A Species Action Plan for the
White-Crowned Pigeon
Patagioenas leucocephala

Final Draft
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EXECUTIVE SUMMARY

The Florida Fish and Wildlife Conservation Commission (FWC) developed this plan in response to the determination that the white-crowned pigeon (*Patagioenas leucocephala*) in Florida should remain listed as Threatened on the Florida Endangered and Threatened Species List.

In Florida, the white-crowned pigeon occurs primarily in the extreme south portion of the state. Population decline is largely due to loss of nesting and foraging habitat resulting from human development, habitat degradation, hunting pressures outside of Florida, and frequent and intensive tropical storms. Other threats include predation, human disturbance, oil spills, disease, and sea level rise.

The goal of this plan is to improve the white-crowned pigeon’s status to the point that the species is secure within its historical range in Florida. The objectives of the plan are to: 1) maintain a stable or increasing population of the white-crowned pigeon in Florida over the next 10 years, 2) maintain or increase current known area of occupancy (≥ 400 km\(^2\) [≥ 150 mi\(^2\)]) of the white-crowned pigeon in Florida over the next 10 years, and 3) where possible, contribute to efforts to reduce or eliminate threats to the white-crowned pigeon population on their wintering range outside of Florida.

This plan recommends several actions that would benefit populations through habitat management, research, education, collaboration and regulation. The plan outlines methods to improve habitat management for white-crowned pigeon by identifying current breeding and foraging areas and by using this information to guide future acquisitions, regulation, and habitat protection. The actions for research would improve population status by addressing research gaps in knowledge concerning reproductive success and mortality factors. This plan also outlines actions for education and outreach to improve knowledge of the pigeon’s life history and habitat requirements. Since most of the white-crowned pigeons breeding in Florida winter outside of the United States, actions concerning international collaboration on hunting pressure and habitat improvements in other countries are vital for protecting local populations. This plan also includes rule and permitting guidance language that will improve and standardize white-crowned pigeon protections.

This plan details the actions necessary to improve the conservation status of the white-crowned pigeon. A summary of this plan will be included in the Imperiled Species Management Plan (ISMP), in satisfaction of the management plan requirements in Chapter 68A-27, Florida Administrative Code, Rules Relating to Endangered or Threatened Species. The ISMP will address comprehensive management needs for 60 of Florida’s imperiled species and will include an implementation plan; rule recommendations; permitting standards and exempt activities; anticipated economic, ecological, and social impacts; projected costs of implementation and identification of funding sources; and a revision schedule. The imperiled species management planning process relies heavily on stakeholder input and partner support. This level of involvement and support is also critical to the successful implementation of the ISMP. Any significant changes to this plan will be made with the continued involvement of stakeholders.
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GLOSSARY OF TERMS AND ACRONYMS

ACP: Area Contingency Plan. The ACPs outline sensitive wildlife areas, site manager contact information, species present and special precautions to take in the event of a hazardous material spill such as an oil spill.

ARCI: Avian Research and Conservation Institute

Area of Occupancy: The area within its extent of occurrence which is occupied by a taxon, excluding cases of vagrancy. This reflects the fact that a taxon will not usually occur throughout the area of its extent of occurrence, which may contain unsuitable or unoccupied habitats.

Breeding Productivity: The number of fledged young produced by a pair or population, usually calculated annually or per breeding season. [Productivity = clutch size * nesting success (fledges per clutch) * number of clutches laid per breeding season].

BSR: Biological status review report, the summary of the biological review group’s findings. Includes a Florida Fish and Wildlife Conservation Commission (FWC) staff recommendation on whether or not the species status meets the listing criteria in Chapter 68A-27.001, Florida Administrative Code. These criteria, based on IUCN criteria and IUCN guidelines, are used to help decide if a species should be added or removed from the Florida Endangered and Threatened Species List. In addition, FWC staff may provide within the report a biologically justified opinion that differs from the criteria-based finding.

Buffer Zone: Posted areas established around nesting or foraging sites necessary to prevent disturbance of white-crowned pigeon.

Chick: A young bird not yet flight-capable and dependent upon adults for food, shelter and/or safety.

Clutch: A group of eggs produced by a female in a single breeding attempt.

Colony: A congregation of 1 or more species of breeding birds that nest and roost in close proximity at a particular location.

Crop: An expanded muscular pouch near the gullet or throat of birds

DEP: Florida Department of Environmental Protection

Extent of occurrence: The geographic area encompassing all observations of individuals of a species, including intervening areas of unoccupied habitat. Synonymous with range. See Also Area of Occupancy (as defined by IUCN).

F.A.C.: Florida Administrative Code
Foraging: Searching for, acquiring, and ingesting food.

Frugivorous: An herbivore or omnivore that prefers fruit as a food type.

FWC: Florida Fish and Wildlife Conservation Commission, the state agency constitutionally mandated to protect and manage Florida’s native fish and wildlife species.

FWRI: Fish and Wildlife Research Institute, the fish and wildlife research branch of the FWC.

Habitat: The area used for any part of the life cycle of a species (including foraging, breeding, and wintering).

Incidental Take: Any taking otherwise prohibited, if such taking is incidental to, and not the purpose of the carrying out of an otherwise lawful activity (as defined in Rule 68A-27.001(5), F.A.C.).

IRC: Institute for Regional Conservation

ISMP: Imperiled Species Management Plan


LAP: Landowner Assistance Program, a federal cost-share program administered in Florida by the FWC.

LDR: Local government Land Development Regulations.

Mangrove: Salt-tolerant hardwood trees found throughout the world in tropical and sub-tropical latitudes. Mangroves mostly occupy low-energy marine and brackish shorelines and can create dense shoreline fringes, extensive forests and entire offshore islands. Three mangrove species occur in peninsular Florida; red mangrove (*Rhizophora mangle*), black mangrove (*Avicennia germinans*) and white mangrove (*Laguncularia racemosa*). These 3 species, along with buttonwood (*Conocarpus erectus*), are the dominant trees in Florida’s mangrove communities.

MCCP: Monroe County Comprehensive Plan

Migratory Bird Treaty Act: The federal statute (16 U.S.C. 703–711) which protects nearly all native birds, their eggs and nests. Specifically, the statute makes it unlawful to "pursue, hunt, take, capture, kill, attempt to take, capture or kill, possess, offer for sale, sell, offer to purchase, purchase, deliver for shipment, ship, cause to be shipped, deliver for transportation, transport, cause to be transported, carry, or cause to be carried by any means whatever, receive for shipment, transportation or carriage, or export, at any time, or in any manner, any migratory bird, included in the terms of this Convention . . . for the protection of migratory birds . . . or any part, nest, or egg of any such bird."
Nest: A structure or place chosen by birds in which to lay and incubate eggs. The nests of white-crowned pigeons are typically frail platforms constructed of 3.2 to 6.4 mm diameter twigs and lined with finer twigs. Nests are typically constructed over water in red or black mangroves and are usually well-camouflaged by surrounding vegetation.

No Entry-Zone: A white-crowned pigeon nesting or foraging site with regulations that prohibit entry by persons not specifically authorized to enter.

NGO: Non-Governmental Organization

NPS: National Park Service

Pine Rockland: A natural community unique to extreme south Florida characterized by an open canopy of south Florida slash pine (*Pinus elliottii* var. *densa*) with a diverse understory and herbaceous layer. Rare and endemic plant and animal species are abundant in pine rocklands. The substrate consists of exposed oolitic limestone with numerous depressions and solution holes where nutrient poor soil and organic debris accumulate. Pine rockland is a fire dependent natural community and similar habitat occurs in the Bahamas where Caribbean pine (*Pinus caribaea*) is the dominant pine.

Population: The total number of individuals of the taxon. Population numbers are expressed as numbers of mature individuals only (as defined by IUCN).

Site: An area or location that contains and supports 1 or more breeding pairs of white-crowned pigeons, their nest(s), and/or dependent young.

SLAMM: Sea Level Affecting Marshes Model, a model created by Jonathan Clough of Warren Pinnacle Consulting, Inc. that simulates the dominant processes involved in wetland conversions and shoreline modifications during long-term sea level rise. Map distributions of wetlands are predicted under conditions of accelerated sea level rise, and results are summarized in tabular and graphical form.

Take: As defined in 68A-27.001, F.A.C. (Definitions) to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in such conduct. The term "harm" in the definition of take means an act which actually kills or injures fish or wildlife. Such act may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding or sheltering. The term "harass" in the definition of take means an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding or sheltering.

Tropical Hardwood Hammock: Tropical hardwood hammock: Also called rockland hammock, is a highly diverse upland forest rich in rare and endemic plant and animal species. The forest floor is mostly covered with a thin layer of well drained organic soil and leaf litter. Exposed limestone and solution holes are common. Over 120 species of native trees and shrubs can be found in tropical hardwood hammocks. Many of the plant species are also
native to the Bahamas, the West Indies and the Yucatan peninsula and most occur in Florida at the northern limit of their range. Typical canopy trees include gumbo limbo (Bursera simaruba), wild tamarind (Lysiloma latisiliquum), pigeon plum (Coccoloba diversifolia), strangler fig (Ficus aurea), Jamaican dogwood (Piscidia piscipula), poisonwood (Metopium toxiferum), and West Indies mahogany (Swietenia mahagoni). In the continental U.S., remaining tropical hardwood hammock only occurs in south Florida, where it is restricted to coastal areas of southern Miami-Dade County, the Florida Keys and a small area of Big Cypress Preserve in Monroe and Collier counties. Mesic and maritime hammocks which may also provide foraging areas for white-crowned pigeons are also found in south Florida and although they may share common species, they are biologically and geologically distinct habitats from tropical hardwood hammocks.

USFWS: United States Fish and Wildlife Service, the federal agency mandated to protect and manage the nation’s native freshwater fish and wildlife resources.

WEA: Wildlife and Environmental Area
INTRODUCTION

This plan was developed in response to the Florida Fish and Wildlife Conservation Commission’s (FWC’s) determination that the white-crowned pigeon (*Patagioenas leucocephala*) be recommended for listing as Threatened on Florida’s Endangered and Threatened Species List.

Biological Background

Distinquishing Characteristics

The white-crowned pigeon was previously placed in the genus *Columba* but is now included in the *Patagioenas* genus of New World pigeons. There are no recognized subspecies (Bancroft and Bowman 2001). White-crowned pigeons are obligate frugivores similar in size and shape to the common rock dove or feral pigeon (*Columba livia*) but with a longer neck and tail. The white-crowned pigeon is dark slate gray, with a white cap on the top half of the head (Figure 1). There are greenish, iridescent feathers on the upper back and sides of the neck. The bill is red with a white tip, and the legs are reddish or pink. The bill and legs of males become brighter red during the breeding season. Females, including the iridescent feather patch and cap, are often browner and generally duller than are the males. Juveniles may appear more brownish with the crown being dark or absent (Bancroft 1996, Bancroft and Bowman 2001). White-crowned pigeons are strong and fast in flight and are known to travel daily in straight flight-lines, sometimes over 50 km (31 mi), for foraging. They can fly more than 150 km (93 mi) over the water during migration, generally flying low until reaching land. White-crowned pigeons are very arboreal and rarely seen on the ground (Bancroft and Bowman 2001). They are extremely skittish and easily flushed from both nesting and foraging areas (Bancroft 1996, Bancroft and Bowman 2001).

Habitat

In Florida, 2 specific habitat types are critical for the survival of the white-crowned pigeon: mangrove islands for breeding and tropical hardwood hammock for foraging. White-crowned pigeons primarily nest on tidally inundated mangrove islands and then fly daily to forage in tropical hardwood hammocks and, to a lesser extent, pine rocklands that contain an understory of fruit-bearing trees and shrubs (Bancroft and Bowman 2001). They also feed heavily on individual fruit-bearing trees in small, vegetated patches in suburban environments where a quality food source is present (Meyer and Wilmers 2006).

Food

In south Florida and the Florida Keys, white-crowned pigeons feed primarily on the fruits of hardwood trees and shrubs in deciduous seasonal forests, mostly in tropical hardwood
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hammocks. They consume the fruits of at least 36 species (Bancroft and Bowman 2001). In Florida Bay, Bancroft and Bowman (1994) found the fruits of 5 native species to be the most important food sources during nesting. These 5 species, combined, made up over 97% of the mass of the fruit found in the crops of nestlings. Poisonwood (Metopium toxiferum) was determined to be the most important, followed by bloolly (Guapira discolor). Fruits of strangler fig (Ficus aurea) and wild banyan (F. citrifolia) were combined as the next highest species ingested, followed by black torch (Erithalis fruticosa). For a comprehensive list of fruit-producing species consumed by white-crowned pigeons, see Appendix 1. During nesting, adult white-crowned pigeons produce liquid from their crops, referred to as crop-milk, which they feed to their young. The crop-milk is high in protein and lipids and provides 100% of the chick’s diet for the first 2 days. The adults then begin supplementing the crop-milk with fruit, gradually increasing the proportion of fruit to milk as the chicks mature. Adults may continue to provide some crop-milk to the young during the entire nestling period (Bancroft and Bowman 1994). White-crowned pigeons are important seed dispersers. The feeding patterns of white-crowned pigeons and their long-range mobility likely make this species critical to maintaining the biological diversity of imperiled tropical hardwood hammocks in south Florida (Strong and Bancroft 1994).

Breeding Behavior and Reproduction

White-crowned pigeons breed in south Florida from May to early September where they commonly nest semi-colonially on tidally inundated mangrove islands which provide some protection from predators such as raccoons (Bancroft and Bowman 2001) (Figure 2). Males are semi-territorial on nesting sites and assist females with nest construction (Wiley and Wiley 1979). One to 3 eggs are laid, with 2 being the most common. In the daytime, males care for the eggs and nestlings; females care for them at night. The eggs hatch in 13 to 14 days, usually on successive days. The young will leave the nest after 16 to 22 days, though they may remain in the vicinity of the nest for up to 40 days after hatching (Bancroft 1996). Juveniles will disperse from the nesting islands after 26 to 45 days from hatching (Strong and Bancroft 1994).

Distribution

The white-crowned pigeon is a subtropical frugivorous species occurring in low-lying forest habitats with ample fruiting trees. Distributions of local populations in south Florida are influenced by temporal forage availability and level of habitat fragmentation (Bancroft and Bowman 1994). Due to the species’ reliance on seasonal fruiting of 5 species of plants, micro-ranges in Florida Bay can vary spatially and temporally (Bancroft and Bowman 1994). Breeding range for the species (Figure 3) is centered on the Bahamas and Greater Antilles, although

Figure 3. White-crowned pigeon breeding distribution for entire range. Adapted from Bancroft and Bowman 2001.

Its breeding range in the United States is restricted to Florida Bay, Barnes Sound, Card Sound, Biscayne Bay, and the Florida Keys, although a few individuals probably nest inland in Monroe and Miami-Dade counties (Figure 4; Bancroft and Bowman 2001, FWC 2003, National Park Service [NPS] 2011, Strong et al. 1991). In Florida, nesting occurs almost exclusively on mangrove islands; nesting birds fly to the mainline Keys, uplands on smaller islands, or the mainland to forage on fruit-bearing trees (Bancroft and Bowman 2001). In 1987 through 1989, Strong et al. (1991) found that 52% of mangrove keys supported white-crowned pigeon nests in Florida Bay. More islands close to the mainline Florida Keys supported nests than did islands closer to peninsular Florida, with the highest nest densities in the center of Florida Bay (Strong et al. 1991).
The Biological Status Review (BSR) estimated the species’ range in Florida, or total extent of occurrence, at <5,000 km² (<1,930.5 mi²) and noted that a large majority of this area was open water; the land area actually occupied by white-crowned pigeons in Florida is probably <1,250 km² (<482.6 mi²). Some white-crowned pigeons that breed in Florida overwinter here, while most of the population migrates south or southeast for the winter (Bancroft 1996, Robertson and Woolfenden 1992). Studies suggest that 80% to 90% of white-crowned pigeons breeding in Florida winter in the Bahamas and the Caribbean (Bancroft and Bowman 1994, Bancroft and Bowman 2001, Meyer and Wilmers 2006).

Figure 4. White-crowned pigeon breeding and foraging distribution in Florida.

Conservation History
In the late 19th and early 20th Centuries, white-crowned pigeons were hunted and young were collected for food (Bancroft and Bowman 2001). Currently, most of the Florida population nests...
on public lands in the islands of Everglades National Park (Florida Bay), Key West National Wildlife Refuge, National Key Deer Refuge, and Great White Heron National Wildlife Refuge, which were established in the early to mid 1900s. This habitat protection likely allowed the population to recover from declines due to hunting, though populations never recovered to historic levels. Although hunting of white-crowned pigeons is no longer allowed in the United States or Puerto Rico and was recently banned in Cuba (M. Acosta, Cuban bird ecologist, personal communication), hunting has continued throughout the most of the remainder of the species’ range.

Tropical hardwood hammock serves as important foraging and stopover habitat for white-crowned pigeons, but has been severely reduced and fragmented (Figure 5). Remaining habitat in north Key Largo has been protected by the establishment of Crocodile Lake National Wildlife Refuge in 1980 and Dagney Johnson Key Largo Hammock Botanical State Park in 1982. The United States Fish and Wildlife Service (USFWS), Florida Department of Environmental Protection (DEP), FWC, Monroe County, and private conservation organizations have cooperated to acquire and manage some of the remaining fragments of hammock, although several significant tracts remain in private ownership.

Surveys of nesting colonies have been conducted annually since 2001 in the lower Keys refuges, and law enforcement patrols aim to minimize disturbance to the pigeons (USFWS 2009). Hurricanes in 2005 caused severe damage to nesting and foraging areas. Nesting returned to pre-storm levels by 2007 (Meyer et al. 2008). Body mass of pigeons differed significantly among foraging areas, suggesting that habitat quality may vary spatially (Meyer et al. 2008).

The White-Crowned Pigeon Working Group met for the first time in 2007 to discuss conservation efforts throughout the species’ range (Hay 2008). Participants from Jamaica, Puerto Rico, the Bahamas, Dominican Republic, U.S. Virgin Islands, Haiti, Mexico, Belize, and Florida determined that populations are declining range wide, but most notably in Puerto Rico and the Dominican Republic. Cooperative and collaborative research and conservation in Florida and range wide are essential to reversing this decline.

**Threats and Recommended Listing Status**

The global population of the white-crowned pigeon is assessed as Near Threatened according to the International Union for Conservation of Nature (IUCN) Red List Category and Criteria due to intense habitat degradation and deforestation (BirdLife International 2008). Protection measures have reduced hunting pressure on this species within Florida; however, white-crowned pigeons that breed in Florida continue to be heavily hunted on their wintering grounds, especially
in the Bahamas (Bancroft and Bowman 2001, Meyer and Wilmers 2006, Wells and Wells 2001). Bancroft and Bowman (2001) list hunting and harvesting, pesticides and other contaminants, collisions with structures or objects, degradation of habitat, and human disturbance impacts as primary threats to white-crowned pigeons. Nest predation by raccoons (Procyon lotor) and other predators is also a documented threat (Strong et al. 1991).

Disturbance of nesting colonies by ecotour operators has also been identified as a potential threat by avian researchers (K. Meyer, Avian Research and Conservation Institute [ARCI], personal communication). The Florida white-crowned pigeon population is contained within Monroe and Miami-Dade counties, where it is vulnerable to hurricane events, both because of its geographic location and its restricted range. Historical storm records corroborate the vulnerability of these geographic locations. The hurricanes of 2004 and 2005 eliminated substantial areas of nesting habitat in the lower Florida Keys (T. Wilmers, USFWS, personal communication). Increasing frequency of severe tropical storms and hurricanes (Webster et al. 2006) as well as sea level rise due to climate change are expected to degrade and reduce the available nesting habitat for the species. In addition, critical foraging habitat continues to decline. For example, the area of tropical hardwood hammocks in the upper Florida Keys declined by 31% between 1991 and 2004 (Karim and Main 2009), primarily due to development. Nest numbers and productivity are strongly correlated to the food supply (Bancroft and Bowman 2001).

Recommended Listing Status
The white-crowned pigeon met the following criterion for listing as Threatened: Criterion B Geographic Range. The species occurs only in portions of Monroe County and Miami-Dade County with a total area extent estimated <5,000 km² (<1,931 mi²). The land area is <25% of extent of occurrence (i.e., < 1,250 km²); at any time no more than 1/3 of keys and islands (ca. 400 km² [154.4 mi²]) are occupied. The species exists in only 3 to 4 breeding locations, where it is subject to tropical weather events that can severely impact all breeding individuals. The increasing frequency of severe tropical storms and hurricanes has caused long-term habitat destruction (Webster et al. 2006). Nesting substrates in black mangroves (Avicennia germinans) is especially affected and does not regenerate for decades. The hurricanes during 2004 and 2005 resulted in partial or complete loss of nesting substrate in large portions of the lower Keys, including Barracuda Keys, Little Crane Key, upper Harbor Key, Little Spanish Key Mangrove, and Joe Ingram Key (T. Wilmers, personal communication).

The Florida Fish and Wildlife Conservation Commission recommends that the white-crowned pigeon remain listed as Threatened on the Florida Endangered and Threatened Species List.
CONSERVATION GOALS AND OBJECTIVES

Goal
Conservation status of the white-crowned pigeon is improved to the point that the species is secure within its historical Florida range.

Objectives
I. Maintain a stable or increasing population of the white-crowned pigeon in Florida over the next 10 years.

Rationale
White-crowned pigeon populations may have declined due to disturbance at their breeding and foraging areas from people, vessels, and aircraft (Conomy et al. 1998; Carney and Sydeman 1999) or mortality from predators and disease. The loss, degradation, and habitat fragmentation of breeding and foraging areas have also been implicated in their decline. Climate change may be responsible for recent population declines due to more frequent and intense hurricanes. Because of the small spatial scale of the Florida Keys, habitat shifts are less likely to occur, and net loss of nesting and foraging habitat could be expected. Where possible, threats to the Florida population should be addressed.

II. Maintain or increase current known area of occupancy (≥ 400 km² or ≥ 154.4 mi²) of the white-crowned pigeon in Florida over the next 10 years.

Rationale
Ongoing declines in extent and quality of habitat threaten existing population levels. Maintaining or increasing current population levels requires stabilizing or increasing suitable habitat. The extent of occurrence of the white-crowned pigeon is approximately 5,000 km² in Florida; however only about 1,250 km² of that area is on land. Rising sea levels may reduce white-crowned pigeon nesting and foraging habitat in some areas where mangroves are drowned in place, while increasing it in other areas as mangroves replace other habitats. Data indicates that Atlantic, Gulf Coast, and global sea levels have been steadily increasing since measurements have been conducted (Douglas 1991, National Oceanic and Atmospheric Administration 2001). Tidal data from Key West Harbor indicates a mean sea level rise of 0.73 feet has occurred from 1913 to 2006; (National Oceanic and Atmospheric Administration 2012). Losses due to sea level rise will require an increase in the extent of suitable habitat within and outside current foraging and breeding areas if we are to meet the conservation objectives.

III. Where possible, contribute to efforts to reduce or eliminate threats to the white-crowned pigeon population on their wintering range outside of Florida.

Rationale
There are no data to indicate that Florida’s white-crowned pigeon population is supplemented by immigration from outside the state. An estimated 80% of the Florida breeding population overwinters outside of the United States (Meyer and Wilmers 2006). Florida white-crowned pigeons are subject to high mortality rates due to hunting, as well as habitat loss on their wintering grounds, especially in the Bahamas, Cuba, and Hispaniola (Strong and Johnson 2001).
Though it may be difficult to accomplish, it is critical that conservation planning consider the winter range of Florida’s white-crowned pigeon population as they are vulnerable to threats beyond the state’s boundaries.
CONSERVATION ACTIONS
The following sections describe the conservation actions that will make the greatest contribution toward achieving the conservation objectives. Actions are grouped by category (e.g., Habitat Conservation and Management, Population Management). The Conservation Action Table (Table 1) provides information on action priority, urgency, potential funding sources, likely effectiveness, identified partners, and leads for implementation.

Habitat Conservation and Management

**Action 1** Reduce clearing and degradation of tropical hardwood hammocks in Florida through coordination and education.

**Action 2** Maintain or increase tropical hardwood hammock tree species on public lands to provide season-long forage and maintain productivity throughout the entire breeding season.

Two specific habitat types support critical life stages of the white-crowned pigeon: mangrove islands for breeding and tropical hardwood hammock for foraging. The majority of mangrove habitat in the species’ range is provided some type of protection by existing regulations. Foraging areas are most at risk, as foraging takes place on many unprotected properties (Figure 6). Many large tracts of hammock are in public ownership, although there are notable exceptions: Crane Point Hammock, Sugarloaf Keys, and Torch Keys, among others, contain large tracts that remain in private ownership. Species experts suggest even very small parcels of tropical hardwood hammock with appropriate forage species can play an important role in providing habitat for nearby white-crowned pigeon populations (Figure 7; Meyer and Wilmers 2006). In Florida, research indicates that maintaining the availability of sufficient areas of suitable foraging habitat is critical to securing Florida’s population of white-crowned pigeons (Bancroft 1996, Meyer and Wilmers 2006). Tropical hardwood hammocks and pine rockland habitat provide essential nesting and foraging habitat for numerous state- and federally-listed species and migratory birds in addition to the white-crowned pigeon (Lott et al. 2006). Tropical hardwood hammocks also provide crucial habitat for other Endangered or Threatened species such as the Schaus’ swallow-tail butterfly (USFWS 1999) and the Florida tree snail (Deisler-Seno 1994). In particular, protection of poisonwood and other fruiting trees is critical, as it is often removed and discouraged from planting near urban areas due to its potential to cause skin irritations. Loss of hardwood hammocks and selective removal of fruiting trees, especially poisonwood, can reduce the extent and quality of foraging for white-crowned pigeons.

Land managers on public lands need to manage tropical hardwood hammocks to ensure the habitat remains healthy. This may involve exotic plant removal, native plantings, and restoration of disturbed areas. The FWC and partners also need to coordinate with local governments to encourage enforcement of local ordinances designed to protect remaining tropical hardwood

Figure 6. Tropical hardwood hammock on unprotected private property in Marathon, Florida. Photograph by Carol Rizkalla, FWC.
hammock (Action 26) and provide incentives for private land owners to conserve the fruiting trees (Action 24) and the habitat (Action 21).

**Action 3** Identify and prioritize potential breeding and foraging areas for acquisition and protection inside and outside the species’ breeding range, taking into consideration potential habitat shifts caused by sea level rise.

**Action 4** Manage suitable potential breeding and foraging areas outside the species’ range to mitigate for sea level rise.

Both large and small tracts of tropical hardwood hammocks containing fruit-producing tree species should be prioritized for acquisition and preservation. Diversity of native species in both the canopy and the understory is also critical to maintaining the integrity and ecological functionality of a healthy tropical hardwood hammock. Because the timing of fruiting varies among hammock species, this diversity also ensures a constant availability of suitable food throughout the white-crowned pigeons annual nesting cycle (Strong and Bancroft 1994).

Consideration should be given to the large reduction in habitat in low-lying areas (such as most of the Florida Keys) that will result from sea level rise. Identifying suitable foraging and breeding areas outside of the white-crowned pigeon’s present range may be a way to proactively mitigate problems associated with sea level rise by providing alternate habitat for this species and others inhabiting the Florida Keys. This type of proactive management may also help to reduce vulnerability to stochastic events, such as hurricanes, by increasing the amount of currently available habitat for the species.

With the assistance of partners and stakeholders, tracts of tropical hardwood hammock not currently in public ownership should be prioritized for acquisition, with emphasis on identified core foraging habitat. Potential sites should be identified using ground truthing in addition to remote sensing and county property records. Priority should be given to tracts with a large diversity of native fruit-bearing trees. Currently, there are no data linking value of a foraging area to its proximity to a nesting site; previous telemetry studies have shown white-crowned pigeons will travel long distances to forage repeatedly day after day (Meyer and Wilmers 2006). Prioritized sites could be purchased through programs such as the Florida Forever program or through partnerships with organizations such as Audubon of Florida or The Nature Conservancy, organizations that on occasion purchase properties and donate to local, state, or federal governments.

Management activities should include controlling invasive exotic plants, planting native species, and maintaining the biological integrity of the habitat, especially a diversity of seasonally variable fruiting native food species.
**Action 5** Establish buffer zones or no-entry zones as necessary and post signage to reduce human disturbance from motorized and non-motorized vessels at the largest and most sensitive breeding sites.

Human presence near nests can cause white-crowned pigeons to bolt from their nests, sometimes knocking eggs or chicks out of the nest in the process (Bancroft and Bowman 2001). Signage and/or brochures should identify the locations, closure dates, and regulations for breeding sites where there are human disturbance issues. Signs should be maintained and visible. Many white-crowned pigeon breeding sites may also be shared with other mangrove nesting birds. Coordination with NPS, USFWS, and other land management agencies is needed to ensure breeding sites of white-crowned pigeon and other mangrove-nesting birds are marked and protected wherever threatened.

A combination of buffer zones and no-entry zones will most likely be necessary to protect breeding sites. Individual breeding sites should be evaluated to determine which strategy is most appropriate for minimizing disturbance to the colony while allowing for appropriate recreational activity (seasonal closures can be sufficiently effective and less restrictive). Nesting sites close to human populations are generally the most vulnerable to disturbance and may require additional protection. The FWC will continue to protect and manage white-crowned pigeon foraging areas in the Florida Keys Wildlife Environmental Area (Florida Keys WEA) and will work with other agencies that manage land where white-crowned pigeons nest to determine where additional buffer and no-entry zones are needed.

Buffer zones and no-entry zones will need to be enforced by law enforcement (**Action 19**).

**Action 6** Post signage and enforce restrictions at core foraging areas where necessary and where feasible.

Bancroft and Bowman (2001) found that white-crowned pigeons in foraging areas readily flushed when humans walked or jogged near them. Core foraging areas should be closed to the public where human disturbance is a problem. Emphasis should be placed on public lands such as FWC’s Florida Keys WEA, which contains significant areas of foraging habitat. These areas are already protected from development and can be actively managed through removal of exotic vegetation and native tree planting. If identified as a core foraging location, areas within the Florida Keys WEA can also be seasonally closed if necessary. Posting key foraging areas on private lands should be encouraged where feasible and with the cooperation of land owners. Using sea-level-rise inundation studies, such as those found in “Application of the Sea Level Affecting Marshes Model (SLAMM 6) to Key West National Wildlife Refuge” (Warren Pinnacle 2011) can help inform where vulnerable habitat is located and where less vulnerable habitat may be found for the future.

**Population Management**

**Action 7** Protect white-crowned pigeon from effects of sea level rise through *ex situ* conservation (assisted migration) and social attraction techniques if necessary.
Assisted migration may be used as a tool for management of species in the event of sea level rise (Ross et al. 2009). However, this is not possible with birds since they will generally return to the place of capture immediately. Instead, white-crowned pigeons may have to be attracted to new breeding and foraging areas outside of their range through the use of social attraction techniques, such as decoys and recorded calls. If nesting and foraging habitat is affected by sea level rise, these techniques, which have been successfully used for other avian species, could be used to attract them to new areas (Arnold et al. 2011).

**Monitoring and Research**

**Action 8** Inventory all breeding sites throughout the white-crowned pigeon’s Florida breeding range.

**Action 9** Maintain a database of all significant breeding sites with status, estimated number of nests, threats, and monitoring dates.

The range-wide breeding population and breeding locations of the white-crowned pigeon in Florida is not known. This information is necessary for land managers and environmental agencies and organizations to make informed decisions on habitat and species management. Land managers should undertake a comprehensive survey of all known breeding sites as well as potential breeding areas. Data on the number of breeding pairs per site should be collected.

The lower Keys population of white-crowned pigeon has been well-monitored by the USFWS through the use of ongoing flight-line counts. Portions of the upper Keys and mainland population were monitored in the 1990s by the National Audubon Society (Strong et al. 1994), but there has been little to no recent monitoring of breeding populations outside of the lower Keys. Additional surveys need to be completed for breeding populations within the northern part of their breeding range. Precautions will be taken to avoid unnecessary disturbance of the pigeons at their breeding sites while conducting these surveys. The FWC can coordinate with counties, USFWS, and NPS to accomplish needed surveys. The status, number of nesting pairs, threats, and monitoring dates for all significant breeding sites can be entered annually into a long-term database that is accessible to all agencies and land managers.

**Action 10** Develop a standardized monitoring protocol.

Strong et al. (1994) first developed the use of flight-line counts as a non-disruptive method of counting nesting populations of the white-crowned pigeon in the upper Florida Keys. However, some researchers suspect flight-line counts may be a poor index of nesting pair abundance in areas where white-crowned pigeon colonies are small or spread out (Hay 2008). Transect surveys have been used at colonies in Puerto Rico (Rivera-Milan 2001). To date, there has been no targeted research to determine the most accurate methods for long-term population trends. A feasible standardized survey method that will accurately determine population trends should be developed. Private conservation organizations have done similar surveys on smaller scale and may be the best resource to continue and expand on current research.
**Action 11** Identify core foraging areas throughout the Florida range.

**Action 12** Determine foraging patterns and ranges for known populations.

Foraging areas for white-crowned pigeons nesting in the lower Keys may cover large distances. The species has been found to occur as far north as the upper Keys, Everglades National Park, and Miami-Dade and Broward counties (Bancroft and Bowman 2001, Meyer and Wilmers 2006). Additionally, an unknown percentage of white-crowned pigeons winter in Florida (Hay 2008). More information is necessary to determine the location of important foraging areas for breeding and wintering white-crowned pigeons in Florida. A long-term study on commutes to foraging habitat is needed to gather information on foraging pattern and ranges. It would also be useful in better identifying priority foraging habitats.

Information about optimal breeding areas and proximity to foraging sites has not been collected. This information is critical for effectively posting colonies, creating and enforcing appropriate protections, and educating the public so that disturbance may be prevented. Visual reports, banding and telemetry studies will help determine important foraging areas.

**Action 13** Determine which method is the most effective in preventing human disturbance from motorized and non-motorized vessels at breeding sites: buffer zones around island or no-entry zones on the islands.

Human disturbance at breeding sites can cause adults to flush from their nests and in the process knock eggs or young off their nests. Eggs or young left on their own are more vulnerable to predators and the elements (Bancroft and Bowman 2001). Unfortunately, there is disagreement as to which method – buffer zones or no-entry zones – is the most enforceable and therefore the most effective at reducing human disturbance at white-crowned pigeon breeding sites (T. Wilmers, personal communication). Buffer zones are posted areas established around nesting sites at a certain distance necessary to prevent disturbance of white-crowned pigeons. No-entry zones are white-crowned pigeon nesting sites with regulations that prohibit entry by persons not specifically authorized to enter. Research is necessary to determine which method should be employed.

**Action 14** Determine population growth rate by estimating adult survival, juvenile survival, and reproductive success at representative sites throughout the white-crowned pigeon’s breeding range.

The effect of management actions or impacts from human disturbance on breeding populations can only be measured by determining breeding success. When monitoring all colonies is not feasible, monitoring a subset of key colonies throughout the Florida range will give a more accurate estimate of breeding success rather than focusing on a few colonies within a specific population. Unfortunately, there are no recent studies estimating breeding success in the Florida Keys. Additionally, the true impact of human disturbance on reproductive success and adult survival is not known. Precautions should be taken to avoid unnecessary disturbance of the pigeons at their breeding sites while conducting this research.
**Action 15** Examine impact of disease transmission from bird feeders.

Anecdotal information suggests occasional pigeon die-offs (of unknown frequency) in the Key West area may be linked to contaminated birdseed from unclean bird feeders (K. Meyer, personal communication). Further research of this observation may result in information necessary to preventing future disease transmission. There are many options for lab testing include the University of Florida Veterinary School or USFWS National Lab, which may be able to test birds suspected of dying from contaminated bird feeders. Additionally, the FWC has an existing online Avian Mortality Database where agencies or the public can enter information such as the location, species, and number of birds found dead. FWC veterinary and biological staff as well as staff from other agencies monitor that database. If it is deemed necessary, arrangements can be made to collect the bodies of the birds for necropsies to determine the cause of death.

**Action 16** Determine the susceptibility of white-crowned pigeons to trichomoniasis and other diseases and parasites common to doves and pigeons.

Although avian trichomoniasis (also known as canker) is quite prevalent in most white-crowned pigeons, it is thought that this species is mostly resistant to infection (Kocan and Sprunt 1971). Nevertheless, die-offs from avian trichomoniasis have been documented in the Bahamas (K. Meyer, personal communication). Lice, mite, and warble fly larvae have all been reported to infect adults and young (Bancroft and Bowman 2001). However, the impact these diseases and parasites have on adult and young survivorship is unknown. This information is necessary to identify potential causes of mortality. Options for lab testing include the University of Florida Veterinary School or USFWS National Lab, which may be able to test dead young collected from nest to test for parasites or diseases.

**Action 17** Determine the extent of mortality from native predators such as raptors and raccoons on adults and young at breeding sites.

Raccoons (*Procyon lotor*) are a primary predator of white-crowned pigeon adults, eggs, and young in the Keys. Red-winged blackbirds (*Agelaius phoeniceus*) also prey on eggs. Raptors such as peregrine falcons (*Falco peregrinus*) are known to target white-crowned pigeon adults and young (Bancroft and Bowman 2001).

**Action 18** Determine the impact of non-native species such as cats, rats, pythons, and iguanas on white-crowned pigeon adults, eggs, and young.

There have been little to no studies on the impacts of non-native predators on white-crowned pigeons. Feral and free ranging cats (*Felis catus*) are quite common in the Florida Keys and have been documented preying on adult white-crowned pigeons (Meyer and Wilmers 2006). Brown rats (*Rattus rattus*) have been documented depredating nests of white-crowned pigeons in Puerto Rico (Bancroft and Bowman 2001). The Burmese python (*Phyton molurus bivittatus*) has been recorded consuming at least 25 species of birds in south Florida, among them an unidentified pigeon species (Dove et al. 2011). Direct predation may reduce the white-crowned pigeon population or cause abandonment of nests. Competition for food sources by non-native
herbivores such as green iguanas (*Iguana iguana*) may indirectly reduce fitness and increase mortality. There is anecdotal evidence of green iguana predation of roseate spoonbills (*Ajaja ajaja*) eggs in Florida Bay (Audubon Tavernier Science Center personal communication) so they may also be a threat to white-crowned pigeon nests. Determining extent of mortality from non-native predators is an appropriate action for university, or private researchers or conservation organizations.

**Rule and Permitting Intent**

Rule 68A-4.001 (1), F.A.C., prohibits take of white-crowned pigeons and their nests, eggs, and young, where take is defined as taking, attempting to take, pursuing, hunting, molesting, capturing, or killing (Rule 68A-1.004 [79], F.A.C.). The Federal Migratory Bird Treaty Act (16 U.S.C. 703), which has been adopted by the FWC (Rule 68A-16.001, F.A.C.), establishes similar prohibitions. There is a need to protect white-crowned pigeon’s from human disturbance at their nesting sites (mangrove islands) and their foraging areas.

Provisions for permits to take white-crowned pigeons, including incidental take, will be similar to those offered for other species and are provided in Rule 68A-9.002, F.A.C. Specifically, this rule authorizes the Executive Director to issue permits authorizing the taking or possession of white-crowned pigeons or their nests or eggs for scientific, educational, exhibition, propagation, management, or other justifiable purposes. Such permits are only operative if the holder also has a permit from the USFWS for the activity.

Some impacts to mangrove islands and tropical hardwood hammocks may result in the “take” of white-crowned pigeons. According to Rule 68A-27.001, F.A.C., take is defined as “to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in such conduct.” The term “harm” in the definition of take means an act which actually kills or injures fish or wildlife. Such act may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding or sheltering. Research and Monitoring actions listed in this plan are intended to identify impacts to habitat used by the white-crowned pigeon and may provide guidance for permitting issues.

Protection of mangroves is regulated by DEP. Mangroves are protected by the Florida Statues (403.9321 through 403.9333) via the 1996 Mangrove Trimming and Preservation Act, which includes provisions for mangrove alteration and trimming. Clearing of tropical hardwood hammocks continues legally and illegally. There is a need to protect core white-crowned pigeon foraging areas in tropical hardwood hammocks through better enforcement.

**Law Enforcement**

**Action 19** Enforce buffer zones or no-entry zones to reduce human disturbance from motorized and non-motorized vessels at the largest and most sensitive breeding sites.

The FWC’s Division of Law Enforcement, in conjunction with federal, state, and local partners, is responsible for enforcing Florida’s wildlife and fisheries laws. FWC law enforcement officers and USFWS special agents may partner to protect Florida’s wildlife and fisheries resources.
through a Cooperative Law Enforcement Agreement. Additionally, Rule 68A-13.002, F.A.C.,
adopts the federal Migratory Bird Treaty Act as state law and applies state penalties for
violations. Agents from USFWS and FWC often jointly investigate wildlife. Additional law
enforcement staff may be needed to improve protection of colonies and enforcement of posted
areas. Maintaining proper signage for no-entry zones or buffer zones (Action 5) will also allow
for more effective enforcement (USFWS 2009).

**Action 20** Develop strong coordination between law enforcement officers, land managers, and
wildlife biologists.

Interagency workshops and increased outreach to law enforcement officers, land managers, and
wildlife biologists should be conducted once every 1 to 2 years in order to share information,
concerns, and data, as well as to develop collaborative strategies that will result in enhanced
enforcement and resource protection.

**Incentives and Influencing**

**Action 21** Develop incentives and cost-sharing agreements or programs for private landowners
to conserve and enhance pine rockland and tropical hardwood hammock habitat for frugivorous
bird species.

Cost share programs, such as FWC’s Landowner Assistance Program, which reimburses
landowners for managing for imperiled species, provide opportunity for more widespread
management of habitats that benefit the white-crowned pigeon. FWC staff from these programs
can continue to maintain communication with local landowners to bolster relationships, provide
education, and (when and where possible) assist with conservation efforts on private property.
Actions that benefit the white-crowned pigeon include protection of tropical hardwood
hammocks from development, as well as planting of early-season forage species, such as
longleaf blolly.

**Education and Outreach**

**Action 22** Provide education and outreach to appropriate user groups regarding disturbance of
breeding sites.

Brochures, public-service announcements, press releases, public meetings, kiosk displays, and
effectively placed signs can all be used to inform the public regarding rules and regulations
pertaining to protection of white-crowned pigeon breeding sites. FWC Public Information
Officers and the Office of Community Relations can partner to develop informational brochures
and media releases that can be distributed annually prior to the breeding season. Brochures can
be distributed at bait and tackle shops, marinas, and boat-rental facilities. Ecotour operators can
inform the public about the breeding biology of white-crowned pigeons and the importance of
maintaining a safe distance from islands with nests. Increased outreach with ecotour operators
may equip them with the information necessary to educate their guests about conservation of
white-crowned pigeons.
**Action 23** Develop and disseminate aviation guidelines where low-flying aircraft impact mangrove-nesting birds.

Aircraft flying low over breeding and non-breeding birds may cause impacts to their foraging and breeding success (Carney and Sydeman 1999, Conomy et al. 1998). Regional and national airports as well as a military naval base all occur near white-crowned pigeon breeding colonies and foraging areas. Additionally, ecotour aircraft are known to approach these areas frequently to provide more scenic views. Guidelines should be developed and disseminated by FWC to local airports and commercial ecotour operations to promote responsible wildlife viewing as well as aircraft safety.

**Action 24** Educate private property owners on the importance of maintaining or increasing tropical hardwood hammock tree species that produce fruit early in the nesting season.

In the Florida Keys, most tropical hardwood hammock species do not produce ripe fruit during the winter and early spring. Species experts have indicated there is a lack of ripe early nesting season forage available for white-crowned pigeons, particularly in the lower Keys (T. Wilmers, personal communication). Typical early season forage species, such as strangler fig and wild banyan are often discouraged from being planted in urban areas due to their size and extensive root systems. Alternative species like the blolly, which is fast-growing, can provide critical early-season forage for fructivorous birds, but it does not have extensive root systems. Bancroft and Bowman (1994) ranked blolly as the second most important forage species for white-crowned pigeons and noted it was used year-round. An important consideration, however, is that while early-season forage is important, breeding productivity is low relative to later in the season. Bancroft and Bowman (2001) found a higher breeding productivity of white-crowned pigeons later in the season when poisonwood fruit is more available, as well as higher productivity in years with more abundant poisonwood fruit availability. Providing education and assistance to the public to ensure sufficient forage is available year-round on private lands would help support productivity for white-crowned pigeons and other fruit-eating birds. The FWC can take a lead role in coordinating with appropriate partners to initiate educational outreach and incentive programs for private landowners interested in growing fruit trees that may increase forage availability for white-crowned pigeons at key times during the year. Further, the FWC can coordinate with various organizations, (local utility companies, parks, garden clubs, and other non-governmental organizations) that sponsor native plant giveaways or low-cost native tree sales. Organizations such as local Audubon chapters, the University of Florida’s Institute of Food and Agricultural Sciences, the Institute for Regional Conservation (IRC) and Monroe County, along with the FWC, may be appropriate partners to develop and distribute educational material. The IRC, for example, compiles information on backyard-friendly plants, and may provide excellent opportunities for coordination and public education. The FWC’s Office of Public Access and Wildlife Viewing Services can create a brochure to be distributed to interested parties.

**Coordination with Other Entities**

**Action 25** Ensure white-crowned pigeon colonies are included in updates of Coast Guard Area Contingency Plans (ACPs) for hazardous material spills.
The FWC has actively been engaged in the development of ACPs. The FWC’s Fish and Wildlife Research Institute (FWRI) and other biological staff participate in ACP workshops and oil spill drills. The ACPs outline sensitive wildlife areas, site-manager contact information, species presence, and special precautions to take in the event of a hazardous material spill, such as an oil spill. During the Deepwater Horizon oil spill, the U.S. Coast Guard’s Incident Command actively coordinated with FWC staff to ensure sensitive wildlife areas and species were protected from oil carried in by winds and currents. It is equally important to ensure that sensitive wildlife areas are protected during cleanup efforts; these sensitive areas include the breeding and foraging habitats of the white-crowned pigeon. The FWRI will continue to coordinate with FWC Regional Biologists and agency land managers where white-crowned pigeon breeding sites occur to ensure all active white-crowned pigeon colonies are identified in the ACPs and are protected in the event of a hazardous material spill during the breeding season.

**Action 26** Encourage enforcement of local codes for protection of tropical hardwood hammock and pine rockland habitats.

Privately owned tropical hardwood hammock and pine rockland habitats are not specifically protected by state and federal law. There are some existing development guidelines in place for tropical hardwood hammock habitat within the species’ range. This work is already being conducted, to a certain extent, through local governments. Miami-Dade County (2006) cites general hammock protection guidelines in Element 4 of their Comprehensive Development Master Plan – Adopted Components. The items do allow for hammock clearing, but state that impacts should be minimized through buffer zones, zoning, and reduced road widths.

The Monroe County Comprehensive Plan (MCCP) and Land Development Regulations (LDRs) do not specifically address white-crowned pigeons but do have provisions for protection of native habitats (Monroe County 2012). Development in tropical hardwood hammocks and pine rocklands is discouraged by the MCCP and Monroe County codes. The current Monroe County LDRs restrict the amount of native tropical hardwood hammock and pine rockland habitat that may be cleared for new development to a maximum of 40% or 7,500 square feet per parcel based on the designated environmental sensitivity of the habitat (Section 118-9, Monroe County Code). Section 118-10(1) of the Monroe County Code helps to protect white-crowned pigeon habitat by requiring that all areas of tropical hardwood hammock required for open space are maintained in their natural condition, including the preservation of canopy, midstory and understory vegetation, ground cover and leaf litter layer (Monroe County 2012).

The management guidelines for natural areas in Miami-Dade and Monroe counties extend some protections for tropical hardwood hammocks; however, current guidelines still allow for some development and clearing of this habitat type (Meyer and Wilmers 2006).

Chapter 163.3177, Florida Statutes, requires that county comprehensive growth management plans include a conservation element. The conservation element must include the identification of areas within the county that are locations of important wildlife or habitat resources, including State-listed species. This element must contain principles, guidelines, and standards for conservation that restrict activities known to adversely affect the survival of these species. The FWC is identified as a state agency authorized to review county growth management plans and, including any amendments to ensure important state fish, wildlife, and habitat resources are
adequately considered. In addition, local government land development regulations require conditions for land and water uses that specify how such uses will be administered to be consistent with the conservation element of the county growth management plans. Therefore, interagency collaboration on the review and development of the conservation element of these plans is essential for ensuring that they consider wildlife habitat within the county.

**Action 27** Expand and restart the Florida Mangrove Nesting Bird Working Group.

A working group is an effective way to exchange information and address conflicts between species experts, landowners, and critical stakeholders. A Florida Mangrove Nesting Bird Working Group was started in 2003 and was active until 2008. Its primary focus was the mangrove cuckoo (*Coccyzus minor*) and mangrove nesting songbirds but also included the white-crowned pigeon. This work group should be revitalized and expanded to place more focus on the white-crowned pigeon. Members may be recruited from stakeholders identified during creation of this plan, or they may be solicited once the plan has been finalized. Habitat goals for white-crowned pigeons are compatible with other mangrove-nesting and fruit-eating bird species in south Florida. A coordinated effort is an efficient way to provide benefit to a suite of species. Members may include local, state, and federal governments, commercial recreation outfitters, land managers, private landowners, law enforcement officers, and conservation groups. By bringing together stakeholders and landowners, information sharing and education is easier and coordinated conservation efforts are more likely.

**Action 28** Collaborate with public and private organizations and workgroups outside of the United States to support sustainable white-crowned pigeon hunting regulations and promote habitat conservation and restoration.

A 6-month hunting season in the Bahamas is open during the same time the Florida breeding population is migrating from and overwintering outside of the United States. Hunting in the Bahamas is poorly regulated. Very high bag limits (50 birds per day) make the Bahamas stand out as the most liberally regulated hunting area within the species’ range (Bahamas National Trust 2010a, Bahamas National Trust 2010b, Meyer and Wilmers 2006). Habitat destruction in Jamaica, Haiti, Puerto Rico and the Dominican Republic has led to population declines of this species (Arendt et al. 1979, Bancroft and Bowman 2001, Wiley 1979). In addition to stronger regulation of hunting in these countries, greater effort should be made to protect remaining white-crown pigeon wintering, nesting, and foraging habitat and to restore degraded or destroyed habitat.

International interest in conserving species such as the white-crowned pigeon is increasing, providing coordination opportunities for FWC and other organizations to influence the range-wide conservation of the species. International government entities, such as the Bahamas National Trust; international conservation groups, such as The Society for the Conservation and Study of Caribbean Birds; and attendees of the 2011 White-crowned Pigeon Working Group meeting (see Hay 2008) may all provide excellent opportunities for coordination and education. The FWC and other conservation partners can explore these and other opportunities. Achieving range-wide conservation will also require education of hunters, landowners, and other user groups.
<table>
<thead>
<tr>
<th>Objective(s) Addressed</th>
<th>Team Assigned Priority Level</th>
<th>Action Item Number</th>
<th>Action Items</th>
<th>Conservation Action Category</th>
<th>Ongoing, Expanded or New Effort?</th>
<th>Authority</th>
<th>Man Power</th>
<th>Estimated Cost To Implement</th>
<th>Funding Source(s)</th>
<th>Lead for Implementation: FWC Program(s) and/or Section(s)</th>
<th>External partners</th>
<th>Likely Effectiveness</th>
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<th>Urgent?</th>
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<td>Reduce clearing and degradation of tropical hardwood hammocks in Florida through coordination and education.</td>
<td>Conservation &amp; Mgmt</td>
<td>EXPANDED</td>
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<td>YES</td>
<td>TBD</td>
<td>NGWTF Trust Fund, Existing budget</td>
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<td>Maintain or increase tropical hardwood hammock tree species on public lands to provide season-long forage and maintain productivity throughout the entire breeding season.</td>
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<td>TBD</td>
<td>Trust fund, grant, legislature</td>
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<td>Identify and prioritize potential breeding and foraging areas for acquisition and protection inside and outside the species’ range, taking into consideration potential habitat shifts caused by sea level rise.</td>
<td>Conservation &amp; Mgmt</td>
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<td>Manage suitable potential breeding and foraging areas outside the species’ range to mitigate for sea level rise.</td>
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<td>YES</td>
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<td>Grant, Legislature, Unknown</td>
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<td>Establish buffer zones or no-entry zones as necessary and post signage to reduce human disturbance from motorized and non-motorized vessels at the largest and most sensitive breeding sites.</td>
<td>Conservation &amp; Mgmt</td>
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<td>Post signage and enforce restrictions at core foraging areas where necessary and where feasible.</td>
<td>Conservation &amp; Mgmt</td>
<td>NEW</td>
<td>YES</td>
<td>YES</td>
<td>TBD</td>
<td>Existing budget</td>
<td>HSC</td>
<td>USFWS, NPS</td>
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<td>Protect white-crowned pigeons from effects of sea level rise through ex situ conservation (assisted migration) and social attraction techniques if necessary.</td>
<td>Population Mgmt</td>
<td>NEW</td>
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<td>YES</td>
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<td>Inventory all breeding sites throughout the white-crowned pigeon’s Florida breeding range.</td>
<td>Monitoring &amp; Research</td>
<td>EXPANDED</td>
<td>YES</td>
<td>YES</td>
<td>$0-25k</td>
<td>NGWTF</td>
<td>USFWS, NPS, Audubon, ARCI</td>
<td>Highly likely.</td>
<td>Very feasible.</td>
<td>No.</td>
<td></td>
</tr>
<tr>
<td>1 4 9 9</td>
<td></td>
<td></td>
<td>Maintain a database of all significant breeding sites with status, estimated number of nests, threats, and monitoring dates.</td>
<td>Monitoring &amp; Research</td>
<td>EXPANDED</td>
<td>YES</td>
<td>YES</td>
<td>$0-25k</td>
<td>Existing budget</td>
<td>HSC, SCP</td>
<td>USFWS, NPS, Audubon, ARCI</td>
<td>Highly likely.</td>
<td>Very feasible.</td>
<td>No.</td>
</tr>
<tr>
<td>1 2 10 10</td>
<td></td>
<td></td>
<td>Develop a standardized monitoring protocol.</td>
<td>Monitoring &amp; Research</td>
<td>NEW</td>
<td>YES</td>
<td>YES</td>
<td>$100-150k</td>
<td>Existing</td>
<td>FWRI</td>
<td>ARCI, USFWS</td>
<td>Highly likely.</td>
<td>Feasible.</td>
<td>No.</td>
</tr>
<tr>
<td>1 1 11 11</td>
<td></td>
<td></td>
<td>Identify core foraging areas throughout the Florida range.</td>
<td>Monitoring &amp; Research</td>
<td>NEW</td>
<td>YES</td>
<td>YES</td>
<td>$25-50k</td>
<td>Existing budget</td>
<td>HSC, SCP, WM</td>
<td>USFWS, NPS, Audubon, Local government, ARCI</td>
<td>Highly likely.</td>
<td>Very feasible.</td>
<td>No.</td>
</tr>
<tr>
<td>2 1 12 12</td>
<td></td>
<td></td>
<td>Determine foraging patterns and ranges for known populations.</td>
<td>Monitoring &amp; Research</td>
<td>EXPANDED</td>
<td>YES</td>
<td>NO</td>
<td>$30-100k</td>
<td>Grants</td>
<td>HSC, FWRI</td>
<td>ARCI, Audubon</td>
<td>Likely.</td>
<td>Feasible.</td>
<td>No.</td>
</tr>
<tr>
<td>1 2 13 13</td>
<td></td>
<td></td>
<td>Determine which method is the most effective in preventing human disturbance from motorized and non-motorized vessels at breeding sites, buffer zones around islands or no-entry zones on the islands.</td>
<td>Monitoring &amp; Research</td>
<td>NEW</td>
<td>YES</td>
<td>NO</td>
<td>$50-100k</td>
<td>Grant</td>
<td>FWRI, HSC, SCP</td>
<td>Universities, ARCI</td>
<td>Likely.</td>
<td>Feasible.</td>
<td>No.</td>
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<tr>
<td>Objective(s) Addressed</td>
<td>Team Assigned Priority Level</td>
<td>Action Item Number</td>
<td>Action Items</td>
<td>Conservation Action Category</td>
<td>Ongoing, Expanded or New Effort?</td>
<td>Authority</td>
<td>Man Power</td>
<td>Estimated Cost To Implement</td>
<td>Funding Sources(s)</td>
<td>Lead for Implementation: FWC Program(s) and/or Section(s)</td>
<td>External partners</td>
<td>Likely Effectiveness</td>
<td>Feasibility</td>
<td>Urgent?</td>
</tr>
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<tr>
<td>1</td>
<td>3</td>
<td>14</td>
<td>Determine population growth rate by estimating adult survival, juvenile survival, and reproductive success at representative sites throughout the white-crowned pigeon's breeding range.</td>
<td>Monitoring &amp; Research</td>
<td>NEW</td>
<td>YES</td>
<td>NO</td>
<td>$50-100K</td>
<td>Grant</td>
<td>FWRI, HSC, SCP</td>
<td>ARCI, Audubon</td>
<td>Likely.</td>
<td>Feasible.</td>
<td>No.</td>
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<tr>
<td>1</td>
<td>5</td>
<td>16</td>
<td>Determine the susceptibility of white-crowned pigeon's to trichomoniasis and other diseases and parasites common to doves and pigeons.</td>
<td>Monitoring &amp; Research</td>
<td>NEW</td>
<td>YES</td>
<td>NO</td>
<td>$25-50K</td>
<td>unknown</td>
<td>FWRI</td>
<td>USFWS, NPS, Universities</td>
<td>Difficult.</td>
<td>Somewhat feasible.</td>
<td>No.</td>
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<tr>
<td>1</td>
<td>3</td>
<td>17</td>
<td>Determine the extent of mortality from native predators such as raptors and raccoons on adults and young at breeding sites.</td>
<td>Monitoring &amp; Research</td>
<td>NEW</td>
<td>YES</td>
<td>NO</td>
<td>$25-50K</td>
<td>Grants, Unknown</td>
<td>FWRI</td>
<td>Universities, NGOs, USFWS</td>
<td>Likely.</td>
<td>Feasible.</td>
<td>No.</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>18</td>
<td>Determine the impact of non-native species such as cats, cats, pythons and iguanas on white-crowned pigeon adults, eggs, and young.</td>
<td>Monitoring &amp; Research</td>
<td>NEW</td>
<td>YES</td>
<td>NO</td>
<td>$25-50K</td>
<td>unknown</td>
<td>FWRI</td>
<td>USFWS, NPS</td>
<td>Likely.</td>
<td>Feasible.</td>
<td>No.</td>
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<tr>
<td>1, 2</td>
<td>2</td>
<td>19</td>
<td>Enforce buffer zones or no-entry zones to reduce disturbance from motorized and non-motorized vessels at the largest and most sensitive breeding sites.</td>
<td>Law Enforcement</td>
<td>EXPANDED</td>
<td>YES</td>
<td>YES</td>
<td>TBD</td>
<td>New budget, Legislative</td>
<td>LE</td>
<td>USFWS, NPS</td>
<td>Likely.</td>
<td>Feasible.</td>
<td>No.</td>
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<tr>
<td>1</td>
<td>2</td>
<td>20</td>
<td>Develop strong coordination between law enforcement officers, land managers, and wildlife biologists.</td>
<td>Law Enforcement</td>
<td>EXPANDED</td>
<td>YES</td>
<td>YES</td>
<td>$0-25k</td>
<td>New budget</td>
<td>LE, HSC</td>
<td>USFWS, NPS, State parks, Local government, Land owners</td>
<td>Likely.</td>
<td>Feasible.</td>
<td>No.</td>
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<tr>
<td>1</td>
<td>2</td>
<td>21</td>
<td>Develop incentives and cost-sharing agreements or programs for private landowners to conserve and enhance pine rockland and tropical hardwood hammock habitat for frugivorous bird species.</td>
<td>Incentives &amp; Influencing</td>
<td>NEW</td>
<td>YES</td>
<td>YES</td>
<td>$0-25k</td>
<td>New budget</td>
<td>HSC</td>
<td>Landowners, Local Government</td>
<td>Likely.</td>
<td>Feasible.</td>
<td>No.</td>
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<tr>
<td>1</td>
<td>4</td>
<td>22</td>
<td>Provide education and outreach to appropriate user groups regarding disturbance of breeding sites.</td>
<td>Education &amp; Outreach</td>
<td>EXPANDED</td>
<td>YES</td>
<td>YES</td>
<td>$0-25k</td>
<td>New budget</td>
<td>HSC, SCP</td>
<td>USFWS, NPS, NGOs, User groups</td>
<td>Likely.</td>
<td>Feasible.</td>
<td>No.</td>
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<tr>
<td>1</td>
<td>4</td>
<td>23</td>
<td>Develop and disseminate aviation guidelines where low-flying aircraft impact mangrove-nesting birds.</td>
<td>Education &amp; Outreach</td>
<td>NEW</td>
<td>YES</td>
<td>NO</td>
<td>$0-25k</td>
<td>Grant, Existing budget, Grant, Existing budget, DEP, State Parks, Local Government, Native Plant Societies</td>
<td>Likely.</td>
<td>Feasible.</td>
<td>No.</td>
<td></td>
<td></td>
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<tr>
<td>1</td>
<td>2</td>
<td>24</td>
<td>Educate private property owners on the importance of maintaining or increasing tropical hardwood hammock tree species that produce fruit early in the nesting season.</td>
<td>Education &amp; Outreach</td>
<td>NEW</td>
<td>YES</td>
<td>NO</td>
<td>$0-25k</td>
<td>Grant, Existing budget, DEP, State Parks, Local Government, Native Plant Societies</td>
<td>Likely.</td>
<td>Feasible.</td>
<td>No.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>25</td>
<td>Ensure white-crowned pigeon colonies are included in updates of Coast Guard Area Contingency Plans for hazardous material spills.</td>
<td>Coordination with Other Entities</td>
<td>EXPANDED</td>
<td>YES</td>
<td>YES</td>
<td>$0-25k</td>
<td>New budget</td>
<td>HSC, FWRI</td>
<td>USFWS, NPS, DEP, State Parks, Local Government</td>
<td>Highly likely.</td>
<td>Very feasible.</td>
<td>No.</td>
</tr>
<tr>
<td>1, 2</td>
<td>1</td>
<td>26</td>
<td>Encourage enforcement of local codes for protection of tropical hardwood hammock and pine rockland habitats.</td>
<td>Coordination with Other Entities</td>
<td>EXPANDED</td>
<td>YES</td>
<td>YES</td>
<td>$0-25k</td>
<td>New budget</td>
<td>HSC</td>
<td>Local government, Land owners</td>
<td>Likely.</td>
<td>Feasible.</td>
<td>No.</td>
</tr>
<tr>
<td>1, 2</td>
<td>3</td>
<td>27</td>
<td>Expand and reestablish the Florida Mangrove Nesting Bird Working Group</td>
<td>Coordination with Other Entities</td>
<td>NEW</td>
<td>YES</td>
<td>YES</td>
<td>$0-25k</td>
<td>New budget</td>
<td>HSC, SCP, USFWS</td>
<td>Likely.</td>
<td>Feasible.</td>
<td>No.</td>
<td></td>
</tr>
</tbody>
</table>
Table 1. White-Crowned Pigeon (Patagioenas leucocephala) Conservation Action Table

<table>
<thead>
<tr>
<th>Objective(s) Addressed</th>
<th>Team Assigned Priority Level</th>
<th>Action Item Number</th>
<th>Action Items</th>
<th>Conservation Action Category</th>
<th>Ongoing, Expanded or New Effort?</th>
<th>Authority</th>
<th>Man Power</th>
<th>Estimated Cost To Implement</th>
<th>Funding Sources(s)</th>
<th>Lead for Implementation: FWC Program(s) and/or Section(s)</th>
<th>External partners</th>
<th>Likely Effectiveness</th>
<th>Feasibility</th>
<th>Urgent?</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>1</td>
<td>28</td>
<td>Collaborate with public and private organizations and workgroups outside of the United States to support sustainable white-crowned pigeon hunting regulations and promote habitat conservation and restoration.</td>
<td>Coordination with Other Entities</td>
<td>NEW</td>
<td>YES</td>
<td>NO</td>
<td>TBD</td>
<td>Grants, Unknown</td>
<td>HSC</td>
<td>ARCI, USFWS, NGOs, Universities, International governments</td>
<td>Likely.</td>
<td>Feasible.</td>
<td>Yes. Unregulated hunting and habitat loss outside of Florida may lead to local extirpation or extinction.</td>
</tr>
</tbody>
</table>
LITERATURE CITED


APPENDICES

Appendix 1. Fruits known to be consumed by white-crowned pigeons.
As determined from nestling crop samples, adult gut contents, visual observations, and fecal samples collected throughout the year in the Florida Keys (from Bancroft and Bowman 2001).

<table>
<thead>
<tr>
<th>Fruit family</th>
<th>Species</th>
<th>Common names</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anacardiaceae</td>
<td>Metopium toxiferum</td>
<td>Poisonwood</td>
</tr>
<tr>
<td></td>
<td>Schinus terebinthifolia</td>
<td>Florida holly</td>
</tr>
<tr>
<td>Aquifoliaceae</td>
<td>Ilex cassine</td>
<td>Dahoon holly</td>
</tr>
<tr>
<td>Arecaceae</td>
<td>Thrinax morrisii</td>
<td>Key thatch palm</td>
</tr>
<tr>
<td></td>
<td>Thrinax radiata</td>
<td>Florida thatch palm</td>
</tr>
<tr>
<td>Boraginaceae</td>
<td>Bourreria ovata</td>
<td>Bahama strongbark</td>
</tr>
<tr>
<td>Burseraceae</td>
<td>Bursera simarouba</td>
<td>Gumbo-limbo</td>
</tr>
<tr>
<td>Canellaceae</td>
<td>Canella winterana</td>
<td>Cinnamon bark</td>
</tr>
<tr>
<td>Celastraceae</td>
<td>Schaefferia frutescens</td>
<td>Florida boxwood</td>
</tr>
<tr>
<td>Celtidaceae</td>
<td>Trema sp.</td>
<td>Trema</td>
</tr>
<tr>
<td>Chrysobalanaceae</td>
<td>Chrysobalanus icaco</td>
<td>Coco plum</td>
</tr>
<tr>
<td>Euphorbiaceae</td>
<td>Drypetes lateriflora</td>
<td>Guiana plum</td>
</tr>
<tr>
<td>Fabaceae</td>
<td>Pithecellobium unguis-cati</td>
<td>Catclaw blackbead</td>
</tr>
<tr>
<td>Lauraceae</td>
<td>Nectandra coriacea</td>
<td>Lancewood</td>
</tr>
<tr>
<td>Moraceae</td>
<td>Ficus aurea</td>
<td>Strangler fig</td>
</tr>
<tr>
<td></td>
<td>Ficus citrifolia</td>
<td>Wild banyan</td>
</tr>
<tr>
<td></td>
<td>Ficus microcarpa</td>
<td>Indian laurel fig</td>
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<tr>
<td>Myrsinaceae</td>
<td>Ardisia escallonioides</td>
<td>Marlberry</td>
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<tr>
<td>Myrtaceae</td>
<td>Calyptranthes sp.</td>
<td>Spicewood</td>
</tr>
<tr>
<td></td>
<td>Eugenia foetida</td>
<td>Spanish stopper</td>
</tr>
<tr>
<td>Nyctaginaceae</td>
<td>Guapira discolor</td>
<td>Blolly</td>
</tr>
<tr>
<td>Passifloraceae</td>
<td>Passiflora suberosa</td>
<td>Small passion vine</td>
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<tr>
<td>Polygonaceae</td>
<td>Coccoloba diversifolia</td>
<td>Pigeon plum</td>
</tr>
<tr>
<td></td>
<td>Coccoloba uvifera</td>
<td>Seagrape</td>
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<tr>
<td>Rhamnaceae</td>
<td>Krugiodendron ferreum</td>
<td>Black ironwood</td>
</tr>
<tr>
<td>Rubiaceae</td>
<td>Chiococca alba</td>
<td>Snowberry</td>
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<td></td>
<td>Erithalis fruticosa</td>
<td>Black torch</td>
</tr>
<tr>
<td></td>
<td>Randia aculeata</td>
<td>White indigoberry</td>
</tr>
<tr>
<td>Sapindaceae</td>
<td>Exothea paniculata</td>
<td>Inkwood</td>
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<tr>
<td>Sapotaceae</td>
<td>Bumelia salicifolia</td>
<td>Willow buctic</td>
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<td>Chrysophyllum oliviforme</td>
<td>Satin leaf</td>
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<td></td>
<td>Mastichodendron foetidissimum</td>
<td>False mastic</td>
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<tr>
<td>Simaroubaceae</td>
<td>Simarouba glauca</td>
<td>Paradise tree</td>
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<tr>
<td>Solanaceae</td>
<td>Solanum erianthum</td>
<td>Potato tree</td>
</tr>
<tr>
<td>Surianaceae</td>
<td>Suriana maritima</td>
<td>Bay cedar</td>
</tr>
<tr>
<td>Verbenaceae</td>
<td>Lantana camara</td>
<td>Lantana</td>
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