Urban Growth in Proximity to Joshua Tree National Park

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Abstract

This project looks at the growth around Joshua Tree National Park between 1994 and 2017 to quantify the amount of urbanization happening within 70 miles of this National Park. ArcMap was used to analyze population changes and land use changes within a 70-mile radius of the park. We found that population has increased in most cities close to the park and the developed land has increased by 2,726 acres between 2001 and 2011.

Introduction

In this project, we hope to use our data analysis abilities to succinctly determine the amount of urban growth surrounding Joshua Tree National Park (JTNP) located in the Colorado and Mojave Deserts in Southern California. JTNP is in close proximity to many major urban areas, including San Diego, Los Angeles, and up-and-coming housing areas such as Coachella and the High-desert. JTNP is a renowned national park for many reasons, including being home to 813 major plant species, 40 species of reptiles, and 240 bird species while also protecting 700 archeological sites, 88 historical structure, and 19 cultural landscapes (National Park Service, 2016). These all act as priceless additions to the park's natural beauty and attract guests from all over the world. Approximately 28% of the park's nearly 2 million annual visitors, come to the park for the night views. In July of 2017, JTNP was designated as the 10th Dark Sky International Park in the United States, meaning that it is a "land possessing an exceptional or distinguished quality of starry nights and a nocturnal environment that is specifically protected for its scientific, natural, educational, cultural heritage, and/or public enjoyment" (Sabala, 2017).

The need to analyze and monitor the urban growth surrounding the park is furthered by the Environmental Protection Agency (EPA) insistence that national parks skies be protected from certain levels of air pollution in addition to enforcing the nation-wide federal law, The Clean Air Act. Created in 1970, the Clean Air Act to enforces National Ambient Air Quality Standards (NAAQS) for hazardous air pollutants in the United States with the goal in mind that each state in the United States would achieve these NAAQS by 1975 (Summary of Clean Air Act, 2017). The act has been amended a few times throughout the years however, its goal of reducing the number of harmful air pollutants created by the United States still stands and affects the treatment of pollution in the areas around Joshua Tree National Park.

Joshua Tree National Park's air pollution has exceeded the 120 ppb ozone concentration levels set by the EPA at the northwestern-most side of the park (National Park Service, 2016). In 2015, the nonprofit National Parks Conservation Association gave JTNP an "F" grade for smog. At the ground level, these pollutants affect the levels of nitrates in the desert soils. Globally deserts are low in nitrates which are important for plant life to exist in the area. As a result, any plants that do grow in deserts naturally are adapted to these low nitrate-soils. With higher levels of nitrates being observed within the park comes the influx of non-native species that could potentially throw off the balance of the desert ecosystem.

We are interested in looking at the percent change in population from 1994 to 2017 as a way of quantifying the growth around the park. We will also be looking at land use changes to see if there in an increase in developed land around the park. In addition, we will look at pollution data to see if there are any trends that may impact the park.

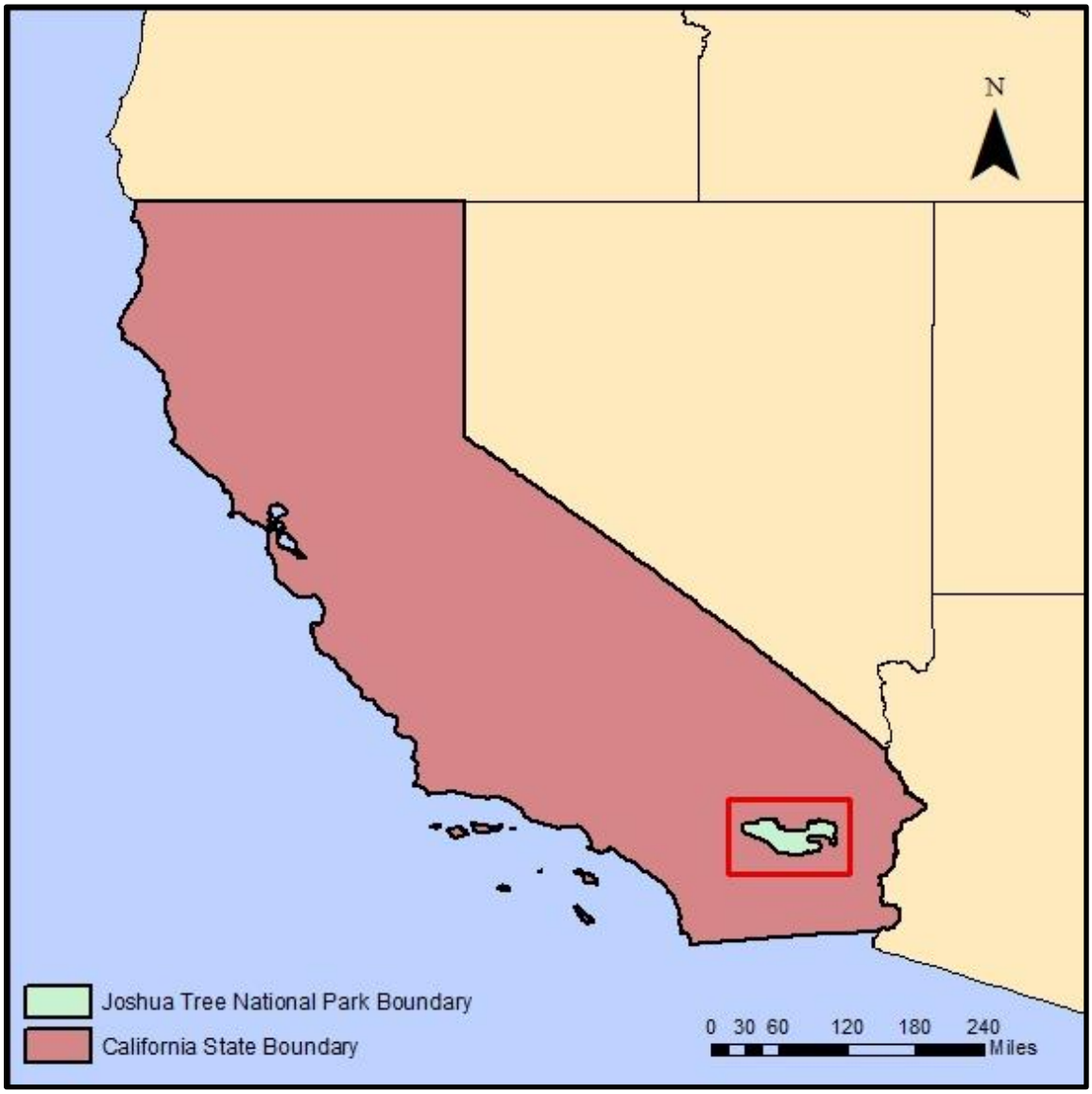

Figure 1: Locator Map for Joshua Tree National Park

Methods

First we downloaded state, county and city data from the California Department of Transportation website and a park boundary from the National Park Service GIS website. We used ArcMap 10.4.1 to project data into the same coordinate system and then we established a 70-mile zone around the park to identified cities/urban areas that fell within that zone using Select by Location. We chose this 70-mile radius based on research done on various types of pollution, such as light and air pollution, and their possible extent from

urban areas. Data on population change came from the State of California Department of Finance. Population data was selected for 1994 and 2017 and converted into an Excel table and then joined to the attribute table of the cities shapefile (Fig 2). A map was then generated to show the percent change between the two years.

For the second part of this project, we used data from the National Land Cover Database (NLCD) from 2001 and 2011. Using ArcMap 10.4.1 we first made a 70-mile buffer around the park, then exported a shapefile of the park boundary with the 70-mile buffer. The Extract by Mask tool to create a 2001 dataset showing the land cover for the 70-mile buffer and the park. The process was repeated for the 2011 dataset. The two new rasters were projected into WGS 84 UTM Zone 11N and the raster calculator was used to find all developed land for both rasters. Then, the 2001 raster was subtracted from the 2011 raster to show the areas that had increased growth.

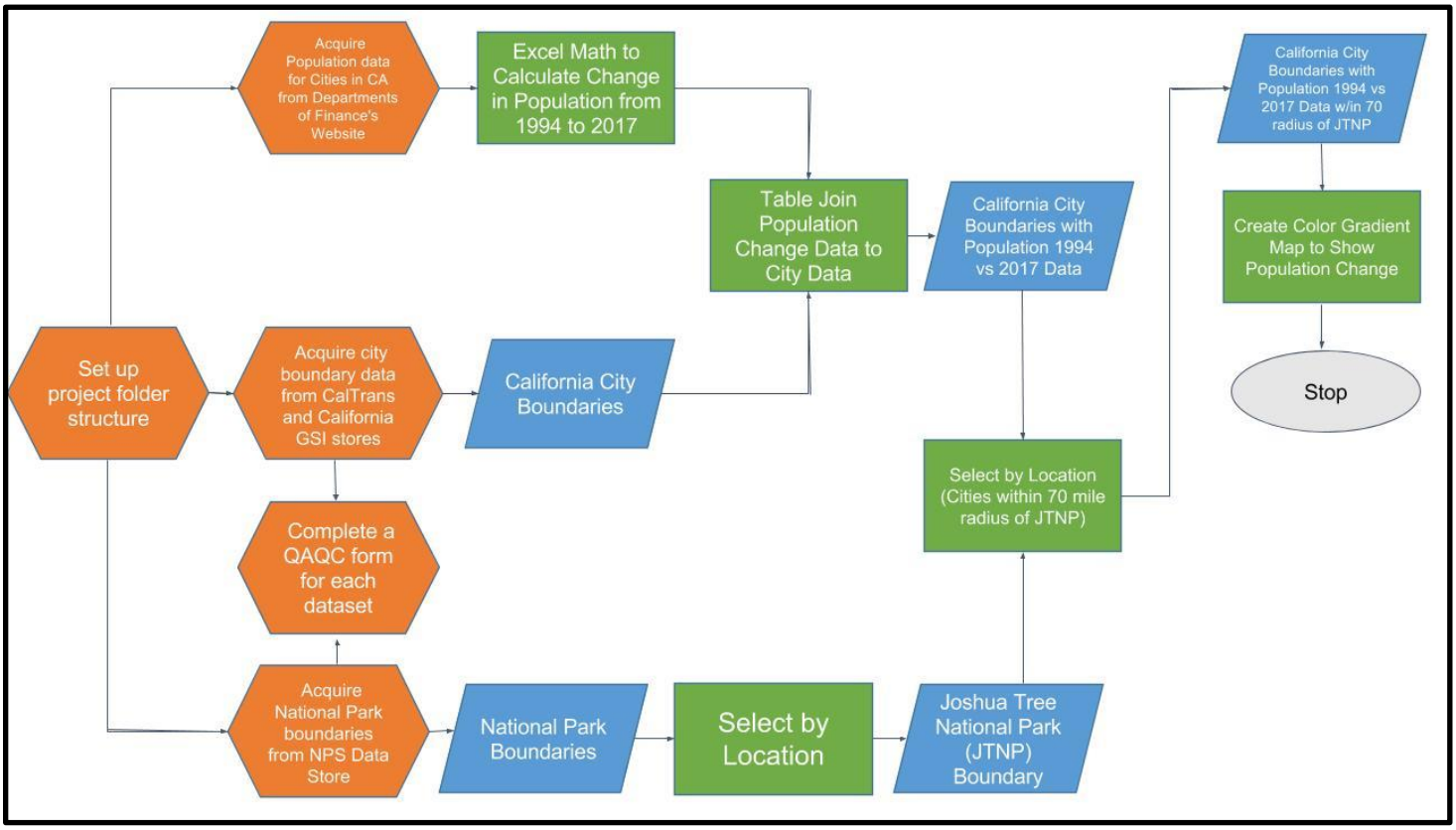

Figure 2: Flowchart of steps used to analyze population data.

Results

We found that there was an increase in population for the cities located within 70 miles of the park (Fig. 3). The percent change varied, with the highest changes occurring in Palm Desert, Victorville and cities located within Riverside County, San Diego County and one city in Imperial County. Cities with the lowest change included Needles and Barstow (Table 1).

When looking at changes in land use, we found an increase in developed land between 2001 and 2011 (Fig 4). There is an increase in developed land on the southern boundary of the park, in Riverside County, however, most of the increase is concentrated on the far western end of Riverside County. Between 2001 and 2011, there was an increase of 2,726 acres classified as "Developed" (Table 2). This data is based off of Landsat imagery with a 30 m resolution.

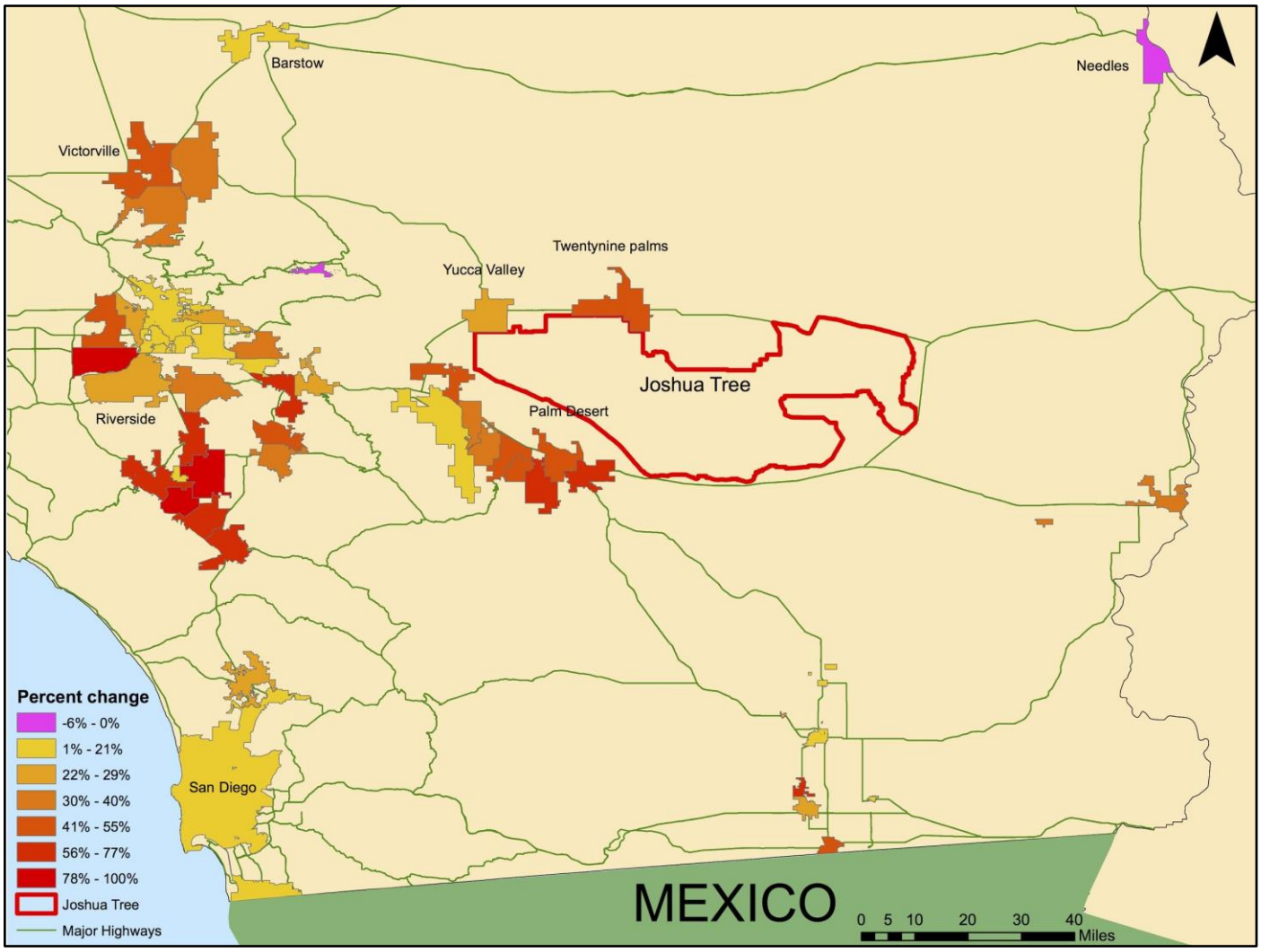

Figure 3: The percent population change from 1994 to 2017 within a 70-mile radius of Joshua Tree National Park.

Table 1: The change in population for the cities with the largest change and the least amount of change.

Example Cities within 70 Mile Radius of JTNP and Their Population Data				
City Names	Population in 1994	Population in 2017	Population Change	Percent Change
Barstow	21397	24248	2851	11.76%
Needles	5360	5044	-316	-6.26%
Palm Desert	28108	50740	22632	44.60%
Riverside	238112	326792	88680	27.14%
San Diego	1139569	1406318	266749	18.97%
Twentynine Palms	14544	26919	12375	45.97%
Victorville	55672	123565	67893	54.95%
Yucca Valley	16327	21519	5192	24.13%

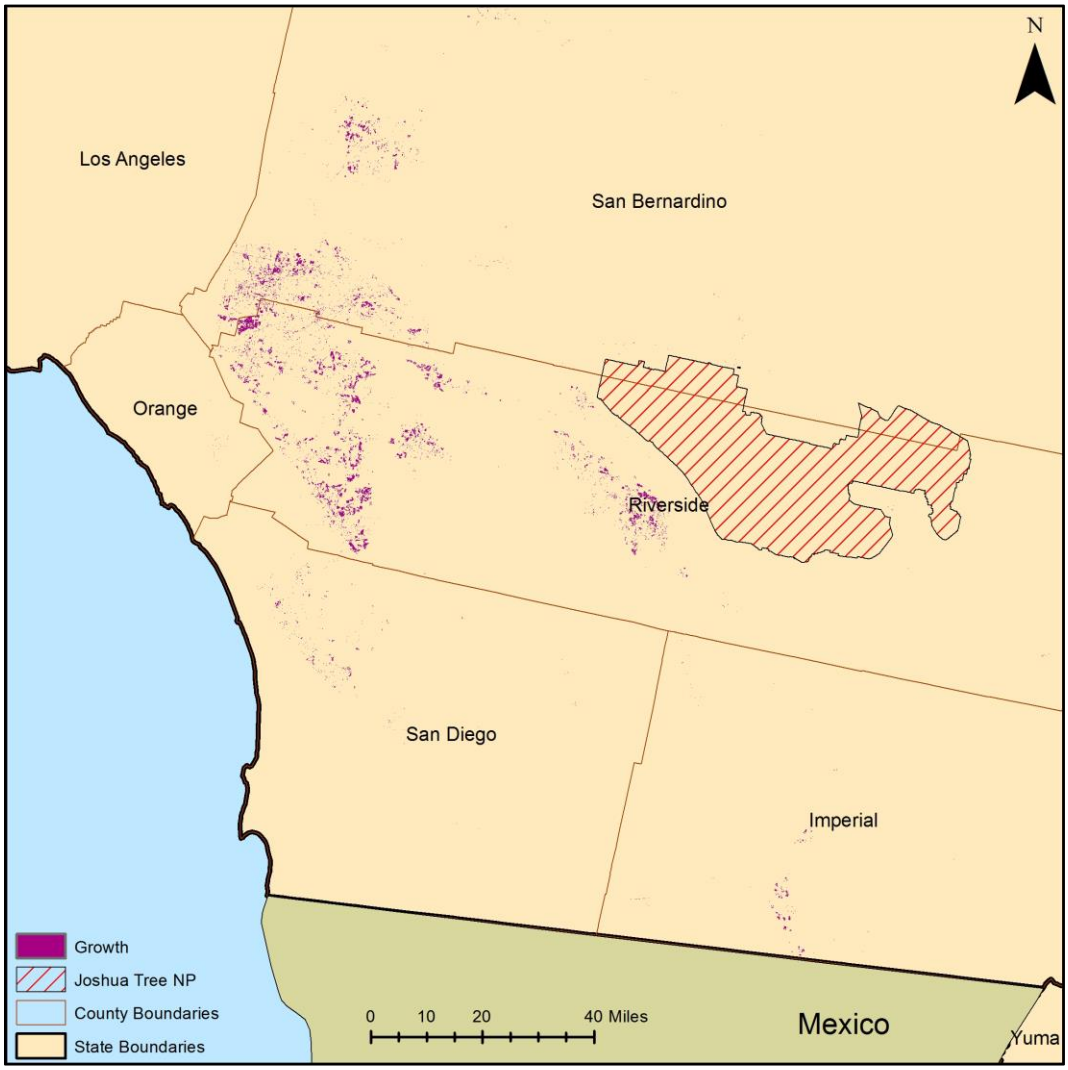

Figure 4: Areas within 70 miles of Joshua Tree National Park that have seen additional development between 2001 and 2011.

Table 2: Land that is classified as developed by the National Land Cover Database within a 70-mile radius of Joshua Tree National Park.

Year	Acres	Change
2001	19196.68	-
2011	21923.18	2726.5

Discussion

The increased urbanization seen around Joshua Tree National Park is seen in both the increase in population of nearby cities and the increase in developed land around the park. This is concerning given that increased urbanization may lead to habitat fragmentation outside the park's boundaries and increased pollution levels. Overall, the state pollution levels are dropping (Figure 4), however pollution concentrations may be increasing slightly in areas that have had historically low emissions in the past as undeveloped land is converted to developed land.

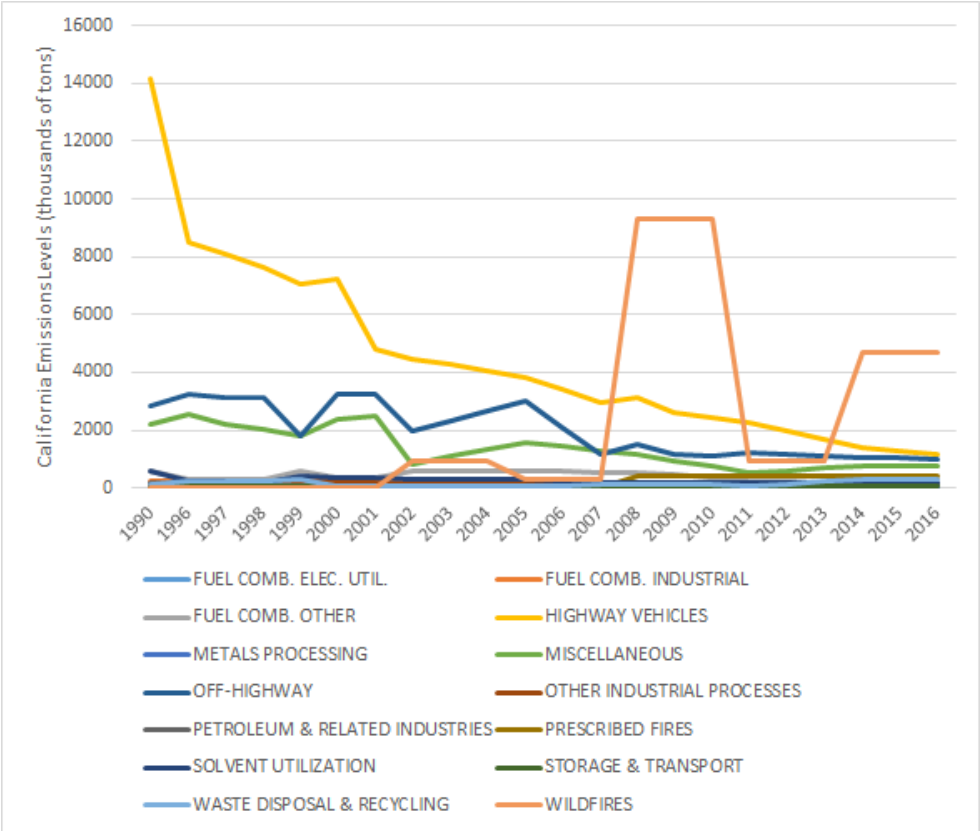

Figure 4: Chart denoting annual EPA emission levels and sources for the State of California (Environmental Protection Agency, 2016).

Vehicles are one of the highest contributors to air pollution in California, succeeded only by wildfires (Figure 4). Traffic, and the pollution it creates, has become a problem for other national parks -- for example, Yosemite National Park saw an average of 8,200 cars entering the park per day during the summer

of 2017, and up to a three hour wait for a parking space (Sahagun, 2017). As interest in visiting national parks increases annually, and parks are seeing exponential quantities of visitors, an increase in localized pollution in the area of JTNP is concerning.

The main components that create air pollution are spelled out by the national ambient air quality standards (NAAQS) in the Clean Air Act. The NAAQS main air pollutants include gaseous forms of lead (PB), nitrogen dioxide (NO2), ozone (O3), particulate matter (PM), sulfur dioxide (SO2), and carbon monoxide (CO); all of which are created in different ways and have different effects on health and the environment (Environmental Protection Agency, 2016). These pollutants all mostly created by human actions such as the combustion of fuel for boilers, smelters, vehicles, and various equipment we use every day. This includes turning on lights, starting up our cars, or even making a cup of coffee. Individually, these pollutants then have different environmental effects.

Conclusion

Increased development is happening around Joshua Tree National Park. Taking steps to better understand how to manage harmful emissions can help preserve our National Parks for future generations. Desert ecosystems are especially sensitive to pollution of any type because they are nutrient/nitrate-lacking environments. This means that ecosystems found in the desert contain processes and inhabitants that have adapted to these less-than-pleasant living conditions over a long period of time; however, the pollution these ecosystems are exposed to may cause them to rapidly change, potentially even crossing a threshold from which the ecosystem cannot return. Exposure to nitrate pollutants, such as nitrogen dioxide, cause the normally nutrient-poor soils to suddenly be more inviting to invasive plant species that can outcompete native species and cause upheaval in the ecosystems (National Park Service, 2016). The chain reaction of soil nutrients changing even slightly could cause species to be destroyed or removed of their homes. As the

population of southern California continues to grow, urbanization around National Parks could affect the flora and fauna of the parks. As good stewards of the land, we need to take steps to protect these areas, such as continuing to monitor pollution levels in and around parks and taking steps to prevent increasing levels of pollutants.

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