Dispatches

Future food depends on ecosystem-based agriculture

Jen Fela

To provide enough food for a projected world population of 9 billion by 2050, planners and policy makers must focus on supporting healthy ecosystems, according to a report released in late August by the United Nations Environment Programme (UNEP; Nairobi, Kenya) and the International Water Management Institute (IWMI; Colombo, Sri Lanka), in cooperation with 19 additional organizations. The report, *Ecosystems for Water and Food Security* (www.unep.org/pdf/depi-ecosystems-food-secur.pdf), addresses the need to "produce approximately 70% more food [by 2050] to cope with growing population and dietary changes" and the "paradox of having to grow more food with less water", as written in the foreword by Colin Chartres, IWMI Director General.

Eline Boelee, Senior Researcher of Water and Health at IWMI and Scientific Editor of the report, says "Our publication brings authors from the environmental sector together with agricultural scientists in all disciplines (crop, livestock, aquaculture, and agroforestry) to produce a coherent message. Where other publications have focused on water and environment, food and water, or environment and food, our document focuses on the three-way interdependence [among] ecosystems, water, and food security, demonstrating how ecosystem management can be improved to ensure water availability and avoid future food crises."

Boelee continues, "Agriculture needs to change to provide food security in the long term without degrading its own resource base – to grow food and encourage healthy, natural and agricultural ecosystems. In a farming context, nature essentially supports nurture (for example, with pollination, soil health, water quality, and biodiversity). We need to think about ecosystems plus (not versus) agriculture, or conservation plus (not versus) cultivation."

The report contains specific recommendations to encourage and sustain the health of farmland, drylands, wetlands, fisheries, and livestock systems, including planting diverse crops and species of trees on farmland that will ensure soil health and conserve water; managing the collection of rainfall and runoff; and educating people on appropriate livestock-grazing practices – even children, who in many parts of the world are responsible for this task.

Directed toward policy makers and mid-level professionals, the report will "help them take up their responsibility in enhancing food security in a sustainable way", says Boelee. "The sooner people start managing agro-ecosystems, the higher the chance for success in reducing degradation and enhancing production and productivity." ■

A fish out of water: adapting to life on land

Jane Bradbury

A field study that quantifies the behavior of the Pacific leaping blenny (*Alticus arnoldorum*), a largely terrestrial fish, provides new insights into some of the adaptations that may have been necessary for the colonization of land by aquatic creatures in the late Devonian period. "Our study gives us a glimpse into the past", says Tonia Hsieh (Temple University, Philadelphia, PA), "and can help us understand one of the most critical ecological transitions that vertebrates had to make during evolution".

The Pacific leaping blenny is a small marine fish (3–5 cm in length) that lives along rocky coastlines in Micronesia, including the island of Guam. Although the fish needs to stay moist to enable it to breathe through its skin, it is almost entirely terrestrial and is extremely agile on land, where it uses a combination of tail-twisting and expanded pectoral and tail fins to move.

ST Hsieh

A female Alticus *perched on a rock above water.*

During their investigation, Hsieh and behavioral scientist Terry Ord (University of New South Wales, Kensington, Australia) made detailed observations of the abundance, behavior, and morphology of *A arnoldorum* on the eastern side of Guam during the breeding season (*Ethology* 2011; doi:10.1111/j.1439-0310.2011.01949.x). The researchers report that the blennies – despite eating and breeding on land, and defending terrestrial territories as part of a complex social behavior – were heavily constrained by the tidal cycle and temperature. "Even though these fish spend their whole adult life on land, they are still very tightly connected with the aquatic realm", explains Hsieh, "and are only active during a brief period at mid-tide".

"This well-conducted study quantifies aspects of the terrestrial behavior of *A arnoldorum* in a way that has not been done before", comments intertidal fish researcher John Green of Memorial University (St John's, Newfoundland and Labrador, Canada), "but probably adds little to our knowledge of the role of ecology in evolution". Both Green and Hsieh note, however, that comparative studies of members of the family Blenniidae that exhibit different degrees of "terrestriality" and that live around Guam have the potential to reveal fundamental insights into the transition of vertebrates from water to land. ■

Arctic ice, ecosystems changing fast

Nancy Bazilchuk

As this year's Arctic sea-ice coverage shrank toward record summer lows, a synthesis report from the Arctic Monitoring and Assessment Programme (AMAP; Oslo, Norway) described other regional global warming trends, including a fourfold loss in mass of the Greenland Ice Sheet as compared with conditions between 1995 and 2000.

Entitled the *Snow, Ice, Water and Permafrost Assessment* (http://amap.no/swipa/), the synthesis report – also known as SWIPA – was produced by AMAP for the Arctic Council, an eight-nation intergovernmental group focused on environmental protection and sustainable development. The SWIPA report predicts that – if current trends continue – global sea-level rise could top 1.6 meters by the end of the century, or more than double that predicted by the Intergovernmental Panel on Climate Change's Fourth Assessment Report from 2007. "This is alarming", says SWIPA chairman Morten Skovgård Olsen (Danish Ministry for Climate and Energy, Copenhagen, Denmark). "The SWIPA report documents how all parts of the Arctic cryosphere are changing, and scientists have been surprised by the speed of the changes."

K Steffen/CIRES, University of Colorado

Surface meltwater disappears down a moulin on the Greenland Ice Sheet.

The SWIPA report records changes and trends since a previous 2004–2005 assessment. Among these is a doubling in the speed of some glaciers feeding into the ocean along the Greenland Ice Sheet's front, according to geophysicist Dorthe Dahl-Jensen (Centre for Ice and Climate, University of Copenhagen, Denmark) and a SWIPA author. "The fastest of these are moving as much as 30 meters a day." Fully 60% of mass losses from the Greenland Ice Sheet come from icebergs that drop off these glacial tongues; but whether this process will accelerate, and by how much, is difficult to forecast because there is no large predictive model for ice sheets, she explains. "We need to boost the tools we have, to predict what the ice sheets will do in the future."

Ecologist Terry Callaghan (Royal Swedish Academy of Sciences, Stockholm, Sweden), another SWIPA author, remarked on the rapidity of change documented therein. "Things are happening much faster than expected." The accelerated change is partly due to feedback mechanisms that further amplify global warming, such as an earlier snowmelt that results in greater surface heat absorption and higher spring temperatures. Callaghan also noted that several of the ecological changes recorded are counterintuitive, including a southward or downslope movement of the tree line in some areas, due to smaller snow packs that melt earlier. This, in turn, results in summertime soil moisture stress that ultimately kills the trees. ■

Solar, wind power curtailed

Claire Miller

The renewable-energy industry in the Australian state of Victoria has suffered a serious setback under new rules to restrict wind farms and slash tariffs paid to households feeding solar power into the electricity grid.

The conservative State Government has introduced new planning laws to stop wind turbines from being built within 2 km of homes unless owners agree, and 5 km of large regional towns. Wind farms are also now banned altogether in several tourism regions, including some of the country's windiest coasts. The move delivers on an election promise last November to voters concerned about negative visual impacts and alleged health effects from associated noise and vibration.

Victoria's Planning Minister Matthew Guy (Melbourne, Victoria) said it was important that wind energy did not develop to the detriment of rural Victorians, but critics argued that the restrictions were arbitrary and without scientific foundation, and meant that more than half the future wind farms proposed would now not be built.

In the same week, the State announced that tariffs paid to Victorian homeowners feeding solar-generated power into the national electricity grid would be more than halved. It was claimed that solar-power systems cost about 50% less than when the tariff scheme started in 2009, reducing the need for high incentives to encourage households to install panels. According to Russell Marsh (Clean Energy Council, Melbourne), the falling costs meant the industry was unlikely to require support by 2020. "But we are not there yet, and the right support is crucial to ensure the industry remains intact to deliver clean energy, emissions cuts, and jobs."

Mark Wakeham (Environment Victoria, Melbourne) sees the wind and solar decisions as economically damaging. "It appears that the only plan the new government has on climate change is to ensure Victoria misses out on the clean-energy investment boom. It's now harder to build a wind farm than a new coal mine or coal-fired power station in Victoria."

The changes came as the Australian Government prepares legislation to establish a national emissions-trading scheme. The scheme is strongly opposed by conservative politicians, fossil-fuel companies, and energy-intensive industries, despite a generous compensation package. ■

Use of wildfire retardants under scrutiny

Noreen Parks

Since the 1950s, the US Forest Service (USFS) has relied on fire-retardant chemicals as one method of battling wildland blazes, primarily in the American West. From 2000 to 2010, over 340 million liters of ammonium-phosphate-based retardant were dropped via aircraft over public forestlands. During the past decade, however, this policy has triggered considerable controversy because of the danger of aviation accidents and the environmental risks posed by the chemicals.

In 2004, the Forest Service Employees for Environmental Ethics (FSEEE; Eugene, OR) sued the USFS over its use of retardants, which prompted a federal court to order the agency to conduct an environmental analysis of the practice. The conclusion that retardants cause no significant impacts provoked further court action, and last year a federal judge directed the USFS to produce a more detailed environmental impact statement (EIS).

The draft EIS, released in May 2011, proposes the continued use of aerial spraying, albeit with revised guidelines to address wildlife concerns. In a public statement, USFS Chief Tom Tidwell (Washington, DC) said, "Research and experience demonstrate that aerially applied fire retardant, used in an appropriate manner, reduces wildfire intensity and the rate of spread, which increases the effectiveness of our fire suppression efforts on the ground".

Says FSEEE Director Andy Stahl, "There is simply no scientific evidence in the draft EIS that retardant improves initial attack success rates [preventing fires from spreading to ~120 hectares or less], diminishes average fire size, or lessens property loss. While anecdotal reports suggest it may affect fire outcomes, other reports suggest no beneficial effect".

The US Fish and Wildlife Service and National Marine Fisheries Service have identified 61 protected species that could be jeopardized by exposure to retardant. "If it enters a water body, ammonia is released, potentially poisoning miles of aquatic habitat", Stahl contends. And rain that falls on retardant-treated land releases nutrients that can benefit invasive plants competing with threatened species, he says.

Except in extraordinary circumstances, aerial drops are prohibited within a ~90-meter buffer around waterways, according to USFS spokesman Glen Stein (Ogden, UT). USFS data show that in 2010, retardant contaminated waterways and/or protected habitat in only 21 instances (out of nearly 8000 aerial drops). To better protect sensitive terrestrial species, USFS is developing maps identifying "avoidance areas" for inclusion in policy guidelines, Stein says.

A final decision on fire retardant policy, which will apply to all federally managed lands, is due by the year's end. ■

Global cypress epidemic traced to CA

Robin Meadows

Massive die-offs of Italian cypresses from Portugal to Greece have been linked to California's Monterey cypresses (*Cupressus macrocarpa*), solving a long-standing puzzle in the world of plant pathology and surprising researchers. "When I was a student, this was one of the big mysteries", says study co-author Matteo Garbelotto of the University of California, Berkeley. "The cypress canker epidemic was first seen in California in the 1920s – 100% of the Monterey cypresses in several San Joaquin Valley sites suddenly died – so the most credible theory was that the pathogen was exotic here", he explains.

Identified as the fungus *Seiridium cardinale* early on, the pathogen has since hit Europe, Africa, Asia, Australia, New Zealand, and South America, killing up to 95% of native cypresses, cedars, and junipers locally. Genetic analysis of *S cardinale* from the Mediterranean, the Southern Hemisphere, and California pointed to the last as the source. Whereas the Mediterranean samples were clones, the California samples were genetically diverse. Moreover, there are two distinct genetic variants of the fungus in California, but only the first was found in the Mediterranean and only the second was detected in the Southern Hemisphere in this study, which appeared online in August in *Phytopathology* (2011; doi: 10.1094/PHYTO-05-11-0144).

A Potov/Wikimedia Commons

International trade in Monterey cypresses caused a canker disease pandemic.

Garbelotto attributes the initial California epidemic to the fact that the Monterey cypresses were planted "out of place" – not in their cool, coastal native range, but in the hot interior of the state. "We know they don't belong there", Garbelotto points out. Indeed, *S cardinale* is largely benign in cool areas but causes cankers in hot areas, which is where Italy's native cypresses grow best. Monterey cypresses were popular in Italy beginning in the 1920s, and eyewitness accounts put the start of the canker epidemic there in the 1930s.

Canker-resistant cypresses have now been developed in Europe. However, even these would be vulnerable to California's second genetic variant, making testing cypress imports a priority. "Legally, they can't be regulated because the pathogen species is in both continents – the law doesn't account for genetic variants", Garbelotto explains. "But before, we didn't know what to look for and now we do." ■

Species management leads to unintended consequences

Virginia Gewin

Twelve years ago, in an effort to save young salmon (*Oncorhynchus* spp) from predation, the US Federal Government moved the world's largest colony of Caspian terns (*Hydroprogne caspia*) ~25 km down the Columbia River to East Sand Island, a low-lying island near the river's mouth. The terns' consumption of salmon smolts decreased – from roughly 74% to 30% of their diet – as they switched to anchovies and herring. But the smolts still aren't safe.

Large numbers of double-crested cormorants (*Phalacrocorax auritus*) – bigger birds, able to eat five times as many fish than the terns – also moved to East Sand Island, devouring about 19 million smolts in 2010 alone. East Sand Island is now so densely settled with birds that predators, including eagles and gulls, have turned the tables, at least on the terns. Not a single tern chick was raised this year, while the cormorants continued to slurp smolts.

D Roby

A Caspian tern (Hydroprogne caspia) *carries home dinner.*

It is unclear why the eagles shifted their attention to terns, but researchers suspect climate change is somehow involved. For example, the late, heavy snowpack flushed the estuary with fresh water, probably lowering the number of marine forage fish. "There is an aspect of global climate change that hasn't been fully appreciated, and that's the global 'weirding' factor – an increase in the variance of everything from snowpack to oceanic upwelling", explains Daniel Roby, a wildlife biologist at Oregon State University (Corvallis, OR).

Species management has never been predictable in its effects, but Roby admits that the uncertainties associated with global weirding have made him more circumspect about predicting the future. Instead, uncertainties need to be accounted for in management plans. "It's about bet-hedging", he admits. He uses the existing science to recommend actions that, at least, won't back managers into a corner – for example, turning to lethal control of bird populations to protect juvenile salmon.

Gary Fredricks, a fisheries biologist at the National Marine Fisheries Service (Portland, OR), agrees but worries that "analysis paralysis" can stymie actions needed to protect salmon. "We have to do the best we can with the existing data to save listed species like salmon." At the same time, he says, this year's tern crash makes it clear that the bird colonies on East Sand Island lack resilience. Moving some of them, which is likely to be a component of formal management proposals being developed now, could potentially help bird and smolt survival. Doing nothing isn't an option. "Everything is a grand experiment, so we need to proceed cautiously", Fredricks concludes. ■

Climate engineering: not ready for prime time

Mike Faden

A new assessment from the US Government's watchdog agency, the Government Accountability Office (GAO), concludes that climate- or geo-engineering technologies – which involve direct, large-scale interventions in Earth's climate – do not currently offer a viable response to global warming. "We are not yet at a level of technology maturity to consider engineering the global climate system", warns Tim Persons, Chief Scientist at the GAO (Washington, DC).

The GAO report, *Climate Engineering: Technical Status, Future Directions, and Potential Responses*, assesses technologies that aim to cool the Earth by removing CO_2 from the atmosphere or reducing incoming solar radiation. All technologies reviewed were considered immature, based on a standard maturity assessment scale. Even the highest-scoring proposal – scrubbing CO_2 directly from the air and then sequestering it underground – could be two decades away from large-scale commercialization, Persons continues.

Overall, the technologies – some involving unprecedented logistical challenges, such as deploying millions of reflective space-borne objects – lack experimental proof and engineering analysis to assess feasibility and cost. In addition, gaps in current climate models make it hard to analyze the potential effects of such efforts. "The word 'engineering' is misleading, because it's not engineering at this point", Persons explains. "It's technology research."

The GAO reiterated calls for a federally coordinated research effort into climate engineering, expanding to include international involvement. Experts interviewed for the report also said that technological development might be accelerated by the input of federal funding or the establishment of a carbon market to spur entrepreneurial activity.

Climate-engineering schemes also carry substantial risks. For example, some studies suggest that intentionally injecting particles into the stratosphere to deflect sunlight might greatly reduce precipitation elsewhere in the world, and could therefore increase international tensions or even spark a war. "In the short term, it's probably not possible to do this – technologically or politically", admits Brian Toon, a professor at the University of Colorado at Boulder. "The main goal of people working on this at the moment is to understand what the possibilities are, and where there might be problems. Most people would envisage that the only way this could become a reality would be if the Earth was facing [imminent] disaster." ■

The future of ozone monitoring

Lindsay Deel

Increasing ground-level ozone (O_3) concentrations may reduce soybean (*Glycine max*) yields, resulting in over US $1 billion in lost crop production, according to a study published in *Atmospheric Environment* (2010; doi: 10.1016/j.atmosenv.2010.01.015). Using a combination of satellite imagery and ground measurements, Jack Fishman (National Aeronautics and Space Administration's Langley Research Center, Hampton, VA) and colleagues found clear links between elevated O_3 and crop damage. "Farmers are potentially losing significant [soybean] yield to O_3 damage – perhaps up to 10–15%", says US Department of Agriculture (USDA) molecular biologist and study co-author Lisa Ainsworth (University of Illinois at Urbana-Champaign, IL).

As Fitz Booker, a USDA plant physiologist (North Carolina State University, Raleigh, NC) explains, "Satellite technology can be used to estimate [O_3] concentrations across much larger geographical regions than is currently possible with the US Environmental Protection Agency's O_3 monitoring network. The majority of monitors are operated in urban locations. Satellite technology allows us to better measure O_3 concentrations in rural locations, which is more relevant to effects on vegetation".

Monitoring O_3 levels remotely from space may provide more informed guidance to policy makers, both nationally and internationally. "We can measure O_3 and estimate its impacts on human health and food production in countries that have no comprehensive O_3 monitoring network, which is often the case in developing nations with severe pollution problems", continues Booker.

Nationally, the policy implications of this research became more complicated with the recent US decision to postpone evaluation of O_3 standards until 2013. President Obama announced, "Work is already underway to update a 2006 review of the science that will result in the reconsideration of the O_3 standard in 2013. Ultimately, I did not support asking state and local governments to begin implementing a new standard that will soon be reconsidered".

Environmentalists are protesting the decision, although results from the 2010 study suggest that farmers may have as much or more to lose by such a postponement. Despite the politics of the issue, scientists remain optimistic about the future of O_3 monitoring. "The next step is to extend the initial observations to a longer timeframe and perhaps to more crop species", concludes Ainsworth. ■

US and EU team up to combat illegal fishing

Johanna Polsenberg

In September 2011, the European Union (EU) and the US signed a historic bilateral agreement to combat illegal, unreported, and unregulated (IUU) fishing. The collaboration promises joint support for the adoption of effective management measures for regional and international fisheries and trade organizations; the development and use of tools to thwart economic incentives for IUU fishing; an exchange of information on IUU activities; and sustainable fishing worldwide.

"This is the beginning of the end of IUU fishing", comments Maria Damanaki, EU Commissioner for Maritime Affairs and Fisheries (Brussels, Belgium). "IUU fishing is both an environmental and an economic issue, and accounts for nearly 20% of global catch and more than 30% in certain regions."

"[IUU] fishing is one of the most serious threats to American and global fishing jobs and fishing communities, as well as to the health of the world's oceans", warns Jane Lubchenco, Administrator for the US National Oceanic and Atmospheric Administration (NOAA; Washington, DC). "We will use all the tools at our disposal to clamp down on IUU fishing and prevent illegal seafood from entering our market."

K Kelleher/NOAA

Illegal vessel transferring its catch off the coast of Sierra Leone.

One of the tools already being used is satellite-based vessel monitoring systems (VMS), which can track the position, course, and speed of VMS-equipped boats, and extrapolate from those data whether a vessel is simply traveling or is exhibiting behavior that indicates they are actively fishing. Expanding the number of both countries and international fisheries that require VMS-equipped boats is a goal of this agreement, according to Russell Smith, Deputy Assistant Secretary for International Fisheries, NOAA (Washington, DC). "NOAA is also working hard to develop additional tools, such as radar, to provide greater surveillance of fishing activities, especially of boats that are not VMS-equipped", explains Smith.

Damanaki is also promoting the worldwide adoption of the catch certificate scheme, signed into law in the EU in 2010, which requires every seafood product entering the EU to have a catch certificate as a guarantee of origin and legal harvest. "A global catch certificate would help ensure there was no market for products derived from IUU fishing", she says. ■

Human pathogen contributes to coral decline

Madeline McCurry-Schmidt

Fifteen years ago, reefs surrounding the Florida Keys commonly included colonies of Caribbean elkhorn coral (*Acropora palmata*). This species, like other hard corals, provides a coastal buffer against storm-associated wave action and serves as a shelter and nursery for many reef species. Since then, however, elkhorn coral has suffered dramatic population losses and has been listed as "threatened" under the US Endangered Species Act.

"We've really lost an iconic species", says Kathryn Sutherland, an Associate Professor and coral ecologist from Rollins College (Winter Park, FL). Sutherland has studied elkhorn coral since 1996. Since then, she has seen coral damaged by storms, pollution, and rising water temperatures. However, another cause of elkhorn death has been on the rise: a coral disease known as white pox or acroporid serratiosis. Typically, elkhorn reefs suffering from white pox first display characteristic patchy tissue losses, which can eventually lead to the death of the entire colony, creating underwater areas that Sutherland calls "elkhorn graveyards".

JW Porter/University of Georgia

White pox disease on elkhorn coral in the Florida Keys.

In a recent paper (*PLoS ONE* 2011; doi:10.1371/journal.pone.0023468), Sutherland and her colleagues investigated whether the bacterial pathogen, *Serratia marcescens*, found in the human gut and in untreated sewage, is the causal factor of white pox. Sutherland and her team examined various *S marcescens* strains found in fecal matter from different animals living in the Florida Keys, as well as from humans, using standard genetic techniques. They showed that the *S marcescens* strain causing white pox was the same strain as found in human waste. The researchers then inoculated healthy fragments of elkhorn coral kept in aquaria with the *S marcescens* strain found in wastewater samples and isolated from pox-infected corals. The coral died within a few days, confirming that "humans are a source of the pathogen that causes white pox".

The good news, Sutherland says, is that there is a solution. She and other coral researchers have convinced many residents in the Florida Keys to shift from using unreliable (ie leaky) septic tanks to more advanced sewage treatment systems – ones that filter out suspended solids potentially harboring *S marcescens*. The next step is to promote improved wastewater management efforts throughout the wider Caribbean region, where funding for water quality projects is more limited. ■