SCIENCE

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NOTEBOOK

The perils of polar ice

Recent dramatic changes in the behavior of Antarctic glaciers are causing concern among scientists who believe that part of the continent's ice sheet may collapse, spewing so much ice into the ocean that sea levels around the world could suddenly rise by as much as 20 feet.

Scientists have worried for years that global warming might cause part of the Antarctic ice cap, the world's largest, to melt. But in a report issued recently by the National Science Foundation, a diverse panel of experts presents data showing that the stability of the ice cap could prove to be a more catastrophic problem.

The report notes that the flow of two major ice streams — massive rivers of ice 300 miles long and 50 miles wide that feed the West Antarctic ice sheet — have been disrupted over the last decade. Scientists believe that as the ice streams slow and the sheet itself begins to recede, the stability of the entire ice cap may begin to break down.

The panelists were unable to predict how soon the change may take place, or even whether it will. Nor is it clear whether the recent trend of global warming is anymore to blame than what's taken place since the end of the last ice age thousands of years ago. But scientists view the threat from the ice cap as serious.

The inherited wheeze

If your spring rushes in with a wheeze, wheeze, sniffle and sneeze, you can probably blame your genes.

A Johns Hopkins University researcher has identified two inherited proteins that can trigger an allergic reaction to ragweed. The proteins are members of a family of genetically dictated molecules called the "major histocompatibility complex," which determines each person's individual tissue type.

The proteins, found on the surface of some people's cells,

ROB MARVIN

Fred Bierlmaier, forest technician with the U.S. Forest Service, measures snow pack in the Andrews

CASCADES RUNOFF

STUDYING THE EFFECTS

☐ Two scientists plot the ways snow, rain and soils interact to produce flooding

By ROB MARVIN
Special writer, The Oregonian

Somewhere on the way to the ski slopes, drivers leave the rainy valley and enter the realm of snow. But in between lies a stretch of mountain high enough for snow and low enough for rain.

Hydrologists call it the "transient snow zone." It covers about a fifth of the Northwest's forests and has been the source of Oregon's worst floods.

Gordon Grant and Dennis Harr, U.S. Forest Service hydrologists, are studying the zone to learn how water moves through the forest.

Harr, also on the University of Washington faculty, studies the life cycle of a speck of moisture as it travels from the clouds to the streams, focusing on why rain often melts snowpacks into a flood of water. It takes more than rain, because rain alone lacks the heat to melt a snowpack. Other sources of heat are needed to warm the snow, and Harr wants to know what they are.

Harr's work in the 1980s showed that clear-cutting of timber increased the runoff from melting snow. His research helped lead to new restrictions on logging in the transient snow zone.

Working with him is Grant, who is on the Oregon State University faculty. Grant studies why rivers act as they do and how human activity affects them.

In the woods and on the computer, they trace the life history of a snowflake.

Snow falls as small, six-pointed stars. As they accumulate and mature, snowflakes lose their tiny tips. The spiny flakes become granular and evolve into a snowpack that may be yards thick.

As soon as it falls, the snow begins picking up heat until it "ripens" at 32 degrees Fahrenheit, the threshold of melting.

Using instruments and time-lapse photography, Harr records how fast the snow disappears and calculates how much heat is needed to melt it. By looking at changes in snowpack conditions, humidity, air temperature and wind speed, he can calculate where the heat comes from.

Snow picks up some of its heat from infrared radiation from the air, trees and clouds. That is the long-wave radiation that, coming off buildings and pavement, makes a city hot on a summer day while the countryside is cool. But most of the heat in the snow comes from moisture that condenses when snow chills the warmer air.

Condensation puts more heat into the snow than a warm rain does.

ger an allergic reaction to ragweed. The proteins are members of a family of genetically dictated molecules called the "major histocompatibility complex," which determines each person's individual tissue type.

The proteins, found on the surface of some people's cells, act as receptors, tiny chemical portals that are able to recognize and lock on to another protein, called an allergen, found in ragweed pollen, says researcher Shau-Ku Huang.

When a person who has inherited one of the proteins is exposed to ragweed, specialized blood cells called macrophages carry the receptor and are able to pick up the allergen and "present" it to other immune-system cells, triggering an allergic reaction.

Those who have not inherited either of the proteins will probably never develop the allergy, Huang said.

Improving the egg

Researchers have found they can lower the cholesterol content of eggs by feeding hens a drug commonly prescribed for humans with high cholesterol.

The drug, lovastatin, blocks the activity of an enzyme involved in cholesterol synthesis. Robert Elkin and John Rogler of Purdue University found that when lovastatin was added to feed, the hens produced eggs with 13 percent to 15 percent less cholesterol.

The drug, marketed under the name Mevacor, costs about $80 a gram at a pharmacy, making it too expensive to be used by the egg industry. But the results raise the possibility that similar, less expensive compounds may be developed.

The drug has no adverse effects on the hen's health, on the number of eggs produced or on the size of the egg or yolk.

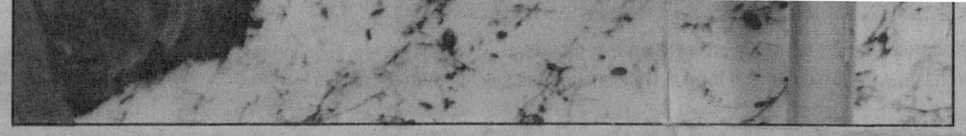
Motoring to the future

Using recent advances in high-temperature superconductor technology, engineers have built a model electric motor using a coil made of a superconducting ceramic.

Engineers at the Argonne National Laboratory in Illinois and the Reliance Electric Co. in Cleveland believe the device is the first electric motor built around a superconducting coil.

Although the motor, about the size of a paperback and able to generate just 10 watts of power, is not commercially viable, scientists believe it portends a future in which huge electric motors would have superconducting coils.

— From staff and wire reports



ROB MARVIN

Fred Bierlmaier, forest technician with the U.S. Forest Service, measures snow pack in the Andrews Experimental Forest west of the Three Sisters. After collecting snow in the tube, he will weigh it to measure the amount of water the snow contains.

ber increased the runoff from melting snow. His research helped lead to new restrictions on logging in the transient snow zone.

Working with him is Grant,

Rob Marvin is a free-lance science writer and photographer based in Eugene.

But most of the heat in the snow comes from moisture that condenses when snow chills the warmer air.

Condensation puts more heat into the snow than a warm rain does.

Please turn to SNOW, Page C2

Trees squeeze water from low-flying clouds

By ROB MARVIN
Special writer, The Oregonian

Trees draw moisture from the soil, using water that could otherwise go into Portland's water supply from the Bull Run Watershed.

Clear-cutting the watershed's timber in the Cascades east of Portland could provide residents with an extra sip, except that the trees also snatch water from the clouds.

The trees cause an additional 35 inches of precipitation a year.

The bonus 35 inches comes from "fog drip," one of the little surprises hydrologists run into as they probe water cycles in the Cascades.

What started as a simple question is full of unpredictable unknowns. Working to make these unknowns more predictable is Gordon Grant, research hydrologist with the U.S. Forest Service in Corvallis. He is helping adapt a U.S. Geological Survey computer model to trace the flow of water through the forest.

Fog drip was first noticed by forest crews working in the Bull Run Watershed. On clear sunny days, they'd leave their rain gear behind, but under the Douglas firs they would get soaked. When they left the forest at the end of the day, they'd ask "How much did it rain?" When they looked at the rain gauge, it was empty, said

Rob Marvin is a free-lance science writer and photographer based in Eugene.

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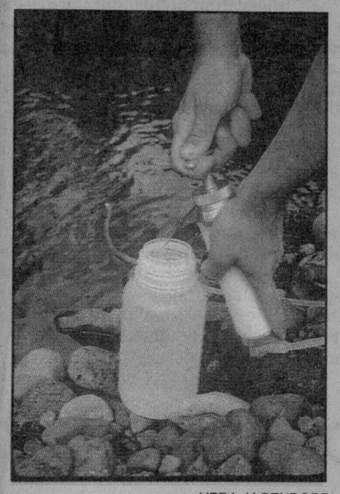


VERA JAGENDORF

A Cascades hiker uses a Katadyn filter to make stream water purer. Filters such as the Katadyn force water through a filtration unit, which removes the giardia parasite and other impurities.

Cold, clear streams carry nasty parasite

By RICHARD A. LOVETT
Special writer, The Oregonian

There was a time when Oregon campers and hunters freely dipped their cups into cold, clear mountain streams for a refreshing drink.

No so today.

Indulging in this practice may result in stomach cramps, nausea and diarrhea, along with heartburn and a bloated feeling. More than 1,000 Oregonians a year catch giardiasis, an intestinal malady caused by the single-celled parasite *Giardia lamblia.*

Richard A. Lovett is a free-lance science writer based in Portland.

"There is no way of knowing precisely what proportion of the reported cases are acquired by drinking untreated surface water," said Dr. David Fleming, deputy state epidemiologist for the Oregon Health Division. "But the organism certainly is present in the Oregon backcountry, so we advise people who are going out in the woods to treat their water, regardless of how clean or pure the source looks."

Giardiasis is seldom life-threatening, but it can be a miserable experience, persisting for weeks without proper treatment. And it is a particular problem among campers,

Please turn to GIARDIA, Page C2

Medicare studies long-term home care for patients with Alzheimer's disease

☐ Caring for the patients eats energy and time, which means the project has trouble finding participants

By OZ HOPKINS KOGLIN
of The Oregonian staff

Alzheimer's disease is so emotionally overwhelming that researchers are having a hard time finding patients and caregivers for a national study on long-term care.

The federally funded Medicare Alzheimer's Disease Project is using the traditional scientific model — a treatment group weighed against a control group — to determine the kinds of services families need so they can take care of a relative at home. The government wants to know whether home care for these patients would be cost-effective.

Medicare covers many acute care services for patients over the age of 65, but little or nothing for long-term care.

Alzheimer's disease, a progressive degenerative brain disease of unknown cause, strikes approximately 10 percent of Americans over the age of 65, and 47 percent of those 85 or older. An afflicted person can live many years before declining into physical illnesses. In the terminal stages, patients lose weight and have difficulty swallowing, controlling bladder and bowel function, walking and speaking. Victims often die of repeated infections or pneumonia.

Poppy A. Warren directs the three-year, $3.5 million project at Good Samaritan Hospital & Medical Center, one of eight study sites in the country. She said the project represents the first national effort to study Alzheimer's disease and other dementias, with family caregivers, as well as people who have the disease.

"There is a blatant need out there for things like adult day care and respite and in-home services, and much of that is not reimbursed by anything other than out of pocket," Warren said.

Mentally disoriented Alzheimer's patients require a lot of care, which often makes caregivers feel forced to

Please turn to ALZHEIMER'S, Page C3

The Oregonian/KRAIG SCATTARELLA

Elmer Brown, a retired policeman, serves tea to his wife of 45 years, Mildred, a retired teacher and librarian who was diagnosed as having Alzheimer's disease. They are participating in a study to determine whether home care for Alzheimer's patients is cost-effective.

CASCADES RUNOFF

Run river run: how water gets in the flow of things

By ELLEN MORRIS BISHOP

The raucous voices of spring's rushing mountain streams invoke thoughts of the perfect cast into a placid pool, of hooking trout in rocky riffles, of defying white-water rapids in frail canoes, or of hiking to the roar of hurried cascades.

But why are the pools, riffles, rapids and cascades there? What quirk of nature coaxed mountain streams into geological gymnastics on their endless journeys downward? Why not just one long, monstrously monotonous straight and narrow stream bed?

Gordon Grant and Fred Swanson, two researchers at the U.S. Forest Service's Pacific Northwest Research Station in Corvallis, along with M. Gordon Wolman of Johns Hopkins University, have figured it out.

Ellen Morris Bishop is a consulting geologist who also teaches geology for Central Oregon Community College, Community Education. Letters can be addressed to her at Route 1, Box 248, Terrebonne, Ore. 97760.

TIME TRAVEL

They studied two major, fast-flowing streams in the Cascades' McKenzie River drainage. Rough, rugged, and unharassed by man, French Pete Creek flows through the western prong of Three Sisters Wilderness into Cougar Reservoir. Its waters plummet 3,200 feet downward in its nine-mile length. Fourteen miles to the north, Lookout Creek rushes through the H.J. Andrews Experimental Forest, tumbling 4,000 feet downward in a little less than 10 miles. These two streams are typical not only of the steep creeks of the Cascades, but of streams in mountain terrain worldwide.

The words "pools," "riffles," "rapids" and "cascades" form powerful and poetic images in our minds. But they have precise geological definitions, too.

"Pools" are areas of slow, tranquil water with few boulders exposed at low flow. As trout and bass well know, there is commonly a fast-flowing waterfall at their deep upper end and much shallower water at their outlet.

"Riffles" are generally places where water flows faster over an irregular, rock-strewn bottom. In technical terms, that translates to "areas of subcritical flow modified by local free-surface instabilities and small hydraulic jumps over bed roughness elements."

"Rapids" are rougher yet. They are more perilous to canoeists because in rapids, boulders are aligned into "ribs" across much of the channel blocking the easy passage of water — and canoes. And the velocity of the water is, obviously, rapid.

Finally in this litany of stream-flow terminology there are "cascades." Not the mountains, but steep channel areas where water flows over large boulders in a series of well-defined steps. Cascades often have a stair-step appearance, and there are two types: one in which boulders create the "steps" and the other with "steps" carved out of bedrock.

Several factors combine to determine what form a mountain stream's channel will take, according to Grant and his colleagues.

Perhaps the most obvious of these is the slope or steepness of the stream. Pools occur where the channel is flattest, usually dropping less than 6 inches in 100 feet. Riffles are found in channels that drop about 1 foot per 100 feet; rapids fall about 3 feet in 100. Cascades develop where the channel is steepest, plunging an average of 5.5 feet for every 100 feet of channel length.

But rather than hurrying downhill at constant slope, mountain streams alternate frenetic falls and placid interludes. More specifically, their steepest stretches are composed of alternating cascades and pools, with the cascade segments longer and the pools shorter as the stream gradient steepens. Generally, cascade segments of the channel are 2 to 4 times as long as the channel is wide. Riffles and rapids occur where stream gradients are, overall, less precipitous.

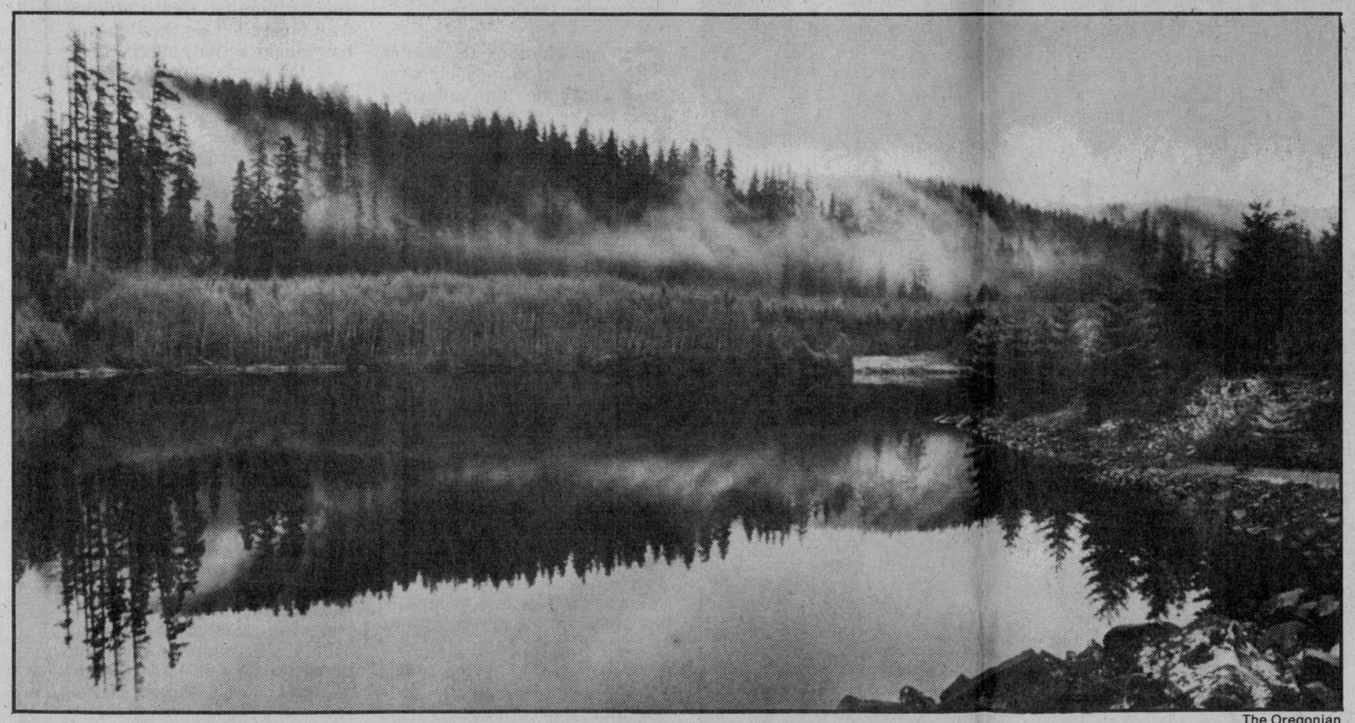
A careful look at stream bottoms and stream banks shows a difference in the material that cascades or riffles or rapids must flow through and transport. The cascade-pool sequence are often found in rougher country where the mountain creek has steep side slopes that periodically deliver large rocks and vast quantities of debris or must negotiate stream-blocking landslides. Riffles and rapids, on the other hand, seem to flow through areas with flatter or more forested side-slopes where little coarse debris enters the channel.

Exactly why the cascade-pool sequences form is not clearly understood. The most plausible hypothesis, according to Grant, Swanson and Wolman, is that streams sort their load of rocks and sand longitudinally into segments of fine material — riffles and rapids — and more congested segments of boulders — cascades and pools. According to this model, the stream segments should migrate downstream with time.

The character of each segment may also be influenced by such catastrophic changes as landslides, filling the channel, or clear-cutting, which allows more sediment and debris to reach the stream.

Major storms are the principal reorganizers of stream channels. High flow rates and high energy may resculpt the stream bed, changing riffles to rapids, and rapids to cascades, changing stream gradient locally, providing new pools as respites for rushing waters. Such storms occur theoretically every 50 years — or, more accurately, there is a one-in-50 chance of this magnitude of storm each year. Lesser tempests, according to Grant and his colleagues, have little influence on overall channel form.

So there is a lot to think about and a lot to learn while venturing along a mountain stream, for these energetic mountain streams carry well-sorted loads. They make major changes only at the bidding of great storms. And they alternate fast with slow, interweaving riffles and rapids and pools and cascades, adding an orderly variety to their journey.



The Oregonian

Trees in the Bull Run Watershed provide an additional 35 inches of precipitation a year by wringing water from low clouds.

Trees: Loggers get rained on despite sun

Giardia: Hikers, campers can feel weeks of misery

■Continued from Page C1

hunters and hikers, who often rely on untreated mountain streams for their drinking water.

Giardia spreads through contaminated water supplies and unsanitary food handling, both of which can be problems on camping vacations. A dormant form of the parasite — referred to as a cyst — is excreted in the feces of infected individuals and can survive for months in even the coldest and seemingly purest mountain stream water.

When someone drinks that water, the cyst becomes active, thriving in the small intestine. A hundred cysts — possibly as few as 10 — may be enough for an infection, sending the victim running for the nearest toilet. The incubation period varies widely but is usually seven to 10 days, making it difficult to trace the exact source of contamination.

Giardia can also be spread through contaminated food, either if the food-handler fails to wash his or

Although giardia is a relatively new concern among backpackers, there is no indication that the illness itself is new. Instead, there are indications that some of Oregon's pioneers knew of the ailment as "beaver fever."

Fleming said that until recently it had not been more widely recognized because of its long incubation period and the fact that the infection is one that even without treatment will generally resolve on its own. "As far as I know," he said, "giardia's been there all along. What is different is that it has been increasingly recognized."

There are a number of ways for campers and hikers to protect themselves against giardia. On short trips, it may be best simply to carry water from a known source. On longer trips where that is impractical, water must be treated where it is found. Adequate treatment techniques include boiling, chemical treatment and filtration.

The Oregonian

Trees in the Bull Run Watershed provide an additional 35 inches of precipitation a year by wringing water from low clouds.

Trees: Loggers get rained on despite sun

■Continued from Page C1

research hydrologist Dennis Harr of the U.S. Forest Service in Seattle.

Harr, then with the Forest Service in Corvallis, guessed the forest was wringing the "rain" from the clouds as they blew through the trees. To find out, he put troughs in open clear-cuts and in the forest. In a study costing taxpayers $372, Harr learned that the mature trees were snagging a big portion of Portland's water supply.

Fog drip, or as some might say, low-flying-cloud drip, is the forest's way of getting water that doesn't fall as rain.

The fog involved is not the ground fog that hugs streams and hangs on the Willamette Valley floor. Rather, fog drip comes from the bottom of narrow gray stratus clouds 500 to 1,000 feet thick. Southwest winds concentrate fog in the upper basin for Bull Run's rich fog drip.

Bull Run has everything it needs for fog drip: wind, moisture, and plenty of fir needles for the fog to crash into.

Both fog and clouds are made of microscopic droplets. In rain clouds, embryonic raindrops have been "twirled and swirled, rolled and aggregated," Grant said. As the drops get physically mashed together, they grow until the drops are too heavy for the upward air currents to keep them aloft. The result is rain.

In the forest, embryonic droplets crash into needles instead of each other.

As winds drag a cloud through the forest, the needles skim water out of the cloud. The size of the tree is important. If trees are large and the forest dense, a droplet of water has little chance of making it through miles of trees without hitting one, Harr said.

Needles provide the kind of nucleation points a droplet needs to turn it into a raindrop, much as an oyster needs a grain of sand to make a pearl.

The bonus moisture is a boon for plants and animals needing the 121 inches of water a year in the Bull Run Watershed. Without the extra water, Harr said, some of these species may become endangered. Species most affected may be in the drier marginal areas where forests meet the grasslands, where there is barely enough water to go around.

Coastal species are also vulnerable. The coast is a major beneficiary of fog drip, especially in the otherwise dry summer.

Deforestation in fog zones can reduce summer precipitation in the dry season when rainfall is needed the most. But man's meddling can work both ways.

In the deserts of Peru, which haven't seen rain in 30 years, people have hung old cargo nets on posts and planted trees beneath them. The nets, once used to load ships, comb enough moisture from the air to water the trees. When the trees grew large enough to catch their own moisture, the nets were removed. Now, said Harr, the Peruvian desert has a small forest sustaining itself on its own fog drip.

And what does hydrologist Grant know from all this?

"The single answer is that there is no single answer," he said. "The more you know, the more you need to find out."

Snow: Forests can prolong runoff, halt flood

■Continued from Page C1

It takes a whopping amount of heat to evaporate or boil water. The vapor stores the heat, and when the drop condenses, all that heat is given off. A drop of condensation provides many times more heat than a drop of rain. Even in a 2-inch rain, the little bit of condensation provides up to three times more heat than the rain itself.

Wind brings heat to the snow. It swirls in little eddies, recycling the vapor again and again against the snow. With every little eddy more water is condensed and more snow is heated.

Harr has found the best way to keep the snow from the wind and to keep it cool is to keep it in the forest.

As back-country hikers know, exposed areas are windier than sheltered ones. Forests stop the wind and catch snow in their branches. With the trees gone, clear-cuts not only collect more snow to melt, but the snow melts 10 percent to 40 percent faster, Grant said.

Forests prolong the runoff by only a few days, seldom more than a week, but stretching out the runoff even a few days can stop a flood, Grant said. Rivers flood when too much snow melts all at the same time.

In most years, snow falls down to around the 1,200-to-1,500-foot elevation and can alternate with rains falling up to the 4,500-foot elevation, Grant said. The zones of rain and snow overlap by about 3,000 feet.

But in 1964 a Pacific front spun storm after storm into the Northwest. Snow fell clear down to sea level, and snowpacks built up in the mountains. Next, clouds dumped 20 inches of rain up to the 10,000-foot elevation in air warmed to shirt-sleeve weather. Snow turned to water, causing serious flooding in Oregon and Northern California and as far east as Idaho and western Nevada.

This winter the Willamette Valley was fortunate.

As in the storms of 1964, a warm air mass stalled over the Northwest in early January. Rain fell high in the mountains and especially along the coast, and winds tore trees from the ground. But this year things were different. It hadn't snowed yet.

The late arrival of snow was hard on the ski resorts, but it was the salvation of the valley, Grant said. If the Cascades had been building snowpack since Thanksgiving, the rain would have flushed all that moisture into the valley below.

Rain on snowpack can cause more than flooding. The sudden melting of snow can saturate the soil, soaking it faster than water can seep through it. Once saturated, the soil can slip off the mountains in landslides.

On the basis of Harr's work, the Forest Service had adopted recommendations by the mid-1980s to protect forests in the transient snow zone.

Today, there is an effort to keep 75 percent of the land within a watershed forested with trees at least 25 to 35 years old, said Michelle McSwain, zone hydrologist for the Willamette National Forest. By that age, the trees are large enough to shield the ground.

Rather than following a rigid 75 percent, the question is "How fast does water move through the soils, and how stable are the channels?" she said.

If the transient snow zone is too heavily clear-cut, a storm of the size that comes along every five or 10 years can damage the stream channels as well as cause flooding, McSwain said.

Rapidly moving water can erode the channels and cloud the streams with sediments. Channel sides can be sloughed off. Channels once rich in pools, riffles and backwaters wind up straight, "almost as though a Cat had gone down and straightened a channel out," she said. When that happens, gravel beds needed for fish spawning can be washed away or clogged with silt.

McSwain said that the 75 percent figure was a recommendation, not a rule, and that limiting the cut was up to the discretion of the district rangers. Stable watersheds with channels cut in bedrock can tolerate somewhat higher cutting.

Grant acknowledged that the 75 percent rule was based on rough approximations. Once completed, a computer model should help the Forest Service fine-tune its policies on timber sales and logging.

Both Grant and Harr are working with researchers from the U.S. Geological Survey to build a computer model to analyze relationships between land use, stream flow and channel behavior. They will use the computer model to experiment with alternative patterns of cutting and their effects on high and low stream flow. Grant will use the model to predict how logging affects flooding.

The model is important because there is no such thing as a generic forest. Subtle changes in slope, soils, vegetation and hundreds of other characteristics distinguish one plot of forest from another. They shape a forest as clearly as small changes in noses and eyes distinguish one face from another.

One curious thing Grant has found is that selective clear-cutting may help prevent floods as well as cause them.

Grant said that every time it rains or snowpacks melt, water runs off the hill into a series of ever-larger streams. The streamflows build up into a torrent, or peak, and then die down again.

Basins and valleys are made up of thousands of little watersheds, each with its own little streams. The size of a flood is partly determined by the timing of the peaks on all the streams relative to each other, Grant said. Streams draining clear-cuts peak sooner, and the peaks may be larger than on streams draining forested land.

But what if forests could be cut so the streams could crest at different times when they hit the river? If that could be done, Grant believes flooding could be reduced.

One purpose of the computer model is to look at the complex combinations of soils, slopes and streams and predict how different patterns of clear-cutting will affect the timing of peaks.

"In the face of that complexity, I think we have to proceed with a certain amount of humility in the way we use our forests," Grant said.

victim running for the nearest toilet. The incubation period varies widely but is usually seven to 10 days, making it difficult to trace the exact source of contamination.

Giardia can also be spread through contaminated food, either if the food-handler fails to wash his or her hands, or if the food is rinsed in polluted water. People who swim in contaminated water are also at risk, but the most common source of backcountry infection is probably untreated drinking water.

Since giardia affects animals as well as humans, it isn't safe to drink directly from any mountain stream. Even if there is no human contamination, there is always the danger of infected rodents, including beavers, rats, and mice, and probably marmots and picas as well. In fact, giardia is so non-specific that all animal species, including birds, must be regarded as potential carriers, and any water source can be contaminated.

A single careless backpacker — or a single infected beaver — can pollute an entire stream. According to some estimates, one stool from an infected human may contain enough giardia cysts to contaminate as many as 10 million gallons of water.

Furthermore, just because someone isn't ill, it doesn't mean that the person is unaffected. Many people may contract giardia without ever showing any symptoms, but these asymptomatic carriers may pollute the water just as thoroughly as people who are more obviously infected.

It's not yet clear how many people are giardia carriers. Various studies have identified the parasite in from 1 percent to 20 percent of the surveyed individuals, but none of these studies can be generalized to the population at large. What is clear is that there is a substantial number of asymptomatic carriers, perhaps as many as 10 of them for every individual who's obviously ill.

These carriers, along with animal carriers, assure that once giardia is established in a watershed, it will remain there.

For outdoor enthusiasts, this is bad news. Since giardia can survive in the coldest mountain waters, this means that hikers must even abandon the time-honored rule that if you can see the snowfield from which the water comes, it's probably safe.

"Why should people think that if they got to the snow, animals couldn't get higher?" said Dr. Ben Werner of the California Department of Health Services, which is also concerned about giardia. "And other people may have been there also."

"No matter how pristine, cold, or delicious the water may be," Werner continued, "the backpacker must accept the possibility that that water is contaminated, and take appropriate measures to protect himself."

selves against giardia. On short trips, it may be best simply to carry water from a known source. On longer trips where that is impractical, water must be treated where it is found. Adequate treatment techniques include boiling, chemical treatment and filtration.

Boiling is the most foolproof technique and is the one recommended by the National Park Service. Giardia cysts are well adapted for survival in cold mountain streams, but they cannot tolerate heat, dying almost immediately at temperatures as low as 175 degrees Fahrenheit. Nevertheless, the Park Service recommends bringing the water to a full boil anyway, since that provides an adequate margin of safety and does not require the use of a thermometer.

The sterilized water should not be returned to a possibly contaminated cup or canteen. Because the infectious dose of giardia is small, only a few drops of contaminated water may suffice to undo treatment efforts.

Chemical treatment is simpler than boiling and does not require the use of large amounts of fuel.

Commercial chemical tablets that claim to kill giardia and other microorganisms are inexpensive, but the effectiveness of such tablets depends on the temperature and acidity of the water. Cold water, such as is likely to be found in mountain streams, generally requires more tablets than the normal dosages, but it can be difficult to determine what dosage is appropriate.

One solution is to lengthen the treatment period suggested by the manufacturer, letting the water stand overnight instead of merely for the 15 or 20 minutes usually recommended. Another possibility might be to let the water warm up before treating it. Neither of these solutions will be feasible under all circumstances, however.

One product, called Polar Pure, consists of a thermometer, a small bottle containing iodine crystals, and instruction sheets telling how to make iodine solution and how many capfuls of it to use at various temperatures.

Filtration may be the best form of treatment, combining simplicity and effectiveness. And unlike chemical treatment, it allows the water to retain its natural taste.

Although at least three brands of filters commonly are found on the market, all of them work on the same basic principle: a plastic tube — or in one case, the filter itself — draws water from the creek, while a plunger simultaneously provides suction and forces the water through the filtration unit. Another tube or a spout allows the user to direct the purified water into a container.

In the process, the water is forced to pass through a filter whose pore size is smaller than a giardia cyst.