Leaf Litter
Summer Solstice 2011 Restore the Earth and Inspire Ecological Stewardship www.biohabitats.com
Vol. IX Edition 2

Thoughts on Water Conservation and Ecology

You don't have to be an ecologist to understand that without water, there'd not only be no biodiversity, there'd be no life. Yet even the U.S. Senate admits (in a February, 2011 report related to water scarcity) that the need for this fundamental, finite resource is "often one of the most overlooked aspects of our daily lives."

According to this same report, global water use has been growing at a rate more than double that of the world population in the last century. Today, more than a billion people worldwide live without clean drinking water. What about Earth's plants, animals, and other living things? How does water scarcity impact ecosystem integrity? What is being done to study and address the ecological impacts of poor water management?

Join us as we go beneath the surface of water conservation and explore its relationship to the fields of ecological restoration, conservation planning and regenerative design.

For some global perspective and a tall drink of inspiration, we chat with world-renowned author, activist, physicist, philosopher and feminist Dr. Vandana Shiva.

We also share the insight of an ecological design and engineering pioneer, Dr. John Todd.

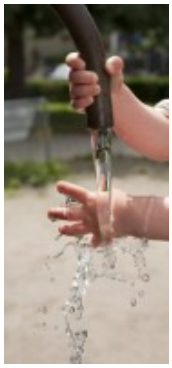
With the demand for water and the increasing instability of our planet's climate, the need for sustainable solutions to preserve ecosystems and support biodiversity through innovative water conservation and management has never been more critical. Recognizing this, Biohabitats recently acquired the visionary water resources firm, Natural Systems International (NSI). We're delighted to introduce you to these incredibly talented folks and show you how they are integrating ecology and water related infrastructure by highlight some of their recent projects. NSI's founder, Michael Ogden, shares a personal and international perspective on wastewater/water issues and the associated environmental impacts of international trade.

From the seat of an airplane window, ecological landscape designer Jennifer Dowdell muses about the role of water in landscape ecology and provides a bucketful of water-related facts and figures in the form

of a "Water Index."

For those who want to learn more about water conservation and ecology, we provide loads of links and resources.

What are YOUR thoughts about water conservation as it relates to ecology? Share them on our Rhizome blog, or email us about being a guest blogger!



Leaf Litter Talks With Dr. Vandana Shiva

Vandana Shiva is the founder of the Research Foundation for Science Technology and Ecology, an independent public industry research group, and Navdanya, a grassroots conservation movement in India. She received her doctorate in physics from the University of Western Ontario, but when it comes to defining what she does, an entire collection of labels is required: activist, philosopher of science, ecological advisor, teacher, eco-feminist, science policy advocate, author, and organic farmer.

For several decades, Dr. Shiva has fought all over the world for biodiversity and for the rights of all people to food and water. She has received numerous awards, including the1993 Right Livelihood Award (also known as the Alternative Nobel Prize), the Global 500 Award of the United Nations Environment Programme and the Earth Day International Award of the United Nations. Our own Ryan Case was fortunate enough to have worked with Dr. Shiva in India. Ryan recently caught up with her to discuss the future of water and life on our planet.

Within the complex subject of climate change, most people tend to focus on the effects of greenhouse gas emissions. In what major ways is humanity's management of our freshwater resources affecting the Earth's climate both on local scales and globally?

The activities that intensify fossil fuel use, by and large, also intensify water use. Industrial agriculture is a very good example. Industrial agriculture uses ten times more water than equivalent ecological farming systems. As a result, we not only get the emissions of greenhouse gases from the fossil fuel use, but also the desertification of soils and the destruction of the ability of soils to both mitigate and adapt to climate change.

Farms that are chemically fertilized-and chemical fertilizers also come from fossil fuels-are farms that have absolutely no water holding capacity.

Without that water holding capacity, if you are hit with a drought, you have no ability to survive it; if you are hit by a flood, the flood intensity is higher. So water use and climate impact are very intimately linked.

In addition, there are only two sources of water for intensive irrigation: one is making large dams, and the second is draining aquifers. Large dams are increasingly being recognized as major sources of greenhouse gas emissions because they stagnate the water. They create algal blooms in the stagnant reservoir and I've seen this happen with the dam on the Ganges, the Tehri Dam, where fresh blue water is now a stagnant, rotting, stinking green pool.

Over 60% of the world's wetlands have been destroyed in the last hundred years. Considering the critical role they play in the hydrologic cycle, what strategies do you think might help us to preserve our remaining wetlands and to restore the ecological function lost by the vast destruction?

The most important thing is that wetlands are destroyed either by urban sprawl, infrastructure, or by expansion of industrial agriculture. Industrial agriculture is not able to deal either with soils that have too much moisture or soils that have too little moisture. It deals with a very, very narrow niche as opposed to ecological farming. For example, we have wetlands in India where in one season you can cultivate shrimp and in the next season you cultivate rice and the wetland is a food producing system but you also conserve it as a wetland. So the first step we need to take to protect ecological functions of wetlands is to stop the encroachment. This must be treated as a crime. It is, by and large, illegal in most countries because there is a wetlands convention, but it hasn't been stopped and won't stop until people realize that a wetland is vital to our water security and our ecological security.

The second most important thing that needs to be done is to recognize the indigenous, traditional uses of the wetlands which combine conservation and production, so that you don't destroy wetlands or treat them as wastelands. We need to create new wetlands, create new areas for storage of water, and try as best as we can-even though we can't be as smart as nature-to increase wetlands wherever possible through human intervention.

In North America and Europe, ecological restoration is gaining more value in the eyes of the public and in the marketplace. How do you see the restoration of the earth happening in places where the environmental degradation is perhaps far worse and where there may not be the money or the local expertise for it to happen there in the same way?

Well, there are two kinds of expertise. One is the form of professional expertise, but in my experience of forty years as an ecological activist, I have found that local expertise is very, very sophisticated.

No one knows local ecosystems better than indigenous communities, people who have lived there for millennium. Therefore, what I would suggest in countries where the public resources aren't huge is first not allowing the destruction of vulnerable and fragile ecosystems. That's where it becomes extremely important that people start movements in parts of the country to protect the natural resources. Where the ecosystems have been degraded, rehabilitate them through community

participation. The minute the community is involved, communities contribute and you need less external resources. You can either leave everything to capital and financial inputs or you can have large participation of community with a slight intervention of financial inputs that are necessary to do certain pieces of work.

With all of the traveling you do, I believe you must have a good pulse on humanity's ability to adapt in situations of water scarcity. Can you give two examples of the most impressive adaptations you have encountered, one in a natural situation of scarcity and one in an anthropogenic condition?

In the natural example of scarcity, I can tell you it is the ability of the people of Rajasthan to live in a desert and yet create one of most sophisticated cultures and some of the best agriculture we know through conserving rain. They get very little rain-less than four inches-but when they get it and where they get it, they conserve every drop in systems of conservation that absolutely blow my mind.

Navdanya, the Research Foundation for Science, Technology, and Ecology I head, has translated an amazing book, written in Hindi by Anupam Mishra, called the Radiant Raindrops of Rajasthan, in which we basically say in Rajasthan, a desert, 'people convert their sweat into water, into fresh water for maintaining not just a life, but a sophisticated and good life.'

Biohabitats senior engineering technician (and Leaf Litter journalist for this interview) Ryan Case helped teach a Navdanya course on low-tech wastewater treatment to farmers in India's Utter Pradesh region.

In terms of adaptation to water scarcity as a result of climate instability, a wonderful example is the regions and communities who have saved seeds with us through Navdanya.

Navdanya means 'nine seeds.' Two years ago we had one of the most severe droughts in India. These communities have saved seeds of millets, which use only 250mm of rainfall compared to the 2500 needed for growing a Green Revolution (rice) paddy. So the rain had been reduced by 70% by the drought, but the water demand for the crop they were growing had reduced to 1/10 and they could have a wonderful crop. In the process, they realized that these old seeds that were called primitive are actually seeds for the future.

Navdanya's demonstration farm features a field interplanted traditionally with nine different grain crops.

You have invested much of your time and energy in defending the rights of the poor and the planet from the corporate exploitation of water resources. There is no doubt that when there is huge profit potential and regulations are lacking, or governments corrupt, profits are being put first and the basic, vital needs of people and planet second. What do you see as being the most effective way to reconcile this situation, where you have the poor and the planet, both often without political voice, versus enormous sums of corporate money and power?

I've been part of movements where people without money, and people

without a voice in the international system, were still able to stop the corporate theft and corporate hijack of water.

One example is the village called Plachimada in Kerala, where Coca-Cola set up a plant and was extracting 1.5 million liters of water per day. Due to the running dry of local wells, as well as the pollution of local water, women were walking 10 miles to retrieve water. Then a woman from the village said, "Why should we walk further and further for this company to maximize its profits? This company must shut down so we can have our water." She started a protest outside the gates of Coca-Cola.

A year after they had been protesting, they invited me and I realized how unequal the fight was. I started to do what I normally do in such circumstances: wake up the people in places of power, wake up the local government, ask them to join the women's movement, create strategies for legal action, get wider political support. And the women shut the Coca-Cola plant down.

In another big case, the World Bank along with one of the world's biggest privateers, Price Waterhouse Coopers, the government of India, and the government of Delhi, were all hell bent to privatize Delhi's water supply. When we realized this was going to happen, we organized a movement for water democracy and we created a very broad alliance of people who were displaced by the dam from which the water would come. The alliance included communities located in the very sacred pilgrimage spots like Haridwar, where the sacred Ganges flows; farmers who were going to lose their water; urban slum dwellers who were going to lose their public supply of water; and even the rich, bringing them in by asking, "Do you want a higher flow of water at the cost of farmers, the poor, and nature?" We created this alliance and we were able to shut down the privatization of Delhi.

So people might not have a voice in distant places, but when they join hands they can create a powerful force locally and that local force can then have reverberations in very distant places.

In the United States, every citizen has, at least in theory, a political voice. What will it take to motivate people to advocate for better water resource management when, for the most part, we here are so accustomed to having plentiful access to clean water.

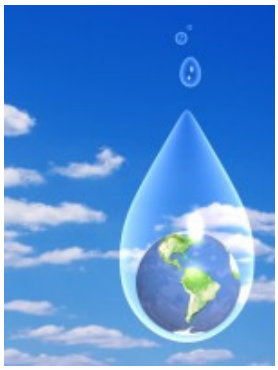
I think we live in times when none of us can isolate ourselves from the web of life that supports us. None of us can think, "I am just a person, a resident of this village, of this town, this particular place," because the most important consciousness for our times is the recognition that we are part of Earth, and the flow of Earth is a flow of water. Our water today is linked to raindrops far away in space and in time.

That consciousness of being interconnected through the hydrological cycle is an awareness we each need to have to live our life as Earth citizens. Once you do that, you realize that my tap might have water flowing, but if the system is depriving people of water far away, then I have to have solidarity with them. If Coca-Cola is depriving the women of Plachimada their water, then Coca-Cola is not just a problem for them, it is also a

problem in my life. Even in areas which have never had a problem of freshwater availability, issues like fracking will force us to join in recognition that we are part of Earth.

So these two leaps of our consciousness-that we are part of the Earth and we are part of a water cycle-allow us to think beyond our narrow isolated places.

What advice would you give to those in the professional community of planners, architects and engineers?



I would give a one line advice: bow to the water cycle. So much of water planning has been based on the idea of human beings conquering water systems, conquering the river with a dam, conquering the water of a distant place to overcome a scarcity somewhere else. This idea of conquest has guided too much of water thinking-this idea of owning water as property, and the idea of profiting from it. I think these are extremely crude, extremely primitive ways of thinking and any water expert, professional, or policy person should 1) recognize the water cycle and 2) recognize that we don't create water, water creates us. That is why I say 'bow to the water cycle'.

What would be your advice for students who are deeply concerned about the future of our water resources but don't know what to do about it or what to study to enable them to do something about it?

I think the beauty about water is it's everywhere and most of our bodies are water and most of the planet is water. So if you start to look, you can find a water issue everywhere. You can find it as a local activist in your community. You can find it in subjects of study no matter where you begin. You could begin in political science and politics over water - water wars is the subject of my book and those are becoming important issues. You can begin with geography - the entire pulse of the land is water. You can begin with agriculture and work on ways to create more water-conserving systems of farming. So it doesn't matter where you begin. You can, if you are really seeking water, find the water.

How would you summarize your perspective of the state of the world's water and what might lie ahead?

I think there are two trends related to water resources, and all resources on the planet. One is a trend that's coming from higher consciousness, a trend of conservation, a trend of equal sharing, and a trend of caring for our water bodies. There's another trend of irresponsibility, of water carelessness, of water abuse.

Abuse for me is also the idea of trying to control water. That is abusing water because water has its own life, it is has its own integrity, it has its own flow. That second trend is butchering the earth and destroying places that are vital for the water system. I am very happy that we were able to play a role in supporting a major movement in Orissa where a mountain that is the source of 22 streams was going to be mined for bauxite, which would have killed that water system. The mountain is called Niyamgiri and it is a sacred mountain for the indigenous communities. We were able to stop the mining.

Mining is a very big abuse to water systems. Mining destroys water in the mining itself; mining destroys water in the processing into steel, into aluminum, into gold, into whatever else. Hundreds and thousands of tons of water are used in this type of processing, and tar sands is a clear example of how the entire water system of the area can be polluted.

We have reached a time where we need to assess every human action on the basis of its impact on water. We have taken water for granted and we can't take it for granted anymore. It has become the single most important reason for child and infant deaths in the world. It is the biggest depravation: the depravation of water to people who have as equal a right to water as the richest person because biologically, we are all equal. Financially we might have been made unequal, but biologically, we are one species and we have an equal right to water. Every action needs to be measured against what it does to the water cycle.

Leaf Litter Talks With Dr. John Todd

John Todd is one of the pioneers in field of ecological design and engineering and the founder and senior partner of John Todd Ecological Design. Beyond his numerous awards and citations, including the 2008 Buckminster Fuller Award, Dr. Todd has degrees in agriculture, parasitology & tropical medicine from McGill University and a doctorate in fisheries and ethology from the University of Michigan. He is currently a tenured research professor at the School of Natural Resources and both a Distinguished Lecturer and Fellow of the Gund Institute for Ecological Economics at the University of Vermont. He is also the founder and president of Ocean Arks International, a non- profit research and education organization established in 1981.

You've worked in water for years. What do you see as the most crucial work remaining?

Four things. First, getting safe water into the hands of hundreds of millions of mothers who do not have safe water for their families. In this regards, to design an ecological technology that kills pathogens, cleans water and can be used and understood very widely. Also the technologies must cost little or nothing to own and operate. A true living microcosmos.

Two: developing Ocean Restorers capable of treating huge volumes of sea water daily with the goal of bringing back to life the oxygen deprived " dead" zones along the coasts of the world. These were once the nurseries that helped sustain much of humanity.

Three: changing the paradigm of waste treatment to one of resource reutilization producing fuels, medicines, biological products and even foods from sewage and other resource rich wastes.

Four: mining or recapturing important nutrients such as phosphorus from wastes and bodies of water to be reused as fertilizers when phosphorus becomes scarce say in a decade or two.

What have you been working on lately? What are you most passionate and excited about these days?

I have been working on the four above plus trying to figure out how best to capture atmospheric CO2 and transform it into carbon rich soils using a host of ancient and new techniques in common.

Also trying to grow oysters, fish and shrimp in my greenhouse

Your work with the Eco-Industrial Park/closed loop system concepts has had some powerful ripples out into the aquaculture and urban agricultural communities. What's one of the most exciting ripples you've seen?

Let me say that the work of Will Allen and others in creating urban foods systems a-la New Alchemy is just fabulous to behold. There is a real movement out there.

Where do you see this work going? What's new?

One of the most exciting new directions is the work of Sam Gorton, a doctoral student of mine who is developing a real model of whole, complex energy and food systems for the 21st Century. He is fusing his backgrounds as a Vermont dairy farmer, chemical engineer and most recently applied ecologist to change how we design our support systems from the bottom up.

Another is a former doctoral student, Anthony McInnis, who has designed and developed eco-machines to break down toxic wastes involved in the mining industry. He is beginning to peer into the inner workings of complex eco-machines.

Thirdly, my graduate student Rebecca Tharp, for her design of household scale eco-machines to convert polluted and contaminated waters into safe water for cooking and drinking.

And the list goes on and on.

Whose work in the world of water do you most admire? Read any good books lately?

There are many, many people including quite a few former students of H.T. Odum, but I have to say my hat goes off to my former and current graduate students.

Have public perceptions of your work changed over the last 20 years? If so, how and why?

Apart from a small audience of environmentalists and concerned citizens, I have never been too well known. I was pretty much invisible. Now that is all changing as more and more people are seeing the application of Nature's operating instructions as a possible key to saving the planet for ourselves and a steady state future.

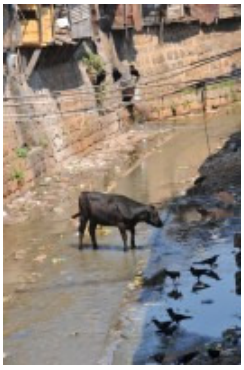
With a colleague, I am working on a big book that is a guide to the future, called the EDEN ALMANAC. We want to make it so exciting that large numbers of people will be influenced by it.

If you were to provide a few words of wisdom or advice for those following in your footsteps - those working to transform our relationship with water and how we manage it - what would they be?

I know this sounds a bit simple or perhaps to some even corny, but my advice is to begin to see water as the source of all life and as such it is sacred and should be served with wonder and patience.

Water - An International Perspective

By Michael Ogden
Founding Director of Natural Systems International



The Clean Water Act was passed in 1972. The U.S. had put a man on the moon and I had just finished my undergraduate degree in Civil Engineering in the era of "anything is possible." Projects like the California State Water Project and Arizona's Central Arizona Project were well underway in the planning phases. There was even a model in the entry hall of the College of Engineering (UC Berkeley) that showed how we might change the course of the Yukon to bring water to California. Big dams were still revered by the World Bank, and my ecology class (an elective) text book was entitled "Ecology - the Subversive Science."

It took a fire burning on the surface of the Cayahoga River in Cleveland fire so hot it destroyed a railroad bridge-to get Congress to pass the Clean Water Act. These were the early days of the environmental movement, and most of the focus was on chemicals and solid waste. Very few people, if any, were thinking about the consequences of big water projects, and certainly, no one-or so it seemed-could comprehend the consequences of the Clean Water Act and the "free market."

Much of my early work with wetlands in the U.S. involved some pretty nasty stuff - process water from a tannery, an egg factory, and a slaughter house; landfill leachate, acid mine drainage and ore mining leaching ponds. Stormwater management and CSOs (combined sewer overflows) were still on the horizon. Initially, this work was in the U.S., but in the early 90s a group of Mexicans came to visit, with the goal of designing and building constructed wetlands for the treatment of municipal wastewater. At that time, only about 7% of the municipal wastewater in Mexico was receiving any kind of treatment. The scale of the problem was immense, and most of us had no idea of the impact on the environment unless we were living in San Diego, Nogales or El Paso.

Let me repeat the statistic -even now, 93% of the Mexican population has no wastewater treatment, or only primary treatment. This is essentially true in all of Central America. The capital of Costa Rica has no wastewater treatment; Costa Rican beaches are experiencing the same problem as Mexican beaches. They are no longer safe to swim in. Panama City, with over a million people, discharges all of its raw sewage into what was once a beautiful bay.

For those of us who eat imported food, the lack treatment comes back to us in the following manner. Wastewater treatment is expensive. The cost of electricity in Mexico is 14-18 cents/kWHr, and when faced with a budget shortfall, the municipal mayor may simply turn off the wastewater treatment system and send operators to some other

department. When faced with a choice between schools or clean water, Mexican mayors will choose schools. The farmers downstream actually prefer the untreated sewage since it is much higher in nitrogen and phosphorus. If they are growing root vegetables, like green onions that are used in fresh salsa, people in Pennsylvania die from hepatitis.

This kind of experience in Mexico and Central America was nothing compared to what I witnessed in China and India. When I first went to Shanghai for a master planning project, we were informed that only 5% of the wastewater in a city with 17 million people received wastewater treatment, and only primary treatment at that. The raw sewage was discharged into the Whampoa and Yangtze, which empty into the coastal fisheries. All of the metal-bashing industries on the Yangtze upstream from Shanghai also discharged their metal-laden process water into the rivers. You might think this is not our problem, in that you are unlikely to eat Chinese seafood, but here is where the idea that we are all connected comes home.

The free trade agreements and outsourcing of production in the U.S. began with the impact of the Clean Water Act. As the federal and state governments began implementing the new standards, certain industries in the U.S. began to make location choices which were based on labor AND water pollution standards. Textile industries moved from New England to the southeastern U.S., where larger rivers allow a larger discharge of the process water (saltier than sea water and with heavy metals and non-biodegradable dyes. How many of us know what it takes to color cotton blue?).The principle that "the solution to pollution is dilution" drove this relocation because water quality standards were originally based on concentrations. If your discharge met the concentration you would be okay as far as your permit was concerned. Eventually the textile industry moved to South and Central America, India and the Philippines. Why? Cheap labor and lots of water with no regulations. As an example, one of my early projects involved a denim manufacturer that was being forced out of Southern California due to water quality regulations. Mexico was their relocation choice because they would be allowed to mix process water with raw sewage. (Although they were doing the same in California, the standards are much lower in Mexico.)

All of those items which we consider essential for the American lifestyle, when manufactured or grown in other countries, have a price. The environmental cost is not as easily quantifiable, but is there nevertheless. The Chinese can make the stuff that we buy because the labor is less expensive, but also because the air and water pollution regulations are less strict than the U.S. standards and are not enforced unless the violations are egregious. In the particular case of China, the environmental costs show up in contaminated food, and children's toys decorated with lead paint, and in California, in the plume of coal smoke which delivers mercury to the snow in the Sierra Nevada. The American public is becoming more aware of the environmental costs of our consumption, but how many of us are prepared to give up raspberries and strawberries from Mexico, or blueberries from Chile, irrigated with polluted water and treated with herbicides and pesticides that are banned in the U.S.?

When the Clean Water Act was passed, I don't think anyone foresaw that we would simply export our pollution. I live in a part of California that has

relatively clean water and unpolluted air, and I am particularly grateful for the laws that ensure a clean environment. I don't propose that we change our standards, but we do need to address the economic cost of regulations.

There is a lot more to be done in the U.S. In 772 American cities, raw sewage discharges into local rivers or coastal littoral when it rains. But what if the costs associated with clean-up simply drive business out of the country? Most of us never see the water pollution in India, Mexico or China (and if our Congressmen and Senators did, they might be more supportive of the U.S. EPA). Nitrogen from sewage and fertilizer has created some 472 zones of hypoxia in the coastal regions of the world where these polluted rivers discharge (let's not forget that the Mississippi has created the largest such region in the Gulf of Mexico). We cannot ignore the fact that what we buy has a water pollution cost, just because the pollution takes place in another country.

If you knew the water environmental cost of the food or clothes you buy, would you reconsider or look for alternatives? This is a fundamental question for all of us, since our personal choices affect the environment. Ideally, our aim would be that the stuff we purchase be produced locally and that it meet high standards, or be produced in countries that have similar or higher standards. Shifting the burden to poorer parts of the world is neither morally or environmentally defensible, and has proved to be nonsense in a world in which everything is connected to everything.

Our collective awareness of the role water plays in the production of food, clothing and other material goods has greatly improved over the last 40 years. The mangroves of South East Asia are being protected, the Chinese (some) have accepted that the Three Gorges Dam was a mistake, and Biohabitats is cleaning up harbors in New York, Philadelphia, and Baltimore. The rise of professional firms like Biohabitats and NSI is a reflection of the increased global concern for the environment. Clearly there is still a great deal of debate on how clean the water needs to be. We need only look to the production of natural gas in the eastern U.S. to understand how our demand for energy affects our streams and rivers. Do we turn off the gas or figure out how to get the gas and keep the water clean? Or should we export the pollution and buy the gas from Libya?

Water, Through The Lens of Landscape Ecology

By Jennifer Dowdell
Ecological Landscape Designer

The landscape can be seen as a mosaic of interrelated and interdependent systems, a series of habitat patches and corridors that provide spaces for both wildlife and humans to function and survive. This mosaic is part of what we use in landscape ecology, the interdisciplinary study of spatial patterns and processes in the landscape. It is easiest to grasp these patterns and imagine habitat potential and connections when one can see them broadly, from the window seat of an airplane, for instance. This opportunity came as I returned this April from "Examining Sustainability in Dynamic Landscapes," the International Association of Landscape Ecology's annual symposium in Portland, Oregon...

As the plane lifts off the runway, Portland's fir trees and small houses give way to patches of residential hamlets nestled in dark hills. Once we hit cruising altitude the mountains appear, never ceasing to take my breath away with their powdery white peaks. Further on, agricultural fields come into view, the most familiar to me and yet the most alien, as they are the part of the landscape that seems to have been altered the most. Perfect irrigation circles centered in perfect squares-quilted swaths of industrial agriculture. As we get closer to the Midwest, our midway point on this flight home to Baltimore, the patterns change slightly. The irrigation circles are gone but the broad swaths of farms remain.

While the farms are still squares and rectangles in the landscape, darkly colored, sinuous lines appear.

These streams and rivers are often lined with trees, irregularly shaped buffers that cut across the farm land and break the monotony. At some points, small woodland patches appear as dark blotches, while at others the streams skirt the farmland, teasing a curve out of the right angles. If the light is just right, I can pick out the older patterns from water that has been drained from the land, the dark splotches and lines of ancient streams, wetlands, prairie potholes, and fens-shadows of the former hydrology.

My mind drifts back to the symposium. What was unique about this year's meeting was that while there was still a lot of attention on the study of the patterns and processes of forest and other terrestrial habitat patches, there was more focus on rivers and streams as important corridors and habitat locations. There was a much greater emphasis on the practical application of such research in planning and design for future resilient landscapes. Water was described as both a resource and a critical element in the landscape mosaic. Highlights included talks by researchers examining hydrologic systems as elements in landscape ecology. Lee Benda from the Earth Systems Institute presented work on river catchment connectivity as the context for regional restoration projects along the Pas River in Spain while Peter Kiffney from the Northwest Fisheries Science Center and Hedmark University College presented research on the importance of tributary confluences as habitat connections for salmon in the Pacific Northwest. Stormwater management and riparian habitat function were highlighted in a study being conducted in Vancouver, Washington and Portland, Oregon which links green infrastructure planning work at the site scale with larger habitat function and community resilience

As I make the connection between these talks and the view from my window seat, I sense, more than ever, the importance of ecological restoration and conservation of functional hydrologic systems in the effort to regenerate and sustain the natural landscape mosaic that underlies our communities, both natural and human-dominated.

To help illustrate the water resource challenges we face in planning for resilience and regeneration, Jennifer assembled a "Water Index" of facts and figures, based on information she culled from various conservation web sites.

A Water Index
The ancient Romans had better water quality than half of the people alive now. (http://water.org)

Less than 1% of the world's fresh water (or about 0.007% of all water on earth) is readily accessible for direct human use. (World Health Organization Fact Sheet Health in Water Resources Development.)

By 2025, 52 countries-with two-thirds of the world's population-will likely have water shortages. (http://www.rivers.gov/waterfacts.html)

A 1982 study showed that areas cleared of riparian vegetation in the Midwest had erosion rates of 15 to 60 tons per year. (http://www.rivers.gov/waterfacts.html)

An American taking a five-minute shower uses more water than a typical person in a developing country slum uses in a whole day. (2006 United Nations Human Development Report.)

Only 62% of the world's population has access to improved sanitation - defined as a sanitation facility that ensures hygienic separation of human excreta from human contact. (UNICEF/WHO. 2008. Progress on Drinking Water and Sanitation: Special Focus on Sanitation.)

The United States consumes water at twice the rate of other industrialized nations.
1.2 Billion - Number of people worldwide who do not have access to clean water.
6.8 Billion - Gallons of water Americans flush down their toilets every day. (http://www.rivers.gov/waterfacts.html)

More than 80% of sewage in developing countries is discharged untreated, polluting rivers, lakes and coastal areas. (2004, Wastewater Use in Irrigated Agriculture- http://water.org)

The average single-family home uses 80 gallons of water per person each day in the winter and 120 gallons in the summer. Showering, bathing and using the toilet account for about two-thirds of the average family's water usage. (http://www.rivers.gov/waterfacts.html)

At home the average American uses between 100 and 175 gallons of water a day. That is less than 25 years ago, but it does not include the amount of water used to feed and clothe us. (http://water.org)

Agriculture is the largest consumer of freshwater by far: about 70% of all freshwater withdrawals go to irrigated agriculture.(United Nations World Water Development Report, "Water in a Changing World")

Only 7% of the country's landscape is in a riparian zone, only 2% of which still supports riparian vegetation. (http://www.rivers.gov/waterfacts.html)

The U.S. Fish and Wildlife Service estimate that 70% of the riparian habitat nationwide has been lost or altered. (http://www.rivers.gov/waterfacts.html)

More than 247 million acres of U.S. wetlands have been filled, dredged or channelized-an area greater than the size of California, Nevada and Oregon combined.
(http://www.rivers.gov/waterfacts.html)

Riparian areas in the West provide habitat for more species of birds than all other western vegetation combined; 80% of neotropical migrant species (mostly songbirds) depend on riparian areas for nesting or migration. (http://www.rivers.gov/waterfacts.html)

Fully 80% of all vertebrate wildlife in the Southwest depend on riparian areas for at least half of their life. (http://www.rivers.gov/waterfacts.html)

Of the 1200 species listed as threatened or endangered, 50% depend on

rivers and streams. (http://www.rivers.gov/waterfacts.html)

One fifth of the world's freshwater fish-2,000 of 10,000 species identified-are endangered, vulnerable, or extinct. In North America, the continent most studied, 67% of all mussels, 51% of crayfish, 40% of amphibians, 37% of fish, and 75% of freshwater mollusks are rare, imperiled, or already gone. (http://www.rivers.gov/waterfacts.html)

At least 123 freshwater species became extinct during the 20th century. These include 79 invertebrates, 40 fishes, and 4 amphibians. (There may well have been other species that were never identified.) (http://www.rivers.gov/waterfacts.html)

Freshwater animals are disappearing five times faster than land animals. (http://www.rivers.gov/waterfacts.html)

In the Pacific Northwest, over 100 stocks and subspecies of salmon and trout have gone extinct and another 200 are at risk due to a host of factors, including dams and the loss of riparian habitat. (http://www.rivers.gov/waterfacts.html)

One mature tree in a riparian area can filter as much as 200 pounds of nitrates runoff per year. (http://www.rivers.gov/waterfacts.html)

Resources

LINKS

Alliance for Water Stewardship

AQUASTAT is the Food and Agriculture Organization of the United Nations' global information system on water and agriculture, developed by the Land and Water Division.

The CEO Water Mandate

Circle of Blue is an international network of leading journalists, scientists and communications design experts that reports and presents the information necessary to respond to the global freshwater crisis.

Conservation International-Fresh Water

Food and Agriculture Association of the United States: Water: A Finite Resource

Greywater Alliance

International Water Management Institute

Ocean Arks International

Pacific Institute

Sustainable Solutions for a Thirsty Planet

UNESCO Institute for Water Education

UN Water

UN World Water Assessment Program

Water Environment Federation

Waterfootprint.org

Watereuse.org

Water Witness International

World Business Council for Sustainable Development's Global Water Tool

World Health Organization's Water Scarcity Fact File

World Water Council

BOOKS

Blue Covenant: The Global Water Crisis and the Coming Battle for the Right to Water by Maude Barlow.

Blue Gold: The Fight to Stop the Corporate Theft of the World's Water by Maude Barlow and Tony Clarke

Constructed Wetlands in the Sustainable Landscape by Michael Ogden and Craig S. Campbell

The Big Thirst: The Secret Life and Turbulent Future of Water by Charles Fishman

Water Wars: Privatization, Pollution, and Profit by Vandana Shiva

FILM

Blue Gold World Water Wars, a film by Sam Bozzo

Biohabitats' Projects, Places and People

PROJECTS

We're delighted to showcase some of the amazing, water-related work of Biohabitats subsidiary, Natural Systems International.

An Urban Water Reuse Model In Tempe, AZ

A city that boasts an 85% chance of glorious sunshine year-round is not without its disadvantages, and an annual rainfall of only 7.63 inches is one of them. Fortunately, the City of Tempe, Arizona's new LEED-certified Transit Center building makes the most of every drop by reusing stormwater and greywater. NSI designed a treatment system to produce reclaimed, non-potable water by processing greywater, 'cooling tower blowdown,' and stormwater runoff. Every day, 400 gallons of greywater from the building's sinks and 1,000 gallons of water from its cooling tower are treated in a recirculating sand filter, disinfected, and reused to flush the building's toilets. Stormwater from roofs and parking surfaces

is captured, filtered for sediment and oil reduction, stored in an underground cistern and then used to supply the site irrigation system. These two systems provide a constant supply of high-quality reuse water. Potable water is used as a back-up supply only when reclaimed water is not available. Both systems emphasize simplicity, ease of maintenance, and energy efficiency. By harvesting and recycling water in this arid region, the Tempe Transit Center serves as a model for urban water reuse.

Stroud Water Research Institute Grows Greener

The location of the Stroud Water Research Center, which conducts pioneering research on streams and rivers, couldn't be more appropriate. Situated adjacent to White Clay Creek, which bears the Commonwealth of Pennsylvania's highest classification ("Exceptional Value"), the Center encompasses an 800-hectare drainage basin. Designated as an Experimental Ecological Reserve by the National Science Foundation, the site has been deemed an outstanding representative of an ecosystem of its type.

When the Center needed to add a new lab, office and classroom, they called upon NSI to create a natural wastewater management system. The treatment system, which replaces outdated septic fields, will process flows from the entire campus. Funded through a Pennsylvania Growing Greener Grant, it will integrate directly into the landscape and provide a relevant backdrop to the Center's research. It will also help protect groundwater and nearby streams. The facility includes a primary treatment tank with built-in equalization and secondary treatment through a series of terraced wetlands and a trickling filter tower. A recirculating sand filter polishes effluent prior to dispersal in a subsurface drip irrigation field. Stroud's research team will monitor the treatment system and drip dispersal field to evaluate its performance.

'Learning Landscape' Treats Wastewater At Largest U.S. Wildlife Refuge

When the U.S. Fish & Wildlife Service (USFWS) recently began a project to expand its interpretive and educational experience for visitors to the 1.5-million-acre Desert National Wildlife Refuge (DNWR), it sought to provide wastewater management that was sensitive to the unique setting. The DNWR is the largest wildlife refuge in the continental U.S., and its mission is to protect native species and preserve their habitat. The DNWR's main visitor center and access to the greater refuge is based at the Corn Creek Field Station in Southern Nevada.

Corn Creek Visitor Center. Image courtesy of Lucchesi Galati Architects.

This location is the center of a unique riparian and wetland ecosystem for the Mojave Desert that is fed by several deep aquifer springs. Native Americans, who were attracted to the area's lush plant and animal resources called Corn Creek home for at least 5,000 years. The USFWS intends the new Com Creek Visitor Center to be an example of a sustainable and environmentally friendly facility, striving for a LEED Platinum Certification and net-zero energy usage. As a subconsultant to the architectural firm Lucchesi Galati, NSI designed an advanced system that uses constructed wetlands as a major component to naturally treat wastewater. The wastewater infrastructure will be built as a learning landscape, providing educational opportunities for people in the Las Vegas

area to learn about and respect this dynamic environment. Construction for the 16,000-square-foot facility is expected to finish in 2012.

Visionary Wastewater Treatment Design For A Visionary's Institute

Founded by J.I. Rodale, one of the first advocates of sustainable, organic farming in the U.S., the Rodale Institute in Kutztown, Pennsylvania is a nonprofit dedicated to pioneering organic farming through research and outreach. When the Institute needed a wastewater treatment system for its new visitor center, NSI created a fitting solution for an organization that devotes itself to studying the link between healthy soil, food and people. The innovative wastewater system is comprised of three main components: rainwater to flush toilets, wetlands to treat wastewater, and a drip irrigation system that uses the treated water to irrigate the building's landscaping. The system is believed to be the first of its kind in the U.S. We'd like to think J.I. Rodale would be proud.

Wise Use of Water Benefits Penguins and People

Seattle's Woodland Park Zoo, cherished by the Puget Sound region and visited by people from all over the world for more than a century, encompasses 92 acres and features more than 1,000 animals representing nearly 300 species. Among them is the Humboldt penguin, a timid species named after the cold Humboldt Current, which flows along the coast of North and South America. The Humboldt penguin exhibit at the Woodland Park Zoo contains pools, a beach and a viewing area. Partnering with Northwest-based planning and design firm, Studio Hanson Roberts, NSI designed a system

that treats and filters water from the exhibit through both a settling and equalization tank and constructed wetlands. By minimizing the use of potable water, preventing exhibit backwash from entering the sewer system and harnessing the natural power of a functioning wetland, this unique treatment system saves water, creates habitat, improves water quality, and enhances the exhibit and the zoo experience for visitors.

Doris Duke Foundation's NJ Farm Expands Sustainably

Duke Farms, the Hillsboro, New Jersey estate once owned by tobacco and hydropower magnate James Buchanan Duke (and then his daughter, Doris) is now a 50-acre property striving to become a regional center for environmental stewardship. Managed by the Doris Duke Charitable Foundation and the Duke Farms Foundation, Duke Farms intends to provide healthy and sustainable habitat for native flora and fauna, and environmentally-oriented programming for 150,000 visitors a year. This expansion necessitated an upgrade to the facility's wastewater management system, and NSI was called upon to develop a solution that was in line with the site's environmental goals. NSI jumped at the challenge, and designed a wastewater treatment and collection system that integrates tanks, constructed wetlands, sand filters and a subsurface drip land application. This low-energy, low-maintenance solutions was designed so that it could be constructed in phases to meet development growth. We're delighted that our team is assisting in the stewardship of this important cultural asset.

PLACES

Next week, Senior Ecologist Joe Berg is heading to Lansing, MI for the U.S. Society for Ecological Economics 2011 Conference. This year's theme is "Building a Green Economy," and Joe will present "A Federal Method for

Cost-Benefits Analysis of 40 Restoration Projects: We Need More" and "Creation for the Collection and Conveyance of Stormwater Runoff as a Form of Green Infrastructure."

From July 17-21, Biohabitats Great Lakes Bioregion leader, Ivette Bolender will attend the Coastal Zone 11 Conference in Chicago. For over 33 years, this biennial international symposium has been the largest international gathering of ocean and coastal management professionals in the world. This year's theme is "Winds of Change: Great Lakes, Great Oceans, Great Communities!"

From August 1-5, the National Conference on Ecosystem Restoration will be held in Baltimore, right in the backyard of Biohabitats' Chesapeake/Delaware Bays Bioregion. Our folks are super psyched to lead technical field trips focused on regenerative stormwater conveyance, urban stream restoration and tidal wetland and vernal pool restoration. You won't want to miss conference sessions featuring Biohabitats staff. Landscape designer Nicole Stern will moderate an exciting session about the interjuristictional Baltimore Watershed Agreement. Senior ecologist Terry Doss will present "Restoring Coastal Habitat in the Heart of New York City." Senior Ecologist Joe Berg will share suggestions for "Prioritizing Watershed Restoration: Headwater Versus Downstream Projects."

This year, the folks who normally put on the Maryland Streams Symposium have teamed up with colleagues in Delaware, Pennsylvania, Virginia and West Virginia to present the 2011 Streams Symposium and Mid-Atlantic Volunteer Monitoring Conference. The event, which takes place August 10-13 in Westminster, MD, will showcase state-of-the-art stream restoration techniques and address the challenge of "Sustaining Volunteer Involvement in Water Quality Management." We hope to see all of our Mid-Atlantic friends there!

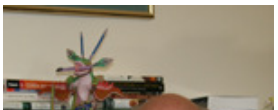
From August 21-25, the Society for Ecological Restoration International will present the4th World Congress on Ecological Restoration. This year's event will take place in Mérida, Mexico, with a theme of "Re-establishing the Link Between Nature and Culture" (Restableciendo la Unión entre Naturaliza Y Cultura). As Global Restoration Ambassador for SER, Biohabitats president Keith Bowers will speak about the economic aspects of ecological restoration at the event's opening plenary session.

August 28-31 will find two Biohabitats senior ecologists at the EMECS9 Global Summit on Coastal Seas in Baltimore, MD. Terry Doss, who head up our Hudson River Bioregion office will present "Sustainable Approaches to Coastal Habitat Restoration in the Heart of New York City" Joe Berg from our Chesapeake/Delaware Bays Bioregion office will present "Towards Sustainable Watershed Restoration Projects: Source Reduction versus Interception." Be sure to say hi to Terry and Joe if you're attending this event. (If you're in from out of town, Joe can tell you where to get the best crabs and beer!)

PEOPLE

Meet the Newest Members of the Biohabitats Family

Early in 2011, Biohabitats acquired the visionary water resources firm Natural Systems International (NSI). What makes NSI visionary? Long before the rest of the world was talking about water security, the staff at NSI was helping clients all over the world to conserve, manage and reuse water. You've read about some of their recent projects. We thought it was about time you met some of these talented folks.



Michael Ogden is the Founding Director of Natural

Systems International, has a BS from the University of California (Berkeley) in Civil Engineering and an MBA from the University of Chicago (MBA in mathematical methods and finance). He is a registered professional engineer in 10 states. His engineering practice focuses on the use of natural systems - the ecologies of the pond, marsh, river, prairie, and woodland- for the treatment and reuse of wastewater and storm water. Michael has been involved in more than 500 projects involving sustainable natural systems. He has worked in 40 states, and internationally in Canada, Mexico, Costa Rica, Panama, India, China, Afghanistan, and Australia. Michael has participated in some of the first commercial LEED projects. Michael co-wrote the textbook 'Constructed Wetlands in the Sustainable Landscape', published by John Wiley and Sons. The text was also translated into Chinese to assist in moving water sustainability concepts around the world.

Erin English grew up playing alongside (luckily not in-she knew better, even at that age) a little stream polluted from septic tank seepage, acid mine drainage and runoff from a nearby golf course. Despite the strange 'colorful' state of the water, the wooded ravine was a wondrous playground, so when someone told her cattails could help 'clean up' water, she organized a small posse of neighborhood kids to plant some from the seed heads they found nearby. Almost 23 years later, she now delights in helping other communities reap the benefits of using natural systems (and yes, cattails) to manage wastewater and stormwater runoff. Erin focuses her chemical engineering background on integrating conventional process-design with the ecological concepts of natural systems. She has worked in both non-profit (Ocean Arks International) and design firm environments on community, school, zoo, and agricultural projects. Having studied permaculture and sustainable design, she works to integrate these concepts into her water and community work. Interested in the intersection of agriculture, soil, nutrients and water, Erin has served on the Board of the Santa Fe Farmers Market Institute for the last five years. She has helped develop NSI's approaches to water master planning and water reuse systems, and is a registered professional engineer in five states.

As a child, Pete Muñoz used to think his cereal bowl was the ocean and that the Cheerios were trash. It was his job to clean everything up. Since then, he hasn't stopped fighting for the preservation and restoration of our waters. Along the way he picked up a few skills solo biking through Europe at age 18, locking-down in front of a bottled water semi-truck, and hiking the Inca Trail to Machu Picchu. More formally Pete picked up a couple useful nuggets at Michigan State University (BS-Biosystems Engineering) and the University of Vermont (MS - Civil and Environmental Engineers). Pete helps manage our office in Santa Fe, NM, but works around the global helping to connect communities with appropriate inspirational water infrastructure. He is frequently asked to speak on green infrastructure, sustainable water management, and ecological design, and he also teaches at Yestermorrow Design/Build School in Warren, VT. Pete has deep love for Michigan, the Great Lakes and sugaring. Pete is a cancer survivor, extreme tinkerer, avid gardener, master of science, student of life, foodie, music lover, woodworker, baker, LEED AP, wastewater treatment operator, coffee drinker, chicken tender, activist, soccer player, dish washer, and father of three girls (including

one four-legged).

Until he moved to the arid Southwest, senior engineering technician Ryan Case had always lived alongside water-the Gulf of Maine, Vermont rivers, the Pacific Ocean or Lake Champlain. This exposure to both the abundance and scarcity of water no doubt affected his understanding of humankind's relationship to water. Ryan's passion for protecting water resources really came alive when he discovered the work of Dr. John Todd while at Middlebury College. He went on to join Dr. Todd's team at Ocean Arks International, where he helped design and build experimental systems for treating wastewater that were analogs of wild ecosystems. He also began developing the organization's educational outreach. Ryan later started his own non-profit, the Water Stewards Network, which worked with an international network of water rights activists and water experts to amplify and unify the voices of communities around the world affected by global water politics and our mismanagement of water resources. As far as we know, Ryan the only member of the Biohabitats staff who can claim to have directly influenced a U.S. president. In a former non-political job managing services for President George H.W. Bush's family estate, Ryan actually convinced the President to let him build a floating island to improve the ecology of the President's favorite-and badly polluted- pond. According to Ryan, the President was so pleased with the ecological restoration project he had Ryan show it to former Soviet leader, Mikhail Gorbachev, during his visit to the estate. Ryan's interest in sustainability extends far into his life outside of work. He continues to refine his Vermont homestead, which he built by hand using traditional timberframing techniques, with principles of permaculture.

Growing up on the East Coast, Project Engineer Justin Lyon spent a significant amount of time around the ocean. This was a major factor leading to his dream of becoming a boatbuilder. Though he continued to spend a significant amount of time with boats, including a long-distance sail from California to Nicaragua in 2008, his career focus switched to civil and environmental engineering. Justin has a B.S. in Civil Engineering from Bucknell University and is currently working on his M.S. in Environmental Planning and Management at Johns Hopkins University. Before joining Biohabitats, Justin worked in land development and environmental planning in California where he honed his drafting and design skills and enhanced his working knowledge of civil engineering. Justin left California to begin his own sustainable engineering firm in Nicaragua where he was exposed to a wide variety of projects such as eco lodges, shipping container hostels, recycled tire and bottle houses and organic farming. Now that Justin has moved to a landlocked state, he can most likely be found skiing, hiking, golfing, playing tennis or just generally wandering and exploring new places.

Growing up in Espanola, New Mexico, Rachel Arrietta dreamed of becoming a truck driver. Somewhere along the road, however, she rerouted her aspirations toward the field of drafting. Though she began by drafting by hand for a civil engineering and land surveying company, Rachel ultimately discovered an affinity and knack for Computer Aided Drafting (CAD). As CAD Engineer, she has applied her skills to environmentally focused water resources projects for more than

six years. When she's not busy drafting, Rachel can usually be found spending time with her family, motorcycle, fishing rod or garden trowel. Does Rachel think her CAD work helps improve the earth? That's a 10-4!

After high school, Project Engineer Alan Garrido dreamed of becoming a rock star like "Slash" to rock on with his friends every weekend. Instead of becoming a rock star, Alan was involved in different styles of traditional Colombian music in his home university while studying Agricultural Engineering. Alan wrote a thesis with his brother addressing the technical improvement of production of Calcium Oxide in his home state of Huila. In a short period of time after graduation, Alan started a new research topic with his research team and lead meetings between academics, the government, and entrepreneurs in the area of mining and mining industrial processes. Alan was offered the opportunity to study abroad at the University of Oklahoma (OU) where he started his Master's in Environmental Engineering. At OU Alan developed a research plan to determine the effects of acid mine drainage on agricultural produce and human health at the mining district of Potosi, Bolivia. He also got involved in the development and monitoring of passive technologies to treat acid mine drainage at the Tar Creek Superfund Site. While working on his graduate degree, Alan shared his time with his band where he played the rhythm guitar and back-up voice around Dallas, Houston, Austin, Oklahoma City, and other cities in the south of the United States. Before joining Biohabitats, Alan recorded a CD with his band, presented his research at international and national conferences, and played "Rock Band" every weekend with his friends. Nowadays, Alan enjoys the outdoors in Santa Fe and feels like Captain Planet when working at Biohabitats.

With over 400 years of ancestry in the "City Different," Rose Marie Price's roots extend deeply into Santa Fe soil. Perhaps that's why she's able to manage the operations of our busy Santa Fe office so stably. Rose Marie's 16 years of administrative experience have equipped her with strong skills in accounting, budgeting, organization and communication. Outside of work, Rose Marie's passion is fortifying her ancestral roots with genealogical research. She has spent ten years compiling her 1600-person family tree, which, by the way, includes Ritchie Valens of "La Bamba" fame. One of the many things Rose Marie likes about her job as office manager/administrator is that it gives her the chance to learn new things and broaden her skills. With her strong foundation, it's not surprising that she branches out so easily!

Growing up in a remote high mountain valley of Southern Colorado inspired senior engineering technician Olin Christy with the pure joy and contentment that comes from being closely connected to one's environment. The happiness Olin found in natural areas led him to believe he would have a career as an outdoor guide in Colorado's Wilderness areas. However, interests in philosophy, the environment and the winding river of life carried him in a different direction, to that of water and land stewardship. In his time away from the office, Olin tries to live from the land as much as possible on seven acres of northern New Mexico farm land, where he and his fiancé are attempting to grow most of their own food. If there is a free moment, he also enjoys camping, making

metal sculpture, reading, movies, mechanics and mountain biking.

New Biohabitats Hudson River Bioregion Staff

For ecologist Justin Bowers, work was just a day at the beach before he joined Biohabitats. That's because he was working at NOAA's oceanfront facility in Sandy Hook, NJ, compiling a database containing 20 years' worth of ecological restoration projects completed within the NY/NJ Harbor Estuary. In addition to this body of regional restoration knowledge, Justin brings five years of hands-on conservation planning and GIS project experience, including a stint with the USGS' North Carolina Water Research Center. He has also performed GIS analysis for wind, solar and LNG energy projects. Justin holds a B.A. in human ecology from the College of the Atlantic and a Master of Environmental Management from Duke University. Equally impressive, he manages to maintain loyalty to his hometown Red Sox in an office full of New York and New Jersey natives! Although he is undoubtedly helping us in the Hudson River Bioregion office, his work on the NOAA database will help everyone in the restoration community.

Glossary

Backwater: A body of water in which the flow is slowed or turned back by an obstruction such as a bridge or dam, an opposing current, or the movement of the tide. (water.usgs.gov)

Cistern: Waterproof receptacle for holding liquids, usually water. (wikepedia.org)

Discharge: The volume of fluid passing a point per unit of time. (water.usgs.gov)

Drip Irrigation: An irrigation system in which water is applied directly to the root zone of plants by means of applicators (orifices, emitters, porous tubing, or perforated pipe) operated under low pressure. The applicators can be placed on or below the surface of the ground or can be suspended from supports. (water.usgs.gov)

Effluent: Outflow from a particular source, such as a stream that flows from a lake or liquid waste that flows from a factory or sewage-treatment plant.

Fracking: Hydraulic fracturing; the process of initiating, and subsequently propagating a fracture in a rock layer, employing the pressure of a fluid as the source of energy. (wikipedia.com)

Greywater: Wastewater from water from your bathroom sinks, showers, tubs, and washing machines. Also known as graywater, grey water and gray water. (greywateralliance.org)

Hypoxia: the condition in which dissolved oxygen is below the level

necessary to sustain most animal life- generally defined by dissolved oxygen levels below 2mg/l [miligrams/liter] (or ppm [parts per million]). (Committee on Environment and Natural Resources, 2000)

Infiltration: The movement of water from the surface of the land through the unsaturated zone and into the groundwater. This occurs during and immediately after precipitation events. It can also occur at the bottom of lakes and rivers. (civil.engr.siu.edu/ray/glossary.htm)

Potable Water: water that can be consumed by humans without ill effects. Government agencies have adopted standards of quality that specify limits of chemical constituents in water sources. (floridadep.org/geology/geologictopics/glossary.htm)

Wastewater: Consumed or used water from a municipality or industry that contains dissolved and/or suspended matter. (civil.engr.siu.edu/ray/glossary.htm)

Water harvesting: the activity of direct collection of rainwater. The rainwater collected can be stored for direct use or can be recharged into the groundwater. (rainwaterharvesting.org)

About Leaf Litter

Leaf Litter is a publication of Biohabitats, Inc. Coinciding with the earth's biorhythms, it is published at the Fall Equinox, Winter Solstice, Spring Equinox and Summer Solstice to probe issues relating to conservation planning, ecological restoration, and regenerative design. Biohabitats has attempted to ensure the accuracy and veracity of the information provided in *Leaf Litter*, however, information contained in *Leaf Litter* should not be construed as a recommendation or endorsement by Biohabitats. Please click here to contact Leaf Litter editors with questions, comments or content ideas.

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Chesapeake/Delaware Bay Bioregion
Baltimore, MD
(410) 554-0156

Great Lakes Bioregion
Cleveland, OH
(216) 921-4430

Ohio River Bioregion
Louisville, KY
(502) 561-9300

Southeast Bioregion
Raleigh, NC
(919) 518-0311

North Charleston, SC (843) 529-3235

Southern Rocky Mountain Bioregion
Denver, CO
(303) 477-0660

Hudson River Bioregion
Glen Ridge, NJ
(973) 748-9800

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