Analyzing the efficacy of wetland mitigation using a Black-crowned Night Heron population in Long Beach, California

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ABSTRACT

The National Environmental Protection Act (NEPA) was enacted in the early days of the environmental movement to ensure that development projects would not destroy the planet's resources for future generations. However, the requirements in the legislation are often vague and it is up to researchers to determine effective scales and time frames for projects, making it possible that NEPA is ineffective in selecting the best option of many alternatives for the environment. I used a case study of Black-Crowned Night Herons (*Nycticorax nycticorax*) that had been relocated in Long Beach, California, in the late 1990s to address this possibility. At the time, several sites were considered as potential relocation sites. I looked at these sites today and used GIS to create suitability maps of each site to determine whether they would be considered well-suited to the herons nesting, breeding, and feeding requirements in the present day. I found that the sites had changed in ranking since they were first ranked in 1996, and the site that I determined was the best choice for relocation today was not the site chosen in the 1990s. This indicates that longer monitoring periods should be required to gain as much information about future changes to sites as possible, and post-hoc monitoring should also be required under NEPA and similar legislation to ensure that projects continue to meet their desired goals while still conserving the environment.

KEYWORDS

Geographic Imaging System (GIS), suitability analysis, opportunity, constraint, National Environmental Protection Act of 1969 (NEPA)

INTRODUCTION

The modern environmental movement flourished in the 1960s and 1970s, when legislation began to be written in support of environmentalism (Silveira 2001). The National Environmental Policy Act of 1969 (NEPA) is one such piece of legislation that specifically states that environmental policy is a goal of the United States. Additionally, NEPA requires that Environmental Assessments (EAs) and Environmental Impact Statements (EISs) be submitted from all federal agencies with proposed development (NEPA 1969). The goals of these measures are to assess the environmental effects of the proposed action, list and assess any alternatives that were considered, and discuss how long-term productivity of the ecosystem in question will be affected (NEPA 1969). However, NEPA does not have a universal standard for retrospective analysis of actions, and thus it is not always clear whether the best alternative is actually selected.

This uncertainty regarding NEPA's success is due mainly to the dynamic nature of the environment as it changes by both natural and anthropogenic means. As it is impossible to know with certainty what will happen to a particular ecosystem in the future, scientists must make what they believe to be the "best choice" when choosing study sites and methods of study (Brookes et al. 1998). Changes may take a long time to occur, and thus studies should ideally include long-term monitoring on the scale of decades rather than years, and include a retrospective baseline study when feasible (Kondolf 1995, Brookes et al. 1998). However, due to various limitations (such as lack of funding), researchers are frequently incapable of continuing studies for more than a decade (Kondolf 1995). Because wetlands are particularly beneficial yet vulnerable ecosystems, they are the focus of many efforts to manage and mitigate adverse changes in the environment. In these cases of wetland mitigation, a "best choice" is made by weighing the different available options, but is not usually monitored once it has been implemented.

I will use one particular case of wetland mitigation as a case study to investigate the long-term efficacy of wetland mitigation under NEPA. The Port of Long Beach had planned development on a former naval base where a population of up to 500 pairs of Black-Crowned Night Herons (*Nycticorax nycticorax*) lived (Crouch et al. 2002). However, the herons are protected under the Migratory Bird Treaty Act of 1918, and thus cannot be harmed (MBTA

1918). As part of an agreement with the United States Fish and Wildlife Service, the population was relocated in 1998 to Gull Park, a location about two kilometers from the original site that was originally used as a recreational facility (Crouch et al. 2002). The population was found to be the largest breeding colony in Southern California and was monitored for five years, two years before the relocation and three years after. NEPA did not have a set requirement for how long this monitoring should take place, thus this time frame was deemed by the scientists involved to be an appropriately long period to determine the success of the relocation. The numbers of both nests and young had a general increasing trend over the five years, even after the relocation (from 357 active nests in 1996 to 423 active nests in 2000.) Thus, the relocation effort was deemed a success. However, as the environment in and around the relocation site may have changed since the move occurred, it is possible that another site that was originally discounted could have been a better choice in the long term for the maintenance of the population of herons.

For this case, a two-year monitoring of the population of herons occurred at the original site pre-move to ascertain the size of the population as well as any habitat requirements that would be needed in a relocation site. After the relocation, the population was monitored for three years at the Gull Park relocation site. Through this case study, I will determine how effective this population relocation was on a larger time scale than the original five-year survey. I will assess whether the herons are currently in a habitat that supports all of their nesting, breeding, and feeding requirements. I will also examine other sites that were considered for the relocation, but not ultimately chosen, for the same factors. By comparing the chosen site to the other alternatives, I will establish whether the chosen site is in fact the one best suited to the herons' needs over a time frame of fifteen years.

METHODS

Study population and location

The study species is a relocated population of Black-Crowned Night Herons (*Nycticorax nycticorax*) in Long Beach, California. This particular population was relocated from their original site on a naval base to a new location about two kilometers away in 1999 (Crouch et al.

2002). The population is estimated to be around 500 mating pairs of birds, making it the largest population in Southern California (Crouch et al. 2002). The population resides in the Port of Long Beach, a coastal city with many estuarine areas but a great deal of urbanization and development (Crouch et al. 2002). The herons' original site is a Naval Station on Rattlesnake Island, a sand spit at the mouths of the Los Angeles and San Gabriel Rivers (Crouch et al. 2002). The relocation site is Gull Park, about 2 kilometers away from original site, and which was used as a recreation facility prior to the relocation (Crouch et al. 2002).

Life history of the Black-Crowned Night Heron

The Black-Crowned Night Heron is the most widespread heron in the world (Hothem et al. 2010). The Black-Crowned Night Heron is a migratory bird, though most populations in California are fairly sedentary and remain in the same areas year-round (Figure 1) (Hothem et al. 2010). The species is sexually monomorphic, though females are generally slightly smaller than males (Hothem et al. 2010). Because they fill a niche in the higher trophic levels, these herons can be good indicators of ecosystem health due to bioaccumulation of toxins (Hothem et al. 2006, Newman et al. 2007). Another threat is predation, particularly by dogs, cats, and raccoons in urban areas (Kelley et al. 1993, Crouch et al. 2002, Hothem and Hatch 2004, Kelley et al. 2007).

Black-Crowned Night Herons occupy a variety of habitats (Hothem et al. 2010). They feed primarily along lakes, rivers, and in wetlands (Granholm et al. 1990). Nesting and roosting occurs in dense foliage, generally near to feeding areas (Granholm et al. 1990). Populations in different regions prefer different substrates, but this population appears to prefer tall, rounded trees (Crouch et al. 2002). The diet of the Black-Crowned

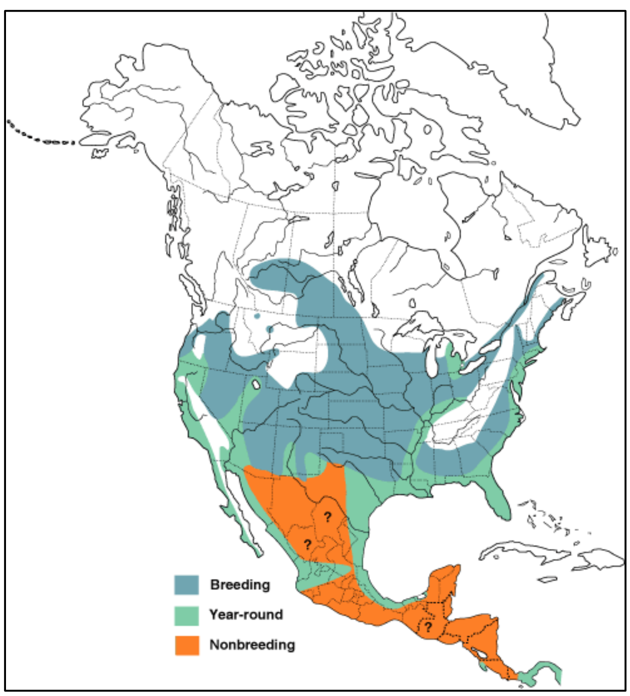

Figure 1: Range of BCNH in North America (from Hothem et al. 2010)

Night Heron is variable as well, consisting of fish, crustaceans, insects, amphibians, reptiles, snakes, small mammals, birds, eggs (Granholm et al. 1990, Hothem et al. 2006). However, fish, shrimp, and birds are the most common food sources (Hall & Kress 2008). Black-Crowned Night Herons typically forage individually in shallow, weedy ponds, creeks, and marshes (Hothem et al. 2010). They are primarily nocturnal and crepuscular (Perlmutter 1992).

These herons are monogamous breeders who nest colonially, with multiple nests in the same tree (Granholm et al. 1990). The breeding season generally occurs from February to July (Granholm et al. 1990). Average clutch size for Black-Crowned Night Herons is 3-4 eggs per nest, and herons reach a breeding age at 2-3 years of age (Granholm et al. 1990). Black-Crowned Night Herons can live to be 20 years old (Hothem et al. 2010).

Existing data: pre-relocation

I used the original data used to assess the population pre- and post-relocation to determine how to perform my present-day analysis. The existing data gave me information on alternative sites that were considered, as well as the criteria that were originally used to assess suitability. This data was collected by several researchers associated with MBC Applied Environmental Sciences.

The original researchers examined and placed 16 potential sites into four categories: highly feasible relocation/enhancement opportunities in the vicinity of the port; highly feasible relocation/enhancement opportunities not in the near vicinity; apparently feasible sites in need of further study; and potential sites that do not appear feasible (Paquette and Curtis 1997). These categories were based on the following factors: proximity to the original site; size large enough for 40 or more Indian Laurel trees (which the herons were inhabiting at the original site); isolation from human activities; and distance from nesting sites of other endangered birds to avoid heron predation on those species (Paquette & Curtis 1997). I focused on those sites in the highly feasible category that were also in the vicinity of the original site of the heron population, as Black-Crowned Night Herons will form satellite colonies near to their original habitats when they suffer disturbances (Kelley et al. 1993). Since these sites were feasible and close enough that a satellite colony could be formed, they seemed like the most likely sites to be chosen. The sites in this category are Golden Shore Mitigation Park, Los Cerritos Wetland, and El Dorado

Park. Gull Park, the site that was chosen for relocation, was not listed in this category, but I still analyzed it due to the fact that it was the chosen site.

To assess the original site and determine the habitat requirements of the Black-Crowned Night Herons in their original location, the researchers of MBC performed surveys in which they estimated the number of nests and young, characterized trees by shape and density, and identified relationships between trees and nesting. They noted the number of nests, eggs, and young observed upon each visit, as well as whether or not the nests appeared to be occupied. They also classified trees by their density (dense vs. sparse foliage) and shape (hedge-like, rounded, or straight). Their results indicated that dense, rounded trees were most used by the herons. In 1997 and 1998 (pre-relocation), the surveys were performed twice a year, in April and June (Crouch et al. 2002). From 199-2001, the surveys were performed every six weeks during the breeding season, from March to August (Crouch et al. 2002).

Golden Shore Mitigation Park

Golden Shore is a 6.4 acre site of tidal salt marsh located at 33.76292°N, 118.20255°W. The area was originally the location of a great deal of sediment deposition from the Los Angeles River, before its flow was diverted. A boom located in the water a short distance from the shore prevents trash and debris from entering the reserve from the ocean. The vegetation of the park is mainly different kinds of grasses.

Los Cerritos Wetland

The Los Cerritos Wetland is the largest salt marsh in Los Angeles County located at 33.76194°N, 118.10833°W. It is composed of 13 different habitats in 776 acres. It is in the process of being restored, with the efforts of several neighboring cities. A stewardship group for the wetland began organizing in 1994, and the wetland gained a land trust in 2001 and a wetland authority in 2006. The vegetation of the site is mostly grasses, with some trees.

El Dorado Park

El Dorado Park is located at 33.813812°N, 118.135471°W, and is over 400 acres, with 100 of those acres kept as natural habitats in the El Dorado Nature Center. Part of the Nature Center is a wetland habitat, and there are plans to expand this wetland habitat to be even larger. There are also two lakes and a stream within the Nature Center that provide potential feeding grounds for the herons.

Gull Park

Gull Park is an 8.4 acre site located in the naval yard complex about two kilometers from the original site at 33.743393°N, 118.219242°W (Crouch et al. 2002). The park is mostly grassy, with a copse of trees. When the 1996 assessment was performed, it was not listed specifically, but it was noted that choosing a relocation site within the naval complex could be more easily achieved (Paquette & Curtis 1997). The authors do not state specifically why this site was chosen above any of the three sites that were listed as highly feasible and in the vicinity of the port, but it seems likely that economic and legislative factors may have been involved, since the land was owned by the same organization as the original site.

Existing data: post-relocation

After the relocation of the population of Black-Crowned Night Herons to Gull Park after the nesting season in 1998, the new site was then monitored for three years. Researchers employed the same survey techniques as in the pre-relocation data collection to assess the stability of the population. The number of birds observed as well as the number of nests per tree were comparable in the following years to the original site, and the population began to grow in 2000 (Crouch et al. 2002).

Current analysis

Once I determined the sites that were considered and the criteria used to assess them in 1996, I performed a parallel analysis of Golden Shore Mitigation Park, Los Cerritos Wetland, El

Dorado Park, and Gull Park in the present day. I followed the methods for data collection of the existing data as closely as possible when performing my own analysis of the sites. To perform my present-day analysis, I used Geographic Information System (GIS) to conduct suitability analyses of the current habitats at each site (ESRI 2012).

Assessing suitability

To determine which of the four proposed sites is currently the best suited to the needs of the herons, I performed a suitability analysis of the sites using ArcMap version 10.1 (ESRI 2012). For the suitability analysis, I classified each of the different factors affecting suitability into constraints and opportunities, and assigned weights to each based on the existing data and my own estimation of benefit/risk.

The constraining factors were: proximity to human population centers; barren landscape (lack of vegetation); and distance to the original site. Since none of the sites but El Dorado Park are located in residential areas, I decided to use "locations of interest" in Long Beach that would draw large numbers of people rather than population density of census blocks (Los Angeles County GIS Portal). These locations, determined by the Location Management System, include areas such as parks, colleges, airports, hospitals, etc. that would draw large amounts of human activity (Los Angeles County GIS Portal). I added 50-meter buffers around the locales to ensure that the herons would not end up in a location that would be too close to densely populated areas. I used Calveg data provided online as a subset of the United States Department of Agriculture (USDA) to determine areas that were barren, which would not support the herons (USDA). I used the ArcMap distance tool to calculate the distance of each potential site to the original site (ESRI 2012). I then ranked the sites from closest to furthest from the original site and gave them weight values from 0 to -3 (0 for the site closest to the original site and -3 for the furthest site). I gave the locations of interest and vegetation scores a weight of -1.

I next solved for the opportunity score of each site by calculating: presence of dense foliage; size of the site; and presence of existing parks nearby. The last factor was not included in the 1996 analyses but, since the herons are mobile organisms, I believed that they would move around to areas adjacent to their roosting site, and nearby parks could thus boost the area of a relocation site. Using CalVeg data on vegetation type, I isolated those vegetation types that are densely foliated (USDA). Next, I used the ArcMap area tool to determine the area of the sites (ESRI 2012). I ranked the sites from smallest to largest and assigned weights of 0 to +3 to each site (0 for the smallest site and +3 for the largest). I obtained park data from the Los Angeles GIS Portal online, and created 50-meter buffers around existing parks to account for heron mobility. The factors other than area all received weights of +1.

By combining the overall constraint and opportunity scores of the various sites, I determined the habitat suitability for each of the potential relocation localities. Each constraint factor would provide negative consequences for heron survival and fecundity, and was thus given a negative weight. Similarly, each opportunity factor was given a positive weight indicating a positive effect on the herons. I used the total suitability to create maps that showed the degrees of suitability for each site, from -2 to 2. The numerical values correspond to suitability scores of: not suitable (-2); poorly suitable (-1); moderately suitable (0); suitable (1); and highly suitable (2). After the maps were complete, I compared the acceptable suitabilities between the sites, which I defined as highly suitable, suitable, and moderately suitable. I used this acceptably suitable area combined with examination of the surrounding areas to rank the sites for 2013.

RESULTS

Golden Shore Mitigation Park

The suitability scores for Golden Shore Mitigation Park ranged from 0 to 1. The area of the suitability map for Golden Shore is 0% highly suitable; 83.60% suitable; 16.40% moderately suitable; 0% poorly suitable; and 0% not suitable (Figure 1). 100% of the area is an acceptable suitability (highly suitable, suitable, and moderately suitable), while 0% is an unacceptable suitability (poorly suitable and not suitable) (Figure 1). There are a large number of points of interest surrounding the site, shown in orange (Figure 1).

Los Cerritos Wetland

The overall suitability score for the Los Cerritos Wetland ranged from -1 to 2. The area of the map of Los Cerritos Wetland is 6.08% highly suitable; 83.64% suitable; 10.09% moderately suitable; 0.19% poorly suitable; and 0% not suitable (Figure 2). 99.81% of the area is an acceptable suitability (highly suitable, suitable, and moderately suitable), while 0.19% is an unacceptable suitability (poorly suitable and not suitable) (Figure 2). There are both parks and locations of interest in the vicinity of the Los Cerritos Wetland, shown in green and orange, respectively (Figure 2).

El Dorado Park

El Dorado Park's overall habitat suitability score varied from -1 to 0. The area of El Dorado Park's suitability map is 0% highly suitable; 0% "suitable; 90.16% moderately suitable; 9.84% poorly suitable; and 0% not suitable (Figure 3). 90.16% of the area is an acceptable suitability (highly suitable, suitable, and moderately suitable), while 9.84% is an unacceptable suitability (poorly suitable and not suitable) (Figure 3). There are two large parks nearby, shown in green (Figure 3).

Gull Park

Gull Park's overall habitat suitability score varied from 0 to 1. The area of Gull Park's suitability map is 0% highly suitable; 75.85% suitable; 24.15% moderately suitable; 0% poorly suitable; and 0% not suitable. 100% of the area is an acceptable suitability(highly suitable, suitable, and moderately suitable), while 0% is an unacceptable suitability (poorly suitable and not suitable) (Figure 4). The orange circles around the site indicate that there are locations of interest nearby (Figure 4).

Figure 1: Suitability map for Golden Shore Mitigation Park

Figure 3: Suitability map for Los Cerritos Wetland.

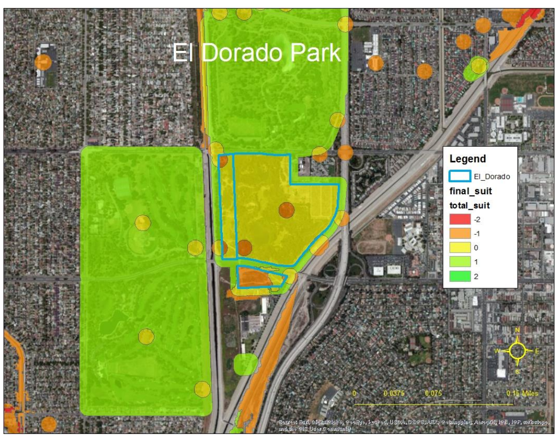

Figure 2: Suitability map for El Dorado Park.

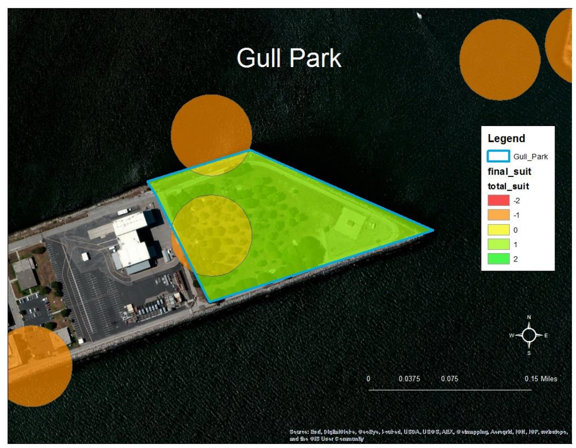

Figure4: Suitability map for Gull Park.

Figures 1-4: Colors indicate suitability: Dark green for highly suitable; light green for suitable; yellow for moderately suitable; orange for poorly suitable; and red for not suitable.

Summary

Of the four sites, Los Cerritos Wetland is the only one with any habitat that is highly suitable, and has the highest percentage of suitable habitat, at 83.64% (Table 1). El Dorado Park has the lowest amount of suitable habitat, with 0% (Table 1). The majority of all of the sites is acceptably suitable (Table 1).

Looking at the composite "acceptable" suitability score, Golden Shore Mitigation Park and Gull Park have the largest area, at 100% acceptably suitable (Table 1). Los Cerritos Wetland has an intermediate area of acceptable habitat suitability, with 99.81%, and El Dorado Park has the smallest area of acceptable habitat, with 90.16% (Table 1).

Table 1: Total percentages of area with highly suitable, suitable, moderately suitable, poorly suitable, and not suitable habitat, and composite percentages of areas of Acceptable and Unacceptable habitat suitability for all sites.

Site	% Highly Suitable	% Suitable	% Moderately Suitable	% Poorly Suitable	% Not Suitable	% Acceptable	% Unacceptable
Golden Shore Mitigation Park	0	83.60	16.40	0	0	**100**	**0**
Los Cerritos Wetland	6.08	83.64	10.09	0.19	0	**99.81**	**0.19**
El Dorado Park	0	0	90.16	9.84	0	**90.16**	**9.84**
Gull Park	0	75.85	24.15	0	0	**100**	**0**

DISCUSSION

Overview

Taken as a whole, my data from 2013 shows that the sites have changed since 1996, which has changed their suitability as habitats for the herons. Based upon my suitability analyses, today the ranking of the sites (from highest to lowest) would be 1) Los Cerritos Wetland, 2) Golden Shore Mitigation Park, 3) Gull Park, and 4) El Dorado Park. This compares to the 1996 categorization, which ranked the sites 1) Golden Shore Mitigation Park, 2) Los Cerritos Wetland, and 3) El Dorado Park (with Gull Park not ranked) (Crouch 1997). There appears to be a discrepancy between the goal of the relocation being to find the site that was and would remain the most suitable for the population of Black-Crowned Night Herons, and the results today showing a different suitability than in 1996 (Crouch et al 2002). If the researchers in 1996 had been able to anticipate the changes in the sites that would occur over the next 17 years, they would have been better equipped to manage the relocation of the herons. Although the site chosen in 1997 is no longer the most suitable, the researchers were nevertheless fairly successful in their efforts to choose a suitable site. The site that was chosen in 1996 is not unsuitable in 2013, simply less suitable than other options.

Changing sites: Golden Shore Mitigation Park

The relative suitability of the Golden Shore Mitigation Park (GSMP) site decreased from 1996 to 2013. Several factors could have caused this decline. GSMP was being expanded around the time that the herons were going to be moved (www.longbeach.gov). It is possible that the intended results of this mitigation made the site seem more suitable than it became in reality. Additionally, it is likely that a trend of increased urbanization resulting in higher population density near the site is the cause of this change in suitability. In 2009, development began in the Golden Shore area, including residential, office, and retail spaces, which further increased the population density immediately surrounding GSMP (Winklepleck 2009). While it is doubtful that this development could have been foreseen in 1996, it would have been beneficial and realistic to assume that population density would increase and to factor that into the relocation and conservation plan for the Black-Crowned Night Herons. This increase in the number of people living in close proximity to the herons could disrupt the nesting success of the herons, both by humans visiting the park and their pets preying on the herons themselves (Hothem and Hatch 2004).

Changing sites: Los Cerritos Wetland

The suitability of Los Cerritos Wetland relative to the other sites increased from 1996 to 2013. Efforts have been made to increase the acreage of the protected areas at this site, increasing the area and creating more of a buffer between the habitat and nearby urban areas. Phase I of this expansion occurred in 2006-7, while Phase II occurred in 2010 (www.lcwetlands.org). The site also has a land trust and stewardship organization, which could aid conservation efforts by making mitigation a priority and preventing development in the vicinity of the Los Cerritos Wetland. The California least tern, an endangered species, is found in the Los Cerritos Wetland, which is a constraining factor for the herons. However, by increasing the size of the wetland, the required buffer between herons and terns can be achieved even with both species living in the wetland. The site is not located near a very urbanized area, so increases in population density have not affected it greatly. Again, the expansion of the Los Cerritos Wetland would have been hard to predict and thus be accounted for in 1996. However, the presence of the stewardship groups could have been an indicator of a high priority for conservation and mitigation, and the trend of population density could have been inferred. Additionally, if researchers had monitored the sites for a longer period, they could have seen the addition of the land trust in 2001 and incorporated that into their analysis.

Changing sites: El Dorado Park

The relative suitability of El Dorado Park did not change over the period in question, but the site did undergo some changes nonetheless. The park is located in the middle of a suburban residential area, meaning that the likelihood of the park expanding in size is unlikely, and the probability of increased population density is likely, which could have been deduced in 1996. Though the suitability of the site did not change with relation to the other two sites, by including the trends for population density growth, researchers could have formulated a more in-depth analysis and management plan for the Black-Crowned Night Herons in 1996.

Limitations

This study is unique in that it is uncommon to assess the effectiveness of conservation efforts more than three or four years after they have been implemented. There are likely budget and resource limitations that have made this the case. Because of this, I have no similar studies with which to compare my results. As more studies of this nature are conducted, the importance of the studies and their results will become more and more significant. Additionally, since my data sets were obtained from government web sites and other free software, my results were not as accurate as they could have been with higher quality, more expensive data (Becker & Encarnacão 2012). I was unable to find freely available data regarding threatened and endangered bird species, which were incorporated in the original assessment, but if researchers in the future were to use similar methods they could obtain access to restricted data sets that I was unable to access. Perhaps the most notable limitation of this study is that, although the same factors were used to assess suitability, the methods of assessment differed from 1996 to 2013. This allowed me to compare rankings between 1996 and 2013 broadly, but I could not be more specific without making inferences and conjectures that might not be entirely correct. GIS technology was not as prevalent or developed in 1996 as it is today, so it was not used for the original assessments. However, I believe that GIS is a very useful tool for the purposes of suitability assessment, and will continue to be used in the future, and thus used this method for my research. Since GIS technology and data is becoming more widely available across the globe, it could be easier to standardize legislation requirements in the future if they are based on GIS.

Future Implications

My research indicates that long-term study of populations is crucial in conservation and management efforts in the future. Since environmental systems are unstable over time, it is beneficial to incorporate these longer term studies and post-project appraisals in conservation and management plans (Brookes et al 1998). This becomes even more important when human factors must be included, since human population, industrialization, and urbanization trends have been on the rise for the past several centuries. The only way to measure the changes in habitat suitability over the years (incorporating all of the various influential factors) is to conduct a long-term study to better understand how populations fluctuate with these changes. When the proposal for this relocation was presented to bird specialists in Southern California, several urged that the time frame be extended in order to ensure that the relocation was successful (Paquette & Curtis 1997). However, the project continued at its faster pace because there was no legislation mandating that it move at a slower pace.

Since I reached different conclusions using the data from 2013 than the conclusions reached in 1996, it is apparent that the suitability of sites can change over time. In order to understand why these changes occur, we must use long-term studies with data taken during many intervals of time in order to compare population fluctuation data with suitability factors and stochastic events. Consequently, it would be advantageous to amend NEPA to ensure that conservation and management decisions are made based on the best information and after a longer period of study. I believe that NEPA should have a minimum required surveillance period of at least five years before an EIS can be approved, to ascertain if any opportunity or constraint factors seem likely to change. This minimum surveillance period can still vary on a case-by-case basis, but should reflect the life history and population trends of the species in question (NEPA 1969). Future research should use GIS and other technologies to incorporate models for human growth and any other factors that are likely to change with time. As technology improves, more factors can be modeled and included, bettering the accuracy of the models. By incorporating as many factors as possible and accounting for future changes in those factors, we can assess future suitability more accurately and improve conservation techniques.

When NEPA was created, the environmental movement was just taking off. It has grown in the decades since, as has our concern with human impacts on the environment. To ensure that our planet remains viable and suitable in the future, we must put even more effort into ensuring that our conservation measures are as effective as possible. With the ever-changing environment of our planet, it would be beneficial for us to look more to the future when making the decisions of today.

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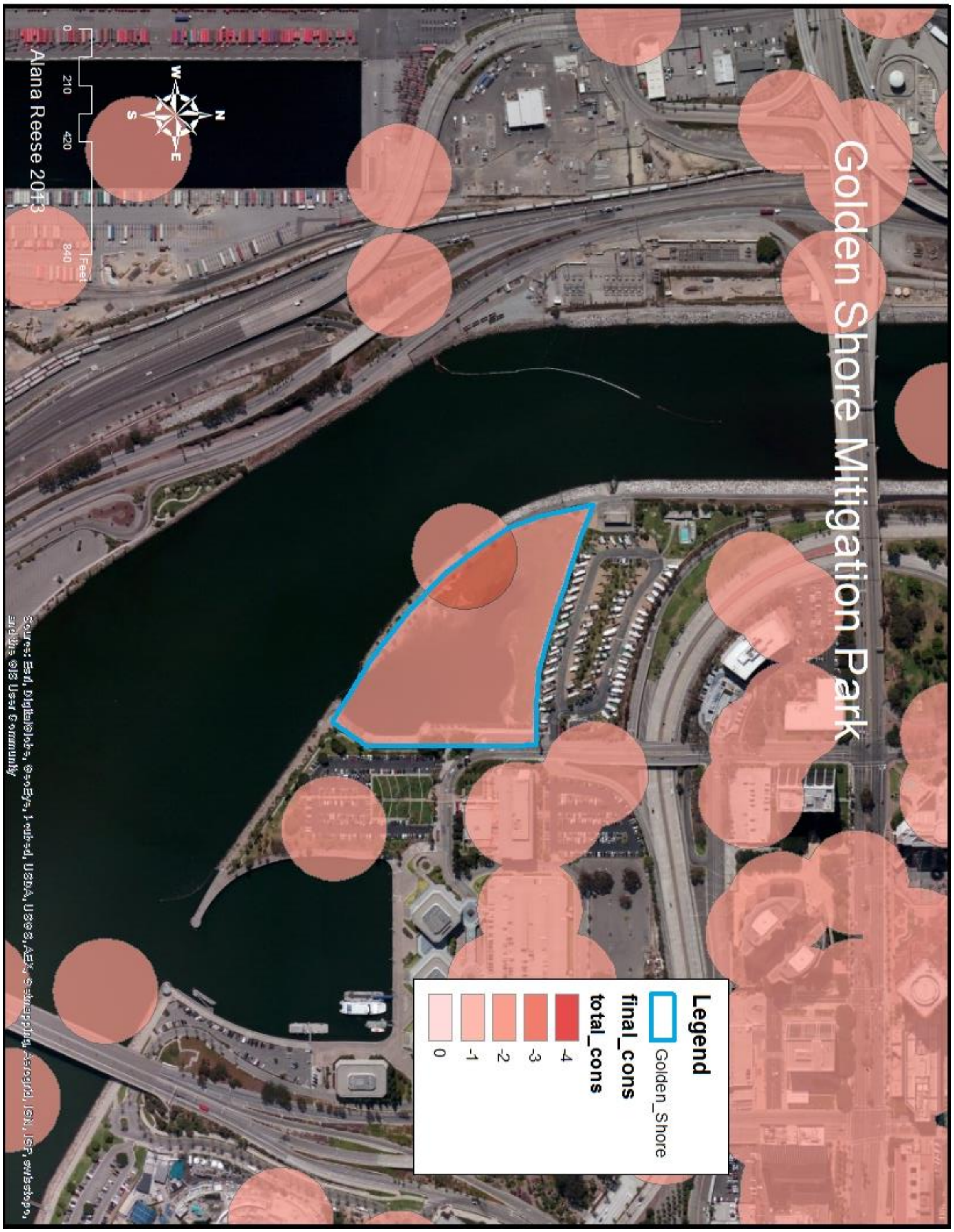
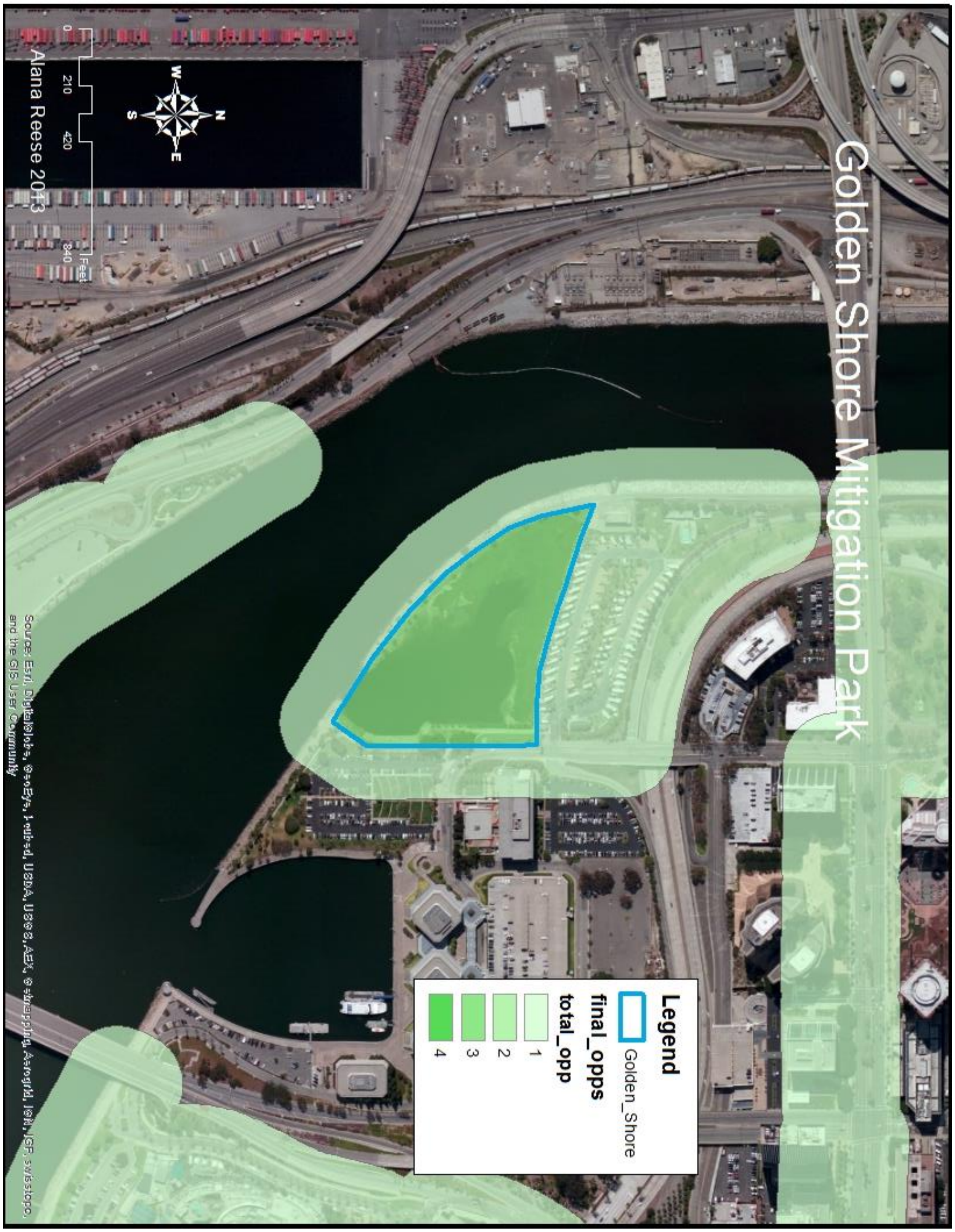
APPENDIX A: FULL MAPS FOR ALL SITES




Golden Shore Mitigation Park
Legend
Golden_Shore
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total_opp
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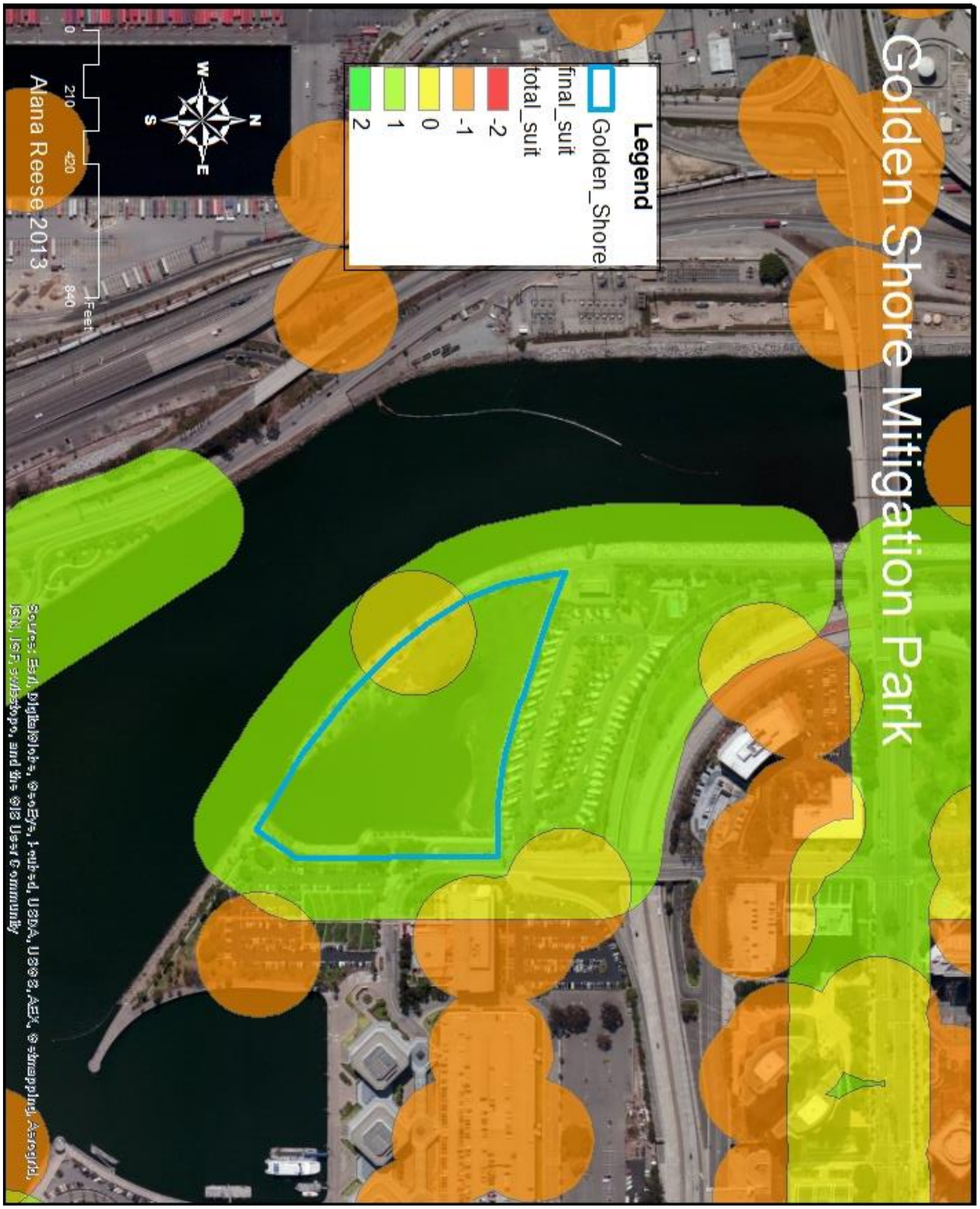
2
3
4
0 210 420 840 Feet
Alana Reese 2013
Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community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Legend
Golden_Shore
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total_suit
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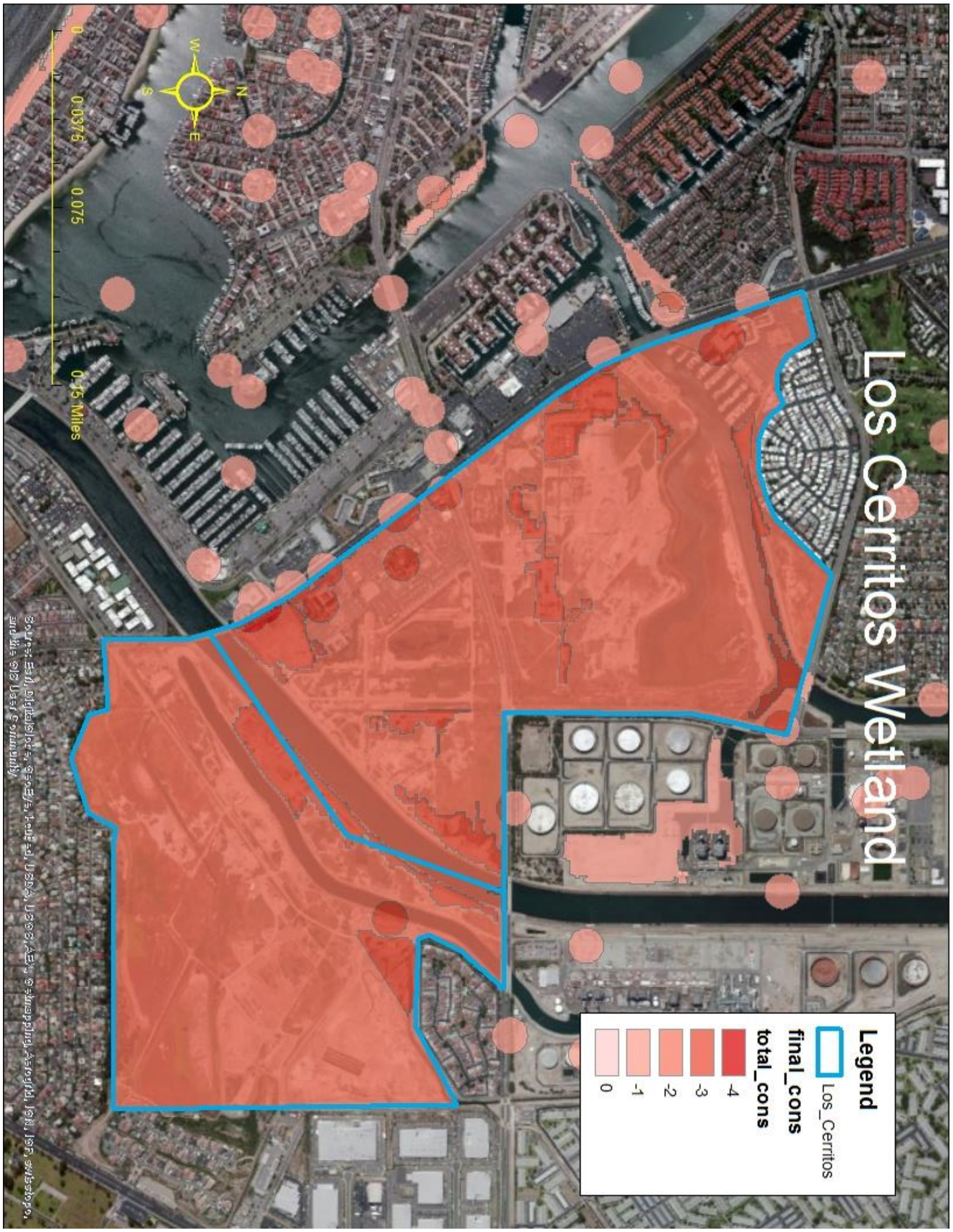
-1
0
1
2
N
S
E
W
0 210 420 840 Feet
Alana Reese 2013
Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community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Legend
Los_Cerritos
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total_cons
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-1
-2
-3
-4
0
0.0375
0.075
0.15 Miles
N
E
S
W


Los Cerritos Wetland
Legend
Los_Cerritos
final_opps
total_opp
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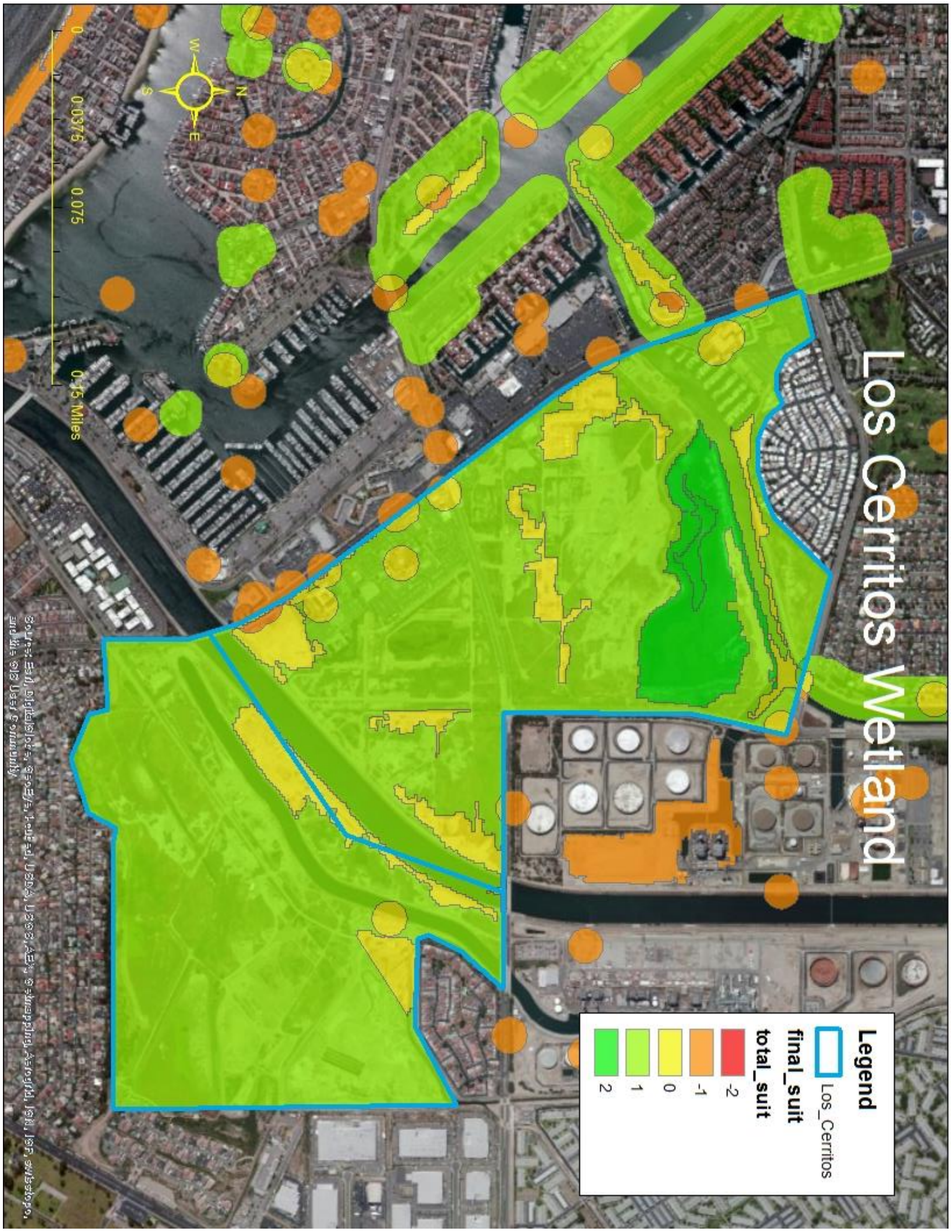
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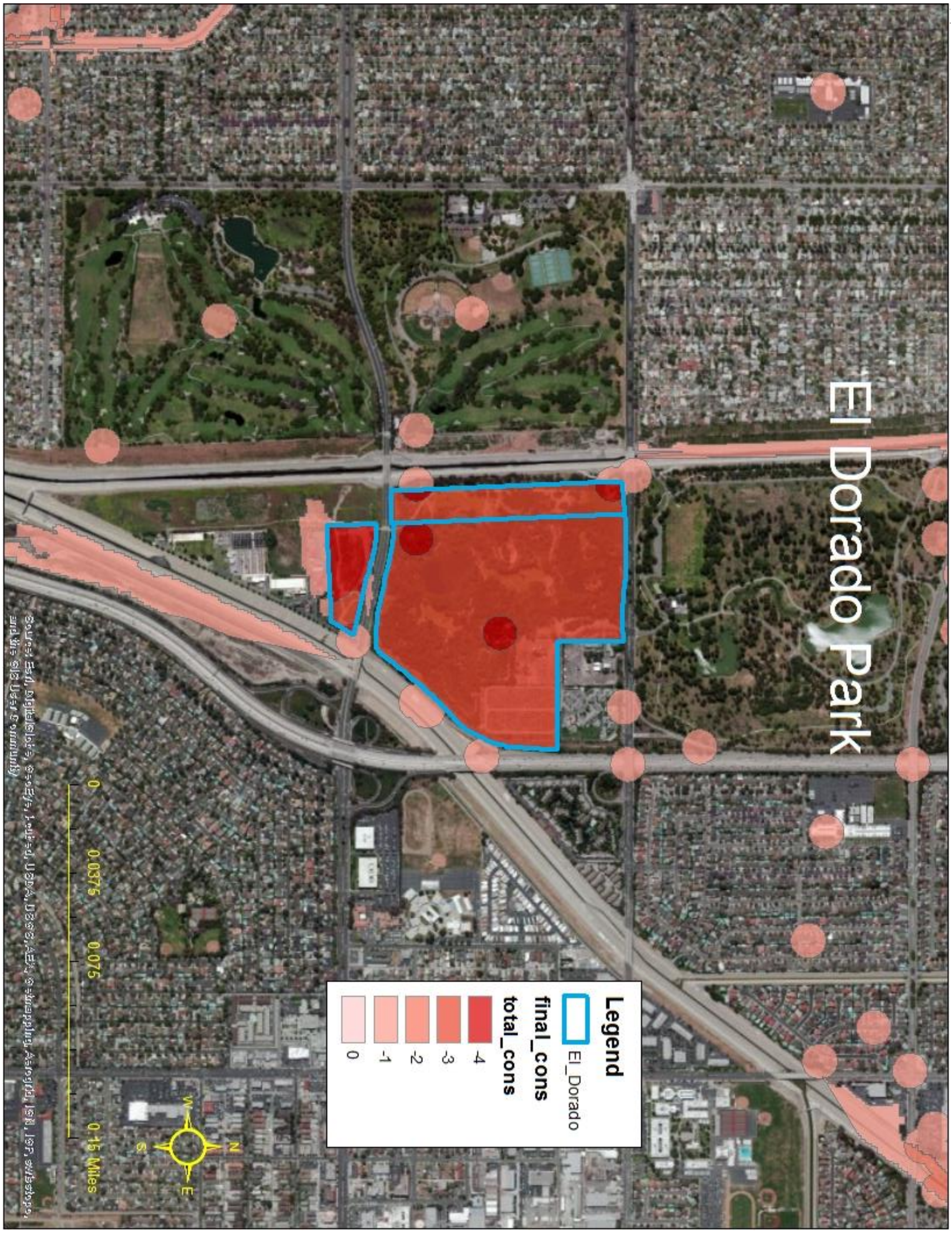
3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total_cons
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0.0375
0.075
0.15 Miles
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S
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Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community


El Dorado Park
Legend
El_Dorado
final_opps
total_opp
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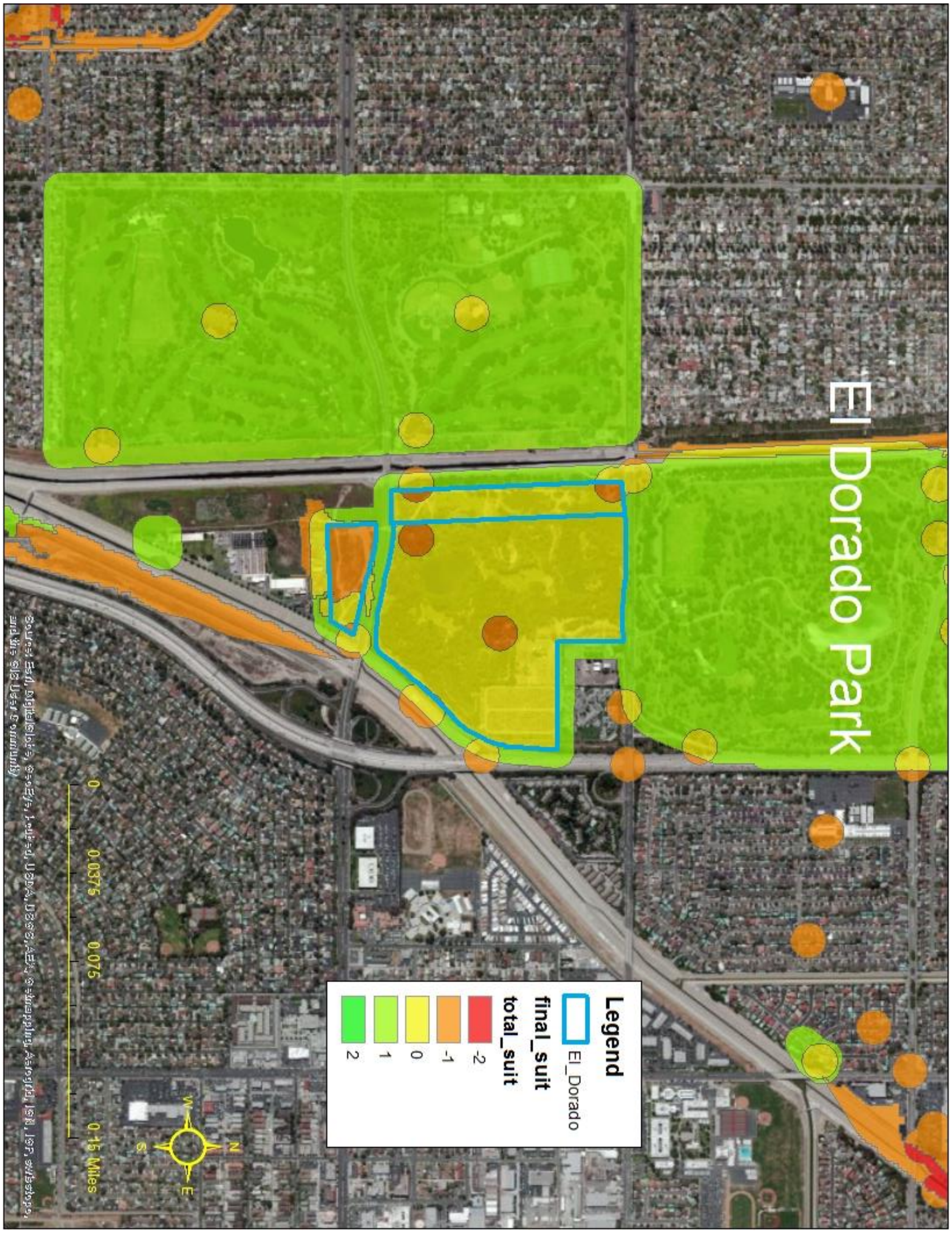
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El_Dorado
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2
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0.075
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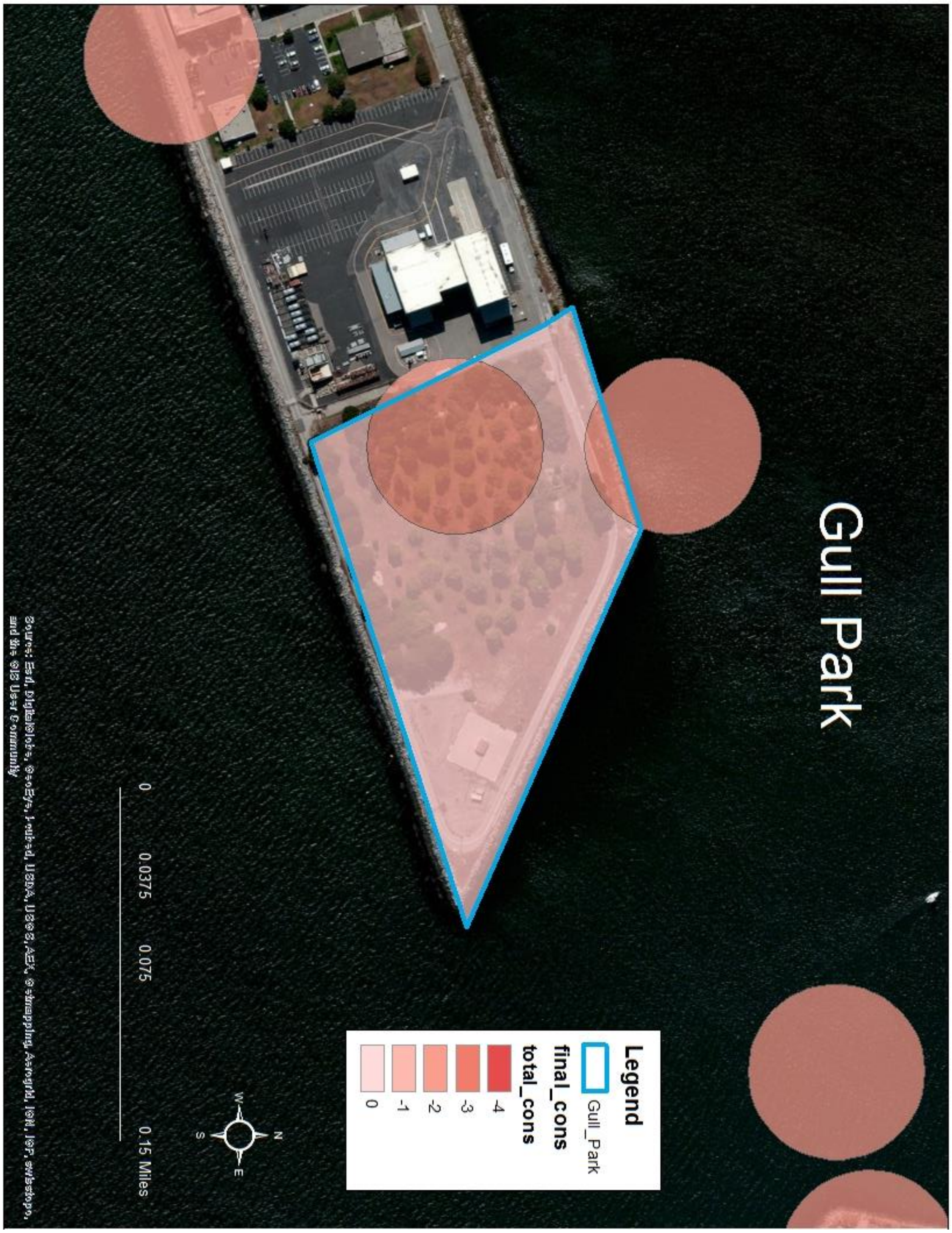
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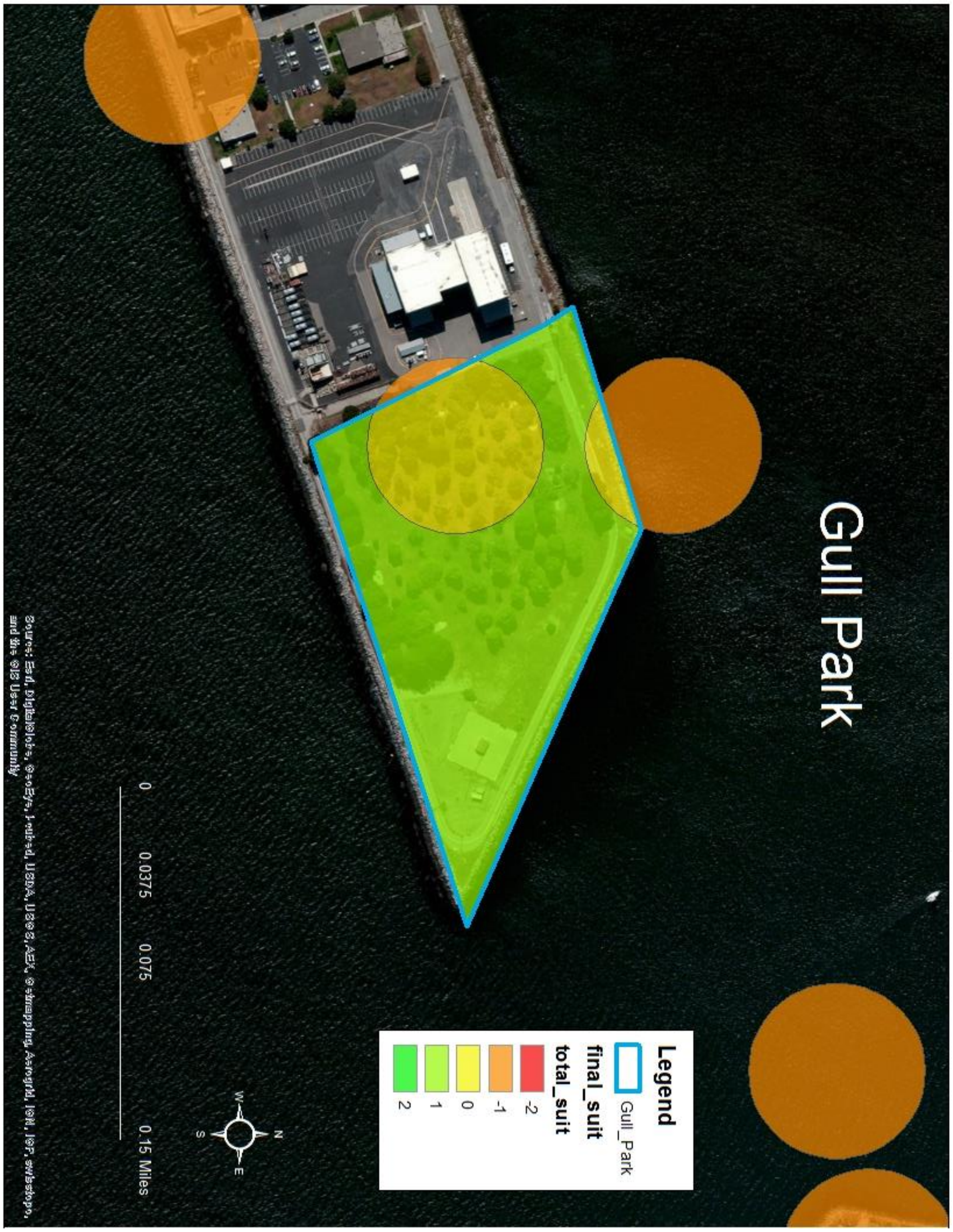
0.075
0.15 Miles
N
S
E
W


Gull Park
Legend
Gull_Park
final_opps
total_opp
1
2
3
4
0 0.0375 0.075 0.15 Miles
N
S
E
W
Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community


Gull Park
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Gull_Park
final_suit
total_suit
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1
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0.0375
0.075
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N
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W