Communicating Interdependence:
Ecological Thinking and the Natural History Museum

Molly H. Adams

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By Molly Adams

Advised by Christopher Jensen and Peter Nekola

"This planet is an exquisitely arranged and interconnected system. What's controlled in one place is going to have consequences in another place. Our job as gardeners is to try and figure this out no matter how small our allotted space might be. Discipline has to be the watchword for our controlling hands. It means not gardening without thinking of the garden as a habitat: for mice, for squirrels, for bees and wasps. For other living creatures beyond ourselves."

- Marjorie Harris

The natural world, as we know it, relies on a physical and chemical equilibrium that is generated by healthy relationships amongst organisms and their habitats. We, as humans, are just one of the millions of species that depend on the stability of Earth's ecosystems and the natural processes that take place within them. Unfortunately, due to the harmful impacts of human behavior over the past few centuries, crucial ecosystems are being destroyed along with the irreplaceable organisms that are a part of them. It is estimated that between 100 and 200 species go extinct every 24 hours[1], more than 30,000,000 people were labeled "climate migrants" after having been displaced from their homes in Asia due to weather and environmental related disasters in 2010 alone[2], and natural resources used by all living organisms are continuing to shrink while becoming less and less usable[3]. The global changes taking place are due to mass habitat destruction, pollution and climate change, transport of invasive species, and direct exploitation of species (loss of biodiversity). The human actions causing these changes are driven by the predominant idea that humans are separate from nature, and free to act as if natural resources are limitless. Without a developed awareness of the interdependencies that exist within the natural world, it is impossible to realize the long-term consequences of our actions on the environment, other living beings, and ourselves.

Currently, the planet we live on is undergoing a critical transformation as a result of various destructive human activities that are supported by a particular way of thinking about the world. Scientists estimate that if habitat conversion and other destructive human activities continue at their present rates, half the species of life on Earth could either be gone or endangered by the end of the century.[4] "If the extinction rate continues to rise, the cost to humanity, in wealth, environmental security, and quality of life, will be catastrophic."[5] Today, many of us are unaware or in denial of the current biodiversity crisis and other ways in which we are drastically transforming the biosphere. For this reason, it has become increasingly important that the public has access to adequate environmental education, where they can discover the connections that they maintain with their environment. E. O. Wilson stated, "Scientific knowledge, humanized and well taught, is the key to achieving a lasting balance in our lives."[6] We must use science education to encourage the rethinking of our relationships with the natural world, to recognize that we are part of it rather than apart from it.

This paper explores some of the ways that we can articulate our place within nature in order to help individuals reevaluate their relationship with the natural world, specifically within the work of natural history museums. I describe some of the ways humans view nature and how this knowledge has been translated through representations in particular natural history museums. I first discuss broad ecological concepts that are important for people to understand if they are to form a more knowledgeable relationship with the natural world. In the following chapter, I explain the concepts further through examples of why it is important to care about the natural world and some of the different ways that

people conceptualize their relationships with it. An awareness of these beliefs, as well as other versions of them, is important for bringing about a necessary shift in thinking about our responsibility towards nature. After these introductory chapters, I focus on analyzing particular natural history exhibits and their ability to accurately represent the interconnectedness of the natural world through various elements of their displays. In my conclusion, I offer further critiques of current representations as well as alternative approaches to holistically communicating the vital interconnectedness of the natural world. Nature is sometimes represented through displays as something that is external and singular. Such a way of thinking can miss an opportunity to understand the natural world and its systems as a set of processes and relations, thereby missing the opportunity to communicate their importance and our dependence on them.

The Importance of Ecological Interconnectedness

"We are seeking another basic outlook: the world as an organization. This would profoundly change the categories of our thinking and influence our practical attitudes. We must envision the biosphere as a whole with mutually reinforcing or mutually destructive interdependencies."

- Ludwig Von Bertalanffy

"A human being is a part of the whole, called by us Universe, a part limited in time and space. He experiences himself, his thoughts and feelings as something separated from the rest--a kind of optical delusion of his consciousness. This delusion is a kind of prison, restricting us to our personal desires and to affection for a few persons nearest to us. Our task must be to free from this prison by widening our circle of compassion to embrace all living creatures and the whole nature in its beauty."

- Albert Einstein

Many of us are familiar with an interconnectedness that is brought about by the Internet, a complex communication system that constantly links people to people and people to data. The process of globalization first allowed for the development of an extremely interconnected world enabled by trade routes linking continent to continent, transporting people, goods, and ideas. Long before this ongoing process produced our current state of increasingly global relationships between people, culture and economic activities, interconnectedness was implicit in the conditions that support all life on Earth. An interwovenness can be traced from the universe, the largest of all things, to the very smallest pieces of the Earth and tiniest microscopic organisms that exist here. On Earth, the oceans, land and atmosphere exist because of their linkages with one another that form its natural systems. The systems have given birth to all forms of life, and have continued to nurture their evolution. The variety of life on Earth, or biodiversity, exists in conjunction with the non-living, or abiotic, features of the environments in which they live. These

relationships formed by organisms and the physical components around them are what make the proliferation of life and functioning ecosystems possible. In order to understand the ways in which humans affect these natural systems, one must first attempt to grasp how they function by learning about the relationships within them.

Ecology is the study of these relationships, which exist amongst organisms as well as between organisms and their environments. There are several sub-sections of ecology that help scientists deal with the vastness of these relationships and the variety of organisms and environments. Organismal ecology considers the ways in which organisms have adapted and evolved to their environments in order to survive. Population ecology describes how populations of species grow and interact with other species, and community ecology focuses on factors that influence the number of interacting species in an area. Ecosystems ecology "deals with the flow of energy and cycling of nutrients among organisms within a community and between organisms and the environment."[7] Ecosystems are made up of various communities, each of which is made up of various populations, which are then made up of various individuals. One can get outside and observe these types of relationships and patterns in their local environments, but ecologists study these interactions and patterns in order to further understand the development and sustainability of ecosystems.

An ecosystem is a group of organisms interacting with one another and with their physical environment. Ecosystems include physical and chemical components, such as water, soils and nutrients that support the variety of organisms living within them. According to the World Resources Summary from 2000-2001, "Ecosystems are intricately

woven together by food chains and nutrient cycles; they are living sums greater than their parts."[8] Different ecological communities form and are stable in different abiotic environments. Certain ecosystems are terrestrial, which means they are found only on land. These ecosystems are classified as either being a tundra, taiga, temperate deciduous forest, or grassland. Aquatic ecosystems are typically either considered marine (ocean) or freshwater, and can be divided further in order to study the relationships within certain types of environments such as lakes, rivers, estuaries, and ponds. Within each of these different environments exist relationships between organisms and their environment that are unique to each ecosystem. "Each species possesses a unique combination of genetic traits that fits it more or less precisely to a particular environment."[9] The stability of an ecosystem depends upon these adaptations and the fact that each organism has evolved in order to live alongside other organisms. The health of an ecosystem also relies on that of the organisms and the physical elements that constitute it.

For example, the ideal conditions that produce a normal coastal Marine biome are destroyed when excess nutrients are dumped into that biome as a result of fertilizer runoff and fossil fuel use. This dumping results in massive areas of ocean called "dead-zones" that are depleted of oxygen (hypoxic), and are therefore uninhabitable for a majority of sea life. "At the root [is] eutrophication, an excessive inflow of plant nutrients that resulted in an overgrowth of algae and other small floating photosynthetic plants, which [leads] indirectly to hypoxia and to the death of plants and animals in the lower depths."[10] There are over 400 of these dead-zones worldwide, and they continue to spread with the increase of pollution from agriculture runoff.[11] In the early 1960's, a dead-zone appeared in Japan's

Seto Inland Sea after noticeable stages of change. First the predator species targeted by local fishers declined, leaving mainly small prey fish, which then died or fled, leaving only the most tolerant, invading species, such as jellyfish.[12] Once the dead-zones are depleted of their biodiversity, the ecosystems are depleted as well.

Biodiversity, or the Earth's biological diversity, also can be considered on a variety of different levels. According to the Ecological Society of America, "Biodiversity includes all organisms, species, and populations; the genetic variation among these; and all their complex assemblages of communities and ecosystems. It also refers to the interrelatedness of genes, species, and ecosystems and their interactions with the environment."[13] This particular definition of biodiversity can virtually include any and all variations of life forms and the complex systems and processes that they are a part of. When one thinks of preserving the Earth's biodiversity, species are not the only things that must be saved. One must think of the complex relationships that connect organisms to one another and to their environment, and the ways in which humans affect these relationships. For it is these relationships that constitute communities and ecosystems, and if humans destroy these relationships, we inherently destroy species of organisms as well.

One example of how one action can lead to unintended and unknown effects that reach throughout an ecosystem can be seen in the removal and subsequent reintroduction of wolves into Yellowstone National Park. In the early 1930s, the Grey Wolf was eliminated from the park by government predator control programs. Without the presence of important top predators, the park's Elk population exploded devouring young Aspen trees and other types of vegetation causing a cascade of impacts on flora and fauna in the

surrounding area. "Without young trees on the range, beavers for example, had little or no food, and indeed they had been absent since at least the 1950s. Without beaver dams and the ponds they create, fewer succulents could survive, and these plants are a critical food for grizzly bears when they emerge from hibernation."[14] In 1995 the National Park Service and the U.S. Fish and Wildlife Service brought 14 wolves into Yellowstone from Canada and 17 more the next year. These wolves were the first to call Yellowstone home since hunters caused their disappearance 60 years ago. Once the wolves were reintroduced into the park's ecosystem, it was possible for scientists to notice the broad range of negative effects of their absence. The reemergence of the wolf forced the elk population to successfully decline allowing for species, such as aspens, willows, bears and beavers to flourish once again.

Neglecting to preserve biodiversity affects complex services of microorganisms and their ability to function properly in order to sustain life on Earth. It is unreasonable to think that humans are capable of technologically replicating the natural cycles that require several different species of organisms and particular environmental conditions in order to function. For instance, humans don't make soil, ecosystems do. All life depends on molds, maggots, worms, fungi, flies and bacteria to transform all dead organic matter into nutrients that help produce and feed new life. These decomposers are part of the essential process of decomposition, in which organic matter, or dead plant and animal biomass, is physically and chemically broken down. The final result is a conversion of organic matter, into inorganic nutrients, carbon dioxide, and heat.[15] The regeneration of life in terrestrial environments depends on the depositing of nutrients from dead plants back into the soil

in order to enable new plant growth. Without the process of decomposition, there would be an eternal layer of organic matter covering the Earth where life wouldn't be able to benefit from the recycling of nutrients.

Natural processes that benefit human life, such as decomposition, are often called ecosystem services. The E.S.A describes ecosystem services as being "the processes by which the environment produces resources that we often take for granted such as clean water, timber, and habitat for fisheries, and pollination of native and agricultural plants. Whether we find ourselves in the city or a rural area, the ecosystems in which humans live provide goods and services that are very familiar to us."[16] A devastating example of irreversible natural resource depletion through the destruction of ecosystems is Haiti. The once densely wooded nation has experienced mass amounts of deforestation for agricultural purposes since the late 1400s. First, the Spanish cleared land to plant sugar, then the French cut down more forests for coffee, indigo, tobacco, and timber. "Soon after independence, upper-class speculators and planters pushed the peasant classes out of the few fertile valleys and into the steep, forested rural areas, where their shrinking, intensively cultivated plots of maize, beans, and cassava have combined with a growing fuel wood-charcoal industry to exacerbate deforestation and soil loss. Today less than 4 percent of Haiti's forests remain, and in many places the soil has eroded right down to the bedrock."[17] From aerial photographs, one can see the striking distinction between the infertile soil of Haiti and the lush forests on the other side of border in the Dominican Republic (Figure 1).

The human population depends on these services provided by ecosystems and their components - organisms, soil, water, and nutrients, and these components depend on the level of responsibility that humans take in their actions. In order for people to take responsibility for the health of their environment, they must realize the ways in which they are connected to it. In the next chapter, I will look at some of the different ways that people view the natural world, what has happened as a result of people having a disconnected relationship to nature, and the reasons why this relationship needs to change.

The Ethical Dimensions of Ecological Thinking

"A thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends otherwise."

- Aldo Leopold

"Lack of awareness of the basic unity of organism and environment is a serious and dangerous hallucination."

- Alan Watts

The ecological concepts discussed in the previous chapter demonstrate how the natural world is a multifaceted web of interconnectedness. The preservation of these processes and systems is essential for (almost) all forms of life, especially human civilization. Humans have developed another type of complex web that is becoming increasingly interconnected as well; we call this web "culture". One characteristic that clearly separates humans from other sentient beings in nature is our ability to create complex civilizations surrounding cultural developments, all based on shared beliefs amongst groups of people. Culture isn't what makes up the world, but is rather how people make meaning of the world. The meaning then manifests itself in material objects that then shape the environments in which we live. Through symbols and language, people communicate to one another what they think about the world, which results in several varying and often conflicting worldviews, or perceptions of how the world is. These views differ according to individual beliefs and values pertaining to nearly everything, but in this chapter I will examine a variety of views concerning the human species' relationship to nature. The subtle differences in the way that individuals perceive this relationship have drastically shaped the ways in which humans interact with the natural world on a variety of levels.

One of the most predominant views of nature is that it is something external to humans, something that we are apart from rather than a part of. Although problematic in many ways, this view of the natural world and humans as separate from one another has heavily influenced the course of human history and in turn has had innumerable impacts on the natural world. The role of human as dominator was emphasized around the time of the industrial revolution, where new technology was being used to control not only the environment, but other humans as well. During this time, nature was portrayed as being something separate in order to encourage the notion of "progress" through technological advancements and the conquering and development of "wilderness." The role of humans as domineer can be traced back at least as far as to several ancient religious texts; Lynn White gives Genesis Chapter 1:28 as an example of an origin in orthodox Christian theism. According to White, by linking man with God's transcendence of nature, the Christian worldview "made it possible to exploit nature in a mood of indifference to the feelings of natural objects."[18] The combination of the claim that humans are superior to the natural world, the insistence of their god's will that humans exploit nature for his "proper ends," and the persuasive nature of Christianity contributed to the vast proliferation of this worldview. This worldview established a dualism, or a philosophical position that considered humans as separate from nature.

This dualism still has a heavy influence on the decisions that are made today, an influence that can be seen on the individual, group and sometimes even world level. Many economies are run as if they can function as independent entities that exist separate from natural cycles on Earth. Capitalism is dependent upon our current growth economy, which

depends upon the mass production of products, values and ideas that reinforce the culture of consumerism. When a society has been concerned with production and exchange for the sake of an immediate profit, the costs have not always included shared costs that result from destroying the natural world. Frequently, connections between the economy and ecology are often overlooked in the process. Capitalism as we've experienced it thus far in history has relied on several unsustainable practices that continue to degrade the quality of the Earth's natural systems. One of the fundamental assumptions of capitalism is that growth will be continuous and unlimited, but this presupposes that the natural world has an infinite amount of resources. According to Paul Ekins the "most current economic policy, indeed the very orientation of economic theory, boils down to the pursuit of economic growth, as indicated by an increasing Gross National Product (GNP)."[19] This widespread delusion has led to the over-exploitation of numerous ecosystem services around the world.

For example, timber harvesting and conversion to farmland have removed 50 percent of the Earth's original forest cover. The majority of original forests in Madagascar have been cut down in the 2000 years since humans arrived there.[20] Deforestation is required for the clearing of farmland for monocultures that produce a single type of crop (such as wheat, corn and rice) to be sold to demanding Western markets. Clearing forests for monocultures destroys the local biodiversity of the region, and agricultural processes use pesticides and other chemicals that then seep into the soil and the surrounding bodies of water. Runoff from agricultural practices pollutes local water supplies making it unusable and also creates dead zones by destroying the aquatic biodiversity. Coastal

pollution or "red tides" and algae blooms are linked to coastal nutrient pollution from fertilizers, industry and sewage. These blooms contaminate shellfish and cause food poisoning, as well as the death of humans and other vertebrates. We also see the widespread death and bleaching of coral reefs. For example, the Great Barrier Reef is being greatly affected by the continued use of the pesticide diuron by Australian Farmers[21]. Sewage and pollution have also been linked to mysterious die offs of larger mammals like manatees and dolphins.[22] Industrial fishing practices have drastically reduced the abundance of aquatic species in oceans today. The use of trawlers, gill nets, drift nets, mechanical dredges and suction devices allow humans to presently catch and use about 85 million tons of fish and marine invertebrates each year. These current technological advances also results in the removal and death of far more species than are commercially valuable, further depleting populations that cannot recover quickly enough to sustain continued exploitation. [23]

Globalization has caused the proliferation of these effects by spreading capitalism across the globe. Approximately 40-50% of Earth's ice-free land surface has been heavily transformed or degraded by human activities, 66% of marine fisheries are either overexploited or at their limit, atmospheric CO^2 has increased more than 30% since the advent of industrialization, and nearly 25% of Earth's bird species have gone extinct in the last two thousand years.[24] Often times, we aren't aware of how critical the natural world's resources are to our survival. In their book, *The Limits of Growth*, Donella Meadows, Dennis Meadows, Jørgen Randers, and William W. Behrens III state that an economy based on infinite growth in a finite system is impossible. One of their conclusions affirms, "If the

present growth trends in world population, industrialization, pollution, food production, and resource depletion continue unchanged, the limits to growth on this planet will be reached sometime within the next one hundred years."[25] We must realize that critical benefits are only available through healthy, functioning natural systems and that they are indeed limited. In order for these destructive trends to be altered, we must act immediately to establish a condition of ecological and economic sustainability.

An increasingly influential view of nature involves realizing that the resources of Earth required for survival don't exist solely for human consumption nor is there an infinite supply of them. This view takes into consideration the effects of human activities on the environment, particularly the parts of the environment that humans benefit from. The benefits derived from a multiplicity of resources and processes provided by natural ecosystems have been described as "ecosystem services." Some of the benefits from ecosystem services include clean drinking water, decomposition of waste and other processes (discussed in the last chapter). Once people realized that these critical benefits are only available through the processes of a functioning, healthy natural world and that they are limited, attempts have been and are being made to conserve them.

Some recent conservation strategies have adopted the approach called an "ecosystem services strategy." This strategy is geared towards protecting ecosystems that are valuable to human health and development. In this case, it is important to make people's dependence on various ecosystems clear and to identify the ecosystems that are most threatened in which damage will harm neighboring residents. For example, poor farming and logging practices in the Andean highlands have led to the destruction of the habitats

of a variety of endemic plants and animals, including the near threatened Andean condor. These practices have also led to the pollution of much of the water supply of which people who live downstream, in and around Quito, Ecuador's largest, city depend upon. Although a condor reserve had been set up, enforcement was poor, so in the year 2000, a water fund was established that has since collected 4.9 million dollars in order to support conservation, education and other water projects upstream from Quito. As of 2007, public enthusiasm for water conservation has grown dramatically coinciding with the more than 3.5 million trees that have been planted, new hired park guards, and a farmer education program that will result in cleaner water for all components of the ecosystem.[26] Here we see the recognition that humans are a part of nature and the importance of preserving the resources that it provides for us. According to the article, "Conservation to the People", "As people see more clearly their reliance on various ecosystems for their health and economic security, they will support conservation projects. As a result, biodiversity will be preserved, but not at the expense of humans."[27]

For others, conservation is about preserving the natural world for reasons other than its instrumental value. Throughout history, the natural world has played a crucial role in our cultural and spiritual lives. In attempts to understand the natural world, traditions of faith have relied on a multitude of interpretations of its existence. Many spiritual practices rely on the existence of particular aspects of the natural world in order to make meaning, making preservation an increasingly important aspect of many people's faith. For example, many of the Lakota worship Wakan Tanka, who is known as the creator. According to Luther Standing Bear, the creator was linked with all things through a

unifying life force that created the active principle of kinship with all creatures of the earth, sky and water.[28] The Lakota felt that all things Wakan Tanka touched had the right to exist, as well as the right to protection from humans.

Today, other groups are prioritizing conservation as a result of their spiritual beliefs by creating organizations dedicated to preservation programs across the world. The Christian conservation group *A Rocha* is founded on principles that highlight the role of the Christian church in caring for the environment. They believe, based on what is written in Genesis, that all creation belongs to their god, who made the Earth and left humans responsible for it. Therefore, Christians must care about preserving the heritage of their god because it is his and as humans, they must fulfill their role as stewards to the land and its life.[29] This idea however, is based on the belief that humans are the only species responsible for preserving biological heritage and are therefore considered to be separate from the natural world. Other relationships with the natural world that are based on philosophical beliefs rather than religious beliefs, focus on the idea that humans are one of many species and no one species should take priority in arguments for preservation.

While some humans create value in nature by envisioning themselves as stewards of a natural heritage, other environmental philosophers question the necessity of including humans or human priorities in our value of nature. Holmes Rolston III, Arne Naess and other "deep ecologists" make arguments for why humans should value the natural world simply because it exists and not for what it offers humans. Rolston's essay "Naturalizing Values: Organisms and Species" defends the thesis that the natural world has intrinsic and objective value or that nature is good in itself, so a world without sentient beings would

still have value and be good. This thesis implies that humans are not necessary for the existence of value and that nature is valuable independently of its use to humans. Much natural value is not generated by humans and is not dependent on humans in any way. Ned Hettinger proves this in his essay *Comments on Holmes Rolsten's "Naturalizing Values"* by discussing nature's usefulness to non-human sentient animals. For instance, Hettinger states that, "Deer are instrumentally valuable to wolves, whether or not these animals benefit humans or are noninstrumentally valued by them." [30] It's hard to say whether wolves are consciously capable of valuing their food, but food is instrumental to their survival therefore it is inherently good for the species. It is important to keep in mind that these types of value differ from those that are culturally constructed by humans. Instrumental goods for insentient beings, such as water for the proliferation of trees, are apparent examples of objective values in nature. Insentient organisms cannot consciously apply value to something, but many things can be either good or bad for them. In this case, the notion of good or bad is not one that is subjective, but rather is related to either the proliferation of life or the destruction of it. Rolston successfully argues that the Earth's multitude of species and habitats deserve our respect, simply because, (just as we have) they have evolved and exist today.

Similarly Rolston argues, "there is something subjective, something philosophically naïve, and even something hazardous in a time of ecological crisis, about living in a reference frame where one species takes itself as absolute and values every thing else in nature relative to its potential to produce value for itself."[31] Such a way of thinking is both naïve and hazardous because of its ignorance of the value of all other things that have and

can continue to exist without us. Were the Earth and its life unimportant or invaluable before humans? The way of thinking that Rolston is actively critiquing in this quote, and most of his writing, is one that is considered anthropocentric. As humans, our brains are most uniquely capable of understanding larger phenomena and planning for the future, but this doesn't mean that everything else in the world exists for, or in relation to, us. For example, if one thinks that thousands of acres of forest should be cut down regularly for the production of goods that are used by humans, with no regard for the habitats and lives of other species in those forests, one is thinking anthropocentrically. Anthropocentric thinking can also lead to the perception that the natural world is something that is both external to humans and limitless in supply. This then leads us to partake in hazardous behaviors that deplete natural resources and destroy the ecosystems that provide them. Rolston's and other's arguments for biocentrism and intrinsic value help to clarify an alternative to the dangerous culture of anthropocentrism.

If humans are to prevent further destruction of the living and physical world, we must drastically change the relationship we have with our environment and the way in which we think about it on a planetary level. We must realize that people are very much a part of the natural world that we constantly take from, and by doing harm to it, we in turn do harm to ourselves, our future, and the future of all other life on Earth. We are responsible for the wellbeing of the planet, but not solely because it provides us with essential resources, but because it has inherent value, it can exist without us, it has demonstrated that it has value beyond what we can ascribe to it alone and because we are the ones responsible for its present state of decline. If we are to alter the path we are

currently on, we will have to learn more about how natural systems allow for our survival, the survival of other organisms, and the devastating effects the actions of our species have on them, in order to clearly see the interdependence that exists within the natural world.

That we are on such an isolated path suggests that something has failed in how we are educated about the natural world. If there is one type of institution that has an opportunity to communicate the critical parts of the complex, interrelated web of life besides schools, it is the natural history museum. Natural history museums are public institutions dedicated to educating visitors about the natural world. No matter where they are located, they can offer us insight into the world around us and help us form our relationships to it. Natural history museums should be responsible for moving away from using human-centered values while conveying the history and present state of our environment so that people can help change the path of its future. In the following chapters, I will explore how certain museums have done this in the past, what some are currently doing and some possible ways of doing so in the future.

Representations of Interconnectedness in the American Museum of Natural History's *Hall of Biodiversity*

For people living in urban areas, natural history museums are often the foremost resources for providing a greater understanding of the natural world. Many museums, located in cities where tourism is prevalent, serve as national attractions that receive visitors from all over the world who are empowered to explore their curiosities about the many mysteries of the natural world. Museums in densely populated cities serve as auxiliary classrooms for the millions of students living nearby. Natural history museums are responsible for informing people's ideas of nature and the multiplicity of processes that constitute the natural world. Therefore, it is increasingly important that these museums aim to communicate to these visitors that humans are an integral part of a greater ecological system. Museums must make it possible to visualize and experience the interconnectivity of the natural world so that visitors are able to develop an awareness and appreciation of various functioning relationships upon which our very survival depends. Museums must foster a stimulating learning experience in order for visitors to realize the effects they have on these complex systems and their living components, and the dependence we have on them.

The American Museum of Natural History in New York City uses an array of different resources, such as dead and living specimens, replicas, models, charts and different types of computer technology to create a variety of environments that invite people of all ages to explore the details of their representations of the natural world. Because displays from the early 20th century share the museum with "cutting edge" exhibits

installed in more recent years, the museum serves as a time capsule, allowing us to observe how humans have chosen to represent the natural world at different points throughout the history of the museum. Despite this benefit, there are key halls in the museum dedicated to educating audiences about the living world that fail to use visual devices in effective ways in order to highlight the ecological interdependencies of the living world they are trying to represent.[32] In this chapter, explore how well the American Museum of Natural History's *Hall of Biodiversity* and the surrounding exhibit, the *Milstein Hall of Ocean Life,* portray the nature of interconnectedness. I will examine how various visual tools are used in order to represent the idea of the natural world as a set of processes and relations that humans are a part of.

When stepping into the *Hall of Biodiversity*, one is immersed in an incredibly dark space where numerous representations of the variety and interdependence of Earth's life forms lie in the shadows. The 11,000 square foot space, which opened in 1998[33], may be in need of some critical changes but, nonetheless, the carefully crafted environment still offers a lot to look at. The center of the hall is a leafy, life-size diorama designed to mimic an environment in the Central African Republic's Dzanga-Sangha Rainforest, complete with a vast array of replicas representing a multitude of species that inhabit this ecosystem. Surrounding this seemingly lush space are two large screens that loop programs illustrating the importance of biodiversity and the ways in which humans are contributing to the crisis that it faces. Nearby is the newly renovated corridor called the *Resource Center* (that opened at the end of 2011) and the intricate "Spectrum of Life", a 100-foot-long wall with well over a thousand specimens cascading down and around it. All of these elements, fighting to

attract the visitor's attention, create a rather overwhelming combination of information. However, the initial experience of feeling dwarfed and entangled has the potential to spark an individual's sense of being a part of something much larger, that can only be understood further by actively pursuing the details of the hall.

The hall's mission to educate the public about the present biodiversity crisis is introduced by a message written on a translucent wall plaque, which is easily missed, failing to welcome one into the space. Similar plaques placed sporadically on the hall's walls and columns that attempt to verbally communicate the space's goals are often hard to read due to the lack of proper lighting and the color choices used for the text. One dark, black column defines biodiversity as "the sum of all species living on Earth." It goes on, in smaller text, to define evolutionary biodiversity as the range of species organized by their evolutionary relationships, and ecological biodiversity, as the interaction of the variety of different species from [various groups of life] to form the web of life in local ecosystems the world over.[34] Here, the language utilized, as well as the poor display of the text, fail to deliver an important message to visitors. The word *interaction* implies and places emphasis on individual agents acting at a community level, rather than on the important interdependencies involving various organisms and their environments on a larger, systemic scale. Interconnectedness could be more effectively communicated by using terms that indicate the notion of a whole, such as the "biotic or ecological system." In a museum, text must be used sparingly and strategically in order to be useful, but the expectation that museum-goers will read each bit of scattered text is unrealistic and in the end, key ideas must be communicated by visually manifesting them in the displays.

The *Hall of Biodiversity's* installation labeled the "Spectrum of Life" (Figure 2) uses more than 1,500 specimens and models, organized into 28 living groups to show over 3.5 billion years of evolution and to display the awe-inspiring diversity of life.[35] The Linnaean taxonomical approach of categorization, which is used in this display, groups all life into three kingdoms that are divided into classes, and then into orders, families, genera and species. It helps viewers to see an extremely wide variety of different types of organisms by separating microorganisms from mammals and bacteria from birds. This technique of organization emphasizes the quantitative aspects of biodiversity rather than qualitative ones. Because of this, the visual display of replicas and specimen fails to communicate the importance of each organism in the ecosystem of which they are a part. In other words, somewhat ironically, the roles of ecosystems themselves are neglected, and rather the emphasis is placed on the range of different species and the diversity of their visual characteristics. For example, several organisms are shown either in a linear fashion according to size, ranging from smallest to largest, or collected in naturalist boxes, neglecting to visually represent any ecological relationships that add biological meaning and context (Figures 3 and 4). These organisms have been dissected from the communities and ecosystems in which they actually reside in nature, making it impossible to realize the greater context that they are pulled out of.

Similar methods of categorization have been used by humans throughout history as a means of simplification imposed to create a sense of order. As Bennie Ricardo Brown explains, this "order" often reflected a naturalized hierarchy of the power relations evident in human cultures at the time. Before Charles Darwin was born, the anthropologist

Johann Friedrich Blumenbach created a method of classification for humans based on the shapes of their skulls, geographical location and subjective descriptions of visible characteristics. His book, *De generis humani variete nativa* (1781) (Figure 5) classifies all Ethiopians as being "black" and having "muscular, prominent upper jaws, swelling lips, upturned noses, and very curly black hair" while Caucasians from "Europe, including Lapps, Northern Africa, America, Eskimo and Greenlanders derived from Lapps, and Western Asia" are all "white" and "beautiful in form."[36] Carl Linnaeus had classified human variety in a similar way in the tenth edition of *Systema Naturae* (1758-59). These two men's distinctions of difference inadvertently justified a framework for methods of domination and control by humans over humans by means of Colonialism, slavery and Imperialism. These constructed classifications based on an extremely limited understanding of one another as a species, created boundaries that are made larger by exploitative relationships amongst humans that they have allowed to form. These types of relationships leave no room for the development of awareness of the difference through greater understanding. In *Ideas of Nature*, Raymond Williams writes that "it is very significant that most of the terms used in this relationship—the conquest of nature, the domination of nature, the exploitation of nature—are derived from the real human practices: relationships between men and men…If we alienate the living processes of which we are a part, we end though unequally, by alienating ourselves."[37]

Misrepresentations are often designed to serve the dominant controlling paradigm. More recently, we have been led to believe that nature can be treated as an endless resource. As a result, often times our economies treat it as one, stacking up organisms

based on their value to us, but without any sense of what processes give us resources (which are certainly not infinite). The contemporary application of categorization techniques in the "Spectrum of Life" not only separates species; it creates a representational boundary between humans and the natural world. Resources are isolated from what produce them, creating an illusion of endless bounty. The exclusion of a human replica from the spectrum furthers the pre-existing binary relationship between humans and nature, rather than showing the natural world as a set of processes that include relationships between *all* forms of life. Nevertheless, the role of humans is present in the construction of the wall itself, which represents our species' tendency to intervene and manipulate the natural world by thinking of itself as something separate from it.

However limiting the Linnaean taxonomical structure of representation is, it is important to acknowledge the essential contributions it makes to our understanding of evolution. Through this understanding, we were able to see evidence of a unifying, common ancestor amongst all organisms, as well as the variation of life that make natural processes and ecosystems possible. That said, I firmly believe that the "Spectrum of Life" lacks clarification that explains the function of the wall to the general public and that biodiversity is more efficiently communicated through visual displays that attempt to replicate ecological relationships in natural systems.

Examples of interconnectedness are not ignored completely in this installation, but are rather displayed on a detached platform within arms reach of most visitors, containing charts and maps that illustrate several different types of relationships and cycles that constitute the natural world. To some degree, these help to contextualize the organisms

represented on the wall behind it. One must look down and away from the visually seductive organisms in order to see the heavily text-based webs, which also combine illustrations and photographs (Figure 6). Before *the Resource Center* opened at the end of 2011, it was here alone where the hall briefly explained key natural processes and systems such as specific food webs, climate regulation aided by diatoms removing large amounts of carbon from the atmosphere, and nitrogen and carbon cycling and storage in the oceans. The museum also uses this space to present ecosystem services by showing images of various plants and animals from which humans derive products and other benefits. These lists (Figure 7) labeled "Values and Benefits" identify plants people use, such as aloe and cotton, representing the value of these organisms from an anthropocentric perspective. The objective of this display is to only discuss the benefits of certain plants and animals for humans, while ignoring the other species that also benefit from the organisms depicted. Failing to see this interconnection prohibits acknowledge what allows biodiversity to exist and thrive. Here, the museum encourages visitors to value the species presented solely for the individual's benefit, neglecting the value of the interdependent ecosystems that actually make these species available for human use.

Nearby, there is a similar diagram of a shark showing different parts that humans have used such as: the fin for soup, teeth for necklaces and liver oils for cosmetics. It includes the ways that these anthropocentric actions have lead to the decline of the species. However, this information fails to discuss the myriad of other organisms that are affected by humans. The point is that the dynamic systems that all species are a part of are not articulated successfully because of the unreliable usage of text, small two-dimensional charts

and the primarily anthropocentric approach used to define value of biodiversity in this display.

The central display in the *Hall of Biodiversity* has enormous potential to more successfully communicate interrelationships in ecosystems, although the Dzangha-Sangha rain forest exhibit (Figure 8) seems to fall short of expectations in achieving these goals. One of the reasons why the entire hall is immersed in darkness is in order to replicate a nocturnal environment in the first section of the exhibition, "The Dense Forest at Dawn" which "reveals the immense diversity of the rainforest." One is supposed to "see the nocturnal world of the dense forest, with its spectrum of animal life and sounds, as if it might appear just before sunrise."[38] The description of this zone poetically describes what this exhibition fails to accomplish due mainly to its conceptual design. Because of the lack of light, one must really search for the various replicas of insects, mammals, birds[39] that are entangled in the over 160 species of flora and fauna[40], and even then it is a challenge to begin to identify, let alone see the relationships that sustain the ecosystem being represented. A temporary solution would be to add spotlights that are activated by visitors, but even once they are seen they still fail to emphasize the important qualities of a functioning system. A more recent example of complex relationships within ecosystems being represented within the constraints of a museum setting is located a step away, in *the Milstein Hall of Ocean Life.*

Here taxonomy is largely replaced with ecology, showing various ecosystems within habitats as living environments including the important relationships that sustain them. The eight new ecosystem displays (Figure 9) on the first tier of the hall were revealed after

the renovations in 2003. After these renovations, the president of the museum, Ellen V. Futter said, "When visitors step into the rejuvenated Milstein Family Hall of Ocean Life they are immediately confronted by the vitality, the immensity, and the mystery of the seas, and through a unique marriage of leading-edge 21st-century technology and classic diorama artistry, they come to an understanding of the critical importance of the oceans to all life on Earth."[41] The HD videos (Figure 10) that are located above each ecosystem display show unique interactions between species, luring the audience in by capturing the beauty of these relationships, even if the critical importance of them isn't necessarily shown. This is done more so in the carefully composed ecosystem displays that consist of replicas of different organisms that exist in specific environments, as well as strategically placed text and images behind and around the models. Each exhibit depicts relationships within ecosystems as well as small bits of text explaining their importance and why humans should strive to protect them. For example, the kelp forest exhibit contains models of otters and other species that kelp often provides food and shelter for, such as plankton, crabs, snails, and seabirds. The text in this exhibit informs the visitor of the ways in which global warming can affect kelp habitats, as well as the ways in which humans use kelp once it is harvested. Although these ecosystem displays represent a fairly successful way to portray the dynamic interconnectedness of ecosystems, the individual displays create a false sense of bountifulness and health that isn't present in all of the ecosystems that actually exist.

Lurking in the shadows behind the Dzangha-Sangha, is a small corridor that reopened at the end of 2011 called the *Resource Center* (Figure 11). This hallway-like space "examines in great detail the value of biodiversity" but does so using a much newer

perspective than the other displays in the *Hall of Biodiversity*. The right wall, "The Transformation of the Biosphere" explores, in depth, a variety of different ways in which humans have changed the surface of the planet with specific examples in each. The issues are broken up into: "Cultural Extinction," "Global Environmental Change," "Damage to Soils and Freshwater," "Human Health and Biodiversity Loss," "Introduced Species," "Vacuuming the World Oceans," "Deforestation," and "Urbanization and Agriculture." Inside each section are examples of human activities that have led to the destruction of specific species, habitats, and/or ecosystems, as well as the ways in which this destruction has affected both humans and other species. For instance, "Damage to Soils and Freshwater" looks at issues of soil compaction due to overgrazing, water pollution due to industrial complexes worldwide, as well as the contamination of the limited supply of freshwater suitable for human consumption. It also explores siltation caused by soil erosion that often kills phytoplankton and buries reefs, which then leads to the reduction of the local population of fish as well as the reduction of hydropower, navigability and usable water for humans.

Across from the display of problems are four larger "Solutions" sections, scattered with quotes from Aldo Leopold and Rachel Carson which offer examples of projects that are currently taking place. They also offer multiple suggestions for individual visitors about how to live more responsibly and actively participate in the dialogue surrounding the value of biodiversity in your community. These are split up into four sections: "Protection and Restoration," "Management for Biodiversity," "Research and Outreach," and one of the most emphasized, "Reducing Resource Demand" (Figure 12). Each has a map of the world

with indications of what projects are taking place and their locations, and a smaller chart along the bottom with different types of suggestions for people in different circumstances (Figure 13). This wall covers many important possibilities for change on an individual, familial, communal, and governmental level, while emphasizing the importance of action on each. One of the quotes from Albert Einstein reads, "We can not solve the problems that we have created with the same thinking that created them," encouraging people to think in new ways about new things. The combination of thoughtful quotes, factual examples and encouraging suggestions has the potential to inspire the visitors who are able to read them.

At the end of the exhibit lies a small but exciting addition to the hall of biodiversity. There is a column with a large block of text that reads:

> "Life's varied expressions – its millions of species and thousands of habitats – deserve our respect by the simple fact of their existence. They have evolved and survived, as we have, to this time and place on earth. Biodiversity is a crucial force in our cultural lives. It is the medium through which our aesthetic and spiritual values are expressed. Around the world, traditions of faith have drawn upon biodiversity for both insight and imagery. Humans rely on biodiversity for many essential goods: food, fuel, fiber, medicine and countless natural products. Of equal importance are the sustaining functions that all life requires – cleansing, recycling, and renewing. Biodiversity plays a central role in making and keeping the earth a habitable place. These ecological services include: purification of air and water, control of floods and droughts, protection from ultra violet rays generation and renewal of soil fertility, detoxification and decomposition of wastes, pollination of crops and natural vegetation, maintenance of diverse habitats and ecosystems, control of agricultural pests, cycling of crucial nutrients, and moderation of temperature extremes and the forces of wind and waves. We depend on biodiversity in our creative and spiritual lives and indeed, for our physical survival."

We see very different ideas here in contrast to those dealing with values that are placed beneath the "Spectrum of Life" that suggest value strictly based on anthropocentric

judgments. This shows that the way of thinking about biodiversity's value has shifted over time, coinciding with the increasing urgency of the problems that the environment and its inhabitants are facing today. This text includes all three of the different reasons for valuing the Earth, its species, habitats and processes discussed in the previous chapter. The one that is left out is one that natural history museums and all environmental education should be trying to do away with, which is that nature is external and limitless and should be valued only for what is benefitted by humans.

While analyzing a museum's ability to communicate ideas of interconnectedness, it is important to keep in mind that there are several constraints on cultural institutions such as the natural history museum. Lack of funds often limit museums while forcing them to cater to popular demands of the general public. This frequently involves replacing older forms of representation in museums with current technology to meet these demands. I think that it's important to preserve past exhibits in museums that document the history of ways in which humans have interpreted the natural world, but it is also critical that these spaces are identified as being influenced by perspectives that have now changed. The *Hall of Biodiversity* has recently introduced informative displays that are based on communicating interconnectivity and its importance, but the rest of the hall does not seem to share the same goal. The "Spectrum of Life" isolates the Earth's species from their environments, reinforcing the illusion that nature is separate from humans and a bottomless pit of resources that individuals can endlessly take from. The representational ecosystem models and dioramas (Figure 14) show the acceptance and integration of evolution and ecology in the museum. By showing species within the environments that

shape them, the dioramas and displays depict important relationships and allow them to be seen within a larger context. *The Resource Center* does an excellent job summarizing the ways in which humans are transforming the biosphere, as well as ways in which we can change this, although it is heavily based in text, which reduces the amount of visitors to which it is accessible. Educational institutions, such as the American Museum of Natural History must strive to combine visual and interactive elements in new ways in order to facilitate a museum experience that communicates ecological interconnectedness and highlights the important relationships and processes humans are effecting.

Communicating Interdependence at the South Fork Museum of Natural History and Nature Center

More recently in the United States, we are beginning to see new natural history museums with different missions and different designs. At the end of 2011, the new Natural History Museum of Utah reopened in a LEED Gold Certified building that blends in with the natural landscape, further emphasizing their goal: *to illuminate the natural world and humans' place within it*.[42] The museum explores many different layers of interconnectivity within the physical landscape, climate, astronomy, local flora and fauna, ecosystems, native nations as well as the future of all these elements in the state. The museum accomplishes this by utilizing a variety of interactive exhibitions throughout the interior and exterior of the building, in surrounding trails, and on the rooftop terrace. The construction of new museums like this are made possible by museum design firms that share similar visions.

For example, the award-winning studio Evidence Design in Dumbo, Brooklyn specializes in contemporary museum exhibition planning and designing for science and history museums across the United States. Their vision states that they "create new directions for spatial communication and learning" and that their "design process focuses on revealing connections among people, places, things, and ideas and choreographing relationships that engage communities, cultures, and environments."[43] The design firm plans to open a permanent environmentally-influenced exhibition space at Flat Rock Brook Nature Center in New Jersey in the summer of 2012 and has worked with other

notable natural history museums such as the Natural History Museum of Los Angeles County and the South Fork Natural History Museum on the East End of Long Island, which I will be exploring in depth below. For the South Fork project, "The design team's task was to creatively present the exhibit content — the area's natural history, its glacial origins, natural habitats and wildlife – as well as the interdependence of all life on our planet."[44]

In May of 2005, the South Fork Natural History Museum and Nature Center opened its 6,400 square foot space to the public. The site is nestled within over 800 acres of preserved land that is part of the Long Pond Greenbelt system in Bridgehampton, New York. The museum aims to familiarize their visitors with the surrounding Greenbelt, which is a unique natural system rich with biodiversity as well as over nine miles of hiking trails where one may encounter the many rare and endangered species that make their home there. The interior of the museum has two floors; the main floor consists of exhibit space that aims to tell different "ecological stories" based on distinct, local ecosystems (Figure 15) while the bottom floor has indoor classrooms, aquarium tanks with local species of animals and plants, and a large "U" shaped touch tank with a variety of local crabs, snails and fish. (Figure 16) One of the key goals of South Fork Museum's mission is to "Engender, in children and adults, a sensitivity to the natural world through direct observation and joyous hands-on nature experiences in the museum and in the out-of-doors, and to give them the tools they need to become engaged and responsible caretakers of our planet now and in the future."[45] Evidence Design assisted the museum in order to create an indoor

experience introducing local areas that would allow one to feel comfortable indoors while evoking a curiosity to have new experiences outdoors.

When one enters the museum, a member of the museum staff will offer a unique exhibit field guide to the museum that can direct one through the various displays and lead to learning through independent inquiry. Rather than functioning as a traditional field guide that helps to identify what one observes in nature, it teaches the visitor how to observe nature (Figure 17). It does this by asking and answering questions that help the reader think about the relationships among animals, plants and their environment, encouraging the visitor to look and listen while guiding them through the museum exhibits. Each display, which represents a particular environment, is indicated on a color-coded decal with an image of an important animal specific to each ecosystem that has been used as a starting point in the exhibit. These simple visual representations aid the viewer in connecting animals to their environment, and then prompt the visitor to find the animal model or specimen in the display. By using an inquiry-based method of learning, these tools are used to facilitate an experience for the visitor that is driven by curiosity and varies with each visit.

Upon entering the exhibition space the first thing that one is instructed to do is to open a door to a closet that contains several items that are traditionally carried and used by a naturalist (Figure 18). This interactive element draws in the museum visitor, especially children, introducing them to some of the important ideas that the museum was founded on and that are seen throughout the space. The museum states, “A naturalist is keenly aware of nature’s complexity and notices subtle change. A naturalist asks questions such as:

What is here and why is it here?"[46] The organization was originally conceived by field naturalists, so the museum often incorporates the key ideas that they define a naturalist into their methods of teaching, which are emphasized by their decision to avoid traditional, didactic methods of learning by including interactive, explorative elements such as drawers, peep holes, doors and pull out devices. This introductory exhibit makes it clear that the museum invites the visitor to become a "naturalist for the day," in hopes that curiosity will propel him or her to keep asking questions about the natural world, even after his or her experience at the museum is finished.

As part of the introduction exhibit, one is also presented with a three dimensional map showing the Long Pond Green Belt, stretching from the Atlantic Ocean to the Long Island Sound, in order to contextualize the habitats that are represented in the museum and to show the visitor where to go in order to directly experience them. The three dimensional map also shows the viewer that this area is an outwash plane, highlighting that a glacier is responsible for the landscape of the East End of Long Island, which can also be seen in a looping video in this exhibit that also includes several images of species that are local to the area. The goal of this exhibit is to show the way in which the physical environment of Long Island was formed, as well as the parts of the island that are being represented in the museum. Carol Crasson, the education and communications director of the museum, pointed out to me that the map and video don't always function as planned because they lack any interactive elements and fail to pose any questions for the visitor. After this point in the museum, one can choose to start at any one of the habitats

represented, which include: Ocean, Dune and Soil, Coastal plane pond, Salt Marsh, and the Vernal Pond (Figure 19).

The South Fork Natural History Museum makes it clear that people are very much a part of the natural world by including examples of a variety of human impacts on the specific local ecosystems represented in the museum. The Dune Swale exhibit has been designed to represent the habitat of the Red Fox. The ecosystem is represented in front of a large, wall-sized photograph of the animal's local habitat, and is complete with models and specimens of native competitors and prey. Next to this elaborate display, one can pull out a vertical drawer with textual information relating to the Red Fox's relative, the Grey Fox. The text here is minimal and accompanied by photographs, but is used to present the fact that the clearing of land for farming and development on the East End of Long Island has forced the grey fox to live only on a small portion of the island where forest areas have been preserved. Here in the museum, one is introduced to an extremely prevalent, local issue by highlighting effect of humans through the destruction of the habitat of a specific species. The exhibit lets the visitor know that the Red Fox has been able to remain in this area of Long Island due to its ability to coexist with humans, but as the forest area continues to become fragmented, the animals are forced to live in densely developed areas with high levels of traffic that put the species at risk.

The issue of forest fragmentation on the East End is emphasized even further in the exhibit focused on the Scarlet Tanager. The Scarlet Tanager is a neo-tropical bird (meaning it migrates south for the winter) that requires uncut forest space in order to live and breed successfully. Once their traditional habitat within a forest's interior is exposed by

deforestation, they are susceptible to predation and brood parasitism from the Cowbirds and Blue Jays, which are also represented in the exhibit (Figure 20). The field guide gives the visitor more detail, showing contrasting aerial view photographs of an unfragmented forest and a fragmented forest. The photograph labeled "fragmented forest" depicts a large piece of property that has cut down numerous trees for multiple mansion-sized homes with swimming pools, huge lawns, driveways and tennis courts.

Another exhibit explores the life of the dying tree in order to show the visitors why it is important not to cut them down. Here one sees a replica of a tree that has been killed by a lightning strike and has become a snag (a standing dead or dying tree) (Figure 21), while another part represented is meant to be undergoing the natural process of decomposition while resting on the forest floor. In and around the tree one can see an array of different organisms that utilize the tree in their day-to-day lives. Inside there is an opossum (the only native marsupial), little brown bats and a Red Bellied Woodpecker "pecking" on the exterior of the tree. A visitor may ask, "Why's that woodpecker pecking?" and one is able to lift a bit of bark from the tree to reveal Carpenter Ants and beetles that the bird would be trying to eat if it were alive. One can also open flaps on the model of the fallen log in order to see the endangered Eastern tiger salamander, grubs and termites. (Figure 22) According to Crasson, "this exhibit is meant to express to people how important it is to leave standing dead wood if it's healthy. Over 1,200 different species depend on dead wood for their survival, and then when it falls and decomposes, it adds much needed nutrients to the sandy soil that is characteristic to the East End."[47] When people realize the potential effects of their actions, it more likely that they will keep in

mind that which is harmed and make more conscious decisions. Here, one can see, to a small extent, the amount of organisms affected by a human's decision to cut down and remove dead wood from a forest. This helps to fulfill another important part of the museum and nature center's mission, which is to "raise the level of ecological awareness to prepare the individual to make intelligent environmental decisions."

There are four other exhibits that represent life in a vernal pond, coastal plane pond, salt marsh, and the ocean, dune, and swale. Each tank has a "wet" and "dry" side that has live species that would normally live in the habitat being represented in the former and a more didactic representation that visually illustrates relationships within the ecosystems with models and sometimes specimens on the latter. The dry sides are reminiscent of the ecosystem displays in the *Milstein Hall of Ocean Life* at the American Museum of Natural History, working to highlight important relationships between plant life and animals in a particular ecosystem. In the exhibit representing a vernal pond, one can see different types of salamanders that rely on these types of environments for breeding. A vernal pond is a low point in the ground where water collects during fall, winter and spring but dries up in the summer. The field guide assures that the visitor understands why it is necessary not to fill in these vernal ponds, and why they are important to several species while they are in both their wet and dry stages. Some information that is not included in the text, but was told to me by a nature educator that was on the museum floor, was that a home's cesspool and runoff can often contaminate a vernal pond if one develops land within a certain proximity of a pond. Even though this information is not available through text, the museum makes sure that there is at least one

nature educator on the floor at all times so that a unique learning experience is always possible.

All of the exhibits on the first floor are presented in relation to the landscape outside, which can be seen at all times through a glass wall that borders the East side of the building. The interactive replicas of natural environments inside combined with the clear visibility of the Old Field habitat outdoors creates a space that serves a reminder of one's place within the natural world. One can either observe the landscape through the glass or go outside onto the 15 by 45 foot observation deck in order to see another ecological story being told (Figure 23).

Through text and images, the museum shows the ecological process of field succession that is taking place in the surrounding Old Field that is visible from inside the museum and on the deck. The environment was originally a forest, which was cleared for farming, and is currently in the state of an Old Field. If left alone, the field will soon turn into shrub land and will eventually turn back into a forest ecosystem. Currently, the Old Field is being kept as is, in order to preserve the habitat that is home to specific species and to show that this is the type of land that is desirable for home development. Since there is limited space inside the museum, this space is also important because of it is used as an outdoor classroom. The trails, teaching ponds and the butterfly garden are all great for interactive educational programs that reinforce the museum's inquiry based teaching techniques, where both children and adults are invited to act as naturalists. The South Fork Museum utilizes the land around their building as a site to explore the local landscape and understand one's place in it. During spring salamander searches, nocturnal owl walks,

and full moon hikes, the nature educators facilitate experiences that are designed to "Emphasize the universal interconnectedness of all living things and stress the need for conservation and preservation of our natural resources."[48]

Compared to the *Hall of Biodiversity* at the American Museum of Natural History, this museum makes use of some very different techniques in order to communicate the interconnectedness of the natural world. While the *Hall of Biodiversity* tries to tackle these issues on a universal level, the South Fork Natural History Museum does so on a particular, local level. In doing so, the museum points out local instances of larger environmental issues, such as habitat destruction, but fail to mention larger scale examples that are less directly related to Long Island. Although the American Museum of Natural History has far more examples of how humans are transforming the biosphere, they are displayed using mostly wall text and photos. The South Fork Museum uses little to no wall text, encouraging the visitors to learn about the environments by experiencing them and creating their own inquiries. The nature center places the visitor directly within an environment, either indoors or outdoors, and facilitates an explorative learning experience that is both interactive and educational. The naturalist approach to learning about nature allows for the visitor to better understand their local environments as well as the effects that they can potential have on them. The emphasis on interactive programming and the presence of a nature educator on the museum floor allows for the possibility of conversation at all times. These conversations may then continue outside the museum, spreading ideas about ecology deeper into the community and getting more people talking about them. One thing that the museum doesn't really emphasize is the way that the

ecosystems of the East End provide for humans. This may be to encourage a type of thinking that values the natural world intrinsically, irrespective of the benefits that humans may get from it. Although, in times when these processes, from which we benefit are being depleted, it is important that we, as a species, are aware of where they come from and what we must do to preserve them. In order to communicate interconnectedness most effectively, it is essential that natural history museums incorporate ecological thinking by using a multitude of perspectives.

The Future of Ecological Thinking in the Natural History Museum and Beyond

As the surface of the planet continues to transform, it becomes increasingly important that educational institutions are on the cutting edge of the information pertaining to these changes. Natural history museums are responsible for communicating this information to the public in a way that is both stimulating and capable of being understood by a wide variety of audience members. Whether a museum is trying to communicate a particular local ecological story, or one that is more globalized, it should use ecological patterns and relationships to convey interconnectedness by utilizing a variety of approaches inspired by a multitude of perspectives.

I argued that museums should not be the place where one can find only answers, but places that provoke questions and encourage visitors to be active and want to learn more. Natural history museums were once a place where people came to pursue answers to their own complex questions, inspired by a greater curiosity about life and history. Because of serious funding constraints, museums have more recently been forced to cater to the popular demands of the public. For example, Ronald Reagan cut museum funding in the United States during his years in office, forcing an influx of gift shops, restaurants and forms of public entertainment within museums.[49] Lack of funding is one of the main constraints of museums today, forcing many educational jobs into the hands of volunteers and unpaid interns. Popular demand has also forced many museums to adopt the use of technological spectacles in order to attract viewers. Many museums have turned to Imax theaters, large HD screens and interactive computer interfaces for entertainment that may

also be educational. These expensive features also require museums to charge premium prices for their exhibits, somewhat diluting their role as an institution devoted to public education.

For example, the American Museum of Natural History has several interactive computer screens installed in the *Hall of Biodiversity*; some that are in front of the older "Spectrum of Life" exhibit and newer ones that are in the recently added *Resource Center*. The ten interactive computer stations that were installed in front of the "Spectrum of Life" wall were once meant to help visitors identify the specimens that are displayed, although the screens and buttons have since taken a beating and few remain working. Those that are installed near the "Solutions" wall in *the Resource Center* are working, but serve a similar purpose by providing the visitor with the option of choosing from four different anecdotal videos that provide examples of the material in the exhibit (Figure 24). Since the museum has chosen to incorporate interactive methods of computerized communication, it would be beneficial to utilize those that function as a dynamic network by including the use of Internet connection. The only place where this is used in the *Hall of Biodiversity* is through an interactive station where the visitors can record themselves and share it through email. If similar technology was put towards both education and entertainment rather than focusing mainly on the latter, it may be more successful in communicating complex relationships that are taking place in various parts of the world.

Rather than using screens as interactive technology that solely tell the visitor what is happening, interactive technology can be used to create an experience that helps to show us what is going on. New technology can be integrated in order to create a new, exiting

interactive experience that highlights the ways in which humans are a part of the natural world, and the effects we have on its vital, interdependent ecosystems. Weight and infrared sensing technology can be used to indicate approximately how many people are in a space. This can be used to display an average of how many ecosystem services may be used daily or yearly by the amount of people in the space. Different ecosystem services can be represented in different exhibitions, and then within that exhibit, people can learn about particular species and habitats they effect depending on the different products they consume. Or different ecosystems can be represented by the exhibitions, and then within them one can find out which services are derived from them. The interaction can become more personal through the utilization of individual use monitors, but these monitors must have access to interactive software that allows visitors to input information about their lifestyles. Since technology is sometimes over used and poorly used in museums meant to appeal to public, it is important to think more carefully about its use and make sure that it interactively displays the natural world's interconnectedness.

Rather than focusing on using interactive technology to replicate interconnectivity in the natural world, natural history museums can focus on using the natural environment to show local examples of interrelationships. Within the American Museum of Natural History, the amazing dioramas can be used to show the public interrelationships through different tours. Museum educators would focus on developing inquiry based conversational tours meant to highlights parts of the permanent collection that show relationships within ecosystems while explaining our relationships to them. The American Museum of Natural History also has central park and its zoo right next door. Here

educators can use guided tours to show examples of local biodiversity, decomposition, and other natural processes, as well as the ways in which the surrounding city may affect the other species that live there. Collaborating with surrounding institutions will strengthen the community while promoting a higher standard of ecological thinking throughout it.

We can learn from exploring, on a conceptual level as well, how we represent the interconnectedness of life on Earth. One contemporary artist whose work greatly considers the implications of how the natural world is represented in natural history museums is Mark Dion. His work explores the ways in which public institutions and dominant ideologies form our understanding of history, knowledge and the natural world.[50] He has closely examined the role of natural history museums throughout their history and has done surveys of their techniques of display, which have greatly shaped the nature of his artwork. He often adopts the methods of museums in order to perform a form of institutional critique within particular institutions. His background in ecology and as a naturalist also often influences the subjects and methods of his work.

Mark Dion frequently works to bring conceptual ecological exhibits to otherwise traditional art museums and spaces. One of his more recent installations, *Neukom Vivarium* (2007)(Figure 25), is currently in the Seattle Art Museum's sculpture garden. For this piece, a 60-foot long fallen hemlock was removed from its forest ecosystem and relocated in a custom designed green house with advanced climate control technology. Dion and a team of ecologists gathered some of the surrounding soil, and moss, as well as several different species of fungi, insects, and plants that were in and around the tree in order show that these nurse logs (or fallen trees) support a complex, living ecosystem within it. The

conditions within the greenhouse allow for natural processes to continue and communities to thrive after the tree has been removed from its original ecosystem. These conditions are made possible by complex machines such as a water catchment, irrigation system, cooling system, and light regulation devices. Dion describes how these devices are meant to highlight the difficulty of mimicking a natural environment and states "It really shows that despite all of our technology and all of our money when we destroy a natural system it's virtually impossible to get it back."[51]

Beneath the tree is a platform lined with tiles that show detailed drawings done by naturalists in the community that show the different species of organisms that live in, on and around the tree. Near these tiles are several drawers that the visitor can pull out in order to see plans and drawings explaining the different mechanisms, which reveal just how difficult and complex the process truly is. There is also a field guide that was assembled by the ecologists that helped Dion collect the organisms from the forest. All of these tools, and especially the tree itself, can be used as teaching tools for anyone who comes into the greenhouse. Each time one visits the tree; it's a different experience that highlights the process of nature and its interrelationships. One is able to notice the proliferation of life that is made possible by decomposition, and one can learn about the different species of fungi and insects that contribute to this process through direct observation as well as by using the field guide. Visitors are provoked to ask questions, especially given that the work is surrounded by completely different sculptures done by other conceptual artists using more traditional artistic mediums.

In 2011, Mark Dion completed an 18 month long collaborative project with the Oceanic Museum of Monaco and the Villa Paloma at the Nouveau Musée National de Monaco (NMNM) called *OCEANOMANIA: Souvenirs of Mysterious Seas, from the Expedition to the Aquarium*. This research project was influence by two recent ecological events: the *Census of Marine Life* (2010) and the Deep Water Horizon Oil rig explosion. The former concluded that in many ocean environments, more than half the species have yet to be discovered and the latter, an environmental disaster that has had ecological impacts that we have also yet to full realize. One part of the project takes place at the NMNM and has multiple exhibitions within it. The exhibitions include work from famous naturalists such as Ernst Heackel, placing them alongside paintings of the sea by celebrated landscape artists Claude Monet and J.M.W. Turner as well as contemporary artists such as Allan Sekula, whose research based work deals with historical, sociopolitical and aesthetic connections between seaports.[52] The amalgamation of artworks shows a variety of interdisciplinary approaches to conveying our relationship with this vast part of the natural world. In this setting, we can explore ecological interrelationships through a different lens that includes an interconnectedness that we construct by developing material relationships as well as psychological ones, to a multitude of objects and experiences.

For the second part of the project, Dion was commissioned to curate one of the largest curiosity cabinets at the Oceanic Museum of Monaco. Dion rearranged artifacts, specimens and art objects from a variety of different parts of the collection, and included works of his own that function to "examine our perception of the oceans and engage our sense of wonder at its diversity and our melancholy at its depletion."[53] It is through this

that we are able to realize interdependence and form our diverse understandings of it. As humans, our perception is one of our most important tools for developing awareness for the natural world and the interrelations within it. By noticing differences in perception, we are able to realize what aspects of science education need to be adjusted in order to adequately reach everyone. Dion uses artistic tools that are not often utilized by scientists in order to communicate interconnectedness within the natural world and illuminate the ways in which our relationship to it is always mediated by human perception. One critic stated "The exhibition as a whole acts as a reminder of the neglectful exploitation of a rich and diverse aquatic life and mineral resources, playing on the sentiments of wonder, the marvelous, melancholia, and the apocalyptic, subject to the changing myths of the times and the market."[54] By using an interdisciplinary artistic approach to show how we are embedded in the interrelationships of the natural world as well as the impacts we have on them and ourselves, Mark Dion's work goes beyond being a "simple reminder" of our actions.

As our ecological problems become increasingly daunting, it is important for us to not just focus on the vast array of problems, but rather to be committed to finding new solutions. These solutions must take into account the value of ecosystems not only insofar as they serve us but as they, in themselves, constitute a whole. Natural history museums should apply our best understanding of existing ecological patterns and our relationships to them in order to convey an interconnectedness fundamental to our life on the planet. As such museums continue to experiment with ways that this can be done, they have begun to innovate using techniques that increasingly immerse us, conceptually and pedagogically,

in that interdependence. It is essential that new strategies continue to emerge and instill a heightened sensitivity to the interconnectedness of all life in the generations to come.

Notes

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[32] *I hope that none of the critical comments that I have made throughout this paper will offend anyone affiliated with the aforementioned museums. I also hope that it is understood that my analysis and critiques are done not out of abhorrence, but out of admiration, and a desire to see more effective and interesting cultural institutions in the future.*

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Appendix

Figure 1

Satellite image of the border between Haiti (left) and the Dominican Republic (right) showing severe deforestation

Source: <http://www.globalsecurity.org/military/world/haiti/environment.htm> March 2012

Figure 2

Left side of the "Spectrum of Life" exhibit in the *Hall of Biodiversity* at the American Museum of Natural History

Source: Image taken by the author September 2011

Figure 3

Close up of a detail showing how species of organisms are arranged by size in the "Spectrum of Life" exhibit in the *Hall of Biodiversity* at the American Museum of Natural History

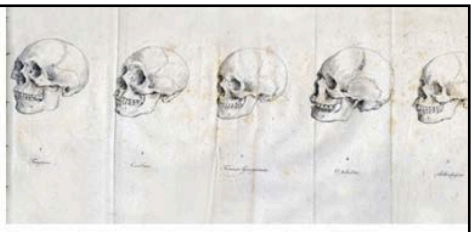
Source: Image taken by the author February 2012

Figure 4

Close up of detail showing how species of organisms are grouped based on visual characteristics and evolutionary relations in naturalist boxes in the "Spectrum of Life" exhibit in the *Hall of Biodiversity* at the American Museum of Natural History

Source: Image taken by the author February 2012

Johann Friedrich Blumenbach



Blumenbach's Classification, from *De generis humani varietate nativa, 1781*

Name	Geographical Location	Color	Characteristics
Caucasian	Europe, including Lapps, Northern Africa, America, Eskimo and Greenlanders derived from Lapps, Western Asia	White	Beautiful in form
Mongolian	Rest of Asia	Brownish/Olive	Straight face, narrow eyelids, scanty hair
Ethiopian	Africa excluding Northern Africa	Black	Muscular, prominent upper jaws, swelling lips, Upturned nose, very curly black hair
American	Non-European Americans	Copper	Broad nose, scanty hair, thin habit of body
Malayan	Southern Pacific	Very deep brown	Broad nose, thick hair

Figure 5

Johan Friedrich Blumenbach's Classification chart, *De generis humani varietate nativa* 1781

Source: B. Ricardo Brown's presentation *Diversity, Culture, Theory and Data: Science on Human Variety* which is documented on blog "Until Darwin: Science and the Origins of Race" <http://until-darwin.blogspot.com/2011/11/diversity-culture-theory-and-data.html> November 2011

Figure 6

Detail showing "Birds: Ecosystem Services" on platform in front of the "Spectrum of Life" exhibit in the Hall of Biodiversity at the American Museum of Natural History

Source: Taken by author January 2012

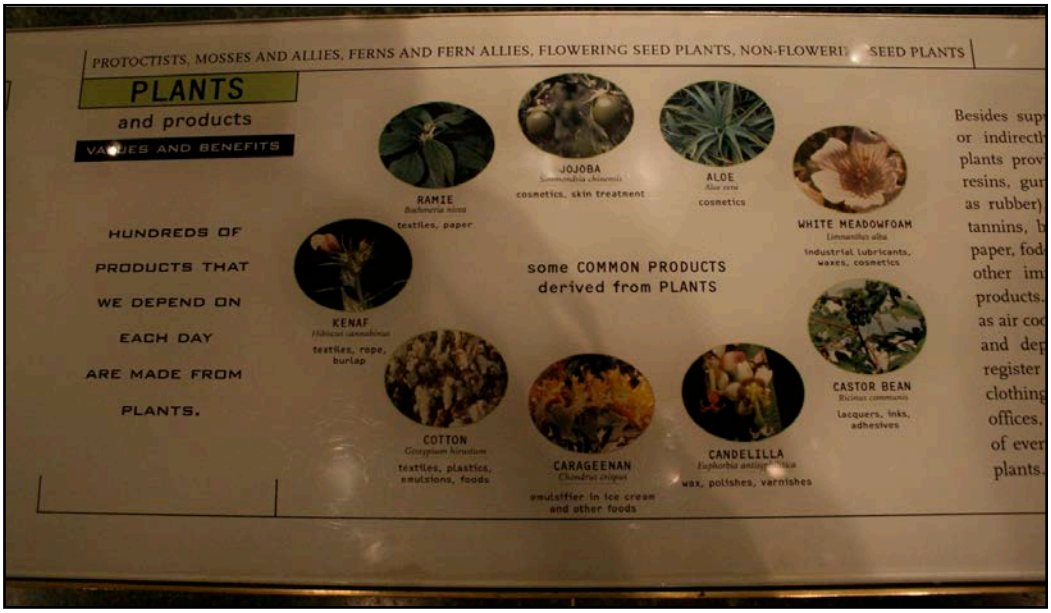


Figure 7

Detail showing "Plants and Products: Values and Benefits" on platform in front of the "Spectrum of Life" exhibit in the Hall of Biodiversity at the American Museum of Natural History

Source: Taken by the author November 2011

Figure 8

"Dzanga-Sangha Rainforest Diorama" in the *Hall of Biodiversity* and the American Museum of Natural History

Source: (c) AMNH / Denis Finnin <http://www.amnh.org/exhibitions/permanent/biodiversity/rainforest/> 2012

Figure 9

Kelp Forest Ecosystem Diorama in the Hall of Milstein Ocean Life at the American Museum of Natural History

Source: Taken by the author March 2012

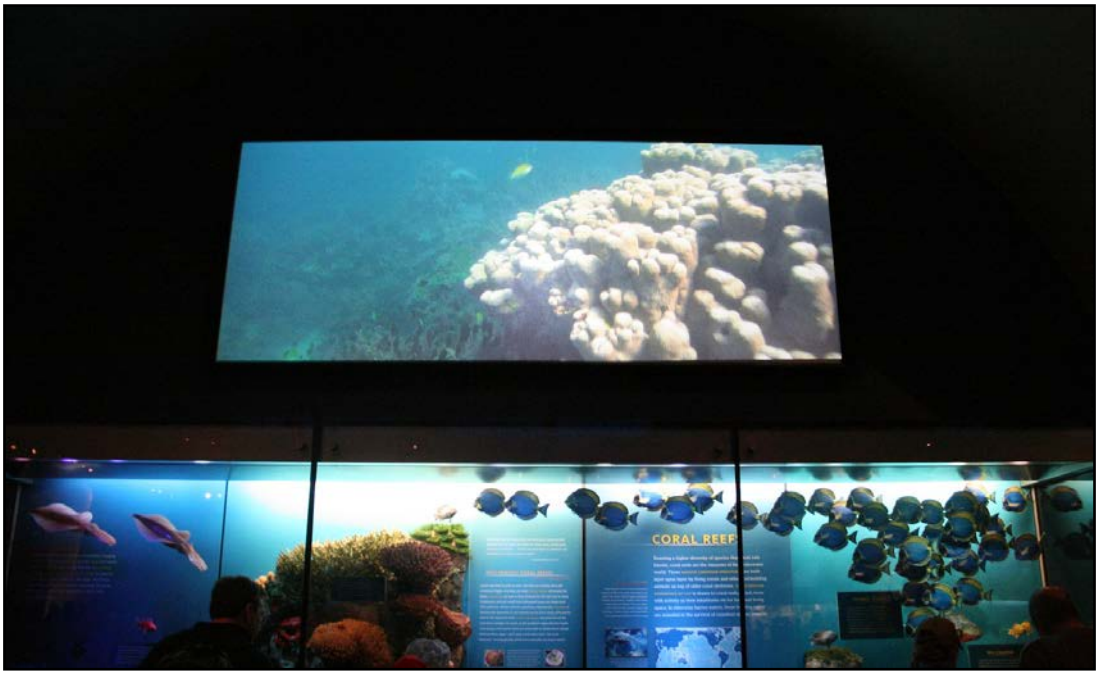


Figure 10

Image showing one the eight HD screens that coincide with the eight ecosystem displays in *the Milstein Hall of Ocean Life* at the American Museum of Natural History

Source: Image taken by the author March 2012

Figure 11

Image showing the entrance to *the Resource Center* with the "Transformation of the Biosphere" wall to the right and a text column to the left. *The Resource Center* is in the Hall of Biodiversity at the American Museum of Natural History.

Source: Image taken by the author February 2012

Figure 12

Detail showing map of "Reducing Resource Demand" on the "Solutions" wall in *the Resource Center* in the *Hall of Biodiversity* at the American Museum of Natural History

Source: Image taken by the author January 2012

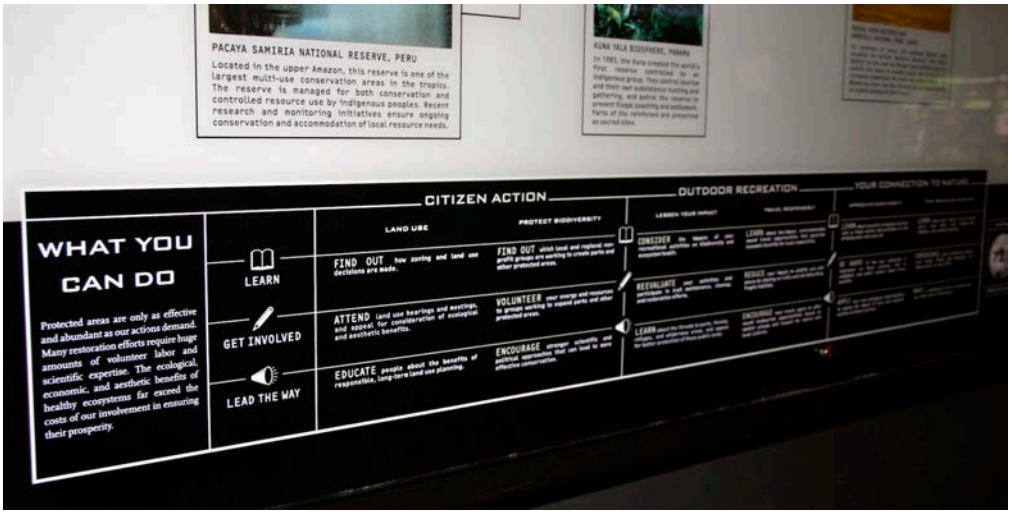


Figure 13

Detail showing suggestions for students, teachers and activists on the "Solutions" wall in *the Resource Center* in the *Hall of Biodiversity* at the American Museum of Natural History

Source: Image taken by the author January 2012

Figure 14

Image of a diorama from *Birds of the World* and the American Museum of Natural History, showing different species of birds that live in the Pampas grasslands and marshes in Lake Chascumos in Argentina.

Source: Image taken by the author March 2012

Figure 15

Image of the "Fox in the Swale" exhibit at the South Fork Natural History Museum

Source: Evidence Design

Figure 15

Touch tank on the bottom floor of the South Fork Natural History Museum and Nature Center

Source: Image taken by the author March 2012

Figure 16

South Fork Natural History Museum Field Guide

Source: Evidence Design / South Fork Natural History Museum

Figure 17

Detail of the "Naturalist's Closet" at the South Fork Natural History Museum and Nature Center

Source: Image taken by author March 2012

Figure 18

View of the top floor of the South Fork Natural History Museum's dual, circular habitat exhibits from the perspective of one entering the museum.

Source: Evidence Design / South Fork Natural History Museum

Figure 19

Detail of the inside of a "peep hole" display in the Scarlet Tanager exhibit at the South Fork Natural History Museum and Nature Center

Source: Image taken by the author March 2012

Figure 20 (Left)

Image of the two standing stag models in "The Life of the Dying Tree" display at the South Fork Natural History Museum and Nature Center

Source: Image taken by the author March 2012

Figure 21 (Above)

Detail of the fallen log with movable flap open to reveal different organisms that live in and around the log

Source: Image taken by the author March 2012

Figure 22

View of the Old Field, pond and trails from the deck on the East side of the South Fork Natural History Museum

Source: Image taken by the author March 2012

Figure 23

Image of one of the ten screens in *the Resource Center* in the *Hall of Biodiversity* at the American Museum of Natural History

Source: Image taken by the author March 2012

Figure 24

Image of the inside of Mark Dion's *Neukom Vivarium* (2006) at the Olympic Sculpture Park in Seattle, Washington

Source: Image taken by Janine Robinson <http://lagunadirt.blogspot.com/2011_04_24_archive.html>

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