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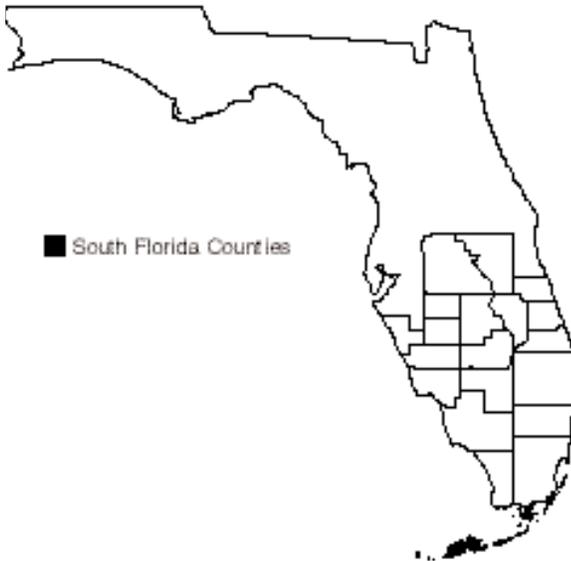
# Key Deer

## *Odocoileus virginianus clavium*

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<b>Federal Status:</b>	<b>Endangered (March 11, 1967)</b>
<b>Critical Habitat:</b>	<b>None Designated</b>
<b>Florida Status:</b>	<b>Endangered</b>
<b>Recovery Plan Status:</b>	<b>Revision (May 18, 1999)</b>
<b>Geographic Coverage:</b>	<b>Rangewide</b>

**Figure 1. Distribution of the Key deer; this species is endemic only to the Florida Keys.**



By the late 1940s, over-hunting and killing by Keys residents and visitors had nearly driven the Key deer to extinction. By the early 1950s only 25 deer remained. Efforts to enforce hunting bans and to protect the deer from human disturbance allowed the Key deer population to increase slowly. The Key deer remains federally listed due to the continued loss of its habitat and because of high, human-related mortalities and disturbances.

This account represents a revision of the existing recovery plan for the Key deer (FWS 1985).

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### Description

The Key deer is the smallest subspecies of the North American white-tailed deer. Adult males average 36 kg and adult females 28 kg. Fawns weigh about 1.5 kg at birth. Height at the shoulder averages 69 cm for adult bucks and 65 cm for adult does (Hardin *et al.* 1984).

The body appears stockier than that of other deer (Klimstra *et al.* 1978a); the legs are shorter, and the skull is shorter and relatively wider (Klimstra *et al.* 1991). Pelage varies from deep reddish-brown to grizzled gray, and a distinct black cross or mask is often present between the eyes and across the brow (Klimstra 1992). Antler size and number of points for male Key deer are less than those of other white-tail deer (Folk and Klimstra 1991a). Bucks typically grow spikes until their second year, when forked antlers are produced; they attain eight points usually by the fourth year.

In addition to their size, a number of other characteristics distinguish Key deer from other white-tailed deer; these include high saltwater tolerance (Jacobson 1974), low birth rates, low productivity (Folk and Klimstra 1991b), more solitary habits, and weak family bonds (Hardin 1974). According to Ellsworth *et al.* (1994), the Key deer population is the most genetically divergent deer population in the southeastern United States.

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### **Taxonomy**

The Key deer is a member of the Cervidae family of the order Artiodactyla, class Mammalia. It was first recognized as a subspecies distinct from the races of *O. v. osceola* and *O. v. virginianus* when it was described by Barbour and Allen (1922).

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### **Distribution**

The Key deer's historical range probably extended from Key Vaca to Key West (Klimstra *et al.* 1978a). The current range includes approximately 26 islands (330 km<sup>2</sup>) from Big Pine Key to Sugarloaf Key (Folk 1991) (Figure 1). The National Key Deer Refuge and Great White Heron NWR encompass much of this territory and are managed for the Key deer and other imperiled species. Big Pine Key, the largest of the Lower Keys (2,500 ha), is the center of the Key deer's range and supports about two-thirds of the entire population (Klimstra *et al.* 1974).

The principal factor influencing the distribution and movement of Key deer in the Keys is the location and availability of fresh, surface water. Key deer swim easily between keys and use all islands during the wet season (May to October), but during the dry season (November to April), suitable water is available on only 13 islands (Folk 1991). Big Pine Key and No Name Key provide the most fresh water and support the majority of the Key deer population.

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### **Habitat**

Key deer utilize all habitat types within their range, including pine flatwoods, pine rocklands, hardwood hammocks, buttonwood wetlands, mangrove wetlands, and freshwater wetlands. They may use these habitats year-round or seasonally for foraging, cover, shelter, fawning, and bedding. Pine rocklands, in particular, are very important to Key deer because they contain permanent freshwater sources that are critical to the long-term survival of the species. Only five of the 26 islands, Big Pine, Little Pine, Sugarloaf, Cudjoe, and No Name keys, support extensive pine rocklands. Key deer forage on mangroves in tidal wetlands and use open areas for foraging and resting. Key deer also use residential and commercial areas extensively where they feed on ornamental plants and grasses and where they can seek refuge from biting insects.

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### **Behavior**

Key deer have well-defined patterns of activity and habitat use (Klimstra *et al.* 1974). Established trails, worn deep into the marl soil from years of daily use, are clearly visible in many of the Key deer's movement corridors. Bedding and feeding areas are used regularly by individuals, and hot spot road crossings are

**Key deer.**

Original photograph courtesy of U.S. Fish and Wildlife Service.



clearly apparent from roadkill data (Klimstra 1992).

The social structure of the Key deer varies throughout the year with the reproductive cycle. Their behavior is more solitary than northern white-tail deer (Klimstra *et al.* 1978a), although feeding by people has resulted in aggregations on the human-inhabited islands (Folk and Klimstra 1991a). Bucks associate with females only during the breeding season and will tolerate other males when feeding and bedding only during the nonbreeding season. Does may form loose matriarchal groups consisting of an adult female with several generations of her female offspring, but these associations are not stable (Hardin *et al.* 1976).

Home ranges vary seasonally and with age and also may be affected by the degree of urbanization. Average monthly home range size for adult males is about 120 ha and for adult females is about 52 ha, while yearly ranges are larger with an average of 320 ha for males and 175 ha for females. Males tend to disperse from their natal range as fawns or yearlings. Adult males range over much larger areas during the breeding season (Silvy 1975) and may shift to an entirely new area (Drummond 1989). Territorial behavior is limited to a buck's defense of a receptive doe from other bucks and is not used to defend a specific territory size or area (Klimstra *et al.* 1974). Aggressive male behaviors, such as fighting between rutting males, may be more serious in Key deer populations than in other white-tailed deer populations.

The sociobiology of many Key deer on Big Pine Key appears to have changed in recent years as a result of increasing contact and influence by humans (Folk and Klimstra 1991a). Increase in group size, reduction in movements, and change in behavior from the early 1970s (Hardin 1974) to the early 1990s (Folk and Klimstra 1991a) in several subdivisions on Big Pine Key indicate increasing domestication of the deer and urbanization of its habitat.

### Reproduction

On average, Key deer produce fewer young than any other free ranging white-tailed deer population in North America (Folk and Klimstra 1991b). This may be a result of a nutrient deficiency (possibly phosphorus) or an adaptation to a restricted, insular environment. Either way, fecundity (number of fetuses/female) and rate of reproductive activity (percent of females reproducing) are low, and fetal sex ratio (males to females) and mean age of first breeding are high, resulting in reproductive potential that is lower than any other North American deer population (Folk and Klimstra 1991b). The sex ratio is skewed towards male offspring; with a 1.75:1 fetal ratio and 2:1 fawn ratio. The tendency for male offspring may be caused by inbreeding, high population densities, or a decrease in nutrition (Seal and Lacy 1990).

The breeding season for Key deer begins in September, peaks in October, and declines through December and January (Hardin 1974). Younger animals apparently breed later in the season, if at all (Klimstra *et al.* 1978b). Male fawns do not breed and female fawns rarely do so. Most yearling males do not breed; however, many females will breed as yearlings. Even adults may fail to breed, especially young bucks that are excluded from breeding by older, more aggressive males (Klimstra 1992).

Parturition occurs about 204 days after breeding and peaks in April and May, although spotted fawns have been observed in every month of the year (Hardin 1974). The coincidence of fawning with the rainy season ensures an ample food supply for lactating females. Open hammocks and pinelands are preferred fawning habitats (Silvy 1975). Twinning is infrequent, and triplets have been documented once.

### Foraging

The Key deer's diet varies seasonally with availability of specific plants and changes in nutritional requirements (Carlson *et al.* 1989, Klimstra and Dooley 1990). Seasonal availability of special foods [e.g., black mangrove (*Avicennia germinans*), palm (*Thrinax morrisii*, *Coccothrinax argentata*), and dilly fruits (*Manilkara bahamensis*)] influences Key deer movements. Key deer forage on more than 160 other species to meet nutritional requirements (Klimstra and Dooley 1990), especially red mangroves (*Rhizophora mangle*), blackbead (*Pithecellobium keyense*), grasses, acacia (*Acacia pinetorum*), Indian mulberry (*Morinda royoc*), and pencil flower (*Stylosanthes hamata*). Red and black mangroves constitute 24 percent by volume of the diet of the Key deer (Klimstra and Dooley 1990).

Many of the important food plants occur in pine rocklands and are stimulated by fire, which arrests succession, reduces the canopy, promotes understory growth, decreases invasion by woody species, increases plant palatability, and reduces ground litter (Carlson *et al.* 1989). Gross energy values of most Key deer foods are comparable to commercial feeds (Morthland 1972), but may be high in calcium and sodium and low in phosphorus

(Widowski 1977). Although Key deer have been observed drinking water half as saline as seawater (15 ppt), Key deer may not be able to survive for long periods without fresh (<5 ppt) water (Folk *et al.* 1991).

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### Relationship to Other Species

The complex relationships that occur between the endemic species of the Lower Florida Keys and their habitats depend upon the integrity of the entire ecosystem. If a link in that relationship is removed, the whole system is disrupted. The Key deer uses a variety of habitats in the Lower Keys for foraging, resting, and reproduction. The deer's dependence on these habitats is also shared by several other endangered species such as the Key tree-cactus (*Pilosocereus robinii*), Lower Keys marsh rabbit (*Sylvilagus palustris hefneri*) and silver rice rat (*Oryzomys argentatus*).

Key deer frequently use cactus hammock (the sole location for the Key tree-cactus) for foraging and resting, and as a travel corridor. Foraging behaviors of the Key deer may play an important role in windthrow or dispersal of the Key tree-cactus in this area (Hennessey and Habeck 1994). Deer, marsh rabbits, and silver rice rats use similar vegetation in salt marshes (*e.g.*, *Sporobolus virginicus*), transitional areas (*e.g.*, *Conocarpus erectus*), and freshwater marshes (*e.g.*, *Cladium jamaicense*). Deer and silver rice rats both rely on mangrove swamps. Coastal berm areas on Long Beach and Sugarloaf Beach on Big Pine Key are used by marsh rabbits, as well as by Key deer who use these same areas for bedding and birthing (Folk *et al.* 1990). Sugarloaf Beach is also used by nesting Atlantic loggerhead (*Caretta caretta*) and green sea turtles (*Chelonia mydas mydas*).

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### Status and Trends

Prior to Anglo settlement in the Keys in the early 18th century, the Key deer probably was exposed to very few natural competitors or predators. The population dynamics of the Key deer had evolved to withstand natural phenomena such as drought, hurricanes, fire, *etc.* Behavioral responses (*e.g.* migration) and physiological adaptations (*e.g.* low reproductive output) were a result of conditions as they existed before human influence (Hardin 1974, Klimstra *et al.* 1974, Silvy 1975).

Since the widespread settlement of humans in the Keys, Key deer have been exposed to influences they had not evolved to overcome, which almost led to their extinction between 1940-1950 and is the cause of their endangerment today. A Federal refuge was established in the 1950s, and the Key deer was officially listed as federally endangered on March 11, 1967 (32 FR 4001). The Key deer was listed as an endangered species because of the loss of its habitat to residential and commercial construction and because of high, human-related mortality and

human disturbances.

Historically, the maximum population of Key deer was probably between 600 to 700 individuals occupying about 7,695 ha of habitat in the historical range (Seal *et al.* 1990). A 1998 survey indicates the Key deer population is between 579 to 678 individuals which is a 250 percent increase on Big Pine Key and a 379 percent increase on No Name Key from 1970 levels (Lopez and Silvy 1999). Due to continued urbanization of Key deer habitat, there is little opportunity to increase the carrying capacity of the Keys, although habitat enhancement on outlying islands may afford some opportunities.

In addition to habitat loss, the persistence of the Key deer is highly vulnerable to natural events such as hurricanes and sea-level rise. A population viability assessment (PVA) completed in 1990, when population estimates were 250 to 300 individuals, assessed the risk of extinction, predicted the impacts of management options, and set targets for recovery (Seal *et al.* 1990). The PVA predicted that a Key deer population of 250 animals, under existing conditions, had a 74 percent probability of going extinct within 67 years. Road mortality continues to increase, as does habitat fragmentation and loss. As long as such threats exist, the status of the Key deer will continue to be in question.

### Threats

Key deer were threatened by over-hunting until it was prohibited in the early 1950s. Since that time, other human-caused threats are placing pressures on the abundance and distribution of the Key deer, including habitat loss, vehicular traffic, habitat degradation, and illegal feeding. In recent years, the most intensive threat to the continued existence of the Key deer is the loss or alteration of habitat. Residential and commercial construction activities have destroyed essential components of Key deer habitat including vegetation and freshwater resources. Fencing has resulted in a loss of habitat and interference with migration routes. In addition, other human-induced actions adversely affect the Key deer. Vehicular traffic is responsible for the most mortalities. Illegal feeding of Key deer may result in an alteration of habitat use patterns, spread of parasites and disease at feeding sites, and aggregations of deer in residential areas. Key deer are also negatively affected by illegal dumping, contaminants, open pit mining, and feral and domestic dogs. All of these threats are altering the Key deer's distribution, damaging essential habitat, and disturbing behavioral activities, such as foraging, and reproduction.

Loss of habitat, particularly on Big Pine Key, is the major threat to the future of the Key deer (Klimstra *et al.* 1974). Nearly half of the islands in the range of the deer are currently inhabited by people, and eight have large subdivisions and commercial areas (Folk 1991). In 1990, the human population of Big Pine Key was estimated at 4,208 permanent residents, a 77 percent increase since 1980; an additional 2,154 seasonal residents spend winters on Big Pine Key (Monroe County Growth Management Division 1992).

Habitat degradation and fragmentation has reduced the Key deer's

distribution and affected behavior. Habitat fragmentation from fencing and development restricts deer movements, creating bottlenecks that interfere with their ability to reach permanent water and feeding areas and often forcing them to cross roads in areas of heavy traffic. Exotic plant species such as Australian pine (*Casuarina* spp.), Brazilian pepper (*Schinus terebinthifolia*), and leatherleaf fern (*Colubrina asiatica*) are invading disturbed areas and outcompeting native vegetation, reducing Key deer foods and habitat. Fire suppression is responsible for deterioration of important pine rockland communities in the Keys (Klimstra 1986, Carlson *et al.* 1989), and the ability of land managers to use prescribed fire is hampered by increasing urbanization. The availability of fresh water is affected by filling, ditching, draining, pollution (septic tanks), illegal dumping, and pumpage from private wells (Folk 1991).

Human-related mortality, primarily roadkills, is the greatest known source of deer deaths. In 1998, road mortality accounted for 67 percent of all known deaths (Wilmers 1998). The total number of roadkills was 90 that year, the highest in the history of the refuge. Since 1985, more than 90 percent of all deer roadkills have occurred on Big Pine Key, mainly on U.S. Highway 1 and Key Deer Boulevard. Other sources of mortality include poaching, drowning in ditches and canals, running by dogs, entanglement in fences, sparring between bucks, and foreign debris in the digestive tract from feeding in trash containers (Klimstra 1992).

Illegal feeding has been reported to cause the deer to become more sedentary and to lose natural alarm and flight responses (Folk and Klimstra 1991c). This may lead to nutritional imbalances, increased chance of disease and parasite transmission, dependence on humans, density-related problems, and loss of genetic interchange (inbreeding). Increased harassment of deer by people, automobiles, and dogs may also stress the deer, and may result in higher mortality and lower reproduction.

The Key deer is more susceptible to a loss of genetic diversity because of its island environment and the population bottlenecks it has already experienced (Seal and Lacy 1990). Possible adverse genetic consequences include loss of heterozygosity, adaptability and reproductive potential resulting from genetic drift and inbreeding depression (Seal and Lacy 1990). The small population is also at greater risk from the effects of a natural catastrophe (*e.g.*, hurricane) or disease outbreak.

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## Management

The National Key Deer Refuge was established in 1957 for the purpose of protecting and maintaining the remaining 1,643 ha of habitat for the Key Deer and actively managing the Key deer population. To date, the FWS has acquired over 3,238 ha to be managed as part of the National Key Deer Refuge and Great White Heron NWR. Acquisition of these lands is the most significant recovery action to protect the Key deer.

Management and restoration of habitat is a major conservation effort that involves prescribed burning, mowing of clearings and fire breaks, filling of

ditches to prevent fawn drownings and limit influx of saline water, removing exotic vegetation and planting native vegetation, and development and protection of habitat corridors. The FWS also coordinates with the SFWMD to improve water resources by removing cesspools and installing septic tanks, allowing no net increase of pollution. To alleviate road mortality, the FWS is cooperating with DOT and Monroe County to establish and enforce speed zones and maintain warning signs for deer crossings. FWS law enforcement is working to minimize human interactions with Key deer, especially feeding by the public. Other management activities include guzzler (water tank) maintenance, relocation of nuisance and rehabilitated animals, and coordination of volunteer activities including exotic plant removal, law enforcement, and public education.

Other areas protected within the range of the deer include a 81 ha tract on Big Pine Key managed by SFWMD's Save Our Rivers Program, a 8.1 ha Nature Conservancy tract on Big Pine Key, and an 75 ha Nature Conservancy preserve on Little Torch Key. Several hundred acres of land have been acquired on Big Pine Key for the DEP's Conservation and Recreational Lands Key Deer-Coupon Bight project. The Monroe County Land Authority has also purchased land in the No Name/BigPine/Torch Keys area.

Efforts to inform the public about Key deer are continuing on the refuge. The Key Deer Protection Alliance, a local citizens' group formed in 1988, is also working to increase awareness and public education by providing accurate information, sponsoring direct action projects, and supporting preservation of Key deer habitat.

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# Recovery for the Key Deer

## *Odocoileus virginianus clavium*

**Recovery Objective:** RECLASSIFY to threatened.

### Recovery Criteria

The Key deer has a narrow geographic range and low reproductive performance causing it to be susceptible to extinction. Recent information indicates the Key deer has experienced local extirpations and a contraction in range due to the loss, fragmentation, and degradation of its habitat and other anthropogenic factors. Consequently, the objective of this recovery plan is to reclassify the Key deer from *endangered* to *threatened* by protecting, managing, and restoring its habitat in the Lower Keys; increasing the size of its population; and increasing its range. This objective will be achieved when: further loss, fragmentation, or degradation of suitable, occupied habitat in the Lower Keys has been prevented; when native and non-native nuisance species have been reduced by 80 percent; when all suitable, occupied habitat on priority acquisition lists for the Lower Keys is protected either through land acquisition or cooperative agreements; when Key deer habitat is managed, restored, or rehabilitated on protected lands; when stable populations of the Key deer are distributed throughout its historic range; and two, additional, stable populations have been established along the periphery of the historic range of the Key deer. These populations will be considered demographically stable when they exhibit a stable age structure and have a rate of increase ( $r$ ) equal to or greater than 0.0 as a 7-year running average for 14 years.

### Species-level Recovery Actions

- S1. Determine the distribution and status of the Key deer and its habitat.** Survey all appropriate Key deer habitat. Focus surveys on determining the status of the Key deer and the status of its habitat.
- S1.1. Develop a Master Census Plan to determine the status of the Key deer and its habitat.** Revisit the Silvy (1975) study and gather information on sex ratios, population numbers, age structure, group size, interaction of deer, home range size, and minimum area. Include behavioral aspects and how they affect the Key deer's range. Develop the census to address the above issues and be feasible to repeat for future monitoring. Develop the census to include mark/recapture methods and telemetry work.
- S1.2. Survey for the presence/absence of Key deer in suitable habitat.** Identify any additional potential habitat patches and survey for suitability of vegetation and presence/absence of Key deer. Using past studies as a baseline, determine current habitat condition and characterize how deer are using it. Determine why deer are

present in some suitable habitat areas, but are absent in other areas (*i.e.*, suitable habitat exists on Sugarloaf, but deer are not permanently established there anymore).

- S1.3. Maintain and improve the GIS database for Key deer information.** Compile and maintain Key deer distribution information through the FWS Geographic Information System (GIS) database. Produce GIS maps to overlay the status of the Key deer and its habitat. Overlay presence/absence data with habitat status to help develop a reserve design plan for the Key deer.
- S2. Protect and enhance existing populations.** Human-induced or human-related mortality must be minimized if the deer is to survive.
- S2.1. Staff the National Key Deer Refuge with a new biologist.** The FWS biologist will coordinate Key deer recovery and implement recovery actions for the Key deer, including reintroductions, surveying and monitoring, protection efforts, research, and habitat management. The biologist will coordinate with Key deer experts on the progress and evaluation of the deer's recovery program and develop an annual progress report on the Key deer recovery program.
- S2.2. Conduct Key deer reintroductions from natural wild populations.** The sociobiology (*e.g.*, group size, movements, behavior) of the Key deer has changed in recent years due to increasing contact and influence by humans (Folk and Klimstra 1991a). As a result, there has been a contraction in the distribution and range of the Key deer, resulting in an unusually high concentration of deer on Big Pine Key. In order to support a sustainable population of Key deer, the distribution and range must be maintained. Release Key deer into suitable habitat with low or no Key deer presence in order to maintain the Key deer's range and distribution.
- S2.2.1. Develop a standard protocol for conducting, monitoring, and evaluating all reintroduction, translocation, and supplementation efforts** of Key deer using the IUCN Species Survival Commission's Guidelines for Reintroductions. Develop criteria that determine the type of release to be conducted, evaluate and select release site, identify source and health of release stock, develop and monitor short and long-term success indicators, and develop a policy on intervention. Develop a soft release site to acclimate deer prior to release. Ensure release sites are free of threats prior to any release of Key deer.
- S2.2.2. Reintroduce Key deer to suitable public lands.** Several areas within National Key Deer Refuge property are appropriate for reintroduction, translocation, or supplementation of Key deer, including Upper and Lower Sugarloaf and Cudjoe keys. Radio collar and monitor all released deer.
- S2.2.3. Educate the public on the need for and process of Key deer reintroductions.** Public awareness and support is important for reintroductions to be successful.
- S2.2.4. Enforce protection of reintroduced or released Key deer.** Enforce Federal laws (*i.e.*, speed zones, no feeding, *etc.*) as they relate to released deer. Full Federal protection is necessary to ensure the survival of released deer.

- S2.3. Conduct consultations on Federal activities. Determine jeopardy thresholds for the Key deer.** Estimate and evaluate the type of Federal activities over the next 20 years that are likely to cause jeopardy and determine threshold levels for the total population. Coordinate with law enforcement to prevent take under section 9. Identify what activities could result in take of Key deer, such as habitat loss, dog predation, and vehicular traffic.
- S2.4. Provide information about Key deer to Federal, State, county, and city agencies.** Distribute information regarding the presence of Key deer, its protection under the ESA, and ways to minimize impacts. Non-Federal agencies that may influence the Key deer include DEP, DCA, GFC, DACS, Monroe County Mosquito Control, Florida Keys Aqueduct Authority, and Monroe County Government.
- S2.5. Reduce mortality of Key deer.** Address illegal activities that impact deer. Enforcement of state and federal regulations protecting the Key deer is, and has been, critical to the preservation of the subspecies. Man-induced mortality must be minimized.
- S2.5.1. Control poaching.** The Key deer population will never be large enough to support hunting. Eliminate poaching.
- S2.5.2. Prohibit animal trespass.** Dog-related deaths of Key deer are the second most frequent cause of man-induced mortality. Enforce refuge regulations prohibiting illegal animal trespass. The problem with dogs is of growing concern in light of developmental pressures. Coordinate with Monroe County to implement and enforce leash law. Coordinate with the Big Pine Key Animal Shelter in identification of offenders and in periodic round-ups of free-roaming dogs.
- S2.5.3. Minimize vehicle collisions with Key deer.** Coordinate with Monroe County to identify and prioritize road concerns. Develop management methods to reduce vehicle collisions with deer.
- S2.5.3.1. Reduce speed limit on primary and secondary roads.** Continued efforts by refuge staff have kept the speed limit of Key Deer Boulevard to 50 kmph (30 mph). Enforce speed limits in posted areas. Identify other areas in need of speed regulations and reduce speed limits.
- S2.5.3.2. Continue and increase enforcement of speed zones.** Enforcement of speed zones has been effective in reducing deer mortality and increasing deer awareness. Continue, and if necessary, increase enforcement of speed zones.
- S2.5.3.3. Identify deer crossings.** Determine areas where deer commonly cross US Highway 1 and secondary paved roads. Continue to post in these areas signs, reflectors, flashing lights, etc., in order to warn motorists. Monitor the frequency with which deer utilize the crossings.
- S2.5.3.4. Investigate the use of fencing to reduce collisions.** Evaluate the potential hazards of fencing, including dogs cornering deer at fences, deer becoming entangled in fences, and deer being channeled to new, hazardous crossing sites. The negative results of fencing might

outweigh the benefits. If beneficial, install fencing along selected roadways to protect crossing areas and/or to redirect deer movements.

**S2.5.3.5. Identify roads that could be constructed or upgraded.** Identify areas where roads can be constructed. Continue coordination with FDOT and Monroe County to minimize impacts on deer from road building and widening projects.

**S2.5.4. Minimize the impact of accidental drowning in mosquito ditches.** Mosquito ditches pose a threat to fawns, which may drown in them. Approximately 55 km of ditches occur on refuge lands. Several areas of concern have been identified, surveyed, and mapped. Those ditches have been identified as to ease of filling according to access and level of impact on habitat and wildlife. Identify any additional ditches that may pose a threat to deer and manage appropriately.

**S2.5.4.1. Fill mosquito ditches in selected areas of the refuge.** The refuge has been filling mosquito ditches to minimize impacts on Key deer. Continue with mosquito ditch management.

**S2.5.4.2. Monitor effects of filling ditches.** Monitor the impact of filling on wildlife, plants, hydrology, etc. Use monitoring reports to upgrade filling procedures and selection of ditches for filling.

**S2.6. Reduce and eliminate disturbance, interference, and harassment of Key deer.**

**S2.6.1. Control public access and use of the refuge.** The refuge is one of the few protected areas for the Key deer and should be maintained as such. Control public access so as to minimize disturbance of habitat and wildlife. Conduct supervised visitation to selected areas of the refuge (*e.g.*, Watson's and Cactus hammocks) when deemed necessary.

**S2.6.1.1. Eliminate incompatible uses on the refuge.** Beekeeping has been eliminated. Eliminate other incompatible uses such as paintballing activities.

**S2.6.1.2. Continue to limit access to daytime use.**

**S2.6.1.3. Continue to prohibit camping and military maneuvers.**

**S2.6.1.4. Continue to limit all vehicles to paved roads except for refuge and emergency operations.** Vehicle trespass has greatly increased with the advent of all-terrain vehicles and non-motorized dirt bikes. These vehicles destroy habitat and disturb wildlife and must be restricted to paved roads and parking areas. Barricades have been erected at most fire trails and access roads on the refuge. Post signs noting areas that are open to foot traffic only. Enforce regulations prohibiting vehicle use.

- S2.6.1.5. Erect fences around developments when deemed necessary.** Investigate the erection of fences in areas where public access by vehicle, or the feeding of deer adjacent to the refuge boundary, continues despite other protection efforts.
- S2.6.2. Prohibit feedings.** Supplemental feeding, particularly with enriched food, alters the behavior, morphology, and population structure of the herd. In addition, supplemental feeding may cause the deer to frequent roadsides and inhabited areas more often, increasing chances of negative deer/human interactions.
- S2.6.2.1. Post signs.** Maintain signs informing the public of the problems of artificial feeding and warning them of legal consequences of their actions. Install signs at additional locations as necessary.
- S2.6.2.2. Distribute educational brochures.** “No feeding” brochures are available at the refuge and are distributed to the public during routine patrols. Provide the public with additional educational materials.
- S2.6.2.3. Increase enforcement of illegal feedings.** Artificial feeding provides a direct threat to maintenance of the uniqueness and integrity of the subspecies. Increase enforcement of illegal feeding by increasing the staff personnel.
- S2.7. Continue rehabilitation program of Key deer.** Develop rehabilitation protocol and criteria. Coordinate with public outreach groups (*e.g.*, parks, zoos) to develop an adoption program of non-releasable deer.
- S2.8. Investigate captive propagation options.** At this time the Recovery Team does not believe captive propagation is necessary for the Key deer, but agrees that guidelines and protocol should be established prior to any authorized captive propagation. The Recovery Team recommends that any captive propagation efforts should be conducted in the Lower Keys in as similar to natural conditions as possible and all propagation efforts should be strictly monitored and continued only as long as established in the Captive Propagation Protocol. Determine a threshold for when you need to captive breed.
- S3. Conduct population ecology research.** A great deal of information has been collected over the years on the Key deer. Collect additional biological information on this species, including number of individuals, age-class structure, habitat use, reproductive viability, food use and availability, and threats.
- S3.3.1. Determine the finite rate of increase for the Key deer population.** The Key deer population experiences natural cycles where the population may exceed or drop below the stabilized population estimate. The fecundity and rate of reproductive activity are low in the Key deer, suggesting poor reproductive output. Investigate what stable rate of increase is necessary for this species to persist.

- S3.3.2. Determine if the total population size is large enough to prevent functional extinction and genetic extinction.** The PVA predicted that an initial Key deer population of 250, under existing conditions, has a 74 percent probability of going extinct in the next 67 years. Investigate the likelihood of this prediction.
  - S3.3.3. Determine the effective population size.** The population was recently estimated as 579 to 678 on Big Pine and No name keys. Investigate the stability of the population and determine if it is stable enough to prevent extinction.
  - S3.3.4. Determine the number of subpopulations or breeding herds necessary to maintain a stable or increasing population.** Key deer are located throughout their range but Big Pine Key supports about two-thirds of the entire population. Investigate the number of subpopulations, especially on backcountry islands, and determine what number is necessary to support the Key deer.
  - S3.3.5. Determine a stable age structure, sex ratio, and group size for the Key deer.** Investigate the stability of reproductive parameters. Monitor genetic variation in extant and future populations with comparisons made to more fecund white tail deer populations to identify inbreeding depression. Also, link the lack of genetic heterozygosity to physiological traits so that etiology of reproductive success is traceable.
  - S3.3.6. Characterize social behavior and compare past behaviors with current trends.** Previously, the Key deer was a fairly solitary species, but today there is evidence of aggregating and ganging behaviors. Investigate why deer are aggregating on Big Pine Key and determine how it affects the species' overall persistence and survival.
  - S3.3.7. Continue necropsy of all Key deer mortalities.** Investigate deer mortalities, with added emphasis on reproduction and abomasal parasite counts (APC). Continue skeletal collection for aging.
  - S3.3.8. Update and compile all existing roadkill data.** Compile and assess trend analyses from roadkills, total mortalities and road census reports. Utilize this information to develop management guidelines.
- S4. Monitor Key deer populations.** Continue to conduct monthly road census. Develop and/or utilize additional census methods for Big Pine/No Name Key complex and selected outer Keys.
- S4.1. Develop methods to monitor demographic parameters.** Monitor sex ratios, age class structure, survivorship, home range size, age of dispersal, and dispersal distance of the deer.
  - S4.2. Conduct long-term monitoring of the status of the deer.** Monitor presence/absence and degree of abundance every year until the deer is recovered.
- S5. Increase public awareness and instill stewardship.** Develop educational materials and host public workshops to increase awareness about Key deer and instill a sense of stewardship for the protection of this endangered species. It is essential that the public be made aware of the Key deer and the efforts of the refuge to protect and maintain the population. The maintenance of a wild population within the confines of a highly developed insular environment is greatly dependent on the awareness, concern, and cooperation of the public.

- S5.1. Provide funding to build and operate a visitor center.** Establish a visitor center on/near the refuge as a site for dissemination of information to the public. A centralized visitor center will provide greater education opportunities and reduce the need for visitors to drive around looking for deer. Investigate the opportunity to combine a visitor center with the deer rehabilitation facility.
- S5.2. Continue volunteer program.** Promote through community organizations, media, etc., the need for volunteers and the role they can play in the Key deer management program. These volunteers can assist in a variety of ways, from posting signs and distributing informational leaflets, to monitoring areas and reporting on problem areas. Current volunteer groups, like AmeriCorps and Youth Conservation Corps have lent a great deal of assistance to the recovery of the Key deer. The Key Deer Protection Alliance, a local citizens' group formed in 1988, is working to increase awareness and public education by providing accurate information, sponsoring direct action projects, and supporting preservation of Key deer habitat. Promote volunteer programs by forming a Key deer "Friends" group to participate and implement recovery actions and assist at a Visitor Center.
- S5.3. Prepare informational material for the general public.** Distribute materials at visitor information centers and local chamber of commerces. Provide public with information on the Key deer recovery program. Conduct programs with schools, community and social groups and other special interest organizations. Conduct teacher workshops addressing the Key deer program. Continue press releases through the media highlighting the status of the recovery program.
- S5.4. Provide public officials, planning agencies, and private developers with information on all phases of Key deer management and about potential threats.** Continue to provide technical assistance to the public.
- S5.5. Inform the public through media as to the problems with feeding.**
- S5.6. Inform the public through media as to the problems with animal trespass.** Radio announcements addressing the problem of free-roaming dogs on Federal property have been issued since early 1984. Numerous newspaper articles and television spots have been produced concerning the effects of dogs on the herd. Continue media efforts.
- S6. Establish reclassification criteria.** Develop measurable reclassification criteria based on factors that result in a stable or increasing population including total population size, number of subpopulations, sex ratio, age structure, habitat condition and availability, and level of threats. Evaluate and monitor the Key deer status in relation to reclassification criteria.
- S7. Conduct multispecies recovery actions.** Develop a Lower Keys multispecies recovery program to combine recovery actions for the Key deer with other listed species' recovery actions including efforts to survey, monitor, manage, research, and educate. Coordinate recovery actions with other agencies and concerned parties to ensure the needs of other protected species are considered. Integrate survey and monitoring of the Key deer with the silver rice rat, Lower Keys marsh rabbit, and Stock Island tree snail. Share research information to benefit other affected species.

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## Habitat-level Recovery Actions

- H1. Prevent degradation of existing habitat.** Habitat loss is the main reason for the Key deer's decline. Habitat protection and management is paramount to the deer's survival. Habitat degradation or loss can decrease the number of deer an area can support, contributing to the overall chance of extinction. Currently, there are approximately 5,272 ha of Key deer habitat that remain vulnerable to residential and commercial construction.
- H1.1. Acquire unprotected Key deer habitat.** Loss of habitat has been identified as a major limiting factor in the recovery of the Key deer. Increasing and maintaining available habitat is essential to the survival of the Key deer. A major program objective of the National Key Deer Refuge is to expand its existing holdings to ensure that adequate habitat will be available for the future survival of the Key deer. A Land Protection Plan has been prepared by the FWS to accomplish this objective. Movement corridors in the Land Protection Plan will be ground-truthed this year. Develop a reserve design and acquire habitat.
- H1.1.1. Continue Federal acquisition efforts.** Continue to acquire habitat adjacent to the National Key Deer Refuge and Great White Heron NWR boundaries.
- H1.1.2. Support State acquisition efforts.** Continue to support the acquisition of state lands by programs such as Florida's CARL program.
- H1.1.3. Support and encourage land acquisition by non-governmental agencies.** Habitat not listed for Federal, State, or county acquisition may become available for private purchase and management by such organizations as TNC and Florida Keys Land Trust.
- H1.1.4. Purchase and/or trade for lands adjacent to larger tracts of the refuge.** Securing large blocks of land (40 ha or more) is preferred. Smaller tracts would be of marginal value to Key deer if surrounding areas were developed in the future. Purchase lands outside of the refuge that lie within the conceivable range of the Key deer (*e.g.*, Sugarloaf Key). Improve habitat qualities and simplify management and enforcement of widely dispersed refuge land by purchasing, or trading for, small isolated tracts of refuge land adjacent to larger parts of the refuge.
- H1.1.5. Purchase easements when necessary on private property important to Key deer.** Easements can protect vital Key deer habitat until funds become available for land purchases.
- H1.2. Protect and manage habitat.** Human disturbances and degradation of habitat are detrimental to Key deer and other wildlife. Evaluate habitat status and assess additional management strategies. Provide long-term maintenance of habitat. Update management strategies in order to provide the best quality habitat possible for Key deer.
- H1.2.1. Protect Key deer on private lands.** Protect Key deer populations on private land through acquisition, conservation easements or agreements, and education of land owners. Develop agreements or coordinate ESA section 10 permits between the FWS and private landowners to minimize impacts.

- H1.2.2. Protect Key deer on public lands.** Develop a habitat management plan that outlines priority habitat for acquisition and methods to protect, restore, and minimize impacts on deer and their habitat. Acquire and incorporate deer habitat to Federal, State, and county land protection systems. Manage public lands to control exotics, off-road vehicles, dumping, predators, and vehicular traffic. Identify and minimize other causes of deer injury or mortality on public lands.
- H1.2.3. Protect important corridor areas.** Protect these areas by coordinating with the appropriate permitting offices to avoid negative impact on the deer.
- H1.2.4. Eliminate threats from invasive exotic flora and fauna.** Invasive exotic plant species such as Australian pine, Brazilian pepper, and leatherleaf fern reduce Key deer food and habitat. Feral hogs (*Sus scrofa*) and the habitat destruction they cause has become a major threat to Key deer on Little Pine Key and may threaten fawns. Reduce and eliminate threats from exotic species.
- H1.2.5. Implement refuge fire management plan.** Fire suppression is responsible for deterioration of important pineland habitat (Klimstra 1986, Carlson *et al.* 1989). The Refuge Fire Management Plan provides for a prescribed burning program for habitat enhancement and fire safety. Utilization of prescribed burning, to set back successional stages, will become increasingly important as more private lands are allowed to mature in the absence of fire, increasing wildlife hazards.
- H1.2.5.1. Prohibit campfires in the National Key Deer Refuge.**
- H1.2.5.2. Establish and maintain fire breaks and fire trails.** Trails and breaks are critical to both the refuge lands and the adjacent private properties for protection from fire. In addition they provide travel routes for the deer and other wildlife.
- H1.2.5.3. Conduct prescribed burns on the National Key Deer Refuge when necessary.**
- H1.2.6. Fence or barricade areas where off-road vehicle use and/or dumping is a threat.**
- H1.2.7. Address the management and protection of non-refuge lands.** The insular nature of the Key deer's environment requires that all land practices must be considered in light of the effect(s) on Key deer and other wildlife. Management of non-refuge lands is a vital part of the overall habitat protection program for the deer. Aid in the development of a Monroe County land use plan emphasizing preservation of vital Key deer habitat and the reduction of damage to resources by development practices. Continue to participate in all planning aspects such as the Interagency Management Committee and public meetings. Continue consultation with County biologists and planners as to the needs of Key deer.

- H1.2.8. Conduct experimental habitat management on selected outer Keys.** Consider prescribed burning of Little Pine Key and monitor the effects of burn on plants and animals.
- H1.2.9. Maintain and evaluate present deer exclosures on Big Pine Key.** Establish exclosures on selected outer Keys that have the greatest potential for management (*e.g.*, Little Pine, Water Keys, *etc.*).
- H2. Restore and create Key deer habitat.**
- H2.1. Restore natural tidal flow and hydrology by placing culverts or removing fill.**
- H2.2. Maintain and manage mosquito ditches so they do not impact deer habitat.** Manage mosquito ditches on the refuge and in other areas of deer habitat.
- H2.3. Improve water quality in freshwater sources and restore freshwater sources.** The principal factor influencing distribution and movement of Key deer in the Keys is the location and availability of fresh surface water. Improve water quality in freshwater areas and monitor. Sample and maintain manmade water holes on outer Keys to assure suitability for use by Key deer. Identify other freshwater sources on outer Keys and consider the use of a “guzzler” or other catchment device for fresh water.
- H2.4. Enhance Key deer habitat.** Re-establish pines and associated plant communities in areas damaged by severe fire.
- H2.5. Improve habitat by planting or encouraging native plant species.** Plant native vegetation in areas that have been scarified or degraded. Encourage homeowners to plant native tree species.
- H2.6. Create habitat by refilling and recreating areas that have been dredged or altered.**
- H3. Conduct research on Key deer habitat and how it affects the deer’s distribution and abundance.** The decline of the Key deer is attributed to the loss or degradation of its habitat. Understanding the relationships between the deer and its habitat will allow for better management of this species.
- H3.1. Investigate how Key deer use different habitat components for survival** (*e.g.*, food, shelter, nesting, traveling). Red and black mangroves are important food sources for the Key deer. Investigate important food plants throughout Key deer range so their production can be incorporated into the management program if necessary.
- H3.1.1. Conduct radio telemetry on various subpopulations.** Determine how deer use components of their habitat and which components are most limiting, especially back country island deer.
- H3.1.2. Investigate the effect of habitat change.** Determine how habitat change affects the deer’s persistence, investigating factors such as road mortality, habitat degradation, and hydrology.
- H3.2. Determine an index of habitat fragmentation.** Much of the Key deer habitat is fragmented by roads, housing, and commercial facilities.
- H3.2.1. Investigate movement patterns and the spatial use of habitat to identify important core areas and corridors.**

- H3.2.2. Determine stable home range and minimum area required.** Yearly ranges for adult males and females average 319.7 ha and 173.6 ha, respectively, with males having even larger ranges during the breeding season. Investigate the effects of habitat loss and fragmentation on home ranges and minimum habitat area requirements.
- H3.2.3. Determine if the amount and configuration of habitat is sufficient to support a stable or increasing population of deer.** The number of Key deer is currently estimated between 579 to 678 individuals. Determine the carrying capacity of the remaining suitable habitat.
- H4. Monitor the status of Key deer habitat and examine ecological processes.** Conduct yearly monitoring evaluations of the deer's habitat. Overlay habitat quality with GIS mapping of habitat locations, including what patches are being altered or lost each year. Monitor the availability of deer habitat by updating the loss or change of habitat due to residential or commercial construction.
- H5. Increase public awareness of Key deer habitat and instill stewardship.** Conduct workshops with the public to educate private landowners on appropriate management practices to preserve deer habitat. Encourage private landowners to remove exotics, maintain natural water flow, plant native vegetation, and restore disturbed areas. Prepare literature to provide information regarding the Key deer habitat and ways to protect and conserve it.

