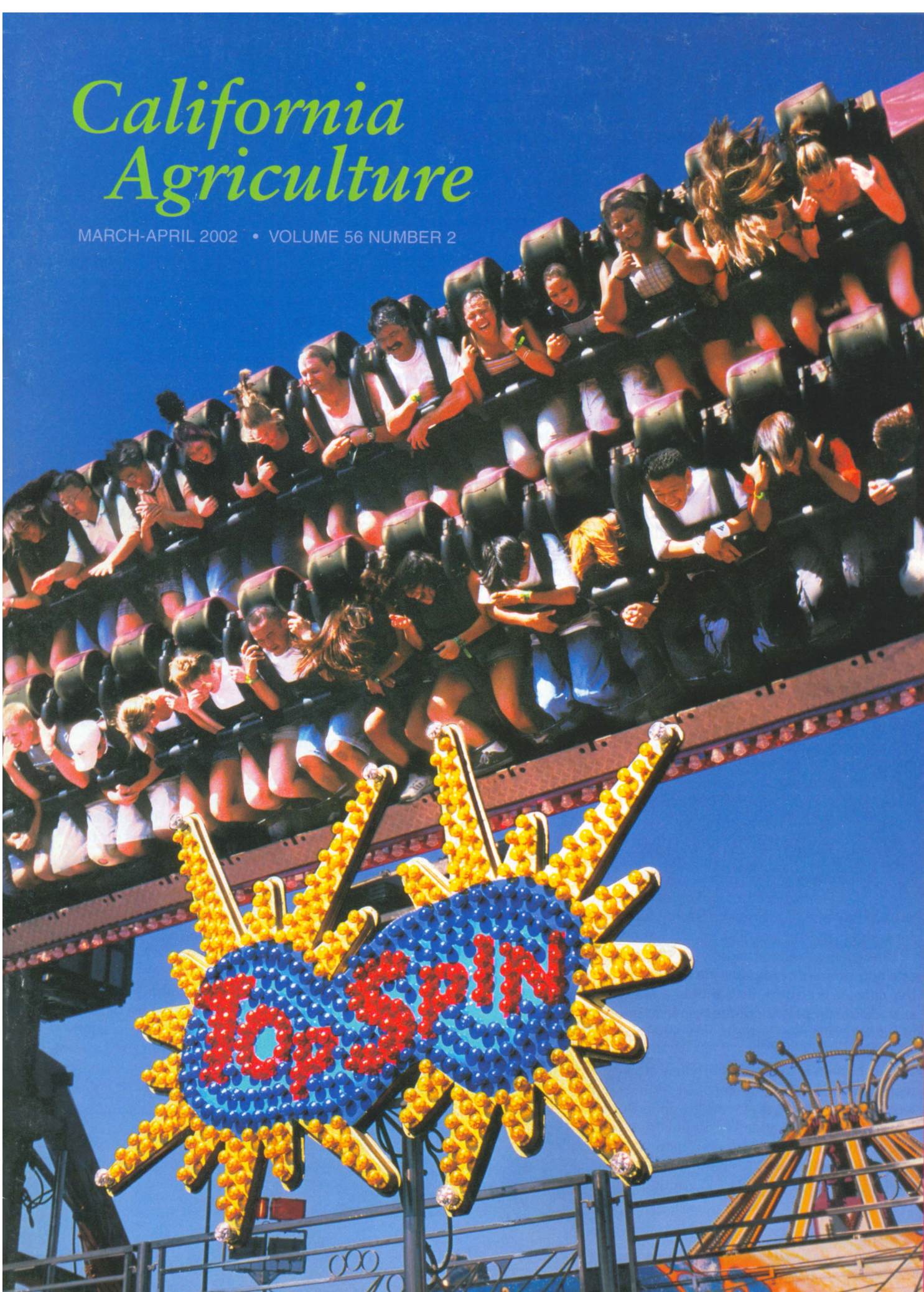


California Agriculture

MARCH-APRIL 2002 • VOLUME 56 NUMBER 2



YOUTH & WORK: THE RIDE AHEAD



W.R. GOMES
Vice President
Agriculture and
Natural Resources

As early as 1892,

UC demonstrated its commitment to help youth prepare for college and beyond. That year UC Berkeley established the Department of Pedagogy — then consisting of one faculty member. Elmer Ellsworth Brown would soon develop uniform statewide standards for high school teachers. In 1894, UC issued the first high school teaching certificate awarded in California based on these standards.

By 1913, the University was working with school districts to form rural boys and girls clubs. These were the forerunners of UC's statewide 4-H program; by 1918 California 4-H clubs had enrolled 2,000 youth.

Today there are hundreds of outreach programs on all our campuses and throughout the system. They reach tens of thousands of elementary and secondary students. Efforts range from programs that target health and nutritional needs of youth, to special tutoring and counseling, to enrichment and training for teachers.

Yet in spite of many efforts, an increasing number of young Californians need help. While more high school students than ever before attend college, many fall short of their goals. Of California students who enter 4-year colleges, 47% do not attain a degree within 5 years.* Youth leaving high school often lack basic skills needed for success in college and the workplace.

In this issue, Agriculture and Natural Resources (ANR) academics present new research into high school students' career awareness and preparation for the workforce (see p. 48–64). Workforce preparation — or lack thereof — has become one of the most pressing human resources issues, and is the subject of state and national initiatives.

Research on understanding the best ways to reach, educate and prepare young people to become active, productive citizens is critical. By building a knowledge base in this area, ANR can play a unique role in supporting the efforts of California communities to prepare their youth for the world of work.

Our human resources faculty has already formed several workgroups dedicated to this task. For example, the workforce preparedness workgroup in the Division, in collaboration with the state Workforce Investment Board Youth Council, conducts research on young people's perceptions of their needs for help; 4-H youth development advisors serve on several local youth councils of the board.

These councils were created to provide local workforce preparation programs and services primarily to low-income and at-risk youth. Another ANR workgroup has developed a money management curriculum for teens (see p. 65).

ANR faculty are uniquely positioned to extend the results of their research, taking the University to the people statewide. Human resources faculty at UC Davis, Berkeley and Riverside, and the statewide 4-H Center for Youth Development, support the work of 36 youth development advisors and their front-line staff. These advisors in turn provide curricula and programs to schools and community groups, providing enrichment activities, 4-H club work, after-school programs, special interest projects and leadership camps (see p. 46). Today, more than 120,000 children participate in 4-H youth development programs, more than half of them in urban school settings.

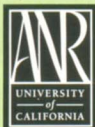
Programs in 4-H youth development focus on fostering leadership and citizenship, and developing life skills, through programs that range from hands-on science experiments to nutrition education. Several have become nationwide models for action. For example, we started the nation's first 4-H School-Age Child Care programs in 1983 at two schools in Placer County, a model later adopted in 42 states. Similarly, three 4-H science literacy programs have become national models for community-based science education.

The 4-H Youth Development Program is now in the process of evaluating its mission to build upon such successes. A task force is developing a 4-H mission statement and recommending specific, realistic, high-impact goals for the next 5 to 10 years.

Unique attributes of 4-H are its link to UC research, its strong academic base, and its accumulated expertise in delivering programs to California youth. Through academic work, and work with agencies and community organizations, ANR's programs have the potential to reach the majority of youth and families across California.

Through our human resources faculty and 4-H youth development programs, we seek to address the needs and aspirations of young people — one of the historic missions of the land-grant university. While we are not in the business of preparing or recruiting students for UC admission, we are in the business of preparing young people for life.

*Source: *Measuring Up 2000: The State-by-State Report Card for Higher Education*, National Center for Public Policy and Higher Education.



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ON THE COVER: In 1999, 29% of California's 9.35 million children under 18 were living at or below the poverty level, placing them at significant risk for compromised educational performance. At the same time, global forces have transformed the U.S. economy into a fast-paced, highly competitive, skills-based arena – one in which innovation and changing conditions result in a constant turnover of occupations. While the ride may be bumpy, the University seeks to provide research, guidance and support to help make the transition from school to the world of work as smooth as possible for today's youth. Teenagers enjoyed the California State Fair in Sacramento in 2000. *Photo by John Stumbos.*

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Continuous page numbering

After consultation with our Associate Editors Panel, *California Agriculture* will initiate continuous page numbering with this issue. This change brings us into conformity with a standard practice used by the vast majority of peer-reviewed science journals. We understand that this convention may be unfamiliar to some of our lay audience, and apologize for any inconvenience it may cause.

YOUTH AND WORK: THE RIDE AHEAD

Letters



Al Murphy, first superintendent of the Hopland Research and Extension Center, died in December.

Hopland special issue

My father, Alfred Murphy, was superintendent of the Hopland Field Station for more than 30 years. We were all very excited about the special issue (November-December 2001). I grew up on the Field Station and have very fond memories of those years. We plan to share the issue with family and friends. I even have a copy of your July 1976 special issue on the station's 25 years of research.

You may not be aware that my father passed away on Dec. 22 in Cartersville, Georgia. We both missed California very much and Hopland even more.

Peg (Murphy) Baron
Cartersville, Georgia

The issue devoted to the UC Hopland Research and Extension Center is excellent, with much good information. I've worked closely over the years with researchers at UC Davis/Hopland and value the contributions they have made to sheep research.

David L. Thomas
Professor of Sheep Genetics and Management
University of Wisconsin, Madison

BIOS cost data

I really enjoyed the recent article about almond management ("BIOS and conventional orchard management compared," September-October 2001). It seemed to me to be solid evidence for the viability of less insecticide use. I wonder if you have cost data that correspond with these treatment years, such as what's the difference in investment in insecticides versus not doing so. The last paragraph was a little unsettling: "Many growers will not stop applying the broad-

spectrum insecticides," "until reliable predictive techniques are identified." If this study doesn't persuade people, perhaps information on the cost differential will provide a needed "assist."

Dennis Pendleton
Dean, UC Davis Extension

Author Walt Bentley responds: No one has yet performed a comprehensive economic analysis. With fewer input costs, BIOS methods would appear to be more profitable. However, that doesn't take into account bonuses paid by processors for damage of 2% or less (up to 10 cents per pound). Many growers may use insecticide sprays to achieve this goal.

Agricultural easements cover

I am very concerned about the cover of your magazine (January-February 2002). The pictures were spliced together to depict homes encroaching on virgin land. You have planted the seed of urbanization encroaching on this land.

M. Bowerman
Anza, California

Editor's response: We juxtaposed two images on the cover, identifying them in the caption and demarcating them in the composite image itself (with a light green line where the houses "broke" and the green trees began). We made a composite of these images intentionally to dramatize the two forces at work in California, the movement to preserve farmland and natural lands, and the movement to develop those lands. Our intent was to provide an arresting and thought-provoking image that would motivate readers to examine the contents and draw their own conclusions.

Science briefs

Africanized bees discovered in central San Joaquin Valley

UC Davis entomologist Dave Nielsen has identified two Africanized bees in Tulare County, the first time the highly defensive bees have been found in the central San Joaquin Valley.

Last fall, Nielsen sampled about 150 bees from 30 different sites between Atwater to the north and Bakersfield (Oildale) to the south, in the region of Highway 99 and the Sierra foothills. The two Africanized bees were identified near the towns of Lindsay and Posey, using PCR-amplified mitochondrial DNA markers.

"There are a great number of bee colonies in the area," Nielsen says. "If you don't find Africanized bees, it doesn't mean they're not there. Therefore, our results are a conservative estimate of their range expansion."

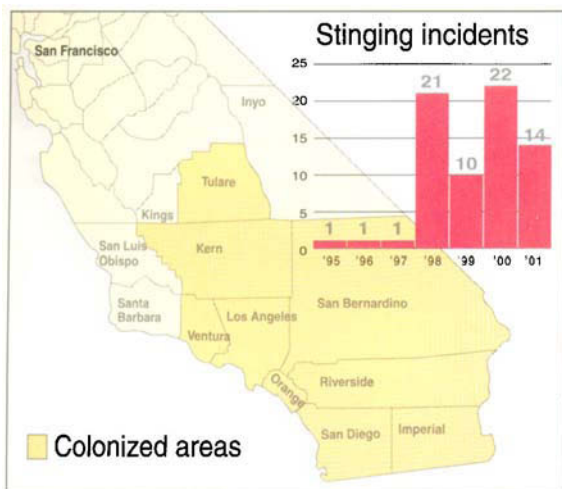
"They're moving up the San Joaquin Valley," says Scott Kinnee of the California Department

of Food and Agriculture's (CDFA) Plant Pest Diagnostic Center. "They're probably even further up than that, but the sampling hasn't been done yet."

Bees from South Africa were released in Brazil in 1956, and have been slowly making their way northward. California's first Africanized honeybees were discovered in Blythe (Riverside County) in October 1994. More than 51,000 square miles of the state are now considered colonized.

Africanized and European honeybees have the same appearance and venom, and each bee stings only once. But Africanized honeybees guard a larger area around their hives, respond faster and in larger numbers, and can chase their foes for as much as a quarter-mile.

Their impact on agriculture, which relies on bees for pollination, has been minimal. "Agriculture generally relies on commercial hives from out of state," Kinnee says. Beekeepers continue to



Since entering California in the mid-1990s, Africanized bees have slowly made their way northward; the latest confirmed finds were in Tulare County (map). At the same time, reports of multiple stinging incidents (inset) by Africanized bees have increased. Source: California Department of Food and Agriculture.

tend their hives, but must be vigilant and replace the queens in aggressive colonies.

However, Africanized honeybees tend to colonize niche spaces in urban areas, such as abandoned structures and vehicles, fences and empty boxes. "As the range of the bee has grown, there has been increased contact with areas populated by humans and domestic animals," Kinnee says. "This has resulted in a rising number of stinging incidents."

Seventy incidents of multiple stinging were reported to CDFA between December 1995 and late January 2002, when a 5th-grade boy in West Covina (Los Angeles County) was stung after throwing rocks at a hive.

For more information, go to: www.cdfa.ca.gov/phpps/pdep/ahb_profile.htm

New wildlife center cleans oiled birds

The new San Francisco Bay Oiled Wildlife Care and Education Center, which opened its doors in February 2001, faced its first crisis 11 months later when hundreds of oiled birds started turning up in Pacific waters from Point Reyes to Monterey.

As of February, the spill had incapacitated or killed more than 1,500 seabirds, mostly common murrelets. Hundreds were taken to the center for treatment and rehabilitation; more than 200 birds were released back into the wild.

Located in Cordelia, the facility is one of nine regional centers in the statewide Oiled Wildlife Care Network, which is managed by the UC Davis Wildlife Health Center, a unit of the UC Davis School of Veterinary Medicine. The California Department of Fish and Game (DFG) funds

the network with monies assessed on the oil industry.

"Unlike any previous spill in the Bay Area, we now have a facility in place, designed specifically to care for up to 1,000 oiled birds," says Michael Ziccardi, one of four UC Davis wildlife veterinarians who manage animal care for the network. "From the first day, birds have received care as soon as they were found, instead of having to wait, sick and cold, while we put together a rescue center."

When a bird arrives at the 12,000-square-foot, \$2.7 million center, it is evaluated, treated, washed and rehabilitated by professional staff, with the assistance of volunteers.

The U.S. Coast Guard Marine Safety Office (San Francisco) and the DFG Office of Spill Prevention and Response announced Feb. 8 that the source of the current spill is the SS Jacob Luckenbach, a 468-foot freighter that sank about 17 miles west of the Golden Gate Bridge on July 14, 1953, after a collision.

Oil samples gathered from the ship matched oil found on the feathers of birds and tarballs on the shoreline. Furthermore, oil from the current spill matched samples from similar incidents in 1992, 1997, 1999 and 2001. Altogether, oil from the SS Luckenbach's leaking hull may have killed as many as 10,000 seabirds. Officials are now working on a plan to bring up or seal the freighter.

For more information, go to: www.vetmed.ucdavis.edu/owcn/

— Compiled from U.C. and other news sources



Nancy Ottum

The San Francisco Bay Oiled Wildlife Care and Education Center faced its first crisis when oiled birds began washing up on Bay Area beaches in late November 2001. Above, veterinarians Marty Haulena of the Marine Mammal Center and Christine Kreuder of UC Davis Wildlife Health Center treat a murre.



4-H “national conversation” garners new ideas for youth development

Youth development and educational organizations around the country have been participating in a series of conversations convened by 4-H, aimed at improving the future for America’s youth.

These discussions began last fall, as county 4-H programs invited youth, adult leaders, parents, teachers and others to come together to jointly explore what actions can be taken to help the young people in their communities lead successful lives. Their priorities were then taken up at “state conversations” organized by the umbrella 4-H organization in each of the 50 states and five U.S. territories.

Finally, on Feb. 28, more than a thousand individuals from across the nation convened in Washington, D.C., for a 3-day “national conversation” to mold the best ideas into a national action plan. The plan will be presented to President Bush, U.S. Department of Agriculture (USDA) Secretary Veneman and Congress in April.

“It’s exciting to be involved in something that has the potential to have a dramatic impact on

the young people of this state and the nation,” says Carole MacNeil, statewide director of the California 4-H Youth Development Program.

“We’re creating a blueprint for youth programs that could be used in any community in America.” About 35 organizations participated in the California state conversation.

The nationwide conversations mark a centennial being observed this year by the National 4-H Council, celebrating the formation of the first out-of-school boys and girls clubs, which eventually became 4-H.

Although 4-H has its roots in agricultural clubs at the turn of the last century, its focus today is on helping young people from all backgrounds fulfill their potential. More than 30% of the nearly 7 million young people in 4-H nationwide are from minority racial or ethnic groups. And just 1 in 10 of its members lives on a farm; almost 60% reside in suburbs, towns and cities, including in inner-city communities. According to the National 4-H Council, 4-H is now one of the nation’s most diverse organizations, serving youth in all economic, racial, social and geographic categories.

Programs serve diverse clientele

The California 4-H Youth Development Program illustrates this trend. It delivers a rich mix of innovative educational activities for use in a variety of settings beyond the traditional 4-H club, including during, before and after-school programs.

California 4-H, a program of the UC Division of Agriculture and Natural Resources (ANR), taps the research and educational resources at UC and other institutions of higher learning to provide curriculums in dozens of subjects, ranging from math and environmental science and rocketry to money management and career preparation.

Here are a few examples of the work under way in California 4-H:

World of Work study. Researchers with the 4-H Center for Youth Development at UC Davis collaborated with 4-H advisors in six counties to study what factors shape the choices young people make about a career and education after high school. The study, “Preparing Adolescents for the World of Work,” revealed important differences among ethnic groups. The findings are being widely disseminated (see p. 48–64) and used to craft new 4-H curriculum.

Animal Ambassadors. Directed by Martin Smith of UC Davis Veterinary Medicine Extension, the Animal Ambassadors program encourages interest in science through exploration of the world of animals, with a hands-on, inquiry-based approach that emphasizes scientific thinking. Older teens act as mentors to younger learners. “We found a positive trend in the family’s involvement in the child’s science education,” says 4-H advisor Richard Enfield, who co-developed the program and helped implement it in San Luis Obispo County.

Homework Club. A 2-year collaboration between 4-H, school principals, teachers and parents, the Homework Club meets for 1.5 hours

“We’re creating a blueprint for youth programs that could be used in any community in America.”

— Carole MacNeil, statewide director, California 4-H Youth Development Program

California-based 2001 “Programs of Excellence” (awarded by National 4-H Headquarters)

- Animal Ambassadors
- 4-H Computer Corps
- Seeds for Larger Service
- Teens as Teachers
- Youth Experiences in Science

CCC searches for glassy-winged sharpshooter

Since May 2000, the California Conservation Corps (CCC) — the state program that combines youth development with natural resources protection (see p. 61) — has been helping to combat the glassy-winged sharpshooter. The nonnative sharpshooter spreads the pathogen that causes Pierce's disease, which can kill grapevines. CCC members have been trained to identify larvae and other signs of the sharpshooter, and to capture the insects. To date they have provided more than 77,000 hours of assistance in 11 counties, in conjunction with county agricultural commissioners and the California Department of Food and Agriculture.



California Conservation Corps

after school, 4 days a week. Aides assist small groups of children in grades 3 to 5 with their homework and reading assignments. "There's been an increase of 33.3% in the number of students turning in homework 100% of the time," says Tehama and Glenn counties 4-H advisor Jeanne George. Ninety-five percent of students, many from Spanish-speaking families, said they became better students and over 92% of parents said the club improved their child's self-image and school success.

YES. Teen teachers in the Youth Experiences in Science (YES) project bring hands-on science education to young elementary school students after school. Developed by UC Cooperative Extension youth development specialist Richard Ponzio and 4-H advisor Sharon Junge, YES is now used nationwide. In Sacramento County, the 4-H YES program partners with Sacramento START to reach children in lower income areas.

Junior Master Gardeners. Developed by Texas A&M University's extension service, the Junior Master Gardener program was introduced in California 2 years ago by 4-H program representative Susan Gloeckler and 4-H advisor Dan Desmond. "It's a fun program, yet educational and easy for the teachers," Gloeckler says. Kids learn basic concepts in horticulture, ecology, nutrition and health, and participate in leadership and community service activities. The program is also available in Spanish.

4-H Computer Corps. The 14 young people of the 4-H Computer Corps are the webmasters for the California 4-H statewide Web site. They also lead computer workshops at 4-H events and assist local 4-H clubs in developing Web sites. They learn computer technology, teaching, writing and editing, as well as organizational communications and behaviors.

Migrant education. For 10 years, Orange County 4-H advisor Mike Mann has been a part-

ner with the Santa Ana Unified School District in a local migrant education program. He facilitates training for the bilingual staff in how to help children of migrant workers build basic leadership communications skills. Each year up to 10 high school kids receive scholarships from ANR, and the district pays travel costs to send them to the statewide 4-H leadership conference.

"The kids really enjoy it," Mann says. "These activities and lessons in basic leadership skills are normally not available to them."

School enrichment. Fresno County 4-H advisor Dave Snell established the 4-H School Enrichment Program to teach basic science and physics concepts as well as improve agricultural literacy. Since 1992, more than 72,000 elementary students have participated in the 3- to 6-week program, which provides curriculum and classroom materials in avian embryology, plant science and water rockets. Snell and his assistants also provide in-service to classroom teachers. — *Gabriele Kassner*



In Los Angeles County, 4-H members participated in an entrepreneurship program funded by the Kaufman Foundation. They displayed and sold their wares at the Spring Show, above



Richard Mahacek

California high school students participated in an "engineering bowl" at the National 4-H Engineering, Science and Leadership Event at Purdue University in 1999.

Survey explores influences on youth workforce preparation

Ella R. Madsen ■ Ann Brosnahan ■ Isela Valdez
 Susan Donohue ■ Teresa McAllister ■ Marc T. Braverman

Craig Paterson



The career exploration network for youth includes a combination of school, parents, youth groups and community programs. In Vallejo, Monica Macdonald, a 2001 graduate of Hogan High School, assists at a day care center.

To develop programs and resources that help youth succeed in today's workplace, it is important to understand the various factors that influence their career exploration and decision-making process. A survey was conducted with 1,433 high school seniors in Northern California. Results indicate that the number of young people planning to seek education or training beyond high school continues to rise. There are distinct differences in the educational aspirations and expectations among different ethnic groups. The majority of students surveyed did not use school counseling services, and among those who did only a small percentage found them helpful. For most youth, parents are the primary source of help in preparing for further education and work. There is a strong positive relationship between academic achievement, and both participation in extracurricular activities and positive parent-child relations.

Today's workplace is characterized by innovation and rapid change as technology creates new possibilities and current practices become obsolete. Occupations disappear and new ones are created. The impact of global economic forces is felt even in the most sheltered communities (Greenwald 1997). Success in this workplace requires preparation throughout childhood and youth as well as planning on the part of young people (CCAD 1989).

Throughout young people's lives a variety of factors influence their ideas and attitudes about work and their place in the world of work. The need to identify and understand the factors that lead to productive career planning and decision-making becomes more urgent as growing numbers of young people find themselves ill prepared for today's job market (SCANS 1991, 1992). In addition to the need for basic skills and competencies, young people must be able to make career choices and decisions that will lead to a productive and satisfying future (Stevenson et al. 1998). However, they often approach career exploration and decision-making with ambiguity, uncertainty and stress. After high school, many young people — uncertain about what they want to do — move from school to school, school to job, job to job, or job to school, frustrated by the lack of information and guidance that would help them plan effectively for the future (Santrock 1995).

Providing all youth with the appropriate information, opportunities for career exploration, and guidance to prepare for the future is a challenging and important task. Schools, parents and families, youth-serving organizations and community programs are all valuable components of their career-exploration support networks (Bergman and Killen 1999; Lamborn et al. 1991; Rehberg and Westby 1967; Trice 1991; Vondracek 1993). These efforts, however, should be grounded in a clear understanding of the develop-

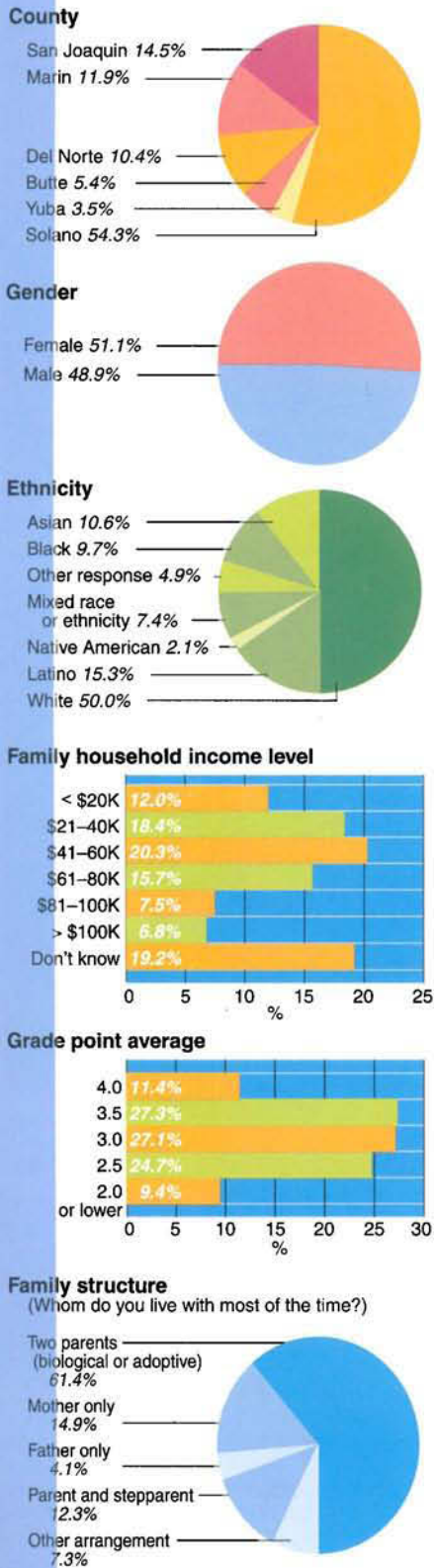


Fig. 1. Demographic characteristics of high school survey sample. Percentages include valid cases only (missing data excluded).

mental processes related to career choice, as well as the factors that will lead adolescents to think about their life work in productive and appropriate ways (Harren 1979).

Seniors provide insight

The "Preparing Adolescents for the World of Work" study aims to increase understanding of influential factors in young people's decisions and preparation for the world of work. In spring 1997, 1,433 high school seniors from six counties in Northern California were surveyed through a collaborative research effort by UC's 4-H Center for Youth Development (CYD) and county 4-H youth development advisors. The advisors contacted public high schools in the six counties, and nine schools agreed to participate. The survey was administered by graduate students and 4-H CYD research staff during a regular 50-minute class period.

The survey consisted of 120 multiple choice, yes/no, and Likert-scale type questions plus two additional measures: The Career Key, a 60-question assessment of occupational interests developed by Lawrence K. Jones of North Carolina State University, and the Task Specific Occupational Self-Efficacy Scale developed by Osipow, Rooney and Temple of Ohio State University. Most participants completed the first two sections of the survey, which form the basis for this report. Data was gathered on demographic characteristics, school experiences, extracurricular activities, work experiences (see p. 55), support networks, educational and career expectations, and career exploration and decision-making activities.

The students surveyed represent a cross-section of California youth (fig. 1). The ethnic distribution of the participants is representative of California's population with the exception of Latinos, who make up 32.1% of the state's high school

seniors but only 16% of the survey sample (California Student Trends 2001).

Aspirations and expectations

Across the country, more and more high school graduates are seeking postsecondary education as entry-level positions demand more sophisticated skills and the wage disparity between trained and untrained workers increases (Stevenson et al. 1998). Students in this study were asked how far they *aspired* to go in their education as well as what level of schooling they really *expected* to attain. Overall, 83% aspired to a bachelor's degree or higher, yet only 72% actually expected to attain this goal (fig. 2A). Girls exceeded boys in both their aspirations and expectations for a college degree. In terms of ethnicity, white, Asian, black and mixed-race students were fairly similar in their aspirations for a college degree (84% to 88%), compared with only 72% of Latino students. The percentage of each group that actually expected to achieve their educational aspirations was lower in all groups, but especially so among Latinos (72% aspired versus 56% expected) and blacks (85% aspired versus 66% expected). Twenty percent of the students reported no perceived barriers and 47% cited lack of money as the greatest obstacle to achieving their educational aspirations, followed by lack of information (13%) and low grades (12%)(fig. 2B).

Who are the students who do not believe they will go as far in their education as they would like? We looked more closely at cases in which students' reported aspirations exceeded their expectations, a category that included 37.5% of our respondents (fig. 3). Neither gender nor current work status was a discriminating factor between students who expected to achieve their educational aspirations and those who did not, but level of reported family income was. As the self-reported family income increased,

National trends inform workforce research

Ella R. Madsen

IN this series of research reports, UC's 4-H Center for Youth Development and 4-H youth development advisors provide scientific underpinnings for the development of workforce preparation programs that will meet the needs of California's diverse and growing population of youth. Several educational, economic and social trends will have implications for American youth as they prepare to enter the world of work at the beginning of the 21st century.

Qualified workers. The American labor force seriously lacks qualified workers. The 1991 Secretary's Commission on Achieving Necessary Skills (SCANS), prepared by the Department of Labor, identified the characteristics a person needs in order to be productive in today's global economy, including foundation skills (such as reading, writing and math) and workplace competencies (such as interpersonal skills, communication and using technology effectively). Unfortunately, more than half the youth leaving high school lack these basic skills and competencies. Consequently, employers are finding it necessary to import employees or export jobs (SCANS 1991).

In 1997, Joseph Stiglitz, chairman of the President's Council of Economic Advisors stated: "In the 19th century, the frontier of America was moving from agriculture to manufacturing. Today the frontier is going from manufacturing to services and technology, much of which can be exported." In addition to technology, qualified teachers, nurses, physical therapists, accountants and skilled craftsman are also in high demand (Bureau of Labor Statistics 1999; Greenwald 1997). At the same time, entry-level positions generally require more sophisticated skills, and high school graduates are seldom able to advance to a position that provides a comfortable living wage (Stevenson et al. 1998).

Earning power. The disparity in earning power between workers of varying educational levels continues to grow. Between 1973 and 1995 the real hourly wages of workers without a high school diploma declined by over 23%, with a high school diploma by more than 14%, and with some college education by 13%. At the same time the earning power of college graduates and those with ad-

The 4-H National Center for Workforce Preparation has formed several partnerships with industry to prepare youth for future employment. California 4-H members from Merced attended a 5-day hands-on training and mentoring program at the Honda Technical Training Center near Stockton. Cesar Aguilar, top and center right, and Paul Mahacek, bottom (center), learned how engines operate, as well as the chemistry of batteries, and combustion, physics and metrics. Photos courtesy of Richard Mahacek.

vanced degrees increased 4.3% and 12.1%, respectively (Stevenson et al. 1998).

Specialized training. Due to tightening budgets and increasing emphasis on college preparation, vocational training in high school has greatly diminished (the Regional Occupational Program being a wonderful exception). The federally funded School-to-Work or Career Initiative has helped to link academic learning to applications in the workplace, but the major emphasis is still on college preparation. In contrast, in countries such as Japan and Germany there is a tradition of tight linkages between secondary schools and the worlds of work and college (Stevenson et al. 1998). These types of alliances provide young people with opportunities to understand how academic experiences are relevant to their future work as well as to develop important skills and competencies.

Nationwide response. Two major initiatives have been put forth on the national level in recent years to address these problems. First, in 1996 the Cooperative State Research, Education and Extension Service of the USDA instituted the National Workforce Preparation Initiative, in order to "marshal the extension, teaching and research resources of the land-grant university system to address workforce preparation throughout the country."

Second, under the direction of the National 4-H Council, the National Center for Workforce Preparation was established in 1996. The center developed a model based on SCANS and launched a multifaceted program, called Preparing Youth for Employable Futures. The center has partnered with a variety of major corporations to offer mentoring, internship and apprentice programs as well as grants to support local programs.



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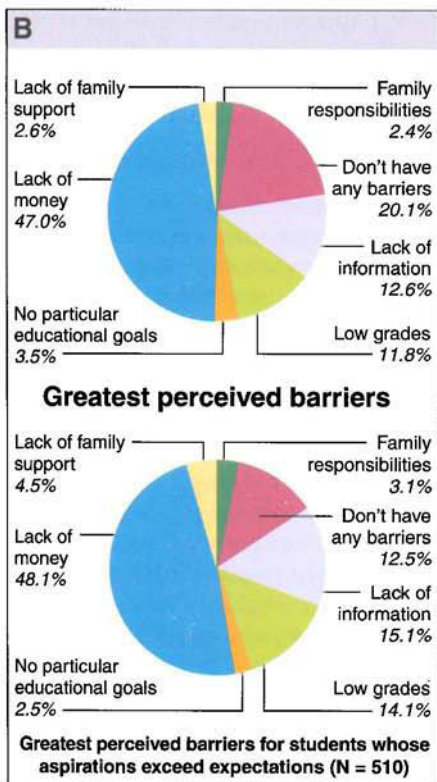
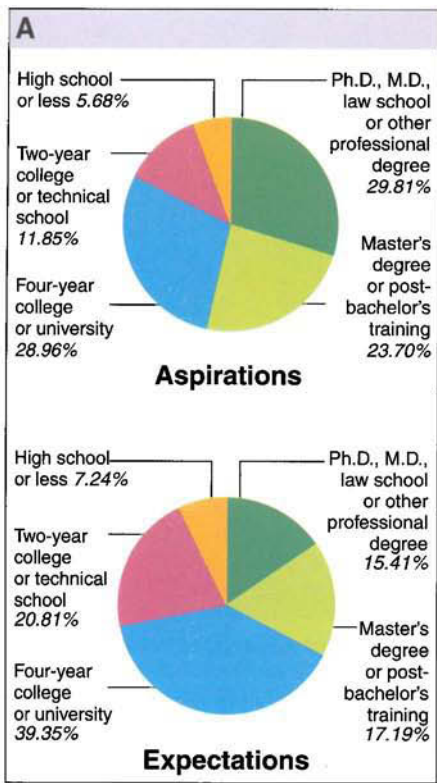


Fig. 2. (A) Students' educational aspirations and expectations, and (B) greatest perceived barriers to accomplishing educational goals.

the percentage of students expecting to realize their aspired educational goals also increased.

Combined with the finding that lack of money was most often cited as the obstacle to educational ambitions, it appears likely that a certain amount of the difference between educational aspirations and expectations may be driven by financial factors. However, the influence of other factors, such as parental encouragement and support, needs to be explored, considering that (a) students whose expectations matched their aspirations perceived the barriers to educational goals in much the same way as those students whose expectations were lower than their aspirations; and (b) nearly half the students in the lowest income group *did* expect to achieve their educational goals.

Not all students seeking post-secondary education or training aspired to a 4-year college degree. Over the past few years an increasing percentage of students have been attracted to technical programs offered through community colleges and technical schools (Stevenson et al. 1998). In our sample, 29% of black and 29.9% of Latino students expected to earn an A.A. (associate in arts) degree or special certification from a 2-year college or technical school, compared with fewer Asian (16.9%), white (17.1%) and mixed-race (18.1%) students. Most high school graduates planned to continue their education or training immediately following high school, but 20% planned to enter military service, work full time or pursue other activities (see p. 61).

Gender differences in preparation and planning for the future were reflected in girls' significantly higher reported grade point average (GPA), educational aspirations, educational expectations, career decidedness and reported benefit from school counseling services.

School counseling services

For the large majority of seniors (80%), school counseling services were

perceived as a source of practical information materials to help achieve educational or career goals. Information about financial aid and help with applications and interviews were the services used most often and rated most helpful. However, only a little over half of the students took advantage of these resources. When it came to individual counseling services, career-exploration computer programs, and career-exploration and planning classes, only 28.3% of the total sample participated. An average of 50% to 55% of the students either thought the services were not offered or did not know about them, and 21% of the students who knew about these services did not use them. Of the 405 students (28.3%) who participated in individual counseling, computerized career-exploration programs or classes, the majority ranked them as somewhat helpful or not helpful.

Considering the efforts reported by most of the participating high schools to inform and encourage students to use career centers and counseling services, it is difficult to understand why such a large percentage of students were unaware of them. If these find-



Fig. 3. Characteristics of students for whom aspirations exceed expectations.

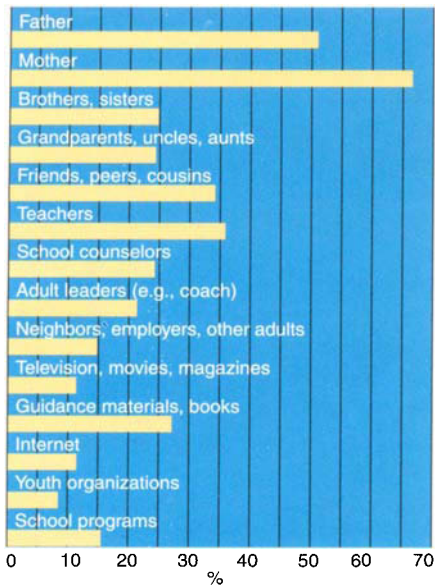


Fig. 4. Students' primary career-planning resources. Bars represent percentages of youth answering that a resource was "very helpful" or "extremely helpful" in planning for their future work.

ings are representative, it appears that a relatively small number of high school students are benefiting from counseling services offered.

One possible explanation is that high school counseling services focus on getting students into college and consequently there is little perceived relevance for students who do not plan to go. In this study, significantly more of the students planning to attend a 4-year college (61.8%) did use the counseling service than those planning to attend community colleges or technical schools (52.9%), enter the military (44.9%), pursue other activities (44.7%), work full time (36.6%) or who were undecided (34.8%). Other possible reasons may be as straightforward as limited hours of career counseling facilities and students' work and activity schedules. Additionally, the student load per counselor may be so excessive that counselors have little time to spend with any one student and must instead focus on students perceived as having the most critical needs. Further study is needed to understand the factors that would make counseling and career services attractive to a broader spectrum and larger proportion of students.



Craig Paterson

Nearly 90% of high school students surveyed were involved in extracurricular activities. Emmanuel Yeboah assists Helen Wincentsen at an Internet café in a downtown Vallejo church. In the school-based program, which is assisted by 4-H, teenagers learn how to teach computer skills. Yeboah is a senior at Jesse Bethel High School in Vallejo.

Support networks

The support network enjoyed by an adolescent can have a significant impact on the quality and quantity of information and guidance that he or she receives concerning decisions and planning for the future. A majority of students rated mothers (66%) and fathers (51%) as "very" or "extremely" helpful with regard to planning for future work (fig. 4). These percentages were even higher among students who indicated that they had especially good relationships with their parents. Parents may also have an indirect influence on their children's expectations and plans. Youth whose parents had some college education and/or a higher reported income level were more likely to aspire to a college degree. These findings are compatible with other studies in which the mother's educational level was a key predictor of a child's educational attainment (Rehberg and Westby 1967).

Slightly more than one-third of the students ranked teachers and friends as very important sources of help, and about one-fourth found school counselors, guidance materials and books to be an important resource for career planning. Among the youth participat-

ing in extracurricular activities, those involved in student government, newspaper or yearbook, 4-H and other youth organizations indicated that their adult leaders were a good source of help.

Extracurricular activities

The American adolescent today mirrors society in many ways, moving ever faster to accomplish more and more. Their typical activities include work, school, extracurricular activities, social relationships, chores at home and community service. Of the students in this study, 88% were involved in one or more extracurricular activities, typically involving up to 8 hours per week. Community service involved the most students (48%) but also received the smallest investment of time on a weekly basis (1 to 5 hours). In comparison, 46% of the students participated in sports, reporting an average of 11 to 15 hours per week. Other extracurricular activities, listed in descending order of involvement, were performing arts, religious youth groups, youth organizations, student government, school newspaper or yearbook and 4-H, at up to 5 hours per week each. Note that students may



Students involved in extracurricular activities had higher grades, were at lower risk of dropping out, and had the highest educational aspirations. At Vacaville High School, agriculture instructor Nick Johnson, left, helps student Albert Hall trim a sheep's hooves at the school's minifarm. Hall is president of the local Future Farmers of America.

participate in several of these activities simultaneously, and many are not necessarily ongoing throughout the school year. Nor do they consistently demand the same investment of time.

For most activities there were no significant gender differences in level of participation. Participation in sports was 10% greater for boys than for girls, perhaps because of several sports that are traditionally dominated by boys. Girls' participation in the performing arts and community service was 20% greater than boys. All ethnic groups were well represented in the different types of activities. Overall participation for black, Asian and white students ranged between 87% and 89%. For Latino students, it was 81%.

Comparison of young people involved in extracurricular activities with those who were not involved revealed some striking differences. The involved students had higher grades and lower risk of dropping out (6%), as well as the highest educational aspirations and expectations. They liked school and differed significantly from uninvolved students in how helpful they perceived adult leaders to be in planning for the future. They also indi-

cated that "usually" or "almost always" their "family does fun things together." In contrast, students not involved in any extracurricular activities (12%) were twice as likely as involved students to not care if they graduated, to plan to work full time after high school, or to view a community college degree as the extent of their postsecondary education aspirations. Compared to 71% of the sample, only 48% of uninvolved students expected to earn a 4-year college degree. This group indicated "lack of goals" as a major obstacle to future plans; 28% were at risk of dropping out. Although uninvolved students, like involved students, felt that they could "count on parents to help them out," they indicated that their "family does fun things together" "almost never" or only "once in awhile."

However, the involved and uninvolved students were very similar in some areas. About the same percentage of young people from both groups worked (56% and 53%, respectively) and there was no significant difference in the number of hours. The percentage of each group working more than 15 hours weekly was also similar (33% and 28%), as was the pri-

mary reason for working: to earn spending money. In each group, 60% indicated that they would like help in identifying careers to best suit their personalities, and both categories felt that they needed a clearer idea of their interests (47% involved, 50% uninvolved) and of their major strengths and weaknesses (53% involved, 55% uninvolved). It might be expected that there would be greater differences between involved and uninvolved students with regard to career decision needs, but this turned out not to be the case.

Implications for preparedness

Our findings indicate that young people would benefit from and are interested in more knowledge about themselves, careers and how to tap the resources that will help them achieve their aspirations. They could particularly use information and guidance on overcoming financial and other perceived educational barriers. In California, an excellent higher education system provides a variety of pathways to a college education, but many students need help in learning how to make wise choices and tap into scholarships, grants and loans.

Students also want help in evaluating their interests and aptitudes in order to gain a clearer idea of what field of work would hold the greatest opportunities for satisfaction and success. Considering the dynamic nature of the workplace, it is important that people entering the workforce understand their strengths and how to use them effectively in diverse situations. Finally, young people would be well served by opportunities to gain firsthand knowledge about possible career opportunities that fit their interests and aptitudes. Knowledge in all of these areas needs to be developed through a wide variety of experiences in the home, school and community.

Through this study we identified some weaknesses and strengths in the support networks of youth. We found that school counseling services are not attracting most students to use their services — especially those who may



Despite many schools' best efforts, students found career-planning services only marginally helpful. At San Marin High School in Novato, sophomore Amber Miller investigates the career center.

need them most. And the majority of students who do use the services find them only marginally helpful.

It has always seemed logical for the public high-school system to be the primary provider of guidance about future work and education. If this continues to be the case, schools should look more closely at the effectiveness of these services, as well as how they are "marketed" to students. It is only fair to say that responsibility also rests with the student to be informed and to make the most of their school's resources. If the needs of those who stay in school are not being met, it is even more discouraging to think about those youth who drop out along the way.

The students in this study felt that their parents were the most helpful people in their support network. However, we do not have a clear understanding of what parents do that is perceived as helpful. Further research will provide insight about the parent-adolescent dynamics that influence career decision-making and preparation for the workplace. This insight can help schools and youth development

organizations such as 4-H to refine their programs, and in turn help parents to more effectively support their children's career exploration and decision-making.

Knowledgeable, caring, listening adults form the support network that all youth need as they make the transition to adulthood and work (SCANS 1992). Creating a strong support network for Latino and black youth is especially important; their comparatively low expectations for further education, coupled with a current high dropout rate, is cause for serious concern. Although there has been a dramatic decrease in the school dropout rate among all ethnic groups since 1992, in 1998 the rate was 16.3% for Latino and 17.4% for black youth, in comparison to 7.5% and 6.3% for white and Asian students, respectively. The magnitude of the problem becomes more apparent when one considers that during the same year, 40.5% of the 5.7 million children enrolled in California public schools were Latino and 8.8% were black (California Student Trends 2001; Clark 2000).

Preparing to enter the workforce as a self-sufficient, responsible member of society is a developmental process that is affected by experiences from preschool through young adulthood. As the world of work becomes more dynamic and complex, we need to further our understanding of the workforce preparation process and develop effective ways of meeting young people's needs for knowledge, skills and guidance in this important aspect of their lives.

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National trends inform workforce research

Ella R. Madsen

IN this series of research reports, UC's 4-H Center for Youth Development and 4-H youth development advisors provide scientific underpinnings for the development of workforce preparation programs that will meet the needs of California's diverse and growing population of youth. Several educational, economic and social trends will have implications for American youth as they prepare to enter the world of work at the beginning of the 21st century.

Qualified workers. The American labor force seriously lacks qualified workers. The 1991 Secretary's Commission on Achieving Necessary Skills (SCANS), prepared by the Department of Labor, identified the characteristics a person needs in order to be productive in today's global economy, including foundation skills (such as reading, writing and math) and workplace competencies (such as interpersonal skills, communication and using technology effectively). Unfortunately, more than half the youth leaving high school lack these basic skills and competencies. Consequently, employers are finding it necessary to import employees or export jobs (SCANS 1991).

In 1997, Joseph Stiglitz, chairman of the President's Council of Economic Advisors stated: "In the 19th century, the frontier of America was moving from agriculture to manufacturing. Today the frontier is going from manufacturing to services and technology, much of which can be exported." In addition to technology, qualified teachers, nurses, physical therapists, accountants and skilled craftsman are also in high demand (Bureau of Labor Statistics 1999; Greenwald 1997). At the same time, entry-level positions generally require more sophisticated skills, and high school graduates are seldom able to advance to a position that provides a comfortable living wage (Stevenson et al. 1998).

Earning power. The disparity in earning power between workers of varying educational levels continues to grow. Between 1973 and 1995 the real hourly wages of workers without a high school diploma declined by over 23%, with a high school diploma by more than 14%, and with some college education by 13%. At the same time the earning power of college graduates and those with ad-

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vanced degrees increased 4.3% and 12.1%, respectively (Stevenson et al. 1998).

Specialized training. Due to tightening budgets and increasing emphasis on college preparation, vocational training in high school has greatly diminished (the Regional Occupational Program being a wonderful exception). The federally funded School-to-Work or Career Initiative has helped to link academic learning to applications in the workplace, but the major emphasis is still on college preparation. In contrast, in countries such as Japan and Germany there is a tradition of tight linkages between secondary schools and the worlds of work and college (Stevenson et al. 1998). These types of alliances provide young people with opportunities to understand how academic experiences are relevant to their future work as well as to develop important skills and competencies.

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Career awareness and part-time work examined in lives of high school seniors

Marc T. Braverman ■ Jane Chin Young ■ Nicelma J. King
Carole A. Paterson ■ Robert S. Weisskirch

Craig Paterson



A study of career awareness among Northern California high school seniors found that working part-time was linked to a greater likelihood of believing one's future career is an important consideration during senior year. Kevin Fontanoz, a senior at Hogan High School in Vallejo, works as a courtesy clerk at Safeway. He plans to attend college after graduation.

In a survey of career awareness among high school seniors in Northern California, almost all students agreed that career is an important consideration for them, and about two-thirds reported that they had decided on an occupational field. However, only about half reported that they were comfortable with their current career decision-making, had a clear idea of their own interests and abilities, or had sufficient knowledge about potential occupations. Minority students tended to express

greater needs with regard to career exploration than white students. Compared to other groups, significantly fewer Latino males had made an occupational decision. Part-time work during the students' senior year did not appear to hinder school grades or school engagement. In fact, working was associated with generally higher levels of career awareness, especially regarding the importance of career planning. However, part-time work was associated with increases in reported stress levels.

The end of high school constitutes a major transition in the lives of adolescents. Whether they plan to move on to work, college or another post-high school alternative, it is beneficial for students to make active, informed decisions about their ultimate career paths. Unfortunately, many youths approach high school graduation poorly prepared for this transition. In this report, the second of two from our investigation of work transitions of high school seniors in Northern California (see p. 48), we examined students' career awareness, and the potential benefits and drawbacks of part-time work.

We surveyed 1,433 seniors in nine Northern California high schools during spring 1997. Students completed a 17-page questionnaire, containing multiple scales and item formats, in a single class period. The questionnaire inquired about demographic background factors, an estimate of their grade point averages (GPA) and current work experiences. The students also completed a multidimensional scale called the Career Decision Profile (CDP), which enabled us to examine a number of facets regarding their awareness of and priorities for their future careers.

We use the term *career awareness* to refer to adolescents' reflectiveness about their future work lives. This may or may not include a specific career decision, in which a student can identify with certainty the career field that he or she wants to pursue. However, our definition does include students' active consideration of the elements upon which a decision can be based, such as understanding one's own talents and interests or understanding the opportunities and requirements of various career fields.

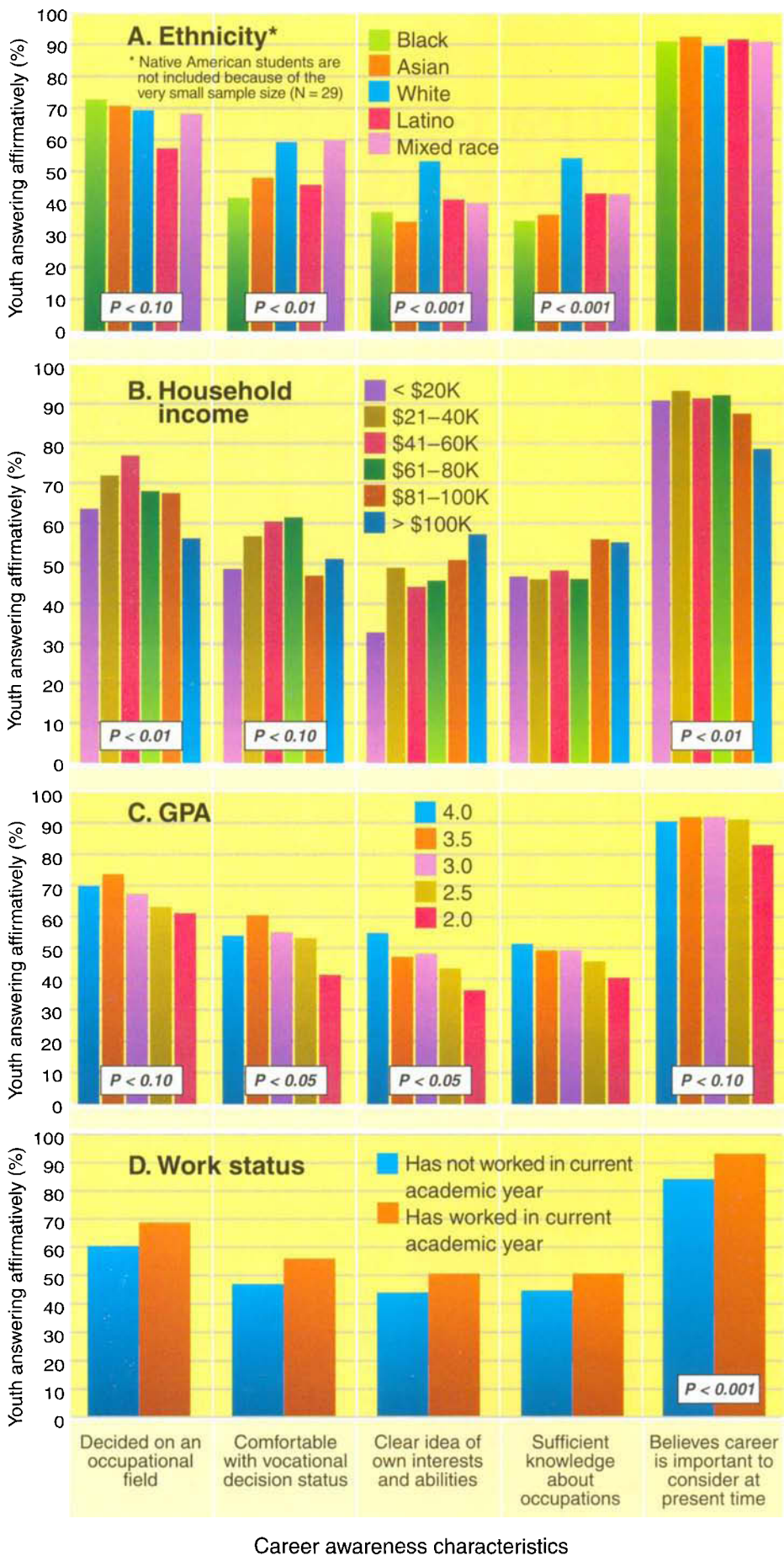


Fig. 1. Relationship of (A) ethnicity, (B) annual household income, (C) grade point average (GPA), and (D) current academic year work to students' self-assessed career awareness characteristics. Listed P values are based on chi-square statistical tests crossing each demographic characteristic (e.g., ethnicity) with each career awareness variable, expressed dichotomously.

Developmental research suggests that it is not necessarily desirable or undesirable for a young person to have decided on a career choice while still in high school (Silbereisen et al. 1997). It may be quite appropriate for one individual to decide relatively early and for another to delay the decision. However, whatever their current level of commitment to a specific career field, high school students should be engaged in an exploration process relating to potential careers and vocational identities (Vondracek 1993). This exploration will enable them to make informed choices, whether those choices involve higher education or entry into the workforce. By examining whether students have decided on an occupational field, along with the reasons behind their decision or lack of decision, we can build a more complete picture of their vocational development at the current time.

Measuring career awareness

We included the CDP (Jones 1989) as part of the survey materials in order to explore the students' career decision status. This instrument has six subscales that measure the students' self-perceptions on the following characteristics:

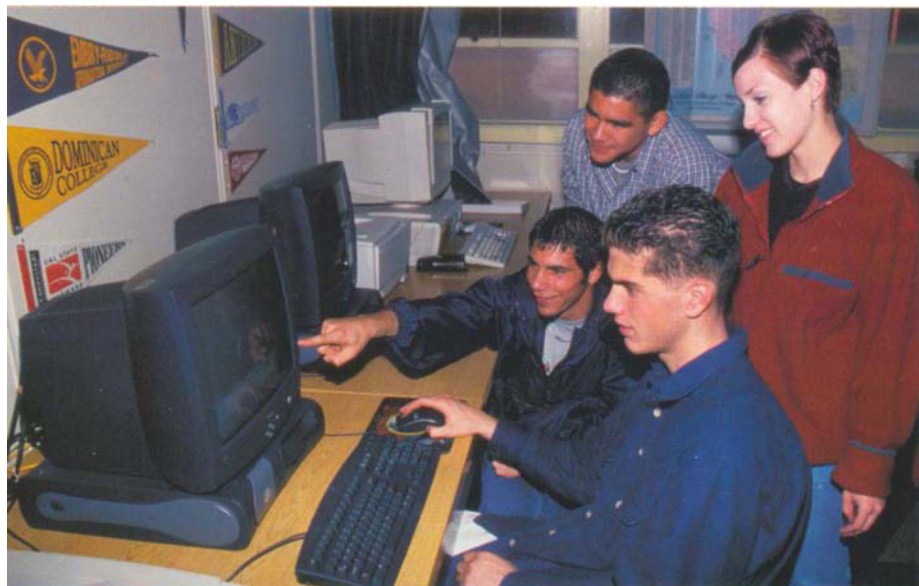
- "Decidedness" regarding their occupational choice (2 items).
- Level of comfort regarding that vocational decision status (2 items).
- Clear idea of their own interests and abilities (3 items).
- Sufficient knowledge about occupations (3 items).
- Belief that their career is important to consider at the present time (3 items).
- Comfort in making decisions in general (3 items).

Each item presents a statement to which students respond on a scale of 1 (strongly disagree) to 8 (strongly agree), and the individual item scores are summed to provide a total score for each subscale. We report here on only the first five subscales, as we judged the general decisiveness scale to have limited relevance for our current discussion.

To facilitate our data analysis, we divided the students' total scores for each CDP subscale into two groups: those who generally tended to agree with the item statements (average item score of 5 or higher) and those who tended to disagree (average item score lower than 5). This process enabled us to classify students as generally *decided* or *undecided* on their future occupations, *comfortable* or *uncomfortable* with that decision status, *clear* or *unclear* about their vocational interests, and so on. In trying to understand what kinds of support can be helpful to adolescents in the career exploration process, we are particularly interested in the total pattern of students' responses across scales; that is, whether they feel comfortable or worried regarding their current vocational decision, their assessments of their knowledge about themselves and the occupational world, and the degree of importance they place on career considerations. These patterns are more informative than the single question of whether students are decided or undecided about their occupational field.

Career awareness levels vary

About two-thirds of high school seniors reported being decided, to at least some degree, on their occupational field (table 1). However, only slightly more than half reported being comfortable with their decision status. Furthermore, slightly less than half felt they had a clear idea of their interests and abilities or sufficient information about occupations. The overwhelming majority (90.8%) felt that it was important to consider their future work at the present time. There was no significant difference between males and females and comfort level, but



School-based career guidance programs should focus on helping youth to understand themselves as well as the world of work. The Vacaville High School career center provides up-to-date resources such as college catalogs and software, scholarship information, speakers and mentors from the local business community. *Clockwise from front: Students Dustin Clark, Jeff Motta, Carlos Rodriguez and Amanda Dietrich.*

significantly more males than females reported feeling clear about their own interests and abilities (49.4% versus 42.5%), as well as having adequate knowledge about occupations to support a career decision (50.9% versus 42.8%). These data don't address whether the boys' greater confidence in these areas can be objectively justified. Significantly more females than males (93.8% versus 87.6%) reported that career considerations are important for them at the present time.

Ethnicity and gender. Minority students (black, Asian, Latino and mixed race) appeared to express greater needs with regard to support in career planning than the white students in our sample (fig. 1A). While the great majority of students in all ethnic groups (between 89% and 93%) believed that career planning is important in their senior year, black, Asian and Latino students all expressed less comfort with their current vocational decision status, less clarity about their own interests and abilities, and less knowledge about occupations than white students.

In addition, whereas most groups

were about equal in the percentage that had decided on an occupational field (between 68% and 73%), Latino youths were a significant exception at 57.4%. Further examination revealed a striking gender difference: While 65.2% of Latina girls were decided — a figure that is only slightly lower than the percentages for other groups — for Latino boys the corresponding percentage was 44.8, far below any other ethnicity-gender category. Among the Latino students, then, boys and girls differed from each other by more than 20 percentage points, whereas in all other ethnic groups the difference between genders was less than 6 points.

Household income. Surprising results were also found with respect to self-reported household income. The students who were most decided and most comfortable with their decisions were those with household incomes in

TABLE 1. Students reporting affirmatively (%) on career awareness characteristics*

Career awareness variable	Total	Gender	
		Male	Female
Decided on occupational field?	67.6	65.3	70.3
Comfortable with current decision status?	54.5	54.9	54.8
Clear idea of own interests and abilities?	46.3	49.4	42.5
Sufficient knowledge about occupations?	47.7	50.9	42.8
Is career choice important at present time?	90.8	87.6	93.8

* Percentages for total sample differ slightly from combined gender percentages because of missing data for several cases.

the range of \$20,000 to \$60,000 (fig. 1B). Students in the lowest income category (less than \$20,000) tended to be less decided on their future occupations and less comfortable with their decision status. Furthermore, low-income students reported the lowest levels of self-clarity but relatively moderate levels of occupational knowledge and career choice importance. On the other hand, high-income students — especially those from households over \$100,000 — reported low levels of decidedness and low levels of comfort. While the high-income students reported high self-clarity, high occupational knowledge and moderate decisiveness, they were the lowest of all groups, by far, on the importance they placed on current career planning.

These results regarding household income level are intriguing. Students in the middle-income brackets appeared to have the highest concerns about their careers, suggesting that a moderate level of family income might contribute to some perceived economic pressure that sharpens young people's awareness of career preparation issues. On the other hand, high family income appears to relieve students of the need to be concerned about this topic, resulting in lower priority ratings for career considerations.

Grades. As might be expected, grades were associated with career preparation (fig. 1C). Students reporting GPAs of approximately 3.5 (A's and B's) appeared to be the most career-aware, with the highest percentages of any group on both decidedness and comfort level. Students with GPAs of about 4.0 (usually all A's) were fairly close behind, and students with GPAs of 3.0 (mostly B's) and below displayed a fairly linear descending pattern. Students in the highest grade category reported the highest self-clarity. Scores on occupa-



Across the nation, unique partnerships are being formed to better understand the workforce preparation needs of young people and guide them into productive careers. UC's statewide Mathematics, Engineering and Science Achievement (MESA) program has become a model for programs in seven other states and recently received a grant to expand nationwide. The MESA Agricultural Initiative is funded by UC and based at California Polytechnic University, San Luis Obispo, with the goal of getting precollege students interested in careers in agriculture. Top, Middle school students participate in the Junior MESA Soil Science Contest at Cal Poly; left, Cal Poly senior Tony Marshall helps a visiting high school student dissect a mouse; right, Phil Bailey demonstrates chemistry principles. Photos by Bret Harrison.

tional knowledge and general decisiveness were statistically about equal across groups. Career choice importance was also about equal, except for students in the lowest grade category who reported the lowest levels of importance.

Career guidance programs. Based on the students' self-perceived needs, these findings highlight the strong need for greater support of career exploration and planning processes for adolescents, particularly those from minority populations. These processes must focus on helping youths understand themselves as well as the work world. The students' responses suggest that they would be very receptive to reliable sources of information, such as information that can be provided in school-based career guidance programs. The fact that the school programs are underutilized should prompt educators to reexamine those programs and the approaches used to reach and engage students (see p. 48).

The low rate of occupational decisions found among male Latino students deserves particular attention. Although, as we noted, a decision on occupation is not necessarily a desirable goal for high school students, the total pattern of response for these youth — in which low decidedness is accompanied by relatively low prevalences of comfort level, perceived self-clarity and occupational knowledge — suggests that they need better assistance than they currently receive in critical developmental tasks related to career exploration.

The results also demonstrate that approaches to career guidance should be sophisticated enough to address the varying patterns of need among students. For example, adolescents who feel they know their chosen field require different types of support than those who are at an earlier stage in the career planning process. Guidance programs, both within and outside of school set-

tings, need to ascertain whether they provide a sufficiently tailored approach.

Part-time work during high school

The great majority of U.S. adolescents work for pay at some point during their high school years (Mortimer and Johnson 1998). Given the recognized importance of preparing adolescents for the work world, the prospect of employment during high school is often viewed as a valuable opportunity. Many adults believe that part-time work exposes youths to the real-world necessities involved in getting and keeping a job, helps them learn the value of punctuality and other self-organizational skills, and helps them develop personal interaction skills from relating to coworkers.

However, there are potential costs involved. Several studies have documented negative effects on schooling such as reductions in time spent on homework and reduced school en-



Youth group programs and activities can introduce students to a wider range of opportunities. Jack Crane and Cassandra Barajas were among a group of high school students from California who attended the 4-H National Conference in Washington, D.C.

agement, higher daily stress levels, and increased exposure to alcohol and drug use in the workplace (Bachman and Schulenberg 1993; Steinberg et al. 1993). A critical factor in this double-edged relationship is the number of hours worked. Students who work more than 15 to 20 hours per week are particularly susceptible to becoming disengaged from school and more involved with problem behaviors. Students who work fewer hours per week generally show fewer difficulties in balancing school and work. In fact, Mortimer and Johnson (1998) found that high school seniors working fewer than 20 hours per week had higher grades than their peers who either worked more than 20 hours or did not work at all. In sum, then, although the research literature is generally consistent on the detrimental effects of heavy part-time workloads, there is still some disagreement regarding the overall advisability of working less than 15 to 20 hours per week.

We asked our student survey respondents a number of questions relating to their work experience, including whether they had worked at all in the current school year, the number of hours and the type of work. Overall we examined the effects of part-time work in terms of school, perceptions of cost and benefit, and career awareness.

As has been noted in other studies,

we found in our survey that most high school seniors worked. In the full sample, 78.5% of the students reported having worked for pay in a structured setting at some point in time, and 58.6% reported having done so during the current academic year. Working during the current academic year was not statistically related to either income level or ethnicity, but it was significantly related to gender, with more females (62%) than males (54%) having worked (chi-square = 6.73, $P < 0.01$).

With regard to grades, working students did not at all tend to be the lowest school achievers, as grades were not statistically related to either "ever worked" status or current-year work status. In fact, the highest percentage of current-year employment (56.9%) was found among students reporting a GPA of 3.5 and the lowest percentage of employment (48.5%) was found among students reporting GPAs of 2.0 or lower.

However, as noted in previous studies, a critical factor is not merely whether students work but how many hours. Therefore we compared the GPAs of students in five categories: not working in current academic year, or working 1 to 5, 6 to 10, 11 to 15, or 16 or more hours. There was no statistically significant relationship between the number of hours students worked each week and their GPAs. In fact, nonworking students reported a mean GPA essentially equivalent to those working 16 hours or more (3.02 versus 3.01, although the middle groups showed slightly more variability).

We also looked at students' school engagement, using a scale with six items (for example: "I enjoy going to school"; "I have a hard time caring about much of the material in my classes" [scored in reversed direction]). The range of possible school engagement scores was 0 (low) to 15 (high), and the mean of the overall sample was 10.70. Once again, this variable was not statistically related to work status. Overall, then, we found absolutely no evidence that students'

part-time work is detrimental to school achievement or school engagement.

We next examined whether students' work status might be associated with differences in career awareness. Students who worked during the current year were compared with those who did not work on the five career-awareness variables described previously (fig. 1D). Slightly higher percentages were found for working students on four of the variables, reaching marginal statistical significance with P values between 0.06 and 0.09: occupational decidedness, comfort level with current vocational decision status, self-clarity about interests and abilities, and sufficient occupational knowledge. In addition, a highly significant difference ($P < 0.001$) was found for students' belief that career is important to consider at the present time: A greater percentage of the working students responded that it was important. Overall, these results suggest that the students who worked in their senior year were more



John Stumbos

The great majority of high school students work for pay at some time. The study found that part-time work was not detrimental to students' grades or engagement with school. Stress levels were, however, correlated with the number of hours worked. Above, A young person works at the California State Fair in Sacramento.

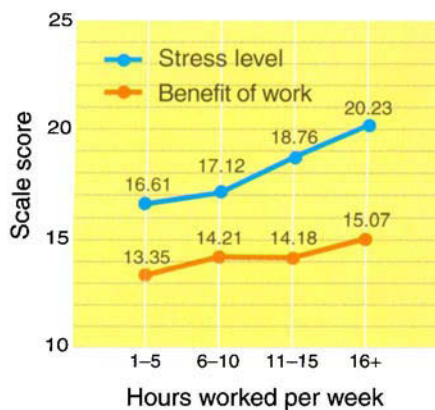


Fig. 2. Relationship of work level to stress and perceived work benefit. Scale range for benefit of work: 0 (lowest) to 24 (highest). Scale range for stress level: 5 (lowest) to 38 (highest).

active in exploring career options and more convinced of its importance.

Finally, we looked at students' perceptions of working. For this purpose we developed two scales, one with 11 items pertaining to stress at work (sample items: "Because of my job, I come to school tired"; "Being a worker and student is stressful") and one with eight items pertaining to the potential benefits of working (sample items: "Working has helped me develop my ability to be on time"; "Working has helped me feel positive about myself and my abilities"). Only students who reported working during the current academic year answered these questions. We found two statistically significant linear trends (fig. 2). On the positive side, the perceived benefits of work increased along with the number of hours worked ($P < 0.05$). However, an even stronger statistical relationship was evident indicating the costs of working: perceived stress increased with the number of weekly hours worked ($P < 0.001$). In sum, these students reported both positive and negative consequences of an increasing level of part-time work.

Our findings suggest that part-time work is generally not detrimental to other areas of students' lives. The students who worked in their senior year did not appear to be hindered in their

grades or engagement with school. They perceived benefits to their work experiences, and even appeared to be somewhat more attuned to tasks related to career development. The one negative finding associated with part-time work was that students' stress levels increased as well. The level of stress reported was directly related to the number of hours worked per week, suggesting that the students may have been experiencing some difficulty in balancing demands of different parts of their lives.

A critical question voiced by researchers is whether the negative findings often associated with part-time work are due to the work experience itself or to a self-selection process, in which students who are lagging academically simply enter the workforce at an earlier age than their classmates. Some studies have found that both processes are operative: students who work long hours are indeed different from their peers even before their work experience, but the work experience can exacerbate the existing risks and accelerate the disengagement from school (Bachman and Schulenberg 1993). However, there is also general agreement that one cannot make sweeping statements applying to all students in this age group. Some students thrive with additional work responsibilities while others find it difficult to strike a successful balance. Furthermore, work experiences will be more valuable for adolescents if some degree of complexity and autonomy can be incorporated into the work tasks (Vondracek 1993).

Need for career preparation

Our study's results confirm that there is a clear need for more effective career preparation programs for young people. Nationwide over the past several years, the Cooperative Extension System has played a leading role in providing informational outlets to educators and youth programmers regarding current ap-

proaches and federal recommendations for workforce preparation. The topic of career preparation will undoubtedly occupy the national spotlight in coming years, as the complexity and rate of change in the modern workplace continue to accelerate.

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California Conservation Corps offers youth career development opportunities

Sally M. Stanley

Young people who leave high school without going on to college are a critical population to understand in terms of career development. This report highlights findings from a study of 166 youth who had recently joined the California Conservation Corps (CCC). Thirty percent of those surveyed had not completed high school. About one-fourth of the corps members had joined CCC with the hope of an eventual career with the Corps, and more than one-third were using CCC to explore job and career opportunities.



All photos courtesy of California Conservation Corps.



Since 1976, California Conservation Corps (CCC), a state agency, has provided employment for youth and labor for natural resource protection and enhancement. Today many young people also utilize the program for career development. Above, Corps members completed a project at the U.S.-Mexico border near San Diego.

Entering the working world has never been an easy transition, but for young people today it involves many new challenges (see p. 48). Consequently, one would expect the first few years after high school to be a critical time in the lives of young people who do not go on to college. In today's labor market a college education is frequently required for work that can provide a decent income; as a rule, high school programs generally focus on preparing youth for college (Glover and Marshall 1993). However, in California, only 50.5% of students graduating from high school in 2000 entered a 4-year college program directly after high school, lower than the national average of 62.9% (Children Now 2001).

For some young people in California, the California Conservation Corps (CCC) presents an interesting alterna-

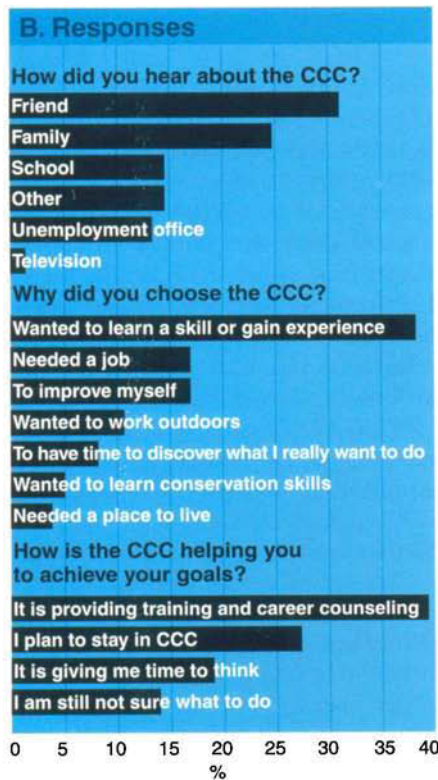
tive to college. The program is considered one of the oldest and largest youth conservation corps programs in the United States today (Grossman and Tierney 1993), and currently operates as a service-learning program for exploring career options. Researchers at UC's 4-H Center for Youth Development (CYD) and their colleagues were interested in finding out if youth used the CCC program for career development. This study was conducted to investigate how reflective these young people were about their career choices and whether they were developing skills that would be helpful in the working world.

Jobs for youth

The California Legislature established the CCC in 1976 as an innovative state agency to focus on the employment and development of Cali-

fornia youth, as well as the protection and enhancement of the state's natural resources. The CCC seeks to generate feelings of civic responsibility as well as provide labor needed for state projects. Along with its day-to-day conservation work and training, the CCC provides emergency assistance in floods, fires, oil spills or earthquakes.

The CCC offers an opportunity for California residents between the ages of 18 and 23 to participate in a work-learn program and to develop their career interests. Young persons applying to CCC must pass a physical exam, and they cannot be on probation or parole. Interested persons generally apply throughout the year at a CCC recruitment office. The number of youth allowed to participate varies by budget year. In 1997, the year the CYD study was conducted, the governor's office allotted 1,496 positions. How-



ever, 2,962 young people in California applied for the Corps that year. Generally, more applications are accepted than allotted because many of the applicants do not show up to their assigned district, and many leave after the program has started.

There are 11 geographical CCC districts throughout the state. Each district requests a specific number of recruits depending on the number of positions that need to be filled. Some districts are specialized for training in particular industries at specific times, as new needs develop. For example, when the survey was conducted the Auburn CCC district specialized in auto mechanics; Humboldt County had a salmon restoration program; and in San Luis Obispo County, youth were being trained in geographic information systems (GIS).

New recruits are allowed to look through a list of open positions at the various CCC sites and choose when and where to serve the Corps. Corps members are required to continue their education by taking classes to earn a general equivalency diploma (GED) or enrolling at a community college. The CCC pays college tuition and costs associated with obtaining the GED.

Corps members can choose to live at home and report to work daily, or live in a dormitory in residential centers located at the CCC site. Corps members earn minimum wage for a typical 40-hour workweek, and can earn more for overtime. If they choose the residential option, a small amount (currently \$260) is deducted from their paychecks. If they live at home, they bring their own lunches; dormitory residents eat in dining halls and receive lunch. A typical workday begins at 8 a.m., and ends with evening



In 2002, about 2,000 CCC positions were allocated among 11 geographical regions. The majority of corps members are male and about 40% enter directly out of high school.

classes to continue their training. Corps members are on their own on the weekends, although the residential districts try to provide healthy activities.

Corps members are assigned to fill the current needs of the state. For example, they may do energy audits of government buildings, plant trees or clear brush or flood channels. They often work in state parks, and can be seen landscaping schools or maintaining medians on state highways. When there is a state emergency such as a flood or fire, crews from various districts are dispatched, and regular work stops until the emergency needs are met. Comments from alumni of the CCC program suggest that youth are quite proud of the contributions they make to the state during times of emergency.

All new and incoming corps members must attend Career Orientation Motivation and Education Training (COMET) classes that are designed to provide training in basic work ethics and information on career development. After completing 1 year in the program, corps members receive assis-

Fig. 1. (A) Demographics of California Conservation Corps (CCC) entrants participating in 1997 survey; and (B) their responses to questions about the CCC program. Percentages are based on total number of valid responses. Some respondents declined to answer some questions.



◀ In a survey of 166 young people entering the corps, the CCC appeared to fulfill a career-counseling role for youths who did not take advantage of school-based services. A corps member works on a creek restoration project in the San Francisco Bay Area.

tance in locating employment, and a transition program guides them in tasks such as interviewing and resume writing. For example, CCC may help youth obtain entry-level positions with the Parks and Recreation Department. Some corps members (about 10%) choose to pursue CCC as a career, for which they must pass a civil service exam.

Little research has been conducted on the CCC. However, in their 1993 evaluation Grossman and Tierney found that 58 to 63 months after participation in the program, CCC participants showed lower-paying jobs than youth in their comparison group. However, the authors acknowledged that their study design was flawed. Because CCC participants were more generally disadvantaged and more likely to have dropped out of high school, the study's findings were bi-

ased in favor of the comparison group. Grossman and Tierney therefore concluded that the comparison group only appeared to fare better than the CCC participants. Whereas Grossman and Tierney focused on financial outcomes for CCC participants, this study focuses on the use of the CCC program for career development.

Career exploration at CCC

The 4-H CYD surveyed 166 incoming CCC recruits, in COMET classes in nine of the 11 state districts. All new recruits entering the program in June and July 1997 in each district participated. All corps members were allowed to take as long as needed to complete the 237-item, multiple-choice survey as well as several write-in questions. The survey requested information on demographics, family, school, reasons for selecting the Corps and future occupational goals. Corps members also took the Career Decision Profile (CDP) to measure career awareness (see p. 55)(Jones 1989). The term *career awareness* refers to reflective processes about future work life rather than decidedness. They also took a Career Key and a Task Specific Occupational Self-Efficacy Scale, which focus on personality variables; these have not yet been analyzed. Although no formal interviews were

conducted, the researcher visited with youth and toured the sites.

Demographics. Although there was 100% participation at the sites surveyed, our sample includes only about 11.1% of the new CCC recruits for that calendar year. Most of the respondents were white, male and 18 or 19 years old (fig. 1A). Many corps members elected not to answer gender- or income-related questions. Almost half of those surveyed lived at the CCC site in a dormitory situation, while 27% lived at home with their parents. Although about one-fourth of the corps members hoped CCC would lead to a permanent career, most of the new recruits in our sample had joined to help develop their job skills and explore career opportunities (fig. 1B).

Career awareness. In general, 60.7% reported being decided on their career field. Of the total, only 44.7% were comfortable with their current decision status. Only 47.2% reported having a clear idea of their interests and abilities, and 50.9% felt they had sufficient knowledge about occupations (table 1). However, 85% felt it was important to make a career choice at the present time. There were no significant differences noted between demographic characteristics and career awareness, though the older corps members were slightly less comfortable and more concerned about their lack of knowledge about careers.

Work histories. The research team was also interested in the previous work histories of the corps members. Work histories usually develop prior to the transition to adulthood (Entwisle et al. 2000). The majority of youth in the United States perform some type of paid work while in high school. Recent studies have shown that this does not affect academic performance unless youth work more than about 20 hours per week (see p. 55). Although 46% of the corps members surveyed said they had worked for pay while in high school, only 10.8% of this group said they worked in order to explore careers or gain work experience. Their attitude

TABLE 1. California Conservation Corps members reporting affirmatively (%) on career awareness characteristics, 1997 survey*

Career awareness variable	Total	Gender	
		Male	Female
Decided on occupational field?	60.7	58.3	67.9
Comfortable with current decision status?	44.7	43.0	50.0
Clear idea of own interests and abilities?	47.2	46.3	50.0
Sufficient knowledge about occupations?	50.9	53.1	44.4
Is career choice important at present time?	85.0	83.8	88.9

* Percentages based on total number of valid responses for each item. Some respondents declined to answer some items.

toward working was positive, but 48.6% of corps members who worked during high school said the main reason was to earn spending money. Saving for school (16.2%), supplementing parents' income (10.8%) and fun (13.5%) were other reasons corps members listed. Corps members were divided into those who had worked during high school and those who had not, and into youth who were high or low on career decidedness. Of the youth who had worked, significantly more were in the highly decided group than in the low-decided group (chi-square, $P = 0.051$).

Corps members. Sixty-eight percent of survey participants self-reported their high school grade point average (GPA) as 2.5 or less. Thirty percent (30.2%) had not completed high school and were completing GEDs as part of the CCC program. When GPAs were divided into corps members who reported a 3.0 GPA or higher versus those with 2.5 or lower, there was a significant relationship between dropping out of high school and having a lower GPA (chi-square, $P = 0.000$).

There was also a relationship between GPA and reasons for joining the CCC. More youth with higher GPAs indicated they had joined CCC to learn a skill or gain experience, and youth with lower GPAs indicated they had joined CCC because they needed a job (chi-square, $P = 0.024$). Of corps members who were continuing their education, only 15% thought they would obtain a college degree. Lack of finances and information were the two barriers youth felt most frequently prevented them from reaching their occupational goals.

Supportive influences. Corps members reported they had received the most support in career planning from their parents. Around 20% stated they were unaware of any counseling programs offered in their high schools, and 24% said their high schools did not offer individual career counseling. A little over 18% said their high school did not offer classroom career counsel-

ing, or any practical information. Almost 30% said that computerized career-counseling programs were not available. When programs were offered, 16% to 22% of corps members chose not to use them. Of corps members who did participate in high school counseling programs, only one-fourth felt they were of any help. Of these, 33.2% said practical information — unrelated to careers, per se — was most helpful, such as about financial aid or military services. Corps members who had completed high school were more likely to have used counseling services and know that they existed.

The CCC alternative

The CCC program provided us with some insight into the career exploration that continues after high school. Although dependent on the level of state government funding, the CCC offers an opportunity for many California young people to continue their career exploration while performing useful work for the state. The CCC also seemed to fill a career counseling role for youth who did not take advantage of counseling opportunities offered in their high schools.

Like Grossman and Tierney (1993), we found that most youth joining the CCC tended to be more economically and scholastically disadvantaged than most young people their age. However, our study did not focus on long-term outcomes but on the use of the program for career development. Although this study reports on only a small sample of participants in the CCC that year, it confirms that youth who do not continue on to college are not only concerned about their work lives but continue to explore career paths after high school. In the survey participants said they needed more information on career development, and joining CCC was their way of taking the initiative to understand some of the options available for future work. Our study did not provide enough information on the thought processes involved in their understanding of

career development. Nor is it clear what type of information young people would find most useful.

California is faced with a projected increase of 5 million youth by 2025 (Russell 2000). These youth will need to find work. College is not the only alternative for gainful employment. There is also a definite need for qualified, skilled workers in occupations that do not require college, such as electricians, machinists and welders (Barrows 2000). What is needed now is a way to help fit the skills and interests of young workers with the needs of the workplace.

S.M. Stanley is Researcher, 4-H Center for Youth Development (CYD), Department of Human and Community Development, UC Davis. She would like to acknowledge Marc Braverman and the researchers at CYD and in the counties who participated on the research team as part of this project. She is also grateful to Robert Weisskirch, who collected data at two of the California Conservation Corps (CCC) sites, and Susanne Levitsky of CCC for helpful comments. This study was funded by the UC Division of Agriculture and Natural Resources and conducted in cooperation with the CCC.

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Teen financial literacy evaluated to develop outreach materials



Teenagers spend an estimated \$155 billion per year, mostly for recreation and luxury items. A study by the UC Money 2000+ for Teens workgroup examined what kinds of outreach materials teenagers want and need for financial information. In Moreno Valley, 18-year-old Christina Craig shops at a mall for CDs.

Teenagers have access to and spend a great deal of money each year, yet research indicates that their financial literacy is low. Many curricula for teaching money management exist, but we do not know if we are teaching teens what they want to know in a way that they want to learn. This study, conducted by the Money 2000+ for Teens Workgroup of the UC Division of Agriculture and Natural Resources, sought to find out what teens want to know about financial management. Questionnaires were administered to 323 teens from five diverse groups: teens who were in juvenile hall or on probation, in public high schools, migrant education programs, pregnancy and parenting classes, and youth groups. The data were used to develop educational materials with "teen appeal," which are currently being evaluated for eventual distribution nationally.

National surveys indicate that today's teenagers spend a great deal of money — \$155 billion in 2000, according to Teenage Research Unlimited (2001) — and most of that spending is related to the self-gratification of immediate wants (Sivy 1997). Their desire for goods and services motivates employment, and they often buy brands that parents view as "too expensive." A study by Alhabeeb (1996) indicated that most of adolescents' discretionary income is spent on "recreation and luxury items." Evidence that adolescents practice or appreciate saving is limited. In contrast, a more recent study by the American Savings Education Council (ASEC)(1999) found that 54% of students felt that it was important to save money on a regular basis and "49% of students always saved some money when they received an allowance or got paid."

Does this mean that teens know how to manage their money? Not according to a recent survey. The average score for high school seniors on a national money management test was 52%, a failing grade by standard grading systems (Jump\$tart Coalition 2000). In addition, their knowledge

level appears to be falling; the average score on the same test completed in 1997 was 57% (Jump\$tart Coalition 1997).

High school seniors have little knowledge of money management, savings, investments, income and spending. Although experts contend that children can grasp the concept of money as early as age 3 (Wang 1993), the ASEC study found that the majority (79%) of students aged 16 through 22 had never taken a class in personal finance. Two-thirds of these respondents admitted that they could use a few more lessons on money management, and 9% of the respondents were rolling over credit card debt each month (32% had a credit card). Teenagers' spending behaviors and their limited understanding of money management can promote habits that may lead to costly mistakes today and in the future.

Effectiveness of education

A recent study of a financial planning curriculum indicated that high school students respond positively to instruction aimed at improving their money management skills (Danes et

TABLE 1. Characteristics (%) of teenagers surveyed about financial literacy

	Prb* (N = 72)	Mig (N = 39)	Prg (N = 77)	Sch (N = 74)	Yth (N = 61)	Total (N = 323)
Gender						
Male	60	55	4	43	39	38
Female	40	45	96	57	61	62
Grade						
7th or 8th	9	0	0	25	15	10
9th	21	11	7	0	9	9
10th	15	31	21	1	33	18
11th	22	19	37	10	22	23
12th	25	39	36	63	22	38
Other/not in school	8	0	0	0	0	2
Ethnicity						
Black	17	21	14	11	11	14
White	12	3	12	14	46	17
Latino	49	69	60	48	16	48
Native Am., Eskimo, Asian, Pacific Islander, other	23	8	15	27	28	21

* Prb = juvenile hall/probation; Mig = migrant; Prg = pregnant/parenting; Sch = school; Yth = youth groups.

al. 1997). As little as 10 hours of classroom instruction produced significant knowledge and behavioral changes; a follow-up evaluation showed that positive changes tended to last over time. This supports findings of the Economic Research Institute that adults who grew up in states where personal finance education was mandated in high school are saving 5% more money than their peers (Stanger 1997). Also, their net worth is higher by roughly a year's worth of earnings.

In contrast, the 2000 Jump\$tart Coalition study found that teens who had taken a financial management class did not necessarily improve their financial behavior. They were no more likely to save money or budget their income or expenditures than teens who had not taken a financial educa-

tion course. Financial management education can make a difference but does not always result in positive outcomes. One reason for this difference could be whether or not the curriculum focuses on what teens want to know.

Teen survey

Because teenagers are a unique audience, identifying their interests can help to develop programs and outreach materials with "teenage appeal." In fall 1998, using a convenience sample, the Money 2000+ for Teens Workgroup of the UC Division of Agriculture and Natural Resources (ANR) surveyed five groups of teenagers: those in juvenile halls or on probation, migrant education programs, pregnancy and parenting programs,

public high schools and youth groups such as 4-H.

UC Cooperative Extension advisors in Los Angeles, Imperial, San Bernardino and San Luis Obispo counties made contact with adults who worked with each of the five groups. The adults gave the surveys to the students to complete independently. The 21-question survey was kept short to encourage participants to complete it. Multiple-choice questions were used to inquire about sources of income, how teens use money, what types of financial information they would like to receive and how they would like to receive it. A total of 323 surveys were completed.

Sample characteristics. Of the teen respondents, 38% were male and 62% were female, and the majority were in 12th grade (38%) or 11th grade (23%)(table 1). The largest ethnic group represented was Latino/Hispanic (48%), followed by white (17%) and black (14%). The large Latino representation roughly approximates the population of Southern California, where the data was collected.

Income. Although there were variations in the amount of income, 70% reported that their parents were their main source of income — an average of \$10 a week. This was especially true for the high school and youth groups, who reported allowance and gifts as their primary sources of income. Pregnant or parenting teens primarily received income from their boyfriends and assistance programs, while the juvenile hall or probation group listed working, hustling (obtained by questionable means), selling drugs, prostitution and stealing as their sources of income. In addition, 34% of all teens received some income from odd jobs.

Use of money. When asked what makes money important to them, most of the teens indicated that it helps them to buy the things they need. This

TABLE 2. Comparison of significant teen group responses (%) to financial literacy survey

	Prb* (N = 72)	Mig (N = 39)	Prg (N = 77)	Sch (N = 74)	Yth (N = 61)	Significance†
What makes money important to you? (check up to three)						
Buy things I need	59	61	93	57	44	P < 0.001
Help my family	52	36	58	35	15	P < 0.001
Do things with my friends	24	17	7	35	41	P < 0.001
Buy things I want	44	31	13	35	62	P < 0.001
Do you currently have a (check all that apply)?						
Savings account	25	39	29	47	52	P < 0.01
Investments (bonds, stocks)	3	3	9	7	20	P < 0.01
None of the above	71	54	56	42	37	P < 0.001

* Prb = juvenile hall/probation; Mig = migrant; Prg = pregnant/parenting; Sch = school; Yth = youth groups.

† Significance of chi-square, test of independence in a 5 x 2 frequency.

was especially true for 93% of pregnant or parenting teens (table 2). Second, most of the teens wanted money to help their families, which is not surprising given the survey sample. The juvenile hall and probation teens (52%) and pregnant or parenting (58%) youth were more likely to give this response. The teens from public high school and youth groups were more likely to indicate that money was important to them so they could do things with friends (35% and 41%, respectively) and buy things they wanted (35% and 62%, respectively).

Interestingly, there were significant differences among the groups in whether or not they had a savings account, investments or neither. About half of teens surveyed in high school classes and those in youth groups had a savings account, as compared to only 25% of the incarcerated, 39% of migrants and 29% of pregnant or parenting teens. Only 37% of youth group and 42% of high school teens did not have a savings account or investments, while over half of the other groups did not have savings accounts or investments.

Financial information. In general, the teens wanted to know about opening and using checking and savings accounts, obtaining credit, car buying and buying clothing/personal-care items (table 3). The migrant (54%) and high school (45%) teens were interested in saving for college, while the pregnant or parenting (41%) and juvenile hall or probation (38%) teens were most interested in learning how to save for a home.

Not surprisingly, the teens were more interested in learning “how to get credit” than about “what credit is” and the consequences of bad debt. They wanted to learn how to deal with creditors, although the juvenile hall or probation (25%), migrants (27%) and public high school (23%) teens were much more interested than pregnant

or parenting (6%) and youth groups (9%). Across the groups, 14% did not want to learn about credit. Unfortunately, if not offered an extensive course in personal finance, these young people will have to learn by trial and error.

Finally, all the young people surveyed wanted to learn more about how to buy a car and clothing/personal care items. Fortunately, 35% also realized that they need to know more about how advertising makes consumers spend.

Financial information delivery. Most of the respondents agreed that “during school” is the first choice for learning about money topics, although the migrant teens preferred to learn from organizations outside of school. Magazines and newsletters delivered to home were the second choice, followed by organizations outside of school and Web pages.

Money Talks newsletters

In response to the survey findings, the Money 2000+ for Teens Workgroup developed a series of four attractive newsletters with corresponding leaders’ guides. To improve the financial literacy of teens, we sought to find the “teach-

able moment” and “teachable topic.” The newsletters focus on topics identified by the teens: money personality (what influences them to spend) and spending habits, easy ways to save, shopping tips and car buying. The newsletters are designed to be hands-on and used at local schools and after-school programs — the places where the teens said they wanted to learn. The newsletters include quizzes, informational articles and games related to a main topic such as saving or car costs.

Through a five-county pilot study, the workgroup is currently in the process of evaluating the effectiveness of these newsletters. Teens from a variety of groups including those surveyed originally are being asked questions after they use the newsletters. Based on pretest and posttest surveys, preliminary analyses indicate that they are successful in engaging and educating teenagers. For example, after being involved with the program, respondents reported talking more frequently with their families about their use of money, the importance of savings, family finances and how the family’s money should be spent.

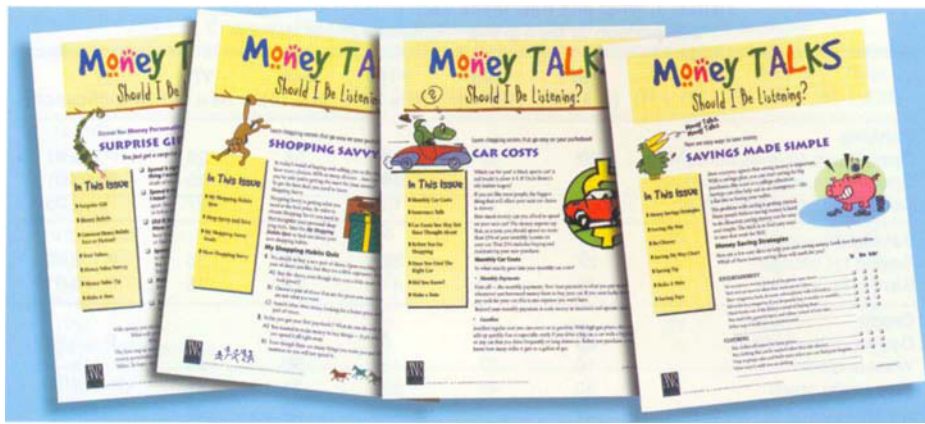
The teens also reported thinking more about saving money for the fu-

TABLE 3. What and how teens want to learn about money, comparison of teen group responses (%) to survey

	Prb* (N = 72)	Mig (N = 39)	Prg (N = 77)	Sch (N = 74)	Yth (N = 61)	Significance†
Banking						
Open & use savings account	52	42	49	35	23	P < 0.01
Open & use checking account	52	42	49	35	23	P < 0.01
Don't want more information	6	11	13	17	27	P < 0.05
Saving my money						
Saving for college	27	54	32	45	30	P < 0.05
Saving for a home	38	30	41	22	15	P < 0.01
Credit						
Dealing with creditors	25	27	6	23	9	P < 0.01
What is credit	19	27	15	20	21	NS
How to get credit	43	49	57	35	45	NS
Consequences of bad credit	28	8	28	20	21	NS
How to buy						
Car	74	62	68	65	61	NS
Clothing/personal care	43	24	34	23	22	NS
How would you like to learn about the money?						
During school	65	30	67	57	49	P < 0.01
Groups outside of school	40	38	19	15	23	P < 0.01
Magazine/newsletters	44	43	41	35	42	NS

* Prb = juvenile hall/probation; Mig = migrant; Prg = pregnant/parenting; Sch = school; Yth = youth groups.

† Significance of chi-square, test of independence in a 5 x 2 frequency table; NS = not significant.



Teenagers wanted to receive information on opening checking and savings accounts, obtaining credit, buying cars, and purchasing clothing and personal care items. Based on these results, the workgroup developed four newsletters, above, which are being evaluated before national distribution. *Right*, Christina Craig leaves the mall.

ture, and this finding was supported by an increase in the number who saved some money weekly (74% before versus 90% after the program). In terms of shopping, they reported comparing prices more often and waiting to buy, reducing impulse buying. The financial skills were especially relevant when it came to buying and maintaining a car. Most reported an increased awareness about ways to save money on car insurance costs, such as drivers' education, having good grades, not getting traffic tickets and being added to their parents' insurance policy.

Future directions

As a society, it is our role as educators and parents to teach youth how to develop into successful and productive adults. Inherent in this outcome is teaching youth how to successfully manage their personal finances. Through the initial survey, we learned about the extent of teens' knowledge about money and how they plan to use their money. Most importantly, we learned how teens want money management information to be presented.

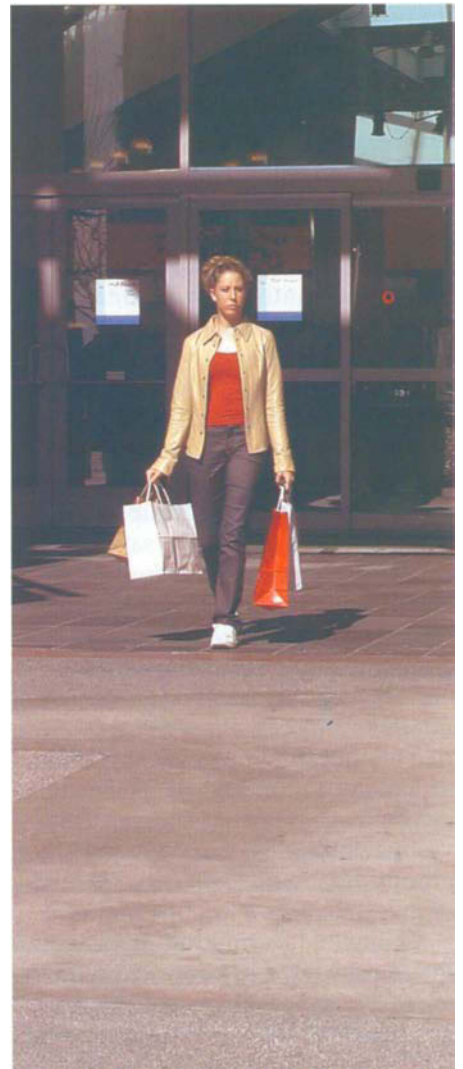
After completing an evaluation of the newsletter and teacher's guide, the workgroup will revise them before distribution nationwide. The workgroup is also developing a video and Web site, which will include many of the activities from the Money Talks newsletters in an interactive format.

These will be available on compact disc for individuals and groups without Internet access. In the future, the workgroup plans to create a money management program for elementary school youth. Like reading and math, money management is a developmentally based skill, and the earlier we teach basic skills, the easier it will be for youth to learn the complexities of money management.

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Long-term studies find benefits, challenges in alternative rice straw management

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California state legislation passed in 1991 mandated a phased reduction of rice straw burning in the Central Valley, to reduce air pollution. In 1993, UC Davis scientists launched an 8-year research project on the long-term effects of various alternative means of managing rice straw. Burning, incorporation into the soil, rolling, and baling and removing the straw were compared, with and without winter flooding. None of the various practices reduced

grain yields on our experimental plots, but there was an increase in weeds when straw was incorporated, and in particular when the fields were not winter flooded. However, when straw is incorporated, nutrients are returned to the soil and less nitrogen fertilizer can be applied, resulting in lower production costs and less potential for water pollution. In addition, waterfowl on the Pacific Flyway benefit significantly from the wetlands created when fields are flooded during the winter.



The burning of rice straw, top left, was the norm until 1991, when a state law was passed to phase out the practice in order to prevent air pollution. Growers have turned to alternative practices such as winter flooding of fields, above, to reduce weed and disease pressure. Winter flooding has also been a boon for birds on the Pacific Flyway.

Rice straw management in California's Central Valley has undergone profound changes over the past decade. Historically, rice growers routinely burned their field to dispose of rice straw for sanitation and seedbed preparation purposes. In 1989, when 400,000 acres of rice were grown in California, 95% of the resulting debris was burned in the field, creating air pollution in the Central Valley and statewide.

California state legislation passed in 1991 (Connelly-Areias-Chandler Rice Straw Burning Reduction Act) mandated a phased reduction of rice straw burning. The final step of the phase-down started in September 2001, when the law allowed burning only for disease control. Under the current scenario, disease-control burning will be limited to 25% of the approximately 500,000 planted acres or 125,000 acres, whichever is less. In the future, further

reduction in burning is likely. The intent of the phase-down was to allow growers to make a gradual transition and allow some burning while alternative uses for straw were developed. Unfortunately, the market for rice straw has failed to grow as anticipated. Less than 3% of straw that is not burned is used off site (CRARB/CDFA 2000), resulting in a dramatic increase in the incorporation of rice straw.

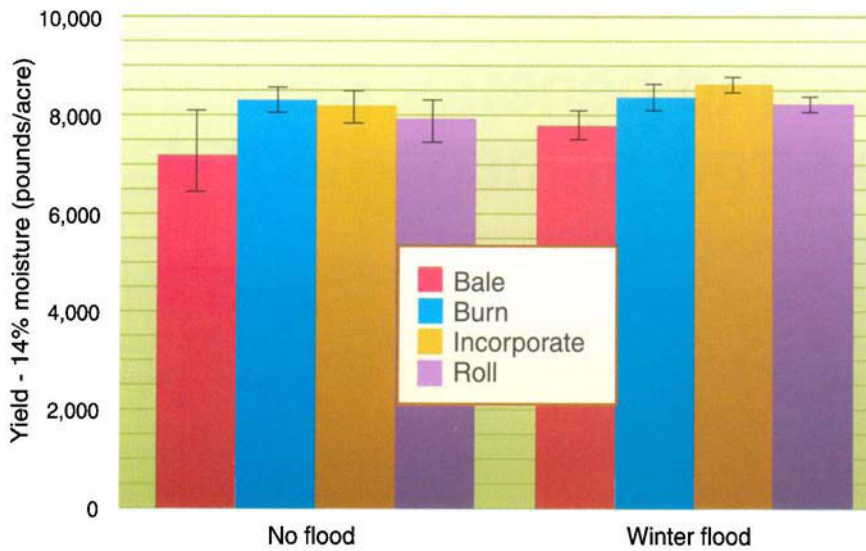


Fig. 1. Yield of rice grain in Maxwell (Colusa County) in 2000, after seven seasons of alternative straw management practices. Lines in bars represent standard error.

In 1993, UC Davis scientists launched an 8-year research project on the long-term effects of various alternative rice straw management practices. With funding from the California Energy Commission, Ducks Unlimited and the California Rice Research Board, several alternatives to burning were examined for their effects on rice yield, soil fertility, insect pests, diseases and weeds. Four straw management practices were examined: burning, incorporation, rolling, and baling and removing the straw. Each of these straw treatments was compared with and without winter flooding, resulting in the evaluation of eight different straw management practices. In this review, we summarize the key findings of several related studies.

The research effort

The primary purpose of the project was to examine the impact of long-term straw incorporation and winter

flooding on nutrient cycling and rice production. An experimental site was established in fall 1993, at Maxwell in Colusa County. The experiment was laid out in a randomized split-plot design with four replications. The main plot treatments for the experiment were winter flooding and no winter flooding. The subplot treatments were the four straw management practices mentioned above.

Cultural practices typical for California rice production were used for flood water, tillage, pest and fertilizer management. Field plots were large (2 acres per subplot treatment) to allow the use of commercial field-scale equipment. Fields were flooded during the growing season and then drained before harvest. Each fall following harvest the straw was either (1) burned, (2) chopped and then incorporated using a chisel plow or disc, (3) rolled with a heavy roller to crush the straw into the soil surface, or (4) wind-

rowed, baled and removed from the field.

Fields were winter flooded 4 to 6 inches deep following the completion of the straw management practices and drained in early spring to allow sufficient time for soils to dry before spring tillage. Fields were tilled in the spring and nitrogen (N) fertilizer was applied at an average rate of 150 pounds per acre as aqua ammonia, and phosphorous (P) at an average rate of 20 pounds per acre as ammonium phosphate prior to seeding. Rice variety M202 (medium-size grain, early variety, approximately 140 days to maturity) was aerially seeded.

Straw management and yield

Rice growers in California have expressed concern that the conversion from burning to incorporating straw will increase weed and plant disease problems and possibly immobilize available soil nitrogen, thereby increasing the need for pesticide and additional fertilizer inputs. Grain yield was determined for each straw treatment from yield plots that ranged in size from 10 to 1,000 square feet (fig. 1). When averaged across years, grain yield was not significantly different among all straw treatments. Winter flooding had no significant effect on grain yield.

When straw is baled and removed, nutrients are exported from the field. Rice straw was collected when the straw treatments had been in place for 6 years. Straw was analyzed for elemental composition in the UC Division of Agriculture and Natural Resources (ANR) Analytical Laboratory at UC Davis using standard procedures (table 1). The nitrogen in rice

TABLE 1. Nutrient content of rice straw (pounds/acre) after 6 years of treatment (assumes 10,000 pounds straw/acre)

	N*	P	K	S	Ca	Mg	Na	Cl	B	Zn	Cu	Mo
Burn	61	14	72	10	29	18	79	8	0.15	0.41	0.31	0.02
Incorporate	67	13	80	10	28	18	77	8	0.14	0.41	0.31	0.02
Roll	69	13	75	10	28	18	79	8	0.16	0.42	0.37	0.03
Bale	70	14	79	10	27	19	74	8	0.15	0.41	0.23	0.02
Mean	68	14	77	10	28	18	78	8	0.15	0.41	0.31	0.02

* N = nitrogen; P = phosphorus; K = potassium; S = sulfur; Ca = calcium; Mg = magnesium; Na = sodium; Cl = chlorine; B = boron; Zn = zinc; Cu = copper; Mo = molybdenum.



In an 8-year study, a variety of alternatives to rice straw burning were evaluated for impacts on yield, soil fertility, insect pests, disease and weeds. From left to right: burned, cut, stubble-disked and baled rice straw.

straw ranges between 61 and 70 pounds per acre, and the amount of potassium (K) can be as much as 80 pounds per acre. Phosphorus levels in the straw ranged from 13 to 14 pounds per acre. It should be pointed out that approximately 50% to 60% of the straw will actually be baled and removed, and therefore the absolute amounts of nutrients removed will be less than reported in table 1.

Although nitrogen and phosphorus fertilizers were applied, potassium was not. Since most of the potassium taken up by the rice plant is in the straw and roots, the bale and remove treatment would result in substantial potassium losses from the system.

Soil fertility

Several studies were conducted to determine the effects of straw management practices on soil fertility. Zero-nitrogen microplots were established within each main plot treatment. The microplots received no nitrogen fertilizer. Phosphorus was added to the zero-nitrogen plots at rates equivalent to those applied to the main plots.

After 3 years, rice grain yield in the zero-nitrogen microplots was significantly affected by straw treatment (Eagle et al. 2000, 2001). From 1996 through 1999, treatments where straw was rolled or incorporated showed higher grain yields for every year than where the straw was burned or baled. Overall, winter flooding had no impact on grain yields with or without nitrogen fertilizer. This data suggests that rolling or incorporation of rice straw had increased the soil nitrogen supply of the fields after 3 years of straw retention. This appears to contradict the finding of no improvement in yields with standard rates of nitrogen fertilizer with straw incorporation. This is due to the fact that the amount of nitrogen fertilizer applied exceeds the amount needed for optimum yields.

To determine the amount of nitrogen fertilizer that can be reduced with annual straw incorporation, a nitrogen fertilizer response study was initiated in 1998 and carried out for three growing seasons. Progressively increasing levels of nitrogen fertilizer were ap-

plied on subplots located within the subplot treatments where rice straw was either burned or incorporated, with and without winter flooding (fig. 2). Similar nitrogen-fertilizer response curves were observed in all three years. As the level of nitrogen fertilizer applied increased, grain yields increased when straw was burned or incorporated. However, grain yields when straw was incorporated were higher than when straw was burned and received nitrogen fertilizer up to a rate of 120 pounds nitrogen per acre. These rate trials indicate that nitrogen fertilizer application can be decreased when straw is incorporated, because no yield response was further observed when more than 100 pounds nitrogen per acre was applied.

Based on all the results of the nitrogen application-rate study, we recommend that nitrogen rates can be decreased by at least 25 pounds per acre after 5 years of straw incorporation (Eagle et al. 2000, 2001).

Cycling of nitrogen and carbon

To further investigate the increased soil-nitrogen availability due to straw incorporation, new experiments were started in 1997 using labeled (heavy) nitrogen (¹⁵N). These experiments sought to answer three primary questions:

1. How much of the nitrogen taken up by the crop is from fertilizer and how much is from the soil?
2. Does the efficiency of added nitrogen fertilizer differ with straw incorporation or burning?
3. Does annual straw incorporation build up soil nitrogen and carbon (C)?

The ¹⁵N experiment confirmed the finding of increased soil nitrogen up-

TABLE 2. Total soil nitrogen (N) pool size (pounds/acre) as affected by 5 years of incorporating or burning straw, winter flooding and no winter flooding fields, May 1998*

Treatment	Soil N pools				Total soil N
	Inorganic N	Microbial biomass	Light fraction	Mobile humic	
Burn/flood	16.2	62.2	40.2	493	1930
Burn/no flood	11.5	66.3	43.8	455	1974
Incorporate/flood	16.0	79.8	47.3	536	1927
Incorporate/no flood	13.7	86.6	52.7	522	1940
P values					
Straw	0.039	0.003	0.095	0.109	NS†
Flood	0.055	NS	NS	NS	NS
S × F	NS	NS	NS	NS	NS

* Least-squares means (N = 12).

† NS = not significant.

take through incorporation. The cumulative effects of straw incorporation over the years led to greater net nitrogen mineralization, an increase in microbial biomass nitrogen and greater recovery of ^{15}N in the soil 1 year after application (Bird et al. 2001, in press)(table 2).

Carbon and nitrogen are retained in soil organic matter when straw is incorporated (fig. 3). The carbon is fixed by the plant via photosynthesis; the nitrogen is taken up by the crop from soil mineral nitrogen. This pool of available soil nitrogen consists of native soil nitrogen that has been mineralized by microbes or introduced to the system through the application of nitrogen fertilizer. When the crop residue is incorporated into the soil, some of the carbon and nitrogen move into what is known as the labile soil organic matter pool, which consists of partially broken-down residues and soil microbes. Some of the carbon and nitrogen is sequestered in the more stabilized fractions.

The study showed that a consistently larger soil microbial biomass nitrogen pool was observed when straw was incorporated than when burned

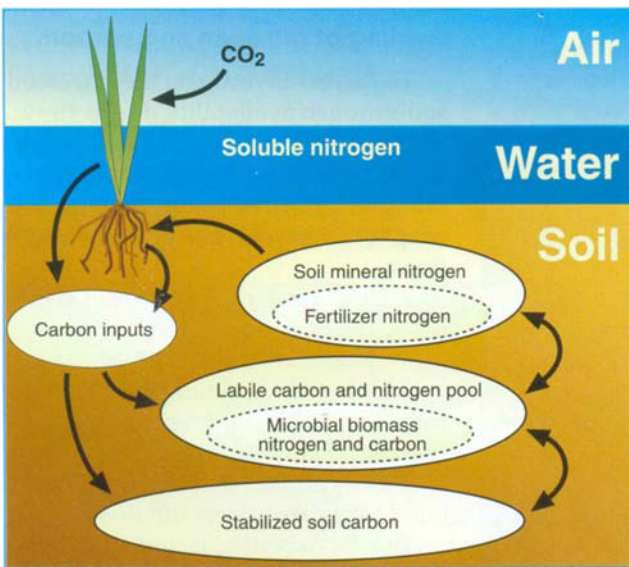


Fig. 3. Carbon-nitrogen interactions in rice.

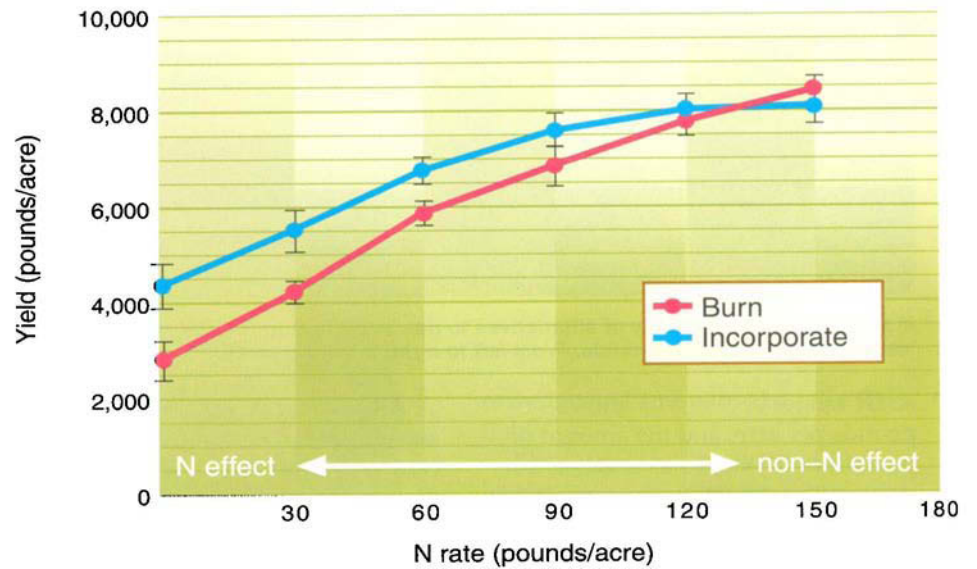


Fig. 2. Impact of burning and straw incorporation on grain yield as affected by nitrogen (N) fertilizer application in 1999. Lines in bars represent standard error.

(Bird et al. 2001)(table 2). The soil microbial biomass carbon was always significantly greater when straw was incorporated than when burned. Because soil microbial biomass is a prime source of available nitrogen for the crop, the incorporation of straw led to an increase in the crop-available soil nitrogen. Although the total soil nitrogen content had not changed after 5 years of straw incorporation or burning, a significant increase had taken place in the more labile soil nitrogen pools (that is, humic substances)(Bird et al. in press)(table 2). Those more labile soil nitrogen pools remain key sources of readily available nitrogen for crop utilization.

N fertilizer use efficiency

Determining the amount of nitrogen recovered by crops is reported as the nitrogen fertilizer use efficiency (FUE). Two methods of calculating FUE were compared as part of the study (Eagle et al. 2001). The first is the commonly used nitrogen-difference method. The amount of nitrogen in the crop that received nitrogen

fertilizer is compared with the crop that received no nitrogen fertilizer. The difference between these two values in total nitrogen is assumed to be the amount of nitrogen from the fertilizer taken up by the crop, expressed as a percentage of the total nitrogen fertilizer applied.

A second method of determining FUE is the isotope dilution method. The total amount of nitrogen taken up by the plants is calculated using labeled nitrogen fertilizer (^{15}N). The proportion of ^{15}N in the crop is expressed as a percentage of the total ^{15}N applied. A significant difference was found between the estimation of FUE using the two methods for each of the treatments (Eagle et al. 2001)(fig. 4). Although there was no significant treatment difference in FUE when calculated using either method, the large discrepancy between the two methods of estimating FUE suggests the presence of an added nitrogen interaction (ANI)(Eagle et al. 2001).

An ANI effect occurs when applied ^{15}N is made unavailable for crop uptake by soil microorganisms. Soil microorganisms immobilize the ^{15}N -labeled nitrogen that would have been accumulated by the crop. On the other hand, through mineralization, unlabeled nitrogen becomes available, replaces fertilizer ^{15}N in the soil solution and is accumulated by the crop. Therefore the unlabeled

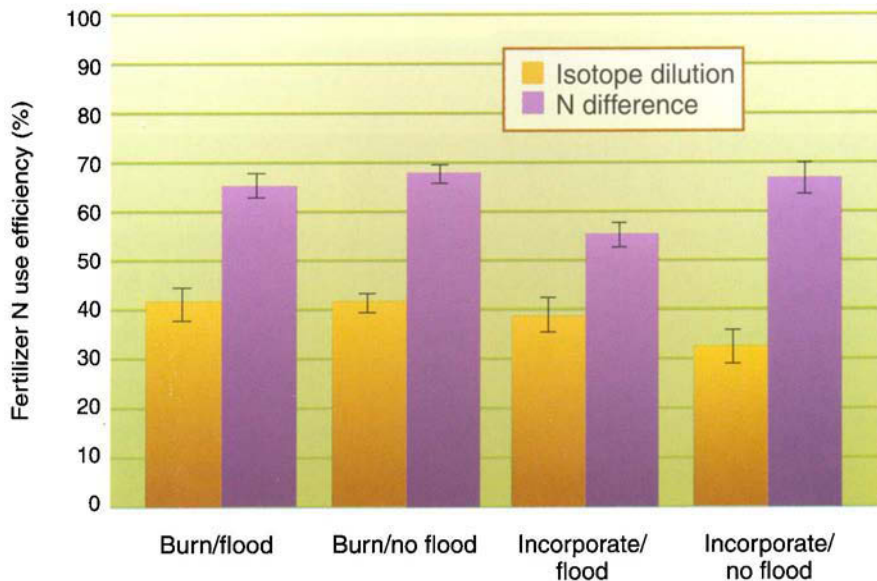


Fig. 4. Comparison of nitrogen (N) fertilizer recovery by plants using labeled fertilizer (FUE-¹⁵N) and N balance (FUE-ND) techniques. Lines in bars represent standard error.

nitrogen previously immobilized by the soil microorganisms now becomes available for crop uptake. In other words, ¹⁵N-labeled fertilizer is replaced by unlabeled nitrogen that is accumulated by the crop. This explanation is supported by the finding that the gross mineralization of nitrogen in the soil was increased significantly in the treatments where straw was incorporated (Eagle 2000). The nitrogen fertilizer recovery by the ¹⁵N-isotope dilution method

would have underestimated nitrogen fertilizer recovery when an ANI occurred. The actual nitrogen fertilizer recovery would then have been higher than observed by using ¹⁵N isotopes and be closer to the value for the recovery of nitrogen that was observed for the nitrogen-difference method. However, it accurately describes the fate of fertilizer and shows the importance of soil nitrogen in supplying crop need.

Subsequently, we determined how much of the labeled fertilizer nitrogen was available for the following year's crop (Eagle et al. 2001). The percentage of labeled nitrogen present that was recovered in the grain of the next year's crop reached 2.9% when straw was incorporated followed by winter flooding. The recovery declined to 1.7% when the straw was burned and the field was winter flooded (Eagle et al. 2001).

Two years after the application, the total loss of nitrogen fertilizer, based on the ¹⁵N isotope balance, was approximately 50% and was largely independent of straw management practice (Bird et al. 2001). Incorporating straw did not lead to lower fertilizer nitrogen losses compared to when straw was burned. Although there were no significant differences in total soil nitrogen under the various straw management practices, there was an increase in soil microbial biomass (Bird et al. 2001) and the more available soil organic matter nitrogen pool — that is, humic nitrogen (Bird et al. in press)(table 2). An increase in total soil microbial biomass in combination with a large amount of added straw could have led to a temporary strong sink for nitrogen fertilizer. The ensuing immobilization process could have led to lower nitrogen fertilizer losses.

Mixed findings on weeds

Examining the effects of the various practices on weeds showed that straw incorporation tended to increase the prevalence of grassy weeds, particularly water grass. This effect of straw incorporation became less strong when the field was winter flooded (fig. 5). When rice fields are flooded during the winter months, they attract larger numbers of foraging waterfowl. The higher incidence of weeds in the incorporated, non-winter-flooded fields may be due to a lower incidence of waterfowl for-



There were no major differences among various alternative practices (including burning) in terms of yield, but there was an increase in weed pressure when straw was incorporated into the soil, especially when not winter flooded.

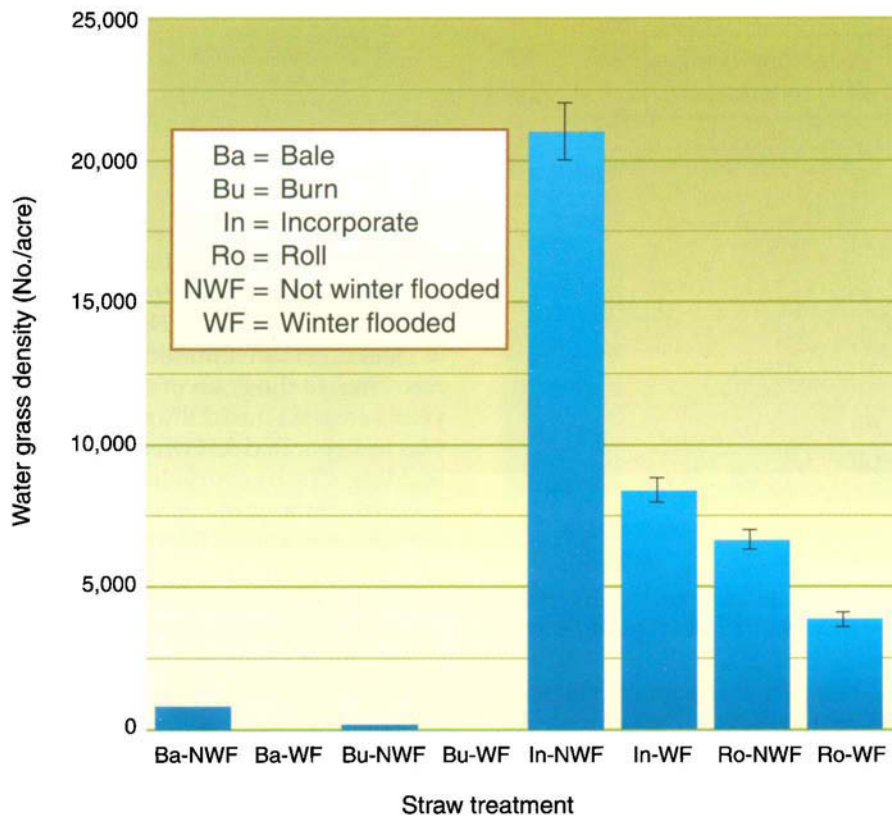


Fig. 5. Average density of mature water grass plants (*Echinochloa* spp.) in rice grown under different straw management practices for 7 years at Maxwell (Colusa County). Means and standard error bars are shown.

aging in these plots. Researchers found lower waterbird densities in nonflooded fallow rice fields compared with flooded in California (Elphick and Oring 1998). Winter flooding demonstrated significant benefits for weed control, whether the field was burned or not. In this study, burning and baling/removal with winter flooding produced the least water grass. Incorporation without flooding resulted in the highest amount of water grass seeds, followed by rolling without flooding. In addition, winter-flooded fields provide habitat for waterfowl, providing an example of a wildlife-friendly agronomic practice.

It is important to note that the rice fields in this study were treated with herbicides for weed control, following standard management practices. An herbicide program was used each year during this study, primarily to address the development of thiocarbamate herbicide resistance in the water grass population. For both incorporate/

winter flood and roll/winter flood, the number of water grass seeds was significantly reduced as compared to rolling or incorporating without winter flooding. The mechanism for this decrease in the density of water grass seed may be in part due to the foraging of waterfowl in winter-flooded fields (unpublished data). If rice growers cannot burn, and decide not to bale due to the cost and negative effects on fertility, then a combination of incorporation and winter flooding would be an attractive alternative in terms of weed control.

Environmental benefits and costs

One question raised by researchers in this long-term study was the possibility that anaerobic decomposition in the winter-flooded fields might lead to the formation of methane, an important greenhouse gas. A research project examining methane production showed that methane was produced in all of the winter-flooded treatments, with significantly more methane pro-

duced when the residue is incorporated or rolled compared to burned or baled (Bossio et al. 1999).

Over the long term, however, incorporation or rolling may also provide benefits through the accumulation of carbon as soil organic matter. To help reduce the amount of greenhouse gases in the atmosphere, it has been suggested that producers be paid for the amount of carbon they return to the soil. Farmers would be compensated for soil carbon storage in the form of carbon credits. This policy, if implemented, could enhance farm income and offset the effects of methane production under straw incorporation.

Less N fertilizer needed

The various alternative rice straw management practices we tested did not lead to a decline in grain yield on our experimental plots. However, there was an increase in the weed population when straw was incorporated, in particular when the fields were not winter flooded. Increased weed pressure when straw is incorporated for a prolonged period of time remains a concern.

When straw is incorporated, nutrients are returned to the soil. Clearly, the incorporation of straw led to an increase in the soil fertility, in particular nitrogen and potassium. Less nitrogen can be applied to fields where the straw has been incorporated, resulting in reduced production costs and decreasing the potential for water pollution. When straw has been incorporated for 5 years, we recommend a reduction of 25 pounds nitrogen per acre in the rate of nitrogen fertilizer applied.

Winter flooding slightly increased rice straw decomposition in combination with straw incorporation, but decreased straw decomposition of rice crowns and stubble remaining after burning (Bird 2001). In addition, winter flooding along with waterfowl foraging at regionally observed densities



Incorporation of rice straw returned nutrients to the soil, allowing for reductions in the application of nitrogen and potassium fertilizer, without any impacts on yield.

has been shown to increase straw decomposition rates in both tilled and untilled rice fields (Bird et al. 2001; unpublished data). As compared to burning, winter flooding also reduces the production of pollutants known to cause smog. Finally, ducks, geese and other birds on the Pacific Flyway benefit significantly from the wetlands that are created when fields are flooded during the winter months (Bird et al. 2000). Other studies show some benefits of winter flooding for controlling rice water weevil and the important rice disease stem rot (Hill et al. 1999).

As stated earlier, the major disadvantage to incorporation of rice straw as compared to burning is the increase in weed and possible pest pressure (Hill et al. 1999), an effect that is minimized by winter flooding. The long-term effects (more than 10 years) of straw incorporation on the occurrence and build up of weeds and pests, and how the buildup may affect the maximum yield potential for rice in California, remain to be determined. The study, which has been completed, exemplifies the need for continued long-term research because agronomic systems can take up to 10 to 20 years to respond to or equilibrate as a result of changes in residue management.

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Repeated soil applications of fungicide reduce activity against cavity spot in carrots

James J. Farrar ■ J. Joseph Nunez ■ R. Michael Davis

In recent years, carrot growers in the San Joaquin Valley have suffered economic losses due to cavity spot, a soilborne disease, despite frequent applications of the fungicide mefenoxam. Although the pathogen remained highly sensitive to mefenoxam in laboratory studies, the effective dosage of the fungicide was apparently compromised in certain fields. Compared to its longevity in soils with no history of mefenoxam use, such as fields using organic production methods, the fungicide degraded rapidly in soil from fields with repeated mefenoxam use. Our research reveals that repeated applications of the fungicide to soil can increase the activity of microorganisms that degrade it, potentially reducing its efficacy against cavity spot. This is problematic in California since mefenoxam is the only fungicide available to carrot growers for cavity spot control. It may be prudent to practice long crop rotations and to limit use of mefenoxam, where possible.



Carrots infected with cavity spot are usually deemed unsuitable for the fresh market. Caused by the fungus *Pythium*, cavity spot can also infect other crops such as beets, broccoli and wheat.

Cavity spot is one of the most damaging diseases of carrots in the San Joaquin Valley, where more than 50,000 acres are planted annually. Although the disease does not reduce carrot weights, infected carrots are deemed unsuitable for the fresh market due to the unsightly blemishes. The economic impact of the disease can be substantial. In extreme cases, growers have abandoned fields of carrots with high levels of cavity spot.

The disease is characterized by root lesions that are elliptical (oriented across the breadth of the root), generally less than 0.5 inch in length, and shallow. The lesions are generally more numerous on the upper third of the taproot. There are no symptoms on the aboveground parts of the plant.

Cavity spot is caused by at least two species of *Pythium*, including *P. violae* and *P. ultimum*. In California, cavity spot is most often attributed to *P. violae* (Vivoda et al. 1991). Little is known about the life cycle and population dynamics of *P. violae* in soil. It is assumed that the fungus survives as thick-walled oospores, which germinate in response to sugars and other nutrients that exude from roots. Because the fungus has a wide host range on such diverse plants as alfalfa, beets, blackeye beans, broccoli, celery, cucumber and wheat, it probably persists in the soil for years (Schrandt et al. 1994). None of the carrot cultivars commonly grown in California possess useful levels of resistance. Growers have observed that disease

incidence in a field increases in proportion to the number of successive carrot crops.

Timely harvests and good water management can help reduce the occurrence of cavity spot. Unfortunately, there is no accurate means of predicting disease risk in an individual field, and applications of a fungicide are sometimes necessary. Today, only one fungicide, mefenoxam (Ridomil Gold EC), is registered to control cavity spot on carrots. Applied to the soil up to three times in a growing season, it usually results in adequate disease control (Davis et al. 1991). Recently, however, the fungicide has failed to control the disease in a number of fields. In at least two fields, the entire carrot crop was abandoned due to a high incidence of cavity spot. The purpose of this study was to determine the cause of the reduced efficacy of mefenoxam on carrots in the San Joaquin Valley.

Isolate sensitivity

We first examined the possibility that the loss of cavity spot control was due to the development of resistance to mefenoxam within the pathogen population. To obtain isolates of the pathogen, carrots with cavity spot lesions were collected from 13 fields from 1998 to 2000. The history of mefenoxam applications ranged from no applications in organic fields to many applications in conventional fields, including those fields where mefenoxam failed to control cavity spot. After the carrots were washed in running tap water, cavity spot lesions and a minimal amount of surrounding healthy tissue were removed with a sterilized scalpel and plated on corn-

meal agar amended with antibiotics. When the colonies were 2 to 4 days old, the isolates were transferred to and subsequently maintained on cornmeal agar plates. Isolates were identified based on morphological characteristics of the colonies grown on sterile grass blades in water culture. Pathogenicity of the isolates was confirmed by placing 4-millimeter-diameter agar plugs from the margin of 3-day-old cultures on surface-disinfested carrots. After the sites of inoculations were covered with sterile moist cotton, the carrots were incubated for 14 days at 68°F (20°C) in the dark.

A total of 31 isolates of *P. violae* and 26 isolates of *P. ultimum* pathogenic to carrot were evaluated for sensitivity to mefenoxam. Four-millimeter-diameter plugs from the margin of 3-day-old cultures of each isolate were placed on cornmeal agar plates amended with 0, 0.1, 1, 10, 50 or 100 parts per million (ppm) mefenoxam. Colony diameters were measured after the plates were incubated at room temperature in the dark for 3 days. Each treatment was replicated three times.

Based on the inhibition of the growth of the colonies on mefenoxam-amended agar, all *P. violae* and *P. ultimum* isolates were sensitive to the fungicide (fig. 1). The average colony diameter of both species on plates amended with 1 ppm mefenoxam was less than 40% of the colony diameter on unamended agar. These results were similar to the results of our unpublished 10-year study on the sensitivity of *Pythium* spp. to metalaxyl and mefenoxam, which is the active isomer of metalaxyl, and the only compound in use today on carrots. To date, no re-

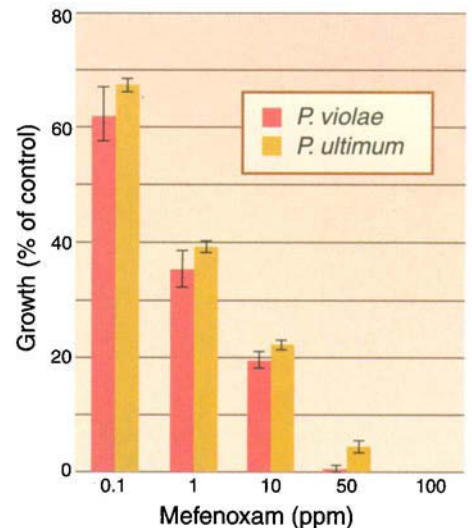


Fig. 1. Relative growth of *Pythium violae* (31 isolates) and *P. ultimum* (26 isolates) on cornmeal agar amended with various concentrations of the fungicide mefenoxam. Colony diameters were expressed as a percentage of the colony diameter on unamended cornmeal agar. Bars represent standard errors. Both fungi were highly sensitive to the fungicide.

sistance to metalaxyl or mefenoxam has been identified in carrot isolates of *P. violae* and *P. ultimum*.

Degradation of mefenoxam

Since we found no evidence that isolates of *P. violae* and *P. ultimum* were insensitive to mefenoxam, we designed two experiments to determine whether mefenoxam degraded more rapidly in soil where it had been used repeatedly. An increased rate of metalaxyl (and, therefore, mefenoxam) degradation has developed in avocado, citrus and tobacco soils with a history of metalaxyl use (Droby and Coffey 1991).

Soil was collected from four conventionally farmed carrot fields in the San Joaquin Valley with a history of repeated mefenoxam applications, and from four certified organic fields. Each field served as a replication (the trial was repeated once with a different set of fields). Soil from the surface to 8



The fungicide mefenoxam initially provides effective control of cavity spot, but after repeated applications over several years its efficacy can be reduced. Carrots are harvested in Kern County.

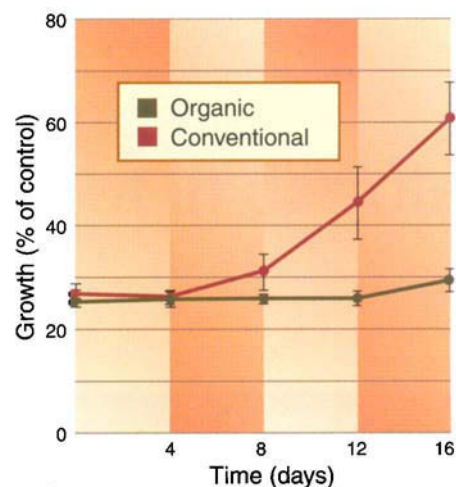


Fig. 2. Relative growth of *Pythium violae* on agar amended with the fungicide mefenoxam and soil extracts from four organic and four conventional fields. Bars represent standard errors. After 8 days, the fungicide in soil extracts from conventional fields was significantly less inhibitory to *P. violae* than in soil extracts from organic fields.

inches deep was collected in a W-shaped pattern across each field with a soil core that was 1 inch in diameter. Twenty cores from each field were bulked, sifted and placed in a large plastic tub to receive and facilitate the incorporation of 350 microliters (μ l) mefenoxam in 50 milliliters deionized water. In order to quantify the degradation of the fungicide, the amount added to the soil was 100 times the labeled rate. Immediately after the fungicide was thoroughly mixed into the soil, a 100-cubic-centimeter (cc) sample of soil was collected and dried in a 158°F (70°C) oven. Once dried, the soil was ground with a mortar and pestle and stored in a plastic bag. This process was repeated at 4-day intervals for 16 days. Between samplings, the soil was stored at room temperature in a plastic pot with a top diameter and depth of 5 inches. The soil moisture content was adjusted to approximately field capacity by the addition of deionized water each time the soil was sampled. A 200-cubic-centimeter aliquot (portion) of soil collected prior to spiking with mefenoxam served as the control for each field.

Bioassay designed, conducted

In the first experiment on mefenoxam degradation, a bioassay designed to quantify mefenoxam activity was conducted with an isolate of *P. violae* (isolate ctl-4a) originally isolated in carrots from Kern County. The bioassay method was similar to methods used in earlier studies (Bailey and Coffey 1984; Wicks 1988). An aliquot of 50 grams of dried soil from each sample was agitated in 100 milliliters deionized water for 1 hour on an orbital shaker at 150 rpm. After the soil suspension was filtered through #1 Whatman paper, cornmeal agar was added to the filtrate at a rate of 0.017 grams of cornmeal agar per milliliter of filtrate. The amended agar was then autoclaved and poured into three petri plates. A 4-millimeter plug from the margin of a 3-day-old colony of *P. violae* was placed in the center of each plate. After 4 days at room temperature, the colony diameter on each plate was measured. The experiment was performed twice and the data combined. The inhibition of colony growth on the fungicide-amended

agar was expressed as a percentage of the diameter of colonies grown on plates amended with nonspiked soil. Data from the two trials were combined.

The colony diameter of *P. violae* on plates prepared from spiked organic soils over the duration of the experiment remained at 25% to 30% of the control (fig. 2). The mefenoxam applied to the organic soil on day zero was not markedly degraded during the 16 days of the experiment. In contrast, the colony diameter on plates prepared from conventionally farmed soils increased on days 12 and 16, indicating reduced activity of mefenoxam in these soils after 8 days.

Soil analysis

In the second experiment on mefenoxam degradation, a direct measurement of mefenoxam levels in soil was determined with a gas chromatograph (Farrar and Davis 2000). An aliquot of 5 grams of dried soil from each sample was added to 5 milliliters of methanol and shaken. After the methanol was allowed to evaporate at room temperature, the contents of the

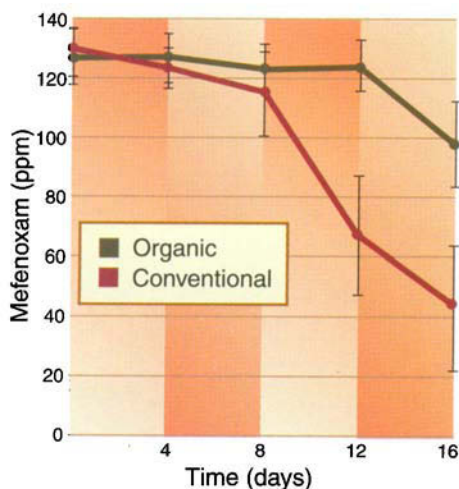


Fig. 3. Degradation of mefenoxam in four organic and four conventional field soils spiked with the fungicide. Mefenoxam concentration (ppm) was determined by gas chromatography. Bars represent standard errors. After 8 days, the concentration of mefenoxam in soils from conventional fields was significantly lower than that in organic soils.



Soil microflora apparently degrades mefenoxam more rapidly after repeated applications. Carrot growers may need to rely on longer crop rotations and limit use of the fungicide in order to ensure a healthy crop.

vials were resuspended in 1 milliliter of hexane. Standards, controls and samples were analyzed in a gas chromatograph. The concentration of mefenoxam for each soil extraction was calculated using a standard curve prepared for each field. Data from the two trials were combined.

In the organic soil, the concentration of mefenoxam remained at about 125 ppm from day zero to day 12, and then decreased to 100 ppm (fig. 3). In contrast, the concentration of mefenoxam in the conventional soil degraded rapidly after 8 days. At 16 days, the concentration of mefenoxam in soil from conventionally farmed fields was less than half the concentration of mefenoxam in the organic soils.

Microflora degrades fungicide

Both the bioassay and gas chromatography methods of quantifying the concentration of mefenoxam gave similar results. In the organic soils, mefenoxam levels decreased slightly over the 16 days of the experiment, whereas levels of mefenoxam in the

conventional soils decreased rapidly after 8 days. These results indicate a more rapid degradation of mefenoxam in carrot field soils with a history of mefenoxam application.

Apparently, the soil microflora that degrades mefenoxam is stimulated after repeated applications of the fungicide (Bailey and Coffey 1985, 1986); they are stimulated simply because the fungicide is a source of nutrition.

This is problematic in California's carrot fields since mefenoxam is the only fungicide available to growers for cavity spot control. Because of the recent failures to control the disease, it may be prudent to practice long crop rotations and to limit the use of the fungicide, where possible.

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ISSUE

There is little scientific doubt that human activity is leading to increased concentrations of greenhouse gases in the atmosphere, and that these substances are having an impact on global climate. However, scientists continue to debate the magnitude of the resulting changes and how they will affect factors such as weather, agriculture and life on earth. In California, the impacts of global climate change could include lower water availability, increased air pollution, biodiversity shifts and crop yield changes. In the May-June issue of *California Agriculture*, UC meteorologist Bryan Weare reviews current scientific evidence on global warming and how it will affect the state in the coming century.

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