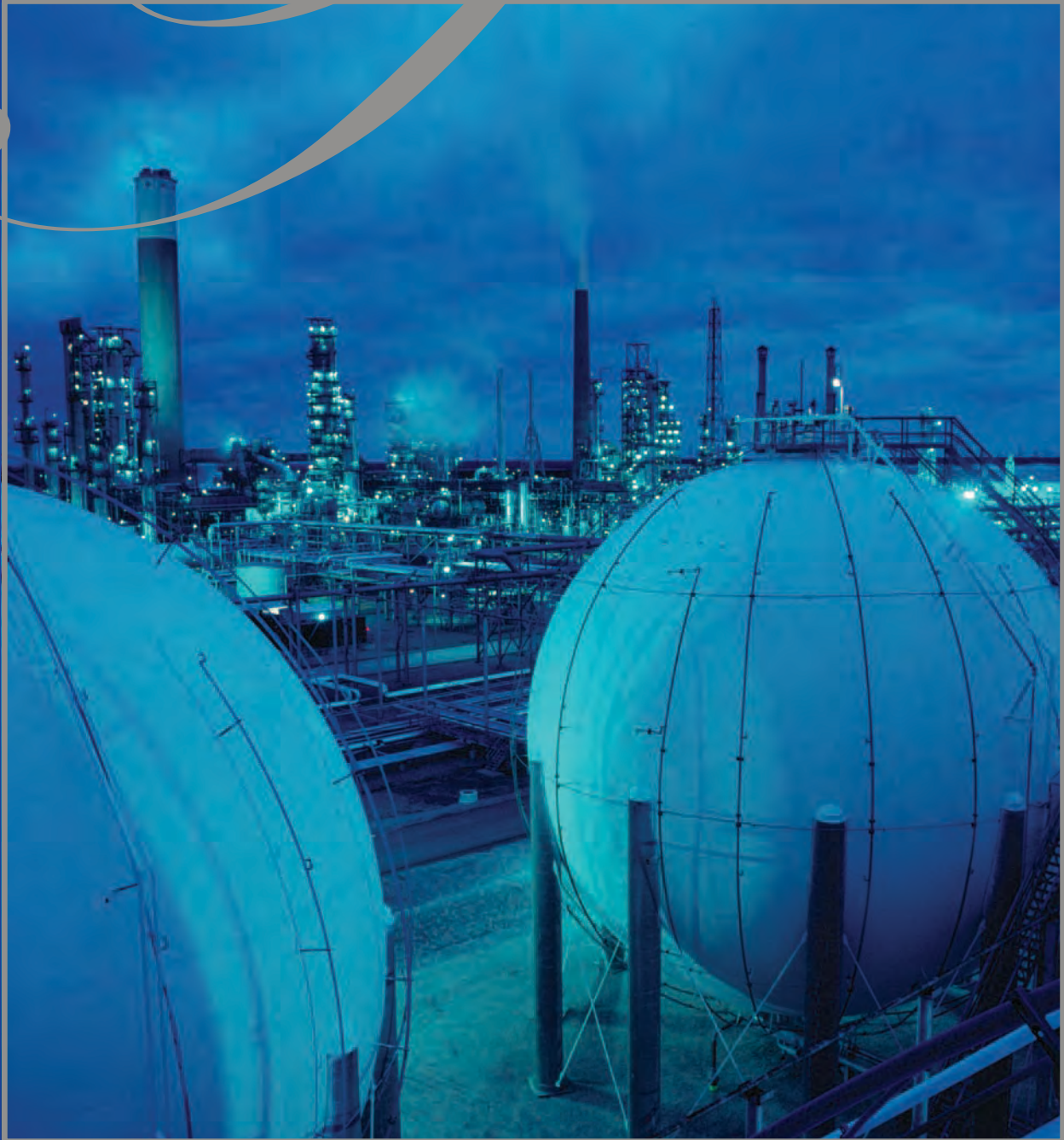


VOLUME 22 NUMBER 3 SEPTEMBER 2004

PERC REPORTS

Property and Environment Research Center



ARE WE RUNNING OUT OF OIL?

FROM THE EDITOR

A FOUNT OF IDEAS

I'm particularly pleased with this issue of *PERC Reports*. Nearly every article offers a new way of thinking about a familiar environmental or resource topic. I hope the issue will provide intellectual fodder for discussions in classrooms and over brown bag lunches.

Few readers, I suspect, have heard of University of Texas economist Erich Zimmermann, who died in 1961. As Robert L. Bradley Jr. shows in our cover story, however, Zimmermann had a strong grasp of why natural resources keep becoming more, rather than less, available. His "functional theory" holds that materials are not resources until humans take advantage of them. This idea supports the late Julian Simon's argument that humans are the ultimate resource and reveals the value of a political and social structure that allows resource entrepreneurship.

By now, readers of *PERC Reports* are aware that mandatory recycling has its flaws (see "Recycling Rubbish," by Daniel K. Benjamin, September 2003). But voluntary cycling is a different story. PERC senior associate Andrew P. Morriss reports that private recycling of plastic in Guatemala is growing rapidly.

Conservation biologists embrace wetlands for cleansing water and promoting biodiversity. But they rarely look at the negatives of additional wetlands, such as the proliferation of disease-carrying mosquitoes. University of Arizona entomologist Elizabeth Willott bridges this gap by examining the links between wetlands and mosquitoes.

In 1998 Mark Heller coined the term "the tragedy of the anti-commons." He pointed out that too many owners, all with veto power, can cause a resource to be underused. In this issue, PERC senior associate Donald R. Leal warns that the "anticommons" can surface in the process of designing individual fishing quotas. Leal's article—which I hope will spur more "anticommons" analysis—is based on a longer paper he presented at the Association of Private Enterprise Education (APEE) annual meeting in April.

"Greener Pastures," as usual, offers an optimistic view of environmental innovation. Home Depot is monitoring wood suppliers and goats are eating invasive weeds.

Finally, today's western water laws are often criticized for placing many restrictions on water markets. In his column "Tangents," Daniel K. Benjamin shares the reasoning behind some of those restrictions. Benjamin surmises that if the courts ruled rationally in the early twentieth century, perhaps they will do so today, but with quite different outcomes.

Jane S. Shaw

From left: Bradley, Morriss, Willott, and Leal.



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Cover: Storage Tanks at Oil Refinery
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ARE WE RUNNING OUT OF OIL?

Hubbert's model correctly predicted that U.S. oil production would peak around 1970. A sister prediction, that U.S. gas production would peak in 1970, was errant, however. And his prediction that global oil production would begin an irreversible decline around 2000 is off to a poor start.

"FUNCTIONAL THEORY" SAYS NO

By Robert L. Bradley Jr.

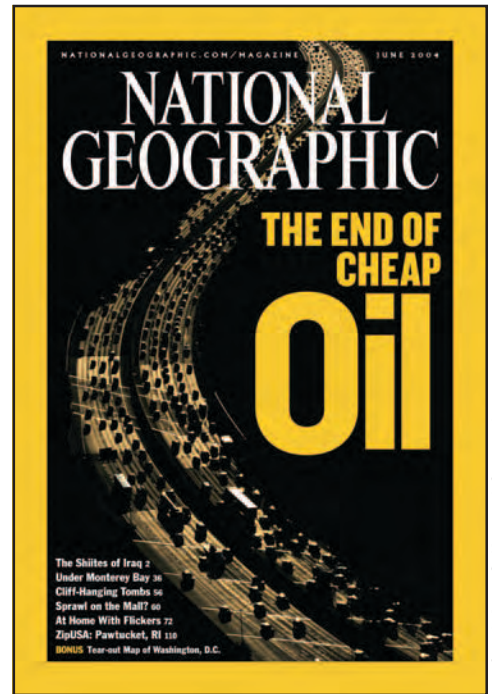
"This time it's for real," says the cover story of the June 2004 issue of *National Geographic*. "We're at the beginning of the end of cheap oil."

Books and articles written by geologists, environmentalists, and others regularly announce a new era of increasing oil scarcity.¹ Today's resurrected hero of the depletionists is M. King Hubbert (1903–1989), a Shell Oil Company geologist who a half-century ago presented a bell-shaped curve depicting oil production over time. But the theory of a little-known twentieth century economist, Erich Zimmermann, suggests this is unsound.

Hubbert's model correctly predicted that U.S. oil production would peak around 1970. A sister prediction, that U.S. gas production would peak in 1970, was errant, however. And his prediction that global oil production would begin an irreversible decline around 2000 is off to a poor start (Hubbert 1956). World oil production in 2003 was about 2.5 percent above 2000 (U.S. Energy Information Administration [U.S. EIA] 2004b).

The logic behind mineral-resource pessimism is simple. It goes like this: Oil is a finite resource, incapable of being reproduced in human time frames. Any usage reduces the stock, and geometric demand growth, such as the 1.9 percent annual increase in oil demand predicted for the next two decades (U.S. EIA 2004a, 167), will rapidly deplete remaining supplies. Fixed supply plus rising demand equals depletion and increasing economic scarcity.

"But look at the data," expansionists respond. The resource base for different minerals has expanded tremendously over time to meet growing demand—and at steady, and even falling, prices when adjusted for inflation. Resource availability has been positively, not negatively, correlated to consumption when human ingenuity has been allowed free rein.



Sarah Leen © National Geographic

The expansionist position is often associated with Julian Simon, who in 1990 won the most famous wager in the history of economics. He bet Paul Ehrlich, John Holdren, and others that the inflation-adjusted price of mineral resources would be less in 1990 than in 1980, and it was. A similar bet undertaken today would likely be a winner, too. Prices of global oil and North American natural gas in recent years have been higher than their historical average, but supply and demand adjustments promise to bring these prices down over time—given access to reserves and entrepreneurial incentives.

The gulf between the depletionists and expansionists can be better understood—even resolved—by appreciating the insights of the functional theory of mineral resources developed by Erich Zimmermann (1888–1961), an economist at the University of North Carolina and later the University of Texas. His insight provides a theoretical foundation for modern expansionist thought.

Zimmermann rejected the assumption of fixity. Resources are not known, fixed things; they are what humans employ to service wants at a given time. To Zimmermann (1933, 3; 1951, 14), only human “appraisal” turns the “neutral stuff” of the earth into resources. What are resources today may not be tomorrow, and vice versa.

“Resources are highly dynamic functional concepts; they are not, they become, they evolve out of the triune interaction of nature, man, and culture, in which nature sets outer limits, but man and culture are largely responsible for the portion of physical totality that is made available for human use” (Zimmermann 1951, 814–15). Zimmermann concluded that “knowledge is truly the mother of all resources” (10).

Zimmermann drew a clear distinction between the ways in which natural scientists and social scientists view resources. “To the physicist the law of the conservation of matter and energy is basic. The economist, however, is less interested in the totality of the supply than in its availability”

(Zimmermann 1933, 45). He warned: “To those who are used to view resources as material fixtures of physical nature, this functional interpretation of resources must seem disconcerting” since “it robs the resource concept of its concreteness and turns it into an elusive vapor” (4).

Physical to functional; objective to subjective; absolute to relative; static to dynamic; one-dimensional to institutional—Zimmermann’s real-word theory was ignored by the economic orthodoxy in its quest to remake their discipline into a “hard” science based on mathematical relationships. Economists embraced deterministic ideas of known, fixed resources that enabled them to calculate the “optimal” extraction rate of a “depletable” resource (Krautkraemer 1998). But it was at the expense of understanding the dynamics of real-word resources.

Depletionists-qua-alarmists err on their own ground by neglecting the vast size of the estimated carbon-energy resource base. The World Energy Council (2001, 161) has concluded that “fossil fuel resources are adequate to meet a wide range of possible scenarios through to 2050 . . . and well beyond.” Similarly, the Intergovernmental Panel on Climate Change (IPCC) found that fossil fuels are so abundant that they “will not limit carbon emissions during the 21st century” (IPCC 2001, 4). The IPCC estimates that only about 1.5 percent of the total physical resource base of the Earth’s crust was produced and consumed between 1860 and 1998 (236). Such supply represents, potentially, many thousands of years of increasing consumption (Bradley and Fulmer 2004, 91).

Geologists divide the earth’s resource base into three categories: “proved” (found and ready to be produced), “probable” (expected to become proved in time), and “speculative” (estimated but uneconomic). *Resource-ship*—that is, entrepreneurial development of resources—turns probable into proved, and speculative into probable (McDonald 1995). What is high cost today becomes lower cost tomorrow. Heavy oils, such as orimulsion in Venezu-



ERICH ZIMMERMANN
(1888–1961)

ERICH ZIMMERMANN'S FUNCTIONAL THEORY OF RESOURCES

RESOURCES & MAN

P “Previous to the emergence of man, the earth was replete with fertile soil, with trees and edible fruits, with rivers and waterfalls, with coal beds, oil pools, and mineral deposits; the forces of gravitation, of electro-magnetism, of radio-activity were there; the sun set forth its life-bringing rays, gathered the clouds, raised the winds; but there were no resources.” (1933, 3)

RESOURCES & INSTITUTIONS

A “A functional interpretation of resources . . . makes any static interpretation of a region’s resources appear futile; for resources change not only with every change of social objectives, respond to every revision of the standard of living, change with each new alignment of classes and individuals, but also with every change in the state of the arts—institutional as well as technological.” (1933, 216)

RESOURCES & CONSERVATION

I “If petroleum resources were in their entirety available from the beginning and could not increase but only decrease through use, it might be correct to advocate ‘sparing use so as to delay inevitable exhaustion.’ But if petroleum resources are dynamic entities that are unfolded only gradually in response to human efforts and cultural impacts, it would seem that the living might do more for posterity by creating a climate in which these resource-making forces thrive and, thriving, permit the full unfolding of petroleum reserves than by urging premature restraint in use long before the resources have been fully developed.” (1957, 8–9)

Sources: *World Resources and Industries* (Harper & Brothers, 1933); *Conservation in the Production of Petroleum* (Yale University Press, 1957).

Photo courtesy of Prints & Photographs Collection, the Center for American History, the University of Texas at Austin.

ela and bitumen in Alberta, Canada, are now rivals to crude oil. These are examples of Zimmermann's "resources are not, they become" that he did not live to see.

Vainly, economists working in the fixity paradigm have looked for a "depletion signal" in the empirical record—some definitive turning point at which physical scarcity overcomes human ingenuity. A new research program is in order. Applied economists should focus upon institutional change to explain and quantify changes in resource scarcity. The legal framework of a country, and even a people's customs, explain the abundance or paucity of mineral development.

The 1970s' price spikes with crude oil can be better understood in terms of human factors rather than as a depletion signal. Nature's "tank" was not running low; rather, government-imposed price ceilings distorted market processes. Similarly, today's high oil prices, at least in part, reflect an "institutional signal"—an artificial scarcity partly caused by the political blockage of oil production in the Arctic National Wildlife Refuge in Alaska and other technologically producible oil provinces around the world.

Resources grow with improving knowledge, expanding capital, and capitalistic policies, including privatization of the subsoil, that encourage market entrepreneurship. Resources shrink with war, revolution, strife, nationalization, taxation, price controls, and access restrictions. Man is the creator of resources, but man can also destroy and immobilize resources.

Whether or not oil, gas, and coal are exploited far into the future depends not only on consumer demand but also on whether government policies will allow the ultimate resource of human ingenuity to turn the "neutral stuff" of the earth into resources in ever-better ways. With this understanding, it may be appropriate to join energy economist M. A. Adelman (1997, 26) and abandon the term "exhaustible" to describe mineral resources.² The end of the mislead-

ing renewable-nonrenewable framework would bring Zimmermann's functional theory to full flower and improve understanding for better real-world decision making.

NOTES

1. Four such books are: Kenneth Deffeyes, *Hubbert's Peak: The Impending World Oil Shortage* (Princeton: Princeton University Press, 2001); Richard Heinberg, *The Party's Over: Oil, War and the Fate of Industrial Societies* (Canada: New Society Publishers, 2003); David Goodstein, *Out of Gas: The End of the Age of Oil* (New York: W. W. Norton, 2004); and Stephen Leeb and Donna Leeb, *The Oil Factor: Protect Yourself—AND PROFIT—from the Coming Energy Crisis* (New York: Time Warner, 2004).

2. The term "renewable" for such mainstays as hydropower or wind power can be abandoned as well. Economic, environmentally workable sites are scarce and, by depletionist thinking, limited.

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RECYCLING: A SUCCESS STORY

Having begun with relatively clean, post-industrial scrap from local plastics factories, Ecoplast now recycles dirty post-consumer waste (that is, household trash) taken from Guatemala City's sprawling garbage dump. In this photograph, two of Ecoplast's partners, Ernesto Gil and Ramón Parellada, stand amid piles of collected plastic.

GUATEMALA ENTREPRENEURS DO WHAT U.S. CITIES CAN'T

By Andrew P. Morriss

It is increasingly evident that in industrialized nations such as the United States and Sweden mandatory post-consumer recycling programs often raise costs, waste resources, and even harm the environment.¹ In Guatemala, however, a competitive recycling industry that successfully recycles both post-industrial and post-consumer waste has grown up without any coercive government action. In fact, Guatemalan entrepreneurs are competing for sources of recyclable materials, expanding the industry's reach beyond its initial niche of recycling post-industrial scrap.



Courtesy of Ecoplast

Eight years ago, the partners in a Guatemalan plastic packaging company began a small recycling operation they named Ecoplast. The recycling company has grown from a single, jury-rigged machine at the back of the packaging company to a 24-hour-per-day, 7-days-a-week operation using imported Italian machinery capable of handling more than 400 kg/hour of plastics, with more than thirty-five full-time employees and as many as twenty temporary workers at busy times. Most impressively, the company has expanded to additional waste streams—and is looking for more.

Having begun with relatively clean, post-industrial scrap from local plastics factories, Ecoplast now recycles dirty post-consumer waste (that is, household trash) taken from Guatemala City's sprawling garbage dump. Ecoplast sells the recycled plastic pellets it produces to customers in China, Mexico, and the United States, as well as to local plastics producers.

Guatemala is a relatively poor country (per capita gross national income was only \$1,910 in 2003 compared to \$37,610 in the U.S.), so its citizens use less plastic than those in wealthier countries. Even so, the Guatemalan recycling industry has succeeded at doing what wealthier countries struggle with—recycling post-consumer waste. Why has private-sector recycling been so successful in Guatemala?

For one thing, Guatemala does not domestically produce the plastic pellets used to make packaging and other products. The transportation costs of bringing such pellets from the United States (the primary source of raw materials for the



Recycling post-consumer material is dependent upon dividing garbage into its separate components. This separation can either occur through compensated, voluntary work at the end of the waste stream, as in Guatemala, or through mandatory uncompensated labor in the home, as with most U.S. municipal recycling programs.

Guatemalan plastics industry) created a business opportunity for plastics recycling.

Another factor is the relatively low cost of labor in Guatemala. Recycling post-consumer waste is labor-intensive. It requires separating the various types of plastic from one another and from the remainder of the garbage, and then cleaning it for recycling. (The high cost of labor in the United States is one reason why U.S. municipal recycling programs require consumers to presort their garbage.) In Guatemala, sorting and cleaning garbage are accomplished without making the recycled product more expensive than virgin materials.

Turning an opportunity into a successful business takes more than a potential cost advantage, of course. Guatemalan entrepreneurs have found new ways to separate recyclables from other garbage. Recycling begins in the trucks (operated by private concessionaires, not the government) that pick up Guatemala City's garbage. As the trucks circulate through the

city, employees work inside the trucks sorting out recyclable materials, including the bags households use to dispose of their trash. By the time the truck arrives at the dump, a first pass at removing recyclables has already taken place. (By combining trash collecting and sorting in one truck, the Guatemala method reduces truck air pollution emissions and lowers costs. In New York City, in contrast, one set of trucks picks up trash and another picks up recyclables—leading to high costs, including environmental ones.)

Once the garbage is unloaded at the Guatemala City dump, an army of independent garbage sorters sifts through it a second time in search of recyclables. A series of specialized markets exists at the dump, including various types of plastics, glass, and metal. Ecoplast recently opened a facility next to the dump. This cut its transportation costs (and truck emissions) significantly, since on-site shredding reduces the volume that must be trucked to the main plant.

The life of a garbage sorter is not an easy one. Guatemala's city dump has been featured in documentaries that focus on the difficult lives of the poor people who work there. Many have scarred arms and legs from the cuts they receive sifting through the refuse. The smell and clouds of insects that hover around the dump make working conditions unpleasant. Yet garbage sorting provides a source of income for hundreds of people.

Without the efforts of the garbage sorters, the critical separation of valuable materials from trash would not take place. Recycling post-consumer material is dependent upon dividing garbage into its separate components. This separation can either occur through compensated, voluntary work at the end of the waste stream, as in Guatemala, or through mandatory uncompensated labor in the home, as with most U.S. municipal recycling programs.

As more businesses have entered plastics recycling, they have expanded their search for recyclable plastic beyond the city dump and other original sources. Ecoplast, for example, has persuaded several food companies to sell it their plastic packaging waste rather than burn the waste in open air fires. The food companies earn income from a waste product, Ecoplast secures more plastic, and air quality improves as open-air burning of heaps of plastic ends.

By providing remote collection points with equipment to crush bottles, recyclers can cut the costs of transporting post-consumer waste. Ecoplast, for example, plans to collect post-consumer plastic at schools throughout Guatemala.

Another Guatemalan company found a unique opportunity to gather post-consumer materials. A hydroelectric plant on the Las Vacas River had to deal with floating trash in the river that snarled its equipment. To keep the trash out, the company built a screen across the river upstream from the intake point. The firm then built a plant to recycle the plastics that accumulated. It now creates plastic fence posts from the post-consumer trash it removes from the water.

Recyclers face challenges unimaginable in developed economies. Recycling requires substantial amounts of electricity, transportation services, and clean, cold water (inputs that are often obscured by recycling's "green" image). None of these is cheap or readily available in Guatemala. Ecoplast, for example, spends more than \$8,000 per month on electricity, more than twice what it would pay to operate the same plant in even the most expensive parts of the United States.

A "garbage mafia" operates at the Guatemala City dump. A series of bosses hold "concessions" for various types of material at the dump from the main organized crime groups. Only individuals authorized by the relevant boss may sort trash, and all the recyclables they find must be sold to the boss. The lack of competition among suppliers led to substandard loads of recyclables being delivered to Ecoplast, including unsorted plastics and dirty material.

Ecoplast decided to circumvent the garbage boss and posted a sign at the dump seeking direct sales of recyclables. The garbage mafia quickly retaliated, cutting off sales to Ecoplast and physically threatening the facility and the company's owners. Because of the power of the garbage mafia—which stems from its ability to shut down the dump completely—no public authority was willing or able to prevent this lawless behavior. By complaining to higher authorities within the mafia, however, Ecoplast was able to induce the plastics boss to change his behavior.

Even a major advantage, low labor costs, is not what it would be in a freer market. The Guatemalan government raises labor costs through a variety of taxes and regulations, including a requirement that employers pay workers an additional month's salary every six months (effectively requiring the payment of seven month's pay for six month's work), a mandatory bonus each month, and fifteen working days of vacation per year. Together with unemployment insurance and other taxes, these costs add approximately 45 percent to labor costs.

Someday Guatemala may, like the United States, become so wealthy that its citizens won't be eager to sort garbage for their livelihood, and recycling may recede as a business. But today it is providing opportunities for increasing prosperity in Guatemala, while showing that when recycling makes economic sense, entrepreneurs will provide it.

NOTE

1. The *New York Times* reported (February 2, 2004) that New York City's Independent Budget Office found that the city's recycling program cost from \$34 to \$48 more per ton than simply collecting all garbage and sending it to landfills, largely due to the additional cost of operating two separate fleets of trucks to pick up garbage and recyclables. For more analysis, see Daniel K. Benjamin, "Eight Great Myths of Recycling," *PERC Policy Series* PS-28, September 2003 (www.perc.org/publications/policyseries/recycling.php).

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UNWELCOME VISITORS

Wetlands are generally good habitat for mosquitoes, some of which may transmit harmful viruses (such as yellow fever or West Nile) or pathogens (such as malaria).

RESTORING WETLANDS CAN BRING BACK MOSQUITOES

By Elizabeth Willott

The benefits of restoring wetlands are widely appreciated. Wetlands help purify our waters, control flooding, promote biodiversity, and provide aesthetic benefits. The federal government has a policy of “no net loss” of wetlands, and a key way to achieve that goal is to restore or create wetlands. However, there is a downside. Wetlands are generally good habitat for mosquitoes, some of which may transmit harmful viruses (such as yellow fever or West Nile) or pathogens (such as malaria). Malaria and other mosquito-vectored diseases are a brutal form of population control.



© CDC/Graham Heid, Dr. Harry D. Pratt

Since at least the time of the Romans, people have associated malaria and wetlands and have worked to reduce rates of malaria by draining swamps and marshes.¹ Although most people now associate malaria with the tropics, historically malaria was present as far north as England and the Scandinavian countries.

Malaria, yellow fever, and other mosquito-vectored diseases have significantly affected U.S. history. For example, in 1802, Napoleon sent 33,000 men to conquer Haiti and the Mississippi River region. Twenty-nine thousand died of yellow fever. Unable to sustain such losses, France sold Louisiana to the U.S. government in 1803. Malaria reached epidemic proportions in the Midwest up to the latter part of the 1800s; southern states saw epidemics until the early 1900s. Even the desert Southwest suffered: Several Arizona territorial Army camps closed due to malaria.

Malaria's decline in the United States and Europe in the late 1800s was due mainly to draining swamps and removing mill ponds, improvements in housing, and isolation of sick people in mosquito-proof areas. Draining swamps also exposed good agricultural land, enabling people to afford better houses and thus isolate the sick. Actuarial statistics for North Carolina in 1910 (the earliest figures available) show annual mortality from malaria was 32.2 per 100,000 people; by 1932, it was 1.6 per 100,000.

With our current standard of living, it is unlikely that malaria or yellow fever could return to historical levels. Still, there is reason for concern. West Nile virus, introduced into New York in 1999, killed 264 people in 2003 and seriously sickened at least 9,862, according to the Centers for Disease Control. Other viruses present elsewhere in the

With our current standard of living, it is unlikely that malaria or yellow fever could return to historical levels. But the West Nile virus, introduced into New York in 1999, killed 264 people in 2003 and seriously sickened at least 9,862, according to the Centers for Disease Control.

world could similarly be introduced into the United States, as well as new species of mosquitoes. In the mid-1980s *Aedes albopictus* arrived; in the late 1990s *Ochlerotatus japonicus*.

In only a few years, a newly opened wetland can have a mosquito problem. Between 1974 and 1988, at least five of nine pilot water treatment plants using aquatic plants closed because of mosquito problems (Eldridge and Martin 1987; Martin and Eldridge 1989). Mosquitoes increased a hundredfold after operation started at a constructed, surface-flow wastewater treatment wetland in Tucson (Karpiscak et al. 2004).

In listening to students and colleagues, I received the impression that introductory courses in biology and conservation biology largely ignore mosquitoes (and other similar potential disvalues in nature). Checking web-posted syllabi for conservation biology courses, I discovered that the most common textbooks were Meffe and Carroll (1994, 1997) and Primack (2000). These texts barely mention mosquitoes or suggest that restoring nature likely will have some negative consequences. Yet both texts discuss the negatives arising from the loss of wetlands.

Mosquitoes are also only cursorily addressed in key professional publications for restoration biologists and others managing or creating wetlands for water treatment. For example, a key reference on wetland construction is *Treatment Wetlands* (Kadlec and Knight 1996). “Mosquitoes” is not in the index. With searching, one finds mosquitoes discussed on two of the 893 pages. The authors conclude that mosquitoes are not usually much of a problem unless organic loadings are excessive, or bulrush or cattail growth gets too dense, or there is debris (such as floating cattails) on the surface.

In practice, vegetation grows, debris accumulates, and mosquito-eating fish die or cannot be used. I searched three key journals that address wetlands. The *Journal of the American Water Resources Association* does not include “mosquito” as a searchable term. The one paper I found that came close to addressing mosquito problems said that education may be needed to help neighbors with “perceived vector problems” (Sauter and Leonard 1997, 162).

In *Wetlands*, fifteen of 254 papers mentioned mosquitoes. Only four of these could be classified as significant for people interested in mosquitoes—they do connect mosquitoes to site design and they cite some relevant papers. But only one of the three potentially relevant papers to which they direct the reader was published in a fully refereed journal, and that is not a wetlands journal but the *Journal of the American Mosquito Control Association*.

Of the 560 papers published since 1992 in *Ecological Engineering*, only three address primarily mosquitoes and wetlands; only one is about a U.S. wetland (Thullen et al. 2002).



© James Guthary/CDC/PHIL

(One does give a useful Australian perspective, however.) In sum, in three key journals with more than 1,000 research papers, only one was devoted to managing mosquitoes in the United States.

Yet entomologists, restoration biologists, hydrologists, and others are actively working to manage mosquitoes. Several journals and conferences target people active in mosquito management. A gap exists. The knowledge of these field scientists is not included in the textbooks about conservation biology, nor do these scientists generally participate in projects to develop or restore wetlands.

One reason for this gap may be that restoration project funding is often short term, and a serious mosquito problem may emerge only later. Applicants also may fear loss of funding if they talk about possible negatives. Yet representatives of funding agencies have assured me that addressing an obvious problem strengthens a proposal.

Steps can be taken. The project can incorporate design elements to reduce the risk of mosquitoes becoming a major problem,² and mosquitoes can be monitored. Advance planning may stimulate sufficient interest that some people will even volunteer to help.

Novel and better solutions can emerge. For example, mosquito control personnel often suggest adding the fish *Gambusia*, also called mosquito-fish, to ponds, since *Gambusia* eat mosquito larvae. However, *Gambusia* also eat some native fish species, including the endangered Gila top-minnow (which also eats mosquitoes).

Because the Gila top-minnow is endangered, it is illegal for pet stores to sell it and wetland managers who wish to add it face more regulation. Several individuals have been working, however, to overcome the obstacles, and soon, private citizens may be able to introduce Gila top-minnows to their property without incurring excessive legal liability.³

I want to close by moving from ecological to social considerations. When we teach, when we work as professionals, or when we go out to enjoy the products of others, we also create and maintain human

social environments. We have a responsibility to remember relevant history, see the negatives as well as the positives, and realistically address problems, be they social or biological.

NOTES

1. To access the literature citations on this and most topics in this article, please see the longer article, Willott (2004), on which this *PERC Reports* essay is based. Two other key resources are Gillett (1972) and Spielman and D'Antonio (2001).

2. A partial bibliography can be found online: research.biology.arizona.edu/mosquito/Ecology/WetlandBib.html.

3. This Safe Harbor Agreement can be accessed at: arizonaes.fws.gov/ then choose Document Library, then Safe Harbor Agreements.

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A NEW FISHING TRAGEDY?

The tragedy of the anticommons was popularized by Michael A. Heller to depict the exact opposite of the tragedy of the commons. It occurs when there are many owners of a resource, each with a right to exclude another person from using it. It typically leads to underuse. The Alaska crab fishery could see the tragedy of the anticommons.

THE "ANTICOMMONS" LEADS TO UNDERUSE

By Donald R. Leal

The tragedy of the commons explains why ocean fisheries are prone to overuse (Hardin 1968).¹ The good news is that individual fishing quotas, called IFQs or ITQs (for individual transferable quotas), have overcome this tendency in a growing number of fisheries around the globe. I am currently working with the Reason Public Policy Institute and Environmental Defense to educate policy makers, fishing groups, and the public about them (see www.ifqsforfisheries.org).



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In our enthusiasm for individual fishing quotas, however, we should be aware of the possibility that poor design of an IFQ program could lead to the tragedy of the anticommons. This idea was popularized by Michael A. Heller (1998) to depict the exact opposite of the tragedy of the commons. It occurs when there are many owners of a resource, each with a right to exclude another person from using it. Just as the tragedy of the commons leads to overuse, the anticommons typically leads to underuse.

The original example used by Heller was Moscow retail store property after the fall of the Soviet Union. As commerce emerged in Russia, numerous well-stocked kiosks dotted the streets. Yet many of the stores along city streets in Moscow remained empty. Stores were better sites for enterprise, but something held back their use. Heller (1998, 636) argued that the property rights associated with store property were a confusing array of arcane property rights mostly linked to the previous Soviet regime. Ownership might be shared by local, regional, or national governments, occupants (which could be a workers' cooperative), and others such as government regulators and "balance sheet holders."

Each rightholder had veto power—the right to block the use of a store without the holder's permission. Even though it was potentially in the interest of each owner to obtain value from the store, getting this heterogeneous set of owners to agree on store use was next to impossible. As a result, many Moscow stores remained empty for most of the 1990s.



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For decades, governments have tried to avoid the tragedy of the commons through regulations. They have limited season length, constricted the areas open to fishing, dictated types of gear and the size and power of vessels, and set a minimum size for landed fish. Here, a halibut fisherman collapses after 24 hours of fishing.

This concept can be applied to ocean fisheries. For decades, governments have tried to avoid the tragedy of the commons through regulations. They have limited season length, constricted the areas open to fishing, dictated types of gear and the size and power of vessels, and set a minimum size for landed fish. These approaches have not eliminated overfishing, nor have they prevented the enormous waste and hazards of the destructive race for fish.²

With IFQs, however, each fisherman is entitled to catch a specified portion of the total allowable catch³ that is set each season by fishery managers. The fisherman can take the quota when he wants to, and the race to fish disappears. Because the quota shares are transferable, current holders can adjust the size of

their fishing operations by buying and selling quota shares, or even retire from the business.

New Zealand and Iceland now use individual quota programs to manage nearly all their commercial fisheries. Canada, Australia, the United States, Greenland, and the Netherlands use them for some fish species. Overall, these programs have generated higher incomes for fishermen, improved product quality, reduced fleet excesses, and nearly eliminated instances where the actual harvest exceeded the total allowable catch (see, for example, De Alessi 1998; Repetto 2001; Wilen and Homans 2000).

The Alaska halibut fishery illustrates the improvements. Under the old regulatory regime, the seasons got shorter and shorter, but fishermen still tried to catch as much as they could as quickly as they could, and the overall harvest often exceeded the total allowable catch. By the early 1990s, halibut fishermen could fish during just two or three 24-hour periods a year.

When IFQs were adopted in 1995, the fishing season lengthened to more than eight months a year. Fishermen could sell more fresh fish and receive higher dockside prices (General Accounting Office 2002, 21). Safety improved and gear loss declined (Hartley and Fina 2001, 34). Actual harvests no longer exceeded the total allowable catch each season (Dinneford et al. 1999). Fleet excesses were reduced as well.

Alaska crab fisheries are among the next in line for IFQs. The reasons are obvious: The fishing season is short, down to less than a week per year. Fishermen deliver all of their catch to processors at once, resulting in a glut of crab and lower prices. The hectic pace of fishing increases fishing costs, complicates management of the fish stocks, and increases danger for fishermen.

IFQs have been proposed, but there is a catch. Congress has authorized

an additional factor, IPQs or individual processing quotas. That's where the anticommons comes in.

Processors—the companies that receive and process crab meat brought to the dock—can be hurt when fishermen shift to IFQs. With longer seasons, fishermen will be able to bring in crab when prices are high, and processors will no longer be processing huge quantities of crab all at once. The expensive refrigeration equipment that some invested in may become unnecessary, at least in the short term.

To aid these processors, Senator Ted Stevens of Alaska pushed an appropriations rider earlier this year that requires IPQs as a prerequisite for IFQs in the crab fisheries. Under the requirement, fishermen will have to sell most of their catch to certain processors. In one crab fishery, for example, ninety percent of the catch must go to eight processors (North Pacific Fishery Management Council 2002).

With the supply of crab guaranteed, processors may experience the anticommons. Even though market prices will be higher for fresh crab, they may prefer lower returns to idling some of their costly processing and storage capital (Matulich, Mittelhammer, and Reberte 1996). Fishermen locked into less-than-competitive prices too may join the anticommons. They may find the prices too low to justify harvesting all the outstanding quota shares. Some of the shares may go unused.

Already in the Alaska halibut fishery, we have seen that too many restrictions on IFQs can lead to underuse. The initial rules prohibited selling quota shares if they were less than 20,000 pounds. The goal was to protect small part-time fishermen by preventing a large operator from buying up a lot of small shares. But some quotas were simply too small for their owners to use them. (This led to redesign of the program.)

In sum, IFQs are an important solution to the tragedy of the commons. But we should examine how well these programs are being implemented. One of the problems to watch for is the tragedy of the anticommons.

NOTES

1. Note that economist H. Scott Gordon (1954) examined commons problems in the fishery nearly a decade and a half earlier.

2. For examples, see Leal (2002).

3. The total allowable catch is generally the maximum amount of fish that can be caught in a year without depleting the resource.

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By Linda Platts

THE GREENING OF HOME DEPOT

As summer draws to a close, Home Depot stores across the nation are flooded with eager customers loading their carts with lumber, tile, and paint as they rush to complete home improvement projects. It is a far different scene than that of the late 1990s when angry protesters picketed hundreds of stores belonging to the world's largest lumber retailer, accusing the company of endangering native forests.

Fearing a consumer backlash that could lead to sliding sales, executives agreed to stop using products from endangered forests and to speed the transition to more environmentally friendly practices. Overseeing these new policies was Roland Jarvis who was given the title of environmental global project manager. It is a big name for a big job, as Jarvis has the authority to sever logging contracts with any supplier whose practices harm endangered forests or otherwise hurt the environment.

Indonesian suppliers were some of the first to feel the effects of Home Depot's new green policies. Jarvis asked the loggers to stop using slash-and-burn methods to raze large swaths of rain forest, but the practice continued. In response Jarvis cut 90 percent of Home Depot's purchases of Indonesian lumber. In Gabon, slash-and-burn methods were being used in habitat occupied by the endangered lowland gorilla. When Jarvis demanded changes from the company's suppliers and didn't get them, he looked elsewhere, transferring contracts to tree plantations in Brazil and Central America.

Jarvis admits that cutting ties with Indonesia and Gabon posed no threat to the company's bottom line as 95 percent of its wood comes from North America. And while harmful logging practices may not have changed significantly in some countries where Home Depot did business, pressure from the giant U.S. corporation has had an impact. In Chile, Jarvis brokered a deal that will discourage landowners from converting native forests to tree farms, even though the company depends on tree farms for supply.

Even though Home Depot's success has been limited at times, environmentalists are encouraged by the impact of markets in bringing about environmental improvements. It appears that corporations can produce environmental benefits more quickly and effectively than either governmental legislation or the courts.

—*Wall Street Journal*

GOATS TO THE RESCUE

The Rio Grande's cottonwood forest is overgrown with water-sucking, fire-fueling salt cedar and other invasive weeds. To clear the bosque, the Middle Rio Grande Conservancy District in New Mexico is hiring up to 1,000 goats to munch

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their way through the unwanted vegetation and preserve both the cottonwoods and the water flow.

Goats have already been used successfully on smaller projects and proved themselves to be both effective and economical. The larger 100-acre project is due to begin in mid-September after the migratory bird nesting period. The goats will be confined to plots of two to five acres by temporary fencing. Herders must supervise the goats around the clock to track down any escapees and monitor interactions with wildlife and domestic animals in the area. They will also have to move the goats once an area has been thoroughly munched.

The goat project provides an opportunity for livestock owners and goat herders in New Mexico to supplement their incomes while allowing the conservancy to improve the health of the bosque at a reasonable cost.

—*Albuquerque Tribune*

SHRIMP MOVE INLAND

More than sixty miles from the nearest ocean, Pacific white shrimp are growing plump and juicy in pure fresh water from deep artesian wells. They have been certified by the U.S. Department of Agriculture as organic, meaning they are produced without any antibiotics, growth hormones, conventional pesticides, or fertilizers made with synthetic ingredients.

OceanBoy shrimp farms, located in south central Florida, are the brainchild of David MacMahon. With a doctorate in marine biology, MacMahon says he has witnessed the destruction wrought by both shrimpers at sea and shrimp farmers, and set a goal for his company of providing a superior product without any environmental damage. Traditional shrimpers scour the bottom of the ocean floor with drag nets harming ocean floor habitats and reefs, while shrimp farmers have destroyed thousands of acres of mangrove swamps with the pollution created by coastal shrimp farming. Mangrove forests and their estuaries are the nurseries for many ocean fish.

MacMahon raises his shrimp in a system of ponds

that are lined with high-density polyethylene allowing no exchange between the ponds and the ground. Water is pumped into the ponds from artesian wells. Dirty water containing waste products is cleaned with filters as well as natural systems such as young mangroves living in the ponds. There is no discharge, and all of the water is recirculated through the system. The mangrove trees are sold or donated to groups that are replanting mangrove forests along the coast.

Organic shrimp from OceanBoy can cost nearly twice what other shrimp are selling for, but MacMahon believes there is a growing demand for products such as his that assure people the food is safe and healthy. In addition, he says, shrimp is the second most popular seafood after tuna. He already has plans to double and triple the size of his operations over the next few years. In his view, the future of marketable and affordable seafood is in aquaculture, not the open ocean.

—*Fort Myers News-Press*

SHOOTOUT AIDS TEXAS WILDLIFE

The South Texas Wildlife Shootout is helping preserve wildlife habitat on private land and educating the public about the unique wildlife in the region. Sponsored by the Valley Land Fund in McAllen, Texas, the shootout is one of the largest and richest wildlife photography contests in the nation, offering top prizes ranging from \$15,000 to \$30,000.

This unusual contest pairs photographers with private landowners who open their property for the contest. Winning teams share the prize money thus rewarding the landowners for maintaining and enhancing wildlife habitat.

Photographs from each contest are compiled into stunning coffee table books. Proceeds from the sale of the books are used by the Valley Land Fund to purchase conservation easements on private land, establish land preserves, and manage native habitat on acreage that has been donated to the fund.

—*www.valleylandfund.com*

TO TRADE OR NOT TO TRADE

By Daniel K. Benjamin

Every western state limits its citizens' ability to transfer water rights. Most commonly, although owners of water rights may use water in ways and amounts consonant with historical patterns, they cannot freely sell or lease the rights to that water. Now that the economic value of water is rising rapidly and new uses for water are being developed, such restrictions seem to be classic examples of regulations and laws that waste resources.

Research by Mark Kanazawa (2003) focusing on the history of water law in California suggests, however, that such restrictions were originally devised to sensibly *conserve* resources. If Kanazawa's reasoning is applicable to today's jurists and policy makers, one might reasonably hope that contemporary courts (and even legislatures) will soon look more favorably on allowing water transfers.

Water resides in two forms: as surface water, such as streams, and as groundwater, located under the Earth's surface, typically in permeable strata such as sandstone. Like many jurisdictions, California sharply limits the sale or other transfer of groundwater "out-of-basin", i.e., from one hydrologic unit (such as an aquifer) to a different one. Kanazawa shows why these restrictions originally were imposed.

Until about 1900, California permitted out-of-basin transfers, basing its policy on long-standing precedents in English common law. Under the principle of *ad coelum* (literally, "to the sky") water under the ground was considered to be part and parcel of the property above it. Just as the property owner had broad discretion to use the ground, so too did he have broad discretion in his use of groundwater. Beginning in 1903, however, judicial thinking on this matter changed rapidly. Within a few years the California Supreme Court had laid down the sharp limitations on out-of-basin transfers that have since dominated California water policy.

Kanazawa argues that the Court was guided by two forces in deciding to limit groundwater transfers. First, scientific understanding had advanced rapidly in the late nineteenth century. Previously, although it had been acknowledged that removing groundwater could adversely affect the ability of others to make withdrawals from an aquifer, the mechanics and extent of such effects had not been well understood. Hence, courts had been reluctant to restrict a landowner's ability to use the water under his land. By the end of the

economist, *n.* a scoundrel whose faulty vision sees things as they really are, not as they ought to be.

—after Ambrose Bierce

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century, hydrologists were able to ascertain both the nature and likely extent of the effects elsewhere in a basin due to a withdrawal from any given location. This knowledge gave courts the tool they needed to evaluate the costs that one user might inflict on another and to assess damages and restrict usage accordingly.

In Kanazawa's view, the second critical development was a series of events that sharply raised the costs that one groundwater user could impose on other users in the same basin. In the 1890s, the number of irrigated farms in southern California doubled and the amount of irrigated acreage rose 43 percent. Moreover, beginning in 1893, southern California experienced a decade of drought, which reduced the supply of surface water. Finally, a contemporaneous series of technological advances in pump technology reduced pumping costs sharply, leading to a rapid increase in the depth and extraction rate of wells.

The reduced supply of surface water and increased irrigation raised the costs imposed on within-basin users of any out-of-basin transfers. And the improved pump technology made it more likely that large-scale pumping for such purposes would take place. Given the courts' view that the groundwater in a basin was implicitly owned by the basin's landowners, it became clear that court-mandated transfer restrictions had the potential to benefit landowners, despite the owners' resultant loss of the right to freely transfer groundwater. Hence, in Kanazawa's view, the California Supreme Court decided on quite pragmatic (albeit implicit) cost-benefit grounds to restrict such transfers.

The historical developments in California are important because of contemporary developments there and elsewhere. The economic value of water is rising, often because of new uses (such as increased stream flows to enhance trout populations in Oregon) or new users (such as recent émigrés to otherwise-arid Las Vegas). When compounded by several years of drought-reduced surface water supplies in the West, these developments suggest that the highest valued users of water today may be outside the basins where groundwater is most plentiful. If so, principles of economic efficiency inform us that the out-of-basin transfers that courts opposed a century ago could today increase, rather than decrease, welfare in exporting basins.

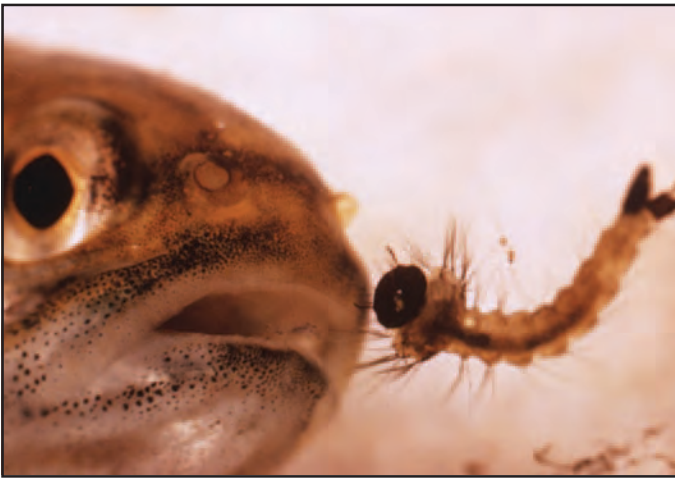
More generally, the changing demands for and supplies of water over the last 20 years both imply that transfer restrictions for surface water or groundwater are well worth reviewing for their equity and efficiency. One can only hope that the willingness of California courts to take into account economic factors early in the twentieth century will be repeated by courts there and elsewhere early in the twenty-first century.

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PERC REPORTS

A mosquito-fish (Gambusia) is about to eat a mosquito larva. Adding such fish is one way to slow the increase in mosquitoes caused by wetlands restoration. But conservation biologists tend to ignore the problem of mosquitoes. See page 10.



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INSIDE THIS ISSUE

- 3 ARE WE RUNNING OUT OF OIL?**
Not according to Erich Zimmermann.
By Robert L. Bradley Jr.
- 7 RECYCLING: A SUCCESS STORY**
It works in Guatemala, for good reasons.
By Andrew P. Morriss
- 10 UNWELCOME VISITORS**
Along with ecosystem services, wetlands bring mosquitoes. *By Elizabeth Willott*
- 13 A NEW FISHING TRAGEDY**
The "anticommons" leads to underuse.
By Donald R. Leal
- 16 GREENER PASTURES**
Home Depot protects endangered forests.
By Linda Platts
- 18 TANGENTS**
Making sense of early court cases on water trading. *By Daniel K. Benjamin*



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