

CONSERVATION PROJECT REPORT

PARROT CONSERVATION ON DOMINICA: SUCCESSES, CHALLENGES, AND TECHNOLOGICAL INNOVATIONS

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Abstract: Over the past half-century, Dominica's endemic Amazon parrots, the Imperial and Red-necked (*Amazona imperialis* and *A. arausiaca*, respectively), have proven to be effective conservation flagships for Dominica's diverse rainforest ecosystem. Continuous parrot-conservation and public-education efforts focusing on the Imperial, Dominica's national bird and emblem, have achieved a broad base of public support and awareness, along with significant protection of parrot habitat, including the oldest forest stands on the island. Both parrot species' secretive natures and Dominica's terrain have impeded quantitative research into the parrots' ecologies, even as a comprehensive parrot-conservation program has yielded tangible results. Current field-research activities aim to quantify the parrots' distribution and abundance using GPS/GIS survey methods, which contrast with conventional ornithological abundance estimates. Research teams also use new camera technology to monitor and document reproduction and parental care, and are quantifying the botanical inventories of critical parrot nesting and foraging habitats. The Dominica parrot-conservation program has stimulated novel research and enhanced protected-area policies island-wide, ensuring a future for Dominica's vast montane forests and its native fauna.

Key words: *Amazona arausiaca*, *Amazona imperialis*, conservation flagships, Dominica, parrots

Resumen: CONSERVACIÓN DE LAS COTORRAS EN DOMINICA: ÉXITOS, RETOS E INOVACIONES TECNOLÓGICAS. Desde la mitad del siglo pasado, las cotorras endémicas de Dominica, la Cotorra Imperial y la Cotorra de Cuello Rojo (*Amazona imperialis* y *A. arausiaca*, respectivamente) han demostrado ser efectivas especies sombrillas para la conservación del ecosistema de bosque lluvioso de Dominica. La conservación de la cotorra y los esfuerzos de la educación pública enfocados en la Cotorra Imperial como emblema y ave nacional de Dominica han logrado crear una base amplia de apoyo y reconocimiento público junto con la significativa protección del hábitat de estas especies, lo que incluye los bosques más viejos de la isla. Tanto la naturaleza secreta de las cotorras como la geografía de Dominica han impedido una investigación cuantitativa sobre la ecología de las cotorras, aunque un comprensible programa de conservación ha producido algunos resultados. Las actuales actividades de campo persiguen cuantificar la distribución y abundancia de la cotorra usando métodos de muestreos que empleen GPS/SIG, lo cual contrasta con los estimados de abundancia usando los métodos ornitológicos convencionales. Los equipos de investigación también utilizan cámaras de nueva tecnología para monitorear y documentar la reproducción y el cuidado parental, y están cuantificando. El programa de conservación de la Cotorra de Dominica ha estimulado noveles investigaciones y mejorado las políticas de áreas protegidas a todo lo ancho de la isla; con lo que se asegura un futuro para los vastos bosques montanos de Dominica y para su fauna nativa.

Palabras clave: *Amazona arausiaca*, *Amazona imperialis*, cotorras, Dominica, especies sombrilla para la conservación,

Résumé : CONSERVATION DES PERROQUETS EN DOMINIQUE : SUCCÈS, DÉFIS ET INNOVATIONS TECHNIQUES. Au cours des dernières cinquante années, les espèces de perroquets endémiques de Dominica, l'Amazone impériale (*Amazona imperialis*) et l'Amazone de Bouquet (*A. arausiaca*), se sont révélées d'excellents porte-drapeaux pour la conservation des écosystèmes de forêt humide de Dominique. Des actions continues de conservation des perroquets et des efforts d'éducation du public ciblés sur l'oiseau emblème national de la Dominique, le Sissérou, ont permis d'aboutir à un large soutien et sensibilisation du public, parallèlement avec une protection significative de l'habitat des perroquets, incluant les plus vieilles forêts de l'île. La discrétion des deux espèces de perroquets et le milieu dominiquais ont freiné les recherches sur l'écologie des amazones, bien qu'un programme d'ensemble de conservation ait conduit à des résultats tangibles. Les activités de recherches en cours ont pour objectif d'évaluer la distribution et l'abondance des perroquets grâce aux techniques d'études cartographiques utilisant les méthodes GPS/SIG, parallèlement aux méthodes ornithologiques classiques d'estimation d'abondance. Les équipes de recherche utilisent aussi les nouvelles technologies vidéo pour suivre la reproduction et l'élevage des jeunes et développent des inventaires botaniques des habitats critiques pour la reproduction et l'alimentation des perroquets. Le programme dominiquais de

conservation des perroquets a stimulé de nouvelles recherches et favorisé les politiques d'aires protégées dans toute l'île, sécurisant l'avenir des vastes forêts de montagne de la Dominique et de sa faune.

Mots-clés : *Amazona arausiaca*, *Amazona imperialis*, *Dominica*, étendard de la conservation, perroquets

DOMINICA'S RAINFOREST ranks as a top conservation priority for the Caribbean (Mittermeier *et al.* 1999). Known as the "Nature Island of the Caribbean," Dominica is the largest and most pristine of the Windward Islands, boasting high species diversity and endemism. Mountains comprise roughly 75% of the island, with most slopes carpeted in undisturbed primary forest, of which over 21,060 ha are government owned (28% of the total land area; ECU Dominica 2002).

The endemic Imperial Parrot (*Amazona imperialis*), Dominica's national bird and the largest of the Caribbean Amazon parrots, inhabits interior, montane forest in and adjacent to the Morne Diablotin and Morne Trois Pitons National Parks (Collar *et al.* 1992, Statterfield and Capper 2000). The Red-necked Parrot (*A. arausiaca*) is more widespread, occupying primary and secondary forest throughout Dominica (Reillo *et al.* 2002). Ever since Hurricane David in 1979—the most devastating hurricane in Dominica's recorded history—conservationists have feared for the Imperial's extinction (Butler 1989), as the species was reduced to a small remnant population (~50 birds) on the slopes of Morne Diablotin (Gregoire 1981, Evans 1986, 1988). While the Red-necked Parrot was also severely impacted by David, its populations have rebounded impressively throughout its former range over the past 20 yr, largely due to Dominica's progressive policies for land conservation and protected areas (Wiley *et al.* 2004).

The Imperial has been the focus of intense field research over the past 27 years by Dominica's Forestry, Wildlife and Parks Division. The parrot conservation and research program commenced with field monitoring of wild populations and nesting sites—with staff equipped with little more than binoculars, pad, and pen (Durand and Zamore 1996). Technology and methods have evolved over the past three decades, but ecological data collection remains challenging, as the Imperial is sparsely distributed, exceedingly shy and reclusive, and exhibits a low reproductive rate. While the Imperial has exhibited a slow, steady recovery and has nearly attained its pre-hurricane-David distribution, the ever-present hurricane threat is a sobering reminder that its future is far from secure (Reillo 2000a).

CONSERVATION PROGRAM

Since 1997, the Rare Species Conservatory Foundation (www.rarespecies.org, hereafter RSCF) and Dominica's government have partnered to research and conserve Dominica's parrots. The program is multifaceted, and includes: (1) extending formal, legal protection to all forests surrounding Morne Diablotin, nesting stronghold for the Imperial; (2) developing management and conservation strategies for the Red-necked and Imperial Parrots with Dominica's Forestry, Wildlife and Parks Division, including new policies for protected areas (Morne Diablotin National Park and recent annexations, 1999-2005) and wildlife legislation (Wildlife Act, amended 2003-2006 and currently under Cabinet review); and (3) coordinating support for ongoing research, staff capacity building, and education programs with public zoological facilities, other non-profit organizations, the United Nations Development Programme, and local and international NGO's. Efforts include field training, delivering new research technologies and equipment, infrastructure enhancements (e.g., renovating the Parrot Conservation and Research Centre), field vehicles, and funding outreach programs (e.g., continuous Public Service Announcements on commercial and governmental television and radio, annual Caribbean Endemic Bird Festival, trail and road signage, publications).

The broad-based conservation program has produced a number of landmarks, including first-ever, intra-cavity documentation of reproduction in the Red-necked Parrot (Reillo *et al.* 1999, 2000), first video recordings of Imperial rearing and fledging, and quantitative analyses of biparental care and recruitment in both species (Reillo *et al.* 2000, 2002). Most significantly, on 21 January 2000, culminating a 2-yr, US\$1.086 million campaign spearheaded by RSCF and the Dominican government, Dominica formally declared the Morne Diablotin National Park, encompassing ~3443 ha of primary rainforest and the principal nesting area for the Imperial (Wiley *et al.* 2004). Since then, RSCF funds have enabled seven adjacent, private land parcels to be annexed into the park, and the Morne Diablotin National Park Visitors Centre and Forestry Field Station to be completed and serve as a vital management outpost for the park.



Fig. 1. Telescoping, intra-cavity video probe.

Dominica's government-driven parrot program serves multiple functions: to (1) monitor parrot populations; (2) collect and analyze natural and life-history information on parrots, other wildlife, and forest habitat; and (3) develop and recommend mitigative strategies for wildlife and habitat protection. Since 1998, specialized technology has been developed and deployed to improve monitoring capacity while minimizing disturbance to parrots.

CAMERA MONITORING SYSTEMS

An intra-cavity video-probe system (Sandpiper Technologies, www.sandpipertech.com) has been used to record high-resolution, color images from within parrot nest cavities without tree climbing (Fig. 1; Reillo *et al.* 1999). A small, boom-mounted, 12-volt DC, self-illuminated camera is mounted to a lightweight, telescoping Hastings or Crain fiberglass pole (used for surveying and high-tension electrical line service), and the video image is captured on any mini-DV camcorder equipped with a remote video input (Fig. 2). Recently, this system has been updated to employ an inexpensive, weatherproof 7.2-volt DC, color/infrared camera with built-in microphone (US\$40, available at www.harborfreight.com) that provides excellent video output images compatible with camcorder/NTSC video format. The latter system, including camcor-



Fig. 2. Video image of Red-necked Parrot chicks in nest, using intra-cavity video probe system.

der, 7.2 volt DC, 2000 mAH power supply (NiCad or NiMH batteries/charger for radio-controlled toys, available from Radio Shack), and 15.24 m telescoping pole (www.crainsurvey.com, model #90182), can be assembled for under US\$350, and allows fast, easy access to parrot nests. For nests above 15 m, multiple fiberglass poles can be attached; teams on Dominica have successfully probed cavities with entrances up to 24.4 m above ground, with internal depth of up to 3 m—all with researchers at ground level. Weighing less than 9 kg, the probe system can easily be carried long distances over difficult terrain, and set-up and recording can be accomplished within 10 min per nest site.

Non-invasive, time-lapse monitoring of parrot cavities on Dominica has acquired substantial data on biparental care, while requiring less than 5 min of site-visitation time every 3 d (Reillo *et al.*, 2000). The recording system uses a standard 12 VDC, color security TV camera mounted within a camouflaged, weatherproof housing, with an appropriate-length, auto-iris telephoto lens attached (typically 80-135 mm zoom). The video image is recorded onto a 12 VDC time-lapse field VCR housed within a weatherproof storage box, and the system is powered by one or more 12 VDC deep-cycle marine batteries. Dry-cell surveillance-system batteries (48 AH) are also suitable, but require more frequent charging. Programmed for daytime activity cycles, the time-lapse unit can record up to 4 d of activity on a single VHS tape. This custom system, including batteries/charger, camera, lens, housing, and recorder, can be deployed for ~US\$1,500.

PARROT SURVEYS

Historically, efforts to quantify the distribution and abundance of Dominica's parrots have been hampered by limited access, challenging terrain, the parrots' secretive habits, and generalized cartographic data for Dominica's interior. From 2000-2003, through a partnership between the U. S. Geological Survey EROS Data Center, RSCF, and Dominica's Ministry of Agriculture and the Environment, a ground-truthed, high-resolution landcover assessment was completed for all of Dominica, characterizing over 14 vegetation/landcover categories and coregistering existing topographic maps with SPOT and LANDSAT images and georeference data (www.usgs.gov; published maps in prep.). The result is a series of digitized map interfaces that enable GIS and GPS information to be downloaded immediately from the field and geographic and spatial features (e.g., altitude, area, distance) to be estimated and interpreted accurately. The resolution for GPS data on the topographic template is better than 3 m in virtually all areas with clear satellite signal. The parrot team uses Garmin III+, IV, and 76-series non-mapping, iterative-sampling GPS receivers (typically with the WAAS function disabled) equipped with remote, active-gain antennas. To improve reception in deep forest or heavy canopy, the remote antenna is mounted on a steel plate affixed to the top of a researcher's hat, or to an expandable lightweight pole. GPS track and waypoint data are downloaded to the GPS utility OziExplorer (www.ozieplorer.com).

Commencing in 2000 and running almost continuously thereafter, the parrot team has surveyed Dominica's parrot populations using the above system (Reillo *et al.* 2002, Wiley *et al.* 2004). To date, over 22,258 ha of forest have been surveyed. Teams of two or three experienced Dominican parrot researchers conduct surveys on foot throughout the forest. Discreet calls and sightings are recorded and denoted by unique waypoints that also record time and date. The surveyed area for each expedition is estimated using OziExplorer's area-calculation function, with perimeters of surveyed areas created graphically on a digitized topographic map delineated by manually assigned track points. Combining the observation and spatial data with the topographic information, researchers calculate a local density estimate (number of birds per unit area) for each expedition, for both parrot species.

The GPS-based, direct-observation survey method departs significantly from traditional distance-estimation, "watch-point," and transect-type bird-

count methods typically used by ornithologists, including many parrot researchers (Snyder *et al.* 2000). Researchers attempting to quantify parrot populations in the Lesser Antilles have long noted discrepancies between traditional-method estimates and apparent abundance (Gregoire 1981, Evans 1986; P. Butler, N. Snyder, and J. Wiley pers. comm.). Falsely inflated local-population estimates can arise from exaggerated encounter incidence (e.g., duplication of observations, pseudo-replication of overlapping sample areas), statistical or spatial distribution functions that do not account for parrots' quick movements across vast forest areas (which observers cannot cover on foot), the birds' secretive habits, and some observers' limited detection abilities. The direct-count method aims to account for all birds within a surveyed (i.e., topographically constrained) area without making assumptions about the detection function of censused birds. The method's accuracy depends upon observers' skills and ability to cover considerable distance (>400 ha/day) over difficult terrain quietly and quickly. The GPS method is considered a conservative density estimator, but most closely corroborates other, local-abundance determinations (e.g., numbers offered by volunteer observers, distribution patterns described by local people). Used during the non-breeding season when birds are dispersed, it applies well to sparsely distributed, predominantly non-flocking parrot species like the Red-necked and Imperial Parrots, and generates consistent, repeatable encounter frequencies. Total population sizes for Dominica's Amazons are extrapolated from local density estimates multiplied by the total suitable forest available to each species. Therefore, the survey method is as important for determining habitat utilization as it is for estimating local abundance.

While historical survey data for Dominica's parrots are summarized elsewhere (Wiley *et al.* 2004), some discussion is warranted here. Cumulative surveys over the past 6 yr indicate that the Red-necked Parrot has largely reestablished its pre-hurricane-David distribution (1979), except for forests that were sacrificed to agriculture during the banana boom of the mid-to-late 1980's. Within agricultural areas adjacent to primary forest, local Red-neck densities often exceed 8 birds/ha, and aggregations of 30 or more birds in roost trees are common in secondary forest habitat adjacent to both agriculture and protected areas. These congregations represent typical local densities across interior montane forest, where Red-necks are widely distributed at between 2.8-4 birds/1000 ha surveyed. As in most

Amazon parrot species, Red-neck nest-site fidelity is remarkable, with some cavities being occupied by the same breeding pair for 7 or more consecutive yr. Less selective than the Imperial in habitat use, Red-necks are commonly seen foraging and nesting in small stands of trees in farmer's fields or along roads.

Distribution and density patterns for Red-necked parrots reveal that the species is well established across Dominica's interior, with a population of 650-800 individuals. Whereas agriculture has eliminated vast tracts of mature forest over the last 30 yr, citrus, banana, guava, and passion fruit plantations have facilitated the Red-neck's range expansion and enhanced local recruitment in many areas since 1990. With a clutch size of three and strong biparental care throughout the nesting and post-fledging periods, overall recruitment is high; most Red-neck nests successfully fledge one or two chicks per year (Reillo *et al.* 2000). The species' social attributes and boldness near humans, combined with its reproductive potential, increase the Red-neck's population resilience in the face of anthropogenic perturbation and hurricanes (Reillo 2001). Distribution and abundance patterns suggest that the species is not imminently threatened, but merits continuous monitoring. Its range and recent population history render it vulnerable, and warrant its continued protective status. The Red-neck's recovery is dependent upon effective wildlife law enforcement and Dominica's comprehensive system of land management and protected areas (Reillo *et al.* 2002).

The Imperial occurs at low density throughout its range, although the species now occupies nearly all of the remaining, mature montane forest that it inhabited prior to Hurricane David in 1979. Steep slopes to the south and east of Morne Diablotin are the species's stronghold, but densities here rarely exceed 4 birds/1000 surveyed ha. Imperials are difficult to detect and are particularly challenging to observe in dissected, high-elevation terrain that receives frequent precipitation (up to 9 m/year). The Imperial's low density and non-random distribution in mature forest over 700 m elevation have required GPS surveys to be conducted over an expansive area, with encounter frequencies and density-estimate reliability increasing with total area sampled and area surveyed per expedition.

Caution must be used when estimating the Imperial's total population size from local density estimates. With average local densities of 1.2-1.6 birds/1000 ha, extrapolation to 22,275 forested ha yields a total population of 165-220 Imperials. Sur-

veyed acreage is estimated flat within OziExplorer, but Dominica's extreme topography often produces surface-area:flat-area ratios in interior forests of 3:1 or greater. Imperials are encountered most frequently in such habitats on extreme grades. While the GPS-based, direct-count method appears to estimate local Imperial densities better than other methods, very low encounter incidence across many surveyed areas raises concerns when extrapolating total population size. A potential, systematic sampling bias for the most challenging terrain may underestimate local densities where they are greatest, as well as frustrate the certainty of absence data (i.e., confidence that birds are truly absent when no birds are seen/heard). This potential error is difficult to quantify, and repeated surveys are of limited value due to their temporal uniqueness. Unlike most psittacines, Imperials may either flush from cover when humans approach or perch silently and remain camouflaged in thick canopy for many hours at a time, even with humans nearby (Reillo 2001, Reillo *et al.* 2002). Cumulative surveys from 200-2003 support a total population of roughly 200 birds (Wiley *et al.* 2004).

Perhaps the most important product of GPS-based surveys for the Imperial has been quantifying range expansion and general population recovery (Reillo 2001). By all measures, the Imperial population has exhibited a noticeable recovery from post-hurricane levels (1979-80), when the species was determined to be absent everywhere but the upper slopes of Morne Diablotin (Gregoire 1981, Evans 1986, 1988, Collar 1992). A small southern population in Morne Trois Pitons National Park, which over the past 4 yr has exhibited stability or a modest increase, strongly suggests the species is again breeding in the south of Dominica. Further, surveys confirm its presence in nearly all primary forest habitat remaining in its former, pre-hurricane David range, indicating that the species has benefited from government's long-term protection of Dominica's interior forests (Wiley *et al.* 2004). Protected areas running roughly north-south along the spine of Dominica facilitated the Imperial's recolonization of Morne Trois Pitons National Park over a 20-yr period (Reillo 2001). In 2006, a study to inventory and botanically characterize Imperial nesting and foraging habitat was initiated, which will help identify additional forest habitat for future surveys and protection (Ickes in prep.).

CONCLUSIONS

The Imperial's recovery illustrates the fundamen-

tal link between mature forest expanse and island population resilience in an endemic, island parrot. It nests only within mature montane rainforest above 526 m elevation, and requires vast, contiguous corridors of undisturbed habitat to rebound from catastrophic hurricanes. Quantitative life-history information for the species remains scant, but observations over the past 10 yr indicate that nest sites are the principal limiting resource. Breeding pairs exhibit strong nest-site fidelity and biparental care, with females laying no more than two eggs per season. Parents typically fledge a single chick every other year. Survey data suggest that the present expanse of interior forest is likely sufficient to support a healthy Imperial population of pre-1979 levels. However, expanding agriculture over the past 30 yr has restricted the species to a much smaller total forest area than was available prior to 1979; hence, land protection strategies now must target all remaining, suitable habitat. The GPS/GIS-based parrot surveys are invaluable in this regard, identifying areas within the Northern Forest Reserve, unallocated state lands, and private holdings for inclusion under Dominica's National Parks and Protected Areas System. Formally annexing such properties into existing protected areas has become the thrust of the parrot conservation campaign, particularly in the northern half of the island (Reillo 2000a, b, Wiley *et al.* 2004).

With continuous monitoring, vigilance, and protection, the Red-necked and Imperial Parrots' futures are encouraging. As island endemics reliant upon the largest of Dominica's rainforest trees for survival, both species are compelling indicators of rainforest well-being, and the Imperial has become a sentinel for evaluating the magnitude of montane forest perturbations, both natural and anthropogenic. With dedicated forestry staff, NGO and government support, and novel research technologies, Dominica's parrot program is a vital instrument for strengthening environmental awareness as well as detecting and thwarting potential threats to wilderness and wildlife. Progressive conservation measures surrounding Dominica's national bird illustrate how a parrot conservation and research program can leverage ecosystem-level conservation and biodiversity protection (Reillo 2000a, b, Connors *et al.* 2001). This is the essence of the flagship species concept.

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BOOK REVIEWS

BIOMETRICS OF BIRDS THROUGHOUT THE GREATER CARIBBEAN BASIN.—Wayne J. Arndt, John Faaborg, George E. Wallace, and Orlando H. Garrido. 2004. *Proceedings of the Western Foundation of Vertebrate Zoology*, Vol. 8, No. 1. 33 pp. and CD. ISSN: 0511-7550. \$25.00; available from the Western Foundation of Vertebrate Zoology, 439 Calle San Pablo, Camarillo, CA 93012, USA; website: www.wfvz.org.

The smallest bird in the world is generally thought to be the Bee Hummingbird (*Mellisuga helenae*) from Cuba. Just how small is it? An average of about 2.15 g ($n = 4$), according to the authors of this amazing compilation of morphometric data. And according to this database, it has some rivals in mass. Try the Blue-tailed Emerald (*Chlorostilbon mellisugus*) with a slightly lower mean weight of 2.12 g ($n = 5$). But the Bee Hummingbird remains the overall champion. After all it only has a 2.5 cm mean tarsus length, nearly half of its closest rival.

You could get lost playing with the vast descriptive statistics of these proceedings, but the authors had more important ideas for this dataset. They list seven major uses for morphological datasets such as this one, each backed by a daunting laundry list of citations: 1) avian genetics and evolution; 2) systematics; 3) energetics; 4) ageing and sexing; 5)

morphology and ecomorphology; 6) conservation and management; and 7) avian biogeography, and population and community ecology. I quickly thought of another use for the data: setting measurement ranges for each species to avoid errors in both the actual measurements as well as data entry.

The authors present biometric data for about 30,000 individual birds of 276 species in 15 orders, 45 families, and 144 genera on 30 islands. This represents around 45% of all the bird species found in the Caribbean basin!

A data set of this size didn't come about overnight. The authors and contributors spent more than 40 years compiling these data. Most of the measurements were taken from live individuals during banding operations. Almost half of them come from a banding station in the Guanica dry forest in southwestern Puerto Rico. A third of the records come from Cuba and Cayo Coco, a small satellite island.

The heart of the proceedings is the accompanying CD-ROM that includes a morphometrics table summarizing the descriptive statistics for each species, and also all individual species' "raw" data files. The user simply inserts the CD-ROM and follows the directions on the screen. I found it easy and intuitive to follow. It does require Adobe Reader, which is included on the disk for installation. However, this is an older version and I recommend users simply