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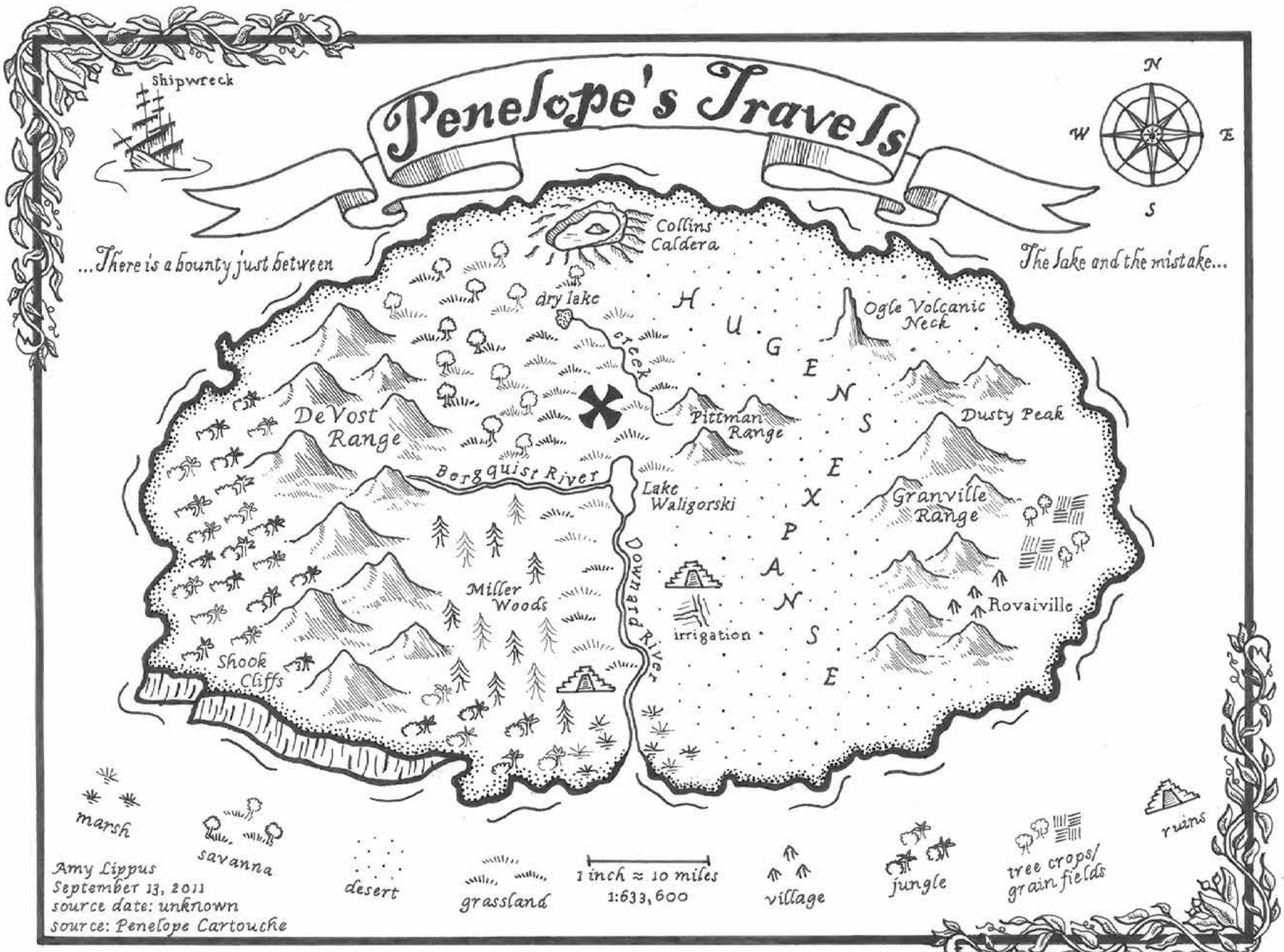

This hand-drawn map by Amy Lippus, titled "Penelope's Travels," placed first in the Paper Cartography category at the CGS conference in April 2013. The map was an assignment from an Introductory Cartography course at Chico State University, which required students to hand draw a map of a fictional island, using only a journal description of the island landscape. The assignment required geographic expertise, attention to detail, and a steady hand. The process was intended to develop appreciation for traditional analog cartography. This is Amy's second year in a row placing at the CGS Conference.

Intraurban Spatial Fluctuations in Crime by Season and the Temperate Sacramento Climate

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and
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Abstract

Geographic and climatic modeling has garnered recent attention among criminologists, but few have combined these techniques to form a single model of crime. Among limited intraurban spatial-climatic models, each explores municipalities with wide-ranging seasonal variation. While not yet tested, there is reason to believe that climatically temperate cities would show little seasonal fluctuation in the spatial distribution of crime. Using Sacramento, California, as our spatial unit, we first explore monthly fluctuations in crime, followed by a test of spatial distribution in crime by month. We find no meaningful seasonal fluctuation in crime; raster density maps show no discernible seasonal fluctuation in the spatial distribution of crime; and spatial correlations reaffirm a lack of seasonal patterning. Our methodology and findings address the lack of intraurban modeling on climatically temperate municipalities and call for the requisite inclusion of a spatial component in all criminological research on climate, seasons, and weather.

Key words: crime, climate, seasonal, weather, intraurban, spatial

Introduction

In a recent survey of the American Society of Criminology (ASC), members were asked to identify the sources of a potential paradigm shift in the discipline (Cooper, Walsh, and Ellis 2010). Conspicuous in its absence was any mention of spatial or climatic predictors. Yet advancements in technology have led to a modern renaissance in the spatial analysis of crime (Althausen and Mieczkowski 2001). And growing concern over climate change has spurred an interest in criminological research on climatic, seasonal, and weather influences (Agnew 2011). The real neglect involves the dearth of criminological research that combines climatic and spatial data into one model. What makes this important is the ubiquity with which research finds spatial variability in climate and climate change, including subsequent geographic variations and changes in seasonal and weather patterns (IPCC 2007, 2013).

In this paper we review contemporary research on spatial and climatic variations in crime. We then outline recent attempts at spatial-climatic crime modeling, focusing on the lack of intraurban modeling in more-temperate climates. Using five years (2005–2009) of Sacramento, California, crime data, we test for seasonal fluctuations in two forms of crime: one personal, and one property. This is followed by an exploration of spatial patterning in personal and property crime by season. In doing so, we parallel extant research in that we do not provide a test involving climate *per se*, but rather, seasonal (and spatial) variations within a particular climate. Nevertheless, our model addresses the need for intraurban tests on more climatically temperate municipalities (such as Sacramento) when exploring spatial fluctuations in crime by season. Given the well-documented spatial variations in climate and subsequent season and related weather parameters, we argue for the requisite inclusion of spatial methodologies in all criminological research on climate/seasons/weather and crime.

Spatial, Climate, and Crime

Despite the longstanding inattention, spatial and climatic analyses stand as two of the earliest empirical observations on crime. Befittingly, these observations were made by Lambert Adolphe Jacques Quetelet (1796–1874), arguably the most neglected figure in criminology (Bierne 1987; Sylvester 1984). Using three years of data (1827–1829) on France and the Low Countries, Quetelet (1831, 1842) rendered separate, personal and property, shaded choropleth crime maps and fleshed out spatial variations for both types of crime. Quetelet also found that the greatest number of personal crimes and fewest number of property crimes occurred during the summer months, and vice versa for the winter months.

Spatial Analyses of Crime

Quetelet's (1831) spatial observations of crime quickly stagnated until resurfacing with social ecology and the Chicago School at the turn of the 20th century, then stagnated again until recent advances in spatial software. Geography is now included in Criminal Justice curriculum (Althausen and Mieczkowski 2001); several textbooks have since been dedicated to the geography of crime (Brunsdon, Corcoran, Higgs, and Ware 2009); and an increasing number of police departments now utilize spatial maps (Markovic and Scalisi

2011). In 1997 the National Institute of Justice (NIJ) established the Crime Mapping Research Center (currently known as Mapping and Analysis for Public Safety—MAPS); and in 2008 the NIJ released *Geography & Public Safety*, a quarterly bulletin dedicated to crime mapping.

Current spatial analyses of crime typically center on municipal units of analysis and spatial variations within. This is expected, given the use of crime mapping to pinpoint and devote resources to crime clusters (Markovic and Scalisi 2011). Vector modeling is largely employed in such intraurban analyses and generally finds crime clusters in areas marked by impoverished socio-demographics (see McCord and Ratcliffe 2007; Suresh and Vito 2007; Fornango 2010; and Andresen 2011). Limited raster models report similar findings (see Caplan, Kennedy, and Miller 2011). Regardless of modeling, most studies explore the spatial distribution of personal crime, though property crime also displays intraurban spatial patterning.

Seasonal Analyses of Crime

Since Quetelet, seasonal and weather analyses of crime halted until spurred by the broader concerns of climate change. With each successive Intergovernmental Panel on Climate Change (IPCC) report, the anthropogenic sources of climate change are concluded with increasing confidence (Goodman, Boykoff, and Evered 2008); the most recent (Fifth) IPCC Assessment Report (2013) concluded that anthropogenic warming of the planet is certain. The current interest in crime and climate is essentially a byproduct of the empirical confirmation of climate change in general. Nonetheless, when it comes to climatic and other environmental influences, the current criminological paradigm remains well behind other social science disciplines (Lynch and Stretesky 2001; Simon 2000). But as noted by Agnew, "there is good reason to believe that climate change will become one of the major forces driving crime as the century progresses" (2011:21).

Despite climate concern, extant criminological research essentially centers on seasonal and/or weather parameter variation rather than the broader spatial and temporal elements of climate or climate change *per se*. Nevertheless, geographic variations in climate beget seasonal and weather differences, and climate change is known to alter seasonal and weather patterns (Mann 2012; IPCC 2013). Most studies find seasonal fluctuations in crime and that weather parameters (particularly temperature) influence crime. Recent studies comparing seasons and weather find that seasonal influences wash out the effects of temperature and other weather parameters (Brunsdon, Corcoran, Higgs, and Ware 2009; McDowall, Loftin, and Pate 2012). Either way, the influence of season and/or weather is better supported for personal crime than property crime.

Spatial-Climatic Modeling of Crime

It is not surprising that Quetelet neglected the potential for a crime model that combines seasons and geography. Climate change was not an issue in the days of Quetelet, and spatial technology was limited to shaded choropleth mapping. But spatial technology is now formidable, and climatic influence on crime is an emerging concern. We argue that a combined model is not only possible; it is requisite due to the known geographical variation in climate and climate change. Climate warming is known to vary by latitude (IPCC 2007, 2013). Changes in surface temperature are found to vary regionally (Christy, Norris, Redmond, and Gallo 2006). Research finds that differences in urban design generate microclimate variations in temperature (Stone 2012). With all geographic variations in climate come related variations in seasons and weather (Mann 2012).

Recent studies have addressed the viability of a combined model, focusing largely on intraurban methodologies. Harries, Stadler, and Zdorkowski (1984) tested for intraurban differences in assault by month in Dallas, 1980, using neighborhood vectors. They found that low-status neighborhoods displayed more distinct summer peaks in assault. Twenty-five years later, Brunsdon, Corcoran, Higgs, and Ware (2009) used raster modeling to test weather and seasonal influences on disorder and disturbances in an urban area of the United Kingdom. The authors found that high temperature and humidity increased incidents outside (but not inside) the city center during the summer and winter quarters. More recently, Sorg and Taylor (2011) examined community-level connections between temperature and street robbery in Philadelphia, 2007–2009. Intraurban raster modeling indicated that higher temperatures increased robbery in lower SES communities. Using 2001 Vancouver, Canada, data, Andresen and Malleson (2013) used vector modeling to compare quarterly fluctuations in various personal and property crimes. They found that most crimes fluctuated by season. In turn, crimes with the least seasonal fluctuation displayed little, if any, spatial patterning by season.

At least two studies exist that test seasonal fluctuations on larger (than intraurban) spatial units. Hipp, Bauer, Curran, and Bollen (2004) tested for bi-monthly fluctuations in crime at the state level. Using Uniform Crime Reports (UCR) data, they found seasonal oscillations in both personal and property crime for all states under study; however, states with more-temperate climates displayed less seasonal variation, with California revealing the least fluctuation. In a comparison of eighty-eight U.S. cities, McDowall, Loftin, and Pate (2011) used 2000 Census and UCR data to explore monthly variation in personal and property crimes. The authors found that cities with more-temperate climates displayed little seasonal fluctuation in crime, with several California cities displaying the least in seasonal variation.

In sum, research shows that states and municipalities located in temperate climates reveal fewer seasonal fluctuations in crime. Intraurban modeling by season suggests that when crime fluctuates little by season, there is little spatial patterning by season. In combination, temperate cities lack seasonal fluctuations in crime; subsequently, temperate cities are unlikely to display spatial patterning in crime by season. Yet there are currently no intraurban spatial analyses in crime by season on climatically temperate municipalities exhibiting little seasonal variation. This study explores intraurban spatial variations by season on a temperate California city.

Method

We chose Sacramento, California, for two reasons. One, previous research shows that California has a “temperate Mediterranean climate,” making it one of the “states with the least seasonal variation” (Hipp, Bauer, Curran, and Bollen 2004:1361–1362). This is particularly true of California’s Central Valley, where Sacramento is located. The coolest average temperature in our study is a relatively comfortable forty-two degrees, and Sacramento is dry in the summer, negating the interaction between high temperature and humidity (a.k.a. heat index). Two, Sacramento police data is publicly available and includes spatial location [(X,Y) coordinates]. Using Sacramento as a geographic unit, our analyses begin with exploring seasonal variations in personal and property crime. We then test for seasonal variation in the intraurban spatial distribution of each crime. Based on previous research, we hypothesize that (1) crime varies little, if any, by season in temperate Sacramento; and, as a consequence, (2) the intraurban spatial distribution of crime does not differ by season. Moreover, extant intraurban crime analyses tend to employ vector modeling; but crime patterns tend to form in hot spots, making raster models more ideal since they allow hot spots to form in natural patterns over a continuous space (Filbert 2008; McLafferty, Williamson, and McGuire 2000; Vann and Garson 2001). Therefore, we choose raster mapping for our intraurban spatial analysis by season.

Data

Data for the years 2005–2009 was retrieved from the Sacramento Police Department website (City of Sacramento 2014). We chose these five years of data due to the consistent Uniform Crime Reports (UCR) coding during this period; data for 2004 and 2010 was omitted because of changes in the interdepartmental data coding system during each of these years, making them incompatible with the five chosen years. From this data, we used battery civilian (UCR code 1313-8) as the representative personal crime, and petty theft (UCR code 2399-2) as the representative property crime. These two crimes have the largest number of reported incidences (corresponding to personal and property crime) in the Sacramento data. All other crimes were excluded from this analysis.

Design and Findings

To test for seasonal fluctuations in crime, the five years of data are summated by month for each crime; incidences per month are then compared as a test of seasonal fluctuation (Table 1). High incidences of personal and property crime appear more common during the warmer months, with low incidences more common during the winter months—but this interpretation is provided with caution. For personal crime, the four lowest incidences per month are in the winter (December, November, February, and January, respectively), which suggests the potential for seasonal patterning; however, the remaining months show no overt seasonal pattern. For property crime, three of the four highest months are in the summer (June, July, and August, respectively), yet December reveals the third-highest incidence, and no overt pattern emerges among the remaining months. Overall, there seems little to suggest a clear seasonal fluctuation in crime based on monthly comparisons.

Turning to the spatial analysis by month, a series of spatial map layers was uploaded to GIS. Spatial map layers included the Sacramento city map layer and the Sacramento city coordinate system to identify geographic locations based on (X, Y) coordinates. Two steps are required in our test of seasonal fluctuations in the monthly distribution of crime. The first step is the creation of overall raster-density spatial maps for personal and property crime. To do this, the five years of battery civilian and petty theft were uploaded as separate point layers, with each individual point representing an incidence of personal and property crime, respectively. These point layers were used to create separate raster-density map layers via the ArcMap kernel density tool. Due to the geometric spatial distribution of both personal and property crime data, we employed the geometrical interval method to create five density classes.

Table 1: Monthly Fluctuations in Crime.

Month	Personal	Property
January	442	486
February	409	412
March	475	525
April	478	485
May	516	529
June	480	562
July	478	543
August	458	533
September	488	467
October	460	510
November	405	484
December	356	535
Total	5,455	6,371

For the second step, these two spatial maps are used to create monthly density maps. To do so, the five years of data were summated by month for personal and property crime, and spatial point layers were used to create concentric density maps for each of the twelve months. To calculate monthly spatial density classes, manual breaks were formed by dividing the original geometrical intervals by twelve. Doing so achieves the equivalent parameters necessary for direct comparisons (see Bolstad 2008; Caplan, Kennedy, and Miller 2011). In line with our overall breaks (and for the sake of visibility), monthly maps were classified according to five densities. These classes are represented by five shades (red, orange, green, light blue, and dark blue) that center on crime hot spots and corresponding lesser densities, respectively (Figures 1 and 2).

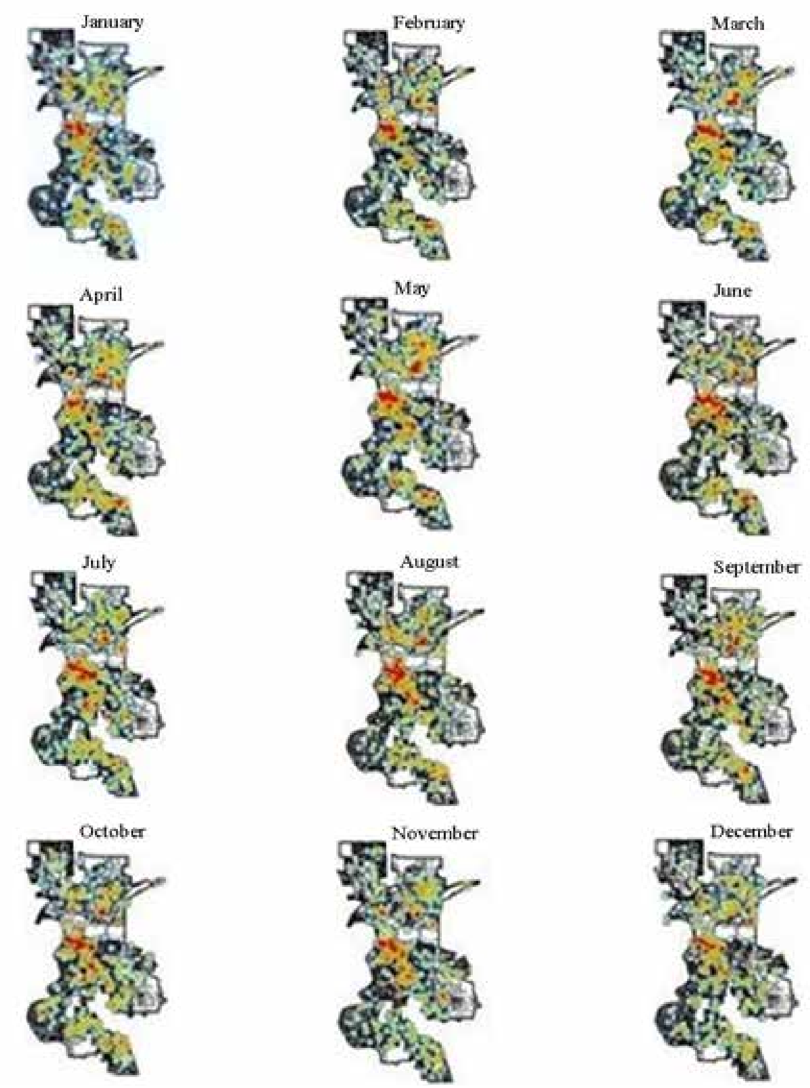

Figure 1.—Monthly Density Maps, Personal Crime.

Figure 2.—Monthly Density Maps, Property Crime.

When comparing the two crimes by density classification, three basic visuals emerge. One, crime hot spots are in the same areas for both personal and property crime. Two, property crime displays clearly larger hot spots (red) as well as greater expanses of least crime (dark blue). Three, there is no discernible variation by month for either personal or property crime. The spatial variations are trivial at best, with hot spots remaining within the same, heavily concentrated areas regardless of month or crime type, and the same is true for areas with least crime. Even if subtle differences can be detected, there is nothing to suggest a seasonal pattern in the spatial distribution of either crime. This is not surprising, given the general lack of seasonal fluctuations in crime by month presented in Table 1.

The final analysis involves monthly comparisons of bivariate spatial correlations (Table 2). Based on the aforementioned density classification in Figures 1 and 2, coefficients reflect spatial correlations between months and were calculated using an ArcGIS Spatial Analyst Multivariate tool, Band Collection Statistics. A seasonal impact on crime density would be reflected by stronger correlations between seasonally similar months and weaker correlations between months of dissimilar season. Our spatial correlations indicate three things. One, all coefficients are of the moderate to strong variety, with inter-month spatial correlations being somewhat stronger for personal crime. Two, little monthly variation exists among spatial correlation within either type of crime. Three, most importantly, no clear seasonal pattern emerges among spatial correlations by month for either personal or property crime. At times, winter months are most strongly correlated with other winter months; at other times, with summer months. The same is true for spring and fall months. If nothing else, the inability to distinguish the coefficients from one another is evidence of no apparent density variation by season. The coefficients essentially confirm the spatial maps, suggesting that season has little or no patterned effect on the spatial distribution of crime in Sacramento.

Discussion and Conclusion

As expected, we find little, if any, seasonal patterning for personal or property crime with the Sacramento data. This appears to translate into a lack of spatial patterning by season. For both personal and property crime, our findings support our hypothesis: there is little, if any, seasonal patterning in crime; as a consequence, the spatial distribution of crime does not differ by season. This is not surprising, since Sacramento is a climatically temperate municipality, which lacks meaningful variations in season. The lack of seasons are believed to account for the stability in personal and property crime by month and the subsequent stability in monthly density maps and spatial coefficients.

If anything, the temperate climate and subsequent tempered results signal a need for additional intraurban research on the spatial mod-

Table 2: Bivariate Spatial Correlations.*

	J	F	M	A	M	J	J	A	S	O	N	D
Jan		.677	.674	.662	.659	.642	.676	.661	.624	.672	.674	.624
Feb	.865		.679	.701	.664	.657	.668	.666	.640	.640	.649	.601
Mar	.890	.884		.735	.750	.717	.714	.707	.675	.727	.710	.660
Apr	.804	.810	.830		.699	.654	.683	.659	.578	.667	.680	.584
May	.784	.779	.806	.795		.626	.678	.691	.656	.692	.644	.592
Jun	.844	.818	.853	.787	.788		.680	.649	.585	.635	.659	.605
Jul	.856	.835	.867	.819	.812	.846		.663	.673	.680	.682	.621
Aug	.775	.790	.777	.777	.796	.781	.818		.636	.678	.669	.618
Sep	.850	.826	.840	.797	.818	.820	.845	.803		.641	.593	.612
Oct	.796	.803	.803	.780	.784	.810	.840	.801	.820		.668	.627
Nov	.841	.826	.845	.819	.820	.811	.855	.772	.826	.816		.618
Dec	.893	.863	.903	.794	.795	.849	.868	.764	.856	.820	.854	

**Personal Crime Above Diagonal; Property Crime Below Diagonal* eling of crime by season, including a wide variety of climatically different municipalities. Spatial units could follow vector explorations of climate, seasons, weather, and crime, as well as more-sophisticated techniques in extant research. By knowing intraurban patterning by season, crime can be seasonally identified using hot-spot analysis to better utilize limited resources. This not only includes police resources, but resources dedicated to urban design as it relates to climate and climate change. Seasonally driven spatial analyses of crime can also continue on broader geographic units such as state and regional tests, though given the policy emphasis on intraurban crime, intraurban analysis by season seems most appropriate.

A wider shortcoming of our particular test mirrors the shortcoming in climate and crime models in a changing climate; we do not directly test the influence of climate or climate change *per se*. Nevertheless, we see value in a seasonal model that includes spatial variation. Seasons and weather are known to shift with a shifting climate. This being the case, seasonal analysis remains valuable as the climate continues to change. Moreover, our particular model can be extended to explore monthly (and other seasonal) increments longitudinally, over a period of time necessary to address climate change.

We agree with Agnew's (2011) assessment that climate change will become a focal point of criminology in the near future, but we add that the future of climate and crime research must address geographic variation. In the end, spatial-climatic models are limited by neglect, not opportunity. Our methodology and chosen municipality is but one example of the seemingly innumerable spatial-climatic combinations. Bottom line: climate and anthropogenic climate change are known to vary spatially, requiring spatial analyses of crime on a variety of climates.

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Geography as a "Jedi" Discipline

Steve Graves
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"You're a college professor? What do you teach?"

Ugh! How I dread that question, because *I know* if I respond, "Geography," I'll hear something like, "Oh, I loved geography in school! I memorized all the mountain ranges and rivers in India!" or "I have a subscription to *National Geographic!* I love pictures of elephants!" or "How *can* you keep up with all those crazy new countries in Europe?"

Occasionally I've been met with the worst retort of all, the disapproving, "Oh." What's *that* supposed to mean?

I'm a bit defensive when it comes to my dear-old-friend geography, so I'm always convinced that people who are ignorant about "real geography" are disgusted with the thought that anyone could make a living mastering the world of maps and trivia. I am paranoid that they suspect me a sham. The weight of such incrimination is unbearable, even if it's untrue.

I've had that exchange many dozens of times in the years since I first declared geography my major, and I cannot think of a single instance in which I did not feel compelled to set the record straight, to defend my craft from either exuberant ignorance or patronizing scorn. I quickly find myself in full-blown, first-day-of-the-semester lecture mode, with people who really don't want a lecture on geography. I fear my own pedantic tendencies, but I can't control them in the face of a challenge to my career and my love for my discipline.

For a few years, I plotted to avoid all this unpleasantness by answering the *dread* question with, "I teach astrophysics" or "nanotechnologies" using a fake BBC-flavoured British accent for effect, but the risk, however small, that my interrogator would know something of astrophysics or nanotechnology, was always too great. I'd be exposed as a fraud, an American…and a geographer. Eventually, I found that I could proudly announce my career *while* inviting others to hear a little geography propaganda lecture by noting that I teach "Business Geography," "Medical Geography," or "Forensic Geography." When I note the *specific* courses I teach, rather than the department

affiliated with those courses, the response I get is more along the lines of "Wow, I didn't know there was such a thing. What's that all about?" *Now* I have an entrée to launch a much-abridged spiel about how geographers can study any subject, as long as that subject *takes place*, because geography isn't really much of a *subject* but rather a *discipline*, with its own strategy for seeing the world, asking questions, solving problems, and communicating results, that allows geographers to study just about anything, anytime, anywhere.

If time for conversation is abundant (as when I'm flying to Kazakhstan or standing in line at the DMV), I explain what geography is and what geographers do. If I were ever at a Sci-Fi convention talking to a guy dressed like Darth Vader, I would explain it like I do on the first day of class in my introductory courses. In those courses, about five years ago, I started using *Stars Wars* analogies to add color to my lecture about geography-as-discipline. Since this imagery has proven to be so powerful, I've written this essay so that others interested in geography may use or experiment with these analogies. In this essay, I rely on Lucasfilm terminology, derived from the double trilogy, to illuminate what geography is and what geographers do, partly in hopes that it might begin to shed its unfortunate reputation as the study of place names and maps. I hope the curmudgeonly image of geography can be replaced by something not only more accurate but bearing a bit of ultimate-space-fantasy-badass imagery. Maybe we'll all get a few more majors. Who knows?

I can claim with some certainty that the students who've taken a few classes with me have energetically embraced the analogies and the imagery associated with *Star Wars*, and that includes those students who weren't predisposed to nerdy science-fiction references. Today, geography students at CSUN regularly incorporate *Star Wars* references and photos on the Facebook page used by the student geography club to organize events and share geography-related tips and GIS (Geographic Information Software) frustrations. Some students bought plastic lightsabers to carry during commencement exercises this year, as a way of noting the completion of their apprenticeships as a Jedi-Geographers. I'm waiting for a few to openly demand that the university replace the traditional graduation march, "Pomp and Circumstance," with the Imperial Death March (Darth Vader's Theme) so they can receive their diplomas in a proper soundscape. As a bonus, I also get to occasionally accept the uber-cool title, "Master Graves," which, for obvious reasons, I vastly prefer to "Doctor Graves." I don't mind the Obi-Wan references, but I'm a little less sure about being likened to Yoda.

Outlined below are the Star Wars analogies I've used over the years to help students understand that, by majoring in geography, they are entering into an apprenticeship from which they should emerge, after a few years of training, with a set of guild-craft skills that are really quite unique. What follows is my contribution to the programmatic debates that raged among a previous generation of geographers.

Jedi Googles

The first of the Jedi skills a geographer-in-training (a "youngling" for undergrads or a "Padawan" for graduate students?) should develop is a heightened mindfulness about both the physical and humanized environment. Geographers must learn to read the landscape. A well-developed ability to notice, then interpret patterns, processes, and meaning in both the physical and cultural landscapes is a key Jedi skill. Indeed it is a type of literacy. Accomplished Jedi can read the landscape as a sort of text. There is a large and fascinating landscape literature, in which master Jedis look at a scene or landscape (everything from a meandering stream to a fast-food restaurant) and, using their Jedi skills, spin an expansive story about the forces that produced the landscape and the force that the landscape exerts on those around it. I frequently urge students to put on their "Jedi goggles" so they can see such patterns. Eventually, with practice, they are able to derive rich meaning from the landscapes they encounter. I must admit that I rely heavily on another

pop culture reference, Harry Potter, here as well. In a scene from one of the Potter movies, Harry finds himself on a noisy, purple, triple-decker bus streaking at break-neck speeds through London. When Potter asks the bus conductor, "What about the Muggles? [i.e., nonmagical folk] Won't they see us?" The conductor replies, "Muggles? They don't see nuthin', do they?" Geographers are not Muggles. We must be able see what others don't, because we look for meaning where others assume there is none. We find meaning in a text that others rarely notice, and almost inevitably fail to understand. Advanced Jedi become adept at using their other senses to inventory and analyze the landscapes around them.

Jedi Mind Tricks

The reason geographers look for meaning where others assume there is none is because geographers also have a special "Jedi way" of acquiring knowledge. I tell students to "Use the Force." Others might call this engaging an epistemology. Geographers seek knowledge in a way that is peculiar to our discipline and because this style of knowing is so powerful, it seems legitimate to characterize it as "the Force," that mystical energy that fuels the Jedi way. Students and scholars of all disciplinary backgrounds are interested in understanding why things are the way they are, how they came to be that way, why things work the way they do. Geographers ask these very questions, but as Jedi-geographers seek to understand "why," we invoke the force—and, by doing so, privilege the question "where?" Place, location, and space are the tools that allow us to invoke the force. When Luke Skywalker was in training, he was encouraged to learn to "stretch out with his feelings" in order to use the force. Padawan learners in geography are instructed (in a Yoda voice): "As you seek the answer to 'Why?', 'Where?' is the question you must ask."

I generally present the following example of how I have used the Force while explaining how a Jedi mind trick might work to answer a tough question. While trying to determine the target demographic of predatory lenders, I made a request for a database of loan office addresses. The person who possessed the dataset had

been researching the topic for years, but still asked me, "Of what value is this address roster?" I replied, "I'll use this to map the locations of these storefront lenders, and analyze the patterns I find against the demographics of the neighborhoods where they cluster. That way, we'll better understand this industry's business model." The reply: "We've had this data for years. Nobody has once considered *mapping* it to address that question." My reply (under my breath): "It's the first thing I thought to do. I am a Jedi."

Light Sabers

Of course, students want to know about brandishing lightsabers. They ask excitedly, "When can I learn how to use a lightsaber so I can smite that guy who stole my prom date?" Well…we don't have lightsabers per se, but we do have tools (or "weapons" if you must!) that are unique to the Jedi way. The most lightsaber-like tool geographers have at our disposal is GIS. Like the lightsaber to the Jedi, GIS is a unique weapon, nearly exclusive to our ancient order, which, when used skillfully, can help conquer foes, like hypotheses, and occasionally strike down other enemies (economics majors?). The *GIS-saber* is a remarkable tool because it allows geographers to grapple with datasets and data types that elude the software and analytic devices of other disciplines (SPSS?). For starters, GIS allows Jedi to easily analyze data from widely disparate data sources, like incidence of robbery and elevation and rainfall totals. This is not to say that Jedi geographers can't pick up a blaster (survey instrument) or pilot a death star (Excel?); rather, it can be said that GIS allows Jedi to make use of data that practitioners of other disciplines find incompatible. By combining GIS with a powerful set of spatial analysis techniques (*Guard! Turn! Parry! Dodge! Spin! Ha! Thrust!*), Jedi can wield the GIS-saber with tremendous effect. Additionally, once a Jedi has become adept with the *GIS-saber*, he or she begins to use the force more effectively; he or she learns how to better ask more powerful questions and solve more difficult problems—by

engaging the force (epistemology) more wisely and by probing more deeply into the bag of Jedi tricks (methodologies).

Jedi Language

The last of the special Jedi skills that geographers should master is the unique language of our ancient order: cartography. Cartography, the ability to read and write in the language of maps, is a type of literacy that is generally restricted to geographers, and to specialists known as cartographers. GIS and various graphics software, such as Adobe Illustrator, have eliminated some of the truly arcane elements of manual cartography, but making high-quality maps that are easy to read, and that communicate clearly and forcefully, is both an art and a science that may look easy, but takes the practiced hand of the Jedi-cartographer. Certainly, a well-trained Jedi-geographer must possess robust textual literacy and numeracy skills, but in our graphics-centered, light-speed society, well-crafted maps are especially useful.

Maps have power. An example of this power was related to me by a Congressional staffer with whom I worked to pass a law regulating financial products sold to members of the military. The staffer recounted how their bill languished on Capitol Hill until she distributed a series of maps showing the intense concentration of subprime lenders near military bases. Faced with the threat of *maps* displaying these clusters of subprime lenders at the gates of dozens of military bases appearing in the local newspaper of each legislator's home district, the bill suddenly found dozens of co-sponsors—and passed easily into law. My research wasn't advanced; the data was publicly available and the analysis was simplistic. The analysis was made powerful by *the map*. What was once invisible was made obvious to anyone who saw the maps. It was like whispering to Congress, "These aren't the droids you're looking for." I had performed a Jedi *map* trick.

The Dark Side

OK, so geography majors might find this useful, and additional majors are always at a premium, but our geography program is under attack from the Death Star we call "Administration." Is there a way to battle Death Stars? Sure, but you have to know the weakness to exploit.

One of the problems geography departments face is articulating the value of geography courses (and departments) to budget-obsessed administrators. Several universities in California have lost their geography program in recent years, at a time when demand for the *skills* those programs teach is at an all-time high. The danger comes at the same time administrators have begun to embrace assessment, a task many faculties find as annoying as Jar Jar Binks. The utility of your geography program can be made far more visible by focusing less on what your students must learn (knowledge) and more squarely on what skills they must demonstrate after having a geography course. The assessment mania that has swept through academia and the public schools can be turned away from the dark side and can strengthen geography, because geographers actually have demonstrable *skills* that are both methodologically and epistemologically unique to geography. These skills are undeniably valuable, and only Jedi masters can train students in the Jedi arts. That point cannot be surrendered. No other *disciplinary practitioners* are equipped to teach spatial thinking, cartography, or GIS. Jedis cannot be trained by geologists, nor by historians, nor by anthropologists, nor even sociologists, because none of those disciplines have mastered the Jedi skills that are specific to geography.

Perhaps in a time not so long from now, in galaxy well-known to us, geography will shed its suffocating reputation as a *subject* and will finally be understood as the fully flowered *disciplinary practice* that it is. Sure, there will remain a smallish core of *subject matter* expertise involving crops, capitals, climates, and it is important for Padawan learners to acquire a certain measure of facility with that knowledge so they may leverage it quickly, but such facts must cease

to be central to the public's concept of geography the way spelling, dates, and times tables have become peripheral to the public understanding of English, history, and mathematics. We could start by petitioning Alex Trebec of *Jeopardy!* to stop featuring geography in his TV trivia contests. Here in California, geographers could demand updates to the State Standards for both pupils and pre-service teachers so we can bury our nineteenth-century geography and replace it with a twenty-first-century version. The administrations at all campuses have to be re-educated so they understand that geography is an essential core discipline, an indispensable element of a proper education in the Arts & Sciences. It's ancient and it's futuristic. In your own classes, steer your ship away from memorization. Urge your students to "use the force," allow them to wield a light saber (even in introductory courses), and share with them how Jedi mind tricks (geography methodologies) can solve pressing, real-world problems.

Evaluating the Potential Impact of the Proposed Land Development on Coastal Sage Scrub in Northern Orange County, California

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Abstract

Southern California's coastal sage scrub vegetation, found in limited coastal lowlands, is directly threatened by habitat loss due to urban sprawl. The West Coyote Hills, located in the city of Fullerton, California, is one of the last existing open coastal scrublands remaining undeveloped in northern Orange County, but it has been proposed for housing development. The objective of this study was to evaluate the potential impact of the proposed land development on the remaining coastal sage scrub habitat in the West Coyote Hills area. The analysis was based on a map of vegetation communities, developed from the classification of field inventory data, and a map of the proposed housing tracts from the Revised Environmental Impact Report for the study area. FRAGSTATS was used in conjunction with these maps to quantify the possible changes in landscape composition and spatial configuration. The results indicated that the landscape would become highly fragmented with a great amount of loss of scrub vegetation. The remaining vegetation patches would become smaller, more isolated, and less contiguous. Both coastal sage scrub (CSS) and disturbed coastal sage scrub (dCSS) were examined at the class and patch levels. The results showed that 84 CSS patches over 45 ha and 78 dCSS patches over 9 ha would be lost to the development. The changes in patch extent and patch size distribution of CSS would be more substantial than those of dCSS. Many large CSS patches would be reduced, and the allowable distance for organisms to move within the patches would decrease.

Keywords: landscape structure, landscape metrics, coastal sage scrub, habitat fragmentation, FRAGSTATS

Introduction

Located within the California Floristic Province, one of the world's thirty-four biodiversity hotspots, southern California's coastal sage scrub (CSS) vegetation is concentrated between Point Conception, California, and Northern Baja California, on the interior and exterior sides of the Coast Range. It is usually found in coastal lowlands adjacent to the Chaparral adapted to the semi-arid Mediterranean climate. The vegetation is characterized by the dominance of drought-deciduous shrubs with shallow roots, soft leaves, and a fairly open canopy (Westman 1981a, 1981b, 1983; O'Leary and Westman 1988).

The CSS vegetation has been considered as an endangered plant community due to human disturbances and land-use change (Underwood et al. 2009). The human disturbances of habitat, from the Spanish explorers' development of ranchos in the late eighteenth century to the early settlement of the European-Americans in the nineteenth century, have made it difficult to determine the original range of CSS (Riordan and Rundel 2009). But it was estimated that the direct and indirect effects of human activities have diminished nearly 90% of the original CSS habitat (Riordan and Rundel 2009).

Land-use change is another main contributor to the elimination of native vegetation, including CSS (Kowarik 1995). The landscape of southern California has transitioned through conservation, utilization, and replacement, and is currently predominantly in the final land-use phase of removal (Mooney and Hobbs 2000). Direct habitat loss, caused by urban development and the demands for new housing communities, has become an important issue in southern California (McKinney 2002). Much of the native CSS vegetation in southern California has been converted into freeways, housing communities, and strip malls (South Coast Wildlands 2008). When permanent structures are built over a landscape, the previous vegetation in the area is lost and unable to be restored (Riley et al. 2003; Markovchick-Nicholls et al. 2007). In Orange County, California, the Department of Forestry reported that 6,216 ha of CSS vegetation was destroyed between 1945 and 1980 (Bowler 1990).

A limited habitat can support only a limited number of organisms. Besides, when habitat loss occurs, the landscape breaks up into smaller pieces; this is known as habitat fragmentation. Fragmentation of a natural landscape creates patches of habitats. A fragmented habitat can remain healthy if the patches are large in scale and well connected (Bastin and Thomas 1999; Swenson and Franklin 2000; Williams, Mc Donnell, and Seager 2005; Oneal and Rotenberry 2008). Habitat patches that are intact will have greater species populations, species survival rates, and biodiversity. If habitat patches are disconnected and grow smaller in size, biodiversity will decline drastically. The isolation of habitat patches will eventually lead to inbreeding and the extinction of species (MacDonald 2003). Therefore, in growing urban areas, such as the few remaining open spaces in southern California, it is critical to protect biological diversity by keeping habitat patches intact.

The West Coyote Hills (WCH) is one of the last existing open coastal shrubland remaining undeveloped in northern Orange County, but it has been proposed for a housing development. The objective of this study was to evaluate the potential impact of the proposed land development on the entire WCH landscape and remaining vegetation communities, including both CSS and disturbed coastal sage scrub (dCSS). The specific questions asked in relation to the impact of development are: How much CSS and dCSS would be removed and lost? How would the landscape composition and spatial configuration be affected by habitat loss? Would the development disrupt current wildlife corridors or habitat patches?

Study Area

The WCH is located in the city of Fullerton, Orange County, California (Figure 1). Within the city of Fullerton, the WCH is located on the northwest side of the city limits, between Rosecrans Avenue and Euclid Avenue. The WCH is part of a range of low hills connecting from the east in Yorba Linda to the west in Santa Fe Springs. The elevations vary from around 91 m near the southern boundary to 186 m at the top of the northern hill. Past oil-field activities have altered the natural landscape and topography with well pads, graded roads, canyon fills, and sheer cuts into slopes.

The WCH encompasses 235.6 ha of open space and is the largest undeveloped section of land in northern Orange County. For eighty-seven years, from 1907 to 1994, the WCH was used for oil production. Since the closure of the oil fields, maintenance procedures have taken place, such as reducing brush to prevent fire hazards. Chevron currently owns the WCH property. The hired developer for the property, Pacific Coast Homes, has proposed building a maximum of 760 homes within 72.8 ha of the property; 556 of these homes will be single-family, detached homes; the remaining 204

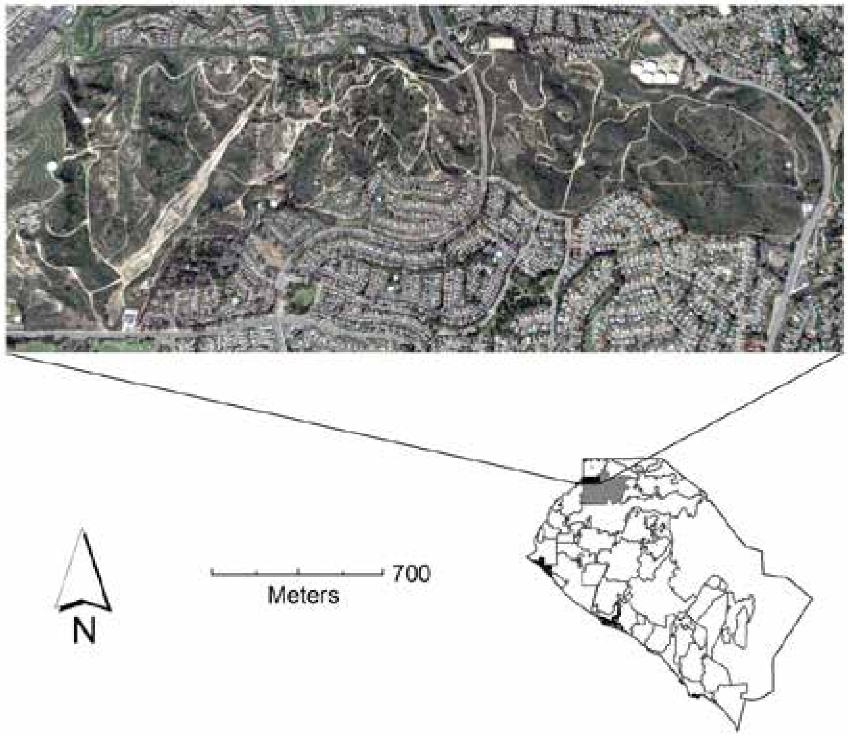

Figure 1.—Map displaying the West Coyote Hills (Google Earth Image 3/7/2011), located in the city of Fullerton, Orange County, CA.

homes will be single-family, attached units (Figure 2). There is also a plan for a commercial center, recreational areas, and open space. The proposed development also includes 29.3 ha of the Robert E. Ward Nature Preserve, which is part of the WCH (Keeton Kreitzer Consulting 2006).

The area has not been incorporated in the Natural Community Conservation Program or any type of habitat conservation plans by the Federal Endangered Species Act (FESA). However, the U.S. Fish and Wildlife Service has been in negotiations over this property due to its identification as a critical habitat for California gnatcatchers (Dudek and Associates Inc. 2003). The California gnatcatcher is one of the species included in the FESA, and thus 25.9 ha of this study site has been designated for this species.

Typical to Mediterranean climates, the study area has dry, hot summers, with most rainfall occurring in the mild winter months. The study area receives about 340 mm of precipitation per year, mostly

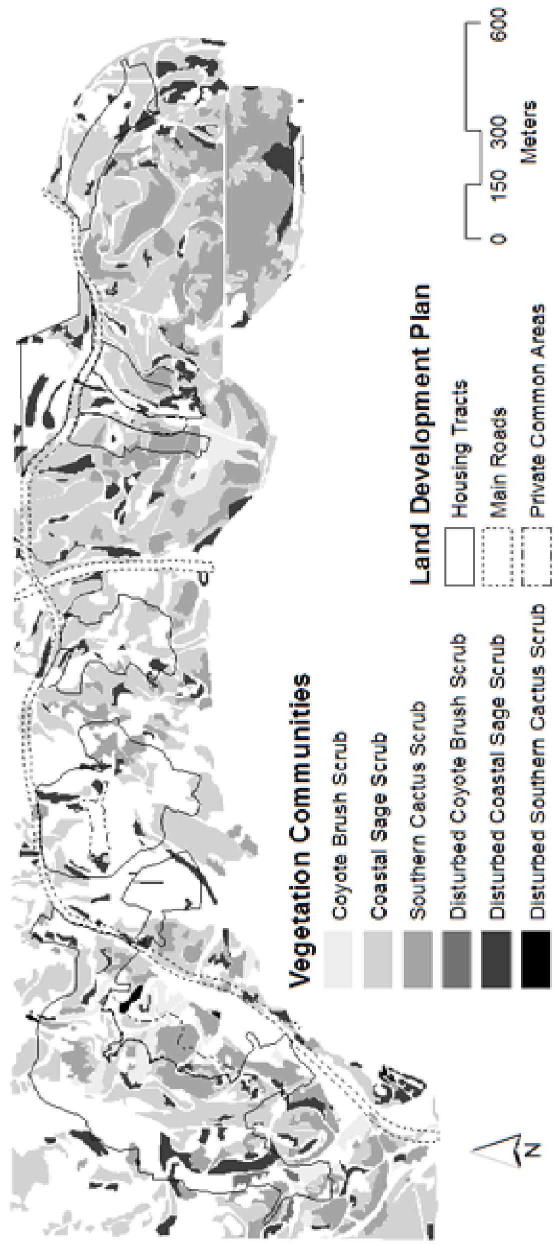

Figure 2.—Vegetation communities of the West Coyote Hills and the proposed land-development plan. Both were digitized and classified from the data in the 2008 Recirculated Revised Draft Environmental Impact Report (Keeton Kreitzer Consulting 2008).

as rainfall from north Pacific storms. In the summer, temperature characteristically ranges from 10 to 31°C, with occasional days surpassing 38°C. The winter high temperature ranges from 10 to 21°C, and the winter low temperature ranges from -1 to 10°C, with a no-frost period of approximately 220 to 300 days per year. The winds in the area alternate from strong spring and fall coastal winds to dry, hot, eastern Santa Ana winds at the end of fall and early winter.

Data and Methods

Vegetation and Land Development Maps

The main data used in this study were a vegetation community's map and a map of the proposed land development from the 2008 Recirculated Revised Draft Environmental Impact Report (RRDEIR) (Keeton Kreitzer Consulting 2008) (Figure 2). A second vegetation community's map was developed for the area under the scenarios of the proposed land development.

The biological resources documented in the Environmental Impact Report (EIR) were recorded from a literature review, field reconnaissance, unofficial consultation with species experts from the U.S. Fish and Wildlife Service, California Department of Fish and Game, U.S. Forest Service, TW Biological Service, and Dudek and Associates, Inc. Field reconnaissance started in 1992 and was completed by Dudek and Associates, Inc. (2003) in the 2003 EIR. The Dudek biologists visited the site around 220 times to monitor maintenance procedures and field closures, and they mapped the change of vegetation communities from February 1994 to July 2003. In June of 2003, the biological consultant of the City of Fullerton peer-reviewed the vegetation map and confirmed it was accurate. Due to no recent impact from oil-field closures, the vegetation map has not been revised in 2008 RRDEIR.

The vegetation classifications used in this study for reporting the plant communities were based on Holland (1986). Seventeen vegetation communities were documented with the total area coverage of 131 ha. However, only six types were recorded on the map, due to their significance. They are coastal sage scrub (CSS), disturbed coastal sage scrub (dCSS), southern cactus scrub, disturbed southern cactus scrub, coyote brush scrub, and disturbed coyote brush scrub. Both CSS and dCSS were evaluated in this study, due to their abundance and endangered status. A large portion of the study site supports CSS (74.2 ha) and dCSS (15.8 ha). The vegetation mostly consists of California sagebrush (*Artemesia californica*), smaller amounts of flat-top buckwheat (*Eriogonum fasciculatum*), white sage (*Salvia apiana*), bush monkey-flower (*Mimulus aurantiacus*), poison oak (*Toxicodendron diversilobum*), and Mexican elderberry (*Sambucus mexicana*).

Map Digitization and Georeferencing

Both the vegetation community's map and the proposed land-development map were digitized and georeferenced. The finalized vegetation map was added as a layer on a 2008 Google Earth image (August 27, 2008), concurrent with the RRDEIR, and every vegetation community was digitized and converted to polygons. The proposed land-development map was also overlaid on the same Google Earth image, and then digitized as a second polygon layer. The polygon layers for the vegetation communities and land development were saved as the Google Earth KMZ files, which were then converted to GIS shapefiles separately with Quantum GIS 1.8.0.

To develop a second layer for vegetation communities under scenarios of the proposed land development, vegetation communities that interfered with the proposed development layer were removed. The vector data for the vegetation communities were selected within the development vector data by location in ArcGIS 10.0. The vegetation layer was the selected feature for the target layer, while the development layer was the source layer. The chosen method for spatial selection was "target layer(s) features intersect the source layer." Basically, all of the vegetation communities that overlap the proposed development were selected. The selected vegetation communities were then deleted from the map with the editor tool. The updated vector data displayed the remaining vegetation communities after the proposed land development.

The polygon vector data for the vegetation communities before and after the proposed development were converted to raster data with 1 m spatial resolution and the UTM projection. The raster data contained 3,337 columns and 1,188 rows and were used as input grids in FRAGSTATS (version 4), a spatial pattern-analysis program for categorical maps (McGarigal, Cushman, and Ene 2012), for the vegetation communities before and after the proposed land development, respectively.

Selected Landscape Metrics

FRAGSTATS uses landscape metrics to quantify landscape composition and spatial configuration (McGarigal, Cushman, and Ene 2012).

Landscape composition refers to the abundance and the variety of different patch types, while landscape configuration provides information about the spatial characteristics, arrangement, orientation, or position of patches within a land-cover class or the entire landscape mosaic (Leitao et al. 2006). Both landscape composition and configuration were quantified in this study because both are important to the understanding of ecological processes, interactively and independently.

Landscape metrics describe the spatial structure of habitat patches, patches in each class, and patch mosaics as a whole (Leitao et al. 2006). Three levels of landscape metrics were used to quantify landscape composition and spatial characteristics of CSS and dCSS patches before and after the proposed land development. Landscape level metrics were calculated for the entire WCH, since the WCH as a whole can be considered one habitat patch with dispersed scrub vegetation. The selected landscape-level metrics for quantifying landscape composition included total area (TA), number of patches (NP), largest patch index (LPI), and Simpson's diversity index (SIDI). The selected metrics for quantifying landscape configuration included total edge (TE), mean patch area (AREA_MN), area-weighted mean patch area (AREA_AM), median patch area (AREA_MD), range in patch area (AREA_RA), standard deviation of patch area (AREA_SD), coefficient variance of patch area (AREA_CV), mean patch area radius of gyration (GYRATE_MN), area-weighted mean patch radius of gyration (GYRATE_AM), mean similarity index (SIMI_MN), and area-weighted mean similarity index (SIMI_AM) (McGarigal, Cushman, and Ene 2012).

At the class level, the collective properties of all the patches belonging to CSS and dCSS were determined. The selected class level metrics were nearly the same as those at the landscape level. The composition metrics included class area (CA), percentage of land (PLAND), NP, and LPI. The configuration metrics included TE, AREA_MN, AREA_AM, AREA_MD, AREA_RA, AREA_SD, AREA_CV, GYRATE_MN, GYRATE_AM, SIMI_MN, and SIMI_AM.

At the patch level, only CSS patches were estimated for this study. The AREA metric was used to identify patches that were larger than or equal to 1 ha before and after the proposed land development. The purpose was to determine how many large individual CSS patches were able to maintain their coverage after the proposed development because of the species reliance on native vegetation and space for survival and persistence.

Results and Discussion

Landscape-Level Changes

After the proposed land development, many vegetation patches would be reduced in size or completely lost to development, although all six vegetation classes would remain. The landscape-level composition metrics showed a great loss in scrub vegetation after the development. Both TA and NP would be significantly reduced (Table 1). TA would lose about 70 ha, and NP would lose 213. Because of the significant loss in habitat area coverage and the disproportionate alteration of the size of patches covering the landscape, LPI would increase from 8.53% to 10.77%, and the patch type diversity, estimated by SIDI, would increase slightly by 0.03.

Table 1: Landscape-level composition metrics, before and after the proposed land development.*

LANDSCAPE METRICS	BEFORE	AFTER
TA (ha)	130.95	61.40
NP	484	271
LPI (%)	8.53	10.77
SIDI	0.59	0.62

*****_TA, NP, LPI, and SIDI refer to total area, number of patches, largest patch index, and Simpson's diversity index, respectively._

Variable changes were found in the landscape-level configuration metrics. Patch TE would decrease significantly by 170,128 m due to the loss of TA (Table 2). After the proposed land development, patches would be reduced in size across the landscape, as indicated by the first-order statistics for AREA. AREA_MN, AREA_AM, and AREA_MD would decrease by 0.05 ha, 0.75 ha, and 0.02 ha, respectively. These decreases displayed potential habitat loss and increased fragmentation, post-development.

The second-order statistics also demonstrated a decrease in patch variability. After the proposed land development, many large patches would disappear or be reduced in size. AREA_RA, AREA_SD, and AREA_CV would decrease by 4.56 ha, 0.2 ha, and 31.98%, respec-

Table 2: Landscape-level configuration metrics, before and after the proposed land development.*

LANDSCAPE METRICS	BEFORE	AFTER
TE (m)	174,968	4,840
AREA_MN (ha)	0.27	0.22
AREA_AM (ha)	2.11	1.36
AREA_MD (ha)	0.10	0.08
AREA_RA (ha)	11.17	6.61
AREA_SD (ha)	0.70	0.50
AREA_CV (%)	259.25	227.27
GYRATE_MN (m)	22.19	20.45
GYRATE_AM (m)	63.10	53.34
SIMI_MN	6,842.55	4,400.96
SIMI_AM	12,215.83	9,120.11

**TE, AREA, GYRATE, and SIMI refer to total edge, patch area, patch radius of gyration, and similarity index, with a search radius of 50 m and a similarity weight of 0.5, respectively. MN, AM, MD, RA, SD, and CV refer to mean, area-weighted mean, median, range, standard deviation, and coefficient variance, respectively.*

tively. The large values of these configuration metrics showed high variability and heterogeneity of the landscape.

The mean and area-weighted mean for GYRATE and SIMI would also decrease in value after the proposed land development. GYRATE_MN and GYRATE_AM would decrease by 1.74 m and 9.76 m, respectively, while GYRATE_AM is a more accurate index representing the average traversability of the landscape, due to the high probability of wildlife inhabiting larger patches. The potential loss of landscape connectivity was shown in the results of SIMI. With a search radius of 50 m and a similarity weight of 0.5, SIMI_MN and SIMI_AM would decrease by 2,441.59 and 3,095.72, respectively. Changes in both GYRATE and SIMI indicated less continuity and more fragmentation in patch distribution across the landscape after the proposed land development.

Table 3: Class-level metrics for coastal sage scrub before and after the proposed land development.*

CLASS METRICS	BEFORE	AFTER
CA (ha)	74.18	28.81
NP	189	105
LPI (%)	8.53	3.88
PLAND (%)	56.65	46.92
TE (m)	95,578	4,243
AREA_MN (ha)	0.39	0.27
AREA_AM (ha)	2.75	0.91
AREA_MD (ha)	0.14	0.11
AREA_RA (ha)	11.17	2.38
AREA_SD (ha)	0.96	0.41
AREA_CV (%)	245.13	152.54
GYRATE_MN (m)	27.31	24.29
GYRATE_AM (m)	74.31	50.14
SIMI_MN	4,569.62	5,825.49
SIMI_AM	10,161.77	8,055.38

**CA, NP, LPI, PLAND, TE, AREA, GYRATE, and SIMI refer to class area, number of patches, largest patch index, percentage of land, total edge, patch area, patch radius of gyration, and similarity index, with a search radius of 50 m and a similarity weight of 0.5, respectively. MN, AM, MD, RA, SD, and CV refer to mean, area-weighted mean, median, range, standard deviation, and coefficient variance, respectively.*

Class-Level Changes

Changes of Coastal Sage Scrub

As the vegetation matrix for this study area, CSS currently covers 57% of the landscape (PLAND) with the largest CA, the highest NP, and the greatest amount of TE among the six vegetation classes (Table 3). However, after the proposed land development, the results showed a great amount of habitat loss. A vegetation matrix would no longer be present due to the PLAND of CSS being reduced below 50%. CA, NP, and TE would be reduced correspondingly by 45.37 ha, 84, and 91,335 m, respectively. With only 28.81 ha of CSS remaining and fragmented, this amount of vegetation probably will not be large enough to support native vertebrate species for more than a few decades in arid habitats (Soule, Alberts, and Bolger 1992).

In addition to the considerable reduction of CSS composition, the spatial configuration of CSS was found to be changed as well. As quantified by LPI, the percentage of total landscape area comprised by the largest patch would decrease from 8.53% to 3.88%. Thus the decline in CSS patch dominance is expected. In fact, all of the CSS patches would become smaller and closer in size, post proposed development, as indicated by the first- and second-order statistics of AREA. Before the proposed land development, AREA_AM is 2.36 ha greater than AREA_MN and 2.61 ha greater than AREA_MD. This means there are many small CSS patches that were factored into the calculation of AREA_MN and AREA_MD. After the proposed development, AREA_MN and AREA_MD would be reduced slightly by 0.12 ha and 0.03 ha, respectively. But the AREA_AM would be reduced significantly by 1.84 ha due to the decrease of LPI. Thus the differences between AREA_AM and AREA_MN or AREA_MD would be only 0.64 ha and 0.8 ha, respectively.

The same trend of change was shown in the significant reduction of AREA_RA, AREA_SD, and AREA_CV. CSS currently has the largest AREA_RA and is the most variable vegetation class in size as indicated by the large values of AREA_SD and AREA_CV. However, after the proposed development, AREA_RA, AREA_SD, and AREA_CV would be reduced significantly by 8.79 ha, 0.55ha, and 92.59%, respectively. The estimates of the radius of gyration and similarity index showed that the reduced CSS patches would also become further dispersed and isolated. After the proposed land development, GYRATE_AM and SIMI_AM would decrease by 24.17 m and 2,106.39, respectively.

Changes of Disturbed Coastal Sage Scrub

Disturbed coastal sage scrub covers only about 12% of the landscape, which is much smaller than that of CSS (i.e., 57%) (Table 4). But dCSS has almost as many patches as CSS, though the patches were not significant in size, as indicated by NP and AREA. After the proposed land development, dCSS would be reduced by 8.82 ha and lose 78 NP.

With the decrease of area coverage of dCSS, TE would decrease by 34,287 m but LPI would increase by 0.7% because most patches lost in the development will be relatively small in size. As a result, after the proposed development, AREA_MN would be reduced only slightly, by 0.01ha, and AREA_AM and AREA_MD would stay the same. No or little change was also observed in the second-order statistics for AREA. AREA_RA and AREA_SD would not change, while AREA_CV would increase only slightly. These insignificant alterations of the spatial configuration of dCSS indicated that in comparison to CSS, dCSS would not change much in patch size distribution.

GYRATE metrics showed that the dCSS patch extent would not change much, as well. After the proposed development, GYRATE _MN and GYRATE_AM would be reduced by only 1.13 m and 1.52 m, respectively. However, from the landscape mosaic perspective, dCSS patches would become more isolated, as indicated by SIMI.

Table 4: Class-level metrics for disturbed coastal sage scrub before and after the proposed land development.*

CLASS METRICS	BEFORE	AFTER
CA (ha)	15.8	6.98
NP	155	77
LPI (%)	0.62	1.32
PLAND (%)	12.06	11.38
TE (m)	35,094	807
AREA_MN (ha)	0.1	0.09
AREA_AM (ha)	0.23	0.23
AREA_MD (ha)	0.06	0.06
AREA_RA (ha)	0.81	0.81
AREA_SD (ha)	0.11	0.11
AREA_CV (%)	113.06	125.46
GYRATE_MN (m)	16	14.87
GYRATE_AM (m)	25.66	24.14
SIMI_MN	7,502.73	3,126.62
SIMI_AM	9,223.1	7,252.07

**CA, NP, LPI, PLAND, TE, AREA, GYRATE, and SIMI refer to class area, number of patches, largest patch index, percentage of land, total edge, patch area, patch radius of gyration, and similarity index, with a search radius of 50 m and a similarity weight of 0.5, respectively. MN, AM, MD, RA, SD, and CV refer to mean, area-weighted mean, median, range, standard deviation, and coefficient variance, respectively.*

SIMI_MN and SIMI_AM would decrease by 4,376.11 and 1,971.03, respectively, after the proposed development.

Patch-Level Changes

The results showed significant decline in CSS patch dominance (Table 5). However, it was difficult to quantify how each patch would change, because there was no correspondence between patch identification numbers in FRAGSTATS outputs between before and after the proposed land development.

Table 5: Patch Identification (PID) for large coastal sage scrub (CSS) patches (patch area ≥ 1ha), before and after the proposed land development.

CSS BEFORE DEVELOPMENT		CSS AFTER DEVELOPMENT	
PID	AREA (ha)	PID	AREA (ha)
1	1.25	1	1.25
9	11.17	59	1.87
47	1.98	84	2.19
65	1.69	112	2.38
91	1.60	246	1.60
116	1.15		
131	3.68		
144	3.55		
151	2.93		
181	1.94		
202	2.14		
248	2.27		
250	1.20		
456	1.60		

Currently, CSS contains 189 habitat patches (Table 3), among which 13 habitat patches are over one ha (Table 5). After the proposed development, 105 CSS patches would remain, but only five patches would remain over one ha. For these five patches, only two patches would not be altered in size after the proposed land development and three would be reduced from existing larger patches. For instance, the present largest CSS patch would be reduced from 11.17 ha to 2.38 ha after the proposed development.

Conclusions

Surrounded by densely populated urban matrix, the West Coyote Hills is the last habitat remnant in northern Orange County, California. We evaluated the potential impact of the proposed land development on the remaining habitat at the landscape, class, and patch levels. Various possible changes were revealed in landscape composition and spatial configuration.

At the landscape level, if the study area were to be developed, the landscape would become highly fragmented, with a great amount of loss of scrub vegetation. More than 53% of habitat area and more than 44% of habitat patches would be lost after the proposed land development. The remaining patches would become smaller, more uniform in size, more isolated, and less contiguous. Thus, the similarity between the patches and the allowable distance for organisms to travel within the patches would decrease, and the habitat corridors could be disturbed due to the land development.

At the class and patch levels, for the 131 ha of scrub vegetation in 484 patches, CSS and dCSS contain the most patches. CSS covers 74 ha in 189 patches, and dCSS covers 16 ha in 155 patches. After the proposed land development, CSS and dCSS would lose 61% and 56% of the coverage, respectively. A vegetation matrix would not be present within the urban matrix of northern Orange County.

The results indicated that the changes of the CSS landscape composition and spatial configuration would be particularly significant. After the proposed development, 84 CSS vegetation patches (45 ha) would be completely lost and many large patches would be reduced. The remaining CSS patches would become further fragmented and isolated. Thus, there is a high probability that the CSS would slowly transform into dCSS.

With lesser area coverage and a high number of patches, dCSS patches are already highly fragmented and much smaller than CSS. With the proposed land development, although the changes in dCSS patch extent and patch size distribution would be insignificant, a great amount of dCSS vegetation could be lost and the connectivity between the patches would be further reduced. Thus, the remaining dCSS vegetation would be less likely to be restored after the proposed land development.

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Geographic Chronicles

2013 Conference Report: San Luis Obispo, California

by Benjamin F. Timms, Cal Poly San Luis Obispo

The 67th annual California Geographical Society Conference was held in San Luis Obispo from April 26th through the 28th, with more than 340 geographers from the academic, government, private, and nonprofit sectors making the trek to the wonderful central coast of California. The event was hosted by the geographers in the Social Sciences Department at California Polytechnic State University in San Luis Obispo (Cal Poly). Special thanks are extended to the student volunteers from Cal Poly who worked extremely hard to make the conference a success, particularly Hannah Panno, who coordinated the volunteers and should be considered a conference co-organizer. Cal Poly Geography faculty who lent a helping hand include James Keese, Greg Bohr, William Preston, and myself. Of course we cannot forget to thank our former CGS President, Steve Graves, for his Herculean efforts. While we will miss his stewardship of the society, it has been left in great hands with James Wanket. Jim, along with the other board members, also put forth great effort at the conference and are deserving of praise.

The conference kicked off on Friday, April 26th, with four field trips. The first was led by Steve Graves and included a private tour of Hearst Castle, lunch in old San Simeon, and a nature hike of coastal open space recently acquired by the State of California. One participant stated, "Outstanding tour! Experiencing Hearst Castle in that exclusive setting was truly a once in a lifetime opportunity." To extend our gratitude, the CGS donated $300 to the Friends of Hearst Castle foundation, to be used for site restoration and maintenance.

The Edna Valley Wine Tour was led by Cal Poly geography professor Benjamin Timms and visited three wineries with vineyard tours. A highlight was touring Tolosa Winery's solar array, which provides 104 percent of their energy needs (with the extra 4 percent going back to the electrical grid) and learning about other sustainability measures the winery has undertaken. The tour also included visits to Talley Vineyards and the boutique winery Claiborne & Churchill, which many of the participants claimed as their favorite.

In contrast to solar-powered wineries, the third tour was Diablo Canyon Nuclear Power Plant, led by Cal Poly geography professor Gregory Bohr. While security was tight, participants found the fieldtrip to be fascinating and informative. One stated, “Most of all, visiting the Diablo Canyon nuclear plant was a unique opportunity. Its uniqueness was perhaps the primary motivating factor for my attendance at CGS this year.” Regardless of viewpoints on the nuclear industry, the ability to tour such a facility was indeed unique.

The fourth tour on Friday was related to the Morro Bay Watershed. Led by Cal Poly professors James Keese and William Preston, the tour addressed estuary and watershed issues. One participant claimed, “The Morro Bay Watershed: Fantastic. I think I read the description wrong and was expecting something different but it didn’t matter because it was so good. Each stop, each guest speaker, was amazing!” Special thanks go to Cal Poly professor of animal sciences Bob Rutherford, also a rancher, who met with the tour and gave the participants an opportunity to engage in a discussion about sustainable ranching. His contribution was noteworthy, as one tour member stated (paraphrased from personal conversation), “I’ve never actually talked to a rancher, and his insights on sustainability were mind opening.”

After the field trips, we had our opening barbeque at the historic Jack House in downtown San Luis Obispo. Santa Maria-style BBQ was served with vegetarian options, and one of our former Cal Poly geography students, Jordan Traub, provided musical entertainment. Afterwards, William Bowen delivered an excellent presentation, “Seeing California and Planet Earth: Little Data and Big Data.” We are very grateful to Bill and his wife Marilyn for their contributions to the conference and the CGS in general. They are true gems and wonderful resources for geographers in California and beyond.

On Saturday, April 27th, the conference presentations began on the Cal Poly campus. The poster session had twenty-six participants, and nineteen presented in either the analog or digital cartography sessions. Throughout the day there were seventy-six paper presentations, with more than half of them delivered by undergraduates—exemplifying the CGS service toward undergraduate research. In addition, four workshops were provided: Comparing and Standardizing SLOs and Assessment Tools, hosted by Robin Lyons; Best Practices in Teaching GIS, hosted by Vanessa Engstrom; Learning Outcomes for Field Trips in Introductory Geoscience Classes, hosted by K. Allison Lenkeit Meezan; and The Joys and Challenges of Fieldwork in Geography, hosted by Tiffany Seeley and Jennifer McHenry. Carol Cox presented the Presidential Plenary, titled “Myanmar: The New Crossroads of Asia.” It was a fascinating talk about recent events in Myanmar, particularly in relation to its increasing openness to the world, for better and worse. The tour she gave us through this amazing place was illuminating.

Saturday evening we held our Awards Dinner at the Ludwick Community Center. Two hundred twenty participants filled the room to capacity, and Steve Graves entertainingly oversaw the presentation of awards. We are extremely grateful to Bill and Marilyn Bowen for sponsoring all the student presenters for the dinner, and to Robert and Bobbe Christopherson for their endowed Geosystems Award, which exemplifies their generosity and outstanding dedication to student research. Additional gratitude is extended to all the donors for the student presentation, travel, and scholarship awards. Dan Walsh of Saddleback College was awarded the Outstanding Educator Award; Eugen Turner of CSU Northridge was presented the Friend of Geography Award; and Robin Lyons earned the Distinguished Service Award.

On Sunday four more field trips were offered. Cal Poly professor James Keese and former Cal Poly professor, local businessman, and all-around city guru Pierre Rademaker led a San Luis Obispo urban tour. By all accounts it was excellent, covering slow urban-growth policies, from limits on extent and height of growth, to open-space acquisition, to no drive-through restaurants! One participant commented, “SLO Smart Growth: Fantastic!!! Pierre was amazing and everywhere we went was so good.” The second field trip was a physical geography hike of Valencia Peak in Montaña de Oro State Park, led by Cal Poly professor Tony Garcia. Garcia augmented the amazing views and great lunch with a talk highlighting the geomorphology of the area. Participants loved the hike and emphasized they would like more physical geography field trips in the future.

The Paso Robles Wine Tour was led by Dr. Tom Rice, a Cal Poly professor of soil sciences who has been working for more than twenty years in the Paso Robles wine region. The group visited two wineries, with in-depth vineyard visits of locales in which Rice is currently collecting soil samples and GIS mapping of vineyards. One respondent stated, “This was a great mix of both learning and wine tasting! I really enjoyed getting to know two wineries very well rather than many quick stops. It was fantastic to get the insiders perspective and very unique to other wine tours I've been on. Was great learning about the science as well."

Finally, we put forth a fun and informative Santa Margarita Ranch zipline tour, led by former CSUN geography professor James Hayes, who was a wealth of information on oak trees. We zipped through the old Estrada family Spanish land grant, with 13,000 acres of old-growth oak forests, and learned about their sustainable vineyard growing practices and ranching activities. We finished with a wine tasting and ordered hamburgers, which we ate in my backyard with a bit more wine.

In summary, we had a wonderful and successful 67th annual California Geographical Society Conference in San Luis Obispo. Cal Poly was grateful for hosting the event. The CGS is a great community of geographers, and I hope you all continue to participate. Onward and upward; see you all in Los Angeles!

California Geographical Society Student Award Winners 2013

DAVID LANTIS SCHOLARSHIPS

Graduate Award ($500)

Zia Salim, SDSU/UCSB

Undergraduate Award ($400)

Matthew Wigginton Conway, UC Santa Barbara

BOBBE AND ROBERT CHRISTOPHERSON GEOSYSTEMS AWARD

Graduate Award ($500):

Veronica Roach, CSU, Fullerton

Coastal sage scrub: A diminishing habitat in North Orange County, California

Undergraduate Award ($500):

Talisa Rodriguez, CSU Humboldt

Primary succession and edge effects in a coastal dune habitat

TOM MCKNIGHT PROFESSIONAL PAPER AWARDS

Graduate Papers

First Place ($150):

Zia Salim, SDSU/UCSB

Islands on an island: Urban and social geographies of gated communities in Bahrain

Second Place ($125):

Ali Hamdan, UCLA

Where's the state: Practices & policies of memory in Beirut, Lebanon

Third Place ($100):

Leaa Short, CSU Fullerton

Trade, globalization, and production transition in the Louisiana crawfish industry

Undergraduate Papers

First Place ($150):

Ryland Karlovich, CSU Humboldt

Losing identity in England's historic counties

Second Place ($125):

Chase Takajo, CSU Sonoma

Sediment transportation throughout Copeland Creek

Third Place ($100):

Marissa Hultgren, CSU Stanislaus

The geography of spies: Communism and American intelligence in World War II

PROFESSIONAL PAPER CARTOGRAPHIC AWARDS

First Place ($125):

Amy Lippus, CSU Chico

Penelope's travels

Second Place ($100):

Katherine Willis, UCLA

Conservation-based monitoring of landscape dynamics in the Santa Monica Mountains National Recreation area

Third Place ($75):

Garin Wally, CSU Chico

South American viticulture

JOE BEATON PROFESSIONAL POSTER AWARDS

Graduate Posters

First Place ($125):

Sahoko Yui, UC Davis

Oil palm expansion on deforested lands in the Amazon—too good to be true?: A case study in Para, Brazil

Second Place ($100):

Elizabeth Machado, CSU Stanislaus

Transnational activities and its impact on the Azorean cultural landscape in Southeastern Massachusetts

Third Place ($75):

Jessica Medina, CSU Stanislaus

Research and management of biodiversity hotspots: Madagascar and the Indian Ocean islands

Undergraduate Posters

First Place ($125):

Chris Westover, CSU Sonoma

Sonoma County oak hybridization

Second Place ($100):

Jennifer Campbell, CSU Sacramento

The city of Sacramento's resilience and recovery in the face of disaster from 1850–1880

Third Place ($75):

Alyssa Caldwell, CSU Chico

Geography of ownership and land fallowing decisions with rice farmers in Butte County, California (1984–2012)

PROFESSIONAL DIGITALLY DISPLAYED CARTOGRAPHIC AWARDS

First Place ($125):

Michael Shensky, CSU Fullerton

CSUF interactive campus web map

Second Place ($100):

Aldo Garcia, CSU Stanislaus

Recreational bicycling: An interactive online map of bicycle trails along the Stanislaus River, Ripton, California

Third Place ($75):

Miles Ross, CSU Humboldt

The geography of hate: Placing racist, sexist, homophobic sentiment in online social media

STUDENT TRAVEL AWARDS ($150)

Crystal English, SDSU/UCSB

Stephanie Redding, SDSU

Dylan Thomas, UC Berkeley