Project - Travel Combination Sabbatical Leave
Fall 2000 & Fall 2001

Cynthia J. Shannon

December 2001

MT. SAN ANTONIO COLLEGE
Salary and Leaves Committee

APPLICATION FOR SABBATICAL LEAVE

Name of Applicant Cynthia J. Shannon

Address 9574 Hidden Farm Road, Alta Loma, Ca. 91737

Employed at Mt. San Antonio College beginning August 19, 1991

Dates of last sabbatical leave:

From _____ To _____

Department Biology Division Natural Science

Length of sabbatical leave requested:

One semester _____
Fall _____ Spring _____

Two Semesters X

Purpose of sabbatical leave:

Study _____ Project X

Travel X Combination (specify) X

NOTE: Sabbatical periods are limited to contractual dates of the academic year.

Effective dates for proposed sabbatical leave:

From August 2000 To May 2001

and (if taken over a two school year period)

From _____ To _____

Attach a comprehensive, written statement of the proposed sabbatical activity(ies) including a description of the nature of the activity(ies), a timeline of the activity(ies), an itinerary, if applicable, the proposed research design and method(s) of investigation, if applicable.

Attach a statement of the anticipated value and benefit of the proposed sabbatical activity(ies) to the applicant, his/her department or service area, and the College.

Any change or modification of the proposed sabbatical activity(ies) as evaluated and approved by the Salary and Leaves Committee must be submitted to the Committee for reconsideration.

Cynthia J Shannon
Signature of Applicant

11-29-99
Date

Applicant's Name Cynthia J. Shannon

THE ACKNOWLEDGMENT SIGNATURES REFLECT AWARENESS OF THE SABBATICAL PLAN FOR THE PURPOSE OF PERSONNEL REPLACEMENT. COMMENTS REQUESTED ALLOW FOR RECOMMENDATIONS PERTAINING TO THE VALUE OF THE SABBATICAL LEAVE PLAN TO THE COLLEGE.

APPLICANTS MUST OBTAIN THE SIGNATURES OF ACKNOWLEDGMENT PRIOR TO SUBMITTING APPLICATION TO THE SALARY AND LEAVES COMMITTEE.

ACKNOWLEDGMENT BY THE DEPARTMENT/DIVISION

Signature of Department Chairperson William L. Wagner Date 11/29/99
Comments:

Signature of Dean Larry L Rudd Date 30 Nov 99
Comments: See attached comments

ACKNOWLEDGMENT BY THE OFFICE OF STUDENT LEARNING

Signature of Vice President,
Student Learning _____ Date _____
Comments:

NOTE: DEANS ARE REQUESTED TO SUBMIT A STATEMENT OF RECOMMENDATION REGARDING THE VALUE OF THE SABBATICAL PLAN TO THE COLLEGE, DIVISION/DEPARTMENT, AND INDIVIDUAL, IN CONSULTATION WITH THE APPROPRIATE DEPARTMENT CHAIRPERSON.

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FINAL ACTION BY THE SALARY AND LEAVES COMMITTEE:

_____ Recommend approval to the Board of Trustees

_____ Not recommend approval to the Board of Trustees

_____ _____
Signature - Chairperson, Salary and Leaves Comm. Date

_____ _____
Signature - Authorized Agent of the Board Date

SABBATICAL LEAVE PROPOSAL, for the 2000-01 school year
Cindy Shannon, Biology Department

Proposed sabbatical Activities

This proposal consists of four parts: 1) I propose to visit primary transfer colleges (UC and State colleges) and community colleges to discuss their science major's programs and any anticipated future changes, 2) I propose to complete a literature search and a manuscript on, "Avian Use of Modified Coastal Sage Scrub," 3) I propose to collect current data in study areas at California Polytechnic University, Pomona, in a collaborative effort with Dr. David J. Moriarty of the Biology Department to submit a comprehensive manuscript on data collected in study areas from 1985 to present on the response of avian fauna to fire, 4) I propose to visit local wildlife areas to update our Field Biology course.

First, I propose to visit a total of 10, University of California, State colleges and community colleges in central and northern California. (Please see Appendix A for a list of colleges). In fall 2000, I plan to visit colleges in central and northern California to discuss the future of science major curriculum. I plan to interview the coordinators of the major's courses at these schools and research future changes in curriculum, class activities, lab exercises and equipment used. I will also request to sit in on a class in their major's curriculum, if possible. I would also like to visit local natural areas in the vicinity of the colleges visited, in order to gather information and photographs to enhance the courses I teach at Mt. SAC. Most courses I teach include an ecology/conservation component, such as Biol. 1 (General Biology), Biol. 4 (Biology for Majors), Biol. 6 (Humans and the Environment) and Biol. 3 (Ecology and Field Biology). In Spring 2001, I will visit 10 local colleges for a three week period (please see list in Appendix B) for the same purpose.

Second, I propose to complete a manuscript on, "Avian Use of Modified Coastal Sage Scrub." The data for this manuscript were collected as a part of and used in my Master's Thesis for completion of my Master's degree in Biology at Cal Poly Pomona. I would like to continue my research and add current data to this study originally conducted from 1986-88 and rewrite it in manuscript form.

Third, I would like to collaborate with Dr. David J. Moriarty, Professor of Biological Sciences at Cal Poly Pomona, on a manuscript combining data from various individuals who have collected data on study sites comparing bird use of burned and unburned coastal sage scrub. This data base began after a wildfire in 1981 and continued until 1997. I would like to collect current data on the avian use of these study areas. The proposed research design is a monthly bird census conducted at three Cal Poly research sites in the Voorhis Ecological Reserve. These would include recording bird species, number of individuals,

plants utilized, and the behaviors exhibited. I would collect data from August of 2000 through April 2001. These data would be combined with the existing research database for these study sites.

Fourth, I would like to investigate various local wildlife areas for updating the field trips in the Ecology and Field Biology course at Mt. SAC. We currently spend one weekend at the Santa Rosa Plateau and Oak Grove Campground area and another weekend at Joshua Tree National Park. Due to intense, rapid development, I feel the need to investigate other possible sites for our weekend trips. I would also like to investigate areas that could accommodate weekend trips in the fall semester, making it possible to offer this class in the fall semester in the future.

Proposed value of this Sabbatical

First, the visitations and research into the major's programs at other colleges will help update our major's course curriculum in Biol. 4 (Biology for Majors), Biol. 2 (Plant and Animal Biology), and the newly proposed Cell and Molecular Biology course. We have currently been experiencing some articulation problems with some of our courses. Different transfer colleges are currently changing their major's curriculum in various ways. This sabbatical will enable me to research what our transfer colleges want our students to have, and how they are accomplishing this curriculum in their major's courses. As a result, I will update our Biol. 4 course curriculum and lab manual, where needed. This will enable our science students to transfer more easily, as our courses will articulate more readily. I also plan to hold informal seminars with the coordinators of our Biol. 2 and Cell and Molecular Biology courses, to share knowledge and insights I gained for their course curriculum as well. I see this as an exciting and extremely timely chance to benefit myself, our students and my colleagues.

Second, the writing of the thesis, "Avian Use of Modified Coastal Sage Scrub" into manuscript form will benefit the college and myself in terms of the possibility of publication. Mostly though, I see it as benefiting the students in the Biol. 4 (Biology for Majors) course. These students conduct a research project on vegetation biodiversity, which they then write up into a formal paper. This manuscript will be of great use to these students as a reference to their papers. The knowledge gained by me, will also benefit my teaching at Mt. SAC.

Third, the writing of the manuscript on the comprehensive data collected on avian response to fire will be of use to the Biol. 4 (Biology for Majors) students in writing their research papers. The knowledge gained by me, will also benefit my teaching at Mt. SAC, since I discuss these ecological issues in Biol. 4 (Biology for Majors) and Biol. 3 (Ecology and Field Biology). This joint effort between myself and Dr. David Moriarty of Cal Poly Pomona, will continue ties and facilitate collaboration between the two

biology departments at Mt. SAC and Cal Poly.

Fourth, due to rapid development of the Santa Rosa Plateau, currently visited by the Biol. 3 (Ecology and Field Biology) class, I would like to research other possible locations for our weekend trip. In addition, many students have requested the course be offered in the fall as well as the spring. Historically the course has only been offered in the spring, since many locations we visit have their highest biodiversity in the spring. While these locations are impressive in spring, they are not as impressive in the fall, due to seasonality. I would like to investigate the following local areas for use in this course: Anza Borrego, Big Bear campgrounds, New York Mountains, Day Creek Canyon, Cucamonga Canyon, Claremont Wilderness Area and Palm Desert. The biodiversity of these areas is different from one another and from season to season in the same area. I would keep species lists in each area.

Upon my return I would offer informal seminars to my colleagues. Included in these seminars would be slide and video presentations of lab facilities at other colleges, flora and fauna of northern and central California and the local wildlife areas I visit, and the two research projects.

I believe that my value to my students and my colleagues would be enriched by this opportunity to conduct research and travel during my one year sabbatical.

Appendix A

Proposed Colleges to be visited in central & northern California.

I propose to visit 10 from this list:

University of California, Berkeley
University of California, Santa Cruz
University of California, Santa Barbara
University of California, Davis

California State University, Monterey Bay
California State University Sacramento
California State University, Channel Islands
Humboldt State University
San Jose State University
California State Polytechnic University, San Luis Obispo
Sonoma State University

Ventura College
Contra Costa College
Santa Barbara City College
San Jose City College
Shasta College
Napa Valley College
Monterey Peninsula College
Lake Tahoe Community College
Cuesta College
College of the Redwoods
College of the Canyons
Cabrillo College
Allan Hancock College
College of the Sequoias
Evergreen Valley College
Foothill College

Appendix B
Proposed Colleges to be visited locally.

I propose to visit 10 from this list:

School	Contact Established
University of California, Los Angeles	Steven Strand
University of California, Riverside	
University of California, Irvine	David Fouts
California State Polytechnic University, Pomona	Keith Arnold & Chris George
California State University, Fullerton	Joyce Ono
California State University, San Bernardino	Colleen Bonney
California State University, Northridge	
Fullerton College	Chuck Leavell
Riverside Community College	Terry Shaw
Chaffey College	
College of the Canyons	
Crafton Hills College	
College of the Desert	
Citrus College	
Los Angeles Pierce College	
Mount San Jacinto College	

Natural Sciences Division

AGRICULTURE•BIOLOGY•CHEMISTRY•EARTH SCIENCES/PHOTOGRAPHICS/ASTRONOMY
MATHEMATICS/COMPUTER SCIENCE•NURSING•PHYSICS/ENGINEERING

INTER-OFFICE MEMORANDUM

TO: Peter Parra, Chair, Salary and Leaves Committee

FROM: Larry L. Redinger, Division Dean
Natural Sciences Division

DATE: 29 November 1999

SUBJECT: Support for Cindy Shannon, Application for Sabbatical Leave

This letter is to indicate my support for Cindy Shannon, Professor of Biology, in her request for approval of sabbatical leave for the 2000-2001 academic year. Cindy has been a dedicated and innovative individual in the Biology Department, routinely making significant contributions to curriculum development in nearly all areas of the Life Sciences. Her enthusiasm and commitment to her students is evident in all she does. A direct correlation between her proposed activities and her instructional responsibilities is evident in the proposal. Moreover, the benefit to the college programs and the learning opportunities available through her proposed activities will be of significant value to Mt. SAC at many levels of the college. Cindy has the support of the Biological Sciences Department.

Although the Biology Department and its students will miss her expertise and contributions, Cindy's absence for a one-year period can be reasonably accommodated by the department membership.

Please give this proposal your full consideration. I am certain that Cindy Shannon will carry out her proposed activities with devotion to both her personal and professional growth, and encourage you to look favorably on her application.

Cc: Rita Burleigh

ACKNOWLEDGMENTS

I would like to thank the Board of Trustees of the Mount San Antonio Community College District for granting my sabbatical leave for Fall 2000 and Fall 2001. As a result of this sabbatical I was able to update my knowledge concerning the requirements of our biology major transfer students. I was able to make contacts at the UC, State College and Community College levels in order to learn about their majors programs and update our program accordingly. I was also able to expand my knowledge of the ecology of birds in coastal sage scrub habitat in response to fire, which is extremely pertinent to courses I teach. I was able to explore various locations in southern California as future field trips sites for my courses as well.

I also wish to acknowledge the Dean of Natural Sciences, Larry Redinger, and the Assistant Dean, Debbie Boroch for their unending support before, during and after this sabbatical leave. Finally, I wish to acknowledge the scores of college professors in southern and central and northern California, who not only made time in their busy schedules to share information with me about their biology major's programs, but also shared their enthusiasm, ideas and hospitality with me.

TABLE OF CONTENTS

STATEMENT OF PURPOSE

The purpose of this sabbatical leave was to increase my knowledge concerning the avian ecology in response to fire in coastal sage scrub, update my knowledge of biology majors programs in central and southern California colleges and explore potential field trip areas in southern California. In order to complete these goals, this sabbatical included four parts. First, I completed a manuscript on avian use of modified areas of coastal sage scrub. This required an extensive literature search on the subject. As a result, I updated and increased my knowledge in this area of ecology. This will benefit my Ecology and Field Biology (Bio. 3) course since we cover this topic extensively and my Biology for Majors course (Bio. 4), since we not only cover this topic but they write a research paper on the topic as well. Tied into part one was the second part, a collaboration with David J. Moriarty, Professor of Biological Sciences at Cal Poly Pomona on a manuscript combining data from past studies on bird use of burned and unburned areas. I contributed by collecting the necessary field data in Fall 2000 and Fall 2001. The field work I completed not only contributed to the study, but helped me brush up on my bird identification skills used in my Ecology course.

The third part involved travel to 10 colleges in central and northern California and 10 in southern California, in order to investigate their biology majors programs. I created and taught the first Biology for Majors course in Spring of 1996 at Mount San Antonio College. Since that time, many colleges had changed their curriculum for their biology majors. It has been confusing and frustrating for our transfer students at times, because the changes were not always consistent between colleges. I found other biology professors at these colleges I visited had great interest in my project for these same reasons. I was able to discover what topics are being addressed at which schools so that our students will get the best preparation possible prior to transfer.

The fourth part enabled me to explore areas of southern California during the fall semester, when I am interested in offering the Ecology and Field Biology course. However, since this course is traditionally taught in the spring and the locations we visit are extremely seasonal, some are also under the threat of development. so time in the fall to explore alternatives was invaluable. I was able to assess which locations would be suitable for future field trips and which are not. I found the New York Mountains to be lacking the necessary biodiversity for a successful field trip in the fall. Although Big Bear would be a good alternative, I found it to be quite crowded. An excellent alternative was found at the James reserve in Idyllwild. This UC run reserve is not open to the public, so it offers the same mountain habitat without the crowds. I found Anza Borrego State Park and Palm Desert to be viable alternatives, even in dry years. Day Creek Canyon, Cucumonga Canyon and the Claremont Wilderness Area were found to be good alternatives, but were not found to offer a more desirable location for field trips than Sandstone Canyon in Diamond Bar, which is already used for similar trips. The opportunity to visit these location at this time of year, enabled me to assess the benefits of these areas for future field trips.

MANUSCRIPT ON AVIAN USE OF MODIFIED COASTAL SAGE SCRUB

I began my sabbatical work with a literature search on avian use of coastal sage scrub areas , which have been affected by fire. This part of the sabbatical was intended to be used to eventually complete an updated manuscript, based on my Master's Thesis completed at Cal Poly Pomona in March 1991 (Appendix 1). Since 9 years had gone by after the thesis completion, I suspected many new studies had been published on the topic that would help generate an updated manuscript. I spent 3 weeks conducting the literature search at the library at Cal Poly Pomona. I began the search on August 14, 2000 and completed it on September 1, 2000. In 1991, I found little data concerning the effects of fire on coastal sage scrub habitat. In my search in fall 2000, I found the literature on this topic was still somewhat sparse and difficult to locate, but I was pleased to see the literature had grown on this topic since the early 1990's. I have included a list of the literature I found in this search (Appendix 2) and have described below the particular articles that were used from this list and the justifications as to why these articles were selected for use.

It would be appropriate to review some background information on what was known concerning the effects of fire on avian communities in coastal sage scrub at the time I left this field of research in 1991. At this point in time it was known that avian community structure could vary depending on season, habitat diversity, food abundance and shelter against predators (Karr 1968, Willson, 1974, Menge and Sutherland 1976, Ricklefs and Travis 1980, Rotenberry 1980). Vegetation structure was thought to be the predominant factor effecting bird species diversity (MacArthur and MacArthur 1961, Karr and Roth 1971, Willson 1974, Avery and Van Riper 1989). Willson (1974) suggested a tree layer offers a more consistent environment within seasonal changes of vegetation, thereby sustaining a more consistent level of avian species biodiversity. Beissinger and Osborne (1982) had found the presence of horizontal layers of vegetation to increase bird species diversity and important to support ground dwellers and shrub dwellers. Although

fire is a natural part of the coastal sage scrub community, human alteration of natural fire patterns and increased urbanization of habitats prompted some to suggest that not all ecological niches in coastal sage scrub were fire adapted (Stanton 1986, Soule et. al. 1988). Soule (1988) for example found only the most facultative bird species to survive a disruption to the ecosystem such as fire due to urbanization and fragmentation effects. Therefore, my thesis aimed at understanding the relationship between the avian community and disturbance in terms of bird species diversity. In my Master's Thesis work I had investigated six study sites. Three at Spadra Landfill and three at Cal Poly Pomona. The three sites at Spadra Landfill included Site 1: a revegetated wildlife area, Site 2: a covered landfill and Site 3: a walnut woodland. The sites at Cal Poly Pomona included Site 1: a partially burned canyon, Site 2: a mature coastal sage scrub canyon and Site 3: a canyon severely burned in August 1981. I found more species to prefer the unburned (Site 2) to the burned (Site 3) at Cal Poly, even six years postfire. I also found the least disturbed site at Spadra (Site 1) to be most similar in bird species diversity to the most disturbed site at Cal Poly (Site 3). My data also indicated a lack of ground dwelling bird species such as California Quail, California Towhee, California Thrasher, and Rufous-sided (Spotted) Towhee, due to the lack of cover and spatial heterogeneity for these species following a disturbance. Soule et. al. (1988) had found many of the same species to leave isolated canyons in response to urbanization including: California Quail, California Thrasher, Rufous-sided (Spotted) Towhee, Wrentit and Bewick's Wren. Regeneration patterns of vegetation after a fire was emphasized in effecting bird species diversity as well (Stanton1986). Keeley and Keeley (1984) found herbs to dominate the first season after a fire with shrub resprouts into the second year. Westman and O'Leary (1986) suggested recovery of an area after fire is related to whether the area is dominated by vegetation that is classified as strong or weak resprouters. And that coastal sage scrub may not be as resistant to repeated fire if the area is dominated by weak resprouters. So, at this time, the importance of vertical heterogeneity of a habitat was considered of utmost importance to

the bird species diversity and disruption of that heterogeneity was thought to result in a negative impact on the avian community.

The following is a review of the pertinent articles I found and the current information on the reaction of coastal sage scrub to fire, and how they were used to write the updated manuscript. Wilsey and Potvin (2000), varied species evenness in an old field in Quebec. They were looking to see if plant productivity will lead to decreased primary productivity. They found total biomass to increase linearly with increasing levels of evenness. Wilsey and Potvin also found human influenced and natural events such as revegetation and fire effect many aspects of plant and animal diversity by reducing primary productivity of plants. Diversity is composed of species richness (the number of species) and evenness (how well distributed abundance is in an area). Whether disturbance is natural or human influenced, reduction or plant primary productivity can reduce diversity of the area overall. This relates to my study because if human influenced or natural events such as revegetation and fire reduce plant primary productivity, then animal diversity (such as avian species diversity) could be adversely affected as well.

Greenberg et. al. (1995) found similar bird assemblages in like structured habitats result from various types of disturbance. They found the bird community to persist in an area of clear cutting to be similar to that of a high intensity burn area. This relates to my study because I found the least disturbed area at Spadra (the revegetated wildlife area) to resemble the most disturbed area at Cal Poly (the burn area). The disturbance at the Spadra area included landfill activities, but produced a similar bird community in terms of bird species diversity as a burn area at Cal Poly.

Breininger and Smith (1992) compared bird densities in coastal scrub and slash pine flatwoods following fire. They found shrub dwelling birds to prefer unburned stands and to decline with frequent fire regime. They found that within the first year after the fire, no shrub species had the highest density in terms of vegetation. They found fire therefore to have a negative influence on shrub dwelling birds. Two shrub dwelling

species preferred areas that had not burned for 10 years and two preferred intermediate areas. Higher densities of woodpeckers were found in recently burned areas. This was attributed to the higher density of snags in the area. They found correlations between densities of shrub-dwelling birds and mean shrub height to suggest that these bird populations would decline under frequent fire regime. Many slash pine trees were found to have been killed in recent fires because of high fuel levels that accumulated during long time periods with no fire. Since large lash pines provide nesting sites for bald eagles and slash pines require bare soil for seedling establishment, frequent fire disturbance would have negative effects on bird species diversity. Repeating burning can reduce snags, so severity and frequency of disturbance could effect species currently found to use burn areas. They found in pine flatwoods that burning as frequently as every 7 years would have a negative influence on shrub dwelling birds. This relates to my study because I found certain species of shrub dwelling birds to decline following a fire as well. I also found a recovery period of about 6-7 years in terms of the bird species diversity.

Breininger and Schmalzer (1990) compared the avian communities of oak/palmetto scrub and disturbed oak scrub. The disturbed scrub area had been mechanically cleared in the early 1960's. The disturbed area differed from the undisturbed in having more bare ground and more herbaceous species with greater herb cover. The mechanical clearing of this area produced a community that has remained different in species composition from the adjacent undisturbed area for more than twenty years. They found revegetation following the mechanical clearing of natural vegetation, results in a community which is different in vegetation composition, vegetation structure and thereby supports a different bird community than an undisturbed area. Recovery from fire was compared to recovery from mechanical clearing. Recovery from fire involves sprouting of shrub species, with relatively continuous canopy developing within two years postfire. Fire areas require 4-6 years to reach mean height of 1 meter. Spotted Towhees had significantly higher densities in undisturbed areas as in disturbed areas. This relates to my study because fragmentation,

fire, urbanization or other alterations result in a decrease in bird species abundance and less bird activity associated with reproduction and foraging (Moriarty et. al. 1985, Stanton 1986, Soule et. al. 1988) and supports my findings as well concerning a decrease in abundance of Spotted Towhees with lack of cover.

Bolger et. al. (1991) found fragmented habitats compare readily to islands in terms of extinction vulnerability and overall decrease in diversity. They centered around five resident bird species that are considered shrub species: California Quail, Wrentit, Spotted Towhee, Bewick's Wren and California Thrasher. They found fragmented areas to have a decreased species diversity as compared to unfragmented areas. A strong positive correlation was found between density and persistence in undisturbed habitat. They found the species that occur in smaller, older fragments to be a subset of those that occur in larger, younger fragments. The smaller older fragments were found to support species less vulnerable to extinction. They suggest the poor dispersal ability of the five shrub bird species limits recolonization of the fragments leading to local extinction. This supports my findings on the same 5 species, which were in a significantly higher abundance in mature coastal sage scrub (that had at least seven years recovery) as compared to a revegetated area.

Callaway and Davis (1993) investigated disturbance in coastal sage scrub vegetation mosaics by using aerial photographs. Unburned and ungrazed grassland was converted to coastal sage scrub over time, while coastal sage scrub was often replaced by oak woodland. In burned plots, transition from grassland to coastal sage scrub were significantly lower due to the silt clay to clay soil located there. They also found disturbance in the form of fire maintains coastal sage scrub distribution by preventing invasion by chaparral species. So, disturbance such as fire may lead to shifts in vegetation types. The speed with which it occurs may depend on factors such as soil type. Disturbance such as fire can trigger shifts from one vegetation type to another and effect overall diversity in an area. This relates to my study because the habitat was found to be

recovering from fire 6-7 years later. This is within the 5-10 year estimation for recovery by Minnich (1983), but toward the high end. The Cal Poly area contains silt clay to clay soil and would therefore tend to be in the more slowly recovering group.

After I returned from my travel part of this sabbatical, I began writing the updated manuscript November 6th, 2000 and completed it December 15th, 2000 (Appendix 3). I also improved the graphics of the tables and corrected some errors.

COLLABORATION ON AVIAN USE OF BURNED AND UNBURNED AREAS

For this part of the sabbatical, I collaborated with David J. Moriarty, Professor of Biological Sciences at Cal Poly Pomona on a research project to monitor avian use of burned and unburned coastal sage scrub. My part in this project included collecting current data at three study areas on the Cal Poly Pomona campus, entering the data into a spread sheet, analyzing for outliers and turning the finished product over to Dr. Moriarty for incorporation into a manuscript. I collected data bimonthly from August 2000 through December 2000, then from August 2001 through December 2001. The data in the form of spreadsheets is in Appendix 4. We also constructed some graphics demonstrating the data that had been collected by various individuals up until this point in these study areas (Appendix 5). Most of the work I did on this project occurred in the form of data collection in the field. This helped me brush up on my bird identification skills enormously which has helped in teaching my Ecology and Field Biology (Bio. 3) course. It also allowed for an excellent opportunity for collaboration between the biology departments at Mount San Antonio College and Cal Poly Pomona.

VISITATIONS TO 10 COLLEGES IN CENTRAL CALIFORNIA AND 10 COLLEGES IN SOUTHERN CALIFORNIA REGARDING THEIR BIOLOGY MAJORS PROGRAMS

From October 2 through October 17, I worked on the itinerary for the trip to the schools in central and northern California concerning meetings on their biology majors programs. I also worked on emailing the individuals at these schools, pinpointing the correct person for me to meet with and coordinating a meeting time and day that would work in the itinerary and work with their schedules.

From October 18-October 30, 2000, I traveled to schools in central and northern California. My first stop was at University of California, Davis. Then I visited Napa Valley College. I continued north to lake Tahoe Community College. I then came down the coast and stopped at University of California Berkeley and Cabrillo Community College. While in Monterey, I visited California State University Monterey and Monterey Peninsula College. I continued south to San Luis Obispo and visited California State Polytechinc University at San Luis Obispo and Cuesta College. When I reached Santa Maria, I visited Allan Hancock College. Photographs of the classrooms I saw and places I went are located in Appendix 6. At each college I visited, I offered copies of a detailed syllabus for our Biology 4 and Biology 2 majors courses. I also gave each person a copy of our Bio. 4 lab manual. Many of the professors I met with gave me some of their lab materials in trade. Examples of materials used by other colleges in their majors classes are located in Appendix 10.

1. University of California, Davis

At UC Davis, I met with Tom Rost the Associate Dean of Biological Sciences. He told me there are 3,600 students registered as biology majors at Davis. It is the largest major on campus. All biology majors take their 1A, 1B, 1C courses. 1A is cell and molecular, 1B is an animal survey course and 1C is animal and general ecology. Their

courses used to be locked in order. 1A was a prerequisite for 1B and 1B for 1C, but that has been removed. The only prerequisite is chemistry for 1A. Mr. Rost feels transfer students are very prepared and do better than students who start as freshman at Davis. They use both Campbell and Purves as majors text books.

2. Napa Valley College

My contact at Napa Valley College was Barb Klamanok, Biology Professor. Their equivalent of our Bio. 4 course is called Bio. 120. Majors also take Botany and Zoology for 3 semesters of core course work. Their majors transfer to UC Davis, UC Berkeley, Sonoma State and San Jose State. It is a very small campus with 3,000-5,000 students and 15-25 biology majors per year. Behind the college is a natural riparian area. I enjoyed bird watching in this area before I met with Barb. A list of species seen in located in Appendix 7.

3. Lake Tahoe Community College

My contacts at Lake Tahoe Community College were Kathy Strain the Science Assistant and Mike Noble, Biology Instructor. This was the smallest college I visited. There are 3,000 students total at the college. The college was built in 1988, before that it was a motel. They do not have separate majors and nonmajors classes, they are all together. They use the nonmajors, Campbell, Mitchell, Reece book. Mike Noble has taught here 25 years. When he first came they taught one course in biology, one in chemistry and one in physics. They found that students needed anatomy and physiology for Allied health and after that Microbiology was added. Eventually Zoology and Botany were offered. Most transfers attend UC Davis, Sacramento State, Berkeley or UCLA. After meeting with Kathy and Mike, I visited Lake Tahoe-Nevada State park (Sand harbor). A species list is found in Appendix 7.

On the way back south, I visited Yolo Bypass Wildlife area in Sacramento. A species list is found in Appendix 7.

4. University California Berkeley

At Berkeley, I was supposed to meet with Mary Beth Bernside. But either she forgot or something came up that she couldn't make it. The graduate student in her office was not sure why she wasn't there. This was the only appointment that did not work out of all 20 colleges visited (both local and up north). Since I was on a schedule of meeting individuals at various colleges, I could not reschedule the appointment. However, I was able to talk with the graduate student in her office and get some information. One of the helpful tips she gave me was the website for the courses. She told me that at Berkeley their majors take Bio 1A and Bio 1B. The website address is http://ib.berkeley.edu/courses/biol1b/ and I was able to find the information there that I needed to be sure their Bio 1A and 1B are equivalent to our Bio. 4/Bio. 2 combination. Berkeley also used the Campbell book as we do.

5. Cabrillo College

On the way down the coast to Monterey I stopped at Cabrillo College. It is located in Aptos, California. Mary Hagler is the Division chairperson. Biology majors take Biology 1A, 1B and 1C. Biology 1A is cell and molecular, 1B is Zoology and 1C is Botany, so they are on the 3 semester core system at Cabrillo. They find it prepares the students better for transfer. There are 11 full time members of the department. The entire college has an enrollment of about 14,000 students.

6. Monterey Peninsula College

At Monterey Peninsula College, my contact was Andres Durstenfeld who is the head of the majors program there. He first explained that their majors take two core

courses called Biology 21 and Biology 22. Biology 21 contains information on cell and molecular biology, genetics and physiology. Biology 22 contains information on biodiversity, ecology and evolution. They can be taken in any order. Biology 21 uses the lab manual, Experimental Cell Biology by Baxter and Bowen. It includes two weeks of histology. The class meets for 3 hours of lab per week and 4 hours of lecture (one hour more of lecture per week than we do.) The Biology 22 class meets for 6 hours of lab and 3 hours of lecture per week. The first 10 weeks are dissections. The last 6 weeks are field ecology labs including use of radiometers and pH meters to describe the nature of a pond ecosystem. Most students transfer to UC Santa Cruz, UC Davis and UC Berkeley. There is also a bridges program to facilitate transfer to UC Santa Cruz from both Monterey Peninsula College and Cabrillo College mentioned earlier. This involves money to support minority students going into the biomedical sciences. Students do summer internships working in research labs. They end up doing presentations on their projects at a conference at the end. This sounded like an excellent idea to me, since future scientists need to be well versed in communicating in writing and orally.

There are no longer botany and zoology course offered here. Biology 21 and 22 meet the core requirement for biology majors. There are 6,000 full time students on campus with approximately 40 biology majors. Andres mentioned there is not a lot of financial support from the local community, which surprised me since it is in an affluent area. But, he said since it is affluent, parents want their kids to go straight to a UC or to Stanford.

I was quite impressed to see the new majors biology lecture room at Monterey Peninsula College. The arrangement of the room is very user friendly. I liked the whiteboard with the screen off to the side for powerpoint, slides, over heads or movies. I especially like the control panel and computer in the front podium. It seems when lecturing in this room, everything would be at your fingertips.

7. *Cal State University, Monterey*

When I visited CSU Monterey, it was still quite a new campus, having been established in 1995. There was technically no "Biology" program. The closest to that is an integrative program called ESSP. This stands for Earth Systems Science and Policy. This program is directed at training students for working in areas of science where a background in economics and the politics of environmental issues is important. Many of these students are being trained to work in agencies and marine laboratories such as the laboratory at Monterey bay Aquarium. This is a specialized program that serves this particular function well. However, one criticism I heard was that if a student decides to go on for a higher degree (above Bachelors) into graduate school, being accepted into another school's program may be a challenge. I decided it would be most beneficial to check back on this program and its success in a few years.

On my way back down the coast I decided to stop at some local natural areas that many of these college use for field trips. I stopped at Big Sur, Ragged Point and San Simeon. Big Sur of course make a wonderful natural and beautiful laboratory. We have many beautiful places in southern California to take our classes on field trips, but I don't think we come close to the beauty of these areas in central California.

I also stopped at Ragged Point, as the Monarch butterfly migration was in full swing. The large numbers of these beautiful butterflies in the gardens at ragged point was extremely impressive and something I will show my classes via photographs.

On the beach at San Simeon, I learned that Northern Elephant Seals come here to breed each year beginning in late fall and extending into early winter. This is the southern most breeding site that is located on a mainland. I was also able to view the seal myself.

The seals are quite distracted with territorial boughts and breeding rituals commencing. They could be observed quite closely without disturbing them. There are volunteers docents from "Friends of the Elephant Seals" (a local conservation group) on hand to be sure the seals are not disturbed and to offer interpretive descriptions of their

behavior. I found it quite educational and informative and I plan on sharing this information with my ecology class.

8. *Cal Poly San Luis Obispo*

At Cal Poly San Luis Obispo, I originally had an appointment with V.L. Holland, Dean of Natural Sciences. However, when I arrived he was not available, an emergency had arisen that needed his attention. So, instead I met with Archie Waterbury who is in charge of scheduling. He told me that biology majors take their Biology 151, 152 and 153. Biology 151 is equivalent to our Bio. 4 core majors course. Biology 152 is botany and 153 is zoology. He suggested their courses would be equivalent to our Bio. 4, botany and either zoology 1 or zoology 2. Each of these courses meets for two labs per week. This is the traditional arrangement in terms of a core program for majors, which explained why some of the local community colleges, such as Alan Hancock College, still follow this traditional arrangement as well. Even though some are going to phasing out botany and zoology.

9. Cuesta College

Cuesta College is located off highway 1, just north of San Luis Obispo. My contact at Cuesta College was Pete Pedersen, the department chair of the Biology Department. Pete has been at Cuesta College since 1971and was able to fill me in on the background of the department as well as their current biology program. He told me that their current biology buildings used to house the nursing department. The nursing department was built a new building, so these buildings were converted for biology. I was quite impressed by the computer work stations in the back of the majors biology room. The computers are used for running such programs as population genetics simulations and CDs on various lecture topics. Pete was very happy with the current set up of their majors room and highly recommended it.

He also recommended the Assisted Tutoring Lab set up they have in their department. Anatomy classes use one side of this lab and nonmajors and majors biology students use the other side. In this room are tape recorders, computers and CDs for student tutorials. The students use a workbook and every so often have it signed off by their instructor. The learning lab is manned by biology faculty who each sign up for a certain number of hours each week and earn lab credit for their hours spent there. I found out the equivalent of our Bio. 4 course at Cuesta would be Biology 1A and the equivalent of our Bio. 2 course at Cuesta would be Biology 1B. He sees the Botany and Zoology courses being phased out. They use all the same books we do. The Campbell biology book for majors, the Smith, Elements of Ecology book for their ecology class which is the equivalent of our Bio. 3, the Krough book for nonmajors biology and the Miller book for their environment class. I found out their program was originally established by someone who came from Citrus College so it is very similar to Mt. SAC. Their student population is about 10,000 with about 1,300 in biology.

10. Alan Hancock College

Hancock College is located of the 101 in Santa Maria. My contact at Hancock College was Mick Bondello, zoology professor. At Hancock College majors take 3 semesters of core courses: Bio 150 (the Bio. 4 equivalent), Botany and Zoology. Most transfer students attend Cal Poly San Luis Obispo and UC Santa Barbara. There are about 8,500 students with 30-50 majors in biology. It is predominantly and agricultural area with a low tax base. The school and size of faculty was quite small. They have 5 full time and 4 part time faculty in their department.

I was given a tour of the majors biology lab, geology and open access labs. The open access lab is a computer lab area in the library where students can engage in independent tutorial programs and CDs.

While in this area I visited Morro Bay natural area and the beach at Cambria, California. A species list in located in Appendix 7.

For the month of October 2001, I emailed and visited local schools concerning their majors programs. I set up meetings with many individuals at these schools as well. The 10 local schools I contacted were: University of California, Riverside, Chaffey College, University of California, Irvine, University of California, Los Angeles, Cal Poly Pomona, Cal State Fullerton, Riverside Community College, Cal State San Bernardino, Cal State Los Angeles and Fullerton Community College.

1. University of California, Riverside

Since Neil Campbell is a faculty member at UCR, they of course use the Campbell book that we use. The majors take Bio 5A, 5B and 5C at UCR. Bio 5A is cell and molecular. It includes in laboratory the microscope, spectrophotometry, enzymes, biological membranes, fermentation and respiration and mitosis and meiosis. Biology 5B looks at plant and animal structure and function. It includes a survey of major groups such as invertebrates and protists, plant anatomy and energy metabolism. The Bio 5C class is ecology and evolution. The students conduct the same plant transect project as our do on a north and south facing slope rather than a burn and nonburn hillside. Since our Bio. 4/Bio. 2 combination was modeled somewhat after UCR's 5ABC series our program transfers perfectly. Dr. Clay Sassman assured me that their program will remain as is for the next 10 years at least and we do not have to worry about the transferability of our courses.

2. Chaffey College

My contact at Chaffey College was Robin Ikeda, professor of zoology. Chaffey College has not yet made an equivalent to our Bio. 2. They offer only 3 semesters of core courses, rather than one year. Biology 50 is called Core Biology. It has a chemistry

prerequisite recommended and concentrates on cell biology. It consists of 3 hours of lecture and 3 hours of lab per week. Biology 52 is General Botany which consists of 3 hours lecture and 6 hours lab. Chaffey still teaches Zoology in two semesters, as Mt. SAC does. All other colleges have combined vertebrate and invertebrate zoology into one semester. At Chaffey, Biology 55 is Vertebrate Zoology and Biology 56 is Invertebrate Zoology.

3. University of California, Irvine

At UCI, the core courses for those majoring in the biological sciences include Biology 94, 96 and 97. Biology 94, which is called "Patterns of diversity, ecology and evolution", emphasizes the Tree of Life and how its members interact. Biology 96, studies the processes of ecology and evolution, emphasizing organismal diversity. Biology 97 or Genetic biology, concentrates on expression of DNA, cell division, gene transmission, recombination and mutation. All of these core courses are lecture only. Our Bio. 4/Bio. 2 combination should more than cover this year of core courses.

4. University of California, Los Angeles

At UCLA, the core curriculum is slightly different than any other college, which makes transferring difficult for our students. Fred Eiserling is the Dean of Life Sciences. The curriculum consists of a series of four courses (Life Sciences 1,2,3 and 4). Life Sciences 1 includes information on biodiversity, ecology and evolution. Life Sciences 2 deals with cells, tissues and organs and has a writing component to the course. Life Sciences 3 is an introduction to molecular biology and Life Sciences 4 is genetics. Currently our Bio. 2/Bio. 4 combination transfers for Life Sciences 1 and 2. Our Biology 8 transfers for Life Sciences 3. We do not have a course that is equivalent to Life Sciences 4, but our molecular biologists have plans to propose one.

5. Cal Poly Pomona

The core curriculum class that our Bio. 4 transfers for is Biology 115 at Cal Poly Pomona. My contacts were Chris George and Keith Arnold the coordinators for this course. It concentrates on the basics of the cell, genetics, ecology and evolution. Our course was modeled to some extent from this course, so it transfers well. In addition to Bio 115, majors also take Botany 124 and 125, which cover plant structure and function and morphology. Our Botany 3 and Bio. 2 courses cover these. They also take Zoology 137 (invertebrate) and Zoology 138 (vertebrate). Our Zoology 1 and 2 transfer for these courses. There is apparently talk of changing this core curriculum, but as of the time I talked with Dr. George and Dr. Arnold, the old curriculum was still in place.

6. Cal State Fullerton

My contact at Cal State Fullerton is Dr. Joyce Ono. CSUF used to follow the traditional 3 semester core curriculum of State Colleges, but has since changed their curriculum. The new curriculum is unique to Cal State Fullerton and will therefore be challenging to meet for our transfer students. The new curriculum includes 4 core classes. Biology 171 includes biodiversity and evolution. Biology 172 is cell and molecular biology. Biology 173 is genetics and Biology 174 is physiological ecology. I met with Joyce Ono and the coordinators for each of these courses to discuss the details of the course outlines, their new curriculum and how our students might best transfer. Since the Biology 171 course covers biodiversity and evolution, our Bio. 2 course fits best for that. However, some of that information is in Bio. 4 as well. The same for the Biology 172 course. Some of the information is in our Bio. 4 course and some is in our Bio. 8 course. We don't have a course on genetics to match up with the 173 course, but as mentioned earlier our molecular biologists are working on it. Since the 174 course has never been taught, they do not have the course outline completely nailed down. So, they could not tell me if our Ecology and Field Biology course (Bio. 3) would articulate just yet. They

said to check back with them in Fall 2002. Ideally it would be best if our students could transfer Bio. 2,3,4,8 and our new genetics course for their four core courses. But for now we agreed that our Bio. 2,4 and 8 would count for their 171 and 172.

7. Riverside Community College

RCC follows Mt. SAC and Chaffey in retaining Zoology in two semester courses. So, their core curriculum consists of Biol. 1 which is general biology covering cell and molecular biology, physiology and taxonomy, Biol. 2A which is invertebrate zoology, Biol. 2B which is vertebrate zoology and Biol. 5 which is general botany. They do not have a course that matches our Bio. 2 yet. This is the same as what I found at Chaffey. I think we are at an advantage offering our students a choice between the traditional system of 3 semesters and the new system that everyone seems to be switching to of one year of core courses.

8. Cal State San Bernardino

My contact at CSU San Bernardino is Colleen Talbot a biology professor. The core series at San Bernardino is Biol. 200, 201 and 202. This is similar to UCR's set up with a cell and molecular course, a survey of biodiversity and an ecology and evolution course. So, our Bio. 4/Bio. 2 combination transfers perfectly.

9. Cal State Los Angeles

CSU Los Angeles requires a series of three courses for core requirements, but they are slightly different in content from some of the other Cal States. The series includes Biol. 101, 102 and 103. Biology 101 is an introduction to animal biology, survey of phyla, organ systems and adaptation to the environment. This course is very much like our Bio. 2. Biology 102 is the same course but for plants. It includes a survey of plant phyla,

structure and function, adaptations and evolution of plants. Biology 103 covers genetics, ecology and evolution. The combination of our Bio4/Bio2 covers this completely.

10. Fullerton Community College

My contact at Fullerton College was Maala Allen who teaches the first in their 4-course core sequence which is Organismal Biology (Bio 170). The other three courses are Ecology (Bio 171), Cell and Molecular Biology (Bio 172) and Genetics (Bio 173). Fullerton College began this core sequence about 2 years ago in response to the unique curriculum changes that Cal State Fullerton was making. Since CSUF is their major transfer school, they felt it was to the students benefit to match the program at CSUF. They do still offer Zoology once a year for those students who transfer to an institution that still requires it. It is a one semester (invertebrate and vertebrate) course. Since there has not been much interest in botany, they have not continued to offer it. This is quite different from any other community college in the area. I have to wonder how much of a disadvantage the students are at who do not transfer to CSUF. Since their organismal biology looks very similar to our Bio. 2, most transfer schools probably take the first 3 of their core series for their core requirements. I do know from our transfer students though that the further a course set up is from the transfer college, the more difficult it is for the student to get courses counted.

INVESTIGATION OF LOCAL WILDLIFE AREAS

Anza Borrego

Due to rapid development around the Santa Rosa Plateau, I was interested in finding alternative field trip locations for the Ecology and field Biology (Bio. 3) course. In particular I was interested in Anza Borrego State Park and Big Bear for overnight trips. Anza Borrego State Park is located off S22. From Mt. SAC area I took the 10 freeway east to 86 south to S22 west. Anza Borrego lies in a pocket between three mountain

ranges: the Santa Rosa Mountains, the San Ysidro Mountains and the Vallecito Mountains. It is located in San Diego County, with portions extending into Imperial and Riverside Counties as well. The park consists of over 600,000 acres and is the largest desert state park in the U.S. It is representative of the Colorado Desert in flora and fauna. The park name is derived from a combination of the name of Spanish explorer Juan Bautista de Anza and the Spanish word "borrego," referring to bighorn sheep.

I visited Anza Borrego for two weeks from November 1, 2001 to November 15, 2001. I entered Anza Borrego State Park on S22. Before entering the park I stopped at Truck Haven Pediment. As the base of the mountains erodes here, and alluvial fan is built on a pediment.

The dominant plants here are creosote bush and ocotillo. Creosote Bush (*Larrea tridentata*) is a perennial, evergreen shrub found in both the Colorado and Mojave deserts. It dominates well-drained, gravely soils. A variety of insects including grasshoppers, praying mantids, moths and beetles take shelter on it and are camouflaged to look like parts of the plant. It exudes a sticky sap made up of flavinoids, lignins, volatile oils, saponins and waxes, which repel grazers such as cattle and insects. Creosote also protects itself with odors. In northern Mexico, the bush is called *hediondilla* or "little stinker." Creosote also release chemicals into the soil to deter other plants from growing too close and competing for water. A process known as allelopathy. Ocotillo (*Fouquieria splendens*) does not occur in the Mojave as creosote does, only in the Colorado Desert. It is also called "coachwhip" for its bare 8-15 foot long stems. As the soil dries out, ocotillo sheds its leaves until the next rain, photosynthesizing from the remaining green stem. I saw the ocotillo in the fall, so they were not in bloom. But in the spring, fiery-red tubular blossoms appear at the end of the long stems. These blossoms attract hummingbirds and other nectar feeders. Even though the blooming ocotillo are spectacular, I decided the ocotillo in the fall are a beautiful site as well. I would bring my class here at either time of year.

I then officially entered Anza Borrego Desert State Park. I took the four mile long dirt road to Font's Point. This is an overlook for the area called the "badlands." The badlands in view from Font's Point contain colored sediments that have been uplifted and eroded. These badlands range in age from 250,000 to four million years old. Animals such as ice-age horses, camels, mammoths and sloths thrived here at one time.

In the wash on the road to Font's Point I noticed Desert Willows and Smoke Tree. I also spotted several White-tailed Antelope Ground Squirrels (*Ammospermophilus leucurus*). These are small squirrels (about 9 inches long) with a white eye ring, a white stripe on each side and they hold their tail arched over their back. They are named from the tail resembling an antelope's tail. I spotted one feeding in an ocotillo, but all were to fast for me to catch on film! At Font's Point I saw a cactus wren and two ravens. Cactus wren (*Catherpes mexicanus*) has a rufous belly, brown crown and white throat and upper chest. It makes a descending, flute-like call that echoes off the canyon walls. They live on rocky mountain sides like those that line Font's Point. I saw this bird foraging on a rock. The ravens (*Corvus corax*) were soaring overhead. They are a glossy black bird with a large heavy bill. These are one of the only all black animals in the desert. They can sustain intense sun because their stocky bodies do not gain or lose heat quickly. They also eat carrion and insects which contain relatively large amounts of water.

At the Anza Borrego State Park Visitor's Center in Borrego Springs, I was quite impressed with the variety of slide shows available to visitors. The visitor's Center is located at the west end of Palm Canyon Drive in Borrego Springs. It is open October through May. From June through September it is open on weekends and holidays only. These hours should not affect my class trip as we are usually on our long field trips on weekends. The slide show I was most impressed with was the wildflower show. If I were to bring my ecology class here in the fall, they would not get to see the spring bloom. However, this slide show details a typical spring bloom and would show them how different the area looks in that season and perhaps entice them to return then. At the

visitor's center there is a well maintained garden of native plants. I observed two bird species a verdin (*Auriparus flaviceps*) feeding on an ocotillo and a Cooper's hawk (*Accipiter cooperii*). I also spotted a Western Fence Lizard (*Sceloporus occidentalis*). I found a campground that accommodates groups at Borrego Palm Canyon.

I then took S3 south to Yaqui Pass, which is located at an elevation of 1750 feet. I walked the Bill Kenyon Trail to the Bill Kenyon Overlook. Along the trail I noticed Desert Agave (*Agave deserti*), Teddy Bear Cholla (*Opuntia bigelovii*) and Pencil Cholla (*Opuntia arbuscula*). The overlook presents a beautiful view of the Mescal Bajada.

I continued on south S3 to Tamarisk Grove Campground. I found this to have a great deal of potential as a future site to take my class. The campground is fairly remote, but has solar powered restrooms. It has excellent picnic facilities as well. However, it is closed from May until October, so I would be required to plan my trip with the class in October. I see not problem in that, the temperatures would probably be best then in the desert for camping anyway.

I then headed east on highway 78 to Buttes Road. I photographed a beautiful display of soil colors along the road. Then after a great deal of searching, I was able to find what is know as "The Slot." This is a land formation of plateaus done in a valley that has formed through water erosion over geologic time. The formations are unbelievable.

I continued east on highway 78 then turned right on Split Mountain Road to the Elephant Trees Nature Trail. I had heard of elephant trees before but had never seen one in person. This area is in an alluvial fan, which is a gently sloping accumulation of material that has been deposited at the mouth of a canyon. The sand, boulders and rubble here, arrived by violent flash floods rising in the Vallecito Mountains to the west. So, these floods have been building this fan for thousands of years. Along this trail I saw Creosote Bush (*Larrea tridentata*), smoke tree (*Psorothamnus spinosus*) and ocotillo (*Fouquieria splendens*) again. I learned that although ocotillo has spines it is not a cactus. The ocotillo spines are actually small plates that cover the stems. Rather than being in small

bunches as on cactus, which are separate from the outer surface of the plant. I finally came upon the Elephant Trees (*Bursera microphylla*), but was extremely disappointed. Apparently the trees did not make it through our last year of drought. They were all dried and dead. It was very sad. As I continued on the trail I came across Catclaw (*Acacia greggii*) this is also known as "wait-a-minute bush" due to the sharp grabbing spines that catch on clothes easily. This plant in a member of the pea family. Pods were gathered by Native Americans for food. At the Elephant Tree Nature Trail, I also saw a Black-tailed Gnatcatcher (*Piplioptila melanura*) and a Costa'a Hummingbird (*Calypte costae*). A complete listing of species seen at Anza Borrego is in Appendix 6.

I returned to Anza Borrego State Park November 20-30, 2001, but I explored other areas in the park this time. I also decided to include a trip to the Santa Rosa Plateau, where I usually take my class to see how I could fit Anza Borrego into that trip. I began at the Santa Rosa Plateau. The vernal pools were of course dry in the fall and there were no wildflowers out at this time. At the visitor's center I met Zack Principe, the preserve ecologist for the Nature Conservancy. I decided if I were to bring a class here, I would need Zack, to take us out on the reserve to areas where we could find water and therefore find life! I spoke with Zack about the possibilities of bringing my class out. He suggested in that situation that we would probably want to take the class to the Adobe's. This area of the preserve is where most of the water holes remain in dry seasons. These water holes resemble water tanks and are therefore called "tenajas." They are extremely important to the wildlife, particularly in dry years. Since there is no camping allowed at the plateau, I headed south on I15, then east on Highway 79 to Oak Grove Campground. I found Silk Tassel *(Garrya)* on the hiking trail leading out of Oak Grove. It has vertical leaves and long dangling seed pods. I also spotted sugar bush (*Rhus ovata*) and great basin sage (*Artemisia tridentata*)on this trail.

I then returned to the 79 east and took that to S2 north to the S22. I eventually ended up at Culp Valley in Anza Borrego State Park. In Culp Valley I noticed an

immense amount of desert varnish. This is a result of a combination of geology and biology. Desert Varnish appears as a dark washed area on the rock. In the rain, clay deposits on the rock and the water holds it in place. A type of bacteria cement the clay on the rock, making a ceramic covering on the rock. Normally rocks colors are a result of minerals inside the rock, but this time it is due to events occurring on the outside of the rock. Plants I found at Culp Valley include: creosote bush, ocotillo, smoke tree (all seen on the previous trip) and desert lavender (*Hyptis emoryi*). Desert lavender is a member of the mint family and blooms from January to May. Its flowers are violet-blue and smell of lavender. Verdins and gnatcatchers like to nest in this bush.

Big Bear/James Reserve/Palm Desert

From September 17-28, 2001, I explored the San Bernardino and San Jacinto Mountains. My initial intent was to evaluate Big Bear as a potential field trip site. I began at Mill Creek in the Thurman Flats area on highway 38, the road to Big Bear. This is alluvial scrub habitat. It contains incense cedar, toyon and scrub oak. In the nearby riparian area was mulefat, elderberry, poison oak and buckwheat. There were also elm trees with sapsucker holes drilled in them. This is when a type of woodpecker called a sapsucker drills holes into the tree to access the sap. I also saw white-crowned sparrows which come here from Alaska to spend the winter. I also saw American robins which are year round and breed here, although there are some that come in from Canada as well. I then saw a phainopepla which is also known as a "silky flycatcher" due to the shiny black appearance of the male. It was eating berries off the toyon. As I hiked around Thurman Flats I found a pile of bear scat with coffee berries in it that the bear had been eating. A northern flicker flew over. This is another kind of woodpecker, but its numbers have been decreasing lately due to an introduced species, European starling, taking over its nesting cavities. I then moved about one mile up the road to Mountain Home Village. I saw stellars jay, European starling, acorn woodpeckers, band-tailed pigeon and Cooper's

hawk. A gray squirrel was in a pine tree as well. This area is a mixture of what are know as "yellow pines" due to their yellowish color. This would include both Ponderosa Pines and Jeffrey Pines. I continued up highway 38 to Barton Flats Visitor's Center. The visitor's center was closed the day I visited, but I did see: dark-eyed junco, white-headed woodpecker, Anna's hummingbird, mountain chickadee and western bluebird. I was thinking at this time that this would be a wonderful alternative for the desert trip for the ecology class trip, particularly if it were offered in summer school. In this area I noticed the Ponderosa Pines on the wetter sides of the mountain, while the Jeffrey Pines were on the dryer side. If you smell the bark of Jeffrey Pines it smells like vanilla. I saw a Clark's Nutcracker and a white-breasted nuthatch here. I noticed many of the conifers were infested with bark beetles. They are deadly to these trees, since the female beetle bores in, lays larvae that feed on the living tissue and girdle it. I found manzanita also know as "little apples" here. This plant was named for its berries that ripen in the fall. These berries were important to the Serrano Indians for food. Other conifers included the sugar pine with its long dangling cones. I saw chipmunks, which can be distinguished from squirrels by the stripes on their faces.

I camped at Southfork Campground while here and I found it to be quite crowded and noisy. This is when started to change my mind concerning the potential of this area for a class field trip. There were very inconsiderate campers with loud radios. The camp spots were very close together and there was a great deal of alcohol consumed by many there. I decided this was not suitable for a class trip and went to the San Jacinto Mountains to check out the James Reserve instead. This is a reserve run by the University of California system, in particular UC Riverside. It is not accessible top the public and is a research facility. When I discovered this, I had much higher hopes for the James Reserve.

I felt very good about the potential of the James reserve for future class trips. In order to get several opinions, I invited Michael Bondello, professor of Zoology from Hancock College in Santa Maria and an expert on mountain ecosystems to come along.

Mr. Bondello teaches courses to the Sierra Nevada mountains and was quite helpful in identification and natural history of the area. Also, several past Mt. SAC students joined me on a hike to offer their opinions from a student's perspective.

On the way to the James Reserve we stopped at Twin Pines Road, where we explored an area of chaparral. I decided it had great potential for a class hike. One side of the area is composed of a south facing slope. One side of the area is composed of a south facing slope. This causes it to be more xeric and contain vegetation such as white sage, chamise, yucca and scrub oak. Across the road is the north facing slope, which is a drastic contrast. This area is more mesic with clusters of coast live oak trees. It appears much more lush and green than the south facing slope. We walked up the dirt road at Twin Pines. Plants we identified on this road included: white sage, chamise, yucca, scrub oak, golden yarrow, and buckwheat. Chamise (*Adenostoma fasciculatum*) is usually the dominant plant in chaparral habitat. It has a reduced leaf size as an adaptation for living in such a dry habitat. That way water loss through transpiration is reduced.

We continued up highway 243 until the turn off for the James Reserve. Since it is a research facility that is not open to the public, special permission was acquired for us to visit. As we drove in on the road to the reserve we passed Lake Fulmor. This is a man-made lake that the Papoose Creek (from the reserve) feeds. On this hillside next to the lake we found a plant with beautiful, red trumpet shaped flowers called scarlet bugler. As we walked down the bride we found black phoebe's had built their mud nests under it. We found cattails growing in the lake, sedges and rushes. Then, as we walked along the lake we encountered a bird watching group from a UCR extension class. They were following some stellar's jays. We walked all the way around the lake. It would be a nice place to take the class, but this part of the area is still open to the public, so avoiding those with radios would be through the locked gates that lead into the James Reserve. The smell of the pines was extremely prevalent as we got out of the car. I checked in with Sheri Lubin, the Reserve Steward.

The reserve is located 9 miles north of Idyllwild on highway 243. To get there from Mt SAC, take the 10 freeway east. Exit 8th street and turn right. Left on Lincoln then right on highway 243. When I arrived I met with the Reserve Director, Mike Hamilton and the Reserve Steward, Sheri Lubin. They informed me of some of the rules and regulations of the reserve. They also informed me that the reserve is located on an alluvial bench which is protected for research and study by the U.S. Forest Service. The reserve is mostly mixed conifer and hardwood forest, mountain stream and man-made reservoir (Lake Fulmor). The species found here are extremely similar to the Big Bear area. As can be seen from the species list in Appendix 7. I saw dark-eyed junco, white-headed woodpecker, Anna's hummingbird, mountain chickadee and western bluebird at the feeder at Trailfinder's lodge. Also seen were: stellar's jay, European starling, acorn woodpeckers, band-tailed pigeon, ground squirrels, gray squirrels and chipmunks. The James Reserve is full of diversity. There are records of 259 species of vascular plants, 35 species of nonvascular plants, 6 species of amphibians, 18 species of reptiles, 125 species of birds, 35 species of mammals and about 1,000 species of invertebrates.

We stayed at Trailfinder's Lodge while at the James reserve. This lodge sleeps about 30 people. It has beds with mattresses upstairs and a kitchen and meeting room complete with chalkboard down stairs. There is also an impressive collection of study skins available for use.

We decided to take a hike on one of the two trails at James Reserve. We first hiked the trail that runs through the campground, then circles the hillside. As we went by the stream area we noticed sapsucker holes in a white alder tree, just as I had seen at Big Bear. We also spotted and alligator lizard (*Gerrhonotus multicarinata*) in the leaf litter.

Down in the stream area we found many azaleas (*Rhododendron occidentale*) blooming. This plant has a beautifully fragrant flower on it. And as we continued walking we were impressed with the vast array of conifers in the area. There are Jeffrey

Pines, Ponderosa Pines, Coulter Pines and Sugar Pines. Many of the very same species I saw at Big Bear. The drooping appearance of the long cones on the sugar pine make it readily identifiable. These are large sharp cones. If they fell on a person's head they could potentially kill that person. In the days of lumber jacks, these trees then got the nickname "widow makers."

As we walked this trail we also noticed various bird species such as, white-headed woodpeckers, stellar's jays, white-breasted nuthatch, acorn woodpeckers and band-tailed pigeons. Again, many of the same species I saw at Big Bear. At the top of the trail there is an ecotone. This is where one type of habitat abruptly changes to another type. In this case coniferous forest changes to chaparral. The area opens up and there is much sun exposure. This makes it a drier are of the hill and more conducive to chaparral plants. Species seen here included, manzanita, scrub oak, white-bark ceanothus, coffeeberry, chamise, and yucca. The manzanita (*Arctostaphylos manzanita*) is a beautiful plant with red bark and vertical leaves that help decrease the water loss called transpiration for this plant.

I felt the James Reserve was the perfect alternative to Big Bear. There are no public crowds to deal with, there are excellent accommodations and it is a research facility. The past Mt. SAC students who came along were Smita Sambui, who now attends UC Berkeley in Botany and Karen Morrison who now attends Cal State Fullerton in Environmental Science and Geology. They felt the James Reserve was an excellent choice for a field trip. This is invaluable information, as these students have taken the ecology course and can give a perspective from a students point of view. Mr. Bondello also felt the area had a great deal of potential for field trips. A complete listing of organisms seen at the reserve can be found in Appendix 7.

When we left the James Reserve, we turned left out of the Reserve onto Highway 243. Then left again on highway 74, this is the Palms to Pines highway. This curved around and eventually took us to Palm Desert. This highway travels through several life

zones and biotic communities. At San Jacinto Peak, the highest elevation the life zone would be alpine with lichens and limber pine. Next would be Hudsonian/Canadian which includes Lodgepole Forest. At the elevation of the James reserve (about 5,000 feet) the transition zone is found which includes Upper Montane and Yellow Pine Forest. Examples of plants here include; white fir, sugar pine, Jeffrey Pine and Ponderosa Pine. below 5,000 feet is Upper Sonoran which includes chaparral and coastal sage scrub habitats. Until finally the lowest elevational zone, the lower Sonoran which includes desert scrub. I took the 74 until I reached Palm Desert, I stopped at the Bureau of Land Management Visitor's Center. It is located on highway 74 west of the town of Palm Desert. I was quite impressed with the displays on desert ecology. I plan to take my class there when we make this trip. There is also an impressive desert garden surrounding the Visitor's Center.

New York Mountains

The New York Mountains are located off I-15. To get there take I-15 north from Ontario area to Cima Road. Turn east on Cima Road to Cima. Turn south at Cima to Cedar Canyon Road. Turn east on Cedar Canyon Road to Ivanpah Road. Turn north on Ivanpah Road to New York Mountains Road. Turn west on New York Mountains Road, then west to Pinto Valley or North to Carruthers. I went to visit the New York mountains from September 9-12, 2000. I was not terribly impressed. Although the New York Mountains offer an impressive pinyon-juniper woodland area. it had been such a dry year that very little wildlife was active I found it to be quite inactive and ended up staying just a couple days as opposed to the week that I had originally planned. I did not see a potential at all for class field trips here. The rock formations are impressive and tribute to the years that plate tectonics has shaped this area. But other than that, I did not see this functioning as a field trip area.

Day Creek Canyon/Cucamonga Canyon/Claremont Wilderness Area

From September 15-30 I made several visits to Day Creek Canyon and Cucamonga Canyon in Rancho Cucamonga and Claremont Wilderness Area. Day Creek Canyon is located at the top of Day Creek Road in Rancho Cucamonga. From Baseline Road in Rancho Cucamonga, I headed north on Day Creek Road which dead ends at the canyon. I found the organisms at this canyon to be the same as those found in Cucamonga Canyon. To get to Cucamonga Canyon, I took Baseline Road west to Archibald. Headed north on Archibald to 19th street, then took 19th street west to Sapphire. I took sapphire north until it ended. The trail to Cucamonga Canyon starts there. They are both comprised of coastal sage scrub vegetation type, so it is not surprising that they would contain the same species. I therefore made a combined species list for the two areas found in Appendix 8. I did not see these two areas offering anymore to the class than the similar canyons I already visit in Diamond bar and at Cal Poly Pomona. In fact at Cucamonga canyon there were many abandoned cars and other debris that made this area very undesirable for a field trip location. The areas we already go to are closer in terms of travel as well.

At Claremont Wilderness Area, I found a mixture of coastal sage scrub, chaparral and mountain ecosystems. A complete listing of species found at the Claremont Wilderness Area is located in Appendix 7.

In December 2001, I wrote my sabbatical report.

CONCLUSIONS (VALUE TO THE COLLEGE)

In 1991, I completed my thesis on Avian Use of Modified Coastal Sage Scrub. At the time, there was little known about the response of birds to fire in coastal sage scrub habitat (Moriarty et. al. 1985, Stanton 1986). In fact, coastal sage scrub was just beginning to be recognized as a distinct habitat type from chaparral (Soule et. al. 1988).

When I established the Biology for Majors course (Bio. 4) at Mount San Antonio College in 1996, I established a scientific report as one of the writing assignments. This idea was inspired by my past research in this area, but also by the fact that University of California, Riverside used a similar assignment in their majors biology course. Since 1996, Biology 4 students have collected data on vegetation changes in a postfire area, analyzed it and written it up in a formal paper. Over the years, I noticed new references and a larger number of references becoming available. I decided that this area of the course needed to be updated by updating myself on the current information. That is what this part of the sabbatical has done for the Biology 4 course. By researching the most current information in this area, I have been able to update myself so that I may pass the most current information on to my students. In addition, these references were used to write the thesis into manuscript form, which may now be used as a reference by the students when they write their papers. The knowledge I gained form researching this topic has also benefited my Ecology and Field Biology (Bio. 3) course since we discuss fire as a disturbance and its ecological impact. We do an extensive field trip to examine fire ecology in various habitats. This has helped me to relay the most current information to my students in this class as well. The literature on the effects of fire on bird ecology has grown extensively over the last 10 years. At the time I wrote my thesis, it was thought that coastal sage scrub being a drought deciduous community, would have less bird species diversity after a fire due to decreased layers of vegetation as a result of the fire (Moriarty et. al. 1985, Stanton 1986). This was supposed from the literature showing increased layers of vegetation led to increase bird species diversity (Karr 1968, Willson, 1974, Menge and Sutherland 1976, Ricklefs and Travis 1980, Rotenberry 1980). I found more recent studies to verify this idea in a variety of habitats (Breininger and Schmalzer 1990, Bolger et. al. 1991, Callaway and Davis 1993, Breninger and Smith 1992, Greenberg et. al, 1995, Wilsey and Potvin 2000). As a result I was able to add more to my class discuss in terms of the reaction of bird species diversity to coastal sage scrub. I was also able to provide

more updated references for my students to use when they write their papers. Our science majors will now transfer better prepared to in this area of avian ecology.

As for the second part of my sabbatical, which involved a joint project between myself and David J. Moriarty of the Biological Sciences department at Cal Poly Pomona, there were several beneficial outcomes. First it was quite beneficial in strengthening relations between the biology department at Mt. SAC and Cal Poly. This project allowed me to spend a great deal of time conferring with members of the department at Cal Poly. It was not only intellectually stimulating, but I think they greatly appreciated the opportunity for collaboration and the fact that I shared responsibly for this project. Dr. Moriarty told me it was very useful to him in motivating him to revisit this postfire study. Second, it gave me the opportunity to be out in the field twice a month, brushing up on my bird identification skills. Although I love being in the classroom, it tends to keep me out of the field, which makes it difficult to keep up my field identification skills. This will greatly benefit my Ecology and Field Biology (Bio. 3) course, as we visit this coastal sage scrub habitat quite often in the course of the semester. I had the opportunity to work on the graphs in Appendix 5, as well. This allowed me to brush up on my data analysis skills, which we talk extensively about during our scientific methods lecture in the Biology for Majors (Bio. 4) course. it also allowed me to see the trends that have developed in bird species diversity in the area over the last 20 years, which I can incorporate in to my lectures in both classes. I feel I am a much better teacher, more useful to my students and able to give them updated information on postfire recovery to prepare them more for transfer as a result of this part.

The third part of the sabbatical also made me feel more able to counsel my students better for transfer. Since many 4 year colleges are changing their science majors programs, students often come to me frustrated about which coursework to take for their core biology work. I would get bits and pieces of information from transfer schools sometimes. But, to actually be able to go out and visit the transfer colleges, meet the

instructors and find out what their future plans are for their programs is invaluable to our students. To visit the community colleges, helped me to get an idea of what other community college professors are doing to cope with this situation. I found that most community colleges model their programs after their nearest transfer schools. Particularly in the more northern areas of California where community colleges tend to be smaller and near just one or two transfer colleges. The two choices of program seem to be the one year (2 semesters) of core coursework, similar to our Bio. 4/Bio. 2 combination, or a year and a half (3 semesters) of core coursework, similar to our Bio. 4/Zoology/Botany combination. Some professors I talked with kept the 3 semester system at the community college even though their transfer college had switched to the year of coursework because they felt it prepared the student better for their future in biology and they felt the student would be covered at transfer no matter where they went. Barb Klamanok at Napa Valley College and Mick Bondello at Hancock College both felt this way. It helped me to see the biology departments and campuses at Universities such as Davis and Berkeley because our students who are interested in transferring to these colleges often ask my opinion. It is hard to give an opinion without actually visiting the campus. I will now be able to counsel my students much more effectively.

For the southern California colleges, I found many of the transfer schools are changing their programs to be quite different from one another. In talking with faculty at these colleges, they seem to realized this makes it very difficult on the transfer student. I found the community colleges tend to respond by offering students several pathways to complete their coursework. This is also possible here because the community colleges in southern California tend to be larger and more able to offer a variety of courses. I think that keeping our two possible tracks: Bio. 4/Bio. 2 or Bio. 4/Zoology/Botany is most beneficial to our biology majors at Mt. SAC.

This part of the sabbatical also enabled me to make long term contacts at these colleges that I visited. I felt it helped to spread the word and bring to the forefront the

problem students sometimes have in choosing coursework when transferring. I feel everyone I talked to at all 20 colleges understood and had noticed the difficulties students are encountering due to changes in programs.

The fourth and last part of the sabbatical, which involved investigating local wildlife areas for future use in the Ecology and Field Biology (Bio. 3) was extremely useful. I am usually not available to investigate these areas at the time I would actually want to take my class there. This makes it difficult to predict if the area would be worth the trip. With the increase in enrollment in this course over the past few years, we have been offering an additional section in summer. (In addition to the spring section.) When budget restraints and enrollment allows, I would like to offer a section in the fall. But many of the areas selected for the course are best for visits in the spring and summer. This sabbatical allowed me to visit areas at the time they would be used which greatly helped in the assessment. I was also able to make contacts at areas such as the James Reserve, so that I may be able to add these unique areas to the course outline. I did find some areas I investigated such as Claremont Wilderness Park to be very similar to areas we already visit and not really worth an additional trip at this point. I think this way the students get the best in quality education.

Lastly, I found this sabbatical increased my enthusiasm for teaching. It gave me a break from the classroom routine and made me miss my place there! It allowed me to feel more confident in my teaching and as though I am better able to serve our students. I have been sharing ideas that resulted from my sabbatical, with my colleagues and my students and will continue to do so.

Appendix 1.
Original thesis version of "Avian Use of Modified Coastal Sage Scrub"

AVIAN USE OF MODIFIED COASTAL SAGE SCRUB

A Thesis

Presented to the

Faculty of

California State Polytechnic University, Pomona

In Partial Fulfillment

of the Requirements of the Degree

Master of Science

in

Biological Sciences

by

Cynthia Jean Shannon

1991

SIGNATURE PAGE

THESIS: AVIAN USE OF MODIFIED COASTAL SAGE SCRUB

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DATE SUBMITTED: 3-12-91

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ACKNOWLEDGMENTS

I would like to thank my committee members, David Moriarty, Glenn Stewart and Curtis Clark for their invaluable comments, suggestions and discussions. Through the efforts of these three and many more concerned individuals to preserve the hills around Cal Poly, field biology students and wildlife continue to have a home. Special thanks to Rick Clements, for taking me under his wing (so to speak) and introducing me to the wonderful world of birding. I also thank Rick Clements for many helpful comments and suggestions at the start of this project. I would like to thank the many field assistants, who faithfully joined me at the crack of dawn so many times. I would like to thank Gerald Braden, for many insightful discussions and comments. I also thank Gerald Braden and my parents for all their support and encouragement. Lastly, I find it difficult to express the impact D. J. Moriarty has had on my life and future as a professional ecologist. I thank D. J. Moriarty not only for filling the role of mentor in my research and statistical training, but also for being my friend.

This research was supported in part by a "Landlab" grant from the Los Angeles County Sanitation District which was distributed by the Cal Poly Kellogg Foundation.

ABSTRACT

Bird species diversity and activity were compared between areas of mature coastal sage scrub which had been burned, unburned and used for landfill activities. A damping of bird species cycling was seen in a recovering coastal sage scrub burn area. Bird species in mechanically modified areas that lacked vertical plant structure, showed a tendency to react similarly to severely burned areas in repetitive cycling trends. Disturbances such as clearing of coastal sage scrub were found to decrease bird species diversity and lead to a predominance of introduced bird species. Areas which sustain vertical heterogeneity were preferred by a greater diversity of birds for a wider variety of behaviors. The knowledge gained from this study will assist in the planning of future environmental modifications and fire management.

TABLE OF CONTENTS

INTRODUCTION

The forces organizing avian community structure can vary widely from community to community and even from season to season within a single community (Rotenberry 1980). The ecological role of such forces as competition in shaping avian communities is increasingly questioned, while evidence for such forces as similar adaptive morphologies, habitat structural diversity, food abundance, energy requirements, biomass, productivity, shelter against predators, and adverse weather conditions, or several combinations of these, is accumulating (Karr 1968, Willson 1974, Menge and Sutherland 1976, Ricklefs and Travis 1980, Rotenberry 1980). Ricklefs and Travis (1980) suggest that all avian communities have a core of species, while added species occupy the periphery of this space, increasing community diversity. Furthermore, Avery and Van Riper (1989) suggest that temperate bird communities are composed of a core of permanent resident species, complemented in the winter and spring by seasonal species.

Ultimately, avian community structure can be associated with vegetation structure (Willson 1974). Vegetation complexity and foliage height have long been associated

with bird species diversity (MacArthur and MacArthur 1961, Karr and Roth 1971, Willson 1974, Lynch and Whigham 1984, Avery and Van Riper 1989). MacArthur and MacArthur (1961) showed that in deciduous forests the diversity of breeding bird species depends upon foliage density and foliage height rather than plant species composition. Avery and Van Riper (1989) and Willson (1974) found greater structural complexity of vegetation to be positively associated with bird species richness. Willson (1974) emphasized the importance of a tree layer, and found that an increase in avian species may not be due to an increase in productivity of resources, but rather a more constant environment (in terms of annual resource productivity) with varying structure. Therefore, the constant resources maintained in a more complex environment may be more beneficial to more species of birds than a less complex area, such as a field, with high annual productivity.

Beissinger and Osborne (1982) found the occurrence of foliage in three general horizontal layers (herbaceous, shrub and canopy) to increase bird species diversity. These horizontal layers of vegetation lead to a greater variety of patches in an environment and are simultaneously supportive of ground dwellers, shrub dwellers and canopy dwellers (MacArthur et al. 1962). Lynch and Whigham (1984)

found tree, shrub and herb layering to significantly influence almost every breeding bird species in upland forests including permanent residents, short-distance migrants, and especially long-distance migrants. Karr and Roth (1971) found that bird species diversity is not only linearly related to foliage height diversity but also sigmoidally related to percent vegetation cover. This indicates the cover of vegetation in addition to the layering and distribution among the layers is also an important predictor of bird species diversity.

Avian community dynamics of coastal sage scrub have rarely been studied, even though coastal sage scrub is a common plant community in the coastal areas of southern California. Coastal sage scrub and chaparral bird communities share many similar species, such as Bewick's wren (Thryomanes bewickii), wrentit (Chamaea fasciata), rufous-sided towhee (Pipilo chlorurus), California quail (Callipepla californianus), and Anna's hummingbird (Calypte anna). Locally breeding species that are year-round residents in coastal sage scrub include scrub jay (Aphelocoma coerulescens), cactus wren (Camplyorhynchus brunneicapillus), California thrasher (Toxostoma redivivum), and California towhee (Pipilo crissalis). Migratory species include white-crowned sparrow (Zonotrichia leucophrys) and Cooper's

hawk (Accipiter cooperii) in winter, and black-chinned hummingbird (Archilochus alexandri) in spring and summer (Stanton 1986, Dodd 1988, Soule et al. 1988, Avery and Van Riper 1989). When flying, coastal sage scrub birds rarely ascend higher than a meter or so above the vegetation (Soule et al. 1988). This limited flight pattern is obvious in many feeding behaviors of coastal sage scrub birds described by Soule et al. (1988). The California thrasher, rufous-sided towhee, and California quail feed on or near the ground. Bewick's wren and the wrentit feed almost exclusively within the bushes. Flycatchers such as the black phoebe (Sayornis saya) can be found sallying from the vegetation for insects. However, even though the majority of birds in the coastal sage scrub community are found on or near the vegetation, raptors such as the red-tailed hawk (Buteo jamaicensis) can commonly be found surveying from high in the air (Dodd 1988).

Coastal sage scrub plant taxa, such as the genera Artemisia, Salvia and Eriogonum, are characteristically more drought deciduous than chaparral species, with light brittle stems and typically fibrous shallow root systems. Chaparral contains more evergreen sclerophyllous species (Munz 1974, Mooney 1977, Kirkpatrick and Hutchinson 1980, Gray and Schlesinger 1981, Westman 1983, Westman and

O'Leary 1986). Coastal sage scrub is found at lower elevations than chaparral (below 600 - 900m), in a climate with lower rainfall, more severe water stress, and a shorter growing season (Gray and Schlesinger 1981, Gray 1982, Minnich 1983).

Fire is a natural part of the history of this plant community and therefore of the bird community that occurs there. The adaptability of birds in coastal sage scrub to fire disturbance would presumably be quite high, although the increasing human alteration of "natural" fire patterns may require consideration. For instance, in areas of increased urbanization, human activities may start wildfires that would not otherwise occur.

Allowing wildfires to burn is argued to be beneficial in terms of decreasing the fuel levels in the area, leading to easier containment of future fires. Wirtz 1982 and Dodd 1988, demonstrated that fires allowed to burn in chaparral, increased bird species diversity. However, fire management has been continually questioned in coastal sage scrub habitat, suggesting that coastal sage scrub plants and birds react differently to fire than chaparral (Minnich 1983, Keeley and Keeley 1984, Moriarty et al. 1985, Stanton 1986). Kozlowski and Ahlgren (1974) suggest that fire

proponents ignore the possibility that not all ecological niches within an environment are fire-adapted. Moriarty et al. (1985) showed a decrease in bird species diversity after a coastal sage scrub fire, especially in the first few months. Stanton (1986) expanded on the study of Moriarty et al. (1985) to show that seasonality and fire create cyclical changes in bird species diversity, making burned areas adequate for foraging only in the highly productive spring season.

Increased urbanization not only increases the unnatural chance of fire occurrence, but also creates additional nonadaptive alteration of the environment. Soule et al. (1988) point out the effect on bird community structure of fragmentation of coastal sage scrub by the rapid encroachment of urbanization. Soule found only the more facultative bird species to survive the resulting disruption of normal predator-prey relations caused by increased extinctions in isolated canyons. This type of ecosystem disruption can cause a previously adaptive feeding and reproductive strategy (such as ground dwelling verses shrub or tree dwelling) to become nonadaptive with a shift in dominant predators (Soule et al. 1988). Bowman and Harris (1980) suggest that decreased heterogeneity and complex cover make nests more vulnerable to predators, decreasing nesting

success of ground-nesting birds.

Many times it is the introduced bird species which are able to feed and breed in the nonnative habitat which results (Soule et al. 1988). Beissinger and Osborne (1982) found a decrease in volume of foliage, synergism of habitat structure and human disturbance population suppressing factors (such as domestic predators in urban areas) to create a prime habitat for only a few bird species. Often the bird species that can reproduce in artificial habitats are considered undesirable.

A better understanding of the relationship between the avian community and disturbance of coastal sage scrub habitat can lead to knowledge of the forces which shape bird species diversity. In 1987 and 1988, I continuously censused birds in coastal sage scrub habitat at both California Sate Polytechnic University, Pomona (Cal Poly), and Spadra Landfill. I monitored bird species diversity and activity in burned, unburned, and disturbed coastal sage scrub. The observation of the burned and unburned areas at Cal Poly expands on both the Moriarty et al. (1985) and Stanton (1986) studies, which examined avian species diversity, species cycling, and inferior foraging opportunities at burn areas. The Spadra Landfill contained

areas in various stages of disturbance attributed to human modifications (excavating, filling, revegetation and cattle grazing).

The objectives of my study were: (1) to assess the long-term effects of fire on bird species populations, in terms of species richness and abundance; (2) to compare areas of disturbance to burned areas in terms of bird diversity; (3) to examine temporal patterns of the recovery of bird species in burned and disturbed areas and the relationship between bird species diversity and greater vegetation complexity; and (4) to determine whether bird behaviors differ with the degree of disturbance and vegetation complexity.

Data were also collected for six months following the last wildfire at Cal Poly, which occurred on July 28, 1989. These data were dealt with in separate analyses to examine bird species diversity immediately after a fire.

METHODS

Study Areas

A total of six study areas were established, each approximately 1 ha in size, with three being on the campus of California State Polytechnic University, Pomona, Los Angeles County, California. The remaining three were located at Spadra Landfill, Walnut, California, approximately 1.85 km away. The Cal Poly areas were of relatively contiguous coastal sage scrub, while the Spadra areas contained varying mixtures of coastal sage and introduced plant species. A summer drought period characteristic of Mediterranean climates was prominent, with the majority of rainfall occurring in the late winter and early spring.

The Cal Poly sites include a mixture of the following habitats: coastal sage scrub, canyon bottom, and walnut-oak woodland. The vegetation in the study areas is described by Clark (1990) and is as follows. Site 1 (CP1) was partially burned in a wildfire in the summer of 1983, although more than half the canyon remained relatively undisturbed. A southeast-opening canyon, at an elevation of approximately 300 m, which contained a southwest facing slope composed of mostly California sagebrush (Artemisia

californica) and cactus (Opuntia littoralis), and a northeast facing slope composed of California sagebrush, elderberry (Sambucus mexicana), toyon (Heteromeles arbutifolia), walnut (Juglans californica), and herbaceous cover. Site 2 (CP2), composed of mature coastal sage scrub, also opened to the east, with many of the same plant species as CP1, although there was a tendency for less herbaceous and more vertical vegetation relative to CP1. This relatively undisturbed site was used as a "control" by Moriarty et al. (1985) and Stanton (1986). Common plant species on the north-facing slope included California sagebrush, elderberry, toyon, white sage (Salvia apiana), coast live oak (Quercus agrifolia), Rhamnus ilicifolia and black sage (Salvia mellifera). On the south facing slope, California sagebrush and cactus were prominent as in CP1. Site 3 (CP3) was selected from a 9-ha area of coastal sage scrub that burned severely in August, 1981. This eastward-opening canyon is the "burn" area of Moriarty et al. (1985) and Stanton (1986), which bordered on a woodland composed of walnut and toyon, with other vegetation being composed of black sage, bush mallow (Malacothamus fasciculatus), and various grasses (Poaceae).

The Spadra sites contained vegetation which had been modified extensively by human influences. Site 1 (SP1) was

intended to be a man-made wildlife area composed of revegetated hillsides, and included eucalyptus (Eucalyptus globulus), tree tobacco (Nicotiana glauca), and a wide array of annuals and grasses. Site 2 (SP2) is an area of covered landfill which is seasonally planted with crops by Cal Poly agriculture personnel, and had some edge species such as milk thistle (Silybum marianum) and bush mallow. Site 3 (SP3) consisted of walnut woodland (Juglans californica) and annual grassland (Poaceae). Botanical nomenclature follows Munz (1974). A summary table of the major characteristics of each site is in Appendix 5, and a map showing their locations is in Appendix 6.

Bird Census

The census period at Spadra was from January 1987 through December 1988, while Cal Poly sites were sampled from October 1986 through December 1988. After the most recent wildfire on July 28, 1989, the Cal Poly sites were censused again from July 1989 through December 1989; these data were dealt with in separate analyses.

A total of 75 species of birds were observed in 4172

recorded observations. I censused the birds at each of the six sites on a bimonthly basis, one location (random order of Cal Poly or Spadra) per day. All three sites at a particular location were censused on the same day, and the locations were censused on consecutive days. Each area was censused for a period of 30 minutes, within one hour of sunrise. I recorded the bird species, the number of individuals, the plant species being used (if any), and the behavior exhibited. To avoid disruption of bird activity by moving through the dense vegetation of the mature coastal sage scrub found in some of the sites, I observed each site from a fixed elevated point overlooking the entire study area at that particular site. I observed all birds actively using the site ("flybys" were not counted) for as long as they were in the area. The problem of missing one bird while watching another was minimized by low bird densities and the aid of at least one field assistant.

I recorded all sequential behaviors, since no difference has been found in analyses of single point versus sequential observations except in detecting rare foraging strategies (Morrison 1984, Stanton 1986). Behavior categories included perching (resting or preening), foraging (gleaning, flycatching, and surveying from the air by

hawks), aggression and reproduction (nest building, copulation, courtship display), and calling (the bird call was heard but the location of the bird in terms of plant species was undetermined).

Guilds (granivore, insectivore, omnivore and nectarvore) were determined from observations of the foraging birds during the study. Only granivore and insectivore species were used in the analysis due to the extremely low number of nectarvores and widely varying behaviors and feeding patterns of omnivores (Appendix 1). Resident and migrant species were not compared in analyses, since it is suspected that migration of so called "resident" species may occur within a particular species according to food availability (Avery and van Riper 1989, Breininger and Schmalzer 1990).

Statistical analysis follows Zar (1984) and Dixon (1988). A critical value of 0.05 was required for rejection of the null hypothesis in all statistical analyses.

RESULTS

Bird species diversity: comparisons of burned and unburned habitats.

Species common at one Cal Poly site were found to be common at all other Cal Poly sites (Spearman rank correlation; Table 1). These significant positive correlations between partially burned (CP1), unburned (CP2) and completely burned (CP3) areas indicate that the rank order of species abundance at one site can be predicted by knowing the overall rank order at another site.

Closer examination of the 25 most regular species occurring at CP2, CP3, or both (unburned and burned sites, respectively) showed no significant correlation (Spearman rank correlation; $n = 25$, $r = .25$, $P > .05$). This indicates distinct differences in the bird species present at each of these two sites. Thirteen of these 25 species were found to have a significant preference for CP2 over CP3, while only three preferred CP3 over CP2 (Chi-square goodness of fit; Table 2). Besides a greater richness of these twenty-five species, CP2 also supported a significantly larger number of individuals (abundance) than

CP3 (Wilcoxson paired sample test; n = 25, T = 0.03, P < .05).

Bird species diversity: comparisons of burned and disturbed areas.

Just as the bird species common at one Cal Poly site were common at the other Cal Poly sites, the bird species at one Spadra site were common at all other Spadra sites (Table 1). In comparing between locations, however, a significant correlation was found only between CP3 and SP3, the Cal Poly completely burned area and the Spadra walnut woodland, respectively (Table 1). This indicates the bird species found on the most disturbed area at Cal Poly are similar to the least modified area at Spadra. Other than these two sites, the bird communities at Cal Poly and Spadra are very different.

This generates the question of whether certain guilds are more prevalent in specific areas during specific seasons. When all seasons are combined, the ratio of granivores to insectivores was found to differ at all six sites (contingency tables; P < .05). A difference in ratio of granivores to insectivores was found between years for

specific seasons at certain sites (contingency table analysis; Table 3). Looking at the two guilds individually, however; these findings appeared to be due to the occurrence of a few highly gregarious, flocking species. Large flocks of granivores such as house finch and California quail were found at CP2 in summer and fall. Large flocks of house finch were also found at SP1 in spring and fall, and large flocks of an insectivore, namely bushtits, were found in fall at CP3. Therefore, the differences found in these sites may have been caused by a small number of species with very large flocks of individuals. Consistent numbers of different species were found at one site in one season (CP3 in spring). This indicates a possible fluctuation in resources at CP3 in the spring of both years. Also notable was a dramatic drop in insectivore species at SP3 in the fall of 1988, when landfill activities began in that area.

When these flocking effects are removed by using the number of insectivore or granivore species observed, rather than the number of individuals of insectivores and granivores for CP2, CP3, SP1 and SP3, no difference is found between these two guilds (Fisher Exact Test; $P > .05$). Therefore, no difference in the ratio of granivore to insectivore species was found for CP2, CP3, SP1 and SP3

individually or combined for all seasons, which previously showed a difference between granivores and insectivores $P < .05$ in Table 3. Since the polynomial regression (see below) found no cycling in individuals and there was no difference in granivores and insectivores, it appears that the difference must be in the omnivorous species, or just in species in general.

Closer examination of the 24 species which most commonly occur at Cal Poly, Spadra, or both shows no significant correlation (Spearman rank correlation; $n = 24$, $r = -.25$, $P > .05$). There is also no significant difference between the number of individuals found at Cal Poly verses Spadra (Wilcoxson paired sample test; $n = 24$, $T = .32$, $P > .05$). Thirteen of these 24 species were found to prefer Cal Poly over Spadra, while eight preferred Spadra over Cal Poly (Chi-square goodness of fit; Table 4). Two of the eight species which preferred Spadra over Cal Poly, Nuttall's woodpecker and mourning dove, were found to be significantly more abundant on SP3 (the walnut woodland) than the other two Spadra sites combined (Chi square goodness of fit; Nuttall's woodpecker ($x^2 = 25.3$, $df = 1$, $P < .001$) and mourning dove ($x^2 = 21.2$, $df = 1$, $P < .001$).

Temporal patterns of the recovery of bird species richness in burned and disturbed areas.

No cycling patterns were found for number of individuals at any of the six sites (Polynomial regression; $P > .05$). Cycling patterns for the number of species were not found at the following sites; CP1, CP2, SP2 (which consistently had a low number of species present) and SP3 (Polynomial regression; $P > .05$). This indicates these areas support relatively the same number of species all year round. Cycling was verified for number of species (third degree polynomial) at CP3 ($F = 2.47$, $df = 41$, $P < 0.05$, Fig. 1), and (fourth degree polynomial) at SP1 ($F = 8.02$, $df = 32$, $P < 0.001$, Fig. 2). The cycling pattern verified at CP3 (Fig. 1) shows a significant increase in bird species using the area in spring and summer of 1987; a decrease in fall of 1987 and winter 1988, but the significant increase in species is not repeated in spring and summer of 1988. The cycling pattern verified for SP1 (Fig. 2) shows a significant increase in species in spring and summer of 1987, a significant decrease in species in fall 1987 and winter 1988, and a significant increase in species in spring and summer 1988.

Bird behavior in conjunction with degree of disturbance and vegetation complexity.

Behaviors

Behaviors tended to be more variable in a more heterogeneous environment. In CP2, the most heterogeneous environment, behavior differed with season (contingency table; $P < .05$ for spring, summer, and fall 87-88) while in the less heterogeneous areas SP1 and SP3 there was no difference for behaviors observed between seasons (contingency table; $P > 0.05$ for all seasons). CP3 (the Cal Poly burned area) falls in the middle, with varying behaviors appearing in just a few seasons ($P < .05$ for winter and spring 87-88). A significantly higher occurrence of perching was found at Spadra verses Cal Poly (Chi-square goodness of fit; Table 5), while there was a significantly higher occurrence of foraging and reproductive/aggressive behaviors at Cal Poly (Table 5). In comparing the two Cal Poly sites CP2 and CP3, the fraction of occurrence out of the total number of occurrences at Cal Poly sites (relative frequency) was used in the chi-square calculation to correct for the significantly larger abundance of individuals at CP2

overall. In all three categories of behavior there was no significant difference in occurrence between the two sites (perching, foraging and reproductive/aggressive categories; $x^2 = 0.0$, $P > .05$).

Plant Preference

The three basic layers of vegetation (trees, shrubs and forbs), were not used in equal proportion at any of the six sites (Chi-square goodness of fit and Bonferroni technique [Byers et al. 1984]; Table 6). The birds at all three Cal Poly sites showed a significant preference for trees, shrubs, and forbs in that order. This indicates that trees were preferred and used at a higher proportion than shrubs, and shrubs were used more than forbs. The bird species at the two most populated Spadra sites (SP1 and SP3) showed a significant preference for trees, forbs, and then shrubs. The bird species at the Spadra site with the smallest number of species, SP2 (the agricultural field), showed a preference for forbs, trees, and then shrubs. These preferences were not compared to plant availability, since the area burned severely on July 28, 1989, before plant availability data could be acquired. Grouping of plant species into trees, shrubs and forbs is

in Appendix 4.

After Fire Data

No significant correlations were found between the three Cal Poly sites after the last wildfire on July 28, 1989 (Spearman rank correlation; Appendix 2). This indicates that immediately following the wildfire, and for at least the first six months thereafter, species common at one Cal Poly site were not common at another. A listing of species and the Cal Poly sites where they occurred is in Appendix 3.

DISCUSSION

Bird species diversity in burned and unburned habitats.

My study supports the idea that bird community responses in coastal sage scrub are very different than those of bird communities in chaparral (Stanton 1986). Periodic burning in chaparral is instrumental in maintaining the relatively open grass and shrub nature, and mosaic of structural layers as reported by Dodd (1988). In fact, Dodd (1988) found relatively few cases of a decrease in bird species diversity due to burning in chaparral. Wirtz (1982) found a higher bird species diversity in all burned plots of chaparral, beginning about 10 months and continuing through 42 months postfire. This includes a higher number of granivore species in burned chaparral areas, whereas Stanton (1986) found that granivores prefer unburned coastal sage scrub from 17 through 34 months postfire. Kirkpatrick and Hutchinson (1980) suggested that the lack of evergreen sclerophyll shrubs in coastal sage scrub causes it to react very differently than chaparral to fire, drought stress and water loss. I think these differences in vegetation are intimately connected with the difference in bird species diversity between coastal sage scrub and chaparral after a fire.

Both Stanton (1986) and Moriarty et al. (1985) found a lower bird species diversity in recently burned coastal sage scrub. Increased bird species diversity and a preference for undisturbed coastal sage scrub over burned coastal sage were also found in my study. More species preferred the more heterogeneous CP2 (unburned area) to CP3 (burned area) even six to seven years following the last wildfire. In examining the 25 most regular species at CP2 and CP3, there is no relationship in terms of rank order of occurrence at these two sites. The abundance of individuals differs significantly, with the majority of regular species clearly preferring CP2. The only species which preferred CP3 were bushtit, northern mockingbird, and northern flicker. The bushtits appeared to move through CP3 in flocks, taking advantage of certain seed-producing shrubs such as the bush mallow. The northern flickers were commonly found perched on previously burned snags in the area. The mockingbird, however, is somewhat of an opportunist and appeared to forage in a wide variety of vegetation. It is therefore, probably more likely to be sustained in an area recovering from fire than a more specialized migrant.

Dodd (1988) suggests that certain bird species are more "fire-adapted", and thereby able to use nearby dense canopy cover for nesting and fire-induced openings for

foraging. In severe burns, however, the inadequate cover that remains could seriously affect the species able to breed and survive in that area. Egg loss has been shown to be inversely correlated with the amount of overhead cover in an area, suggesting that visibility of eggs is a major factor in their destruction (Dwernychuk and Boag 1972, Duebbert and Lokemoen 1976, Bowman and Harris 1980). Bowman and Harris (1980) found that when spatial heterogeneity was increased, raccoon foraging efficiency for ground-nesting bird eggs decreased. This lead them to suggest that managing for increased spatial heterogeneity may be useful in increasing both nest density and the nest success of ground-nesting birds. This indicates a more heterogeneous environment not only provides more foraging opportunity, but more cover and protection for the bird species that are found there as well.

My data indicate a lack of ground-dwelling bird species at CP3 relative to CP2. Species such as California towhee, California quail, California thrasher and rufous-sided towhee all significantly prefer the unburned CP2 over the burned CP3. Possibly CP3 does not provide sufficient cover or spatial heterogeneity for these ground dwellers to enable successful nesting and foraging activities. Even the wrentit and Bewick's wren, which feed almost exclusive-

ly in shrubs, prefer CP2, again suggesting that specific layers of vegetation used at CP2 are not sufficient at CP3.

Bird species diversity in burned and disturbed areas.

My study suggests that birds in areas disturbed by landfill activities react similarly to birds in severely burned areas in coastal sage scrub, often producing a bird community different from undisturbed areas. This is seen in the dissimilarity of bird species at Cal Poly sites in contrast to Spadra sites. The overall rank order of species abundance at one site at Cal poly can be predicted by knowing the rank order of occurrence of species at another site at Cal Poly, and the same within Spadra sites. However, only the most disturbed site at Cal Poly (CP3) and the least disturbed site at Spadra (SP3) show a similar significant correlation. Furthermore, this close correlation disappeared even between the Cal Poly sites after a severe fire, as shown by the data collected after July 28, 1989.

Overall, different bird communities occur at Cal Poly compared to Spadra. There was no preference for unburned areas by granivores nor a predominance of insectivores in CP3 as found by Stanton (1986). However, more species prefer the heterogeneous Cal Poly sites than those of

Spadra, and a greater abundance of introduced bird species is seen at Spadra. This supports Avery and van Riper (1989), who found that greater habitat complexity leads to increased species richness. Even the recovering burn area at Cal Poly (CP3) had a greater diversity of vegetation layers (trees, shrubs and forbs) than any of the Spadra sites. One Spadra site (SP2) was simply an agricultural field composed of mostly grasses and a few scattered shrubs. SP3 offered trees and grasses in the walnut woodland, but very little shrub layer. SP1 was the most heterogeneous of all the Spadra sites, with some tree tobacco and eucalyptus mixed with some shrubby annuals and grasses, but it proved to be very cyclic in supporting bird species.

Although there is no difference between the abundance of individuals at these two locations, a much larger number of regular species prefer Cal Poly over Spadra. Introduced species prefer Spadra, as do certain other regular species such as red-tailed hawk, Nuttall's woodpecker, house finch, mourning dove and yellow-rumped warbler. The opening of a canyon by fire or a disturbance could explain the regular species dominant in Spadra over Cal Poly and the species found to prefer Cal Poly over Spadra. For instance, the high incidence of red-tailed hawks at Spadra supports the suggestion that open areas are better foraging spots for

many raptors (Dodd 1988). Red-tailed hawks are one of several species of raptors reported to be attracted to recent burns, where they have the ability to nest and hunt on open edges created by fire (Dodd 1988).

Even though the Nuttall's woodpecker and mourning dove were found to prefer Spadra, it is important to note that their occurrences were significantly higher at SP3, which is the walnut woodland (the least disturbed area at Spadra at the time), than at the other two Spadra sites combined. This implicates walnut woodland as preferred habitat for Nuttall's woodpecker and mourning dove and suggests that SP3 may potentially support more bird species than SP1 or SP2. The species found to prefer Cal Poly over Spadra habitats are extremely similar to those found by Soule et al. (1988) to leave isolated canyons of coastal sage scrub in response to urbanization, namely California quail, California thrasher, rufous-sided towhee, Bewick's wren and wrentit. Two species which prefer Spadra, mourning dove and yellow-rumped warbler, were similarly found to prefer a disturbed oak scrub by Breininger and Schmalzer (1990). House sparrows and starlings, which were found by Beissinger and Osborne (1982) to predominate in urban areas, also prefer Spadra.

Soule et al. (1988) suggest that a predator shift occurs in disturbed or fragmented canyons. When canyons become too small or disturbed for larger dominant predators like coyotes, smaller predators such as foxes, cats and raccoons become increasingly more abundant. Soule et al. (1988) showed that coyotes help control the smaller predators in the canyons, possibly contributing to the maintenance of the native avian fauna. In the absence of the larger predator, the smaller ones drive the ground dwelling bird species, such as California quail, to extinction in these canyons.

Temporal patterns in the recovery of burned and disturbed areas.

My results and those of Stanton (1986) support the importance of vertical heterogeneity of vegetation to the diversity of coastal sage scrub bird communities. The vertical heterogeneity found in CP1, CP2, and SP3, and the lack of cycling of numbers of species in these areas, agrees with Stanton's (1986) finding that a vegetationally heterogeneous area supports more species more consistently all year round than a relatively uniform area in recovery. The fourth noncycling area (SP2) had an extremely low number of birds and species of birds through the entire

study.

The estimated recovery time of coastal sage scrub after a fire of 5 to 10 years (Minnich 1983) is also supported by my data. Stanton (1986) found cycling in CP3 to a third degree polynomial. However, where Stanton found an increase in number of species over two consecutive spring seasons, I found an increase in number of species in spring of 1987 and a decrease in spring and summer 1988. A clear biological cycle of species numbers is diminishing at CP3, which indicates this area may be losing its tendency to cycle. If cycling is induced by fire or disturbance, a damping of the cycle may indicate that the habitat is recovering. Since this area burned in August, 1981, the damping of the cycle agrees with the 5 to 10 years estimated recovery time of coastal sage scrub (Minnich 1983).

A cycling pattern in species number was found to the fourth degree polynomial in SP1. Figure 2 indicates a very repetitive cycling trend from year to year at this site. This area then reacts like a severely burned area as a result of the serious disturbance. Due to the lack of vertical vegetation and predominance of annuals in this area use is extremely high in spring when productivity is high, through both years of my study.

Bird behavior in conjunction with degree of disturbance and vegetation complexity.

Behaviors

All behaviors occurred consistently in proportion to each other at SP1 and SP3 from season to season. However, these proportions fluctuated from year to year in CP2, as would be expected in a constantly changing more complex area. When comparing all Cal Poly sites to all Spadra sites, perching was significantly higher at Spadra. The birds at Cal Poly tended to be engaged more in foraging and reproductive/aggressive behaviors. This suggests that although Spadra may be an important resting area for birds, the Cal Poly areas are more important overall for sustaining coastal sage scrub bird populations.

Within Cal Poly sites, there was no significant difference in behavior between CP2 and CP3 (the unburned and burned areas, respectively). Although there were differences in abundance of individuals and rank order of species, the birds at the two sites were engaged in the same general activities.

My study supports that of Breininger and Schmalzer (1990) in finding that revegetation following the mechanical clearing of natural vegetation results in a community which is different in vegetation composition, vegetation structure and thereby supports a different bird community than an undisturbed area. Furthermore, the fragmenting of contiguous coastal sage scrub by fire, urbanization, or other alteration (Moriarty et al. 1985, Stanton 1986, Soule et al. 1988) results in a decrease in bird species diversity and brings about certain bird activity and behavior, such as perching, which is characteristic of disturbed areas. Recovery of vegetation requires vertical heterogeneity and a time period in the range of 5-10 years (Minnich 1983).

Plants

In a vegetation study including these three Cal Poly areas, Clark (1990) found the dominant genera in both frequency and cover to be: Brassica, Artemisia, Centaurea and Bromus. These shrub and forb species which dominate, are clearly not key species in maintaining bird species diversity, since the birds in the area still significantly prefer trees. This preference for trees by birds also occurred at two Spadra sites (SP1 and SP3). The lack of

shrubs and a lower tree density at Spadra, may be a notable difference in the vegetation, which could influence the significant decrease in bird diversity at Spadra as compared to Cal Poly. The decrease in bird species at less heterogeneous habitats supports various studies in suggesting that bird species diversity and foliage diversity are not only related, but that varied layers of vegetation are important as well (Karr 1968, Karr and Roth 1971, Willson 1974, Beissinger and Osborne 1982, Lynch and Whigham 1984).

Keeley and Keeley (1984) found that herbs dominate coastal sage scrub sites in the first season after fire, with shrub resprouts increasing into the second season (second year after a fire) as herb cover begins to decrease. My study, in conjunction with Stanton's (1986), shows the recovery of bird species diversity as the vegetation recovers. Immediately after CP3 was burned in August, 1981, Moriarty et al. (1985) found a decrease in bird species diversity. Stanton (1986) found a cycling of bird species in CP3, with the greatest bird species abundance in the spring, indicating the area provided adequate foraging only in the spring 2-3 years later. My study shows that 6-7 years after the fire the cycling was diminishing and the area was becoming much more comparable in bird species diversity to the unburned area (CP2).

Westman and O'Leary (1986) suggest that the resilient behavior of coastal sage scrub is directly related to the presence of a maximum of inherently strong or weak sprouting species. Sites dominated by weak resprouters (such as Artemisia californica and Salvia mellifera) exhibit a lower rate of recovery following a disturbance than sites dominated by strong resprouters (such as Encelia californica, Stipa lepida and Salvia leucophylla). Coastal sage may not be as resilient in repeated fire situations if weak resprouters dominate (Westman and O'Leary 1986). The long recovery time of CP3 may be an indication of an abundance of weak resprouting vegetation in the area.

Westman (1981) estimates coastal sage scrub has already been reduced to 10-15% of its former extent in California. With increased urbanization, the decrease in remaining coastal sage scrub and the potential extinction of species (both plant and bird) appears significant.

This study shows the importance of vertical heterogeneity in coastal sage scrub to the bird community there. Beissinger and Osborne (1982) point out the difficulty in measuring the effects of human disturbance such as motor vehicles, domestic predators, traffic, and noise upon urban

avifauna. They also suggest manipulating urban habitats to enable more desirable bird species to be favored. Bessinger and Osborne (1982) suggest that vegetative cover in urban habitats should be increased by preserving natural islands of complete habitat consisting of vegetative cover in various layers. Preservation of the natural vegetative layering could help maintain bird species diversity in modified areas. Maintenance of bird species diversity should be considered in conjunction with prescribed burns, urbanization, mechanical clearing of vegetation and other modifications to coastal sage scrub.

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Table 1. Spearman Rank Correlations between all Cal Poly and Spadra sites.

	CP1	CP2	CP3	SP1	SP2	SP3
CP1	1.00					
CP2	**.74***	1.00				
CP3	**.53***	**.54***	1.00			
SP1	.05	-.03	.22	1.00		
SP2	-.04	-.08	.13	**.37+**	1.00	
SP3	.08	.06	**.44***	**.30+**	**.61***	1.00

n= 72, **p < .05 (+), p<.001 (*).**

Table 2. Ratios of individuals of 25 predominant species at Cal Poly sites 2 & 3. CP2 and CP3 indicate a significant ($p < .05$) preference (pref.) for the control area or the 1981 burn area, respectively, (--) indicates no significant preference for either.

	Ratio (CP2/CP3)	Pref.	x^2
Resident			
Anna's Hummingbird (Calypte anna)	55/48	--	0.4
Bewick's Wren (Thryomanes bewickii)	15/4	CP2	6.3
Blue-gray Gnatcatcher (Polioptila nigriceps)	16/0	CP2	15.8
Bushtit (Psaltriparus minimus)	15/154	CP3	114.1
Cactus Wren (Campylorrhynchus brunneicapillus)	28/1	CP2	25.0
California Quail (Callipepla californica)	110/0	CP2	109.8
California Thrasher (Toxostoma redivivum)	16/4	CP2	7.1
California Towhee (Pipilo crissalis)	87/45	CP2	13.3
Northern Mockingbird (Mimus polyglottos)	34/66	CP3	10.2
Northern Flicker (Colaptes auratus)	6/24	CP3	10.7
Red-tailed Hawk (Buteo jamaicensis)	5/8	--	0.6
Rufous-sided Towhee (Piplo chlorurus)	58/7	CP2	39.9
Scrub Jay (Aphelocoma coerulescens)	141/74	CP2	20.8
Wrentit (Chamaea fasciata)	99/9	CP2	74.8
House Finch (Carpodacus mexicanus)	169/39	CP2	81.1
Song Sparrow (Melospiza melodia)	12/1	CP2	9.1
Mourning Dove (Zenaida macroura)	24/23	--	0.0
Lesser Goldfinch (Carduelis psaltria)	8/10	--	0.2
Visitant/Migrant			
White-crowned Sparrow (Zonotrichia leucophrys)	16/0	CP2	15.8
Phainopepla (Phainopepla nitens)	46/7	CP2	28.6
Black-headed Grosbeak (Pheucticus melanocephalus)	13/8	--	1.1
Ash-throated Flycatcher (Myiarchus tyrannulus)	3/4	--	0.1
Sharp-shinned Hawk (Accipiter striatus) & Cooper's Hawk (Accipiter cooperii)	3/4	--	0.1
American Robin (Turdus migratorius)	3/10	--	3.7
Wilson's Warbler (Wilsonia pusilla)	3/2	--	0.2

Table 3. Contingency table analysis using Cochran's correction for continuity on number of observations (individuals) for granivores (G) verses insectivores (I) verses season.

		W87-88	SP87-88	Su87-88	F87-88
		G I	G I	G I	G I
CP1	1987	29 4	62 13	32 28	60 22
	1988	55 4	54 11	42 22	3 14
		(0.595)	(0)	(1.644)	**(16.436)
		G I	G I	G I	G I
CP2	1987	0 4	44 30	44 35	51 14
	1988	5 23	42 21	126 27	8 18
		(0.542)	(0.503)	**(17.864)	**(17.064)
		G I	G I	G I	G I
CP3	1987	1 0	29 15	19 74	3 29
	1988	1 1	9 26	2 7	7 2
		(0)	**(11.559)	(0)	**(14.306)
		G I	G I	G I	G I
SP1	1987	68 5	66 19	134 5	129 8
	1988	39 0	162 3	198 12	67 0
		(2.705)	**(26.973)	(0.581)	(3.687)
		G I	G I	G I	G I
SP2	1987	0 3	27 7	26 1	19 1
	1988	21 0	1 0	19 2	0 0
		**(15.728)	(0)	(0.361)	--
		G I	G I	G I	G I
SP3	1987	22 19	9 7	54 6	80 26
	1988	12 8	25 15	38 19	77 1
		(0.075)	(0.092)	**(8.603)	**(17.774)

** = P<0.05
x^2 = ()
-- = insufficient data for x^2

Table 4. Ratios of individuals of 24 predominant species at Cal Poly and Spadra. CP and SP indicate a significant ($p < .05$) preference (pref.) for Cal Poly or Spadra, respectively, (--) indicates no significant preference for either.

	Ratio (CP/SP)	Pref.	x^2
Resident			
Anna's Hummingbird (Calypte anna)	137/33	CP	63.5
Bushtit (Psaltriparus minimus)	171/13	CP	135.5
Cactus Wren (Campylorrhynchus brunneicapillus)	55/0	CP	54.8
California Quail (Callipepla californica)	264/0	CP	263.8
California Thrasher (Toxostoma redivivum)	50/0	CP	49.8
California Towhee (Pipilo crissalis)	221/29	CP	147.3
Northern Mockingbird (Mimus polyglottos)	128/26	CP	67.4
Northern Flicker (Colaptes auratus)	31/18	--	3.4
Red-tailed Hawk (Buteo jamaicensis)	22/46	SP	8.4
Rufous-sided Towhee (Piplo chlorurus)	86/0	CP	85.8
Scrub Jay (Aphelocoma coerulescens)	274/79	CP	107.6
Wrentit (Chamaea fasciata)	193/0	CP	192.8
Nuttall's Woodpecker (Picoides nuttallii)	16/33	SP	5.8
House Finch (Carpodacus mexicanus)	369/1056	SP	331.1
Song Sparrow (Melospiza melodia)	32/19	--	3.3
Mourning Dove (Zenaida macroura)	58/211	SP	86.9
Lesser Goldfinch (Carduelis psaltria)	25/6	CP	11.5
Visitant/Migrant			
White-crowned Sparrow (Zonotrichia leucophrys)	39/26	--	2.6
Yellow-rumped Warbler (Dendroica coronata)	6/38	SP	23.1
Phainopepla (Phainopepla nitens)	63/0	CP	62.8
Black-headed Grosbeak (Pheucticus melanocephalus)	25/3	CP	17.1
"Introduced species"			
American Crow (Corvus brachyrhynchos)	1/69	SP	65.9
Red-winged Blackbird (Agelaius phoeniceus)	0/196	SP	195.8
Brewer's Blackbird (Euphagus cyanocephalus)	0/276	SP	275.8

Table 5. Ratios of behavior occurrence at Cal Poly and Spadra. Behaviors considered were Perching, Foraging, and Reproduction/Aggression. CP or SP indicate a significantly higher occurrence of this behavior at Cal Poly or Spadra, respectively.

BEHAVIOR	RATIO (CP/SP)	OCCURRENCE	x^2
Perching	1219/1835	SP	124.2
Foraging	718/559	CP	19.8
Repro/Aggr.	84/52	CP	7.5

Table 6. Order of major plant groups in terms of bird use on each of the six sites. T = tree, S = shrub, F = Forbs and grasses. () = number of observations (use) of that plant category. All were significant at $P < .05$. Individual proportions were also all significant at $P < .05$ using the Bonferroni technique.

Site	Order	Cumulative x^2
CP1	T(394)-S(102)-F(73)	332.42
CP2	T(618)-S(207)-F(40)	613.75
CP3	T(384)-S(59)-F(2)	572.58
SP1	T(605)-F(55)-S(36)	900.32
SP2	F(74)-T(16)-S(0)	101.07
SP3	T(286)-F(56)-S(0)	403.02

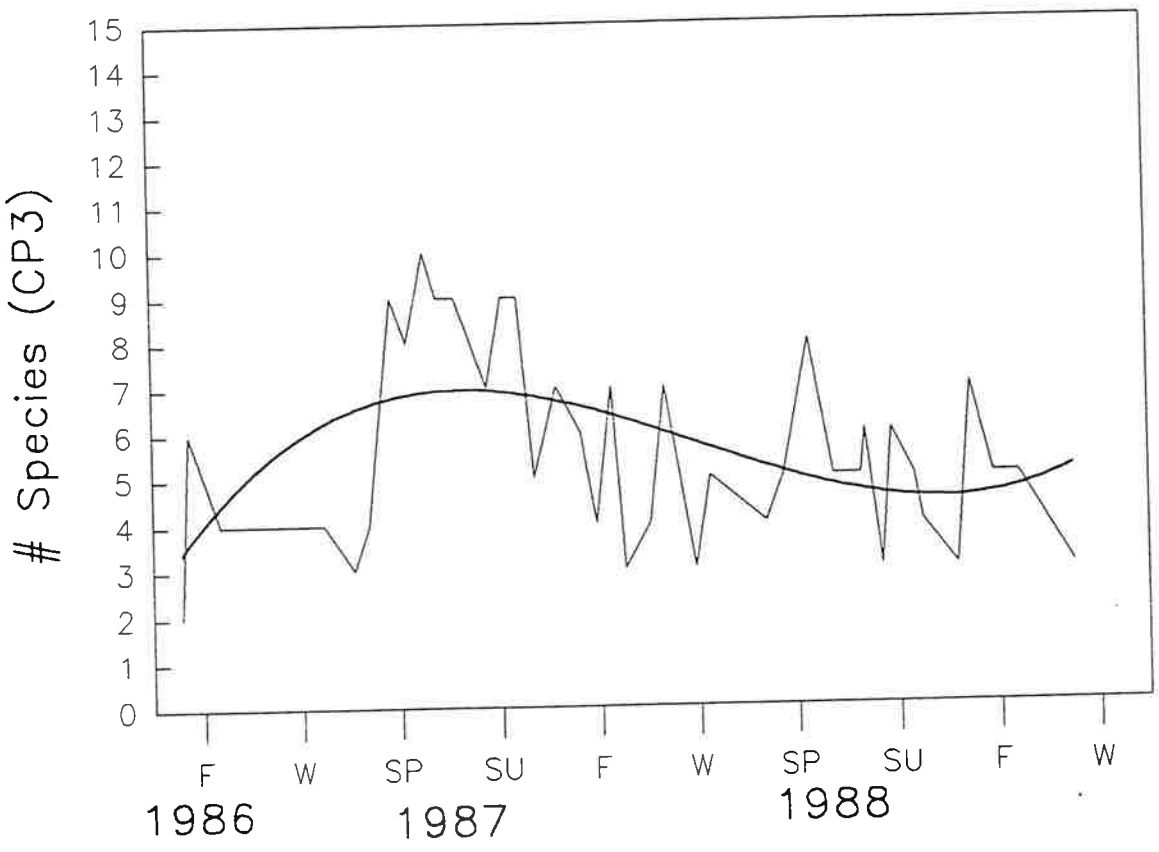

Figure 1. Number of species plotted as a function of time at CP3 (Cal Poly burned area). Cycling pattern verified to the third degree polynomial ($P < .05$).

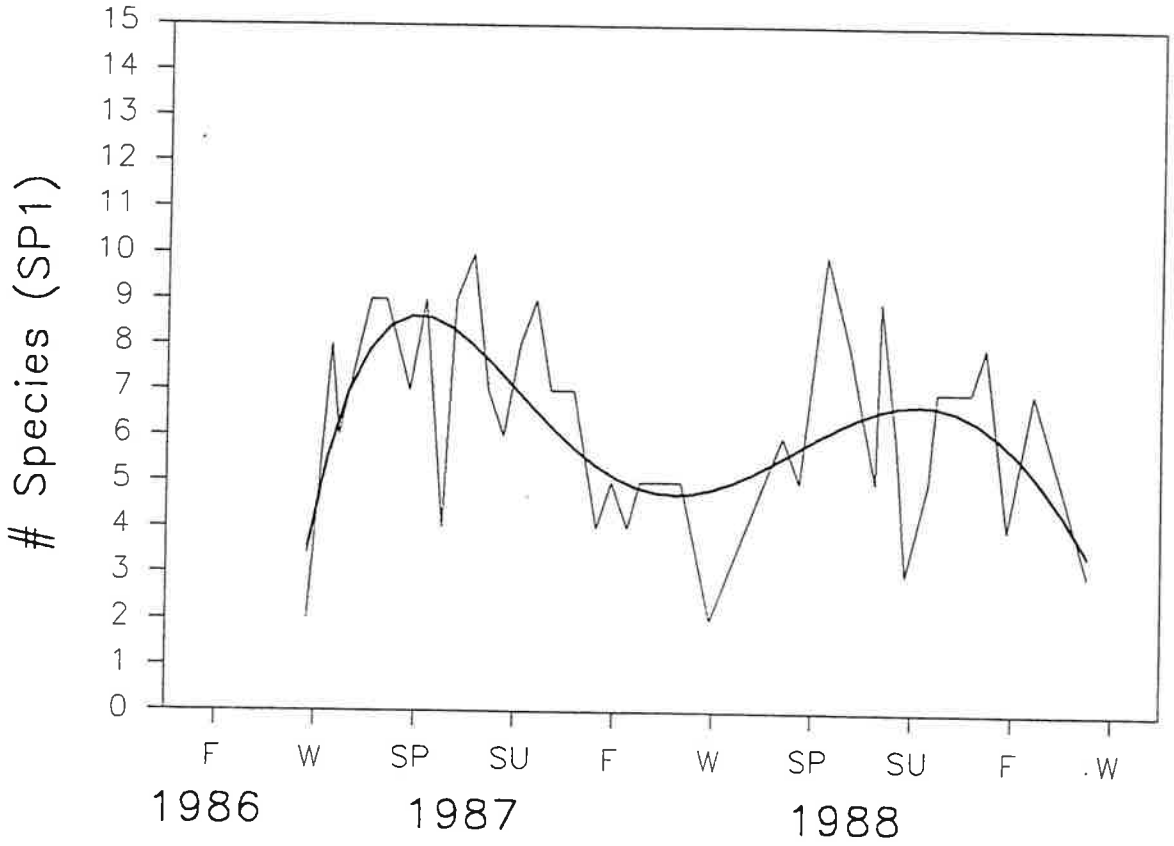

Figure 2. Number of species plotted as a function of time at SP1 (Spadra revegetated area). Cycling verified to fourth degree polynomial ($P < .05$).

APPENDIX 1

Species considered "granivores" and "insectivores".

Granivores
House Finch (Carpodacus mexicanus)
California Quail (Callipepla californica)
American Goldfinch (Carduelis tristis)
Lesser Goldfinch (Carduelis psaltria)
Horned Lark (Eremophila alpestris)
Mourning Dove (Zenaida macroura)
Band-tailed Pigeon (Columba fasciata)

Insectivores
Blue-gray Gnatcatcher (Polioptila nigriceps)
Northern Flicker (Colaptes auratus)
Nuttall's Woodpecker (Picoides nuttallii)
Western Bluebird (Sialia mexicana)
Ruby-crowned Kinglet (Regulus calendula)
Warbling Vireo (Vireo gilvus)
Nashville Warbler (Vermivora ruficapilla)
Ash-throated Flycatcher (Myiarchus tyrannulus)
Wilson's Warbler (Wilsonia pusilla)
Yellow Warbler (Dendroica petechia)
Black Phoebe (Sayornis nigricans)
Western Flycatcher (Empidonax difficilis)
Townsend's Warbler (Dendroica townsendi)
Say's Phoebe (Sayornis saya)
Yellow-rumped Warbler (Dendroica coronata)
White-throated Swift (Aeronautes saxatalis)
Western Kingbird (Tyrannus verticalis)
Cassin's Kingbird (Tyrannus vociferans)
Violet-green Swallow (Tachycineta thalassina)
Cliff Swallow (Hirundo pyrrhonota)
Mountain Chikadee (Parus gambeli)
Bushtit (Psaltriparus minimus)
Wrentit (Chamaea fasciata)
Bewick's Wren (Thryomanes bewickii)
Rock Wren (Salpinctes obsoletus)
House Wren (Troglodytes aedon)

APPENDIX 2

Spearman rank correlation coefficients comparing all three Cal Poly sites, using data after the last fire on July 28, 1989. No significant correlations were found (n = 34, P > .05).

	CPSite1	CPSite2	CPSite3
CPSite1	1.0		
CPSite2	.10	1.0	
CPSite3	.28	.17	1.0

APPENDIX 3

The following is a listing of species and which sites they occurred at Cal Poly after the last fire (July 28, 1989).

Common Name	Sites of occurrence (CP__)
Anna's Hummingbird	1,2,3
Brown Towhee	1,2,3
Mockingbird	1,2,3
N. Flicker	1,2,3
Red Tailed Hawk	1,2,3
Scrub Jay	1,2,3
Dark eyed Junco	1,2,3
Mourning Dove	1,2,3
Black Phoebe	1,2,3
Say's Phoebe	1,2,3
Nuttall's Woodpecker	1,2
House Finch	1,2
Am. Kestrel	1,2
Ash Throated Flycatcher	1,2
Bewick's Wren	2,3
Lesser Goldfinch	2,3
Golden crowned Sparrow	1,3
White Crowned Sparrow	1,3
B\G Gnatcatcher	1
Cactus Wren	1
Ca. Quail	1
Wrentit	1
Loggerhead Shrike	1
Turkey Vulture	1
Ca. Thrasher	2
Western Bluebird	2
Small Accipiter	2
American Robin	2
Cassin's Kingbird	2
Cedar Waxwing	2
Prairie Falcon	2
Rock Wren	2
Yellow rumped warbler	3
White throated Swift	3

APPENDIX 4

Grouping of plants into trees, shrubs, and forbs & grasses.

Trees
Coast Live Oak Quercus agrifolia Nee
Elderberry Sambucus mexicana Presl.
Toyon Heteromeles arbutifolia M. Roem.
California Walnut Juglans californica Wats.
Eucalyptus Eucalyptus globulus Labill.
Tree Tobacco Nicotiana glauca Grah.
Snag (many different species)

Shrubs
Bush Mallow Malacothamus fasciculatus (Nutt.) Greene
Coastal Sagebrush Artemesia californica Less.
Lemonade Berry Rhus integrifolia (Nutt.) Benth. & Hook.
White Sage Salvia apiana Jeps.
California Buckwheat Eriogonum fasciculatum Benth.
Black Sage Salvia mellifera Greene
Oleander Nerium oleander L.
Oleander seedling
Eucalyptus seedling
Castor Bean Ricinus communis L.
Prickly Pear Opuntia littoralis (Engelm.) Ckll.
Wild Cucumber Marah macrocarpus (Greene) Greene
Laurel Sumac Rhus laurina Nutt. in T. & G.
Western Ragweed Ambrosia psilostachya DC.
Poison Oak Toxicodendron diversilobum (T. & G.) Greene
Deerweed Lotus scoparius (Nutt. in T. & G.) Ottley
Mulefat Baccharis glutinosa Pers.
Rhamnus ilicifolia Kell.

Grasses & Forbs
Grass family (Gramineae)
Common Sunflower Helianthus annuus lenticularis (Dougl.) Ckll.
Soapweed Chlorogalum pomeridianum (DC.) Kunth
Black Mustard Brassica nigra (L.) Koch
Milkweed Sarcostemma cynanchoides Dcne.
Milk Thistle Silybum marianum (L.) Gaertn.
Horehound Marrubium vulgare L.
Sow Thistle Sonchus asper (L.) Hill

APPENDIX 5

Characteristics of the six study areas.
S= shrub layer, F = forbs layer, T= tree layer occurrance at each site.
(+) = high heterogeneity of vegetation. (m) = moderate heterogeneity. (-) = low heterogeneity of vegetation.

Site	Level of Disturbance	Heterogeneity
CP1	Partial burn in 1983	(+) S, F, T
CP2	Unburned, control	(+) S, F, T
CP3	1981 Box Canyon burn	(m) S, F, T
SP1	Man-made Wildlife Area (revegetated)	(m) F, T, S
SP2	Landfill/Ag Field	(-) F, T
SP3	Walnut Woodland	(-) T, F

APPENDIX 6

Map of study site locations.

Appendix 2.
Results of literature search on "Avian use of modified coastal sage scrub"

New Literature Cited

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Tyler, Claudia M. 1996. Relative Importance of Factors Contributing to Postfire Seedling Establishment in Maritime Chaparral. Ecology 77(7): 2182-2196.

Wilsey, Brian J. and Catherine Potvin. 2000. Biodiversity and Ecosystem Functioning: Importance of Species Evenness in an Old Field. Ecology 81(4):887-892.

Appendix 3.
Completed Manuscript of "Avian Use of Modified Coastal Sage Scrub"

AVIAN RESPONSE TO HABITAT MODIFICATION, SUCH AS FIRE AND REVEGETATION IN COASTAL SAGE SCRUB

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ABSTRACT

Bird species diversity and activity were compared between areas of mature coastal sage scrub which had been burned, unburned and used for landfill activities. A damping of bird species cycling was seen in a recovering coastal sage scrub burn area. Bird species in mechanically modified areas that lacked vertical plant structure, showed a tendency to react similarly to severely burned areas in repetitive cycling trends. Disturbances such as clearing of coastal sage scrub were found to decrease bird species diversity and lead to a predominance of introduced bird species. Areas which sustain vertical heterogeneity were preferred by a greater diversity of birds for a wider variety of behaviors. The knowledge gained from this study will assist in the planning of future environmental modifications and fire management.

Avian community structure may be composed of a core of resident species, complimented in winter and spring by seasonal migrants which increase community diversity (Ricklefs and Travis 1980, Avery and Van Riper 1989). Willson (1974) showed avian community structure to be strongly associated with vegetation structure. Foliage height and foliage density have been shown to have a profound effect on diversity of breeding bird species (MacArthur and MacArthur 1961). Numerous other studies have linked vegetation complexity and foliage height with bird species diversity (Karr and Roth 1971, Willson 1974, Lynch and Whigham 1984, and Avery and Van Riper 1989). More recently, human influenced and natural events such as revegetation and fire have also been found to effect many aspects of plant and animal diversity by reducing total primary productivity (Wilsey and Potvin 2000).

Modifications such as prescribed burning, clearing and revegetation of coastal sage scrub may have extreme deleterious impacts on the bird species diversity in these areas. Greenberg et. al. (1995) found similar bird communities occur in like structured habitat that results from disturbance, regardless of the agent of disturbance. Breininger and Smith (1992) found birds considered to be shrub species to decline under frequent

fire regime. Although fire in other scrub habitats, such as chaparral has been shown to increase bird species diversity (Dodd 1988, Wirtz 1982), fire has been shown to decrease bird species diversity in coastal sage scrub (Moriarty et. al. 1985, Stanton 1986). Knowledge of the factors that shape the avian community in coastal sage scrub, may help in conservation of this community and avoiding extinction of avian and other species through proper management techniques.

The objectives of my study were: (1) to compare a revegetated landfill area to burned areas in terms of bird species abundance; (2) to examine seasonal changes of bird species abundance over time relative to degree of modification, and (3) to determine whether bird activities differ in revegetated, burned and unburned coastal sage scrub.

MATERIALS AND METHODS--There were six study sites established, three at the Spadra Landfill, Walnut, California, and three were approximately 1.85 km away on the Voorhis Ecological Reserve, on the campus of California State Polytechnic University, Pomona, California. A summer drought period characteristic of Mediterranean climates was prominent, with the majority of rainfall occurring in the late winter and early spring.

The Spadra study sites had been modified extensively by human influences. Site 1 was a revegetated hillside area (hereafter known as SP Site 1), composed of eucalyptus (Eucalyptus globulus), oleander (Nerium oleander), tree tobacco (Nicotiana glauca), and a wide array of annuals and grasses. Site 2, was a covered landfill area (hereafter known as SP Site 2) used as a landfill site in 1969-1970 and thereafter seasonally planted with crops. Edge species at SP Site 2 consisted of milk thistle (Silybum marianum) and bush mallow (Malacothamus fasciculatus). Site 3, was a walnut woodland area (hereafter known as SP Site 3) consisting of California walnut (Juglans californica) and annual grasses (Poaceae) and was periodically grazed.

At Cal Poly, Site 1 was a partially was burned area (hereafter known as CP Site 1), was burned by a wildfire in summer 1983, although greater than 50% of the study site remained relatively undisturbed. CP Site 1 was composed mainly of California sagebrush (Artemisia californica) with lesser amounts of cactus (Opuntia littoralis), elderberry (Sambucus mexicana), toyon (Heteromeles arbutifolia), California walnut, and herbaceous cover. Site 2, was an unburned area (hereafter known as CP Site 2) composed of mature coastal sage scrub with similar plant species to CP Site 1, such as California

sagebrush, elderberry, toyon, cactus, and with lesser amounts of white sage (Salvia apiana), coast live oak (Quercus agrifolia), Rhamnus ilicifolia and black sage (Salvia mellifera). CP Site 2 was used as a "control" by Stanton (1986). Site 3 (hereafter known as CP Site 3) bordered on a woodland composed of walnut and toyon, with other vegetation being composed of black sage, bush mallow and various grasses (Poaceae). CP Site 3, was the burn area, selected from a 9-ha area of coastal sage scrub that burned severely in August, 1981. CP Site 3 was the "burn" area of Moriarty et al. (1985) and Stanton (1986).The vegetation at the Cal Poly study areas is described by Clark (1990) and a detailed description of the three Cal Poly sites can be found in Shannon (1991). Botanical nomenclature follows Munz (1974).

I counted the birds at each of the six sites twice a month. Each area was surveyed for a period of 30 minutes within two hours of sunrise. I recorded the bird species, the number of individuals, the plant species being used, and the bird activity. The activity categories were perching (resting or preening), foraging (gleaning, flycatching, and surveying from the air by hawks), aggression and reproduction (territoriality, nest building, copulation, courtship display), and calling (the bird was heard but the location was undetermined). To avoid disruption of bird activity by moving through the dense

vegetation at some of the sites, I observed from a fixed elevated point overlooking the entire site. I recorded all known bird activity for as long as they were in the area. Birds flying over the site, but not specifically using it were not counted, whereas others such as Red-tailed Hawk that were foraging above sites were counted. The problem of missing one bird while watching another was minimized by low bird densities and the aid of at least one field assistant. I recorded all sequential behaviors, since no difference has been found in analyses of single point versus sequential observations except in detecting rare foraging strategies (Morrison 1984, Stanton 1986).

To determine how habitat modification effects the avian community, I compared the rank order of bird species abundance between the Cal Poly and Spadra sites using Spearman rank correlation. I then narrowed the scope comparing rank order of abundance of only the 24 most regular species at Cal Poly, Spadra or both. Then, to determine if any of the 24 regular species occurred in higher abundance at Cal Poly over Spadra or vice versa, chi-square goodness of fit with Yates' correction was used.

Because disturbance might be expressed by the types of food resources available, I separated the species according to guild

to determine if birds of a particular feeding guild were more abundant at one site over another. Guilds were determined from observations of foraging birds during the study, and consisted of granivore, insectivore, omnivore and nectarvore. Only granivore and insectivore guilds were used in the analysis due to the extremely low number of nectarvores and widely varying behaviors and feeding patterns of omnivores.

Since abundance among sites may be effected by one species with many individuals, I used the Fisher exact test to remove flocking effects by using the number of granivore and insectivore species observed, rather than abundance.

Different types of habitat modification may affect seasonal bird species abundance, so I compared bird species abundance in different seasons (hereafter refferred to as cycling) at each site using polynomial regression.

Bird activity may differ with intensity of habitat modification. So, I compared bird activities among sites by season with contingency tables. Since the habitat modification at Spadra focused on revegetated areas and the habitat modification at Cal Poly focused on burned areas, I grouped all Spadra areas together and all Cal Poly areas together. Then, to determine if bird activities occurred in the same amount at Cal Poly Verses Spadra, I used chi-square goodness of fit using

Yates' correction. Resident and migrant species were not compared in analyses, since it is suspected that migration of resident species may occur depending on food availability (Avery and van Riper 1989, Breininger and Schmalzer 1990).Statistical analysis follows Zar (1984) and Dixon (1988). A critical value of 0.05 was required for rejection of the null hypothesis in all statistical analyses.

RESULTS-- A total of 75 species of birds were observed in 4172 recorded observations. In comparing Cal Poly and Spadra locations, a significant correlation in the rank order of bird species abundance was found between CP Site 3 (burn area) and the SP Site 3 (walnut area) at Spadra. This indicates the rank order of bird species abundance at the most disturbed area at Cal Poly was similar to the least modified area at Spadra (Table 1). Other than these two sites, the bird communities at Cal Poly and Spadra are very different.

Closer examination of the 24 most regular species occurring at Cal Poly, Spadra, or both shows no significant correlation (Spearman rank correlation; $n = 24$, $r = -.25$, $P > .05$). Thirteen of 24 species were found in higher abundance at Cal Poly over Spadra, while eight were found in higher abundance at Spadra over Cal Poly (Table 2). Two of the eight

species which preferred Spadra over Cal Poly, Nuttall's woodpecker and mourning dove, were significantly more abundant at the WWA (walnut woodland area) than the other two Spadra sites combined; Nuttall's woodpecker (Chi-square = 23.8, DF = 1, $P < .001$) and mourning dove (Chi-square = 20.6, DF = 1, $P < .001$). There was a significantly higher number of species per census found at Cal Poly verses Spadra overall (Sign test; $n = 31$, $Z = 5.89$, $P < .0001$).

When all seasons are combined, the ratio of granivore to insectivore species was found to differ at all six sites ($P < .05$). A difference in ratio of granivores to insectivores was found between years for specific seasons at CP Site 2 (unburned area) and CP Site 3 (burned area) and SP Site 1 (revegetated area) and SP Site 3 (walnut area) at Spadra ($P < .05$). When flocking effects are removed by using the number of insectivore or granivore species observed, rather than abundance grouped by guild, no difference is found between these two guilds (Fisher Exact Test; $P > .05$).

Concerning the seasonal species richness at any of the six sites, no difference was found in the total number of bird species when comparing seasons (Polynomial regression; $P > .05$). No difference was found in bird species richness among seasons at CP Site 1 and CP Site 2, or at SP Site 2 and SP Site 3

(Polynomial regression; $P > .05$). Indicating these areas support relatively the same number of species all year round. A significant difference in bird species richness among seasons was found (fourth degree polynomial) at SP Site 1 (revegetated area) ($F = 8.02$, $DF = 32$, $P < 0.001$, Fig. 1) and (third degree polynomial) at CP Site 3 (burn area) ($F = 2.47$, $DF = 41$, $P < .05$). SP Site 1 (Fig. 1) shows a significant increase in bird species richness in spring and summer, and a significant decrease in species richness in fall and winter, (cycling) for both years of data. CP Site 3 showed a significant increase in bird species richness in spring and summer and a significant decrease in bird species richness in fall and winter the first, but not the second year of the study.

Bird Activities among season tended to be more variable in the least disturbed environment. The bird activities considered were perching (resting or preening), foraging (gleaning, flycatching, and surveying from the air by hawks), aggression and reproduction (territoriality, nest building, copulation, courtship display), and calling (the bird was heard but the location was undetermined). CP Site 2, the least disturbed environment, bird activities differed with season (chi square = 10.345, $DF = 3$, $n = 301$, $P < .025$ for spring, summer chi square = 9.663, $DF = 3$, $n = 399$, $P<.025$, and fall chi square = 18.028,

DF = 3, n = 225, P<.001). In more disturbed and less heterogeneous areas, which were at Spadra (SP Site 1 and SP Site 3) there was no difference observed for bird activities among seasons (P>0.05 for all comparisons). CP Site 3 falls in the middle, with varying bird activities appearing in just a few seasons (P < .05 for winter and spring 87-88).

A difference was found in bird activity when comparing revegetated sites (Spadra) to burned and unburned sites (Cal Poly). A significantly higher occurrence of perching was found at Spadra versus Cal Poly (Chi-square goodness of fit using Yates' correction; Table 3), while there was a significantly higher occurrence of foraging and reproductive/aggressive behaviors at Cal Poly (Table 3).

DISCUSSION--In examining bird abundance and species richness in burned and revegetated areas, my results suggest that birds in revegetated landfill areas react similarly to birds in severely burned areas in coastal sage scrub. This is seen in the dissimilarity of bird species at Cal Poly sites in contrast to Spadra sites, and is similar to Greenberg et. al. (1995) who found the bird community found in an area of clear cutting mimicked that of high intensity burns.

Overall, different bird communities occur at Cal Poly compared to Spadra. There was no preference for unburned areas by granivores nor a predominance of insectivores in the burn area as found by Stanton (1986). However, more species prefer the less disturbed Cal Poly sites than those of Spadra, and a greater abundance of opportunistic bird species were seen at Spadra. This supports Avery and Van Riper (1989), who found that greater habitat complexity leads to increased species richness.

Not only were more species seen at Cal Poly, but a much larger number of native coastal sage scrub species were found at Cal Poly over Spadra as well. Opportunistic species such as the American crow, Brewer's blackbird and red-winged blackbird were found in higher abundance at Spadra, as were certain other regular species such as red-tailed hawk, Nuttall's woodpecker, house finch, mourning dove and yellow-rumped warbler. These regular species could be drawn to the opening of a canyon by disturbance. For instance, the high incidence of red-tailed hawks at Spadra supports the suggestion that open areas are better foraging spots for many raptors (Dodd 1988). Red-tailed hawks are one of several species of raptors reported to be attracted to recent burns, where they have the ability to nest and hunt on open edges created by fire (Dodd 1988).

Even though the Nuttall's woodpecker and mourning dove were found to prefer Spadra, it is important to note that their occurrences were significantly higher at SP Site 3 (the walnut area and the least disturbed area at Spadra at the time), than at the other two Spadra sites combined. This implicates walnut woodland as preferred habitat for Nuttall's woodpecker and mourning dove and suggests that SP Site 3 may potentially support more bird species than SP Site 1 or SP Site 2. These findings are especially notable due to the continuing reduction in the already limited California walnut community. Quinn (1989) states that remaining native populations of California walnuts face an increasingly precarious status. In fact, this particular site at Spadra (SP Site 3) was severely modified by landfill and Cal Poly regenerative studies projects, at the end of this study.

The species found to prefer Cal Poly over Spadra habitats are extremely similar to those found by Soule et al. (1988) to leave isolated canyons of coastal sage scrub in response to urbanization, namely California quail, California thrasher, spotted towhee, Bewick's wren and wrentit. Two species found in higher amount at Spadra, mourning dove and yellow-rumped warbler, were similarly found to prefer a disturbed oak scrub by Breininger and Schmalzer (1990). House sparrows and starlings,

which were found by Beissinger and Osborne (1982) to predominate in urban areas, also predominate at Spadra.

Concerning cyclical patterns of bird species utilization, my results and those of Stanton (1986) support the importance of vertical heterogeneity of vegetation found in mature coastal sage scrub to coastal sage scrub bird communities. The lack of disturbance at CP Site 1, CP Site 2 and SP Site 3, and the lack of cycling of numbers of bird species in these areas, agrees with Stanton's (1986) finding that a mature vegetationally heterogeneous area supports more species more consistently all year round than a relatively uniform area in recovery. A more heterogeneous environment provides more foraging opportunity, cover and protection to native (especially ground dwelling) species (Bowman and Harris 1980, Soule 1988). Breininger and Smith (1992) found no shrub species to have their highest density in a 1-2 year old burn area. Ground dwelling species such as the California quail, California towhee and California thrasher require much ground cover, while shrub species such as Bewick's wren and wrentit require a little higher level of cover (Soule 1988, Dodd 1988). My study supports Bolger et. al. (1991) who focused on California quail, wrentit, spotted towhee, Bewick's wren and California thrasher as shrub species and found them more vulnerable to extinction in fragmented areas. I found

the same 5 species to be in significantly higher abundance in mature coastal sage scrub (that had at least 7 years recovery) as compared to a revegetated area.

I found revegetation to induce a larger number of bird species supported in spring and summer with a decrease in number supported in fall and winter (cycling). Similar to Stanton's (1986) findings for recently burned areas. I found cycling in Stanton's (1986) burn area the first year of this study (6 years post fire) but no difference the second year of this study (7 years post fire). Indicating that the habitat is recovering. Since this area burned 7 years prior, the decrease of the cycle agrees with the 5 to 10 years estimated recovery time of coastal sage scrub (Minnich 1983). However, the areas in this study contain silt clay to clay soil type which has been found to have the slowest transition rate from grassland back to coastal sage scrub (Callaway and Davis 1993). This may account for the similarity in bird species abundance at the Cal Poly burn area and Spadra revegetated area. The cycling pattern in species number found at SP Site 1 (Fig. 1) indicates a very repetitive cycling trend from year to year at this site. This area then reacts like a severely burned area as a result of the serious disturbance, similar to the findings of Stanton (1986). In areas that lacked trees and shrubs and had a predominance of

annuals, use is extremely high in spring when productivity is high, through both years of my study. Kolb and Davis (1994) found early rapid growth in coastal sage scrub in spring and leaf shedding due to low water, which characteristically occurs at the end of summer.

When looking at bird activities in conjunction with degree of disturbance and vegetation complexity, all activities occurred consistently in proportion to each other at SP Site 1 (revegetated) and SP Site 3 (walnut) from season to season. However, these proportions fluctuated from year to year in CP Site 2 (unburned), as would be expected in a constantly changing more complex area. When comparing all Cal Poly sites to all Spadra sites, perching was significantly higher at Spadra. The birds at Cal Poly tended to be engaged more in foraging and reproductive/aggressive behaviors. This suggests that although Spadra may be an important resting area for birds, the Cal Poly areas are more important overall for sustaining coastal sage scrub bird populations.

My study supports that of Breininger and Schmalzer (1990) in finding that revegetation following the mechanical clearing of natural vegetation results in a community which is different in vegetation composition, vegetation structure and thereby supports a different bird community than an undisturbed area.

Furthermore, the fragmenting of contiguous coastal sage scrub by fire, urbanization, or other alteration (Moriarty et al. 1985, Stanton 1986, Soule et al. 1988) results in a decrease in bird species abundance and brings about less bird activity associated with reproduction and foraging.

This study shows the importance of mature coastal sage scrub to the bird community there. Beissinger and Osborne (1982) point out the difficulty in measuring the effects of human disturbance such as motor vehicles, domestic predators, traffic, and noise upon urban avifauna. They also suggest manipulating urban habitats to enable more desirable bird species to be favored. Beissinger and Osborne (1982) suggest that vegetative cover in urban habitats should be increased by preserving natural islands of complete habitat consisting of vegetative cover in various layers. Preservation of the natural vegetative layering could help maintain bird species diversity in modified areas. Maintenance of bird species diversity should be considered in conjunction with prescribed burns, urbanization, mechanical clearing of vegetation and other modifications to coastal sage scrub.

I thank D.J. Moriarty, G.R. Stewart, C. Clark and G. Braden

for their invaluable comments, suggestions and discussions. Special thanks to R. Clements, for many helpful comments and suggestions at the start of this project and the many field assistants involved.

This research was supported in part by a grant from the Los Angeles County Sanitation District which was distributed by the Cal Poly Kellogg Foundation.

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