

**BBVA Foundation Frontiers of Knowledge Award in Ecology and Conservation**  
**Biology**

## **The BBVA Foundation honors Gene E. Likens and Marten Scheffer for decisive advances in the science of predicting the ecosystem impacts of human activity**

- For the jury, their work has contributed in major ways to improving science's ability to analyze and predict the "gradual, abrupt and potentially irreversible changes" caused by environmental pollution
- Likens uncovered the damage being wreaked by acid rain in North America in the late 1960s, and his research hastened the adoption of legal measures to allay this threat; a product of industrial and automotive emissions
- In the early 1990s, Scheffer was the first to identify the "tipping point" in ecosystem deterioration; a turning point which can propel the system to catastrophic and at time irreversible changes
- Together, the two scientists "have transformed our understanding of how human activities are changing the structure and function of natural ecosystems," while providing "tools" to check its deterioration, in the words of the award citation

**Madrid, February 7, 2017.-** The BBVA Foundation Frontiers of Knowledge Award in the Ecology and Conservation Biology category goes, in this ninth edition, to ecologists Gene E. Likens and Marten Scheffer for contributing decisively to what the jury describes as "one of the major challenges" of this scientific discipline: to understand and, where possible, anticipate ecosystem responses to human-induced alterations of the natural environment. Likens revealed the impact across North America of acid rain, a phenomenon with severe environmental consequences, and Scheffer subsequently showed that human action, though gradual, can trigger abrupt and fundamental ecosystem shifts of a potentially irreversible nature. The work of the American and Dutch ecologists is today instrumental in informing decisions on how to confront pollution risks, and policies to manage ecosystems safely, and even successfully restore them after serious deterioration.

Working independently, Likens and Scheffer have, says the jury, contributed to understanding and finding solutions for “gradual, abrupt and potentially irreversible ecosystem change” in response to pollution and other ecological threats. Together, the two scientists “have transformed our understanding of how human activities are changing the structure and function of natural ecosystems, and provided tools to inform ecosystem management.”

The work done by Gene E. Likens (Indiana, United States, 1935), founding president of the Cary Institute of Ecosystem Studies in New York, “was instrumental to develop effective policies to reduce the acid rain problem,” according to the prize jury. His discovery, published in 1974, paved the way for measures like the Clean Air Act Amendment of 1990, “with great impact on environmental law and clean-energy research.”

Likens was also a pioneer in the conduct of long-term experimental studies spanning an entire ecosystem (such as a drainage basin), and the use of decade-long measurements (instead of the two- or three-year standard length of most research projects). The discovery of acid rain in the United States dates from the early 1970s, and Likens’ continuing research in the same zone has provided proof that the resulting harm is not only intensive but lasting.

The original finding, Likens recalls, was entirely a product of chance. He and his team were studying forest lakes in New Hampshire (United States), when they detected acidity levels in rainwater samples a hundred times greater than expected. “It was quite a shock. We didn’t know the causes of the problem, or how far it might extend,” he relates. It took them almost ten years to confirm the link with pollutant emissions, primarily those released by the burning of fossil fuels. They published their results in *Science* in 1974, warning that the scale of the problem was still largely uncharted. This is considered one of the first scientific discoveries to have ushered in successful environmental legislation.

“Acid rain is a serious environmental problem that affects water, soil, forests ....” Likens explains. “In the United States we have achieved a notable reduction in the main compound causing acid rain, and the acidity of rain and snow has decreased by 80%. But acid rain has been falling for many years, which has made the soil far more sensitive to other impacts.”

### **Abrupt and potentially irreversible change**

Marten Scheffer (Amsterdam, 1958), a professor at Wageningen University in the Netherlands, helped to identify the risk of an ecosystem suffering abrupt change, and how such transitions could be avoided. His studies, like Likens’ based on long time series of data, can serve to anticipate the consequences of global climate change, and to prime specific ecosystems – like the Doñana marshes and other wetlands – to cope when they appear.

His first contribution was to confirm the reality of those critical ecosystem transitions known as “tipping points” (turning points and also, potentially, points of no return). Prior to Scheffer's studies, their existence had been postulated but no examples ever found. The Dutch scientist uncovered the first empirical evidence in the early 1990s in shallow lakes in different parts of Europe. The water of the lakes had turned murky due to an excess of nutrients from agricultural fertilizers, and Scheffer was able to prove that reducing these pollutant inputs failed to restore them to their previous state. The deteriorated ecosystem had transitioned to a new equilibrium, and was in need of “shock therapy,” as he described it: no less drastic a measure in this case than extracting all the fish. This remedy is still practiced today, even in large lakes – with nets, he explains, several kilometers long – and marks a radical break with the strategies previously attempted.

Scheffer declares himself “especially happy” about the practical utility of his findings, not just for the recovery of lakes, but also other ecosystems poised to reach their own tipping points. For instance, his work showed that it is sometimes possible to harness natural phenomena, like El Niño, to help restore degraded forests: the current provides humidity and its arrival marks the best time to withdraw livestock and initiate successful reforestation.

In a 2015 paper published in *Science*, he applies his ecosystem model to the wetlands of Doñana, with suggestions on how to improve their resilience to climate change. This National Park is threatened by several tipping points; a particular trigger being the cyanobacteria toxins increasingly present due to both rising temperatures and higher concentrations of nitrogenous and phosphorus waste from the fertilizers used on nearby strawberry crops. With the prospect of hotter weather ahead, the strategy should be reduce such nutrient inputs.

The next step in Scheffer's research was to look for reliable indicators as to whether ecosystems are heading for “catastrophic and potentially irreversible change,” as the citation puts it. This is an open project, as yet with no readily applicable conclusions, but one that may eventually come up with predictive tools of immense value in environmental management.

“What we do is try to determine how far we are from a tipping point,” Scheffer explains. “In practice, this gives you a measure of an ecosystem's ability to recover from a perturbation.”

### **Bio notes: Gene E. Likens**

Gene E. Likens (Pierceton, United States, 1935) completed a degree in zoology at Manchester College (Indiana, United States) in 1957, then went on to earn an MS (1959) and PhD (1962) in the same subject at the University of Wisconsin-Madison (United States). From 1969 to 1983 he held a series of teaching and research posts at Cornell University in New York, where he rose to be Charles A. Alexander Professor of Biological Sciences. A professor at Yale University since 1984 and Rutgers University

since 1985, he also holds the Einstein Professorship of the Chinese Academy of Sciences.

In 1963, Likens was co-founder of the Hubbard Brook Ecosystem Project in the White Mountains of New Hampshire. This was the study during which he discovered acid rain and its ecosystem impact. In 1983, he founded the Cary Institute of Ecosystem Studies in Millbrook, New York – originally part of the New York Botanical Garden – where he is now President Emeritus and Distinguished Senior Scientist Emeritus.

Author of more than 580 papers and book chapters and 25 books, in all, his published studies have been cited nearly 200,000 times. Likens has received numerous awards and distinctions. He is a distinguished member of the American Academy of Arts and Sciences, the U.S. National Academy of Sciences, the Royal Swedish Academy of Sciences and the Austrian Academy of Sciences, among other learned societies. His many awards include the ECI Prize, the Tyler Prize for Environmental Achievement, the National Medal of Science, the Blue Planet Prize and the Alfred C. Redfield Lifetime Achievement Award.

### **Bio notes: Marten Scheffer**

Marten Scheffer (Amsterdam, Netherlands, 1958) earned a PhD in Ecology from the University of Utrecht in 1990. From 1985 to 1997, he held research posts at the Institute for Forestry and Landscape Planning, Wageningen (Netherlands) and the Institute for Inland Water Management and Waste Water Treatment. Currently, Scheffer is Professor of Aquatic Ecology and Water Quality Management at Wageningen University, where he heads the department of the same name.

Founder-director of the Synergy Program for Analyzing Resilience and Critical Transitions (SparcS), he is also the driving force behind the more recent creation of two interdisciplinary research institutes: the Institute Para Limes at Nanyang Technological University (Singapore) and the South American Institute for Resilience and Sustainability Science (Uruguay).

In 2004, Scheffer received the Sustainability Science Award of the Ecological Society of America (where he has been an honorary member since 2011). He also holds the Spinoza Prize (2009) of the Netherlands Organization for Scientific Research (NOW in its Dutch initials). He is the recipient of an Advanced Grant from the European Research Council (ERC) to work on early warning signals for critical transitions, and of a prestigious Gravitation Grant from the Dutch Government for research into climate tipping points.

Scheffer serves on the science board of the Resilience Alliance, a group of ecologists, economists, and specialists in organizational dynamics, politics, and sociology aiming at developing an innovative research on resilient society-nature interactions. He is author of the books *Ecology of Shallow Lakes* (2004) and *Critical*

*Transitions in Nature and Society* (2009), as well as devoting time to playing and composing music.

### About the BBVA Foundation Frontiers of Knowledge Awards

The BBVA Foundation has as its core objectives the promotion of scientific knowledge, the transmission to society of scientific and technological culture, and the recognition of talent and excellence across a broad spectrum of disciplines, from science to the arts and humanities.

The **BBVA Foundation Frontiers of Knowledge Awards** were established in 2008 to recognize outstanding contributions in a range of scientific, technological and artistic areas, along with knowledge-based responses to the central challenges of our times. The areas covered by the Frontiers Awards are congruent with the knowledge map of the 21st century, in terms of the disciplines they address and their assertion of the value of cross-disciplinary interaction.

Their **eight categories** include classical areas like Basic Sciences and Biomedicine, and other, more recent areas characteristic of our time, ranging from Information and Communication Technologies, Ecology and Conservation Biology, Climate Change and Economics, Finance and Management to Development Cooperation and the innovative artistic realm that is Contemporary Music.

The BBVA Foundation is aided in the organization of the awards by the **Spanish National Research Council (CSIC)**, the country's premier public research agency. As well as designating each jury chair, the CSIC is responsible for appointing the technical evaluation committees that undertake an initial assessment of the candidates put forward by numerous institutions across the world, and draw up a reasoned shortlist for the consideration of the juries.

### Ecology and Conservation Biology jury and technical committee

The jury in this category was chaired by **Emily Bernhardt**, a professor in the Department of Biology at Duke University (North Carolina, United States). The secretary was **Pedro Jordano**, Research Professor in the Department of Integrative Ecology at Estación Biológica de Doñana, CSIC (Spain). Remaining members were **Wilhelm Boland**, professor in the Department of Bioorganic Chemistry at the Max Planck Institute for Chemical Ecology (Jena, Germany); **Gerardo Ceballos**, professor at the Instituto de Ecología of the Universidad Nacional Autónoma de México (UNAM); **Hanna Kokko**, Professor of Evolutionary Ecology at the University of Zurich's Institute of Evolutionary Biology and Environmental Studies (Switzerland); **Rik Leemans**, Professor of Environmental Systems Analysis at Wageningen University (Netherlands); **Guangchun Lei**, Dean of the School of Nature Conservation at Beijing Forestry University (China); and **Yonglong Lu**, Research Professor and Co-Director at the Research Center for Eco-Environmental Sciences (RCEES) of the Chinese Academy of Sciences.

The **CSIC technical committee** was coordinated by **Ana Guerrero**, the Council's Deputy Vice President for Scientific and Technical Areas, and formed by: **Eulalia Moreno Mañas**, Research Professor in the Arid Zones Experimental Station (EEZA); **Daniel Oro de Rivas**, Research Professor in the Mediterranean Institute for Advanced Studies (IMEDEA); and **Xavier Querol Carceller**, Coordinator of CSIC Natural Resources Area and Research Professor at the Institute of Environmental Assessment and Water Research (IDAEA).

#### CALENDAR OF UPCOMING AWARD ANNOUNCEMENTS

<b>Contemporary Music</b>	Tuesday, February 14, 2017
<b>Economics, Finance and Management</b>	Tuesday, February 21, 2017
<b>Development Cooperation</b>	Tuesday, February 28, 2017

#### **Previous awardee in this category**

The **Ecology and Conservation Biology** award in last year's edition went to **Ilkka Hanski**, for opening up an area of ecology that explains how species survive in fragmented habitats and allows to quantify the extinction threshold.

A list of remaining laureates in the previous edition can be accessed through the following link:

<http://www.fbbva.es/TLFU/tlfu/ing/microsites/premios/fronteras/index.jsp>

**Five of the 79 winners in earlier editions of the BBVA Foundation Frontiers of Knowledge Awards have gone on to win the Nobel Prize. Shinya Yamanaka**, the 2010 Biomedicine laureate, won the Nobel Prize in Medicine in 2012; **Robert J. Lefkowitz**, awardee in the same Frontiers category in 2009, won the Chemistry Nobel in 2012. In Economics, Finance and Management, three Frontiers laureates were later honored with the Nobel: **Lars Peter Hansen**, winner of the Frontiers Award in 2010 and the Nobel Prize in 2013; **Jean Tirole**, Frontiers laureate in 2008 and Nobel laureate in 2014; and **Angus Deaton**, 2011 Frontiers laureate and Nobel laureate in 2015.

#### LAUREATE'S FIRST DECLARATIONS AND IMAGES

A video recording of the new laureate's first interview on receiving news of the award is available from the Atlas FTP with the following coordinates:

Server: **5.40.40.61**

Username: **agenciaatlas5**

Password: **premios**

The name of the video is:

**"PREMIO ECOLOGÍA"**

In the event of connection difficulties, please contact Alejandro Martín at Atlas:

**Mobile:** +34 639 16 58 61

**E-mail:** [amartin@atlas-news.com](mailto:amartin@atlas-news.com)

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For more information, contact the BBVA Foundation Department of Communication and Institutional Relations (+34 91 374 5210/+34 91 374 3139/+34 91 374 8173, [comunicacion@bbva.es](mailto:comunicacion@bbva.es)) or visit [www.fbbva.es](http://www.fbbva.es)