United States
Environmental Protection
Agency

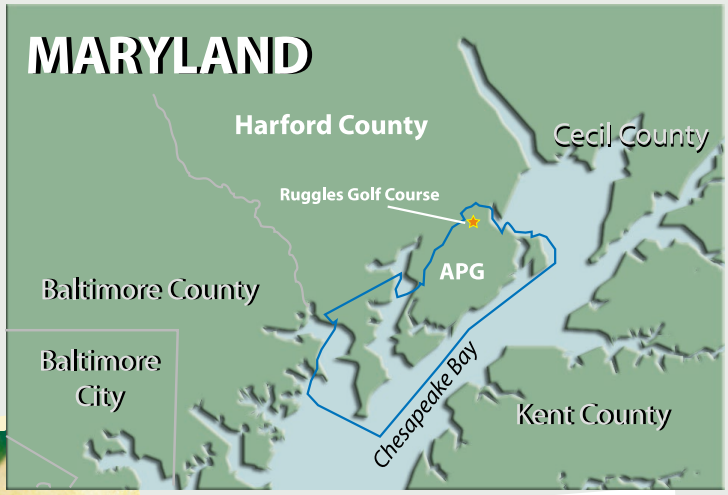
June Bugs Invade Links

Army Wins Battle, Loses War, Retreats, Finally Wins with New Tactics

June beetle larvae infested an Aberdeen Proving Ground golf course, severely damaging the turf. Applications of insecticide finally killed the larvae, but the resulting odor of decaying insects closed the course. Golf course managers needed a new approach.

Background

The reduction of risks from exposure to pests and pesticides continues as a major goal for pest management in the 21st Century. The Ruggles Golf Course, a military troop-support recreation facility funded without tax dollars, had a long-standing problem with green June beetle larvae. The larvae infested the fairways, greens, and driving range, leaving mounds of dirt and damaging the turf. In an attempt to avoid turf damage, golf course staff would spray the complete course with long-lasting (3-4 months) pesticides in May and June to disrupt the molting and development of the larvae during the summer and fall. Reapplication was often needed. Insecticides were applied to many areas of the course with inconsistent long term success. In the fall of 1995, intense spraying at the Ruggles Golf Course resulted in hundreds of thousands of dead larvae, which produced such an odor that the course was closed. The closure resulted in loss of revenue, bad publicity, and staffing changes.



Broadcast spraying of long-lasting pesticides is of concern due to their potential to leach into and contaminate groundwater. Due to the location of Ruggles Golf Course, there was also the potential of surface runoff carrying pesticides into Chesapeake Bay. The increased pesticide use hindered progress of the Army's Measure of Merit to reduce pesticide use by 50% between 1993 and 2000, and strained the course's budget. The application of long-lasting pesticides as preventive treatments violated the principles of Integrated Pest Management or IPM (minimization of pesticide use through careful evaluation). An innovative solution was needed quickly.

Implications

Beetles, Pesticides & Golf Courses

Green June beetles are known to be one of the top five insect pests on military golf courses and have been ranked as one of the most common golf course pests in the Eastern United States. Green June beetle larvae (grubs) kill the grass by eating its roots. Large patches of dead turf can be rolled up like a carpet, become unsightly, hinder play, and contribute to erosion. Because quality turf is essential to golf courses, managers apply hundreds of thousands of pounds of insecticides annually in an attempt to eradicate the larvae before and after burrowing begins. Golf course managers often apply pesticides over entire golf courses, not just on the high maintenance areas such as the greens and tees.

There are approximately 200 18-hole military golf courses in the United States; all operate with non-taxpayer funds. In the Army, golf courses are a $100 million business. They are very profitable and those profits often go to fund other military community outreach programs. Pest management requires significant use of pesticides and an ever-increasing annual expenditure for labor.

At Ruggles Golf Course, the cost of pesticides to treat the larvae was approximately $45/acre. It took several days to spray the infested area of the golf course. When pesticides are applied in the late summer or early fall (larvae are large at that time of year), the larvae come to the surface to die. The decomposing larvae emit a strong odor, attract gulls and songbirds (which can be poisoned by the chemicals in the larvae), and make the course unplayable. In 1995, this caused the Ruggles course to be closed for a week and reoccurring infestations continued to damage the turf and the course's finances.

New Methods Developed

The Army's Center for Health Promotion and Preventive Medicine, Entomological Sciences Program, has a mission to protect military personnel from diseases transmitted to humans from other living organisms (vector-borne) and to minimize the risk to human health and the environment from the use of pesticides. As part of this mission, they provided technical advice to Army installations. This program follows the concept of Integrated Pest Management (IPM), which is designed to provide long-term management of pests, not temporary eradication of them. IPM is the coordinated use of pest and environmental information with available pest control methods to prevent unacceptable levels of pest damage by the most economical means and with the least possible hazard to people, property, and the environment. Because pest problems are often symptomatic of ecological imbalances, the goal is to attempt to plan and manage ecosystems to prevent organisms from becoming pests. Critical to IPM is extensive knowledge of the timing of pest life cycles, methods to estimate damage thresholds, when remedial action must be taken, and availability of selective treatments.

GPS

consists of earth-orbiting satellites, ground stations, and a portable receiver (plane, ship, car, hand-held). The position of the receiver can be determined any time, anywhere, in any weather by knowing its distance from at least four of the satellites. The calculation of the position of the receiver is made possible by knowing the precise location of the satellites at any given time and how long it takes a radio signal to reach the receiver from each of the satellites. The position of the receiver is given in latitude, longitude, and altitude. The precise location of each satellite is determined in a similar manner using the stationary ground stations. New technology in the 1990s allowed affordable, accurate, hand-held GPS receivers to be developed.

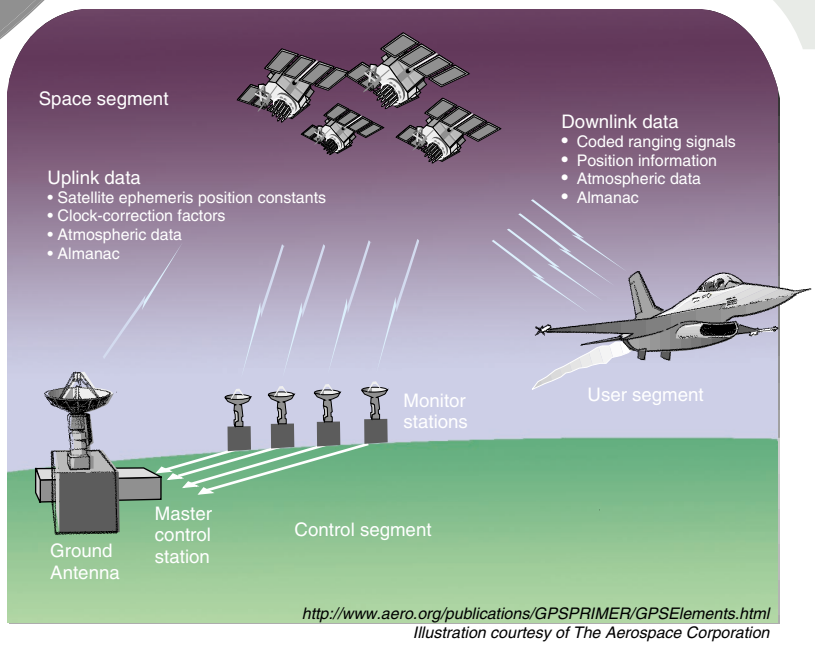


Illustration courtesy of The Aerospace Corporation

The Entomological Sciences Program has a long-term working relationship with the Agricultural Research Service (ARS) of the U.S. Department of Agriculture. Beginning in the 1970s, the ARS recommended identifying areas where pests live and breed at maximum concentrations and targeting those areas for treatment. This would greatly reduce the amount of pesticide necessary to control the pests, while also reducing the environmental impact. In the 1990s, the advancement of the global positioning system (GPS) and geographic information systems (GIS) provided ARS with a new technology to locate and map the areas with the highest concentrations of pests. In 1996 ARS received funding from the Strategic Environmental Research and Development Program (SERDP), a partnership between the Department of Defense (DoD), the Department of Energy, and the Environmental Protection Agency, to develop new software and conduct pilot projects using GPS and GIS to pinpoint concentrations of pests. In 1998 a partnership between the U.S. Army Environmental Center, the ARS, and the Strategic Environmental Research and Development Program was formed to test the new methods using GPS and GIS at several military sites. Army golf courses were some of the first of these sites. Agricultural Research Service used GPS and GIS to locate and map the areas with the highest concentrations of pests.

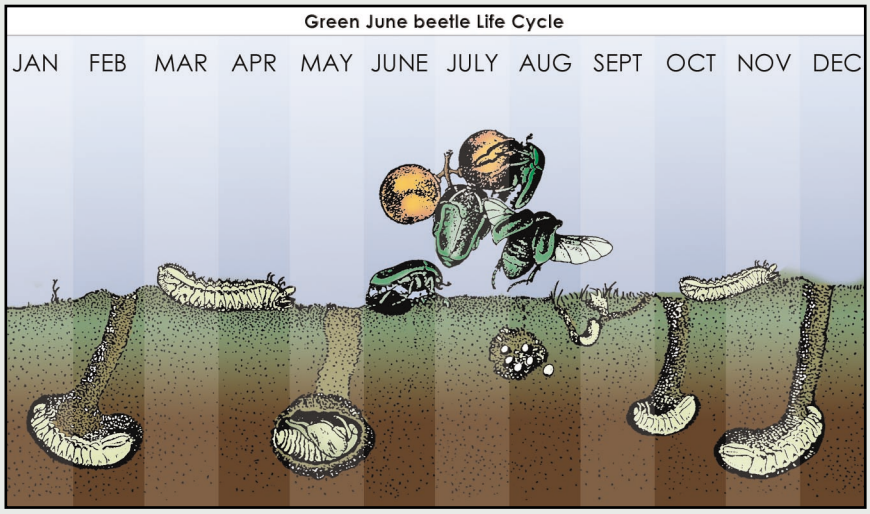


Illustration courtesy of: Alabama Cooperative Extension System (Alabama A&M and Auburn Universities)

Using an ArcView™ GIS platform, the ARS team developed Precision and Spatial Analysis software designed for field data collection, data visualization, and field application. Staff can locate concentrations of pests on the golf course using a coordinate system or a GPS and then record their location on a pen tablet or pocket PC. The software can then be used to produce maps pinpointing the location and contouring the density of the pests. Other data such as percent soil-moisture, soil type, land-use, plant type, and man-made features can be collected and produced as GIS layers. Staff can use the Precision Targeting and Spatial Analysis software to combine the additional GIS layers with the location of concentrations of pests for visual display on maps. These maps can then be used to target the precise locations of pest concentrations that need to be treated with pesticides. By targeting the areas to be treated, rather than a broadcast application of the complete golf course, the amount of pesticide used can be greatly reduced.

GIS *is a computer system capable of assembling, storing, manipulating, and displaying geographically referenced information, from many different sources, in many different forms. The primary requirement for the source data is that the locations for the variables are known. Location may be longitude, latitude, and elevation, ZIP codes, highway mile markers, or other grid systems. Any variable that can be located spatially can be fed into a GIS. Different kinds of data in map form can be entered into a GIS. A GIS can also convert existing digital information, which may not yet be in map form, into forms it can recognize and use. By storing data digitally, a GIS map can combine many layers of information. In the 1990s, powerful personal computers and software packages designed for the layperson have brought GIS from the realm of the researcher and government to a variety of businesses, local communities, and environmental organizations.*

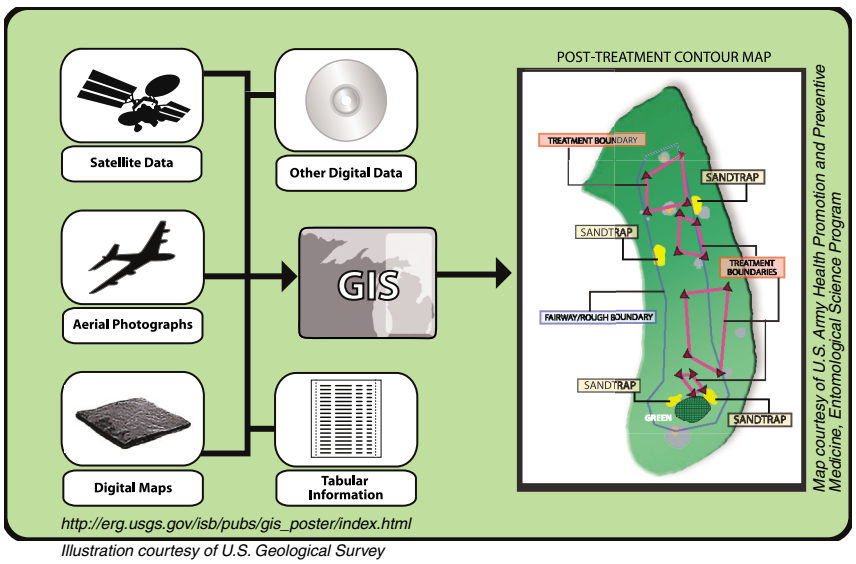


Illustration courtesy of U.S. Geological Survey

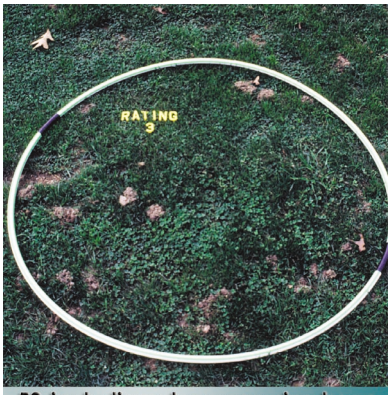
Pilot Test at Ruggles Golf Course

Using a military GPS receiver and a pen tablet for data entry, the researchers were successful in finding green June beetle larvae locations on several fairways on the golf course at Fort Meade. Researchers from the Entomological Science Program then used the Precision Targeting and Spatial Analysis software to map the locations where green June beetle larvae numbers exceeded treatment thresholds. The concept worked! The next step was to apply the technology to the pilot project at Ruggles Golf Course the following year.

The pilot project began in August 1999, after the larvae had molted several times. The larvae were 1.5 to 2 inches in length and tunneling/mounding activity was visible on the surface of the turf-grass. Using the military GPS and pen tablet, the researchers mapped the features of the course, including the fairway-rough interface, sand traps, sprinklers, and fairway distance markers. The 18th fairway was mapped in about four hours. Then the larvae infestations were mapped. To do this in a repeatable manner, a hoop (50 inch diameter) was placed over an area and the number of mounds within that circle were counted. The process was repeated over the entire fairway and surrounding roughs to obtain a density of larvae at each location. The area and density numbers were entered into the GPS system. Finally, a map of the golf course showing the beetle larvae density and locations was created. Boxes were drawn around the areas that were most heavily infested (equal to or exceeding six green June beetle larvae mounds per hoop). This amounted to about 20% of the fairway and surrounding rough. These areas were targeted for pesticide application. The map focused on key landmarks (fairway-rough interface, bunkers, distance markers, sprinklers), making it easier for a grounds keeper driving the sprayer to locate the areas to be sprayed.


Adult green June beetle

Courtesy of University of Georgia Archives, The University of Georgia. www.forestryimages.org



50-inch diameter measuring hoop

Courtesy of U.S. Army Center for Health Promotion and Preventive Medicine, Entomological Science Program


Dead larvae next to golf ball

Courtesy of U.S. Army Center for Health Promotion and Preventive Medicine, Entomological Science Program

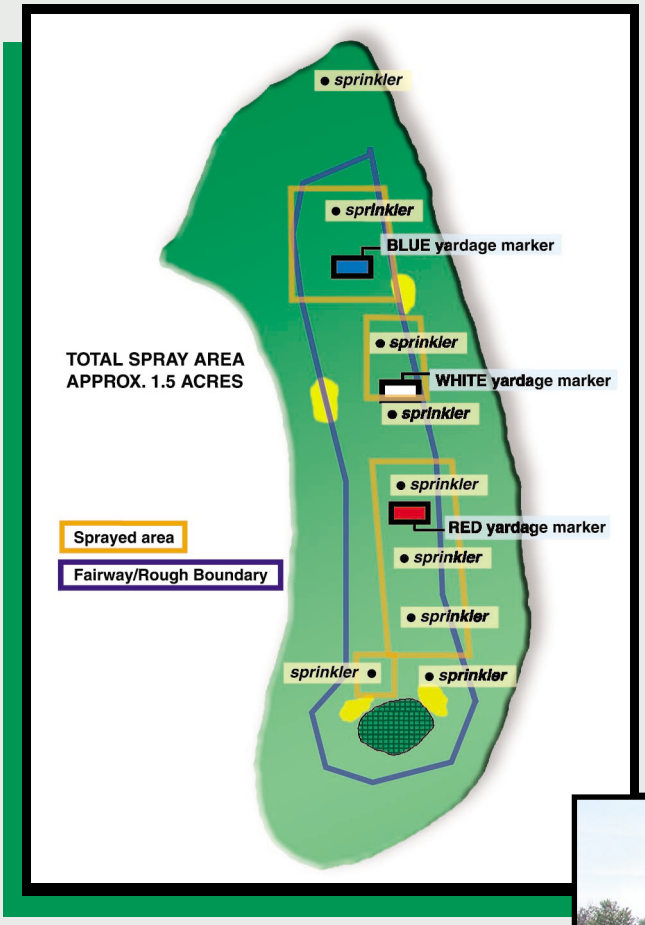
The next day, the map of the 18th fairway was given to the Ruggles Golf Course superintendent who then applied the pesticide. The pesticide used for these sprayings was an organophosphate. Spraying in the morning resulted in dead larvae by the afternoon. The golf course superintendent chose this chemical because it was on-hand, was quick acting, and had low persistence in the environment.


Green June beetle larva

Courtesy of Clemson University - USDA Cooperative Extension Slide Series, www.forestryimages.org

Since only 20% of the fairway had to be sprayed, it was accomplished in one run, well within the early morning window, and in significantly less time than a broadcast application over the entire fairway and adjacent roughs would have taken. Researchers tracked the sprayer and marked where the applicator actually sprayed, which was a slightly smaller area than had been mapped. The spraying was as effective as broadcast spraying in reducing the larvae infestation and resulted in significant time and cost savings.

18th Fairway, Ruggles Golf Course



Map courtesy of U.S. Army Health Promotion and Preventive Medicine, Entomological Science Program

> Recommendation: Apply pesticides only to areas with sufficient moisture and depth of thatch in the early summer when the larvae are small.

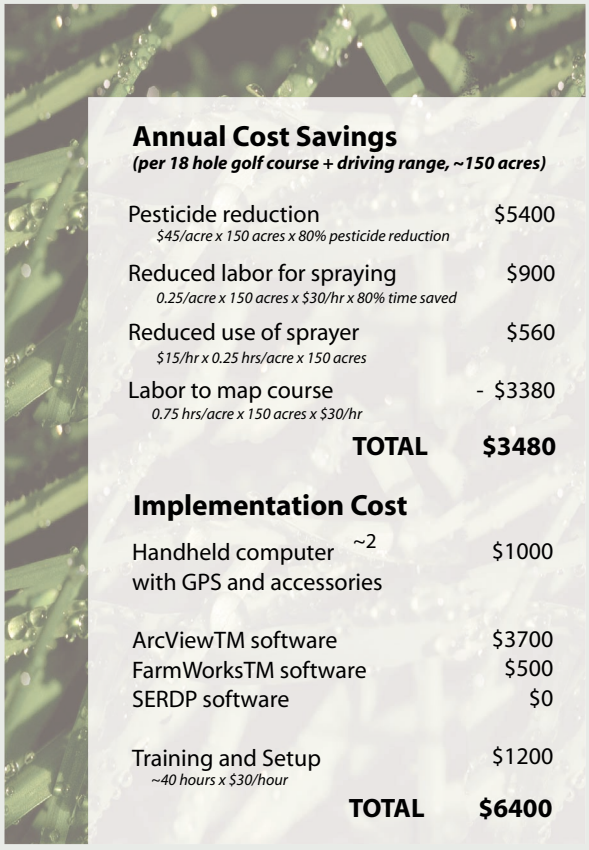
Photo courtesy of G. Bradley

The superintendent was very satisfied with the successful results on the 18th fairway, and other fairways were mapped and sprayed with similar pesticide reductions and success. The superintendent asked to have the driving range done in September. The driving range is a larger area (12 acres) with lower quality grass, so it was expensive to broadcast spray the whole field. The range was mapped in the same manner with similar spray area reductions. The driving range was heavily infested and the precision targeted spraying resulted in a large number of dead larvae on the range. However, it successfully solved the infestation and Ruggles Golf Course did not have significant recurrence of larvae in the following years. Thus, the long-term effectiveness of the targeted application was better than the broadcast spraying that had been conducted the previous 6 years, was less expensive, and posed a reduced environmental risk.

Researchers also tested several variables to determine if there were other factors that could predict areas with a high probability of green June beetle larvae and other types of grubs. A good correlation between soil moisture and larvae was found and it was determined that there was a minimum level of thatch necessary for the larvae. Based on this information, the recommended method is application of pesticides only to areas with sufficient moisture and depth of thatch in the early summer when the larvae are small. This reduces the need to broadcast persistent pesticides over the golf course early in the spring, avoids the damage associated with tunneling activities of the larger grubs, and reduces problems associated with high numbers of large, dead larvae on the golf course.

Results

The main success of the program was 95% control of the green June beetle larvae obtained by treating 20 to 30% of the acres compared to a normal broadcast application. Significant cost savings from reduced pesticide use and reduced labor means that investment in the technology pays back after two years or two applications. Other benefits include the ability to use pesticides with less persistence in the environment, less worker and golfer exposure to chemicals, and reduced labor time.



Annual Cost Savings
(per 18 hole golf course + driving range, ~150 acres)

Pesticide reduction *$45/acre x 150 acres x 80% pesticide reduction*	$5400
Reduced labor for spraying *0.25/acre x 150 acres x $30/hr x 80% time saved*	$900
Reduced use of sprayer *$15/hr x 0.25 hrs/acre x 150 acres*	$560
Labor to map course *0.75 hrs/acre x 150 acres x $30/hr*	- $3380
TOTAL	**$3480**

Implementation Cost

Handheld computer ~2 with GPS and accessories	$1000
ArcViewTM software	$3700
FarmWorksTM software	$500
SERDP software	$0
Training and Setup *~40 hours x $30/hour*	$1200
TOTAL	**$6400**

Return on Investment = Implementation/Annual Savings ~2 years

Percent Return on Investment ~50%
Assumes only one application per year for this technology, although many other uses are possible

The technology has changed significantly since 1999. Implementation costs for the Ruggles Golf Course project were significantly higher than they would be today. GPS technology has become widely available at significantly less cost than the system used in 1999. Thus, in preparing a simple return on investment analysis, the prices for a modern GPS were used. The most current version of the Precision Targeting software is available by contacting ARS (see contact information on back cover).

Reaction to the program has been very positive and there was general consensus that the program should be implemented at other DoD facilities. (This would require development of a technical users' guide, a plan for cost-effective implementation at the base level, and an education/information program.) The Entomological Sciences Program staff has improved on the technology by upgrading to the newer GPS and handheld computers. The Ruggles Golf Course superintendent and business manager were both pleased with the results. The golf course and the superintendent received positive publicity about the project, including an award. The superintendent felt that the original system was complex, but has since become familiar with handheld PCs and the use of commercial GPS based technology and he has expressed particular interest in expanding its use to target invasive weeds, such as clover and nutsedge, for treatment.

Based on the results of this and the other pilot studies mentioned, the team received the inaugural "Pollution Prevention Project of the Year" award in December 1999, from the Strategic Environmental Research and Development Service.

The Entomological Sciences Program and Army Environmental Center staff would like to expand the use of this technique to other military golf courses and other areas where pesticides are used.

Audubon Cooperative Sanctuary Program for Golf Courses
www.audubonintl.org/programs/acss/golf.htm

U.S. Golf Association
www.usga.org/home.html

"GREEN" GOLF COURSES

A growing trend at some golf courses across the United States is to make them environmentally friendly. Jointly sponsored by the U.S. Golf Association and Audubon International, the Audubon Cooperative Sanctuary Program (ACSP) for Golf Courses is a comprehensive program of land and water conservation, and minimization of chemical use designed to promote environmental stewardship of the land used for golf courses. Golf courses can participate at various levels in ACSP and those that fulfill a set of strict requirements can be certified as sanctuaries. Over 2300 golf courses participate in the program and about 300 are certified. A growing number of military golf courses are enrolled and several have attained sanctuary status.

Keys to Success of the Pilot

- Belief in the use of integrated pest management to minimize risks associated with the use of chemicals to control pests
- The DoD Measure of Merit requiring a 50% reduction in pesticide use and a written pest management plan with established thresholds
- Materials and labor cost savings
- Environmental concerns of the Army's Morale Welfare and Recreation Division
- Good public relations created by reducing the use of pesticides
- Willingness to support and use a new technology
- Understanding of the behavior and lifecycle of the beetle
- Funding to develop the software

CHEMICALS AND GOLF COURSES

At over 16,000 golf courses in the United States, pesticides (i.e., herbicides, insecticides, fungicides, plant growth regulators) and fertilizers are used intensively to maintain the fairways, tees, and greens. This is often done through broadcast application of chemicals over large acreages on the golf course. Runoff from these chemicals into streams and groundwater can be a source of surface and groundwater pollution, exacerbated by the fact that many golf courses are located in areas with shallow aquifers and most courses have surface-water features as hazards. In addition, pesticides have an adverse impact on aquatic life and insects treated with pesticides can poison birds that eat them. Research also suggests that insecticides can be harmful to humans.

As a non-point source of pollution, golf courses are not as heavily regulated or studied as point sources are, although this is slowly changing. The Environmental Protection Agency cites one study that showed that more than 50% of the nitrogen in fertilizer leached from the turf when improperly applied. A Japanese study found that the pesticides from a golf course reaching surface drainage and groundwater ranged from less than 4% up to 23% depending on the pesticide; another study found rates between 9% and 15%. Yet, other reviews have shown less severe impacts. More research needs to be done, but most agree that minimizing chemical usage is the most effective first step to reducing environmental and human health impacts.

FACTORS NECESSARY FOR SUCCESS OF A NEW PROJECT

- Currently spending over $5,000 per year for broad application of pesticides and/or herbicides to treat specific turf problems (this would provide a minimum 2 year payback on the technology investment)
- Purchase of a handheld GPS, handheld computer, and associated software
- Willingness and time to learn to use GPS, handheld computers, and GIS-based software
- Management and staff support and commitment to minimizing pesticide usage

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Pest Management in the 21st Century

The reduction of risks from exposure to pests and pesticides continues as a major goal for pest management in the 21st Century.

GIS computerized precision targeting software could play a major role in achieving this goal. As applied to pest management in this study, ArcView™ with the Precision Targeting Extension provided a standardized system that supported, documented and verified pest infestations and targeted intervention strategies that managed pests and pesticides, thereby reducing pesticide use, exposures, risks and associated costs. Under an Interagency Agreement between EPA's Pesticide Environmental Stewardship Program (PESP) and USDA's Agricultural Research Service (ARS), ARS applied the technology to military, residential and commercial indoor and outdoor integrated pest management strategies for insect pests such as lone star ticks, German cockroaches, mosquitoes, red imported fire ants, pharaoh ants, Indian meal moths, diamondback moth, medfly as well as the June beetle white grubs in the Ruggles Golf Course project reported here. In these demonstrations, ArcView™ GIS precision targeting with Integrated Pest Management, using least toxic methods, reduced pesticide use from 60 to 100%, increased efficacy and reduced costs. The technology was also applied to mitigating exposures of inner city children to cockroach and dust mite allergens that have been associated with asthma and to lead dust from lead-based paints that may cause neurological damage in children.

MAIA Best Management Practices Case Studies Course

Organizations throughout the Mid-Atlantic region have developed and implemented unique approaches to respond to environmental problems and concerns. The Mid-Atlantic Integrated Assessment (MAIA) has also conducted considerable research in the region, much of which has been used by environmental managers to meet their responsibilities.

MAIA and UMBC initiated a graduate-level research seminar where students document these success stories so that other managers and organizations can also use these approaches and research.

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U.S. Army MWR - Ruggles Golf Course
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