



Delight in Creation

Scientists Share Their Work with the Church

Edited by Deborah Haarsma & Scott Hoezee

6 Ecology

by David Warners

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I come from a family that spent a great deal of time in the outdoors. As a child, I helped my mother in our family vegetable garden, took bike trips to explore a nearby swamp with my friends, enjoyed extended family camping trips that took us all over the continent, and participated in local environmental groups like the Junior Audubon Society. Through these experiences, I cultivated a deep affection for the natural world and developed aspirations of becoming a park ranger when I grew up.

As a college student, my favorite classes were those that involved a great deal of time outdoors. I also became very interested in ecological research, which is dedicated to uncovering some of the mechanisms of how the creation works. As an undergraduate, I took a break from my studies to hike the Appalachian Trail from Georgia to Maine. This trip further convicted me of my love for the natural world and convinced me to pursue a vocation devoted to learning as much as possible about the creation. In graduate school at the University of Wisconsin, I discovered that my joy in the creation was heightened when I was able to share it with others, and I fell in love with teaching. Later, while doing Ph.D. work at the University of Michigan, I developed a similar love for doing research. Every time I am outdoors, I still find myself drawn to the questions and mysteries that present themselves and I have a deep desire to learn as much as I can and convey this learning to anyone who is willing to listen. These are deeply embedded passions that have been nurtured by various individuals and experiences in my life—passions that I believe have also been knit into my core being by my Creator and Redeemer.

Ecology: A World of Interaction

“In creation there is no existence, only coexistence.” So said a theologian friend of mine, Dr. Steven Bouma-Prediger, during a summer conference on Christian environmentalism. His words sum up the field of ecology quite nicely, which is the study of biological interactions. An experience from the time I spent working for the Christian Reformed World Relief Committee in Tanzania offers helpful insight.

It was one of those hot, painfully bright days in northwest Tanzania when my wife, Teri, and I went out to Buhumbi village to help a youth



Planting seeds in a tree nursery.

group set up their fruit tree nursery. For the past several weeks, the group had been collecting seeds from citrus, guava, stafeli, and papaya. When we arrived, we were shown that they had cleared a level site for the nursery and were ready to begin.

I recommended mixing some manure with the sandy soil before we planted seeds. However, I was informed that this would be difficult because at this time of year, the farmers had just transported all of their *mbolea ya ng'ombe* (cow manure) out onto their fields. Then someone mentioned that as an alternative we could use *mbolea ya maskini* (poor man's manure), a proposal which was met with much approval from the group. I innocently asked, “What is this *mbolea ya maskini*?” With some good-natured laughter, the group led me away from our nursery site, shovels and buckets in hand.

A short distance away stood a very large mango tree and with wide, proud smiles, the group started digging soil from under the tree. Someone explained to me that rural Tanzanians too poor to own sufficient cows to keep their fields fertile with cow manure would dig soil from under the mango trees to use as fertilizer. At first, I was amazed because mango trees do not fix nitrogen (like legumes) and I naively commented, “Wait, this is only a mango tree.” After another healthy round of laughter, the group

vouched that the soil under these trees—especially soil under old, large mango trees—had a profoundly positive effect on their crops.

Throughout the course of the morning, I asked many questions about *mbolea ya maskini* and learned that there were many factors that contributed to the fertility of this soil. A large mango tree produces dense shade from the equatorial sun, supporting soil conditions markedly more cool and moist than soil in the open. These conditions supported a rich soil fauna of decomposers, many of which were clearly evident in the shovelfuls of soil that we dug. These trees also generate abundant leaf and fruit litter, as well as subsurface root litter, which is quickly broken down by these organisms, returning nutrients to the soil. The mango fruit is attractive to humans, but also to many birds and animals that eat the fruit and then defecate, further adding nutrients to the soil. Also, when rain falls, it cascades down the many layers of leaves or trickles down along the branches carrying with it organic residues from the leaf and wood surfaces. Ground-dwelling animals also frequent the shady, cool confines under these trees and, while resting, defecate directly onto the soil. All of these factors and more work together to produce a substrate rich in nutrients and high in organic matter.

I've never quite looked at trees the same way since that day in Buhumbi village. I had been promoting trees to these and other villagers as a valuable component of a village landscape because they provide fuel wood and building materials, food products, nectar for honey-producing bees, and shade from the hot sun. But now I had been given a firsthand lesson in how trees are also natural composting sites. By simply being allowed to exist and function in the way God intended, trees offer a significant and ecologically beneficial blessing to their surroundings.

This little story illustrates Bouma-Prediger's statement: species don't simply exist—they necessarily exist interactively with other components of the earth and these interactions are all part of God's good creation. Such interactions may occur between individuals of the same species (*population-level interactions* or *population ecology*), between members of different species (*community ecology*) or among the living and non-living elements of the landscape (*ecosystem ecology*). Ecologists try to understand these interactions at many different levels depending on the organisms they are studying. I have a colleague at Calvin College, Dr. John Wertz,



IMAGE CREDIT: DAVID WARNERS

Digging "poor man's manure" under a mango tree.

who calls himself a “microecologist.” He studies the interactions that take place among various microbes in the guts of termites. In contrast, other ecologists study the interactions among living creatures on a broader scale, sometimes in an ecosystem context.

Understanding the multitude of interactions that occur in the creation provides an essential backdrop for learning how best to care for the creation. Without knowing what a particular species eats or what eats it, what types of diseases it may be susceptible to, what kind of habitat requirements are necessary, and so on, we are hard pressed to know how best to provide for this species. Therefore, the biblical stewardship mandate requires humankind to develop an informed understanding of the ecological interactions required by the creatures God has entrusted to our care. Theologian N. T. Wright expresses this connection well in *Surprised by Hope*, writing, “Stewards need to pay close, minute attention to that of which they are stewards, in order the better to serve it and to enable it to attain its intended fruitfulness.”

In addition, by understanding how creation is knit together by these interactions, we gain insight into how our own species can best fit into the broader creation. Far too many humans assume that our species was created to be separate from the rest of the created order. However, our biological basis requires that we, too, depend upon ecological relationships for our health and flourishing. We need to shift our self-perception from emphasizing that we are *apart from* the rest of creation to a deeper recognition that we are also *a part of* God’s created world. Development organizations such as the Christian Reformed World Relief Committee have come to understand this concept well, and are beginning to incorporate more environment-related projects to their ministries. They recognize that for human beings to thrive, they must live within the context of a healthy, thriving environment.

Naming the Species

As a humbling backdrop to understanding the myriad of interactions occurring on the planet, consider that scientists have not yet identified all of the living species on earth. In fact, even by conservative estimates, fewer



IMAGE CREDIT: DAVID WAFNERS

A woman purchasing a tree from a tree nursery.

than half of the approximately six to thirty million species on earth have been officially catalogued. While some groups have been well studied and mostly documented (85% of plants, 90% of birds and 95% of mammals), other groups have received far less attention. For example, at most, only 33% of our planet's insect diversity has been catalogued and more than 90% of the total number of fungal species has yet to receive a name. While this may seem like a small oversight, remember that insects are foundational to many food chains and the primary pollinators for most flowering plants. Fungi play a crucial role as both the acquirers of nutrients for most plants and decomposers that support the internal sustainability of the creation.

It is hard to deny that the entirety of creation gives testimony to God the Creator's love of diversity. But we, his image bearers, seem to be falling far short in expressing such love given that the important task of naming the creatures, begun by Adam, is still far from complete. Beyond the task of naming the elements of God's creation, we are even further behind in appreciating the beauty, intricacy, ecological importance, and potential human benefits inherent in this biodiversity. An appropriate first step in stewarding this rich diversity of life on planet earth should be developing humility and reverence as we recognize the immensity of the stewardship command, and the significant lack of understanding we have as we try to make sense of how it all works.

A final sobering acknowledgement of our predicament is that paleontologists have identified six periods of mass extinction in the history of our planet. These are times when extinction rates significantly outpace the rate of new species appearances. The fifth mass extinction period led to the demise of the dinosaurs, and was likely stimulated by intense climatic changes brought about when a large meteor struck the earth in the area of the Yucatan Peninsula in Mexico. We are currently in the midst of the sixth mass extinction period, a time when we are losing species at a rate that continues to climb and is unmatched by any of the previous five mass extinction periods. Moreover, extinctions today are mainly occurring because of the significant landscape and climatic changes brought about by one particular species: our own. We are now losing species at the rate of approximately twenty thousand per year (a number that is increasing), which means many species are being lost even before scientists have been

able to give them a name. When a lineage of a species is snuffed out, there are reverberating effects on all of the other parts of creation that interacted with that particular species. At the risk of stating the obvious, Rev. Peter Ilyn from the Christian environmental organization Restoring Eden reminds us that "extinction isn't stewardship."

What's for Dinner?

Since all of life depends upon the basic physiological processes of photosynthesis that are carried out mostly by plants, understanding this group of organisms is foundational for understanding the interactions that occur in the whole of creation. The land surface of the planet is green for a very important reason: green is the color of the light spectrum that is not used in photosynthesis and is therefore reflected back off a plant's surface. The planet is green because so much photosynthesis is needed to support every food chain on the planet. Plants are *autotrophs*, making their own food out of the sun, carbon dioxide, and water. Organisms like fungi and animals, including humans, are *heterotrophs*, which gain their food from another source like plants or other creatures that eat plants.

Whenever an animal eats a plant, most of the ingested plant biomass is utilized by the animal for its own physiological requirements. Warm-blooded animals need energy from food to keep their body temperatures elevated to an acceptable level. All animals, whether cold-blooded or warm-blooded, need energy from food to move around and to keep their vital organs functioning properly. For most animals, approximately 90% of caloric intake is utilized in these ways, with only 10% invested in additional animal biomass (i.e. growth and cell replacement). This principle is one that motivates many vegetarians to eat a meat-free diet. Plant-based diets can support approximately ten times more people than meat-based diets. This principle also focuses most preservation work on the protection of plant communities, for in preserving the plants, preservation of all of the creatures that depend upon those plants is enhanced as well.

Many of creation's most dramatic interactions are based on eating requirements. Lions stalk gazelles, wolves hunt moose, and owls catch mice. But other creatures may eat from a food source that is not killed, such

as grasshoppers chewing on leaves, deer grazing on stems, or human beings harvesting garden peas. Some plants actually invite other creatures to feed off them and in doing so, the “guest” performs a service to the plant, such as seed dispersal or pollen transfer. Pollination is a notable example of a mutualistic interaction, one in which both participants benefit. A pollinator will acquire some type of reward from the flower of a plant (nectar, wax, aromatic compounds, or pollen itself), while the plant effectively uses the pollinator to achieve cross-fertilization. Some pollination interactions are more general in nature, when a pollinator visits several different plant species or a plant invites multiple species of pollinators, while other relationships are more exclusive, where a plant can only be pollinated by a single pollinator species. One example of exclusive pollination is the yucca plant. Around twenty yucca species grow in North America, most of which are pollinated by a particular species of moth. Clearly, the loss of one moth species will necessarily result in the loss of one plant species, not to mention associated impacts on other creatures that utilize either the moth or yucca plant. Pollination is a highly underappreciated interaction that is essential for most of our food crops, as well as for a host of other species, many of which produce valuable products for human beings.

Protective Plants

By contrast, many plants will also try to discourage other creatures from eating them by producing chemicals referred to as *secondary metabolites*, compounds that are not essential to the physiological requirements of the plant, but which perform a protective function. Humans have benefited greatly from the production of these secondary metabolites, many of which have been used as medicinal agents including salicylic acid (aspirin) produced by willows; taxol, an anti-cancer drug from the Pacific yew; digitoxin, a heart regulator from foxgloves; and morphine, a pain killer derived from poppies.

On a recent trip to Costa Rica, I learned about a plant used by local people to treat insomnia. The plant produces a secondary metabolite that causes insects feeding upon it to fall asleep, after which they are unable to eat the plant both because they are asleep and because they subsequently

fall off the plant! Likewise, nicotine and caffeine are produced by plants to accelerate the metabolism of potential herbivores to an unhealthy level, an outcome that frees the plant from these hyper feeders, and an outcome humans have tapped into extensively (for better or for worse) in the form of tobacco and coffee.

In the past two decades, several multinational pharmaceutical companies have launched a concerted effort to acquire indigenous knowledge of the medicinal uses of plants, many of which come from secondary metabolites. This area of study is called *ethnobotany* and, since fewer than 1% of all plants have been thoroughly assessed for their potential medicinal value, many useful compounds are likely to be discovered in this way. An early success story from this approach is the small rosy periwinkle, a flower found on the island of Madagascar. This plant, which was on the verge of extinction before its value was recognized, is now grown to produce two highly effective anti-cancer drugs, vincristine and vinblastine. Before vinblastine was discovered as a powerful treatment for Hodgkin’s lymphoma, a patient with Hodgkin’s disease had a 20% chance of survival; now, simply because of this single drug, survival has increased to 90%.

The upshot of all of these interactions is that creation is not a collection of individual species; rather, it is a tapestry of interwoven fibers. These relationships work together to promote and preserve biodiversity. The loss of interactions—through the thoughtless destruction of habitats, introduction of alien species and application of pesticides, herbicides, fungicides, and the like—frays the fabric, contributing to the unprecedented species loss we are currently witnessing.

Diversity and Adaptation

Biodiversity occurs both at the species level and within each species. Sexual reproduction is a valuable interaction within species because it promotes genetic diversity. No offspring resulting from sexual reproduction is identical to either of its parents. To us, each robin, earthworm, or trillium may appear identical to other members of its species, but each has individual characteristics distinguishing it as unique. A Tanzanian pastor I worked with understood this very well, and once told me that God sees zebras the

way we see people: although zebras all look the same to us, every single one is preciously different in God's eyes.

In temperate regions each spring, new gene combinations never before seen on the planet arise, and they ensure variability within a species. This variability is essential for the perpetuation of the species lineage in a landscape context that is constantly in flux. The work of Peter and Mary Grant on an island in the Galapagos chain, detailed in the book *The Beak of the Finch* by Jonathan Weiner, has illuminated the vital importance of this variability. For over twenty years, these researchers have banded and taken physical measurements of every individual bird on the island of their study. What the Grants have shown is that physical changes within species occur constantly, albeit subtly and at inconsistent rates. During a time of intense drought on the island, they showed that the physical traits of these birds shifted as some food items become scarce while others remained relatively constant. After this intense time of selection, the species that emerged looked quite different than the species that was present before the drought.

While the concept of evolution remains somewhat controversial outside the scientific community, such changes even over short periods of time have been widely documented by ecologists. This mechanism—sexual reproduction that insures genetic variation within a species—can be interpreted as a wonderful expression of God's providence and grace. By equipping his creation with the ability to exhibit variation, God provides for his creatures and allows them the capacity to perpetuate within the context of shifting environmental conditions.

Yet, before we take too much confidence in such resilience, it must be noted that some environmental changes occur too rapidly and too significantly to allow for species to adapt. The climatic alterations we have invoked on the planet provide a case in point. Already, scientists have documented climate-mediated decoupling of essential interactions between migratory birds and the insects upon which they depend for food. For example, while most birds time their migratory movements based on day length, most insects will mature according to temperature cues. Therefore, for many insectivorous migratory birds who return to their seasonal nesting grounds according to a consistent annual schedule, their



IMAGE CREDIT: DAVID WARNERS

A meeting under a mango tree in Tanzania.

return no longer coincides with the maturation of insects that they depend upon for food, since these insects are maturing at earlier and earlier times. Studies have shown that for some species, their primary prey upon returning to their seasonal nesting grounds is too large to ingest. This decoupling has many significant outcomes: bird health is diminished, reproductive success decreases, and insect pests proliferate, compelling farmers to spend more money on pesticides, which in turn elevate residual toxins in agricultural soils and groundwater.

A lesson from these observations is that for Christians who are responding seriously to the stewardship mandate to care for God's creatures, much attention needs to be directed toward the preservation not only of species, but more importantly of the interactions required to support these species. Loss of interactions leads to an erosion of a diversity-loving Creator's interdependent tapestry of biological complexity.

The Intersection of Ecology and Theology

This last discussion leads us into the relevance of a sound ecological understanding of the creation for theology. As a Christian ecologist, I find it very difficult to separate ecology and faith, and in this section I would like to address this intersection directly. To begin, let me suggest that too many North American evangelical Christians have been quick to dismiss environmental concerns as ancillary to the primary message of the gospel, that being the redemption of humankind. We have largely failed to recognize the comprehensive, cosmic nature of God's redemptive plan as encompassing all he has made.

Much of this misreading of the scriptures has its foundation in one particular text from 2 Peter: "But the day of the Lord will come like a thief. The heavens will disappear with a roar; the elements will be destroyed by fire, and the earth and everything in it will be laid bare" (2 Pet. 3:10). According to Bouma-Prediger, this passage is likely one of the most egregiously mistranslated texts in the Bible. This passage has led many Christians to develop an attitude of ambivalence toward the deterioration of the creation; since it will be destroyed in the end anyway, it makes no

sense to work for its preservation today. Additionally, some Christians have promoted the notion that the sooner the earth is destroyed, the quicker Christ will return.

Bouma-Prediger passionately makes the case that this is not what Peter wrote in the original Greek manuscript. A better translation than "destroyed" by fire is that the elements will be "refined" by fire; and instead of being "laid bare," the earth and everything in it will be "discovered." The passage should more properly read, "But the day of the Lord will surprise us like a thief. The heavens will disappear with a roar; the elements will be refined by fire, and the earth and everything done in it will be revealed." Therefore, God's coming will render the creation pure again, removing all of the blemishes of sin and neglect, resulting in a renewed creation that will once again glorify the Creator as it was originally intended to do. Creation will be rediscovered and God's place will then be here on earth, to reign forever with human beings and all the members of his creation.

The significance of this insight is critical and holds much relevance for how we live. The Bible describes this process of renewal as something born out of God's deep love for the cosmos (John 3:16), a process that is brought into focus with Christ's resurrection, and which is continuing now in the work of the Creator at least partially mediated through his image-bearers. Christ came to redeem all of creation (Col. 1:15-20) and with his death and resurrection, the refining has begun. In this light, Revelation 21:5 provides a cogent summary: "Behold I am making all things new!" This promise is not something God will fulfill at some later date, but something already happening. Also, God will not destroy all he previously made and replace it with something brand new; rather, he is in the process of making all of the things in his creation new again.

As an ecologist, the excitement for me comes from availing myself to this work of God—to allow God to work through me to diminish the ugliness and promote the goodness inherent in his truly good creation. Just as we human beings become new creatures in Christ, so too the entire creation is being won back and just as I, by God's grace, work toward redemption from my fallen ways, so too should the beauty and inherent goodness of the whole of creation be recovered and promoted.

Five Scriptural Principles

But how should we undertake this monumental task? Scripture is rich with instructive teachings and I would like to highlight five guiding principles that have certainly informed my work as a Christian ecologist and might be helpful to all of us as the body of Christ. First of all, we must learn to recognize that the creation is not ours but that it fundamentally belongs to God. God has entrusted us to help him care for it as his image-bearers but he retains rightful ownership (Ps. 24:1). Therefore, my yard is not my yard but it is a portion of God's creation that he expects me to help care for. My resources (financial, material, temporal) do not belong to me either; God owns these things too and enlists our assistance in their appropriate care and use. Recognizing that we actually own nothing outright but that everything in our lives belongs to God is a vital first step in restoring a proper understanding of our rightful place in the cosmos.

We can draw a helpful analogy by thinking about a priceless work of art. Let's say a caretaker of the Rembrandt estate who loves the artist's work stumbles upon a previously unknown but magnificent painting by Rembrandt in the basement of the estate. Since this curator deeply admires Rembrandt, the painting would receive the utmost care even though the curator doesn't own the painting himself. The creation is God's beloved masterpiece and we, who declare not only our admiration but our deep love for God, have been asked by God to help him care for it. Surely then we would do whatever is in our capacity to treat the creation with reverence and awe in a way that honors the owner and gives expression of our love for the Creator and his works.

A second principle is that we human beings have been assigned to be rulers of God's creation (Gen. 1:26). We are thereby separated from any other creature in being given the responsibility to oversee the rest of the created order. But this ruling is not a license to do with the creation as we please. Throughout the Old Testament, God judges his rulers as good or bad depending on how the people under their rule have fared. A good ruler leads in a way that insures the flourishing of the people who are being ruled. Therefore, to rule over the creation bears the responsibility of making sure the creation is flourishing. Interestingly, God's command to

rule is first given to Adam as a command to rule over the fish of the sea and the birds of the air. These same creatures also received a command from God to be fruitful and increase in number (Gen 1:20). As rulers, then, it is our responsibility to make sure the fish, the birds, and all creatures are able to carry out their Creator's directive to procreate.

A third principle, included along with ruling, is the responsibility to subdue (Gen. 1:28). The Hebrew word here is "kabash" and it means "to beat back" or "to control." This principle places us firmly within the creation; we are participants who are expected to interact with the creation in a manner different from the way other creatures interact with the creation. Growing crops for food, domesticating animals, collecting solar energy, and mining metals from the earth are all examples of subduing the creation. Yet, the mention of this directive in the same sentence as ruling underscores the care that should infuse all of our subduing. Subduing should never be done in a way that jeopardizes our ability to rule well, for the sake of those we rule.

For the fourth principle, we move to the second creation narrative in the second chapter of Genesis. In Genesis 2:15, Adam is told to "tend the garden." The Hebrew word here is "abad," which elsewhere in the Old Testament is translated as "to serve." Joshua, in his famous speech to the Israelites, declares boldly, "Choose this day whom you will 'abad,' but as for me and my household, we will 'abad' the Lord" (Josh. 24:15). So Adam, and by extension, all of us, are to live lives that reflect dedicated service toward the rest of creation. By definition, serving requires making one's own needs secondary to the needs of those who are being served, just as Christ, the servant king, modeled for us in giving up his life so that all of creation could be redeemed (Phil. 2:6-8, Col. 1:20).

Finally, the fifth principle is also presented in the second chapter of Genesis, when Adam is also told to "shamar" the garden (Gen. 2:15). "Shamar" is usually translated as "to keep" or "to preserve." The blessing that God gives to the Israelites in Numbers is, "May the Lord God bless you and 'shamar' you" (Num. 6:24). The image here is one of protection, and this blessing, often given by the pastor at the close of a church service, sends the congregants out with the assurance that God will be watching over them, keeping them from harm, making sure they are cared for.

This is a tender, rich directive, and one that deserves much meditation as we consider how to interact with creation on a daily basis in a way that demonstrates faithfulness.

Stewardship

These five principles—to recognize that all of creation belongs to God and that he has established human beings as his image-bearers on earth to rule, subdue, serve, and preserve his beloved creation—provide an ample foundation on which to build our understanding of how we relate to the creation in which we reside. As we serve as God’s ambassadors of shalom here on earth, these principles provide a working model for how to be good stewards of God’s good creation as we work to promote the beauty and integrity with which God made all things.

God has filled me with love and reverence for creation. Alongside these feelings is a deep lament over the erosion of creation’s beauty and function, which is often the result of human carelessness. This lament compels me to dedicate my life to cultivating such love in others through the faithful practice of the science of ecology. Creation has the capacity to raise the most beautiful song of praise to our Creator, but the best expression of that melody features all of the earth’s voices. As stewards of this grand symphony, it is our task to protect the chorus, cherish the music, and learn how to join in the song ourselves.

Further Reading

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