Creating Marketing and Promotional Materials for Advocates of Dark Sky Preservation

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D-Term

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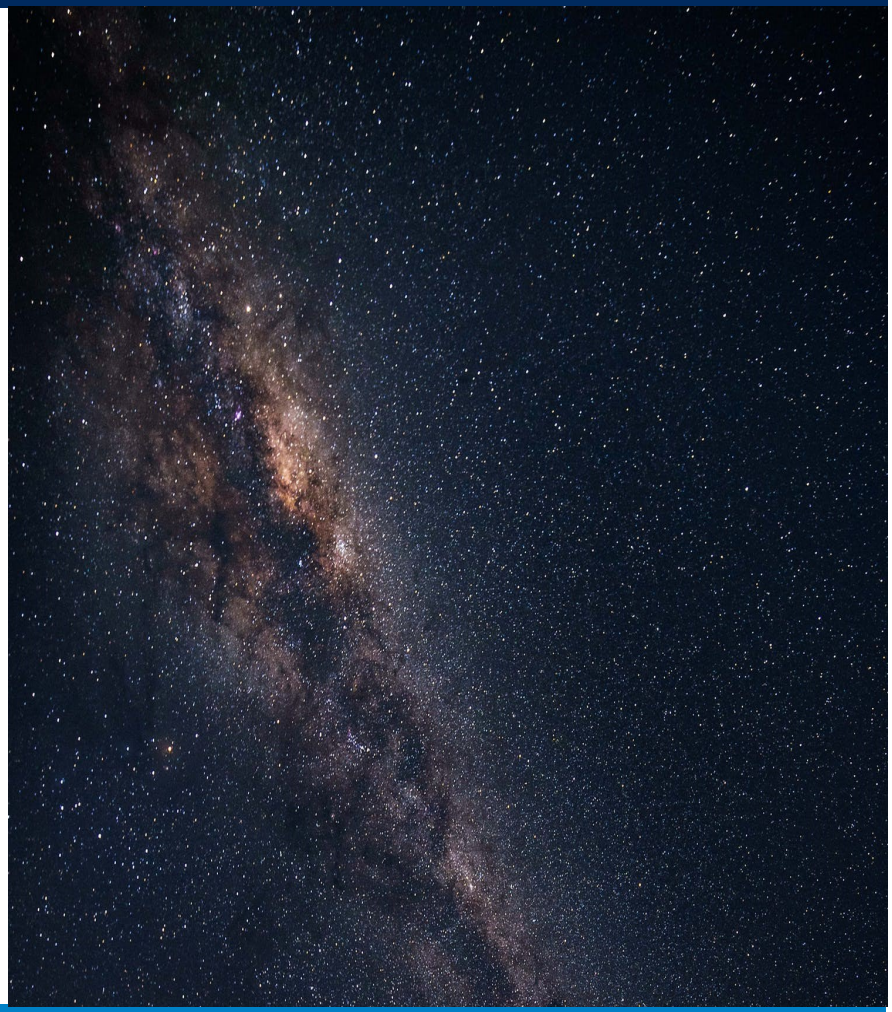

Artificial light emissions at night have caused an increase in the phenomenon known as light pollution, where dark night skies are illuminated by light sources on the ground. Our team worked with the Leibniz-Institute of Freshwater Ecology and Inland Fisheries (IGB) to promote organizations who advocate for the restoration of night skies. Our project consisted of creating marketing and promotional materials for the citizen science endeavor, the Loss of the Night app, and a scholarly journal, the International Journal of Sustainable Lighting (IJSL). Our team combined research and survey analysis to create deliverables for the organizations within the given parameters, where both the Loss of the Night app and the IJSL required a social media plan, and further development produced a tutorial video for the app and a promotional poster for the journal.

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WPI

Light Pollution: A Blinding Problem

Light pollution is the brightening of the night sky caused by artificial light sources. The *Space Daily* Journal found that nighttime light emission is a global issue increasing at 2% per year that affects everything and everyone in an environment from bugs and animals to everyday people.[1] While light is necessary for visibility and safety, much of it is wasted into the sky or in used areas where the light is not needed.

While the scale of light pollution is global, any locality should be interested in finding solutions to the issue. Since light pollution is concentrated around high-density populations, we explored the situation in Berlin, as our sponsor is located in Germany. Currently, light pollution in Berlin is not being effectively addressed. As seen in Figure 1 below, light pollution affects the entirety of Berlin. The issue has become so significant that an article written in *Der Spiegel International Newsmagazine* cited that over 44% of Germans under the age of 30 have not seen the Milky Way as of 2013.[2]

Organizations such as the International Dark Sky Association (IDA) recognized light pollution as a pressing matter that needs to be dealt with and advocates for reduction in night time light emissions because it harms our planet and prevents the opportunity to experience the wonder of the night sky.[3] Awareness groups and programs have been made to illuminate the problem, yet, there are many challenges including lack of public awareness and concern regarding the harmful effects of light pollution. The Helmholtz Centre for Environmental Research created and distributed a survey to 205 light pollution experts across three continents, with questions pertaining to difficulties in dealing with light pollution. Of the total respondents, 97% replied that a major issue with reducing light pollution is that many people are not aware that light at night has harmful effects, showing that lack of awareness is a key missing factor for creating a solution.[4]

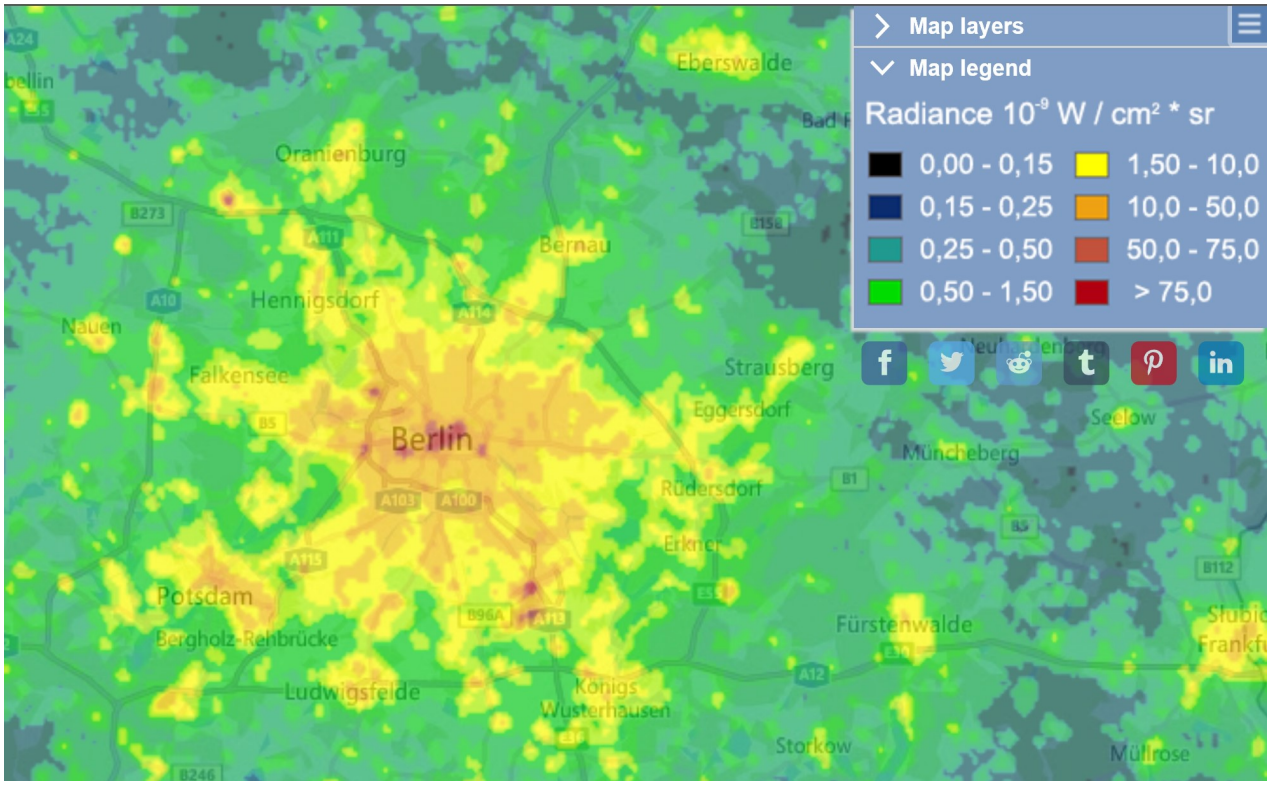

Figure 1: Radiance Levels of Berlin, 2019

The Leibniz-Institute of Freshwater Ecology and Inland Fisheries (IGB) is a research center focusing on freshwater research. They are concerned with sustainability on all fronts, including lighting and how it affects the environment, in addition to supporting citizen science and open access organizations like the two our team were working with. They are collaborating with the *International Journal of Sustainable Lighting* and the *Loss of the Night* app, to increase the user base of these resources. The *Loss of the Night app* was created by Dr. Christopher Kyba, designed to gather data

collected by its users. Our group identified that a marketing approach would be the optimal way of increasing the visibility. Our project sought to help the IGB increase the visibility and usership of the *Loss of the Night* app and the *International Journal of Sustainable Lighting*. In order to reach these goals, our work consisted of the following objectives:

1. Create marketing materials and strategies for the *Loss of the Night* app
2. Develop marketing materials and strategies for the *International Journal of Sustainable Lighting*

In order to accomplish these objectives, data was obtained through interviews, surveys, and analysis of the current statistics of the app and journal. Our materials were made with the intention of helping the IGB increase the usage and visibility of the *Loss of the Night* app and the *International Journal of Sustainable Lighting*. Increasing usage for the app will allow more measurements to be taken, creating a more comprehensive map of data points to track. The IJSL will see the advantages of highlighted visibility through a future increase in impact factor and reputation.

Background

Light pollution is the misuse of artificial light that negatively affects the surrounding environment by brightening the night sky. However, in comparison with other environmental problems around the globe, light pollution remains a low priority. In this section, we will give a general overview of the types of light pollution and the effects caused by light pollution. We will then explain how the general public is unaware of the problem, and give examples of how to rectify the situation.

Main Types of Light Pollution

In a general sense, there are three main types of light pollution: glare, trespass and skyglow. Glare is the main form of light pollution. It occurs when the use of artificial light is uncontrolled, thus causing a visual sensation that is rather uncomfortable for the eye. Uncontrolled light is referred to as artificial light that is not appropriately designed. Proper lighting designs focus on the direction of the light in the intended area. Improper light fixtures allow uncontrolled light to reflect off surrounding objects, thus intensifying the glare effect. Figure 2 depicts different types of street light fixtures utilized. When lights are uncontrolled, they can reflect off neighboring objects that intensifies the lights causing an increase in the effects of artificial light.

Another form of light pollution is called light trespass. Light trespass occurs when unwanted light is directed into a space in which it is not intended. This unwanted light is also defined as spill light. For example, a street light that shines into a window of a house or building. This can occur when light sources are not properly guarded. There has been a recent push to reduce this form of light pollution by redesigning light covers to direct the light in the intended space. Light trespass can also occur when lights are not properly angled. When lights are not angled to luminate the intended area, the light tends to shine in unwanted spaces. Light pollution defined as light trespass can be rather subjective, however, because it is difficult to determine when, where, and quantify how much light defines light trespass. Nonetheless, light trespass defines the waste of artificial light.

The last form of light pollution is skyglow. Skyglow occurs when surrounding areas are excessively illuminated to the point where a glowing effect can be seen from far away. Typically, the amount of skyglow increases with the population size and density of urban areas. Much like glare and light trespass, skyglow can be caused by intensified and unprotected light sources. The National Lighting Product Information Program cited that street lights are one of the most significant causes of skyglow.[5] In an effort to curb this, street light fixtures have been redesigned to light the amount of upward light emitted. As only the street needs to be illuminated, the International Dark Sky Association stated that light emitted upward, measured in terms of the ratio of upward light output (RULO), is a waste of light.[6] Illustrated in Figure 2, the first example of a light fixture emits the most upward light. Skyglow can be caused by not only light directed upward, but also light that is reflected off the ground and intensified by dust and gas molecules in the atmosphere. Depending on immediate weather conditions, skyglow can vary tremendously. The glowing effect is primarily caused by the reflection of light in the atmosphere, thus, on nights where weather conditions are poor, skyglow can be more

Figure 2: Different Light Fixture Designs in Respect to Their Ration of Upward Light Output

visible than on a clearer night. The increase of artificial light emissions at night perpetuates light pollution of the night sky, which contributes to negative effects felt by the local environment and human inhabitants alike.

Effects Caused by Light Pollution

Throughout the world, light pollution is a rising ecological issue that has been linked to various environmental issues for both humans and ecosystems. Although the use of artificial light is human made, humans can be negatively affected by these lights. Glare light pollution by either street lights or even headlights on cars can cause unsafe driving conditions. In fact, the National Highway Traffic Safety Administration declared that artificial glare is a rather large cause of many car accidents.[7] Glare produced by vehicles moving in opposing directions can cause decreased visibility distance for drivers and increase reaction times needed to avoid an accident. In addition, glare light pollution can also cause direct damage to human eyes, especially the older one gets. This is due to the glare light causing loss of contrast as it enters the eyes, which can also cause temporary blindness. Artificial light has been linked to many disorders. The human body produces melatonin when it is dark; excess light emissions at night suppresses this production. This has been related to various health problems, such as sleep disorders and anxiety. These effects on one's health can eventually lead to depression, which illustrates a link to the effects of light pollution on the human body.

In addition, many people's hobbies and professions are compromised by night-time light pollution, specifically astronomers. In order to view stars accurately, astronomers in cities are forced to travel to remote locations that are unaffected by light pollution. This can be limiting to the astronomer. Across Europe, the visibility of stars is minimal as depicted in Figure 3, which shows the number of visible stars throughout different parts of Europe. It is evident that most of Europe has limited access to visible stars, and an article published in the *Science Advances* journal cited that 60% of the European population as of 2016 cannot see the Milky Way.[8]

Light pollution can also have very problematic effects on animal life around the world. Similar to human beings, wild animals depend on natural light and darkness to trigger bodily instincts such as when to eat or sleep. When excess light enters an animal's environment, the animals think it is still

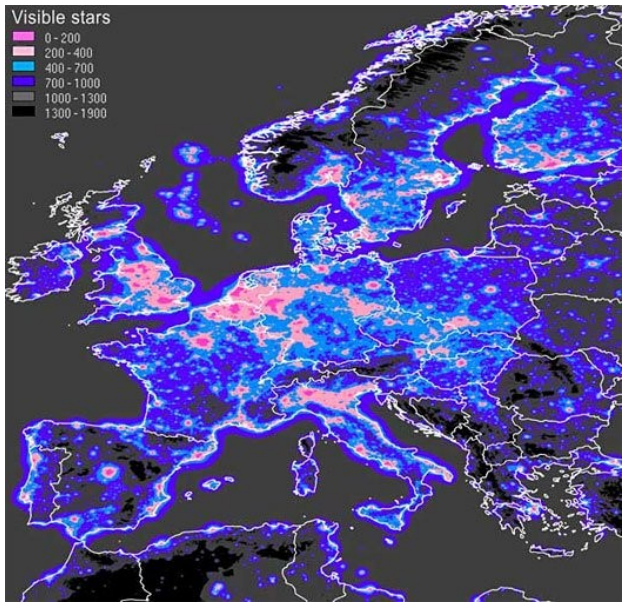

Figure 3: Distribution of Visible Stars throughout Europe

daytime.[9] All forms of light pollution affect living beings, altering their natural tendencies and instincts.

Much like animal life, light pollution can be very harmful towards the plant life of ecosystems. Light pollution has been linked to the decline in coral reef population through the masking of the moon phases for which they depend on to reproduce. Excess light penetrating forests can lead to some species of plants to not grow flowers. This makes the rate of reproduction of plants through pollinators decline, thus destroying our ecosystems. Due to the saturation of nighttime light sources, spurred by developments in lighting technology and access, the negative effects of light pollution go unnoticed as shown by the billions of dollars a year in wasted lighting in the United States alone.[10]

People are not Aware of Light Pollution as a Problem

Light pollution is not a priority for most people, and in some cases is not a concept with which people are familiar. Compared to other environmental issues, such as climate change, light pollution has had little research done on the subject. This is in part due to the negative effects of light pollution being more indirect than smog, litter, and other, more obvious signs of pollution. Developments in technology show the disinterest of people in reducing light pollution. When offered a superior product, people often do not consider the long-term consequences of using it, exhibited in the rise of consumer demand for Light Emitting Diodes (LEDs). According to the *Environmental Quality Management* journal, LEDs are attractive to consumers because they take less power to light and last longer and brighter than traditional bulbs.[11] The *Journal of Ecological Applications* stated that the popularity in LED lighting has contributed to the rise in nighttime light emissions by emitting more powerful light into the night sky, including harmful artificial blue light.[12]

While there seems to be an obvious solution, turning off outside lights at night when they are not needed, it is not that simple. To keep up with the round-the-clock life in the 21st century, the world has developed lighting strategies that allows us to continue daytime activities throughout the night. Lights are thus left on at night for a myriad of reasons including visibility on roads and walkways, security, and aesthetics. But there is evidence that certain uses of light are due to misconceptions or misinformation. For example, studies have shown that leaving lights on at night for security causes vulnerabilities that would not occur if no lights are on. The study, published by the Astronomical Society of Victoria, showed that lighting a property with security lights creates a built-in source of light for potential burglars and limits visibility for whoever is inside.[13] Thus, the

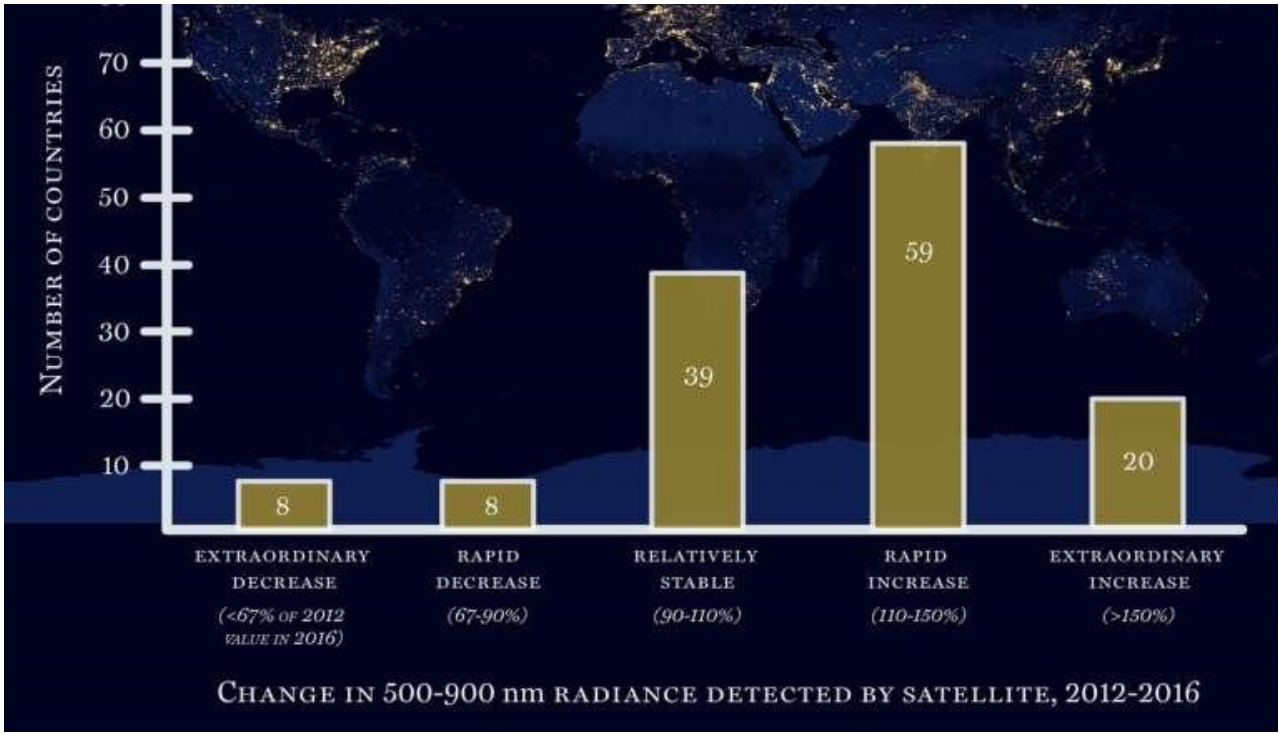

Figure 4: Change in Radiance Detected by Satellite

excess lighting poses more of a danger than a benefit both in safety and in the light pollution that it creates.

Light pollution levels are increasing in many places across the globe. A study from 2012 to 2016, as illustrated in Figure 4, shows the increase in radiance in the 500-900nm wavelengths given off by 134 countries measured by satellites. The study, published by the *Science Advances* journal, showed that 42% of the countries that were studied experienced a 110-150% increase in radiance.[14] With the majority of countries showing some sort of increase in radiance, it shows that nighttime light emissions are a growing problem for many countries across the globe. For people who do not know or care about the problems associated with nighttime light emissions, it is important to find and give them reasons to care. Widespread use of LEDs and misguided reasons for turning on lights at night contribute to light pollution, showing a lack of concern for light pollution and highlighting the importance of creating motivation for using sustainable lighting. Since the public is not aware of the adverse effects of light pollution, few laws or regulations are considered and enforced to remedy the issue.

Government Regulations are Important to Solve the Problem

As light pollution becomes a larger problem with each passing year, the need for stronger government regulations becomes apparent. Although new laws would be effective, there are not enough laws in place across the world. In the US only certain states and laws aimed at reducing light pollution; these include eighteen out of the fifty states, the District of Columbia, and Puerto Rico.[15] For example, the state of Texas prohibits the use of state funds to install or replace outdoor lighting that does not maximize power efficiency and minimize light pollution. However, this law allows for numerous exemptions such as emergency lighting, night time construction, street lights, and more. Most other states include laws that encourage local governments to create laws specific to their area known as "dark sky laws".[16] The problem of lax laws is not limited to the US. In Hong Kong, the only lighting ordinance in place, known as the Guidelines on Industry Best Practices for External Lighting Installations, is not mandatory. All it does is encourage businesses to turn off outdoor lights from 2300 to 0700 hours. Since it is a voluntary practice, it has not been effective, and night time outdoor lighting has continued.[17]

The main reasons that laws about light pollution are not widespread are ignorance and commercial lighting interests lobbying against governmental regulations. Light pollution experts have found that many people do not know that light pollution is a significant issue, as evidenced by Figure 5. This ignorance is further perpetuated by misconceptions about lighting. People tend to feel safer in a well-lit area, but evidence has shown that the amount of lighting in an area has little to no effect on crime.[18] Also,

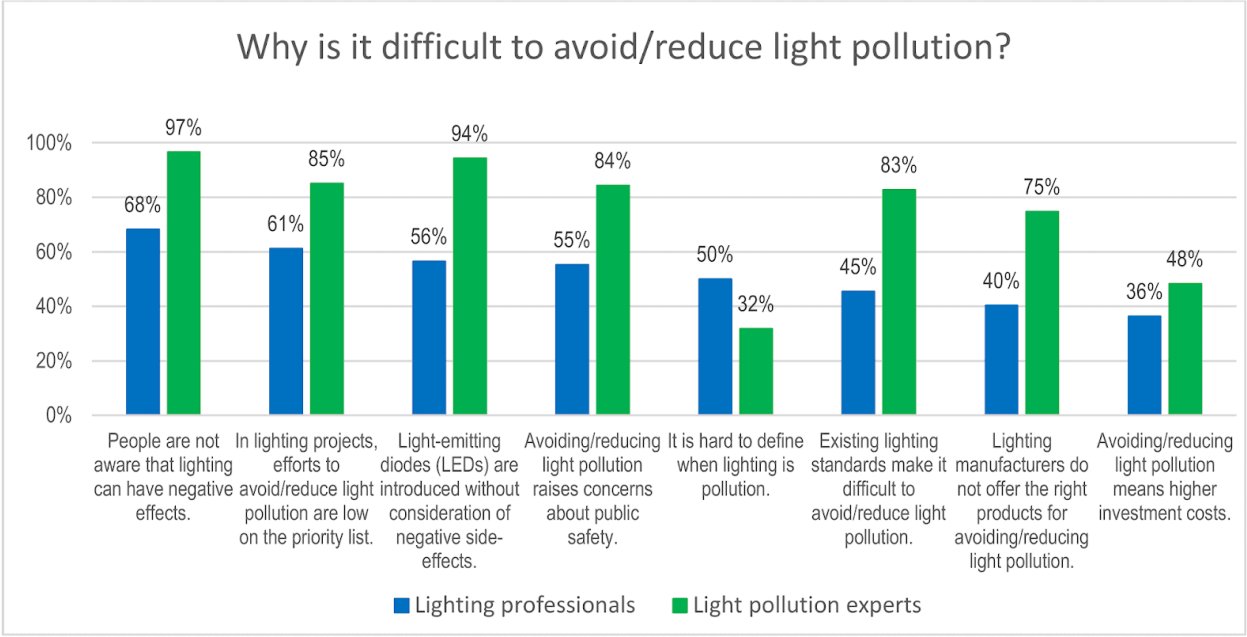

Figure 5: Results from a light pollution survey directed towards experts

people think that more efficient LED lights are completely better for the environment than older lighting technologies. While this is the case in terms of energy efficiency, the harmful effects of the increased brightness offered by LEDs are not considered, shown in Figure 6.

Another reason behind lack of effective ordinances is that light pollution is being downplayed as an issue by lighting professionals. Figure 5 depicts the results from a survey given to 205 lighting professionals and light pollution experts regarding the struggle to reduce light pollution. The results show that lighting professionals consistently agreed at lower rates than light pollution experts on questions highlighting the negative effects of light pollution. The lighting industry has a vested interest in selling more lights, which in turn leads to light pollution increasing as more lights are installed, along with the lights themselves becoming brighter. The lighting industry also lobbies governments to have looser restrictions in place regarding light pollution and efficiency. From 2017 to 2019, The National Electrical Manufacturers Association, a lobbying group that represents national brands such as General Electric and Philips, spent over 5 million lobbying against pollution and efficiency standards.[19]

The lack of night time lighting ordinances is a concern because they have been proven to be effective. Northern Italy has some of the strictest laws against light pollution. The National Unification Italy (UNI) 10819 regulation, created in the spring of 1999, tolerates a maximum of 1% of the total light from any light source to be emitted upwards.[20] Placing these limits, in addition to subsequent laws reducing light emitted above horizontal, was effective because 75% of skyglow is caused by upwards directed light. As a result, light pollution has not increased since the law has been in place, despite continued installation of new light fixtures.[21] Another effective law can be seen In France, where offices are required to turn off all lights no longer than one hour after the last employee leaves. Along with this, public buildings and shops must turn off all lights at 0100. These laws allow France to preserve as much energy as 750,000 households would use each year. With the introduction of such measures by other countries, the annual growth rate of light pollution can be decreased and ultimately halted.

The creation of effective regulations requires an increase of public and research. As noted by Lukas D. Schuler in *Environmental Science and Policy*, spreading awareness of the many issues caused by light pollution within the public increases the likelihood of new laws being proposed.[22] A second hurdle when creating regulations is understanding the issue and its effects. To aid in research, citizen science can be a helpful tool in collecting, analyzing, and understanding data so that a quality solution to the issue can be created. With enough research and awareness for the problem, appropriate laws and regulations can eventually be developed to handle the issue.

Citizen Science is Critical to Developing an Effective Solution

A key factor in spreading awareness and providing research and data about light pollution is citizen science. Citizen science is a method for scientific research that involves the collaboration between a small group of professional scientists and a much larger group of everyday people known as citizen scientists. The scientists leverage the interest and energy of citizen scientists to gather a large amount of data that they would not feasibly be able to collect themselves. After conducting research in the viability of citizen science, NASA astronomer Sten Odenwald commented on the fact that citizen science projects get cited four times more than those sources not involving the public, saying "This should be very heartening news for citizen science project developers, and encourage scientists to seriously consider citizen

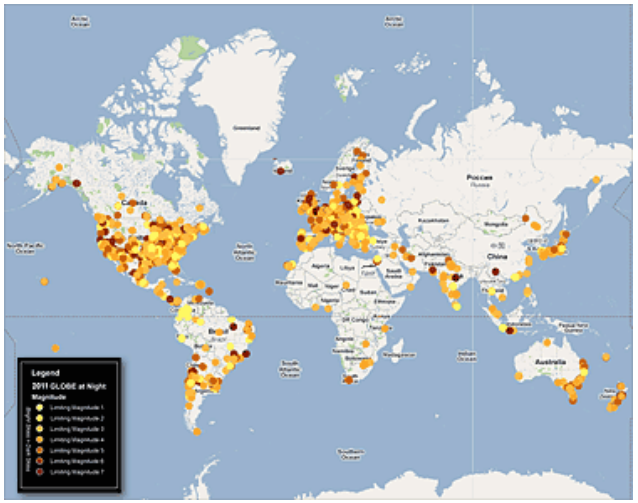

Figure 6: 2011 Globe at Night Observations

science project methodology as a valuable adjunct to how they conduct their research," showing his support for citizen science's involvement in research.[23] This large amount of data is extremely valuable to the scientific community as it can be analyzed by scientists to produce meaningful, quality research.[24]

Tasks required by citizen scientists are typically relatively simple in order to negate the need for formal training. According to Jennifer Shirk, who contributed to the *Handbook of Citizen Science in Ecology and Conservation,* simpler tasks make it easier for volunteers to collect higher quality data and widen the scale of research.[25] In the case of light pollution, the blog site for the *Loss of the Night* app asks its users to estimate the number of visible stars in the sky.[26] Due to the simple methods of data collection that the app employs, there is a potentially massive pool of participants. If it can be promoted in an effective way, a citizen science application can spread awareness to its many users and provide a great deal of data and research on a subject.

The magnitude of the research and public awareness generated by citizen science is critical to developing solutions to the issue of light pollution. When the public becomes familiar with the issue and requests regulations to curb it, scientific research will help back up any proposed laws. Participation of citizen scientists generates amounts of data that are not possible from small groups of scientists, which increases the validity of its claims. Figure 6, a map detailing the results of over 14,000 observations submitted by citizen scientists, demonstrates the potential of citizen science to contribute immense data sets. It is clear that citizen science can be a valuable tool to both spread awareness of light pollution and provide evidence for future programs, initiatives, and changes.

Methods

To complete the project, our two objectives were to develop marketing strategies and materials to increase the usage of the *Loss of the Night* app as well as increase the number of articles published and the reader base of the *International Journal of Sustainable Lighting*. In this section, we outline the specific actions taken to complete both objectives. Figure 7 displays the process utilized to accomplish these objectives.

Objective 1: Develop strategies to increase the usage of the *Loss of the Night* app

The Loss of the Night app can be defined as a citizen science project as it depends upon its users to collect data to be mapped. By

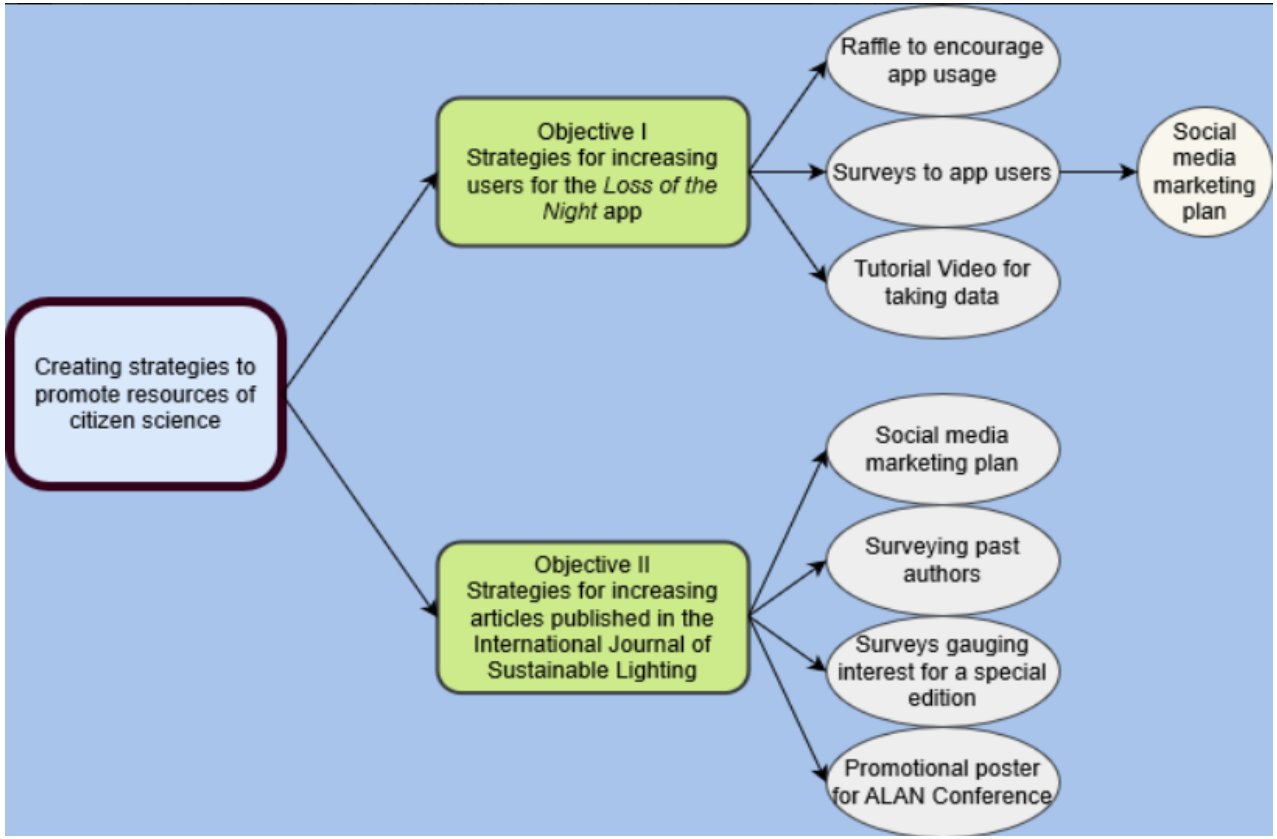

Figure 7: Roadmap for methods

increasing the user base of the app, it creates a larger force of citizen scientists, therefore expanding the scope of the project. To start increasing the user count, we sought to learn how to improve the app. We employed surveys as our first method to get valuable feedback, which provided data directly from the user base about the app's user interface, function, aesthetics, and future improvements easily from a large number of users. This was accomplished by emailing a pre-existing mailing list, of about 250 people, and newer users who took their first measurement in the last 60-120 days as of April 2020. Additionally, we created an advertisement for a raffle held by our sponsor for a TESS photometer. A TESS photometer is a sensor that measures the sky quality at night. The advertisement was mailed out in their newsletter, in which one set of eight measurements submitted on the app gave one raffle "ticket". The Loss of the Night team hoped that by creating an incentive, users would be more likely to take measurements. Social media advertising is another tactic we used in promoting the app. With social media advertising, we can present our app to a much larger pool of potential users and we can target a specific demographic of people, specifically people who have shown an interest in citizen science or ecology. Figure 8 is the social media marketing plan we executed. The data collected through the survey of our app users helped us narrow down our demographic further. We used social media statistics websites to find the best places to advertise our app.[27]

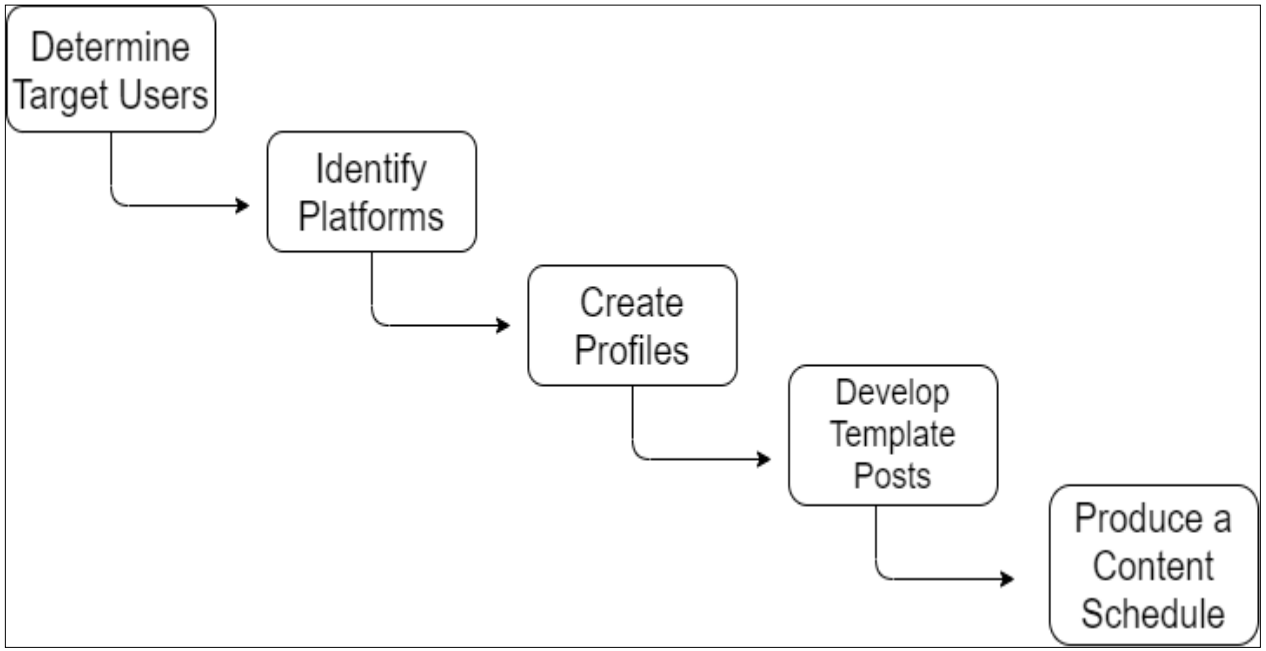

Figure 8: Social Media Marketing Plan

A final strategy for increasing the accessibility of the app is providing more documentation and support for the use of the app itself. Currently, the *Loss of the Night* app has text guides for taking measurements, which are helpful, but are not supplemented by a video. The existing tutorial video was found on YouTube. It was over two minutes long, which some sources say is too long for a tutorial video.[28] Therefore, we constructed our video to be less than ninety seconds, which encourages viewer retention and allows the video to be put in the app directly. Our video was based on the existing tutorial, specifically explaining how to take measurements. Within this, we put more emphasis on using the human eye to observe rather than the phone's camera, which were major sources of confusion among users. Creating a short, concise tutorial video will help new users become fluent with the app's function which will help in retaining users in the future.

Objective 2. Develop marketing strategies for the *International Journal of Sustainable Lighting*

The International Journal of Sustainable Lighting (IJSL), is an academic journal that publishes materials pertaining to sustainability and the issues with lighting. Our goal is to help find ways in which the IJSL can expand its library and increase its impact factor. In order to learn about potential changes or improvements, our group began by surveying

authors of papers published within the *IJSL* to gain critical insight into people's opinions about the journal. The research involved reaching out to all previous authors of the journal and requesting them to fill out a survey using the Qualtrics software. This survey was sent via email to the authors as email yields the fastest response time for a survey.[29] It contained questions regarding how they heard about the journal, their reasons to publish in it, and what they liked and disliked about the process of publishing their papers. Using the responses collected, we proposed suggestions to increase the journal's visibility and impact.

In addition to surveying past authors, we also surveyed attendees of the Artificial Light at Night (ALAN) Conference. The ALAN conference is an event that hosts members of our target audience to engage in conversations and spread connections. Instead of asking for opinions of the journal, we sought to gauge the interest of the attendees in publishing their work in a special 'ALAN Conference' edition of the *IJSL*. This survey was sent out by email to the ALAN Conference mailing list. To further promote the journal at the ALAN Conference, we developed a promotional poster to be displayed at next year's ALAN Conference. The poster advertises the benefits of publishing in the *IJSL* and will be seen by all attendees, emphasizing the open access nature of the journal. Combining the information we gathered from research and results from the field, we created strategies and materials with the ultimate goals of seeing more scientists who are willing to have their work published by the journal and gaining more readers.

Social media is an excellent platform for advertising because it instantly provides access to millions of people, allowing us to directly reach our target audiences: scientists, researchers, and industry experts in lighting and sustainability. To find these groups and individuals, we leveraged trends and groups on any given platform. In Germany, Facebook is the most commonly used social media platform, with 53.61% of user share as of January, 2020.[30] On Facebook and other social media platforms we created an account for the *International Journal of Sustainable Lighting*. We subsequently created templates and suggestions for content to reach out and engage people with similar goals and knowledge about sustainability and lighting. This will allow the *IJSL* to continue posting content to keep an engaged community with minimal effort after our project timeframe.

Analysis for the basis of our marketing strategies

To conclude our research, we reported and analyzed data acquired through our methodology crucial to the impact of our project. Through analysis of the results from a user survey, we determined trends and themes that were applied to the design of our social media plan. Along with this, we gave the design process for creating our deliverables to meet the parameters curated by our sponsors. Additionally, our survey to the ALAN conference attendees gauged the interest of authors to publish in a special edition of the *IJSL*. Finally, we gave an in-depth social media strategy for the *IJSL*.

Survey results define the demographics of the current app users

Prior to being able to properly promote the app, we had to acquire key information about the demographics of the app's users. We wanted to hear from *Loss of the Night* app users via survey, to explore who was using the app and why. Our survey was sent to all users who provided their email in the app, and of the total 350 people on the list, 51 responded. The statistics of the survey provided vital information about the app users. We found that 90% of the respondents answered that they were over 30 years old, with 48% of the respondents falling in the 51-70 range. Further analysis showed that most of the respondents had a high level of education. Only 28% of respondents did not have a 4-year degree, and 46% held a master's degree or a doctorate. These data points mark a clear absence of users in the younger generation, those without an advanced degree, and those who might not already be interested in science. Based on these findings, we can conclude that the user base is mostly made up of highly educated individuals who are between 41-70 years old with interest in citizen science . This assertion can be proven by our

investigation into why people choose to use the app, where we found that 47% percent of responses included reasons citing astronomy, science, and light pollution. In addition, we found that when asked how the respondents had heard about the app, 28.3% said they had heard about the app on a citizen science outreach platforms. This marked an important step in defining a general subject matter for promotional materials.

In order to determine the ideal approach with which we would promote the app, we sought to figure out how users first heard about the app. Of the 51 respondents, only 11 (or 21.6%) had heard of the app through social media. This statistic is surprising due to the high online presence of scientific experts on media platforms such as Twitter, yet also might speak to the age gap in the user base. Thus, this provided an opportunity to further extend the promotion of the *Loss of the Night* app on platforms that have yet to be reached.

Survey Results Mark Direction for Social Media Strategies

The analysis of the survey provided crucial information to inform our social media strategy. We decided to bolster the online presence of the app through a social media kit. The kit focuses on platforms, Twitter and Reddit, and provides recommendations and guidelines for our sponsor and potential future staff to effectively leverage the platforms. The full kit, which contains rationale, recommendations, and relevant information on how to use each platform, is located in Appendix F.

Twitter Allows for Connection to All Age Groups

The survey showed that most app users are between the ages 41 and 70. Twitter, with 330 million users, would allow the Loss of the Night to extend its name to all age groups, including younger generations that may still be in school. As shown in Figure 9, Twitter users who are 50 and older only make up for 24% of the entire population of adult users. The survey revealed that ten percent of the app's users are under 30 years of age and, with its large proportion of younger users, Twitter allows the app to be marketable to a broader range of people.

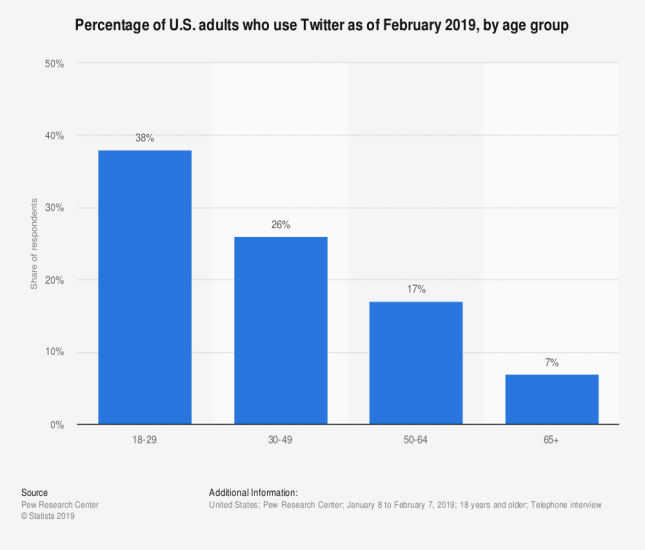

Figure 9: Distribution of Twitter users by age group

In addition, a significant proportion (47%) of survey respondents indicated a motivational interest in science, astronomy, and light pollution in engaging with the app. Twitter provides a platform for the scientific and academic community, so the Loss of the Night should leverage the congregation of these communities by utilizing the tools provided by Twitter. For example, hashtags are used in posts that are related to a current trend or topic. Hashtags are essentially a link between posts, allowing people to search for that hashtag and see all posts that contain it. The Loss of the Night can take advantage of the attention on a relevant topic such as astronomy or light pollutionand attach the most popular hashtags to its tweets.

Using Reddit to engage with new audiences

While Twitter provides the opportunity to engage with the scientific and academic communities, other social media platforms can be used to include new demographics that the Loss of the Night has not reached. Survey results

demonstrate app users who are motivated to take multiple observations are those that have an interest in light pollution, its effects on astronomy, and science in general. Those who have interest in these topics can visit a variety of platforms for information, including Reddit. Our goal with Reddit is to increase name recognition and participation in the Loss of the Night app to users under 30. In contrast to Twitter's 88%, only 43% of Reddit users are over 18, as shown in figure 14. Promoting on this platform will increase the odds of the Loss of the Night app being recognized by younger people.

A feature unique to Reddit in contrast to Twitter is the use of subreddits. Subreddits are communities focused on a specific topic. These subreddits range from a couple hundred members to millions, and there is a subreddit for nearly every topic imaginable. The subreddit format creates an easy way to promote the app to subreddit communities that are passionate about light pollution. There are many subreddits that are focused on space and astronomy, topics that are heavily impacted by light pollution. Some particular subreddits that fit this description are "r/space" with over 16 million subscribers, and "r/astronomy" with over 1 million subscribers. By posting relevant content promoting the app on these subreddits, we can possibly reach millions of potential users easily and for no cost. Another advantage to Twitter is that Reddit is not intended for following specific accounts, but rather subscribing to whole communities; thus, individual entities do not need an existing following to gain traction and attention.

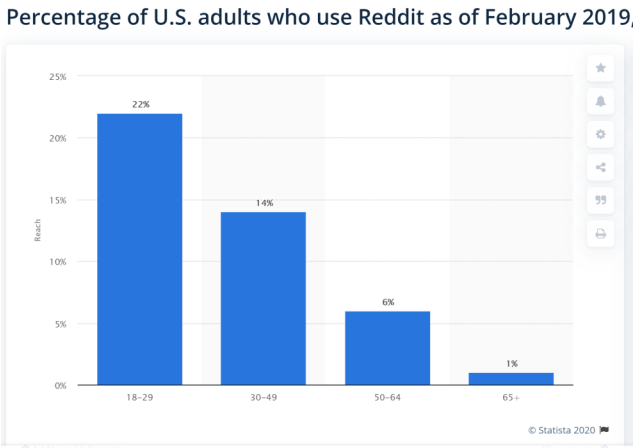

Figure 10: Percentages of people of use Reddit

A Social Media Guide is useful to raise online presence

Combining our analysis of the survey and social media research, we developed a set of guidelines for the Loss of the Night team. The guide is a document outlining the advantages and nuances of using each respective platform. This guide consisted of three categories: post timing, what material to post, and how to increase and engage with followers. For example, good posts would consist of engaging visuals and trending topics. The posts should be made on Twitter in the timeframe between 0700 -1000 from Monday through Friday.[31] Following the recommendations, we gave several example posts for both platforms. Since the point of creating an online presence is to increase brand awareness, a part of posting content will be self-promotion. However, when promoting on social media, it is important to take a step back from self-promoting posts and include posts that are interesting and engaging. These posts can be images, quotes, or recent news, that followers may find interesting. For Twitter, we concluded the guide with relevant hashtags to use in posts, as shown in Table 1, and for Reddit, we concluded with relevant subreddits to join and contribute to, as shown in Table 2. Results from research and survey

Table 1: Relevant Hashtags for the Loss of the Night

Light Pollution	Citizen Science	Environmentalism	Astronomy/ Space
#darksky	#doyourpart	#sustainablelighting	#stargazing
#darkskies	#scientist	#lightpollution	#science
#lightpollution	#citizenscience	#awareness	#astronomy

Table 2: Relevant Subreddits for the Loss of the Night

r/space	r/lightpollution	r/astronomy	r/citizenscience
r/darksky	r/telescopes	r/environment	r/sustainability

distributions provided the insight needed to create a social media guide.

A tutorial video will increase comprehension of app function

Based on the previous experiences of the users mentioned by our sponsors, some users had difficulties figuring out the functionality of the app, specifically the process of making measurements. The goal of our tutorial video was to be short and focused on aiding users in the process of making measurements. Our research concluded that tutorial videos should be as short as possible. Thus, we developed a short ,less than 2 minute video that put emphasis on using the eyes rather than the phone's camera and proper locations to observe. In order to determine the effectiveness of the video, we surveyed 10 individuals of varying ages, having them try to use the app before and after watching the video and rating whether the video was helpful or not in teaching them how to take measurements. Out of the 10 people, all of them found the video to be helpful. While this is a small sample size, it seems likely that our video is indeed helpful in raising the competency of users.

Survey Results Determine the Viability of a Special Edition in the *IJSL*

Prior to the start of this term, our sponsor and the IJSL were considering a special issue to promote the ALAN conference and the specific research that would be highlighted at this year's convening. To determine for our sponsor whether a special edition of the *IJSL* would be viable, we sent a short survey to all attendees of the 2020 ALAN conference. The intention of the "special edition" survey was to gauge the interest of authors to publish their work that was presented at the conference. The special edition is important because it connects the *IJSL* with the ALAN conference, therefore, increasing the number of publications in the journal.. Upon analyzing the results, seven of the ten respondents said they were willing to publish work in the journal. We determined, with our sponsor, that the survey showed a significant enough interest to plan for a special edition of the IJSL.

A social media guide will help raise name recognition for the *IJSL*

Much like we did for the Loss of the Night, we developed a similar social media guide for the *IJSL*. This time, we chose to focus exclusively on Twitter. Our research showed that academics and scientists rely on Twitter to communicate and stay on top of current news. The social media guide was structured like our guide for the Loss of the Night. We included the same recommendations for how to successfully obtain, engage, and increase the followers for the *IJSL* account. Additionally, the example posts that we included were specific to

Table 3: Twitter hashtags for the *IJSL*

Light Pollution	**Citizen Science**	**Environmentalism**	**Publishing**
#darksky	#stem	#sustainablelighting	#peerreview
#darkskies	#scientist	#lightpollution	#openaccess
#lightpollution	#citizenscience	#awareness	#publishing

the journal, as well as the hashtags, which are displayed in Table 3.

A promotional poster will help raise awareness for the *IJSL* at the ALAN conference

The ALAN conference is an ideal opportunity to spread awareness of the *IJSL* as both the conference and the journal have a mission statement regarding light pollution. In an interview with the Chief Editor Dorin Beu, we learned that the *IJSL* fills a specific niche: emerging lighting issues such as chronobiology, light pollution, and sustainable buildings. We created a poster to be displayed in the reception area of the conference that extolled the unique advantages of the *IJSL* and a request for help in growing the journal, which is shown in figure 11. The goals of the poster were to highlight specific aspects of the journal. These aspects include that it is more nuanced than contemporary lighting journals, with a focus on sustainability through a multidisciplinary approach, and it is free to publish in and to read. The poster also provides an overview of the journal and encourages the readers to publish relevant material in the journal.

Figure 11: ALAN Conference poster

Conclusions and Recommendations

Our group dynamic include Ryan as the project manager, Kai as the designer, Aaron was the archivist, and Vinit was the communications manager. Our project consisted of two main objectives, creating marketing materials for both the *Loss of the Night* and the *International Journal of Sustainable Lighting*. Specifically, we created methods for our two objectives, that included surveying users to gain an insight into the user base of the app, surveying to gauge interest for a special edition of the journal, developing social media strategies for the app and the journal, and developing a promotional poster for the IJSL. Results for the app survey suggested an older age group with almost half the results being in the 51-70 range, likely part of an existing scientific community, and very highly educated, with 46% carrying a master's degree or doctorate Developing a social media strategy for the app required the research to decide upon the optimal platform. In the end we decided upon Twitter and Reddit because of how effective their features can be for the app. Because Twitter has the large presence in academia and Reddit is used by a high proportion of the younger generation, they deemed the best fit to market the app to both a new audience and expand the existing one. With the proper attention to the strategies given, specifically the social media tool kits, we believe that both the journal and app can see true increases in their viewership and user base.

Our work on this project met the parameters set by our sponsors. However, throughout the term there were extenuating circumstances that caused a colossal shift in our work patterns . The unusual circumstances caused by COVID-19 posed unique problems such as the reliance on remote working entirely which forced us to maximize our time management by exploring different applications for communication, different work dynamics such as work load management, and by utilizing screen sharing applications to collectively work on deliverables. Because of the international travel ban, the time -zone difference hampered our communication with our sponsors. Rather than sharing a workspace with the sponsors on a daily basis, we were forced to rely on the video conferencing. Along with this, we were limited to about one hour a week for discussion and feedback. However, all of the work was done efficiently and in a timely manner. Our deliverables were made with respect to the guidelines set by our sponsors and supported by research and analysis. For future continuation of the project, we would like to present a list of recommendations.

1.) Sharing the tutorial video and gathering opinions will illuminate areas of improvement.

We have tested our video on a few friends and family members each, but it would be good to get the opinions of a larger sample size. A survey to the email list simply asking for ratings for quality and effectiveness. Additionally, the video can be shared on social media, and the comment section can be analyzed for opinions as well.

2.) Tasking another team to analyze our strategies will prove the effectiveness.

Unfortunately, we are unable to see the impacts and effectiveness of our materials due to the limited seven week timeframe. Therefore, in the future, we suggest another group look into the statistics of the user base of the app and viewership of the journal after the introduction of our marketing plans. This will allow for further analysis on the impacts of certain marketing strategies, especially through social media, and the ability to adjust any strategies to optimize the interaction. Additionally, surveying the attendees of the ALAN conference to gauge the effectiveness of the IJSL promotional poster will reveal future improvements to the promotion of the IJSL.

3.) Hiring a postdoc graduate student to manage the social media.

One key element of our goal to promote the journal and app is the use of social media. Without proper attention, the social media guides provided will not be useful. We also identified that the current staff is at capacity for the number of responsibilities they have. Thus, we are recommending dedicating the time of a graduate student to take on this role and be hired each year to maintain that presence. a dedicated postdoctoral graduate student could be assigned as part of their work to the communities on social media, thus effectively market the two sources.

4.) A major update of the app's design and functions will attract and retain a larger audience.

Through the analysis of the survey results, we were able to determine that many people were unhappy with some of the app's functions. For example, notifications of when proper times to take measurements would be helpful to remind users. Also, an update on the app's star map would allow for observations to be taken more clearly and effectively. Our survey discovered that even amateur astronomers had a difficult time distinguishing the correct star in the sky. Lastly, another trend in responses deemed that the full length of eight responses required for a valid data set is too long. We recommend exploring an option for a shorter set of observations.

5.) Creating a logo for the IJSL will increase brand awareness

Although the IJSL is not a "brand", in the traditional sense, there is an opportunity to increase name recognition for the journal with a logo associated with it. The logo should characterize the spirit of the journal, in sustainability and lighting. Creating such an icon will be appropriate for creating a complete profile on social media platforms. This will help the journal achieve its goals faster, as a logo will help gain name recognition and a unique identity. It should be designed by a talented post-doc, professional, or a future IQP group who can place considerable time, talent, and effort into the creation of the logo. Creating a logo is an important strategic decision in developing a brand identity which will visually communicate the principles of the journal.

Conclusion

As evidenced by our analysis and recommendations, there is ample opportunity for the continuation of this work to promote the academic and collaborative study of light pollution and bring together citizens scientists and researchers to fight it. This project meant a great deal to us as it created revelations into the world of sustainability. It allowed us to research upon a topic of environmental conservation that is not entirely well-known, but is critical to a host of ecological processes. This project increases the visibility of a citizen science project, develops new venues for sharing work with the scientific community, and expands access to the research and insights found in the IJSL. In the future, we hope to see the implementation of the recommendations we provide above, leading to the effective marketing for the app and journal. Along with this, we also hope to see a future project continue what we have started and produce concrete results, raising the profile and the readership of the IJSL and participation by citizen scientists in work on light pollution. We believe these resources are important to the scientific community. Therefore, a continuation of this project will allow an increase visibility for the result of light pollution.

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