Habitat Earth

DRAFT Script • Version 2.4 • Story Reel 110 • Times Frames Shots • 27 October 2014

:13 00390 hm010	We live in a connected world… Objects and ideas travel around the globe—nearly instantly or laboriously slowly.
:30 00900 hm010	These massive shipping containers will make their way across thousands of miles of ocean. Our cities and economies grow along these connections, nodes on a network that defines much of modern life.
:57 01720 hm010	But this world we have built exists within and alongside a more ancient, evolved network. The tight-knit fabric of the natural world. If we take time to look, to listen, we can begin to sense its allure.
1:26 02590 hm020 in010	We start to see relationships and connections far removed—and yet not so different—from our day to day existence. A multitude of birds—sandpipers, avocets, and curlews—probe the shoreline for invertebrate prey. And this tall, white egret stands stock still, waiting to grab its breakfast.
1:55 03450 in010-020	Some animals find their food with a more dramatic flourish. This Forster's Tern spots a herring from above and plucks it from the water.

2:13 04000 in020-030	We animals can't produce energy on our own: we need to eat. Through their feeding relationship, the tern and the herring share a bond, a connection. They play different roles in a community of organisms, interacting with their environment… And with each other. Ecosystems lack hard boundaries, but we can recognize in this place the elements of a network, actions that define a web of connections.
3:05 05550 kf010	Far away from our portside park, in this underwater forest, kelp grows tall, reaching toward the sunlight above. Its fallen blades litter the seafloor below, providing nutrients for a host of creatures…
3:27 06200 kf010	Including these spiny purple sea urchins, which move slowly in search of food.
3:40 06600 kf020-030	Sea urchins make a tasty meal for this marine mammal. Sea otters help keep the sea urchin population in check. Too many sea urchins will devour living kelp, destroying the forest. We consider otters a keystone species: their sea-urchin diet protects the kelp and helps to maintain diversity and balance in this ecosystem.

4:19 07760 kf040 kf045	But we're seeing just one small part of an intricate network… Sunflower stars also prey on sea urchins—and may become dinner for a hungry sea otter! But otters prefer abalone and crabs. Kelp provides food and shelter for snails as well as crabs and their tiny crustacean cousins. They find some protection among the kelp blades, but small fishes can still surprise them! All these animals and plants are immersed in a rich food source—a sea of microscopic phytoplankton drifting in the water.
5:08 09230 kf050	From the smallest microbes to the largest animals, these species take part in a diverse **food web** that links more than a thousand species. The connections in the web represent the transfer of energy with every meal. Where does all this energy come from?
5:31 09930	Our star, the Sun, drives all this activity. It supplies energy for almost all life on Earth. Kelp and phytoplankton, with their ability to capture the Sun's energy, are known as primary producers. We consumers would be nowhere without them.
5:57 10690 am010	Like kelp, trees on land also reach upward, competing for sunlight that fuels their growth… Each tree transforms carbon dioxide in the air into leaves and branches, deep roots and towering trunks. These Douglas firs, some of the tallest trees on Earth, rise above others to absorb most of the Sun's energy. They seem peaceful and at rest, but they work tirelessly.

6:31 11730 am020	Much of the trees' activity happens out of sight, underground. During the day, the largest trees draw water from deep beneath the forest floor… At night, they can spread water back into the soil, benefitting their neighbors.
6:55 12450 am020-030	Trees thrive on air, water, and sunlight, but they need other nutrients, too—especially nitrogen and phosphorous. To nourish themselves, these Douglas Firs orchestrate a transaction that extends from the forest's floor to its canopy. But they **can't** do this job on their own.
7:21 13220 am030	Knitted through the tree roots and soil, fungi bind trees to the ground—and to one another. We typically see only the fungal fruits that poke above the soil—mushrooms! Let's dive below ground to take a closer look.
7:52 13800 am030-ts010	Living fungal threads called hyphae connect the mushroom to an underground network. Ants help maintain healthy soil, aerating the dirt, circulating water, and moving nutrients around. Tiny moss mites dine on miniature worms called nematodes…
8:22 14680 ts010-020-030	The nematodes dine on single-celled amoebas, far smaller than our eyes can see… Amoebas consume even tinier bacteria… And bacteria also need to eat! They feed on the remains of previous generations of forest dwellers. In nature, nothing is wasted. The fungal hyphae decompose matter, too, and we can follow them toward the roots of the Douglas Fir.

9:03 15930 ts030-040-050	The fungus wraps around the root tip. Viewing a slice through the root, we see hyphae pushing into the spaces between the tree's cells. At the molecular scale, a chemical exchange takes place. The fungus supplies the tree with much-needed minerals, while the tree provides the fungus with energy-rich sugars. Nutrients for energy: a fair trade.
9:42 17430 ts050	Water provides the medium for this transaction, and the tree's thirsty roots draw the nutrient-filled water toward the trunk…
9:53 17780 nt010	This Douglas Fir acts like a giant water pump. Thick bark protects thin layers of tubes where fluids move up and down the tree.
10:05 18140 nt010-020-050	Far above us, in the tree's needles, photosynthesis takes place. The tree uses sunlight to produce energy-rich, sugary sap that flows down the outermost layer of tubes… But deeper inside, we find hair-thin fibers that transport water skyward. We're heading along a direct route that connects the deepest roots to the highest needles, where water is needed for photosynthesis.
10:57 19680 fn010	Water escapes from tiny pores on the needles. This helps keep the forest cool, and water vapor can collect into clouds and eventually fall as rain. Recycling water, forests transform their local weather. And collectively, plant life influences climate around the globe.

11:34 20800 fn010	Water and weather connect widely-separated ecosystems, and from this vantage point, we can now seek a new perspective—one that embraces the evolved network that connects individual species to global phenomena.
11:54 21390 fn010	Trees exhale water that eventually travels along rivers to the sea, carrying sediments, nutrients, and life along with it. But some members of the ecosystem reverse this flow.
12:09 21850 ss010	In this river, salmon that feasted in rich, offshore seas swim back upstream to spawn in the cool headwaters. These fish exhaust all their energy in travelling and reproducing, then perish in streams far inland. Their sacrifice provides safety and nourishment for their unborn young…
12:32 22800 gd010-020	But it also links inland forests to the distant ocean. The salmon carry nutrients from feeding offshore, and the streams to which they return show increased health and productivity. Eight native species of salmon inhabit the forests that circle the North Pacific, each performing similar roles in countless small rivers and streams—with benefits felt deep inland. They enrich a vast region of North America and Asia.
13:13 24020 gd020-030	Life in our forests and oceans exerts a global influence. Earth-orbiting satellites can measure the amount of carbon dioxide absorbed by plants. Bright regions on this map show where producers devour the most carbon dioxide, turning energy from the Sun into living matter.
13:42 24930 gd030	Life requires other raw materials as well. As water flows from the continents to the sea, it carries nutrients that can increase productivity offshore. From space, we observe vast “blooms” of phytoplankton near where rivers enter the sea. These microscopic photosynthesizers form the base of the ocean food web.

14:13 25830 gd040	And because these plants depend on sunlight, **all** ocean life responds to changes in the seasons. In spring, when sunshine strikes the cold, nutrient-rich waters of the North Pacific, productivity skyrockets…
14:33 26100 gd040	In summer, whales arrive in the north, feasting on krill and small fish taking advantage of the productive seas. As the waters cool in the autumn and winter, the whales follow the sun, fanning across the Pacific over a period of months. These ocean-going giants connect disparate parts of the globe.
15:02 26990 gd050	Our ships cross these waters, too, making the trip in mere days or weeks. These shipping lanes connect human societies, but they also link the biological environments through which they pass, often carrying species from their native ranges into new territories.
15:34 28230 gd060	Like whales, birds also migrate to take advantage of summer's productivity, feasting on the season's abundant insects. Here in the Northern Hemisphere, birds follow the sun's path southward during the winter, along routes made familiar over evolutionary time. Like other great migrators, they connect widely separated regions—living links between faraway places.
16:15 29850 gd070	Modern humans make much faster aerial migrations, traversing continents and oceans in a matter of hours. Airline flights connect our species in an unprecedented way, bringing people, countries, and continents much closer together. But we fuel these flights without the efficiency of nature's solar-powered systems.
LIVE SEGMENT	**We have set ourselves up to address a variety of topics in the live section.** **End with the question of how humans fit into this story…**

16:41 30220 gd080	Human influence is felt around the globe—and indeed, our species has changed the entire planetary habitat. Let's turn back the clock to find out how…
16:56 30700 gd090	After the most recent Ice Age, some 10,000 years ago, our ancestors invented agriculture. They began to cultivate plants for food, and eventually rear livestock for meat and milk. These innovations began in several places around the globe, and the ideas spread rapidly. People took over land to raise animals and plants, in the regions shown here in green. The ability to store crops allowed human populations to expand. Towns and cities, seen in yellow, fueled the need for even more agricultural activity. Humanity's hunger changed Earth's ecosystems. As land shifted from wild to cultivated, we unraveled networks that had evolved over millions of years.
18:03 32700 gd090-100-110	And in the last few centuries, technological developments have accelerated the pace of change. The sheer number of people on our planet, the industries that have developed to feed our growing population, the massive diversion of water, and the rapid spread of cities—all these factors have made our world a very different place. We have worked hard, with no small success, to feed Earth's growing human population. But this effort comes at a great cost.
18:44 33950 gd110-120	California's Central Valley feeds millions, but its fertilizers and pesticides wash into the ocean—much of it passing through San Francisco Bay.
18:56 34310 gd120	From the opposite direction, the Bay's busy ports bring products from around the globe. But ships have also transported many stowaways—clams, crabs, sea slugs, and jellyfish, just to name a few—making it the most invaded aquatic environment on Earth.

19:18 34960 gd120 fw	These invaders have changed the Bay. Scientists study the changes and catalog the participants. We can visualize this complicated web of interactions… We start with the herring and the tern. Then add the producers and other consumers, prey and predators, all linked together. Scientists wrestle with understanding this complex food web, but we have learned that the health of an ecosystem depends on the number, strength, and diversity of these connections.
20:00 36220 fw	We know that the Bay does not look the same as it did a century or two ago… And although we don't know when many of these invasive species arrived in the Bay, we know that people brought them here. These newcomers nudge aside native species, breaking some links and creating new ones, testing the resilience of this complex network.
20:31 36880 vn	Our presence has changed the Bay, and similar stories of human impacts have played out around the globe—including places we have already visited. As we look to the future, we must find new, sustainable solutions to the challenges we face.
20:52 37530 - vn	We establish terrestrial protected areas and marine sanctuaries that allow ecosystems to thrive…
21:01 37800 - vn	We protect watersheds and make choices about what we eat, where our food comes from and how it is produced…
21:10 38050 - vn	And we look for new ways to preserve the resilience of living networks.

21:17 38290 cw010	We live in a connected world—inhabitants of a global ecosystem, an evolved network of species and environments. We have much to learn from these systems—finding strength in diversity, proficiently recycling water and nutrients, powered only by the light of the Sun.
21:38 38920 cw010-020	We must value our connections to other species and to Earth as a whole. Out of sight and out of mind, these relationships recede to the periphery of our modern existence. But if we pay more attention, we will better understand, and learn to protect, the vast networks that support life on our precious habitat Earth.