SAN FRANCISCO BAY
BIRD OBSERVATORY

Effects of Flora on Bay Area Bird Populations

Teen Volunteer Program Project Report

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Summary

In the face of increasingly abundant nonnative flora in the Bay Area, we wanted to determine what kind of an impact these trends might have on local bird populations. We analyzed photographic data of 26 breeding waterbird colonies around the San Francisco Bay Area to link colonies of Black-crowned Night-Herons, Great Egrets, Snowy Egrets, and Great Blue Herons with the tree species they nested in. Ultimately, we found that trees of the genus *Eucalyptus* are increasingly replacing native species as the most commonly used trees in breeding waterbird colonies, accounting for 43.64% of all pairings between bird and plant species studied.

Introduction

Since 1982, the San Francisco Bay Bird Observatory (SFBBO) has monitored local populations of breeding birds as part of its Colonial Waterbird Program[1]. SFBBO biologists and volunteers track numbers of breeding herons, egrets, terns, gulls, and other birds that nest in colonies around the Bay Area each year in an effort to document population trends. In addition to population trends, this wealth of data can be used to explore other questions about colonial waterbirds, such as the preferred nesting sites of these species.

Many species of colonial waterbirds build their nests in vegetation such as trees and bushes. This vegetation may include both native and non-native plant taxa. There have been concerns over whether to remove invasive plant taxa such as *Eucalyptus* due to their capacity to reduce native biodiversity[2] as well as being a fire hazard, but if birds are nesting in these invasive plants, removing them may negatively impact local bird populations. Therefore, we wanted to

look into the flora used by local colonial waterbird species to shed light on the importance of different plants to different bird colonies. In particular, our goal for this study was to determine if colonial waterbirds tended to nest in non-native or native plants. Many considerations should go into the removal or retention of non-native plant taxa, particularly those considered to be invasive, and one of these is how native bird species rely on them for nesting.

Methods

To determine which waterbird colonies to include in this study, we first explored SFBBO's Colonial Waterbird Nest Map[3], which shows the locations and names of each colony and lists the years that different species nested there. We looked specifically for colonies that included bird species that nest in vegetation: Black-Crowned Night-Herons (BCNH), Great Egrets (GREG), Snowy Egrets (SNEG), Great Blue Herons (GBHE), Green Herons (GRHE), and Double-Crested Cormorants (DCCO), resulting in 109 sites. For each site that included any of these species, we recorded the site name, the species that have nested there, and what years each species has been recorded nesting there. Because Colonial Waterbird Program surveys appear to be more geographically comprehensive in recent years, we focused our search on sites that have included nests since 2000. We then identified candidate sites from the East Bay, South Bay, and Peninsula where breeding activity by colonial waterbird species of interest was recorded across multiple years (ranging from 4 to 21 years of activity, a median of 14) from 2000–2021.

For selected sites, we gathered pictures of their colonies taken by Colonial Waterbird Program volunteers and attempted to identify the plants used by the colony to genus. For plant identification, we primarily used iNaturalist[4] and the National Audubon Society Field Guide to North American Trees Western Region[5]. When plant photos were unclear, we also used Google Maps satellite view and street view, park websites, and notes from Colonial Waterbird survey datasheets to aid in plant identification. We then sorted the identified plant genera into native and non-native categories. Because many sites (65.38%) included more than one bird species and/or more than one plant taxon, we also listed our data in terms of 55 species-habitat associations (hereafter links) where each link represents one instance of a particular bird species nesting in a particular tree genus.

To analyze associations between nesting bird species and plant genera, we calculated: the percentage of overall links for each plant genus; the percentage of overall links for each bird species; the percentage of each bird species' links for each plant genus; the percentage of each plant genus' links for each bird species; and frequency and relative frequency of use of native and nonnative plants over time, from 2000–2021. We also performed a chi-squared test for independence to determine whether there was significant association between specific bird species and plant genera.

Results

We analyzed data from a total of 26 colonies of Black-Crowned Night-Herons (BCNH), Great Egrets (GREG), Snowy Egrets (SNEG), Great Blue Herons (GBHE), Green Herons (GRHE), and Double-Crested Cormorants (DCCO) (Figure 1, Table 1). The final 55 links (see Table 2) included 14 SNEG (25.45%), 14 GBHE (25.45%), 11 BCNH (20.00%), 10 GREG (18.18%), 5 DCCO (9.09%), and 1 GRHE (1.82%), with 0–6 bird-tree links per year from 2000–2021. Because of the limited data, we excluded DCCO and GRHE links for the rest of our study.

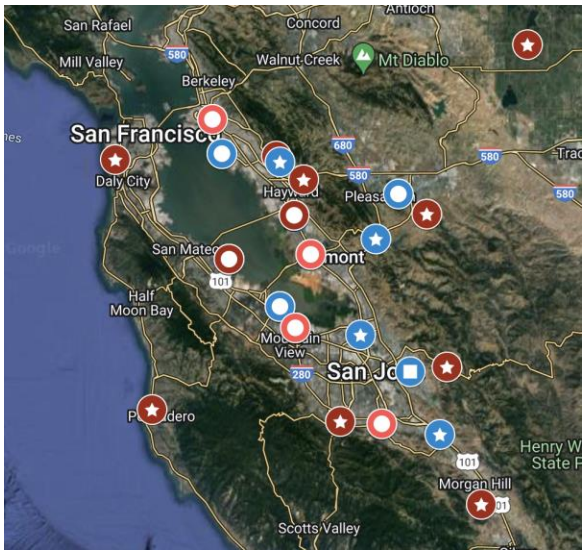


Figure 1: Map of studied breeding heron and egret colonies.

Key: shape indicates bird species (star = GBHE, circle = SNEG, square = BCNH, diamond = GREG), color indicates tree genus (blue = native, dark red = Eucalyptus*, light red = nonnatives other than* Eucalyptus*).*

Link to interactive map:

https://www.google.com/maps/d/viewer?mid=1VI5xf6GllPggFfRfd14CiLSY-HUBtIg

Table 1: List of studied waterbird colony sites.

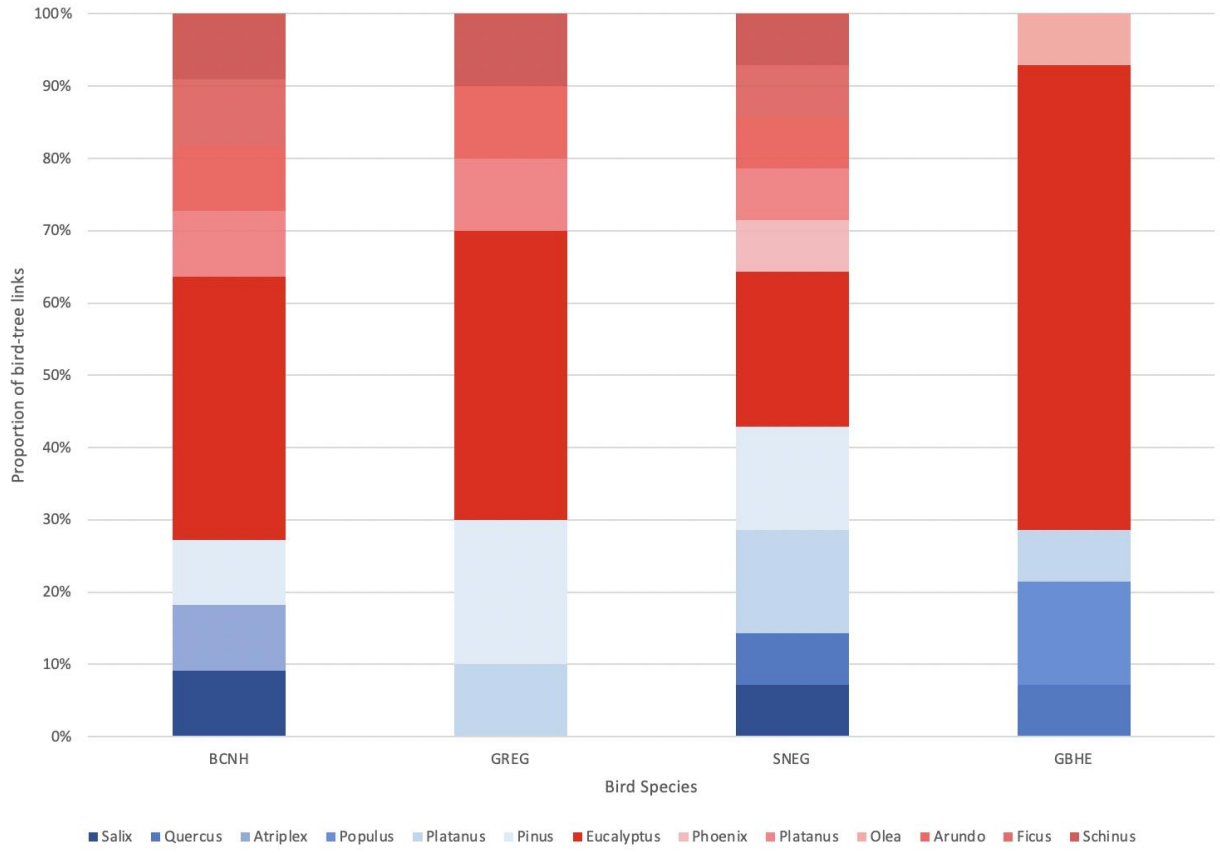
Almaden Lake	Lakeshore Park (Channel Island)
Bacon Island	Livermore VA Park And Hospital
Bay Farm Island	Llagas Creek
Coyote Ranch Rd Colony	Other Lakeshore Park Sites
Don Castro	Ovation Court
Downtown Oakland	PA Baylands
Grant Lake	Pescadero Marsh
Lake Chabot	Redwood Shores Water Treatment Plant
Lake Cunningham	Ruus Park
Lake Elizabeth	Shadow Cliffs
Lake Merced Mesa	Shorebird Way
Lake Merced N	Sunol Water Temple
Lake Merritt	Vasona Reservoir Island

Table 2: Bird-tree links by bird species and tree genus. *Platanus* is split into native and nonnative categories of species.

	BCNH	GREG	SNEG	GBHE
Salix	1	0	1	0
Quercus	0	0	1	1
Atriplex	1	0	0	0
Populus	0	0	0	2
Platanus	0	1	2	1
Pinus	1	2	2	0
Eucalyptus	4	4	3	9
Phoenix	0	0	1	0
Platanus	1	1	1	0
Olea	0	0	0	1
Arundo	1	1	1	0
Ficus	1	0	1	0
Schinus	1	1	1	0

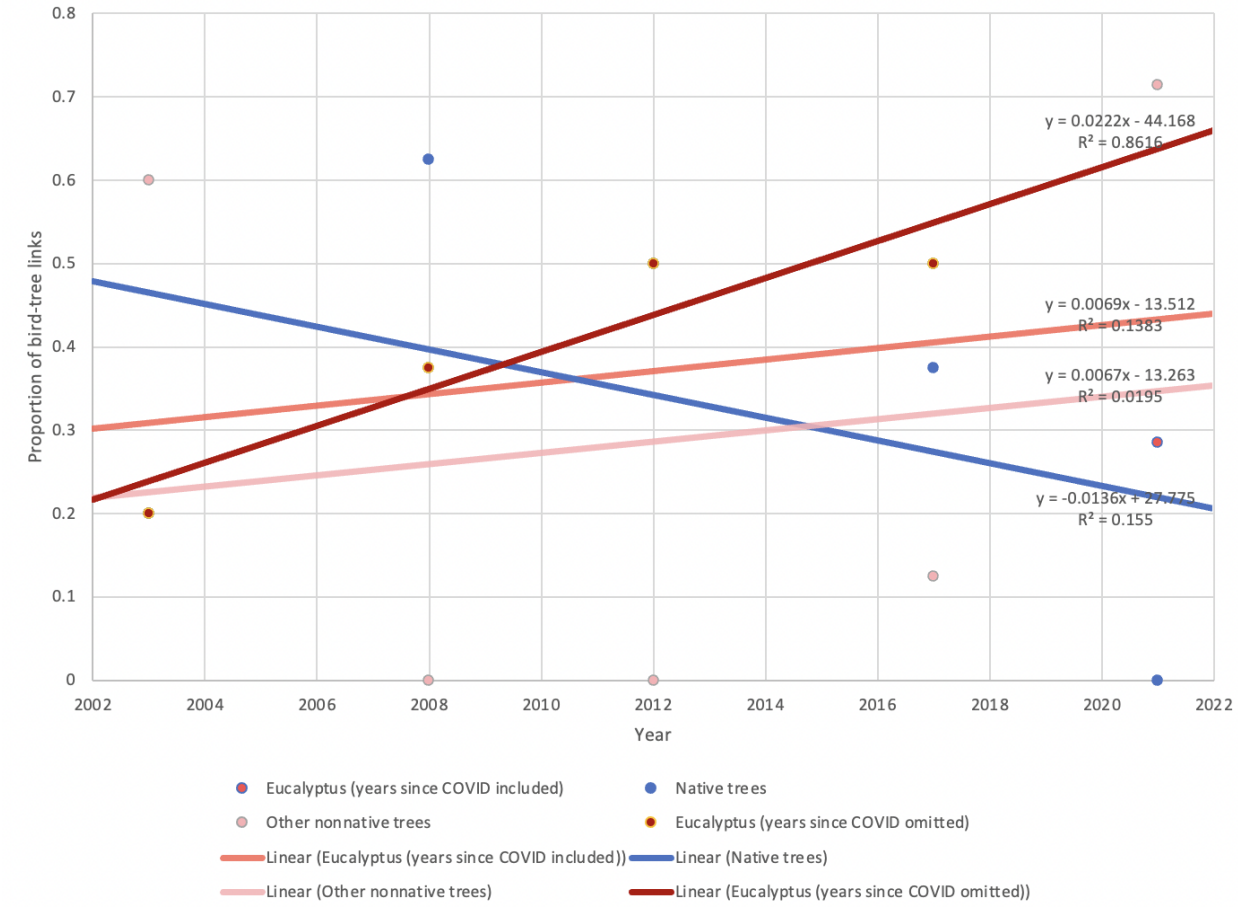
After analyzing our data by performing a chi-squared test for independence, we obtained a chi-squared value of 30.21 at 36 degrees of freedom and a p-value of 0.74, leading us to conclude that there was no significant association between bird species and tree genus. However, there was one major trend of interest in our data: 43.64% of all links in studied waterbird colonies used trees of the genus *Eucalyptus* during breeding, while the remaining links were split between 32.73% native taxa and 23.64% nonnative taxa other than *Eucalyptus*. After *Eucalyptus*, the next most common plant genera were *Platanus* (12.73%; total includes both native and nonnative species) and *Pinus* (9.09%). The use of *Eucalyptus* was most prevalent in GBHE colonies, where 64.29% of all links were with the genus; the proportions for BCNH, GREG, and SNEG were 36.36%, 40.00%, and 21.43%, respectively (Figure 2).

Figure 2: Proportion of links of each bird species by tree genus. *The series in blue represent native trees, series in red represent nonnative trees. Note the great overrepresentation of* Eucalyptus *species.*



Judging by analysis of these data over time, the relative use of *Eucalyptus* and other nonnative tree genera has shown slight increases over the past two decades, while relative use in native plants has shown slight decreases. Due to limitations in our data, especially given the recent pandemic that resulted in decreased available information, these trends are not very well supported ($R^2 < 0.2$). However, excluding years since the pandemic (2020–2021), we obtain a much better-supported trend ($R^2 = 0.862$) of increase in the relative use of *Eucalyptus* over the past 22 years (Figure 3).

Figure 3: Proportion of links by tree species over time. *Use of* Eucalyptus *and other nonnative trees seem to be increasing over time, while use of native trees has been decreasing. Note also that removal of datapoints taken since the pandemic greatly increased the* R^2 *value – judging from this restricted dataset, it seems more reasonable to conclude that use of* Eucalyptus *trees has been increasing with time.*



Discussion

We found that many colonial waterbirds are using non-native tree taxa, especially those in the genus *Eucalyptus*, as their breeding sites. So far, the debate among conservationists over *Eucalyptus* in the Bay Area has centered on the potential fire hazard that they pose[2,6]. Due to the hanging strips of bark and the oils produced by Eucalyptus species, they are likely much more of a fire hazard than many other trees. Debate continues, however, over whether they could be less of a fire hazard than the shrubs and grasses that would be likely to replace them if tracts of Eucalyptus forest were removed, and there is no firm consensus on the ultimate impact that large-scale eucalyptus removal would have on fire safety. The primary biodiversity-related

argument centers around the idea that *Eucalyptus* forests are less biodiverse than native mixed woodland and deter native species. However, given that our data demonstrate a high rate of use *Eucalyptus* species by colonially nesting waterbirds, and given that some of these same bird species (GBHE, in particular) have a tendency not to readily switch which species of tree they use from year to year for breeding[7], it is important to recognize that *Eucalyptus* trees are now important for the breeding success of our local waterbird populations. This is important information to bear in mind when deciding how to proceed with *Eucalyptus* control or removal. More investigation would also be advisable to determine best practices to conserve our native biodiversity and ensure safety. In particular, it could be useful to experimentally determine what factors influence the fidelity to tree species exhibited in various colonially nesting waterbirds, since data involving the behavior of individual birds was beyond the scope of our study.

While we found that relative use of *Eucalyptus* appears to be increasing over time, we do not know if birds are preferentially selecting these trees over other tree taxa or if the availability of other tree taxa is decreasing. Collecting data on the distributions of tree taxa, including *Eucalyptus*, around the Bay could allow us to use the data in this study to compare the relative frequencies of bird-tree links for each pair of species to a baseline of the relative local abundance of each plant taxon, giving us a clearer picture of trends that might exist between bird species, or across regions. By comparing this to the historical distribution of trees, we could also determine how anthropogenic change has affected both the distribution of trees and the birds that nest in them. Collecting this type of data over time, as well as collecting more data on bird-tree links in the future, could also help illuminate the impact of shifting tree distributions and abundances on changes in populations of colonially nesting waterbirds.

When conducting this study, we encountered several challenges and limitations that should be considered when interpreting the results. First, identifying the plant species that colonial waterbirds were recorded nesting in was difficult in many cases, or photos of the plant species were unavailable. When we could not identify the plant species, we excluded the site from our study, which may bias the results. The Colonial Waterbird Program also relies on volunteers to be available to record colonies present at different sites throughout the Bay Area. In some cases, lack of volunteer availability may affect the consistency of the data. For example, COVID-19 restrictions impacted the ability of volunteers to assess all the sites. Without records in recent years, we are left with missing blocks of information on many colonies. Because of

these challenges with the availability and consistency of data, we ended up with a small sample size, so our results should be interpreted with caution and may not be representative of trends in the Bay Area as a whole. Nonetheless, our study provides an example of how long-term data collection by scientists as well as citizen/community scientists can be used to explore questions relevant to bird conservation and trends over time.

Acknowledgments

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