

WHAT'S UP?

THE NEWSLETTER OF THE INTERNATIONAL CANOPY NETWORK

NALINI NADKARNI, EDITOR

HANNAH ANDERSON, EDITORIAL ASSISTANT

CANOPY WALKWAYS: THE STATE OF THE ART

Industrial society, as opposed to some indigenous cultures, has recognized the need for conservation of nature fairly recently. While the urgency of conservation is becoming ever more clear, how to achieve it is not. National Parks, endangered species legislation, anti-pollution laws and more rational forestry practices are some of the approaches we are using to tweak our culture into living more sustainably.

Many conservation efforts attempt to protect areas of scenic, recreational or biological importance by locking them up in protected areas. Obviously this is essential, but these protected areas are subject to the whim of governments and changing values. However daunting the idea of making society more sustainable may be, those of us optimistic enough to try are forever in need of new ideas on how to go about it.

After long apprenticeships in conservation and community development, Ian Green and I, founders of Greenheart Conservation Company Ltd., are attempting to demonstrate a new approach to conservation. Our specialty is designing conservation strategies for protection of areas of ecological

importance based on canopy tourism, education and research. We design canopy walkways as economically viable businesses that support conservation.



Recently completed demonstration walkway at Oxbow Meadows Ecology Centre, Columbus Georgia, USA

Canopy walkways are a series of suspension bridges hanging from tree to tree, or tower to tower, or a mixture of these components. They travel out from a hillside, although sometimes over flat ground using inclined bridges, and allow tourists to walk in the upper canopy of the forest. They are effective at attracting visitors who then become an audience ripe for information about environmental issues and approaches such as Ecoforestry.

We believe that conservation can, in some cases, be economically viable. The fastest growing part of the global economy is tourism, and the fastest growing segment of tourism is ecotourism. Unfortunately, this term has been misused so often, it has become almost meaningless, encompassing everything from trophy hunting to bird watching.

The best in ecotourism profiles a natural environment and often a local culture. It aims to protect, or at least cause a minimal impact on a small area while generating the finan-

cial capacity to protect a larger area of ecological value. Even this type of tourism is ultimately unsustainable because it relies on jet fuel and other travel requirements. But it can serve as an interim step between purely destructive resource development and something approaching sustainability. What sustainability in the modern world actually looks like is unclear to me. Sustainability is somewhat like health. A person is more or less healthy; a development is either more or less sustainable.



Platform at approx 30m in a Brazil Cedar, Iwokrama Guyana

Conservation planning around a viable ecotourism business is a huge topic. This aspect of Greenheart project development is equally important to what is actually built. However, what is probably of most interest to readers of ICAN is the actual design of the walkway.

Greenheart is a B.C. registered business and all our designs satisfy Canadian engineering standards (similar to U.S. standards, and our engineer is U.S. certified). Everything we build around the world satisfies these same standards to protect the canopy walkway concept. It must continue to be seen as a safe activity in the long term. Every facility has to have proper engineering drawings that are signed off by a P.Eng, and remain on site. If an accident happens in any country on a sub-standard walkway a smart lawyer can always point to a properly engineered design and say, look, this was not built to the acceptable standards of the day. From a liability point of view, based on our new designs, there is no longer any excuse (including lack of budget) for building something that is built to less than Canadian engineering standards.

The Greenheart walkway system is protected by a US patent and includes 26 sub patents. Bridges and platforms in trees hang from the Treehugger (patent pending), a suspension system designed by Greenheart and our engineers to allow trees to grow while supporting huge loads. We use the latest, very sophisticated computer modeling to analyze

designs. Bridge spans are up to 80m, although usually less than 50m. Loading level is 150 lbs per ft². Our system uses exact bridge geometry, loading conditions and considers external conditions such as tree sway. We do not use cable clamps because they are ugly, and prone to catching clothing, cutting hands and they damage the cable. Lastly, we build in real redundancy in our suspension system to maximize public safety.

A testimonial to the strength of our system is that the walkway in Georgia was hit by a hurricane shortly after being installed. A big tree fell and landed on the backstay cables holding a bridge. Although it moved a few things around, nothing broke and the affected bridge and platform can be repaired with nothing more than a little adjustment.



Middle Canopy Platform, Iwokrama, Guayana, South America

Another requirement is to assess the health of the trees in the system. Dr. Julian Dunster, an arborist, uses a resistograph to produce an image of the structural integrity of the tree. He signs off on trees, much like an engineer signs off on the structure.

One additional important point is that Greenheart can help finance projects for those without funds. Export Development Canada, and a similar, but private agency called Northstar, aim to help Canadian companies export. They enable a foreign buyer that can satisfy credit requirements to borrow up to 80% of the value of a walkway at reasonable interest rates. Designed properly, the walkway can then pay for itself and leave the buyer, be it a non-profit organization, park, or whatever, with a permanent revenue-generating tool to sustain their conservation program over time.

Looking back, a project we built in Ghana in 1994 has been a remarkable success. Prior to the walkway, Kakum National Park had fewer than 900 visitors per year. Currently, with the walkway installed, it gets about 80,000 visitors per year and grosses about US\$1million while regional economic spin-off is valued at about \$5million. The walkway pays for the anti-poaching team, funds economic development in surrounding communities, directly employs about 50 people in the park and uncounted numbers in the region and country. However, it is based on a US Army Corps of Engineers design and is not acceptable from an engineering point of view for public use. Although it has been in place for 10 years, and served well with no accidents, it has many design flaws that have been improved upon in subsequent designs.

Greenheart currently has a long list of projects in development. We are building a project in the cloud forest near Cuzco, Peru, for Amazon Conservation and ACEER. This will be a tower-based walkway in a Dr. Suess-like forest filled

with bromeliads and orchids. It will attract tourists from Cuzco who presently only visit Machu Picchu. It will generate revenue and raise awareness of the unprotected cloud forest, a necessary refuge for Amazonian life in a warming climate. National Geographic Conservation Trust is a partner in this project.



Old-style walkway at Kakum National Park, Ghana, built by John Kelson. Arguably the most successful walkway in existence. Although not properly engineered, it's been hanging in there since 1994 without problem.

A project that is just becoming operational is in Cross River State, Nigeria. This will be a tree-based walkway in a beautiful forest remnant. Afi Mountain Wildlife Sanctuary is home to the last 20 or 30 Cross River gorillas and the walkway holds the promise of protecting this area. The walkway will be built for the State Government at the site of Pandrillus, an NGO that rehabilitates primates. Another exciting project in development is a 300-metre walkway in Madagascar's Ranomafana National Park where visitors will be able to view tree-nesting lemurs. A business plan has been done on this project showing that a canopy walkway in the poorest part of Madagascar, one of the 3 or 4 poorest countries in the world will make money. The president of the country has recently doubled the protected areas of Madagascar showing their hope for ecotourism as a future driver of the economy. The head of the national parks system said the walkway was his dream.

These projects, among others, give us hope we can make a living in conservation. Is that not the best one can hope for?

by John Kelson

Greenheart Conservation Company Ltd.
Suite 100 The Sun Tower
100 West Pender Street
Vancouver, British Columbia
Canada V6B 1R8
Tel. (604) 683-3227
Fax (604) 683-3228
«www.greenheartconservation.com»
<john@greenheartconservation.com>
<ian@greenheartconservation.com>

MOVING THE PARQUE NATURAL METROPOLITANO CANOPY CRANE IN PANAMA: A SURVEY TARGETING CANOPY BIOLOGISTS

The Smithsonian Tropical Research Institute (STRI) owns two canopy cranes in Panama. The two cranes are 80 km distant from each other and are located in a semi-deciduous Pacific coastal forest (Parque Natural Metropolitano) and a wet evergreen Caribbean coastal forest (San Lorenzo). Since there is a steep rainfall gradient from the Pacific to Caribbean coast in Panama, this provided an ideal opportunity to compare the influence of rainfall on different forest processes. Annual rainfall averages 3,400 mm at San Lorenzo and just 1,740 mm at the Parque Natural Metropolitano (for more background information, please see <<www.stri.org/tesp/ftshtm>> and <<www.stri.org/tesp/PNM.htm>>, respectively).

For various reasons, STRI is contemplating moving the Parque Natural Metropolitano (PNM) crane to another location in Panama. In December 2003, a survey targeting canopy biologists was initiated with the aim of identifying the most preferred option among canopy researchers regarding the relocation of the PNM crane. Fellow canopy biologists were contacted and suggested 7 main options for the relocation of the PNM crane:

1) Relocation in an old growth dry forest on the Pacific side of the country, allowing comparison of the influence of rainfall gradient on forest process [coded dry old];

2) relocation in a disturbed dry forest on the Pacific side of the country, allowing comparison of the influence of forest disturbance [dry disturbed];

3) relocation in a wetter old growth forest, closer to Barro Colorado Island (BCI), allowing a similar scientific approach than (1) and to serve better scientists bound to BCI [intermediary old];

4) relocation in a wetter disturbed forest, closer to Barro Colorado Island (BCI), allowing a similar scientific approach than (2) and to serve better scientists bound to BCI [intermediary disturbed];

5) relocation in an old growth wet forest on the Atlantic side of the country, allowing spatial replication with the San Lorenzo crane [wet old];

6) relocation within the San Lorenzo forest, to match better spatial replication [wet old];

7) relocation in wet disturbed forest on the Atlantic side of the country, allowing a similar scientific approach than (2) [wet disturbed].

A total of 191 colleagues were contacted by email in various fields of canopy research, including past users of the canopy cranes at STRI. None of the messages sent went undelivered. By mid-March 2004, the response rate was zero so that the survey was closed.

Response rate was low (54 answers or 28% of the total). A few colleagues favored several options with equal preference so that 75 answers were considered for the analysis of the results. There was no indication that other option(s) than those listed above could be of interest.

The survey indicated that the colleagues who voiced their opinion clearly preferred relocation in an old growth forest, as opposed to a disturbed forest. Within the rainfall gradient, the most preferred option was that of relocation in a dry forest. When all categories were

considered (Fig.1), the most preferred option was of relocation in a dry old growth forest, followed by relocation in an old growth forest near BCI, and closely by relocation in a wet old growth forest. Within the latter category, 10 colleagues (out of the 15 who voted for that category, 67%) specifically preferred a relocation in the San Lorenzo forest to provide replication of existing data (option 6).

As far as possible, relocation of the PNM canopy crane, in principle scheduled for 2005, will take into account the preferences voiced by fellow canopy biologists in this survey. I thank all of the colleagues who took time to answer to this survey.

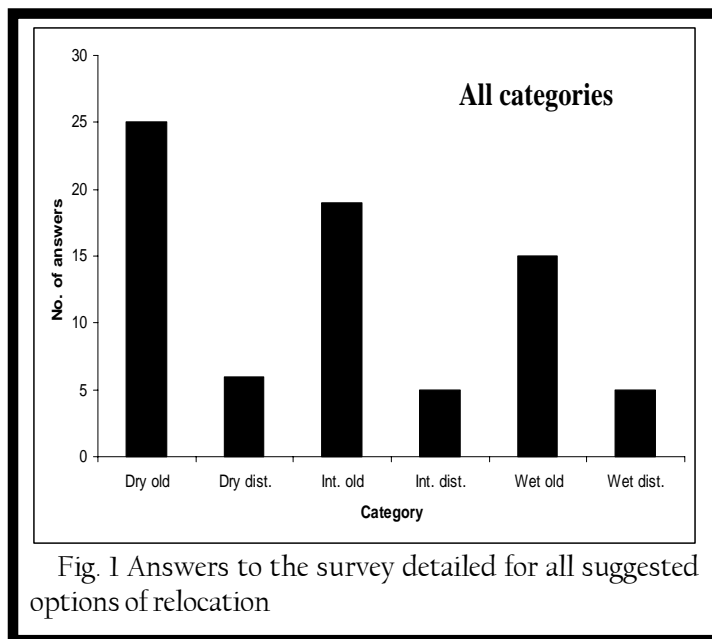


Fig. 1 Answers to the survey detailed for all suggested options of relocation

by Yves Basset

Smithsonian Tropical Research Institute

bassety@tivoli.si.edu

TREE CANOPY SYMPOSIUM

A symposium was organized entitled “Tree Canopy Biodiversity in the Great Smoky Mountains National Park” as part of the Mycological Society of America (MSA) 2004 Annual Meeting held jointly for the first time with the North American Mycological Association (NAMA)



and hosted by the University of North Carolina, Asheville. The theme of this meeting was “Biodiversity of Southern Appalachian Fungi” which included field trips into the Great Smoky Mountains National Park (GSMNP) during the period from July 18 to July 26. Hundreds of attendees, including amateur and professional mycologists, from all over the United States and foreign countries participated in the week-long meeting of workshops, poster and paper sessions, and forays.



Dr. Rinker was the keynote speaker for the symposium. His presentation, “Ecology from the treetops: Accessing the 8th continent,” was highlighted by examples of rope climbing systems, walkways, airships, cranes, towers, and even boats. He discussed the advantages and disadvantages of these access systems and then linked canopy access techniques to forest conservation worldwide. Dr. Rinker also provided handouts on his new book, *Forest Canopies* (2nd edition), co-edited with Dr. Margaret D. Lowman and published by Elsevier Press, San Diego.

Keith R. Langdon presented “Trees and tree canopies in Great Smoky Mountains National Park” which included reference to over 100 native tree species found in the park, many height records for individual species of trees, nearly 20 national champion and co-champion trees, and some of the highest canopied forest in the eastern United States. Over 400 species new to science and over 3,000 new geographic records of species representing different taxonomic groups have been documented in the park in the last several years.

Dr. Keller presented “Tree canopy biodiversity in Great Smoky Mountains National Park,” describing the double-rope climbing technique to collect bark samples from up to 40 meters. The All Taxa Biodiversity Inventory aims to survey and identify all life forms in the

park. This study represents the first inventory of treetop cryptogams (Myxomycetes, macrofungi, lichens, liverworts, mosses, and ferns) in the park. Of these groups only certain myxomycete species are restricted to the bark of living trees. A myxomycete species new to science, *Diachea arboricola*, apparently restricted to upper canopy heights, was discovered by undergraduate student Melissa Skrabal. This species was found directly in the bark fissures on the trunk of the tree and also developmental stages (plasmodia, immature, and mature sporangia) were observed in moist chamber culture. Occurrence, abundance, and assemblages of certain myxomycete species were correlated with differences in bark pH. More details and color images are located at the following web site <<<http://faculty.cmsu.edu/myxo/>>>.

Dr. H. Thorsten Lumbsch presented “Lichen-forming fungi in the tree canopies in the Great Smoky Mountains National Park.” The importance of the GSMNP as a glacial refugium for widely disjunct species is demonstrated by lichen species that occur in eastern North America and the Pontis region and those occurring in eastern North America and eastern Asia, showing the classical Asa Gray distribution. Questions were addressed in the species composition of trunk species and twig species within the Park. Examples of new additions to the lichen biota of the park include many new records and new lichen species such as *Vainionora americana*.

Dr. Barbara C. Reynolds presented “Canopy inputs to soil throughfall and insect frass, on soil processes and soil organisms along an elevation gradient.” The response of fungal-feeding nematodes to these inputs varied with season and elevation. Soil microorganisms, nematodes, and microarthropods are vital participants in decomposition process. Nematodes affect decomposition either directly through comminution of litter or indirectly through feeding on and transporting propagules of fungi and bacteria.



Hemitrichia serpula. A myxomycete fruiting body with yellow, powdery spore mass and delicate threads.

by Harold W. Keller, Ph.D. and
H. Bruce Rinker, Ph.D.



GLOBAL CANOPY PROGRAMME UPDATE

CANOPY SEASON: EXPLORING LIFE ON A DIFFERENT LEVEL AT THE EDEN PROJECT

Canopy Season at the UK's Eden Project, announced in the Spring 2004 edition of *What's Up?*, proved to be a big success. Its aim was to bring greater public awareness about the importance of forest canopies and offer an opportunity for canopy scientists and NGO's from around the world to display their work and open up the fascinating world of forest canopies to visitors and school groups, at the Eden Project. Around, 200,000 people visited Eden during Canopy Season.

The Big Canopy Conversation started off the seven-week season opened by the UK's Minister of Environment, Elliot Morley. He announced a recently awarded Darwin Initiative grant to the GCP for its training courses in Sabah, Malaysia. 20 key figures in the global community of canopy scientists attended the meeting and presented their work.

In the presence of a packed audience the two day conversation brought a diverse range of topics under discussion including the importance of identifying the huge diversity of plants and animals in rainforests by ICAN's President, Dr. Nalini Nadkarni; the importance of canopy invertebrates by Professor Joachim Adis, (Max Planck Institute for Limnology in Germany) and Professor Roger Kitching (Griffith University, Australia); and the future of canopy science by Professor Nigel Stork, (Director of the Cooperative Research Centre for Tropical Rainforest Ecology

and Management, Australia). The role of rainforest people in shaping their environment was discussed by Simon Counsell, Director of the Rainforest Foundation. Andrew Mitchell,

Director of the Global Canopy Programme, (GCP) described the various methods used to access forest canopies and the GCP's vision for a network of 'Whole Forest Observatories' around the world. John Kelson and Ian Green from Greenheart Conservation Company talked about the installation of canopy walkways as a tool for conservation and Dr. Bruno Corbara brought us up to date with developments of the French Canopy Raft Consortium, including their new Canopy Glider.

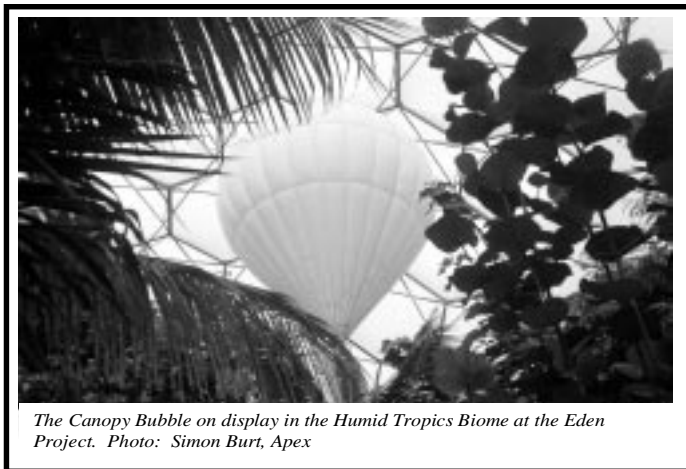
Other talks included wide ranging topics such as 'plant diversity of a South American rainforest' by Scott Mori, 'the story of the largest scientific rainforest expedition' in 1977 by Robin Hanbury-Tenison; 'the market approach to conserving biodiversity and capturing carbon' by Professor Ian Swingland and 'Forests, climate regulation and climate change' by Richard Betts.



The 'Big Canopy Conversation' was a rare opportunity that brought together the two distinct groups of canopy researchers, - the climate change specialists and the biodiversity specialists and allowed them to discuss the interconnected issues of their disciplines. The public was able to participate as well which made the discussion unique. The finale to the week was the canopy dinner, where Andrew Mitchell inspired the guests with a promotional video of spectacular canopy

footage commissioned by GCP and kindly donated by the BBC Natural History Unit, produced by John Lloyd.

Following the Big Canopy Conversation the next six weeks of activities involved speakers ranging from a variety of NGO's and Universities who were invited to give talks about forest canopies and their specialist subject. GCP's John Pike gave climbing demonstrations in the Humid Tropics Biome and Katherine Secoy spoke towards the end of the season about



The Canopy Bubble on display in the Humid Tropics Biome at the Eden Project. Photo: Simon Burt, Apex

the work of the GCP and the importance of forest canopies. These talks were all open to visitors of Eden.

Canopy Access tools, developed by the Canopy Raft Consortium in France, including the Canopy Bubble, IKOS and the Canopy Raft were all on display for the full seven weeks for the public to see. It is hoped that canopy season will be repeated annually over the next 4 years. Following discussions with GCP and Greenheart Conservation Company, the Eden Project has drawn up plans to build a walkway, through the canopy of the Humid Tropics Biome, the world's largest individual biome.

The GCP would like to express its thanks to the Eden Project and especially to Don Murray and his team at Eden for bringing members of the canopy community together and providing an opportunity to convey their work to the wider public and raise awareness of the importance of forest canopies.

For more information about the Global Canopy Programme please go to: <www.globalcanopy.org>

For more information about the Eden Project please go to: <www.edenproject.com>

MEETINGS

The University of Leipzig, Institute of Botany, the UFZ Centre for Environmental Research Leipzig-Halle and the City of Leipzig cordially invite you to join the 4th International Canopy Conference in Leipzig.

As the last Conference in Cairns was held to bring together scientists, environmental managers and policy-makers concerned with the discovery and sustainable use of forests around the world, we have themed the coming International Canopy Conference, Canopy ecology - tropical versus temperate forests. This appears to be quite appropriate as per-



manent canopy access facilities are located world-wide in both tropical and temperate forests. The term 'temperate' is meant here to also include boreal forests. The Conference is intended to bring together experts in forest canopy biology from all over the world in order to spread and share research results and ideas, to strengthen existing collaborations, and to establish new projects.

It is planned to have morning and evening plenary talks, and up to three parallel sessions. The 2005 edition will focus on canopy structure, diversity of arthropods, effects of climate change, fungal diversity and ecology, plant physiology, biomechanics, floral ecology, pollination and seed dispersal.

We are planning to organize the following symposia:

1) Fungi and fungal organisms in the canopy 2) Arthropods in temperate and tropical forest canopies 3) Physiological, biomechanical and allometric constraint on tree height 4) Vascular epiphytes 5) Floral ecology, reproductive systems, pollination and seed dispersal 6) Canopy climate, canopy/ atmosphere interactions 7) Evolution, biodiversity and genetics 8) Herbivory.

The eight-day program will include invited lectures, scientific presentations and posters. Please send your abstracts to the conference secretariat. Deadline for submitting abstracts: December 31, 2004.

When submitting abstracts and articles, please state whether it is a lecture or a poster abstract. Name the number of the symposium in which your talk should be presented. The abstracts must include names and complete addresses

of all authors incl. phone, fax and e-mail address of the contact author, title of paper, statement of objectives, principal results, and conclusion. The abstract should not be longer than 500 words and without figures and tables.

Please submit your abstract electronically as .doc-, .txt- or .rtf-file to the conference secretariat:

Ms. Ogarit Uhlmann MSc.
F&U Confirm Permoserstr. 15
04318 Leipzig, Germany
Tel.: +49 (0)341/235-2264
Fax.: +49 (0)341/235-2782
<canopy@fu-confirm.de>
<<www.uni-leipzig.de/leipzigcanopycrane/>>

NORTH AMERICAN FOREST LEADERS TO MEET IN TORONTO, 1-3 MARCH 2005

If your profession deals with sustainable forestry, forest products trade or certification, and if you want to learn from, be inspired by, and network with the leaders in these fields, the 2005 ForestLeadership Conference is an event you should not miss. Benefit from the best early-bird savings by registering now.

ForestLeadership is pleased to announce the program for its 2005 annual conference, featuring an exciting combination of keynote addresses, plenary and breakout sessions, CEO and customers' panels, focus panels, a strategic certification dialogue, receptions, a gala dinner and awards ceremony, as well as excellent networking opportunities.

Slated to be one of North America's leading sustainable forestry conferences in 2005, conference discussions will explore various aspects of one of the most fascinating trends in North American forestry: the development of Partnerships Towards Sustainability.

Forest certification will be one of the key topics at the conference. Short break-out sessions will also be held dealing with topics such as the Canadian National Forest Strategy, the CSA / Ontario certification agreement, the new SFI standard and membership opportunities in the Forest & Biodiversity Conservation Alliance.

IUFRO COMPLEX FOREST ECOSYSTEMS CAIRNS, AUSTRALIA 15-19 AUGUST 2005

Researchers interested in forest measurement, modelling and/or analysis are invited to prepare and submit a paper for this international conference.

The focus of the meeting is the science of complexity and diversity in complex forest ecosystems, and follows on immediately from the IUFRO world congress in Brisbane the week before.

For more information please go to the preliminary website at <<<http://cms1.gre.ac.uk/conferences/iufro/cfe>>> or contact Keith Rennolls at <k.rennolls@gre.ac.uk>.

ANNOUNCEMENTS

CENTER FOR CANOPY ECOLOGY

Under direction of Meg Lowman, Professor of Biology and Environmental Studies, New College of Florida is proud to announce the relocation of the Center for Canopy Ecology to their Sarasota Campus, effective October 1, 2004. This change occurred because Selby Gardens has eliminated canopy ecology from its mission. The Center for Canopy Ecology will continue its original mission, plus more:

- Internships for canopy students from developing countries
- Distribution of canopy literature including the new Forest Canopies and the upcoming It's a jungle out there.
- Data-basing canopy walkways and their current research programs
- Canopy interpretation, using the Myakka River State Park canopy walkway as a case study
- Extensive canopy files and literature
- Home of Southwest Florida Tree-Climbing Club, operated by New College

Funded by TREE Foundation. For more information go to: <<www.treefoundation.org>> or contact Meg Lowman <m_lowman@ncf.edu> or Bryson Voirin <bryson.voirin@ncf.edu>, research assistant.

NEW PRESIDENT FOR THE ECOLOGICAL SOCIETY OF AMERICA

Dr. Jerry Melillo, Co-Director and Senior Scientist at the Ecosystems Center of the Marine Biological Laboratory (MBL), is the Ecological Society of America's new President.

Elected by the members of ESA for a one year term, Melillo presides over more than 8,700 members in the United States and internationally. The Society, considered the country's premier professional organization of ecologists, was founded in 1915 to stimulate sound ecological research.

An important goal of the society is to promote, clarify and communicate the science of ecology through reports, journals, research and expert testimony to Congress. The Society encourages members to responsibly apply their research and ecological expertise to public issues through education and public interaction. Members conduct research relevant to challenges such as habitat alteration, natural resource management, loss of biological diversity, ecosystem management, ozone depletion and global climate change, sustainable ecological systems, ecological restoration, and biotechnology.

"I am particularly interested in facilitating a dialogue on environmental issues between ecologists and decision makers in government and business. Ecologists need to understand what questions the decision makers are asking about environment problems. Decision makers need the help of ecologists to grasp the essential science needed to think clearly about how to solve the problems," Melillo said. "The Ecological Society of America needs to be viewed by decision makers and the general public as an honest broker of scientific information that is the foundation for the sustainable use of planet Earth."

STUDENT RESEARCH POSITIONS

MS/PhD research assistantships in tree biomechanics are available for outstanding candidates in the Dept. of Natural Resources Management and Engineering. Successful candidates will research how trees sway in the wind. Effort will focus on measuring and understanding detailed tree crown motion in three dimensions. Expected start date is January 2005 and will be opened until filled.

Successful applicants should have a forestry or related degree with strong analytical skills, i.e. calculus, computer programming language or experience in 3-D modeling OR an engineering degree with knowledge of forest ecology, stand dynamics or ecophysiology. Experience working with dataloggers, complex instrumentation, and rope safety training helpful. Students must be eager to work outdoors in all seasons and should not be afraid of heights.

Interested persons should send resume and recent transcripts to:

Mark Rudnicki
University of Connecticut
U-4807 1376 Storrs Road
Storrs, CT 06269-4087
<mark.rudnicki@uconn.edu>
<<<http://www.camr.uconn.edu/nrme/>>>

Master's Degree graduate students are needed for a project entitled "Biodiversity and Ecology of Tree Canopy Biota in the Great Smoky Mountains National Park" These positions are supported by research assistantships. Please find more information at <<<http://faculty.cmsu.edu/myxo/>>>

For additional information, please contact:

Dr. Harold W. Keller
Department of Biology
Central Missouri State University
Warrensburg, MO 64093
telephone 660-543-4823
<keller@cmsul.cmsu.edu>

TRAINING

INTERNATIONAL CANOPY ACCESS WORKSHOP 24-30 APRIL 2005 COSTA RICA

This International Canopy Access Workshop (ICAW) in Costa Rica is intended to provide individuals and organizations interested in tropical rainforest, an introduction to methods of canopy access. ICAW would be of interest to researchers, educators, nature tourism operators, parks developers, international assistance staff (e.g. UN, USAID), foresters, conservationists, and planners of ecologically sustainable economic development, such as nature lodges.

ICAW is planned to be an on-site and hands-on introduction to four methods of enhancing the experience of accessing the "high frontier" of the forest canopy.

Topics to be covered in the workshop are: site selection, tree evaluation, personal safety, climbing techniques, equipment and material review, system design, installation techniques and sequencing, engineering criteria, prolonging longevity of trees used, costs, management and maintenance, business opportunities and fundraising.

Canopy access methods to be covered are 1) Harness and rope systems at Villa Lapas, near Carara National Park, 2) Canopy zip lines also at Villa Lapas, 3) Canopy Walkways at Rainmaker Conservation Project near Quepos and Manuel Antonio National Park, and 4) Canopy tram near Jaco and Carara National Park.

The one week workshop costs US\$2800 and includes instruction, workshop materials and literature, local travel, hotels, meals, entry fees to Canopy Tram, Rainmaker, and Villa Lapas.

For more information contact:

Illar Muul, PhD, President, Integrated Conservation Research <<www.IntegratedConservationResearch.org>>. P.O. Box 63, Braddock Heights, MD 21714, USA. Tel: (301) 371-8988. Email: <illarmuul@aol.com>

Ryan Moore, Director of Training and Education, The International Ecotourism Society, 733 15th Street NW, Ste. 1000, Washington D.C. 20005, USA. Tel: (202) 347-9203. Email <ryan@ecotourism.org>

RECENT CITATIONS IN CANOPY SCIENCE

[Ed. note: Since there is no central journal on canopy science, it is useful to publish citations on canopy studies in the recent literature. Some of the papers listed below were obtained from ICAN subscribers sending in reprints; most were discovered through weekly literature searches on Current Contents on Diskette (CCOD).

CANOPY STRUCTURE

- Godfree, R. C., R. O. Tinnin, and R. B. Forbes. 2003. Relationships between dwarf mistletoe and the canopy structure of an old-growth lodgepole pine forest in central Oregon. *Canadian Journal of Forest Research* 33:997-1009.
- Ishii, H., M. Ooishi, Y. Maruyama, and T. Koike. 2003. Acclimation of shoot and needle morphology and photosynthesis of two *Picea* species to differences in soil nutrient availability. *Tree Physiology* 23:453-461.
- Kozlov, M. V. 2003. Are fast growing birch leaves more asymmetrical? *Oikos* 101:654-658.
- Yanez Espinosa, L., T. Terrazas, L. LopezMata, and J. I. ValdezHernandez. 2003. Leaf trait variation in three species through canopy strata in a semi-evergreen Neotropical forest. *Canadian Journal of Botany* 81:398-404.
- Yin, X. Y., E. A. Lantinga, A. H. C. M. Schapendonk, and X. H. Zhong. 2003. Some quantitative relationships between leaf area index and canopy nitrogen content and distribution. *Annals of Botany* 91:893-903.

ECOSYSTEM PROCESSES

- Leclerc, M. Y., A. Karipot, T. Prabha, G. Allwine, B. Lamb, and H. L. Gholz. 2003. Impact of non-local advection on flux footprints over a tall forest canopy: a tracer flux experiment. *Agricultural and Forest Meteorology* 115:19-30.
- Valentini, R., G. Matteucci, A. J. Dolman, and E. D. Schulze. 2003. Fluxes of carbon; water and energy of European forests - Conclusions: The role of canopy flux measurements in global c-cycle research. Pages 255-266 in R. Valentini, editor. *Fluxes of Carbon, Water and Energy of European Forests*. Springer-Verlag Berlin, Heidelberg Platz 3/D-14197 Berlin/Germany.

FOREST-ATMOSPHERE INTERACTIONS

- Coxson, D. S., and M. Coyle. 2003. Niche partitioning and photosynthetic response of alectoroid lichens from subalpine spruce-fir forest in north-central British Columbia, Canada: the role of canopy microclimate gradients. *Lichenologist* 35:157-175.
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