Cacapon

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State of the River
Cacapon River 1996-1999

Ideally, our concerns about pollution in the Lost/Cacapon watershed could be addressed simply in a few small studies. However, we live in a watershed where many potential problems are scattered across the landscape and widespread non point source pollution is our greatest concern. To find answers to questions like — "how is the river doing?" and "what are the real impacts of intensive farming?" — Cacapon Institute has developed a suite of research programs that are designed to answer both large and small scale questions about the Cacapon. Our most intensive studies occur in the Lost and North river watersheds; these look at the effects of specific land uses on water quality. This article will focus on our more general study of the Cacapon watershed — the Cacapon River Monitoring Study — which is designed to develop a record of information suitable for assessing long term water quality trends.

The Lost River at Squirrel Gap

Study area

The 178 km long Cacapon River is located in the eastern panhandle of West Virginia, in Hardy, Hampshire and Morgan counties (for map, *see website*). With a drainage area of 680 square miles, it is an important tributary of the Potomac River and contains about 7% of the Potomac watershed area upstream of Virginia. Steep topography confines most agriculture to the narrow valleys and gentle slopes, while about 80% of the Cacapon watershed overall is forested. Most of the region's cropland and prime hay land is found on floodplains and river terraces. Most pasture also occurs on gentle slopes; however, some is located on steep, often eroding, shale hillsides. Residences are scattered at low density throughout the watershed, few along the mainstem of the river.

Since July 1996, we have conducted monthly sampling at five sites in the watershed. The sites are the Lost River at Lost City, the Lost River at Squirrel Gap, the Middle Cacapon at Arnolds Ford, the Lower Cacapon at the U.S. Geological Survey (USGS) gage station upstream from Great Cacapon, and the North River at Ice Mountain Estates. Our sampling year runs from July to June, an artifact of the project's July starting date.

Each site is located in a distinctly different region of the Cacapon watershed. The Lost River site at Lost City is centrally located in the Cacapon's most intensive agricultural area, a region dominated by

(Continued on page 2)

INSIDE

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New Watershed Education and Outreach Staff

Originally from Washington State and Pennsylvania, Robin and Peter Maille have lived and worked in 20 countries, many in Africa. Their backgrounds include forestry, sociology and environmental resource management. They both completed masters degrees at the Yale School of Forestry and Environmental Studies. Peter and Robin lived for five years in Arlington, VA working for the Peace Corps and the Forest Service respectively. They moved to the Potomac Highlands in 1997 to open an eco-friendly bed and breakfast--Thorn Run Inn in Grant County, WV (http://members.aol.com/narope/ThornRun.htm). Their objectives have been to promote economic development and environmental conservation, while enjoying a peaceful country lifestyle.

As CI's new outreach and education coordinators, a split, part-time position, their primary task is to establish and maintain classroom and hands on programs that will engage the interest and participation of students and local communities in watershed work. In addition, they will be working with Neil and Nicole on writing tasks which include the newsletter, website, grant proposals, press releases and articles detailing CI's research and other watershed topics of public interest.

Robin, Peter and Nathan at Thorn Run Inn

(Continued from page 1)

integrated agriculture (*see Glossary, page 7*). Squirrel Gap, while still in the Lost River region, is located more than five kilometers downstream of the main agricultural area and is heavily wooded. The Middle Cacapon site at Arnolds Ford is typical of that moderately agricultural region, with a mixture of pasture, forest and light development found upstream. The region upstream of the Lower Cacapon's gage station site is mostly forested with light to moderate residential development. The final site is located within the Ice Mountain Estates development on the North River, the Cacapon's largest tributary. Land uses in the North River watershed are much like the Middle Cacapon region, but without an intensively agricultural area located upstream.

Each sampling site receives the drainage from different sized watersheds (fig. 1, page 3). Since water quality standards are based on concentration, it should come as no surprise that small streams are more susceptible to contamination that exceeds water quality standards than are larger streams and rivers. The same number of bacteria that would generate a concentration of 1000 at Lost City, for example, would only produce about 100 at the gage

(Continued on page 3)

(Continued from page 2)

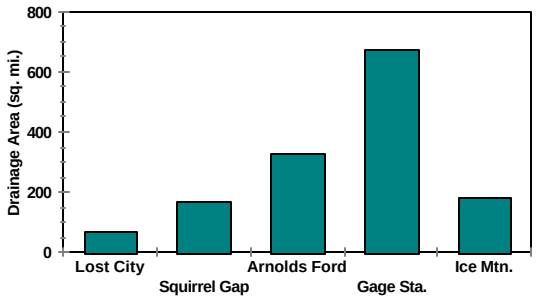
station (assuming Lost City has about one tenth the flow because its watershed is one tenth the size).

Our studies are mostly concerned with **non point source pollution** (*see Glossary page 7*) because we are fortunate to have few point sources of pollution in the Cacapon watershed; these are mostly limited to small municipal sewage treatment plants.

We sample each site monthly for temperature, pH, alkalinity, orthophosphate, total phosphorus (since 9/97), nitrate-nitrogen, ammonia (until 1/99), turbidity and fecal coliform bacteria. This report will focus on sample results for nitrate and fecal coliform bacteria, which are most informative about human impacts on this watershed. (See the box on page 6 for discussion about phosphorus.) Complete data summaries for these and other study parameters are available on our web site. Nitrate is important because it is the most persistent water quality indicator of nutrient use on the land. Fecal coliform bacteria is important because it is the parameter of greatest concern to human health.

Table 1 summarizes our findings so far. Median **concentrations** (*see Glossary page 7*) of nitrate and fecal coliform bacteria dropped sharply in the third year of the monitoring program. However, before we conclude that the Cacapon's water quality has improved, we must take into account the weather conditions during those years. The first sampling year (7/96 to 6/97) had heavier than normal precipitation (48 inches total vs. an average annual precipitation of about 35 inches), much of which occurred during the summer and fall of 1996 (remember Hurricane Fran?). The second sampling year (7/97 to 6/98) had nearly the same total amount of precipitation as the first, but the majority of this precipitation fell during the first six months of 1998, including heavy snows. The third sampling year (7/98 to 6/99) was a period of almost unrelenting drought with precipitation less than half the normal rate. As we discussed in the last issue of *Cacapon*, precipitation is a key factor in water quality studies in basins with primarily non point source pollution. No rain = no run-off — therefore less non point source pollution to degrade our rivers.

Fig. 1 **Cacapon River Sampling Sites**
Drainage area



Bacteria. Fecal coliform bacteria are bacteria that live in the intestines of warm blooded animals (geese, cows, people).

(Continued on page 4)

Table 1. Median nitrate and fecal coliform bacteria concentrations at all sampling sites for each year and overall. Also provided for bacteria are the percentage of measurements exceeding the 400 cfu/100 ml standard each year.

Sampling Site	Nitrate –N Median (mg/L)				Fecal Coliform Bacteria Median cfu/100ml (% exceeding 400)			
	Yr 1	Yr 2	Yr 3	Overall	Yr 1	Yr 2	Yr 3	Overall
Lost R. Lost City	1.0	0.8	0.1	0.7	315 (27%)	227 (17%)	39 (17%)	165 (20%)
Lost R. Squirrel Gap	1.0	0.9	0.2	0.7	50 (36%)	45 (0%)	3 (0%)	27 (12%)
Cacapon R. Arnolds Ford	0.5	0.5	0.1	0.3	220 (27%)	42 (8%)	7 (0%)	23 (12%)
Cacapon R. USGS Gage Sta.	0.3	0.3	0.1	0.1	49 (18%)	15 (0%)	3 (0%)	13 (6%)
North R. Ice Mountain Estates	0.4	0.4	0.2	0.3	110 (18%)	70 (8%)	25 (0%)	49 (9%)

West Virginia's fecal coliform bacteria standard states that a violation occurs if more than 10% of the samples collected exceed a count of 400 colony forming units (cfu)/100mL. The range from 200 to 400 cfu/100ml is marginal and cause for concern.

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They are used to indicate the presence of fecal waste in the water. While fecal coliforms themselves are usually not harmful, they indicate the possibility that pathogenic (disease causing) organisms may be present.

Fecal bacteria can enter rivers from a variety of sources, including malfunctioning or inadequate sewage treatment systems (municipal and septic), manure from livestock and wild animals, and feedlots or land fertilized with manure.

In 1997, in part because of bacterial data collected during the Cacapon River baseline study (Constantz et. al., 1993), the WV Division of Environmental Protection (WVDEP) placed the Lost River on the USEPA 303(d) list for streams failing to meet the bacteria standards for water contact recreation. In 1998, we reported that the Lost River mainstem continued to be degraded by fecal coliform bacteria (Gillies, 1998). In 1999, our data was again requested by the WVDEP to determine if the Lost River should remain on the 303(d) list; on delivering the data we advised the WVDEP that much of this data was collected during a drought and was probably not indicative of more normal conditions.

During the monitoring program's last three years combined, Lost City, Squirrel Gap and Arnold's Ford all exceeded the 400 cfu/100 ml standard (*see sidebar*) 20, 12 and 12% of the time, respectively and the Lost City site exceeded 200 cfu more than 40% of the time (fig. 2, table 1). These sites should, therefore, be considered degraded by bacteria. Those simple numbers do not tell the whole story, however. Table 1 shows that all five sampling sites had more than 10% of the counts in excess of 400 cfu during the first year, only Lost City for years two and three. At Squirrel Gap and the USGS gage station site, fecal coliform counts in excess of 400 cfu were seen only during the first sampling year.

In the third sampling year, the only site with ANY counts above 400 cfu was Lost City (17% exceeded 400), and the highest count seen at the gage station was 10 cfu during that same period. We won't know until a period of more normal precipitation returns if these low numbers represent a real improvement or simply short-term fluctuations due to lack of rainfall. However, the low bacterial counts observed during dry weather DO imply that no regular point sources of bacterial pollution, such as straight pipes, likely occur in the vicinity of our sampling sites — if they did, we would expect to see high counts more often during low flow conditions.

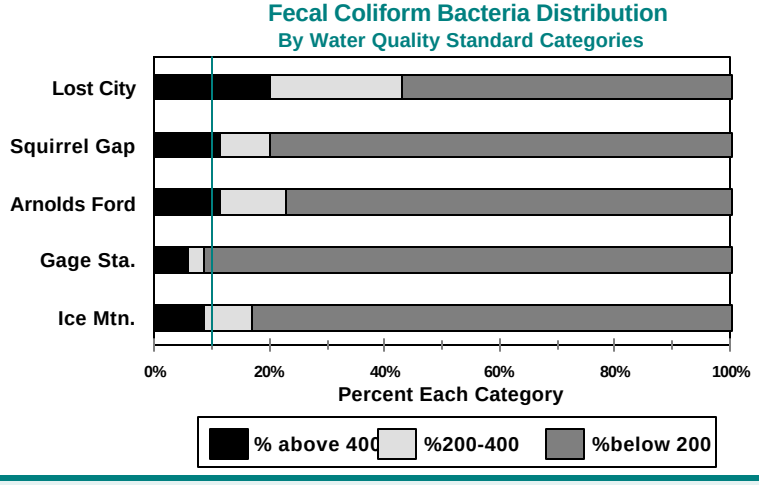

Figure 2. Percent of samples of fecal coliform bacteria falling within specific water quality standard categories for all years combined. Any bar with black to the right of the vertical line at the 10% mark indicates a violation of water quality standards.

Nitrate. Nitrate is a nutrient essential to plant growth and is the most common form of nitrogen typically found in surface waters. While ammonia, another form of nitrogen, can be toxic to fish and may therefore have a more acute impact on the ecosystem, ammonia in streams rapidly disappears -- either taken up by plants or converted by biological action to nitrate. For these reasons, ammonia is not often seen at high concentrations very far from the point of origin (such as a sewage treatment plant or a feedlot).

(Continued on page 5)

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Nitrate, on the other hand, dissolves readily and is chemically stable. Because it moves readily through ground and surface waters, nitrate in the river can be an excellent indicator of the amount of fertilizer (which is rich in nitrogen and phosphorus) applied to the land. High concentrations of nitrate can harm rivers, farm animals, and people. In rivers, high concentrations of nitrate, together with sufficient phosphorus, can promote explosive algal growth. If infants regularly drink water high in nitrate they can become sick and die (i.e.: the "blue-baby syndrome"). Even the health of livestock, such as cattle, can be compromised by drinking water high in nitrate — particularly if their food is also nitrate rich.

Nitrate can enter rivers from a variety of sources, including runoff from livestock manure and fertilized land, sewage and septic systems and atmospheric deposition (both rain and snow).

Nitrate-nitrogen concentrations are highest in the Lost River headwaters of the Cacapon, and decrease in a downstream direction (fig. 3, table 1). This pattern is clear and consistent during all but the driest weather — like last year. In part, the reduction in concentration is due to dilution; as you travel further downstream the river carries more flow from watersheds with diverse land uses. Why, however, if dilution has such a great effect, is the nitrate concentration at Squirrel Gap virtually the same as at Lost City, which drains less than 1/3 the area. This appears to indicate that nitrate is lost from the Lost River watershed into the river at a fairly continuous rate along river's length up to the Squirrel Gap site. We know from our Lost River study that Lost River tributaries are generally lower in nitrate than the mainstem; it is therefore reasonable to assume the nitrate we measure in the Lost River is being "lost" (*see sidebar*) from the intensely agricultural land along the Lost River's mainstem.

A comparison between the Lost River's Squirrel Gap site and the North River's Ice Mountain site supports the conjecture that nitrate in the Lost River is coming from the farm land along the mainstem. These two sites have roughly the same drainage area (fig. 1), and the overall land use pattern in each area is very similar. Floodplain and shallow slope land in each basin is primarily used for agriculture. In the Lost River watershed, much of that agriculture consists of row-crops planted on floodplain land along the mainstem; the watershed's abundant poultry litter resource is a major source of fertilizer. The North River watershed has far less land planted in row crops and therefore relatively little need for fertilizer; it also produces far less fertilizer in the form of poultry manure. Nitrate concentrations at the Lost River's Squirrel Gap site are consistently at least double those seen at Ice Mountain on the North River.

Are the nitrate levels seen at our Lost River sites a cause for concern? They certainly reflect the agricultural land use along the river. Changes in concentrations over time should provide a clear indication of changing land management practices. Between 1970 and 1990, the USGS collected 64 water samples in the Lost River near McCauley (just a few miles upstream of our Squirrel Gap site) and analyzed them for nitrate; they reported a me-

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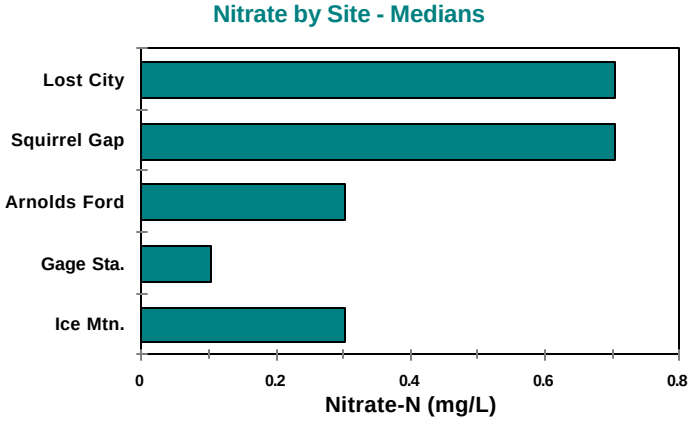

Figure 3. Median nitrate concentrations at sampling sites for all sampling years combined.

Why do we say nitrate is "lost" from the land?
Because the goal is to keep fertilizer on the land where crops can use it, and not put it in the river where it is not welcome.

Currently, no water quality standard exists for phosphorus and the only water quality standard for nitrate is 10 ppm -- a standard for drinking water that is not designed to protect our surface waters from excessive nutrients (i.e.: eutrophication). Recently, the states have been charged by the USEPA to develop nutrient standards that protect our in-stream ecosystems from harm, including algal blooms which can decay and result in toxically low dissolved oxygen levels and poor habitat. Watch our website for more information on this topic.

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dian nitrate concentration of about 0.4 mg/L, about half of what we see now in the Lost River and slightly more than our North River median concentration (Table 1). However, the median nitrate concentration of less than 1.0 mg/L at our two Lost River sites is relatively low in comparison to some similarly sized streams in the Shenandoah's Great Valley immediately to our east. (On rare occasions, we have recorded nitrate concentrations near to or in excess of the drinking water standard of 10 mg/L at certain sites in our intensive Lost River study — levels this high are extremely uncommon in surface waters.) The Shenandoah Valley area has higher density of agriculture than even our Lost River area and also has karst topography. Karst regions with their abundant sinkholes and bedrock cracks are notorious for leaking pollutants of many kinds.

A recent report by the USGS neatly summarized the difficulty of trend analysis in our complicated world. "Water quality is constantly changing, from season to season and from year to year. Long-term trends, as captured by the question "Are things getting better or worse?," are sometimes difficult to distinguish from short term fluctuations" (USGS, 1999). Thus far, what we have seen in the Cacapon River monitoring study bears out the truth of that statement. In the world of trend analysis, our study is still very young. That is why we are committed to continuing the monitoring program into the foreseeable future.

This project is supported by a grant from the WV Division of Environmental Protection's Stream Partner's Program, the U.S. Fish and Wildlife Service and by donations from Cacapon Institute's membership.

Visit our website for more details.

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So, why not phosphorus?

Our intensive studies in the Lost and North river areas have found little, if any, difference in phosphorus (P) levels between sampling sites with vastly different P use rates (as fertilizer) on nearby land. In most cases, P levels for a site with heavy agricultural usage of fertilizer are similar to a mostly forested site. This is due in large part to our particular geology and soil types. West Virginia University researchers are currently studying the capacity of our floodplain soils to store P without leaching; early results indicate some of our soils may have a large capacity to store P (Estepp, personal communication). Why do we bother to collect P data if it appears to tells us so little? There are three main reasons. First, phosphorus is considered by many scientists to be a more important nutrient than nitrogen in fresh water systems -- because phosphorus is usually present at much lower concentrations than nitrogen, it is phosphorus that usually limits plant growth (in most fresh water systems). Second, this is a monitoring study, with a focus on long terms trends. If P continues to be applied to some of the watershed's agricultural soils at a rate that exceeds crop uptake, at some point in the future we expect P concentrations will exceed the soil's storage capacity and we will begin to detect elevated P in those areas. In addition, as the basin's population increases, P from septic fields (even good ones) and sewage treatment will likely become more evident in the Cacapon's surface waters. Third, our other studies include a storm sampling component — during storms P does move readily from the land into our rivers.

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Glossary

Concentration *is the amount of a substance in a certain volume of water. Chemical concentrations are often expressed as parts per million (ppm) or milligrams per liter (mg/L).* ***Fecal coliform bacteria*** *are counted as colony forming units (cfu's) per 100 milliliters*

Integrated agriculture*: is the vertical organizational structure in which a company, such as the poultry producer Wampler Foods, provides birds, feed, medicine and production practices, and contractors, who own poultry houses, serve as the second tier and raise the birds or eggs for delivery back to the company. The presence of a large poultry industry and the manure (fertilizer) it generates often increases the intensity of other agriculture*

Non point source pollution *occurs anywhere precipitation and snowmelt can wash pollutants from the land into a river, as opposed to point source pollution which flows through a pipe. The flow of pollutants from non point sources to streams mostly occurs during and immediately following large storms and, unlike point sources, is neither constant nor predictable. In addition, much of the pollutant load that washes into a stream during a storm either rushes on downstream or gradually drops out of the water column to collect on the river bottom. This makes non point source pollution difficult to study.*

A ***Watershed*** *is the area of land that water flows across or under on its way to a single river. In the Cacapon River watershed, water flows down from various mountain ridges into the Cacapon River basin. The Cacapon River watershed is made up of many smaller watersheds, including those of the Lost River and the North River.*

Map of the project area on the website. Sampling sites indicated by triangles.

The Cacapon and Lost Rivers Land Trust

What is a conservation easement? A conservation easement is a voluntary legal agreement between a landowner and a land trust that sets limits – that have been requested by the landowner — on the uses of the land to permanently protect conservation, historic, agricultural and/or scenic values. The ownership of the land does not change. The land trust holds only the easement and the right to enforce its restrictions. An easement may, for example, limit subdivision, prohibit development, protect riparian zones or preserve productive farmland.

Director's Note: Cacapon Institute has worked for years to document the unique qualities of the Cacapon River watershed and has a long-standing interest in voluntary protection of land in the river corridor. In 1996 we held a public workshop on conservation easements at our first Riverfest. The main speaker at that workshop was Nathalie Black, one of the founders of the Cacapon and Lost Rivers Land Trust (the Trust) and a long time friend of Cacapon Institute. We are pleased to profile the Trust, an organization we believe provides an essential service to the Cacapon watershed.

The Cacapon and Lost Rivers Land Trust is a 501(c)3 corporation formed in 1990, by a group of Cacapon River landowners, to protect the rural nature of the land and water quality in the Cacapon watershed. Spurred by the lack of effective comprehensive land use planning in the region, these people sought a private sector means through conservation and agricultural easements for landowners to voluntarily and permanently prevent unwanted subdivision and development of their property, while retaining ownership and the right to sell the land or transfer the property to heirs. The Trust assists property owners in permanently protecting the natural assets of their land by accepting and defending voluntary donations of conservation or agricultural easements.

In 1999, believing that the river and rural lifestyles of the area cannot be protected if the surrounding land is not, the Trust extended its area of emphasis to the entire Cacapon watershed, which includes parts of Hardy, Hampshire and Morgan Counties. The Trust has worked with local and national organizations to become familiar with the role land trusts can play in protecting land from unwanted development. The Trust is in the process of developing a brochure and mailing to area landowners to expand its membership and support base.

The Trust now holds two easements on over 250 acres of land. Two more easements totaling over 600 acres are being prepared now and another two easements are pending that will protect another 550 acres. In December of 1999, the Trust and Cacapon Institute jointly received a donation of 54 acres of picturesque riverfront property along the Cacapon River. More information on this will be provided in the next issue of *Cacapon*. The Trust enthusiastically embraces the opportunity to serve landowners and the community by accepting easements and by working with developers, realtors, attorneys, tax professionals, farmers, and landowners to protect the quality of life in this watershed. The Cacapon and Lost Rivers Land Trust is a unifying force for permanently protecting the rural nature and quality of life in this valley, as we grow to meet the future.

For more information about the CACAPON AND LOST RIVERS LAND TRUST contact David Warner, (304) 496-8733 or Nancy Ailes at (304) 856-3911.

Did You Know...

- Of all water on earth, 97% is salty. About 2% of all Earth's water is frozen in the polar ice caps, glaciers, and icebergs. Only about 1% of all water on earth is fresh and liquid. Nearly all the fresh water we use comes from rivers, lakes, and groundwater.
- The average person uses about 100 gallons of water every day.
- Use of water: 52% industry, 41% crop irrigation, home use 7%.
- It takes 115 gallons of water to grow the wheat for one loaf of bread.

Board Member Reuben Robertson Passes Away

Long-time Board of Director's member Reuben Robertson passed away January 4th after a brief illness. Reuben, of Washington DC and High View, WV, was a lawyer who had previously served as Vice Chairman of the Institute's Board of Directors and was a major supporter of the Institute's work over many years.

Reuben had a deep love for West Virginia, especially for the Cacapon River and his family's cabin at Foxes Den, which overlooks the river. He is survived by his wife Victoria, his daughters Laura, Hope, Margaret and Cynthia, and by eight brothers and sisters. Reuben's wise counsel and good humor will be sorely missed by his many friends.

On The Web

Yes, its true. CI finally has a website at www.cacaponinstitute.org. The website came to fruition with funding from the Norcross Wildlife Foundation for computer equipment and software and The MARPAT Foundation, Inc. for staff costs. We'd like to especially thank one of our members, Andy Forbes. Andy, a professional web designer, generously donated his time and energy to setting up our website, and even came out to the lab for a day and trained Nicole and Peter. He's currently acting as our advisor.

Check out the website and let us know what you think! Please feel free to send us comments or suggestions about the site to our resident webmasters, Nicole and Peter. Also, if anyone has any great pictures of the Cacapon we could post on our website, let us know!

Supplies/Donations requested:

- **horizontal autoclave**
- **reliable auto for field work**

Cacapon Institute

YES, I want to be a member of Cacapon Institute and help keep the Lost/Cacapon a place my family and I can enjoy.

☐ $35 Individual Membership ☐ $60 Family Membership ☐ $100 Sustainer ☐ Other

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Expiration date:_____ **Signature**_____

All members receive two newsletters a year and occasional alerts.
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Spotlight on Rare and Endangered Species

Harperella

Harperella (*Ptillimnium nodosum*) is a wildflower so rare it is found in only 10 places in the world. In West Virginia it is only found along the Cacapon River and some sections of Sleepy Creek and Back Creek. The plant, which looks a bit like a small Queen Anne's Lace with small white flowers and quill-like leaves, grows on gravel bars, islands and the river's shores. Not much is known about the biology of this plant. However, it's possible that Harperella may have medicinal properties, since many other species in the same plant family (such as hemlock) do.

The WV Division of Natural Resources (WVDNR) reported that Harperella populations and habitat took a beating during the 1996 floods — stem counts went from 10,000 before the flood to 33 after (John Beckman, WVDNR, personal communication). However, WVDNR is optimistic about Harperella's return because the gravel bars that were washed out by the 1996 floods and which are Harperella's main habitat are slowly building back up. Hopefully, we'll see more of Harperella soon.

The Lost/Cacapon River Watershed contains almost 100 rare species of plants and animals. These include organisms with such colorful names as the kidneyleaf mud-plantain, candy's mountain lover, silver nail-wort, West Virginia blind cave millipede, and the mountain pimpernel. We plan to periodically bring you articles that focus on a rare species found in the watershed.