10-2019

Rose-Ringed Parakeets

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U.S. Department of Agriculture
Animal & Plant Health Inspection Service
Wildlife Services
October 2019

Wildlife Damage Management Technical Series

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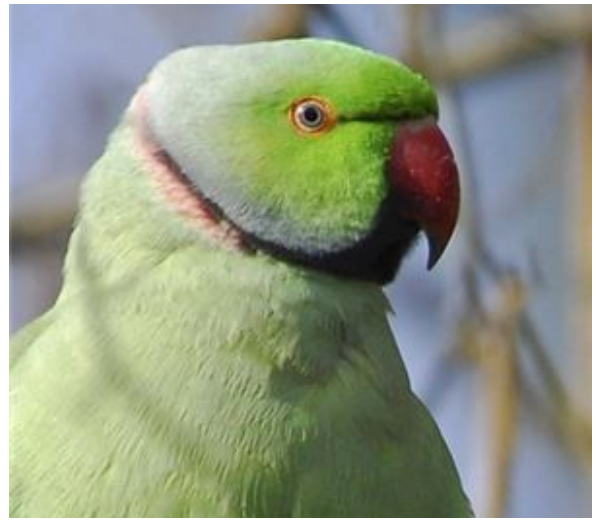

Figure 1. Adult, male rose-ringed parakeet *(Psittacula krameri).*

Quick Links

Human-Wildlife Conflicts

Rose-ringed parakeets (*Psittacula krameri*; hereafter RRPA; Figure 1) are an invasive species in the United States, present in Alabama, Louisiana, Texas, and Virginia, and with established populations in California, Florida, and Hawaii. They are also the most successful species of invasive parakeet, worldwide. RRPA can cause significant damage to agriculture, including grains, oilseeds, fruits, and ornamental plants. Large flocks of RRPA roost near human infrastructure resulting in concerns about human health and safety (e.g., collisions with aircraft, disease transmission, feces accumulation, and noise complaints). The population growth and spread of RRPA is of conservation concern given the potential impact on native wildlife, spread of invasive plant seeds, and destruction of native plants.

Figure 2. Rose-ringed parakeet damage to a) guava, b) corn, c) sunflower, d) mango, e) ornamental flowers, f) African tulip tree (*Spathodea* sp.), and g) royal palm roost tree.

Agriculture

RRPA are a threat to small-scale and large-scale agricultural production across the globe in both native and introduced ranges. On Kauai Island (Hawaii), RRPA negatively impact seed (e.g., corn and sunflower) and fruit crops (e.g., mangos, lychee, longan, guava, rambutan, papaya, and passion fruit). Small, urban populations of RRPA on the mainland U.S. have shown less of an impact on outlying agricultural areas, but as RRPA populations increase the possibility of dispersal to agricultural areas increases.

Natural Resources

Invasive species pose a threat to native ecosystems through predation, aggression, competition, or disease. In Australia, RRPA damage and kill trees by stripping bark, which may lead to changes in tree communities. RRPA have been observed eating fruit and seeds of native plants (e.g., loulu palm and koa trees in Hawaii), and destroying native flowers (e.g., cherry trees in Japan). Corn and invasive yellow guava are main food items for RRPA on Kauai, which helps to sustain RRPA and may contribute to the spread of invasive plants through partially eaten or dropped seeds. In Europe, RRPA directly compete with native wildlife for food and habitat (e.g., nesting cavities) and have attacked and harassed wildlife, including raptors and bats. RRPA also disrupt the foraging behavior of native species by causing a decrease in feeding or an increase in vigilance when RRPA are present. RRPA engage in antagonistic behaviors by excluding native species from backyard bird feeders and outcompeting native birds throughout their invasive range. RRPA can impact the breeding of other invasives (e.g., common myna) by increasing the number of suitable nesting cavities.

Human Health and Safety

Large flocks of RRPA can be a risk to people at urban roosting sites and agricultural foraging sites. Flocking RRPA near airports are a threat to human safety via airplane strikes. The presence of large nighttime roosts in urban and suburban areas produces noise complaints and unsanitary conditions from feces deposits and accumulation capable of increasing the risk of disease transmission to people. Food safety risks by way of foodborne illnesses may increase when large PPRA flocks come into contact with food used for human consumption.

Parakeets are negatively affected by viral diseases including beak and feather disease (psittacine circovirus), proventricular dilatation disease (avian bornaviruses), avian pox virus (avipoxviruses), and avian influenza (influenza A viruses). Pet birds including parrots are reservoirs of the highly contagious Newcastle's disease (paramyxoviruses) that can infect domestic poultry operations. Parakeets are vectors for bacterial diseases, such as erysipelas, pasteurellosis, and avian psittacosis or parrot fever. Chlamydiaceae agents (*Chlamydia avium*) were found in a wild RRPA in France, suggesting sanitary risk to people from invasive parrots.

Damage Identification

RRPA are an agricultural pest with a generalist diet and feeding behaviors that increase the severity of crop damage (Figure 2). RRPA damage corn by feeding on the anthers and pollen of the inflorescence, the tender cob stage, and the milky cob stage up until maturity. RRPA perch on sunflower heads and access the seeds that are hulled prior to consumption. Damage to tree fruits is greater on the top branches compared to the side and bottom branches. RRPA attack stored grains and eat unripe fruit, extending the damage period. RRPA often discard partially-eaten food. Crop damage varies with some fields experiencing more damage due to the timing of crop maturity or location (e.g., field or orchard edges have greater damage than interior). RRPA strip roosting trees (e.g., royal palms in Kauai) of their leaves. A long-term management plan that involves sustained lethal control is necessary to reduce invasive RRPA populations and their damage. In the meantime, the following damage management methods may provide short-term relief from RRPA damage.

Management Methods

No single management method can prevent RRPA conflicts all of the time or in all settings. Methods should be integrated so that one enhances the effect of another. For example, frightening devices often are more effective when used in conjunction with habitat modification (e.g., removal of loafing habitat) to make a site less attractive.

Habitat Modification

When possible, plants or structures (e.g., tree rows; Appendix 1) that are used regularly as RRPA loafing/resting sites near crop fields should be removed. In Hawaii, clearing invasive albizia trees may eliminate potential roosting and nesting habitat, given the number of potential nesting cavities available in mature stands. Trimming roost trees (e.g., royal palms in Hawaii) may reduce the number of birds roosting in a tree, but is not advised by arborists since excessive trimming weakens the tree and is unattractive. Using alternative landscaping and incorporating native plants (e.g., short loulu palm species in Kauai) reduces habitat suitability in urban and suburban areas.

Although not feasible for all crops (i.e., orchards), changing the location and size of crop fields may lessen RRPA damage. For instance, smaller plots provide better access for deploying control tools. Using larger plots or reducing the amount of space between plots may limit preferred foraging areas, where RRPA have space to maneuver and be vigilant to threats. Small, diversified farms may be at a greater risk of RRPA damage because the birds can fulfill all of their nutritional needs in one location given different crops are ripening throughout the year. Farmers should synchronize planting to eliminate early and late-maturing crops in the same locality. In cereal crops, such as sunflower, the harvest date can be advanced two weeks by using a herbicide to desiccate the crop without compromising yield or oil content. In fruit crops, harvest dates can be advanced to reduce losses in hard-hit areas or once RRPA sign is evident.

Decoy crops (i.e., lure crops) may help reduce RRPA depredation on high-value crops. Fields closest to nighttime roosts and daytime loafing areas are best suited for decoy crops. Decoy crops can also be positioned near the fields needing protection. Birds feeding in decoy crops should not be harassed. Fields of sorghum, pearl millet, or hempseed are potential decoy crops that may entice RRPA away from high-value commodity crops. RRPA preference for ground nut kernels (i.e., peanuts) over cereal grains has been shown in lab settings, thus ground nut kernels may be a potential decoy crop. The use of decoy crops is more cost-effective and feasible where tillable land is available. Additional alternative food can be provided by delaying the disking of harvested grain fields to allow access to waste seed or delaying the destruction of unharvestable fruits or plants.

Anti-perching tools (e.g., sharp spikes, wire barriers, an unstable system of coils, electrified cables, and gels or pastes) create an uncomfortable surface and can be used at roosting sites to discourage RRPA perching (Appendix 1). These devices have been effective for discouraging birds perching on human-made structures, but use on trees is not practical given installation logistics and potential damage to trees. Furthermore, the use of water spray devices can cause birds to reflexively withdraw due to direct water pressure or wet feathers. For example, just prior to roosting, a motion-detection sprinkler can be activated to startle birds with a stream of water or a mist system may deter birds as they try to avoid wet feathers.

Exclusion

Exclusion involves physically blocking a bird's access to a site and is an important part of RRPA damage management. Exclusion via netting can be used to protect crops and roosting trees, although the practice is often labor-intensive and expensive (Figure 3; Appendix 1).

RRPA damage to corn is reduced when bags are placed over the ears post-fertilization, and is a practice that could be tried on other sensitive crops (Figure 3; Appendix 1). Any reduction in damage by RRPA from the use of bags is likely due to 1) cobs escaping detection, 2) difficulty of tearing through bags, 3) RRPA unable to preferentially select the best cobs, or 4) the availability of alternative food nearby. Bagging of corn ears is moderately labor-intensive and cannot be done on a large scale, although six people can cover about 120 ears per hour. The practice may increase insects and mold as shown in cloth-covered sorghum, but it depends on the environment and timing of management.

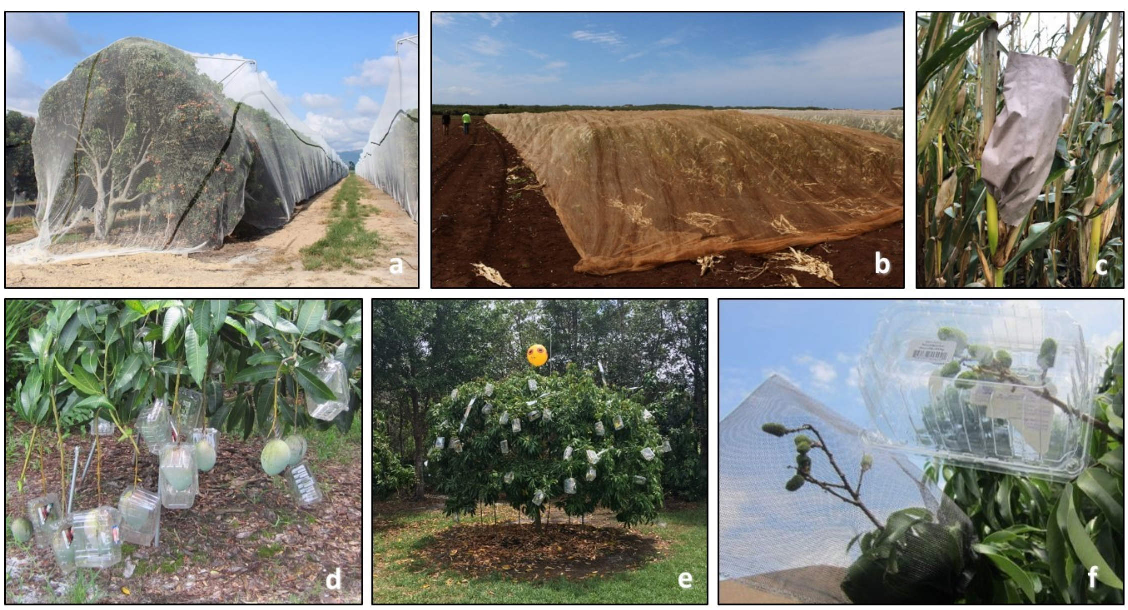

Figure 3. Rose-ringed parakeet damage can be reduced by completely covering a) fruit trees and b) row crops, or at a smaller scale the individual fruiting bodies, examples including c) paper bags over fertilized corn or metal mesh/plastic containers over d) mangoes and e-f) lychees.

Wire or monofilament wire grids can be used to prevent RRPA access to crops and other resources. However, because they are maneuverable fliers and able climbers, RRPA might not be excluded by partial overhead wires which are often effective for larger species that require long, uninterrupted landing and takeoff space. The wire pattern and spacing must be close enough to deter birds from passing through, but wide enough to limit installation and material costs.

Although not tested on RRPA, a “sonic net” is a speaker-based, sound technology that produces directional and contained sound. At 2-10 kHz at 80 dB SPL, the sound masks or blocks communication among birds (Appendix 1). When birds cannot communicate or hear predators their perception of predation risk increases. This may result in reduced foraging or abandonment of foraging grounds. As with most deterrent devices, the effectiveness of the sonic nets is enhanced with real predatory threats, as well as alternative food resources. The sonic net can be used in more rural environments due to directional speakers, but is not feasible at urban roost sites since the noise can be heard by people and RRPA freely use noisy urban areas.

Frightening Devices

Frightening devices modify bird behavior and discourage birds from feeding, roosting, or gathering. Novel sounds and visual stimuli may cause avoidance responses in birds and offer temporary protection from damage for a few days or weeks (Appendix 2). Deterring RRPA with frightening devices requires constantly switching, combining, and moving the stimuli to create a novel environment. For best results, use frightening devices before feeding or roosting sites become established. Randomly present a combination of sounds and visuals and reinforce them with a negative stimulus (e.g., shooting). Globally, numerous devices have been used on RRPA or closely-related species with varying degrees of effectiveness.

Frightening devices include reflecting ribbons, mirrors, lasers, streamers, flagging, gas exploders, “hawk eyes”, distress calls, dead parrot effigies, predator effigies, bioacoustics calls (e.g., barking dogs, raptor calls, and human noise), and reflective plates or plastic bags attached to plants. Most of these deterrent devices have not been adequately tested on RRPA. Efficacy will likely vary with device, landscape, and flock characteristics

When used properly, lasers can be a safe and silent treatment to temporarily disperse birds. The closely-related monk parakeet is sensitive to red lasers (50 mm aperture, 650 nm, 50mW [class3 IIIb]). Handheld lasers are currently used by property owners in Kauai to deter RRPA from roosting trees and automated models are available to spatially and temporally confine laser beams and reduce labor.

Flocking birds are susceptible to bird alarm and distress calls, but habituation often occurs in the absence of actual threats to the flock. Furthermore, distress calls may attract other RRPA, resulting in the opposite of the desired effect, but may provide opportunity for lethal removal.

Birds quickly habituate to stationary, plastic replicas of predators, whereas the presence of actual predators capitalizes on natural predator-prey systems. Erecting nest boxes and perch spaces for owls and raptors has been used to protect fruit farms from other species of pest birds. This technique is best used where native raptor species are common. Trained falcons (falconry) has been used with other pest species, but its high cost and short-term effectiveness are major limitations.

Unmanned aircraft systems (UAS) are a dynamic hazing device that overcomes mobility limitations of stationary devices. Recent UAS technology allows easy-to-operate platforms and the potential for autonomous flight removes the need for a human operator, pending FAA regulations. Adherence to current U.S. Federal Aviation Administration regulations for private and commercial use of UAS and adherence to the Airborne Hunting Act is required. The efficacy of UAS as hazing tools depends on species-specific responses to UAS, which have not been evaluated in RRPA.

Fertility Control

Fertility control or reproductive inhibition is often mentioned as a management option when culling of charismatic animals is not viewed favorably by the public (Appendix 3).

Although fertility control appears promising in the lab, a suitable formulation and species-specific application methods are needed for field use. Furthermore, even if managers were to successfully establish RRPA-specific bait stations that limit access by non-target species, they would still need to condition wild RRPA to feed at the stations. The design and distribution of such bait stations may work for small populations of urban RRPA, but remain questionable in rural settings with abundant alternative food sources. No fertility control methods are currently registered for use with RRPA. Adding RRPA to labels for Ornitrol® (DiazaCon) and OvoControl® (Nicarbazin) would require additional efficacy studies.

Because RRPA nests are difficult to access, egg destruction and nest removal are not practical management actions.

Toxicants and Repellents

Starlicide®, also known as DRC-1339, is an avicide registered with the U.S. Environmental Protection Agency (EPA) for the control of several species of pest birds, but not parakeets.

Methyl anthranilate and anthraquinone are currently registered by the EPA as avian repellents (Appendix 4). Methyl anthranilate (MA) acts as an irritant to birds and is registered for foliar application with label specifications for a variety of pest birds and habitats. Although there are few field efficacy tests, MA has been applied to foliar cereal grains, stone fruits, pome fruit, berries, small fruit, and turf.

Anthraquinone (AQ) causes nausea in birds feeding on treated food, leading to a learned avoidance in a variety of species. AQ is a restricted-use pesticide applied as a seed coating prior to planting and is registered as a Section 24 (c) Special Local Need (SLN) Registration in numerous states. The potential use of AQ for RRPA damage management is limited, given damage to planted seeds or seedlings has not been reported and repellency tests have not been conducted on parakeets. An EPA registration for a foliar application of AQ near harvest is not available nor suitable due to food tolerance restrictions and limited field application strategies for most crops. Natural plant derivatives, such as mint, caffeine, and cinnamon, do not require registration. However, few commercial products made from these derivatives exist due to varying effectiveness and a lack of economic incentives.

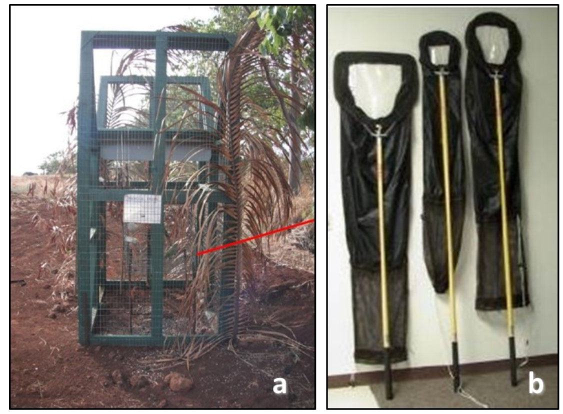

Figure 4. Rose-ringed parakeets can be captured at foraging sites using a) a modified Australian crow-trap baited with food that is more enticing than alternative forage available on the landscape and at roosting sites using b) long-handled nets run along the underside of low-hanging branches or palm fronds.

Trapping

In their native range in Pakistan, RRPA have been successfully trapped using a modified Australian crow trap (i.e., PAROTRAP) in agricultural fields (Figure 4, Appendix 3). For invasive RRPA, a modified Yunick platform trap was effective in urban areas of Spain, but trapping has not been successful or cost-effective in many areas where RRPA have invaded (e.g., Seychelles and Kauai). Remotely triggered, spring-loaded traps can be used if regular feeding stations are established. Feeding stations that exclude non-target birds have been tested for closely-related monk parakeets and could be adapted as traps. Trapping efficacy could be improved if traps are placed over preferred foods (e.g., corn at the milky stage or peanuts) or used when natural forage is limited. Long-handled hand nets have been used to remove RRPA roosting on the underside of low-hanging branches or palm fronds (Figure 4).

The American Veterinarian Medical Association (AVMA) approves euthanasia of birds using CO_2 gas or cervical dislocation by well-trained personnel. Translocation, or the movement of RRPA, is not practical, and many states prohibit the possession, transport, sale, or release of invasive species.

Shooting

RRPA often use human-populated areas to roost, nest, and feed, restricting the use of firearms for population reduction or hazing (Table 3). Shotguns can remove birds flying at far distances, such as on flight lines, whereas more precise and discrete firearms, including air rifles, can target birds perched at roosts, or loafing and feeding areas. An air rifle may be useful to target birds foraging in the canopy at fruit farms while avoiding damage to the tree. Shotguns may be used in row-crop settings or when flocks first approach protected areas. Removing sentinel birds may be effective at deterring fellow flock mates. The only recorded eradication of an invasive RRPA population (i.e., Seychelles) relied heavily on shooting.

A well-funded, coordinated, sustained, and science-guided campaign is needed to achieve invasive RRPA population reduction in an effective, efficient, and humane manner. Follow local and state regulations for firearm use and carcass disposal. A bounty program is not recommended due to the possible proliferation of breeding programs or the intentional release of RRPA to capitalize on financial incentives.

Disposal

Check local and state regulations regarding carcass disposal.

Economics

Current studies on RRPA economic impacts to agriculture, property, and tourism are needed for a full evaluation of the benefits of management interventions. In 1981, RRPA damage was estimated at US$ 1.95 million to ripening oilseed sunflower in Pakistan, a number likely greater in today's economy. In 1984, economic analyses estimated RRPA damage to citrus crops in Pakistan at US$ 660,514. In 1975, the state of California estimated a potential loss of US$ 735,000 per year from a hypothetical population of RRPA damaging only 0.1 percent of the foods they are known to eat. Calculations for Hawaii in 1982 estimated crop losses at US$ 50,000, not including grains. RRPA damages to vineyards in the United Kingdom were estimated to reduce wine production from 3,000 to 5,000 bottles per year. No economic impact studies on RRPA damage to personal property or tourism exist.

Species Overview

Identification

The rose-ringed parakeet (RRPA), also known as the ring-necked parakeet, has two subspecies (*P. krameri borealis* and *P. krameri manillensis*) native to the Indian subcontinent and two subspecies (*P. krameri krameri* and *P. krameri parvirostris*) native to central sub-Saharan Africa. The subspecies from India are thought to dominate the invasive populations.

Physical Description

The RRPA is a medium to large parakeet (weight=110 to 182 g; length=38 to 42 cm). It has a 40 cm wing span and a long tail (up to 25 cm) that is approximately the same length as its body. RRPA have a red bill and bright green plumage with some blue-green and yellow coloration on the wings (Figure 1). Mature males have a dark pink or reddish to black neck-ring, a black lower mandible, and longer tails than females. Juvenile males do not have the diagnostic neck-ring and cannot be easily distinguished from females. RRPA reach maturity at about 1.5 years and acquire their mature plumage at 2.0 to 2.5 years.

Range

RRPA are one of the most successful invasive bird species with sightings in over 76 countries and introduced populations in more than 35 countries. Introductions range from tropical to temperate locations with populations established in Africa, Australia, Asia, Europe, the Middle East, and Central and South America. Sightings and introduced populations in the United States are located in Alabama, California, Florida, Hawaii, Louisiana, Texas, and Virginia. In the Hawaiian Islands, RRPA have been reported on Hawaii, Kauai, Maui, and Oahu.

Voice and Sounds

RRPA are often detected by their loud, gregarious calls including a noisy, loud, screechy, descending kee-ak, kee-ak, kee-ak. When birds are gathered in large groups, in flight, or at roost sites, their combined calls can be quite loud.

Reproduction

RRPA are cavity nesters and breeding pairs can be single or loosely grouped, sometimes in the same tree. Preferred nesting trees have large diameters (> 50 cm) with abundant shrub understory. RRPA typically modify existing holes/nest cavity openings, which average 8 to 10 cm in diameter.

RRPA bite off pieces of bark around cavities, which may be a sign of an active nest. On Kauai, the outside of cavities are often stained orange, either from the iron-rich soil or resins in the wood. In urban settings, RRPA will use cavities in human structures and nest boxes when natural cavities are limited. Thus, nest box traps may be useful for population control in these areas.

RRPA often use the same nesting cavity year after year. Courtship and pair formation generally starts in early December to January in the Northern Hemisphere, and nest selection occurs January to February. The median clutch size is four eggs; however, only two eggs are generally fertile. Two fledglings per nest are common. RRPA will renest after failure and rear one brood a year, although second clutches have been documented in their native range. Nest failure is low, and causes include incomplete development, infertility, predation, weather, and starvation. The female leaves the nest during incubation (22 to 24 days) to feed herself in the morning and evening and rarely leaves the nest during the first 8 to 10 days of brooding. Male RRPA feed females during incubation and brooding and may perch near the cavity to guard the nest. Females feed nestlings by regurgitation with offspring leaving the nest at 6 to 7 weeks. Fledglings rely on parental assistance (especially the male) for two weeks to learn food selection, after which juveniles separate from adults and flock together.

Mortality

Survival rates for invasive RRPA are lacking for most of their range, but in Spain annual survival rates were found to be 83% for adults and 57% for first-year juveniles. RRPA live for an average of 20 years in captivity. Although the estimated survival rate of invasive RRPA is unknown, the lack of predators likely increases survival, especially on the Hawaiian Islands. RRPA are aggressive toward predators, further limiting the ability of predators to control RRPA populations. The median low temperature of an area may limit RRPA establishment, but the species has successfully invaded temperate regions.

Population Status

RRPA have shown exponential growth on the Hawaiian Islands since the early 2000s. As of 2018, approximately 6,800 and 4,650 birds are located on Kauai and Oahu, respectively. The number of parakeets initially remains low for a period of time following invasion. Numbers and dispersal increase with access to abundant food and nesting resources. The largest RRPA population on the U.S. mainland totals 1,394 birds in Kern County, California. Current estimates for other U.S. mainland populations are unknown, but sightings are routinely reported through citizen science programs, such as eBird and Christmas Bird Count.

Habitat

In their native range, RRPA are found in woodlands, urban parks, and cultivated areas surrounded by trees up to 2,000 m above sea level. RRPA favor areas with increased human activity over natural areas. RRPA rely on the availability of cavity-providing trees or human structures. RRPA are capable of flying long distances (e.g., 24 km in Germany) from their nocturnal roost to foraging sites.

Behavior

RRPA are highly social and forage, roost, and nest in flocks. Foraging flocks range from a few to hundreds of birds, with larger flocks forming when harassment is limited. Aggregations in nighttime roosts peak from October to January, with lowest levels from May to July during breeding. Communal roosting areas include night roosts, day roosts, nesting cavities, and foraging trees in some regions, while in other areas roosting sites are separate from nesting and foraging sites. Evening roosts are often located in urban and suburban areas with tall trees (e.g., royal palms in Hawaii). RRPA leave roosts up to 30 minutes before sunrise and return between 60 minutes before sunset to 20 minutes after sunset. The birds are most active in the morning and evening.

Food Habits

RRPA diet includes dry and fleshy fruits and seeds, as well as nectar, vegetables, and flower buds. RRPA are major pests of agricultural crops worldwide. RRPA have been documented damaging crops, such as corn, sunflower, safflower, sorghum, millet, rice, sesame, wheat, barley, soybeans, mustard, cole crops, lentils, and oil palm. RRPA are pests of fruits and nuts, including almonds, dates, mangos, pomegranates, grapes, mulberries, guava, peaches, apples, citrus, lychees, longan, rambutan, papayas, passion fruit, sugarcane, and coffee. RRPA diets were shown to be 45% cereals, 38% fruits, and 16% oilseeds in their native range. On Kauai, diets were shown to be 31% corn, 30% yellow guava, 28% sunflower, and 11% other items, varying with roost location and food availability.

Legal Status

RPPA are non-native to the United States and are not protected by the U.S. Migratory Bird Treaty Act (MBTA). RRPA are not listed as an injurious species under the U.S. Lacey Act (18 U.S.C. 42), but are listed as injurious by the State of Hawaii (Department of Land and Natural Resources [DLNR], http://dlnr.hawaii.gov/dofaw/files/2013/09/Chap124a.pdf). This designation prohibits the release, transport, or export of RRPA with importation restricted by the Hawaii State Department of Agriculture (http://hdoa.hawaii.gov/pi/pq/import-program/). All wild birds including introduced species are protected under Hawaii Revised Statutes (HRS183D and HAR124), thus a nuisance wildlife control permit is necessary to take RRPA in the Hawaiian Islands. All state and local regulations for firearm discharge must be followed.

Acknowledgements

Figure 1. Photo by Frank Adriaensen
Figure 2. Photos by a) Rajat Bhattacharjya, b) USDA-APHIS-Wildlife Services, c) Lonely Traveler (http://icbird.blogspot.com), d) Arindam Aditya, e) Thomas Brown, f) Alina Sofia, and g) anonymous
Figure 3. Photos by a) Marty McCarthy, b) Hawaii Department of Land and Natural Resources, c) USDA-APHIS-Wildlife Services, d-f) Nancy Tibble
Figure 4. Photos by USDA-APHIS-Wildlife Services

We thank Michael Avery, Eric Tillman, and Stephen Pruett-Jones for providing critical reviews of this manuscript.

Glossary

Cavity Nester: A bird that builds nests, lay eggs and raises young inside sheltered chambers or cavities. Primary cavity nesters excavate their own holes or burrows. Secondary cavity nesters take advantage of natural or abandoned cavities.

Effigy: A likeness of a animal. An effigy can be an actual animal carcass, a carcass that has been taxidermically prepared, or an artificial likeness.

Integrated pest management: An ecosystem-based strategy that focuses on long-term prevention of pests or their damage through a combination of non-lethal and lethal techniques.

Roost: Location where birds rest or sleep either during the day or at night.

Keywords

California, Florida, Hawaiian Islands, Introduced birds, Lasers, Netting, Parrots, *Psittacula krameri*, Roosting, Shooting, Tropical fruit

Disclaimer

Wildlife can threaten the health and safety of you and others in the area. Use of damage prevention and control methods also may pose risks to humans, pets, livestock, other non-target animals, and the environment. Be aware of the risks and take steps to reduce or eliminate those risks.

Some methods mentioned in this document may not be legal, permitted, or appropriate in your area. Read and follow all pesticide label recommendations and local requirements. Check with personnel from your state wildlife agency and local officials to determine if methods are acceptable and allowed.

Mention of any products, trademarks, or brand names does not constitute endorsement, nor does omission constitute criticism.

Citation

Klug, P.E., Bukoski, W.P., Shiels, A.B., Kluever, B.M. and S.R. Siers. 2019. Rose-Ringed Parakeets. Wildlife Damage Management Technical Series. USDA, APHIS, WS National Wildlife Research Center. Fort Collins, Colorado. 16p.

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Appendix 1

Camouflage and Exclusion Devices for Rose-Ringed Parakeets

Devices are mainly designed to prevent and control rose-ringed parakeet damage at foraging and roosting sites.

			Type of Damage		
CAMOUFLAGE & EXCLUSION	**Description**	**Challenges and Benefits**	**Seed Crops**	**Fruit Crops**	**Urban Roosts**
Netting	Enclosing crops/trees using temporary or permanent netting	- Labor intensive - Expensive - High maintenance + Complete exclusion	Effective for small crop plots	Effective for small orchards ‡	Reduces roosting in targeted trees ‡
Overhead Wires	Partially enclosing crops/trees using temporary or permanent wire	- Labor intensive - High maintenance + Inexpensive	Narrow openings suggested; pest maneuvers through wires ‡	Teepee design suggested; pest able to maneuver through wires ‡	Not practical in urban/suburban settings ‡
Bagging Crops	Placing bags, mesh, or plastic over fruiting body during damage window	- Labor intensive - Needs alternative food + Inexpensive + Low maintenance	Effective for small crop plots	Effective for small orchards ‡	NA
Sonic Net	Creating a risky environment by projecting a highly directional, contained sound that masks avian communication	- Expensive - Noise pollution - Needs alternative food + Reduces habituation + Automated	May be effective for small crop plots ‡	May be effective for small orchards ‡	Applicable with low human density & low ambient noise ‡
Decoy Crops	Providing alternative food to limit birds feeding on protected crops	- Needs tillable land - Needs preferred crop + Bolsters other tools	Requires space and a preferred alternative crop ‡	Requires space and a preferred alternative crop ‡	NA
Vegetation Trimming	Removing trees, branches or fronds to reduce perch space	- Unaesthetic - Weakens tree/palm + Limited maintenance	Removes loafing areas near crops (tree rows) ‡	Not practical in orchard or forested habitat ‡	Reduces roosting space and cover on tree/palm roosts
Anti-perching Tools	Reducing perch space by creating uncomfortable environment (e.g., sharp spikes, wire barriers, unstable coils, electrified cables)	- Larger birds only - Not for tree roosts + Inexpensive + Limited maintenance	NA	NA	Reduces roosting space and appeal of human structures ‡

‡ Not lab or field tested for rose-ringed parakeets.

Appendix 2

Frightening Devices for Rose-Ringed Parakeets

Devices are mainly designed to elicit a startle response to temporarily move birds and most are not considered long-term solutions.

			Type of Damage		
FRIGHTENING DEVICES	**Description**	**Challenges and Benefits**	**Seed Crops**	**Fruit Crops**	**Urban Roosts**
Lasers & Lights	Handheld or automated lasers	- Labor intensive (hand-held) - Expensive (automated) - Short-term - Light pollution/Eye hazard + RRPA sensitivity	May be effective for small plots ‡	May be effective for small orchards ‡	Reduces roosting in targeted trees
Reflecting Ribbon/Mirrors	Moving objects that shine or reflect	- Labor intensive - Unaesthetic - Short-term + Inexpensive	May be effective for small plots	May be effective for small orchards	May reduce roosting in targeted trees ‡
Propane Cannons & Pyrotechnics	Loud blasts that imitate firearms	- Short-term - Sound pollution + Inexpensive	May be effective for small plots	May be effective for small orchards	May reduce roosting in targeted trees; not practical around human activity ‡
Parakeet Distress Calls	Species-specific distress and alarm calls	- Short-term - Sound pollution + Inexpensive	May be effective for small plots ‡	May be effective for small orchards ‡	May reduce roosting in targeted trees; not practical around human activity ‡
Effigies	Predator models, hawk eyes, or dead parakeets	- Short-term + Inexpensive	May be effective for small plots	May be effective for small orchards	May reduce roosting in targeted trees ‡
Unmanned Aircraft Systems	Unmanned deployment of flying aircraft	- Labor intensive - Short-term + Mobile	May be effective for small plots or flocks ‡	May be effective for small orchards or flocks ‡	May reduce roosting in targeted trees ‡
Falconry & Passive Predator	Human-controlled deployment of raptors or providing predator habitat	- Expensive (falconry) - Short-term + Passive (habitat)	May be effective for small plots ‡	May be effective for small orchards ‡	May reduce roosting in targeted trees ‡

‡ Not lab or field tested for rose-ringed parakeets.

Appendix 3

Lethal Control for Rose-Ringed Parakeets

Lethal control for prevention and control rose-ringed parakeet damage at foraging and roosting sites.

			Type of Damage		
LETHAL CONTROL	**Description**	**Challenges and Benefits**	**Seed Crops**	**Fruit Crops**	**Urban Roosts**
Trapping	Capture with baited live-traps or spring-loaded traps on ground or platform	- Ineffective with alternative food + Lethal	Not practical in preferred forage crops	Not practical in preferred forage fruits ‡	Not practical in non-foraging, roost areas ‡
Hand Nets	Capture with long-handled hand-nets	- Low roosting spots only - Mainly removes non-reproductive or juveniles + Lethal	NA	NA	May reduce limited subset of roosting birds
Shooting	Lethal control by firearm • shotguns for long-distance • air rifles for short-distance	- Limited in urban/suburban areas - Birds move to inaccessible areas - Human safety risk + Lethal	Reinforces frightening devices; Not sufficient for population reduction	Reinforces frightening devices; Not sufficient for population reduction	Reduces roosting birds; Requires coordinated effort for population reduction
Nest Destruction	Reducing reproduction • destroy nesting trees ‡ • modify cavities ‡	- Labor intensive - Inaccessible nests + Lethal	Management tools not deployed at damage sites		
Fertility Control	Inhibiting reproduction • contraceptive bait	- Not US EPA registered - Ineffective on large populations - Requires exclusion of non-target animals from contraceptive bait + Nonlethal	Management tools not deployed at damage sites		

‡ Not lab or field tested for rose-ringed parakeets.

Appendix 4

Bird Toxicants and Repellents for Rose-Ringed Parakeets

Avian toxicants and repellents for prevention and control of rose-ringed parakeet damage at foraging and roosting sites.

			Type of Damage		
TOXICANTS & REPELLENTS	**Description**	**Challenges and Benefits**	**Seed Crops**	**Fruit Crops**	**Urban Roosts**
Toxicant	Starlicide® (DRC-1339) is an avicide registered with the US EPA for control of several pest birds	- Low toxicity - Bitter taste aversion + Lethal	None available	None available	None available
Methyl anthranilate	Human-food additive registered with the US EPA that causes bird aversion and acts as an irritant	- Expensive - Short-term - Olfactory pollution + Foliar application	Foliar application at harvest may be available ‡	Foliar application at harvest may be available ‡	Fogging application may be available; not practical near human activity ‡
Anthraquinone	Secondary repellent with a post-digestive antifeeding effect	- Expensive - US EPA food tolerance - Ingestion required + Learned aversion	Registered seed treatments may be available ‡	Not registered for foliar application at harvest ‡	Potentially absorbed through feet; not registered as perch deterrent ‡
Tactile Repellent	Chemicals cause negative reaction when contacting foot (e.g., polybutenes)	- Short-term - Structures only + Inexpensive	NA	NA	May be effective on human structures, but not vegetative roosts ‡
Water Spray/Mist	Reflexive withdrawal due to direct water pressure or wet feathers impacting functionality	- Initial installation + Limited maintenance + No harm to vegetation	NA	NA	May reduce appeal of roosting space

‡ Not lab or field tested for rose-ringed parakeets.