

## Mixing oil and water

Janet Pelley

A boom in drilling for natural gas in technically challenging shale rock formations is raising alarms about water quality. “This source is projected to meet most of America’s domestic natural gas demand by 2030”, said Exxon Mobil’s CEO Rex Tillerson (Irving, TX) at a US congressional hearing on January 20. “But at what cost?”, asks Dusty Horwitt, a natural gas analyst at the Environmental Working Group (EWG; Washington, DC) and author of a new EWG report, *Drilling around the law*.

Advances in horizontal drilling technology have unlocked the economic potential of shale gas, according to Doug Morris, a group director at the American Petroleum Institute (API; Washington, DC), a trade association. Combining horizontal drilling with hydraulic fracturing, or fracking, of rock has boosted domestic natural gas production by more than 20% over the past 3 years, he explains. Com-



*Pennsylvania residents say their well water became clouded after shale gas drilling commenced nearby.*

panies bore holes into shale rock formations, then inject millions of gallons of fracking fluid under high pressure, creating tiny cracks and liberating natural gas trapped many kilometers below the surface. The fluid is a brew of water, sand, and chemicals that typically include petroleum distillates, and sometimes diesel fuel, Horwitt adds. The distillates and diesel contain highly toxic benzene, toluene, ethylbenzene, and xylene.

According to the API, fracking is well regulated, safe, and does not pose a threat to underground drinking

water. “Currently, there is no federal requirement for companies to disclose the chemicals used in fracking, and the process has exemptions under most major federal environmental laws”, Horwitt continues. The EWG report reveals that companies are using diesel in the fracking fluid without permits, in violation of the Safe Drinking Water Act. Moreover, the petroleum distillates that can be used in fracking fluid without a federal permit contain up to 93 times more benzene than is found in diesel, and could potentially contaminate vast volumes of groundwater. While the oil and gas industry insists there are no studies proving that fracking has contaminated groundwater, as Horwitt points out, neither are there any studies showing the practice to be safe.

The US Environmental Protection Agency acknowledges that there is a risk of fracking fluid seeping into drinking water aquifers and has stated that there are “serious reservations” about whether fracking should take place within New York City’s watershed. Accounts of fracking fluid spills, as well as streams and wells polluted with benzene, suggest that the process is not always well controlled, Horwitt concludes. ■

## Eat your lunch, including the wrapper!

Alison Gillespie

Scientists at the US Department of Agriculture’s Research Service say that casein and whey, major proteins in cows’ milk, could soon become common ingredients in food packing materials and plastic films. Peggy Tomasula (Wyndmoor, PA) is leading a research team working on these products, which are both biodegradable and completely edible. Says Tomasula, “Right now, a lot of the plastic films used are not good oxygen barriers, and these are. We envision them being used as food products”.

People with dairy allergies will probably have a reaction to these new products, which are also water soluble, limiting their application in

the broader marketplace. But with proper labeling, they could be used to strengthen cereals or chips, or as candy coatings, and as edible wrappings or coverings on items like cheese. Eventually, they might even be fortified with vitamins and minerals and consumed as supplements.

Many green consumer groups say they would welcome an alternative to petrochemical polymers for packaging. But others caution that more research is needed to determine the broader environmental impact of these biopolymers, especially if their use leads to an increase in dairy production.

Thomas Harter, who researches groundwater policy at the University of California-Davis, says there are a lot of questions one could ask about the new biopolymers, including what they will do to the milk market, “and would [this new product] possibly

raise the funds for better environmental stewardship?” Theoretically, he points out, it could be that many small-scale dairy farmers might be able to afford the implementation of environmental stewardship practices if they had an additional revenue stream. Only a detailed evaluation could determine the full picture.

“We need to ask: what is the full life-cycle assessment of these biopolymers?”, says Clarissa Morawski (Peterborough, Canada), a consultant who recently authored a report on the economic and environmental impacts of single-stream recycling collection systems. Similar concerns have arisen regarding new, biodegradable plastic drink bottles, which are entering the packaging market. “Just because something is coming from a renewable resource doesn’t always mean it is better”, warns Morawski. ■

## Hitchhiker's guide to emissions reductions

Johanna F Polsenberg

The transportation sector accounts for approximately 25% of total greenhouse-gas emissions in the European Community and nearly 33% in the US. In some urban areas, such as the San Francisco Bay Area, transportation alone accounts for over 50% of total emissions. There is broad recognition of the role public transport and cycling can play in reducing these emissions, especially in cities. However, understanding what motivates an individual's use of, and attitudes toward, sustainable transportation can help develop more effective policies, or measures to encourage sustainable transportation choices.

A recent study in three German cities identified five groups of travelers on the basis of mobility-related attitudes: public transport rejecters;

car individualists; weather-tolerant cyclists (not averse to biking in bad weather); eco-sensitized public transport users (those with strong environmental consciences); and self-determined mobile people (who take the highest percentage of trips on foot) (*Environ Behav* 2010; **42(1)**: 3–43). Each group differed greatly in terms of transportation choices, distances traveled, and ecological impact.

“The objective of our target-group approach is the effective arrangement and communication of transport services for different target groups (eg car sharing, combinations of bicycle use and public transport, and improved public transport)”, says lead author Marcel Hunecke (Ruhr-Universität Bochum, Germany). “We want to create a good fit between transport services and the requests and needs of different target groups.”

“All five target groups react differently to pull (encouragement) or push

(financial or regulatory constraints) measures to use sustainable transport”, continues Hunecke. “The public transport rejecters show the biggest resistance to push measures – they anticipate losing their autonomy. The car individualists are also highly resistant, since they gain a lot of enjoyment from using a car. The weather-tolerant cyclists and eco-sensitized transport users show the greatest acceptance of push measures. Finally, the self-determined mobile group react least, because they do not consider motorized mobility important.”

This study showed that this attitude-based approach was a better predictor of transport choices than groupings based on sociodemographic and geographic factors, which does not surprise Hunecke. “We are social and behavioral scientists, who are convinced that ecological problems can only be solved by conceptualizing them from a social–ecological perspective.” ■

## Mitigating sonar's effect on marine mammals

Adrian Burton

New steps may be taken to protect marine mammals from the damaging and potentially deadly effects of US Navy mid-frequency active sonar (sound pulsed into the ocean to echolocate enemy vessels). The Navy's use of this technology has long been a point of controversy. The military believes it is the only way to detect today's stealthy submarines, or those lying motionless, and that to respond adequately in wartime, crews must constantly train in its use. Marine biologists, however, have underlined the damage that sonar pulses can do to marine mammals, especially cetaceans, which use their own sonar systems for orientation and to search for food.

“Based on the technology available today, active sonar is the only effective means for our sailors to defend [themselves] against hostile submarine threats”, explains Lieutenant Laura Stegherr, a spokesperson at the Navy



US Navy photo / S. Williams

*Listening in for enemy ships may now involve watching out for marine mammals.*

Office of Information (Washington, DC). “However, marine-mammal protection is also a major priority for the US Navy, and we go to great lengths to protect marine mammals and the environment while fulfilling our national security mission.”

The US Navy reports it has spent over \$100 million on marine-mammal research in the past 5 years, some of it on mitigating the effects of military sonar. However, it is also true that “takes” – harassment, injury, or death of these animals – do occur. Indeed, last-minute rules proposed by the latest Bush Administration authorized two million takes per year for the subsequent 5 years. However, the situa-

tion may soon change. A letter sent on January 19 – from Jane Lubchenco, Administrator of the US National Oceanic and Atmospheric Administration (NOAA; Washington, DC), to Nancy Sutley, Chair of the US Council on Environmental Quality (Washington, DC) – outlined NOAA's understanding that mitigation could be improved, and made an undertaking to search for solutions. To begin with, surveys (in which the Navy's involvement will be encouraged) to estimate marine-mammal densities in sensitive areas will be resumed, hotspots identified, and workshops held, to estimate reasonable “sound budgets” for different ocean regions.

Michael Jasny, Senior Policy Analyst for the Natural Resources Defense Council (Washington, DC), which has repeatedly sued NOAA and the US Navy for failing to place sensitive whale habitat off-limits to sonar use, comments, “Depending on NOAA's actions over the next year, this announcement could represent a change in where and how the Navy uses sonar in training.” ■

## Seabirds boycott Palmyra's palms

Kathryn Senior

Anyone visiting Palmyra Atoll in the South Pacific could be forgiven for thinking that the swaying palms are an innocuous feature of this rich tropical paradise. Although the palms look as if they belong there, they have, in fact, been brought there by humans, at some time in history. Their exact origins remain a mystery, but it is becoming clear that non-native coconut palms, while beneficial for people, can have a disruptive influence on the rest of the ecosystem. “Although tropical island ecosystems have a high concentration of endemic species, they are quite vulnerable, and coconut introduction for human use can represent a serious threat to the special biodiversity and ecosystem services of these areas”, explains senior researcher Rodolfo Dirzo (Stanford University, CA).

The main problem with the invasive palms is that seabirds stubbornly refuse to use them as perching and



R. Dunbar, Stanford

*Seabirds just don't see palms as prime real estate for nesting!*

nesting sites. As a result, little of the nutrient-rich guano that falls at the foot of native trees enriches the soil around the palms. This leads to a decreased nutrient input surrounding the palms, which is lowering leaf nutrient quality and palatability of plants that grow nearby. “We are now following up with some experimental manipulations, to analyze the plant traits that define the response of native plants to the gradient of nutrient availability. We are looking at how the nutrient depletion around the palms might ultimately

determine the plant composition we observe on the Atoll”, says Dirzo.

“This is an excellent example of what is often termed ‘invasion facilitation’”, comments Phil Lambdon of the St Helena Nature Conservation Group (Jamestown, St Helena). This occurs when a species invades a habitat and modifies it in some profound way. “The new conditions can favor the new invaders at the expense of the native species, sometimes leading to destruction of the whole ecosystem”, he continues. Clear examples of rapid ecosystem damage, as the coconut palms appear to be producing on Palmyra Atoll, are relatively rare, but serve as a salutary lesson, adds Lambdon. “The Palmyra Atoll situation offers a great opportunity to investigate just how the consequences of such apparently ‘harmless’ introduced species might play out. Unfortunately, the true picture will only be clear in the long term, but we just might see some dramatic changes developing in as little as 10 years”, he concludes. ■

## How plants transformed rivers

Mike Faden

Analysis of ancient river deposits provides new evidence that the colonization of land by early plants dramatically transformed the terrestrial landscape by creating the meandering rivers and floodplains that are familiar today. The stabilizing effect of plant roots is known to affect the development of river channels, and there has been a long-standing hypothesis that early land plants created landscape changes that first occurred more than 400 million years ago.

Researchers at Dalhousie University in Canada tested the evidence through analysis of ancient river sediment deposits. They reviewed 144 published datasets, and also conducted field research (*Earth-Sci Rev* 2010; doi:10.1016/j.earscirev.

2009.11.002). According to Neil Davies (Dalhousie University, Halifax, Canada), lead author of the study, the findings suggest that early plants profoundly changed the landscape. “Before the evolution of terrestrial plants, there weren’t perennial rivers”, he explains. Instead there were sheet-like, braided, ephemeral streams: “big sheets of sand, washing down when there was rainfall”.

In their study, Davies and co-author Martin Gibling, also at Dalhousie University, examined whether specific features were present in alluvial deposits created before and during the evolution of early terrestrial plants. The features included deposition patterns characteristic of meandering river channels; plant-derived charcoal or coal; and evidence of roots. They found substantial increases in the abundance of several of these features at various

times during the periods when plants first colonized the land, then evolved roots, and eventually became tree-like. A key new finding was the increase in mudstone, derived from mud that could have been trapped by plant roots and deposited when rivers began to flow more slowly.

The deposits indicated a shift from the sheet-like systems to a more complex variety of perennial rivers, explains Davies. “Once plants were binding and baffling the river sediments, you were able to get a much wider variety of forms – meandering rivers, branching rivers with tributaries, deep incisions, and stable floodplains.”

Davies points out that the most notable changes occurred about 420 to 400 million years ago, during the late Silurian and early Devonian periods – around the same time that early plants developed roots. ■

## World Heritage lake in jeopardy

Ken Ferguson

Siberia's Lake Baikal – the oldest, deepest, and, by volume, largest freshwater lake in the world – may be a UNESCO-designated World Heritage Site, but that hasn't stopped Russian Prime Minister Vladimir Putin from issuing a new decree, permitting the resumption of the discharge of industrial wastewater into the lake. Not surprisingly, the decree, which also allows for the storage and disposal of hazardous – including radioactive – materials along the lake's shoreline, has been sharply criticized by Russian and international environmental organizations, concerned about the impact these decisions will have on Lake Baikal's unique

ecosystems. Baikal is home to nearly 2500 species of plants and animals, more than 1500 of which are endemic to the lake.

At the heart of the controversy lies a proposal to reopen the Baikalsk Pulp and Paper Mill, a factory sited on the lake's southwestern shore, which was the primary employer for the residents of the town of Baikalsk. "Restart[ing] the mill is being regarded as a necessity to preserve jobs", said Igor Chestin, WWF-Russia Director (Moscow), in a press release. At the height of production, the mill, which is expected to be running at full capacity by March, provided work for nearly 1700 of the town's 2300 inhabitants.

But scientists and environmentalists believe that the mill – which, until it was shut down over pollution concerns in 2008, discharged waste-

water that contained chlorinated organics and associated dioxin byproducts used in the paper bleaching process into the lake for 50 years – was the principal source of chemical pollutants contaminating Baikal's waters. Although representatives of both Baikalsk and the Russian Government claim that restarting production at the mill will do little harm to the ecological integrity of Lake Baikal, environmental groups and many scientists are skeptical.

The decision to allow wastewater to be discharged into Lake Baikal may also affect the lake's current status as a World Heritage Site. "The new [decree] weakens the protection level of the World Heritage Site [designation]...in the future, Lake Baikal would be given the status of a 'World Heritage Site under threat'", according to Chestin. ■

## Reforestation key to economic growth in Kenya

Jen Fela

A tree-planting campaign launched in Kenya's Mau Forest Complex in mid-January marked the beginning of an effort to increase the country's forest cover from 1.7% to 10% by 2020. On January 15, 20 000 indigenous tree seedlings were planted on 20 ha of degraded forestland in the Mau, in a ceremony attended by thousands of members of the local community, including diplomats, members of the UN Environment Programme (UNEP; Nairobi, Kenya), government ministers, and students.

The Mau covers 416 000 ha, making it the largest closed-canopy forest system in Kenya and the country's most vital water catchment area, according to UNEP. Degradation of the Mau over the past two decades has resulted in the loss of 107 000 ha of its forest cover, representing over 25% of its original extent. The degradation has led to severe droughts and floods, and has resulted in the loss of lives, crops, livestock, and livelihoods.

UNEP spokesperson Nick Nuttall says, "This is a long-term project to



Kenyan wildlife depend on the Mau's ecosystem services for survival.

rehabilitate a major forest ecosystem in East Africa – the Mau generates about US\$320 million a year in services for the Kenyan economy, including moisture generation for the tea industry and provision of water for hydroelectricity and tourism sites, such as Lake Nakuru, with its famous pink flamingos, and the Masai Mara".

A report released late last year by the Stockholm Environmental Institute (SEI; Sweden) applauded the Kenyan government's reforestation efforts. However, SEI warns that benefits gained from reforestation could be negated by Kenya's Vision 2030

plan, which aims to increase economic growth by 10% per year and could more than double carbon emissions, as a result of planned investments in infrastructure based around transportation via private cars and coal-generated electricity. SEI urges Kenya to pursue its economic development goals through environmentally friendly and low-carbon means, such as the use of biomass and hydroelectric power resources.

Nuttall agrees that environmental restoration efforts could help drive economic development in Kenya. "The key is generating alternative livelihoods in jobs such as natural resource management, including forests and renewable energy – Kenya is expanding its geothermal generation and is creating the biggest wind farm in sub-Saharan Africa, in northern Kenya's Turkana region. Restoring the Mau is not a choice between economic growth and the environment; the Mau is a centerpiece of the future economy."

Following the Mau project, restoration efforts are also planned for Mount Kenya, the Aberdares, Mount Elgon, and the remaining forests and water catchment areas in Kenya. ■

## Insect conservation kicks off the Year of Biodiversity

Virginia Gewin

The UK's Royal Society for the Protection of Birds (RSPB) is ringing in the International Year of Biodiversity with a plan to reintroduce four endangered insect species to the UK countryside. While charismatic mammals or beleaguered birds are typically the focus of wildlife reintroduction efforts, RSPB conservationists are committed to protecting ecosystems in their entirety.

The four insect species – dark bordered beauty moth (*Epione vespertaria*), pine hoverfly (*Blera fallax*), field cricket (*Gryllus campestris*), and short-haired bumblebee (*Bombus subterraneus*) – were identified as top conservation priorities by the UK Biodiversity Action Plan, developed in response to the Rio Convention on Biological Diversity in 1992. “With over 200 reserves, home to over 1000 rare and threatened species, the



The dark bordered beauty moth (*Epione vespertaria*).

RSPB is well placed to provide ideal habitat for these species”, says Jane Sears, RSPB Biodiversity Projects Officer (Bedfordshire, UK).

Until recently, butterflies have been the focus of most insect reintroduction efforts. Yet efforts to reintroduce other invertebrates are gaining traction worldwide. Scott Black, Executive Director of the Xerces Society for Invertebrate Conservation (Portland, OR), is not surprised that the UK is spearheading non-butterfly insect reintroductions. “The UK has always been ahead of the rest of world in terms of insect conservation”, he

notes. “But I think land managers are starting to understand that, in the face of climate change, conservation efforts need to focus on maintaining redundancy and resilience in ecosystems.”

That said, insect reintroductions can prove tricky – especially if not enough is known about the habitat requirements of the species being reintroduced. For example, early efforts to reintroduce the marsh fritillary butterfly (*Euphydryas aurinia*) in the UK proved unsustainable because of the absence of suitable habitat and a lack of long-term management.

Other concerns stem from the need to captive-breed some species before they can be reintroduced. Little is known, for example, about the diseases that can spread in these captive populations. But Sears says they follow the strict biosecurity guidelines established by the International Union for the Conservation of Nature. “Sure, there is the possibility of failure, but we’re taking every opportunity to learn about these species as we go along”, she concludes. ■

## Changing environments, changing biodiversity

Jane Bradbury

Researchers investigating how fluctuating environmental conditions affect zooplankton diversity in lakes report that temporal changes in temperature tend to increase diversity, while fluctuations in the chemical environment tend to reduce diversity. Furthermore, says lead author Jonathan Shurin (University of California, San Diego, La Jolla, CA), “our results suggest that among natural lakes, patterns of variability are often as important, or more important, than average conditions in terms of zooplankton community diversity”.

Projections of how climate is likely to change over the next few years vary widely in the magnitude and direction of environmental changes at the regional level. Most models predict increased rates of extreme events such as droughts and storms. Fluctuating environmental conditions can exert opposing forces on the co-existence of

species in communities, explains Shurin. Environmental variability, he notes, can increase diversity through temporal niche partitioning or decrease diversity through stochastic extinctions.

To investigate the relative importance of these two forces, Shurin and his colleagues looked for associations between fluctuations in physical and chemical variables and zooplankton richness in 53 North American and European lakes, using data collected over periods of years to decades. They found that large fluctuations in pH, phosphorus, and dissolved carbon concentrations on inter-annual, seasonal, and shorter time scales were all associated with reduced zooplankton species richness. In contrast, lakes with large temperature fluctuations at all time scales contained more species than those with small temperature fluctuations (*Ecol Lett* 2010; doi:10.1111/j.1461-0248.2009.01438.x).

“We think that temperature fluctuations might provide an opportunity

for niche partitioning and increased species richness, because thermal variability is relatively predictable and species can time their life cycle to take advantage of good conditions”, says Shurin, “whereas the extreme variability in pH and productivity that is caused by the intense local influences of human activities might favor stochastic extinctions”.

“How environmental variability affects species diversity is a classic, long-standing question”, comments plant ecologist Peter Adler of Utah State University (Logan, UT). Scientists have mainly used theoretical approaches or have measured how environmental changes alter the population dynamics of a few interacting species to try to answer this question, continues Adler. “This recent research has the advantage of including lots of species and many environmental variables from many sites”, he notes, “and it emphasizes that if we want to predict how diversity will change in the future, we need to consider changes in both climate means and variances”. ■