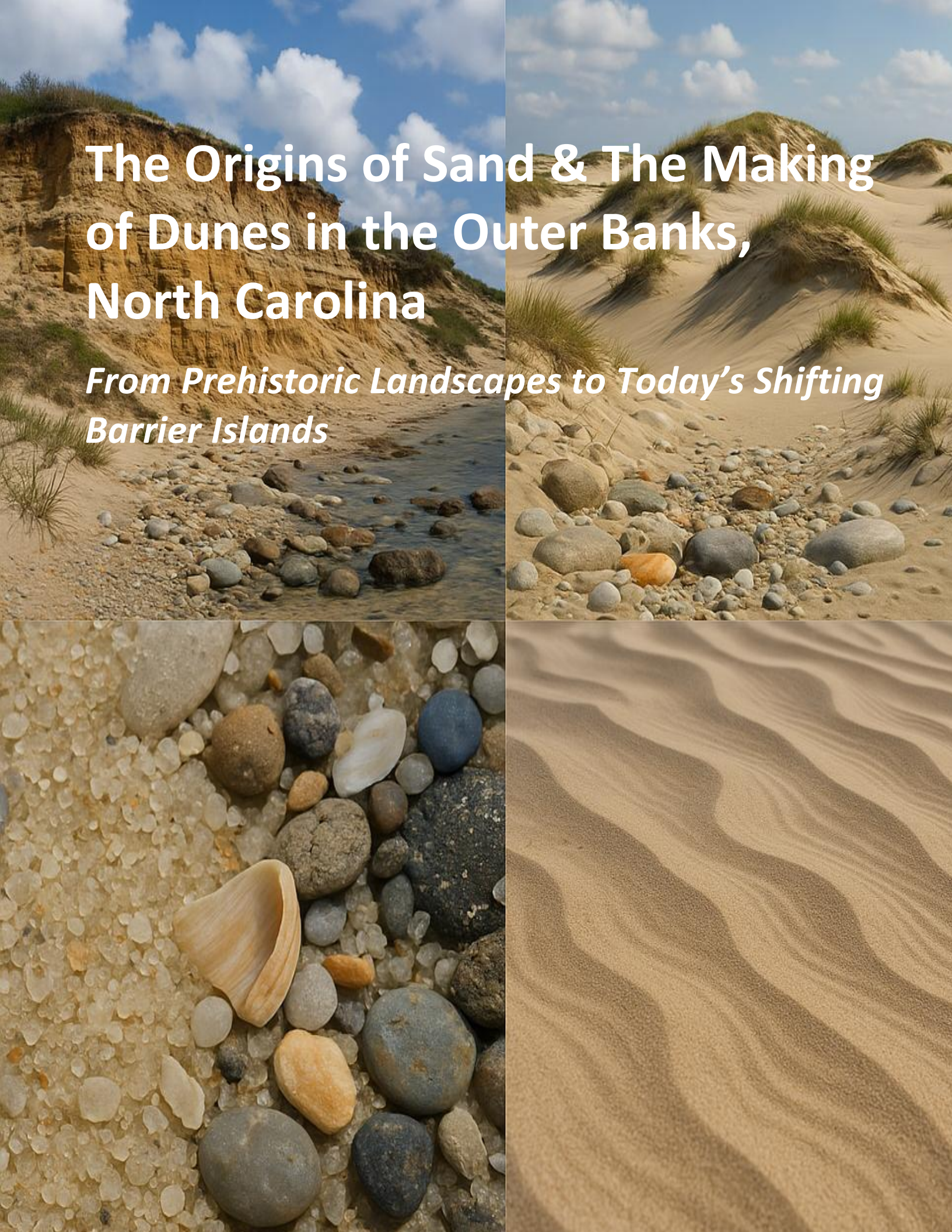


The Origins of Sand & The Making of Dunes in the Outer Banks, North Carolina

From Prehistoric Landscapes to Today's Shifting Barrier Islands

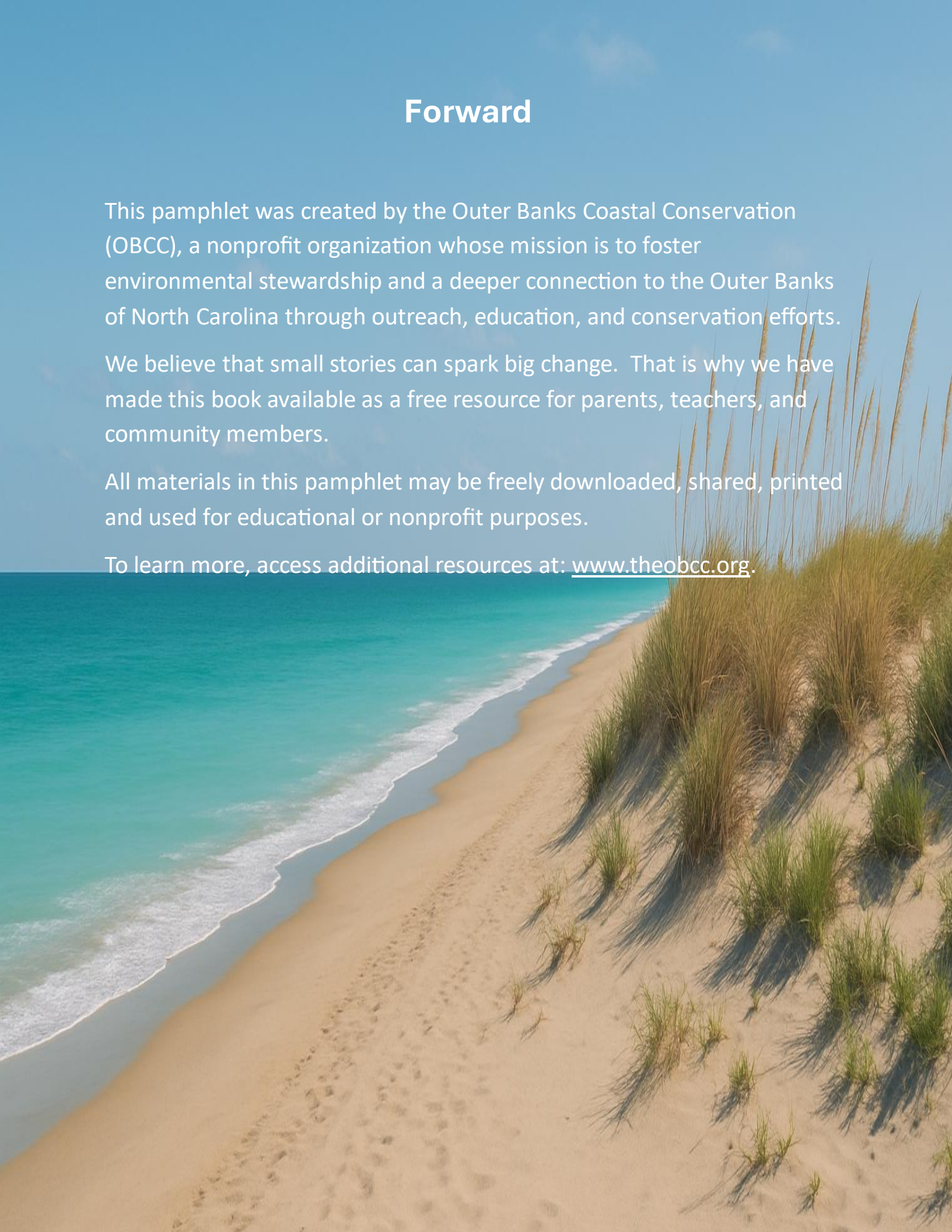
Forward

This pamphlet was created by the Outer Banks Coastal Conservation (OBCC), a nonprofit organization whose mission is to foster environmental stewardship and a deeper connection to the Outer Banks of North Carolina through outreach, education, and conservation efforts.

We believe that small stories can spark big change. That is why we have made this book available as a free resource for parents, teachers, and community members.

All materials in this pamphlet may be freely downloaded, shared, printed and used for educational or nonprofit purposes.

To learn more, access additional resources at: www.theobcc.org.



Introduction

The Outer Banks—those long, slender ribbons of sand stretching along the North Carolina coast—are constantly moving, reshaping, and rebuilding. Their very foundation is sand, but that sand is not just "beach material." It represents millions of years of geological change, ancient mountain erosion, rising and falling seas, and relentless coastal forces.

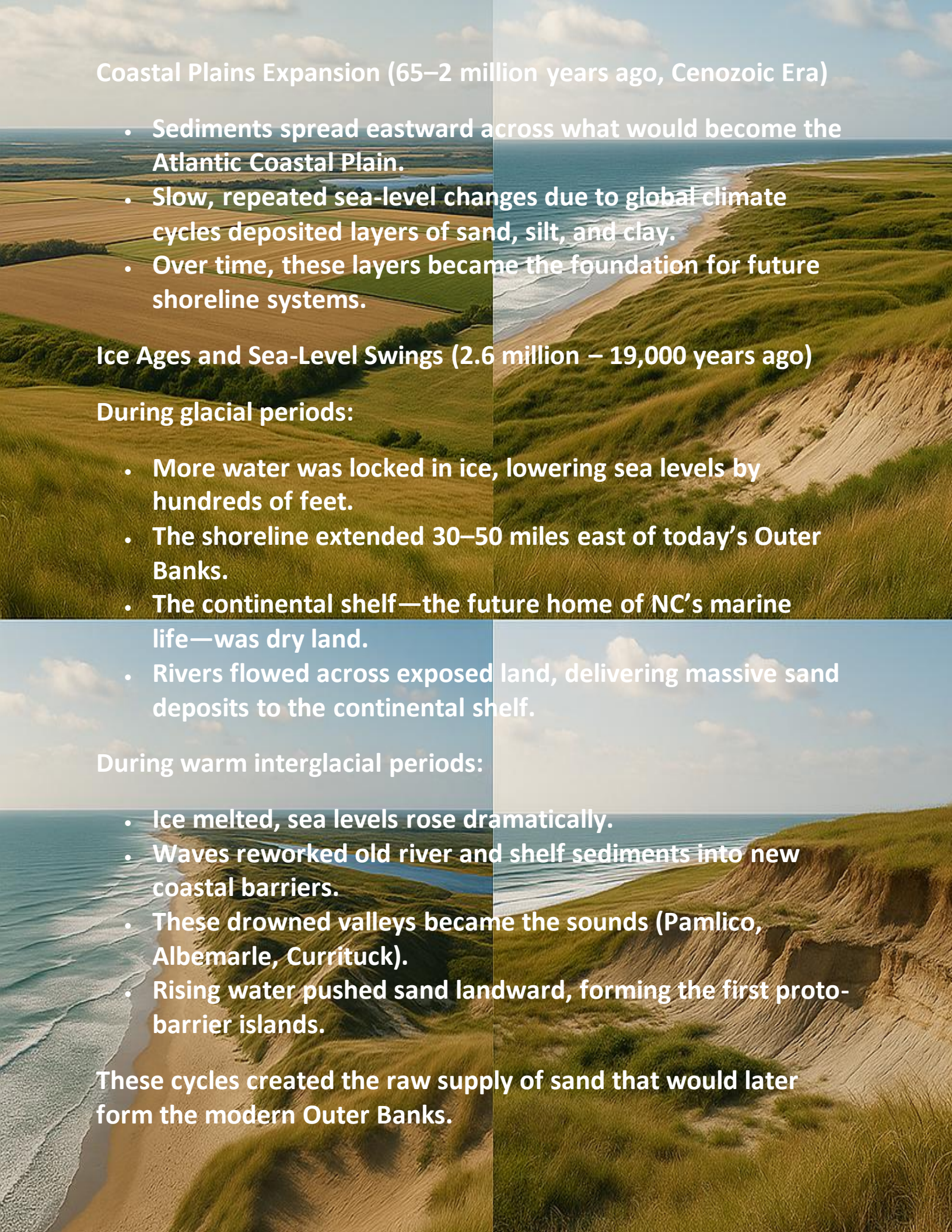
This guide traces the complete story of Outer Banks sand and dunes, from prehistoric origins to modern coastal processes shaping the islands today.

Prehistoric Origins: Where Did the Sand Come From?

The Birth of Sand—Ancient Mountains (300–200 million years ago)

- During the formation of the Appalachian Mountains, rocks like granite, gneiss, quartzite, and feldspar slowly broke down through weathering and erosion.
- Rivers carried these eroded particles eastward over tens of millions of years.
- The quartz grains that dominate Outer Banks sand today are the resistant leftovers from this ancient breakdown. Today's Outer Banks sand is roughly 80–95% quartz, the ghost of prehistoric mountains.

Most Outer Banks sand began as crystals in the Appalachian Mountains.



Coastal Plains Expansion (65–2 million years ago, Cenozoic Era)

- Sediments spread eastward across what would become the Atlantic Coastal Plain.
- Slow, repeated sea-level changes due to global climate cycles deposited layers of sand, silt, and clay.
- Over time, these layers became the foundation for future shoreline systems.

Ice Ages and Sea-Level Swings (2.6 million – 19,000 years ago)

During glacial periods:

- More water was locked in ice, lowering sea levels by hundreds of feet.
- The shoreline extended 30–50 miles east of today's Outer Banks.
- The continental shelf—the future home of NC's marine life—was dry land.
- Rivers flowed across exposed land, delivering massive sand deposits to the continental shelf.

During warm interglacial periods:

- Ice melted, sea levels rose dramatically.
- Waves reworked old river and shelf sediments into new coastal barriers.
- These drowned valleys became the sounds (Pamlico, Albemarle, Currituck).
- Rising water pushed sand landward, forming the first proto-barrier islands.

These cycles created the raw supply of sand that would later form the modern Outer Banks.

Sand on the Move: Formation of the Modern Outer Banks

20,000–7,000 years ago — Sea Level Rise Creates the Islands

As sea level surged after the Last Glacial Maximum:

- **Waves pushed sand landward, forming early barrier bars.**
- **Rising water flooded river valleys to create sounds like Albemarle and Pamlico.**
- **Sandbars welded together into longer, continuous barrier islands.**

By about 7,000 years ago, the ancestors of the present-day Outer Banks were formed.

Longshore Drift (Ongoing for thousands of years)

The Outer Banks exist because sand is in motion:

- **Atlantic waves approach at an angle, pushing sand southward from Virginia toward Cape Hatteras and Ocracoke.**
- **This longshore transport continuously rearranges beaches and inlets.**
- **When storms cut new inlets, sand redistributes again, creating new shoals, spits, and dune fields.**

The Outer Banks are more like river systems made of sand than fixed landforms.

How Wind Turns Sand into Dunes

The Role of Grain Size & Composition

Outer Banks sand is mostly:

- Quartz (hard, light-colored, rounded grains)
- Some shell fragments
- Occasional dark minerals like magnetite or garnet

Quartz's durability makes it ideal for dune-building.

How Wind Moves Sand

Wind transports sand through:

1. Saltation — bouncing grains
2. Creep — rolling along the surface
3. Suspension — very fine particles lifted briefly

Dry, fine grains move inland until something stops them.

Natural "Sand Catchers"

Dunes form when blowing sand hits obstacles, such as:

- Beach grasses (sea oats, American beachgrass)
- Driftwood
- Wrack (seaweed, seagrass, shell debris)
- Microtopographic bumps

Vegetation plays the starring role. Sea oats trap sand and grow upward as the dune builds, creating tall and stable structures.

Ancient Dunes vs. Modern Dunes

Ancient Dune Systems (2,000–5,000 years old)

Behind modern dunes lie older dunes that formed when:

- Sea level was slightly different
- Shorelines were positioned farther east
- Storms deposited massive sand sheets inland

Examples:

- “Relict dunes” near Nags Head Woods and Kitty Hawk Woods
- High wooded ridges — now covered by maritime forest
- These dunes formed during a period of more abundant sand supply and fewer human disturbances

Modern Primary Dunes (last 200–500 years)

The dunes we see directly along the beach today:

- Are mostly young, constantly shifting
- Rise and fall with storms, overwash, and vegetation recovery
- Form primarily from summer winds and sea oats growth
- Are essential for protecting the island from storm surge

Major Dune Types of the Outer Banks

Primary Dunes (Frontal Dunes)

Closest to the beach → take the brunt of waves and wind.

Secondary Dunes

Behind the primary dunes; more stable, higher biodiversity.

Relict Dunes

Ancient dune systems found farther inland—evidence that islands have migrated landward over centuries.

Human Influence on Outer Banks Dunes

Early Human Impacts (1700s–1800s)

Colonists cut maritime forests and grazed livestock, which led to:

- Removal of stabilizing vegetation
- More sand movement inland
- Dune blowouts and migration across villages (e.g., Jockey's Ridge)

1930s–1960s: Civilian Conservation Corps (CCC) Dune-Building Era

To protect NC Highway 12 and coastal communities, humans built artificial, uniform dune lines:

- Planted miles of sea oats
- Installed sand fences
- Stabilized dunes that once moved naturally
- Bulldozing storm-damaged dunes
- Adding pumped offshore sand to renourish beaches

Pros:

- Protected infrastructure
- Reduced overwash

Cons:

- Interrupted natural sand flow inland
- Reduced natural island rollover
- Made the Outer Banks more vulnerable to island narrowing

Today: A Dynamic, Living Dune System

Dunes as Natural Coastal Defenses

Healthy dune systems:

- Absorb wave energy
- Reduce storm surge reach
- Protect freshwater aquifers
- Support sea turtles, ghost crabs, beach mice, and shorebirds

Threats to Outer Banks Dunes Today

- Stronger storms
- Sea-level rise
- Vehicle and foot traffic
- Development too close to dune lines
- Loss of sea oats and other native vegetation

Restoration & Resilience

Modern Outer Banks dune management includes:

- Replanting sea oats, bitter panicum, and dune panicgrass
- Installing fencing to encourage sand deposition
- Allowing controlled overwash zones in undeveloped areas
- Reducing footpaths that cut dune vegetation
- Using nature-based solutions instead of hard structures

Modern Sand Sources

Today's Outer Banks sand comes from three main sources:

Eroded Appalachian Quartz

Still the main source—delivered via rivers → estuaries → nearshore waters → beaches.

Broken Shells & Marine Organisms

- Clams
- Scallops
- Oysters
- Coquina
- Foraminifera

These fragments give certain stretches of beach a more calcareous, ivory-colored appearance.

Offshore Sand Shoals

Storms and hurricanes stir up:

- Cape Lookout Shoals
- Diamond Shoals
- Wimble Shoals

These act like massive sand banks that feed the beaches naturally.

The Future of Sand & Dunes Under Climate Change

Sea-level rise, stronger hurricanes, and more intense nor’easters will:

- **Increase dune overwash**
- **Push islands further landward**
- **Cause more inlet formation**
- **Demand stronger dune restoration practices**

Living with dunes—not fighting their natural movement—will be essential for future resilience.

Did You Know?

- The sand on Outer Banks beaches started as crystals in the Appalachian Mountains more than 200 million years ago.
- During the Ice Ages, sea levels were so low that the shoreline was 30–50 miles east of where it is today.
- Waves slowly pushed ancient river sediments landward, forming the first proto–barrier islands around 7,000 years ago.
- Outer Banks sand is mostly quartz, one of the hardest minerals on Earth—making it perfect for dune building.
- Sea oats and beach grasses don't just live on dunes—they build them, trapping sand and growing upward as the dune rises.
- The islands are constantly on the move: dunes naturally migrate inland, stretch into parabolic shapes, and collapse in storms.
- Inland maritime forests sit atop relict dunes that are thousands of years old—evidence that the Outer Banks have rolled landward over centuries.
- The Civilian Conservation Corps (CCC) built many of today's dune lines in the 1930s–1960s, changing natural sand flow to protect NC Highway 12.
- Healthy dune systems protect freshwater aquifers, wildlife, and communities—but they survive only when allowed to move naturally.

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