2003

STROUD WATER RESEARCH CENTER

YEAR IN REVIEW

A Time of Impact & Recognition

STROUD WATER RESEARCH CENTER

Mission

The Stroud Water Research Center seeks to understand streams and rivers and to use the knowledge gained from its research to promote environmental stewardship and resolve freshwater challenges throughout the world.

Board of Directors – 2003

John R.S. Fisher, DVM
Rodman W. Moorhead, III
Co-Chairmen

Joan Stroud Blaine
Amanda Cabot
Peter D. Davenport
Bernard David
Arthur Dunham, Ph.D.
William L. Elkins, M.D.
John J. Ennis, Esq.
Carol Ware Gates
Robert V.A. Harra, Jr.
Nathan Hayward, III
William Kronenberg, III
Barbara C. Riegel
Stephen M. Stroud
Bernard W. Sweeney
Paul V. Tebo

Director Emeritus
W. B. Dixon Stroud

CONTENTS

Year In Review 2003

© Stroud Water Research Center,

Publication No. 2004001

970 Spencer Road,
Avondale, PA 19311-9514
Phone: 610.268.2153
www.stroudcenter.org

Cover

Jane Goodall, the founder of the worldwide Roots & Shoots movement, delighted by more than 100 children from local chapters.

Photo by Kay Dixon.

From the President

Continuing the Impact!

. . . and thankful for the recognition

Photo by Kay Dixon

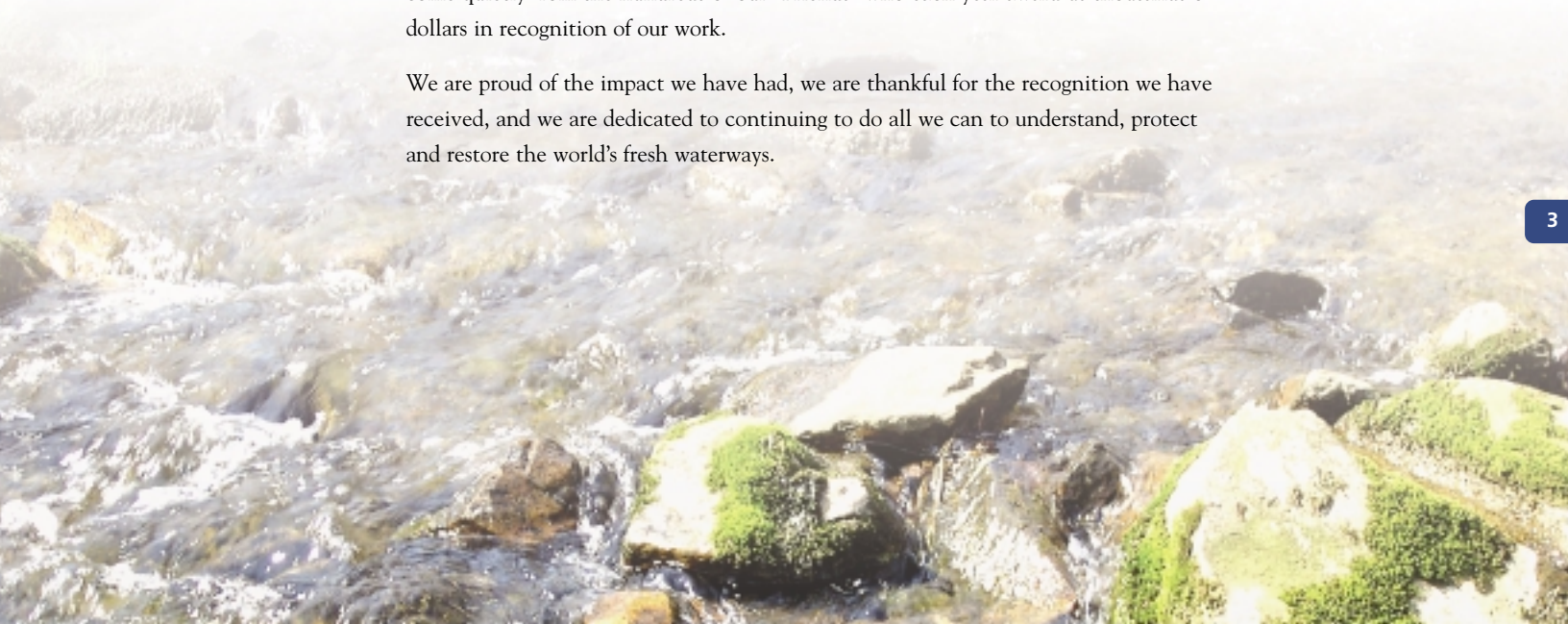
In this report, we celebrate 2003 as the year of "impact and recognition." And we have had an extraordinary year, thanks to the extraordinary efforts of our staff, board, friends and supporters. Yet just as a year is but a snapshot in the album of time, so everything we accomplish at the Stroud Center is built on the foundation forged in years gone by and on the hope that it will make a difference in the years ahead.

In 2003 we completed research projects on 60 streams and eight reservoirs that provide drinking water to New York City, on 25 streams that flow into the Schuylkill River, and on some of the country's major rivers, as well as the world's largest, the Amazon. Our major studies stretch over years, and our ability to design and carry them out is based on the experience we have gained studying the effects of streamside deforestation at the turn of the millennium, understanding the chemistry of drinking water streams in the U. S. and Europe in the 1990s, analyzing the effects of thermal pollution in the 1980s, and testing our "river continuum" hypothesis in the 1970s. Likewise, the expansion of our education program in 2003 reflects over a decade of testing innovative approaches to teaching and learning environmental science.

. . . we are dedicated to continuing to do all we can to understand, protect and restore the world's fresh waterways.

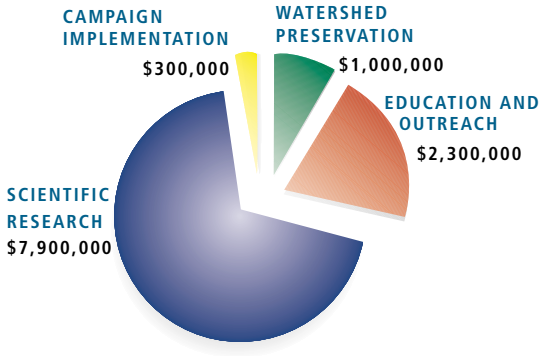
As for the "recognition" part, we received two prestigious awards in 2003: the Natural Resource Conservation Service's National Award for Excellence in Conservation and the Water Resources Association's award for outstanding research and education programs. Over the years we have received awards that are less visible but more important to our mission – such as the string of National Science Foundation grants our staff has received since the early 1970s and NSF's inclusion of our experimental watershed in two of its most competitive programs. Perhaps our most heartening recognition has come quietly from the hundreds of our "Friends" who each year award us thousands of dollars in recognition of our work.

We are proud of the impact we have had, we are thankful for the recognition we have received, and we are dedicated to continuing to do all we can to understand, protect and restore the world's fresh waterways.



'Sustaining the FLOW of Knowledge'

Photo by David Yeats-Thomas



CAMPAIGN OBJECTIVES

Enhance research capabilities.

Build and maintain a staff committed to scientific excellence.

Expand and deepen our ability to educate the public.

Encourage the stewardship of streams, rivers and watersheds.

Broaden the Center's donor base and increase fundraising capacity.

We hope that you, our "Friends of the Stroud Center," will join us in this critical Campaign and help us meet the Kresge Challenge with a generous gift in 2004.

Why a Capital Campaign?

It's about sustaining the FLOW of Knowledge

In the three-plus years since it has become independent from the Academy of Natural Sciences, the Stroud Center has flourished. Its staff has been invigorated by the move and by the challenges and opportunities it has presented. Its board has been expanded in both size and scope, evolving from a family board to one made up of leaders in business, science, government and philanthropy. As one of its first duties, the new board adopted a strategic plan that committed the Center to solidify, and maintain in perpetuity, its core scientific disciplines. This plan is now the road map for the continued success of the Stroud Center.

Since 1999, the Stroud Center's scientific research budget has grown from $1.5 million to $2.5 million, and its total budget has increased by 54 percent to over $4 million. During that same period, the "Friends" annual giving program has increased its donations from $172,000 to $286,000, despite the difficult economic climate. And 2003 marked the 37th consecutive year that the Stroud Center has balanced its budget – having never operated at a deficit.

In December 2001, the Stroud Center's board launched "Sustaining the Flow of Knowledge - The Campaign for the Stroud Center" - an $11.5-million capital campaign, which it announced to the public at the October event, featuring Jane Goodall, at Longwood Gardens. To date, more than two-thirds of the money is either in hand or pledged.

THE CAMPAIGN

The capital campaign began in 2002 with a $2-million gift from the Stroud Water Research Trust and $1-million gift from board co-chairman Rod Moorhead. Since then, our board members have given a total of $2.95 million, more than a quarter of the overall goal.

The initial phases of the campaign have been completed by securing the lead gifts, board participation, and over two-thirds of the total goal. To date, that equals $7.8 million raised in gifts and pledges. We plan to complete the campaign in early 2005.

In September 2003, the Center received a $2-million Science Initiatives Challenge Grant from the Kresge Foundation to buy and endow instruments and equipment.

We must raise $1 million by January 1, 2005, to complete the challenge. At year's end, we had raised, $333,840, a figure which includes gifts or pledges from over 98% of the Stroud Center staff.

The Kresge Challenge helped us launch the "public phase" of our Campaign and the Kresge Foundation has encouraged us to seek a broad base of public support to meet the Challenge.

THE COMMITTEE

Committee volunteers for the Kresge Challenge include:

- Joe Manko
- Anne Hannum
- FM & David Mooberry
- Bert Kerstetter
- John Ennis
- Morris Stroud
- John Fisher
- Rod Moorhead

Stream research impacts legislation

New Jersey requires 300-foot buffers

On January 5, Gov. James E. McGreevey of New Jersey announced what he called "the most comprehensive set of water protections in the nation" to safeguard the state's drinking water and to combat sprawl.

Photos by Dave Funk

DEFORESTED

Stroud technician Andy Byler stands next to a deforested reach, above, and in the channel of a contiguous forested reach, facing page, of Birch Run, Chester County, Pa. The significant narrowing of the channel in deforested streams is caused by the formation of sod by "grass encroachment" along the banks. The shade from riparian forests prevents the growth of bank grasses and enables the stream to maintain a wide, more natural channel.

A cornerstone of the new rules is the requirement of a 300-foot buffer around New Jersey's high quality waters. The purpose of the buffers, which will impact more than 6,000 miles of streams and rivers, is to serve as a filter to keep pollutants out of the stream water. In addition, the new regulations endorse best management practices to substantially reduce the run-off of pollutants into streams; they promote low-impact site designs that rely on natural vegetation and drainage; and they discourage clear cutting and the unnecessary loss of trees.

While the Stroud Center had no direct connection to the New Jersey regulations, the decision to require large buffers, to engage in best management practices, and to retain and plant trees is based on solid scientific research, and the Stroud Center has been at the forefront of that research for several years.

In particular, Stroud scientists have broken much new ground in understanding the roles that streamside buffers play both in preserving healthy streams and restoring polluted ones. Indeed, recent Stroud research suggests that, to most effectively protect the water quality of the streams, the New Jersey regulations need to go further and stipulate that the buffers should consist of native species of trees.

For some time, it was thought that grass buffers might be equally effective, but it turns out that, at least in areas that were originally forested, trees provide critical services in addition to filtering pollutants that would otherwise run into the stream. They enhance water and habitat quality through their contributions of woody debris, leaf litter and dissolved organic food inputs. They provide shade against ultraviolet light levels. And they help control temperature extremes. Perhaps most important of all,

they enable streams to operate far more efficiently and to produce "ecosystem services" whose unrecognized economic value may far outweigh that from more traditional agricultural and timbering uses.

A Stroud Center study of 16 temperate streams in eastern North America found that tree-lined stream reaches are universally wider and shallower than their treeless counterparts. As a result the water moves more slowly through such reaches, and more of it is in contact with the stream bottom. Each of these factors makes a big difference to the health of the stream – and has an enormous cumulative impact on downstream bodies of water.

The New Jersey regulations indicate the important influence that good scientific research can have on public policy.

FORESTED
See photo caption, left page.

The lower velocity enables organisms in the stream to more completely and efficiently consume contaminants in the water. And because most biological and biogeochemical activities take place on the stream bottom, wider streams provide more area for such activities to take place. In both cases, the result is the enhanced ability of the stream to restore itself in the face of pollution and to remove contaminants that would otherwise end up, in massive amounts, in larger rivers, estuaries and oceans.

The New Jersey regulations indicate the important influence that good scientific research can have on public policy. But policy necessarily lags behind the latest scientific findings, and while the regulations are an important step forward, recent Stroud Center research shows that there are additional steps to be taken.

RESEARCH IMPACT!

Stroud Center is a leader in riparian buffer research, a cornerstone of New Jersey's comprehensive new rules to protect water and control sprawl.

Growing the Leaf Pack Network

From North America to Nairobi, the kit reaches out

The Leaf Pack Experiment Kit, developed by the Stroud Center in partnership with the LaMotte Co., continued to be a star of the Education Department's outreach activities in 2003. Together with the Leaf Pack Network, which was established by the Stroud Center as a data-sharing Internet resource, the kit has become a powerful teaching tool for science teachers. The Web site is www.stroudcenter.org/lpn.

Photo by Kay Dixon

ALL HANDS

Students from the Urban Environmental Center in Wilmington, Del. at the Stroud Center.

With a $20,000 grant from the R.K. Mellon Foundation, the Leaf Pack has now expanded into the schools and parks of western Pennsylvania, as Stroud Center educators, working with the Bureau of State Parks, provided workshops and kits to teachers at Ohiopyle and Cook Forest State Parks. By summer's end, 19 teachers had been trained to use both the Leaf Pack Kit and the Watershed Education curriculum developed by the state. These teachers are now back in their schools helping children collect useful information about their rivers and streams.

The Leaf Pack Network will help schools across Kenya understand the connection between water quality and streamside forests.

ROOTS & SHOOTS

The Leaf Pack Network has also attracted the attention of the Jane Goodall Institute and its Roots & Shoots program, which encourages children around the world to initiate projects to improve their local communities.

Stroud Center educators will provide training for both adults and young people at Roots & Shoots' North American Summit on Cape Cod in May 2004. Groups from across the continent will learn how to gather information and launch conservation efforts to improve the health of their streams.

IMPACT!
From Leaf Packs to teacher workshops the Stroud Center's research is helping children understand the critical role streams play in their communities.

LEAF PACKS FOR AFRICA

The latest convert to the Leaf Pack is Kenya's Green Belt Movement, which for over 25 years has used tree planting as a tool for community development. The Leaf Pack Network will help schools across Kenya understand the connection between water quality and streamside forests. Plans are underway to support educators in Kenya with the training and materials they need to incorporate leaf pack activities to local schools. As part of this program, Kenyan teachers will be brought to the Stroud Center for training in river and stream ecology and leaf pack procedures.

LOWER DELAWARE WATERSHEDS

With generous support from Phyllis Wyeth and the Chichester-duPont Foundation, the Stroud Center has introduced the science of watersheds and stream restoration to students throughout New Castle County, Delaware. The project is centered on Phyllis & Jamie Wyeth's Point Lookout Preserve on the bank of Brandywine Creek on the Pennsylvania-Delaware state line. In 2003, school groups planted hundreds of trees along the banks of a small tributary that runs through the preserve into the Brandywine. Students from Sanford School planted trees and kept notes on species, size and location of each plant. The data will be the starting point for a long-term study being coordinated by Stroud Center Director Bern Sweeney. Science teachers will also bring classes to the site to do stream-related activities and to record growth and mortality of trees in the research plots. Other schools from New Castle County will also visit the farm and the Stroud Center laboratory.

Photo by Christina Medved

SCIENCE TEACHERS
Jim McGonigle and Richard Lamotte at the National Science Teachers Association at the Philadelphia Convention Center in March 2003. Lamotte, the vice president of sales and marketing for the Lamotte Company, made it possible for the SWRC education staff to attend this event.

Photo by Kay Dixon

CLOSE UP

Urban Environmental Center students get a close look at the bugs that live on the stream bed.

OUTREACH AND C-SAW

New watershed associations have been springing up throughout Pennsylvania and surrounding states and are becoming actively involved in protecting local streams, restoring streamside habitat, educating the community about local issues and working to limit sprawl. The Stroud Center and other organizations have been providing these associations with resources, expertise, and training through a program called the Consortium for Science Assistance in Watersheds or C-SAW. The Center's educators are helping many groups throughout the Delaware watershed develop their own outreach programs, brochures and videos. Some groups have requested more intensive training programs to help them collect and analyze data about their local streams.

Photo by Christina Medved

WORKSHOP

"Summertime on the Brandywine" workshop and field trips held here at the Stroud Center. This program for Delaware teachers was funded by the Chichester duPont Foundation.

Photo by Christina Medved

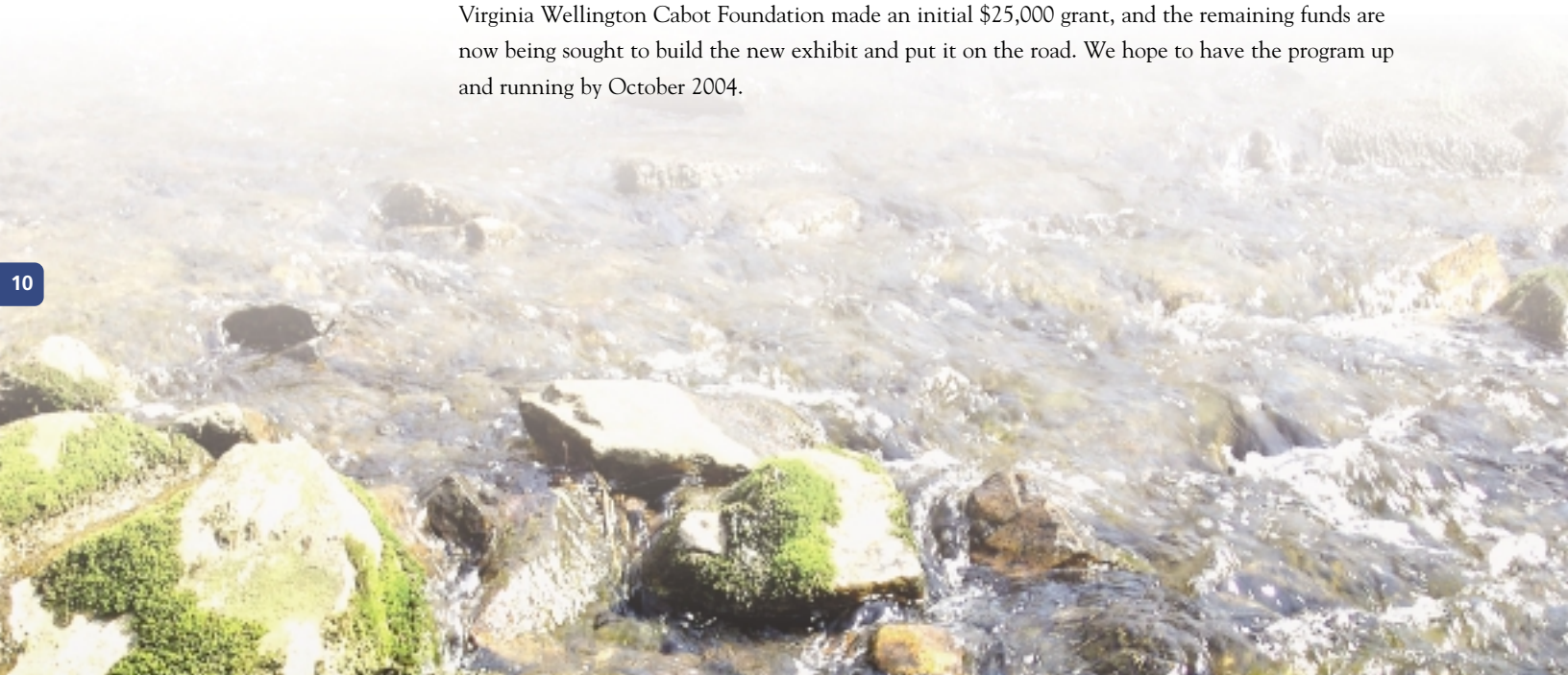
SCIENCE TEACHERS

National Science Teachers Association. Teachers from across the country gather for an all-day workshop at the Stroud Center.

NEW LIFE FOR STREAM DAY

Beginning in 1995, the Stroud Center's popular and well-used Stream Day exhibit provided a traveling interactive program that was used at community events such as the Unionville Fair, the Mushroom Festival in Kennett Square and the Willowdale Steeplechase. The exhibit's hallmark was a 15-foot inflatable frog which overlooked tabletop exhibits at which families explored the nature of watersheds and other aspects of the Center's research.

But time and use took its toll on the exhibit, and it became necessary to try a new approach. With a grant from the Growing Greener Program of the Pennsylvania Department of Environmental Protection, the Stroud Center worked for over a year with colleagues from the Pennsylvania Environmental Council and the Gecko Group, a West Chester-based exhibit design firm. The collaborators developed an exciting new approach that will engage visitors in learning much more about stream ecosystems, water quality, and their personal role in protecting freshwater resources. The Virginia Wellington Cabot Foundation made an initial $25,000 grant, and the remaining funds are now being sought to build the new exhibit and put it on the road. We hope to have the program up and running by October 2004.



Algae, slime that feeds the planet

And cleans the atmosphere

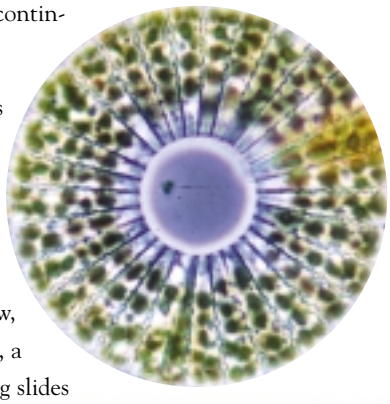
Come spring, when unsightly green slime covers your neighborhood ponds and streams, take a deep breath and be thankful. That slime is really algae. And those algae belong to an ancient group of plants that help keep us alive. Algae take in 30 to 50 percent of the carbon dioxide that we humans produce from burning fossil fuels, and they return it to us in the form of oxygen. They are also the staple diet of billions of tiny insects and fish that make up the food web in streams and rivers.

Not bad for the relatively simple-celled primogenitor of all plants.

Algae have been around for over 2 billion years. Sometime about 3 billion years after the earth was formed, two species of the earliest forms of life, light-dependent photosynthetic bacteria and protoctists, merged in the ocean to become self-sufficient algae.

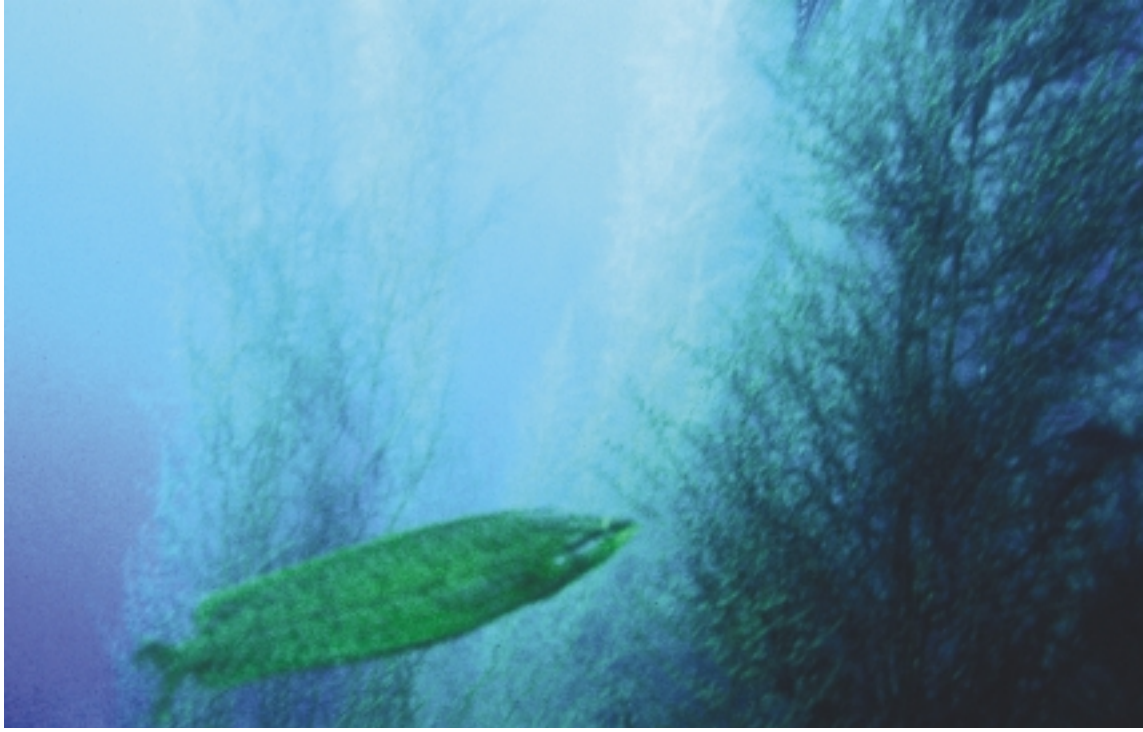
Thus began the plant kingdom. Algae continued to evolve in the ocean into a variety of species including seaweed. Much later, a mere 500 million years ago, a green algae species that lived in the sunlit ocean shallows and tidal pools started a so called "green" revolution by developing ways to keep their insides wet while drying up on their outsides.

At about the same time, marine predators of algae proliferated, and the ever-adaptable algae moved ashore to begin the plant invasion of the land. Naturally, many of the marine insects that depended on algae were quick to follow, and the struggle for survival continued.



The question of whether algae beat fungi onto land remains open.

Despite their age, today's algae are not primitive in the biological sense. They have evolved and diversified into more than 23,000 species that have adapted to life in a wide range of habitats in the oceans and rivers, ice and snow, hot springs and deserts. Microscope photographs of diatoms, a species of algae, so delighted Victorian England that viewing slides became favorite parlor pastimes.



UNDERSEA ALGAE FORESTS
Giant kelp, a member of the algae family and an important fish habitat, can grow as much as 2 feet a day at depths of up to 150 feet.

Courtesy National Oceanic & Atmospheric Administration/Department of Commerce

ALGAE TRIVIA

- Lichens are algae and fungi in a symbiotic relationship.
- Blue-green algae are not algae. They are bacteria.
- "Red tides" happen when certain harmful species of algae in the ocean grow very fast or "bloom." Occasionally these "red tides," or harmful algal blooms, can be toxic, although usually they are harmless.
- A phycologist is a scientist who specializes in algae.
- Diatoms are microscopic algae that are encased in silica, or glass, boxes.
- Giant kelps are algae.
- Sargassum, the seaweed that gives the Sargasso Sea its name, is algae.

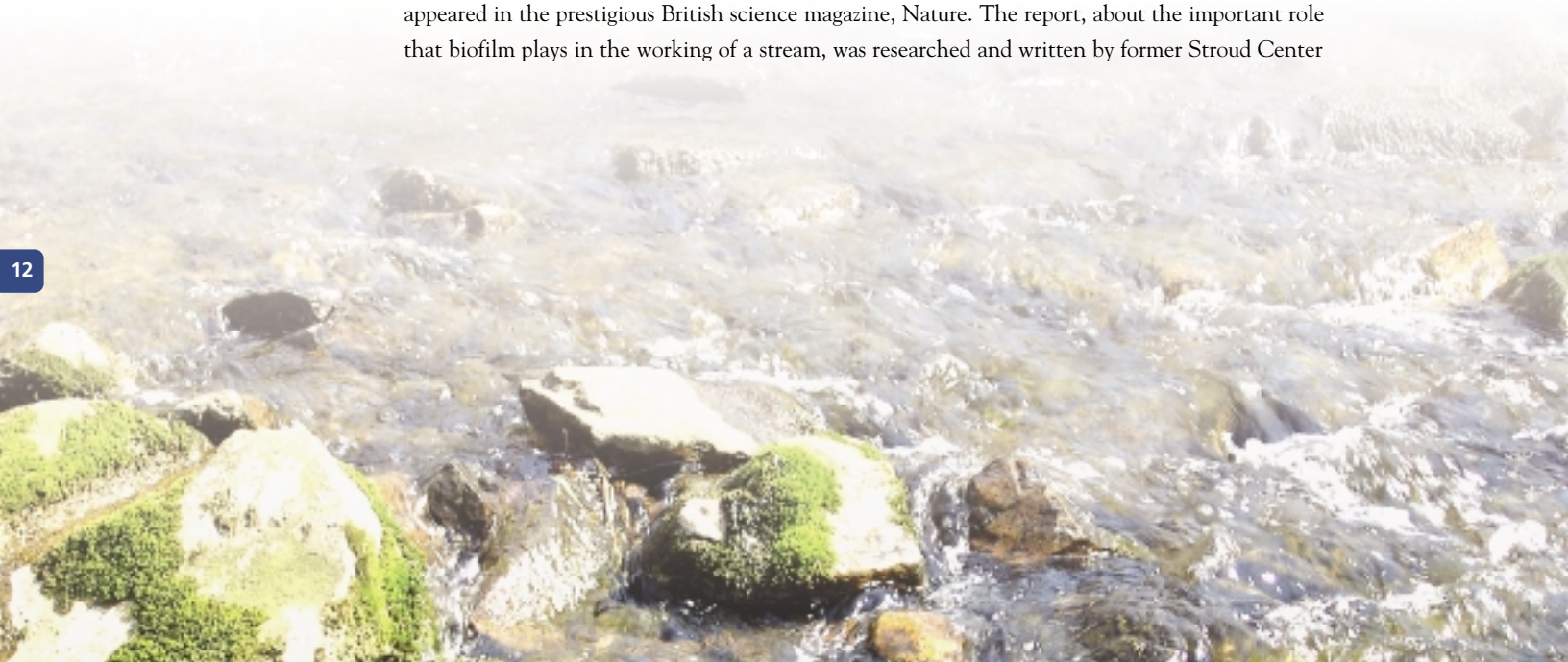
THE ALGAE CONNECTION

One child who was smitten by images of the colorful diatoms while still on her father's knee was Ruth Patrick, who was to co-found the Stroud Center with Joan and Dick Stroud in 1967. Her fascination with algae led to a distinguished career in water science. Among other things, she headed the Academy of Natural Sciences' limnology department and authored the two-volume classic publication, "The Diatoms of the United States." Dr. Patrick's early research on assemblages of diatoms broke new ground by showing that species diversity is critical to the health of streams.

Meanwhile, fast-forward to the Stroud Center of today and you'll find researchers whose studies touch on algae from every conceivable perspective.

"Algae are a big backdrop to most of the work we do," said staff scientist Denis Newbold, whose ecosystem processes department runs complex experiments that measure nutrients' movement downstream as they are consumed and transformed by algae and other microorganisms.

Algae form a major part of biofilms, the slime that lines streams and rivers and plays a critical role in keeping streams healthy. Recently, Stroud Center scientists co-authored an article on the subject that appeared in the prestigious British science magazine, Nature. The report, about the important role that biofilm plays in the working of a stream, was researched and written by former Stroud Center



These studies expanded into the Stroud Center's groundbreaking research that showed how streams and their watersheds work as a single continuum from their headwaters to the sea.

post-doctoral researcher Tom Battin, Newbold and Stroud Center colleague Lou Kaplan, and Claude Hansen of the University of Innsbruck, Austria. The Nature study showed that algae and bacteria are major components of the biofilm and that the structure of the biofilm can affect how particles stick to the streambed and how organic matter is processed by bacteria in the biofilm.

ECONOMIC IMPORTANCE

- Algae take in 30-50 percent of the carbon dioxide that comes from burning fossil fuel.
- Algal seaweeds are used as fertilizer and food, particularly in Japan.
- Extracts of algae, such as agar and carageenan, are used to thicken foods such as ice cream.
- They are also used for surgical dressings and as microbial media.
- Diatomaceous earth comes from the skeletons of diatoms and is used in abrasives, reflective road signs, swimming pool filters and gardening.

FISHING FOR ALGAE

Measuring the growth, quantity and activity of algae in huge rivers and reservoirs or in small streams that meander for miles through diverse ecosystems is the job of Tom Bott and his microbiology department staff.

On the reservoirs, Stroud Center field crews use a boat from which they lower equipment into the water to take temperature and light readings and measure the amount of oxygen at various depths. They also collect samples to measure chlorophyll content, which is directly related to the amount of algae in the water. The crew then measures algal growth at several depths and locations in the reservoir. Growth is a reliable indicator of how much nutrient is available in the reservoir water. Similar sampling is done in streams, though equipment and technique differ. In a drinking water reservoir excessive algal growth is undesirable for at least two reasons. As the cells reproduce, particles are generated that will require filtration and some species can produce taste and odor problems.

Some of the earliest projects at the Stroud Center involved studying how algal growth in streams is affected by temperature, light and nutrients, all of which vary as a stream flows through shaded woods and open meadows. These studies expanded into the Stroud Center's groundbreaking research that showed how streams and their watersheds work as a single continuum from their headwaters to the sea. Hence the River Continuum Concept, a hypothesis proposed for the Stroud Center years ago that helped establish its preeminence in water research.

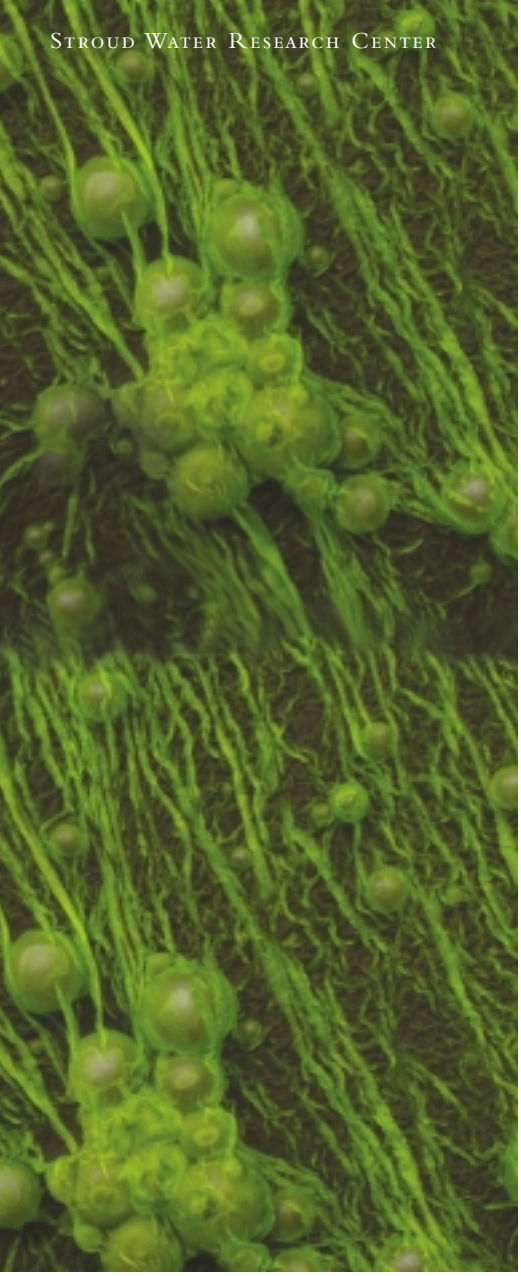


Photo by Dave Funk

To [the entomologists] algae are "bug food," the staple diet of the macroinvertebrates whose quantity and diversity are important indicators of a stream's health.

BUG FOOD

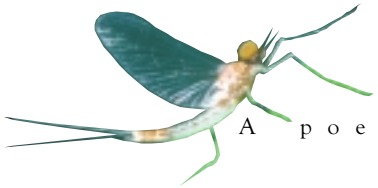
Among the first field staffers to hit the chilly streams and rivers in early spring are the Stroud Center's entomologists. After stringing a long measuring tape along the stream bank, they plunge into the water with their buckets and other paraphernalia and grapple around in the icy mud and rocks collecting samples of water insects.

To them algae are "bug food," the staple diet of the macroinvertebrates whose quantity and diversity are important indicators of a stream's health. "We use algae as a way of assessing what's going on at the different monitoring sites with regard to food availability," said department head John Jackson. "For instance, we may monitor above and below an effluent discharge to see how it affects the food resources of the aquatic insects." This is all part of their research effort to determine whether the effluent is impacting the water bugs that are part of the ecosystem that helps keep a stream clean.

NEW MACHINE

While technology is not about to replace the rigors of field work, the Stroud Center has ordered a $350,000 instrument that will add a powerful dimension to algae research. Anthony Aufdenkampe, who heads the organic geochemistry section, is coordinating the purchase and installation of the isotope ratio mass spectrometer that was recently bought with funds raised through a Kresge Foundation Science Initiative challenge grant.

"It's a very powerful tool that will help us understand algae and their role in stream food webs," said Aufdenkampe.



Ephemeroptera

A poet's tribute to her entomologist brother

BY ALLISON FUNK

For my brother David

Blizzard. Smoke. Interstellar
dust. Even you, an entomologist,
turn to metaphor,

awed by their emergence
over water. So thick
at times you cover your face
to keep from breathing them in.
Pale evening dun,
morning spinner.

How many dawns ago,
numberless dusks?
Call it

what astronomers do –
that past whose light
is just now reaching us:

look-back time. Yours
and mine—our own becoming,
born of the milky ways

of love. Fragile once
as the earliest larva,
brother, instar.

And later – in a house looking out
into a woods of tulip poplar,
rhododendron, down over train tracks

to the banks of a creek
named Red Clay
where, in another eon, fish swam

before the giants
of Atlas Chemical, Hercules,
and National Vulcanized Fiber

put out the lights of mayflies
smaller than the thumb
of the boy with a net

you were then.
Twenty-nine-o-one,
our address as children blurring

with the thousand-some species
of *Ephemeroptera*,
with pre-history, fossil time,

the millions of years mayflies
thrived in Permian streams,
Triassic, Jurassic,

feeding on flotsam
and infinitesimal diatoms
before vanishing from our creek.

It's another century
and we've been gone
from home as long as it's taken

them to return one by one
to their underworld
of silt and mud.

Some clinging to stones
in swift currents, others
hiding in gaps. With oar-like gills

the unbleached nymph
rows for dear oxygen,
spending years in between-time

molting over and over
again, as often as we've left
a self behind –

all for as much
as a single evening
when this wisp

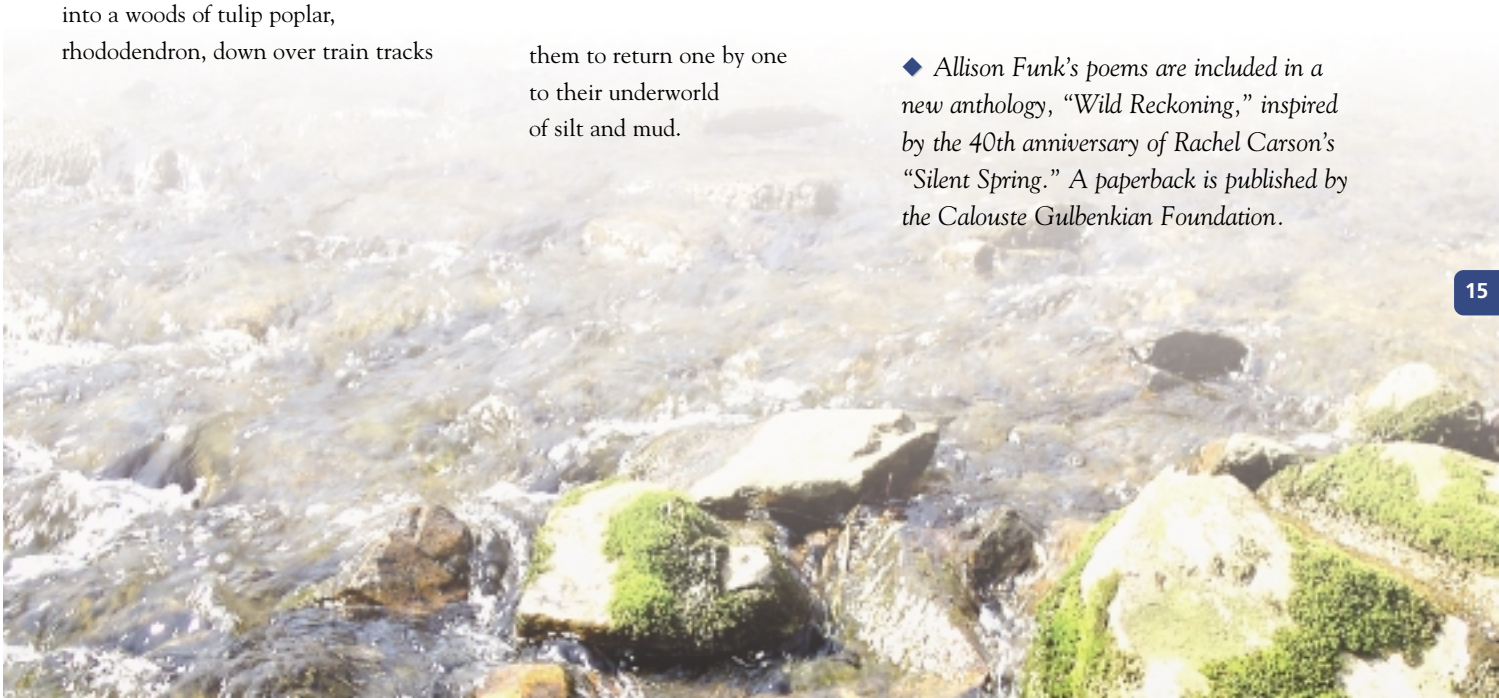
growing not toward death
but into something
like the passions that consume us,

filamentous, breaks the water's surface
with crumpled wings
and, fast as a sleight of hand,

changes shape a final time
to become the luminous, meteoric
imago,

in whose likeness
may I recognize in what passes
what lasts.

◆ *Allison Funk's poems are included in a new anthology, "Wild Reckoning," inspired by the 40th anniversary of Rachel Carson's "Silent Spring." A paperback is published by the Calouste Gulbenkian Foundation.*



Entomology/Macroinvertebrate Ecology

Photo by Kay Dixon

JOHN JACKSON, Ph.D.
Associate Research Scientist

Staff
David Funk
Sally Peirson
Roberta Weber
David Lieb
Bill Crouch
Bryan Lees
Andy Byler
Amy MacCausland
Erika Kratzer
Jan Battle

Interns
Erin Colbert, U. of Delaware
Kristin Comolli, U. of Delaware
Will Dixon, Roanoke College
Amber Eck, California U. of Pa.
Heather Eggleston, Lycoming College
Eryn Jackson, Ohio Wesleyan
Jennifer Korth, Dickinson College
Gordon Rose, U. of Pennsylvania
Matt Spaits, U. of the Sciences
Sam Voss, Washington College
Jenna Wright, Western State

RESEARCH FOCUS

The ecological characteristics of stream macroinvertebrates (especially aquatic insects) in tropical and temperate streams, the role they play in the food web of aquatic ecosystems and how they can be used to assess water pollution in streams and rivers.

2003 RESEARCH HIGHLIGHTS

◆ NY Watersheds Phase 2: Biological monitoring and site classification at 60 sites on Upper Delaware and Hudson river tributaries.

◆ Schuylkill River: Research and education outreach project involving monitoring of microinvertebrates in streams throughout the basin.

◆ National Science Foundation Riparian Study: Looking at stream invertebrate communities in relation to the presence and absence of streamside vegetation.

◆ *Centroptilum triangulifer:* Study of parthenogenesis (virgin reproduction) in mayflies.

◆ Reforestation experiment: Studying changes in invertebrate communities during long-term restoration and management of streamside forests on White Clay Creek.

◆ Continuing macroinvertebrate monitoring at sites in the following rivers and streams:

White Clay Creek (Refuse Authority landfill)

Susquehanna River, Pa.

Flint River, Ga.

Lake Blackshear, Ga.

Savannah River, Ga.

Mississippi River, Mo.

Photo by Kay Dixon

COSTA RICAN RIVER CRABS

The Stroud Center is studying Costa Rican river crabs *Pseudothelphusa tumimanus* in an attempt to better understand the important role they play in tropical streams. The study is a collaborative effort by Stroud staff at the Maritza biological station in Costa Rica and entomologists at the home lab in Chester County, Pa.

Photo by David Yeats-Thomas

SPRING MONITORING

Roberta Weber and Sally Peirson sample a tributary of Brandywine Creek.

Organic Matter Biogeochemisty

RESEARCH FOCUS

Energy flow and nutrient cycling in streams with an emphasis on the interface between chemistry and biology. The study of the relationship between stream and river bacteria and their sources of food and energy.

Photo by Dave Funk

LOUIS A. KAPLAN, Ph.D.
Senior Research Scientist

Staff
Sherman L. Roberts
Michael Gentile
David J. VanHorn
David J.Yezuita

Tracy N. Wiegner, Ph.D.

Part-time staff
Heather P. Brooks

Graduate students (Ph.D. candidates)
Karen M. Rowley, University of Pennsylvania
David C. Richardson, University of Maryland

Volunteers
Joanna Huxter

Student interns
Aaron deLong – U. of Michigan
Erin Shea – MIT

NSF Research Experiences for Teachers
Bob Groover – Bordentown Regional High School
Terresa Friedrichsen – Villa Maria High School

2003 RESEARCH HIGHLIGHTS

◆ NSF long term research in environmental biology along White Clay Creek. Map sampling stations throughout the watershed and determine the elevation of the groundwater table; sample streamwater, groundwater, and soil water for dissolved organic carbon concentrations; sample streamwater under stormflow conditions to measure dissolved organic carbon concentrations.

◆ NSF Biomes: Continuing analyses and evaluation of chemistry and microbiology samples from streams draining local watersheds, watersheds within the New Jersey Pinelands, and watersheds near Estacion Maritza in Costa Rica.

◆ NSF 13C- DOM: Exposure of biofilm reactors to cold water extracts of 13C-labeled tree tissues and the measurements of dissolved organic carbon metabolism, respiration, bacterial production, and incorporation of the 13C label into specific microorganisms.

◆ Chemical and bioassay characterization of cold water extracts of soil aged 13C-labeled tree tissues.

◆ City of Philadelphia Drinking Water Department: measure the efficacy of treatment and changes that occur during flow through the distribution system.

◆ Continue assessment of biodegradable dissolved organic carbon in untreated water from the Schuylkill and Delaware Rivers.

◆ New York Watersheds Phase 2. Sampling of 50 new and 10 continuing sites.

◆ NSF research experience for teachers. Two high school teachers spend summer in laboratory as research technicians to help them enrich their high school curricula.

Photo by Kay Dixon

ANALYSIS

Mike Gentile puts samples in an organic carbon analyzer.

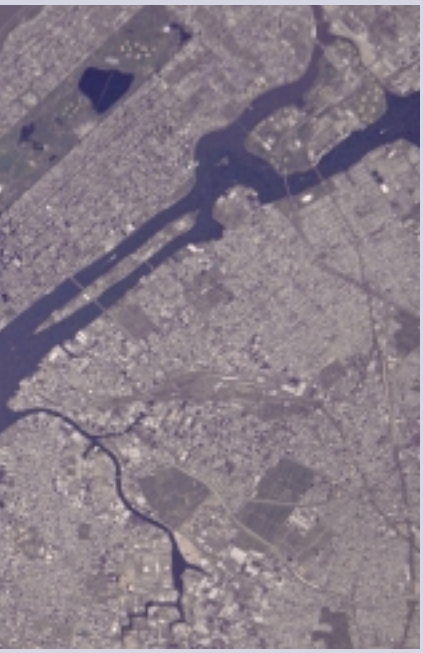
A Year of Impa

We have had an extraordinary year, thanks to the extraordinary efforts of our staff, board, friends and supporters. . . . In 2003 we completed research projects on 60 streams and eight reservoirs that provide drinking water to New York City, on 25 streams that flow into the Schuylkill River, and on some of the country's major rivers, as well as the world's largest, the Amazon. Our major studies stretch over years, and our ability to design and carry them out is based on the experience we have gained studying the effects of streamside deforestation at the turn of the millennium, understanding the chemistry of drinking water streams in the U. S. and Europe in the 1990s, analyzing the effects of thermal pollution in the 1980s, and testing our "river continuum" hypothesis in the 1970s.

Bernard Sweeney

From the President, Page 3

act & Recognition



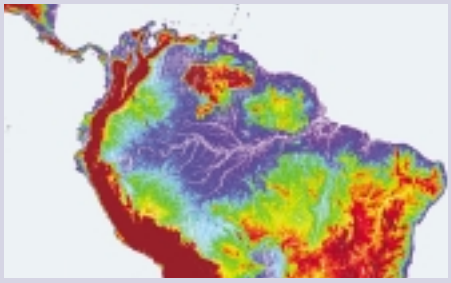


PHOTO CREDITS
Dave Funk (2)
David Yeats-Thomas (4)
NASA (3)
National Oceanic & Atmospheric Administration (2)
Kay Dixon (1)
Bill Fitch (1)

Microbiology

RESEARCH FOCUS

The ecology of bacteria, algae, protozoa and fungi living in streams and rivers.

Photo by Kay Dixon

THOMAS L. BOTT, Ph.D
Senior Research Scientist

Staff
David Montgomery
Nancy Parsons

Part-time
W. Chad Colburn
Brian Hughes
Michael Humphreys

Outside Collaborators
Thomas Gallagher, HydroQual, Inc.
Ed Garland, HydroQual, Inc.
James T. Brock, Rapid Creek Research
Christian Fritzen, Desert Research Institute
Kristen Jellison, Lehigh University

2003 RESEARCH HIGHLIGHTS

- Measurement of ecosystem metabolism in 10 streams and rivers feeding the New York City drinking water reservoirs. Measurement of primary productivity in eight reservoirs that are part of the New York City drinking water supply.
- Thorough analysis of data from Phase I of the New York project and final report preparation.
- Measurement of ecosystem metabolism in White Clay Creek.
- Analysis of data pertaining to the computer model of periphyton metabolism in the Jackson River, Va.
- Completion of analyses of data contrasting ecosystem metabolism in forested and meadow reaches of Piedmont streams.
- Laboratory experiments were conducted to measure algal growth responses to nutrient additions and starvation, light intensity and water velocity. Results are used by collaborating scientists to develop a computer model of periphyton growth in a river impacted by nutrients.

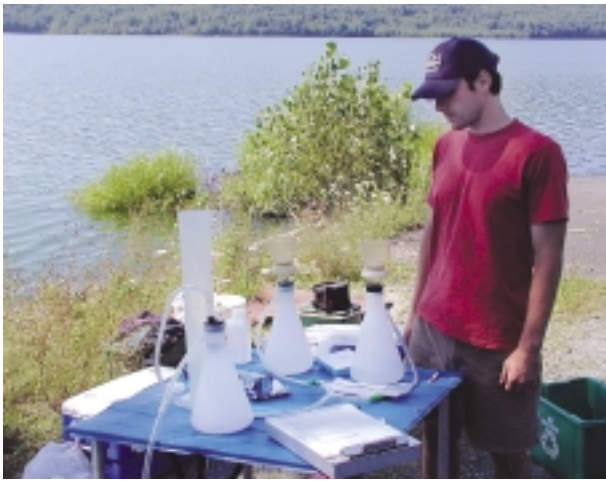


Photo by Nancy Parsons

FIELD LAB

Aaron deLong filters New York's Cannonsville Reservoir water for chlorophyll analysis.

SERVICE AND AWARDS

Bott, T. L. Member of the Editorial Board of 'Applied and Environmental Microbiology' published by the American Society for Microbiology and of 'Microbial Ecology' published by the International Society for Microbial Ecology.

Organic Geochemisty

RESEARCH FOCUS

Investigate processes that control cycling of both natural organic matter and anthropogenic organic contaminants throughout watersheds – from soils to rivers to estuaries.

Photo by Kay Dixon

ANTHONY AUFDENKAMPE, Ph.D.
Assistant Research Scientist

Staff
Karen Jansson
S. Mark Monk
Jan Surma

Post-Doctoral Research Scientist
Ty Truong, Ph.D.

Temporary Staff
Linda Carter, Ph.D.

Outside Collaborators
Ronald Benner, U. of South Carolina
Alex Krusche, CENA, U. of São Paulo, Brazil
Emilio Mayorga, U. of Washington
Jeffery Richey, U. of Washington

2003 RESEARCH HIGHLIGHTS

◆ Molecular Tracers of Contamination in watersheds that feed NY City's drinking water supplies. Contaminants include caffeine, laundry detergent fragrances and fecal steroids, which act as indicators of waste water treatment plant effluent, septic system failure and pathogens that may come from human, agricultural, and wildlife sources.

◆ Carbon Dioxide Outgasing from Tropical Rivers. To better constrain spatial and temporal patterns in CO_2 outgassing and the source of this CO_2 to river waters. Collaborators: Jeffery Richey (Univ. of Washington); Alex Krusche (CENA).

◆ River Metabolism in the Amazon Basin. Examining results and samples from river water incubation experiments to explore factors that control organic matter degradation dynamics as a function of its elemental and biochemical composition by size class. Collaborators: Ronald Benner (Univ. South Carolina); Alex Krusche (CENA).

◆ Radiocarbon Constraints on Organic Matter Turnover in the Amazon River Basin. Surveying spatial and temporal variability in ^{14}C signatures of dissolved, fine particulate and course particulate organic carbon and dissolved inorganic carbon between basins of differing types and sizes. Collaborators: Emilio Mayorga, John Hedges and Jeff Richey (Univ. of Washington); Carrie Massiello and Tom Brown (Center for Accelerator Mass Spectrometry).

◆ Equipment: Purchasing and setting up over $350,000 in new instrumentation. Building new "^{14}C-Clean Lab" for preparing samples for radiocarbon dating of riverine organic matter in a contamination-free environment.

Photo by Kay Dixon

BIG APPLE WATER
Mark Monk filters New York baseflow samples in the lab.

RESEARCH FOCUS

The effectiveness of streamside forest buffers in protecting water quality. The role of headwater streams in generating organic particles that supply food resources to downstream ecosystems.

Photo by Dave Funk

J. DENIS NEWBOLD, Ph.D.
Research Scientist

Staff
Susan Herbert

Volunteer Staff
Harry West and Frank Klein
Student Interns: Amy Kreuger

2003 RESEARCH HIGHLIGHTS

◆ The importance of streamside reforestation for reducing nonpoint-source pollution in small streams. (Demonstration project as part of EPA's National Non-Point Pollution Monitoring Network.)

◆ Field experiments to assess the downstream movement and in-stream processing of nutrients (phosphorus, nitrogen, and carbohydrates) in ten streams and rivers in the watersheds of the New York City water supply system (to quantify and assess the functional aspects of the principal streams providing water to drinking water reservoirs with special reference to landuse differences among watersheds).

◆ Outdoor flume experiments to help model how organic particles are trapped in the bottom sediments of streams.(Modeling the downstream movement of particles in natural streams contributes to our understanding of the sources of food-energy for aquatic organisms, and to predicting the dispersal of pollutants in disturbed streams).

Photo by Denis Newbold

FLUMES

Aaron deLong, left, and Dave Van Horn work at the flumes next to the White Clay Creek on the grounds of the Stroud Center. Pumped from the stream into the flumes, water is studied under controlled conditions that approximate the natural environment.

2003 PEER REVIEWED PUBLICATIONS

Stroud staff in capitals

Füreder, L., C. Welter, and J.K. JACKSON. Dietary and stable isotope (d13C, d15N) analyses in alpine Ephemeroptera and Plecoptera. Pages 11-18 in: E. Gaino (ed), Proceedings of the Xth International Conference on Ephemeroptera and XIVth International Symposium on Plecoptera. Perugia, Italy.

Füreder, L., C. Welter, and J.K. JACKSON. Dietary and stable isotope (d13C, d15N) analyses in alpine stream insects. International Review of Hydrobiology 88:314-331.

These two papers are the result of a collaborative research project that was started while John Jackson was a Fulbright Senior Scholar at the University of Innsbruck in 1998. The project used dietary and stable isotope analyses to look at changes in the aquatic food web as streams in the Austrian Alps pass from the treeless alpine zone into the lower elevation forests. Dietary analyses indicate that stream insects primarily consume detritus, while stable isotope analyses indicate that algae contribute, more to insect growth both above and below the tree line.

Peterson, M. L., S. Lang , A. K. AUFDENKAMPE and J. I. Hedges. 2003. Dissolved organic carbon measurement using a modified high temperature DOC analyzer. Marine Chemistry, 81(1-2): 89 - 104.

We describe improvements to an analytical method for dissolved organic carbon, which is one of the most important yet difficult measurements made by biogeochemists.

Battin, T. J., L. A. KAPLAN, J. D. NEWBOLD, and S. P. Hendricks. 2003. A mixing model analysis of stream solute dynamics and the contribution of a hyporheic zone to ecosystem function. Freshwater Biology 48:1-20.

We installed sampling devices into White Clay Creek streambed at depths of 10, 20, and 50 centimeters. Water analyses from the zone where groundwater and streamwater mix illustrated the importance of that zone to the stream ecosystem.

Battin, T. J., L. A. KAPLAN, J. D. NEWBOLD, X. Cheng, and C. Hansen. 2003. Effects of current velocity on the nascent architecture of stream microbial biofilms. Applied and Environmental Microbiology. 63:5443-5452.

Algae and bacteria cover many surfaces in streams as biofilms. Advanced microscopic and chemical techniques were used to examine the composition and shape of biofilms that grow in fast and slow currents.

Georgian, T., J. D. NEWBOLD, S. A. Thomas, M. T. Monaghan, G. W. Minshall, and C. E. Cushing. 2003. Comparison of corn pollen and natural fine particulate matter transport in streams: can pollen be used as a seston surrogate? Journal of the North American Benthological Society 22:2-15.

Fine particles of organic matter support biological production throughout river ecosystems, but tracking their downstream transport and deposition onto streambeds is difficult. This paper shows that corn pollen, which can be easily introduced into and recovered from a stream, effectively mimics the dynamics of natural particles.

Battin, T. J., L. A. KAPLAN, J. D. NEWBOLD, and C. M. E. Hansen. 2003. Contributions of microbial biofilms to ecosystem processes in stream mesocosms. *Nature* 426:439-441.

We found that biofilms change the physical and chemical habitat in streams. Biofilm growth trapped over 300% more streamwater and increased organic particle deposition by 120%. The study shows how structure and dynamics of biofilms are coupled to ecosystem function.

Cheng, X., and L. A. KAPLAN. 2003. Simultaneous analyses of neutral carbohydrates and amino sugars in freshwaters with HPLC-PAD. Journal of Chromatographic Science 41:434-438.

Amino sugars are important components of bacterial cell walls and neutral carbohydrates are the basic units of plant cells. We developed a method to measure these molecules dissolved in streamwater, which helps us understand their origin and processing in streams.

Frazier, S. W., K. O. Nowack, K. M. Goins, F. S. Cannon, L. A. KAPLAN and P. G. Hatcher. 2003. Characterization of organic matter from natural waters using tetramethylammonium hydroxide thermochemolysis GC-MS. Journal of Analytical and Applied Pyrolysis 70:99-128.

We assessed the utility of a novel chemical method to provide detailed quantitative, molecular-level characterization of the complex mixture of organic molecules in stream and river water. This analytical advance contributes to our understanding of natural organic molecules in streams.

KAPLAN, L. A. and J. D. NEWBOLD. 2003. The role of monomers in stream ecosystem metabolism.pp. 97-119 in S. Findlay and R. L. Sinsabaugh, eds., Aquatic Ecosystems: interactivity of dissolved organic matter. Academic Press.

Small, structurally simple organic molecules in streams are potentially important in providing food and energy for bacteria. We developed a theoretical basis to predict how these dynamics change with downstream direction as streams get larger in a river ecosystem.

2003 TECHNICAL REPORTS

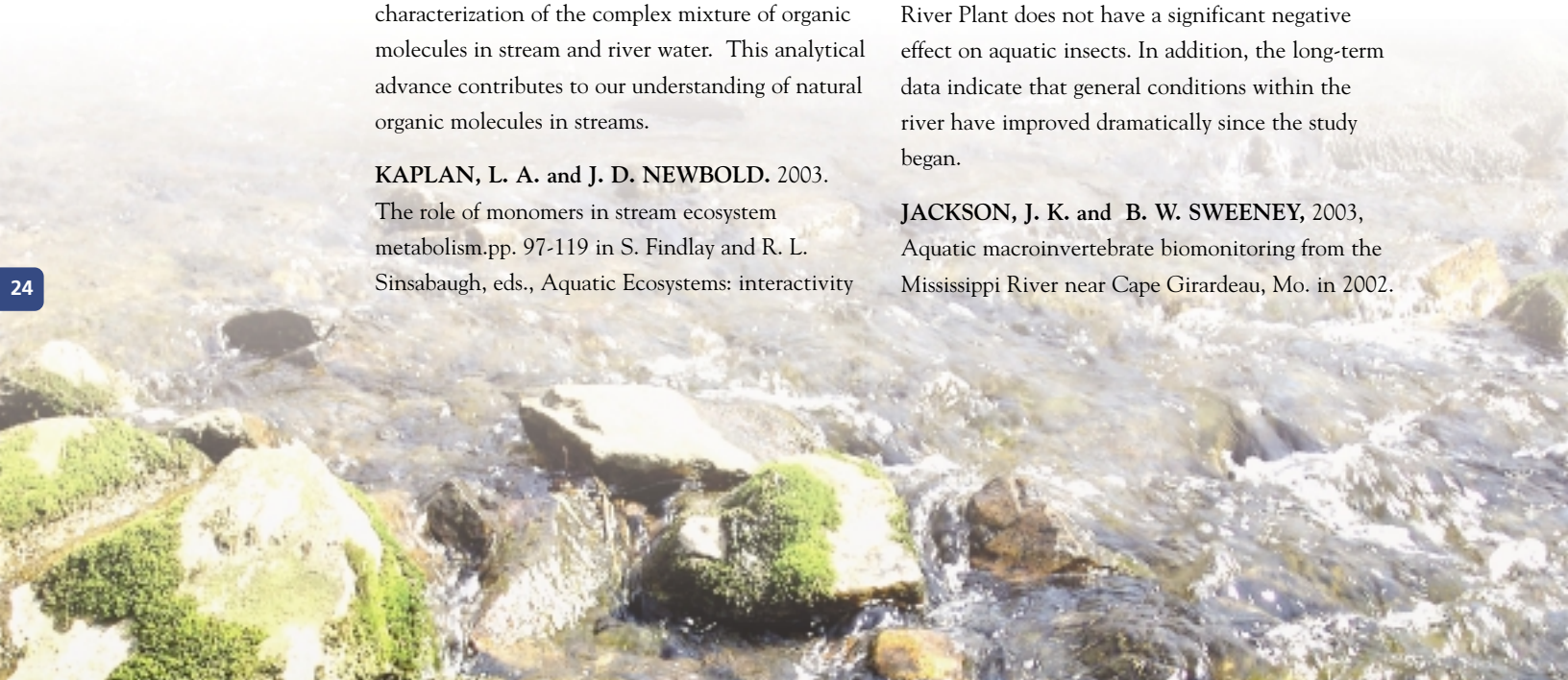
JACKSON, J. K. and B. W. SWEENEY, 2003, Studies of aquatic insects and fisheries on the Susquehanna River near Mehoopany, PA in 2002. Contribution No. 2003004, Stroud Water Research Center. 106 pp.

This report continues a 30-plus year study on the Susquehanna River showing that effluent from a large paper processing plant has not significantly affected the aquatic insects and general conditions as the river continues to improve.

JACKSON, J. K. and B. W. SWEENEY, 2003, 2001 Savannah River Biological Surveys for Westinghouse Savannah River Company. Report No. 03-, Academy of Natural Sciences of Philadelphia.

This report continues a 50-plus year study of aquatic macroinvertebrates in the Savannah River that has found that runoff and effluent from the Savannah River Plant does not have a significant negative effect on aquatic insects. In addition, the long-term data indicate that general conditions within the river have improved dramatically since the study began.

JACKSON, J. K. and B. W. SWEENEY, 2003, Aquatic macroinvertebrate biomonitoring from the Mississippi River near Cape Girardeau, Mo. in 2002.



Contribution No. 2003006, Stroud Water Research Center. 36 pp.

This report describes the response of macroinvertebrates in the fine sediments behind wing dams on the Mississippi River to effluent from a paper processing facility. This project involves both method development and environmental assessment.

JACKSON, J. K. and B. W. SWEENEY, 2003, Benthic Macroinvertebrates in the Flint River (2002) and Lake Blackshear (2003) near Oglethorpe, GA. Contribution No. 2003012, Stroud Water Research Center. 115 pp.

This report continues a 19-year study of macroinvertebrates in the reservoir and river that are exposed to effluent from a large paper processing facility as well as natural disturbances such as drought, extreme floods and drying.

BOTT. T. L. Continued investigation of factors controlling periphyton community metabolism in the Jackson River near the Mead-Westvaco Mill, Covington, VA, 2002 studies. 360 pp.

Laboratory experiments were conducted to measure algal growth responses to nutrient additions and starvation, light intensity and water velocity. Results are used by collaborating scientists to develop a computer model of periphyton growth in a river impacted by nutrients.

NEWBOLD, J. D. Mitigation of Nonpoint Pollution by a Riparian Forest Buffer in an Agricultural Watershed of the Mid-Atlantic Piedmont. Stroud Preserve Watersheds National Monitoring Project Fourth Annual Report: Calendar Year 2002.

In 1992 a riparian forest buffer was planted along a small stream in an agricultural watershed in southeastern Pennsylvania to evaluate the effectiveness of buffers in reducing nonpoint source pollution over the course of forest growth. A decade after planting, the buffer removes approximately 30% of subsurface nitrogen and 50% of overland sediment transport from upslope areas.

KAPLAN, L. A., M. Hullar, L. Sappelsa, D. A. Stahl, P. G. Hatcher, and S. W. Frazier. 2003. The role of organic matter in structuring microbial communities. A WWA Research Foundation.

Our work was performed at the interface of microbial ecology and analytical organic chemistry to provide the drinking water industry with information required to improve treatment processes and control the growth of microbial biofilms in water distribution systems.

ARSCOTT, D., A. K. AUFDENKAMPE, C. DOW, T.L. BOTT, J.K. JACKSON, L.A. KAPLAN, J.D. NEWBOLD and B.W. SWEENEY. Water Quality Monitoring in the Source Water Areas for New York City: An Integrative Watershed Approach. Phase I (2000-2003) Final Report.

NON-PEER REVIEWED PUBLICATIONS

Meyer, J. L., L. A. KAPLAN, D. NEWBOLD, S. L. Strayer, C. J. Woltemade, J. B. Zedler, R. Beilfuss, Q. Carpenter, R. Semlistsch, M. C. Watzin, and P. H. Zedler. 2003. Where rivers are born: The scientific imperative for defending small streams and wetlands. Sierra Club, American Rivers. 23 pp.

With the future federal protection of small streams and wetlands in question, this report cites more than 235 scientific publications to document a summary of the services that small streams and wetlands provide society and the consequences of their degradation.

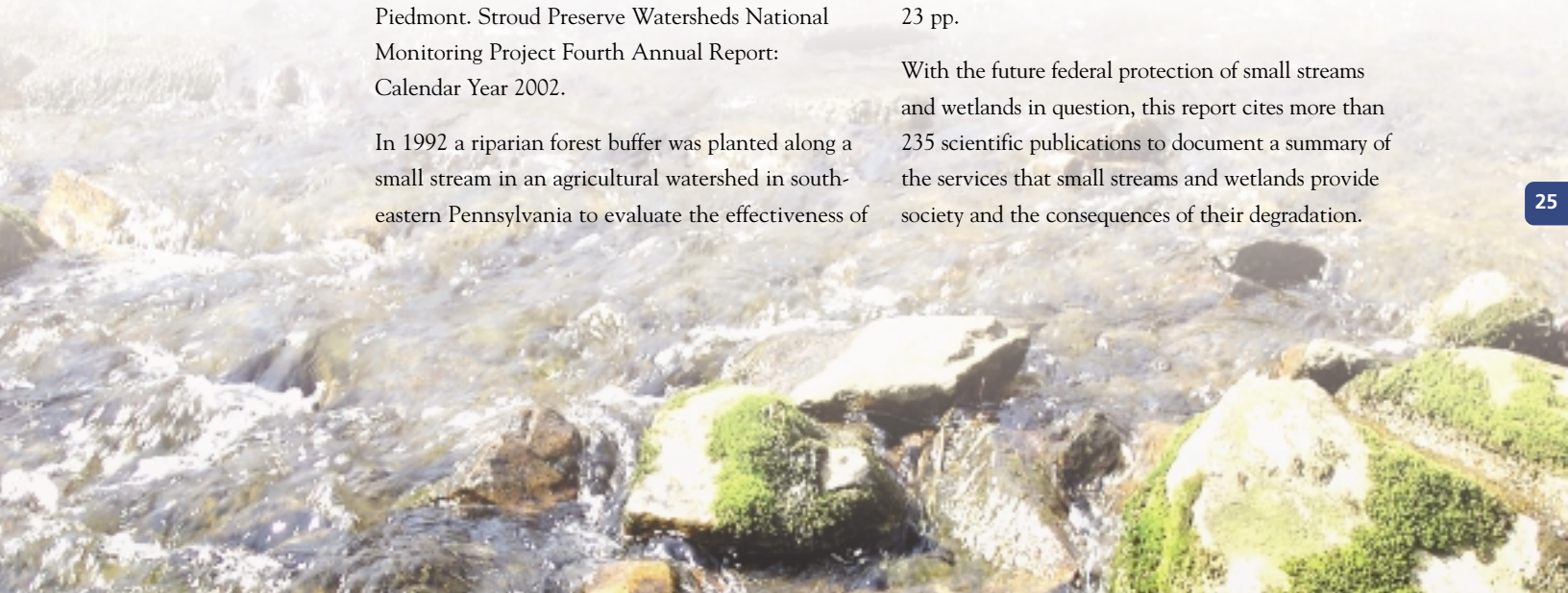


Photo by Kay Dixon

DAVID ARSCOTT, Ph.D.

New York Phase 2 coordinator

Torrential debut for N.Y. Phase 2

Field-hardened staff tackle new sites in vast watershed

Monitoring the 2,000-square-mile watershed that supplies New York City's drinking water went into its final three-year phase in 2003 led by a new coordinator and greeted by torrential rains.

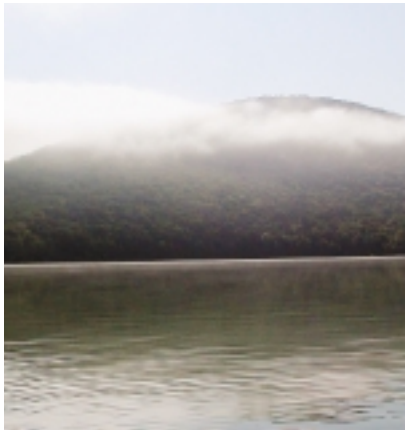


Photo by Nancy Parsons

MISTY MORNING

The Cannonsville Reservoir on the Upper Delaware River, New York.

David Arscott, an aquatic ecologist who joined the Stroud Center in the summer of 2003 from the University of Minnesota Crookston, took over as coordinator from Charles Dow in mid-season. Arscott said his first season went very well despite the erratic weather of the New York Catskill Mountain region. The biggest challenges were high stream flows caused by the heaviest rains in decades. These came on the heels of 2002, which brought upstate New York the worst drought since the 1980s. Extremes and adversity have accompanied this project since the outset. In 2000, its first year, local cloudbursts caused massive flooding and the scouring of some stream beds. In 2001 the weather behaved, but the September 11 attack on the city sent shock waves through the region and heightened security around the critical water supply.

About 25 staff members from all five research labs were involved in the New York project in 2003. Many interns also participated.

NEW SITES

Phase 2 of the six-year project involves changes in some sampling sites but a continuation of the same sampling methodologies and procedures used in Phase 1. The monitoring program's eight "tasks" (see sidebar) are designed to provide an overall picture of the quality of New York City's drinking water sources and the factors that affect that quality.

As in Phase 1, the second three years of sampling focus on 60 stream and eight reservoir sites. Only 12 of the 60 sites, however, remain at the same locations, while 48 are new. Four of the Phase 1 reservoir sites have been retained for sampling along with four new sites – though two of the latter are in different arms of the Pepacton, the largest of the system's 19 reservoirs.

The reason for sampling new sites in Phase 2 is to provide a wider range of data. Retention of some old sites provide a reference in comparing Phase 1 and 2 data.

FROSTBITE AND BUGS

Entomology field staffers were the first to do their sampling. In the early spring, when the water was still frigid from the winter's snow and ice, the technicians donned their neoprene waders and gloves and collected samples at all 60 stream sites. The goal was to use invertebrate communities as a measure of ecosystem health and to evaluate their response to known human impacts in the watersheds.

BASE-FLOW CHEMISTRY

The base-flow sampling and the spiraling experiments were done through the summer months, when the stream flow is close to normal at the 60 sites. Several liters of water were collected from each site for later laboratory analysis for several chemical constituents, such as nitrate, ammonia, phosphate, as well as for dissolved organic carbon. At the same time the temperature, pH and conductance of the water at the site were measured. (Conductance is a measure of electrical resistance that provides a reliable indicator of the concentration of dissolved solids and salinity.)

Photo by Dave VanHorn

FREEZING
Battling the Catskill Mountains' frigid winter, Amy Krueger samples a New York stream.

CYCLING DOWNSTREAM

Spiraling experiments, which were done at 10 of the 60 stream sites fairly close to the reservoirs they feed, is a complex exercise that is both time- and labor-intensive. After the site has been mapped, field crew members operate demarcated stations over about a kilometer of stream length. Watches are synchronized, and a dye and several nutrients are released into the stream. At prearranged times the station operators take samples in small, numbered bottles. The aim is to determine how far carbon (in the sugars, glucose and arabinose), ammonium, and phosphate travel in the water column before being taken up by biofilms. This helps determine the stream's efficiency in consuming certain pollutants, such as nutrients, before they reach the reservoirs.

STORM SAMPLING

When the Stroud Center crews pulled out in October, they left behind three sophisticated machines to continue sampling duties. These automatons handled the storm sampling as the Catskill Mountains' flashy show of leaf colors were receding into the gray of winter. This most weather-dependent of exercises is done at only three sites and is designed to sample streams when they have risen to storm levels. The battery-operated machines, which are automatically activated by rising water levels, take samples at timed intervals and store them until a field staffer can retrieve them. Back at the lab, staffers keep track of the stream levels by Internet via the United States Geological Survey's satellite system. The trickiest part of this sampling is to drive the 250 miles to the site and retrieve the samples before they degrade.

FRIGID SAMPLING

Winter base-flow sampling was done in 2003-04 at 28 of the 60 stream sites. This was a difficult process because the streams were frozen and the weather conditions made access difficult. The main goal was to sample for molecular tracers that could indicate human or animal pollution at a time when the Catskills' tourism shifts from summer sports to hunting and skiing.

Your support makes its mark

Together we are making a difference to the future of fresh water

Photo by Bill Fitch

ADORING FANS

Jane Goodall signs books after speaking at the Stroud Center's Water's Edge event in October 2003.

JOAN STROUD MEMORIAL LECTURES ATTRACT WORLD RENOWNED SPEAKERS

We welcomed 85 new "Friends of the Stroud Center" this year. Thirty percent of Friends increased their support to make an all time high of $286,000 raised for the annual fund. THANK YOU!! One of the benefits of being a "Friend" is receiving invitations to our Joan M. Stroud Memorial Lectures given throughout the year and hosted by Wilmington Trust. In addition to Jane Goodall, our 2003 speakers included Sandra Postel, Alvaro Ugalde and Bruce Wallace who enlightened the Meetinghouse packed with "Friends" on topics ranging from water policy to preserving the Osa Peninsula in Costa Rica to the effects of mountaintop mining.

STANDING ROOM ONLY

Three hundred guests packed the Longwood Pavilion to hear Jane Goodall's message of hope at The Water's Edge on October 3, 2003. A net total of $76,000 was raised from many generous sponsors and tickets buyers at this inaugural event. Proceeds will benefit our research programs and help provide educational programming to thousands of students and teachers in the region.

SAVE THE DATE for October 8, 2004 The Water's Edge featuring Dr. Sylvia Earle, Time magazine "Hero of the Planet" and National Geographic Explorer in Residence!

Photo by Bill Fitch

A TOAST TO WATER

Jane Goodall speaks at the Water's Edge event.

'Sustaining the FLOW of Knowledge'

Photo by Kay Dixon

UPGRADING AGING INSTRUMENTS

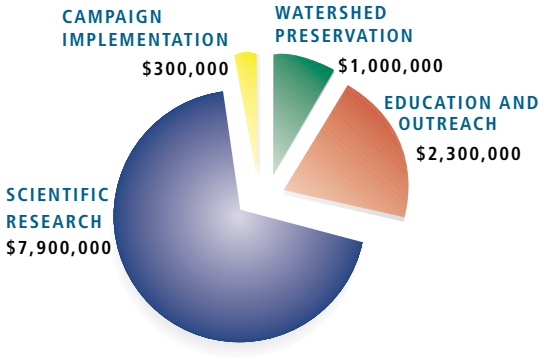
For the first time since our doors opened, we have been able to upgrade most of our scientific instruments and equipment due to the Kresge Challenge grant and the generous individual support to the initiative. Research scientist Anthony Aufdenkampe prepares to use the new surface area analyzer bought with funds from the Kresge grant.

Help us meet the Kresge Challenge in 2004!! We hope each of our "Friends of the Stroud Center" will make a gift toward the $1,000, 000 challenge. Please watch your mailbox or visit www.stroudcenter.org to join us and to help us make sure the Stroud Center has the best instrumentation and equipment today and in the future!

Photo by Kay Dixon

2003 UPSTREAM FESTIVAL AND 5K WALK/RUN

Despite the rainy day, 70 volunteers, 80 runners and 250 visitors participated in the Upstream Festival and the first 5K Run/Walk. The Run and Festival have moved from Spring to Fall! SAVE the DATE for SATURDAY SEPTEMBER 18TH, 2004.



CAPITAL CAMPAIGN

New gifts and pledges to our capital campaign totaled $1,839,135 in 2003. This includes the prestigious Kresge Challenge and brings the total giving to the campaign, as of December 31, 2003, to $7.8 million.

SAVE THESE DATES IN 2004

Contact: www.stroudcenter.org for more information

or Kay Dixon @kdixon@stroudcenter.org 610-268-2153 x247

THURSDAY, JUNE 17

Stream Evening with Lefty Kreh, fly fisherman. Reservations only.

SATURDAY, SEPTEMBER 18

Stroud Run/Walk for Fresh Water and Upstream Festival.

FRIDAY, OCTOBER 8, 2004

The Water's Edge featuring, Dr. Sylvia Earle,

Time Magazine Hero of the Planet and National Geographic Explorer in Residence,

Longwood Gardens

From the Co-Chairs

Pushing the frontiers of research

With impact and recognition

Photo by Kay Dixon

John R.S. Fisher, left, and Rodman W. Moorhead III.

Last year was a wonderful year for the Stroud Center. In fact, because of the successes on so many fronts, we have termed 2003 a year of impact and recognition. Among our accomplishments:

We completed Phase 1 of the New York project and were approved for Phase 2 for three years and $4 million.

Our scientists continued to push the frontiers of research and won recognition through their publications, including an article by Tom Battin, Lou Kaplan and Denis Newbold in *Nature*, perhaps the world's foremost scientific journal.

For our efforts in getting our ideas out where they can make a difference, Bern Sweeney received the Natural Resource Conservation Service's National Award for Excellence in Conservation.

We received a Kresge Challenge, one of the most competitive grants in the nation and a mark of excellence in the world of foundations. This challenge grant will enable us to buy and permanently endow $750,000 of critical scientific instrumentation.

We hosted a two-day visit from Jane Goodall that culminated in a captivating talk and dinner at Longwood Gardens and that has led to collaborative initiatives with her organization.

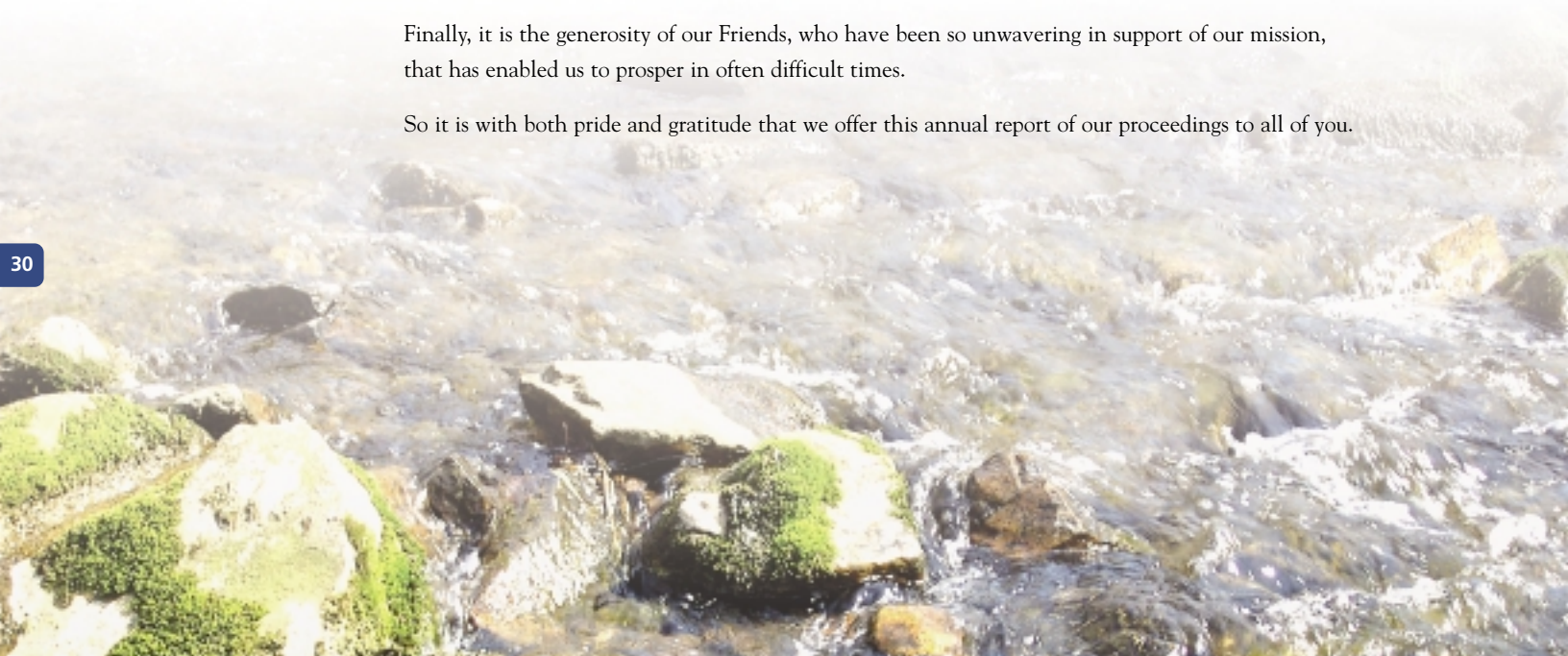
We officially launched our capital campaign . . . and to date have raised over two-thirds of our $11.5-million goal.

We exceeded our annual fund goal, balanced our budget for the 37th consecutive year, and grew our endowment.

All of these achievements and others were the result of the ability of our scientists and educators to win grants and contracts, the effort of our development office to raise funds, sponsor events and increase public awareness, and the determination of our entire staff to be efficient and focused.

Finally, it is the generosity of our Friends, who have been so unwavering in support of our mission, that has enabled us to prosper in often difficult times.

So it is with both pride and gratitude that we offer this annual report of our proceedings to all of you.



Revenues & Expenditures

OPERATING STATEMENT

For the year ending December 31, 2003

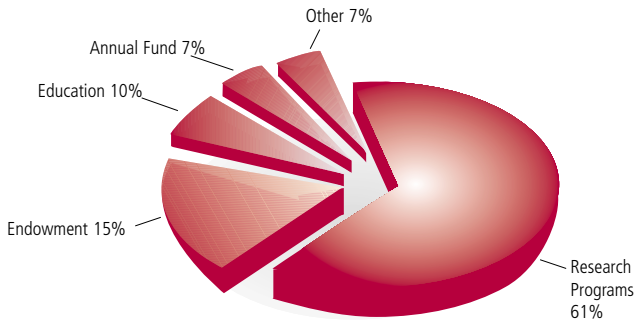
REVENUES & SUPPORT

Research Programs (Grants & Contracts)	$ 2,511,621
Endowment Support	$ 619,376
Education/Public Programs	$ 421,853
Annual Fund	$ 286,005
Other Contributions & Income	$ 286,426
TOTAL REVENUES & SUPPORT	**$ 4,125,281**

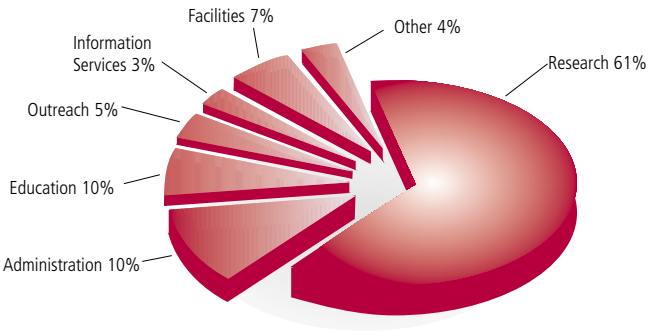
EXPENDITURES

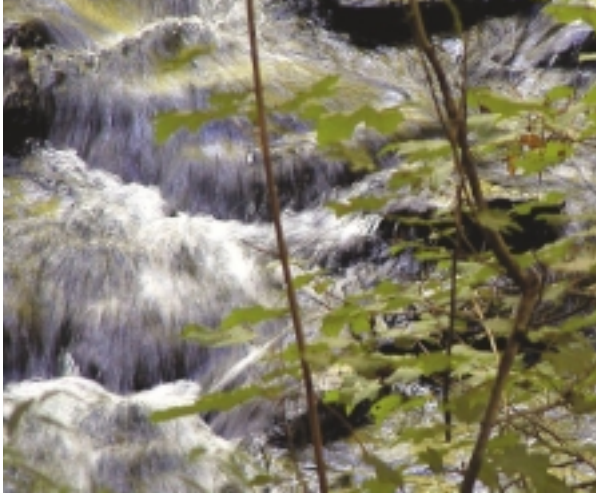
Research	$ 2,486,426
Education	$ 394,396
Development/Outreach	$ 193,467
Information Services	$ 133,649
Administration	$ 419,506
Facilities	$ 280,749
Other	$ 150,830
TOTAL EXPENDITURES	**$ 4,059,023**
OPERATING RESERVES	**$ 66,258**

2003 REVENUES & SUPPORT



2003 EXPENDITURES





Annual Contributions, Capital & Special Gifts

January 1, 2003 to December 31, 2003

The staff of the Stroud Center recognize the tremendous support of our many generous "Friends of the Stroud Center" in 2003. We THANK YOU for making 2003 our most successful year ever! Care has been taken to assure the accuracy and completeness of this listing. We regret any omissions and ask that you bring any corrections to our attention by calling Claire Birney, Development Director, 610-268-2153 x230.

Photos by Kay Dixon, Pages 32-35.

* New Donors in 2003

2003 SPECIAL CONTRIBUTIONS & GRANTS

Joanie & Jamie Blaine
Cabot-Wellington Foundation LLC
The Davenport Family Foundation

CORPORATE PARTNER

Wilmington Trust

2001-03 GIFTS & PLEDGES TO "SUSTAINING THE FLOW OF KNOWLEDGE" CAMPAIGN FOR THE STROUD CENTER

Joanie & Jamie Blaine
Mr. Benjamin Bradford
Mr. Luke Bradford
Mr. Seth Bradford
Cabot-Wellington Foundation LLC
The Davenport Family Foundation
E.I. DuPont deNemours & Co.
Ederic Foundation Inc.
Dr. & Mrs. John R. S. Fisher
Mrs. Anne M. Franchetti
Mrs. Anne S. Hannum

Mr. & Mrs. Nathan Hayward III
John Lazarich Foundation
Mr. & Mrs. Gerrish H. Milliken
Mr. & Mrs. Rodman Moorhead III
Mrs. Elizabeth R. Moran
Premier Woodcraft Ltd.
Ralph & Suzanne Roberts Foundation
Robert J. & Helen C. Kleberg Foundation
Ms. Marion B. Stroud
Mr. & Mrs. Morris W. Stroud
Mr. & Mrs. Stephen M. Stroud
Mr. & Mrs. W. B. Dixon Stroud
Dr. & Mrs. Bernard W. Sweeney
Dr. & Mrs. Paul V. Tebo
Anonymous Donors (4)

2003 GIFTS TO "THE KRESGE CHALLENGE FOR INSTRUMENTATION"

Jessie M. Allred
Yeda & David Arscott
Anthony Aufdenkampe & Bonnie Dickson
Mr. John Battle (in honor of Jan Battle)
Mr. & Mrs. Richard Benjamin
Claire Birney
Joanie & Jamie Blaine
Dr. & Mrs. Thomas Bott
Heather & Charlie Brooks
Kimberly & Christopher Cain
Coventry Health Care
Kay Dixon
Karen & Charles Dow
E. I. DuPont deNemours & Co.
Dr. & Mrs. William Elkins
Catherine Ferranto
Phoebe & Rush Fisher
Barbara & Dave Funk
Susan & Michael Gentile
Libby & Ben Gregg
Susan Herbert
Dr. & Mrs. John K. Jackson
Dr. Louis Kaplan & Ms. Leslee Schad
Sherry & Bert Kerstetter
Erika Kratzer
The Kresge Foundation
Mr. & Mrs. Jeffrey Livingston
Amy MacClausland
Margaret D. Strawbridge Foundation of PA
Sharon McCracken
Patricia Stroud McCurdy
Karla & Jim McGonigle
Mr. & Mrs. Robert D. McNeil
Christina Medved
Will Milliken
Billie Jo & Mark Monk
Gail & Denis Newbold
Nancy J. Parsons
Sally Peirson & John Baker
Mary & John Pepe
Tonya L. Prigg
Gabrielle & Nicholas Principe
H. Donnan Sharp
Sharon L. & Jan Michal Surma
Dr. & Mrs. Bernard Sweeney
Mr. & Mrs. Thomas C. Swett
Kristen Travers
David J. VanHorn
Mr. & Mrs. Randy VonTill
Vivian & Ray Williams
Mr. Allen Wise
Mr. & Mrs. Robert D. Wyatt
Mr. & Mrs. David J. Yezuita
Anonymous Donors (6)

2003 WATER'S EDGE SPONSORS

Joan Stroud Blaine
Dansko Inc.
Lisa & Bernard David
DuPont Company
Helen & Bill Elkins
Essex Envelope
Dolly & John Fisher
Carol Ware Gates
Gawthrop Greenwood & Halsted
The Hankin Group
Marsh Creek Corporate Services
Alice & Rod Moorhead
Oxford Foundation
Agnes Peelle
Barbie & Jerry Riegel
Boo & Morris Stroud
University of Pennsylvania
Wilmington Trust
XL Capital/Marsh McClennan
Young Conaway Stargatt and Taylor

2003 UPSTREAM FESTIVAL & 5K RUN/WALK SPONSORS

Chester County Press
Helen & Bill Elkins
First National Bank of Chester County
Harvest Market Natural Foods
Inverbrook Farm - Claire Murray
Julia Loving
Natural Dairy Products
Newark Natural Foods
North Creek Nursery
Pyle's Home & Supply
Spring Run Natural Foods
Super Fresh of Longwood Village
Seven Stars Yogurt
Bonnie Timmons
Trail Creek Outfitters

SALSA DANCE SPONSORS

Meg & Antelo Devereux
Anne & Jock Hannum
Cathy & Joe Huston
Ann & Michael Moran
Mi Casa Su Casa
Melanie & Sanford Miller

Trish & Bob Scott
Boo & Morris Stroud
Bonnie Timmons & Bill Wunsch
Upland Country Day School
Victory Brewing Company
Wild Thyme

VOLUNTEERS
Suzanne Adams
Terry Anderson
Anthony Aufdenkampe & Bonnie Dickson
Katherine Bartlett
Jan Battle
Diane Belnavis
Patti & Mark Bender
Jill Benjamin & John Hodges
Stephanie Bernasconi
Annie Rose Birney
Jack Blozis
Ashlyn Bodenhamer
Tom Bott
Kim Brosnan-Myers
Virginia Brown
Megan Bushnell
Martha DeFillippo
Meg Devereux
Patty Diggan
Lindsey Flexner
Laura Florence
Terri & Rob Fox
Stephanie & Amanda Giangiulio
Julia Gillette
Libby & Christine Gregg
Aubrey Paula Jessica Gruffunder
Jami Paul & Elise Harry
Terry & Anne Hawkins
Linda & Jake Hicks
John Holloway
Christine Howells
John Jackson
Karen Jansson
Susan Jones
Lou Kaplan
Kayla Kawamoto
Erica & Andrew Kratzer
Ann Lofting
Wendy Lofting
Kitty Loving
Julia Loving
Fran Manitone
Cheri McGrory
Christina Medved
Jim McGonigle
Will Milliken
FM Mooberry
Lilly Moss
Fred Muller
Cintra Murray
Claire Murray
Denis Newbold
Peter Orth
Jean Peirson
Jessica Pfeifer
Cecilia Ross
Jen Roth
Shirley Rozassa
Emily Scott
Claudia Seyler
Andrea Dan & Kevin Sweeney
Andrew Thalheimer
Tim Thomas
Joan & Kevin Travors
Holly Tyson
Carol Urbanc
Fred Wanner
Roberta Weber
Tracy Wiegner
David Yeats-Thomas

WATER'S EDGE VOLUNTEERS
Beryl Barmore
Gayley Blaine
Jake Blaine
Joan S. Blaine
Claire Bobiak
Cindy Conway
Laurie De Grazia
Philip Dixon
William Dixon
Evie Dutton
Margaret Egli
Leslie White Fad
William Kronenberg III
Julia Loving
Melissa McGonigle
Claire Murray
Nancy Parsons
John Pepe
P.J. Simon
Jocelyn Sutton
Paul Tebo
Blair Wyatt
David Yeats-Thomas

WATERSHED PROTECTORS
($5,000 and up)
Mr. & Mrs. Henry I. Brown III
Brown Brothers Harriman & Co.
Ms. Amanda C. Cabot & Mr. Peter Kjellerup
Cabot-Wellington Foundation LLC
Mr. & Mrs. Rodney D. Day III
Fair Play Foundation
Mrs. Anne M. Franchetti
Gerrish H. Milliken Foundation*
Carol Ware Gates
Anne & Jock Hannum
John Lazarich Foundation
Sherry & Bert Kerstetter
Mr. Roger Milliken
FM & Dave Mooberry
Mr. & Mrs. Rodman Moorhead III
Mrs. J. Maxwell Moran
Mr. & Mrs. Stephen M. Stroud
Mr. & Mrs. W. B. Dixon Stroud

RIVERWATCHERS
($1,000 – $4,999)
The Barra Foundation Inc.
Mr. David J. Callard
Mrs. John Cleveland
Mr. & Mrs. Russell H. Crawford
Mr. & Mrs. Bernard J. David
Dr. & Mrs. William Elkins
Dr. & Mrs. John R.S. Fisher
Phoebe & Rush Fisher
Dr. & Mrs. Robert Forney
Richard J. Hutton
Dr. & Mrs. Henry A. Jordan
Dr. & Mrs. Charles T. Lee Jr.
Mr. & Mrs. R. James Macaleer*
Mrs. Lawrence MacElree
Marion Layton Mann
Margaret D. Strawbridge Foundation of PA
Mr. & Mrs. Irénée duP. May
Mr. & Mrs. Robert D. McNeil
Mr. & Mrs. Frederick Meserve
Dr. N. Milliken & Mr. S. Smirnoff
Mr. Gerry Milliken*
Mr. & Mrs. Richard E. Riegel Jr.
Mr. & Mrs. Joseph J. Rishel (in honor of Dick Stroud)
The Roemer Foundation
Mr. & Mrs. Thomas Roosevelt
Dr. & Mrs. Louis Sage Jr.
Mr. & Mrs. Richard Sanford
Mr. & Mrs. Adam Sapp*
Mr. & Mrs. Jesse D. Saunders
H. Donnan Sharp
Mr. & Mrs. Willard Speakman III
Trish & Bob Scott
Ms. Marion B. Stroud
Mr. & Mrs. Morris W. Stroud
Dr. & Mrs. Paul V. Tebo
Mr. & Mrs. John L. Vogelstein*
Mrs. Richard J. Walsh
Ms. Phyllis G. Williams
Mr. & Mrs. William Wylie Jr.
Anonymous Donor (1)

STREAMKEEPERS
($500-$999)
Mr. & Mrs. Francis H. Abbott Jr.
Jessie M. Allred
American Mushroom Institute
Lydia Willits Bartholomew
Mr. & Mrs. Robert H. Bolling Jr.*
Charlotte & Francesco Bonmartini*
Dr. & Mrs. Thomas Bott
Dorothea & George Chidester
Mr. & Mrs. Francis Coleman
Mr. & Mrs. Tristram C. Colket Jr.
Mr. Lammot Copeland Jr.*
Mr. & Mrs. Antelo Devereux Jr.
Dr. & Mrs. James Dow
Mr. & Mrs. Ford B. Draper Jr.

Mr. Henry B. duPont IV
Mr. & Mrs. Charles Fleischmann
Anna B. Francis & Alex Van Putten
Mr. & Mrs. William H. Frederick Jr.
Dr. & Mrs. Timothy Gardner
David J. Garrett
Henrietta George
Mr. & Mrs. Nathan Hayward III
Eileen & Bruce Hooper
Ms. Claire Hopkins
Mr. & Mrs. Charlie Hoppin*
Mr. & Mrs. M. Roy Jackson*
Mr. Eldridge R. Johnson II
Mr. & Mrs. Samuel C. Jones
Mr. & Mrs. Ronald J. Juvonen
Ms. Suzanne Kloud*
Di & Dallas Krapf
Mrs. Greta Layton
Mr. & Mrs. Michael Matz

Patricia & Alexander McCurdy
Mr. & Mrs. Ellice McDonald Jr.
Mr. & Mrs. Douglas Mooberry
Mr. & Mrs. Kenneth Mumma*
Octoraro Native Plant Nursery
Diane & Leonard R. Olsen Jr.*
Mr. & Mrs. Edgar Scott Jr.
Dr. & Mrs. Henry F. Sears
Mr. & Mrs. William M. Sharp
Joy Slater
Jane Sullivan
Dr. & Mrs. Bernard Sweeney
Watershed Sportsman Club

HEADWATERS SPONSORS ($100 - $499)

Mr. & Mrs. Robert M. Aiken
Mr. & Mrs. W. Boulton Alexander
Mr. & Mrs. A. Joseph Armstrong
Kevin R. M. Arnold
Jen & Dan Augustine
Barbara & Bob Baillie
John Gail & Steven Barr
Mr. & Mrs. C. Minor Barringer
Berks County Conservation District
Mr. & Mrs. Arthur Bernardon
Lise & William Bernhard
Claire Birney
Mary & Andrew Bobst
Mr. & Mrs. Robert V. Bock
Mark Borchardt & Gwen Stone
Mr. & Mrs. Jeffrey Bove
Mr. & Mrs. J. Clayton Bright
Mr. & Mrs. Howard Brokaw
Mr. & Mrs. Charles Brosius
Mr. & Mrs. William S. Browne
Mr. & Mrs. John J. Burchenal
Ed Camelli & Bonnie Mosser
Dr. & Mrs. Bayard Coggeshall
Mr. Gene Connell*
Sara B. Corbishley
Mrs. Nancy E. Corroon
Mr. & Mrs. Philip D. Curtin*
Mr. Joseph I. Daily Jr.
Rick P. Darke
Mr. & Mrs. Warren Davies
Mr. & Mrs. Harold A. Davis
Joanne Denworth*
Mr. & Mrs. F. Michael Donohue Jr.
Reeve Draper
Mr. & Mrs. Peter Drayer
Mr. & Mrs. Lee F. Driscoll
Mr. & Mrs. Robert Duprey
Mr. & Mrs. Phillip P. Dutton
Mr. & Mrs. Charles Egli
Mr. & Mrs. Michael Elling*
Mr. Gordon R. Farquhar
Mrs. F.W. Elliot Farr
Mr. Robert Fenza
Ingrid & Rick Fischer
Mr. & Mrs. Jack Fisher
Mr. & Mrs. D.V. Fletcher
Elizabeth G. French M.D.
Mrs. Carol P .J. Fry
Suzanne & John Gaadt
Mr. William Godbold
Dr. & Dr. Leonard G. Gomella M.D.*
Mr. & Mrs. Harold B. Goodall*
Mr. & Mrs. Richard S. Gross
Mr. & Mrs. Charles F. Gummey Jr.
Mr. & Mrs. John S. Halsted
Mr. & Mrs. J. Marshall Hamilton
Mr. & Mrs. N. Peter Hamilton
Mr. & Mrs. Richard P. S. Hannum
Mr. & Mrs. David Harrington
Robin E. Heard
The Hering Family
Mr. & Mrs. Loukianos Hionis*
Mr. & Mrs. Jeff Horstman*
Mr. & Mrs. Joseph H. Huston Jr.
Sarah Jackson
Mr. Russell B. Jones Jr.
Mr. & Mrs. Harvey Journey
Dr. Louis Kaplan & Ms. Leslee Schad
Mr. & Mrs. Ken Keller*
Lucci & Randall Kelly
Maurie Kerrigan
Mr. P. Richard Klein
Mr. & Mrs. Arthur T. Kollmeier*
Debora & John Kollmeier
Gail & Sam Lam
Mrs. Richard W. Ledwith
Mr. William Levy & Ms. Karen Kelly
Sally & Richard Lighty
Mr. & Mrs. Guy Russell Lloyd III
Mr. & Mrs. Hugh J. Lofting
Wendy W. Lofting* (in honor of the Blackfoot Challenge)
Brenda & Thomas Macaluso
Katharine & Whit Maroney
Dr. & Mrs. Robert R. Marshak
Anna B. McCoy*
Mr. & Mrs. Richard A. Mellon
Mr. & Mrs. Robert Merkle
Mr. & Mrs. Floyd C. Montgomery
Mrs. Samuel W. Morris
Betty Musser
Douglas Myers & Kimberlee Brosnan-Myers
Mark & Anna Myers
Mr. & Mrs. Alan S. Nadel
Ann & Thomas Nale
Natural Landscapes
Mr. & Mrs. Irvin S. Naylor
Mr. Donald B. Needham & Sons
Mary & Chris Patterson
Mr. & Mrs. W. Duncan Patterson
The Pauline-Morton Foundation
Mr. & Mrs. William R. Peelle Sr.
Mrs. Jean Peirson
Mary & John Pepe
Mr. & Mrs. Jeremiah W. Powell
Mr. & Mrs. Lewis L. Powell
The Providence Garden Club of PA
Claudia Pulise
Regester Associates Inc.
Mr. & Mrs. John Rittenhouse
Mrs. Frances L. Roberts (in honor of Sherman Roberts)
Mr. Richard E. Robinson
Representative Chris & Cecilia Ross
Mrs. William H. Ruffin
Elizabeth G. Sargent
Mr. & Mrs. William J. Scarlett
Mr. & Mrs. Charles P. Schutt Jr.
Mr. & Mrs. Edgar Scott III
S.E.C.C.R.A
Joyce & Robert Shaffer
Mark Sharnoff & Marcia P. Halio*
Mr. & Mrs. Eli R. Sharp
Ms. Jeanne O. Shields
Mr. & Mrs. Bill Siegl*
Dr. & Mrs. Kevin Skinner*
Mr. & Mrs. Gilchrist Sparks III
Walter & Georgianna Stapleton
Richard Brown & Barbara Stewart
Dr. & Mrs. Bayard T. Storey
Dale Stratton
Brook Stroud*
Mr. David L. Thun*
Mr. & Mrs. James Treadway
Richard F. Ulak
Ms. Carol Urbanc & Mr. John Astell
Ms. Eva Verplanck
Mr. & Mrs. Michael R. Walker
Mr. & Mrs. John M. Watkins Jr.
Waterford Farm
Cynthia & Guy Webster
The Weeders Garden Club
Jane Yates - The Wellesley Club of Delaware*
Mr. & Mrs. W.D. Wells Jr.*
Mr. & Mrs. Harry B. West
Sheila & Rufus Williams
Mr. & Mrs. Gregory M. Wilson
Mr. & Mrs. George Wintersteen
Marcia & Paul Woodruff
Barb & Jim Yeatman
Anonymous Donors (6)

RAINMAKERS ($50-$99)

Melanie & Scott Arnold
Ms. Alexine L. Atherton*
Mr. & Mrs. H. Hudson Barton IV
Mrs. Judith L. Bonifacino
Mr. & Mrs. Mark Bowden*
Mr. Troy Brady*
Mr. & Mrs. Edward S. Brinton
Robert F. Buenaga
Chester County Cooperative Extension
Anita & Terry Clattenburg
Kristin & Craig Coleman
Susan C. & Donald A. Corkran
Wendy Cotton
Mr. David Coye
Tish & Eliot Dalton*
Mr. & Mrs. Bernard S. Dempsey Esq.
Mr. There duPont & Ms. Darla Pomeroy*
Janet Ebert
Mr. & Mrs. J. Clifton Edgar
Helen Edwards
Mr. & Mrs. P. Scott Fad
Dr. & Mrs. James A. Fava
Debra & Chris Ferrier
Ms. Sue Fuhrmann & Mr. Ronald A. Hamlen
Mr. & Mrs. W. Harley Funk
John & Suzanne Gaadt
Gloria & Millard Gamble
Mr. & Mrs. William Gibson Sr.
Mr. & Mrs. Lloyd H. Goodman
Mark & Donna Gormel
Albert M. Greenfield Jr.
Libby & Ben Gregg*
The Half Moon Saloon
David Hawk & Pat Beitel
Nancy H. Hayward
Anne I. Hicks
Mr. & Mrs. William T. Howard
Mr. Ray Hutmacher

Susan C. S. Jones
Mr. & Mrs. James Kilgore
Susan & Robert Kissell
Mr. & Mrs. Richard R. Klair
Mr. & Mrs. Steve Kosiak
Rick L. Leibold DDS
Ginny & Bruce Levy*
Mr. and Mrs. Harrie F. Lewis
Ida K. Lofting
Jennifer Loustau & Wick Williams
Mr. Carl L. Manthey
Mary & Kim McCane
Mr. Robert McKinstry*
Mr. Blaine C. McKusick
Ms. Barbara Miller
Anne & John Moss*
Claire Murray & Hugh Lofting: Inverbrook Farm
Cintra & Bob Murray
Mr. & Mrs. Louis Neilson & Emily Neilson*
Mr. George Nemes*
Roberta W. Odell
Linda & Arthur Polishuk
Sonia Ralston
Mr. & Mrs. Alexander Roe
Lisa & Tim Rubin
Jackie & Locke Rush*
Ms. Lynnette Saunders*
Mr. John Schirk*
Mrs. Sidney Scott
Mr. & Mrs. H. William Sellers
Debra Shenk & Philip Boudant
Mr. Jonathan Sheppard*
Mark Smithgall
Valerie & Rick Stephens
Mr. Charles Walter Stewart
Barbara & Hank Stoebenau
Denise D. Strucko
Mr. & Mrs. William F. Sweeney
Joan & Herbert Thal
Andrew H. Thalheimer
Mr. & Mrs. Edmund Thayer
Elinor Thomforde
Catherine & Collis Townsend
Mrs. Elizabeth Twaddell
United Technologies*
Mr. & Mrs. Stephan M. Waechter
Ms. Daisy Wanamaker
Peter Welling
Mr. John P. Wiley*
Mr. Charles H. Wolfinger
Stacie & Charlie Young*
Paul Zazow
Anonymous Donors (5)

EVERY DROP COUNTS ($1 - $49)

Lorraine Anderson
Mr. & Mrs. Kenneth J. Andrews
Dennis Arias
Mr. & Mrs. Jim Arthur
Mr. & Mrs. Julius E. Bellone
Mr. Robert Brown
Ms. Amy Bruckner*
Mr. & Mrs. Robert Caputo*
Ms. Sally Carpenter
Vicki & Jim Chandler
Dr. & Mrs. Morris J. Cherrey
Mr. & Dr. Andrew Clibanoff
Mr. & Mrs. Richard C. Corkran
Mr. & Mrs. Samuel A. Cousins*
Marie Dalton-Meyer & Les Meyer
Mr. & Mrs. Tyler Dann
Ms. Carol H. Davidson*
Ms. Lowell Dinneen*
Lois H. & B. J. DiVincenzo*
Kay Dixon
Edward R. Doran Jr.
Mr. & Mrs. Werner A. Duerr
Mr. Court E. Dunn
Dee Durham & Barry R. Evans*
Elk Creek Watershed Association
John R. Evans
Ms. Joyce Fangman*
Else G. Fernsler
Trish & Tripp Fischer*
Ms. Amy Foster*
Mr. & Mrs. O. Wells Foster
Ms. Mindy Frankfurt*
Linda & Charles Frick
Mr. & Mrs. Howard M. Fry
Ms. Mary Gagliano
Harry W. Giesecke
Mr. Wayne R. Goeken*
Mrs. Constance Goracci
Mr. & Mrs. Alexander Gordon-Watson
Mr. & Mrs. Michael Gracie*
Lenore B. Guthrie
Sara & David Hadden
Judy Head*
Mr. & Mrs. Earle T. Holsapple Jr.
Claire & Charles Hossack
Bettina L. Jenney
Ms. Judy Jordan*
Mr. & Mrs. Haven S. Kesling Jr.
Mr. & Mrs. Donald H. Kirkland Jr.*
Dr. & Mrs. Charles Korbonits
Mr. Robert Korbonits
Ms. Amy Law
Mr. & Mrs. Michael M. Ledyard
Jane & John Lee
Joseph Lex & Andrea Urban
Dr. Amy J. Liu*
Stephanie & John Madsen*
Mr. & Mrs. Robert J. McClune
Suzan McLaughlin*
Mary H. McLoughlin
William & Erica Mears
Suzanne Michel Pitcher DVM*
Mr. Sam Mirshak*
Mobil Foundation Inc.
Mr. & Mrs. Robert Molzahn*
Ms. Jane Moore
Anne D. Murray
Mr. & Mrs. Edward O'Donnell*
Ms. Nancy Parker*
Sharon Patterson & John Pellini*
Mr. Gary R. Peacerk*
Ms. Barbara Pettinos
Mr. C. Dilworth Pierson
Mrs. Penny Preston
Teddy Price & Richard Squadron
Audrey & Jack Ransom
Alvin J. Reagan
Mr. Homer R. Reese
Ms. Wendy Reynolds
Craig Rinschler
Roberts Education Association* (in memory of Dave Jarvie's mother)
Ms. Christine Rodick*
Jen & Christopher Roth
Nancy & Bernard Shapiro
Ms. Jodi R. Sivak*
Ms. Catherine Smith
Ms. Barbara Sonies
Evelyn & Larry Spencer*
Mr. & Mrs. William F. Stafford
Linda & John Stapleford
Sarah Lee B. Stokes
Becky Stoner
Emery & Josh Taylor*
Mr. William D. Teter
Mr. & Mrs. Conrad K .P. Tou
Mr. & Mrs. Andrew W. Urquhart
Jane & Joseph Vasile
Mr. & Mrs. Richard F. Voldstad
David Walton
Winifred & Sam Wharry
Sally & David Wise
Mrs. H. Zipperlen
Mr. & Mrs. Thomas J. Zunino
Anonymous Donors (8)

2003 – A Year of Impact & Recognition

STROUD
WATER RESEARCH CENTER

Dedicated to understanding, protecting and restoring the world's fresh water.

Photo by Robert Murray

Aerial photo of the Stroud Water Research Center after the December 2003 snow storm with the East Branch of White Clay Creek meandering from middle left across the foreground, crossing under Spencer Road.

WWW.STROUDCENTER.ORG

970 Spencer Road

Avondale, Pennsylvania 19311-9514

Tel: 610.268.2153