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BOTANICAL SOCIETY OF AMERICA

This issue has a little bit of education for everybody! Two years ago Katrina hit the Gulf Coast and suddenly the entire country began to learn about the role of wetlands and wetland loss in South Louisiana. Of course, this is something the natives have known for years. In our first feature we learn about a program, run out of LSU since pre-Katrina, that has school groups growing and transplanting wetland plants to "reroot" coastal Louisiana.

Our second article takes us to the west coast where non-science students at UCLA get some "hands on", "whole plant" biology in the Molecular, Cell, and Developmental Biology Department. "The Green World" provides students with a little bit of the old and a little bit of the new in a format that provides them an awareness of what can be found in the produce section of the local supermarket.

-The Editor

Errata

It seems that the publishing equivalent of a transposable element slipped into Lee Kass' paper, "Landmarks and Milestones in American Plant Biology: The Cornell Connection," in the last issue and deleted individual letters in a number of words. Corrections include: on page 92, "More Notable Botany Departments" section. **relevant** replaces releant; **Director** replaces Diretr, **1913** replaces 113, **and** replaces an, **professorships** replaces proessorships.- - bottom of page 95, last paragraph on left; **after** replaces ater, and **Wellesley** replaces ellesley. A corrected PDF copy has been placed on the web page.

Also, in the review of Rice's "Encyclopedia of Evolution," the reviewer's citation of "Gone with the Wind" should have been "Inherit the Wind."

Coastal Roots: A Pre-college Plant-based Stewardship Program to Connect Students with Coastal Issues

Abstract

The LSU Coastal Roots Program is a sustained pre-college plant-based stewardship program in which students grow native plants in their school-based plant nursery that they will later transplant on a habitat restoration trip. The program integrates both plant and earth science content within the context of a real-world problem, i.e., coastal land and habitat loss in Louisiana, and was initiated to provide a students an opportunity learn about these important issues and have a hand in taking positive actions to preserve and rebuild our coast. Operating in 18 public and private schools in southern Louisiana since 2000, the program has brought nearly 2,000 precollege students (grades 4-12) on 57 restoration trips to plant about 18,000 student-grown plants. Students are involved in every phase of the program, from installing the automatic irrigation system and nursery yard at the start of the program, to planting seeds and propagating grasses, and finally transplanting the seedlings at their long-term partner's restoration site.

Key Words

stewardship, environmental science, pre-college, responsible citizenship, horticulture, habitat restoration

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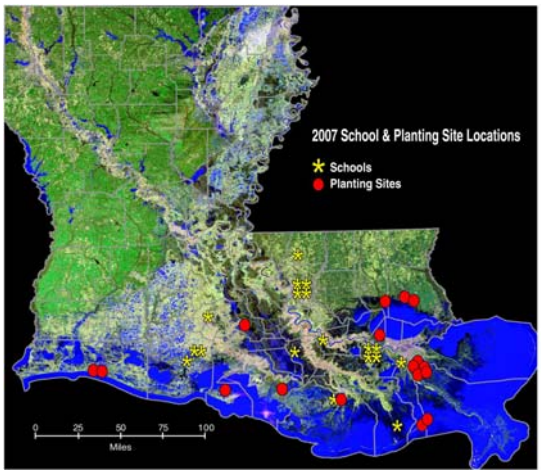
Rationale for the Program

A. Educational Place of Stewardship Projects

The Coastal Roots Program is a sustained pre-college plant-based stewardship program in which students grow native restoration plants in their school plant nursery that they will later transplant in a habitat restoration trip. The program grew out a need to inform students about important issues affecting Louisiana's coastal resources. In 1999, the Louisiana Sea Grant College Program's educational coordinator (the author of this paper) met with LSU wetland and fisheries specialists to discuss how to unite independent efforts to help students grow restoration seedlings into a single project. With the help of a LSU College of Agriculture horticulture professor the group began assembling an outreach program that combined the learning of geological and horticultural science with information on critical coastal issues in a hands-on stewardship project involving student-grown and transplanted native plants. The *LSU Coastal Root (CR) Program* was born. Today, the *CR Program* currently operates in 18 schools in ten parishes (counties). Participating classes are from grades 4-12 and from both public and private schools. School involvement takes many forms, from formal science classes to extracurricular environmental and science clubs to agriscience classes.



B. Louisiana's Situation

Louisiana is losing its coastal land at an alarming rate. Between 1978 and 2000, Louisiana lost 658 square miles (1,704 square kilometers) of land, representing almost half the land area of the state of Rhode Island, with an annual loss rate for this period at nearly 30 square miles (77.4 square kilometers) per year. Future land loss (2000-2050), with consideration for existing restoration projects and diversions, is projected to be 513 square miles (1329 square kilometers), with an annual loss rate of 10.26 square miles (26.6 square kilometers) per year (Barras, et al, 2003).

Land change in Louisiana is the result of a number of both natural and human impacts (Louisiana Coastal Wetlands Conservation and Restoration Task Force, 2003). The leveeing of the Mississippi River reduced and mostly eliminated the replenishment of sediment to the marshes and instead shuttled these sediments into the Gulf of Mexico. Furthermore, the levees served to shuttle the sediment load of the Mississippi River into the deep waters of the Gulf of Mexico, rather than the natural distribution and replenishment that had been in place through a myriad of distributaries into the coastal marshes. The natural subsidence of old Mississippi River delta sediments also accounts for some of the land change. Other impacts include salt water intrusion, herbivo ry (e.g., by invasive species - nutria, *Myocastor coypus*), alterations to the natural hydrology of coastal wetland systems, storm impacts, dam building up-river, oil and gas exploration and canal dredging, and harvesting of wetland forests. Most recently, hurricanes Katrina and Rita in 2005 resulted in an estimated land loss of 217 square miles (526 square kilometers) (Barras, 2006). These two storm events represent nearly half of the projected net land loss for 2000-2050.

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The coastal land loss in Louisiana has serious state and national economic ramifications. Louisiana is the largest producer of shrimp, oysters and blue crab, with a fisheries industry valued at over $2.85 billion. Over 40,000 residents earn their livings through work related to the wetlands or in the fisheries industry. Louisiana brought in more than $10 billion dollars during 2004 (pre-Katrina) in the tourism industry. In terms of oil and gas, Louisiana ranks first in crude oil production and second in total energy production, natural gas production, petrochemical production, and refining capacity. The oil and gas industry employs more than 42,000 men and women at a cost of $2.7 billion dollars. Sugar cane, an agricultural crop found mostly along the coastal plain has an annual economic impact of $1.7 billion dollars (Bourque, 2007). Despite the obvious value of these commodities to the nation, convincing the nation to invest in saving these fragile coastal lands has been a long and arduous process.

Given the coastal land loss crisis and the importance of these lands to the economic well-being of both Louisiana citizens and the nation, the Coast 2050 Executive Summary (Louisiana Coastal Wetlands Conservation and Restoration Task Force, 1998) gives a clear call to action, “Stewardship requires us to care for and nurture what we have and what we are given. For the coast of Louisiana to survive, we must change the way we do business” (p. 11). The *CR Program* was initiated to provide a sustained hands-on school-based stewardship activity that offers students an opportunity learn about these important issues and have a hand in taking positive actions to preserve and rebuild our coast.

Structure of the *CR Program*

The primary goal of the *CR Program* is to assist students in developing an attitude of stewardship toward our natural resources and to provide an active learning situation in which they can explore strategies for sustaining our coastal habitats. Three objectives align with this goal: (a) to conduct an on-going school-based nursery program involving the growing and restorative transplanting of native plants, (b) to develop in students an attitude of stewardship toward natural resources, and (c) to provide teachers and students with instruction on relevant issues such as ecological stewardship, wetlands functions and values, habitat restoration and conservation, as well as basic geology and horticulture skills.

The program components were developed based on a desire to make the program both as hands-on as possible and as meaningfully integrated into school subjects as possible. The program components include school-based plant nurseries, restoration planting trips, teacher professional development, and supporting program materials. The *CR Program* involves a one-time start-up expense of about $1,250 for the can yard and irrigation system materials. Annual expenses of about $200-300 cover materials such as planting media, fertilizer, seeds, and miscellaneous gardening supplies. The annual restoration trip generally costs about $300-500, and includes the cost of the school bus(es), substitute teacher, drinks and snacks, and miscellaneous equipment.

A finished LSU Coastal Roots can yard. One year old cypress seedlings are in the yellow cells; two-year old cypress and wax myrtle are in the black one gallon tree pots.

School-based plant nurseries

When schools join the program, the first task is to have the students help install their plant nursery, which is contained within a 10’x10’ area on school property. This involves digging trenches for irrigation lines, helping to assemble the irrigation system, installing gravel and a groundcover cloth, and assembling a dog kennel to keep stray dogs, balls and children out of the nursery area (Coleman and Bush, 2002; Bush and Blanchard, submitted). An automatic irrigation timer is fitted into the system to facilitate daily watering, as well as watering over school holidays and summer vacations. The teacher

Middle school students help LSU Coastal Roots staff dig the trench for the irrigation system.

and school staff check the irrigation system once or twice a week during the summer to insure that it is working properly and that the plants are receiving sufficient irrigation.

In the early spring, students clean and sterilize reusable plant cells and trays using bottle brushes and a mild soap/bleach solution. Then they plant their seeds in the plant cells filled with planting media. Each plant nursery is outfitted with 980 plant cells that are held in 10 trays. These trays are placed in the plant nursery and students monitor the germination of their plants. After about a month, students begin adding small amounts of fertilizer to

Environmental club students planting cypress seeds.

the cells to enhance plant growth. In the fall, the students continue to monitor seedling growth, pull weeds, and fertilize the plants on a monthly basis until it is time to transplant them in their new habitat.

In 2006-7, each school was partnered with a long-term restoration site. Restoration sites range from state parks, hurricane protection levees, city parks, conservation areas, wildlife refuges, to private property. The restoration site partners agree to allow students to access their property in order to transplant their seedlings, to monitor and help sustain the newly transplanted seedlings, and to help the partner school teacher and students understand the need for the particular seedlings that were requested by the restoration site manager. The current list of native plants growing in the *CR Program* school nurseries includes black mangrove (*Avicennia nitida*), bitter panicum (*Panicum amarum*), ?southern waxmyrtle (*Myrica cerifera*), ?hackberry (*Celtis laevigata*), ?smooth cord grass (*Spartina alterniflora*), ?southern baldcypress (*Taxodium distichum*), ?live oak (*Quercus virginiana*), ?long leaf pine (*Pinus palustris*), ?loblolly pine (*Pinus taeda*), and ?swamp red maple (*Acer rubrum*). Since Louisiana is in one of the main migratory bird flyways in the United States, many of the chosen seedlings fulfill specific food or habitat needs of some of the migratory bird species. Ultimately, the goal for the restoration partnership is for the teacher and students at the school to communicate with the site manager on a regular basis so that they can jointly determine what species of seedlings would best fill the needs at the site in the coming year.

As students ready for their transplant trip in the fall, they will retain about 200-250 trees in their school nursery. These selected seedlings will be “bumped up,” or transplanted, into one-gallon tree pots and grown in the school nursery for an additional year. This extra year of nursery growth ensures a stouter seedling for transplanting the next year – one that will better withstand the rigors of growing in the wild. Thus, after the first year in the program, most schools are transplanting about 300 one-year-old seedlings and 200-250 two-year old seedlings on their fall restoration trip.

Plantings at partner restoration sites

Once a year, generally in the fall or early winter, students transplant the plants they have grown to their partner restoration site. This restoration planting trip generally lasts a full school day, sometimes longer, depending on the distance students have to travel to get to the transplant site. When students arrive at the restoration site, they are instructed about how to properly plant their seedlings, including how to use a dibble and fertilize their seedlings. Students are divided into planting teams, given a bag of slow-release fertilizer and a shovel or dibble, and are sent off to plant their seedlings. In addition, some teachers have students collect data on their newly transplanted seedlings, such as seedling diameter, height, and GPS

A middle school student unloadfing one-year old cypress seedlings at a restoration site.

coordinates. In areas with large populations of nutria and beaver, students install plant protectors to help guard small seedlings. Some restoration sites physically mark areas where seedlings need to be planted with flags, others have personnel on hand to direct the student planting teams. While

most of the plants are grown by the students, *CR Program* students have also helped plant seedlings donated by landowners, the LSU AgCenter, as well as seedlings purchased through school grants.

Part of the planting experience is a tour of the restoration site to learn from the site manager why the site needs assistance and how the specific plants transplanted that day will help restore the habitat at the site. Some of the many ways the student-grown seedlings benefit their planting site partners include helping to stabilizing levees, reforesting wetland preserves and damaged areas from runoff and construction, beautifying areas, replacing invasive vegetation with native plants, reclaiming wetlands that have been drained for agriculture or crawfish ponds, and providing food resources and nesting habitat to local and migratory wildlife species.

Middle school students planting bitter panicum along a badly eroded beach in Cameron Parish

Middle school students planting *Spartina alterniflora* on a hurricane protection levee in Terrebonne Parish

CR Program seedlings have been transplanted in a variety of habitats, including salt marsh, swamp, bottomland hardwood forests, bayou banks, and levees. These habitats can be found in a variety of locations, such as hurricane protection levees, state parks, National Wildlife Refuges, nature preserves, private lands, botanical gardens, wetlands reserves, boat landings, local parks, and zoos.

Supporting CR Program Materials

Information necessary to successfully carry out this type of stewardship program with students is not typically found in text books, and thus, it quickly became apparent that teachers would need access to a wide variety of supporting program materials. These materials range from lesson plans, to a handbook on installing and running a school-based nursery (Coleman and Bush, 2002), fact sheets about plants and specific coastal issues, as well as a multitude of "how-to" information sheets ranging from how to set the irrigation timer to how to bump up one-year-old seedlings. The most expedient and economical way to distribute these materials is via a website.

The *LSU Coastal Roots* website (http://calvin.ednet.lsu.edu/~coastalroots/) accomplishes a number of important tasks. It is one of the primary means of communication with the teachers, students, and families participating in the project and serves as a source of information for those interested in becoming affiliated with the program. The website makes available a list of current schools, a newsletter archive, nursery instructions (e.g., seed preparation and nursery production, fact sheets on selected plants, can yard and cold frame information), teacher information (e.g., grant possibilities and information on the Louisiana Wetland Education Coalition listserve), event calendar, helping hands (acknowledgements of individuals and organizations that have helped the program and individual schools be successful), newsflashes (copies of newspaper articles about school accomplishments in the program) and lesson plans. Occasionally, teachers will have students produce PowerPoint presentations on topics that are of use to others in the *CR Program*. These student-produced materials are also posted on the website and are testimony to some of the learning outcomes these students are taking with them by participating in the program.

Coleman and Bush, in *Putting Down Roots* (2002), introduced the concept of stewardship restoration projects, described the basic decisions that have to be made (including funding sources, what to plant, and where to get seeds), how to build a school nursery (with complete instructions and photos), how to grow and care for seedlings, and how to transplant seedlings at a restoration site. New teachers entering the program are given a copy of this short handbook to help explain what will happen as they progress through the program.

Standards-based lessons and activities are available for teachers to integrate the *CR Program* with the science concepts required by the state science curriculum. The lessons strive to be hands-

on and cover issues about wetlands and coastal restoration (typically found in middle and high school earth science courses, as well as high school environmental science courses) and horticulture (typically found in middle school life science courses, as well as high school biology courses). These lessons are posted on the *CR Program* website (URL above).

Teacher Support

Teachers have many responsibilities, especially in light of the high stakes accountability environment currently in place in the United States. Thus the program resources discussed above are critical support components if the participating schools are to be successful in the program. The most successful schools in the *CR Program* have full

Two teachers"bumping up" one year old cypress seedlings into gallon tall pots.

support of their administrative staff and usually more than one teacher involved in the program. Each year, two professional development workshops are organized for the participating teachers. The summer institute is two days in length and is held immediately after school is dismissed for the summer. This workshop covers critical issues such as the current status of land loss in Louisiana and how to help students manage a successful seedling nursery. The institute includes a number of fieldtrips to highlight specific issues that are discussed during the workshop, such as land loss and restoration efforts. Hands-on training is also an important component of this workshop and includes activities such as on how to troubleshoot irrigation timers or bump up one-year-old seedlings. Perhaps most importantly, teachers have time to talk and share with one other how they integrate the *CR Program* into their existing courses. Institute staff have found that these formal and informal exchanges allow teachers to teach each other how to run a successful program. A second professional development workshop occurs in mid-January. At this one-day Saturday workshop, participating schools share updates on their nurseries, lessons and nursery management ideas, and pick up planting media and seeds for their spring seed planting.

Technical Support

Technical support is key in helping the teachers successfully manage their school programs and begins with the can yard installation at the school. It continues throughout the program in the form of troubleshooting of plant and irrigation system problems, which includes posting useful information on the program website as well as monthly visits by program staff to the schools to ensure that the seedling nursery is weed-, pest-, and irrigation-trouble free. *CR Program* staff also help facilitate the conversation between the teacher and the long-term planting site manager with regard to the plant selection and transplanting trip details. Staff often accompanies the schools on their restoration field trips, and the program loans out shovels, dibbles and other transplanting tools for these field trips. *CR Program* personnel write all the program information that is posted on the website and edit teacher-written lessons for science content accuracy and pedagogical content. Another aspect of the technical support is securing ongoing funding for the program. Grant writing is an important function provided by the *CR Program* staff. More than $175,000 in funded grants since 2000 has supported the program. Staff also assist interested teachers in learning how to write grants to support their individual nursery programs.

Project communication is as important as technical support. Project communication includes newsletters, school visits by Coastal Roots staff, and emails. Newsletters are written by Coastal Roots personnel four to five times over the school year and include timely reminders of information teachers need in order to successfully help students manage their plant nurseries. Also featured are school nursery news articles, which are often written by student authors that describe recent events the schools have participated in. The newsletters contain photos from the events and are a way of encouraging schools to communicate with *CR Program* staff about their accomplishments with the program. Newsletters are sent by mail to teachers, principals, superintendents and supporters of the program. They are also sent by email as PDF files to teachers and principals and are posted on the *CR Program* website for public viewing. As mentioned previously, monthly school visits are made by program staff, with the purpose

of accomplishing two objectives: (1) make sure that the can yard is operating properly and that there are no visible problems, and (2) provide a face-to-face opportunity for the teacher to ask any questions they might have about the program.

Research

Two LSU Master's theses, one in horticulture (Karsh, 2004) and one in education (Somers, 2004), have been based on the *CR Program*. Ongoing research is being conducted by this author on the nature and value of stewardship projects.

Benefits of Fostering Stewardship

The *CR Program* combines science with hands-on opportunities to make a difference. Students in this program learn science by actually doing science. They use plant biology, botany, math and geology skills, and also learn about how the culture of south

A middle school teacher participating in a demonstration planting of bitter panicum on Grand Isle during the Summer Institute

Louisiana is intertwined with and tied to the spaces and places of the coast. Students take ownership of their nurseries, participate in a restoration planting trip that benefits not only themselves but the broader community, and come to realize that they too can make a positive difference. They have the satisfaction and pleasure of seeing the products of their labor being put to good use.

Teachers participate in the *CR Program* for a variety of reasons. Some participate because it makes learning science and math relevant and connects these subjects to serious current issues in Louisiana. It provides a way to integrate a variety of subjects, including math, science, history, civics and geography. The technical support is helpful and the teachers are not left to fend for themselves when it comes to troubleshooting problems or figuring out the best way to teach a particular point. In addition, they can take their students on a restoration planting trip that emphasizes stewardship of natural resources.

In the long run, Louisiana benefits from this project in a number of important ways. The habitats that are the beneficiaries of student-grown seedlings are improved. Students, their families and teachers, become better informed about critical issues facing the residents of Louisiana, especially those issues facing citizens living within the coastal zone. Through the *CR Program* students have had a positive model of how to be a responsible citizen and a better steward of the environment in which they live. It is hoped that this experience will carry over to the places where they choose to live as adults and that they will continue to take action based on an awareness and knowledge of environmental issues.

Highlights of the program

Students in the *CR Program* have been working hard to rebuild or preserve the landscape of south Louisiana. From 2001-2007, *CR Program* schools have involved more than 1,930 students in grades 4-12 in 57 planting events at 25 locations across the Gulf Coast of Louisiana (Table 1). The students, representing 21 schools in 11 parishes, have transplanted 10,283 shrub and tree seedlings, and over 7,660 grass plugs.

CR Program staff and supporting administrative departments at LSU have assisted schools in getting positive news media coverage of student restoration plantings. Many of the participating schools have been featured in the local newspaper and on the evening news. Several schools have had more wide-reaching opportunities to share what they are doing to restore the Louisiana coast:

- Grace King High School students were featured in a National Geographic's TV program entitled *EarthPulse* (2002)
- Montegut Middle School students were featured in the *EstuaryLIVE* video on Elmer's Island (2002)
- Coastal Roots students were invited to visit with Christy Todd Whitman, EPA Director, on her visit to Thibodaux, LA (2003)
- Lafayette Middle School students were featured in *Southern Living Magazine* (summer issue, 2007) doing a restoration trip Fifi Island (near Grand Isle, LA)
- Montegut Middle School students participated in the IMAX production of *HURRICANE!* (2005)
- *CR Program* was awarded the 2003 Gulf of Mexico Program's Gulf Guardian Award (2nd Place).

Table 1. Summary of *CR Program* school participation and restoration plantings

	2001	2002	2003	2004	2005	2006	2007	Totals
Total schools in program	8	14	15	14	14	17	18	n/a
# schools planting	8	13	9	9	8	2	4	n/a
# students planting	227	415	365	409	240	136	141	1933
# plantings	9	13	10	10	8	2	5	57
total plants	1963	1979	2464	1837	2770	580	6350	17943
# shrub seedlings	1963	1979	2464	1757	940	580	600	10283
# grass plugs	0	0	0	80	1830	0	5750	7660
total # plant species	3	3	5	8	4	1	4	n/a

Partners and Support

The Louisiana Sea Grant College Program began the *CR Program* and provided staff time and funding during its first six years. During this time, additional funds supporting the program came from the Barataria-Terrebonne National Estuary Program, the Coalition to Restore Coastal Louisiana through a Restore America's Estuaries grant, and the Coastal Impact Assistance Program for Terrebonne and Lafourche Parishes. In 2006, the program transferred over to the main LSU campus, with several LSU units contributing staff time and expertise to the project, including the LSU Department of Educational Theory, Policy, and Practice, LSU School of Plants, Soils and Environmental Science, and the Louisiana Sea Grant College Program/LSU AgCenter Research and Extension. Both the Louisiana Sea Grant College Program (2000-2006) and the LSU College of Education (2006-present) have contributed expertise in media relations. The LSU College of Education and the LSU Foundation are actively working to identify sustainable funding sources to expand the program to additional schools and sustain it into the future.

The Louisiana Office of State Parks has offered its parks, some of which were severely damaged by the 2005 hurricanes, as long-term planting sites for our schools. Besides providing access to students and teachers on the restoration planting trips, their education staff will work with their partner schools to help students understand how their good work will help the park recover. This partnership will provide schools with an opportunity to track survival rates of previous planting years and opens a whole new area of investigation for participating schools.

Summary

The *LSU Coastal Roots Program* integrates science in a meaningful way with current issues of living on a fragile coast. The program offers an avenue to help make students aware of the issues affecting our coastal zone, builds scientific knowledge about some of the ways these issues are understood and addressed, and provides a meaningful way for students to take responsible action based on that awareness and knowledge. The most successful school nurseries are those in which the principal and teachers understand these connections and are willing to provide watchful oversight of the program and plant nursery. *Coastal Roots* staff provide scientific and pedagogical expertise in support of the students and teachers in the program. The program helps he students will make a real difference by "planting one seedling at a time".

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The Green World: Plants for Now and the Future

Teaching plant biology in a research university, particularly one with a strong emphasis on biomedical research, is a tremendous challenge because plants often get short shrift in non-agriculturally orientated universities. This was the challenge that the late Phillip Thornber and I decided to undertake in 1991 when we debuted a general education (G.E.) course (MCDB80) for non-majors entitled "The Green World: Plants for Now and the Future". The course structure entailed two lectures of 75 minutes each and a 2-hour laboratory course per week, and hence no more than 45 students could enroll per offering. We taught the course every year and it was always enrolled to capacity. Over the years, a wide variety of students ranging from engineering majors to art students took the course, and each year we incorporated new concepts and ideas into our lectures. We covered biochemistry in terms of cooking (denaturation of protein by whisking or frying eggs, etcl), talked about the principles of genetic engineering as well as the promise and controversy of genetically modified organisms, and described the origins of agriculture and use of plants in medicine. All of this was presented in a basic botany framework (the text was Brian Capon's "Botany for Gardeners") with a bit of emphasis on molecular biology because the course was offered by the Molecular, Cell and Development Biology department. The students took the usual exams and we required a final paper, which could be on any topic the student chose, as long as it had something to do with plants. The papers were as variable as the different student majors. There were the usual papers on marijuana, chocolate, and various fruits and vegetables. However, to this day, I particularly remember several student papers. Some of the most memorable included a paper on the perfect martini (after all, the components come from plants!), traditional Mexican plants used in the treatment of diabetes, a tree that produced 5 different kinds of citrus as a consequence of grafting, and the language of flowers in poetry.