

Lee Graham, an ecologist in the School of Renewable Natural Resources who works with ART, has a project with implications for the future of the entire western United States. She is assisting the U.S. Fish and Wildlife Service to produce habitat relationship maps that may help preserve a diversity of wildlife and protect species that might be threatened or endangered during the next century.

"The Fish and Wildlife Service has taken tons of money to save a single species like the condor, and they still failed," Graham says. "Now they believe a lot of common species today are going to be extinct in another 50 years.

"Maybe a better use of our money would be to start preserving habitats."

The agency is compiling vegetation and wildlife habitat maps for 10 states, eight in the West. ART is compiling the Arizona data. Using map overlays, natural resource managers will be able to see the interrela-



Lee Graham and Robert Itami use their computer to derive a map from remote sensing and other data.

tionships of vegetation patterns and wildlife communities. They will be able to locate important ecological communities and existing preserves. The analyses will be repeated every 10 to 15 years, and maps will be archived by the National Ecology Research Center, in Fort Collins, Colo.

The many UA people working in ART agree that demand is increasing for the kinds of data and analysis they can produce. The GIS technology has become a powerful tool for solving complex, pressing human, social and environmental problems.

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Potential Problems of Treated Waste Water

BY MAGGY ZANGER

The desert Southwest is long on population growth and short on water supplies, so treated waste water is being used more and more. Potential hazards also are an increasing concern.

Norval A. Sinclair, the associate head of The University of Arizona's department of microbiology and immunology, and Patricia Rusin, his former graduate student, have checked potential contamination. They were interested in whether antibiotic-resistant fecal coliforms could grow, survive, and compete with other bacteria in effluent (treated waste water).

Fecal coliforms are bacteria normally found in the intestinal tract; they get into waste water through the sewage system. Multiple antibiotic-resistant (MAR) coliforms are bacteria that do not respond to antibiotic treatment. Disease-causing bac-



Norval Sinclair

teria, such as Salmonella and Shigella also are in the intestinal tract if transferred there from feces or contaminated food, such as eggs. The diseases normally are treated with antibiotics, but antibiotic-resistant bacteria can reduce drug effectiveness, Sinclair says.

It's a growing health problem because the ability to resist such antibiotics as ampicillin and tetracycline transfers readily among bacteria.

If MAR fecal coliforms survive waste water treatment and get in effluent used to water parks and golf courses or in recreational ponds, it is possible that people will come into contact with them. If ingested, the bacteria could transfer antibiotic resistance to other bacteria in the intestinal tract, Sinclair says.

"What we're addressing here is a potential," Sinclair says. "It certainly is not a current problem. But it is a potential problem."

Rusin and Sinclair investigated fecal coliforms in effluent from Pima County's Ina Road Wastewater Treatment plant for the

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Selling Apples from Arizona

BY SUSAN M. KNIGHT

How do you choose apples? Do you look for Red Delicious or Granny Smith or the more exotic Gala? And why? Are you attracted by the taste, color, size, price, or the place they're grown?

Researchers in The University of Arizona's department of agricultural economics have been studying consumer behavior and market demand for apples, to help Arizona apple growers plan future production. The economists are analyzing consumer behavior and market demand, as well as the production side of growing apples.

The project responds to difficulties during the past decade with traditional crops, says economist Eric Monke. Market prices for cotton have not been strong and have declined over time. And cotton growers have less access to water.

The future of the federal government's commodity support programs also is questionable, Monke says. Farmers who've received government supports for growing selected crops may not be able to depend on that income in the future. Political and economic pressures to remove government supports from agriculture are stronger.

"If anything makes Arizona apples distinctly different, it's their higher sugar content from the sunshine."

As a result, Arizona's farmers are looking for alternatives to the traditional cotton and cereal crops.

Along with Monke, agricultural economists Russ Tronstad and Gary Thompson are studying the potential for switching from traditional to specialty crops in Arizona, particularly apples.

Apples, like cotton, need a lot of water. But growers can get a more high-value crop for their costs, Tronstad says.

Since the early 1980s, apple production has grown significantly in southeastern Arizona with more than 4,000 acres planted, compared to 1,000 acres in 1984. As Arizona's orchards have matured—usually in about five years—production has increased even more dramatically. The harvest of fresh and processed fruit is expected to reach 40 million pounds this year, compared with 25 million pounds last year, according to Arizona Agricultural Statistics Service in Phoenix.

The market for Arizona's apples should be good. The per capita consumption of apples has risen over the past two decades, Thompson says.

Treated Waste Water—Option or Problem?

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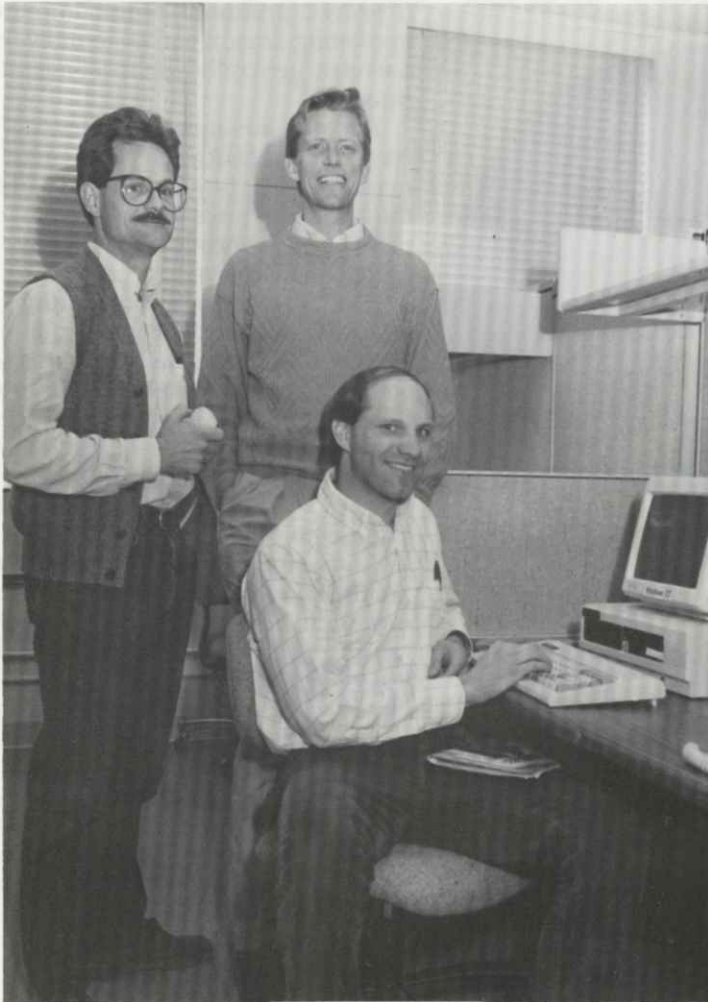
past three years. The plant discharges waste water, disinfected with chlorine, into the Santa Cruz River flowing north from Tucson. Eventually water from the river filters down to the underground water table. Unfortunately, chlorine-treated fecal coliforms become much more resistant to various antibiotics.

"Our results are statistically significant," Sinclair says. "When you chlorinate, you are going to increase the frequency of the antibiotic resistance of fecal coliforms significantly. No one really knows why this happens."

Effluent used to irrigate golf courses and parks is treated more thoroughly than water discharged into the Santa Cruz. After the first chlorination, the effluent is filtered to catch some viruses, bacteria and particulates, and then rechlorinated before going into the reuse system.

Sinclair says that this three-tiered treatment increases effluent quality and guards public health. Chlorination at high enough levels slows the growth of fecal coliform or kills it. By the time the water is ready for use again, it is relatively free of fecal organisms. However, those remaining are more apt to be resistant to antibiotics.

"The bottom line is close monitoring."



Gary Thompson (left), Eric Monke and Russ Tronstad (seated).

"The reason? More single-parent households and more two-income families. People have less and less time to prepare food. Fresh products become more attractive, because all you have to do is wash and eat them," Monke says.

The three economists have investigated the determination of apple prices by certain characteristics of the fruit and by the time of year the apples hit the market. They've considered apple size, grade (fancy, extra fancy, etc.) variety (Red Delicious vs. Granny Smith), origin (Washington, Michigan or New Zealand), and seasonality (when the apples come to market).

"Many wholesalers don't buy for taste. They buy for looks," Thompson says.

Size and grade are responsible for distinct and consistent price differences. Larger apples get a premium, compared to smaller apples. Apples from Willcox are down-graded because they don't have the same coloring as apples from Washington. They tend to be streaked from the effects of sunshine and temperature.

The variety and its origin are two characteristics that don't seem to be significant. Except for Granny Smith apples, variety does not have a distinct price premium, Monke says.

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If effluent is stored too long, the chlorine dissipates. When it declines to ineffective concentrations, these bacteria can grow quickly. They multiply from thousands to millions in just days. In addition, MAR coliforms maintain their ability to resist antibiotics for a long time, perhaps indefinitely. Effluent in storage must be closely monitored to make sure chlorine remains at a protective level.

Waste water discharged for eventual return to the water table can carry the resistant fecal coliforms with it, potentially polluting ground water. Contamination is a particular concern because Tucson and other municipalities use deep wells for

drinking water without further treatment. Sinclair believes contamination is potentially a problem for shallow wells but perhaps not for deep wells. The effluent would probably not filter down that far, he says.

Since arid regions will continue to look for ways to use limited water resources more efficiently, scientists must continue to investigate the obvious potential reused water has for spreading disease. The bottom line is close monitoring, Sinclair says.

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