The study of natural history is the study of a continuum. Individual species and their relationships with their environment, land formations, weather, climate, and human activity all play a part in defining the natural landscape.

A place to start is a look at the forces that shaped our state, historically and presently, and the processes that continue to affect how the natural world functions. We must also gratefuly acknowledge the people who witnessed and documented this natural world and the skills they employed.
Thanks to those who went before us.

**The Yellow Emperor** – a legendary Chinese sovereign and cultural hero believed to reign from 2697 – 2597 BC during the New Stone Age. Credited with bringing agriculture and domesticating animals to China and the founding of large towns and villages. Also introduced raising silkworms and weaving of silk cloth. During his time, written language developed, as well as the Chinese calendar, mathematics and traditional Chinese medicine including acupuncture.

**Hippocrates** – 460-370 Ancient Greek physician in Classical Athens. Outstanding figure in the history of medicine. Believed that disease was caused naturally and not as the result of superstition or the gods. Set high standards for those who practiced medicines and he believed in the healing power of nature. Promoted close observation of disease progression and careful documentation.
Izaak Walton – English; lived from 1593-1683. Wrote ‘The Compleat Angler,’ the art and spirit of fishing in prose and verse. In 1922, the Izaak Walton League of American was founded. It supports “a common-sense approach to protecting our country’s natural heritage and improving outdoor recreation opportunities for all Americans”.

Chief Seattle – 1780-1866. He is remembered best for his response to the US government’s offer to purchase the remaining Salish lands. In it he states his profound ecological insights the moral values of his people. Go a multimedia interpretation: www.halcyon.com/arborhts/chiefsea.html

Alexander von Humboldt – 1769-1859. German naturalist and explorer whose work on botanical geography laid the foundation for the field of biogeography. Advocated an approach to science that would bring the harmony of nature among the diversity of the physical world. Viewed nature holistically. Traveled extensively throughout Latin American and Asia as well as Europe.

Ralph Waldo Emerson – 1803-1882. American Essayist, lecturer and poet, led the Transcendentalist Movement. Believed all things were connected to God so all things were divine. Truth could be intuitively experienced directly from nature.

Henry David Thoreau – 1817-1862. An American author, poet, abolitionist, naturalist, and leading Transcendentalist. He wrote ‘Walden,’ a reflection on simple living in natural surrounds. Walden is not regarded as a classic American work that anticipated the methods and findings of ecology and environmental history. The work explores natural simplicity, harmony, and beauty as models for social and cultural conditions. Thoreau was an early advocate of recreational hiking, canoeing, conserving natural resources and private land, and preserving wilderness as public land.

Charles Darwin – 1809-1882. An English naturalist best known for his theory of evolution which supports the idea that all species of life have descended over time from common ancestry. This process occurs by what he called natural selection, in which those members of a species which have variations that best equip them to survive in a particular environment survive and those less well adapted eventually die out.

John Muir – 1838-1914. Scottish born American naturalist, author and early advocate of preservation of wilderness areas in the United States. He was particularly influential in saving the Yosemite Valley and Sequoia National Parks in California. He also is the founder of the Sierra Club.

John Wesley Powell – 1834-1902. US soldier, geologist, and explorer of the American West. He is famous for the 1869 Powell Geographic Expedition, a three month trip down the Green and Colorado rivers that included the Grand Canyon. He was director of the US Geological Survey. In his proposals for the development of the west, he encouraged
state boundaries that would follow water sheds and thought the most of the West was unsuitable for agriculture due to water shortages. His proposals were largely ignored.

**John Burroughs** – 1837-1921. An American naturalist and essayist who some say was the more important nature essay write after Henry David Thoreau. He was a major advocate of the US Conservation Movement. His work mainly focused on the Catskills Mountains in NY and three of his homes in that area are now National Historic Landmarks.

**Aldo Leopold** – 1887-1949. An American author, scientist, ecologist, forester and environmentalist who is best known for his book titled, 'A Sand County Almanac' which was not published until a year after his death. The book presented a compelling call for environmental ethics and wilderness conservation. As a profession at the University of Wisconsin, his courses emphasized ethics of nature, the importance of biodiversity and he was the founder of wildlife management.

**Rachel Carson** –1907-1964. An American marine biologist and conservationist whose writings are credited with advancing the global environmental movement. While working for the Bureau of Fisheries, she began nature writing. The proceeds from the ‘Sea Around Us’ allowed her to become a full time writer. In the late 1950’s she turned to conservation and environmental problems, culminating in the publication of Silent Spring. This book is credited with the banning of the use of DDT and later the creation of the Environmental Protection Agency.

**Chico Mendes** – 1944-1988. Brazilian rubber tapper, trade union leader and environmentalist. He fought to preserve the Amazon rainforest and advocated for the development of sustainable use of forest products as well as for human rights of Brazilian peasants and indigenous peoples. He was assassinated by a local rancher.

**Wendell Berry** – born 1934 in Henry County, Kentucky. A prolific writer of non-fiction, fiction and poetry. He also was a farmer. Topics discussed in his works include sustainable agriculture, appropriate technologies, healthy rural environments, connection to place, the pleasures of good food, husbandry, frugality, and the inter-connectiveness of life

**James Lovelock** – born 1919. An independent scientist, environmentalists and futurologist best known for the proposal of his Gaia hypothesis. This hypothesis proposes that living and nonliving parts of the Earth form a complex interacting system that can be thought of as a single organism. A main tenet is that the biosphere has regulatory effects on the Earth’s environment that acts to sustain life. Much of his current writing reflects his concern for the disregard human societies have for Gaia and how their activities are overwhelming Earth’s naturally regulatory mechanisms.
E.O. Wilson – born 1929. American biologist, researcher, theorist, naturalist and author. Professor emeritus at Harvard University and recipient of a vast number of awards. A main theme of his work is the importance of preserving biodiversity and he has written many books, given countless lectures and worked on television documentaries to promote this theme. Currently he is working on a musical documentary called *Behold the Earth* with Richard Louv and others that inquires into the reasons for American’s divorce from nature.

Amory Lovins – born 1947. He is considered one of the world’s leading authorities on energy, especially its efficient use and sustainable supply. He and his wife founded the Rocky Mountain Institute, a Think-and-Do Tank that mainly focuses on soft energy technologies.

James Hansen – born 1941. Head NASA Goddard Institute for Space Studies in New York City, part of the Goddard Space Flight Center. Developed and used global climate models which have contributed to the understanding of the Earth’s climate. He is best known for research in climatology and he has helped raise awareness of global warming. In 2009 he published a book called *Storms of My Grandchildren*. 
The basic processes on this planet are being impacted as our human populations grow.
So let's start with the big picture. There is a lot of matter in our universe. These are two galaxies. 100 billion stars in each of a 100 billion galaxies.

Do you know your intergalactic address??
- Maryland
- United States of America
- Planet Earth
- Solar System
- Milky Way Galaxy
- Virgo Super Cluster
- Universe
But there is a long distance between any two celestial bodies.

How many planets do we know about? 300

As we get closer to our planet we see a dynamic surface showing the mixing of 3 phases of matter: gasses, liquid, solid.
The Chesapeake Bay is the largest estuary in the US. It is referred to as “The great protein factory.” Most all life on this planet can only exist on the thin veneer of its surface.
What is the most important physical process that happens on earth?

The cycle of evaporation and condensation that controls the distribution of the earth’s water as it evaporates from bodies of water, condenses, precipitates and returns to those bodies of water.
Drops of water start an amazing process!
Rain and Storm Water Impacts

- Natural infiltration
- Impermeable surfaces
- Storm water management – past and future
- Impacts on streams, bay, ocean

Natural systems and what development does to it.
Average rainfall for Maryland = 44.5 inches
Average annual snowfall across Maryland.
Average monthly rainfall and temperatures across Maryland.
Typical cloud patterns in Maryland.

**Low Clouds:**

*Stratus clouds* are uniform grayish clouds that often cover the entire sky. They resemble fog that does not reach the ground. Usually no precipitation falls from stratus clouds, but sometimes they may drizzle. When a thick fog "lifts," the resulting clouds are low stratus.

*Nimbostratus clouds* form a dark gray, "wet" looking cloudy layer associated with continuously falling rain or snow. They often produce precipitation that is usually light to moderate.
**Middle Clouds:** Clouds with the prefix "alto" are middle level clouds that have bases between 2000 and 7000 m (6500 to 23,000 ft).

**Altocumulus clouds** are middle level clouds that are made of water droplets and appear as gray, puffy masses, sometimes rolled out in parallel waves or bands. The appearance of these clouds on a warm, humid summer morning often means thunderstorms may occur by late afternoon.

**Altostratus clouds** are gray or blue-gray middle level clouds composed of ice crystals and water droplets. These clouds usually cover the entire sky. In the thinner areas of the cloud, the sun may be dimly visible as a round disk. Altostratus clouds often form ahead of storms that will produce continuous precipitation.

**High Clouds:** Cirrus clouds are thin, wispy clouds blown by high winds into long streamers. They are considered "high clouds" forming above 6000 m (20,000 ft). Cirrus clouds usually move across the sky from west to east. They generally mean fair to pleasant weather.

**Cirrostratus clouds** are thin, sheet like high clouds that often cover the entire sky. They are so thin that the sun and moon can be seen through them.

**Cirrocumulus clouds** appear as small, rounded white puffs. The small ripples in the cirrocumulus sometimes resemble the scales of a fish. A sky with cirrocumulus clouds is sometimes referred to as a "mackerel sky."

**Clouds with vertical development:** Cumulus clouds are puffy clouds that sometimes look like pieces of floating cotton. The base of each cloud is often flat and may be only 1000 m (330 ft) above the ground. The top of the cloud has rounded towers. When the top of the cumulus resembles the head of a cauliflower, it is called cumulus congestus or towering cumulus. These clouds grow upward, and they can develop into a giant cumulonimbus, which is a thunderstorm cloud.

**Cumulonimbus clouds** are thunderstorm clouds that form if cumulus congestus clouds continue to grow vertically. Their dark bases may be no more than 300 m (1000 ft) above the Earth's surface. Their tops may extend upward to over 12,000 m (39,000 ft). Tremendous amounts of energy are released by the condensation of water vapor within a cumulonimbus. Lightning, thunder, and even violent tornadoes are associated with the cumulonimbus.
Soils are classified in hydrologic soil groups to indicate the minimum rate of infiltration obtained for bare soil after prolonged wetting.

Group A soils have low runoff potential and high infiltration rates. They consist of well-drained, deep sands and gravels.

Group B soils have moderate infiltration rates; they are moderately deep and moderately drained. They have moderately coarse textures.

Group C soils have low infiltration rates and consist chiefly of soils with a layer that impedes the downward movement of water or soils with moderately fine to fine texture.

Group D soils have high runoff potential and low infiltration rates. They consist mainly of clay, or soils with high water tables or shallows soils on a nearly impervious material.
There are 40,000 species of bacteria in a gram of soil. When that soil is plowed, CO2 is released from it into the air. It takes 1,000 to 10,000 years to produce soil. When rocks - which have different mineral compositions - erode into sand, silt and clay.

There are 750 soil types in Maryland - these are determined by parent material, rainfall, slope and drainage. Organic matter contained in the soil is a combination of plant roots, fungi, insects, microbes and burrowing animals.

These things in combination not only help to prevent the soil from becoming compacted, but also absorb heat and moderate the temperature of the soil during the growing season.
SeaWiFS image of the east coast of the United States, acquired on September 18, 2003, as Hurricane Isabel was about to make landfall on the Outer Banks of North Carolina.
Hurricane Isabel was the most expensive and damaging of the season because of storm surge.
This is hurricane Isabel about to hit us. Our landforms are created by a combination of minute incremental and catastrophic events.
Gulf Intracoastal Waterway under the Route I-510 bridge close to where the Mississippi River Gulf Outlet enters the GIWW. The shot clearly shows the storm surge, estimated to be 18-20 ft. in height.

Katrina surge.
What happens to water when it cannot filter into the soil?

Water that cannot infiltrate into the soil will become runoff and travel over the land until it reaches either a moving or a standing body of water. Some evaporation also occurs depending on the atmospheric humidity.
Chesapeake Bay Watershed includes 64,000 square miles and parts of six states, DE, MD, NY, PA, VA and WVA plus the District of Columbia. The land to water ratio is 14:1, largest of any coastal water body in the world. Over 100,000 streams and rivers run into the Bay.
Severe damage to Maryland streams.

**Runoff** – the water flow that occurs when soil is fully saturated with water and excess rain or melt water flows over the land.

**Infiltration** – the process by which water on the ground surface enters the soil.

**Sediments** – solid fragments of inorganic or organic material that come from weathering rock and are carried and deposited by wind, water, or ice.

**Nutrients** – a chemical that an organism requires to live and grow or a substance used in an organism’s metabolism which must be taken from the environment.

**Impervious surfaces** – mainly artificial structures, such as pavements of roads, sidewalks, parking lots, driveways and rooftops that are covered by impenetrable...
materials such as asphalt, concrete, brick or stone. They prevent the natural infiltration of rainwater and result in increased runoff. The runoff also washes into streams and rivers road way pollutants.

**Scouring of streams** – the disturbance of a stream bottom by the rapid flow of water due to heavy runoff and/or excessive precipitation. Swiftly moving water is capable of moving rocks and debris which has a negative effect on the organisms that live at the bottom of these streams.

**Dropping of water tables** – the water table is the area to which ground water will infiltrate. The lower boundary of the water table may be an impervious layer of rock. The upper level of the water table drops seasonally depending on precipitation and melt water but it also may drop due to excessive withdrawal of ground water for irrigation and other uses.

**Legacy sediments** – when rivers and streams are dammed, a slackwater pond form upstream of the dam. As many of these dams are removed from the tributaries of the Chesapeake Bay, the sediments deposited in these ponds which may have been trapped for centuries, are now free to move down stream, greatly affecting the turbidity and health of the Bay.
40% of the main stem of the bay was a dead zone in 2010.
We have lost enough habitats that it threatens other species.
We are producing much more manmade nitrogen than the system can endure.
Our species has invaded and exploited the Chesapeake watershed.
Chemical and Transport Processes Related to Atmospheric Composition. These processes link the atmosphere with other components of the Earth system, including the oceans, land, and terrestrial and marine plants and animals. Credit: CCSP Strategic Plan (illustrated by P. Rekacewicz).
Streams carry a lot of silt and residue from our society to the rivers, bays and ocean to create unhealthy conditions. It all goes off shore and migrates along the shoreline.
Mapping of carbon concentrations (Carbon enriched areas of the ocean)

Purple = not a lot of life. Base of our food chain is along the coast.