A Look Back at the International Biodiversity Observation Year

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At regular intervals, a sea turtle named Roberta is being tracked by a satellite as she makes her way around the Gulf of Mexico at an average speed of 0.93 kilometers (km) per hour. Small packets of leaf litter are decomposing at various places around the world, and someone is keeping track of them. A diver is cataloguing previously unknown marine organisms in that most dangerous of habitats (for humans, at least), a flooded cave. School children are taking inventories of the organisms they find in their back yards. Academics are constructing a tree of the life on Earth. Scientists are building a network of institutions to monitor the marine life all along Europe's coast. Other scientists are cataloguing the biological diversity in a broad and long swath that extends from Siberia to New Zealand—an enormous field plot that covers mainland and water, forests and islands.

A huge green turtle, nicknamed Zyanya by researchers, makes a stop in her lengthy circuit around the Gulf of Mexico. The transmitter attached to her carapace sends regular signals to a satellite and provides scientists in a project affiliated with IBOY with valuable information about the life and times of sea turtles. Photograph: Michelle Rene Kinzel.

None of this should surprise biologists who keep up with what's happening in their craft. Collecting, inventorying, and classifying are part of what biologists do. What's different is that all the activities listed above, plus dozens of others, have been part of an imposing attempt to gather biodiversity research under one enormous umbrella and expose it to the lay public, to other scientists who may be immersed in their own fields, and to the all-important and often-mentioned policymaker—and to do it under the terrible deadline that hangs now over Earth: the threats of uncontrollable climate change, irreplaceable habitat loss, and the world's first human-made mass extinction. The undertaking is called the International Biodiversity Observation Year. The year is drawing to a close, but the work continues.

IBOY, as the year is known, is producing a bittersweet taste for those who created and maintained it. The effort is clearly a success—a simple count of its projects, along with the enthusiasm of its participants, show that. It is also a success in an area not overly familiar to researchers—the nonscientist community. Says IBOY's chair, Diana Wall, a soil ecologist and head of the Natural Resource Ecology Laboratory at Colorado State University: "IBOY has not been a typical 'International Year of...' because its energy and direction has come from a grassroots community rather than from a large international organization such as the United Nations. Hundreds of scientists from around the world responded to IBOY's call for projects to participate in this year to observe and communicate about biodiversity." The result, she says, "was an enormously varied portfolio of activities that captured the diversity of life and its connections to humans more fully than activities designed by a committee could have done."

BioMare

One of IBOY's most ambitious component projects, "BioMare," is a network to coordinate study of the biodiversity of Europe's 38,000 km coastline.

Marine biodiversity is a neglected stepchild of ecosystem research. The protocols that do exist are often borrowed from terrestrial sciences and may or may not be useful in watery environments. Even among marine research institutions, there's no guarantee that results will be comparable. Carlo Heip, of the Netherlands Institute of Ecology and BioMare's project leader, puts the problem bluntly: "I am still astounded by the reluctance of ecologists to go for...sampling methods that are standardized, calibrated, and validated. The quality of many biological data is appallingly poor. Every scientist uses his or her own method, and it is not easy to make them move to agreed methodology. In taxonomy the situation is perhaps even worse."

"BioMare," which is backed by 21 member institutions from the European Union and neighboring countries, has sought to change that. Through meetings, conferences, and a Web presence, the program has promoted Europe-wide consensus on a network of research centers (called "focus sites"); standardized sets of measures that can serve as indicators for marine biodiversity inventories, some of them long term; and disseminated the results.

Heip says the effort has not been easy. "It took something like five or six years to get from the statement that marine biodiversity was an issue to organizing the research," he says. "BioMare" had the benefit of a continent teeming with established marine research stations, some of which have been conducting inventories for more than a century. But "other areas are virtually unexplored," Heip says. Nations and their marine researchers have eagerly accepted the "BioMare" undertaking, says the project's Richard Warwick. "They all realize that the major biodiversity questions can only be answered by collaboration on this scale, and they all want to be part of it."

Carlo Heip has kind words for IBOY. It "helped to increase the visibility of the 'BioMare' project" both inside and outside of Europe, he says, "resulting in requests for information from individual scientists and improved links to similar North American and Asian initiatives."

Now that it's almost over, Wall and others who were involved in IBOY face the inevitable question: What next? IBOY produced and contributed to a great deal of momentum, both at that grassroots level and among research institutions and individual scientists. Will the global communication fostered by IBOY (largely on a shoestring and through a very busy Web site and e-mail address at Colorado State) be allowed to continue? (See "IBOY's nerve center.")

IBOY has been an unusual undertaking in several ways. For one, it doesn't hand out money. The shoestring, comprising a grant from the international scientific organization Diversitas, plus money scrounged from foundations to support small-scale conferences and the like, did not allow IBOY to write checks for its participating projects. The projects had to do their own scrounging; what they got out of IBOY was inclusion under the umbrella of publicity—which included a well-written newsletter and detailed Web site—and communication among their fellow participants. IBOY participants had every reason to feel that they were not alone.

Also, the observation year did not seek out only the high-rolling biodiversity projects. Some mega-efforts are included among IBOY's list of globe-wide core projects, but dozens more are satellite projects, which involve short-term studies of local or regional habitats or brief schoolroom experiments. Gina Adams, IBOY's program director, says inclusion of such smaller-scale programs was unusual for international science programs. From an administrative viewpoint, she says, "it was a difficult decision, because it is more time consuming to build a global network from many local-scale projects than from a few large international projects." IBOY's planners knew, however, "that incorporating local-scale projects...would be crucial to make the program relevant to sustainable development, because it is at local and regional scales that most research, management, and policy decisions about the environment are made." This is especially true, she says, in developing nations.

IBOY's road was not smoothly paved. The logistics of getting together dozens of core and satellite projects from the four corners of the world meant that the "year" spilled over into two years. Several planned events were postponed after the terrorist attacks of September 11, 2001. A global economic decline didn't help. But as the observation year nears its end, it can boast of several significant achievements.

Almost all the IBOY projects, large and small, recognize that biodiversity has a human dimension, and they incorporate that recognition into their designs. They start from the assumption not that human involvement is a necessary evil that complicates good science, but that it is an important and, indeed, often controlling factor in biological diversity. This is not a startling conclusion, but it's one that often has been overlooked by both policymakers and those who practice "pure science."

Many, if not most, of the IBOY projects combine research from multiple disciplines. Interdisciplinary research is much talked about but infrequently practiced. In almost all IBOY projects, it's taken for granted.

Perhaps the most significant principle behind IBOY and the projects beneath its umbrella is the tacit acknowledgment that we know so little about the planet on which we live. Furthermore, we are a long way from agreeing on what diversity to measure and how to measure it.

Taking stock

As might be expected, a popular activity of IBOY projects is conducting inventories. Not only is there widespread (and relatively recent) realization that we know only a small percentage of the species that exist in, on, above, and under the planet's surface; we also know pitifully little about the interactions among those species and within the ecosystems, landscapes, watersheds, and biomes in which they function. The urge to do inventories has also been spurred by the fact that 186 nations have become parties to the 1992 Convention on Biological Diversity (the United States is not among them), and thus they've agreed to identify and monitor their diversity (*www.biodiv.org*).

Lurking behind inventory taking is the omnipresent danger of extinction. A publication of the Hungarian Biodiversity Monitoring System, one of IBOY's more interesting satellite projects *(www.gridbp.ktm.hu/biodiver/html/angol/),* notes that "the vulnerability of the biosphere was only realized following the rapid mass extinction of species." The system, which represents a collaboration of the Hungarian Academy of Sciences, the Institute of Ecology and Botany, and the Hungarian Natural History Museum, is building a national network of 124 quadrats, each 5 km by 5 km, within which intense inventorying of plant and animal life is carried out. The plan is to repeat this habitat mapping once every eight years.

The Hungarian researchers, who operate under the name Hungarian Biodiversity Monitoring System, have compiled a 10-volume protocol to standardize their methodology. There's an extensive habitat classification system ("artemisia salt steppes" are quite different from "tall herb salt meadows"). The project's ultimate object is not only to collect information but to make it freely available to the scientific community, decisionmakers, and the general public. Getting the program started, according to its authors, was "a monumental project."

IBOY's nerve center

IBOY's own center of diversity is a busy office at the Natural Resource Ecology Laboratory at Colorado State University in Fort Collins. The program originated in 1997, when a group named Diversitas of the Western Pacific and Asia provided the spark for the creation of a global effort to promote and integrate biodiversity science in a holistic setting. Communication among the participants would be an important component.

Before long, IBOY had assembled 47 components ("core" projects) that were built around networks. Another 58 projects were designated as "satellites." The projects were active in more than 160 countries, many of them in the developing world. IBOY chair Diana Wall estimates that some $80 million in research monies was involved.

For many of the IBOY participants, their only communication with the rest of the world was via the World Wide Web. (Participants in some of the smaller undertakings continue to send postcards and letters to Wall and Gina Adams, the program director, filled with progress reports and snapshots.) IBOY relayed these and other reports through its newsletter, press releases, and responses to media queries; its Web site (including one for children); presentations at national and international scientific meetings; and workshops, including one to educate project leaders in dealing with the media. There were also national biodiversity celebrations in several nations; Europeans showed most interest here.

Mapping the Amazon. Mapping of a different sort is under way in the lower Rio Jauaperì area of Brazil. The site lies northwest of Manaus (along the equator at about 61 degrees west), and covers part of the Xixuaù-Xiparinà Nature Reserve. Some 570 people occupy five communities in its 24,000 square km rainforest, which has been described as "unexplored" and "pristine."

Associação Amazônia (*www.amazonia.org*) operates an IBOY project there known as "Amazonia Landscape Mapping and Biodiversity Estimation." The aim, says project leader Luigi Fabbro, is to combine two previously unrelated tools of biodiversity research: indigenous knowledge from the local communities, along with remote sensing and geographic information systems (GIS) technology. "The project," Fabbro explains, "will provide ground truth for the remote sensing of Amazonia and contribute to the baseline data sets of pristine biotopes against which 'trouble spots' can be monitored." Ideally, it will also contribute to sustainable development, which the researcher calls "our best hope yet to stop deforestation and avert the biological catastrophe."

The project uses a number of remote sensing and GIS technologies to gather information, and the people of Xixuaù do the research—not as assistants to outside scientists, but as ground surveyors trained for the job. They are being aided by devices not previously seen in the reserve: computers, GIS equipment, digital cameras, voice recorders, and satellite radio, all powered by solar energy panels. Fabbro hopes the mix of local knowledge and the latest technology will result in a map that "will transform the lower Jauaperì basin into a catalogued *in situ* germ plasm collection," perhaps one useful in future bioprospecting.

Fabbro also thinks use of GIS and allied technology in a remote place like the reserve will be a useful tool in biodiversity assessment "because representations of different, measurable attributes of the environment"—such as soil characteristics, rainfall, canopy cover, distributions of individual species—"can be stored in separate layers within a GIS" and then used in generating predictive maps for unsurveyed areas.

Learning about life in the back yard. The Amazonian mapping project is an enormous undertaking. Inventory taking on a smaller scale was another IBOY project, called Backyard Biodiversity Day *(www.biodiversityday.org)*. A United Kingdom charity, Action for Biology in Education, and its partner, the Chelsea Physic Garden of London, challenged children, aged 9 to 12, to spend 15 minutes searching for, observing, and recording the wild flora and fauna within a mile of their homes or schools. The first such day, in 2001, was such a success that it was repeated in the summer of 2002.

The younger children devoted their energies to drawing pictures of what they saw, while older students specialized in activities ranging from pond dipping to spider wrangling. In London, a class surveyed a previously derelict spot that had been converted into a green area. Lucianne and Sarah, from St. John's Evangelist Church Primary School in Islington, counted legs on centipedes and spiders. Luke, from Peterborough, wrote that "I caught a frog but I let him go."

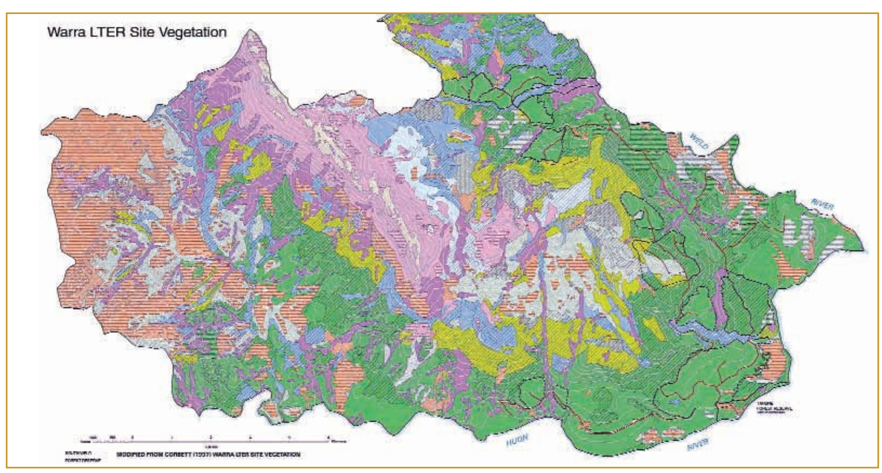
A researcher in Kenya checks the contents of a mesh bag containing leaf litter. It is part of the Global Litter Invertebrate Decomposition Experiment (GLIDE), which is generating data about invertebrates from sites around the world. This GLIDE station is affiliated with the Tropical Soil Biology Fertility program in Nairobi. Photograph courtesy of Frederick Ayuke, TSBF.

Virginia Purchon, of Action for Biology in Education, estimates that some 3000 children took part in the 2002 biodiversity day. "Given that the purpose of the project is to raise awareness about the variety of living things...in people's backyards and local environment," she says, "we feel that if the event can be sustained as an annual activity we may slowly have an impact on some of the very urbanized children of our cities and country towns." Backyard Biodiversity Day could even go global; children participated in India in 2001 and France in 2002, Purchon says. "It would be wonderful to have it as an international event." The organizer thinks the event's connection with IBOY helped attract valuable attention within the biological community.

Down under and beneath the surface. Half a world away, Dick Bashford and colleagues are measuring the diversity in the cool, wet, temperate forest of Tasmania in a manner quite different from Backyard Biodiversity Days. The Warra Long Term Ecological Research (LTER) site *(www.warra.com)* is, as its name implies, an effort to probe an ecosystem over the long term and, its researchers hope, produce designs for the sustainable use of forests.

The Warra site is on Australia's most heavily forested and least populated island-state. It covers 15,900 hectares and has an altitude range from 37 to 1260 meters above sea level. The "Mt. Weld Altitudinal Transect," as Warra's IBOY project is known, uses permanent floristic plots every 100 meters in altitude from near sea level to the top of Mt. Weld to keep track of invertebrates. Each month over the course of one year, someone visits the plots and monitors and measures the invertebrates present. This will yield baseline data on selected invertebrates, which will be studied intensely to determine aspects of biological change. Despite decades of data collection in the forests, researchers still need indicators to help them understand global changes. The Warra LTER is part of an international network of long-term observation stations that aim, among other things, at collating the changes that occur at selected sites. LTER grew out of a US-based network *(http://lternet.edu/)* that the National Science Foundation established in 1980. Currently there are 24 such sites in the United States and about an equal number in the rest of the world.

Warra is also one of many sites taking part in the Global Litter Invertebrate Decomposition Experiment (GLIDE), one of whose leaders is IBOY chair Diana Wall. Her special interest is soil-dwelling organisms, which she feels have been little studied and underappreciated by the scientific community. In GLIDE's first phase, mesh bags containing common leaf litter were placed at experimental plots in 32 sites in 20 countries around the world. At several points in the succeeding two years, the bags are



The map depicts more than 40 years of data collection in the Warra Long Term Ecological Research (LTER) site in southern Tasmania. The purplish area near the middle of the site vegetation map represents rain forest, with greater elevations at its center. Source: www.warra.com/warra/docs/

The "Tree of Life" project

When Michael Donoghue, of Yale University, started work on the "Tree of Life" project, an attempt to assemble a phylogenetic tree of Earth's life, he assumed that the lack of scientific knowledge about 1.7 million described species would constitute a bottomless pit. But he became "astounded at how much work was going on that I didn't know about."

"A lot of it's in real obscure groups of organisms. But real progress is being made on things like flatworms and the like. I was thinking, 'I had no idea there was so much work on flatworms.' And furthermore, there's a lot of people working on them in kind of settled, quiet ways, and publishing their own journals. As the days went on, I got this really overwhelming sense that there's real progress being made in assembling this thing.

"And this is not some central organization sending out checks and saying 'We need the flatworm study by the end of the week.' Not at all. It's just everybody in the world doing what they're doing." Donoghue said he came away from several planning and work sessions with "the overall sense" that this project "was something that was achievable, to a large extent, within our lifetimes—or within the next 25 years; that we could see very, very substantial progress toward the end of actually figuring out how everything on Earth is related to everything else. Obviously, we're not going to get every species in the world into the big Tree of Life. But the major branches of the tree are going to be worked out, and with great confidence, probably within about 20 years."

Why, he was asked, is it so important to figure out the relationships among organisms? "I think that's a little challenging to explain to people. But it shouldn't be too challenging, because what the knowledge of relationships gives you, ultimately, is the ability to make predictions about things. To make meaningful predictions about the distribution of certain traits. For instance, if we were interested in a certain chemical that we found in a certain plant, where would we predict we'd see it in other plants? Well, we'd look at things that were closely related to that species, because they are very likely to share that feature. So if you were going to search for some chemical in the world, then you might go and look for relatives of this species. Any kind of prediction we want to make about the distribution of a chemical or anything else that we're interested in is going to ultimately come down to knowing how things are related to one another."

The initial fruits of the "Tree of Life" project will take the form of a book and contain an estimated 50 papers.

The World Wide Web has made possible the display and exchange of information scientists may never have dreamed of. Entire galleries of illustrations and data on marine flatworms exist, for example. Here are two residents of the Philippines, Pseudoceros lindae *(top) and* Pseudoceros scintillates *(bottom). Photographs: © 2001 Erwin Köhler.*

removed, weighed to provide decomposition information, and the fauna within them identified. The object is to seek answers to these questions:

- Are patterns of organism succession involved in decomposition the same across biomes and latitude even though the rate of succession varies?
- Does the succession of taxa vary with latitude and decomposition rate?
- Are similar taxonomic groups involved in decomposition irrespective of biomes and latitude?
- At varying latitudes, what effect does the exclusion of animals have on the rate of litter decomposition?

Data evaluation is proceeding. So far, 31,000 specimens have been identified, representing 35 orders and 49 families or genera *(www.nrel.colostate.edu/projects/glide/)*.

Big, audacious goals. Two of the more ambitious projects beneath the umbrella would certainly function well without the IBOY logo, but they help to illustrate just how all-encompassing the field of biodiversity research has become.

One of them, called the Tree of Life project, seeks to assemble not just a list of species, but a phylogenetic tree that reveals the relationships among species (see "The 'Tree of Life' project"). Michael Donoghue, chair of the Yale Department of Ecology and Evolutionary Biology, is guiding the tree's cultivation, along with Joel Cracraft, curator-in-charge of the American Museum of Natural History's ornithology department. It is, of course, an audacious undertaking. When Donoghue was explaining the project to a group of other IBOY project leaders not long ago, someone from the audience asked about the "premature" nature of a project that concerns species that haven't even been discovered or described. "Trees grow," the Yale researcher replied. "The key is to get the information out there so people can *use* this information."

The Millennium Ecosystem Assessment (MA; *www.millenniumassessment.org*) is equally ambitious. The \$21-million, four-year project has been billed by IBOY as "the largest ever collaboration of global scientists to assess the consequences of changes to the world's ecosystems." With backing from the United Nations, World Bank, World Resources Institute, and others, MA hardly needs IBOY's imprimatur to attract attention. But the assessment's particular contribution to the observation year will be a published methodology on how to assess the world's ecosystems' ability to sustainably produce goods and services. Some 1500 scientists and research institutions are involved in the assessment, which is coordinated from the campus of the International Center for Living Aquatic Resources Management *(www.iclarm.org)* in Penang, Malaysia.

Coping with change

Compiling inventories of Earth's biological diversity—and, equally significant, of the relationships among species, ecosystems, and landscapes—is a recurring theme among IBOY's projects. Similarly important is the question of how to cope with the alarming and rapid change that all but the most recalcitrant scientists, corporate PR people, and policymakers acknowledge is flooding over the planet. In fact, many of the projects that IBOY classifies under the heading, "What biodiversity do we have and where is it?" fit also under the heading, "How is biodiversity changing?"

AmphibiaWeb is one of several IBOY projects that is concerned with amphibians and their global decline. Its database and photo gallery are especially useful. Pictured here are (clockwise from top left) Ensatina eschscholtzii, *photographed in Madera County, California (photograph © 1998 William Leonard);* Rana pipiens *(Northern leopard frog), in tadpole stage, from Olympia, Washington (photograph © 2000 William Leonard);* Rana catesbeiana *(American bullfrog), in St. Mary's County, Maryland (photograph © 2002 Fred Powledge); and* Ambystoma californiense *(California tiger salamander), Alameda County, California (photograph © 2001 William Flaxington).*

Alarming indications of the extent of this change include climate alteration so dramatic that whole Alaskan villages are melting away. There are runaway invasions by exotic species, rapid increases in extinction rates, and outbreaks of new or forgotten diseases. Few of these cause more sentimental despair among citizens in general than the mysterious global decline in amphibians, particularly frogs.

AmphibiaWeb (*http://elib.cs.berkeley.edu/aw/declines/declines.html*) is a Web site devoted to seeking answers to two vexing questions: How big is the worldwide amphibian decline, and what are the causes of that decline? The well-organized, well-written site documents known declines and extinctions (more than 200 amphibian species have experienced recent declines, and 32 species have been reported to have gone extinct); it also presents probable and confirmed factors behind the dilemma, as well as a list of species that have disappeared and another of those on the watch list. The overall database comprises 5403 amphibian species. Among the factors incriminated in the declines are climate change, habitat loss or modification, competing introduced species, ultraviolet-B radiation, chemical contaminants, disease (a combination of new illnesses and more susceptible amphibians), loss of the creatures to trade, and—a factor that appears more and more likely to be the major one—the synergistic effects of multiple problems that weaken the immune systems of frogs and toads, newts and salamanders, and caecilians.

David B. Wake, biologist at the University of California–Berkeley, maintains AmphibiaWeb. He finds the site and its resources to be growing in popularity and usefulness ("I use it all the time myself in the course of my own research," he says) and emphasizes that it serves as "an easily accessible informatics system" about amphibians, one that supplements the growing body of technical literature on causes of the declines themselves. Amphibians, he adds, are highly useful biodiversity indicators. "They breathe through their skins, thus putting their whole bodies on the front line, so to speak," he says. "We also know a great deal about their endocrinology, physiology, and development and so have good ways of monitoring their general health. Tadpoles are aquatic and many adults are terrestrial, and tadpoles eat vegetation while adults are carnivores, so they sample lots of parts of the environment."

Wake reports that his project "has received some publicity as a result of IBOY, and we have certainly benefited from the useful meetings of IBOY participants. But I have no way of giving any specifics about what IBOY has meant to us. Certainly it has not been a factor in fundraising, for example, but in general it has been a happy relationship." (AmphibiaWeb is not the only IBOY project dealing with amphibians. See FrogWatch and DAPTF, below.)

Coping with biological change often takes place in tandem with inventory taking. Habitats once considered pristine or at least beyond the reach of development are now being changed and obliterated before scientists can assess the flora and fauna they contain. One candidate for such concerted action is the Paraná River system in South America. The river and the region it serves, known as the Gran Pantanal, is gently sloping floodplain that is threatened by an international straightening-and-dredging scheme, similar to those inflicted on American waterways by the US Army Corps of Engineers. A slight drop in water level could have profound effects on a wide area. The "Aquatic Fauna of the Paraná River System" project seeks to establish an information baseline that can be useful in designing the scheme—if its engineers want to use it—and in possible later restoration attempts. Unfortunately, though millions of dollars and the fate of uncounted organisms are riding on the river-straightening plan, the baseline project suffers from a lack of funding. So far, it has been able only to review the existing literature, rather than go into the field and take valuable measurements.

Change occurs too in agricultural systems. These systems often are overlooked in discussions of biodiversity, but it is the genetic variability within them that keeps the planet's people alive. Without that variability and the ability to change that it confers, whether managed by nature, indigenous farmers, or agricultural scientists, crops would soon lose out in their constant contest with pests and pathogens and changing climatic conditions. A Pakistan-based IBOY project, "Collection, Evaluation, Conservation, and Sustainable Use of Agro-Biodiversity," gathers the germ plasm of the wild relatives of wheat and rice from degraded lands, then screens, conserves, and evaluates it. Shafqat Farooq, the project's leader (asim600@fsd.comsats.net.pk) and principal scientific officer of her government's Nuclear Institute for Agriculture and Biology, reasons that such germ plasm may be tolerant of stresses such as drought and high salinity and thus is valuable as breeding material. Shifts in water availability and global warming, she says, may make these genes even more important in the near future.

"We have successfully produced stress-tolerant wheat material through transferring genes from *Aegilops cylindrica,* which has been distributed within the country and abroad for cultivation on saline lands," Farooq says. Two lines of the wheat have been tested, the researcher explains, "for environment-friendly and low-input agriculture to relieve the burden on the economy and the environment and also to provide relief to the resource-poor farmers who can not afford heavy investment in terms of fertilizer and pesticide." In recent field trials, these lines produced good yields with half the usual doses of fertilizer and irrigations.

The project's association with IBOY helped, Farooq says. "While proposing this project to the IBOY, we were convinced that this project would be able to get attention of the people who are interested in biodiversity and wanted to witness its vital contribution to practical agriculture through cultivation of two of our lines in the field during 2001–2002.

"This is exactly what happened when we distributed the seeds to the farmers in the south of the country. The high harvest and low input demonstrated that biodiversity does pay dividends." The results also were presented in publications and at international meetings. "Although our achievements have been recorded in the publications, as well as in the activity reports of the institute," Farooq says, "nevertheless, through IBOY, the sphere of our activities has been made known to the most part of the world through an exclusive place on the IBOY Web site" and elsewhere.

Public awareness

Shafqat Farooq is happy that her project's details are reaching not only her scientific colleagues but also members of the public at large. The major aim of the International Biodiversity Observation Year has been to explain the importance of biodiversity to the lay public and to the all-important policymakers—the people who make decisions about everything from the relative importance of marine organisms to the need for salt-tolerant wheat and how much to spend on preserving them. One of IBOY's big pitches to the policymakers is that biodiversity study and protection are essential to Earth's continued production of ecosystem goods and services.

No one is claiming that IBOY has become a household word, at least unless the household belongs to a scientist immersed in environmental research. An unscientific sampling of leaders of core and satellite projects, when asked about the contribution that IBOY made to their efforts, replied that the publicity was nice, but it would have been nicer if it had attracted more funding sources—clearly not part of IBOY's job description.

Anyone who expended the effort to read IBOY's bimonthly newsletter *(www.nrel.colostate.edu/IBOY/news/newsletter.html)* would have access to an abundance of project descriptions and updates, along with linkages to more information. The program and its information sources are a gold mine for interested students of all ages.

One group guaranteed to attract people's attention is frogs. Adults as well as students are inordinately fascinated by them. They are (to humans) strange-looking creatures with amazing tongues, spellbinding eyes, and an enviable ability to move quickly from one place to another. AmphibiaWeb (described above) is concerned with the global decline in these and other amphibians, but it does not seek the assistance or participation of the lay public. "For the most part," says

A diversity of diversity

IBOY projects represent a great diversity of their own. Some, but by no means all, of them include the following:

Researchers are tracking green turtles by satellite in the Gulf of Mexico. Until recently, researchers have been confined to sandy beaches in their ability to track sea turtles, who lay their eggs there before returning to the sea. This project attaches satellite transmitters to green turtles and then uses global information systems technology to follow their movements. The turtle nicknamed Roberta, for example, traveled 1429 km from her nesting beach in Mexico to feeding grounds of the Marquesas Keys in 64 days. The project's Web site, *www.orf.org/ turtles.html*, contains fascinating maps depicting Roberta's and other turtles' migratory routes, home ranges, and foraging habitat, as well as a pictorial on how to glue a transmitter to the carapace of a very big sea turtle.

Habitat loss and other catastrophes have been identified as reasons for a worldwide decline in pollinators, which are needed for many plants (including important economic crops) to set seed. Bees are widely known pollinators, but mammals, birds, and other insects are also essential. Two IBOY projects monitor pollinators and promote their conservation: the "African Pollinator Initiative" *(www.elci.org/ api)*, and "Indigenous Honeybees in the Himalayas: A community-based approach to conserving biodiversity and increasing farm productivity" *(www.icimod.org/ihbees)*.

Ecosystem health is a popular subject in biodiversity circles, but far too often the health of human inhabitants of ecosystems is overlooked. A project named "Biodiversity: Its Importance to Human Health" promises to "compile what is known about the implications for human health, from a loss of species and the degradation of global ecosystems, into the most comprehensive report yet produced." The project, a major one for IBOY, has the backing of the World Health Organization and the UN Environment Program and is operated by Harvard Medical School *(www.med.harvard.edu/ chge/)*, whose Eric Chivian leads the project.

The world's ecosystems have kilometer after kilometer of flooded inland marine caves, some of them carved by waters from limestone and some created as lava tubes. Tom Iliffe, a marine biologist from Texas A&M University–Galveston, and Geoff Boxshall, of London's Natural History Museum, explore these caves and their inhabitants, some of which have never been confronted with the broad range of predators who inhabit the outside world. Since 1999 the scientists have discovered 2 new families, 16 genera, and 47 new species *(www.cavebiology.com)*.

IBOY's lineage can be traced back more than a decade, to the establishment of an organization called Diversitas Western Pacific and Asia (DIWPA). It is based at Japan's Center for Ecological Research, at Kyoto University, but DIWPA covers an enormous territory: a latitudinal gradient stretching from Siberia to New Zealand, and including both land (the "Green Belt") and coastal regions (the "Blue Belt"). Tohru Nakashizuka of DIWPA explained that the corridor is characterized, north to south, by continuously humid climate, by having escaped effects of glaciation in the last ice age, and by an abundance of biodiversity "hot spots." DIWPA's aim is to build a network of monitoring stations that can create a baseline for the long-term assessment of biodiversity. Nakashizuka thinks his program will have little trouble gaining the ear of policymakers in DIWPA's constituent nations and elsewhere. "They will understand the situation of their ecosystems in the regional context," he says. "DIWPA will provide global or regional criteria on the rarity and uniqueness" of biodiversity "and the urgency to protect the ecosystem." Among DIWPA's valuable contributions so far is a multivolume set of protocols for assessing biodiversity. It, and other materials, are at DIWPA's Web site *(http://ecology.kyoto-u.ac.jp/~gaku/diwpaindex.html)*.

Complete lists, thumbnail sketches, and contact information for IBOY's core and satellite projects may be found at its Web site, *www.nrel.colostate.edu/projects/IBOY/*.

Osmia ribifloris, *shown here on a barberry flower, is quite a busy bee. It is a valuable pollinator of commercial blueberries. Photograph: Jack Dykinga, Agricultural Research Service Photo Unit.*

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AmphibiaWeb's David Wake, "these public involvement approaches do not work well with amphibians." Well-meaning helpers tend to trample habitat and disturb frogs' cover. "My frank opinion," Wake says, "is that these are mainly 'feel-good' approaches of little practical value other than consciousness awareness."

Participants in Frogwatch USA *(www.frogwatch.org)* might disagree. This IBOY project, conceived by the US Geological Survey's Patuxent Wildlife Research Center and now run in partnership with the National Wildlife Federation, recruits volunteers of all ages to monitor the presence and diversity of frogs in their normal habitats. Using a professionally written protocol, the watchers (and listeners, as frog calls are important identifiers of species) record their observations and exact location for three minutes after dusk, then send their results by postal or electronic mail to the Frogwatch headquarters for analysis. As for habitat trampling, the Frogwatch rules request that observers "keep a distance between you and the site" and follow the *DAPTF Fieldwork Code of Practice,* developed by the Declining Amphibian Populations Task Force. (The task force *[www.open.ac.uk/daptf/index.htm]* is another IBOY project.)

Sam Droege of the USGS calls Frogwatch's popularity "spectacular." It is "simple and straightforward, so you can apply this to any group of species that can be easily identified and that allows comparison to a species list. Another good thing about this project is that it's a reconnection of citizens back to the environment." Amy Goodstine of the Wildlife Federation, Frogwatch's new coordinator, said recently that the project has a virtual chorus of participants—more than 1700 volunteers at about 2000 sites around the United States.

Other IBOY projects link nonscientists with biodiversity. Mary T. Kalin Arroyo, a Chilean botanist, leads a satellite project on the mediterranean flora of central Chile. She feels that her job doesn't end with identifying the flora and its stresses and urging taxonomists to move their collecting expeditions away from the cities into the higher altitudes; she also publicizes her findings with the help of journalists and policymakers who know she's a good, reliable source. The Alliance of Religions and Conservation (ARC; *www.religionsandconservation. org/who-home.htm)* is a bridge between religious and conservation groups, which often have looked askance at each other. ARC, in collaboration with the World Wildlife Fund of the United Kingdom (also known as World Wide Fund for Nature), has launched "Sacred Land" and "Sacred Seas" projects to recognize "the environmental and cultural significance of sacred places worldwide." These range from forests on Ethiopian church and monastery grounds to pledges by Muslim fishing communities in Zanzibar to conserve turtle nesting grounds and coral formations.

No project has connected the public with biodiversity more closely than Insect@thon. Namibia, the home of the project, is a poor country with a paucity of amenities and infrastructure. But the country has vast biodiversity resources and was the first in the world to incorporate environmental protection into its constitution. As is often the case with less-developed countries, what's collected here ends up somewhere else. Joris Komen, who helped start Insect@thon when he was curator and information technology manager at the National Museum of Namibia, says that 70 percent of the insects collected over the years in Namibia "reside within the custodianship of First World museums."

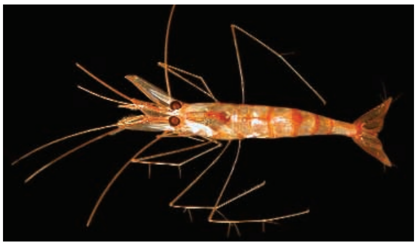
"We in Namibia know that we need to get our records on track, on computers, to make them visible to the rest of the world, to get a better understanding of what we've got in terms of biodiversity in Namibia," Komen says. "But we continue to face the dilemma that there are only two entomologists, no recruitment, and half the population is dying." An estimated 20 percent of the adult population has HIV/AIDS; life expectancy for the total population is about 41 years.

Namibia's children, like kids everywhere, are inquisitive, and they also want things like portable CD players, Internet access, and new sneakers. Enter Insect@thon, a plan to tap kids' energy for the benefit of the National Museum of Namibia, which has between 1 million and 1.5 million natural history specimens, most of them insects. Komen and others devised a scheme in which school children, aged 11 through 19, would enter paper-based museum records into digital computer databases. The "very big carrot," Komen explains, was Internet connectivity and computers for the participating schools. The grand prize would be a school trip to a foreign museum to see how biological records are used. In its first year, kids computerized some 50,000 handwritten inventory records in five regional one-day events.

Insect@thon since has spun off an organization called SchoolNet Namibia *(www.schoolnet.na)*, which provides schoolchildren with computers for a variety of projects. Also in the works is an effort to bring telecommunications to the country's 900 schools that presently do not have electricity, telephone lines, libraries, or, in some cases, running water. SchoolNet is using solar power to drive a combination of wireless communications, satellite, and radio telephones to connect the schools in an educational network.

In the meantime, Namibian schoolchildren can participate in the "Futures" scheme, which Komen, who has moved to SchoolNet, describes as "sort of like frequent flyer programs." In exchange for participation in a community effort, such as data entry for the national geological survey, design of a Web site for a school, or establishment of an ethnobotany site, children win points that can be redeemed for computers, scholarships, and such items as Ray-Ban sunglasses and Levi's jeans. "You can't expect kids to do anything for nothing," Komen explains. "What we're doing here is very simple and fundamental." SchoolNet now has sister organizations throughout Africa.

Part of practically every IBOY project is the aim of influencing the thinking and actions of those who make biodiversity's life-or-death decisions—the unelected and elected decisionmakers who shape local, national, and global policy. Laws may declare that a toad is endangered and entitled to a protected habitat, but it is local authorities who use political means to decide whether the creature officially exists at all and therefore whether it's okay for the habitat to be



The "CaveBiology" project has produced a great diversity of data about organisms that live in flooded caves. Janicea antiguensis *is a crustacean that ranges from the Bahamas to Bermuda to the Yucatan Peninsula. Photograph: Tom Iliffe, Texas A&M University–Galveston.*

bulldozed for a shopping center. They decide whether a nature reserve will be established, where it will go, how large it will be, and its rules of operation. It is uncertain whether the IBOY projects, or any others, are yet at the point where they can call themselves indispensable tools of policymakers.

Next steps

What happens next, now that the International Biodiversity Observation Year is drawing to a close? Like most such undertakings, its designers and backers don't really want it to end—and, in fact, many of the projects affiliated with IBOY will continue on their own. Frog fanatics will continue to listen for the call of the critically endangered *Bufo baxteri,* and Namibian school kids will still compete for new computers and blue jeans. The Tree of Life will germinate more branches and twigs, and discoveries of new species deep within anchialine caves will just spur researchers farther into the hidden underwater chambers.

One agent for continuation will be Diversitas *(www.icsu.org)*, the Paris-based program under whose auspices IBOY came to life. Diversitas was launched in 1991 by three global programs—the United Nations Educational, Scientific, and Cultural Organization (UNESCO), the International Union of Biological Sciences, and the Scientific Committee on Problems of the Environment. Later, sponsorship was broadened to include the International Union of Microbiological Societies and the International Council for Science. After a rocky beginning, Diversitas now has adopted three core projects that it hopes will guide international networks of scientists working on biodiversity. The projects, each of which has several subcomponents, are these:

- Understanding, monitoring, and predicting changes in biodiversity
- Assessing the effects of those changes
- Developing "the science of conservation and sustainable use of biodiversity"

The international organization backed IBOY as a tool to raise public awareness of biodiversity. Diana Wall and Gina Adams and many IBOY project leaders hope, as might be expected, that the observation year will have an even more long-lasting influence on the effort to restore sustainability to the planet. Says Wall: "I believe that IBOY's legacy of a strengthened international community for biodiversity science, with better linkages across disciplines, nations, and to other sectors of society, will help shape long-term international programs for sustainability." And all the programs need not be global in nature: "I hope IBOY's model and resources will encourage international science programs to include local-scale projects," she says, "since this is key to developing science-based solutions to many environmental problems, particularly in developing nations. Global programs that synthesize information from local-scale projects will be stronger since they can relate to specific place-based issues; reflect regional variations in conditions, trends, perspectives, and needs; enable multiscalar assessments; and provide information that is relevant to more end users."

Gina Adams, who as IBOY program manager was in frequent touch with more than a hundred large and small biodiversity networks, watched proudly as those networks, with IBOY's assistance, "added value...by coordinating activities that stimulate information exchange between disciplines and nations and promote emerging research in biodiversity and sustainability. IBOY's scientific meetings and publications have raised interdisciplinary awareness and seeded new local and global partnerships. Its outreach, including seminars, educational materials, articles, and press releases, have helped raise the profile of biodiversity research and its significance among media, policymakers, and the public."

Of great importance, says Adams, was IBOY's contribution to the important goal of making the fruits of scientific knowledge available outside the groves of science itself. "There is a growing awareness within the scientific community that in many instances the scientific knowledge to support conservation and sustainable use of biodiversity already exists," she says, "but it is not in a form that is useful for managers and policymakers." To support sustainable development, there must be "an intensive effort to increase not only basic environmental research but also to increase communication of existing science-based information to end users. IBOY and its projects advanced both of these scientific fronts, promoting basic research to discover biodiversity and understand its significance, and communicating this information to many sectors of society."

IBOY came into being at a difficult time for biodiversity research, and an even more difficult time for getting decisionmakers interested in environmental sustainability. Preoccupation with threats of terrorism and collapsing economies provided real distractions for those who make policy, and it provided a handy excuse for those who never thought biodiversity and environmental protection are all that important anyway. But through those difficult times, a great diversity of science-based projects flourished, from schoolchildren's one-meter quadrat surveys to inventories of the flora and fauna of the lands and waters from Siberia to New Zealand. Not only have they flourished, but for the first time in history, this diversity of diversity is connected by a communication network that includes anyone who wants to listen and learn.

Fred Powledge (e-mail: fredpowledge@nasw.org) is currently creating a Web site for children about biodiversity.