EARTH, WIND, FIRE AND WATER.

SPONSORED BY ROCKY MOUNTAIN NATURALISTS WITH SUPPORT FROM BC HYDRO AND BC NATURE FEDERATION OF BC NATURALISTS.

I am Janice Strong the photographer, author and narrator for this presentation. People know me in the East Kootenay of south-eastern BC as an outdoor photographer and hiking guidebook author.

Along with my husband Jamie we co-researched and took all the photographs for this production. Through our photography I will take you on a fascinating exploration into many things that connect the planet earth to our biosphere and to all of life.

Earth, Wind, Fire and Water. They are collectively known as the 4 elements and with them everything on earth is networked in some way. The minerals in rocks are woven within every animal cell and are essential for all life. Our atmosphere is tied to the molten core of earth. The rainfall and oceans contributes to species diversity.

All ancient civilizations from as far back as 5-thousand-years-ago in Mesopotamia the people wrote about these same four elements. They described the connections of things that shape our lives and planet.

With Today's vast knowledge of the earth sciences and their network of connectivity --- talking about these 4 elements is just as relevant in the present, as it was for the ancients.

Earth Wind Fire and Water has shaped humanity, technology, geology and biology.

Earth section I will talk about:
How various rocks were formed and their interactions with life.
How single cellular organisms changed the rocks and oxygenated the atmosphere.

Wind element is climate and air. I included plants in wind because plants make their structures from the air.

Fire sustains our economy with the burning of fossil fuels. Insects, birds and animals also need to work with combustion as they use the oxygen to ramp-up their cell metabolism.

Water is the substance that makes all of life possible.

Every living thing is either; making something, using something or transforming something.

Biodiversity starts at the very small and it affects biodiversity of the very large.

**** Through the interactions of these four elements and great expanses of time, mountains can be built and eroded, ocean drained and uplifted, Volcanoes can bury huge swaths of the earth under ash or lava or make new islands in the sea.
Glacier cycles can come and go, while the continents can slip around the earth's surface moving great distances and in doing so crash and fold the rock.

And through all of this life evolved.

From rocks to consciousness.

It's a concept we have been contemplating since mankind had the ability to ponder such things.

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But before life got started. Our beginnings started away back in time and space. These images were taken with our telescope and night photography equipment.

This is the ***Orion Nebula*** in the Orion Constellation. It is a birthplace of stars. Stars like our sun might have formed in a nebula like this.

The spiral shaped ***Andromeda Galaxy*** is very similar to our own galaxy. Though Andromeda is 2.5 million light years away -- it is our closest spiral galaxy neighbour.

These star-images are our home galaxy -- the ***Milky Way***. From where we are on earth, we are looking outward along the edge of our own galaxy.

Stardust soaring across space to earth from distant stars or super-novas brings in carbon, nitrogen, oxygen and all the rest of the heavier - atoms like metals. These atomic elements are essential for life to get going and continue on our planet.

Blasted material from thousands of comets also primed the conditions for life on earth. Comets contain water and inorganic compounds. This is ***comet Hale-Bopp*** that flew over much of the northern hemisphere in 1996. We were able to photograph it for about a month.

The ***Northern Lights or Aurora Borealis*** are the result of impacts between gases in the upper atmosphere colliding with high-energy particles streaming to earth from the sun. The gasses light-up or fluoresce similar to what happens in a fluorescent light bulb.

The colours depend on which gases are involved in the collisions. The most common colour is the ***pale yellowish – green*** happens when oxygen fluoresces – 100 kilometres – (60 miles) above the earth.

But go up even higher; up to 350 kilometres (200 miles) above earth, it's also oxygen that fluoresces. But, instead of pale green the high-level oxygen fluoresces to show the rarely seen – ***completely red aurora.***

When the northern lights glow to ***blue and purple colours,*** it's because of nitrogen fluorescing.

The moon is another essential component for life to be sustained on this planet. The moon stabilizes earth's wobble in space. And in so doing the moon prevents extreme climate fluctuations.

The tides are caused by the moon's gravitational pull. Tidal action creates habitat zones for species diversity. Tidal regions are often estuaries and are used by countless species in for fish, birds, reptiles and mammals.

Add some electromagnetic energy in the form of electricity mostly from lightening sparks add a couple dozen volcanic eruptions.

Stir and wait … Voila Complex Life.

Well complex life didn't start -- immediately.

In order for life to have evolved on earth we needed another key component.

Here is a clue by
JR Tolkien in the Hobbit – "a Gollum riddle"
"This thing all things devours:
Birds, beasts, trees, flowers:
Gnaws iron, bites steel,
Grinds hard stones to meal:
Slays king, ruins town,
And beats high mountains down."

It is … Time.

It took a couple billion years for complex life to emerge on earth.

Our planet is estimated to be about 4.5 billion-years-old. The oldest fossils of single cell organisms are about 3.8 billion-years-old. That means from the earth's formation it took only 700 million years (or 3/4 of a billion) for the simplest life to emerge in the fossil record. But it took 2 more billion years for life to evolve from single cellular organisms into complex multicellular.

If you want to get an idea how large a billion is … Count one number every second and it would take thirty years to reach a billion.

The first element is Earth

Earth: is the foundation for all the other 3 elements.

Geology creates beautiful landscapes of rock, carved by glaciers, layered by sedimentation, or sculpted by wind or water.
These rocks on the beach are the effects of big majestic mountains being broken down. Their cycle isn't over. They will continue to break down into sand or clay -- adding another layer of sediment to the sea floor.

And in a whisk of geological time, the deposits of seafloor sediments may again be pressed into stone only to be uplifted someday into mountains.

But mountains are not permanent. We experience only the illusion of permanence through our tiny snapshot of human life span.

Tectonic forces and erosion will crumple that rock, turning them once more into sediments that wash down rivers to the ocean. And around goes the erosion cycle.

Layers of rock twisted vertically were once ocean sediments that were laid down thin layer over layer throughout millions of years. Then as the Pacific Plate pushed eastward into North America it cracked, bent and folded these strata and sent them skyward as today's mountains.

The mountains then splintered and buckled. Each day a little more erosion works away at the rock from these exposed mountain slopes.

Ripple rocks on high mountain sides were also once sediments washed in waves on ancient beaches or laid out grain by grain, carried by the wind. Earth's movements elevated these ripple rocks into today's mountain ranges. It's another example of the interconnections of everything on the earth.

Glaciers also had their-way with these mountains. These examples are all peaks in the Canadian Rockies of southern BC and Alberta. As glaciers carved the mountains into spectacular shapes, it is as if they used a giant ice-cream scoop to do their work.

This creates *wide sloping valleys leaving behind sharply pointed peaks and ridges.*

Whereas, ***rivers carve with the precision of a scalpel*** eroding deeply sided canyons and narrow valleys.

These fabulous looking ***Hoodoos, by Fairmont in southeastern BC,*** were formed and eroded by glaciers. The moving ice brought gravel and rocks down Dutch Creek and dumped them in 100 metre deep (300-foot high) river deltas and beaches by Columbia Lake. The glaciers also ground up limestone into fine rock- dust known as "rock-flour", which acted as a natural kind of cement.

Then rapid melting of the glaciers quickly eroded the gravel banks – leaving these naturally sculpted monuments of the Hoodoos that we see today.

Life Enhanced the Mineral Diversity

I like to ponder the geological story of the rocks. Rocks are part of the ecosystem just moving at a different time-scale.

Without life on this planet we would not have the extensive mineral variety that we have now. Mineral diversity is partially due to ancient organisms spewing oxygen and other bioorganic compounds into the environment.

Life started from simple beginnings. For half a billion years -- erosion crushed rock into finer grains of mud, silts and clay sediments. These sediments in the oceans mixed with other ingredients forming complex chemistry – and it might have eventually coaxed the simplest life to arise.

Some scientists theorize that the sparks of life may not have started in the volcanic hot vents in the deep oceans as previously assumed, but in the warm water seeps on the ocean floor.

Then as life evolved -- the ground rock, complex chemistry including oxygen and the by-products from living organisms mixed with the environment. Over vast stretches of time these bioorganic compounds combined with minerals in seawater plus a mixture of sediments and the mixture eventually turned to stone. Thus life created compounds that increased the overall mineral diversity in rock types from metamorphic to sedimentary.

Red Rocks Hold a Key to How Life Changed the Atmosphere

I just mentioned how rocks might have created life -- and how life changed the rocks. Now I will describe about how life changed the atmosphere.

The atmosphere today contains a lot of oxygen at concentrations far from equilibrium. And oxygen was originally introduced by microbes – billions of years ago.

The red rocks, in these photographs, contain minute particles of rust made from iron-oxide (which is a combination of oxygen and iron). (FeO) And it's ancient red-rocks that hold a key to oxygen in our present atmosphere.

Let me explain:
Billions of years ago a highly successful type of bacteria – using sunlight – figured out how to crack water molecules. They split water (H2O)-- into hydrogen that they needed to run their bodies and discarded the oxygen.

Those cyanobacteria had just -- developed photosynthesis.

Breaking water molecules for photosynthesis was an abundantly successful strategy for almost a billion years, but it had consequences.

Like all life on this planet -- those early microbes created waste products. In this case they discharged great quantities of the oxygen gas into the seawater.

For a while, -- the oxygen mixed readily with everything including the iron in ocean sediments creating the characteristic rusty red.

When the sediments in the sea -- couldn't absorb any more oxygen, it started bubbling up into the atmosphere.

For most bacteria (even today) -- oxygen is a highly poisonous gas. Those early cyanobacteria let loose so much toxic oxygen into the environment -- that it caused epic level death and destruction.

Too much oxygen (O2) -- nearly wiped out all the inhabitants of earth - 2.4 billion years ago.

As those cyanobacteria microbes were choking in their own waste products -- other types of microbes evolved something extraordinary.

They figured out how to use this toxic oxygen to power for their own cellular energy.

This sparked an explosion of oxygen using life forms that continues to this day.

And the story gets even better. Some of the O2 in the atmosphere became O3, which is ozone. Ozone protects life from the ultraviolet radiation from the sun -- and in so doing life protected life.

As those 2 billion year old -- ancient sediments turned to stone they stayed rusty-red and today some ages of red rocks -- are known as the "banded iron formations."

Now I will describe how different kinds of rock formed

Limestone

Most of the ***classic craggy peaks of the Canadian Rockies are made of massively thick layers of erosion resistant limestone*** (or various forms of limestone such as dolomite).

I think it is amazing that some of the rock forming these mountains were created in oceans by life-forms.

Some limestone was made from the skeletons of ancient shells or corral reefs. As the sea creatures buried each other under layer after layer -- they build up a great weight and pressure on the shallow seafloor about 300 to 500 million years ago.

Aside: The seafloor resting on the earth's mantel is pliable. It is like adding rocks to a layer of mud, the rocks rest on the mud for a while, and then by adding more weight of rock the lower rocks sink into the mud. Leaving the mud layer a similar depth allowing more sediment to layer in on top. This is the same as the seafloor sinking into the mantle a little bit with every sediment layer.

Anyway: …. That shallow ocean covered most of western North America spanning from where the Rockies are today and extending into the prairies.

After several million years – those shells and corral eventually turned into limestone almost a half-a-kilometre thick.

Then the thick layers of limestone rode the crest of the continental uplift and today they are several thousand metres above sea level as todays Rocky Mountains.
It never ceases to amaze me -- that dead sea creatures could create these fabulously scenic Rockies.

Fossils

As some limestone is made from coral reefs and shells of sea creatures, it's not surprising that some of those creatures -- fossilized.
These are some of the fossils we have seen embedded in the rocks of the Rockies and Purcell Mountains of southern BC and Alberta.

How can you tell if layers of organisms made the limestone? Clack two bits of limestone together and if the rock smells like sulphur, it confirms once living sea creatures formed the limestone.

Rainwater and surface runoff is slightly acidic and limestone being alkaline is prone to erode into wild shapes. Limestone erodes and weathers into spikey rocks covering vast sloping slabs.

Most of the world's caves are formed of limestone (calcium carbonate).

Plants don't like to grow in soil eroded from limestone, because limestone is very alkaline and nutrient poor. The plants in the bottom of these photos are growing in soils eroded from shale.

That brings us to the next rock type – Shale.

Shale

Shale is made from sediments of mud, clay or silt that deposited along ancient river deltas and tidal mud flats.

I mentioned that the Canadian Rockies are mostly make of limestone, but Waterton National Park and the surrounding region are layered by shale and mudstones. During mountain uplifting the sedimentary rock around Waterton held together as a cohesive block. Some of it, still features the nearly horizontal layering from its original formation.

This shale of south-western Alberta around Waterton are brightly coloured in hues ochre, red, bronze, green and blue.

Argulites the colours come from different minerals.

One Mountain Range west of the Rockies is the Purcell Range, part of the Columbia Mountains.

Purcell sedimentary layers are much older than that of the Rockies. The Rockies are 300-500 million years old whereas the surface rocks of the Purcells are 600 to well over a billion. Being so old -- there were few multi-cellular creatures to fossilize when the Purcell sediments were laid down. ….

Shale and limestone are still the surface rock types at lower elevations of the Purcells. But on the higher slopes, the older softer sedimentary rock has long ago -- eroded away leaving the exposed Granite.
It's the granite or granitic types of rock of the Purcells that attracts my attention.

The Bugaboo Spires are spectacular examples of granite intrusions and they are over 1000 metres 3000 feet higher than the glaciers that surround them.

These granite towers are uniform vertical rock that rock-climbers love and arrive from all over the world to scale these spires.

When we are up at the Bugaboos we love to hike and climb around the spires. This is my husband Jamie on one of our climbs. --- Zoom out.

We are not rock-climbers, but we are avid hikers and some of our favourite hiking places are around the Bugaboos or other places in the high elevations of the Purcell Mountains of southeastern BC.

A miniature granite intrusion. The rock on the right - orange lichen is granite. The black rock on the left is soft burnt shale. Imagine then when erosion removes all the loose shale – only a cylinder of resistant granite would be left.

I will explain how the intrusions were made…
When the tectonic forces were uplifting the neighbouring Rocky Mountains, the adjacent roots of the Purcell Mountains also felt those movements and pressure.

The Purcell rock being older and softer rock suffered huge cracks and erosions.

While this was happening, -- the granite was not rock at that time, but molten magma -- a frothy and sticky material. It was deeply buried 6 km underneath the surface.

This magma -- squeezed up into those cracks in the Purcell sediments. Taking another 65 million years to cool, it gradually hardened -- into erosion resistant and unbroken spikes of granite.

Much of the surrounding rock has eroded.

Leaving the massive granite towers of the Bugaboo Spires -- we marvel at today.

Here are some of the hiking areas of the northern Purcells. We love the area because it has Abundant wildflowers, plenty of surface water, and fabulous scenery draw us to hike the numerous remote trails of the Purcells.

That ends the earth section

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Wind

The wind element is change and the flow air. A change in the wind -- can alter people's feelings. Wind can bring on elation or feelings of threat. Animals and plants need the wind or the exchange of air through their tissues -- to survive.

Gentle breezes can sculpt sand dunes and create a peaceful calm, but high intensity windstorms can destroy everything. Wind can be highly destructive.

This is our house a few years ago. Half a dozen mature fir trees fell on and around our home.

Wind can flap our flags and air can float our planes

Wind energy is expanding its contribution to our power grids -- while gaining our respect -- wind energy is also fuelling growing controversies.

Our climate and our air are also part of the wind's influences. Wind drives our weather and seasonal changes of weather affect all of our lives.

With Wind, I am including plants and trees.

Most of a plant's structure -- including their carbohydrates and sugars are made from carbon. That carbon comes mostly from the Carbon-Dioxide CO_2 -- they take out of the atmosphere.

As I mentioned earlier – plants also break apart water in photosynthesis – to use its hydrogen.

Plants therefore simply need air and water to make their food and support their structures. They also need dozens of micronutrients from soils.

Soil is much more than dirt. Other living things have made healthy soil. It's the Lichen and fungi that contribute to the production, vigour and structure of the soil.

Some of the first life on land was lichens. Lichens don't eat rocks, but they excrete acidic compounds that etch and dissolve rocks. The result is the same -- the break down of rock into various minerals and in doing so, they build soil.

Soil is a living biological network and is made from dissolved rock, microbes and organic matter.

Microbes ultimately rule the biosphere and all life on earth.

I don't have photographs of microbes at work, so instead I will show a series of tiny species of plants, fungi, lichen and moss.
All are plants are in a symbiotic relationship with microbes. They depend on each other.

Plants feed microbes carbon and sugars and in turn the microbes breaks down the complex fertilizers in soil into bioavailable substances that plants can use.

Animals also have dependencies on microbes for our digestion, immunity, and many other processes. For an example: … *There are more bacterial, virus and fungi cells in a human body than there are human cells in a human body.*

The ecosystem and diversity of the small is essential for the diversity of the large.

The microscopic biodiversity just under our feet affects the health of the entire forest.

Microbes are the environmental healers that break down
toxic waste, gasoline, or dangerous chemicals. Microbes can "learn" how to use these substances in a short time. Customized Microbes can be used to break down whatever the scientists throw to them.
They are wizards of pharmaceutical and natural compounds factories.

The visible mushrooms on the surface are only the fruiting body of the complex microscopic network of the fungal mycelia that thrives below ground.

From the lichen and fungi -- Species Diversity increased

Adding ferns and mosses to the ecological mixture. Mosses helped retained soil moisture and air humidity.

Plants eventually grew stiffer stems and could evolve into ferns. Ferns evolved into huge ferny trees.

The ferny suppleness gave way to stiffness of wood.

Now we look at Trees.
A compound in wood that provides the stiffness to the tree's cell walls is called lignin.
Once trees developed the molecular structure of lignin -- It took microbes millions of years to figure out to how to break it down.

As a result, dead wood formed deep layers on top of each other in anaerobic bogs. All the world's coal reserves are made from those huge buried forests that grew in steamy wetlands as old as 400 million years ago.

When microbes finally started consuming lignin, the accumulation or wood lying on the forest floor was reduced. The forests of today are vastly different than before lignin was digested… today wood is quickly recycled and regenerated by microbes – making way for new plants.

The regeneration releases the stored solar energy and carbon from the wood. Allowing the cycle to continue.

Leaves

The leaves are the plant's food factories.

By using selected wavelengths from sunlight for their energy, leaves make sugars for the plant. Chlorophyll is a specialized compound in the green pigment of leaves that helps run the photosynthetic machinery.

Why do some plants loose their leaves in autumn?
With lack of sunlight during winter -- the leaves become a burden to the plant.

Fall Colours

Not only are fall colours beautiful… as a gardener, I find leaf regeneration amazing.

After the growing season perennial plants, especially trees, gather up all the remaining nutrients stored in the leaves. The plant sends those sugars and starches down into its roots for winter storage.

Then the tree discards the nearly empty leaves on the ground. Microbes then decompose the remaining organic compounds breaking them down to simpler substances.

The microbes take over again providing the new growing root tips in spring with freshly recycled bio-available minerals and some nutrients.
Leaf cover on the ground during winter does other important functions. Leaves protect the soil from drying out and they keep the surface of the soil from compacting under heavy snows. Leaves also help maintains the soil aeration.

I will talk about some of the tree species common to south-eastern BC and Alberta.

Larch

In autumn, Larch trees change colour of their needles. In September and October the mountainsides where larch grow are brightly coloured in a vibrant yellow – gold.

Unlike most conifers such as pine, spruce and fir that stay green year round -- larch needles change colour. The slopes are dazzled with gold against an autumn blue sky.
The subalpine larch or lyall's larch has a very limited range from about Lake Louise to northern Montana. More common and widespread is the lower elevation larch the western larch.

The bark of mature larch is corky and thick resisting low intensity forest fires.

Ponderosa Pine

These trees grow in the dry, low elevation grasslands where fires used to rage. Rather than completely resisting fires, the tree seems to encourage small hot blazes. They do this by dropping their needles frequently -- carpeting the ground around them with a deep layer of flammable needles.

When grass fires do start -- the needles burn hot and fast,

But the mature trees have thick corky bark protecting them from damage. These frequent low intensity-fires also reduce competition from other smaller plants – leaving the ponderosa ecosystem as an open-park-like area.

Lodgepole Pine

Has another strategy for dealing with forest fires. They grow fast and in thick stands. Their bark is very thin and any fire will kill the individual tree, but lodgepole pine cones can only open in the heat of a fire. Hundreds of new trees emerge after a fire -- regenerating the stand.

Aspen

Grow in moister areas of the low elevations grasslands or damp areas cleared by fire or other disturbances. The aspens rarely germinate from seed, but instead the roots send up -- many saplings each forming a new stem.

This creates entire stands from the same original tree where each stem is a clone of the parent. Underground the roots loop together and aspen is one single very long-lived organism that covers vast terrain.
Each stem, however, is very short lived, as it has spongy soft wood -- susceptible to damage by elk, woodpeckers and insects.

Forest Regeneration

It is easy to see how trees can reproduce from cones or seeds, but the forest looks after its immature saplings as well.

Scientists have measured transfers of carbon and nutrients from the branches of mature old growth down to the root tissues of nearby young trees. The old and young interact with each other via the fungal mycelia between their roots.

These exchanges increase the health of the entire forest.
If it wasn't for the fungal web in the soil, the young trees couldn't survive in the shade of a mature forest.

The young trees also benefit from the nutrient decomposition and moisture retention of the old wood.

Left to itself, a forest will see a series of successions of different species of microbes, plants and animals that all build the strength of the whole network.
Carpenter ants can turn wood into sawdust. Woodpeckers will make larger holes to eat the ants, leaving nesting cavities for small birds and rodents.

Petrified Wood or Fossilized wood
Petrified wood is ancient trees turned to stone. The trees were buried under volcanic ash. Minerals leaching from the ash gradually replaced the wood chemistry with brightly coloured crystalized silica, pyrite or opal.

End of Wind -- end of section

Fire

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Fire is the builder and destroyer.

Controlling and using fire has been the most powerful tool in all of human history.
Using campfires or burning wood in a fireplace is comforting, warming and imparts a feeling of safety.
Fire gave us control over light and illuminating the darkness.

The most significant use of fire allowed us to cook our food – Cooking makes food more digestible, thus extracting more calories from meats or plants.

Fire turns clay into durable pottery and heating sand we can make glass.

Fire – gave humans a way to melt ore. Ore is essentially rock that contains small amounts of metal. We smelted rock and forged the extracted metals into tools. Humans also used fire to melt sand into glass and with fire we turned dry mud into pottery.

But when fire is out of human control -- it can be terrifying.

Forest Fires can reduce and entire living forest to ash in a matter of hours.

Wild Fires consume huge areas of forests every summer in this part of BC.

Accidental use of fire destroyed this heritage building in Cranbrook – several years ago.

Fire is also the beginning of another cycle.
The forest regenerates and reawakens after a forest fire. These rich healthy plants are thriving on the charred soil only a couple years after a forest fire destroyed the trees.

Fire -- powers our economy.

Coal, as I mentioned in the tree section, is made from thick layers of vegetation mostly carbon from photosynthetic plant tissues. Coal is made from Forests that grew 100 to 400 million years ago that were buried in stagnant bogs. Coal is the most plentiful of all the fossil fuels, and although it was made from ancient forests, coal is non-renewable.

Burning of Fossil Fuels drive our society.

The element fire is also associated with volcanoes.

Volcanic debris covered vast stretches of land in the US northwest and southern Alberta forming thick layers of ash or cooled lava- called basalt.

This black cooled lava in Idaho flowed over the ground sometime between 15 thousand to 2 thousand years ago. Only hardy lichens begin the succession of life on this ancient lava flow.

This Tower lava in Central Washington has cooled slowly deep underground.

Blue- Basin clay stone are ancient layers of volcanic ash laid down in repeating intervals -- from volcanic eruptions as recently as 5 million years ago to 44 million years ago. -- In the John Day area of Central Oregon. The Blue colour is from various minerals within the ash.

The orange coloured Painted Hills in another section of the John Day and are only about 50 km away from the layers of blue-ash. These Painted Hills have different mineral components making them orangey-yellow.

When the ash is dry it looks like crumbly popcorn, but when it is wet the material becomes very sticky mud. Some kinds of this kind of ash make the industrial clay lubricant – Bentonite.

Volcanic ash layers often preserves fossils. The renowned dinosaur fossils of Central Alberta were found in ash deposits near Drumheller. Large dinosaurs were found in ash or mudstone that are 65-70 million year old.

I can't do an earth sciences talk without showing a few photos of dinosaurs. Like all the earth sciences they are fascinating to me…

Grass

There were no grasses until dinosaurs neared extinction. About 50 to 70 million years ago. Grasses allowed for the evolution of herds of large herbivore grazers.

Grasses are relatively drought tolerant compared to trees and unlike trees -- grasses are nutrient rich.

Forage became a mutually beneficial arrangement for the grass and for the grazing animals. The animals get nutritious food.

In exchange -- forage plants thrive on being pruned to crown level. Grazing and periodic low intensity ground fires allow air and sunlight to reach the thin leaves of the low growing plants. Herbivores also help by providing the soils with a fertilizer boost.

Agriculture -- raising livestock and growing food grains are possible because of the evolution of grass.

Healthy Grasslands are a complete ecosystem containing, a huge variety of grass species, beneficial wildflowers, shrubs, birds, animals and insects.

Many "invasive species" take over the grasslands when grazing pressure is reduced. Fences or population declines of wild grazers -- allows weedy plants to predominate.

Invasive spotted knapweed. . Initial research in Montana is showing that wild lupine can be one of the effective biological controls.

Like all ecosystems -- species diversity helps the health of these beneficial grasslands.

****** We still are in the fire section ******

I included Insects, birds and mammals with fire because …

Anything that breathes oxygen to breakdown their fuel such as sugars, starches and fats are utilizing "biological combustion".

Insects

Plants and insects evolved together.
I love photographing insects, as their adaptability and diversity are so interesting. Watching insects connects me to the tiny networks of nature.
Their diversity ranges from being predatory or prey. They can be herbivores, nectar gathering pollinators, parasites, hosts or decomposers.

Insects are found globally in terrestrial and freshwater ecosystems. They account for a large percentage of the world's biodiversity and there are more species of insect than all land animals put together.

This microscope image shows the underside of an apple leaf with aphids siphoning up leaf juices. This hairy texture likely makes it a little harder for the pests.

Now we will go from pests to pollinators…

Some people cannot stand and insects. Here am me with bunch of mosquitoes on my sleeve.

Mosquitoes do some good. These are pollinating a Showy Daisy wildflower.

Domestic and wild bees are increasingly important for pollination of our food crops. Yet both wild and domestic bee numbers are declining due to disease, virus and mites.

Butterflies have two pairs of large wings and an eye-catching fluttering style of flight. Most adult butterflies rely on flower nectar for sustenance, but caterpillars of some species are often crop pests.

Crab spider is a common name for a large family of about 3000 species of spider. They don't build webs but wait on flowers and change colour for camouflage and ambush their prey.

The ants eat the waxy coating from the buds of this domestic peony -- releasing the flower petals. Without ants this plant could not open its flowers.

There are at least 30 thousand different kinds of beetles on earth and each occupies a different niche.

Birds

Birds are more efficient using oxygen than mammals. They take oxygen both on the in-breath and out-breath.

Besides having lungs, birds also have groups of radiator like air sacs in their chests. Air flows through their system in only one direction in a big loop. This adaptation makes birds very good at extracting all the available O2 from the air.

Their bones are ultra lightweight for flying. Avian bones are also very strong for the durability then need for landing and taking off. Bone strength also helps for sustaining flight in wind turbulence.

Their energy metabolism at a cellular level is more efficient than mammals. Birds have better energy factories in their cells.

Birds have better eyesight and scent perception. They also don't waste as much water, as mammals do.

Birds are just better built.

Mammals

When animals, insects or birds eat their food they consume the stored solar energy gathered by plants.

Animals breathe in the oxygen discarded by plants.

Plants use the Carbon dioxide discarded by animals.

Plants break up water and animals make water as part of our cellular metabolism. It's an amazing cycle.

There are many deer around East Kootenay of south-eastern BC and this is a road sign that someone decorated.
We are fortunate to see wildlife travel through our rural property.

Seeing some of the large mammals in their wild spaces -- contributes to great outdoor experiences.

The East Kootenay is known for its wild animal populations. of deer, elk, mountain goats, bighorn sheep, some caribou, black bear and grizzly bear.

Mountain Goats are a symbol of the high rugged alpine where they live. They have long white woolly fur with two insulated layers. Both males and females have beards and long black pointed horns, although the males have longer beards. Mountain Goat are very agile. Their hooves are well adapted to climbing on the narrowest ledges in the steep rocky terrain. The nannies will protect their kids for 2 years in small herds.

Very few caribou live in the Kootenays any more. Attempts have been made to preserve the herd, but human use of the backcountry interferes with their survival.

Bighorn Sheep also live up in the rocky areas of the high subalpine and like all ungulates they are grazers. The males have massive curled horns and the females have short tapered horns.

The prints of grizzly bears have long curving claws that imprint the soil up to 6 cm away from the front edge of their toes. Grizzly bear hind pints resemble human footprints with the high arch and distinctive heel print.

The round paw print of a black bear features short claws right in front of the toes.

It is a thrill to see wild bears, but caution and fear are also important reactions when seeing the large omnivores. Black bears are smaller than grizzlies. Both species mostly rely on plants for their food. Predation and opportunistic hunting keeps them in high protein for their winter hibernation.

Elk are majestic ungulates grazing grass and browsing vegetation at all elevations of forest. The males sport huge antlers in autumn and they use them for display and for fighting other males -- for herd dominance. Antlers are shed in winter to regrow again in April. You won't forget the sound of an Elk bugle in rut. It's a very loud, low frequency squeak.

These … ***Bison*** live in Yellowstone National Park in Wyoming and I included them here as the bridge between wildlife and Yellowstone.

Yellowstone National Park in Wyoming

Yellowstone ties fire and Water

The area below Yellowstone Park is a gigantic active volcanic caldera. All the hot water geysers and other heated water features are caused from a volcanic hot spot directly under Yellowstone. Here the volcanic magma is very close to the surface. The volcano last blew up 600,000 years ago ripping apart mountains and creating this gigantic caldera.

Deep flowing ground water passes beside regions of super heated rock. The heated water builds up pressure releasing it through openings in the surface rock -- forming the numerous geysers.

These living mats of multi-coloured algae are known as extreme-otherms. They are networks of microbes that can tolerate the chemical soup of the geyser water and the extreme temperatures. Scientists assume life may have started out as Extreme-otherms -- like this. Maybe in hot or warm springs under shallow oceans.

These dark blue hot water springs are wonderfully beautiful and inviting, but they are super-heated and almost sterile of life because of the extreme heat.
-- But notice along the slightly cooler edges -- are thriving white, crusty mats of living organisms.

The geology and biology of this unique place is well worth the visit.

Water

The most important element is Water
Ties the 4 elements together
Without water there cannot be life.

Almost everywhere on earth that has liquid water, scientists have looked for life on this planet -- they have found it. In environments that are very hot, very cold, acidic, alkaline, salty and everywhere. They have even recently found life 3 km under the ocean floor inside rocks.

Water is a fascinating substance.
About 65% of our bodies are made of water and most of the surface of the planet is ocean.

Water has been found on the moon and space research indicates that some water is still on Mars. Water is in comet tails.

We know that water is not unique in our solar system, but so far we have not tracked life that goes along with water on earth, to anywhere else but here.

Life started in the oceans. As the waves of the oceans ebb and flow, so does water course within all living things.

A version of seawater is still contained in every living cell. Due to water's unique polarity of its electric charge, it acts as a common solvent with cellular compounds such as salts and minerals.

As life on land evolved, plants and animals found ways to store their precious water within their guarded cell walls.
Cells cannot divide outside of liquid water.

The whole network pattern of life continues on earth, but just as seasons change through time and our earth spins a little slower everyday -- All species that inhabit our biosphere have a lifespan.

All species living today will someday become extinct as new forms of life take over.
Throughout the earth's history life has faced at least
five major extinction events.
So Far -- Life has found a way to adapt to fill niches when other niches disappear.
Each major extinction has left life on the brink but some minor adaptation or some fortunate habitat island was able to keep the biosphere going and life continued.

All parts of the web interact. Life is in a constant flux changing through time.

As we have seen -- Life is tenacious and it could continue on this planet, with or without us.

Every aspect of our lives depends on water. Generally in costs we pay for water doesn't equal the value that it means to our survival. Water is underpriced compared to its universal value.

Water Clean, safe and fresh water is not replaceable. Much of the ground water has been deep underground since the melting of glaciers ten thousand years ago and when we pump it to the surface it doesn't go back.

We can only live about one week without water, whereas we can live for about a month without food.
70% of useable water is used in agriculture, 20% for industrial uses and only 10% of water used today is for residential use.

Without water there can be no life. Even the driest mud or the hard frozen ice has minute pockets of liquid water where organisms take refuge. Some organisms can dry out almost completely by sheltering in vegetative spores.

Some microscopic animals such as ***Tardigrades***, can exist for hundreds of years or even in the vacuum of space -- in static dehydration states – only to pop out again, feed breed and swim around again -- when given some drops of water.

When we have too much water -- the consequences are flooding and mudslides.

Ice

Water is one of the few substances that take up more space -- when it freezes, than it does in its liquid form. Due to the crystal configuration when water freezes it expands and is less dense than liquid water, so it floats on the liquid surface.
Most other liquids contract and sink when cooling down to a solid state.

To see **Rainbows** you have to have your back to the sun. and the air must have to be suspended water-droplets in it. The colours are the effect of sunlight refracting in water droplets - like in a glass prism.

Rainbows are always circular and we only see a portion as the ground blocks the rest of the arc. Sometimes from planes, people can see complete circles of rainbows. The glow inside the arc is always lighter than the illumination outside the arc.

The colour gradient always starts from red on the outer ring and progressed in smooth transitions to violet. Sometimes we can see a double rainbow and the colours are reversed than that of the primary arc.

I always have been fascinated with the interconnections of the earth to its living biosphere. Earth, Wind, Fire and Water are all necessary for diversity and evolution of life on this unique and wonderful planet.

Much of my photography features water components, as water -- it seems to connect me with the viewers -- to my landscapes more than just terrain or plant images do. I love being around streams, lakes, wetlands and other water whether it’s crashing waves or trickling streams. Water completes my outdoor experiences.

Here is me in my element – camping in the mountains of southeastern BC. Here are the 4 elements surrounding me -- the earth beneath my feet. The wind is fresh air I breathe, the fire keeps me warm and water in the lake behind me nourishes my wellbeing.

Thank you for watching this presentation of Earth Wind Fire and Water.

End of talk.