

Visions Magazine

The World We Live In and The World We Want To Live In

Struggling to Survive:

*Environmental Scarcity and
Violent Conflict*

Ashley Leasure

Volume I, 1st Edition
Fall 2007

Camouflage and Survival:

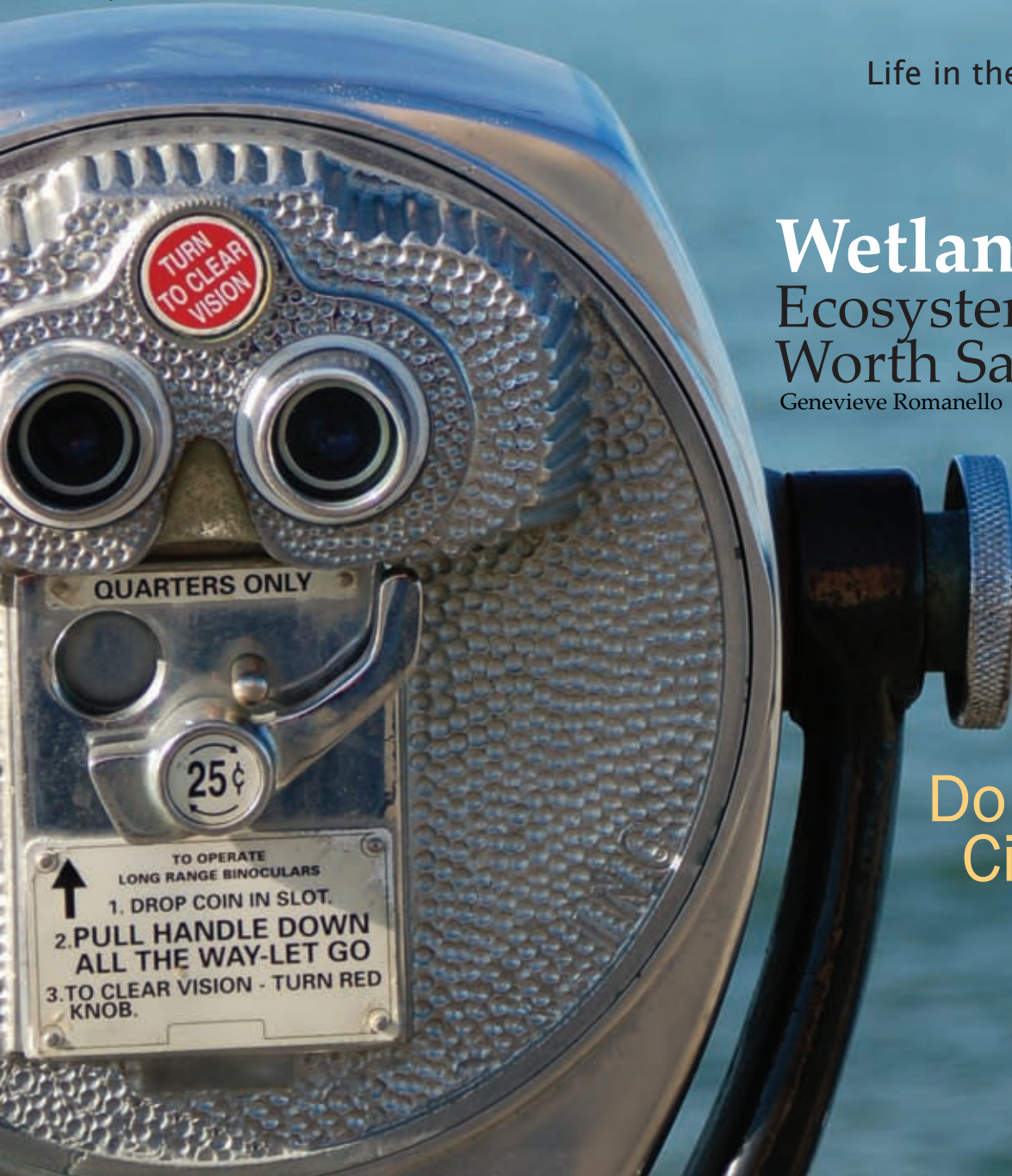
Life in the Galapagos Islands
Molly Pearson

Wetlands: Ecosystems Worth Saving

Genevieve Romanello

From Dominion to Citizenship

Jared Otte



Visions Magazine is about two worlds—the one we call home, and the world we see as ideal. This magazine is a non-partisan, peer reviewed publication that contains articles from disciplines commonly associated with a major in environmental studies. These disciplines include but are not limited to political science, economics, philosophy, religion, art, and english literature including poetry, fiction, and nonfiction. *Visions* Magazine is a faculty-student organized and operated publication which feature the works of Elon University students and Elon University student-faculty collaborations. The primary goal of *Visions* Magazine is to engage students in the scholarly process of research, writing and peer review; an additional vital component is the provision of publishing opportunities for students with an interest in the environment and sustainable development.

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Visions M a g a z i n e



The World We Live In and The World We Want To Live In

Contributing to *Visions* Magazine

Visions magazine seeks compelling, interesting, well-written, creative contributions on environmentally related topics. Major contributions to the magazine should be grounded in scholarly literature and/or reflect the conventions of research and writing associated with a specific academic field of study. All submissions must receive positive blind peer reviews before consideration for publication. We discourage submissions that are political or purely editorial in nature. For the next issue of *Visions* Magazine, we are especially interested in acquiring fiction, poetry and photography submissions.

Submissions for the spring 2008 volume of *Visions* Magazine are due on **December 12, 2007**. Please email visionsmagazine@elon.edu for more information about the criteria for submissions and information about the magazine.

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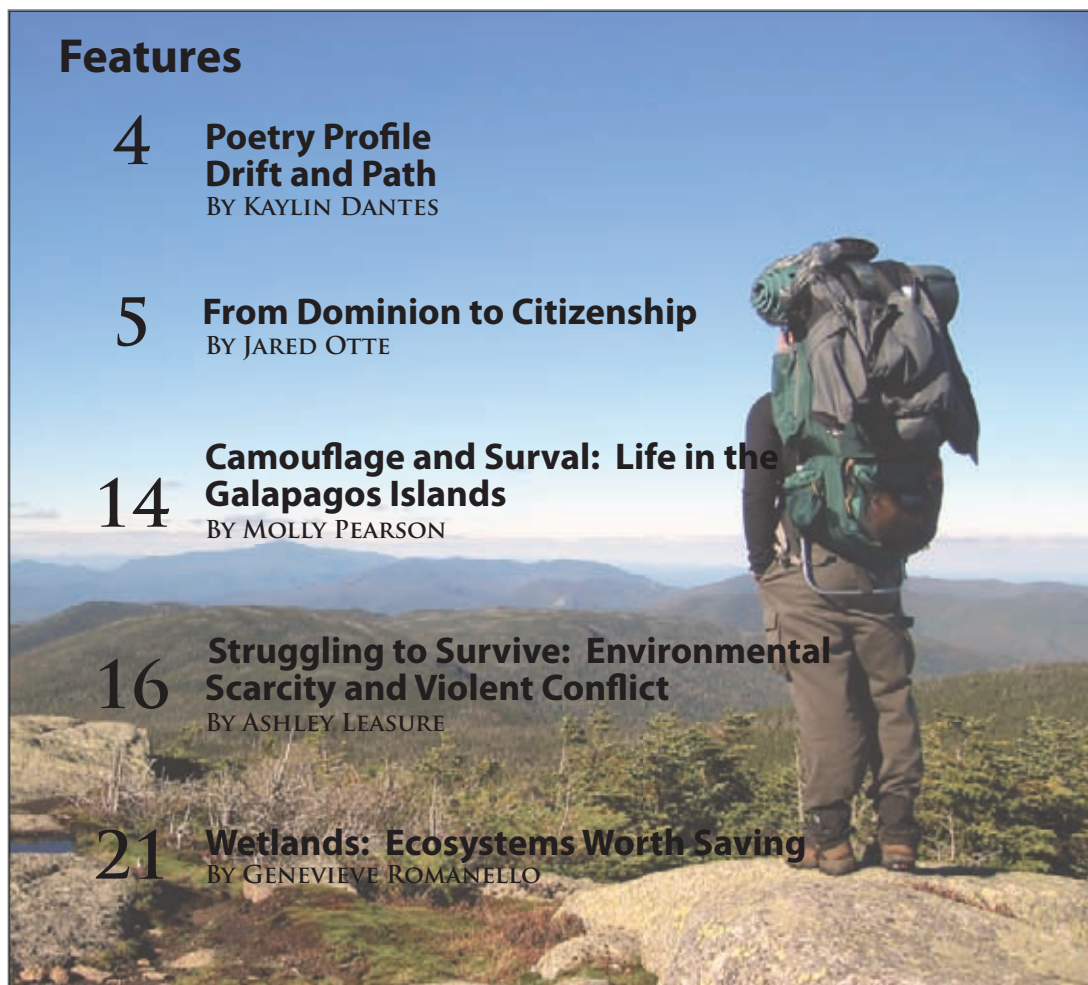
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Dinosaurs in 2007?

The analysis of fossilized organic material found inside a 68 million year old dinosaur bone supports the widely accepted theory that today's birds are the descendants of yesterday's dinosaurs. Although scientists were unable to recover DNA, they did collect collagen proteins, the principal component of connective tissue in animals. The purpose of this groundbreaking study, headed-up by Mary Schweitzer—a paleontologist at North Carolina State University and the North Carolina Museum of Natural Sciences—is to use the molecular make-up of fossilized remains to categorize species that have become extinct.

The discovery of protein and soft tissues within fossilized bone, like many other of its sort, came about by accident. During a 2003 excavation in Montana's Hell Creek area, Montana State University paleontologist Jack Horner was forced to break a large T. rex femur into several pieces for transport. Upon cracking the massive bone, Horner discovered preserved soft tissue from the amazing beast.

Further analysis of the material revealed that the tissue at a microscopic level looked very similar to the cells and vessels found inside modern-day ostrich bones. Upon identification of the soft tissue as collagen proteins, Horner sought to sequence the seven protein strands identified and compare them to an established collagen database. To researchers' surprise, all seven of the sequences were found to have modern-day matches. Three of the sequences matched chicken protein uniquely, while one matched frog protein and another matched that of a newt. The number of protein sequence matches between T. rex and chickens indicate that the chicken may be T. rex's closest modern-day descendant.

The experiment was successfully replicated and conducted several times using synthetic T. rex protein to further validate its accuracy. The collagen extracting techniques further developed in this study have far-reaching applications in the understanding of both human health and disease.

Source: MSNBC, "T. rex analysis supports dino-bird link." Alan Boyle, 12 April 2007.

I'll Take a New Pink One

Have you been thinking about buying a new cell phone lately? Perhaps one of the new, colorful ones that can play music, store photos and cook your dinner? Before throwing out your perfectly good, but obviously, "so last year" model, you may want to take stock of the environmental ramifications of the growing cell phone industry.

The Worldwatch Institute reports that there may be as many as a half-billion obsolete cell phones in the United States, with fewer than 2.5% destined for recycling. That means that demand for the key cell phone component Coltran—an ore found almost exclusively in the Democratic Republic of Congo—will remain a catalyst for violence in that country as warring factions vie for control of this valuable commodity.

One should also keep in mind when upgrading to a new cell phone that turning your phone in for recycling may not have the outcome you anticipated. It is estimated that as much as 80% of the electronics turned in for recycling end up shipped to developing countries where much of the imported e-waste ends up in hazardous dumps. So what should you do? Keep your phone for as long as it works before switching to a new one and pressure manufacturers, who sold over ninety-four million phones in 1994, to develop recycling programs that work for consumers and for the environment.

Source: Vital Signs, 2006-2007. New York: Norton/Worldwatch Books, 2007.

San Francisco Takes Action against Plastic Bags

Often viewed as America's leader in urban environmentalism, San Francisco is now looking for waste reductions in an area that has long been overlooked: the checkout line. The Plastic Bag Reduction Ordinance, approved in late March, will replace the traditional choice of "paper or plastic" presented to shoppers with one of three environmentally friendly alternatives. Under the ordinance, grocery stores with annual sales exceeding \$2 million are required to provide only recyclable paper bags, compostable plastic bags, or reusable bags to their patrons. Recyclable paper bags are those that are 100% recyclable and containing a minimum of 40% post-consumer recycled content with no fiber from old growth forests. The reusable bags are intended to be those manufactured from machine-washable cloth or durable plastic, designed with handles and the intention of multiple uses.

Standard plastic bag manufacturers are likely to be the most upset by the new ordinance. The new ordinance will require grocery stores to provide compostable plastic bags, defined as those meeting specific standards for compostability, as well as containing less than 75% petroleum-derived content (with a target goal of no products from petroleum by 2010), and no products derived from genetically modified organisms. Stores violating the ordinance could face fines ranging from \$100 for a first offense to \$500 for subsequent offenses. So what was the driving force behind this bold move? San Francisco has a goal of diverting 75% of waste from landfills by 2010, and the ultimate goal of zero waste by 2020.

Source: "Proposed Compostable Bag Ordinance". SF Environment. <http://sfgov.org>

South by Southwest is Carbon Conscious

Each year Austin's South by Southwest (SXSW) holds a music, film, and interactive festival, showcasing some of the up-and-coming names in the media industry. This year SXSW partnered with Green Mountain Energy Company to offset all of the festival's carbon emissions. To attain the goal for this year, SXSW reduced emissions where it could, then purchased carbon offsets where it could not. With this strategy, the festival offset 100% of 250 metric tons of carbon emissions by purchasing 376MW of energy credits from their partner Green Mountain Energy Company, also based in Austin. In another move to help reduce future emissions, SXSW donated an additional \$5,000 to Austin Parks Department for replanting and maintaining native trees.

To achieve carbon neutral status, SXSW staff members collected data on all of the activities that generate carbon emissions. SXSW's Environmental Consultant Una Johnston then calculated carbon emissions using the standards, guidelines, and tools contained in the World Resources Institute's GHG Protocol. SXSW staff began by determining emissions from September 1, 2005 to August 31, 2006, a 12-month period used as a baseline year in order to determine future reductions in emissions. They found that SXSW carbon emissions occur due to gas and electricity usage in its offices (18%), from electricity usage in the Austin Convention Center and all the showcase, movie and party venues that it contracts with during SXSW each year (55%) and also from business travel (27%).

According to SXSW, this carbon emission strategy does not end with neutral emissions this year. Rather, the festival plans to create a reduction scheme for the next four years in an effort to reduce the festival's environmental footprint. The festival is also making other efforts to be eco-friendly; SXSW teamed up with Ecology Action of Austin in an effort to recycle all the waste generated from the parties and events. The festival also plans to utilize Biodiesel fuel in generators and production trucks. SXSW realizes that today environmental consciousness is a determining factor in the business world, and the festival plans to play its role in contributing to a more sustainable future. To find out more about the carbon neutral status of South by Southwest, or to learn more about ways to reduce your carbon footprint visit http://2007.sxsw.com/about/carbon_neutral/.

Organic Food Trends

Demand for organic food in the United States continues to grow. Consumers can now find many types of organic products (not just bread, cheese, and milk), from a variety of different producers—all with a noticeably decreased price. This trend is showing up elsewhere in the world as well. Australia has the second largest total land acreage devoted to organic farming, exceeding twelve million acres. Argentina follows with nearly three million acres devoted to organic farming. This provides a sharp contrast to the United States, which ranks fifth in the world with less than a million acres devoted to this booming industry.

For many consumers the growth of the organic food industry would appear to be a positive step. But, the growth of the organic food movement remains controversial because the word 'organic' does not necessarily mean "locally grown" or "sustainable." Organic ingredients can sometimes come from foreign countries, generating "food miles" that contribute to global climate problems. Plus, some organic products are grown on industrial-sized farms rather than small organic farms that are more environmentally sustainable. In the United States, where the number of small farms continues to decline, many non-organic small farmers fear that the demand for organic products may impact their profits.

These concerns will continue to be discussed among consumers, governmental organizations, and businesses, but ultimately it is up to the purchasing power of the consumer to determine whether more organic food will be produced for our tables.

Oberlin's Living Machine: Sustainability at Work

Oberlin College's Adam Joseph Lewis Center for Environmental Studies is drawing a lot of attention thanks to its "living machine." Designed to mimic the closed cycles of natural ecosystems, the building integrates modern principles of wastewater treatment with the natural processes provided by wetlands to treat and recycle wastewater onsite. Wastewater from toilets and sinks in the building is diverted through an initial system of aerobic and anaerobic tanks to separate solids and break down organic wastes into methane and ammonium. The final tanks to receive the wastewater are three open aerobic tanks situated in the Center's greenhouse. These tanks maintain microbial populations that convert ammonium to nitrates. The tanks are hydroponically planted with rafts of large tropical plants that absorb and utilize the nitrates while providing habitats for protozoa and invertebrates that feed on the bacteria. The water is then pumped into a clarifier where any remaining solids settle and are pumped back into the aerobic tanks. Goldfish in the clarifier serve as indicators of the biological health of the clear water. The greenhouse floor is a planted gravel wetland which absorbs the water draining from the clarifier. Plants such as willow, iris, and rush provide habitats for denitrifying bacteria that convert remaining nitrates in the water to atmospheric nitrogen. The treated water is pumped through UV radiation to kill remaining bacteria, and then reused for irrigation and in the building's toilets. Through this system, the Lewis Center is able to recycle 60-80% of the water used to operate the building's toilets.

Source: <http://www.oberlin.edu/ajlc/ajlcHome.html>

Natural Poetry

By Kaylin Dantes

Drift

Sometimes I miss New York,
east of the city out where the sand
sinks deep under your feet
as the receding waves tug
you closer to the sea.

Winter is the saddest season,
but I always take a walk
down to the sound
and sit where the plovers
used to nest, and think
how the cold feels
like a whip, settling
in your bone.

At dusk when the sun
streaks the waves with
bits of yellow light
the water always reminds
me of my grandmother's eyes.
Grayish with quiet sparks.

She was always a good floater,
head back and arms out,
feet sticking out of the water,
remembering days
of wool bathing suits
and swimming in Brooklyn.

She used to say,
"I was never a fast swimmer."
But I like the way she moved
on top of the waves, nimble
fingers tracing the surface,
threading their movement
through the water,
like landing dragonflies.

Path

On a cool, damp, honeysuckle-scented
morning, when the birds were starting
to rouse in the thickness of the pines
and the cicadas were still hidden,
safe in the hard earth,
I went for a walk

past the apple orchard,
its buds starting to appear,
past the beach where
I had once kissed boys
behind the dunes,
and when I came across
tombstones marking the
graves of someone else's ancestors,
I kneeled down,

looking at my hands,
smooth and white, so smooth
that you could almost see
fine bones when I made a fist.
They began to age in front of me,
becoming gnarled and dry,
like a tree branch stretching
towards time.

About The Author

Kaylin Dantes is a senior English major with a concentration in creative writing. She is originally from Long Island, New York and enjoys animals and the beach. Besides being published in *Visions* she also has a poem appearing in this year's *Colonnades*.



From Dominion To Citizenship

By Jared Otte

For the last twenty centuries of the world's history, Christians have attributed a specific hierarchical ideology to the concepts of slavery, treatment of women, marital relationships, and the treatment of nature. The dominion interpretation of Christianity is the oldest and most traditional view ascribed to Genesis 1:28. In the 19th and 20th centuries an alternative view of the ideas introduced in Genesis 1 and 2 was introduced into the main stream of Christian theology. This theological concept referred to as "responsible stewardship" or simply as "stewardship" is described by Thomas Derr:

Man Lives in the Context of history and community and his decisions regarding nature must be responsible to that setting. He does not enjoy absolute right of disposition over natural resources, but is their steward, the caretaker of the Divine owner, using them and preserving their usefulness to future ages (Derr 1975, 15).

Against the backdrop of dominion and stewardship, a third ideology has emerged which is beginning to gain speed and support from across the board. This third ideology is the main focus of the present article. The purpose of this study is to show that what stewardship has done to dominion, the ideology of citizenship will eventually do to stewardship and dominion. It will push them towards the background of the discussion on how to regard the earth.

Before a full mounted discussion of citizenship can begin, the two ancestors of this movement must be introduced. I will begin with the model of Dominion, the most ancient and traditional theology of the three. Dominion theory is a product of traditional hermeneutic translations of Genesis 1:26-28. Up until this point in the text all of creation has been brought into existence except human beings:

²⁶Then God said, "Let us make man in our image, in our likeness, and let them rule over the fish of the sea and the birds of the air, over the livestock, over all the earth, and over all the creatures that move along the ground." ²⁷So God created man in his own image, in the image of God he created him; male and female he created them. ²⁸God blessed them and said to them, "Be fruitful and increase in number; fill the earth and subdue it. Rule over the fish of the sea and the birds of the air and over every living creature that moves on the ground" (The New International Version).

Dominion theory interprets "and let them rule" as the idea of a master to slave relationship. This interpretation is not solely based upon the English translation of "let them rule;" a Hebraic hermeneutical interpretation of this can be witnessed in the exegesis of Environmental historian Roderick Nash:

Hebrew Linguists have analyzed Genesis 1:28 and found two operative verbs: *kabash*, translated as "subdue," and *radah*, rendered as "have dominion over" or "rule." Throughout the Old Testament *kabash* and *radah* are used to signify a violent assault or crushing. The image is that of a conqueror placing his foot on the neck of a defeated enemy, exerting absolute domination. Both Hebraic words are also used to identify the process of enslavement. It followed that the Christian tradition could understand Genesis 1:28 as divine commandment to conquer every part of nature and make it humankind's slave (Nash 1989, 212).

Though this particular interpretation by Nash is questionable due to the specific interpretation and view point that he takes, the majority of traditional interpretations warrant humanity's enslavement of nature because it was given to man to conquer. The theological foundation for this theory could be that Christianity is so concerned with personal salvation that this self-centered desire inspires a Christian to devalue nature as a result. A perfect example of this theological mindset is apparent in the early Christian theologian Origen. David Kinsley describes Origen's view of salvation as:

Primarily an ascent from the material to the spiritual...it is absolutely clear in Origen that the material creation is not humankind's home. That home is in heaven where matter has no place...The material world, according to Origen, is created primarily by God as a Kind of purgatory where fallen human beings are educated through trials and tribulations to return to the realm of pure spirit from which they have fallen (Kinsley 1994, 185).

Throughout history this domination interpretation of Genesis has been carried over to the story of Noah to justify the enslavement of Blacks by the Europeans and Americans. This interpretation has been significant in structuring a hierarchy that carries over to the second chapter of Genesis to justify a man's domination over woman.

In 1967 Lynn White Jr. wrote his notorious article published in *Science* titled "Historical Roots of our Ecological Crisis." This title, made at a time of increasing environmental awareness across the board, was made specifically against the dominion theology that is presented above. Many theologians disagree outright with White and attempt to validate other claims about the state of the environment and Christian ethics. However, White—among others—has contributed significantly to the abandonment of dominion theology in the realm of Christian ethics. Though White's article did help to encourage a movement away from dominion theology, it did not inspire widespread acceptance for what White proposes as the religious solution to the environmental crisis. What resulted more immediately from this movement, where White was a significant spokesperson, was a widespread acceptance for stewardship theology.

Lynn White Jr. was a professor of medieval history at Princeton, Stanford and the University of California. White's main area of research was the role of technological invention in the Middle Ages. His belief that the Middle Ages were a crucial period in the origin of western technological domination and that the militant character of medieval western Christianity provided the foundation for technological inventiveness are consistent ideas which underlay all of his writing. White's view of Christianity in the context of medieval technology, as well as its progression to the present state of society in the West, depicts Christianity intent on dominance and supremacy through constant technological advancement. From White's view of Christianity in the context of his life's work, the role of technological invention in the middle ages, there is logical reason to assume where he would make conclusions about the ecological crisis of the present day. Since he felt that Christianity in the Middle Ages made it possible for the technological advances

to occur that created our society as we know it today, it would follow logically that he would associate Christianity with the ecological crisis that faces the world in the twenty-first century.

The notorious declaration made by Lynn White in the late 1960s analyzes the state of the environment and humanity's effect on it. White attributes the current state of our world to the development of science since the seventh century. Yet White, as stated above, does not blame science itself for the ecological crisis. On the other hand, he blames the West's embrace of orthodox Christian ideologies for the development of science in this way, and through this the ecological crisis. White attempts to illustrate that through the destruction of pagan animism, Christianity transforms the ideology of natural theology from "the decoding of the physical symbols of God's communication with man" (White 1967, 1203) to "the effort to understand God's mind by discovering how his creation operates" (Ibid.). Thus, White offers the solution that man must embrace Franciscan ideology in order to solve the ecological crisis, his interpretation of Franciscan ideology being that all of creation is equal and was created for the exaltation and worship of God without exception or favor. White offers the solution of a Franciscan religious approach because he feels that if humanity adopts modern science as the solution to the environmental crisis we will simply be continuing what got us here in the first place. The movement towards a Franciscan ethic proposed by White is very similar to the citizenship interpretation of humanity and nature which will be discussed later on.

In direct opposition to White's Franciscan ethic is Rene Dubos. Dubos attempts to stop White from progressing towards a citizenship model: "I believe that ecologists should select St. Benedictine as a much truer symbol of the human condition than Francis of Assisi" (Dubos 1972, 153). Dubos takes issue with White about St. Francis because he feels that it rejects the hierarchical concept central to the idea of stewardship. St. Francis regarded all life forms and even inanimate objects as brothers and sisters in the family of God. Dubos, unlike White, accepts enlightened anthropocentrism as the basis of his environmental ethic. Dubos feels that mankind is in charge of the world and should thus "Manipulate nature to his best interests" (Dubos 1968, 7) but always with a feeling of reverence for what is ultimately not his possession. It is apparent through Dubos' refusal to accept a non-anthropocentric ideology that he falls within the more moderate stewardship category of Christian environmental ethics.

In his paper, White proposes a point of view which becomes very popular among those who are both interested in ecology and critical of the Christian religion. Though "Historical Roots of Our Ecological Crisis" certainly has enlisted a large following, for people like Rene Dubos, it has also initiated a very significant backlash based upon some of the flaws found within White's argument and his supporting evidence. For example, in 1999 Rev. John Richardson, the Anglican Chaplain to the University of East London stated that White's argument is "pejorative in its presentation, superficial in its theology and naïve in the solution it puts forward" (Richardson 1998). The first flaw found upon a close reading of White's paper (referred to as a "pejorative presentation" by Richardson) is his use of propagandist style and language to convey his ideas. Because of this polemical presentation of his argument, White

makes a reader automatically skeptical of his intentions. Once a reader has identified the style and language with which the author presents his argument, some begin to analyze some of the theological and historical evidence White employs. For example, White proposes that the ecological crisis should be attributed solely to Judeo-Christian theological beliefs without even entertaining the idea that they may have come from somewhere else. In fact many Greek myths clearly speak to the Greek, Stoic philosophical stories where the world is created by the gods for human enjoyment.

Another example of the flaws within White's argument is how White mentions the deforestation caused by the (pre-Christian) Romans and road construction without explanation, yet later links deforestation with two millennia of Christian missionaries "chopping down sacred groves" (White 1967, 1206). More realistically we are experiencing deforestation due to the poor agricultural practices employed in the third worlds of South America and South Asia which are so endorsed by big business in the United States.

Yet another example would be how White singles out Western Christianity as the source of the ecological crisis and writes of the Eastern Christianity as non-technological. White attempts to trace the origins of this technology of the Western Christians back to the seventh century (the appearance of alternative methods of plowing), yet fails to address how the Eastern and Western churches did not split until the eleventh century, four centuries after the introduction of these revolutionary farming techniques. White was lashing out against the development and the results of dominion theology.

In response, or possibly something that emerged independently, the majority of Christianity adopted some form of a stewardship mentality. This theological approach solidified man at the top, still in control, but with the claim that it was acting with love and care for nature. Stewardship was a step in the right direction from an environmental standpoint but it did not relinquish the anthropocentric foundation which holds it back from taking the necessary action to deal with the environmental crisis. Stewardship, like dominion, begins with Genesis 1:26-28. However, the interpretation of this passage is notably different: As Laurel Kearns accurately describes, proponents of stewardship are different than those of dominion because "They reinterpret it as a divine charge to be good stewards and to take care of and protect (but not rule or perfect, as in older interpretations of the passage) the Creator's creation" (Kearns 1994, 55). Thus, the same passage that the dominion interpretation uses to justify its ideology can be used as well to justify a notion of stewardship which requires people to preserve nature. An expansion of this idea can be found in Genesis 2:15 which says, "The LORD God took the man and put him in the Garden of Eden to work it and take care of it." This interpretation of Man as the steward of the earth, commissioned by the Lord, can be seen echoed in the American Baptist Churches,

USA and the Evangelical Lutheran Church, to mention just a few. The American Baptists declare that "The literal interpretation of steward is manager of the household. As such, we are all called to be managers of God's household, the earth and all that is in it." Thus the Baptists feel they should "promote an attitude affirming that all nature has intrinsic value and that all life is to be honored and revered." In addition to this, the Baptists feel they should "exert our influence in shaping public policy and insisting that industries, businesses, farmers and consumers relate to the environment in ways that are sensible, healthy and protective of its integrity" (American Baptist Churches, USA 1989).

The evangelical Lutheran church feels very similar to the

Baptists in regard to the ideals and ideologies of stewardship. They feel "[h]umans are part of nature, but with a special role on behalf of the whole. We receive dignity and responsibility that distinguishes us from the rest of creation." The Evangelical Lutherans' idea of the role of Humanity as the stewards of creation "in this environmental context means serving life-giving cycles and rhythms of creation through restrained and creative intervention" (Evangelical Lutheran Church in America 1993).

Peter S. Wenz, a Philosophy and Legal Studies professor at the University of Illinois at Springfield, argues that, "On the Stewardship Interpretation, the Bible endorses not

anthropocentrism but environmental synergism" (Wenz 2001, 256). This may be true for some proponents of stewardship, yet as put forward in the context of the American Baptist and Evangelical Lutheran traditions the salvation of humanity for the rest of time is at the center of the desire for environmental stewardship. Though the synergistic qualities of stewardship are leaps and bounds beyond that of dominion, human salvation and the keeping of God's creation for the benefit of humanity is still at the heart of the idea, which is much more anthropocentric than synergistic.

A great example of the viewpoint of the evangelical Lutheran towards environmental stewardship would be Larry Rasmussen. Before he retired, Larry L. Rasmussen was a Reinhold Niebuhr Professor of Social Ethics Emeritus at Union Theological Seminary. As a member of the Evangelical Lutheran Church of America, he has taught at Wesley Theological Seminary and served as director of a national retreat center of the Lutheran Churches. He has served as co-moderator of the Commission on Justice, Peace, and Creation of the World Council of Churches. In his book *Earth Community, Earth Ethics*, Rasmussen brings together a large number of very diverse sources in order to paint a picture of the environment and to offer insight as to what can be done to stop its destruction. Rasmussen develops a number of values which he feels will guide "moral force" towards the change he feels is necessary. In sum, these values are as follows: The idea that all creation is valuable in its own right before God; that creation is only given to us, as keepers, once—we don't get another chance; that there is a dynamic relation between social and environmental justice; finally, that nature shows the face of the divine. Rasmussen concludes that

"This theological approach solidified man at the top, still in control, but with the claim that it was acting with love and care for nature."

nature is of some value; though not on the same level as humanity, it nonetheless deserves consideration from society as a whole. He proposes that the solutions stated within his values are both religious and economic and that only through an effort of faith can the world be saved (Rasmussen 1996, 322).

As proposed above, the evangelical Lutheran tradition is a definite proponent of stewardship and in turn with the Lutherans, the Catholic faith to some extent seems to express a relatively conservative form of this ethic. As has been mentioned, White's paper began a significant debate against Christian faith which was just waiting to be countered with fervor by outspoken theologians. Who better to answer this call than Richard John Neuhaus? Neuhaus was a leading Lutheran theologian until he converted to Catholicism in 1990. One of eight children and the son of a Lutheran pastor, Neuhaus followed his father into the ministry. For 30 years he was a Lutheran pastor to a poor, black community in Brooklyn. Ordained as a Catholic priest in 1991, Neuhaus is a well-known public commentator on civil rights and the anti-war movement. He is a founder-director of the Centre for Religion and Society in New York, the author of several books, and is the Editor in Chief of *First Things*, a contemporary intellectual journal concerned with the creation of a "religiously informed public philosophy for the ordering of society" (Neuhaus 2006).

Neuhaus' view of the environment is in contrast with many, specifically White's. In his book *In Defense of the People* he states that "environmental and population controllers are finally accused of regarding people, at least when found in great numbers, as a kind of pollution" (Neuhaus 1971, 140). Due to his background as a minister to poor and underprivileged com-

munities and a civil rights activist, it is easy to understand why Neuhaus' main focus would be people. Neuhaus views man as "the crown of creation," and though he agrees with some environmentalists that viewing humanity above all things is wrong and in his view idolatrous, he feels that some environmentalists' refusal to make an idol of humanity reaches the point where they eventually make an idol of the universe itself. He feels that the bible, specifically the New Testament in the books of Romans, Ephesians, and Revelation, teaches ideas of stewardship and delegated dominion over nature. Since Neuhaus' stance towards Christian environmentalism is a combination of both dominion and stewardship, it is difficult to put him in one of the two categories. On the other hand, considering I have already portrayed the ideology of dominion as facing extinction within Christian ethics, Neuhaus represents a dying breed of conservative Christians in their view towards the environment.

Even though Neuhaus does hold an extremely conservative perspective about the environment, he is all about development, most likely due to his social reformist background. Neuhaus' theology differs from many in the respect that he feels stewardship fails to "convey the full force of our participation in the destiny of all things." Neuhaus feels the Christian tradition, most likely due to his catholic faith, "is a living tradition, it both can and must develop" (Neuhaus 1997, 1). He feels that though many ecophilosophers and ecotheologians blame the Christian tradition for the ecological crisis, humanity will be more productive in attempting development of doctrine from within the Christian tradition rather than accusing and deconstructing the Christian faith in general.

The ground on which Neuhaus critiques the environmen-



talist position expressed through White's writing is that of his firm anthropocentrism. His view of humanity as the crown of creation is integral to his belief, yet he does not feel that we are therefore entitled to do what we want with the earth. In a 1997 article in *First Things*, Neuhaus summarizes his environmental standpoint through the words of Abraham Joshua Heschel who viewed humanity as the "cantor" of creation. Neuhaus expresses how humanity should "sing the song of God's sovereignty...the song of God's delight in His creations...the song of reason's gift by which we understand the uses of nature to preserve and enhance the well-being of humanity...the song of Francis...the song of wonder at a beauty that is always other...the song of obedience to the command to care...the song of redemptive hope of the resurrection of the body; of our bodies that encompass the stuff of the creation of which we are part". From this a reader can see that Neuhaus calls for an adopting of Franciscan "fellow feeling with all that is and most especially with the animals of which we are forever one," as well as adopting a caretaker/"cantor" role towards creation with the intent of honoring God's sovereignty and His delight in His creation (Neuhaus 1997, 1).

The extreme anthropocentrism of a stewardship mentality akin to Neuhaus' is susceptible to critique: How can one act on behalf of nature if one does not treat themselves or think of themselves as part of nature and one of its components? If humanity is indeed understood as the "Crown of Creation" as Neuhaus claims, how can this ruling body possibly act constructively on the behalf of one of its "subjects" without experiencing the point of view of a part of nature? How can humanity decide what is best for creation if it holds itself so far outside of nature?

Due to these questions being asked over the last fifty years, an ideology has developed in response. Citizenship interpretation inspires Christians to view themselves as part of creation, simply a citizen within the whole of the thing. The idea behind this theory is that once a person views themselves as part of creation they can successfully attempt to address the questions that we need to answer if we are to make a difference in this world.

The next theologian that will be presented is a Catholic Monk who makes the step covering the gap between Stewardship and the third type of Christian Environmental theology: The Citizenship theology, which seems to be the destination of the majority of Christian environmentalism. Father Thomas Berry is a catholic monk who takes a much more liberal approach to stewardship than the conservative views of Richard Neuhaus, approaching that of the radical Deep Ecological views of Arne Naess while remaining within the confines of Christianity, whereas Naess does not attempt to do anything of the sort. Berry understands creation to have a quality of divine mystery. He proposes the order and structure of creation to be understood as:

...emergence...through...self transcendence. Hydrogen in the presence of some millions of degrees of heat emerges as helium. After the stars take shape as oceans of fire in the heavens, they go through a sequence of transformations. Some eventually explode into star

dust out of which the solar system and the earth take shape. Earth gives unique expression of itself in its rock and crystalline structures and in the variety and splendor of living forms, until humans appear as the moment in which the unfolding of the universe becomes conscious of itself (Berry 1990, 132).

From these conclusions about creation, Berry follows with a theology similar to that of Naess:

It is especially important...to recognize the unity of the total process, from that first unimaginable moment of cosmic emergence through all its subsequent forms of expression until the present. This unbreakable bond of relatedness...merges...everything...intimately present to everything else in the universe. Nothing is completely itself without everything else (Ibid.).

Though Berry seems to be operating under an entirely different theology than that of anything resembling stewardship, to some extent he brings it back in the direction it came from:

"We now in large measure determine the earth process that once determined us. In a more integral way we could say that the earth that controlled itself directly in the former period now to an extensive degree controls itself through us" (Ibid.).


By stating that the earth that used to control itself entirely now controls itself through humanity, Berry brings back the idea of humans being the stewards or, in his words, the caretakers of the earth. Humans became the way in which the earth takes care of itself. The difference between Berry's ideas and the ideas of stewardship is that in this model, humans are not care-takers of the earth on their own behalf; in this model the anthropocentrism of stewardship is entirely erased. Humanity, within the citizenship model, is acting on behalf of all of creation for the benefit of all creation, not simply acting for human individual salvation or the hopeful continuation of the human experience.

Berry expresses a citizenship that is far more progressive than the theology that is being proposed to replace that of stewardship. Considering all three of these categories are so broad in themselves, it must be acknowledged that the radical mentality of Berry can not be taken for the norm. The citizenship theology extends into a less radical, less Deep Ecology feeling ethic. A perfect example of citizenship theology that can be taken as more normative and more realistic as a replacement of stewardship is that of Paul Santmire.

Through Berry's ideas it becomes evident that, much akin to slavery in America and the treatment of women throughout history, nature can not be truly liberated until we start thinking from the standpoint of the object we are trying to free. We can no longer think simply of ourselves; we must be mindful of those suffering. Paul Santmire expresses that, in truth, what White is really asking is "whether it is legitimate to think theologically about the liberation of nature" (Santmire 2004, 531). Santmire shares the very citizenship mentality that is introduced above through Thomas Berry, though he expresses it in a different manner:

This is my contention: that in order to reflect the complexities and the richness of the biblical witness in this respect, it is best for us to develop a theology of partnership with nature, which will hopefully, in due course and with sufficient scholarly discussion begin to take the place of what appears to be the more limited theology of stewardship of nature which is now being widely preached and taught (Santmire 2003, 382).

Santmire's idea of Partnership is entirely homogeneous with the theology of citizenship. Santmire feels that this theology of nature will surpass and replace that of stewardship because, as he states in his article "Partnership with Nature according to the Scriptures, even though stewardship has been preached by churches at every level more than any other theology in response to the ecological crisis, the majority of Christians in the West generally have shown little interest in the environmental concerns upon which a theology of nature would have most effect and significance. Given that stewardship is becoming more and more popular as a theological trend in western churches, Santmire feels that it is absolutely imperative to replace this trend simply because each new adherent will adopt the complacency towards nature that is seen throughout the stewardship community today, which is one without significant action (Santmire 1994).

In a time of such ecological tragedy a change will be made. In a world where human negligence and interference is causing seas and oceans to rise, holes in the ozone the size of continents to appear, the majority of drinking water to become contaminated, and air pollution which causes cancer in animals and humans across the globe—with these being only the very beginning of the long list of problems we are facing—humanity has no option but to change. There is no question about whether or not humanity will change in order to deal with the environmental crisis, for if it doesn't it will cease to exist just like the hundreds of thousands of species that have been exterminated in the last century due to human presence on the earth; the question is how it will change. Domination got us to where we are, stewardship is fooling us into keeping ourselves where we are, but citizenship will provide us with a more hopeful and realistic path for the world we live in today. 

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Works Cited

- American Baptist Churches, USA "7040:12/88 American Baptist Policy Statement On Ecology, an Ecological Situational Analysis 'Creations and the Covenant of Caring'" The General Board of the American Baptist Churches 1989
<http://www.abc-usa.org/resources/resol/ecology.htm> [Accessed April 20, 2007].
- Berry, Thomas. *The Dream of the Earth*. San Francisco, CA: Sierra Club Books, 1990.
- Derr, Thomas Sieger. *Ecology and Human Need*. Philadelphia, PA: Westminster Press, 1975.
- Dubos, Rene. *A God Within*. New York: Scribner Publishing, 1972.
- Dubos, Rene. *So Human an Animal: How We are Shaped by Surroundings and Events*. New Brunswick: Transaction Publishers, 1968.
- ELCA Environmental Task Force, Evangelical Lutheran Church in America. *Caring for Creations: Vision, Hope, and Justice*. <http://www.elca.org/social/statements/environment/> [Accessed April 20, 2007].
- Kearns, Laurel. "Saving the Creation: Christian Environmentalism in the United States." *Sociology of Religion* 57 (1994): 55-70.
- Kinsley, David. *Ecology and Religion*. Englewood Cliffs, NJ: Prentice-Hall Inc., 1994.
- Nash, R.F. *The Rights of Nature: A History of Environmental Ethics*. Madison WI: University of Wisconsin Press, 1989.
- Neuhaus, Richard. "About First Things" (*First Things* Website 2006). <http://www.firstthings.com/menus/about.html> [Accessed April 22, 2006].
- Neuhaus, Richard. "Christ and Creation's Longing." *First Things* 78 (1997) 20-25.
- Neuhaus, Richard. *In Defense of the People: Ecology and the Seduction of Radicalism*. New York: The Macmillan Company, 1971.
- Neuhaus, Richard. "The Idea of Moral Progress." *First Things* 77 (1997): Things, 95 (1999): 21-27.
- Rasmussen, L.L. *Earth Community Earth Ethics*. Maryknoll, NY: Orbis Books, 1996.
- Richardson, J. "The Spiritual Roots of our Ecological Crisis—Was Lynn White Right?" Chelmsford Evangelical Anglican Theological Site 1998
<http://www.btinternet.com/~j.p.richardson/lynnwhite/lynnwhite.html> [Accessed May 3, 2006].
- Santmire, P.H. "The Liberation of Nature: Lynn White's Challenge Anew." *Christian Century* 102, 18 (2004): 530-534.
- Santmire, P.H. "Partnership with Nature According to the Scriptures; Beyond the Theology of Stewardship" *Christian Scholars Review* 32, 4 (2003): 381-400.
- Wenz, Peter. *Environmental Ethics Today*. New York: Oxford University Press, 2001.
- White, Lynne Jr. "The Historical Roots of Our Ecological Crisis." *Science* 155(1967): 1203-1207.

Research Note: Analysis of Wastewater Effluent for Estrogens

Ashley Lauren Black, Lisa M. Ponton

ABSTRACT

Estrogens and other endocrine disrupting compounds (EDCs) in the environment present a unique problem for environmental health. As an unregulated class of compounds, an accurate assessment of whether estrogens are present in the environment is critical. Current Environmental Protection Agency (EPA) standards for the analysis of organic molecules in water rely on removal of the compounds via liquid-liquid extraction with methylene chloride. Based on data collected, liquid-liquid extraction is not effective in removing estrogens from water. Solid phase extraction has been found successful in extracting four estrogens (estriol, 17- β -estradiol, 17- α -ethynyl estradiol and estrone) from spiked clean water samples with detection at the ng/L level. This method is currently being scrutinized for its effectiveness in analyzing wastewater effluent. Wastewater effluent samples were collected from the City of Graham North Carolina Wastewater Treatment Plant.

INTRODUCTION

Over the past twenty-five years there has been a rise in the concern of the presence of EDCs in the environment (Koplin et. al. 2002; Petrovic et. al 2004; Richardson 2003). Endocrine disruptors are defined as a class of compounds that, in some way, affect normal hormone function and, therefore, affect growth, reproduction and development of animal life (Sumpter 2005; Jobling et. al. 1998; Takeuchi et. al. 2004; Zeleniuch-Jacquotte 1995; Zou and Fingerman 1997). The recent rise in concern is due to the discovery of the harmful nature of DDT, a pesticide that has been found to disrupt reproduction in gulls and alligators (Snyder et. al. 2003). More recently, in 1996, the EPA stated that one of its six main research initiatives would concern studying the nature of endocrine disruption (Environmental Protection Agency).

Estrogens have been found to be present in low concentrations (ng/L) in water sources in Germany, the United Kingdom, Spain and Sweden (Petrovic 2004; Lee et. al. 1994; Isobe and Budzinski 2005). Most of these compounds come from inappropriate use and disposal of synthetic estrogens, such as birth control (Petrovic et. al. 2004). Since many EDCs are not regulated by the EPA (EPA Endocrine Disrupters) wastewater treatment facilities may not be completely removing this type of contamination (Sumpter 2005; Lee et. al. 1994; Labadie and Budzinski 2005). Once wastewater is treated, it is returned to the environment in the form of effluent via rivers and other natural waterways. This recycling of water means that any contaminants present in the wastewater are transferred back to the environment. Research has shown that these low (ng/L) concentrations of EDCs in the environment are capable of affecting the endocrine system in a wide range of organisms (Jobling et. al. 1998; Takeuchi et al. 2004; Zeleniuch-Jacquotte et. al. 1995; Zou and Fingerman 1997).

MATERIALS AND METHODS

The estrogens chosen for this study are illustrated in Figure 1. Three of the estrogens, estriol, estrone, and 17- β -estradiol are natural estrogens. The 17- β -ethynyl estradiol is a synthetic estrogen used in birth control. Several sample types were utilized for this project. Wastewater effluent was analyzed directly in order to determine the presence of estrogens in water. Spiked samples, consisting of either clean water or wastewater effluent with known amounts of estrogens added, were used to assess the efficiency of the methods.

Two methods were examined for the analysis of these estrogens: 1) liquid-liquid extraction (LLE) using methylene chloride and 2) solid phase extraction (SPE). The LLE method consists of mixing 60 mL of methylene chloride with 1.0 L of water and then draining off the organic (bottom) layer. This was repeated three times with each water sample. The methylene chloride was concentrated down to a volume of 1.0 mL through a boiling regimen. SPE involves passing a 1.0 L water sample through a small cartridge packed with a solid stationary phase (octadecyl bonded silica material). As the water passes over the stationary phase, the estrogens adsorb to the solid material, due to their high affinity to the chemical characteristics of the solid. In order to remove the estrogens from the solid material another solvent (acetonitrile) that the estrogens have a higher affinity for than the solid phase must be pushed through the cartridge. SPE is an improved method because it concentrates

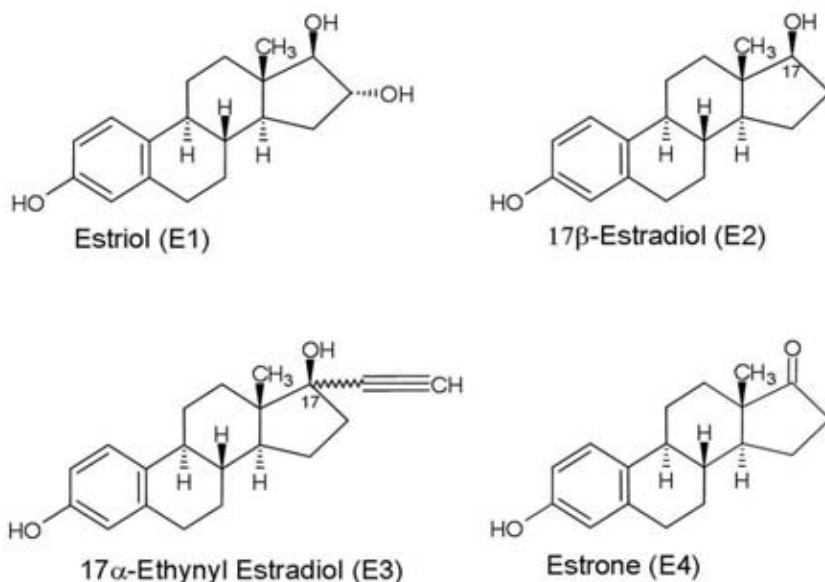


Figure 1. Structure of estrogens currently being examined.

samples effectively and uses little organic solvent, being greener for the environment than other extraction methods (Fritz 1999). A final volume of 1.0 mL is achieved through a boiling regimen. Both methods offer a 1,000 fold concentration factor allowing for the potential detection of estrogens at the ng/L concentration level.

After extraction and concentration, the sample is analyzed on a Varian high performance liquid chromatograph (HPLC) with detection at 220 nm. The four different estrogens are separated in the HPLC due to their differing chemical characteristics and the instrument detects an absorbance peak corresponding to each compound present in the sample, as shown in Figure 2. The peaks can be used to determine the concentration in the sample due to a linear correlation

between peak area and concentration (Beer's Law). The concentration is determined using a previously constructed calibration curve (Figure 3). For all four estrogens, the r-squared value of the line is greater than or equal to 0.9996, confirming a strong linear relationship between peak area and concentration. The concentration of estrogens in the samples collected will be determined using the calibration curve. Once concentrations have been obtained for the effluent and river sites, comparisons will be made in order to determine 1) if Wastewater Treatment Plants (WWTP) are failing to remove estrogens from sewage, 2) if estrogens are present in natural waterways and 3) if the effluent from the WWTP is a contributing source of estrogens in natural waterways.

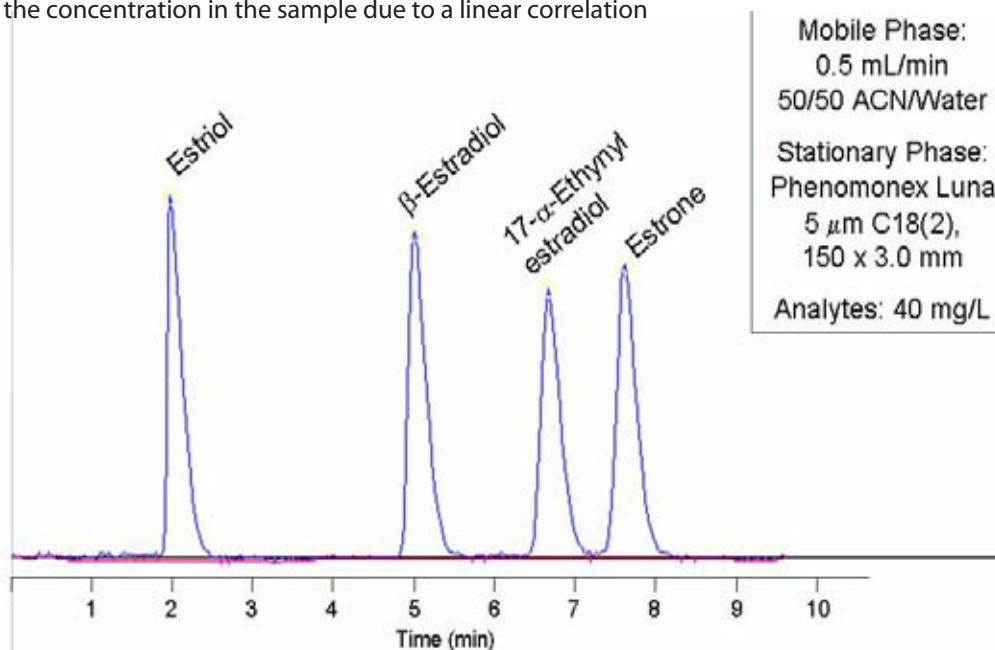


Figure 2. HPLC separation of a spiked blank sample containing estrogens extracted with an octadecyl SPE cartridge.

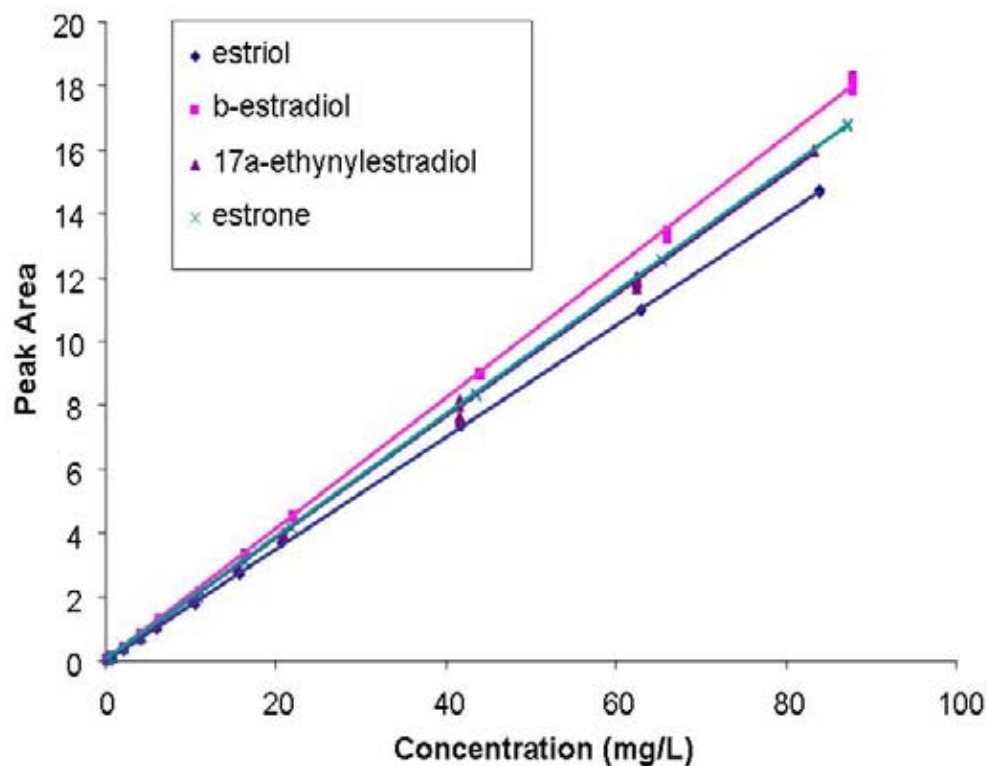


Figure 3. Estrogen Calibration Curve

RESULTS AND DISCUSSION

The EPA approved method of extraction of semi-volatile organics from water involves LLE; therefore, LLE was tested for its effectiveness in the extraction of estrogens. Since the estrogens are organic compounds, it is expected that they will shift into the organic phase during LLE. However, this was not the case due most likely to the high degree of polarity of the estrogens. When concentrated spiked samples were analyzed, no estrogens were detected. A single peak was measured in the chromatogram correlating solely to methylene chloride. Other solvents were examined as a possible replacement for methylene chloride. However, another suitable solvent was not found that met the 3 necessary criteria: not miscible with water, low boiling point, and polar enough to extract the estrogens.

As an EPA approved extraction technique, LLE is the first method of choice employed by environmental testing facilities. Due to the ineffectiveness of LLE for estrogen analysis, environmental testing facilities may be failing to detect the presence of estrogens in water. Therefore, alternative methods such as SPE must be examined.

The SPE methodology described above mirrors procedures in previously published studies (Koplin et. al. 2002; Lee et. al. 2005; Isobe et. al. 2003). As with the LLE study, the effectiveness of SPE is examined by spiking pure water with known amounts of estrogens to determine the extraction efficiency (i.e., are all of the estrogens extracted from the water). While there was an 80% extraction efficiency for the spiked water samples, the analysis of wastewater has proven more difficult.

An agreement was obtained from the Graham North Carolina Wastewater Treatment Facility to collect wastewater effluent samples (grab samples) from their effluent holding tank (post treatment, pre-release into the Haw River). Initial

analysis of the wastewater suggested no estrogens were present. Two possible explanations for this result are: 1) there are no estrogens present, or 2) there are matrix effects complicating the extraction method. In order to test the second possibility, samples consisting of wastewater effluent spiked with a known quantity of estrogens were analyzed. Because estrogens were placed in the effluent, detection peaks were expected to be observed with extraction efficiency similar to that obtained for the spiked pure water. However, other results were obtained.

Several different concentrations of estrogens were added to wastewater effluent and extracted using the methodology described above. The lower concentration matrix spikes ($< 10 \beta \text{ g/L}$ of each estrogen) resulted in no estrogens detected by the HPLC. The higher concentration samples ($40 \beta \text{ g/L}$) resulted in less than 50% recovery of the estrogens. The exact reason for the dramatic loss of recovery is currently under investigation. Preliminary results suggest that certain dissolved humic substances are capable of adsorbing the estrogens onto their surface. The current SPE methodology is incapable of extracting these bound estrogens due to the high polarity of the humic substances. This finding is particularly alarming due to the increased prevalence of employing SPE directly to wastewater samples. A complete picture of possible estrogen contamination in water must include analysis of the dissolved humic substances.

Furthermore, the humic substances are a predominant component of biosoil (sludge) created in the wastewater treatment process. This sludge is often used as fertilizer due to its high nutrient content. This possible adsorption of the estrogens to humic substances implies that the sludge used as fertilizer may contain a significant estrogen concentration as well.

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REFERENCES

- Environmental Protection Agency Endocrine Disruptors Research Initiative [Available from <http://www.gov/endocrine>].
- Fritz, J. S. 1999. *Analytical Solid-Phase Extraction*. New York: Wiley-VCH.
- Isobe, T.; Shiraishi, H.; Yasuda, M.; Shinoda, A.; Suzuki, H.; Morita, M. 2003. Determination of estrogens and their conjugates in water using solid-phase extraction followed by liquid chromatography tandem mass spectrometry. *Journal of Chromatography* 984: 195-202.
- Jobling, S.; Nolan, M.; Tyler, C. R.; Brighty, G.; Sumpter, J. P. 1998. Widespread sexual disruption in wild fish. *Environmental Science and Technology* 32: 2498-2506.
- Koplin, D. W., Furlong, E. T., Meyer, M. T., Zaugg, S. D., Barber, L. B., Buxton, H. T. 2002. Pharmaceuticals, hormones, and other organic wastewater contaminants in u.s. streams, 1999-2000: A national reconnaissance. *Environmental Science and Technology* 36: 1202-1211.
- Labadie, P.; Budzinski, H. 2005. Development of an analytical procedure for determination of selected estrogens and progestagens in water samples. *Analytical and Bioanalytical Chemistry* 381: 1199-1205.
- Lee, H.-B.; Peart, T. E.; Svoboda, M. L. 2005. Determination of endocrine disrupting phenols, acidic pharmaceuticals, and personal care products in sewage by solid phase extraction and gas chromatography-mass spectrometry. *Journal of Chromatography* 1094: 122-129.
- Petrovic, M.; Eljarrat, E.; Lopez de Alda, M. J.; Barcelo, D. 2004. Endocrine disrupting compounds and other emerging contaminants in the environment. *Analytical and Bioanalytical Chemistry* 378: 549-562.
- Richardson, S. D. 2003. Water analysis: Emerging contaminants and current issues. *Analytical Chemistry* 75: 2831-2857.
- Snyder, S. A.; Westerhoff, P.; Yoon, Y.; Sedlak, D. L. 2003. Pharmaceuticals, personal care products and endocrine disruptors in water; implications for the water industry. *Environmental Engineering Science* 20: 449-469.
- Sumpter, J. P. 2005. Endocrine disruptors in the aquatic environment: An overview. *Acta Hydrochimica et Hydrobiologica*, 33: 9-16.
- Takeuchi, T.; Tsutsumi, O.; Ikezaki, Y.; Takai, Y.; Taketani, Y. 2004. Positive relationship between androgen and endocrine disruptor, bisphenol a, in normal women and women with ovarian dysfunction. *Endocrine Journal* 51: 165-169.
- Zeleniuch-Jacquotte, A.; Toniolo, P.; Levitz, M.; Shore, R. E.; Koenig, K. L.; Banerjee, S.; Strax, P.; Pasternack, B. S. 1995. Endogenous estrogens and risk of breast cancer by estrogen receptor status: a prospective study in postmenopausal women. *Cancer Epidemiology, Biomarkers & Prevention* 4: 857-860.
- Zou, E.; Fingerhman, M. 1997. Synthetic estrogen agents do not interfere with sex differentiation but do inhibit molting of the cladoceran daphnia magna. *Bulletin of Environmental Contamination and Toxicology* 58: 596-602.

Camouflage and Survival: Life in the Galapagos Islands

By: Molly Pearson



Male Blue-Footed Boobie Protecting Egg

*North Seymour Island, Galapagos,
Ecuador*

The egg between the boobie's blue feet is well camouflaged by the surrounding rocks.

Sea Lion Pup

North Seymour Island, Galapagos, Ecuador

The round, smooth body shape of the sea lion pup resembles that of the rocks behind it.



Land Iguana

*North Seymour Island, Galapagos,
Ecuador*

The coloration and texture of the iguana's body provides it with camouflage against the dry, volcanic soil of the Island.



“In the struggle for survival, the fittest win out at the expense of their rivals because they succeed in adapting themselves best to their environment.” – *Charles Darwin*

Juvenile Sally Light-foot crab

Isla Baltra, Galapagos, Ecuador

The shiny, speckled surface of the juvenile sally light-foot crab shell closely resembles the wet volcanic rock upon which it sunbathes.



Marine Iguana basking on the rocks

North Seymour, Galapagos, Ecuador

The broken and charred volcanic rocks help the marine iguana to blend in with its surroundings as it regulates its body temperature using the sun's rays.

Molly Pearson is a junior, Environmental Studies and Political Science double major. She is a member of Pi Sigma Alpha, the national Political Science Honors Society. In her free time she tutors at risk Spanish-speaking high school students in civics, economics and US history. Molly is an avid SCUBA diver with a strong passion for sharks of all sizes and plans to pursue graduate work in marine management and shark conservation.

STRUGGLING TO SURVIVE

ENVIRONMENTAL SCARCITY AND VIOLENT CONFLICTS

By Ashley Leasure



On a muddy road in rural Brazil, elderly missionary Dorothy Stang ushered in the struggle for land rights and resource conservation. She faced the daunting task of defying powerful local businessmen in an effort to gain land rights for the impoverished, indigenous people. In February 2005, authorities discovered the seventy-three year old activist shot to death in a remote forested area. Prior to her death, Stang and a rancher engaged in an altercation over a portion of rain forest that she wanted to preserve for poor settlers and he wanted for logging. After several months of evidence gathering, Raifran Das Neves Sales was found guilty of Stang's brutal murder and is now serving twenty-seven years in Belem prison in Brazil. Authorities found Stang's case difficult to prove because this act of violence occurred far from the purview of authorities.

Clearly, protecting the environment can carry a high cost. Many environmentalists in the past few years have lost their lives in their quests to protect local resources. From the Brazilian rainforests to tropical areas of Southeast Asia, protectors of the environment in developing countries seem to be the most at risk. Environmental martyrs include Dorothy Stang, Phra Supoj Suvacano, and Charoen Wadaksorn. Each of these individuals died under dubious circumstances. In all cases, authorities suspect their deaths are tied directly to their work to preserve natural resources.

The threat to environmentalists is only one component associated with resource conflicts and violence. Internal conflicts over valuable resources can have far reaching effects on the global community. Consumerism far from the epicenter of these conflicts is often the driving force behind unsustainable resource extraction. Resource conflicts can inhibit the production of goods, affecting both consumers and producers around the world. Conflicts can also lead to large scale migrations and humanitarian crises which can, in turn, lead to massive relief efforts from the global community. It is also clear that localized resource conflicts can destabilize local governments and increase regional tensions. In sum,

resource conflicts—even those that are localized—should be considered global security problems.

The first hurdle towards action to address natural resource conflicts is to understand the complexity of variables that shape these conflicts. This article attempts to stress the importance of this field of research, to review many of the variables identified by political scholars that link environment and conflict, and to identify areas where additional research is necessary.

Background and Discussion of Key Terms

The basic theory linking environmental scarcity and violent conflict suggests that environmental scarcity affects various social stimuli and those social factors in turn affect the occurrence of violence (Homer-Dixon 1994). This section will explain all of the technical jargon necessary to understand these intricate theories. It will also provide context for the case studies later in the article.

In the context of this article *renewable resources* include cropland, freshwater, fishstocks, and timber; *nonrenewable resources* include natural gas, petroleum, minerals, ores, and tropical timber (regrowth in tropical timber takes centuries). There are both supply- and demand-induced changes that contribute to environmental scarcity; these comprise two of the problem's three dimensions.

Supply induced scarcities occur through the degradation and depletion of an environmental resource, thus affecting the amount of the resource left available (Percival 1998). *Demand-induced scarcities*, on the other hand, result from population growth within a region or increased per capita consumption of a resource; availability does not change, but the number of people who demand the resource increases. Another type of scarcity occurs not from the amount of the resource, but rather from the control over its use and access; *structural scarcities* arise from unequal social distributions of a resource, concentrated in a small number of individuals, while the remainder of the population is strained by their inability to obtain it. Increased environmental scarcity caused by one or more of these factors can have several consequences that may

lead to domestic armed conflict.

Along with the different types of scarcities, there are also other patterns of interaction that may influence the likelihood of domestic armed conflict. *Resource capture* occurs when increased consumption of a resource combines with its degradation. In the developing world, powerful groups within society commonly shift resource distribution in their favor, subjecting the remaining population to scarcity (Percival 1998). *Ecological marginalization* occurs when increased consumption of a resource combines with structural inequalities in distribution. This often causes environmental degradation and intractable poverty to become more and more closely intertwined in particular geographic areas with fragile environmental conditions. Ecological marginalization creates two types of people: those who live in remote and ecologically fragile areas and those who live on the outskirts of growing urban areas. This type of pattern occurs frequently when indigenous people lack land rights in their native villages. Many times ecological marginalization is a by-product of resource capture. When governments deny indigenous people access to the resource, they may be forced to leave the region and migrate to ecologically fragile regions that subsequently become degraded (Homer-Dixon 1994).

These basic resource scarcities do not typically cause interstate resource wars but under some conditions can result in intrastate conflict. The interaction among the three types of scarcities can reduce or constrain economic productivity, affecting both local and regional stability (Homer Dixon 1999). Affected populations may migrate to urban areas or other rural areas, which can trigger various types of conflicts by creating competition for basic resources and jobs. These types of conflicts may originate from relative deprivation; individuals perceive a gap between the level of satisfaction they have achieved and the level they believe they deserve. These grievances can escalate into *insurgencies* or violent challenges to the state. *Civil conflict* or armed confrontation between groups that are contesting political dominance may also arise (Gershenson 2000). Less common instances of violence include military coup d'états, where disgruntled elites may take control of a weakened state (Homer-Dixon 1994). Environmental scarcity can also at times cause rural banditry and gang violence—either organized or sporadic.

Similar conflicts can also occur when there is abundance of a single *non-renewable* resource (Renner 2002). Stricken with the “resource curse,” countries that lack economic diversity and depend heavily on revenue from a single resource are often susceptible to violent power struggles for control of the resource. According to Renner, almost a quarter of approximately fifty wars and armed conflicts in 2001 have a strong connection to resources; either legal or

illegal exploitation of resources may have catalyzed, worsened, or financed these conflicts. This resource wealth creates domestic conflict over resource control; although there is fighting over acquisition of the resource, other conflict also ensues. The fight for the abundant resource is actually a larger struggle for the control of the state itself.

Along with resource abundance, scarcities of *renewable* resources and patterns of resource use can also indirectly cause violence. Degradation of natural resources (supply-induced scarcities) and population growth (demand-induced scarcities) can affect migration patterns among people living in rural areas (Homer-Dixon 1999). Instances of scarcities and degradation of resources is further exacerbated through patterns of *reciprocal*

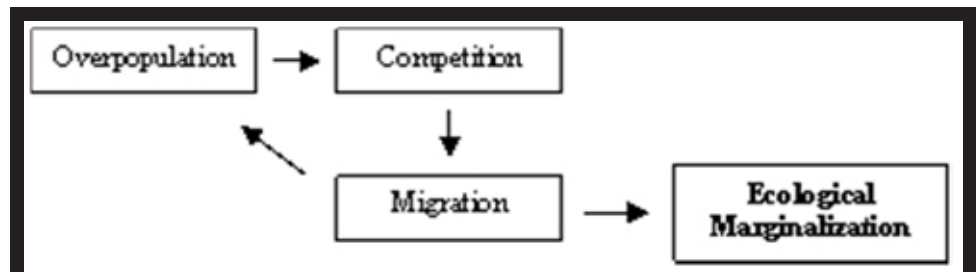


Figure 1: The arrows represent a cause and effect relationship. Overpopulation can lead to competition for resources and jobs, leading to migration, and subsequently ecological marginalization. There is also a feedback loop, where migration can also lead to further overpopulation of an area.

causation. Conflicts generated indirectly by resource scarcity cause increased degradation of these resources, which leads again to higher levels of conflict. In simpler terms, degradation of resources can cause violence; violence, subsequently, can cause further destruction of resources, perpetuating the problem.

It is important to note that scarcity is seldom the sole precipitating factor in resource conflicts. Typically resource scarcities and abundances, coupled with various social stimuli, cause instances of violence. The main social effects due to scarcities and degradation are constrained agricultural productivity, constrained economic productivity, migration of affected persons to either ecologically fragile regions or to ill-equipped urban centers, societal segmentations (ethnic clashes), and disruptions of institutions (Homer-Dixon 1999). Resource abundances such as the pillaging of oil, minerals, metals, gemstones, or timber subsidize wars initially caused by ideological struggles, ethnic clashes, or other external factors (Renner 2002).



Figure 2: Environmental degradation causes a change in various social indicators; these social factors, in turn, cause violent conflict

From Homer-Dixon's *Environmental Scarcity and Violence*

Scholars utilize both qualitative and quantitative studies to explain these theories. Several scholars focused their work on examining how these elements interact within a single case. Others took an aggregate approach, testing the statistical significance of environmental scarcity and social factors in a large number of cases.

Review of the Literature

The conversation about the environment and conflict only began in the past few decades, originating in the late 1970s. This work progressed gradually with academics slowly building upon the work of previous scholars. The early scholars in the field focused their efforts on determining a general link between the environment and security (North 1977). These first pioneers began a discussion surrounding the notion that there was a connection between domestic security and environmental issues (Ronnfeldt 1997). There were a myriad of scholars on each side of this debate, mostly arguing over technical jargon: In specific, the definition of “security”. A second wave of scholars realized little would be accomplished by quibbling over semantics and turned to validating these assertions through empirical and case-based studies (Gleditsch 1998).

One group from Toronto, Canada, headed by Thomas Homer-Dixon launched the movement toward studies utilizing specific cases. Homer-Dixon and the Toronto Group used qualitative data from case studies to explore the effects of environmental scarcity and conflict—a striking difference from prior work in the field. This case study approach is the most prominent in the field and yields highly interesting results. Case studies from the Toronto Group and others illustrate the utility of this approach to the study of this problem.

Learning From Case Studies

The African countries of Senegal and Mauritania provide an example of the connection between environmental degradation and structural scarcity. The two nations built several dams on the river between the nations to alleviate their drought problems. Before the completion of the infrastructure, elites gained control of the affected land, causing a civil conflict among the wealthy and the poor farmers (Homer-Dixon 1994). In this case government was able to maintain the status quo by acquiring the scarce resources and forcibly removing the native people from their land. At the root of the conflict was desertification, a type of environmental degradation that pushed nomadic Arab herders south towards sedentary black African farmers living on both banks of the Senegal River (Parker 1991). Subsistence living was no longer possible in these arid areas, so populations migrated to areas more suitable for habitation, an example of the resource pattern deemed ecological marginalization. A major irrigation scheme undertaken in response to water shortages increased interest in this part of the Sahel,

leading Mauritania to introduce land reforms which revealed two underlying tensions: the historic Arab-black African cultural division, and the struggle for the resources of this important river basin. Environmental scarcity pushed indigenous populations to already populated regions, aggravating ethnic tensions

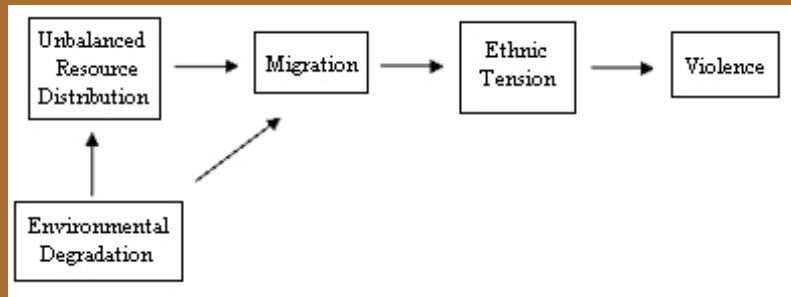


Figure 3: Environmental degradation and unbalanced resource distribution led to migration among the black populations. This migration in turn exacerbated previous ethnic tension among the Arab and Black populations leading to conflict among the two groups.

between the Arab and Black populations.

The Zapatista Rebellion in Mexico is another case study that illustrates the connections between environmental scarcity and violence. This resource conflict occurred over issues associated with indigenous populations’ claims to land, another instance of a structural scarcity (Homer-Dixon 1991). In Chiapas, Mexico, conflicts associated with resources arose mainly out of issues associated with property rights. This rebellion began as a conflict between land-poor peasants and politically connected elites. As the elites gained control of the land, the livelihood of the indigenous population was threatened. People, who had previously relied heavily on natural resources for subsistence living, revolted against the corruption of the elites and the government. One striking difference in this case is that the people were able to form a unified opposition to the status quo. In most other instances of resource scarcity and degradation, populations lack this capacity to organize.

It is important to keep in mind that the presence of environmental degradation or scarcity does not necessarily mean that social friction or violence will occur. In many cases, other variables must also be present. One variable that can link scarcity to conflict is the presence of long-standing ethnic conflicts. An example can be found in the West Bank, where ethnic conflict has been present for generations. In this case, the majority of the country’s water supply comes from aquifers located under the West Bank (Homer-Dixon 1994). Since water is a valuable asset, not only to support populations within the country but also for agricultural reasons, the Israeli government limits water use by both Israelis and Arab citizens in the West Bank. However, there is a remarkable difference among the two populations in regards to water usage. The Israeli government restricts the number of wells Arab settlers can drill, affecting the amount of water available for irrigation systems. This water control limits the number of agrarian job opportunities for Palestinians, forcing much of the population to relocate to urban areas. The link between the political unrest and the competition for urban employment, driven by unequal control of resources, is one of the many contexts in which conflict in this area is aggravated.

Other case studies focus on another form of environmental scarcity: demand-induced scarcity. Sendero Luminoso, Peru is a good example of this type of environmental scarcity. The natural population growth, lack of jobs, and unavailability of land caused an increase in population density in the southern highlands (Homer-Dixon 1999). There was an increase of three people per square kilometer from 1940 to 1980 and during this time cropland availability also dropped. These population densities began to exceed sustainable limits due to the ecological composition of the highlands, which consist of steep hills and thin, dry soil that plagues the region (Percival 1998). The fragility of the land and the population boom induced a decline in food production. Subsistence farmers experienced grave hardships, and family incomes dropped drastically. These people formed a sub-national insurgency to combat their economic hardship, and they were relatively successful since the highlands are far from government control.

Supply-induced scarcities are more common than their demand-induced counterparts; however, these types are also more difficult to connect to violent conflict. The Philippines provides an interesting example of the effects of environmental degradation and depletion on the occurrence of violent conflict (Homer-Dixon 1999). In this case, populations formed anti-government insurgencies to address the deprivation of landless agricultural workers and poor displaced farmers. Although there were several other contextual factors, such as non-existent property rights for the rural population, lack of governmental legitimacy, and a severe domestic debt, the reason urban people joined these insurgencies was largely due to the degradation of their land. These people wanted to acquire land rights only after groups such as the New People's Army and the National Democratic Front enticed them to demand as such.

The causal link between conflicts and non-renewable resource abundance is also apparent through case study analyses. One example is the case of diamond mining in Sierra Leone. Although some insist that the conflict centers upon ideological, tribal, or region differences, it is clear that the epicenter of the bloodshed is diamond mining (Homer Dixon 1999). In a quest for control of the diamond mining industry and subsequently for political control, various groups employed gruesome tactics, scaring many of the local people into submission. In March 1991, the primary subnational insurgency known as the Revolutionary United Front seized complete control of the diamond mines. This rebel group capitalized on the misfortunes of poor locals, acquiring members comprised of disaffected youth and those living in slums (Renner 2002). They also hired professional soldiers or mercenaries from other countries to help them maintain control of the mines. Throughout the 1990s, the country suffered from rebellion, banditry, and military coups.

Learning From Quantitative Single Variable Studies

Hague determined that land distribution, as well as the degradation of land, forest, and water, is linked not only to demographic patterns, but also to economic and political factors (Hague and Ellingsen 1998). Through his statistical study he found that countries suffering from these types of environmental degradation are more prone to civil conflict. Much of the empirical scholarship in the field focuses on the connection of the political regime and the quality of domestic environmental protection. Midlarsky, Payne, and Li and Reuveny also hypothesized that the type of political regime, or governing body, affects the environmental protection within the state. All three studies focused their research on democracy and environmental protection. Midlarsky found that previous studies have shown that as the degree of democracy increases, environmental protection should also increase (Midlarsky 1998). Li also found that democracies carry better environmental protection, especially in the areas of carbon dioxide emissions, nitrogen dioxide emissions, deforestation, land degradation, and organic pollutants in water. Based on past analyses of the Soviet Union, it was believed that democracy produced better environmental protection than communist and totalitarian regimes (Payne 1995). However, as Payne conducted further research, he found that his analysis disproved some of these previous theories regarding regime and environmental protection; the associations between the extent of democracy and environmental protection were mostly negative. Several empirical studies in the field support the notion that as democracy increases, the level of resource depletion and several social conflict factors increase (Midlarsky 1998; Payne 1995; Li 1999).

While case studies such as those discussed above are compelling, a weakness of the case study approach is that scholars are often looking for linkages between a single independent variable (environmental scarcity) and the dependent variable (environmental conflict) and can overlook stronger causal factors that shape the dependent variable. This weakness has shifted much of the research back to exploring variables that help us explain environmental scarcity and degradation. While the newer research has important insights to offer, the field appears to be moving away from looking at the connections between resource scarcity and violence at a time when environmental problems are worsening around the world, especially in areas of greatest vulnerability for violence.

Future Research

A vast array of theories exist explaining resource scarcity and the subsequent connection to violent conflict. However, many of these theorists note caveats pertaining to the level of understanding about the issue (Levy 1996; Gleditsch 1998). One of the major problems with attempting to make causal connections to resource degradation and violence lies in the complexity of the topic and the presence of incomplete or conflicting information. These issues tend to create discrepancies within various case studies and among the few quantitative studies conducted. Another challenge includes failure among scholars to link all the adequate factors among the plethora of problems. Most scholars in this field recognize the complexity of this topic; however, few studies encapsulate all of these issues into one concrete discussion. The problem lies largely in the schism between the environmental and political science communities. Due to the controversial nature of this subject and subsequently, the lack of large scale empirical studies, little research is conducted in the area of resource induced conflict; further research is necessary to support or challenge the qualitative studies.

One avenue for future research may be to determine the extent to which intervening variables such as governmental regime, decreased agricultural production, decreased economic activity, migration, and weakened states affect the instance of violence (Hague and Ellingsen 1998). Shifting methodologies towards empirically based studies as well as large scale studies that analyze a variety of variables across a

large number of cases may solidify the theories from qualitative studies. Determining the relationship between mitigating factors and environmental scarcities and abundances may also supplement the work of the previous scholars in the field.


Other approaches may include studies to flush out the impact of political factors on environmental scarcity and violence. Previous studies established the link between degradation of the environment and increased levels of domestic conflict; however, none have seriously examined the role of governing bodies in the feedback loops associated with environmental scarcity and degradation. Roger Payne and Manus Midlarsky found that there may also be a causal relationship between the type of regime and environmental degradation, but there is little empirical research to support claims of a further connection to violent conflict. Based on this lack of quantitative evidence, data-driven, quantitative studies are necessary to determine the extent to which the type of political regime affects environmental scarcity and civil conflict. Other studies should focus on the implications of resource scarcity and violence, determining prescriptions to combat the problem.

A Global Perspective

The importance of this type of research lies in the policy applications and prescriptions to combat resource scarcity. However, in order to solve many of these problems, it is imperative that we fully understand the problems. Suggesting quick fixes and policy band-aids are not adequate approaches in this field. A better strategy may be realizing the global implications for these kinds of problems and then making the first step towards creating feasible solutions.

These types of conflicts can create serious threats in the area of international security. Resource security, both on the local and international level is an important factor in the area of political or military control (Allenby 2000). Allenby argues that competition for scarce resources within certain countries may provide a security risk for a developed country such as the United States. As stated previously, the likelihood of interstate resource conflicts is unlikely, though the research in this field is still in its infancy.

Resource conflicts may be influenced by the future of global environmental issues. Implications of global climate change are still scientifically uncertain. However, some scholars believe that these changes may have serious consequences for countries already at risk for environmental scarcity and conflict (Fields 2005). Countries that already experience multiple stress factors such as the spread of HIV/AIDS, the effects of economic globalization, the privatization of resources, and armed conflict may experience the brunt of the ill effects of climate change (Fields 2005).

Some models project that global warming will provide increased precipitation to those areas that already get high levels of rainfall while those countries that get little, such as the dry subtropical zones, may get even less (Rowland 1996). Without adequate rainfall, problems such as drought, desertification, and decline in crop production could create severe renewable resource scarcities. These types of changes to the global environment may spark situations where these types of conflicts are common. Understanding these changes and their implications for international environmental issues may be the key to determining the future of resource conflict. 

Works Cited

- Allenby, Braden. 2000. Environmental Security: Concept and Implementation. *International Political Science Review* 21 (Jan): 5-21.
- Fields, Scott. 2005. Continental Divide: Why Africa's Climate Change Burden Is Greater. *Environmental Health Perspectives* 113 (Aug): A534-A537.
- Gershenson, Dmitriy and H. Grossman. 2000. Civil Conflict: Ended or Never Ending? *The Journal of Conflict Resolution* 44 (Dec): 808-822.
- Gleditsch, Nils Peter. 1998. Armed Conflict and the Environment: A Critique of the Literature. *Journal of Peace Research* 35 (1998): 381-400.
- Hauge, William and T. Ellingsen. 1998. Beyond Environmental Scarcity: Causal Pathways to Conflict. *Journal of Peace Research* 35 (May): 303.
- Homer-Dixon, Thomas. 1994. Environmental Scarcities and Violent Conflict: Evidence from Cases. *International Security* 19 (Summer): 5-40.
- Homer-Dixon, Thomas. 1999. *Environmental Scarcity and Violence* Princeton: Princeton University Press.
- Levy, Mark and T. Homer-Dixon. 1996. Environment and Security. *International Security* 20 (Winter): 189-198.
- Li, Quan and R. Reuveny. 2006. Democracy and Environmental Degradation. *International Studies Quarterly* 50 (Fall): 935-956.
- Midlarsky, Manus. 1998. Democracy and the Environment: An Empirical Analysis. *Journal of Peace Research* 35 (May): 341-361.
- North, Robert. 1977. Toward a Framework for the Analysis of Scarcity and Conflict. *International Studies Quarterly*, 21 (Dec): 569-591.
- Parker, Ron. 1991. The Senegal-Mauritania Conflict of 1989: A Fragile Equilibrium. *The Journal of Modern African Studies* 29 (Mar): 155-171.
- Payne, Roger. 1995. Freedom and the Environment. *Journal of Democracy* 6 (July): 41-55.
- Percival, Val and T. Homer-Dixon. 1998. Environmental Scarcity and Violent Conflict: The case of South Africa. *Journal of Peace Research*, 35 (May): 279-298.
- Renner, Michael. 2002. *The Anatomy of Resource Wars*. Washington D.C.: Worldwatch Institute.
- Ronnfeldt, Charles. 1997. Three Generations of Environment and Security Research. *Journal of Peace Research* 4 (Nov): 473-482.
- Rowlands, Ian. 1996. South Africa and Global Climate Change. *The Journal of Modern African Studies* 34 (Mar): 163-178.

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WETLANDS: Ecosystems Worth Saving

By Genevieve Romanello



“A thing is right only when it tends to preserve the integrity, stability and beauty of the community; and the community includes the soil, water, fauna and flora, as well as the people.”

-Aldo Leopold, A Sand County Almanac, 1949

Key Features of Wetlands

A wetland is essentially a middle ecosystem, called an ecotone, because it has characteristics of both terrestrial and aquatic environments but also other characteristics that are quite unique. It is the soil, plants, and microbial communities eccentric to wetland systems that interact to provide crucial ecosystem services for the planet. Erosion control, flood abatement and water filtration are all examples of ecosystem services provided by wetlands. Wetlands are also important because of the amount of productivity, specifically net primary production, which occurs within the system. This energy is important because it cycles through food webs and allows larger animals, including humans, to live (Purves et. al. 2001, 1043). Rainforests and coral reefs are considered to be the most productive systems on Earth. The amount of productivity that occurs in wetlands rivals comparison to both of these ecosystems (US Geological Survey 2003).

Conservation efforts to preserve rainforests and coral reefs are apparent, but wetlands have received much less recognition for their unique attributes and ecosystem services. This is partially due to disagreement between political and scientific communities about the definition of a “wetland”, but also due to the complications that arise when determining the value, either monetary or non-monetary, of preserving a particular wetland system. One of the main reasons that all wetlands are not legally protected from drainage and development is because it is often difficult to estimate the long-term economic consequences associated with wetland removal versus leaving a wetland area intact. In the short term, monetary gain may occur faster if wetlands are drained and the land is developed. However, the degradation of the ecosystem over time may have future costs in regard to flood abatement, erosion prevention and water quality.

Importance of Wetlands

Hydric soils (broadly: soils holding water) promote the growth of certain types of plants that are referred to as hydrophytes because of their ability to live in wetter environments. It is the hydrophytes and the unique microbes in the soil that cycle nutrients and organic matter within wetlands (Peterjohn and Correll 1984). Wetland vegetation assists with both erosion control and water quality improvement through nutrient filtration (Majumdar, Miller and Brenner 1988, 685). Nutrient filtration is one of the most important ecological benefits derived from the conservation and restoration of wetlands. Wetlands are especially important in addressing the problems associated with non-point source pollution such as water that runs off from impermeable surfaces, such as roads and buildings that often contains excessive levels of accumulated nitrogen, phosphorous, and other chemical residues from fertilizers and pesticides. Without filtration, excessive pesticide residues can increase the acidity of a watershed which, in turn, disrupts the metabolic processes of the organisms living within the watershed. If these organisms cannot acclimate then they may die and part of the food web may suffer. Nutrient run-off can result in eutrophication of water bodies, a process that encourages algal growth on the water's surface (called an algal bloom); this does not allow oxygen to reach lower water depths at night and causes fish and other organisms to die due to the lack of

Defining a Wetland

“What is a wetland?” A wetland can be further classified as a swamp, marsh, bog, fen, peatland, mire, moor, muskeg, bottomland, wet prairie, reedswamp, wet meadow, slough, pothole, or playa. Classifying wetlands is not an easy task, but determining whether a certain wetland should receive legal protection is also very difficult because the definition of ‘wetland’ changes depending on which organization (including governmental, non-profit, institutional, private, etc.) provides the definition. Following are a few definitions which demonstrate the confusion:

The “Circular 39” Wetland Definition by the U.S. Fish and Wildlife Service, 1956

“The term ‘wetlands’...refers to lowlands covered with shallow and sometimes temporary or intermittent waters. They are referred to by such names as marshes, swamps, bogs, wet meadows, potholes, sloughs, and river-overflow lands. Shallow lakes and ponds, usually with emergent vegetation as a conspicuous feature, are included in the definition, but the permanent waters of streams, reservoirs, and deep lakes are not included. Neither are water areas that are so temporary as to have little or no effect on the development of moist-soil vegetation.”

U.S. Fish and Wildlife Service Wetland Definition (Cowardin et al. definition, 1979)

“Wetlands are lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water...Wetlands must have one or more of the following attributes: (1) at least periodically, the land supports predominately hydrophytes, (2) the substrate is predominantly undrained hydric soil, and (3) the substrate is nonsoil and is saturated with water or covered by shallow water at some time during the growing season of each year.”

Section 404 Wetland Definition of the Clean Water Act Amendments, 1977

“For regulatory purposes under the Clean Water Act, the term wetlands means ‘those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas.’”

It is evident that the definitions above are broad and provoke debate. For example: Does a shallow pond really have functions similar to a marsh type wetland? How shallow must the pond be to function as a wetland? Must a wetland be continuously wet or can it dry out periodically? How small, in area, could a wetland be and still be considered a wetland? Is the bank of a deep pond with wetland vegetation considered a wetland? It is these questions, along with countless more, that stir debate among scientists and politicians—especially when the fate of a wetland is being determined.

oxygen. Algal blooms can also degrade human drinking water sources and have the potential to cause illness or death in severe cases (Olsen 1993, 685).

An overwhelming variety of wildlife utilizes wetlands as breeding and feeding grounds. In fact, wetlands are often referred to as nurseries for fish, shellfish, macro-invertebrates (like insects and crayfish), reptiles, amphibians, small mammals, and birds. Many species of birds and fish, for example, require these habitats during some part of their life. Removing wetlands removes habitats for these species, and this can have unfavorable economic consequences for recreational industries (like sport fishing and hunting) but also for industries such as commercial fisheries (Spray and McGlothlin 2004, 193).

There are a variety of economic benefits derived from conserving and restoring wetlands. Majumdar, Miller, and Brenner state that, "The economic value of the wetland is simply the maximum amount that individuals are both willing and able to pay to preserve this wetland in its natural state" (Majumdar, Miller and Brenner 1988, 685). Water treatment costs and

treatment plant maintenance decreases when wetlands are protected (Olsen 1993, 214). Preserved wetlands can decrease flooding frequency, thereby causing less flood damage to downstream development. Property values may increase if nutrients are filtered, flooding is abated, and wildlife habitats are preserved (McNaught, Rubek and Spalt 2003).

Non-consumptive values encompass aesthetics and recreation (Olsen 1993, 214). In 1981, the US Water Resources Council analyzed non-consumptive values of wetland and placed them in categories according to uniqueness and visual quality. Features unique to wetlands include endangered species, migratory birds, and plant species adapted to hydric soils. Visual quality includes topography, woodland types, appearance, and condition. Wetlands provide an opportunity for recreational activities such as trail riding, canoeing, fishing, camping, nature watches, and hunting (Lonard et. al. 1981, 35). Conservation and restoration of wetlands preserves the unique and visual characteristics of the land while improving water quality for future generations.

Presently, there is evidence suggesting that in addition to declines in wetland acreage, the quality of wetlands in the United States continues to decline.

A policy calling for a "no net loss" of wetlands began in 1988 under the George H.W. Bush Administration. Permits for drainage and filling of wetlands under Section 404 of the Clean Water Act are under many circumstances tied to a requirement

of wetland restoration or wetland creation after development in order to mitigate wetland losses (USFWS "Status and Trends"). Data, however, does not indicate that this policy has stopped declines in wetlands or adequately addressed the loss of wetland services. Many scientific studies have examined

soils, hydro-geologic features and plant composition in natural versus created wetlands and have found significant differences between the two systems. Created wetlands often do not function similarly to natural wetlands. Thus, scientists and other professionals are working to come up with better wetland mitigation plans to restore vital wetland functions (Brinson and Rheinhardt 1996; Zeder 1996; Cole et. al. 2001; Campbell et. al. 2002; Cole et. al. 2006).

The Status of United States Wetlands

The number and quality of wetlands in the United States continues to decline. In the 1660s there were 221 million acres of wetlands recorded (Dahl and Allord 1997). In 2004, there were 107.7 million acres of wetlands in the United States covering approximately 5.5% of the nation's surface area and most of this area consisted of freshwater wetlands (95%). Most of the wetland loss between 1998 and 2004 was due to urban development. The United States Fish and Wildlife Service (USFWS) creates a report every ten years to look at the status and trends of wetlands. Text box 2 details the acreage of wetlands lost and gained in the U.S. over the past fifty-four years.

It is important to note that the data in Text Box 2 for 1998-2004 includes ponds as freshwater wetlands. During the 1998-2004 time period, there was a 12.6% increase in freshwater pond acreage (the largest wetland type to increase), accounting for 700,000 acres. Freshwater ponds were not included for data associated with other years. When looking at the data on gains and losses, we should also be looking at wetland quality.

1950-1970: 458,000 acres of wetlands lost per year
1970-1980: 290,000 acres of wetlands lost per year
1986-1997: 58,500 acres of wetlands lost per year
1998-2004: Net gain of 32,000 wetland acreage per year

Source: United States Fish and Wildlife Service and United States Department of the Interior, "Status and Trends of Wetlands in the Conterminous US 1998-2004," www.fws.gov [Accessed 2/27/2007].

Decline in North Carolina Wetlands

There were originally 11.1 million acres of wetlands in North Carolina. Today, there are only about 5.7 million remaining acres of wetlands in this state. This is a 49% wetland loss over the last 200 years (Associated State Wetland Managers). In addition, in 1994 the USFWS Report titled "Southeast Wetlands: Status and Trends, Mid- 1970s to Mid- 1980s" stated that "freshwater, forested wetlands declined by 3.1 million acres in the southeast region (Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina & Tennessee). An estimated 38.8% (1.2 million acres) of this loss occurred in North Carolina" (North Carolina Wildlife Resources). Both public and private wetland restoration projects are underway in North Carolina, but the total number of returned or recovered wetlands is not known, due perhaps in part to voluntary registration for wetland restoration projects. Interestingly, the latest economic value for the remaining wetlands in North Carolina as a whole has been set at \$33.9 billion (Clean Water Network 2004). What follows is a discussion of wetland research in North Carolina.

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PLANT-WATER RELATIONS IN A FRESHWATER *JUNCUS EFFUSUS* MARSH AND THE CONSEQUENCES OF SUMMER DROUGHT IN OVERALL PLANT-WATER STRESS AND BIOMASS

Genevieve A. Romanello and Dr. Brant W. Touchette

INTRODUCTION

The “no net loss” of wetlands policy created in 1988 led to the creation of many wetlands that have different hydrological characteristics from natural wetlands. Natural wetlands may actually be dry during certain times of the year based on the surrounding climate and the location (i.e. proximity to groundwater sources and surface water sources). Created, or man-made, wetlands are often wetter than natural wetlands due to an increase in the number of flood events per unit time, longer duration of each flood and longer periods of sustained high water levels. Water availabilities are highly important for all plants because they affect plant physiology, that is, the way a plant grows and survives. Wetland plants are subject to varying environmental conditions that can alter their physiology, and consequently the productivity of the entire wetland ecosystem. As the number and quality of wetlands continue to decrease in North Carolina and the United States, it becomes critical that ecologists understand the relationship between environmental conditions and wetland vegetation.

While in the field, one notices that some plant species are prevalent in some wetland ecosystems but not in others and that some plant species are only present within a certain zone or area of a particular wetland system. This observation provoked the question: “How do plants respond to varying water availabilities within a wetland?” To better understand this concept we developed a study on a common wetland plant species, *Juncus effusus* to determine how its growth is affected by varying water availabilities. This research examined plant-water relations in a North Carolina freshwater *Juncus effusus* marsh and the consequences of summer drought in overall plant water stress and biomass by considering seasonal changes in plant-water relations (as indicated by relative water content and leaf water potentials) as influenced by environmental temperature (air, water, soil, and plant), humidity, wind, and soil-water availability. In this study, fifteen plants were monitored biweekly along transects from low marsh (consisting of emergent *J. effusus*) to high marsh (more terrestrial, well above the mean water table).

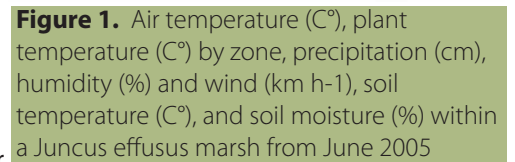
METHODS

The *Juncus effusus* marsh was located in the Piedmont of North Carolina about one kilometer northeast of the Elon University campus. The area was chosen due to the presence of *Juncus effusus*, a common wetland rush growing along a soil gradient ranging of emerged (low marsh), middle marsh, and high marsh (approximately one meter above surface water elevations). Fifteen plants, five from each zone (low-, middle-, and high-marsh) were used to determine biweekly plant-water relations as influenced by environmental conditions (e.g., humidity, wind, temperature, soil moisture). Soil moisture content was



determined by differences in wet and dry weights for soil plugs. Relative water content (RWC) was used to examine the water content of leaf tissue and determined by comparing fresh, turgid, and dry leaf weights, as described in the following equation: $RWC = (W_f - W_d) / (W_t - W_d)$ where W_f was the fresh weight recorded during collection, W_t was the turgid weight after plants were placed in closed test-tubes containing water for forty-eight hours to allow the leaf tissue to soak up as much water as possible, and W_d was the oven dry weight (70°C, until constant weight). Every three months the numbers of leaves for each plant were counted in the field to estimate aboveground phytomass, or biomass. To achieve this, ten leaves from each plant were measured for length and dry weight. These values were then used to conduct nondestructive biomass estimations by counting the total number of leaves and the mean leaf length. Leaf water potentials (Ψ_{leaf}) were measured using a Sholander pressure chamber (Model No. 1000, PMS Instruments, Albany, OR) to determine the amount of pressure required for the plant to pull water from the soil up through the plant. Negative pressure actually pulls water up through the plant and thus the more negative the pressure, the harder to plant is working to obtain water. Greater leaf water potentials, for example, are often noted in plants that are water stressed (due to lack of water), and are represented by more negative values measured from the Sholander pressure chamber.

As expected, overall temperatures (air, soil, and plant) were greater during summer months, and plant and soil temperatures were significantly greater in middle- and high-marsh zones, in comparison to emerged conditions (i.e., low marsh) during this period. Monthly precipitation was the highest around July and August and again in December and January. The increased winter precipitation may have escalated evapotranspiration (water lost through the leaves) as reflected by significant decreases in plant temperature in high-marsh and middle-marsh zones, relative to low-marsh. Soil moisture content significantly decreased in high- and middle-marsh zones during the summer due to a decrease in the amount of precipitation and an increase in temperature-associated evaporation. Generally, seasonal changes and fluctuating environmental conditions affected relative water content (RWC). Significant changes in RWC were exhibited in *J. effusus* over the study period ($p < 0.001$). However, there was not a significant difference in RWC between the three zones ($p = 0.19$). During dry, summer months leaf water potentials (Ψ_{leaf}) were greater for middle- and high-marsh plants. Significant differences were also observed between Ψ_{leaf} and the three *J. effusus* zones over the entire study period ($p < 0.001$). *J. effusus* leaf length, green leaves per plant, and phytomass were significantly higher in the low marsh



zone than in either middle- or high-marsh zones for spring, summer, and autumn. The mean leaf length, green leaves per plant and phytomass were generally less for middle- and high-marsh plants when compared to low marsh plants. Significant declines in Ψ_{leaf} corresponded with increases in RWC for both middle- and high-marsh plants, with the exception of lower marsh plants where Ψ_{leaf} typically decreased as soil moisture content increased. Significant differences between Ψ_{leaf} and soil moisture content for middle- and high-marsh plants were also evident. No significant relationship was observed in lower-marsh/ emergent plants with respect to Ψ_{leaf} , RWC and soil moisture levels. Lower Ψ_{leaf} water potentials were most likely evident in low-marsh plants because of constant water availability.

In general, during a warm-dry summer period, plants within the mid- and high-marsh positions experienced elevated water stress (as indicated by high leaf water potentials and decreased plant biomass), in comparison to low-marsh plants. This water-stress was due to appreciable declines in soil-water content, which was associated with an ongoing drought within the central Piedmont of North Carolina. As temperatures decreased

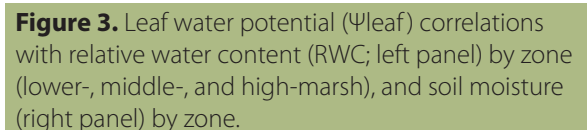
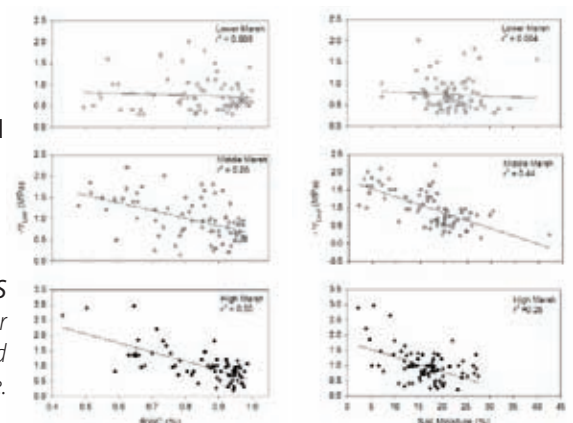


Figure 3. Leaf water potential (Ψ_{leaf}) correlations with relative water content (RWC; left panel) by zone (lower-, middle-, and high-marsh), and soil moisture (right panel) by zone.

Figure 2. Plant-waterrelations (left panel) including relative water content (RWC) and leaf water potential (Ψ_{leaf}) over the study period. Seasonal plant morphological data (right panel) including mean leaf length, number of green leaves per plant, and green biomass per plant.

and precipitation increased in autumn and winter, water stress conditions lessened. However, plant standing biomass remained markedly lower in the plants that experienced summer water shortages. Lower biomass likely represents diminished plant productivity as a consequence of low water availability, and possibly reflects an overall decrease in whole system productivity. This is one of the first studies that demonstrate both increased water-stress and decreased vegetative productivity in a freshwater wetland as a direct consequence of an extended summer drought.

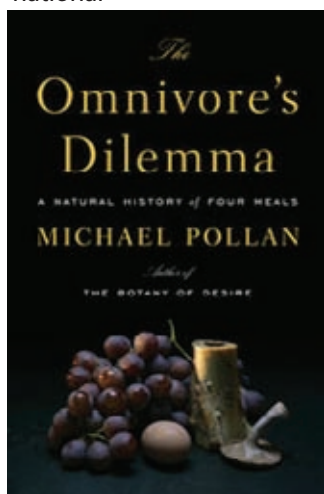


I would like to thank the Elon University Center for Environmental Studies for providing the facilities, materials, and support to complete this research. I would also like to thank A. Frank for field assistance.

Health and Food

Pollan, Michael. *The Omnivore's Dilemma: A Natural History of Four Meals*. New York: Penguin Press, 2006.

The Omnivore's Dilemma is about what Michael Pollan describes as our "national eating disorder." This book presents an intriguing concept -- Americans are obsessed with losing weight, being "healthy," and diet fads. However, we still have more health problems related to what we choose to eat than people living in other countries. Pollan compares the United States to other countries -- where eating choices are often based on pleasure and tradition -- and notes that even though many other countries have unhealthy eating practices,



their people appear to be healthier and happier than us.

Pollan describes our ecological history, including our reliance on corn and corn derivatives in our foods. He also discusses feedlots, processed foods and "big organic". Pollan notes that with our shift from pastoral farming to industrial farming we have lost integral connections to our food and, consequently, our enjoyment and appreciation of our meals. Pollan captures what we have forgotten about our food by sprinkling his own personal experiences into his discussion. He writes with a sense of humor and personal conviction that encourages the reader to examine our own connections to food.

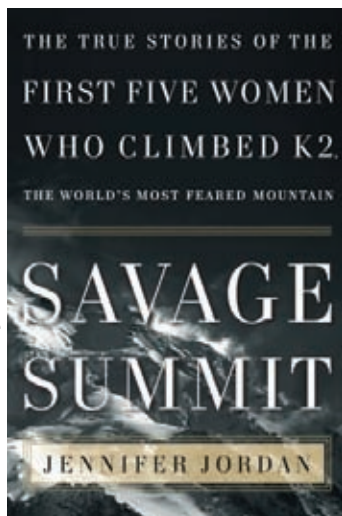
After reading this book you may just find yourself purchasing entirely different foods, seeking local producers, or paying more attention to the ingredients in your meals. *The Omnivore's Dilemma* is ultimately about what we choose to eat (or not eat), as omnivores and the consequences our choices have on the integrity and tradition of our food.

"...We have lost integral connections to our food and, consequently, our enjoyment and appreciation of our meals"

Adventure

Jordan, Jennifer. *Savage Summit: The True Stories of the First Five Women Who Climbed K2, The World's Most Feared Mountain*. New York: William Morrow, 2005.

If you have never set foot on the top of a glacier-covered peak where the temperatures are well below freezing and the air is so thin that even the most well-conditioned athlete knows nature controls their destiny, the allure of high altitude mountaineering may seem dizzyingly irrational. Yet, high altitude mountaineering is one of the fastest growing eco-tourism sports today. Peaks such as Everest, once thought to be conquerable only by an elite few, now has steady streams of climbers making their way to the summit each year.



Jennifer Jordan's book, *Savage Summit*, is a series of accounts about the women who have made it to the top of the world's second highest and most dangerous mountain, K2. Located in the Karakoram Mountain range between China and Pakistan, K2's death toll far exceeds the percentage of deaths per summit attempt of any mountain in the world. By 1998, only five women total had ever made it to the top. More notably, by the end of this same year, all of the women who had reached the summit of K2 had either died on this dangerous mountain or on another.

Jordan's book shares the lives of five courageous, complex women that climbed K2 and left their mark on the modern mountaineering world. Jordan writes about each woman with honesty and empathy, acknowledging their personal strengths and weaknesses while developing a page-turning book about the dangers associated with high altitude climbing. If you ever wondered why some people risk their lives to climb mountains, or would like to understand more about women that break barriers and challenge stereotypes, you should read this book.

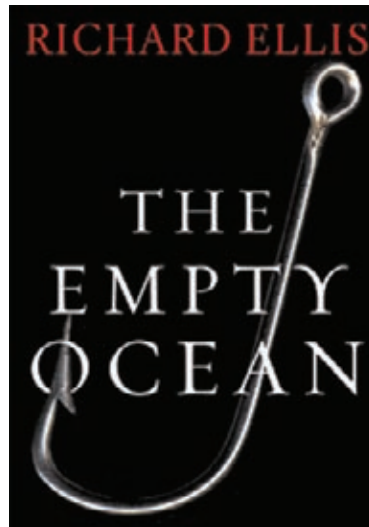
book recommendations

Non-Fiction

Ellis, Richard. *The Empty Ocean*. Washington DC: Shearwater Books, 2003.

The Empty Ocean discusses the impact that humans have had on the world's oceans. In his book, Richard Ellis describes humans as a destructive force that has gradually reduced marine biodiversity, obliterated marine habitats, driven species to extinction and critically endangered others. However, The Empty Ocean differs from other apocalyptic ecology books because Ellis employs the use of imagery-rich narrative to recount human-ocean predation from a historical view. In his book, he discusses a cornucopia of animals ranging from the familiar bottle-nosed dolphin to the lesser-known Patagonian Toothfish. The travels of Ellis' book range from the frigid North Atlantic—a mysterious habitat complete with deep-dwelling creatures that exist nowhere else on earth—to the tropical waters surrounding New Zealand.

Ellis' stories provide deep insight into human abuse and overuse of ocean resources. He also catalogs the impact of torturous fishing techniques, which occur all over the world: Ellis cites the use of gill nets, which can unintentionally



drown marine life, as one of the factors that has driven several species of sea turtles to critical endangerment. The Empty Ocean is chock-full of both historical and scientific evidence that supports Ellis's claims.

Ellis urges individuals and governments alike to reevaluate their impact on the world's oceans, warning that continued increases in human population without profound changes in our outlook on ocean stewardship will likely exacerbate damages which are already severe. The Empty Ocean is set apart from typical ecological sagas because Ellis offers numerous alternatives to modern-day practices. The world's amazing oceanic ecosystems, when given the opportunity to rebound, will often exhibit success. Throughout the book Ellis interjects such stories of success, including the

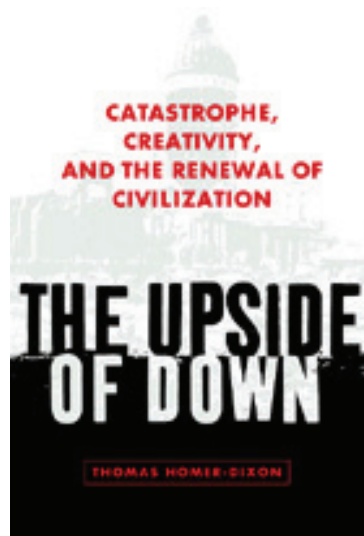
rebound of the sea urchin in Jamaica and the recovery of southern elephant seal populations. This book, which is further enhanced by Ellis' own illustration of some of the oceans most awe-inspiring creatures, is a must read for any ocean lover or seafood connoisseur.

“The world's amazing oceanic ecosystems, when given the opportunity to rebound, will often exhibit success”

Academic

Homer-Dixon, Thomas. *The Upside of Down: Catastrophe, Creativity and the Renewal of Civilization*. Washington DC: Island Press, 2006.

In the Upside of Down, Homer-Dixon uses anecdotal examples to explain the earth's major troubles, illustrating complicated academic research in simpler terms. He compares the energy crisis of the Roman Empire to the energy problems the world faces today. He devotes an entire section to determining the amount of calories Romans spent building their great monuments, explaining that growth of a civilization requires innovation within the realm of energy consumption. When sources of energy become exhausted, locating and acquiring more energy becomes essential. The Romans warred with neighboring countries to secure other sources of energy, creating lifelines of energy from distant places. Americans also thrive on foreign energy, and as low energy output jeopardizes US global dominance, conflict with other power-hungry nations may ensue. However, as severe as



these problems are, the human species has the capacity for adaptation. The fall of Roman civilization may have spawned from a series of stresses such as energy scarcity, environmental damage, climate change, and economic inequality. It remains difficult for people to accept these separate stresses as threats to society until there is a sudden catastrophe. However, evidence of these stresses may exist in the form of “social earthquakes”: in other words, cases where countries or regions are unable to cope with the strain. Homer-Dixon suggests that these “earthquakes” should be taken seriously. Although the problems plaguing the world are severe, humanity is now better equipped to handle these threats; Homer-Dixon believes that the new knowledge our society holds can save us—and the world—from the Romans' fate.



IF I COULD CHANGE THE WORLD

IT TAKES A VILLAGE TO GROW AN APPLE

An Essay By Breanna Detwiler

My environmental vision for the future lies in the promise of an apple. One day I foresee everyone considering the life and spirit of an apple before hastily dropping it into a shopping bag; considering the farmer, the workers, the travel placing this apple in our hands—we will consider Earth. Remembering to consider the apple's particular journey, its particular farmer, its particular worker, and the particular treatment of the earth from which it sprung; appreciate this apple for what it is (for it deserves it!). Taking these things into consideration, we will not accept an apple with poor history. It will not be the appearance of the apple that we are concerned with but its history. We will no longer accept the unappreciated farmer scraping to get by. We will no longer accept the migrant worker living in deplorable conditions. We will no longer stand idly by and let the Earth be robbed of her nutrients and pumped full of harmful pesticides.

On this day in the future we will understand the importance of the farmer, the worker, the Earth, so as not to devalue our sweet, green apple. In fact, we will be so rejuvenated as to go beyond the current organic enthusiasm to a more complete understanding of what a "whole" food is. We will fully appreciate what we fuel our bodies with and, in so doing, make ourselves and our Earth a better place. This will not be an easy journey. It will require careful reevaluation of how precious our food truly is. In the future, we will have to value our food for the service it provides us and for what it has overcome.

In the future, when our food reflects its true value, an apple drenched in pesticides and harvested by workers who have been denied their rights will be much more costly than an apple grown and harvested with care and love in an environment where it, as well as those who helped it survive, thrived. To do this, we must go local. This vision of the future allows us the opportunity to get to know our neighbors again, to work and share in our community through local gardens. Perhaps this

suggestion for the future gives us the blessing of community discussion and problem solving. Wouldn't it be great to be given the chance to teach our children beyond the classroom? To show them what it means to invest in another living thing, whether it is an onion, the kid next door, or even a hungry rabbit, and in doing so, invest in their own selves.

It was not so long ago that communities played a major role in all our lives, that in them we found comfort and guidance. But as we have moved away from an agrarian society we have lost the benefits of deep community, the kind that exists beyond the shared name of a housing development. In the future, we will return to deep community because we will be invested in the spirit of our food and therefore the environment in which it is grown. And in understanding that it takes a village to grow an apple we will seek the support of those around us and, in turn, support them as well.

In community we will find comfort and bring more meaning into our lives in a circle of reliance. Our communities will create strong support structures for all those who stand apart. Our communities will help fight loneliness, devastation, and hunger. Many people today cannot afford quality food day-to-day and are often nutritionally deficient. Many diets lack fresh produce and are saturated in the trans-fats and preservatives that come along with frozen items. But in the future with local food, malnutrition will cease and cost will be no barrier because people will place value in their food production and, accordingly, place value in their community, helping those who need it in solidarity -- not in charity. This will arise from the spirit of the apple, knowledge of the hardships it endured, and understanding we all struggle at times.

I put my hope for the future on the importance of this apple and the values deep community will bring to our lives. 🍏

About The Author

Breanna Detwiler is a sophomore honors student at Elon University. She is a member of the Campus Climate Challenge, College Democrats and the Phi Eta Sigma honor society. Breanna is also the Garden Manager of the Elon Community Garden.

WHO'S COUNTING?

PETROLEUM CONSUMPTION



1 BARREL OF OIL

42 TOTAL GALLONS

19.6	gallons of gasoline
10	gallons of diesel fuel and heating oil
4	gallons of jet fuel
1.7	gallons of heavy fuel oil
1.7	gallons of liquefied petroleum gas
7.6	gallons of other products

After refinement, one barrel of crude oil yields approximately 44.6 gallons of petroleum products. The increase of volume, also known as process gain, is similar to the phenomenon of making popcorn.

THE WORLD

Top five countries or regions that produced the most crude oil in 2005

Persian Gulf Nations	21,501,000 barrels/day
Russia	9,043,000 barrels/day
United States	5,178,000 barrels/day
China	3,609,000 barrels/day
Mexico	3,334,000 barrels/day

Top five countries or regions that consumed the most crude oil in 2005

United States	20,800,000 barrels/day
China	6,770,000 barrels/day
Japan	5,350,000 barrels/day
Russia	2,780,000 barrels/day
Germany	2,620,000 barrels/day

Total World Consumption	84,538,000 barrels/day
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THE UNITED STATES

U.S. population, 2005 estimate	296+ million people
Passenger vehicles registered in 2005	136+ million vehicles
Average miles traveled per vehicle per year in 2005	12,400 miles
Average fuel consumed per vehicle per year in 2005	541 gallons
U.S. citizen/legal resident average consumption per year	1077 gallons
U.S. citizen/legal resident average consumption per day	2.95 gallons

Sources:

Bureau of Transportation Statistics. (2007, September 4). Retrieved from BTS Research and Innovative Technology Administration: <http://www.bts.gov/>
Energy Information Administration. (n.d.). Retrieved from EIA Annual Energy Review: <http://www.eia.doe.gov/>



Visions Magazine is produced in conjunction with the Elon Center for Environmental Studies and Elon University's Environmental Studies Program.

The Elon Center for Environmental Studies provides opportunities for students and faculty to work with outside partners on projects focused on environmental education and stewardship. The Center seeks to strengthen the professional development of Elon students as well as promote environmental stewardship, educate the public and private sectors on environmental issues, and create partnerships in expertise for research and consulting. The Center also provides a forum for discussion of local and regional issues and serves as a clearinghouse for environmentally related information.

The Elon University Environmental Studies Program offers both a B.A. and B.S. degree in Environmental Studies, blending scientific foundations with an appreciation of society's needs and concerns. Students enrolled in the Environmental Studies Program take a balanced, interdisciplinary core of classes grounded in ecological understanding. The program's strength comes from an emphasis placed on considering the environment from many perspectives.