Complementary Cartography: Analyzing National Geographic maps that play a supporting role

Riley D. Champine & Clare Trainor

Among the Orangutans

Orangutans learn most of the behaviors illustrated here from their mothers before reaching adolescence around age 12. Some of the behaviors are ubiquitous. Others occur only in certain areas, suggesting there could be regional cultures.

SNAG CRASHING
Male orangutans push tree snags over to make noise as part of a display of dominant behavior.

Variation 5 6 7
Some ride the snag as it falls, grabbing onto vegetation before the snag hits the ground.

Nest size around 4 ft

NESTBUILDING
Each day the apes make fresh nests for sleep or day rest by breaking and weaving together branches to build a sturdy structure.

Variation 1 — all sites
Some use leaves as pillows, linings, covers, and possibly even mosquito repellent.

Juvenile

UMBRELLA MAKING
Orangutans make umbrellas to shelter from the rain, holding leaves over their heads and sometimes their backs.

"KISS SQUEAKING"
Orangutans make a sound known as a kiss squeak to threaten other orangutans and humans.

Variation 1 4 6 7 8
Some kiss-squeak into a handful of leaves, then toss them on the ground.

Male with facial flange

LEAF WIPING 1 4 5 6 8
Orangutans have been observed wiping their chins, eyes, and bodies with leaves. Sometimes this is to remove sticky residue left by food, but often the purpose is unclear.

THIRST QUENCHING
Orangutans sometimes drink by dipping a hand into water and then dripping it into their mouths, but they get most hydration from food.

Variation 1 6
Some squeeze wet leaves like a sponge.

Variation 3 7
Some bite the bottom of a pitcher plant and suck out rainwater.

Variation 2 6
Some use leafy twigs to get water from very deep tree holes.

Water

Unflanged male

TERMITE FEEDING
Orangutans eat termites, from nests on the ground or in the forest canopy, by tapping the insects into their hands or sucking them out.

Female

Neesia
Hairs
Seeds

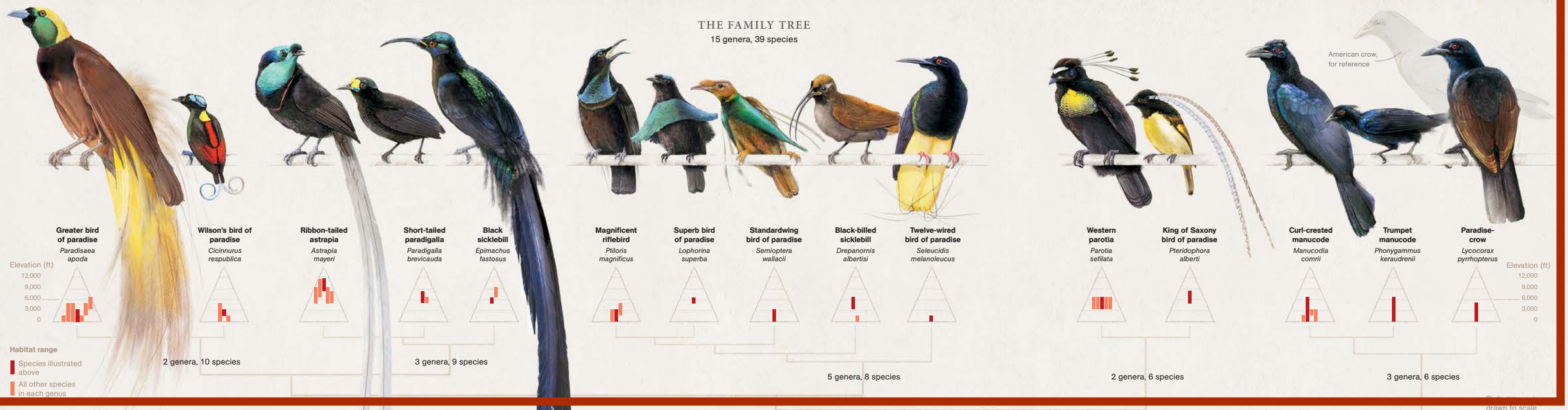
***NEESIA* FEEDING** 4 5 9
In the rain forests where *Neesia* is found, orangutans use their hands and teeth to break open these fruits and eat their fat-rich seeds.

Variation 2 3
Some use sticks to extract the seeds and avoid the fiberglass-like hairs.

FERNANDO G. BAPTISTA, MATTHEW W. CHWASTYK, AND RYAN WILLIAMS, NGM STAFF; MANYUN ZOU

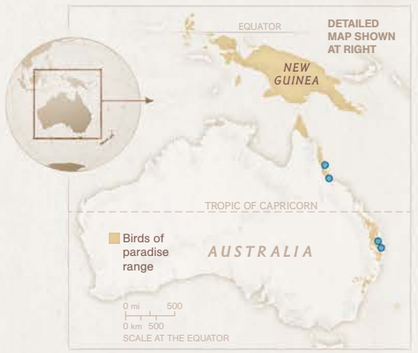
SOURCES: TIM LAMAN; CHERYL D. KNOTT, BOSTON UNIVERSITY; CAREL P. VAN SCHAIK, UNIVERSITY OF ZURICH; SERGE WICH, LIVERPOOL JOHN MOORES UNIVERSITY; MEREDITH BASTIAN, SMITHSONIAN NATIONAL ZOO

Puzzle Piece



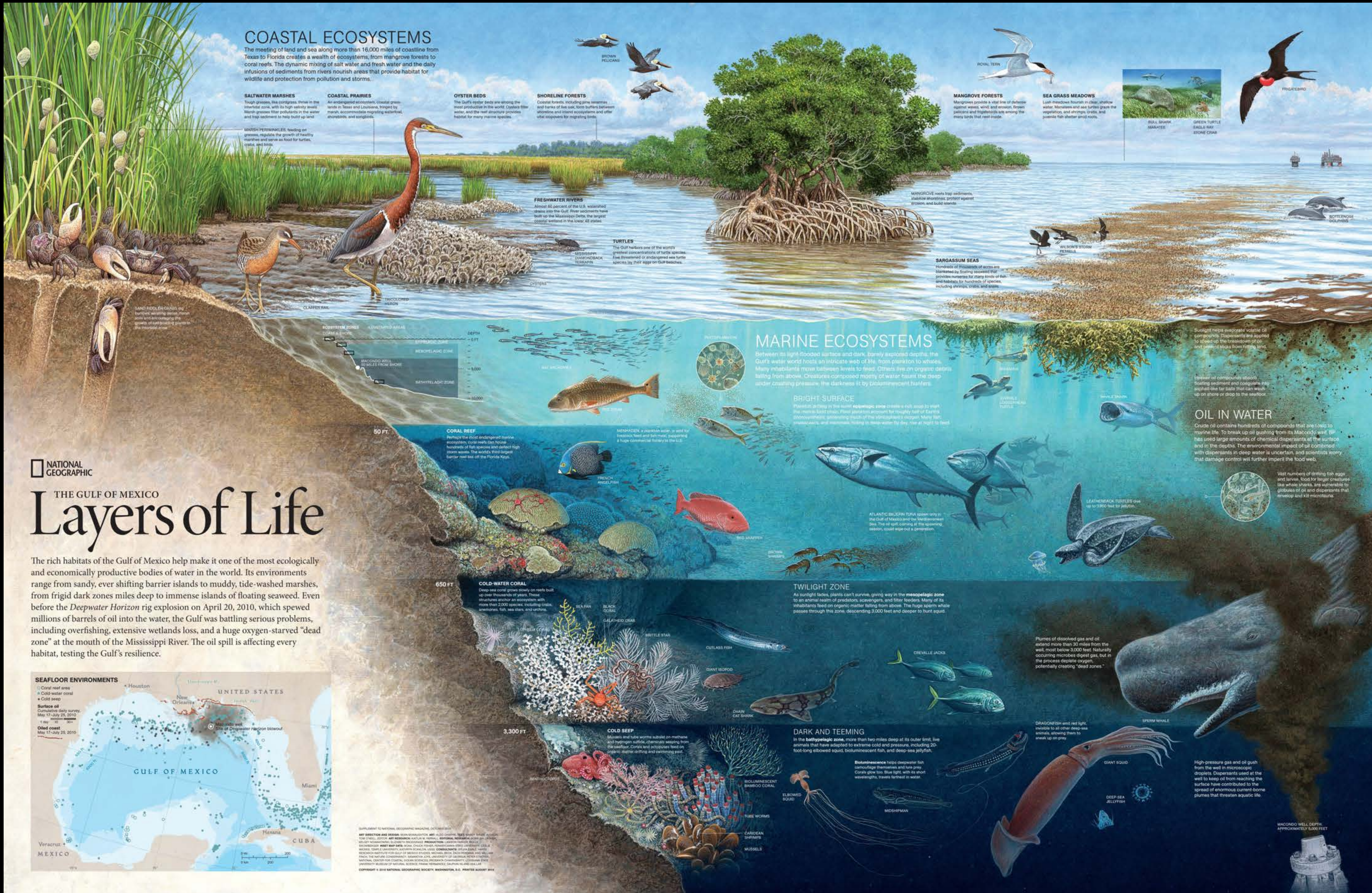
BIRDS OF PARADISE

They are found only from eastern Australia to New Guinea and surrounding islands. They thrive at many elevations, from swampy lowlands to cloud forests more than two miles above sea level. With abundant food, varied habitats, and few predators, the birds have been free to evolve with great diversity. The 39 species can be as small as 8 inches or as large as 49 inches, and plumage ranges from drab to dazzling.



Map + Graphic = Infographic

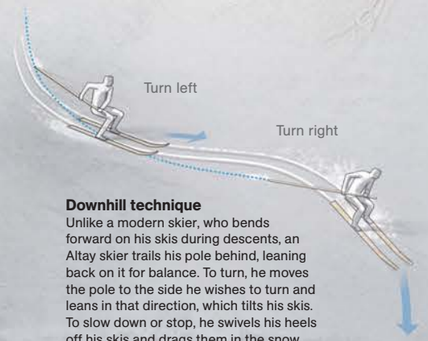
December 2012



October 2010

A History of Skis

After the last ice age, Stone Age hunters began strapping long pieces of wood to their feet to travel farther and faster over snow in pursuit of the game that flourished across Europe and Asia. Adaptations for terrain and snow conditions influenced the design of the skis in different regions. Scientists continue to find evidence of these early skiers engraved in rock and preserved in bogs.



Downhill technique
Unlike a modern skier, who bends forward on his skis during descents, an Altay skier trails his pole behind, leaning back on it for balance. To turn, he moves the pole to the side he wishes to turn and leans in that direction, which tilts his skis. To slow down or stop, he swivels his heels off his skis and drags them in the snow.

8000 B.C. (disputed)
Altay, China
Altay skis are long by modern standards. Skiers use a single pole to aid balance. Some Chinese academics say the earliest Altay skis date back to 8000 B.C., but other scholars say skiing came to the region much later.

6000 B.C.
Vis, Russia
The oldest ski found to date has an elk head carved on one end that may have functioned as a brake.

3200 B.C.
Kalvträsk, Sweden
A long pole with a scoop carved into one end likely served several purposes: steering downhill, shoveling, and as a club for hunting.

ca 1600
Norway
Skiers glided on one long smooth board coated with tar and pushed forward on a shorter, fur-bottomed one.

ca 1800
Telemark, Norway
Foreshadowing modern designs, the shape of these skis, wider at the ends and narrow in the middle, improved control and turning.

ca 1860s
Sierra Nevada, United States
Initially American miners used 10-foot skis to travel in the mountains, and over time they began using longer skis to race each other.

Today
Skis continue to evolve, with lighter and stronger materials that increase speed and control.

ca A.D. 750
Kinnula, Finland
Shorter and wider, this intricately carved ski worked well on soft snow in forest terrain.

1 2 3 4 5 6

Depictions based on archaeological and historical records

Altay skis
The grain of the horsehair is aligned so it digs into the snow as the skier climbs but glides on descents.

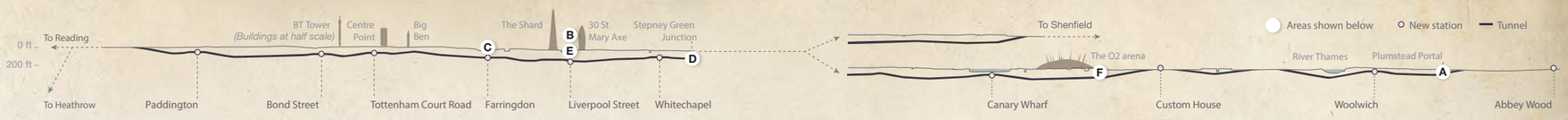
Altay ski bottoms are covered with horsehide. In the past the hide was laced on; now it is tacked in place.

FERNANDO G. BAPTISTA, DANIELA SANTAMARINA, AND MATTHEW TWOMBLY, NGM STAFF; DEBBIE GIBBONS, NG MAPS; PATRICIA HEALY. ART (SKIS, ABOVE, RIGHT): HERNAN CAÑELLAS

SOURCES: E. JOHN B. ALLEN; ESTHER JACOBSON-TEPFER; NILS LARSEN; JEFF LEICH

UNEARTHING LONDON

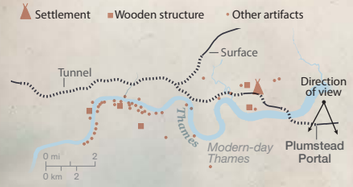
Crossrail project teams are contributing to a rich archaeological record, exhuming historical treasures buried under the city.



A BRONZE AGE (2000–600 B.C.)

Plumstead Portal Area

Nomads built tracks from tree trunks across these marshes to make travel and hunting easier. Crossrail teams found a stone hammer and wooden stakes with pointed ends.



B ROMAN PERIOD (A.D. 43–410)

Liverpool Street

Roman rule marked a period of growth for the settlement of Londinium. Remains of a large road as well as skulls from nearby Roman cemeteries were found at this construction site.

Second-century population **35,000**

C MEDIEVAL LONDON (1066–1485)

Farringdon Station

The discovery of 25 skeletons provides evidence of London's second emergency burial ground for victims of the Black Death (1348-1350). Half the city's population died.

1300 population **80,000**

D TUDOR (1485–1603)

Stepney Green Junction

Archaeologists found the remains of a manor known as King John's Court, which boasted its own moat. The residence later sheltered Protestant nonconformists and Puritans.

1556 population **125,000**

E MID-17TH CENTURY

Liverpool Street

Thousands of skeletons were unearthed here, the first public burial site outside London's city walls dedicated to overflow from city parishes, including casualties of the 1665 great plague.

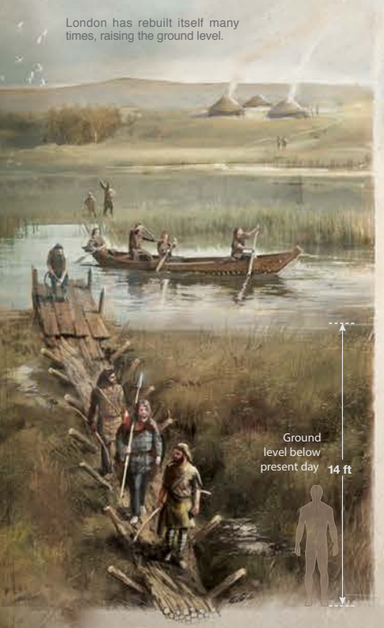
1660 population **450,000**

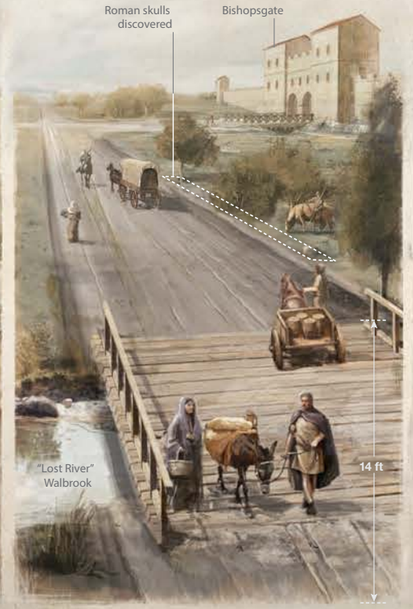
F VICTORIAN ENGINEERING (MID-19TH CENTURY)

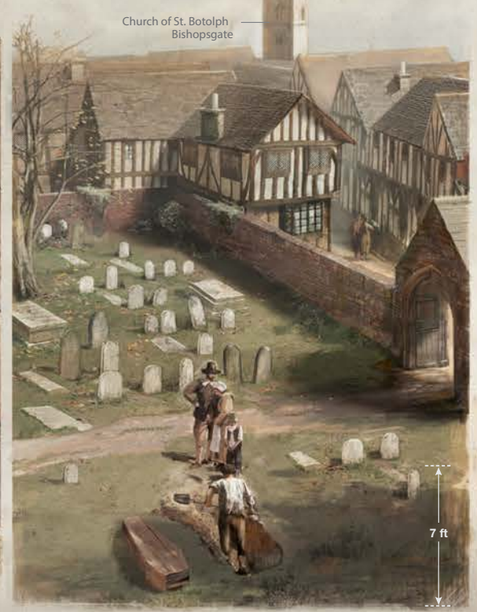
Shipyard

Remains of the Thames Ironworks and Shipbuilding Company, creator of some of the world's most famous warships, bear witness to Britain's industrial past.

1831 population **1,600,000**







LONDON THROUGH TIME

THE BRONZE AGE · 500 · THE IRON AGE (CELTIC BRITAIN) · 0 · ROMAN · 500 · ANGLO-SAXON · 1000 · MEDIEVAL · 1500 · TUDOR · STUART · GEORGIAN · VICTORIAN · 20TH CENTURY

43, Roman invasion · 60, Queen Boudica destroys the city. · 604, St. Paul's Cathedral founded · 1066, Norman invasion · 1215, Magna Carta · 1666, The Great Fire · 1863, World's first underground railway

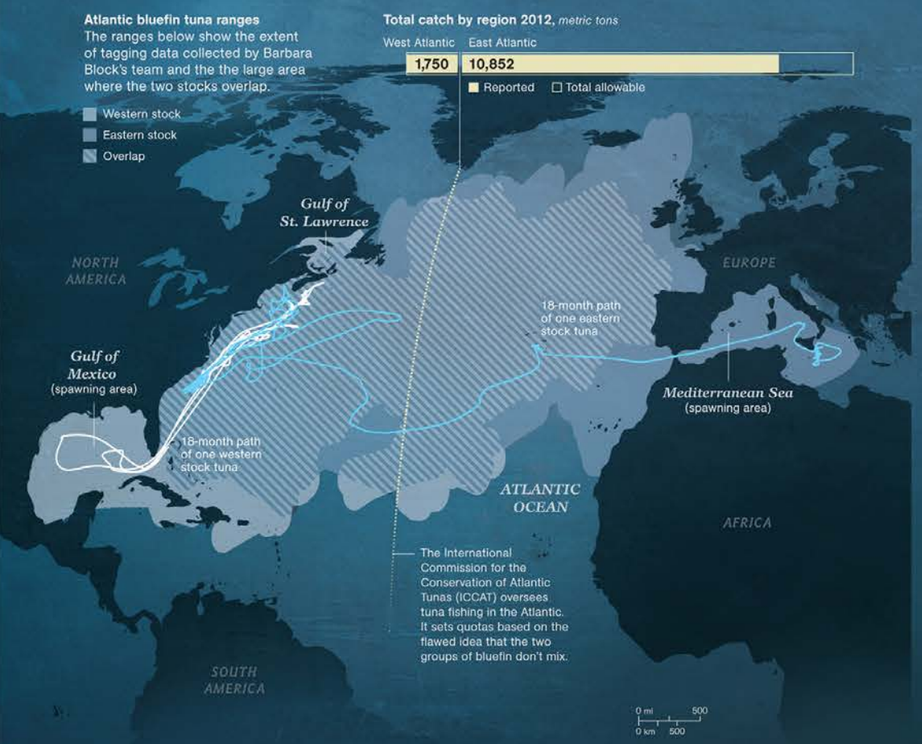
FERNANDO G. BAPTISTA AND LAUREN C. TIERNEY, NGM STAFF; VICTORIA SGARRO, DAISY CHUNG

SOURCES: JAY CARVER (LEAD ARCHAEOLOGIST), MARIT LEENSTRA, AND ANDREW DEMPSEY, CROSSRAIL; JOHN CLARK, MUSEUM OF LONDON; JON COULSTON, UNIVERSITY OF ST. ANDREWS; TRANSPORT FOR LONDON; *THE LONDON ENCYCLOPAEDIA*; ORDNANCE SURVEY; *LONDON: THE ILLUSTRATED HISTORY*; *LONDON: THE INFORMATION CAPITAL*

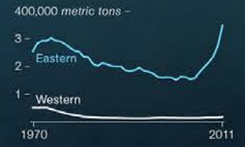
February 2016

Epic Bluefin Migrations

Bluefin are highly migratory fish, crossing seas around the world in yearly cycles of spawning and feeding. At least two groups share the Atlantic. One spawns in the Gulf of Mexico, the other in the Mediterranean. The groups mingle in the center of the ocean. Some fish even spend years on the opposite side of the ocean from where they spawn.



Breeding populations
ICCAT's most recent assessment shows a spike in the eastern population, a result of lower catch quotas. But scientists say the true increase is likely smaller.



SOURCE (BREEDING POPULATIONS AND TOTAL CATCH): ICCAT

The Super Fish

BREATHING

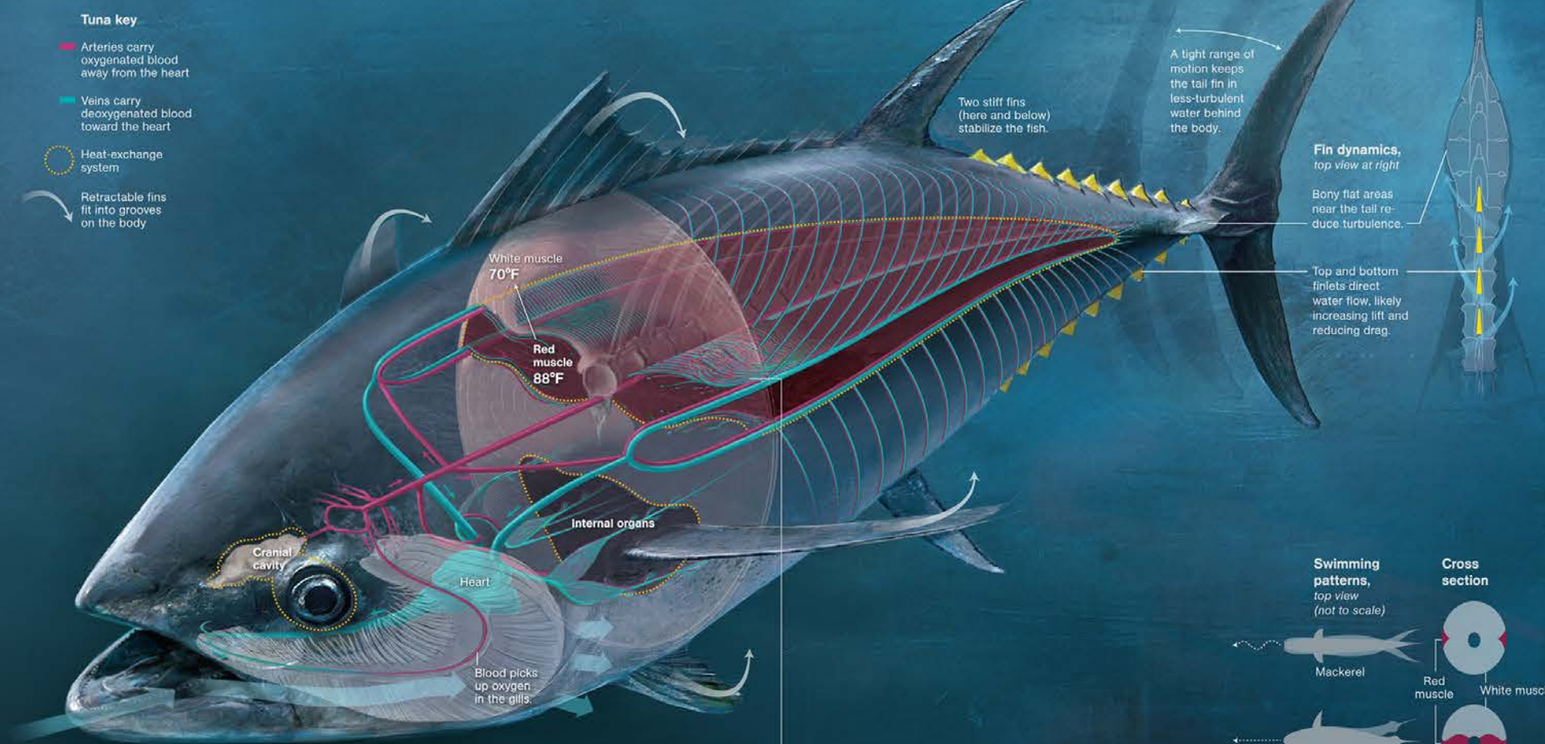
A bluefin swims with its mouth open, forcing water past the gills in a process called ram ventilation. Its gills have up to 30 times more surface area than those of other fish, and they extract nearly half the oxygen dissolved in the water. If the tuna ever stops swimming, it suffocates.

BODY HEAT

Tunas are unique among bony fish in their ability to keep key parts of their body warm. Rather than lose heat to cold water in the gills like most fish, tunas have heat-exchange systems that retain metabolic heat produced in the tissue. These systems are present in three areas (orange outline, below).

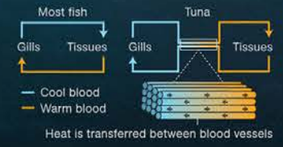
SWIMMING

The bluefin is one of the fastest fish in the ocean, thanks to a combination of physical characteristics. Its large tail maximizes thrust, while the tapered shape of its body minimizes drag. For optimum streamlining, some fins retract into a groove. Others fold into a depression in the body.



Diving deep
Tunas spend much of their lives in the sun-warmed water near the surface. Juveniles and smaller species always hover and feed there, but large adult bluefin dive to deep, cold waters, where their heat-exchange systems keep the brain and eyes alert for prey—and predators.

Heat-exchange system
Tunas rely on a network of tightly packed, parallel blood vessels that allow the transfer of heat between warm and cool blood moving in opposite directions. As a result, heat is retained in the tissues of the body that produced it rather than being lost through the gills.



Muscles and motion
Tunas have a greater proportion of red muscle fiber than do other fish, favoring long-distance swimming over short bursts. And while most fish swim by undulating along their entire length, a tuna's body remains relatively rigid while only its tail whips back and forth, reducing drag.

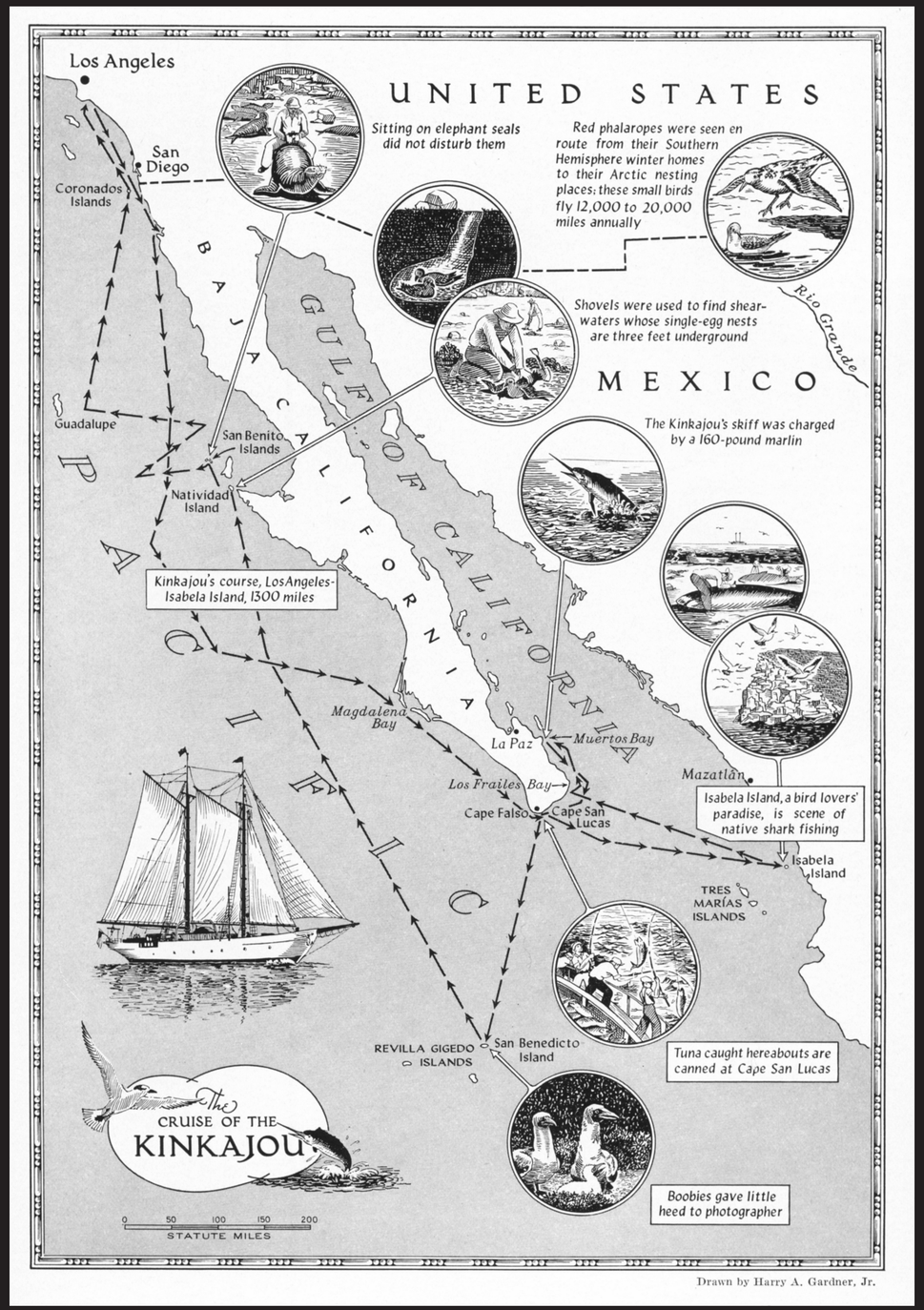
MAP: RYAN MORRIS, NGM STAFF. SOURCE: BARBARA BLOCK, STANFORD UNIVERSITY. GRAPHIC: FERNANDO G. BAPTISTA AND LAWSON PARKER, NGM STAFF; SHIZUKA AOKI. SOURCES: BARBARA BLOCK, STANFORD UNIVERSITY; BRUCE COLLETTE, IUCN TUNA AND BILLFISH SPECIALIST GROUP; DON STEVENS, UNIVERSITY OF GUELPH

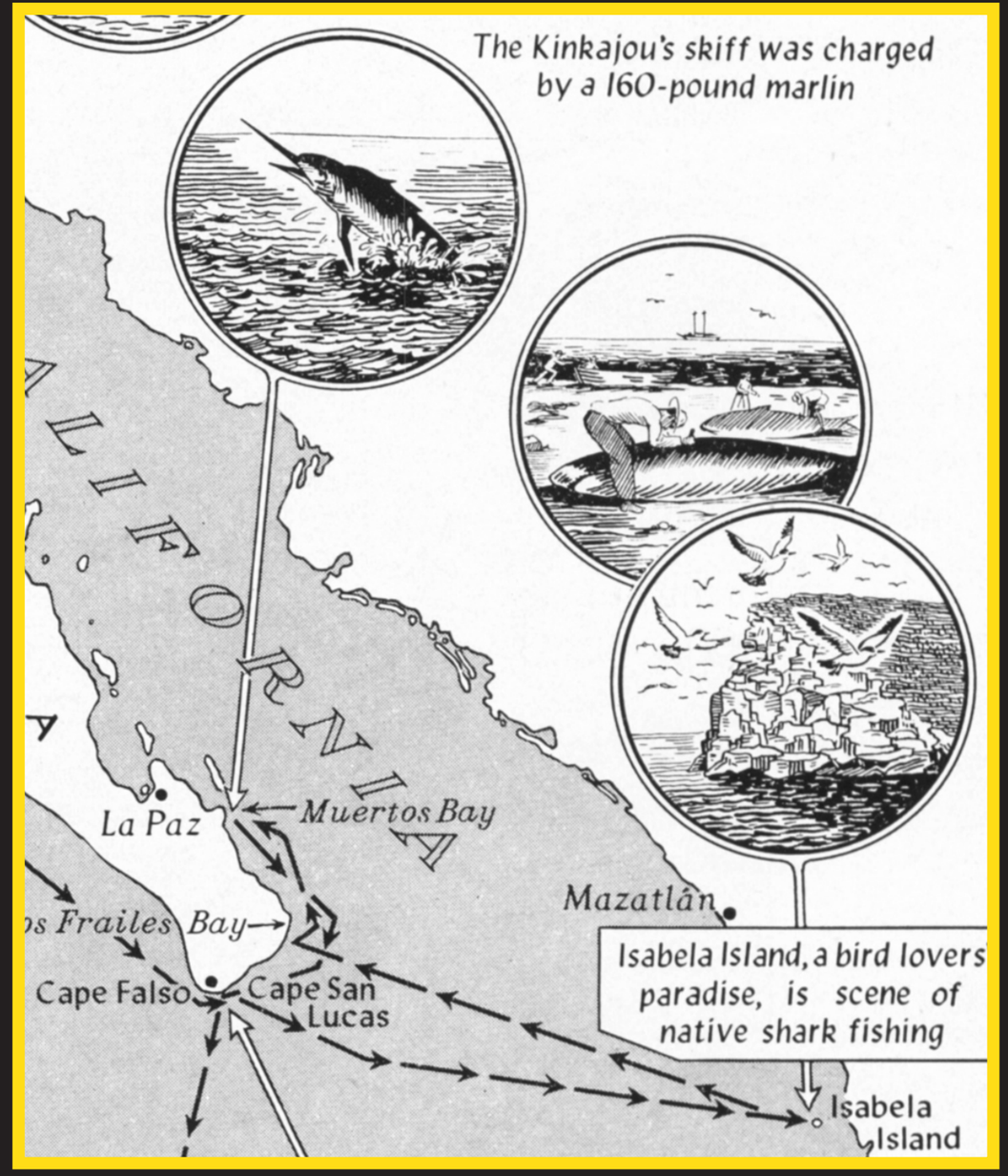
Things to consider:

When the illustration dominates the page, how do you tell a powerful story in a small map?

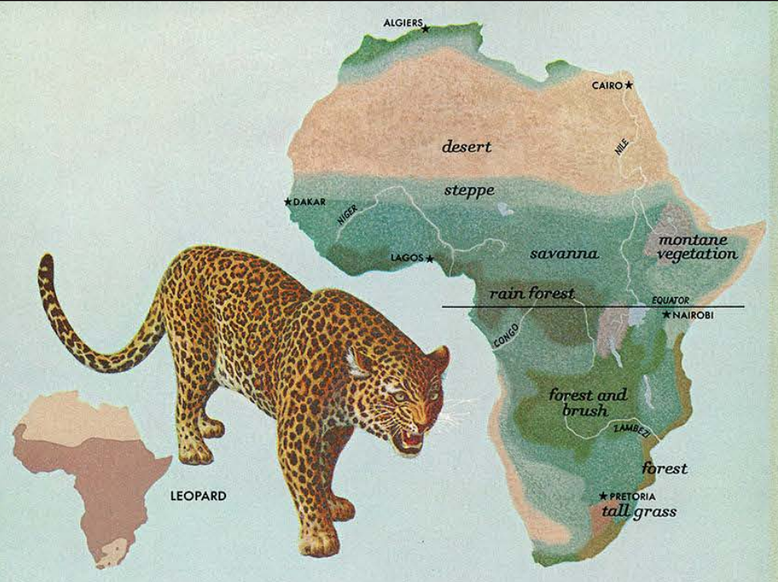
What level of insight can the map provide?

How can we create a good visual hierarchy between both the map and graphic?





September 1941



A Continent's Living Treasure

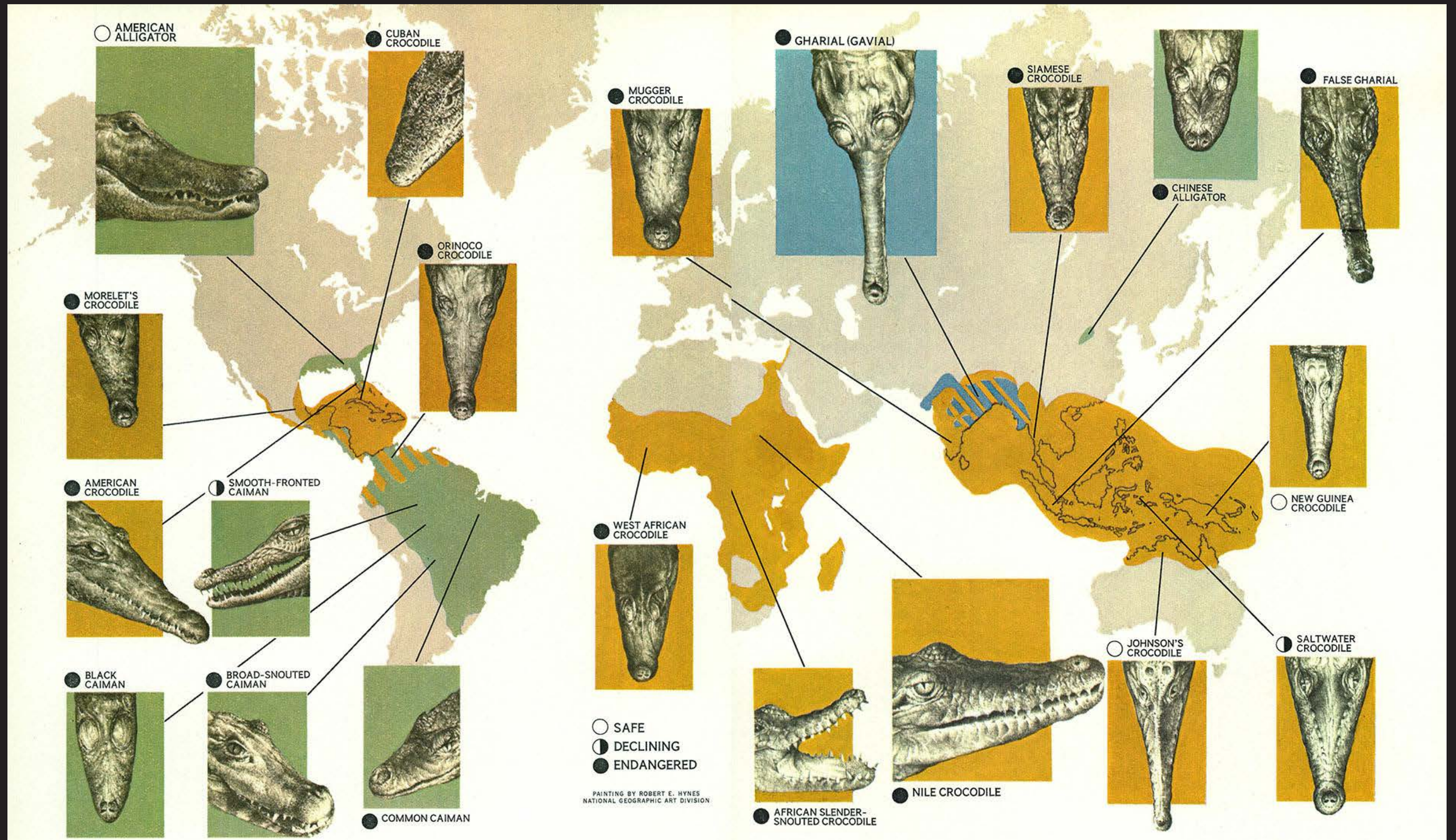
FROM DAINTY DIK-DIK to six-ton elephant, African animals come in shapes and sizes unsurpassed on any other continent. Here the artist, in consultation with Dr. Theodore H. Reed, Director of the National Zoological Park in Washington, D. C., portrays the wildlife a visitor would be most likely to encounter. Beside each animal, a map depicts its range, often rapidly receding before man's advance. Where a variety such as the zebra embraces several species, the map shows a composite of their habitats.

Comparison of the ranges with Africa's vegetation zones (**above**) reveals that many animals, such as the elusive okapi of Central Africa, dwell only in a specific habitat. But others, like the adaptable leopard, range from desert to dense forest.

PAINTINGS BY STAFF ARTIST NED SEIDLER
RESEARCH BY JEAN B. McCONVILLE; MAPS BY ELIE SABBAN

THIS PAGE FOLDS OUT

February 1972

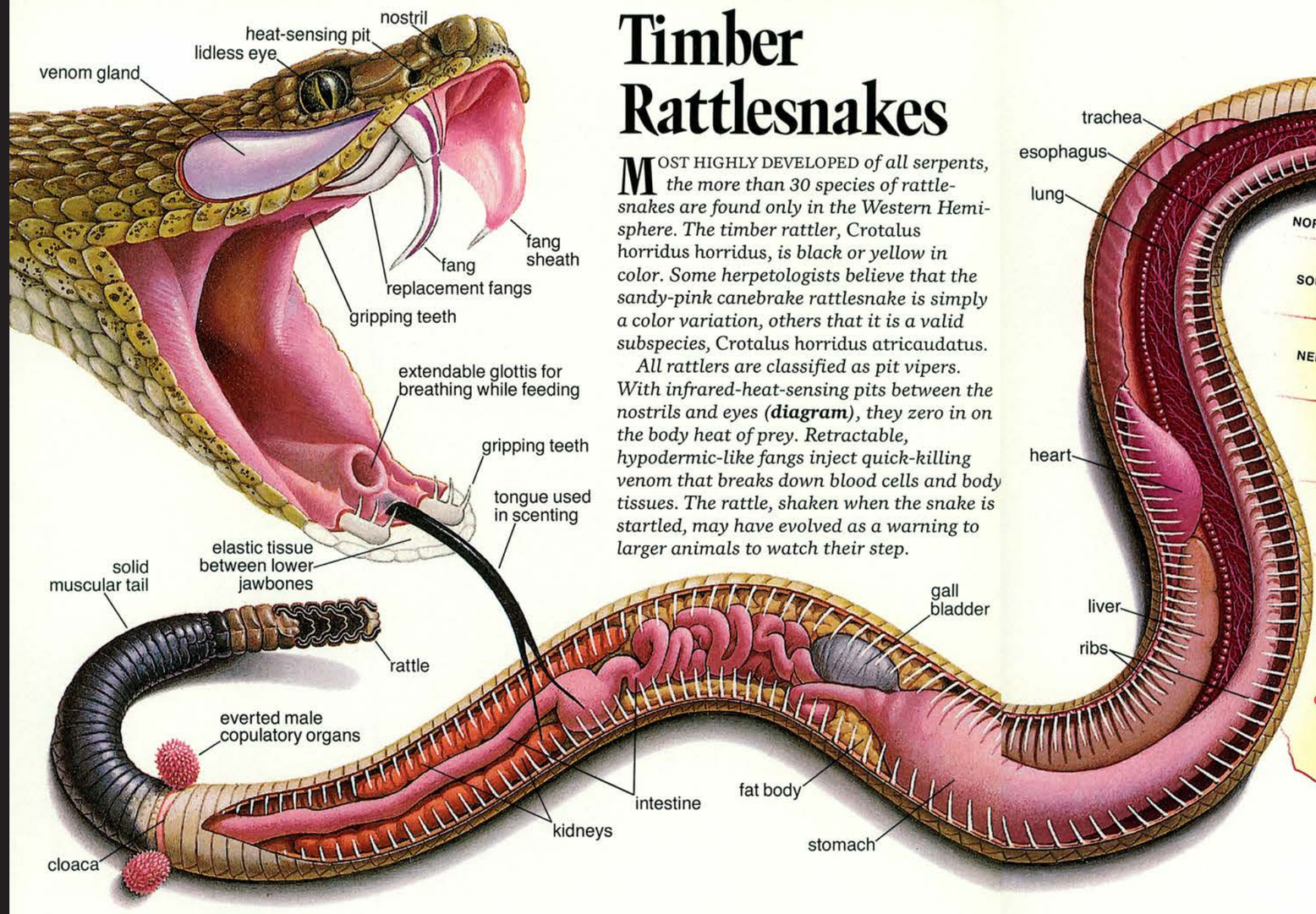


January 1978

Timber Rattlesnakes

MOST HIGHLY DEVELOPED *of all serpents, the more than 30 species of rattlesnakes are found only in the Western Hemisphere. The timber rattler,* Crotalus horridus horridus, *is black or yellow in color. Some herpetologists believe that the sandy-pink canebrake rattlesnake is simply a color variation, others that it is a valid subspecies,* Crotalus horridus atricaudatus.

*All rattlers are classified as pit vipers. With infrared-heat-sensing pits between the nostrils and eyes (**diagram**), they zero in on the body heat of prey. Retractable, hypodermic-like fangs inject quick-killing venom that breaks down blood cells and body tissues. The rattle, shaken when the snake is startled, may have evolved as a warning to larger animals to watch their step.*



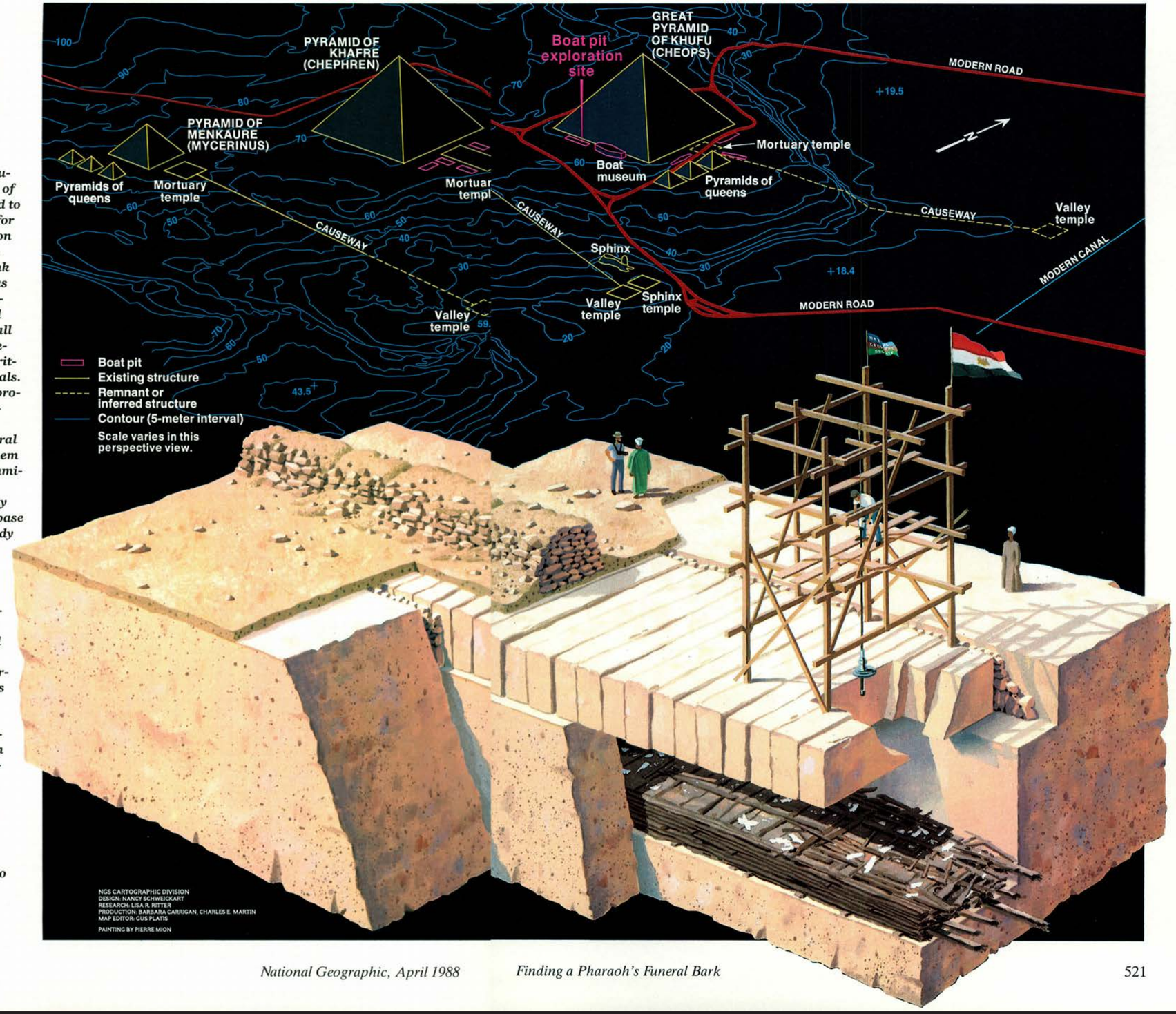
July 1987

Necropolis on the Nile

Testaments to ancient ingenuity, the three main pyramids of the Giza necropolis were wed to the Nile, source of life itself for Egyptian civilization. Built on the Giza plateau, an escarpment that abuts the west bank of the Nile, each pyramid was the focus of an intricate complex of subsidiary tombs and temples. A high boundary wall surrounded each complex, restricting entry to all but the ritually clean priests and officials.

Access from the Nile was provided by a valley temple constructed at the height of the river's floodplain. Here funeral boats would arrive, one of them bearing the dead king's mummified body, which would be carried up a walled causeway to a mortuary temple at the base of his pyramid, where the body would be entombed for eternity.

In 1954 a mountain of debris was cleared from the south face of the Great Pyramid, revealing a previously unknown section of wall and the tops of some large limestone blocks. Removing a portion of the wall, investigators discovered two pits carved into the bedrock. Not until 1985, 31 years after excavating the first pit, did Egyptian authorities decide to investigate the second one, with assistance from NATIONAL GEOGRAPHIC. Similar to the first pit, it was covered with blocks of limestone laid on edge, each weighing about 15 tons and measuring five to six feet thick.

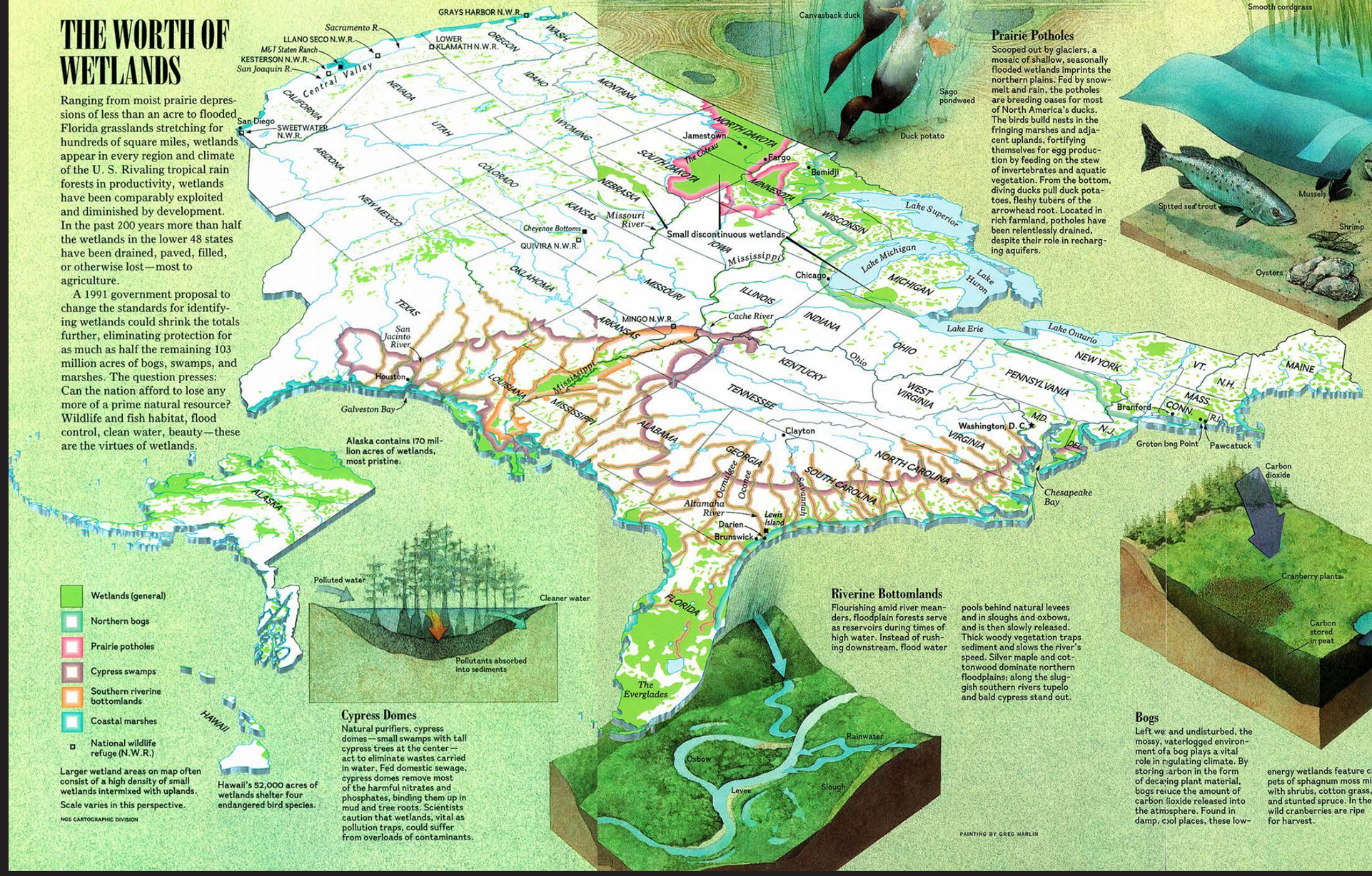


April 1987

THE WORTH OF WETLANDS

Ranging from moist prairie depressions of less than an acre to flooded Florida grasslands stretching for hundreds of square miles, wetlands appear in every region and climate of the U. S. Rivaling tropical rain forests in productivity, wetlands have been comparably exploited and diminished by development. In the past 200 years more than half the wetlands in the lower 48 states have been drained, paved, filled, or otherwise lost—most to agriculture.

A 1991 government proposal to change the standards for identifying wetlands could shrink the totals further, eliminating protection for as much as half the remaining 103 million acres of bogs, swamps, and marshes. The question presses: Can the nation afford to lose any more of a prime natural resource? Wildlife and fish habitat, flood control, clean water, beauty—these are the virtues of wetlands.

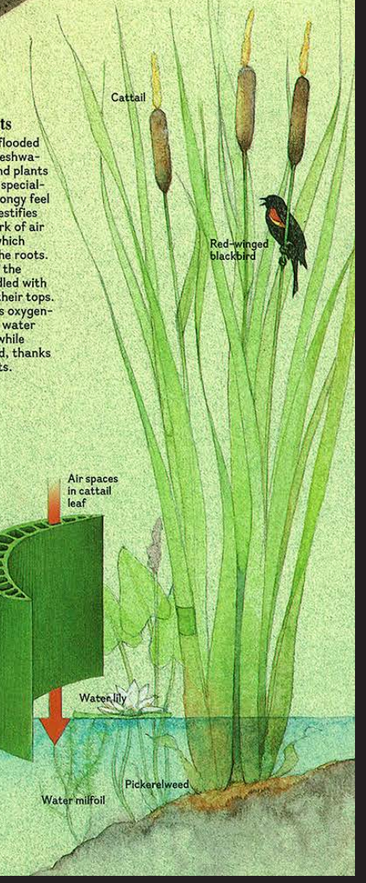


Prairie Potholes

Scooped out by glaciers, a mosaic of shallow, seasonally flooded wetlands imprints the northern plains. Fed by snowmelt and rain, the potholes are breeding oases for most of North America's ducks. The birds build nests in the fringing marshes and adjacent uplands, fortifying themselves for egg production by feeding on the stew of invertebrates and aquatic vegetation. From the bottom, diving ducks pull duck potatoes, fleshy tubers of the arrowhead root. Located in rich farmland, potholes have been relentlessly drained, despite their role in recharging aquifers.

Coastal Marshes

Energized by a daily pulse of nutrients from tides, coastal salt marshes provide habitat for two-thirds of the commercial fin- and shellfish harvested in the U. S. At high tide shellfish pursue an abundant supply of algae and cordgrass detritus or scavenge for invertebrates. The spotted sea trout and many other species come to the marsh to spawn, and young fish use it as a nursery.



Wetland Plants

To survive in the flooded conditions of a freshwater marsh, wetland plants take in oxygen in specialized ways. The spongy feel of a cattail leaf testifies to a dense network of air spaces through which oxygen reaches the roots. The flat leaves of the water lily are riddled with tiny air holes on their tops. In the deeper, less oxygenated regions, the water milfoil can grow while totally submerged, thanks to its porous roots.

Bogs

Left wet and undisturbed, the mossy, waterlogged environment of a bog plays a vital role in regulating climate. By storing carbon in the form of decaying plant material, bogs reduce the amount of carbon dioxide released into the atmosphere. Found in damp, cool places, these low-energy wetlands feature carpets of sphagnum moss mixed with shrubs, cotton grass, and stunted spruce. In the fall wild cranberries are ripe for harvest.

Cypress Domes

Natural purifiers, cypress domes—small swamps with tall cypress trees at the center—act to eliminate wastes carried in water. Fed domestic sewage, cypress domes remove most of the harmful nitrates and phosphates, binding them up in mud and tree roots. Scientists caution that wetlands, vital as pollution traps, could suffer from overloads of contaminants.

Riverine Bottomlands

Flourishing amid river meanders, floodplain forests serve as reservoirs during times of high water. Instead of rushing downstream, flood water pools behind natural levees and in sloughs and oxbows, and is then slowly released. Thick woody vegetation traps sediment and slows the river's speed. Silver maple and cottonwood dominate northern floodplains; along the sluggish southern rivers tupelo and bald cypress stand out.

PAINTING BY GREG HARLIN

October 1992

A MARCH ACROSS MILLENNIA

An extraordinary experiment in evolution, dinosaurs descended from an ancient line of reptiles during the Triassic, the first period of the Mesozoic era. As their world broke into island continents over the next 165 million years (shown on globes), they spread across a great range of habitats.

Evolving from a common ancestor, dinosaurs by the late Triassic had split into two large groups—ornithischians, or bird-hipped herbivores (top of tree), and saurischians, or lizard-hipped carnivores. In turn the saurischian line split into plant-eating sauropods and prosauropods (middle) and mostly meat-eating, bipedal theropods (bottom).

By the late Jurassic, communities of browsers like the strangely plated *Stegosaurus* and the long-bodied *Diplodocus* had developed along with large carnivores, such as the lethal-jawed *Allosaurus*.

New life-forms flourished in the Cretaceous. While flowering plants pushed aside conifers and cycads, herbivores with horns and head frills arose, and the great carnivores grew even larger.

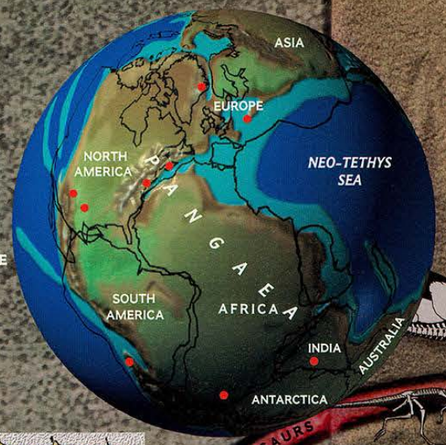
As successful at adaptation as dinosaurs were, none but the birds survived the era.

ILLUSTRATION BY CHUCK CARTER;
DINOSAURS BY GREGORY S. PAUL;
MAPS PROVIDED BY DAVID B. ROWLEY, UNIVERSITY OF CHICAGO.

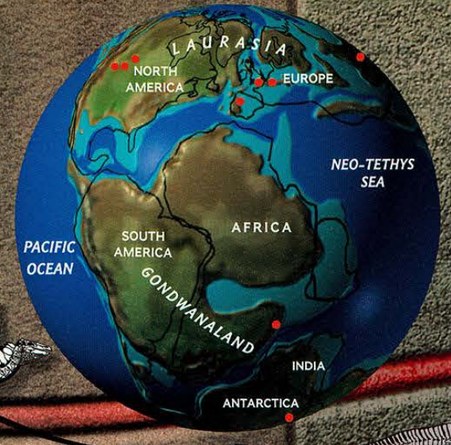
DINOSAURS NOT SHOWN TO SCALE

Late Triassic
210 million years ago
Continents have collided into one large landmass, known as Pangaea, and are on the verge of splitting apart again. A tongue of water has already pushed between Africa and North America. Far from the moderating influence of oceans, many inland areas are deserts. Species of plants and animals disperse unhindered across the globe.

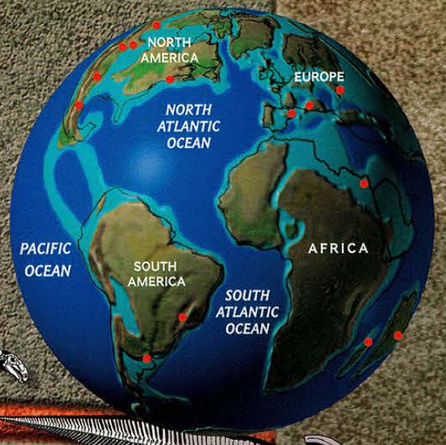
MAJOR FOSSIL SITE



Late Jurassic
152 million years ago
Pangaea has moved apart, with ocean channels separating Antarctica from Africa, Africa and South America from North America, and North America from Europe. Global temperatures are generally warmer than today, allowing plants and animals to live at much higher northern and southern latitudes.

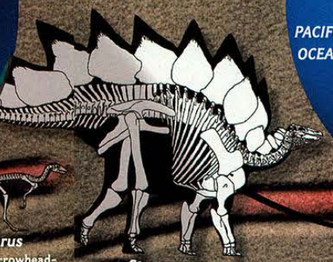


Late Cretaceous
74 million years ago
The world has assumed more of its modern appearance, though shallow seas flood low-lying areas. Dispersal of continents has separated communities of plants and animals to some extent, but intermittent connections allow migrations. With temperatures still warm, forests cover northern latitudes.



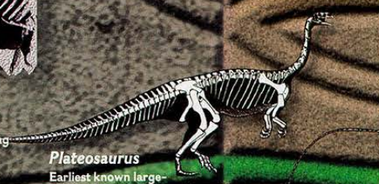
Bird-like hips
Many ornithischians, especially early species, had a new hip structure resembling that of modern birds, with the pubic bone (in red) deflected backward among the other pelvic bones.

Lizard-like hips
Saurischians retained their ancestral pelvic form, with the pubic bone projecting forward. Ironically, birds descended from lizard-hipped dinosaurs, only later developing deflected pelvic bones.



Lesothosaurus
Swift biped; arrowhead-like teeth chopped tough vegetation. Length 3 ft, Africa.

Stegosaurus
Browser whose bony plates may have regulated body temperature. Length 25 ft, western U. S.



Plateosaurus
Earliest known large-bodied dinosaur; browsed on all fours or on hind legs. Length 26 ft, Europe, Greenland.

Dilophosaurus
Carnivore whose thin, fluted head crests may have helped it attract mates. Length 20 ft, western North America, China.

Herrerasaurus
Agile bipedal predator, whose jaws clamped down on a struggling victim while claws on hands held it fast. Length 15 ft, South America.

Diplodocus
Huge long-bodied browser; at 11 tons, lighter than many other sauropods. Length 88 ft, western U. S.

Allosaurus
Large predator with sharp curved claws and long serrated teeth able to stab and cut; may have attacked in packs. Length 30 ft, western North America.

Iguanodon
Herding swamp dweller with iguana-like teeth and a large thumb spike, probably used for defense. Length 33 ft; Europe, western North America, northern Africa, Asia.

Sinornis
Link between *Archaeopteryx*, the earliest bird known, and modern birds. Length 7 inches, China.

Sauropelta
Broad-bodied browser protected by bony studs, pebbly plates, flanking fringe of spikes. Length 17 ft, western U. S.

Homalocephale
Thick-skulled species probably established dominance by butting rivals with a flat head studded with bony knobs. Length 10 ft, Mongolia.

Parasaurolophus
Plant-eater whose head crest may have resonated mating calls. Length 33 ft, western North America.

Triceratops
Herding browser protected by a short, solid neck frill and three facial horns. Length 30 ft, western North America.

Deinonychus
Agile predator that probably hunted in packs and slashed at prey with sickle-like claws. Length 9 ft, western U. S.

Tyrannosaurus
Largest of the carnivores; tore apart prey with large saw-edged teeth set in massive, powerful jaws. Length 45 ft, western North America.

The bitter end
Diversity declined as climates became more seasonal at the end of the Cretaceous. Did the last of the dinosaurs die after an asteroid struck earth 65 million years ago, or were they already extinct? We may never know.

FABROSAURS
STEGOSAURS
ANKYLOSAURS
ORNITHOPODS
PACHYCEPHALOSAURS
CERATOPSIANS
PROSAUROPODS
SAUROPODS
CERATOSAURS
THEROPODS
ORNITHOMIMOSAURS
BIRDS
TYRANNOSAURS
HERRERASAURS
ALLOSAURS

250 MILLION YEARS AGO — TRIASSIC PERIOD — 200 — JURASSIC PERIOD — 150 — CRETACEOUS PERIOD — 100 — TERTIARY PERIOD — 50

January 1993

The World of Cats

DOMESTIC CAT LINEAGE

Pallas's cat
Otocolobus manul

Chinese desert cat
Felis bieti

Sand cat
Felis margarita

Black-footed cat
Felis nigripes

Jungle cat
Felis chaus

Wild cat
Felis silvestris

PUMA LINEAGE

Puma
Puma concolor

Cheetah
Acinonyx jubatus

Jaguarundi
Herpailurus yaguarondi

OCELOT LINEAGE

Ocelot
Leopardus pardalis

Margay
Leopardus wiedii

Kodkod
Oncifelis guigna

Mountain cat
Oreailurus jacobita

Oncilla
Leopardus tigrinus

Geoffrey's cat
Oncifelis geoffreyi

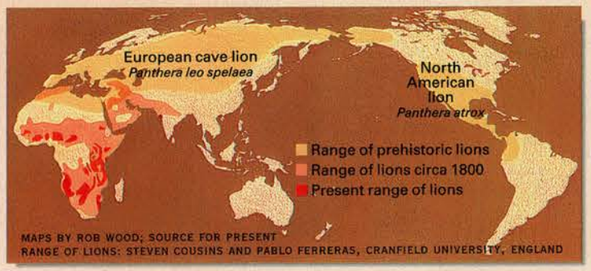
Pampas cat
Oncifelis colocolo

Cats' needs are simple: Prey to pounce on, rangemates to roar to, and space enough for elegant solitude. But in troubling contrast to their flourishing domestic cousins, many wild cats are in decline.

To assemble cat biomedical profiles for use in wildlife protection, the author and colleagues founded New Opportunities in Animal Health Sciences (NOAHS), part of the Smithsonian. Geneticists, veterinarians, and biologists worldwide gathered data that also provided new insights into feline family relationships. The lineages of the living cat species shown here are based on DNA analysis of blood collected without injury to the feline donors. This genetic perspective substantially revises standard cat taxonomies. African cheetahs, New World jaguarundis, and pumas appear closely related, as do the caracal and African golden cat. Detailed knowledge of relationships among cat groups improves our ability to manage the genetic diversity critical to all healthy populations.

Domestic cat
Felis catus

- *North America*
- *South America*
- *Europe*
- *Africa*
- *Asia*
- *Australia*



LOST KINGDOM

Lions once vied with humans for "top cat" status on every continent but Australia and Antarctica. Today western India's Gir forest provides sanctuary for the few hundred wild lions remaining outside Africa. Within Africa, habitat reduction and fragmentation continue to threaten lion numbers and diminish genetic diversity within ever more isolated populations.

PANTHERINES

PANTHER LINEAGE

Lion
Panthera leo

Tiger
Panthera tigris

Jaguar
Panthera onca

Snow leopard
Uncia uncia

Leopard
Panthera pardus

Clouded leopard
Neofelis nebulosa

SERVAL LINEAGE

Serval
Leptailurus serval

RUSTY-SPOTTED CAT LINEAGE

Rusty-spotted cat
Prionailurus rubiginosus

CARACAL LINEAGE

Caracal
Caracal caracal

African golden cat
Profelis aurata

BAY CAT LINEAGE

Bay cat
Catopuma badia

Temminck's golden cat
Catopuma temmincki

ASIAN LEOPARD CAT LINEAGE

Fishing cat
Prionailurus viverrinus

Iriomote cat
Mayailurus iriomotensis

Leopard cat
Prionailurus bengalensis

Flat-headed cat
Prionailurus planiceps

LYNX LINEAGE

Bobcat
Lynx rufus

Canada lynx
Lynx canadensis

Marbled cat
Pardofelis marmorata

Eurasian lynx
Lynx lynx

Iberian lynx
Lynx pardinus

June
1997

EarthPulse

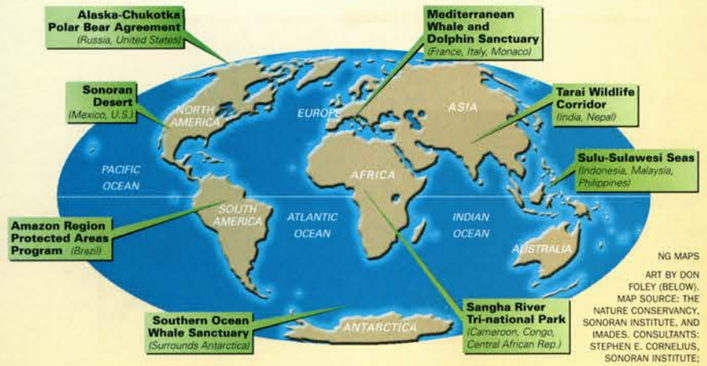
ACROSS BORDERS

Piecing Together Wild Lands

Sonoran Desert: A model for international partnerships

Deserts only seem barren. In the Sonoran, grass roots grow deep. Plants, animals, and people stake their claims across 55 million rugged acres of Arizona, California, and Mexico. These vast lands have owners with sometimes differing interests: military bases, conservation groups, Native Americans, residents rural and urban, and half a dozen state and federal agencies. This crazy quilt's common challenge is how best to preserve the Sonoran's outstanding biodiversity, such as the more than 500 bird species that migrate through, breed, or reside there. The driving concern: The region's human population, six million and climbing, has nearly tripled since 1970.

"All groups must communicate because there isn't a single umbrella organization," says Steve Cornelius. His Sonoran Institute, along with the Nature Conservancy and Mexico's IMADES environmental institute, has made an assessment of conservation priorities. Already Arizona's Pima County, the Tohono O'odham Nation, and the Department of Defense are developing comprehensive environmental plans. To the inventory of land already protected, some since the 1930s, nearly half a million acres has recently been added as the Sonoran Desert National Monument. This map depicts the region's interlocking elements, with pieces lifted to highlight important conservation issues.



NG MAPS

ART BY DON FOLEY (BELOW). MAP SOURCE: THE NATURE CONSERVANCY, SONORAN INSTITUTE, AND IMADES. CONSULTANTS: STEPHEN E. CORNELIUS, SONORAN INSTITUTE; JOHN A. HALL, THE NATURE CONSERVANCY

International Agreements

Cooperation grows between nations with animals and plants that know no borders, as in the Arctic, where the U.S. and Russia have signed a polar bear agreement. Three African countries protect a primate-rich lowland tropical forest. India and Nepal preserve tigers and rhinos in the tarai on the edge of the Himalaya. Brazil is assisted in saving its rain forest by the World Wildlife Fund's protected areas program.

Coordinating Efforts

The information researchers gather on Sonoran ecosystems goes into a geographic information system database that can help agencies share resources and create conservation strategies.

Urban Sprawl

Like Phoenix, Arizona's largest city, Pima County's Tucson has grown with few checks. Pima's proposed Sonoran Desert Conservation Plan was spurred by the need to protect the cactus ferruginous pygmy owl.

Desert Tourism

Saguaro cactuses, unique to the Sonoran, and the native trees of Palm Canyon increasingly lure visitors. A challenge: preserving archaeological remains such as the ancient art at Painted Rocks Petroglyph Site.

Biodiversity

The Sonoran's botanical riches, including 300 types of cactuses, need protection. So do desert horned lizards, peninsular bighorn sheep, and nearly extinct porpoises called vaquitas in the Gulf of California.

Cross-border Management

Endangered Sonoran pronghorns range over Mexico's Pinacate Biosphere Reserve as well as U.S. lands, including the Barry M. Goldwater Range, site of F-16 training missions. Protective corridors may be needed to connect populations.

Get Involved

Learn more about conservation partnerships:
nationalgeographic.com/ngm/0106/earthpulse

The Nature Conservancy:
nature.org/arizona

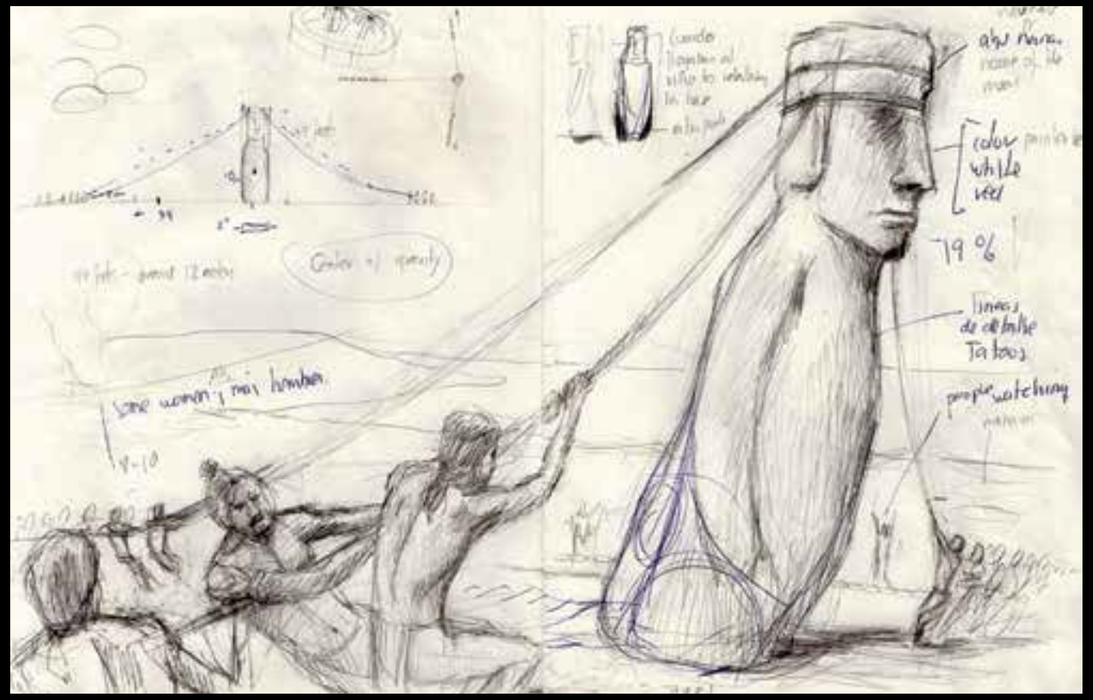
World Wildlife Fund:
worldwildlife.org

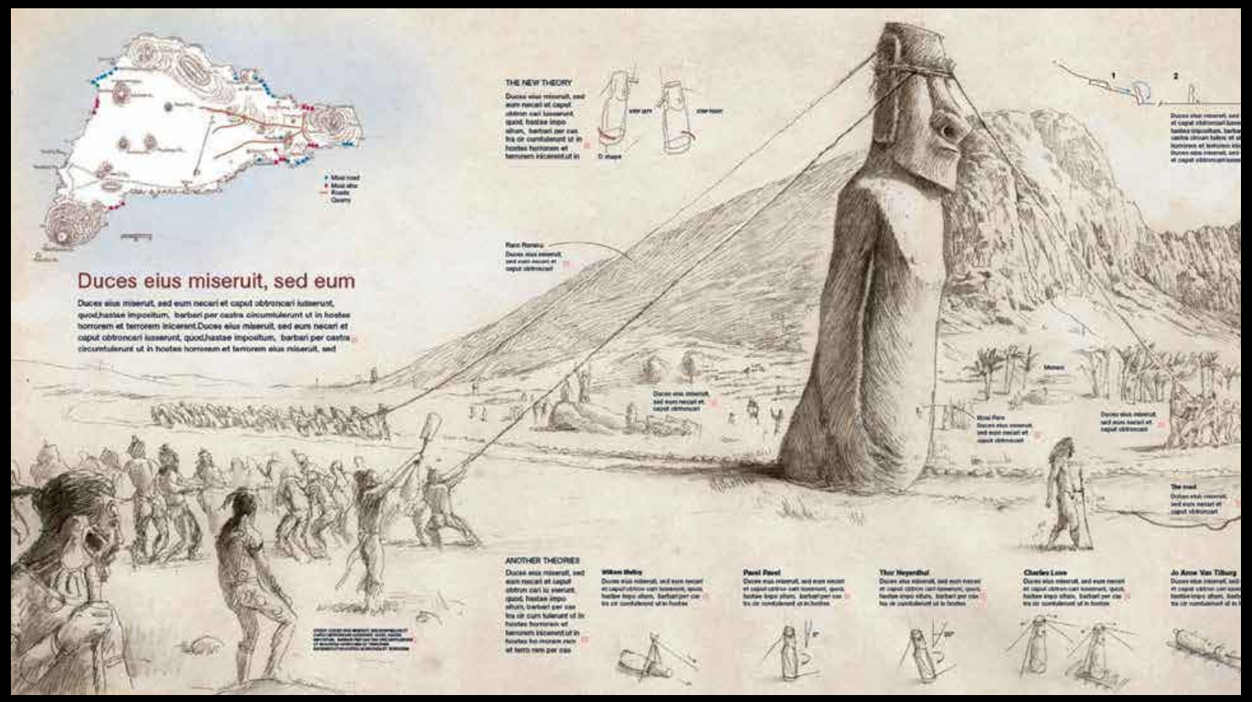
Fernando Baptista

Harmonize artwork and map by:

Consistent lighting
Blending colors
Creating textures
Making a hierarchy for information


Fernando

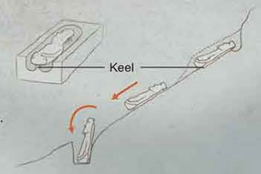



Duces eius miseruit, sed eum
Duces eius miseruit, sed eum necari et caput obtroncari iusserunt, quod,hastae impositum, barbari per castra circumtulerunt ut in hostes horrorem et terrorem inicerent.Duces eius miseruit, sed eum necari et caput obtroncari iusserunt, quod,hastae impositum, barbari per castra circumtulerunt ut in hostes horrorem et terrorem eius miseruit, sed
THE NEW THEORY
ANOTHER THEORIES

How Did They Move?

It's one of Easter Island's persistent mysteries: How were hundreds of giant statues transported across the island centuries ago, over distances as long as 11 miles, by people who lacked draft animals and wheels? The scene imagined here with a 21-foot-tall *moai* illustrates a new theory. It takes its cues from Rapanui oral tradition, which says the moai "walked."

At Rano Raraku, the main quarry, each moai was carved out of sloping bedrock until only a slender "keel" held it in place. The last step was to sever the keel and lower the moai downhill with ropes into a trench to await transport.



White coral eyes with pupils of obsidian or red scoria were inserted after a moai reached its platform. They brought the stone face to life.

Dirt roads radiating from the quarry were constructed with gentle slopes to help moai reach their platforms in one piece.

18 feet

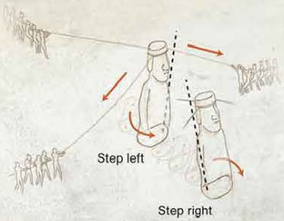
iPad Exclusive
See the stones walk loremsop nus volla pro on our iPad edition.

Statues that rock

Terry Hunt, Carl Lipo, 2011

Archaeologists Hunt and Lipo believe three small groups could have walked a moai: two groups coaxed it forward by rocking it side to side, while a third stabilized it from the back.

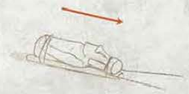
A D-shaped, heavy bottom made a moai rockable. In a 2011 experiment, 18 people walked a 10-foot, 5-ton replica a few hundred yards.



Earlier theories

Thor Heyerdahl, 1955

The Norwegian and a team of 180 strapped a real, 13-foot, 10-ton moai onto a tree trunk, then dragged it. "You are totally wrong, sir," a Rapanui onlooker told Heyerdahl.



William Mulloy, 1970

Using a desktop model, this U.S. archaeologist speculated that a moai might be swung forward in steps while hanging by the neck from an inverted wooden V.

Pavel Pavel, 1986

Czech engineer Pavel, Heyerdahl, and eight helpers walked a 13-foot, 9-ton moai—another real one—with a twisting rather than a rocking motion, which may have been risky.

Charles Love, 1987

U.S. archaeologist Love stood his 13-foot, 8-ton replica upright on a wood sledge and hauled it over rollers. It moved 148 feet in two minutes.

Jo Anne Van Tilburg, 1997

Sixty volunteers pulled a 13-foot, 10-ton model, lying on its back, for 328 feet on a wood sledge over rails of eucalyptus, a non-native tree species.

FERNANDO G. BAPTISTA AND MATTHEW TWOMBLY, NGM STAFF; PATRICIA HEALY; DEBBIE GIBBONS
SOURCES: TERRY L. HUNT, UNIVERSITY OF HAWAII; CARL LIPO, CALIFORNIA STATE UNIVERSITY LONG BEACH; HELENE MARTINSSON-WALLIN, GOTLAND UNIVERSITY; FRANCISCO TORRES HOCHSTETTER, RAPA NUI

Working with Fernando: Basque Whalers

3 gatefold spreads

4.9 ft² of content

PORT OF PASAJES, SPAIN

ON THE HUNT WITH THE BASQUE WHALERS

After the wreck of a Basque galleon—thought to be the *San Juan*—was discovered off the coast of Canada, *National Geographic* wrote about its exploration (July 1985 issue, at left). Now, we revisit the 16th-century ship's history to illustrate what we've learned about the risks and rewards faced by the Basques in the new lands they called Terranova. Their quarry: baleen whales and the oil from their blubber, worth millions in today's dollars.

BY FERNANDO G. BAPTISTA

PREPARING FOR THE TRIP

Casks loaded with beans, dried peas, bacon, and ship's biscuits (flour-and-water crackers) sustained the crew. Hearty meals were washed down with wine and hard cider and supplemented with berries, fish, and whale meat, when available.

Heavy weapons
Ships carried artillery such as swivel guns and cannons to guard whaling waters and project sovereignty over European rivals.

Personal items
Combs, breeches, woolen stockings, leather shoes and boots, and other basic gear were packed in small barrels or chests.

Galleon *San Juan* 79 ft

Cannon (*bombarda*)

Whaling timeline: (1) Provisioning (2) Sailing (3) Hunting and processing oil (4) Sailing — JAN. JUN. DEC.

A DISTANT CHASE

It was voyages to North America to fish for cod that first led the Basques to the whaling grounds more than 2,000 miles from home.

TERRANOVA (NORTH AMERICA)
Greenland
Spitsbergen
Jan Mayen
Iceland
Red Bay
Gulf of St. Lawrence
ATLANTIC OCEAN
London
Bristol
Amsterdam
Antwerp
Rouen
Nantes
EUROPE
Pasajes
SPAIN
AFRICA

Basque fishing or whaling area (1530–1760)
Iceland Other Basque whaling location
Bristol Main trading city for whale oil

Extra-large (*boza*) 247 gallons
Large (*pipa*) 120 gal
Medium (*barrica*) 55 gal
Small (*media barrica*) 15-26 gal
Rope
Ship's biscuits

Shore-station supplies
Whalers brought roofing tiles, nails, knives, saws, and other materials for the onshore oil-processing stations.

Barrel shipping
The cost-conscious whalers carried oil on their return trips in reusable barrels originally designed for the wine trade.

Working women
With sailors gone for months at a time, women regularly worked on the docks. Head wraps distinguished each woman's city of origin.

OUTFITTING THE *SAN JUAN*

Canadian researcher Selma Huxley Barkham pored over Basque archives detailing the fate of the ship and how it was provisioned—analysis that helped locate the 1565 wreck.

SHIP WEIGHT
209 tons

CARGO
239 tons

5 whaleboats (*chalupas*)

5 copper cauldrons

Floorboards could be removed to fit barrels on return trips.

Small barrels: sardines, olive oil, bacon

Ship's biscuits: 240 barrels

WATER LEVEL

1,000 barrels were transported in pieces to preserve space.

Cider: 220 barrels

Stones secured barrels.

Wine

49 ft
60 tons

MASTER AND COMMANDED

On a typical voyage, the captain handled navigation and ship operations; the master managed shore operations and cargo. A ship of this size usually had a crew made up of 60 to 65 men and boys.

OFFICERS

Captain · Master · Steward (shipboard accounts) · Boatswain (rigging and sails) · Gunner · Carpenter · Caulker

OFFICERS

Flenser (strips blubber) · 5 Coopers (barrelmakers) · 5 Chalupa skippers · 5 Harpooners · 20 Seamen · 16 Apprentices

CARGO
290 tons

Cider

PACKING THE WHALE OIL

Barrels were interlocked to prevent shifting and maximize space. On a typical return voyage, chalupas may have been left behind and some men given extra wages to winter in Red Bay to allow more room for oil.

Barrels of ship's biscuits, cod

Fifteen to 20 whales yielded enough oil to fill the cargo hold.

WATER LEVEL

Bundles of baleen—in higher demand at the end of the 16th century—were stacked and bound.

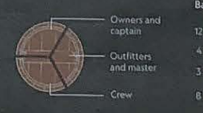
1,000 barrels of whale oil

16TH-CENTURY PROFIT SHARING

The ship's owners, outfitters, and crew each got a third of the cargo. The captain and master negotiated their share with the owners and outfitters, and the crew-members' shares varied based on their position.

$10,000,000
total value of cargo in 2018 dollars

$10,000
per barrel



Barrels per person

12 Harpooners
4 Seamen
3 Apprentices
8 Officers

STRAIT OF BELLE ISLE, CANADA

HOW THEY HUNTED

Scouts patrolled in small boats called chalupas, signaling to other crews when they spotted whales in the Strait of Belle Isle. Skippers of the chalupas, each typically carrying six oarsmen and a harpooner, directed their crews to row in haste—but stealthily—toward the surfacing or sleeping giants.

Sneak attack
Quietly rowing, the crew would close in on the whale from behind—its blind spot.

First harpoon
Standing in the bow, the harpooner struck the whale's body when it surfaced to breathe.

Second harpoon
If the whale broke free of a first harpoon, a buoy on a second one helped track the animal.

Harpooner

Saddle Island

Chalupa skipper

Lances

Sails

Masts

Whale line, 720 ft

Ax to cut the whale line

Buoy

THE CHALUPA

Oak whaleboats, called chalupas, were so fast and maneuverable that native peoples of the region adopted the technology. With adjustable masts, chalupas could also be sailed.

The top two planks of a chalupa overlapped (clinker style), while the rest were set edge to edge (carvel style).

BOWHEADS AND RIGHT WHALES

A thick layer of blubber made these slow-swimming baleen whales a prime target. Bowheads—the whalers' prize catch for their higher oil yield—often swam near pack ice alone or in family groups.

PROCESSING THE PRIZE

The whale carcass was buoyant, so processing could begin on the water. At land-based tryworks, blubber was boiled down to oil; barrels of it were floated back to the ships.

First, slings were attached to the whale; the capstan and pulleys were then used to rotate the carcass as men stripped blubber.

Hunks of blubber were boiled down in onshore tryworks, tiled-roof shelters covering stone ovens with cauldrons.

Blubber was slowly melted, purified, and poured into barrels. Baleen was extracted, cleaned, and bundled.

Deep pursuit
Harpoon lines uncoiled rapidly as the tethered whale sped up or dived underwater to attempt escape.

The kill
Whalers severed strong tail tendons to avoid being flipped by the whale, then lanced its vital organs.

Moving the bounty
Chalupas worked together to drag the whale, a rope tied around its tail, from open water to ship or shore.

Buoy

Tryworks

Cemetery

Basque crews killed about 13,000 whales in these coastal waters during the 16th century.

RED BAY

Each season some 1,000 men on 15 ships hunted or manned 15 tryworks (oil-rendering stations) at the height of Basque whaling in the 1560s and '70s.

Skin

Muscle

Blubber 12 in

The oil harvested from the whales' insulating blubber lubricated Europe's looms, burned in oil lamps, and was mixed into soaps.

Upper jaw

Baleen

Filter-feeding baleen plates, strong and flexible, were used as corset stays and later as umbrella ribs and fishing rods.

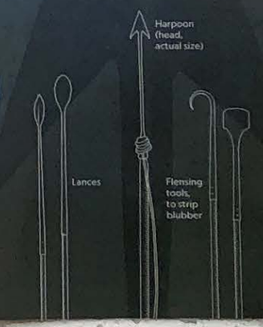
Lip (covering baleen)

Lower jaw

Working in shifts day and night, two teams of men could capture and process a whale into 60 barrels of oil within 2.5 days.

TOOLS OF THE TRADE

Mounted on wooden shafts, iron-headed harpoons and lances were coated with wax to protect against corrosive seawater.



RED BAY, CANADA

READY TO RETURN

The Basques were the master whalers of their day, but not all their ships weathered the voyages. Seamen's court testimony and insurance claims tell of a costly end to the *San Juan*: driven into the rocks by violent winds before departure in 1565. But the crew survived, many barrels were recovered, and the Basques dominated the hunting grounds of the north into the next century.

Whalers relieved themselves over the beakhead with tarred rope as toilet paper.

During voyages, the crew cooked food in cauldrons over a stone-lined firebox.

Beakhead

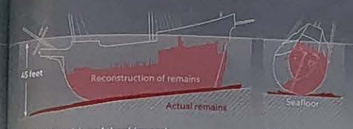
Galley

Flensing operations

Crew's quarters

Barrels were floated from land to ships for loading.

Bottom of mast



1978: RECOVERING THE *SAN JUAN*

Found under kelp and silt, the ship's flattened hull had been preserved for centuries by icy waters. The first plank brought up was oak, not native to the region but known to be used by the Basques. Red Bay is now a UNESCO World Heritage site.

Officers' quarters

Sandglass

Captain

Compass box

Captain's cabin

Bilge pump

Tiller

Crew's quarters

Sailors slept on straw-filled sacks.

Seamen passed the time weaving, playing checkers, and carving designs into baleen or the ship's hull.

Anchors attached by cables were hoisted onto the *San Juan* by the capstan.

When sailing, pilots carefully recorded distances, tides, and the ship's progress, guided by rudimentary instruments such as a sandglass—to measure time and speed—and a compass.

Rudder

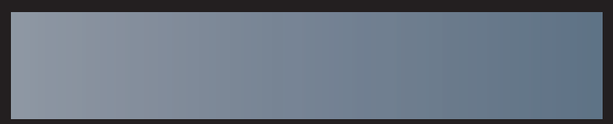
FERNANDO G. BAPTISTA, RILEY B. CHAMPINE, DAISY CHUNG, AND EVE CONANT, NGM STAFF; PATRICIA HEALY, SHIZUKA AOKI AND ELIJAH LEE, BOREMEN IRONHEAD IMAGE, INTERNAL ANATOMY SOURCES: XABIER AGOTE AND MIKEL LEGE AIZPURU, ALBAOLA BASQUE MARITIME HERITAGE ASSOCIATION; BRAD LOEWEN, UNIVERSITÉ DE MONTRÉAL; NINYA MIKHAILA AND JANE MALCOLM DAVIES, THE TUDOR TAILOR; J. CRAIG GEORGE, DEPARTMENT OF WILDLIFE MANAGEMENT, UTQIAGVIK, ALASKA; ROSALIND ROLLAND, ANDERSON CABOT CENTER FOR OCEAN LIFE, NEW ENGLAND AQUARIUM; BRENNA FRASER, SAINT MARY'S UNIVERSITY, NOVA SCOTIA; CINDY GIBBONS, PARKS CANADA

Key strategies for integrating maps

- Working with a horizontal rule

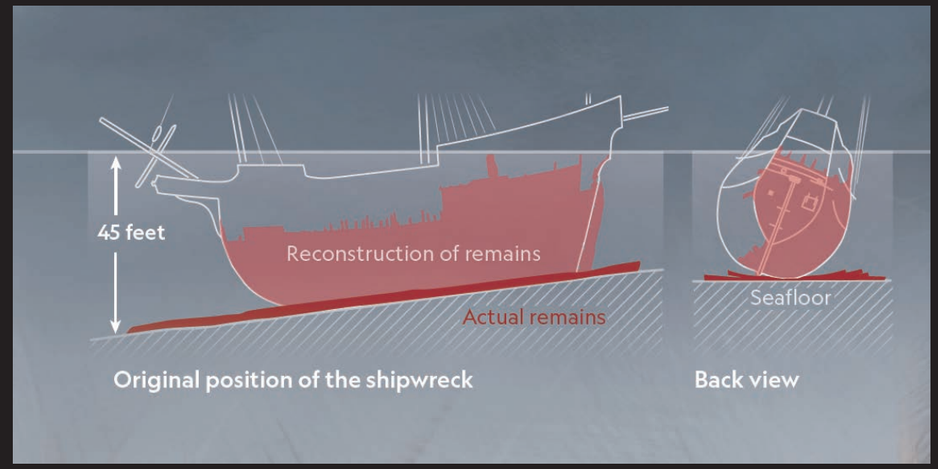
- Repetition of color for key information

- Blending map colors with artwork



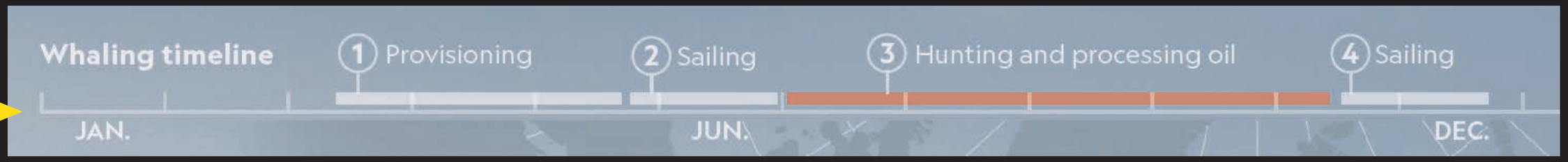
Benefits of repeating a horizontal rule

- Consistent alignment across pages

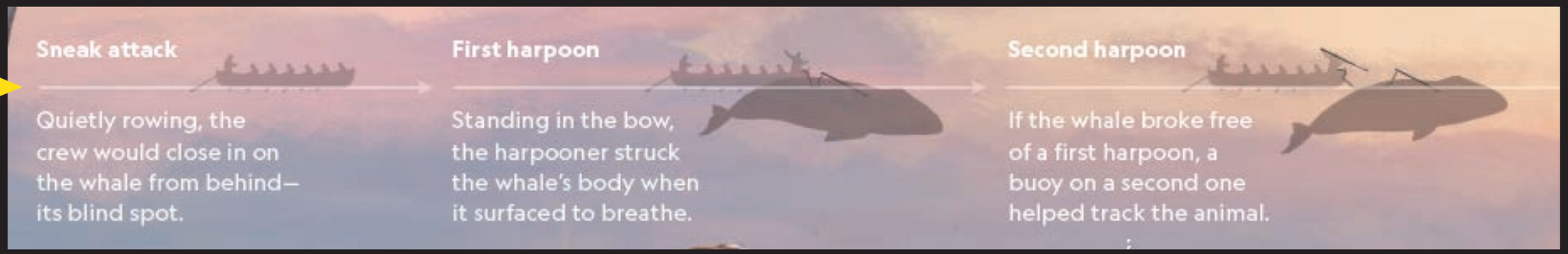


- Connecting different elements

Rule adds a foundation for linear information

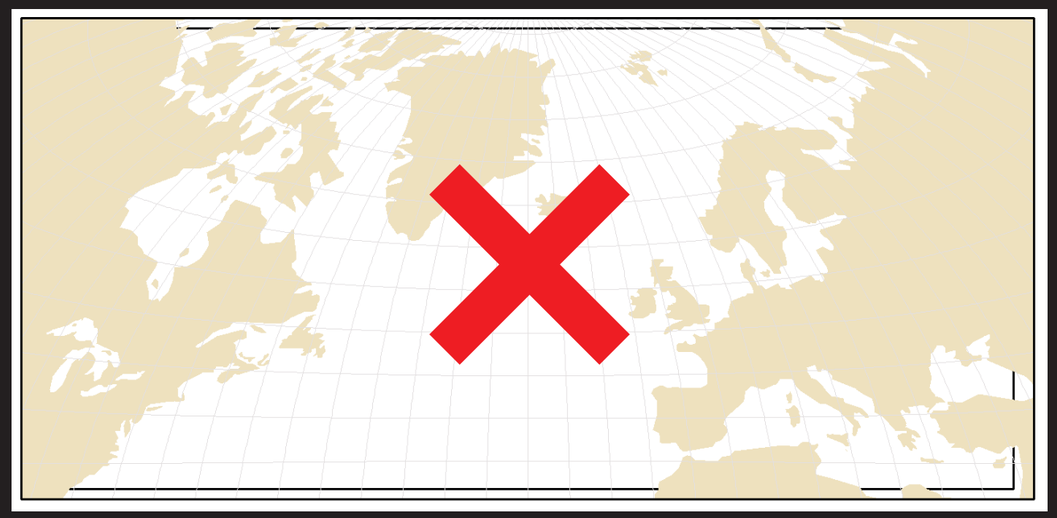


- Whaling timeline



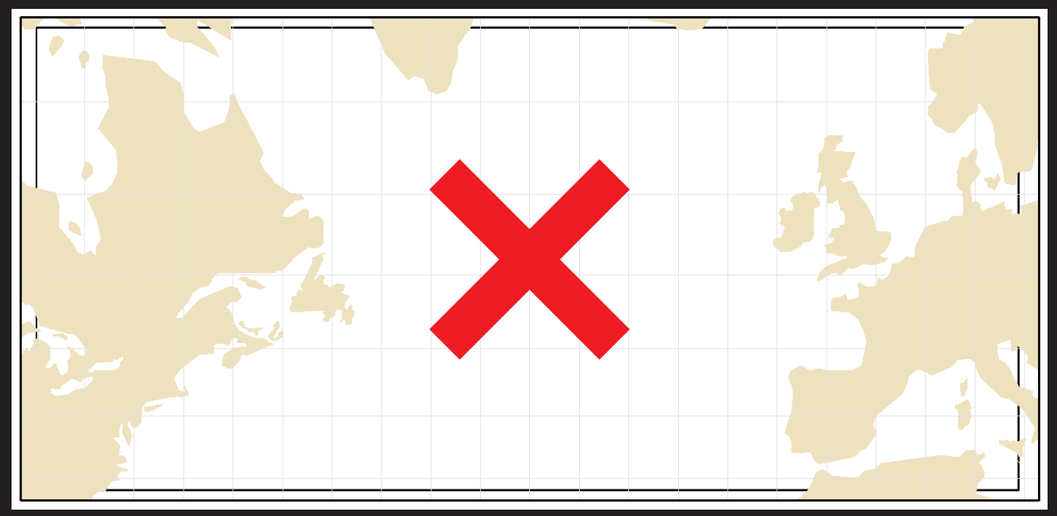
- Hunting process

Choosing a projection to work with rule



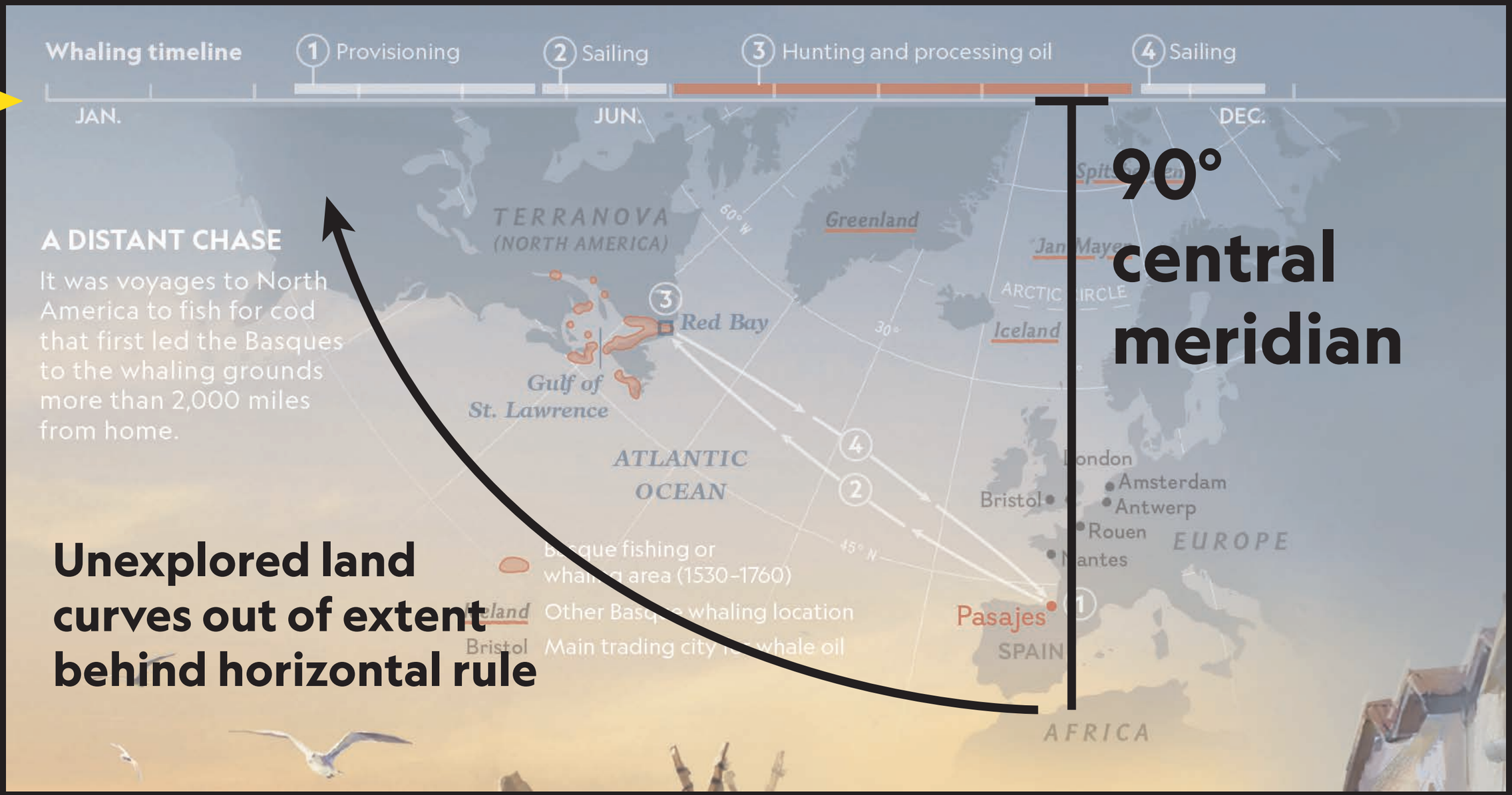
Equidistant Azimuthal
1:75,000,000

Equidistant Conic
1:70,000,000



Mercator
1:65,000,000

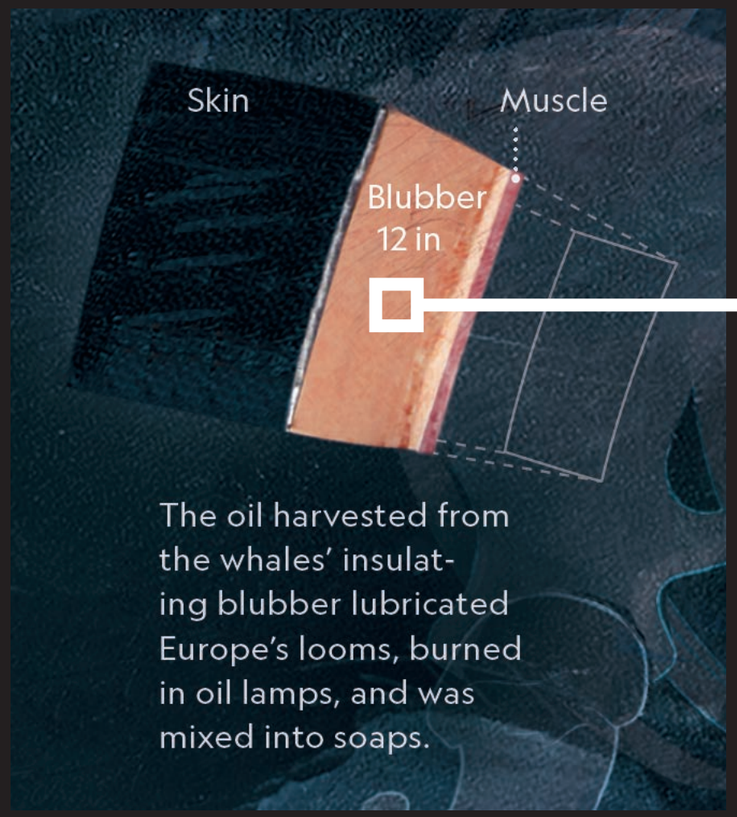
Conic projection interacting with horizontal rule



Movement toward inset map...

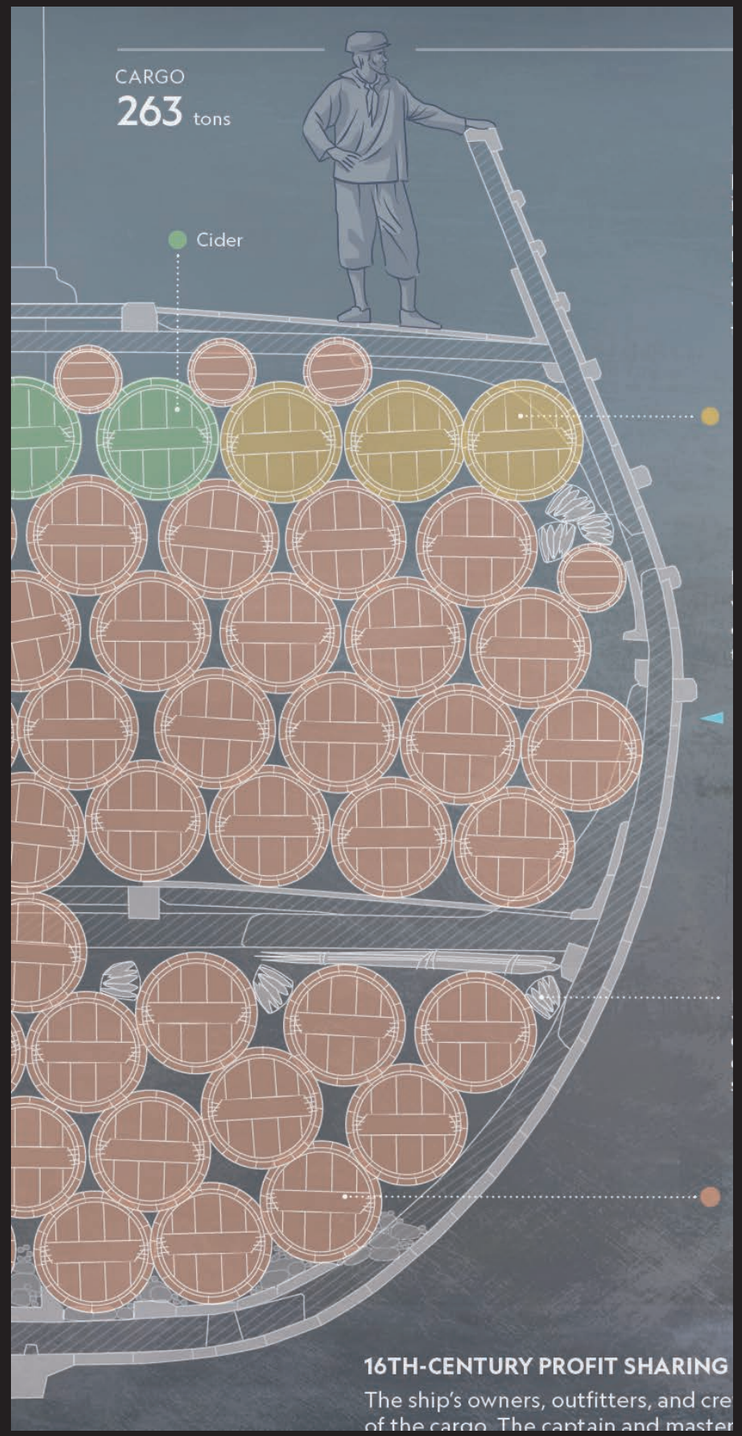
...aligned with latitude tick

Highlighting key information with color repetition

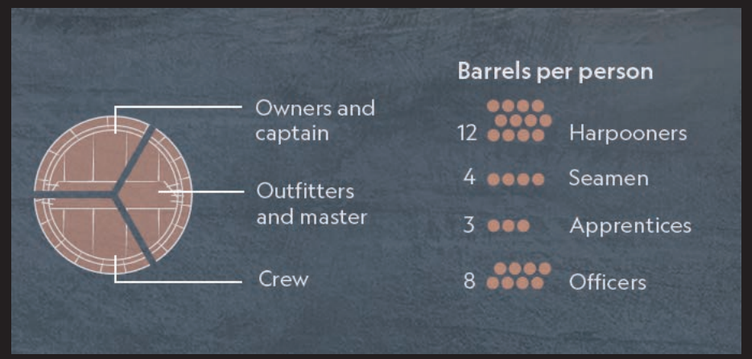


Represents elements in graphic related directly to the Basque Whaler's prize: whale blubber

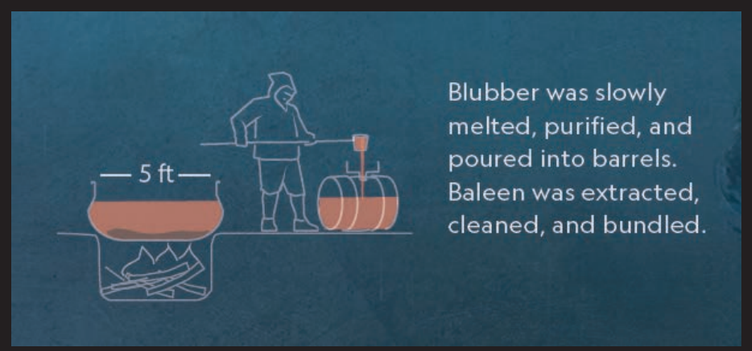
Highlight color used in graphics



Whale oil cargo

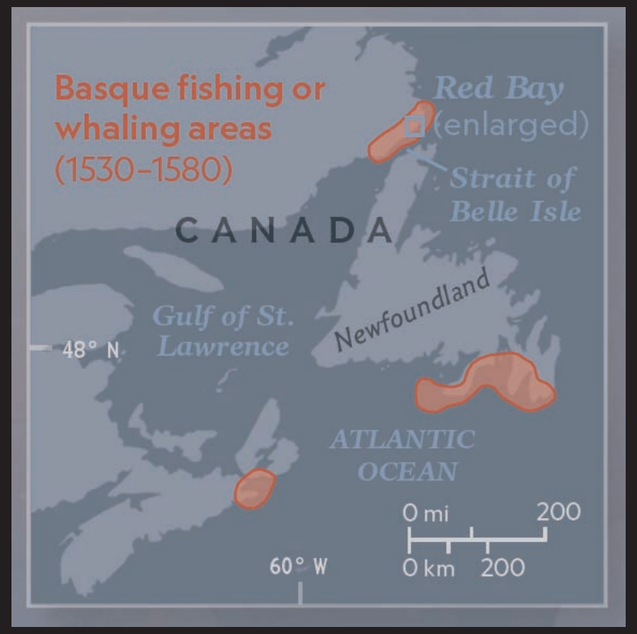


Spoils allocated to whaling crew



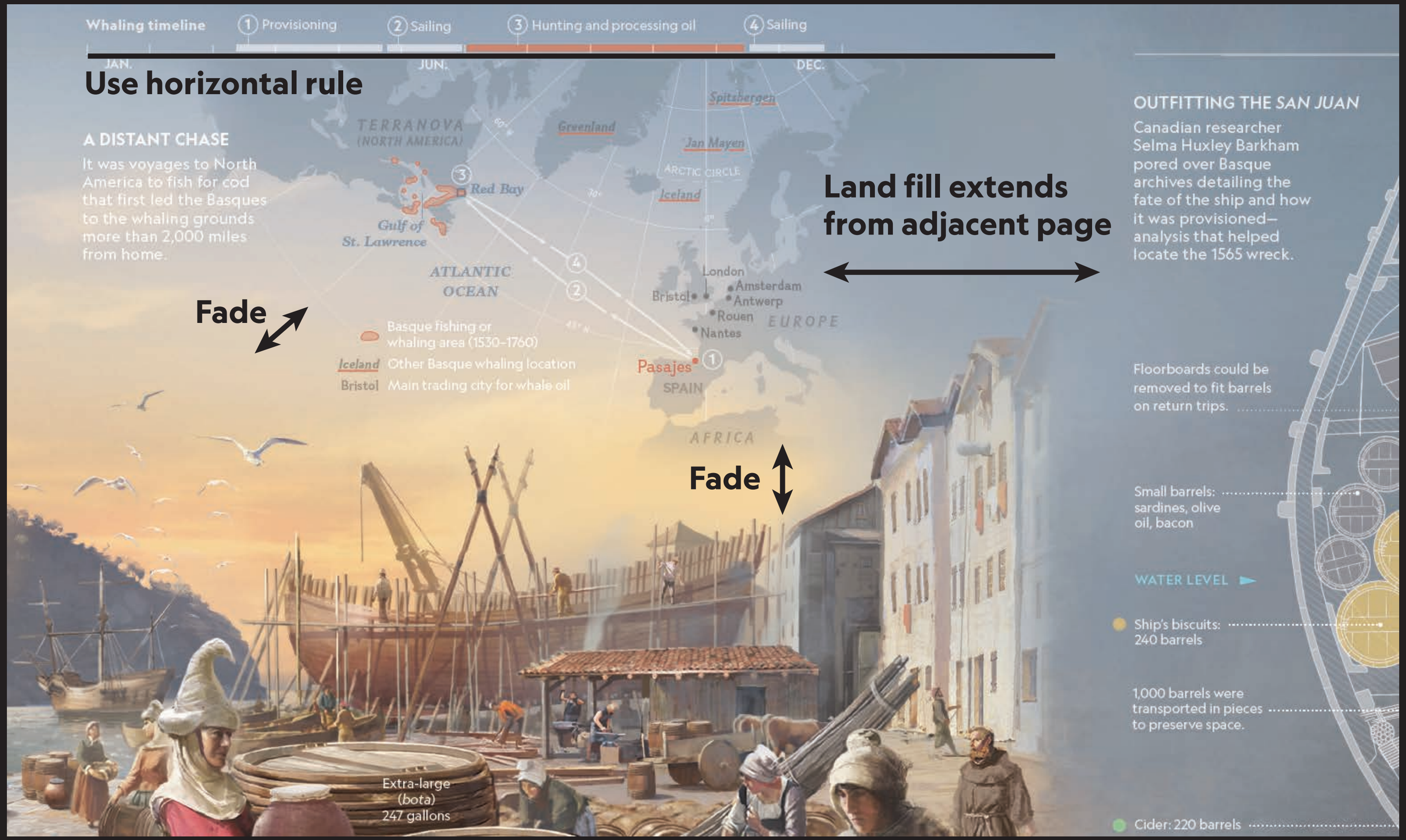
Processing blubber into oil

Highlight color used in maps

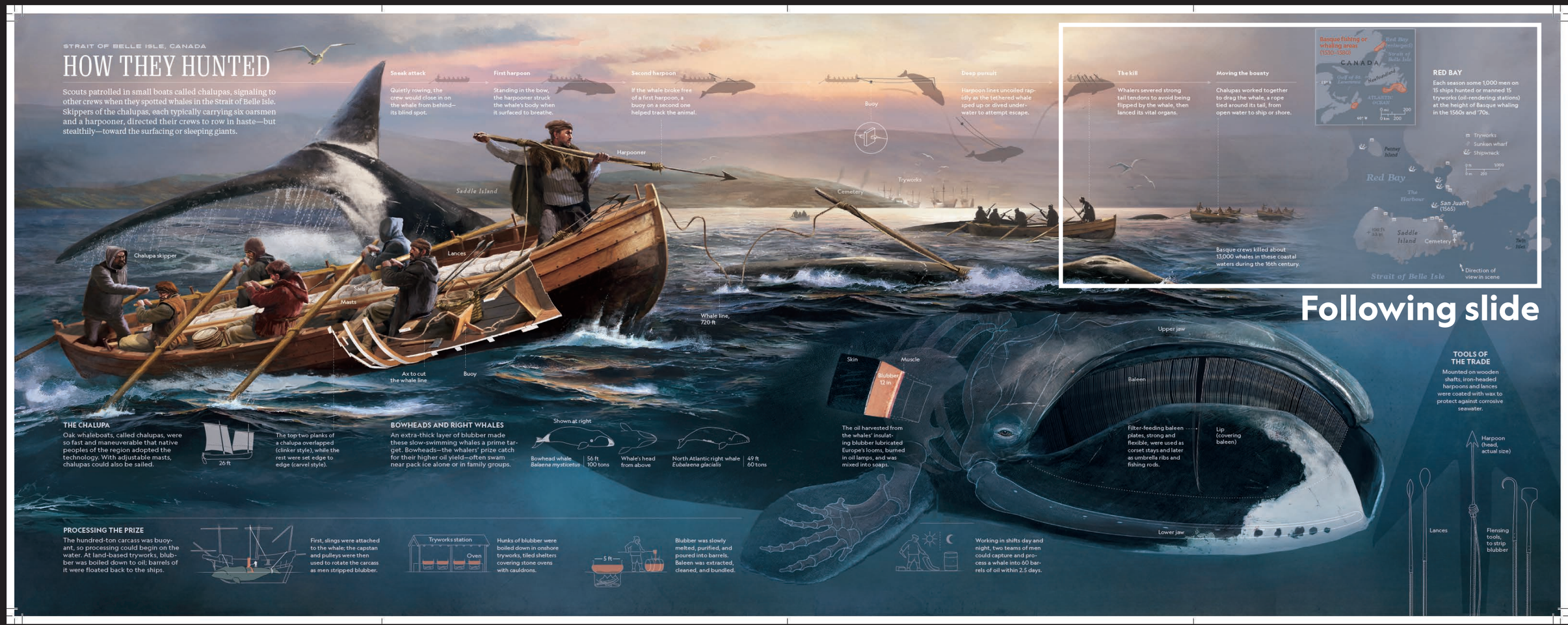


Basque whaling and fishing areas

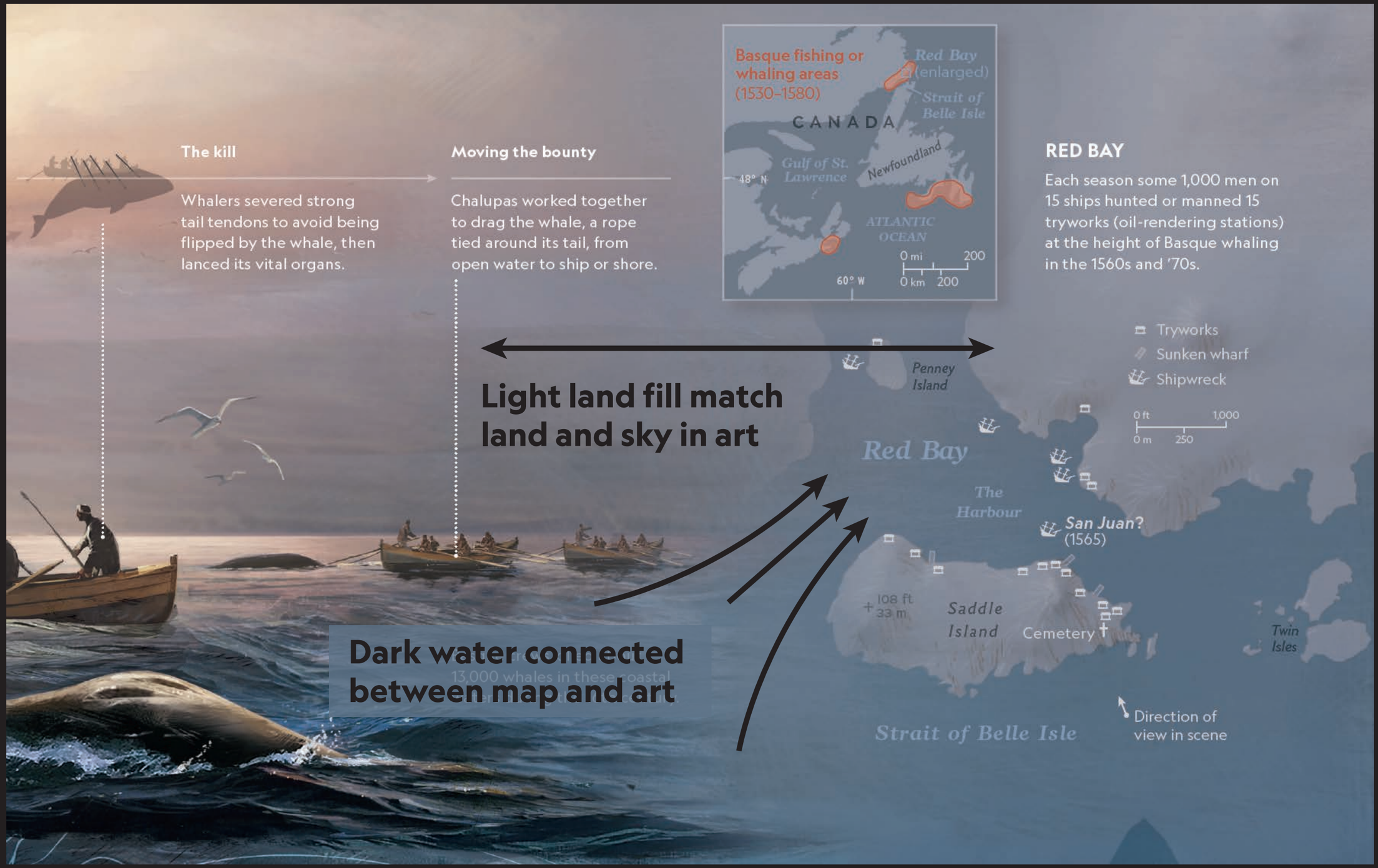
Limit hard edges

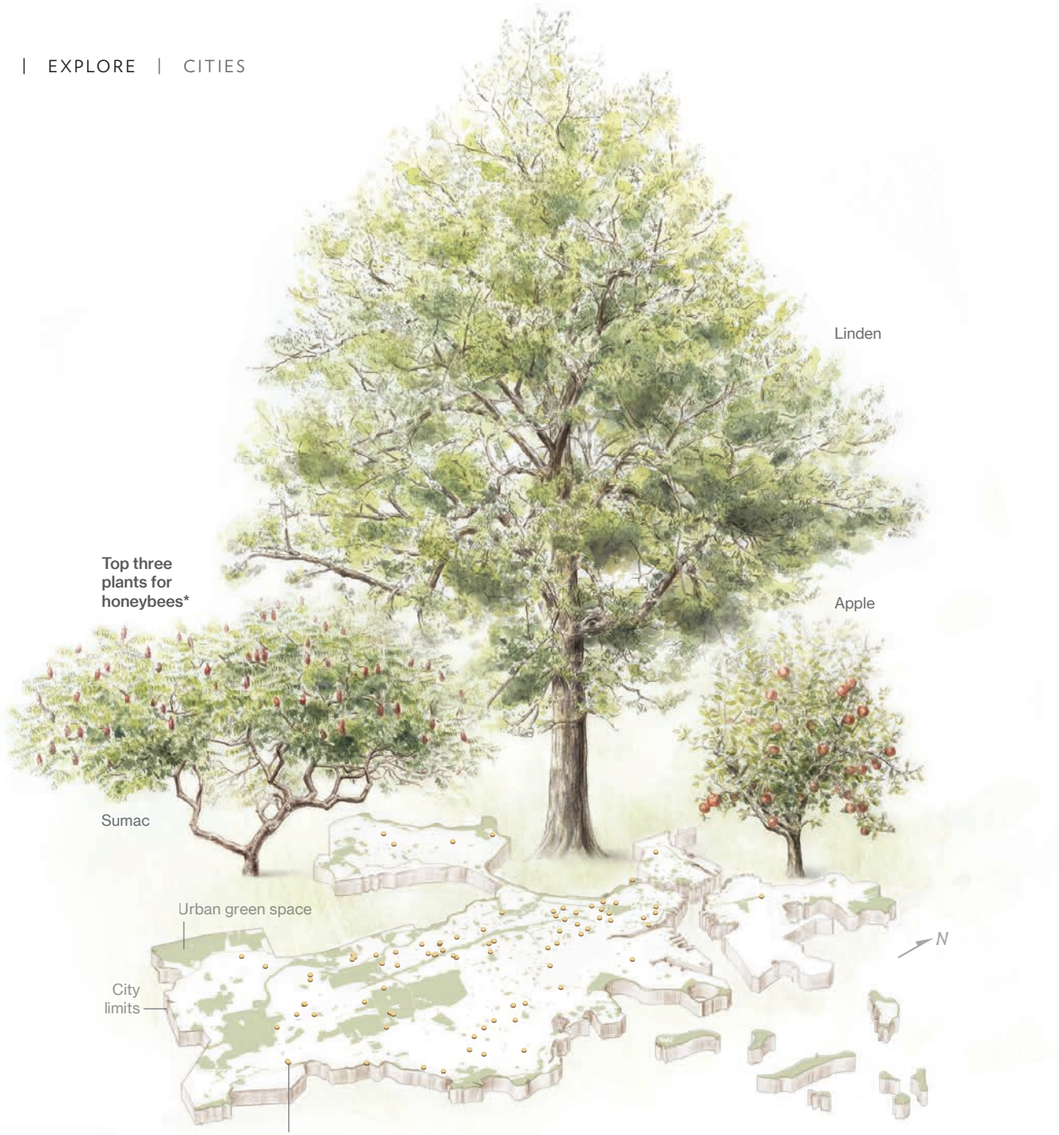


Water flows together



Water flows together





BOSTON *(total land area: 48 sq mi)*†
The number of managed hives in Boston grew from just a handful in past decades to more than 175 today. One honey sample from the city contained 411 plant species – diversity that helps urban bees flourish.

Western honeybee, actual size

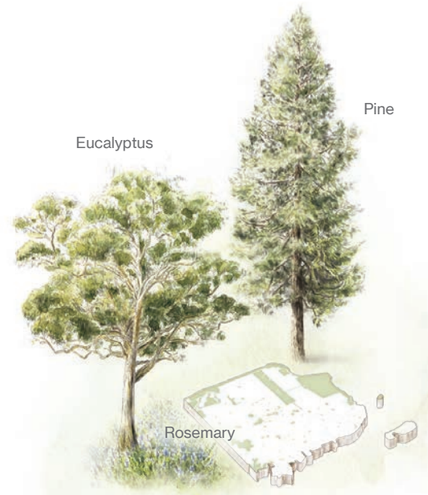
A DOLLOP OF SWEET SCIENCE

By Kelsey Nowakowski

Like wine and beer, honey has an array of flavor notes that can be tricky to pinpoint. A honey's taste is influenced by the types of nectar and pollen bees collect. But until recently scientists couldn't say precisely what bees fed on or where.

Now, by sequencing the genetic material in honey, scientists can tell which plants are in the sweet stuff. Noah Wilson-Rich, founder of the Best Bees Company, an urban beekeeping service, heads a study profiling the DNA of honey from major U.S. cities.

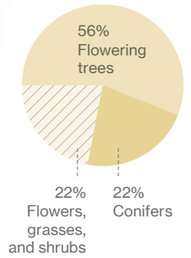
Samples are taken from hives in city centers. DNA tests reveal how many plant species honeybees visit within the foraging range of three to five miles, showing what plants they prefer. Wilson-Rich says higher plant diversity in urban areas could be one reason that city hives are healthier and more productive than many rural ones.

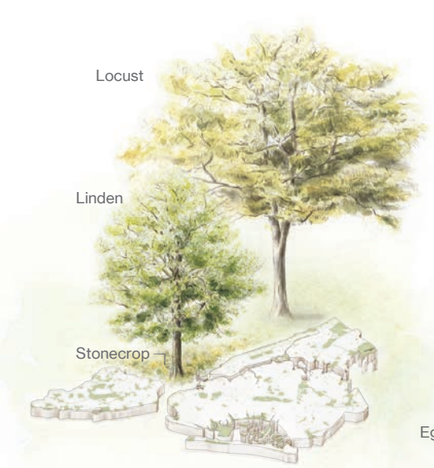


SAN FRANCISCO *(47 sq mi)*
Hospitable climate and residents combine with no restrictions to make the city a haven for bees.

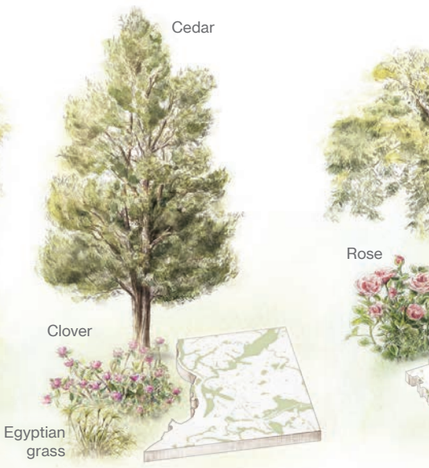
SEATTLE *(84 sq mi)*
A leader in urban farming and sustainability, Seattle was an early adopter of beekeeping regulation.

What's in city honey?
A high diversity of plants – even nonflowering ones – helps bees thrive in cities. Insects that feed on sap-producing plants such as conifers expel honeydew, a sweet secretion that bees collect and make into honey.





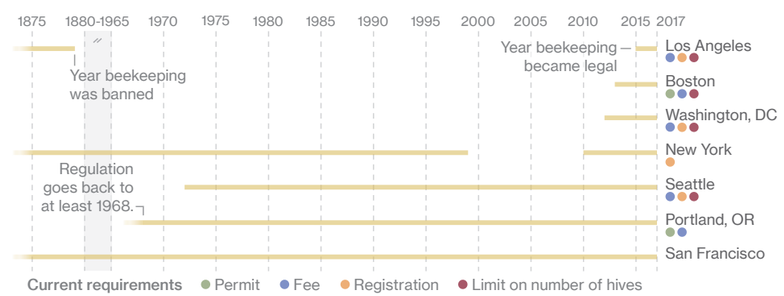
NEW YORK *(303 sq mi)*
Even luxury hotels host hives: The InterContinental in Times Square uses its rooftop honey in cocktails.



WASHINGTON, DC *(61 sq mi)*
In a test to see where bees can prosper, D.C.'s wastewater treatment plant has four hives on its roof.

PORTLAND, OR *(133 sq mi)*
It's called the City of Roses, and the flower is the most prominent plant in its honey DNA.

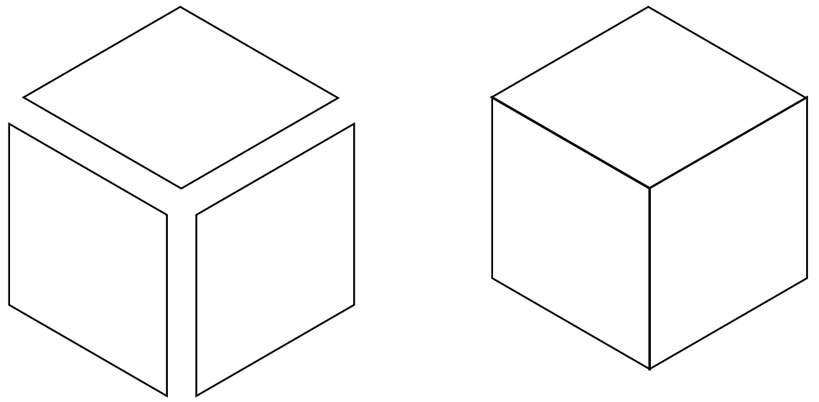
Making city bees legal
Los Angeles outlawed hives in 1879 due to misguided fears that bees attacked fruit crops but joined other major U.S. cities when it legalized hives in 2015. Beekeeping was often present before city regulation. Currently most cities require that hives be kept a certain distance from property lines.



*RESULTS BASED ON PRELIMINARY DATA. PLANTS NOT DRAWN TO SCALE
†CITIES NOT DRAWN TO SCALE

DAISY CHUNG AND CLARE TRAINOR, NGM STAFF. SOURCES: NOAH WILSON-RICH, THE BEST BEES COMPANY; USGS PAD-US; U.S. CENSUS BUREAU; DISTRICT OF COLUMBIA; CITIES OF BOSTON, LOS ANGELES, NEW YORK, SAN FRANCISCO, SEATTLE, AND PORTLAND, OREGON

Visualize maps in 3D perspective.

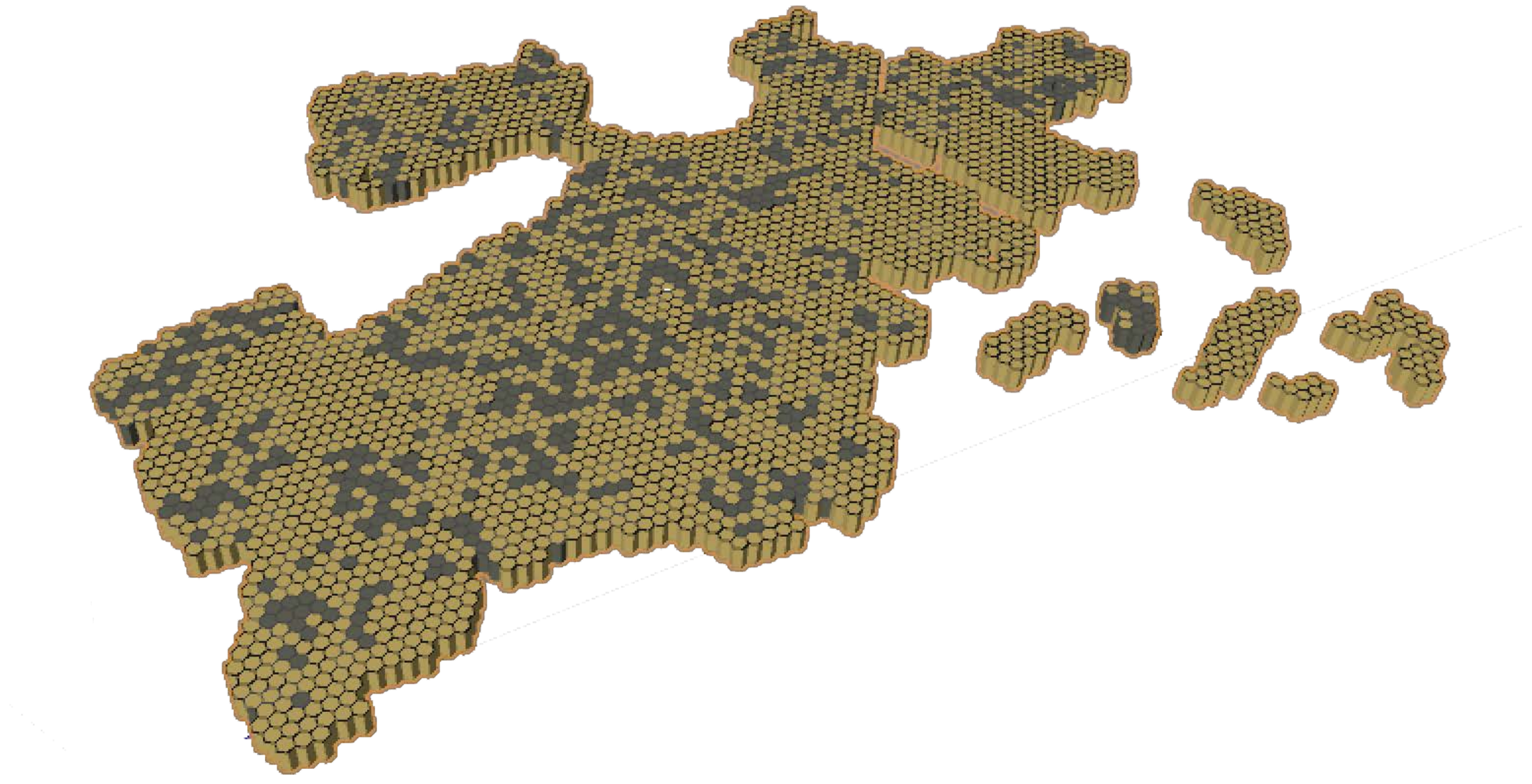


Create line work in illustrator
and then trace over it by hand.

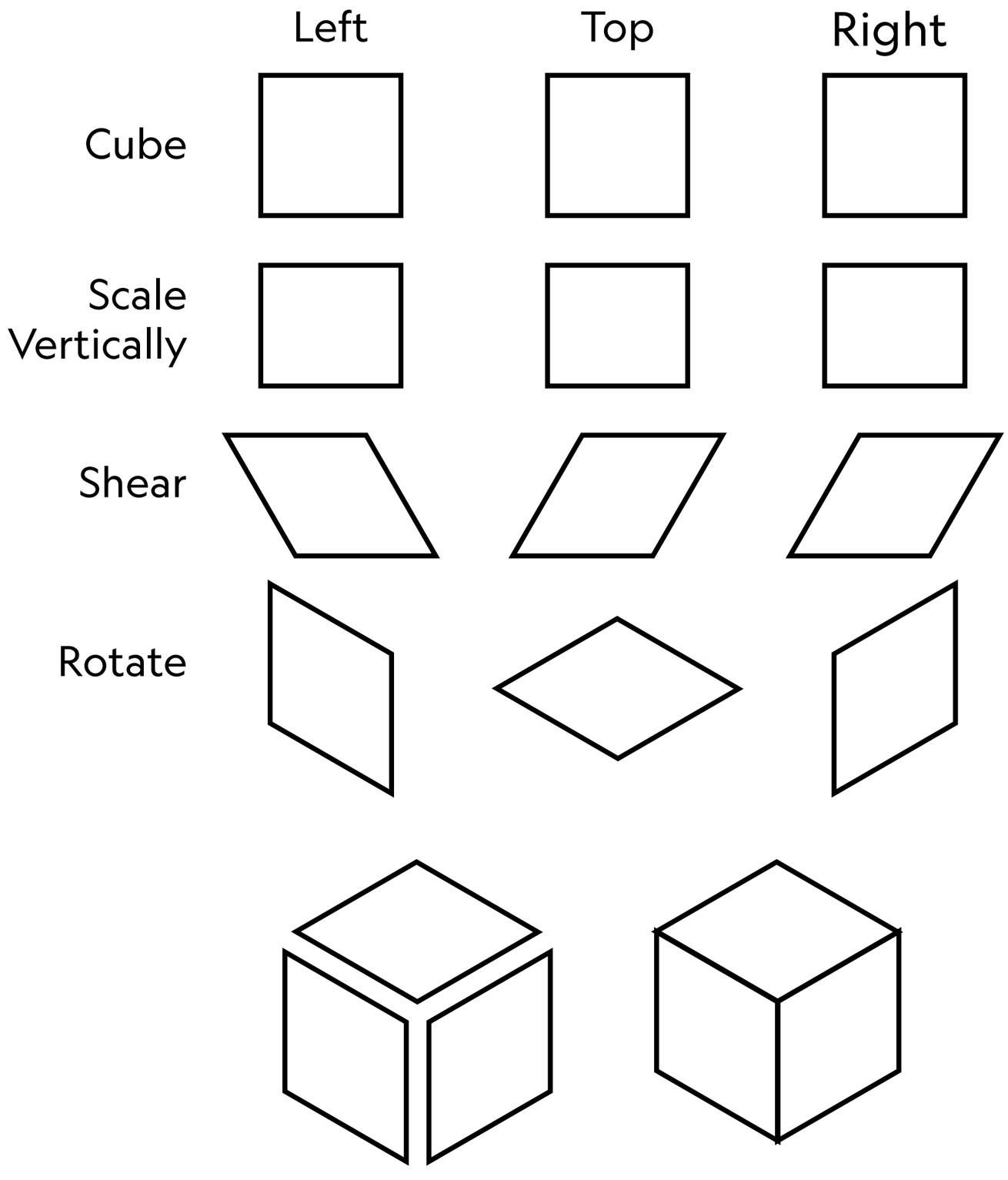
Use a consistent watercolor style.

Original ideas

Other ideas

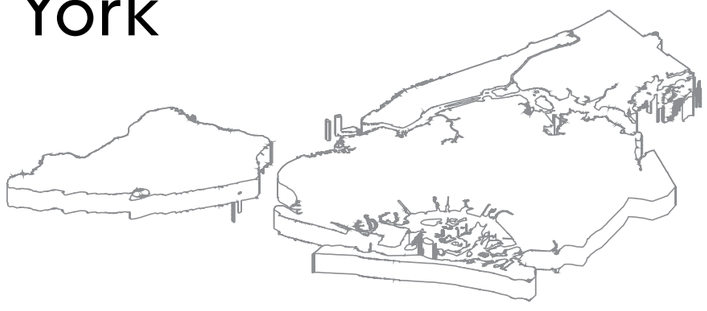


Isometric perspective



Boston

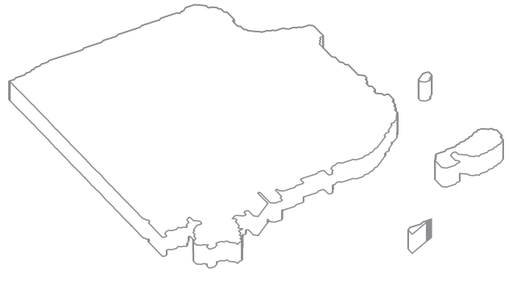
New York



Seattle

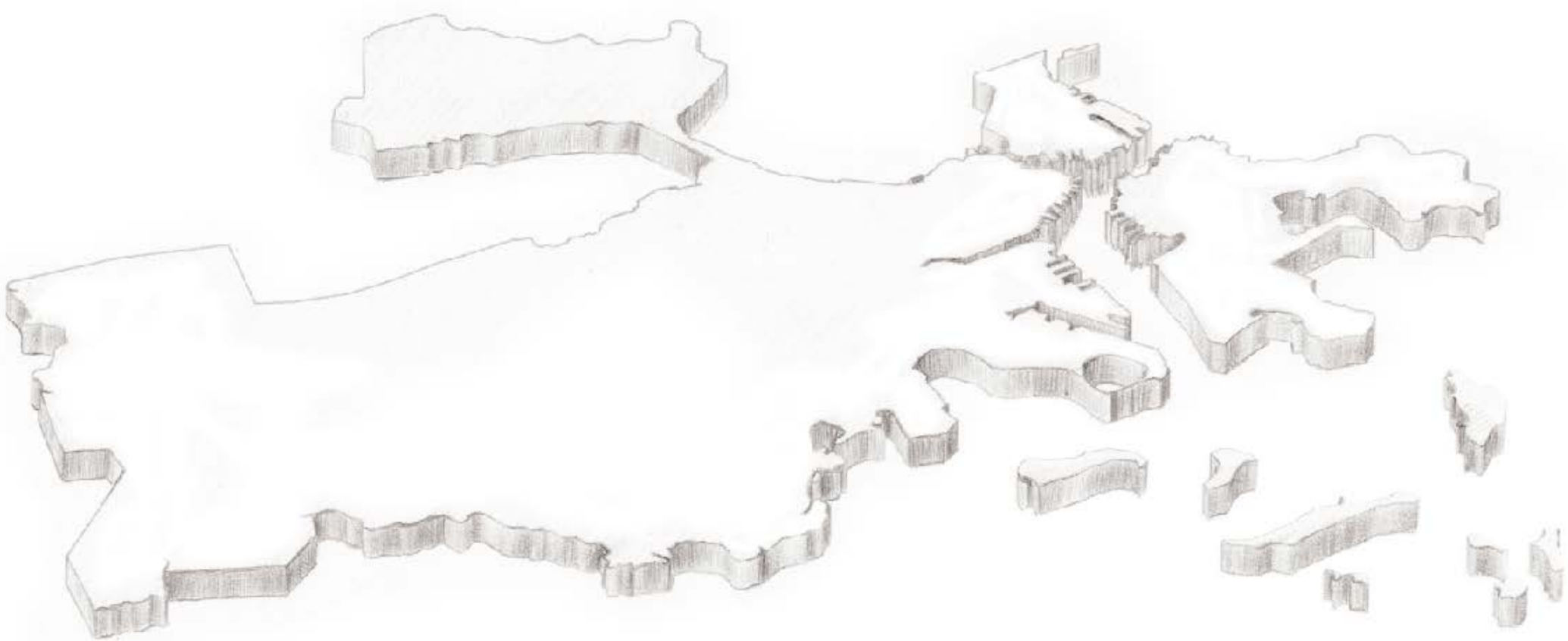
DC

San Francisco

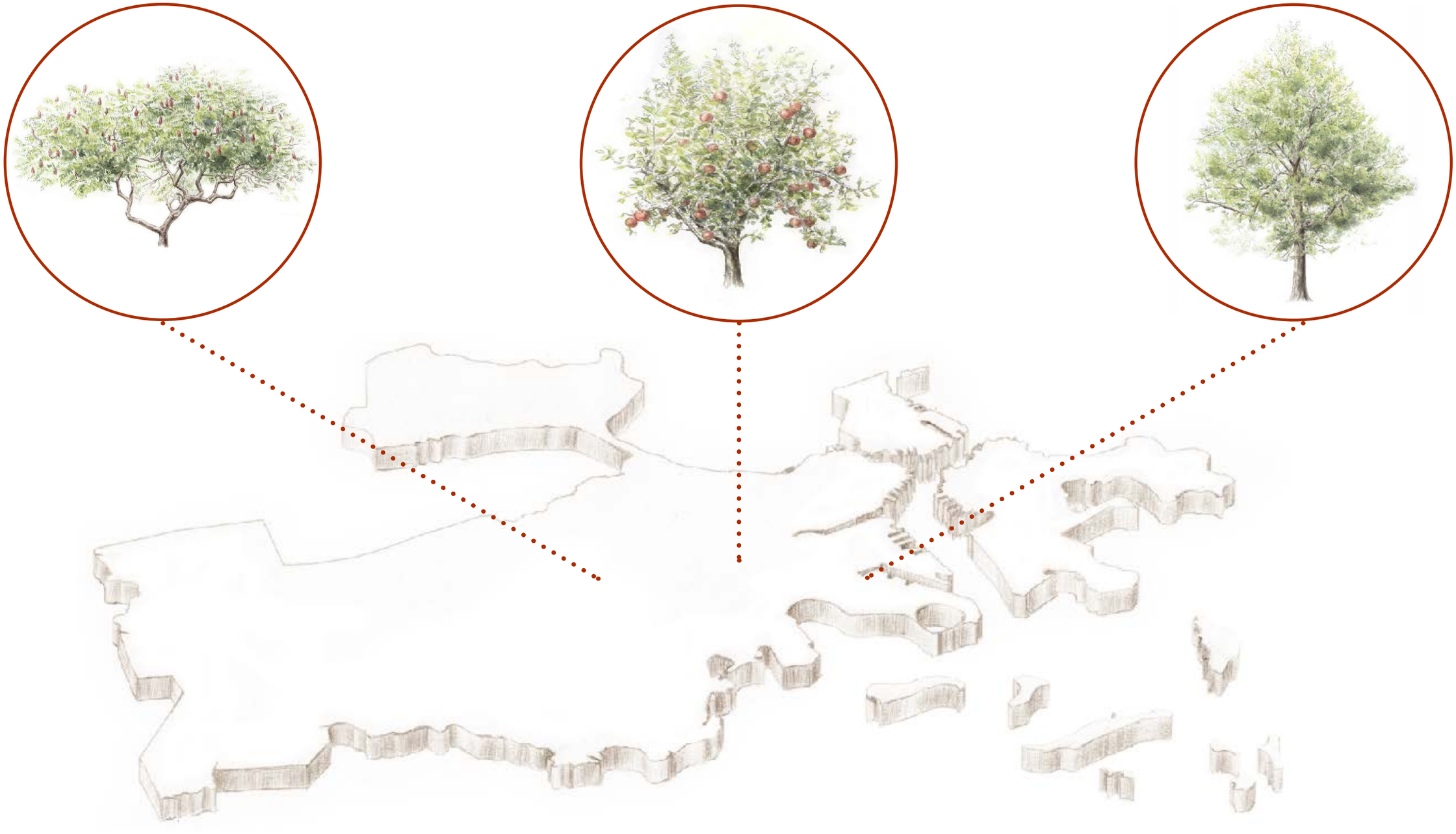


Portland

Vector lines to art



Create a consistent watercolor style



Match to the art treatment

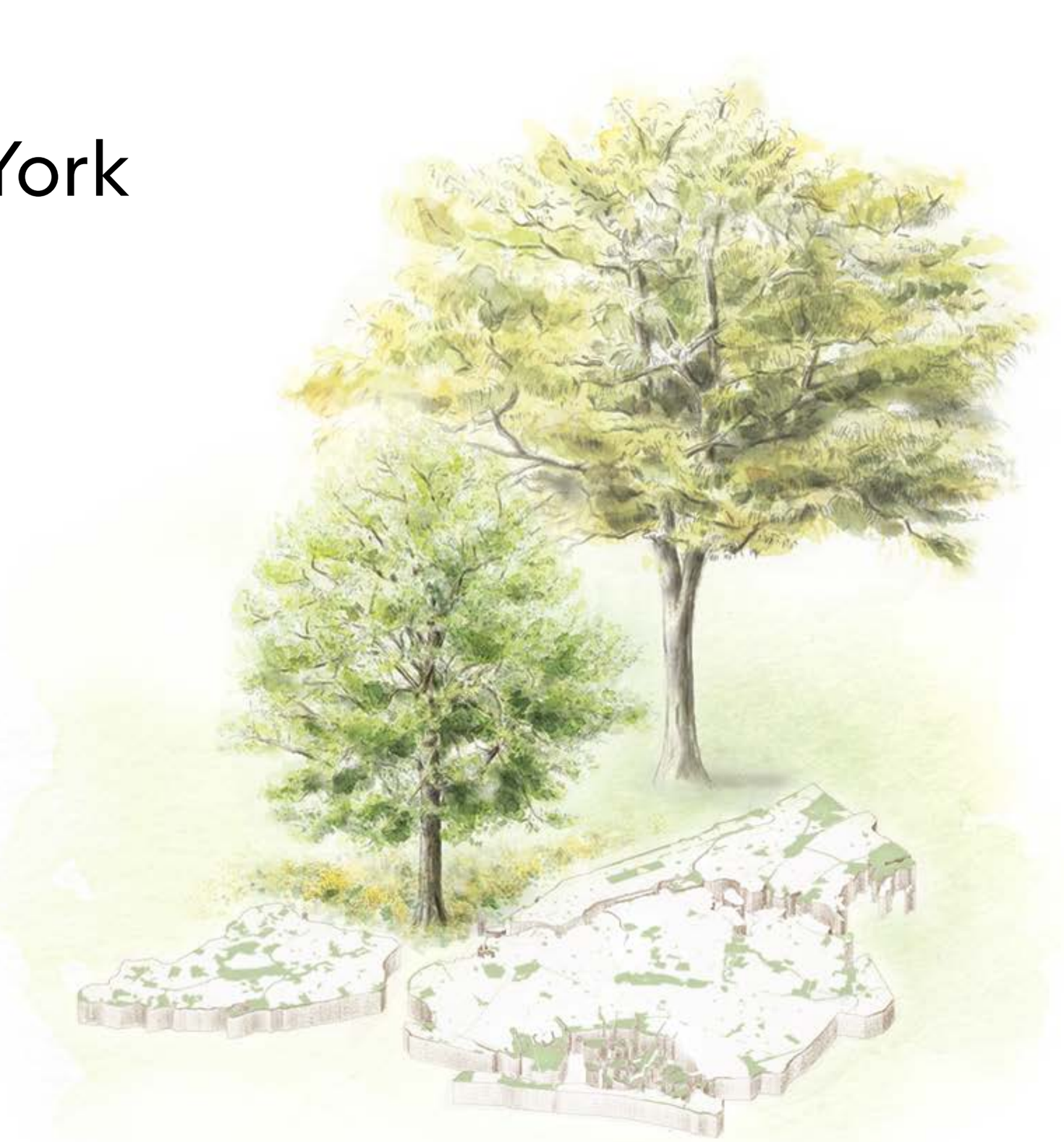
Boston

San Francisco

Seattle

Portland

New York



District of Columbia

THANK YOU!

Clare Trainor @ClareMTrainor
Riley Champine @rileydchampine

Special thanks to...

Fernando Baptista @fg_baptista
Daisy Chung @daisychungart