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A Note from the (past) Editor

The previous issue of *The Geographical Bulletin*, the special issue on Star Trek and geography, was my last as editor. I hope you enjoyed it – it was probably my favorite issue in my dozen years as editor. I had an opportunity to take on the editorship of the *Journal of Cultural Geography*, and it was an opportunity that was too good to pass up. I want to thank Gamma Theta Upsilon and all the various people who have served on the Executive Committee for placing their trust in me over the course of the past twelve years. A lot of things have changed at *The Geographical Bulletin* over that time. When I started in 2005, authors still had to submit all their articles in triplicate, on paper, by post! Now, the submission, editorial, and review process is entirely digital. The journal also only existed in paper form. Today, the entire 47-year archive of past issues is available online, and the journal now can be accessed through numerous online databases, including EBSCO and ProQuest – it has never been more accessible to a wide readership. But other things haven't changed. I felt when I started, and I still feel that *The Geographical Bulletin* has a vital role to play in geography. As the only journal with a strong focus on publishing student research, it gives students first-hand experience with the process of rigorous peer review in a supportive environment. There's not much in academia that compares to that first time seeing your article in print, and *The Geographical Bulletin* has given that opportunity to generations of researchers. Thank you all for reading and supporting the journal.

The Executive Committee of Gamma Theta Upsilon has named Casey Allen as the new editor, and he takes over starting with this issue. Casey has broad interests in geography, an enthusiasm for exploration and getting one's hands dirty in the field, and a passion for helping students learn to be geographers. I have no doubt that his will be a capable, enthusiastic, and creative hand on the tiller, and I look forward to seeing where he steers the journal as editor.

Steven Schnell
Past Editor
*The Geographical Bulletin*
A Note from the (new) Editor

I appreciate the opportunity to serve as Editor for *The Geographical Bulletin*. Gamma Theta Upsilon’s tradition of supporting students in geography remains rich, and being part of that legacy serves as a highlight of my career. Many thanks goes to our past Editor, Dr. Steven Schnell, who accomplished many great things for *The Bulletin*. But, on a more personal note, he has gone above and beyond in helping me come aboard this Editorship. Steve’s guidance, insight, and vast knowledge of all things *Bulletin* remains invaluable, and he always seems eager to help. I want to extend my sincere appreciation to him. He has done a highly admirable job steering *The Bulletin*.

As Editor, my efforts remain focused on four goals, three of which are logistic. First, I intend to further streamlining the submission and review processes started by Steve. Second, expanding solicitation outlets — raising the journal’s visibility beyond GTU and its constituents. Third, increasing the journal’s online availability, extending Steve’s (and the Executive Committee’s) archiving of back issues for general access. Finally, as those who submit articles to *The Geographical Bulletin* know, our peer review process remains a demanding and rigorous one, with reviewers treating each submission as they would a review for any other journal, even though *The Bulletin* is perhaps not as well-known, broadly speaking. This tradition upheld by Steve, I believe, helps account for *The Bulletin’s* high-quality articles over the past decade. I fully intend to continue this trend of exceptional peer review, ensuring the journal’s integrity. That said, my fourth goal centers on promoting *The Bulletin* as an outlet for undergraduate research, alongside its traditionally graduate study-based and faculty-led fare. Too many times outstanding senior theses or projects get overlooked, even when their results may be insightful and impactful. As Steve notes, *The Geographical Bulletin* provides many budding geographers and researchers with their first publication, and such an experience is not only transformative for a student, but a great learning experience. As an Educator, serving as a guide for such students – helping them navigate the peer-review process successfully – lies at my core. I am pleased that this issue — my inaugural as Editor — contains two student-driven articles (Fleming & Mitchell and Shanteau & Allen). I would like to see the trend continue. As you work with students on projects, I hope you think of *The Bulletin* first. Or, if you are a student conducting research you think is impactful, ask a faculty member if *The Bulletin* would be an appropriate outlet, and begin your journey into the intrepid waters of peer-reviewed research...

Casey D. Allen
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Effects of Giant Traveling Map Use on Student Spatial Thinking

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ABSTRACT

Geographic education is crucial for preparing students to navigate the places and spaces they inhabit, and National Geographic’s Giant Traveling Map program seeks to address this need by providing an immersive and kinesthetic learning experience with the use of a gym-sized floor map. In this study, a Giant Traveling Map was tested with sixth grade students to determine the effect of engaging with the map on improving spatial thinking skills. Questions were drawn from the Spatial Thinking Ability Test to assess students’ skills pre- and post-experience. Our results show minimal improvement for a few very specific spatial thinking skills and raise questions concerning the testing of spatial concepts and tying in assessment to map activities and geographic learning. We conclude that more study is needed to accurately evaluate the Giant Traveling Map Program for its educational impact.

Key Words: Giant Traveling Map, Spatial Thinking, Map Skills

INTRODUCTION

“National Geographic Giant Traveling Maps are enormously entertaining and educationally powerful tools for introducing geography and map reading skills to students, grades K-8. What better way to teach young people the power of maps and the limitless depth of geography than a half court-sized map of a continent on which they can explore, travel from country to country, hop around, compete, collaborate and have lots of fun?” (National Geographic 2016).

The National Geographic Society has had success introducing thousands of students to geography through its Giant Traveling Map (GTM) program. These large vinyl floor maps (the smallest are 16 by 20 feet) come with a trunk of activities and materials. Currently available maps include Africa, Asia,
Europe, North America, South America, Pacific Ocean, and the Solar System (Fig. 1). Beginning in 2016, two State Giant Traveling Maps were given to each state geographic alliance.

As noted in the quote opening this article, students find the maps to be fun and “enormously entertaining.” Teachers and parents alike share this sentiment (National Geographic 2016). The quote, however, goes a step further by arguing that the maps are “educationally powerful tools.” The maps are certainly powerful in creating awareness of geography, and the reaction by map users (how well did the learners like the learning process?) has been overwhelmingly positive. But what did they learn (e.g.: knowledge and skills), and what changes in performance resulted from the learning process?

This article highlights a project designed to assess GTM use and changes in student spatial thinking skill development. The use of interactive experiences in student education are an integral component of modern educational curricula, but in this case little data exists on student outcomes post map use. We begin with a literature discussion focused on spatial thinking and kinesthetic learning in geography. The project design follows and we conclude with analysis and recommendations for future work.

LITERATURE

Educators endeavor to find best-practice methods for teaching across all subject areas. This is true for geography education, and a number of efforts have been made to bring “fun” into the learning process. This includes using computer games for urban geography (Kim and Shin 2016), “capture the flag” GPS activities (Hupy 2011), and even treasure hunts (Gaillard and McSherry 2014). It is this quality – enjoyment – that the Giant Traveling Map program seeks to engage as a mechanism for enhancing student learning.

Learners at all levels require, and sometimes prefer, different types of engagement.
Fleming and Mills (1992) suggest that four modalities are used for learning information. These are described as VARK: Visual, Aural, Read/Write, and Kinesthetic. In geography education, there is a rich tradition in the Visual (maps), Aural (lectures, group discussion), and Read/Write (texts). Kinesthetic refers to experience and practice, usually in the form of demonstrations or simulations. Here we view the GTMs as embodying the Visual and the Kinesthetic by representing spatial information visually (on a giant map) while learning takes place through students movement and physical activity on the map. Consider the difference, for example, of a student listening to a description of mountains versus simulating one by laying down on a floor map. Compared to their typical desk work many students find this engagement to be fun, but does this translate into better content and skills development than traditional instruction?

Geography content includes facts (spatial information) about places, their inter-relationships, the processes (both physical and human) that create them, as well as models to explain patterns and change. Also important is “how the human brain learns, stores, processes, and retrieves [this] spatial information” (Gersmehl 2014, 148). There is evidence that age (developmental level) demands different curricular recommendations.

For example, in their review of over 80 works on spatial thinking, Mohan and Mohan (2013, 4) note that “children in early elementary [ages 3 to 6] learn through sensory experiences and do best with tactile, hands-on mapping activities...[and that]... maps should also be big in size to allow children to explore them with their whole bodies.” This would seem to be an opening for a GTM, however children at this age typically do not understand a birds-eye view of the world. As students progressively get older and obtain more real-world experience, spatial concepts such as location, distance, and direction take on more meaning, as does an understanding of symbols and landmarks. The GTM program takes on a unique space both cognitively and physically. It is larger than a traditional map and smaller than the real world, yet the features remain abstract much like a smaller paper or digital map. As such there is a tension at play – does this novel and alternate form of spatial expression lend itself to affecting spatial thinking in a non-traditional way for learners in a formative stage of conceptual development?

**METHOD**

This project was funded by a Magellan grant under the Office of Undergraduate Research at the University of South Carolina. Two factors constrain the method: the rental period of the GTM and the rental cost. In this case the map was shared in partnership with schools in North Carolina over a two-month period. South Carolina was allocated two weeks and paid a pro-rated share of the map cost from the grant. This study attempted to make use of that short instructional period. At this writing a two-week rental costs $610 and is the shortest rental period available. With additional monetary resources, a GTM can be requested for longer periods of time and, as we show here, should be considered to maximize student map exposure to further this type of investigation. Unfortunately, a number of external factors during the rental period required substantive alterations to the original research design; these are described below.

**Study Location**

Historic, 1000-year flooding in October 2015 closed the two public schools originally slated to participate in the study during the two week map rental period. With the map already in our possession, the tight map rental window (the map would soon be shipped to another state) necessitated quickly finding a school capable and willing to host the map and have their students take part in the study. Within two days we were able to identify a private school located near Summerville, South Carolina that was willing to participate. While we report here
on the experiences of fifty sixth grade social studies students, other students from foreign language classes also were able to use the map during the week.

**Participants**

The need to quickly find a participating school necessitated a convenience sample. Fifty-two students participated in the map activities. Two were removed from these results as one was in a different grade (eighth) and the second did not complete the post-test. Of the fifty remaining sixth grade students, 24 were male and 26 were female. No other demographic or distinguishing characteristics were collected (race, age, level of ability, etc.) nor was a control group established. The map activities were led by the students’ regular teacher who has an extensive background in geography (he has been an active member of his state geographic alliance for twenty years).

**Map Activities**

The specific map used was the Europe GTM. Three class sections, each containing close to 20 students, participated in the map activities. The students each received one forty minute session on the GTM. This map exposure was far less than originally planned and, though not ideal, was necessary given the sudden location change. School officials and teachers were very generous in allowing this one class period intervention to take place during an already well-planned and paced curriculum.

While on the map, students began by simply walking around and exploring the GTM on their own. The first structured activity involved “TALDOGS”. TALDOGS is an acronym for the map features of Title, Author, Legend, Date, Orientation, Grid, and Scale. Students were asked to identify these features and they also spent some time looking for European capital cities for an upcoming map quiz.

The students also discussed latitude and longitude, used the plastic chain that came in the map kit for measuring distance and relating cardinal directions, and learned examples of absolute versus relative location. The activities primarily focused on human geography as opposed to any specific treatment of landforms. In the weeks leading up to the GTM activities, the students had learned the Five Themes of Geography, identified continents and major countries on desk-size maps, learned about TALDOGS, and had, in the teacher’s words, a “limited discussion about scale.”

**Spatial Thinking Tool**

The assessment tool chosen for this project was the Spatial Thinking Ability Test (STAT) developed by Lee and Bednarz (2012). Although originally constructed through testing with university-level students, the STAT has been successfully used in other work that has continued to include undergraduate students and also middle school grades (Verma 2015; Collins 2014). While the National Geographic Society also is interested in knowing more about the educational benefits of the GTM program, a separate geospatial reasoning instrument under their construction was not yet complete when this project began (Chung, Cannady, and Kremer 2015). The STAT, then, was chosen. Knowing that the map experience also would focus on coordinate systems, we added one latitude/longitude question from the Geospatial Thinking Scale (Huynh and Sharpe 2013).

The pre-test and post-test both consist of the same nine questions culled from the original two tests. The questions were arranged in a different order from the pre-test to the post-test. These nine questions were chosen as the ones that would most closely match the types of activities performed on the GTM, save for one on 2D/3D visualization. For example, one question has the students identify the latitude and longitude of a city while another has the student navigate a city block using cardinal directions. Some of these skills also match previous classroom instruction from earlier in the school year as
noted. The expectation was that an engagement with those topics on the GTM would lead to improvement on those areas from the pre-test to the post-test. The students were given the pre-test at the beginning of the week with GTM activities occurring mid-week as the three different class schedules would allow. The post-test was given early in the following week (approximately one week after the pre-test).

RESULTS

Overall Test Results

Fifty students took both the pre- and post-tests. Both instruments were approved for use by our university’s Institutional Review Board.

The lowest and highest scores on the pre-test were 0/9 and 8/9; the results for the post-test were 1/9 and 8/9. The average number of questions correct on the pre-test was 4.10; the average on the post-test was 4.36. A t-test confirms that there are no significant differences between the mean test scores before or after the GTM lesson intervention for the group as a whole. Score declines were seen by 17 students (1.71 fewer questions correct), no change by 6 students, and improvement by 27 (1.56 more questions correct). While male students slightly outperformed females students from the pre-test to the post-test (.38 mean score change improvement to .15 mean score change improvement), a t-test confirms that the observed difference between the sample means do not differ significantly.

Individual Question Test Results

The results were likewise mixed for individual questions (Table 1). The table shows the number and percent of students correctly answering the question Pre- and Post, as well as the overall change.

Table 1. Pre- and Post-test Results

<table>
<thead>
<tr>
<th>Question</th>
<th>Question Type</th>
<th># Correct Pre</th>
<th>% Correct Pre</th>
<th># Correct Post</th>
<th>% Correct Post</th>
<th>Change % Correct Pre to Post</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Comprehending Orientation and Direction</td>
<td>25</td>
<td>50</td>
<td>32</td>
<td>64</td>
<td>+14</td>
</tr>
<tr>
<td>2</td>
<td>Comprehending Orientation and Direction</td>
<td>27</td>
<td>54</td>
<td>24</td>
<td>48</td>
<td>-6</td>
</tr>
<tr>
<td>3</td>
<td>Discerning Spatial Patterns/Graphing a Spatial Transition</td>
<td>35</td>
<td>70</td>
<td>36</td>
<td>72</td>
<td>+2</td>
</tr>
<tr>
<td>4</td>
<td>Mentally visualize 3D image based on 2D information</td>
<td>11</td>
<td>22</td>
<td>16</td>
<td>32</td>
<td>+10</td>
</tr>
<tr>
<td>5</td>
<td>Comprehending Spatial Shapes and Patterns</td>
<td>20</td>
<td>40</td>
<td>25</td>
<td>50</td>
<td>+10</td>
</tr>
<tr>
<td>6</td>
<td>Comprehending Spatial Shapes and Patterns</td>
<td>21</td>
<td>42</td>
<td>21</td>
<td>42</td>
<td>0</td>
</tr>
<tr>
<td>7</td>
<td>Comprehending Spatial Shapes and Patterns</td>
<td>26</td>
<td>52</td>
<td>35</td>
<td>70</td>
<td>+18</td>
</tr>
<tr>
<td>8</td>
<td>Comprehending Spatial Shapes and Patterns</td>
<td>22</td>
<td>44</td>
<td>11</td>
<td>22</td>
<td>-22</td>
</tr>
<tr>
<td>9</td>
<td>Coordinates, Latitude, Longitude</td>
<td>18</td>
<td>36</td>
<td>18</td>
<td>36</td>
<td>0</td>
</tr>
</tbody>
</table>
Questions 1 and 2

These students had classroom instruction on cardinal directions prior to GTM use, and also worked out direction problems while using the GTM. These two STAT questions utilize a generic city-grid to examine navigation using cardinal directions and would seem to be directly aligned to the treatment (Fig. 2). Overall Question 1 yielded a +7 correct answer improvement from pre- to post-test, while a very similar Question 2 yielded a –3 correct answer decline. We hypothesize that students performed more poorly on the second question because, although it used the same map, students had to make four direction turns as opposed to only three in the previous question. This extra step may have been confusing. Two points of interest matter here: 1) was there sufficient time spent on the GTM activity to really make a difference, and 2) does a direction activity on a GTM (moving about space on a comparatively small scale map) translate to a direction activity on a hand-held, large scale paper map?

Questions 3 and 4

Question 3 involved relating a graph to a map depicting a rainfall gradient (Fig. 3) and resulted in an overall +1 correct answer improvement. This question had the highest initial success (70% answering correctly the first time). This accords well with the university students in the original STAT study (Lee and Bednarz 2012, 22) where “students could identify patterns on a map and choose a correct graphical display of a spatial pattern.” Our students even outperformed the
DIRECTIONS: Place yourself in the map where the arrow is pointing.

4. If you look at the area above in the direction of the arrow, which terrain view (A-E) most closely represents what you would see?

(A)  
(B)  
(C)  
(D)  
(E)

junior high students in the STAT study (70% to 46%).

Question 4 required the student to look at a shaded relief map from above and then identify a view that most likely represented what terrain you would see at ground level (Fig. 4). This resulted in a +5 correct answer improvement. This question had the lowest initial success (only 22% correct), a similarly poor outcome as in the Lee and Bednarz (2012) study. Those authors believe that this question may represent more than one – or rather a suite of – spatial thinking skills. It may not be possible to devise any one activity that would improve this ability on a GTM.

It is important to note that there were no activities performed by the students that related to these two particular questions. We added these questions hypothesizing that there might be some “geographic osmosis” by simply “doing geography” on the GTM – a type of gateway effect. Potentially hindering success as well: the majority of non-map literacy activities (i.e.: TALDÔGS) focused on human geography while these two questions involve physical geography. The lack of a focused treatment and this topic change may be adding to these inconclusive results.

Questions 5, 6, 7, and 8

Real-world objects are often represented on maps with points, lines, and polygons. Questions 5–8 asked students to identify these features (Fig. 5). Save for Question 8, there was no to only modest improvement on this group of questions despite GTM activities to find point features (cities), line features (rivers), and polygons (countries).

Two questions in this set allow an opportunity to discuss an important issue – question presentation. For example, Question 7 asked students about a shuttle bus route. An obvious spatial feature is a line (the route), but this was not a stand-alone answer. A shuttle bus route has two spatial features (stops = points; route = line), thus the correct answer was (B) Points and Lines. We surmise that had the answer bank included a Lines only answer, students would have missed this question and the finer point about the two spatial features.

Question 8 was especially problematic as it had the largest decline from the pre- to post-test. We also attribute this largely to confusion with the question wording. “Places that can be reached by Franklin County fire engines in 5 minutes or less…” refers to an area, however “places” might have been considered as points by the students. This is a matter of scale. On a GTM, a place such as a city covers more territory and may be considered an area, while on a large scale map it is thought of as a point. This potential language confusion deserves inspection and redress.
Select the coordinate pair that best locates the ‘City’ in Figure 11 below.

a) 51° 50' E, 36° 10' N  
b) 36° 10' N, 51° 50' E  
c) 35° 0' N, 50° 0' E  
d) 51° 50' W, 36° 10' S  
e) 36° 10' S, 51° 50' W

Question 9

The final question (#9) asked the student to select a latitude/longitude coordinate pair that most closely match a point on a map (Fig. 6); this was the question added from the Geospatial Thinking Scale (Huynh and Sharpe 2013). The result was a 0 correct answer increase. While the students did receive latitude and longitude instruction on the GTM, the very short instructional period (already divided among several other topics) likely did not lead to any enduring understanding of the topic. Further, a single item may not have been sufficient to assess this often confusing concept.

DISCUSSION AND CONCLUSION

The testing results indicated no significant change overall after the GTM activities, and rather modest improvements, if any, for individual spatial thinking questions. We do not interpret these results to mean that GTM use cannot have an effect on spatial thinking skill improvement. Rather, we believe that this presents an opportunity to rethink issues related to how we assess and ultimately seek to develop spatial thinking.

First among these issues is the testing instrument. The Geospatial Thinking Scale (Huynh and Sharpe 2013) was tested primarily on high school, undergraduate, and graduate students. Although the STAT did include some junior high (middle level) students, “…the field tests in several different environments showed STAT was useful for testing both university and high school students” (Lee and Bednarz 2012). A claim for its usefulness for younger students, like the sixth grade students in this study, is not made. The new instrument under NGS development (Chung, Cannady, and Kremer 2015) may show more promise as they have modified their test items with middle school student input, although they do include STAT test items that may still prove difficult. Of interest here is whether the questions are 1) written in a non-confusing manner; 2) developmentally appropriate for the tested audience; and 3) truly measuring a particular spatial skill. This is an area ripe for continued investigation. Furthermore, the STAT assesses spatial thinking, and though there are parallels, spatial thinking is not the same as geographical thinking. Geographical thinking involves a particular advantage, as Hanson (2004) suggests, toward approaching an issue. These include recognizing the relationships between people and the environment, the importance of spatial variability, understanding scale, and integrating spatial and temporal analysis. We have concerns that macro-scale map use (GTM) and the intervention activities that include geographical thinking are not fully captured by the STAT. For example, does using cardinal directions on the GTM to locate capital cities translate to better route-finding on a street grid (STAT question)? Clearly better alignment between treatment and instrument is necessary for future work.

A second issue relates to study design. This project was significantly impacted by factors that shortened the study period and removed the opportunity for a student control group. Two questions we raise here include what length of instructional time both before and during GTM use is appropriate for an enduring understanding of geography topics as taught on a GTM, and what should be the time period between pre- and post-testing to assess permanency and retention? Future work should likely encompass longer GTM exposure and narrow the spatial focus (e.g., only working on distance and direction as a start). We further believe that more time must be spent investigating the activities that come with the GTM kit to make sure that they are designed to specifically have an impact on certain spatial thinking skills. It is not unreasonable to expect that learning geography can occur while “doing geography”, but this shotgun approach is unlikely to result in measurable improvement in any one area.

In this work we have not shown that GTM use is superior or inferior to traditional geography instruction for developing spatial
thinking skills, but rather identify issues that can make a determination on that point much clearer. Other efforts, such as a similar project currently underway with the Colorado, Maine, and New Hampshire geographic alliances (NCGRE 2016), along with continuing research by National Geographic, should continue to inform our understanding of how Giant Traveling Maps can not only improve classroom engagement, but also improve spatial thinking development.

NOTES

1. Each map has a notebook containing a variety of activities specific to its map. The Europe map, for example, has a 34-page activity guide. Teachers may review these activities online prior to map arrival.

ACKNOWLEDGEMENTS

The authors thank Chuck Stjern and his students for participating in this project. We also thank the Office of Undergraduate Research at the University of South Carolina for funding support, as well as the journal editor and the three anonymous reviewers whose comments improved this paper.

REFERENCES


Rhizoplaca chrysoleuca as an Alternative Lichenometric Species: a Preliminary Investigation at the Lawn Lake Alluvial Fan, Rocky Mountain National Park, CO USA

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NOTE: This article was peer-reviewed and accepted for publication during the previous Editor's tenure (Dr. Steven Schnell, Kutztown University). It is included in this issue, 58(2), because the prior issue, 58(1), was a special issue on Star Trek Geographies.

ABSTRACT

Lichenometry can be a useful tool to date past events when surface ages are unknown. As a method, lichenometry needs to overcome uncertainties in the understanding of lichen biology. Being fairly ubiquitous, Rhizocarpon geographicum is generally used for dating purposes. Other lichens can and have been used for studies, but are often used in conjunction with R. geographicum. This case study suggests that for areas lacking R. geographicum, Rhizoplaca chrysoleuca may be used as an alternate species if the substrate in question does not have substantial R. geographicum growth. While R. geographicum is well-studied, R. chrysoleuca is not, and growth curves have not been established to any extent close to those for R. geographicum. This study uses an alluvial fan in Rocky Mountain National Park created by a dam breach in 1982 as a preliminary baseline to establish a basic R. chrysoleuca growth curve. Age of the substrate is known and was previously unexposed inside a glacial moraine. Assuming lichen growth began soon after the exposure, and as R. chrysoleuca represents the majority species at the site, a basic growth curve can be established, at least in alpine environments. This initial assessment can potentially aid researchers using lichenometry in alpine environments and, more specifically, where sufficient R. geographicum is not present.

Keywords: lichenometry, alpine environments, fieldwork, Rocky Mountain National Park, Rhizoplaca chrysoleuca

INTRODUCTION

Lichens can be useful in environmental monitoring as they reflect changes in the environment (Seaward 2008), especially when that change is due to anthropogenic factors. Loss of specific species sensitive to particular environmental changes can help
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While not all researchers agree on lichenometry as a valid dating tool (see Osborn et al. 2015 for a full review), it has been used to measure climate change via lichen responses. Lichenometric dating has shown that during periods of warming, glaciers recede rapidly, exposing new surfaces that are subsequently colonized by lichens, aiding in a better understanding climatic responses of surrounding biota. For example, Armstrong (2004) discusses lichenometry as a method for studying glacial fluctuations caused by rapid warming periods, and Trenbirth and Mathews (2010) speculated that lichen growth or survival was influenced by unspecified climatic changes during the Little Ice Age after monitoring a site for 25 years. Lichens are also useful for climate change studies in colder climates with harsh environmental conditions. As the first colonizers after glacial retreat (Sancho, Green and Pintado 2007), lichens tend to be the most abundant plant life in these areas, with their growth rates correlating favorably to environmental factors, including temperature and moisture. The studies Armstrong (2004) discusses (cf., McCarroll 1993, Harrison and Winchester 2000, Oerlemans 1994) contribute valuable data to further validate climate change impacts on glacial retreats over the last century by comparing growth rates of lichens with increasing temperatures associated with global climate change (see also Sancho et al. 2007).

Under-studied areas of lichen biology (Büdel and Scheidegger, 2008) hinder accurate growth curve production for lichen species (Armstrong 2011). Reproduction, transportation of propagules, morphogenesis, lag time of establishment on a substrate, and even understanding of lichen taxonomy are all areas that need further study. These uncertainties should not invalidate lichenometry, since some assumptions can be made using current knowledge to make a case for legitimacy. Lichenometry as a dating technique may not yet be an exact science, but the field is continuing to grow. With more research in these areas, the use of lichens can become a legitimate dating tool, useful in situations where other dating techniques will not yield results.

Lichen growth rates applied to surface dating characterizes the basis for lichenometry and typically uses crustose lichens (Palmqvist et al. 2008), although foliose lichens have also been used (Noller and Locke 2000). Other dating techniques, such as radiocarbon or other elemental dating techniques, are less accurate at dating recent (<500 years) events (Armstrong 2004), and even less useful when rocks are the medium. While Palmqvist et al. (2008) suggest that lichens can grow on surfaces for up to 1000 years, this claim may be undermined by Osborn et al. (2015) who estimated annual lichen mortality rates at 0.38 to 5.09% based on a sample of 2774 marked R. geographicum thalli that were tracked over 19 yrs, concluding that R. geographicum seldom live for more than 160 years. Still, calibration with known dated surfaces remains key to growth curve formation, even if the odds of a lichen thallus living for 1000 years means a 2-3% die-off in all thallus size classes, as noted by Loso & Doak (2006). Since lichens usually grow in a circular formation, the diameter of the lichen can be used to determine the growth rate when the age of the substrate is known (Noller and Locke 2000), though there are

Many aspects of lichen biology remain poorly understood, and when it comes to using lichens as a dating mechanism, controversies are not rare (Osborn et al. 2015 give the most comprehensive account of this ongoing debate). In many instances, however, such as dating late-Holocene glacier fluctuations (Loso and Doak 2006), lichenometry represents the only appropriate method, and this case study, fledgling as it is, speculates that, given new species to work with, perhaps lichenometry as a dating technique still has some merit. Another related issue revolves around the accuracy of statistical analyses concerning lichen size and their growth rate determinations. However, if exact debris deposition times were known, establishing growth rates could be more feasible and reliable. Such an event occurred in Rocky Mountain National Park (RMNP) with the Lawn Lake flood in 1982. This flood washed-out a glacial moraine and deposited previously unexposed debris as a small alluvial fan. Because the exact date and time this flood occurred in RMNP was recorded, a number of previously unstudied factors about lichen growth and distribution, lichenometry dating, and climate change might be determined. Further, using such a young site with a precise time of exposure can give helpful insight into current lichenometry dating controversies. Even if calibrations could be created for a mere 30-year time interval, it could help developers and site managers in instances when environmental and landscape change events (e.g., mass wasting events such as landslides, avalanches, etc.) occur in previously-unstudied locales such as new housing subdivisions or highly touristed areas.

Taking advantage of the 1982 Lawn Lake Flood disaster in RMNP, and gathering data from the site in August 2010, this paper seeks to establish a baseline for using *Rhizoplaca chrysoleuca* as a lichenometric dating technique. First, a comparison of *Rhizocarpon geographicum* and *R. chrysoleuca* is offered before outlining the methods used in this study, including site selection, sampling methods, and study assumptions. Then, findings are discussed, noting such characteristics as general thallus size, thallus size versus boulder size, and lichen relationship to rock face aspect. With repeated measurements, these findings could be used to establish a preliminary growth curve for *R. chrysoleuca* based on a precisely-known substrate exposure date. Finally, after discussing the findings’ implications, succinct concluding remarks are offered.

**COMPARISON OF TWO LICHEN SPECIES**

*Rhizocarpon geographicum*

Also known as yellow map lichen, *R. geographicum* is a crustose lichen classified as a cosmopolitan taxa (Galloway 2008) and found on all continents and most islands, but is not ubiquitous. Completely attaching itself to the substrate, *R. geographicum* is easily distinguishable with a patterned, map-like yellow and black thallus typically found growing on siliceous rocks, and favoring alpine and arctic habitats (Brodo, Sharnoff and Sharnoff 2001). Owing to these characteristics, *R. geographicum* is currently the lichen of choice when performing lichenometric studies. Bradwell & Armstrong (2007) reviewed multiple studies, giving *R. geographicum* growth rates of 0.1 mm yr\(^{-1}\) to 0.5 mm yr\(^{-1}\) depending upon the habitat the lichens were found, with their own study revealing a higher average growth rate (0.65 mm yr\(^{-1}\)). Their study also included differences between thallus size and growth rate, resulting in a parabolic growth rate as opposed to a linear growth rate assumed in many studies. Owing to this discrepancy, more studies into the relationship between thallus size and yearly growth are needed for *R. geographicum* (Fig. 1). Additionally, taxonomic complexities
within this group can add to the problems of using this species and supports the use of alternatives (cf., Armstrong 2011, Bradwell and Armstrong 2007, Benedict 2009, Dabski 2007, Refsnider 2003)

Rhizoplaca chrysoleuca

Commonly called orange rock-posy, *Rhizoplaca chrysoleuca* is typically found on granitic rock and fairly ubiquitous across western North America (Brodo et al. 2001). A foliose lichen, the thallus can be pale yellow-green to yellow-grey in color, with apothecia disks of pale to dark orange. *R. chrysoleuca* attaches to the substrate by a central holdfast rather than completely attaching itself like *R. geographicum*, but can sometimes appear similar to a crustose lichen (Armstrong 2011, Weber 1962). Very few studies have been conducted with *R. chrysoleuca*, as it is not as cosmopolitan as *R. geographicum*. Timoney and Marsh (2004), however, use multiple species to establish growth curves to determine water level changes, and report growth rates for *R. chrysoleuca* between 0.32 – 0.89 mm yr\(^{-1}\) when a lag time of 5.9 years is used. Their study also references three unpublished studies for these growth rates. Given this lack of data regarding the use of *R. chrysoleuca*, especially where *R. geographicum* is not found, it becomes apparent that more study is needed for *R. chrysoleuca*, and can be useful in lichenometric studies if other lichens are not present in abundance (Fig. 2).

**METHODS**

**Study Site Location and Justification**

On 15 July 1982 after years of disrepair, the Lawn Lake Dam in RMNP, an earthen dam constructed in 1903, failed. The resultant breach sent 219 million gallons of water into the Roaring River (Estes 2010). This torrent of water broke through a glacial moraine, intact from the last ice age, sending tons of debris – including large granite boulders from the glacial till – down to what is now called Horseshoe Park (elevation ~2600 m, Fig. 3). Though water continued to wash down through the Cascade Lake Dam, flooding the town of Estes Park and finally stopping in Estes Lake, most debris was deposited at Horseshoe Park (Estes 2010). Many washed-down boulders were part of a glacial moraine that the flood destroyed and, as such, were previously unexposed to lichens,

Figure 1. *Rhizocarpon geographicum* found at site. Note the patchy, map-like appearance in the circled areas that gives this species its name. Usually a greenish-yellow color, it can vary from vibrant yellow to bright or dull green. Photo by J. Shanteau.

Figure 2. *Rhizoplaca chrysoleuca* found at site and used for this study in the circles. Though sometimes a dusty green in color, *R. chrysoleuca* can also be a soft yellow to vibrant orange, and even a yellowish orange, but most often denoted by its defined and raised ledges, typical of a foliose lichen. Photo by J. Shanteau.
Rhizoplaca chrysoleuca as an Alternative Lichenometric Species

Figure 3. Approximate site location (shaded) in Rocky Mountain National Park, Colorado USA. Map by Kaelin M. Groom.

allowing for a well-defined, time-established study of lichen colonization (Fig. 4).

Although *R. geographicum* is the better-established species for conducting lichenometric studies, almost none were found within the study’s boundaries. While Timoney & Marsh’s (2004) multiple species technique was considered because of *Xanthoparmelia* and *Umbilicaria* (as well as unidentified brown, grey/black, and orange crustose lichens) being present at the study site (Fig. 5), the most abundant lichen that could be identified definitively to the species level was *Rhizoplaca chrysoleuca*. Because *R. chrysoleuca*
is easily identified and was found in all areas sampled, the decision was made to lay the groundwork for establishing its growth curve as an alternative to *R. geographicum*, especially for sites lacking *R. geographicum*.

**Sampling**

Given that all the granitic boulders in Horseshoe Park came from inside a glacial moraine, it is safe to say that the substrate had not been colonized by lichens before final deposition on the alluvial fan. Further, since no major floods have been recorded in Horseshoe Park since, it also stands to reason that the boulders on which the lichens are located have not been significantly moved. With those assumptions in mind, thirteen 8m x 8m plots were randomly selected within the boundaries of the alluvial fan at Horseshoe Park, based on boulder cover. The entire site was segmented into four main quadrants (i.e., northeast, southeast, northwest, southwest) using the mainly north-to-south flowing Roaring River and the generally east-and-west Old Fall River Road as the vertical and horizontal Cartesian axes, respectively (Fig. 3). A 4 m buffer between the sampling sites and any hiking paths or roads was used to minimize potential anthropogenic influence on lichen growth, since this site is a popular hiking area and easily accessible for all levels of hikers, lichen colonization would likely be inhibited or influenced by people climbing on boulders – unlike *R. geographicum*, *R. chrysoleuca* is only held by a central holdfast, and even minor disturbances could presumably compromise its long-term survival on a rock surface. Boulder sizes less than 30 cm were not sampled, as they appeared to have little or no *R. chrysoleuca* present. Close to the Roaring River, no lichens were found, and it is suspected that this is either due to seasonal flooding and/or the small debris size. Any *R. chrysoleuca* that was growing closely with another *R. chrysoleuca* was not measured unless there was a clear delineation between
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Since *R. chrysoleuca* does not completely attach to the substrate, it was usually possible to distinguish a separation between two lichens. In the cases where it seemed they were growing together, they were excluded from sampling, as per previous studies (cf., Refsnider and Brugger 2007).

For each sampling site, GPS coordinates were taken at the four corners of the plot, the thallus measured from end-to-end along the longest axis using digital calipers, the approximate size of each boulder’s “face” diameter along the longest axis (e.g., north-facing, south-facing, west-facing, etc.) was recorded, as well as the lichen’s aspect (north, south, east, west, top of boulder). Further, the location of each boulder, and each thallus measured on each boulder, were recorded using a Trimble Juno GPS unit, as well as a corresponding photograph of each thallus. (Note: these data are contained in a large Excel spreadsheet and a large file folder – for each image – and will be made freely available to any researcher who requests it). Although there is no acceptable strategy to measure lichen, this study followed Refsnider and Brugger (2007) – who followed Innes’ (1984) model – where the largest lichens were measured within each plot, rather than utilizing the repeated weighing method outlined by Gauslaa et al. (2009), as the authors were not allowed to gather samples from RMNP. The majority of sampling sites had numerous lichens, and up to 14 thalli in each sampling site were recorded. In some sampling sites, few lichens were encountered, and in these cases, only the largest five were recorded and subsequently averaged.

**FINDINGS**

**Lichen Size**

The average size of *R. chrysoleuca* from all 13 sites, with 65 total lichens measured, is 32.35 mm ± 3.22 mm (Fig. 6, last point). The averages of lichen diameter per site have a median of 31.92 ± 3.22 mm (Fig. 6, second to last point). Thus, using the averages of all samples is not significantly different than using the average of the means of each site, and following the recommendation of Innes.

Figure 6. Thallus sizes of all *R. chrysoleuca* samples taken. A total of 65 samples were taken, though this image shows 67. The final two measurements (numbers 66 and 67) represent thallus median and mean across all samples, respectively. Connecting line does *not* represent continuous data, but is used instead for ease of reference between individual thalli measurements.
(1984), the mean of the five largest thalli of each sample site was used for final analyses (Fig. 7). Across quadrants, thalli sizes varied only a few mm: 30.12 mm for the northeast, 33.35 for the southeast, 34.69 for the northwest, and 30.45 for the southwest.

Thallus Diameter and Boulder Size

There was a varying degree of boulder size among the sampling sites, and all thallus measurements were compared against the size of boulder on which it was found. While McCarroll (1994) did find a slight correlation between thallus size and boulder size (using _R. geographicum_) he also notes that sampling a variety of boulder sizes has no significant effect on mean thallus size. Though admittedly the Horseshoe Canyon site has different lithologies (chiefly granitic in RMNP) than McCarroll’s study, comparison of thallus size to boulder size revealed similar findings, as no significant correlation was found between thallus diameter and boulder size in this case study (Fig. 8).

Boulder Aspect

Rock facet aspect is known to affect lichen growth (Hall et al. 2005, Dabski 2007, Bailey 1976, Gellally 1982, McCarroll 1993, McCarthy 1997), and reviewing _R. chrysobleuca_ growth at the Horseshoe Canyon site, this fact remains true. For the Horseshoe Canyon site, thallus size was correlated with the eight cardinal directions, as well as a “top” aspect for those boulders with flat tops and thus no direct aspect or orientation, since lichens may colonize a surface at the top, perhaps by propagules carried by birds, and then spreads down the face over time (Armstrong 1978). Results show that thalli located on the north, east, south, northeast, or top of the boulder, were substantially larger than those located on the southwest, southeast, northwest, or west facing lichen (Fig. 9). This is similar to Armstrong’s (2005) findings in the Cascades (Washington state, USA), where the smallest growth was found on north-northwest aspects. At the Horseshoe Canyon site, the most abundant growth is found with lichens growing on the top of the boulders with an average growth of 33.41 mm, and the southwest aspect had the least growth with an average of 30.11 mm.

Quadrants

Though many lichenometric studies state that the largest lichens represent the idealized specimens for a particular habitat because they demonstrate fast growth rates and are the therefore the quickest to establish themselves on the substrate (cf., Noller and Locke 2000, Innes 1984, McCarroll 1994, Dabski 2007), Osborn et al.’s (2015: 4) review counter these studies’ findings, noting specifically that, “These observations do not well support three of the most important lichenometric assumptions: i) the largest thalli began growth soon after the surface became stable and exposed, ii) the original colonists are long lived, and iii) the original colonists are the largest in the population.” Still, for those who desire to continue and strive for including lichenometric techniques in their dating applications, fast growth rates and quick establishment times would tend to give the best possible growth curve to estimate substrate age, as previous researchers have noted (cf., Noller and Locke 2000, Innes 1984, McCarroll 1994, Dabski 2007). Differences seen in the growth of different quadrants at the Horseshoe Canyon site may be an indication of earlier colonization, but for purposes of growth curve construction, it is assumed that colonization takes place shortly after the substrates initial exposure. This is not necessarily what happens, as Timoney and Marsh (2004) note, but even their review of other studies show that lag time is inconsistent.

Another possible reason for dichotomy between sites may be that climactic conditions in those areas differ enough to affect growth. At Horseshoe Canyon, vegetation was similar across the site; it is suspected that this was not a factor affecting the lichen growth-aspect
Figure 7. Averages of *Rhizoplaca chrysoleuca* thallus diameter by site (5 samples per site, after Innes 1984). Connecting line does *not* represent continuous data, but is used instead for each of reference between thalli averages and site numbers.

Figure 8. Spatial relationship between lichen thallus diameter and size of each boulder sampled. Boulder size in this instance is the length of its long axis.
Figure 9. A comparison of sample aspect (as exposed on host-rock facies – directionally, as north, south, southwest, etc., as well as the “top”-facing side of the bulder) to sample size. Numbers above bars represent the number of samples measured and used for calculating average thallus size.

Figure 10. Thallus diameter by quadrant sampled.
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connection. However, the two quadrants with lower growth may not receive the same amount of sunlight, precipitation, or the substrate may have different composition than the two quadrants with higher growth. The fact that neither the lower or higher growth quadrants are adjacent to each other makes it difficult to infer the cause for the significant difference seen in growth, unless microclimatic factors are vastly different in each area. Yet at the Horseshoe Canyon site, the largest growth quadrant (northwest) has an average of 34.69 mm, while the smallest growth quadrant (northeast) has an average of 30.12 mm (Fig. 10).

Discussion and Conclusion

In order to understand lichenometry better and validate its usefulness as a dating method when other methods cannot be used, generating lichen growth data beginning with a known substrate exposure date seems like a reasonable method. While this study is by no means complete, it represents a starting place to finding alternative lichens for sites that do not have established Rhizocarpon geographicum. There is no documentation of the growth limit or average lifespan for R. chrysoleuca, and only one reference to annual growth is mentioned by Timoney and Marsh (2004). The ability to use multiple species for a location would aid in establishing a more concrete time of exposure for deposition or substrate.

Since both aspect and quadrant can be ruled out as having an effect on the growth of R. chrysoleuca at the Horseshoe Canyon site, other locations with similar habitat and climate should be able to use this preliminary data to help construct a more robust growth curve for R. chrysoleuca. Since less is known of R. chrysoleuca’s growth rate than R. geographicum, it is difficult to draw precise conclusions. Still, based on this preliminary study, using R. chrysoleuca may be a good alternative where R. geographicum is not found.

Since this study only has data from one point in time, it is not reasonable to expect construction of an overly-reliable growth curve. Still, many questions can be answered about R. chrysoleuca’s growth by re-visiting the site and repeating measurements in the same areas. With repeated sampling, a more accurate and reliable growth curve could be constructed, allowing accurate dating to take place at other alpine sites with unknown ages where R. geographicum is not present. Further studies may also help answer the question of whether R. chrysoleuca experiences linear or parabolic growth. Continued monitoring may also produce more observations of other species, resulting in better understanding of lag times (if any exist for R. chrysoleuca) and also addressing questions about climate change impacts on both lichen growth and the surrounding environment. With ongoing studies of lichen biology, such as morphogenesis, reproduction, and taxonomy, growth studies such as this case study serve to enhance the potential applicability of lichenometry. Establishing more consistent methodologies of research for those that conduct these studies will invariably bring more validity to the field and streamline the process of gathering data so future lichenometric studies are more widely accepted as a useful and accurate dating technique.

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Environmental Impact of Power Five Conference Realignment

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ABSTRACT

NCAA Division I athletic conferences have recently undergone conference realignments. The expanding geographic footprint of these conferences has led to teams having an increased travel distances for all sports. This research investigates the environmental impact that conference realignment has had in the “Power 5” conferences in NCAA Division I football. Based on travel distances, has the carbon footprint of the conferences changed dramatically from pre-realignment to post-realignment? In order to answer this question, we examined the changes in average travel distances for each conference pre- and post-alignment. We then calculated the carbon footprints resulting from travel for 2010 and 2014, as well as the total emission and average emission changes for each team and conference. We found that while there were changes in emissions after conference realignment, these changes were not significant.

Key Words: carbon emissions, conference realignment, college football, sports

INTRODUCTION

Sports can have large environmental impacts on surrounding areas. Events at these venues generate large amounts of waste products, which end up in landfills, incinerators, or sewage plants (DeChano and Hruska, 2006). Wetland and riverine ecosystems, as well as other flora and fauna, can be highly altered with the creation of a new golf course or new sports facility. Environmental issues can also impede athletic performance. Poor air quality can hinder athletes’ performances, as was seen with the 1997 World Track and Field Championships in Athens, Greece (CNN 2004). While some sports and teams have begun to address some of these athlete-environment issues there is still a large range of research to be conducted. This research project attempts to examine how the carbon footprints of the Power 5
college football conferences have changed in light of the recent realignment of teams. The Power 5 College Football Conferences are conferences typically regarded as having the best football teams in the United States. These conferences include the Atlantic Coast Conference (ACC), the Big Ten Conference (B1G), the Big 12 Conference, the Pac-12 Conference (Pac-12), and the Southeastern Conference (SEC). We focus upon football as the shorter season of inter-conference games (9-11) allows for a standard research platform

COLLEGE SPORTS AND THE ENVIRONMENT

The National Collegiate Athletics Association (NCAA) has been engaging in strategies that address some of the environmental impacts of their sports. For instance, in 2011, the NCAA Final Four Division I college basketball tournament was held in Houston, Texas. For the first time a NCAA Final Four Sustainability Committee was created with the founding members being the National Resource Defense Council (NRDC), LG Electronics, Waste Management, Reliant Park the City of Houston and the George R. Brown Convention Center. This committee developed programs to reduce environmental impacts. For instance, an environmental assessment was conducted to determine the current status of sustainability practices at Reliant Stadium and to determine opportunities for improvement. Carbon offsets for wind and solar power projects were purchased to avoid 210 U.S. tons of carbon dioxide equivalent emissions. Unused prepared food and beverages from the stadium were donated to appropriate local organizations. Waste and paper products from Reliant Stadium as well as local hotels and businesses were recycled as much as possible (NRDC 2011). Similar programs have been implemented at every Final Four NCAA Division I basketball tournament since 2011.

In 2014, the NCAA leaders wanted to take these initiatives to the next level by having the greenest tournament in its history so many activities were in place leading up NCAA Final Four at AT & T Stadium, in Arlington, Texas. The city had 1014 trees planted around town. A non-perishable food drive provided the North Texas and Tarrant County Food Banks with supplies. A basketball court was donated to the Martin Luther King, Jr. Community Center that was made nearly exclusively from recycled materials. A community recycled art showcase was held. Finally, a recycling and composting program at AT&T Stadium was created to help manage waste (Pale 2014).

More and more colleges and universities are also promoting sustainability, and university athletic departments are slowly increasing sustainability efforts. Colleges and universities are often central to the local community, giving them the ability to increase environmental awareness and the need for sustainable lifestyles. They can help facilitate change through their ability to engage the community and their ability to link research talent with resources. Athletic department sustainability efforts not only provide educational opportunities for fans and students, they impact the department's the bottom line through cost savings and revenue generation (Casper, Pfahl, and McCullough 2014).

When it comes to college athletic departments and sustainability efforts, it is a low priority, especially as collegiate athletics become more commercialized as they become more self-supporting (Trendafilova, Pfahl, and Casper 2013). This was discovered through a study that interviewed 97 key athletic department personnel at various Football Bowl Subdivision universities (Casper et al. 2012). Casper and his colleagues reported that athletic department personnel have a high awareness of environmental issues. Forty-three percent of respondents indicated that while environmental initiatives may be a high priority at the university level, there were not a high priority within the athletic department. This study also reported that while 75 percent of athletic directors queried believe that environmental programs in athletics will increase, only a small percentage of athletic
department have a plan in place or have even considered developing a plan. Collegiate athletic departments will certainly need to think more about environmental and sustainability efforts and make a more concerted effort to incorporate University sustainability strategies into their departmental mission. (Trendafilova, Pfahl, and Casper 2013).

There are a number of universities working to improve their sports operations’ impact on the environment. When it comes to LEED building practices, 41 athletic departments and 47 recreation departments have built to LEED standards for new facilities, existing facilities, and major renovations.

Among the larger schools, Arizona State University (ASU) has made a substantial commitment to sustainable practices, mostly through use of solar energy. They have 72 solar arrays that direct power to its central system. These solar arrays are able to meet almost 40% of the university’s peak demand during the day. ASU has also constructed new basketball facilities that meet LEED gold standards; 45% of the building’s energy comes from a photovoltaic system on the roof (Henly, 2013). The University of Colorado (Colorado) does Sustainability Gamedays for their basketball teams. They link with a corporate partner, helping to highlight sustainability efforts during men’s and women’s basketball games through various activities (Casper, Pfahl, and McCullough 2014). The University of Florida (Florida) became the first university in the nation to receive platinum certification, the highest rating, for an athletic building from the Leadership in Energy and Environmental Design (LEED) Green Building Rating System (Privett 2009). This rating is based on site planning, energy use, water management, materials used, indoor environmental quality and design process innovation. They now require a minimum of LEED gold certification standards for new projects. Florida is also reducing their carbon footprint through their partnership with We Are Neutral to create the “Neutral Gator” Initiative, which is a carbon offset initiative created through

Earthgivers, Inc., a non-profit organization in Gainesville, Florida (NRDC 2014). Neutral Gator began in 2007 by distributing over 63,000 highly efficient light bulbs (CFLs) throughout Gainesville to create local carbon offsets. Since then they have provided families with low-income energy retrofits free of charge, saved low-income families over 3.4 million dollars in utility savings, planted over 18,000 native trees on local conservation lands, and offset over 10,000 tons of carbon. Their efforts have led to the NRDC to recognize Florida as a Collegiate Game Changer (NRDC 2014).

While efforts to reduce environmental impacts in and around stadiums and events have been increasing, the increased travel by fans and teams due to recent conference expansion and realignments add to a team’s carbon footprint. Until the late 1950s, team travel was not an issue for schools or conferences. Conferences were based upon ease of travel, as teams were geographically closer to each other and traveled by road and rail networks for football and other sports. Conferences defined the region with which they were associated. For example, the Big Ten (or the old Southwest Conference) represented the American Middle West. The popularization of commercial air travel in the 1960s allowed teams to travel greater distances for competitions, since they were no longer limited by road and rail networks (Abbott 1990). Conferences in the past were generally composed of similar sized schools within a single geographic region. However, the NCAA realignments between 2010 and 2013 require some schools to travel large distances not only for football but also multiple other men’s and women’s sports (Weaver 2013). Still, football generates a large amount of revenue with television, contracts, equipment, and brand right’s contracts and this money is one of the drivers behind the recent NCAA realignments (Kercheval 2014).

With realignment, transporting teams and equipment farther distances presumably increases carbon emissions. Since 1990, the fastest growing source of greenhouse gases in...
the United States has been transportation. In 2012, vehicles of all types accounted for 28% of greenhouse gas emissions in the U.S. Of these greenhouse gas emissions, carbon dioxide accounts for 82%. A report to Congress in 2010 emphasized that one of the U.S. Department of Transportation’s strategies for reducing these emissions is the reduction of carbon-intensive traveling (USEPA 2014).

Current college conferences span vast regions and do not fit the traditional view of an athletic conference as discussed previously. While conference realignments obviously impacted institutions by requiring greater travel, we know little about the specific environmental impacts of the new spatial networks. The purpose of this research was to determine if carbon emissions have changed significantly due to conference realignments and if so by how much. Have carbon emissions also dramatically increased with the spatially expanded new conferences?

**CONFERENCE REALIGNMENT HISTORY**

Between 1990 and 2008, 30 schools changed conference affiliations with most of the shifts occurring in 2003 (Leibovitz, 2011). The 2003 movement was a ripple effect that began with the move of teams from the Big East Conference to the Atlantic Coast Conference (ACC). As a consequence, the Big East Conference invited teams from less popular conferences to join which forced further realignments in the conferences (Leibovitz, 2011). At the individual school level, there are a variety of reasons why a school would switch conferences, but the primary factor often revolves around potential increases in revenues. By moving to a more popular conference, such as the teams from the Big East Conference moving to the ACC in 2003, schools are in position to receive more television revenue, receive invitations to better or more prestigious bowl games, and participate in conference championship games. All of these factors can increase revenue for the conference and individual schools (Leibovitz, 2011). Ultimately the decision to stay with a conference or move to another lies in the decisions of the university President and/or the Board of Trustees (Williams 2017).

When looking at realignment from a conference perspective, the addition of new teams can increase revenue for the conference. This benefits all member schools of the conferences as well. With new members, TV contracts for conferences can be renegotiated predicated on an increase in viewers from new television markets (Leibovitz, 2011). When the ACC expanded in 2003-2005, the conference went from nine schools to 12 with the addition of University of Miami (Miami) in Florida, Boston College, and Virginia Polytechnic Institute and State University (Virginia Tech) adding the television markets of these schools to the revenue stream. This increase to 12 teams allowed the conference to host a championship game. A conference championship game means more money for the conference. It also allowed the conference to secure a more lucrative TV contract and increase ticket sales (Katz, 2005).

A historical conference that was a part of the realignment in the 1990s was the Southwest Conference (SWC). The SWC was a premier football conference featuring all Texas based schools and the University of Arkansas (Arkansas) until the conference broke up in 1996. Some reasons for the breakup and subsequent realignment are similar to those that emerged during recent realignments. Arkansas was the only school not located in Texas and left for the Southeastern Conference (SEC) in 1992 making the 1996 breakup inevitable. The SWC breakup was impacted heavily by television revenue. The SWC was unable to secure a lucrative TV contract to meet the demands of the multi-million dollar budgets of its schools. The conference’s geographic footprint only included access to 6.7% of the nation’s TV viewership. This situation can be compared to the SEC, which accessed 18% of the nation’s TV viewers. While some of the SWC teams, Southern Methodist University (SMU) and Rice,
were located in major TV markets including Dallas and Houston, the support for these schools dwindled as professional football grew in popularity in those cities. This led to the top four teams - University of Texas (Texas), Texas A&M, Texas Tech University (Texas Tech), and Baylor University (Baylor) - joining the Big 8 Conference to form the Big 12 Conference in the fall of 1996. The remaining private schools of Rice, SMU, and Texas Christian University (TCU) joined the Western Athletic Conference, while the University of Houston joined Conference-USA which at the time placed greater emphasis on basketball than on football (Writes, 2010).

THE 2010-2014 REALIGNMENT

The most recent realignment started when the University of Nebraska (Nebraska) joined the B1G Conference for the 2011 football season. Nebraska is one of the most successful programs in college football history in terms of their win-loss record. Before Nebraska’s departure, the Big 12 Conference (Big 12) was becoming more unstable based on reports that multiple schools were being courted for membership in other conferences such as Pac-10 and SEC (ESPN 2010; SFGate 2010). Based on these reports, Big 12 leadership asked all member universities for a commitment to stay in the conference for the foreseeable future with a deadline of June 11, 2010. On June 11, 2010, Nebraska applied for and was accepted for membership into the B1G. The University of Colorado (Colorado) left the Big 12 at the same time to join the Pac-12 (Leibovitz 2011).

Nebraska and Colorado were the first “dominoes” to fall in the 2010 realignment that affected the five power conferences: Atlantic Coast Conference (ACC); B1G, Big 12; Southeast Conference (SEC), and Pac-12. In total, 12 teams moved from one power conference to another, or joined from a less popular conference between 2010 and 2014 (Table 1). The realignment eliminated some of college sports’ biggest rivalries, while reviving others. Perhaps one of the biggest rivalries lost is the showdown between the University of Oklahoma (Oklahoma) and Nebraska. Both teams were formerly members of the Big Eight and then the Big 12 until 2010 when Nebraska joined the B1G. There were

Table 1. Teams that changed conferences to one of the Power 5 conferences and when the move occurred (Source: Peloquin, 2015).

<table>
<thead>
<tr>
<th>Team</th>
<th>Old Conference</th>
<th>New Conference</th>
<th>First Year in New Conference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colorado</td>
<td>Big 12</td>
<td>Pac-12</td>
<td>2011</td>
</tr>
<tr>
<td>Nebraska</td>
<td>Big 12</td>
<td>Big Ten</td>
<td>2011</td>
</tr>
<tr>
<td>Utah</td>
<td>Mountain West</td>
<td>Pac-12</td>
<td>2011</td>
</tr>
<tr>
<td>Missouri</td>
<td>Big 12</td>
<td>SEC</td>
<td>2012</td>
</tr>
<tr>
<td>Texas A&amp;M</td>
<td>Big 12</td>
<td>SEC</td>
<td>2012</td>
</tr>
<tr>
<td>Texas Christian University</td>
<td>Mountain West</td>
<td>Big 12</td>
<td>2012</td>
</tr>
<tr>
<td>West Virginia</td>
<td>Big East</td>
<td>Big 12</td>
<td>2012</td>
</tr>
<tr>
<td>Pittsburgh</td>
<td>Big East</td>
<td>ACC</td>
<td>2013</td>
</tr>
<tr>
<td>Syracuse</td>
<td>Big East</td>
<td>ACC</td>
<td>2013</td>
</tr>
<tr>
<td>Louisville</td>
<td>AAC</td>
<td>ACC</td>
<td>2014</td>
</tr>
<tr>
<td>Maryland</td>
<td>ACC</td>
<td>Big Ten</td>
<td>2014</td>
</tr>
<tr>
<td>Rutgers</td>
<td>AAC</td>
<td>Big Ten</td>
<td>2014</td>
</tr>
</tbody>
</table>
several years when this match up had national championship consequences, especially in the 1970s and 1980s (Smith 2012; Trotter 2012). When the University of Missouri left the Big 12 to join the SEC, their rival, the University of Kansas, indicated they would no longer compete against Missouri, ending a 100-year “Border Showdown.” Texas A&M University moved to the SEC from the Big 12 at the same time as Missouri. Texas A&M’s departure led to the cancelation of the Lone Star Showdown rivalry with the University of Texas. The Lone Star Showdown began in 1894, and because the two schools have so much animosity for each other, both schools’ fight songs reference the opposing school (Dennie 2011). When TCU joined the Big 12 Conference in 2012, their fans were ecstatic with the opportunity to revive old rivalries from the 1980s established during the time of the historic Southwest Conference, with teams that include Baylor, Texas Tech, and Texas (Havard and Eddy 2013).

CONFERENCE REALIGNMENT REASONS AND IMPACTS

Schools often want to align with schools that are viewed as being in an equivalent ‘peer group’, with similar athletic traditions, as determined by the University President/Board of Trustees in consultation with the Athletic Director (Williams 2017). This played a role in Nebraska choosing to move to the Big Ten Conference, as the Big Ten has a very strong athletic tradition (Leibovitz 2011). Finances also influenced the decision to switch conferences. Although Nebraska was brought in on a graduated revenue distribution scale ($15.4 million in year two; $16.9 million in year three, $18.7 million in year four; about $22 million in year five [Cordes 2015]) with the Big Ten Conference, it was a better situation than Nebraska had in the Big 12 Conference. In the Big 12 Conference, revenue was not divided evenly among the schools. Instead, revenue was distributed in what was called an “eat what you kill” mentality by Nebraska Chancellor Harvey Perlman where a school’s revenue depended upon television ratings (Lavigne, 2014).

Some conferences now have dedicated television networks including the Big Ten Network and the Pac-12 Network, which generate large revenues. Therefore, media and television rights played a major role in the realignment. According to Notre Dame Athletic Director Jack Swarbrick, the 2006 formation of the Big Ten Network was the biggest development in college sports since the 1984 Supreme Court decision to take the control of television rights away from the NCAA and give them to the schools. Purdue’s Athletic Director, Morgan Burke, indicated that The Big Ten additions of Rutgers University and the University of Maryland in 2014, not only brought an academic fit to the conference, the additions also brought the television markets of Washington D.C., Baltimore, and New York City to the Big Ten Network. The money in television media rights is vast and will continue to grow, since live sports is one of the few types of programming on television that is considered “DVR-proof” (Pointer 2014).

With the evolution of the new conferences, spatial characteristics of these conferences have changed immensely in terms of travel distances. The biggest impact on team expenses for those that switched conferences has been travel-related with more teams flying to games rather than being bussed (Lavigne 2014). For instance, when the University of Utah moved from the Mountain West Conference to the Pac-12 Conference in 2011, travel expenses doubled. This occurred even though the spatial distribution of their opponents did not change much. However, due to trips to cities that are more expensive, such as Seattle where they play the University of Washington, and TV scheduling based on new contracts that require the team to travel during the middle of the week, the school need to provide faster or more direct transportation home so that student-athletes miss a few classes as possible and the University spends as few dollars as possible. Mean travel
cost related to the conference change for West Virginia University from the Big East Conference to the Big 12 Conference has increased by $2 million. West Virginia reported the biggest average increase in travel associated with a conference change, since the closest conference foe is over 800 miles away. Oliver Luck, the former West Virginia Athletic Director, stated that the huge increase in conference payouts received has dwarfed the increased travel expenses essentially making travel costs a non-issue (Lavigne, 2014). However, increased travel has also placed an increased strain on student athletes. Teams that play during the week, including basketball teams, can be at a disadvantage when it comes to student athlete coursework. Sometimes West Virginia is forced to play a late weekday game in the Midwest for TV purposes resulting in the team not returning to campus until around 5 a.m. This puts student athletes with morning classes at a marked disadvantage due to the travel times (Grayson 2013).

Payouts from conferences are not the only thing that increased for many of the schools that changed conferences. Donations and alumni support for some schools has also increased tremendously. Colorado’s switch to the Pac-12 Conference resulted in increased private donations. As reported by Colorado Chancellor Philip DeStafano, in previous years the school averaged $10 million in donations, however $22 million in private donations were made in 2012-2013 (Lavigne 2014). For Utah and TCU, schools that moved into power conferences from the Mountain West Conference, the financial impact has been vast. TCU earned roughly $2 million from the Mountain West in its last year in the conference. TCU now has been brought in on a graduated plan (2012 - $9.8 million; 2013 - $15 million) to the Big 12 Conference and is received 20.4 million in 2014 (Solomon 2016). TCU has also benefitted from large increases in season ticket sales, merchandise sales, and donations. TCU Athletic Director Chris Del Conte says all of this has more than doubled season ticket sales from 13,000 for the last year the school was a member of the Mountain West Conference to 32,000 tickets (Lavigne 2014). Utah’s athletic director says that if the school had stayed in the Mountain West Conference, Utah would have earned approximately $4 million annually compared to the roughly $23 million the school will receive from the Pac-12 Conference in 2014-2015 (Lavigne 2014). These huge financial gains have justified the decisions of these schools to switch conferences.

**METHODOLOGY**

The focus of this study is the National Collegiate Athletic Association (NCAA) Power 5 football conferences: ACC, the Big 12, the B1G, Pac-12, and the SEC. The years of study were 2010 and 2014. The starting year was 2010, since it was the year prior to the most recent shakeup in the college football conference landscape. Only conference games were include for analysis, as teams play a variety of teams non-conference and these games change significantly from year to year. After email and phone conversations with the Director of Football Operations at the University of Michigan, Michigan State University, Purdue University, Stanford University, Florida, and Oregon State University (Oregon State), we determined that most schools use a 3-5 hour window to decide if the team will be bussed or flown to a game. The carbon footprint was calculated for all conference games for all schools that were included in this study for 2010 and 2014 for both the 3-hour and the 5-hour drive times as well as for flights. Our results were summed for each conference to gain an idea of how each conference changed between the two time periods.

**CARBON CALCULATOR**

The carbon calculator used in this research to calculate air travel was the Atmosfair calculator [https://www.atmosfair.de/en/kompensieren/flug]. This calculator is from a carbon-offset retailer, which allows the user
to input the airports between which travel will occur. This calculator used the following set of variables to compute carbon emissions: departure and arrival airports, flight class, type of flight, aircraft type (Boeing 757-300, 767-300, 777-300), and round trip for one passenger (emissions are calculated per person). These types of planes were chosen because the Boeing 757, 767, and 777 are common charter planes for football teams (McCartney 2012). The calculator uses fuel consumption figures for 43 different aircrafts that covers approximately 95% of worldwide air traffic. Atmosfair calculates the great circle route that the plane would take and accounting for flight distance and flight profile for calculating fuel consumption (Kollmuss and Lane 2009). This calculator is also more transparent than others; many carbon calculators do not show the steps used to derive final estimates.

DATA COLLECTION AND ANALYSIS FOR CARBON EMISSIONS

The approximate mileage and travel time between all football stadiums in each conference was calculated. Distances between football stadiums and airports were also recorded. The only exception to this is when Oklahoma plays Texas because this game is played at the Cotton Bowl not at one school or the other. Airports were based on the likelihood of the team being able to schedule a charter flight, as some close airports had an inadequate level of service. The 3-digit airport designation code was noted for all relevant departure and arrival airports to be used in the Atmosfair calculator. Three different plane sizes were included in the analysis because they are the three most commonly chartered planes for football teams (McCartney 2012) allowing more cargo capacity (Boeing 1995-2015). Our ground travel analysis included four and five busses, since each bus typically seats 50-60 people. We assumed that not every seat will be full due to elbow room and transporting equipment and luggage. We also used three different travel party sizes (140, 160, and 180 people). We determined these party sizes by examining flight manifests from the University of Oregon and Oregon State University (Iboshi 2014). Carbon emissions were calculated for every possible combination of plane size, travel party size, and number of busses for 2010 and 2014, resulting in 18 combinations for each year. For example, one combination was a 757-300 plane with a travel party of 140 people using four busses to get to and from the airport.

For air travel, emissions were determined for one person and then multiplied by the party size as air emissions are calculated per person in Atmosfair. Bus emissions were determined using data from the Motorcoach Census of the American Bus Association (John Dunham and Associates 2013). The average mileage (mpg) for busses was 6 mpg (John Dunham and Associates 2013). The mileage was divided by the total number of miles traveled (airports to schools, or school to school) to determine fuel consumption. Fuel consumption was then multiplied by an emissions factor of 10.21 kg of carbon dioxide per gallon (Federal Register 2009) to define emissions per bus. The following equation was used to calculate total trip emissions for each conference game when flying was involved.

\[
\text{Emissions} = (E_{\text{airports}})(\text{Party})(2E_{\text{bus}})(\#Busses)
\]

\(E_{\text{airports}}\) = emissions of plane between two airports (as round trip)

\(\text{Party} = 140, 160, \text{or } 180 \text{ people}\)

\(E_{\text{bus}}\) = emissions of one bus from school to school or to/from school to airport; the multiplier of 2 is for the round trip

\(\#Busses = 4 \text{ or } 5 \text{ busses}\)

When flying was not required, we only used bus emissions to determine the trip emissions level.

RESULTS

EMISSIONS ANALYSIS

Emissions were calculated for each school in the conference using their 2010 and 2014
schedule. We recognize that each school's travel schedule will not be exactly the same between the two years, however the results reflect the actual travel schedule for each team. Table 2 displays the percentage of games for each conference in 2010 and 2014 that were drivable in 3-hour and 5-hour periods. A visual analysis of this table indicates that in the ACC, Big 10, and SEC had the highest percentage of games within a 3-hour window in both 2010 and 2014. When the 5-hour window was considered, the Big 10 had the greatest percentage for 2010 and 2014. The Pac-12 having the fewest drivable games within 5 hours. While conference may have added schools that were within the 3- or 5-hour driving window, the percentage of competitions either did not change (Big 10 and Pac-12 for the 3-hour window), or was reduced by up to 4 percent (ACC for the 5-hour window).

The average driving distance between games (Table 3) once again shows the B1G and SEC having the most drivable games. For B1G games, the average driving distance was 586 km in 2010, and 687 km in 2014. For the SEC the average driving distance was 640 km in 2010, and 717 km in 2014. The average driving distance for the Pac-12, which had the fewest games that were drivable, was 1169 km in 2010 and 1190 km in 2014.

Because bussing has lower emissions than flying, we confirmed that teams who could take busses to more games had lower overall emissions. Plane emissions were calculated per person and then calculated for party size.

Table 2. Percentage of drivable games between 2010 and 2014 per conference.

<table>
<thead>
<tr>
<th></th>
<th>ACC</th>
<th>Big12</th>
<th>Big Ten</th>
<th>Pac12</th>
<th>SEC</th>
</tr>
</thead>
<tbody>
<tr>
<td>3h 2010 (%)</td>
<td>8</td>
<td>7</td>
<td>8</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>3h 2014 (%)</td>
<td>7</td>
<td>7</td>
<td>5</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>Difference</td>
<td>1</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>5hr 2010 (%)</td>
<td>18</td>
<td>17</td>
<td>24</td>
<td>8</td>
<td>20</td>
</tr>
<tr>
<td>5hr 2014 (%)</td>
<td>14</td>
<td>16</td>
<td>22</td>
<td>6</td>
<td>19</td>
</tr>
<tr>
<td>Difference</td>
<td>4</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

For the 3-hour drive time, the B1G had the largest increase (54%) and the Pac-12 has the lowest increase (16%) in total emissions due to realignment (Table 4). These results were mirrored for the 5-hour drive time (B1G: 55%; Pac-12: 7%).

The largest increase in average emissions between these two time periods for both drive times occurred in the Big 12 Conference (Table 5). This large increase is likely due to the inclusion of West Virginia and the changes in conference scheduling that has to occur. Three of the four schools (Colorado, Nebraska, and Missouri) that departed the conference were on the northern edge of the conference. However, the addition of West Virginia made a huge impact on the emissions numbers. Even though all four schools that left were on the edge of the conference, as is West Virginia, the departed schools were still located in states bordering other conference states. West Virginia’s closest team is Iowa State located 1179 km in straight line distance, and 1400 km of driving distance. If the 2010 total emissions number is divided by eight and the 2014 total emissions number is divided by nine (8- or 9-week game schedule) the 2014 total emissions are higher than 2010. This increase reflects the teams’ travel emissions through conference alignment. This is likely the primary reason that the total and average emissions numbers jumped for the Big 12 Conference even while having two fewer teams in 2014. The Pac-12 was also the only conference with a decrease in average emissions per game, declining by 1% from 2010 to 2014 for both drive times.

Table 3. Average driving distances between conference games per conference.

<table>
<thead>
<tr>
<th></th>
<th>ACC</th>
<th>Big 12</th>
<th>Big Ten</th>
<th>Pac12</th>
<th>SEC</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010 (km)</td>
<td>766</td>
<td>586</td>
<td>725</td>
<td>1169</td>
<td>640</td>
</tr>
<tr>
<td>2014 (km)</td>
<td>862</td>
<td>687</td>
<td>926</td>
<td>1190</td>
<td>717</td>
</tr>
<tr>
<td>Difference</td>
<td>96</td>
<td>101</td>
<td>201</td>
<td>21</td>
<td>17</td>
</tr>
<tr>
<td>Change</td>
<td>13%</td>
<td>17%</td>
<td>28%</td>
<td>22%</td>
<td>12%</td>
</tr>
</tbody>
</table>
In sum, all conference increased their total emissions and all but one conference increased their average emissions. These results suggest that the realignment of the Power 5 conferences did not change the amount of carbon emissions these conferences were emitting. These increases in carbon emissions are occurring at a time when environmental impact of sports is viewed more critically. The more carbon dioxide in the air, the more global climate change is impacted. The increase in flying also means that the more emissions are occurring at high altitudes, where impacts on the environment are not as well known yet. In a 2008 study a model showed that with increased carbon dioxide emissions, there is an associated rise with surface ozone, particulate matter, and carcinogens, which increase death, cancer rates, hospitalization and asthma (Jacobson 2008). The increased emissions associated with sports can contribute to the degradation of human health. This is ironic, given that sports have always been viewed as part of a healthy lifestyle (Schmidt 2006).

The new realigned conferences are seemingly having an impact on the environment. This research only looked at football team related travel carbon emissions. It did not look at the carbon emissions of other sports teams or fans traveling to and from games. Basketball may have more conference games than football but fewer people traveling. However, relative to this particular sport, it is logical to infer that the carbon emissions results would be similar to those of football. Sports such as basketball are played during the middle of the week, which means more flying, and thus would result in more emissions. As this research showed, the more

---

Table 4. Total emissions (kg of CO₂) and percent change per conference.

<table>
<thead>
<tr>
<th></th>
<th>3 hour drive</th>
<th>5 hour drive</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Time</td>
<td>time</td>
</tr>
<tr>
<td>ACC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td>3,464,558</td>
<td>3,212,919</td>
</tr>
<tr>
<td>2014</td>
<td>4,499,147</td>
<td>4,230,239</td>
</tr>
<tr>
<td>Change</td>
<td>30%</td>
<td>32%</td>
</tr>
<tr>
<td>Big 12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td>3,306,887</td>
<td>2,983,735</td>
</tr>
<tr>
<td>2014</td>
<td>3,957,214</td>
<td>3,620,950</td>
</tr>
<tr>
<td>Change</td>
<td>20%</td>
<td>21%</td>
</tr>
<tr>
<td>Big Ten</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td>2,497,212</td>
<td>1,996,618</td>
</tr>
<tr>
<td>2014</td>
<td>3,840,257</td>
<td>3,104,675</td>
</tr>
<tr>
<td>Change</td>
<td>54%</td>
<td>55%</td>
</tr>
<tr>
<td>Pac 12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td>4,993,232</td>
<td>4,881,705</td>
</tr>
<tr>
<td>2014</td>
<td>5,812,257</td>
<td>5,700,730</td>
</tr>
<tr>
<td>Change</td>
<td>16%</td>
<td>17%</td>
</tr>
<tr>
<td>SEC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td>2,868,129</td>
<td>2,422,336</td>
</tr>
<tr>
<td>2014</td>
<td>3,752,251</td>
<td>3,237,815</td>
</tr>
<tr>
<td>Change</td>
<td>31%</td>
<td>34%</td>
</tr>
</tbody>
</table>

Table 5. Average emissions (kg of CO₂) and percent change per conference.

<table>
<thead>
<tr>
<th></th>
<th>3 hour drive</th>
<th>5 hour drive</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Time</td>
<td>time</td>
</tr>
<tr>
<td>ACC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td>72,178</td>
<td>66,935</td>
</tr>
<tr>
<td>2014</td>
<td>80,341</td>
<td>75,539</td>
</tr>
<tr>
<td>Change</td>
<td>11%</td>
<td>13%</td>
</tr>
<tr>
<td>Big 12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td>68,893</td>
<td>62,161</td>
</tr>
<tr>
<td>2014</td>
<td>87,938</td>
<td>80,465</td>
</tr>
<tr>
<td>Change</td>
<td>28%</td>
<td>29%</td>
</tr>
<tr>
<td>Big Ten</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td>56,754</td>
<td>45,377</td>
</tr>
<tr>
<td>2014</td>
<td>68,576</td>
<td>55,440</td>
</tr>
<tr>
<td>Change</td>
<td>21%</td>
<td>22%</td>
</tr>
<tr>
<td>Pac 12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td>110,960</td>
<td>108,482</td>
</tr>
<tr>
<td>2014</td>
<td>109,665</td>
<td>107,560</td>
</tr>
<tr>
<td>Change</td>
<td>-1%</td>
<td>-1%</td>
</tr>
<tr>
<td>SEC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td>59,752</td>
<td>50,465</td>
</tr>
<tr>
<td>2014</td>
<td>67,004</td>
<td>57,818</td>
</tr>
<tr>
<td>Change</td>
<td>12%</td>
<td>15%</td>
</tr>
</tbody>
</table>
games that used busses instead of airplanes the lower the emissions were.

CONCLUSIONS

Sports have a major impact on the environment. This research showed that the spatial expansion of the Power 5 conferences caused average emissions to rise in almost every case. The only conference that did not have an increase was the one with the largest average emissions per game and highest total emissions (Pac-12). The ability of teams in conferences like the B1G and SEC to drive to games was reflected in the emissions numbers. The closer opponents are located to each other, the less travel, and fewer emissions are contributed to the environment.

While colleges are becoming more sustainable on campus and at stadiums, the travel-related environmental impact has risen, and may continue to rise. This research demonstrated that it has risen on an average per game basis in four of five power conferences between 2010 and 2014. After researching the spatial patterns, and calculating carbon footprint for the conferences, it is reasonable to show that the carbon emissions as a whole have increased for each of these conferences. While some of this increase is due to more teams or a change in the number of games, each conference’s total emission figures increased. These results are all contingent however on how a school views their environmental impact. As stated above, many schools may not be as concerned about this issue because the financial increases from conference realignment were so large.

With conferences producing more emissions, it is clear that something needs to change. The first suggestion is that conferences and/or schools purchase carbon offsets. Some schools are purchasing carbon offsets, but it should be done more purposefully and consistently, and maybe even on a conference basis. Purchasing these offsets for traveling can help contribute to reducing the impact caused by the increased travel emissions from the realignment. This is the most feasible option. These conferences receive large revenues that could be used to purchase offsets. This may not make conferences carbon neutral, but it would make them more environmentally friendly.

The next suggestion would be to realign divisions within the power conferences. Aligning the schools that are spatially close to one another would reduce emissions considerably. One realignment that could possibly take place would be in the ACC divisions. Having divisions more geographically based would likely help with reduction in emissions. Currently, both divisions in the ACC have teams located next to opposite division schools. The two southern most teams Florida State University and University of Miami, are located in opposite divisions, which mean these two schools are not guaranteed to play each other every season. The same is true for the schools in North Carolina, where four ACC schools are located. Two are in the Coastal Division and two are in the Atlantic Division. These schools are all located close to each other, and having them in the same divisions would guarantee these schools play each other, which would cut down on possible emissions. A realigning of divisions might be a possibility for the SEC as well because of the additions of Texas A&M and Missouri. Realigning the divisions so that Missouri is located in the Western Division rather than the Eastern Division would cut down emissions, as they are the third most western school. This would also mean they are in the same division as University of Arkansas, which is located within the five-hour driving window of the school. While this may seem like a feasible option, we recognize that divisions within conference would be based on economics and strength of schedule relative to post-season plan and not environmental aspects.

Another suggestion would be to look at conference scheduling more closely. For the Big 12, where every team plays every team, this is not possible. However for a conference like the Pac-12 it is. In 2014, for the
out-of-division games, the University of Washington played both the University of Arizona and Arizona State University. This meant that regardless of where the game was played, travel occurred between the states of Arizona and Washington twice that year. Ideally, a team would play these teams on a road trip, however with school demands and the week between games this is not a possibility

FUTURE RESEARCH

In the future, a more in-depth study could provide more detail on the environmental impact of this conference realignment. Researching team by team to determine average party sizes, and the actual airports and airplane types used for each game would provide a more accurate assessment of carbon emissions. The inclusion of out-of-conference games would also be an interesting comparison. Looking at other sports could also provide valuable insight to the impact, especially since those sports are not big revenue generators. Looking at more impacts besides carbon emissions of traveling for games such as stadium emissions or practice facility emissions would provide more details of college sport’s overall environmental impact. For recruiting, coaches must travel quickly often using private jets at power conference schools. It would be interesting to look at the environmental impact of this at Power 5 schools compared to the lower level conferences where travel budgets are not as expansive. Looking at one individual team and the travel of the fans with the team would be an fascinating look at the environmental impact. All in all there is still a great amount of work to be done in the area of college sports and environmental impact.

REFERENCES


ABSTRACT

As Kenzer (2001) has noted, “unlike practitioners in other academic fields, when it comes to the intellectual history of our discipline, geographers love to dabble.” However, examining this dabbling has normally been restricted to examining the contributions of faculty in Ph.D.-granting departments. Indeed, our discipline’s history is rich, but written accounts are incomplete, for the voices of geographers serving in undergraduate programs at colleges and universities of little prestige have for the most part been silent. These programs are housed in institutions that are home to the vast majority of academic geographers, many of whom toil relentlessly in the trenches of academe, teaching large classes of often underprepared undergraduates, mentoring promising students, performing considerable institutional committee work, and engaging in research. They are the backbone of American geography. Leon Yacher is one of them, and this is his story. Hopefully, this piece will spark others to write about mentors and colleagues, creating a more complete history of the geographic discipline.

Key Words: history of geography, mentoring, undergraduate education

INTRODUCTION

It was the Summer of 2011, and I found myself engaging in fieldwork in southern Mexico. Pleasantly surprised with my Blackberry’s reception along the Usumacinta River meandering along the edge of Chiapas, I noticed an e-mail had arrived from an esteemed colleague at the University of Oregon, Susan Hardwick. She asked me to speak at the National Conference on Geographic Education in a special session devoted to Leon Yacher of Southern Connecticut State University, a recipient of the Distinguished Mentor Award. So it was for that reason I found myself in Portland a few weeks later talking before an
audience that included Past Presidents of the National Council for Geographic Education (NCGE), Association of American Geographers (AAG), and Gamma Theta Upsilon (GTU).

Yacher was in many ways an unusual candidate for the award. His scholarship often addressed matters that others normally left unexplored, and he had engaged in fieldwork in many countries at a level that was matched by only a few academic geographers. Moreover, unlike all but a fifth of those honored as Distinguished Mentors before him, he was not on the faculty of a Geography doctoral program. He spent nearly his entire academic career in a relatively ordinary public higher education institution devoted principally to undergraduate studies — the type of academic institution that is home to the majority of American Geography programs, and also the type of institution that has been home to all but two Gamma Theta Upsilon presidents of the past 50 years. It is striking that prior to 2011, of the 66 NCGE Distinguished Mentor Awardees, 54 were affiliated with doctoral programs, 8 served as faculty in departments that awarded master’s degrees, and only 4 served in programs solely devoted to undergraduate studies. Clearly, faculty in doctoral programs are disproportionately represented on the list of those awarded with distinction by the NCGE and AAG, for of the 494 American geography programs recognized by the American Association of Geographers (2016), only 61 actually offer a geography Ph.D.; an additional 18 collaborate with other disciplines in the award of doctorates in related fields, and just 48 Ph.D. programs reported doctoral dissertations having been completed. In essence, 85% of geography programs do not award the doctorate, and it is the programs that are largely devoted to undergraduate studies that house the majority of academic geographers. Leon Yacher in many ways has exemplified the majority of geographers in higher education, and like him, their stories should also be told. Fortunately, as Kenzer (2001) has noted, “Unlike practitioners in other academic fields, when it comes to the intellectual history of our discipline, geographers love to dabble.” However, examining this dabbling has normally been restricted to examining the contributions of faculty in Ph.D.-granting departments. Certainly, our discipline’s history is rich; but written accounts are incomplete, for along with a marked absence of attention directed toward women in geography (DeVivo 2016b), the voice of geographers serving in colleges and universities of little prestige has for the most part been silent. Selected Ph.D. programs are investigated in books devoted to explorations of our discipline’s past (DeVivo 2015; Johnston & Sidaway 2016; Martin 2005); but with the exception of widely scattered unpublished departmental histories, the history of undergraduate programs in geography, and their faculty, is largely unexamined.

Of late, undergraduate programs have drawn considerable interest among those in our discipline’s leadership, for these are the training grounds for many in our field. In 2016, an undergraduate teaching award was established in memory of Harm de Blij, and in a recent article in the AAG Newsletter, the association’s president, Sarah Bednarz, commented, “I believe we need to pay careful attention to undergraduate education in geography to strengthen our research base and to make the case to students, their parents, administrators, and others that geography is a worthwhile investment, financially and intellectually” (Bednarz 2015).

It is important to realize that 67% of the 494 geography programs in the United States listed by the American Association of Geographers are exclusively devoted to undergraduate education, whereas only 18% award the doctorate and another 15% award master’s degrees (American Association of Geographers 2016). Much of the geographic discipline’s history remains missing, given that two thirds of undergraduate programs are unaffiliated with graduate programs,
and the stories of professors filling these vital roles remain to be told.

Certainly, this neglected part of the history of geography needs to be addressed for a sound understanding of our discipline’s past. Hopefully, this piece will spark others to film and write about colleagues and mentors who should not only be recognized for their efforts and achievements, but also for the purpose of creating a more complete history of the geographic discipline. This can be done today with a minimum of expense, and one way is through recording oral histories, which can be made available rather easily on the internet (De Vivo 2016a).

Inspired by Geographers on Film, the Conversation with a Geographer series was founded in 2011 at Grand Rapids Community College (2015) with the intention of not only contributing to our discipline’s history, but also to examine the roles played by various mentors and leaders. These interviews have been incorporated in classroom instruction at the college, and they have proven to be pedagogically useful. Leon Yacher’s interview (De Vivo 2013) is among those that has fostered self-reflection and inspired undergraduates to pursue their dreams. One aspiring geographer in my class commented, Leon Yacher is fascinating! One of my favorite geographers you’ve introduced so far. His endless fascination with all things geographic makes him endlessly fascinating. In so many ways his story of becoming a geographer reminds me so much of myself. I could only hope to ever be so eloquent.

The Yacher interview is among those that reveal much about the value of geography and the character of geographers. Another student remarked,

Although Yacher himself is a very interesting man, what struck me the most about him is that he is very humble. He has published many different papers and is a huge success in his field and in academia in general, but he says that he is unsure of his success. He says it, meaning his success, is up to other people to decide. And when others give him feedback, it gives him a better understanding of himself. For nearly the rest of his interview, Yacher praised other renowned geographers and cartographers, stating all that he has gained from them in education and knowledge. It is amazing to me that such a successful man still humbles himself before others and their work, taking in all that he can to improve himself. What a wonderful characteristic to have in one’s personality.

Certainly, humility is an attractive, but all too often, uncommon attribute among many in academic environments. In the case of Leon, his scholarship, though stellar, often was not known. It is striking that six years ago, immediately after my presentation in Portland, Gamma Theta Upsilon Past President Howard Johnson commented, ‘I’ve known him for years. I shared rooms with him at conferences. I had no idea he had done all this. …. What humility!’ Indeed, it is worth noting that the haughty are not good leaders in academe, whereas those marked by inspiration, integrity, selflessness, scholarship, and proaction tend to make the most significant impacts (De Vivo 2015); Leon Yacher is among those in academe today marked by these traits. Although he and I did not meet until 1983, what follows is my account of his role as an academic geographer over the course of more than 40 years.

“GEOGRAPHY? WHAT THE HELL IS THAT ALL ABOUT?”

In 1983, I walked into the Geography Department at Southern Connecticut State University in New Haven. I had completed military service with the Marines and the Navy and had spent time at sea as a Merchant Marine Officer. Through an act of the Connecticut legislature, my status as a veteran
during a particular time of conflict enabled me to pursue studies at a public university tuition-free, and this meant G.I. Bill benefits would only need to be used for living expenses. Realizing that it was a good idea for me to hold an academic degree of some sort, I picked up a catalog of the institution, thumbed through it, and noticed an entry under “Geography.”

“What the hell is that all about?” I asked myself, and then I looked at the course descriptions. Examining the relationships between people and the environment seemed like a perfect fit for me. I was going to be a geographer. The department included a half-dozen faculty, among them Geoffrey Martin and Martin Glassner, both notable scholars: One, Martin, was the leading authority in the history of geographic thought and the other, Glassner, was a non-governmental officer to the United Nations and expert in landlocked states and the law of the sea. Another fellow, a young assistant professor not yet with tenure, rounded out the more serious faculty. He too had made a solid contribution to geographical scholarship through research and publication. Yet, his role in the department also included a disproportionate share of student advising, institutional committee work, and community service. His name was Leon Yacher.

In a climate of institutional political unrest, marked by strong personalities that at times were driven more by self-interest than the interests of the institution, department, or students, Leon worked tirelessly to elevate the status of the geographic discipline. Spending many hours each week as the department’s representative on a number of institutional committees, ranging from setting the curriculum to determining library acquisitions, Leon worked diligently behind the scenes to enhance Geography at Southern. He too had made a solid contribution to geographical scholarship through research and publication. Yet, his role in the department also included a disproportionate share of student advising, institutional committee work, and community service. His name was Leon Yacher.

Students were impressed that Leon was interviewed on television and the radio about the purpose of geography, as well as by the science editor of the New Haven Register — and that he wrote opinion pieces in various newspapers and offered lectures and workshops at public schools throughout Connecticut. They were also impressed by his scholarship, noting that the maps produced in a political geography textbook used in a course offered at Southern were drafted by him (DeBlij & Glassner 1981). Leon’s role as a mentor was significant. He assisted students in gaining assistantships and fellowships for graduate studies at several different institutions. Some went on to work for government agencies in transportation, planning, mapping, and the intelligence community, while others acquired positions as K-12 teachers and academic geographers in higher education. A few of us that studied at Southern, but at different times, would rendezvous at annual meetings of the NCGE and the AAG, led by Leon on field trips to examine ordinary landscapes. Boston’s Chinatown, San Antonio’s barrios, and Lexington’s urban form, for example, were explored, discussed, and enjoyed. Unfortunately, the untimely death in 2002 of one of our colleagues, Mark Keeney, reduced our numbers. Some of us went on to participate in conferences abroad, where we engaged in similar forays on our own, maintaining frequent contact with Leon, who himself travelled frequently enough engaging in geographical study to warrant not only one, but two supplements to his passport for a collection of visa stamps that was expanding. Leon’s fieldwork abroad held depth and breadth, for he made it a point to spend ample time in out-of-the way places and converse with local residents. This was noted by students. After viewing his Conversation with a Geographer interview, a number of them commented on Leon’s desire to become familiar with a place by going off the beaten path and talking with the residents of a city. One commented: “I think that it is very fascinating that Yacher makes it a priority to talk to a local of each city and ask them...
what it is like to live there. Doing that is the best way to get to know a city and know the true aspects and details that are hiding behinds its name.”

Leon’s stellar fieldwork was also recognized by colleagues in the discipline. At the 2006 National Conference on Geographic Education, I recall Harm de Blij speaking to a group of geographers in a session on the value of Leon’s fieldwork in Central Asia, as it was a rare contribution that lent deep insight into an understanding of the region. The elder scholar, whose record of trekking across the globe was rarely, if ever, matched, also lamented that among geographers this kind of fieldwork had far too often become a thing of the past; his praise of Leon was noteworthy.

AN IMMIGRANT FROM THE ANDES IN A CONNECTICUT DELI

What sparks the passion for this kind of fieldwork among geographers is a matter of conjecture, and where it began with Leon is open to speculation as well. Born in Peru to Rumanian Jewish immigrants, Leon learned at an early age about the challenges of growing up as a member of a minority population, and his talent in soccer served him in good stead as he gained respect on the ball field as the only non-Mestizo and non-Catholic player in his downtown Lima neighborhood. His father, a peddler, traded in animal skins for several years, and Leon would frequently join him on his journeys into the Andean hinterland, as he engaged in the purchase of cattle hides from slaughterhouses scattered along a loosely connected network of trails and roads. Fitting as many as possible in a DeSoto pickup, some of the cowhide would be sold to a number of factories in Lima; but most was sold to be made into handbags for Bata, an Italian company that manufactured shoes and fashion accessories.

In 1964, a month after his mother had left Peru to reside in the U.S., Leon left Lima in what was intended to be a short vacation to see the World’s Fair in New York. Instead, he found himself remaining in America as a young immigrant teenager.7 Throughout his high school years in western Connecticut, he studied a general education curriculum, played basketball with future professional athletes, and ventured into New York City, not realizing at the time he was actually exploring its urban geography. This was a period marked by the Vietnam War and racial unrest, and Leon, having experienced minority status growing up in Peru, developed closely-knit friendships with African-Americans who at times exhibited their frustrations about poverty and civil rights through rioting and violence (DeVivo 2013).

Also while in high school, Leon took on minimum wage part time work at a five and ten store, as well as in a dental lab making false teeth. Neither of these fields interested him as viable career options, and when he talked with his guidance counselor, she recommended he become a plumber because he had long arms. Leon, not inclined to devote his life to unclogging toilets and fixing sinks, decided to continue his education at Norwalk Community College. He also took a job in a deli serving many residents of the region, including the rich and famous that lived in Connecticut’s more affluent suburbs. Leon prepared sandwiches for Walter Cronkite and Dan Rather, and at one point, he delivered a large order to the Chambers Brothers, a soul group known for their 1968 hit, “Time Has Come Today.” In any event, although he was on the verge of mastering the recipe for the perfect blend of pastrami, chopped liver, and onion on rye, following completion of an associate’s degree, Leon ventured west to Albuquerque and found himself captivated by the teaching of Alec Murphy’s father.

RICHARD MURPHY, NEW MEXICO, AND SYRACUSE

Richard Murphy who played a major role in the development of the University of New Mexico Department of Geography engaged in research devoted to the geography of national forests, landform mapping (Murphy
1968), and geographic education, and he served as Leon Yacher’s mentor. Murphy was largely responsible for creating an independent Geography Department and developing the graduate program. Today, the department recognizes his contributions by hosting the Richard Murphy Memorial Lecture.

It was under the guidance of Murphy that Leon chose Geography as a career. At one point, fascinated by the study of landforms, Leon wrote to a former faculty member who had specialized in geomorphology, for he was seeking references on pediments for a term paper that he was writing. Yi-Fu Tuan kindly wrote back to Leon with a number of his works and indicated to him that he was no longer engaging in that type of research. Yet later, when Leon picked up a copy of Tophilia, he was mesmerized by Tuan’s (1974) new research focus, and he directed his attention away from the study of landforms.

Regardless, soon thereafter, Leon completed one of the few Geography master’s theses at New Mexico at the time (1974), and he accepted a fellowship for doctoral work at Syracuse University, where he conducted substantial research devoted to marriage migration in colonial Michoacán (1977). Much of this work later was incorporated in a historical geographical study published by his advisor at Syracuse, David Robinson (1989).

Regardless, Leon learned much at Syracuse, and after serving in a temporary appointment at SUNY-Oswego, he pursued a permanent faculty position. He was offered two positions: one in California and one in Connecticut. He chose to take an appointment at Southern Connecticut, which charged him with developing the cartography program in a newly autonomous geography department.

TEACHING AND RESEARCH IN CARTOGRAPHY AT SOUTHERN CONNECTICUT

At Southern, students considered Leon quite a taskmaster. This was still during an era of pen-and-ink cartography, and because the CIA and USGS allowed only 1/40th of an inch of error, Leon would allow only a 1/40th of an inch of error in the drafting of maps. Courses were highly comprehensive. I recall the introductory cartography course requiring advanced readings in the history of cartography by Woodward (1975), analysis of a variety of aerial photographs, and five-page papers for each of the ten maps produced. Students would congregate in the cartography lab, working on their maps, carefully – ever so carefully – etching ink on to Mylar, satisfied with their work, only to see Leon walk by, glance and note a number of errors, which would then compel several of us to discard the pieces of work we had just completed, and begin again. Yet, the students that took Leon’s highly demanding cartography courses found themselves employable, and many achieved high levels of success in applied geography, especially with government agencies that Leon had developed a network of close and reliable contacts, ready to take on Southern’s geography majors that received Leon’s endorsement. Students realized this, and they also became impressed with Leon’s (1981) article in the Journal of Geography devoted to interpreting a remote sensing image of New Haven, for they saw its relevance to their own prospective careers.

The cartography lab served as a de facto forum, and much of the reason was because of Leon’s approachability. Students wandered in to talk, to listen, to learn, to work on their maps, or perhaps simply to eat pizza and drink soft drinks that Leon had graciously provided.

Students found Leon’s massive array of hand-drawn maps in DeBlij & Glassner’s (1981) Systematic Political Geography textbook impressive. Especially striking was a new polar projection depicting a more realistic view of the geopolitical world during the Cold War, which showed the U.S. and her participant treaty organizations, such as NATO and SEATO, in contrast to the Soviet Union and the Warsaw Pact. Unlike the Mercator projection, which distorted the size of the USSR and had been employed by the Pentagon in efforts to gain funding
from Congress, Yacher’s polar projection essentially displayed the Warsaw Pact countries surrounded by U.S. alliances. This prompted many discussions on how maps have been employed to manipulate the presentation of information. Especially in cartography, Leon demonstrated that sound map design facilitated interpretation, a skill that enhances the employability of geography graduates.

In essence, with Leon’s mentorship and inspiration, students found themselves well-prepared to begin careers as geographers, cartographers, and planners, as well as go on to graduate school. It is important to note that the students at Southern tended to work not just part-time, but full-time in order to complete their studies. This, of course, created problems for many who had difficulty achieving academic progress. It is fair to say that Leon worked diligently, without compromising academic standards, to assist students across a broad socio-economic spectrum in achieving degrees and becoming employed in the field.

RESEARCH IN THE HISTORY OF GEOGRAPHY

Leon’s passion for cartography (and proximity to Massachusetts) led him to pursue research in the life and thought of Erwin Raisz. Although Raisz had died, Leon was able to conduct interviews with his son to learn about the famous cartographer’s life and thought. Raisz had an enormous talent for crafting maps, and his landforms map of the United States was to a large extent based on his own fieldwork. Leon’s research revealed that at Harvard, custodians refused to erase his maps on the blackboard because they were works of art. Raisz was indeed gifted. He flew in airplanes looking out the window and drafting maps at the same time. Leon was convinced that this was a story that had to be told, for Raisz was certainly the father of American cartography. Even Arthur Robinson was compelled to use Raisz’s cartography textbook before he wrote one himself.

Geoffrey Martin, the dean of scholarship in the history of geographic thought, commented on the importance Leon’s (1982) publication on Raisz had on the history of American geographic thought. Martin frequently shared accounts of the history of geography with his colleagues and students. Some of this was published and some of this was reserved for his magnum opus, which was only recently published (2015). Martin left himself open for extended talks about not only material he had discovered while engaging in archival research, such as the matter of Ellsworth Huntington’s non-dissertation Ph.D. “dissertation,” but also his interviews with contemporaries about problems plaguing geography and the demise of individual departments, such as the ones at Harvard, Yale, Columbia and Michigan. To those of us who cared to listen, we learned much as Martin revealed to us in private conversations about the shaping of academic geography in America. For sure, through frequent dialogues, as well his publications, Geoffrey Martin influenced Leon (and others, including me) in carrying out research devoted to the history of geography. With his interest in geographic thought piqued, Leon went on to conduct research in the lives of geographers Raimondi, Tamayo, Rubio, Romero, and Pittier — luminaries in Latin America, but virtually unknown in the United States.

This research has been a valuable contribution to the discipline. Kent Mathewson astutely commented that a Eurocentric or Euro-North American perspective has colored a misperception of Latin American geography, and he asserted, “Yacher demonstrates that geography’s most fundamentally understood and best appreciated attribute — that it is the science of discovery—can be exercised within its own precincts. Here Yacher has performed an act of discovery, or at least, recovery, of … Latin American geography’s foundational figures” (Yacher 2004, xi-xii).

In essence, Leon has sought to explain the history of our discipline in Latin America, and also extend recognition to the heretofore-unknown leaders that established geography as an important field of study in the region.
This is a formidable task, but one that must be done to correct misconceptions and errors, and provide an accurate record of the discipline in a region where geography has played a significant role. One student, deeply impressed with his research, remarked: “Researching Pittier took him to 55 different archives in more than 15 countries, chasing detail and finding things that were different than previously reported. He speaks about him with such amazement and passion; you can really tell he enjoyed this project immensely.”

It should be noted that Leon conducted this research while advising large numbers of students, teaching heavy course loads, leading field trips, and serving as an officer in a number of geographical organizations. Moreover, he helped others who were not his own students in academe and government in the U.S. and abroad with their own research, often offering valuable guidance.

GEOGRAPHICAL RESEARCH ACROSS THE GLOBE

In essence, through his work on the Hungarian-born father of American cartography and the Latin American luminaries, Leon contributed much to the history of geographic thought. Yet, his research spanned several different fields and clearly showed a high level of eclectic interests. For example, in Connecticut, he examined the historical geography of New Haven’s African-American community as well as more recent changes in the state’s ethnic geography (Yacher 2009). Collaborating with colleagues over the course of more than 20 years in biogeographical research, initially funded by the National Geographic Society, Leon found himself trekking across some of the same routes he had traveled with his father in the Andes years ago. This fieldwork resulted in the discovery of new species of the Jaltomata plant, numerous reports of which were published in the journal of the Missouri Botanical Garden and the journal of the New York Botanical Garden, as well as several other journals in two languages in two countries (Mione, Leiva, & Yacher 2000; 2004; 2005; 2007; 2008; 2013; 2015; Mione, Leiva, Yacher & Cameron 2011; Leiva, Mione & Yacher 2007a; 2007b; 2008; 2010; 2013; 2014a; 2014b; 2015a; 2015b; Leiva, Mione, Yacher & Silvestre 2010). Leon also conducted research with a colleague in ornithology devoted to one of the rarest birds in the world, which occupied the cloud forests of the Peruvian Andes (Smith & Yacher 2008).

Leon continued to expand his research horizons following award of a Fulbright fellowship to the Kyrgyz Republic in 2003, and he became one of only a few geographers that developed regional expertise in Central Asia, and the only one to have consistently engaged in fieldwork throughout the region for more than a decade. His work, for example, on the phenomenal growth experienced by Astana, Kazakhstan is at this time one of the few pieces of research published in English on urbanization in Central Asia, as Leon has engaged in a quest to unravel the mystery of the current urban morphology and character that typifies the region’s formerly Soviet cities (Yacher 2011). This can be especially challenging in a region where deceit is often a way of life; for example, in Turkmenistan, government leaders have endorsed changes in school curricula, a rewriting of history, and new traditions that foster isolationism and denude intellectual growth (Stone 2008). Richard Stone (2008), a staff writer for Science, asked Leon to elaborate on the problem and discuss its implications for an article on the impact of a new water resource management scheme proposed by the Turkmen government; he did so, and his comments became a very important part of the publication, as they demonstrated the value of laborious geographical fieldwork to the entire scientific community.

This sort of fieldwork and qualitative research has also resulted in some profound insight concerning journalism in post-Soviet era societies. With Joseph Manzella (2005), he worked to trace the transition of Kyrgyzstan’s media from a purely government-
controlled enterprise to one that will hopefully take on the task of being a “watchdog;” Leon’s public lectures on the subject also have attracted large crowds and received favorable reviews. Incidentally, his later work with Manzella (2010) on the impacts of the Chavez government’s quest to neutralize the press also resulted from substantive fieldwork in Venezuela and Cuba.\textsuperscript{13}

In any event, Leon also has found time to engage in fieldwork in regions that have remained virtually unexplored by geographers for decades (Figure 1). For example, a few years ago, I was conducting research in Fiji, and Leon, coincidentally, happened to be exploring a number of Pacific Islands himself.\textsuperscript{14} Our unplanned crossing of paths resulted in a collaboration in fieldwork, and we discussed some of the characteristics that were similar and different on the islands. Leon had been in the Solomon Islands for some time. The Solomons were a place of notable strategic importance during the Second World War, but have largely been ignored by scholars since. No scholarly works in geography have been written on the Solomons in English since the 1950s, and Leon’s fieldwork offered deep insight into the cultural landscape of the islands.

Leon created photo essays of parts of the world, which proved to be valuable as well. These are the types of things that he assembled for publication in the American Geographical Society’s periodical, Focus. Unlike the typical scholarly article that relied much on previously conducted research in a literature review, Leon’s (2005; 2006a; 2006b; 2007; 2008; 2009b; 2010) photo essays of Palau, Senegal, Venezuela, Panama, Kazakhstan, Kyrgyzstan, and Turkmenistan were original pieces derived solely from geographical fieldwork and supported by illustrations in the form of photographs. The intention was to provide glimpses of ordinary landscapes in faraway places with strange sounding names that would appeal to both academic geographers and a readership beyond the academic geographical community.

Figure 1. Leon Yacher conducting fieldwork among the Himba in Namibia’s Kaokoland.
REFLECTIONS AND CONCLUSIONS

As I reflect upon these matters, I ponder my own research in the history of geography vis-à-vis leadership in the discipline, and I look at the research conducted by Leon Yacher as being reminiscent of the things that were done in an earlier era when it was only through direct field observation that geographical knowledge could be attained about the faces that made up many faraway places. As I consider luminaries that served our discipline, I think of those that did not have a strong following of graduate students behind them. The notable Central Asia scholar that wrote for American Geographical Society publications, Owen Lattimore, was one of them. Mark Jefferson at the Normal School in Ypsilanti, who contributed much to geographical research, served geographical societies in a number of capacities, taught heavy teaching loads, and mentored students that later went on to pursue graduate studies and careers in geography, was another. Like Leon, he fueled a passion in students about geographical study in an institution principally dedicated to its teaching mission.

Here, it is relevant to remark on the cultural shift in American higher education that has occurred over the last three decades. The increased expectations in scholarship that characterize most public institutions have not gone unnoticed in those colleges and universities that were for many years exclusively devoted to teaching. In the 1970s and 1980s, research and publication were often not only unnecessary, but also discouraged. This was the case at Southern until the beginning of the 21st century. It was unusual for any member of the faculty to list one publication, let alone several, since heavy teaching loads made it very difficult for professors to conduct scholarly research. In reference to his colleagues at Southern and peer institutions across the U.S., Leon’s record is praiseworthy, and it demonstrates his leadership skills in urging others to engage in academic research.15

Leon encouraged faculty at Southern and elsewhere to demonstrate evidence of academic scholarship. A desire to elevate others to higher levels, little tolerance for mediocrity, and the pursuit of excellence characterize transformational leaders, along with a willingness to ask difficult questions as well as a willingness to confront difficult situations and difficult people in times of conflict (DeVivo 2015). These too are traits that have characterized Leon. In essence, Leon Yacher has practiced transformational leadership not only in his role as department chairman, advisor, and professor, but also in his many duties while serving geographical societies such as the AAG, NESTVAL, and GTU.16

Sometimes we ponder our lives as academic geographers and wonder about the impacts we’ve made; but as one reflects upon Leon Yacher, it is easily seen that he served as an ambassador for the discipline in many ways for more than three decades and worked tirelessly as a mentor far beyond the classroom. What is especially striking is that Leon accomplished all of these things and more, for he engaged in not only effective teaching and mentoring, but also solid scholarship, without the benefit of being affiliated with a large graduate program. Spending nearly his entire academic career at a largely undergraduate institution that offered little support in terms of secretarial assistance and research funding, and demanding much in terms of teaching, scholarship, and community service, one must wonder how effective Leon would have been if he had been part of a graduate program.

Indeed, this same question can be raised in reference to other academic geographers that have devoted their entire careers to practicing their craft in predominantly undergraduate programs. This is the type of institution that is home to the majority of academic geography departments in the United States, and this is the type of institution that has served as the home to the majority of GTU Presidents for more than eight decades.

Maybe this work can be the first glimpse of a GTU Past President’s life and thought...
published in the *Geographical Bulletin*. The stories of several others should be written about as well, and together these can make up a series in this journal, which will become significant contributions to the history of geography. For sure, there is a need to chronicle the careers of academic geographers whose home is in programs exclusively devoted to the education of undergraduates. Regardless, let this account of Leon Yacher be the first of several to come.

NOTES

1. Leon Yacher was awarded the A.A. from Norwalk Community College, B.A. and M.A. degrees from the University of New Mexico, and the Ph.D. from Syracuse University.
3. Martin's (1968) work on Mark Jeffe- rson, who spearheaded the geography program at the normal school in Ypsi- lanti decades ago when only a handful of Ph.D. programs were in existence, is an exception.
4. Donald Zeigler of Old Dominion Uni- versity, a Past President of Gamma Theta Upsilon, received the first award.
6. Created by the late Wes Dow, our discipline’s oral historian, *Geographers on Film* included filmed interviews of more than 300 geographers (Martin 2013).
7. Leon also served as the director of the graduate program in Urban Studies, supervised master’s theses, and helped to hire faculty, a number of whom he continues to mentor. He also designed a new curriculum in liberal studies, which became one of the most popular majors on Southern’s campus. It’s little wonder he received a number of honors and awards from Southern Connecticut State University, as well as societies devoted to academic geography.
9. Although Leon’s stay in the U.S. has continued to the present day, he frequently returned to the country of his birth, developing an academic interest in this part of South America, as well as Latin America in general. His (1987; 1989) publications on demography in the country of his birth offered much insight concerning regional migration patterns, and collaborative fieldwork in biogeography (e.g., Mione, Leiva G, & Yacher 2000; 2005) resulted in the discovery of new plants in the Andes.
10. Incidentally, it was Leon who steered me to *Topophilia* as an undergraduate, which intrigued me to no end, and later I also wrote to Tuan asking for references to which he also responded. It is interesting that merely a brief response from a luminary that at the time had amassed a hundred and twenty some odd publications meant so much, and still does to this day.
11. Leon presented papers on the subject at regional meetings of the Association of American Geographers, which were
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13. Leon also interviewed the editor-in-chief of Cuba’s official government newspaper.

14. More recent collaborative fieldwork has occurred in southern Africa, where Leon also has engaged in the photography of both natural and cultural landscapes (and, as seen in Figure 1, has been photographed interviewing indigenous people as well).

15. Yacher’s scholarship to date has been evidenced by the publication of a book, a monograph, and more than fifty articles and chapters in books; he has also presented numerous papers at academic conferences across the globe.

16. Bass (1985) asserted that a transformational leader “motivates us to do more than we originally expected to do” (20). Transformational leadership is considered a superior form of leadership behavior (DeVivo 2015).

REFERENCES


_____ . 2008. Dos nuevas especies de *Jaltomata Schlechtendal* (Solanaceae) del


All manuscripts must be in acceptable format and ready for peer review. Contributions to The Geographical Bulletin of Gamma Theta Upsilon should follow the general specifications:

1. All manuscripts should be double-spaced on 8 ½" x 11” page size with 1 ½” margins. Use 10 or 12 point fonts only. Use the same type style and font size throughout the paper. Please italicize book and periodical titles.

2. Submit 1) a digital copy of the manuscript in Microsoft Word format, 2) all figure/table files, and 3) a separate Word file with all figure/table captions. Give the tables and figures consistent titles, with the author’s name in each (e.g., SmithFigure1.jpg; Smith-Table2.xls; SmithCaptions.doc). If the files are too large to submit as e-mail attachments, please use an online file-sharing service such as Dropbox or Google Drive, and make all related files available to the Editor.

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