An Analysis of Wetland Restoration Site Selection for Mitigation Banking in San Diego County

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Abstract
Selecting sites for wetland mitigation can utilize a geographic information system (GIS) to assist in preliminary suitability analysis, in which sets of data can be quantified and aggregated to identify highly suitable wetland restoration sites for use in mitigation banking. Five sets of data were used in this suitability study, including hydrology, wetlands, soils, vegetation, and land use, all of which are key criteria for identifying suitable wetland restoration sites. Identification of these sites is necessary as planned growth and development cannot proceed unless impacts to wetlands are able to be replaced through the purchase of credits at wetland mitigation banks. The San Dieguito Lagoon, a proposed wetland restoration site in San Diego County, was quantitatively compared to five highly suitable wetland restoration sites in San Diego County, as identified through this suitability analysis, and found to be less suitable based purely on the sets of data used. Further feasibility studies must occur prior to wetland restoration site selection; however, this methodology is useful for identifying a large number of potentially suitable sites for use in wetland mitigation banking.
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1.0 Introduction

Wetland mitigation has been a critical component of development in the United States since enactment of the Clean Water Act (CWA) in 1972. The CWA mandated impacted wetlands must be replaced in-kind within the same or nearby watersheds, and resulted in wetland mitigation, through creation and restoration of wetlands, occurring at the county level. Regulatory agencies such as the U.S. Army Corp of Engineers (ACOE), with authority to regulate activities imposing wetland impacts, provide mitigation opportunities through the purchase of wetland credits at certified wetland mitigation banks. Wetland mitigation banks are private entities that create or restore wetlands on their property, and in turn offer the purchase of wetland acreage as credits to developers. Developers who generate an acre of impacts to wetlands must purchase an acre of wetland credit from a mitigation bank to offset wetland impacts from their project. The money from the purchase of these credits is used by the mitigation banks to maintain and preserve the wetlands in perpetuity; this relieves developers of the liability associated with creating and maintaining wetlands for mitigation purposes.

Counties with large development agendas, such as San Diego County (SDC), California, must have mitigation banks with credits available to offset anticipated impacts to wetlands. As of 2014, SDC has nearly depleted it's available wetland mitigation credits, which means development projects throughout the county with impacts to wetlands are unable to begin construction, as regulatory agencies will not grant approval to start without proof of mitigation credit purchase. Due to this dwindling number of mitigation credits, SDC needed to select a wetland mitigation site with the intent of becoming the future location of an approved wetland mitigation bank. SDC selected this new wetland mitigation site to be created in the San Dieguito
Lagoon, located in Del Mar, with the purpose of allowing future construction with wetland impacts to occur.

1.1 Goal

The goal of this project is to analyze the San Dieguito Lagoon to determine if this site is the best location in the county for development of a mitigation site. Through this determination, other potential mitigation sites in SDC will be identified and analyzed for their suitability of becoming wetland mitigation sites. Potential mitigation sites will be identified utilizing GIS to analyze multiple set of data, that will be further evaluated for their viability of becoming a wetland mitigation site.
FIGURE 1
Study Location

Wetland Restoration Site Selection for Mitigation Banking in San Diego County
San Diego County, California
2.0 Background

2.1 Regulatory Setting

*National Environmental Policy Act*

The National Environmental Policy Act of 1969 (NEPA) is the overarching federal environmental law that regulates all actions from federal agencies, or actions with a connection to federal agencies, such as funding or permitting from federal agencies for the action (Ambrose 2010). NEPA requires consideration of potential impacts to the environment to be documented, in which each potential impact to the environment is evaluated against established significance thresholds. The Council on Environmental Quality (CEQ), the federal division responsible for NEPA implementation, instated a policy in which all impacts determined to be significant from a proposed action must first attempt to avoid such impacts; second, if avoidance is not possible, attempt to minimize impacts; and third, compensate for any impacts that are anticipated to occur (Silverstein 1994). While these significance thresholds generally help protect the environment, additional regulatory guidelines were necessary for some sectors, such as water.

*Clean Water Act*

One such additional regulatory guideline originated in 1972 with the congressional approval of the CWA, which is the most important law governing waters in the United States (Clean Water Act of 1972). The U.S. Environmental Protection Agency (USEPA) is responsible for oversight of the CWA, and designated the ACOE to implement Section 404 of the CWA (ACOE 1989). Section 404 of the CWA provides basis for the protection of jurisdictional waters, otherwise known as Waters of the U.S., including navigable waters, interstate waters, tributaries to navigable or interstate waters, adjacent wetlands, and isolated waters of importance, such as
vernal pools. Federal protection of these waters requires any impacts, including dredging or filling, or the removal or placement of material, to obtain a permit from the ACOE. For a permit to be issued by the ACOE for impacts to waters, the permitee must provide evidence that impacts to the waters were unavoidable under all considered alternatives, and if so, impacts must be minimized to the smallest extent possible (Voigt and Danielson 1996). Each permit issued for impacts to waters will require compensatory mitigation, that necessitates the permitee to replace any lost waters in-kind within the same or nearby watersheds (ACOE 2014). As a result of these permit requirements, avoidance of waters and subsequent replacement or creation of impacted waters is a common occurrence during development within the U.S. While the CWA was successful in implementing additional regulatory oversight to waters in the U.S., unacceptable amounts of wetlands were still being lost from development, in which additional language was still imperative.

*Presidential Protection of Wetlands*

President Carter, recognizing this regulatory lapse regarding wetlands, issued Executive Order 11990: Protection of Wetlands (EO 11990) in 1977, that is the first federal guideline specific to the protection of wetlands. EO 11990 requires federal agencies to minimize impacts to wetlands, and designated wetlands as areas of importance to preserve and enhance.

Additionally, per recommendation of the National Wetlands Policy Forum in 1987, President Bush implemented a no-net loss goal for wetlands in 1989, that prompted Congress to pass the Water Resources Development Act of 1990, a federal mandate that all impacted wetlands must be replaced with wetlands of equal or greater acreage and function (Water Resources
Development Act 1990). This goal has been carried fourth by every successive president since President Bush to eventual success, and 25 years later, in 2004, the goal was finally realized and more wetlands were created then destroyed in the U.S. (Bender 2009). The implementation of the no-net loss policy created the framework for what is known today as wetland mitigation (Brown and Stayner 1995).

2.2 Wetland Mitigation

While the concept of mitigation by means of compensation for impacts was introduced under NEPA, wetland mitigation became the primary means of meeting the requirements of the no-net loss policy. Prior to regulatory protection, wetlands were largely converted to farmland and other agricultural uses; however, under President Bush's direction, wetlands received federal protection and began to be enhanced, restored, and created as a result of development impacts, otherwise known as wetland mitigation. Development with unavoidable wetlands impacts were required to replace equal or greater amount of wetlands either on-site or within the vicinity of the impact to comply with the no-net loss policy and mitigate for the lost wetlands. Due to the complexities and nuances of wetlands, many restored or created wetlands are not independently functional, and instead require anthropogenic input to survive, thereby failing to meet mitigation requirements (Kihslinger 2008, Solek and Stein 2012, Zedler and Callaway 1999). Mitigation sites are required to have anthropogenic input, such as irrigation and maintenance, during their initial establishment period to increase their chance of success; however, many sites fail to restore functional wetlands after 5 to 10 years, once these establishment periods end (Ambrose 2010). These unsuccessful wetland mitigation sites were developed to satisfy regulatory requirements and fulfill the letter of the law, but failed to fulfill the spirit of the law to maintain
an equal or greater amount of independently functional wetland throughout the U.S. Analysis of unsuccessful mitigation sites revealed that they failed for many reasons, with the two predominate offenders being inadequate planning and insufficient design (National Research Council 2001). Inadequate wetland mitigation planning often results in poor site selection, which largely determines the viability of the site, and insufficient design, which results in sites failing once maintenance periods end (Van Lonkhuyzen et al 2002, Zedler and Callaway 1999). Mitigation often isn't viable adjacent to the impacted wetland, and in an attempt to mitigate as close to the impact as possible, sites with isolated and limited ecosystem connectivity and functionality are selected, that culminates in mitigation achieving the proper amount of acreage, but not sufficient wetland functionality (Ambrose 2010 and Bunn 2012). This failure of an unacceptable percentage of mitigation sites throughout the U.S. prompted the ACOE to adopt a different approach towards mitigation to achieve the spirit of the no-net loss policy (General Accounting Office 2001, National Academy of Sciences 2001, Zedler 1996).

2.3 Mitigation Banking

In response to the failure of compensatory mitigation sites, the ACOE, in coordination with the USEPA, published new guidance in the National Wetlands Mitigation Action Plan of 2002 (NWMAP), that provided explicit preference for wetland mitigation banks to be used to fulfill compensatory mitigation requirements (ACOE 2002). Wetland mitigation banks are privately developed areas of restored or created wetland in which credits, calculated from the acreage and function of the site, are made available for purchase as compensatory wetland mitigation (Silverstein 1994). Each acre of created or restored independently functional wetland in a mitigation bank translates to a wetland mitigation credit available for purchase.
Previously, development projects resulting in filled wetlands used to be required to create an equal or greater amount of wetlands, but with the establishment of wetland mitigation banks, compensatory mitigation is encouraged through the purchase of mitigation credits (Hunter et al. 2012, Silverstein 1994). As with wetland mitigation, mitigation credits must be within the same or nearby watersheds, that results in mitigation banking occurring at the county-wide level (Martin and Brumbaugh 2013). The NWMAP includes explicit preference for wetland mitigation banks as these banks offer a more reliable means of mitigation then the previously attempted strategy of developing wetland mitigation sites. Mitigation banks are considered more reliable as they are developed and created by experts in the restoration field and must be assessed on its value and functionality by a multitude of federal regulatory agencies before credits are made available for sale (Weems and Canter 1995). Additionally, banks are typically constructed in large complexes, creating wetlands with higher ecological connectivity than smaller scattered wetlands (Solek and Stein 2005, Weems and Canter 1995). Further, banks are established and fully functional at the time when mitigation is necessary, allowing for the ACOE to fulfill the no-net loss policy as any lost wetlands have already been replaced (Balcombe et al. 2005). This process results in a much higher success rate for wetlands in mitigation banks when compared to wetlands restored or created by developers as a requirement of compensatory mitigation (Ambrose 2010, Weems and Canter 1995). A common issue found when utilizing mitigation banks is that in areas with large development agendas, credits are exhausted quickly, in which development is halted and cannot proceed until a new bank with available credits is created and approved.
2.4 San Diego County Wetland Mitigation

Such a county with a large development agenda is San Diego County (SDC), that quickly exhausted the available mitigation credits within the region and was left struggling to continue to meet the goals of SDC as set forth in the county-wide General Plan. A new wetland mitigation complex was proposed at the San Dieguito Lagoon in Del Mar, San Diego County, California, to create up to 247 acres of wetlands (Figure 2 and 3) (San Diego River Park Joint Powers Authority 2000). The wetlands created at this site were used to mitigate a number of projects within the region, a majority being 115 acres for Southern California Edison as a result of pipeline projects within the region, and 42 acres for Poseidon Resources Corporation as a result of a desalination plant project (San Onofre Nuclear Generating 2013). Other smaller projects requiring wetland mitigation in the county have the ability to use wetlands at this site as mitigation; however, available wetlands are expected to be depleted quickly. The San Dieguito Lagoon was selected as the site for wetland restoration due to the proximity to the San Dieguito River, a hydrologic feature, the presence of wetlands existing on the site, the presence of hydric soils, the existence of vegetation consisting of grasslands, vernal pools, meadows, other herb communities, and bog and marsh on largely non-native vegetation, developed areas, or unvegetated habitat, and a land use defined as open space park or preserve (Figure 4 and 5) (Kent and Mast 2005). These factors make the San Dieguito Lagoon a site ideal for wetland restoration and creation to be used as mitigation. A number of other smaller complexes have been identified within SDC to be used as mitigation sites for a variety of protected species and habitats, including wetlands and threatened and endangered species (Figure 6). Even with these additional mitigation sites throughout the region, SDC is still struggling to meet mitigation requirements, and need to identify additional potential sites suitable for wetland restoration projects.
FIGURE 2
San Dieguito Lagoon Restoration Project Vicinity

Wetland Restoration Site Selection for Mitigation Banking in San Diego County
San Diego County, California

Source: ESRI 2013; 04-11-14; Created By: Z. Liptak
FIGURE 3
San Dieguito Lagoon Features
Wetland Restoration Site Selection for Mitigation Banking in San Diego County
San Diego County, California
San Dieguito Lagoon Area

Wetlands - Freshwater Emergent Wetland

Hydric Soils - Tujunga sand, 0 to 5 percent slopes

Vegetation - Bog and Marsh

Vegetation - Grasslands, Vernal Pools, Meadows, and Other Herb Communities

Vegetation - Non-Native Vegetation, Developed Areas, or Unvegetated Habitat

Land Use - Open Space Park or Preserve

Source: ESRI 2008; 04-11-14; Created By: Z. Liptak

FIGURE 5
San Dieguito Lagoon Restoration Site Selection Criteria - Wetlands, Soils, Vegetation, and Land Use

Wetland Restoration Site Selection for Mitigation Banking in San Diego County
San Diego County, California
FIGURE 4
San Dieguito Lagoon Restoration Site Selection Criteria - Hydrology

Wetland Restoration Site Selection for Mitigation Banking in San Diego County
San Diego County, California
FIGURE 6
Mitigation within San Diego County
Wetland Restoration Site Selection for
Mitigation Banking in San Diego County
San Diego County, California
3.0 Methods and Materials

3.1 Resources

The information used in this study (Table 1) was provided by the San Diego Geographic Information Source (SanGIS)/San Diego Association of Governments (SANDAG) GIS Data Warehouse (SANDAG 2014), that is a compiled source of GIS data from both SanGIS, an agency with the responsibility of creating and maintaining GIS data for both the City and County of San Diego, and from SANDAG, an agency with the responsibility to create GIS data used in the modeling of anticipated future growth within the region.

<table>
<thead>
<tr>
<th>Data Name(shapefile name)</th>
<th>Data Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Streams (Hydrology)</td>
<td>Data were compiled from the existing National Hydrography Dataset (NHD) as provided by the U.S. Geological Survey (USGS). Slight corrections were made to the data prior to being distributed by SanGIS to provide the full extent, without gaps, of the streams within the County.</td>
</tr>
<tr>
<td>(streamNHD.shp)</td>
<td></td>
</tr>
<tr>
<td>Wetlands</td>
<td>Data were obtained from the National Wetland Inventory (NWI) and mapped throughout the region. Study excludes wetlands in the Pacific and intertidal zones, as they do not meet the purpose and need of this study.</td>
</tr>
<tr>
<td>(nwipolys.shp)</td>
<td></td>
</tr>
<tr>
<td>Soils</td>
<td>Data were compiled from the Natural Resources Conservation Service (NRCS) from their existing soil surveys. Hydric soils were determined from the previous Soil survey of San Diego Area, California (Bowman 1973).</td>
</tr>
<tr>
<td>(soils.shp)</td>
<td></td>
</tr>
<tr>
<td>Eco Vegetation CN</td>
<td>Data were created using existing aerials and biological map overlays for use in the County Department of Planning and Landuse.</td>
</tr>
<tr>
<td>(eco_vegetation_cn.shp)</td>
<td></td>
</tr>
<tr>
<td>Land Use Current</td>
<td>Data were compiled from the existing land use planning documents used in the City and County’s General Plan, along with documents from the County’s Assessor’s office.</td>
</tr>
<tr>
<td>(land_use_current.shp)</td>
<td></td>
</tr>
</tbody>
</table>

3.2 Limitations

This study was limited by the data made available by SanGIS. The study assumes the data provided are accurate and are the most up to data information in the region. Future studies may
result in different findings if updated data are provided by SanGIS. The data used for the purpose of this study were obtained on March 31, 2014.

### 3.3 Methods

This study utilized the capabilities of ArcMap 10.1, a geographic information system (GIS), to process the selected sets of data and identify potential wetland restoration sites for the purpose of mitigation banking. Using GIS to analyze these data provides an efficient desktop analysis to help better preliminarily locate potential wetland restoration sites, prior to further assessing sites in the field (Tiner 1999). Figures for each dataset can be found at the end of this section.

#### Data Sets

The five sets of data input into GIS included hydrology, wetlands, soils, vegetation, and land use for identifying potential wetland mitigation sites. The hydrology data are a main criteria for success of wetland restoration as the proximity of sites to water sources helps maintain the wetland inundation period and regulates the hydrology of the site (Figure 7) (Hunter et al. 2004, Solk and Stein 2012). As wetland restoration sites move farther and farther away from a hydrological source, the likelihood of restoration success incrementally decreases (Figure 8). The wetland data are important as the existence of wetlands is one of the key criteria to identify potential restoration sites, as these sites are known to be able to support functional wetlands (Figure 9) (Roise et al. 2004, Russell et al. 1999). The soils data included hydric soils, as identified by the Soil survey of San Diego Area, mapped throughout the county (Table 2) (Bowman 1973). Hydric soils are critical components of wetland restoration as soils determine
the ability of water to pond and maintain habitat suitable for functional wetlands, and an area without hydric soils is not ideal for wetland restoration (Figure 10) (Tiner 1999).

<table>
<thead>
<tr>
<th>Soil Abbreviation</th>
<th>Soil Type and Slope</th>
</tr>
</thead>
<tbody>
<tr>
<td>ChA</td>
<td>Chino fine sandy loam, 0 to 2 percent slopes</td>
</tr>
<tr>
<td>CkA</td>
<td>Chino silt loam, saline, 0 to 2 percent slopes</td>
</tr>
<tr>
<td>InA</td>
<td>Indio silt loam, 0 to 2 percent slopes</td>
</tr>
<tr>
<td>IoA</td>
<td>Indio silt loam, saline, 0 to 2 percent slopes</td>
</tr>
<tr>
<td>IsA</td>
<td>Indio silt loam, dark variant</td>
</tr>
<tr>
<td>Lu</td>
<td>Loamy alluvial land</td>
</tr>
<tr>
<td>MoA</td>
<td>Mecca sandy loam, saline, 0 to 2 percent slopes</td>
</tr>
<tr>
<td>MxA</td>
<td>Mottsville loamy coarse sand, wet, 0 to 2 percent slopes</td>
</tr>
<tr>
<td>Rm</td>
<td>Riverwash</td>
</tr>
<tr>
<td>Tf</td>
<td>Tidal flats</td>
</tr>
<tr>
<td>TuB</td>
<td>Tujunga sand, 0 to 5 percent slopes</td>
</tr>
<tr>
<td>VaA</td>
<td>Visalia sandy loam, 0 to 2 percent slopes</td>
</tr>
</tbody>
</table>

Source: County of San Diego, 2007

The vegetation data included all vegetation communities mapped within the region, including vegetation communities known to exist on and around wetlands, as well as areas with non-native, disturbed, or unvegetated vegetation coverage that can be converted to wetlands without significant loss of ecological value (Figure 11) (Brooks et al. 2004, Strager et al. 2011). The land use data included all SDC planned land uses, in which vacant, undeveloped, open space parks or preserves, and landscape open spaces were used as the potential land uses most likely to be able to be used as wetland restoration sites (Figure 12) (Brown and Stayner 1995). These five sets of data were then analyzed using GIS to determine potential sites suitable for wetland restoration.

GIS Analysis

The five sets of data were converted from shapefile features to rasters with a cell size of 10 and analyzed per the methods found in the Suitability Analysis with Raster Data (ESRI 2003a) and Suitability Analysis with Raster Data Part II (ESRI 2003b). The criteria to evaluate potential

<table>
<thead>
<tr>
<th>Metric Name</th>
<th>Score Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proximity to Hydrologic Feature</td>
<td>1-10, 10 being within 0.1 miles of hydrologic feature and 1 being 1.0 miles or farther from feature.</td>
</tr>
<tr>
<td>Existing Wetlands at Location</td>
<td>1, 3, or 10, 10 being an existing wetland present, 3 being estuarine and marine wetland/deepwater, and 1 being all other areas in SDC.</td>
</tr>
<tr>
<td>Hydric Soils at Location</td>
<td>1 or 10, 10 being hydric soils present and 1 being no hydric soils present.</td>
</tr>
<tr>
<td>Vegetation Type at Location</td>
<td>1, 5, 8, or 10, 10 being grasslands, vernal pools, meadows, and other herb communities, 8 being riparian, bottomland, bog and marsh habitat, 5 being non-native vegetation, developed areas, or unvegetated habitat, and 1 being all other vegetation types.</td>
</tr>
<tr>
<td>Land Use at Location</td>
<td>1, 5, 8, or 10, 10 being vacant and undeveloped land, 8 being open space park and preserve, 5 being landscape open space, and 1 being all other land uses.</td>
</tr>
</tbody>
</table>

The data were weighted for wetlands, vegetation types, and land uses based on the need to identify suitable wetland restoration sites. Estuarine and marine wetland/deepwater were weighted lower than other wetland types as this study does not intend to identify tidal wetlands. Additionally, vegetation types were weighted based on their known ability to support hydrophytic vegetation, with grasslands, vernal pools, meadows, and other herb communities weighted the highest, vegetated areas weighted the second highest, and areas with poor vegetation communities of non-natives, developed, and unvegetated areas weighted the lowest. Land Use was weighted base on its potential to become a wetland restoration site, with vacant and undeveloped land weighted the highest as these lands would be the easiest to convert to a
restoration site, with open space park and preserve the second easiest, and landscape open space the third, while all other land uses within the county being rated the lowest.

**Site Selection**

Once the raster calculator ran, the generated suitability scores, between 5 and 50, were doubled, to make the quantified suitability score out of 100, and separated into 10 classified values (Table 4).

<table>
<thead>
<tr>
<th>Raster Calculator Score</th>
<th>Suitability Score</th>
<th>Suitability Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-13</td>
<td>0-26</td>
<td>Lowest Suitability</td>
</tr>
<tr>
<td>13-16</td>
<td>26-32</td>
<td>Low Suitability</td>
</tr>
<tr>
<td>16-19</td>
<td>32-38</td>
<td>Low Suitability</td>
</tr>
<tr>
<td>19-23</td>
<td>38-46</td>
<td>Low Suitability</td>
</tr>
<tr>
<td>23-27</td>
<td>46-54</td>
<td>Medium Suitability</td>
</tr>
<tr>
<td>27-32</td>
<td>54-64</td>
<td>Medium Suitability</td>
</tr>
<tr>
<td>32-37</td>
<td>64-74</td>
<td>Medium Suitability</td>
</tr>
<tr>
<td>37-42</td>
<td>74-84</td>
<td>High Suitability</td>
</tr>
<tr>
<td>42-46</td>
<td>84-92</td>
<td>High Suitability</td>
</tr>
<tr>
<td>46-50</td>
<td>92-100</td>
<td>Highest Suitability</td>
</tr>
</tbody>
</table>

Five sites in SDC with the highest suitability score and ranking were selected for analysis, and compared to the San Dieguito Lagoon suitability score and ranking. These five sites were selected based on the visibility of the suitable areas, as well as parcel ownership, in which parcels located in regional parks and national forests were excluded from analysis. These sites were excluded as they do not have high potential for mitigation banks as they are already protected from future disturbance. The perimeters of the five sites selected for analysis were drawn based on parcel lines, and any built environment within these areas were excluded from analysis. Areas selected for analysis encompassed the extent of the highest suitability score, the surrounding areas, and were limited by the built environment including buildings and roads. The five potentially suitable sites selected and their suitability scores are found in Section 4.0.
FIGURE 7
Hydrology within San Diego County

Wetland Restoration Site Selection for Mitigation Banking in San Diego County
San Diego County, California
FIGURE 8
Hydrology with Buffer within San Diego County
Wetland Restoration Site Selection for Mitigation Banking in San Diego County
San Diego County, California
FIGURE 9
Wetlands within San Diego County
Wetland Restoration Site Selection for Mitigation Banking in San Diego County
San Diego County, California
Study Area

- Chino fine sandy loam, 0 to 2 percent slopes
- Chino silt loam, saline, 0 to 2 percent slopes
- Indio silt loam, 0 to 2 percent slopes
- Indio silt loam, saline, 0 to 2 percent slopes
- Indio silt loam, dark variant
- Loamy alluvial land
- Mecca sandy loam, saline, 0 to 2 percent slopes
- Mottsville loamy coarse sand, wet, 0 to 2 percent slopes
- Riverwash
- Tidal flats
- Tujunga sand, 0 to 5 percent slopes
- Visalia sandy loam, 0 to 2 percent slopes

FIGURE 10
Hydric Soils within San Diego County
Wetland Restoration Site Selection for Mitigation Banking in San Diego County
San Diego County, California
FIGURE 11
Vegetation within San Diego County

Wetland Restoration Site Selection for Mitigation Banking in San Diego County
San Diego County, California

Study Area
Non-Native Vegetation, Developed Areas, or Unvegetated Habitat
Grasslands, Vernal Pools, Meadows, and Other Herb Communities
Riparian and Bottomland Habitat
Bog and Marsh
**FIGURE 12**
Land Use within San Diego County

Wetland Restoration Site Selection for Mitigation Banking in San Diego County
San Diego County, California

- **Study Area**
- **Vacant and Undeveloped Land**
- **Open Space Park or Preserve**
- **Landscape Open Space**
4.0 Results

The suitability analysis was successful in utilizing GIS to identify potential wetland mitigation sites for use as mitigation banks in SDC. Five sites were selected from the highest suitability scores to be compared against the previously identified San Dieguito Lagoon Restoration Project (Figure 13 and 14). The San Dieguito Lagoon Restoration Project was ranked as having high suitability, while the other five site were all categorized as having the highest suitability for being a wetland restoration site (Table 5).

<table>
<thead>
<tr>
<th>Site</th>
<th>Suitability Score</th>
<th>Suitability Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>San Dieguito Lagoon</td>
<td>84-92</td>
<td>High Suitability</td>
</tr>
<tr>
<td>Site 1</td>
<td>92-100</td>
<td>Highest Suitability</td>
</tr>
<tr>
<td>Site 2</td>
<td>92-100</td>
<td>Highest Suitability</td>
</tr>
<tr>
<td>Site 3</td>
<td>92-100</td>
<td>Highest Suitability</td>
</tr>
<tr>
<td>Site 4</td>
<td>92-100</td>
<td>Highest Suitability</td>
</tr>
<tr>
<td>Site 5</td>
<td>92-100</td>
<td>Highest Suitability</td>
</tr>
</tbody>
</table>

The suitability scores are based on the area within each site with the highest suitability score, and are calculated using an aggregate of the five suitability criteria scores for proximity to hydrologic features, presence of wetland, presence of hydric soils, vegetation type, and land use category (Table 6).

<table>
<thead>
<tr>
<th>Site</th>
<th>Hydrology</th>
<th>Wetland</th>
<th>Soils</th>
<th>Vegetation</th>
<th>Land Use</th>
<th>Total Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>San Dieguito Lagoon</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>10</td>
<td>16</td>
<td>86</td>
</tr>
<tr>
<td>Site 1</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>100</td>
</tr>
<tr>
<td>Site 2</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>100</td>
</tr>
<tr>
<td>Site 3</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>16</td>
<td>96</td>
</tr>
<tr>
<td>Site 4</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>100</td>
</tr>
<tr>
<td>Site 5</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>100</td>
</tr>
</tbody>
</table>

The San Dieguito Lagoon scored a 20 out of 20 on proximity to hydrologic features for being within 0.1 mi of a river or stream, a 20 out of 20 on presence of wetland, a 20 out of 20 on presence of hydric soils, a 10 out of 20 on vegetation for being non-native vegetation, developed,
or unvegetated, and a 16 out of 20 on land use for being an open space park or preserve (Figure 15-17). Sites 1 and 2 scored a 20 out of 20 on proximity to hydrologic features for being within 0.1 mi of a river or stream, a 20 out of 20 on presence of wetland, a 20 out of 20 on presence of hydric soils, a 20 out of 20 on vegetation for having a vegetation type of grassland, vernal pools, meadows, and other herb communities, and a 20 out of 20 on land use for being vacant and undeveloped land (Figure 18-23). Site 3 scored a 20 out of 20 on proximity to hydrologic features for being within 0.1 mi of a river or stream, a 20 out of 20 on presence of wetland, a 20 out of 20 on presence of hydric soils, a 20 out of 20 on vegetation for having a vegetation type of grassland, vernal pools, meadows, and other herb communities, and a 16 out of 20 on land use for being open space park or preserve (Figure 24-26). Sites 3 and 4 scored a 20 out of 20 on proximity to hydrologic features for being within 0.1 mi of a river or stream, a 20 out of 20 on presence of wetland, a 20 out of 20 on presence of hydric soils, a 20 out of 20 on vegetation for having a vegetation type of grassland, vernal pools, meadows, and other herb communities, and a 20 out of 20 on land use for being vacant and undeveloped land (Figure 27-32).
FIGURE 13
Suitability Analysis Results
Wetland Restoration Site Selection for Mitigation Banking in San Diego County
San Diego County, California
FIGURE 14
Sites Selected for Suitability Analysis
Wetland Restoration Site Selection for Mitigation Banking in San Diego County
San Diego County, California

Study Area
Scores 0 - 26 (Lowest Suitability)
Scores 26 - 32 (Low Suitability)
Scores 32-38 (Low Suitability)
Scores 38 - 46 (Low Suitability)
Scores 46 - 54 (Medium Suitability)
Scores 54 - 64 (Medium Suitability)
Scores 64 - 74 (Medium Suitability)
Scores 74 - 84 (High Suitability)
Scores 84-92 (High Suitability)
Scores 92 - 100 (Highest Suitability)

San Dieguito Lagoon Restoration Site
Suitable Site 1
Suitable Site 2
Suitable Site 3
Suitable Site 4
Suitable Site 5
FIGURE 15
San Dieguito Lagoon Suitability Analysis
Wetland Restoration Site Selection for Mitigation Banking in San Diego County
San Diego County, California
FIGURE 16
Suitability Analysis - San Dieguito Lagoon Hydrology

Wetland Restoration Site Selection for Mitigation Banking in San Diego County
San Diego County, California
FIGURE 18
Suitability Analysis - Site 1
Wetland Restoration Site Selection for Mitigation Banking in San Diego County
San Diego County, California

Site 1 Suitability Area
Parcels
Scores 0 - 26 (Lowest Suitability)
Scores 26 - 32 (Low Suitability)
Scores 32-38 (Low Suitability)
Scores 38 - 46 (Low Suitability)
Scores 46 - 54 (Medium Suitability)
Scores 54 - 64 (Medium Suitability)
Scores 64 - 74 (Medium Suitability)
Scores 74 - 84 (High Suitability)
Scores 84-92 (High Suitability)
Scores 92 - 100 (Highest Suitability)
FIGURE 19
Suitability Analysis - Site 1 Hydrology
Wetland Restoration Site Selection for Mitigation Banking in San Diego County
San Diego County, California

Site 1 Suitability Area
0.1 mi from River or Stream
0.2 mi from River or Stream
0.3 mi from River or Stream
0.4 mi from River or Stream
0.5 mi from River or Stream
0.6 mi from River or Stream
0.7 mi from River or Stream
0.8 mi from River or Stream
0.9 mi from River or Stream
1 mi from River or Stream
FIGURE 20
Suitability Analysis - Site 1 Wetlands, Soils, Vegetation, and Land Use
Wetland Restoration Site Selection for Mitigation Banking in San Diego County
San Diego County, California

- Site 1 Suitability Area
- Wetlands - Freshwater Emergent and Forested/Shrub Wetlands
- Hydric Soils - Visalia sandy loam, 0 to 2 percent slopes
- Hydric Soils - Tujunga sand, 0 to 5 percent slopes
- Hydric Soils - Riverwash
- Vegetation - Bog and Marsh
- Vegetation - Grasslands, Vernal Pools, Meadows, and Other Herb Communities
- Vegetation - Non-Native Vegetation, Developed Areas, or Unvegetated Habitat
- Vacant and Undeveloped Land
FIGURE 21
Suitability Analysis - Site 2
Wetland Restoration Site Selection for Mitigation Banking in San Diego County
San Diego County, California
FIGURE 22
Suitability Analysis - Site 2 Hydrology
Wetland Restoration Site Selection for Mitigation Banking in San Diego County
San Diego County, California

Site 2 Suitability Area
- 0.1 mi from River or Stream
- 0.2 mi from River or Stream
- 0.3 mi from River or Stream
- 0.4 mi from River or Stream
- 0.5 mi from River or Stream
- 0.6 mi from River or Stream
- 0.7 mi from River or Stream
- 0.8 mi from River or Stream
- 0.9 mi from River or Stream
- 1 mi from River or Stream

Legend
FIGURE 23
Suitability Analysis - Site 2 Wetlands, Soils, Vegetation, and Land Use
Wetland Restoration Site Selection for Mitigation Banking in San Diego County
San Diego County, California

Site 2 Suitability Area
- Wetlands - Freshwater Emergent and Forested/Shrub Wetlands
- Loamy alluvial land
- Mottsville loamy coarse sand, wet, 0 to 2 percent slopes
- Chino fine sandy loam, 0 to 2 percent slopes
- Hydric Soils - Tujunga sand, 0 to 5 percent slopes
- Vegetation - Bog and Marsh
- Vegetation - Grasslands, Vernal Pools, Meadows, and Other Herb Communities
- Vegetation - Non-Native Vegetation, Developed Areas, or Unvegetated Habitat
- Vacant and Undeveloped Land

0 0.5 1 1.5 2 Miles
Site 3 Suitability Area
Parcels
Scores 0 - 26 (Lowest Suitability)
Scores 26 - 32 (Low Suitability)
Scores 32-38 (Low Suitability)
Scores 38 - 46 (Low Suitability)
Scores 46 - 54 (Medium Suitability)
Scores 54 - 64 (Medium Suitability)
Scores 64 - 74 (Medium Suitability)
Scores 74 - 84 (High Suitability)
Scores 84-92 (High Suitability)
Scores 92 - 100 (Highest Suitability)

FIGURE 24
Suitability Analysis - Site 3
Wetland Restoration Site Selection for
Mitigation Banking in San Diego County
San Diego County, California
Suitability Analysis - Site 3 Hydrology

Wetland Restoration Site Selection for Mitigation Banking in San Diego County
San Diego County, California

FIGURE 25

Site 3 Suitability Area

0.1 mi from River or Stream
0.2 mi from River or Stream
0.3 mi from River or Stream
0.4 mi from River or Stream
0.5 mi from River or Stream
0.6 mi from River or Stream
0.7 mi from River or Stream
0.8 mi from River or Stream
0.9 mi from River or Stream
1 mi from River or Stream
FIGURE 26
Suitability Analysis - Site 3 Wetlands, Soils, Vegetation, and Land Use

San Diego County, California

Site 3 Suitability Area
- Wetlands - Freshwater Forested/Shrub and Riverine Wetlands
- Hydric Soils - Riverwash
- Vegetation - Grasslands, Vernal Pools, Meadows, and Other Herb Communities
- Vegetation - Non-Native Vegetation, Developed Areas, or Unvegetated Habitat
- Vacant and Undeveloped Land
- Open Space Park or Preserve
Site 4 Suitability Area
Parcels
Scores 0 - 26 (Lowest Suitability)
Scores 26 - 32 (Low Suitability)
Scores 32-38 (Low Suitability)
Scores 38 - 46 (Low Suitability)
Scores 46 - 54 (Medium Suitability)
Scores 54 - 64 (Medium Suitability)
Scores 64 - 74 (Medium Suitability)
Scores 74 - 84 (High Suitability)
Scores 84-92 (High Suitability)
Scores 92 - 100 (Highest Suitability)
Suitability Analysis - Site 4 Hydrology

Wetland Restoration Site Selection for Mitigation Banking in San Diego County
San Diego County, California

FIGURE 28

Site 4 Suitability Area
0.1 mi from River or Stream
0.2 mi from River or Stream
0.3 mi from River or Stream
0.4 mi from River or Stream
0.5 mi from River or Stream
0.6 mi from River or Stream
0.7 mi from River or Stream
0.8 mi from River or Stream
0.9 mi from River or Stream
1 mi from River or Stream
FIGURE 29
Suitability Analysis - Site 4 Wetlands, Soils, Vegetation, and Land Use

Wetland Restoration Site Selection for Mitigation Banking in San Diego County
San Diego County, California
FIGURE 31
Suitability Analysis - Site 5 Hydrology
Wetland Restoration Site Selection for Mitigation Banking in San Diego County
San Diego County, California

Site 5 Suitability Area
0.1 mi from River or Stream
0.2 mi from River or Stream
0.3 mi from River or Stream
0.4 mi from River or Stream
0.5 mi from River or Stream
0.6 mi from River or Stream
0.7 mi from River or Stream
0.8 mi from River or Stream
0.9 mi from River or Stream
1 mi from River or Stream

Miles

0 0.1 0.2 0.3 0.4
FIGURE 32
Suitability Analysis - Site 5 Wetlands, Soils, Vegetation, and Land Use
San Diego County, California
5.0 Discussion

The GIS suitability analysis resulted in quantifying the potential of the San Dieguito Lagoon as a wetland restoration site, as well as identifying five additional potential wetland restoration sites in SDC. This suitability analysis is intended to be the preliminary step in identifying potential suitable wetland restoration sites for further consideration. This preliminary step does not require field visits or verification of sites, but rather provides initial guidance to where additional focused efforts will be necessary, once a wetland restoration site is selected. Each site identified using this suitability analysis will require further analysis to determine if a wetland restoration project is reasonable and feasible, as these determinations are not possible to be made through GIS. These factors may result in sites identified as having the highest suitability not being selected as the actual wetland restoration site after additional analysis. This is the case for the San Dieguito Lagoon site, as this area scored lower than the other five sites identified from the suitability analysis.

This analysis scored the San Dieguito Lagoon lower than other potentially suitable sites, as the vegetation type and land use at the San Dieguito Lagoon site was found, through the weighted algorithm, to be not as suitable for wetland restoration when compared to other potential vegetation types and land uses within SDC. Although the San Dieguito Lagoon received a score of 86, which is a highly suitable site, this preliminary suitability analysis does not take into account many other factors, such as land ownership, restoration costs, maintainability, ecological connectivity, protected species present, as these factors are necessary to consider when locating actual suitable wetland restoration sites. While the San Dieguito Lagoon site may have scored lower than other sites identified in the study, the San Dieguito Lagoon wetland restoration
project is still necessary to ensure planned development within the county continues, and these
aforementioned additional factors surely contributed to the selection of this wetland restoration
site.

Sites 1, 2, 4, and 5 all received a suitability score of 100, the highest potential score possible, as
each analyzed category was found to be perfectly suitable for a wetland restoration site. Site 3
received a suitability score of 96, as each analyzed category except for land use was found to be
perfectly suitable for a wetland restoration site, and the land use was found to be highly suitable
for a wetland restoration site. Site 1 is located on federally designated Pala Band of Mission
Indian tribal land, Site 2 is located on public land owned by the California Department of
Forestry and Fire Protection (Calfire), Site 3 is located on land privately owned by SSBTLCEV
LLC, and is adjacent to land owned by SDC and a gravel quarry, Site 4 is located on privately
owned land by RCP Sierra Inc, and Site 5 is located on privately owned land by a number of
individuals. With this additional information, the potential for a wetland restoration site to occur
at Site 1 or 2 is heavily decreased, as Site 1 would be difficult to permanently convert from
federally designated tribal land into a wetland restoration site, and Site 2 would be difficult to
permanently convert from land actively maintained by Calfire with the purpose of minimizing
fire risks to a wetland restoration site. Sites 3, 4, and 5 have a much higher potential, and should
be studied further on their potential to become a wetland restoration site, as privately held lands
are more likely to be available for purchase and restoration of wetlands. While these economic
based decisions are not a part of this suitability analysis, such factors must be considered when
selecting suitable sites for further analysis. Failure to consider the potential economic
ramifications when selecting suitable sites may result in a very low percentage of wetland restoration projects ever materializing.

For feasibility studies, potential economically viable wetland restoration sites could be further isolated using a suitability model which federal, state, or existing county designated preserve land weighted lower than privately held lands. This feasibility analysis would remove all of the sites located in national parks, Indian tribal reservations, state parks, and regionally significant parks. While this study did not consider economic factors, the results could have been further improved through the use of feasibility analysis, which would have removed a number of potentially suitable sites that are not economically feasible to become wetland restoration sites.

Although feasibility was not considered, the five sets of data selected for the suitability analysis did yield the anticipated results, although the sheer number of sites rated at the highest suitability level would make analysis of each identified suitable site extremely time consuming. The number of areas scoring perfectly across all categories exceeds 600, and the number of sites scoring in the highest suitability category exceeds 7,500, far more then is practically analyzed for the purposes of finding suitable wetland restoration sites. Future suitability studies should consider additional sets of data to limit the number of highly suitable sites, including mapped invasive vegetation, digital elevation models to map water flows, climate data, annual precipitation, and proximity to roads and/or disturbance. These suggested additional sets of data would further limit the number of potentially suitable sites for analysis, and allow for a more thorough analysis of sites with the highest suitability.
An additional measure to help limit the number of suitable sites would be to convert the aggregate suitability raster back to a shapefile, calculate the areas of each site ranked highly suitable, and prioritize the top five sites based on size. This methodology would yield the suitable sites with the largest areas in the region, and allow for additional focused analysis of these sites, rather than selecting sites based on visibility. Site selection based on size would assist in the site selection of wetland mitigation banks, as the banks prefer large areas in which to perform wetland restoration and creation because the number of credits offered by the bank is directly related to the number of acres of wetlands.

Further, if the only sets of data available are hydrology, wetlands, soils, vegetation, and land use, the spatial constraints can be limited to smaller regions, rather than entire counties. Exclusion of large metropolitan areas, such as city limits, can reduce the spatial scale of the suitability analysis, thereby producing fewer suitable sites for analysis. Future suitability analysis should consider limiting the spatial scope of the study to specific watersheds to produce fewer results, and allow further focused analysis on each identified suitable sites, rather than selecting sites based on visibility, as done in this study. Conducting multiple suitability analyses for each watershed in the county and aggregating the selected sites for further analysis may also yield stronger results, as these spatially limited studies would allow for higher level analysis of each suitable site, leading to an overall analysis of all identified sites. This methodology would work better for large jurisdictions, such as SDC, as there are far too many suitable sites identified for full analysis the determine the most ideal potential wetland restoration area.
The large scale of this study makes it difficult to have a conclusive determination on whether or not the San Dieguito Lagoon is the most appropriate location for a new wetland restoration site in SDC. While the San Dieguito Lagoon did not yield the highest quantitative score in the suitability analysis, is it still a site with high suitability for a wetland restoration project, and should continue to be pursued. SDC’s planned growth is dependent upon the existence of wetland restoration sites, and while the San Dieguito Lagoon is a large site with 247 acres of restored wetlands planned, additional wetland restoration sites are still necessary to allow for development to continue.
6.0 Conclusion

This study utilized GIS to aggregate sets of data, of which hydrology, wetlands, soils, vegetation, and land use were used, to quantify five potentially suitable wetland restoration sites for use in mitigation banking. A proposed wetland restoration site, the San Dieguito Lagoon, was quantitatively scored and compared to these five identified suitable sites to determine if the San Dieguito Lagoon was the best place in SDC for a wetland restoration site. Based purely on the quantitative methodology used in this study, the San Dieguito Lagoon is not the most ideal place in the county for a wetland restoration project, as this site received a suitability rating of high, while the other five sites identified as a result of this study all received the highest suitability rating. Based purely on these five criteria, these five sites identified in this study are more suitable than the San Dieguito Lagoon as restoration sites. Further analysis of these sites reveals that more data is necessary to conclude the most ideal wetland restoration site in SDC, as feasibility, a critical component of site selection, is not addressed in this study. Economic considerations of wetland restoration sites for mitigation banking must be considered, as potentially suitable sites that are simply unfeasible do not help SDC continue planned growth.
7.0 References


