Rose-ringed Parakeets in California: Established Populations and Potentially a Serious Agricultural Threat

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ABSTRACT: The rose-ringed parakeet has been introduced to >40 countries, gaining its status as the most widely introduced parrot in the world. Although regarded as a strikingly beautiful bird by many people, this species is a severe agricultural pest that establishes and experiences a lag time prior to exponential population growth. In addition to agricultural damage, these birds cause noise and fecal pollution, aggregate in large night roosts near human structures, may be involved in disease transfer, and, in some cases, they may help spread invasive plants. In the U.S., rose-ringed parakeets have been reported in several southern states, but established populations are in Hawaii, Florida, and California. Escapees from the pet trade probably account for most introductions, and parakeets have been reported occurring in California as early as 1956. The estimated population in Bakersfield was 3,000 birds in 2012, and additional smaller populations have been reported in San Diego, Anaheim, Santa Cruz, Malibu, and Pasadena. Much of California, excluding expansive natural areas unoccupied by humans, is potentially at risk of rose-ringed parakeet colonization, and this species represents a conceivably important threat to California agriculture. Rose-ringed parakeets are known to consume and damage crops such as rice, sunflower, safflower, rapeseed, and citrus in native India; almonds in rural Italy; and corn and fleshy fruit (e.g., guava, mangos, lychee, papaya) in Hawaii. In 1975, the California Department of Agriculture estimated that the potential crop losses due to a well-established rose-ringed parakeet population could reach US$ 735,000 annually, a value that resulted from an estimate of their damaging 0.1% of crops grown in the area. Rose-ringed parakeets are a serious agricultural pest in several areas outside of California, and all areas where they thrive are in human-altered landscapes. An update is needed on this species' distribution, population changes, and impacts to agriculture within California. Furthermore, we recommend establishing an annual monitoring plan of the established California populations, as well as efforts to prevent their spread and reduce their threat to California agriculture.

KEY WORDS: bird damage management, economic costs, human-wildlife interaction, invasive pest species, parrot pet trade, *Psittacula krameri*, rose-ringed parakeet, urban bird ecology

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INTRODUCTION

At least 33 parrot species have been recorded as naturalized in California (Garrett 1997), and perhaps the most worrisome for potential damage to agriculture is the rose-ringed parakeet (*Psittacula krameri*). The rose-ringed parakeet (RRP) is native to parts of Africa and Asia, and it has now established in over 40 countries including those in tropical and temperate regions (Butler 2005). The RRP is the most widely introduced parrot in the world. Most of the naturalized populations originated from the pet trade, where they escaped or were released by their owners. Because of their colorful beauty and exotic nature, they are cherished by some people, especially in some northern temperate countries (Menchetti et al. 2016); however, they pose a serious threat to agriculture in many locations and are generally considered an unwanted pest when their populations reach high densities (Shiels and Kalodimos 2019).

In this paper, we bring attention to the RRP in California as a result of our recent literature reviews covering this species (e.g., Avery and Shiels 2018, Klug et al. 2019a,b, Shiels and Kalodimos 2019), and our documentation of exponential population growth and problems to humans and agriculture occurring in Hawaii. In Hawaii, RRP have been established on Oahu since the 1930s and Kauai since the 1960s; yet they were not well-recognized as an agricultural pest until the early 2000s (on Kauai) when corn companies were fraught with serious crop loss and damage (Shiels and Kalodimos 2019). At this time, and currently, the populations doubling time was noticeably short, currently doubling each 3.5 years, with ~6,800 RRP on Kauai and ~4,500 RRP on Oahu from the 2018 census (Shiels and Kalodimos 2019), and >10,000 on Kauai in the 2020 census (J. Anderson, unpubl. data). Exotic birds, such as parrots, often exhibit long lag-times before rapid exponential growth (Aagaard and Lockwood 2014), and this simultaneously delays obvious and large-scale crop damage (Gaudioso et al. 2012). We are concerned with the agricultural threats of RRP in California where these birds have been established since 1956, and where little is known about their ecology, population growth and distribution, and negative impacts on humans and agriculture. To avoid ending up in the same situation as in Hawaii, where RRP populations are rising at exponential rates and agricultural damage is prevalent, we suggest immediate research on this species in California, and we urge the prevention of their spread and the reduction of their threats to California agriculture. Here we include known information about RRP in California, including historic and contemporary distributions. We briefly review some of the likely California crops that RRP may threaten, and we share some of the possible management options that are available for RRP control and eradication.

RESULTS AND DISCUSSION

Historic Densities, Distributions, and Behaviors in California

There have been several discrete populations of RRP documented in California during the last ~70 years (Figure 1). The earliest record of an established population in

California was by Hardy (1964), where RRP were recorded in Highland Park (near Occidental College), Los Angeles, nesting since about 1956 near the corner of Armadale Avenue and Charters Avenue. In 1963, during spring breeding attempts by these Highland Park individuals, all were confirmed as abortive as the eight eggs simultaneously collected from a single cavity were infertile (Hardy 1964). Attempted nesting occurred in a deserted woodpecker (probably red-shafted flicker *Colaptes cafer*) nest cavity in a 15-m tall wooden utility pole (Hardy 1964). The nest cavity entrance was about 15 cm diameter and was approximately 45 cm from the top of the utility pole (Hardy 1964). Through consistent observations of the nest cavity from February-June 1963, the presumed female RRP roosted in the nest cavity at night (Hardy 1964). This behavior of the female sleeping at her nest during the nesting season, rather than returning to the communal roost like her flock-mates, is a behavior noted with the large >2,500 RRP roosting in Honolulu, Hawaii (Shiels and Kalodimos 2019). The only time the presumed female RRP in Los Angeles was observed feeding (during the 1963 period of observation) was once on a small almond tree (*Prunus dulcis*) located about 60 m from its nest cavity. Presumably, food resources were abundant in the area, and fruit and nut trees (such as figs, walnuts, and pecans) were recorded nearby (Hardy 1964). This Highland Park community of RRP was thought to be extirpated through unknown causes by 1973 (Hardy 1973).

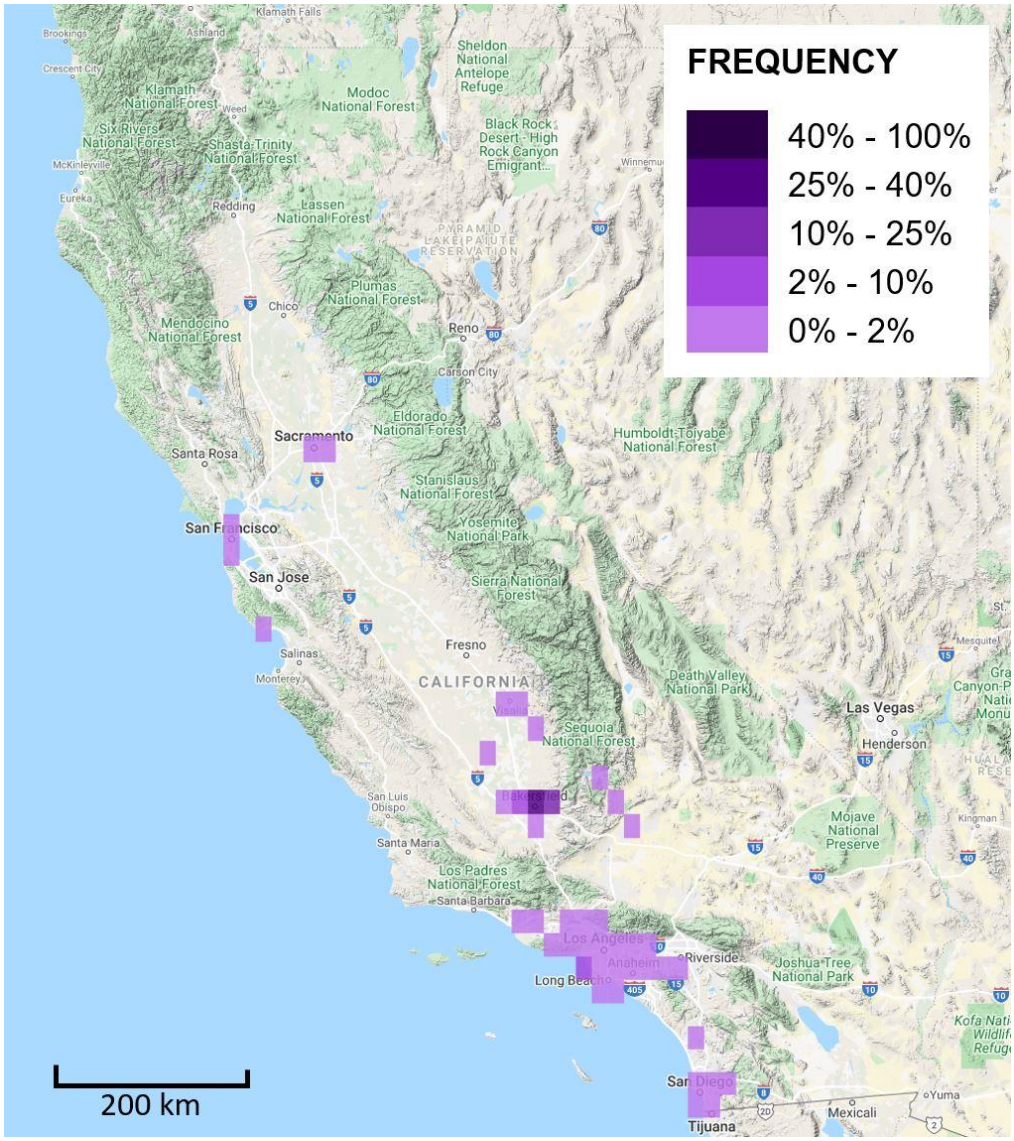

Figure 1. Map of California showing eBird frequencies of rose-ringed parakeet (*Psittacula krameri*) sightings (1950s-present). All sightings of this bird reported to eBird during the last ~70 years were included. Upon recent analysis of the last ~5 years, many of these locations no longer have sightings, as populations never thrived or in some cases have disappeared (K. L. Garrett, pers. commun.). Approximately three locations in the state appear to have populations of >20 rose-ringed parakeets: Bakersfield, San Diego, and Los Angeles County (K.L. Garrett, pers. commun.). eBird data were accessed 12 February 2020.

In the Los Angeles area, there was a self-sustaining population estimated at 60 individuals in 1997 (Garrett 1997). Aside from the Highlands Park RRP population and the 1997 Los Angeles population, other noted populations are not as detailed, neither in observed behaviors nor numbers of individuals. In the past, small populations have been reported in San Diego, Anaheim, Santa Cruz, Malibu, and Pasadena (Sheehey and Mansfield 2015); 1-2 sightings have also been reported to eBird (2020) over the years in Sacramento, San Francisco, and several discrete areas from Visalia to San Diego (Figure 1). However, most of these populations have never thrived or in some cases have disappeared (K. L. Garrett, pers. commun.). The largest population of RRP in California is the Bakersfield population (Figure 1), which was introduced as early as 1977. The estimated population in the greater Bakersfield area was approximately 3,000 individuals in 2012 (Sheehey and Mansfield 2015). The birds thought to be the source of the current-day Bakersfield population originated from the Happy Bird Aviary, where the roof was lost during a strong windstorm on December 20, 1977. The destroyed aviary led to the release of multiple cage-bred species including two pairs of RRP. Since then, Sheehey and Mansfield (2015) have reported an average of one escaped RRP from pet or aviary owners most years from 1985 to 2013 (some years up to six were reported to have escaped, other years none were documented). Based on recent eBird data (eBird 2020), it appears the most sightings of RRP in the Bakersfield vicinity are in urban and residential areas (K. L. Garrett, pers. commun.). Furthermore, one of the roosting sites (a series of palm trees) reported was near the intersection of Union Avenue and California Avenue in Bakersfield (Sheehey and Mansfield 2015).

In February 2020, using eBird data (discounting scattered reports of 1-2 birds, most or all being local escapees), it appears there are small populations (counts <20) in the urban San Diego area and the Playa del Rey area of Los Angeles County. These small populations have not grown or spread in many years. Other small populations have essentially disappeared (e.g., in the San Gabriel Valley and Malibu/Zuma Canyon areas of Los Angeles County). It is suspected that some recent eBird reports in the Malibu area actually represent misidentifications of the much more numerous Nanday Parakeet (*Aratinga nenday*) (K. L. Garrett, pers. commun.). Much of California, particularly in urban/residential areas and excluding expansive natural areas, is potentially at risk of RRP colonization. Furthermore, it is likely that food resources (e.g., backyard gardens, fruit trees, and agricultural settings) that are closest to the urban/suburban roost sites are most likely to be at risk to RRP damage.

All RRP populations in California reside near human habitations that offer an abundance of resources and few predators. Additionally, Strubbe and Matthysen (2007) suggest that dispersal may be limited because of the species' communal roosting behavior. Populations of RRP in Hawaii (both Kauai and Oahu Islands) and California form high-density roosts in public areas, such as in palms lining streets, shopping malls, and public buildings (Gaudioso et al. 2012, Sheehey and Mansfield 2015, Shiels and Kalodimos 2019). RRP worldwide arrive at their communal roost just after sunset to sleep for the night and depart from the roost in the early morning around sunrise (Avery and Shiels 2018). As with most introductions of invasive species, the negative impacts caused by RRP are expected to become more common as more populations become established and the sizes of established populations increase.

Potential for Damage to California Agriculture

RRP represent an important threat to California agriculture. Diet studies and observations of cash crop consumption are the main methods confirming RRP agricultural damage. In native India, RRP find seed crops (particularly oily seeds and beans) desirable, including sunflower (*Helianthus annuus*), safflower (*Carthamus tinctorius*), rapeseed (*Brassica napus*), rice (*Oryza sativa*), beans (*Cajanus cajan* and *Phaseolus* spp.), and maize (*Zea mays*) (Bashir 1979, Rao and Shivanarayan 1981). In a recent diet study in Hawaii where 80% of the RRP diet was seed, common agricultural species consumed included sunflower, beans, and especially corn (Shiels et al. 2018). The same study found that seeds of guava (*Psidium guajava*) were readily consumed, as evidenced by 97% of the 64 birds sampled having guava in their crop-gizzard, which amounted to an average of 30% (by mass) of their diet. Fruit crops such as guava, mango, and citrus were also documented as common components of RRP diets in India (Bashir 1979) and mangos, lychee, and papaya are commonly consumed by RRP in Hawaii (Shiels and Kalodimos 2019). Finally, and of additional importance to California agriculture, RRP are known to consume and damage almonds (*Prunus dulcis*) in rural Italy (>30% of monitored fruit; Mentil et al. 2018) and grapes in the U.K. (Fletcher and Askew 2007).

Almonds were California's third most valuable agricultural product in 2016, accounting for about $5.2 billion (11%) of agricultural output in the state (CASR 2016-2017). Bakersfield is in Kern County, which is the number one county in California for agricultural value (~$7.2 billion in 2016); the leading commodities were almonds, table grapes, milk, and pistachios (CASR 2016-2017). The vineyard damage by RRP in Surrey, U.K., was estimated at £5,000 per year (Fletcher and Askew 2007). There is clear overlap in the wide range of agricultural products that RRP are known to consume and damage elsewhere in the world, with agricultural crops grown as important monetary commodities in California. Many of these crops (e.g., almonds, citrus, rice, grapes, and other fruit crops) are grown within the current RRP distributional range in California, making the potential for crop loss a serious scenario. Furthermore, in 1975 the California Department of Agriculture estimated that the potential crop losses due to a well-established RRP population could reach $735,000 annually, a value that resulted from an estimate of their damaging 0.1% of crops grown in the area (cited in Paton et al. 1982). A more updated estimate of potential crop damage and economic loss in California's agricultural industry is sorely needed.

Damage Management and the Future

Managing RRP damage can take many forms, including population reduction, use of deterrents or hazing

methods, and barriers or coverings to protect resources such as crops. A review of potential and available RRP management methods was recently composed by Klug et al. (2019a,b), including the following: habitat modification (crop characteristics and surrounding landscape), exclusion techniques (netting, crop camouflage, bioacoustics), frightening devices (auditory and visual), fertility control (contraceptives and egg and nest destruction), chemical control (toxicants and repellents), and capture devices (hand nets and trapping). It is important to realize no single method is likely to solve RRP problems, and different areas (e.g., foraging vs. roosting) and timelines likely require use of different methods. An integrated pest management program is typically the most favored strategy.

There are at least three characteristics of RRP ecology that may be key areas to capitalize on for the most efficient population control of this species. First, RRP roost communally in trees and do so in the same trees each night. This equates to their densities being extremely high (hundreds to thousands of individuals; Shiels and Kalodimos 2019) during nocturnal hours, thereby facilitating high numbers of capture or shooting at a predictable location. It has been suggested to carefully decide if lethal control (e.g., shooting) at the roost is appropriate because once several RRP have been removed others can awake and the remaining birds may quickly disperse and abandon the roost indefinitely or at least for multiple months (Bunbury et al. 2019; W. P. Bukoski, pers. commun.). It is also advisable to refrain from shooting at the roost during consecutive nights because of the greater likelihood of roost abandonment relative to one night a week of such suppression methods (W. P. Bukoski, pers. commun.). The efficiency of shooting RRP at the roost while they are sleeping is currently being trialed more thoroughly on the island of Kauai, where RRP now number >10,000 and are spread across three large (>2,000 birds each) roosts (J. Anderson, unpubl. data). Because RRP roost in urban and residential areas, it can be difficult to gain permission to shoot at the roost and otherwise conduct lethal control in a safe and acceptable manner. Attention and adherence to local shooting ordinances is also a factor to consider (Klug et al. 2019b).

A second key behavior of the RRP is that they nest only in established cavities. Most of the cavities are in live trees (see common types described in Shiels and Kalodimos 2019), but some can be in artificial structures such as wooden utility poles (Hardy 1964). Active RRP nest cavities are typically 7-15 cm in diameter, and at least 4 m above ground (but commonly much higher, such as 7-15 m high; A. B. Shiels, pers. observ.). Because RRP will not excavate their own nest cavity (but they will widen an existing cavity), nesting cavities are often limiting (Shiels and Kalodimos 2019). Artificial nest boxes for RRP capture may deserve further investigation for integration into a RRP pest management plan (Klug et al. 2019b, Shiels and Kalodimos 2019).

The third important behavior of RRP that may help control their populations and manage their damage is that they are highly social and often fly and feed in flocks. This flocking behavior not only allows for more efficient capture or lethal control by netting or shooting, but also allows for flocks to quickly learn and follow others in the flock. For example, if one individual in the flock discovers a feeder or responds to shooting or hazing, then others will quickly follow the same behavior as the sentinel (e.g., congregating or dispersing).

Before attempting RRP management in California, it is critical to determine if RRP are a problem and the boundaries of such a problem. A suggested starting point for accomplishing this is to: 1) investigate RRP foraging and foraging distances from roost sites; 2) document crop damage; 3) identify roost sites and estimate densities by conducting roost counts (methods outlined in Shiels and Kalodimos 2019); and 4) determine population density changes at roosts and within California cities and counties. Moving forward, a surveillance plan for RRP should be established in the cities/counties where these birds are known to roost and forage. Implementing such a plan would enable the RRP populations and levels of damage to be tracked at least annually and having these relevant data available will provide justification for RRP management actions and funding to fulfill such actions. Establishing funding sources for these aforementioned annual investigations and documentations will be critical. Preliminary data and the breadth of literature that has previously documented the exponential growth rates of RRP and the elevated crop damage in many areas should be convincing to elicit funding and support in such an important state for agriculture.

All areas worldwide that currently have RRP problems once had RRP populations in the single or double digits. As a cautionary note, there can be long lag times from establishment to high bird densities or substantial RRP damage. It is therefore advisable to remove or greatly suppress this species where it has already established, and to prevent additional areas in California from having RRP populations establish.

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