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The Effects of Acid Deposition on High-Elevation Ecosystems: Values and Duties to Protect in an Ecocentric-Based Environmental Ethic

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The Great Smoky Mountains National Park is one of our nation's oldest and most visited national parks. Founded in June 1934, the Great Smoky Mountains National Park was the first national park to be funded partly by the federal government. Today, the park is the most visited national park in the United States and is a UNESCO World Heritage Site (UNESCO). The park is home to thousands of species of plants and animals and represents one of the most expansive attempts at preserving nature for future generations. Unfortunately, man-made pollution has had a devastating negative impact on the park. In 2003, the National Park Conservation Association rated the Great Smoky Mountains National Park as one of the most polluted national parks in the country (NPCA). Acid deposition, which is caused by emissions from automobiles and power plants, is one of the leading sources of pollution in the park. Acid deposition has caused irreparable damage to a variety of species and ecosystems, but regrettably, traditional environmental ethics theory with its anthropocentric viewpoint does not offer a satisfactory solution to this problem. Holmes Rolston provides the necessary shift in perspective from an anthropocentric view towards the environment to an ecocentric view, which provides value to nature irrespective of its value to man. In this paper, I will challenge the traditional environmental ethics approach to the problem of acid deposition in the Smoky Mountains, and I will demonstrate our greatly expanded duties to preserve the environment and limit pollution when we change our perspective to an ecocentric view.

Acid deposition, also known as acid precipitation, is an environmental phenomenon caused by air pollution and characterized by a decrease in pH of precipitation. The two main pollutants that cause acid rain are nitrates (NOX) and sulfates (SOX), which are released into the air during combustion of fossil fuels in automobiles and power plants respectively (Saltman 1). While much effort has gone into reducing the pollutants, such as the Clean Air Act, coal-fired power plants run by the TVA continue to emit large amounts of sulfates upwind of the Smoky Mountains (Nolt 57). TVA is continuously working to reduce its emissions through the use of cleaner fuels and more efficient plants, but a majority of the region's power still comes from coal-fired power plants (TVA). It is estimated that the amount of sulfates emitted into the park is the equivalent of 200 railroad cars full of sulfuric acid (NPCA). Also, the number of cars operated in the East Tennessee area has increased significantly, thus causing an increase in the emissions of nitrates from gasoline combustion. Once these pollutants are in the air, they combine with water vapor and clouds to form acidified compounds. These clouds follow the prevailing winds and begin their journey towards the Smoky Mountains. Once this water vapor reaches the Smoky Mountains, it cools and condenses to form precipitation. Thus, acid deposition can reach the ground in many forms including acid rain, acid snow, and acid fog; the acidified particles can even precipitate directly out of the air and fall directly to the ground (Nolt 79). Imagine that the Smoky Mountains own namesake, the fog that generally blankets them, is now causing harm to the environment (Rosenthal 11). The negative effects of acid deposition are magnified at higher elevations (over 4,000 feet) because a much greater volume of precipitation falls there. This precipitation then makes its journey towards the waterways, where it collects and causes acidification of streams. The acidification of high-elevation waterways has been devastating to many species including brook trout. The brook trout population has been severely depleted in the Smoky Mountains because of their sensitivity to acidification and other factors (Bugler). Many species of salamanders and snails have been harmed by the acidification of streams due to acid deposition along with the species that feed off them. Yet, the most obvious effect of acid deposition is the destruction of entire forests of red spruce (Pardo). Acid deposition leeches nutrients directly from the needles of the trees and the soil vital to the trees' survival. Entire forests of red spruce have been killed which has a cascading negative impact on the animals that live in the forest. Once these forests are gone, the soil begins to erode which causes further damage and allows more pollution to reach the streams.

Acid deposition has caused the death of much of the Smoky Mountains' red spruce population. The high-elevations of the Smoky Mountains used to have abounding spruce forests, but all that remains are the dead trunks of trees killed by acid deposition. Acid deposition harms red spruce in a variety of ways. First, acid deposition creates sulfuric and nitric acid that directly attack the needles and affect their ability to process light energy into sugars. Essentially, the needles are destroyed by acid. Also, acid deposition leeches away critical minerals from the tree so basic metabolic processes cannot occur. As more acid deposition falls, the soil chemistry is drastically altered, but red spruce require a specific pH range for their roots to efficiently absorb nutrients from the soil. As the soil becomes more acidified, red spruce lose the ability to absorb nutrients such as calcium, phosphorus, and potassium (Shaberg). Without these nutrients, the trees cannot survive. Acid deposition leeches calcium from cell membranes, but this calcium is crucial for cold hardiness. Upon the arrival of winter, the red spruce fall victim to the harsh climate. The acid deposition causes red spruce to become extremely sensitive to winter injuries, and entire populations of red spruce can die in a single season.

Once acid deposition enters the soil, it begins to degrade the quality of the soil and the pH of the soil begins to drop. The soil in the Smoky Mountains has granite bedrock, which does not produce compounds to counteract acidification. Thus, the soil has a low buffer ability, and consequently acid deposition mobilizes many harmful earth metals (Pardo). The increased acidity of the soil allows many tree species to absorb free aluminum. But, aluminum is highly toxic to trees. Along with the direct effects of acid deposition, aluminum poisoning has killed many trees in the Smoky Mountains. Yet, aluminum does not harm only trees. Once mobilized by acid deposition, aluminum makes its way into the many waterways in the mountains (Rosenthal 13). Here, aluminum poses a serious threat to many fish and invertebrate species. Aluminum is highly toxic to these species and has caused brook trout to be exterminated from many of its native streams in the Smoky Mountains.

Acid deposition has lowered the pH of almost 30% of high-elevation streams below the point where animals can safely live in them. During storms when high volumes of acid rain deluge streams, the pH of the water can dip as low as a pH of 3.5, which is about the same acidity as vinegar (Barnett). The effects of acid deposition are magnified over time because as streams become more acidified they lose their ability to buffer future acid deposits. Already, almost 97% of high-elevation streams have little buffer capacity and are subject to the acidity of episodic rains. When streams lose their buffer capability, the acidity of the stream depends solely on the highly acidified acid deposition. It is predicted that in 50 years a majority of Smoky Mountain streams could have a pH of under 5.0, which is harmful to all forms of animal life.

Acid deposition is particularly harmful to the native brook trout population. Brook trout have begun to disappear from many of the Smoky Mountain waterways, and if current trends continue it is predicted that in 50 years all streams in the Smoky Mountains will be too acidified for brook trout to live (Bugler). Acid deposition affects the trout in two ways. The acidified compounds are inherently toxic to fish, but they also have a negative impact on the fish's gills causing the membranes to cease functioning properly. Acid deposition also mobilizes aluminum in the soil, which is also toxic to fish. Aluminum disrupts the membranes in fish's gills, causing severe physiological damage (Bugler). Brook trout are not the only animals affected by acid rain. Many species of reptiles, salamanders, and snails have been harmed as well (Charles 92). Acid deposition hinders a snail's ability to uptake calcium to form its shell. This causes the snail's death since it has lost its main source of protection. Many diverse species of salamanders have also been threatened by acid deposition. Salamanders are very sensitive to changes in pH in the water they live in, and when the water becomes too acidified they die. This should be a pressing concern because many unique species of salamander are found only in the Smoky Mountains. Already some species of salamander have been pushed to the brink of extinction.

The effect of acid deposition on high-elevation ecosystems is a difficult dilemma for traditional environmental ethics because a central feature of this ethic is the anthropocentric viewpoint. According to the anthropocentric view, nature only has value which man gives it. According to this view, nature has only an instrumental value to man. This means that nature merely has value in accordance to how useful it is to man or how much value man is willing to give to it. Strictly speaking, nature has no intrinsic value, or value in and of itself. Man can value nature, but it is only valuable in the needs and desires of man. For instance, the Smoky Mountains may have an instrumental value in the recreation they provide to visitors (Rolston 7). Hikers and campers find much enjoyment in the activities that can be found in the backcountry. Humans can also find aesthetic value in the Smoky Mountains in the scenic vistas and meandering streams (Rolston 10). People impart value to nature in various other ways including value as a life giving system, economic value from the resources taken from nature, and cultural value such as the idealization of wilderness or taking the bald eagle as our national symbol (Rolston 5-27). According to traditional theory, nature's interaction and relationship with man bestow it value. How else could nature have any concept of value? This implies that to give nature any value we must experience it. Nature must be so awe inspiring or moving that it excites us and inspires us to say that it has a value to us (Rolston 28). Taken by itself, the anthropocentric view does obligate humans to have a duty to protect nature. But, this duty is a weak responsibility since it only obligates humans to protect nature that has an instrumental value to people. For example, according to the anthropocentric view, if an insect species is completely insignificant to humans, people have no obligation to protect it and could possibly exterminate it if it is not deemed beneficial to humans. Herein lies the problem of protection of high-elevation ecosystems in the Smoky Mountains from acid deposition. People have only a weak duty to protect the

Smoky Mountains and all the species it houses. Thus, duty pertains possibly to only giving a small donation to the park or recycling on an individual level. But, the pollution harming the park is a humanity-wide issue. Humans value themselves in an intrinsic fashion, valuable in our own right. Thus, human activity out weighs all natural value. Humans place a much higher significance on the electricity we receive from coal-fired power plants or the mobility and convenience from automobiles. The duty to protect the forests and waterways of the Smoky Mountains is highly outweighed by the value humans place on ourselves and what we deem to be important. The weak duty to protect brook trout is greatly outweighed by the value of electricity for one's neighborhood as well as the duty to protect a forest of red spruce is overshadowed by the convenience valued in using an automobile over a bicycle.

In *Environmental Ethics*, Rolston presents a fundamentally different environmental ethic based on a multi-level value system where the continuity of the ecosystem is of paramount importance (Rolston 179-181). In this system, all aspects of nature from the abiotic environment to sentient animals to an entire ecosystem have varying levels of intrinsic and instrumental value independent of their value to humans (Rolston 223). This value system creates a hierarchical structure where intrinsic value and instrumental value have an inverse relationship. The most complex systems, ecosystems and sentient animals, have the most intrinsic value and varying instrumental value while plants and soil have little intrinsic value and much instrumental value.

Most ethicists would agree with Rolston that sentient creatures have a right to not experience unnecessary pain caused by humans. But, Rolston argues that it is a fundamental error to say an animal has rights because a right implies a value held in the possessor. Instead, animals have interests, both biological and psychological, which it hopes to fulfill (Rolston 52). For instance, a brown bear has a biological interest to have a habitat full of food and a psychological interest to hunt that food. By fulfilling these interests, higher animals are able to have fulfilling subjective experiences much in the same way humans do. Thus, higher animals demonstrate intrinsic value by meeting their biological needs. A bear is able to hunt and fish and thus fulfill its purpose of being a bear in nature regardless of human experience. Much in the same way humans value other humans intrinsically just for being human, an animal can also fulfill its natural value and gain intrinsic value. This does not mean that higher animals have the same intrinsic value as humans. But by showing that intrinsic value is found in nature, a new environmental ethic can be formed without nature having mere instrumental value.

Organisms including lower animals, such as reptiles and insects, and plants are harder to give intrinsic value to because it is less certain they have sentience. “Organisms are self maintaining systems” (Rolston 97). All organisms are alive and must strive to meet basic requirements for survival. But where does the source of life come from, that is missing in inorganic matter? For Rolston, an organism’s most important quality is the set of genetic code that defines a particular organism (Rolston 98). Genetic sets provide the necessary information for an organism to function and survive. DNA acts as a guiding agent to encode the proteins, carbohydrates, and enzymes necessary for life. Genetic code acts as a sort of logical system for an organism to organize into a useful being. Thus, genes act as a normative set defining what an organism ought to be. This can be contrasted to what an organism actually manifests itself in the environment. An organism is thought to have some value by viewing genes as a normative set with which to define an organism. An organism will strive to reach its genetically coded ideal state. This ideal state is the maximum fitness achieved in the environment for which an organism is adapted. This may not be the environment the organism currently inhabits, but it will still attempt to maximize its fitness to its current surroundings.

This intrinsic value is in addition to the instrumental value that all organisms have in an ecosystem. Plants have instrumental value in the nutrients they provide to herbivores. Many tree species have a large resource value to humans as is demonstrated in their harvesting to make a variety of products. Most lower animals serve an instrumental purpose when they act as a food source for higher animals.

The intrinsic value of organisms is less than higher species and distinctly less than the intrinsic value of human actions. This is because lower organisms lack sentience and the ability to make choices. But, by demonstrating that individual organisms have intrinsic value independent of their value to humans, a more accurate scale can be developed on which to base environmental decisions. If only a simple additive scale is used, the total intrinsic value of an ecosystem filled with millions of organisms could potentially be enormous. This system is probably incorrect because many values are not additive and possibly not even comprehensible with one another. While this system is most likely incorrect and the true value of each organism lies somewhere on the continuum, it still establishes that ecosystems have value independent of human interests.

It has been shown that all living things have a certain measure of intrinsic value based on their genetic makeup and their actions to fulfill basic interests. Individual organisms are not the only source of intrinsic value in nature. For Rolston, "the living process in the environment" has great value and must be protected (Rolston 137). Individual animals may not have significant value on their own, but as a species, animals can have crucial value in the niche they occupy. Traditional ethics have difficulty assigning value to an abstract concept, such as a species, which is hard to define specifically since a species can mutate over time. However, in biological terms valuing a species is much more sound than valuing individuals. A species line is fundamental to the survival of a species, while individuals can live and die with no effect on the species as a whole. This can be seen in a wide array of examples where an individual animal has little impact on the survival of a species. For instance, consider that every year thousands of deer are killed in the United States during hunting season. The death of these individuals has little impact on the population of deer as a whole. There is some benefit in keeping the population in control to keep the population within the carrying capacity of the environment. On the other hand, a culling effect occurs as hunters prize the largest and most fit bucks in a population. Regardless, the important consideration is that the species as a whole continues and thrives. Values important in an individual organism can also be seen writ large on a species level including, "pursuing a pathway through the world, resisting death, regeneration. . . and creative resilience learning survival skills" (Rolston 149-151).

Thus, “the appropriate survival unit is the appropriate level of moral concern” (Rolston 151).

Expounding on the idea that the appropriate unit of survival must be the level of moral concern, we can see that there exists specific duties to environmental communities. The ecosystem is the ultimate level of concern for environmental ethics because it encompasses all organisms and processes that occur in it. In this context, an ecosystem encompasses all the plants, animals, and environmental resources that form a “community” of cooperation where each organism fills a niche to create overall stability. Much in the same way that the lungs are a necessary organ in humans, so too do trees play a vital role in any ecosystem as the initial supplier of key nutrients. The value in an ecosystem comes from the cooperation of each part working together to promote overall stability. But, cooperation is not the right word because it implies an anthrogenic goodness of charity. Instead, an ecosystem can be seen as the fulfillment of each organism maximizing its own fitness to the benefit of the whole community. The vital life processes are key: diversity, unity, stability, spontaneity (Rolston 163). Yet, conflict is also valued in this system because it promotes overall well being. Selection pressure and carrying capacity of the land are amoral. These are biological functions with no moral value but are products of inherent nature of an ecosystem. Conflict can be a positive action, such as when wolves lower a population of deer to an acceptable carrying capacity through their carnivorous nature. This process reveals the importance of co-evolution required for the stability of an ecosystem. Predator and prey or parasite and host must co-evolve in an environment to maximize their fitness.

An argument against an ecocentric approach to environmental ethics centers around the organization of an ecosystem. An ecosystem is very loosely organized with many of its members mobile and interacting very rarely. This can be compared to a human with very strictly organized organ systems and biological processes that can be observed. A strong counter-example to the necessity of strict organization can be shown as a hiker asks, "where is the forest?" when he is looking only at one tree. The forest is made up of many trees, and it is their aggregation that makes a forest. Likewise, an ecosystem can be seen as a lose organization of organisms that function as "parts" to make a "whole" ecosystem (Rolston 168-169). A lack of complex organization does not imply that an ecosystem does not exist. They simply have a much more interdependent set of relationships where complicated patterns can form. Complexity is crucial to any biological system, and any number of relationships can form ranging from mutually beneficial to mutually detrimental. The only difference is that detrimental relationships often lead to extinction.

This analysis illustrates the flippancy of considering an organism as real because it has strict delineation and an ecosystem as unreal because it only has loose organization. An ecosystem does not require these strict bounds. Instead, an ecosystem's importance lies in its nature of being a "comprehensive, critical survival unit without which organisms cannot survive" (Rolston 180). Forces can act from outside the system or within, but only the ecosystem's continuance is crucial for its member organisms' survival.

In forming a hierarchy of value for an ecological community, the entire system must take precedence over individuals. "In biotic communities, the community is the relevant survival unit; its beauty, integrity, and stability come first" (Rolston 182). When an invasive species comes into an ecosystem, it may be appropriate to remove those individuals. For instance, invasive mussel species have been introduced to many Tennessee waterways and have had a detrimental impact on other native species and the ecosystem. In this case, it may be appropriate to take steps to remove the harmful species because they are endangering an ecosystem. Ecosystems define individuals in a way that gives them freedom to maximize their individuality within the ecosystem. This is important for several reasons. First, an ecosystem defines an individual in a broad evolutionary context where an individual's traits differ to allow for competition. Those with beneficial traits for a particular ecosystem will thrive and reproduce. Secondly, on a geological time scale ecosystems have been the root cause for genetic diversity of all species. Different ecosystems have given rise to a vast quantity of different species. Ecosystems have not only increased the quantity of species but also the quality of species. This can be seen from the rise of one-celled organisms to complex multi-celled organisms. Without a complex ecosystem, this increase in diversity would not be possible.

Stating that an ecosystem has intrinsic value is much harder than determining that an organism has intrinsic value. Organisms have value because of their systemic logic to produce life and act as a selective system. A tree uses the available resources of water, sunlight, and nutrients to thrive. A squirrel eats the nuts the tree provides for its sustenance. A bobcat values the squirrel that it eats to survive. Thus, value is captured and transformed in a hierarchal fashion in an ecosystem. Instrumental value is aggrandized at each level (Rolston 186). Therefore, organisms use the instrumental value from lower levels because of their intrinsic value of their own life. Each organism has an intrinsic value and desire to survive and maximize its fitness through the instrumental value of other organisms. This system of logic can be extended to the intrinsic value of species. These values are present independent of the presence of humans. By following this logic, intrinsic and instrumental values must be found in an ecosystem. Thus, an ecosystem can be viewed as system of intersections between instrumental and intrinsic values of organisms present (Rolston 187).

Rolston coins a new term, “systemic value”, which he believes is inherent to an ecosystem (Rolston 188). Systemic value is a unique feature of an ecosystem and is begotten from the intersection of intrinsic and instrumental values. An ecosystem is not a value beholder but a value producer. One cannot determine that an ecosystem has value for itself, but it does enable other values to exist in it. Ecosystems are just as much selective systems as any organism. Ecosystems choose through the process of natural selection and extend many important qualities such as diversity. Systemic value is of utmost importance because it provides the framework for all other values to be found in nature. Systemic value is the matrix of which all other values are created. Thus, duties to individual organisms are created because of the intersection of instrumental and intrinsic values in this framework.

One possible objection to the argument that an ecosystem does not have subjective experience is that there is no subject from which to give value. But, I agree with Rolston in completely dismissing this argument. Of course, an ecosystem is not a subjective being. It is a community of interdependent individuals. An ecosystem feels no pride at the life it maintains nor should it have this capability. Requiring subjectivity is an unnecessary bias for value. Judging the entire biological world for the presence of sentience leaves out a myriad of value. Instead, an objective morality should be used to judge value. In this view, an ecosystem has value purely because of the life it supports. Individual subjects count and have value, and humans still have the highest subjective value. But, no problem arises when an ecosystem is valued objectively. The simple act of sustaining life and increasing life in both quality and quantity has value in and of itself (Rolston 190-191).

Through the combination of systemic value, intrinsic value, and instrumental value, Rolston forms a coherent system of natural value through which it is possible to make more informed environmental ethics decisions. This system is based on the projective nature of an ecosystem in the sense that an ecosystem allows all other values to be created or held in its matrix (Rolston 197-199). Thus, a model of values can be formed, the apex of which houses the subjective values of humans. Humans have maximum intrinsic value, but almost no instrumental value in an ecosystem. Sentient organisms, such as bears and raccoons, have high intrinsic value in their own ecosystems and varying instrumental value based on their place in the ecosystem. The next lower level covers the flora and lower organisms, which have great instrumental value but little intrinsic value. At the base of the hierarchy are the non-biotic elements of an ecosystem, such as rocks, soil and streams. These elements have no intrinsic value but form the basis for instrumental value because of their necessity for the existence of an ecosystem (Rolston 223). This hierarchal system has important implications for humans because of their position at the apex of the system. Humans only receive value from the system, and as such, humans should not destroy or impair an ecosystem without explicit justification (Rolston 225). By applying the ecocentric value perspective to the issue of acid deposition in high-elevation ecosystems, it can be shown that people's duties to protect these ecosystems is much greater than currently believed. While there is no definitive, proportional link between duties and values, I believe that it is sufficient to assume that an increase in value implies at minimum a consideration for increased duties.

First, I will address the effects of acid deposition on the forest ecosystems in the Smoky Mountains. Acid deposition has a devastating effect on red spruce forests and has almost eliminated many of these forests. From an ecocentric perspective, one can see that we have a large duty to protect these forests because of the immense instrumental value of the red spruce in an ecosystem. These trees, along with Frasier firs, form the basis of the entire ecosystem in these forests. Many herbivores use these trees and other plants supported by these trees as a nutrition source. With their destruction, these organisms lose a vital element for their fitness. Also, the destruction of red spruce forests means that a crucial habitat is lost. Many species of higher animals live in this forest, and without the main source of fauna, these species face uncertainty in a changing ecosystem. These higher animals feed on lower organisms, such as insects and birds, that live in the red spruce. As the tree system is destroyed, these lower organisms lose their habitat, and consequently, the higher organisms lose an important source of food.

As the red spruce forests are destroyed by acid deposition, the ecosystem loses intrinsic, instrumental, and systemic value. A small amount of intrinsic value is lost in the actual death of individual red spruce trees as they die. These trees are unable to fulfill their genetic code or maximize their fitness. A more important lose of intrinsic value comes from the loss of species and individual organisms that are no longer able to survive because of the death of the forest. Higher sentient organisms cannot survive in this ecosystem and either die or move to another ecosystem. An example is the depletion of two endangered sub-species of northern flying squirrels, *G. s. fuscus* and *G. s. coloratus* (Arbogast 123). These flying squirrels face the threat of extinction due to the loss of habitat with the destruction of the red spruce and Frasier fir forests. These animals are isolated to this ecosystem because they require mature hardwood forests for their habitat. As such, their populations dwindle for lack of a suitable habitat. Thus, intrinsic value is lost both in deficit of individual organisms and species, which no longer reside in the forests. Instrumental value is lost on a large level when the instrumental value is aggregated of all individual trees and other fauna that is lost due to acid deposition. Yet, the most important loss of value is the loss of systemic value caused by the destruction of one of the keystone element in these forests. Red spruce are a crucial element in this ecosystem along with Frasier firs and without them the entire ecosystem faces the threat of collapse. This lose of value extends over a large time period because of the time it takes for forests to regrow. This is extended by the fact that acid deposition will continue to fall and be a negative factor on the environment for years to come.

Extraneous to the natural value lost due to acid deposition is the value lost to humans. These forests account for a large portion of one of the most visited national parks in the country. Consequently, the land loses a large amount of aesthetic value from the loss of majestic forests. People will no longer chose to hike and fish in a forest made only of the trunks of dead trees.

Acid deposition has also caused the soil to be severely degraded. Once acid deposition reaches the ground, it acidifies the soil and leeches crucial nutrients. The Smoky Mountain soil has a low ability to act as a buffer because of its makeup. Thus, the soil acidifies and becomes a hostile environment for many types of fauna. Most plants require a specific pH range to survive, and if the pH drops too low many plant species will be negatively impacted. Acid deposition also leeches crucial nutrients away such as potassium, calcium, and phosphorus. Without these nutrients, plants can no longer function correctly. Also, acid deposition causes aluminum in the soil to mobilize, and most organisms, both plants and animals, have low tolerances for aluminum.

Traditional environmental ethics would have no or little duty to protect the soil in remote areas, but the ecocentric approach places value in the soil because of its foundational function. Without healthy soil, no organisms can survive, but this value has traditionally been overlooked. It is evident we have a duty to protect this soil because of its instrumental value to all higher organisms.

The most serious effects of acid deposition occur in high-elevation streams in the Smoky Mountains, and ecocentric-based duties afford these streams more value as well. These high-elevation streams form some of the most pristine ecosystems in all of the Smoky Mountains, and the ecocentric-based value in the streams allows them to receive more protection from acid deposition. Already, some species of fish and reptiles are facing extinction in these ecosystems.

The brook trout population has been devastated in these high-elevation streams, and they have already disappeared from many streams in which they were previously found. These are the apex animals in their own ecosystems and, therefore, have a high amount of intrinsic value according to Rolston's theory. A more pressing concern is the complete extinction and the loss of systemic value. We have a great duty to protect species from extinction and to preserve the overall stability and continuity of this ecosystem. Consequently, we have a greater responsibility than previously thought to maintain these streams. These brook trout have greater value than just the recreation they could possibly provide to anglers. They play an important part in the ecosystem as a food source for bears that live in the mountains as well. Without brook trout, higher animals will lose an important food source.

Salamanders and snails also face a threat of extinction in these ecosystems from acid rain. Again, the duty to protect them arises not only from a duty to individual animals, but from the importance of stability of the ecosystem and preservation of species. These organisms may not have a large intrinsic value especially when compared to a human's value, but their importance lies in their instrumental value and the niche they fill in the ecosystem. Numerous other fish and inhabitants of these streams are no doubt affected the same way, and we have the same duties to protect them as well. Any loss of species is unnecessary and attempts should be made to prevent or minimize these losses.

Much in the same way as the soil is degraded by acid deposition, so is the water in these streams. It follows that we have a duty to protect these waterways because of their systemic function. High-elevation streams have constantly had their pH lowered by acid rain to the point that some of them have become nearly unlivable for many aquatic species. This is unacceptable within the ecocentric view because of their crucial instrumental value. If these streams become unsuitable for aquatic species, then the entire ecosystem is in danger of collapsing.

The implications of altering our viewpoints to an ecocentric duty-based value system are far-reaching and may require a fundamental shift in how our society views nature. This change will be two-fold by addressing not only how we view nature but also our duties to nature. Additionally, we must have a societal change and release our actions that have direct, negative effects on the environment.

First, we must try to avoid irreversible damage to the ecosystem and optimize natural stability (Rolston 267-270). Acid deposition is causing damage to both high-elevation forests and streams that may require generations to repair. Entire forests are being destroyed that could take hundreds of years to regrow. Not only are forests being destroyed, but the soil and water are being degraded to a point where repair may not be possible. The Smoky Mountains have a low buffer capacity, which causes natural de-acidification to be a very slow process. Therefore, we have a greater obligation to protect these ecosystems and attempt to avoid irreversible damage. The loss of species should be avoided, regardless of the expense or effort involved. Stability in these ecosystems is constantly eroded as more damage occurs. We cannot stop acid deposition but we should take steps to minimize its source pollution. Diversity in the environment is constantly threatened, and this will not lead to positive consequences.

Next, we must recognize that acid deposition is a toxic problem, and should be considered an unacceptable problem (Rolston 275). While I am concerned primarily with acid deposition in the Smoky Mountains in this paper, acid deposition is a pollution problem that affects everyone. Pollutants and acid deposition are harmful to all things. Consequently, every effort should be made to minimize it for the good of all humanity. Acid deposition is a poison that is slowly draining the life out of these high-elevation ecosystems. Letting this trend continue is not an option. The effects of acid deposition and other pollutants aggregate over time, so timeliness is key to stopping the harm.

We should also not discount future generations when making decisions that affect the environment. The continuity of ecosystems is on a much larger scale than any generation of humanity. Acid deposition is a problem that is already having a sizeable impact, and if no changes are made the problem will simply continue to worsen. Timeliness is key to halting the problem and reversing the damages. We have an obligation to protect these ecosystems not only for our own interests, but also so that future generations may be able to experience and enjoy them.

A shift in viewpoint will be required if we wish to protect the environment from acid deposition. We can no long stand by the idea, "but we're already doing" (Rolston 279) as an acceptable environmental policy. Merely because we have done something in the past does not mean it is the correct option to continue in the future. While it is impossible to cease polluting, we must have a paradigm shift to look for solutions instead of exacerbating the problem. Instead, a societal change is needed to understand the alternatives and their importance for the health of the environment.

This could take a variety of forms from research into renewable energy sources and more efficient vehicle engines to individuals recycling more and driving less.

Making these types of changes will perhaps make the public realize that there are fundamental values that possibly have not been considered widespread. Instead of only pushing for consumption and progress and the requisite values they entail, perhaps an increased appreciation for environmental values could rise. This could impact efforts on sustainable living. A shift could be made from only exploiting the environment for human gain to an appreciation of the environment and the positive role that people can take. The anthropocentric view traditionally views nature as something distinct from society, which people can visit or enjoy for its aesthetic beauty. An ecocentric view can allow people to realize that humans are not disjointed from nature, but a part of it.

The economic and societal underpinnings of acid deposition must also be reexamined with a shift to an ecocentric perspective. Within this framework, environmental interests deserve as much consideration as the profits and production within the confines of the problem of acid deposition. Big businesses, such as the TVA and car manufacturers, would have a larger obligation to invest in clean energy or technology in order to reduce pollution. They may also have an obligation to attempt to assess environmental damages and determine a dollar amount that is comparable with their profits. These companies have a moral responsibility to minimize their impact on the environment and pay the costs associated with pollution. Morally correct decisions will often exceed what is legally required (Rolston 317). This means that companies should feel this greater obligation and do more than is required. This obligation does not only fall on the shoulders of the companies, though, as individual consumers are the ones using these products.

The burden of protecting the environment and sensitive ecosystems must eventually fall on the shoulders of individual citizens. Individuals must come to realize that all life, not just human life, is valuable and deserves to be protected. In the case of the Great Smoky Mountains, the ecosystems happen to be some of the most beautiful in the world and deserve amplified protection. Specifically for East Tennessee residents, this means an increased duty to minimize pollution. On a practical note, this can happen through a variety of means. Individuals have a duty to minimize exhaust pollution through purchasing fuel-efficient cars. Also, minimizing electrical use will help lower emissions at power plants. Recycling and reducing consumption are other great ways to reduce one's environmental footprint.

Ultimately, a shift to an ecocentric approach for environmental ethics means an increased respect for all types of life and their inherent value. By moving away from an anthropocentric environmental ethic, it is possible to discover much more value in nature than previously thought possible. An analysis of the problem of acid deposition on high-elevation ecosystems with the ecocentric perspective leads to an increased responsibility to protect them. Understanding that all life has autonomous intrinsic value entails a shift from maximizing human well-being to maximizing all well-being. The issue of acid deposition and its intersection with human values is a complex one, but one that can be more completely analyzed when one understands humanity's duty to nature. While emissions of pollution and acid deposition will not end in the near future, it is possible to minimize its effects and respect the Earth. In order to halt or stop the negative impact of acid deposition on the Great Smoky Mountains, society must understand the cumulative, negative impact that is slowly impacting future generations and a valuable natural resource.

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