Setting priorities for the conservation of Venezuela's threatened birds

Jon Paul Rodríguez, Franklin Rojas-Suárez and Christopher J. Sharpe

Abstract We develop and apply a four-dimensional priority-setting process for the conservation of threatened birds in Venezuela. The axes that we consider are extinction risk, degree of endemicity, taxonomic uniqueness and public appeal. Alhough the first three are relatively objective measures of biological attributes, the last one is a subjective judgement of the likelihood that conservation actions in favour of a species may succeed. By grouping higher priority species according to their geographical distribution within Venezuela, we generate a list of the top priorities to save the country's threatened birds, both species- and bioregion-based. The highest priority species are northern-helmeted curassow *Pauxi pauxi*, Andean condor *Vultur gryphus*, red siskin *Carduelis cucullata* and plain-flanked rail *Rallus wetmorei*, followed by eight high priority birds, wattled guan *Aburria aburri*, yellow-shouldered parrot *Amazona barbadensis*, scissor-tailed hummingbird *Hylonympha macrocerca*, rusty-faced parrot *Hapalopsittaca amazonina*, northern screamer *Chauna chavaria*, torrent duck *Merganetta armata*, rusty-flanked crake *Laterallus levraudi*, and military macaw *Ara militaris*. Northern Venezuela stands out as a significantly higher conservation priority than the south. The Andean Cordillera, Central Coastal Cordillera, Paria Peninsula-Turimiquire Massif Complex, and Sierra de Perijá are the highest priority bioregions, followed by Lara-Falcón Arid Lands and Maracaibo Lake Basin. A final set of combined priorities was determined by integrating all top ranking species and bioregions. Our approach is relatively simple and readily applicable to other taxa and regions.

Keywords Birds, conservation planning, endangered, priorities, priority-setting, threatened species, Venezuela.

Introduction

The systematic compilation of global lists of threatened species began with the publication of the first Red Data Books for birds and mammals in 1966 (Scott *et al.*, 1987). Since then, such lists have become increasingly popular in international conservation. In addition to the global *IUCN Red Lists of Threatened Species*, which are updated annually (IUCN, 2003), *c.* 100 countries have produced national Red Lists (WCMC, 1994; UNEP-WCMC, 2004). Historically, their principal conservation applications have been (1) to increase public awareness of the status of threatened species, (2) to act as a baseline for monitoring the status of biodiversity, (3) to identify geographical areas to be incorporated into nature reserve networks, (4) to monitor threatening human activities (such as habitat conversion and hunting), and (5) to set priorities for the allocation of limited conservation resources (Collar, 1996; Possingham *et al.*, 2002; Lamoreux *et al.*, 2003). The last of these applications, specifically at the sub-global level (i.e. regional, national, local), is the main focus of the present article.

A common assumption of priority-setting exercises for threatened species is that taxa facing higher levels of risk should receive a higher proportion of available funds. Although this may not always be the most efficient rule for the allocation of limited conservation resources (McIntyre *et al.*, 1992; Ando *et al.*, 1998; Possingham *et al.*, 2002) it is implicit in our analysis. Our focus, however, is on extinction risk as one of several criteria for priority-setting. The assessment of extinction risk and the definition of conservation priorities, although often related, are two different but often confounded processes (Mace, 1994; Gärdenfors *et al.*, 2001; Possingham *et al.*, 2002; Lamoreux *et al.*, 2003). Risk assessment for individual taxa generally precedes definition of priorities, and entails some form of scientific evaluation; its main aim being to estimate the probability that a taxon will go extinct within a certain timescale (IUCN, 2001). The establishment of conservation priorities, however, is an undertaking to be performed by society at large, and cannot be defined solely in terms of risk (Gärdenfors *et al.*, 2001; Possingham *et al.*, 2002; Restani & Marzluff, 2002; Lamoreux *et al.*, 2003). For example, in priority-setting exercises it may be important to also take into account the scale at which actions are focused (i.e. global,

Jon Paul Rodríguez (Corresponding author) Centro de Ecología, Instituto Venezolano de Investigaciones Científicas, Apdo. 21827, Caracas 1020-A, Venezuela. E-mail jonpaul@ivic.ve

Franklin Rojas-Suárez Conservation International Venezuela, Av. San Juan Bosco, Edf. San Juan, Piso 8, Ofc. 8-A, Altamira, Caracas, Venezuela.

Christopher J. Sharpe PROVITA, Apdo. 47552, Caracas 1041-A, Venezuela.

Received 18 September 2003. Revision requested 6 April 2004. Accepted 2 July 2004.

regional, national), the availability of the necessary financial resources, the existence of possible conflicts of interests between conservation actions and human use of natural resources, the legal framework for the conservation of species and/or habitats, the availability of qualified personnel to plan and manage such a process, the likelihood that the conservation programme will succeed, and the preferences of the public.

Although exceptions exist, priority-setting exercises for threatened species have focused mainly on terrestrial vertebrates, predominantly birds, as these tend to be the better known groups (Table 1). Many of these studies have the desirable characteristic of not defining priorities uniquely on the basis of extinction risk. For example, Pérez-Losada *et al.* (2002) focused on the phylogeography of threatened Chilean freshwater crabs to propose biogeographical conservation priorities, and Lunney *et al.* (1996) integrated information on nine 'biological variables' (one of them being 'status') for the determination of priorities for the conservation of birds, frogs, mammals and reptiles in New South Wales, Australia. In general, however, other than extinction risk, these analyses tend to rely only on information on the biological attributes of the taxa in question, and do not consider other important variables that should be part of priority-setting exercises.

Inspired by the Conservation Cube concept (Avery *et al.*, 1995) we develop here a four-dimensional priority-setting process for Venezuelan threatened birds. The axes that we consider are extinction risk, degree of endemicity, taxonomic uniqueness and public appeal. Although the first three are relatively objective measures of biological attributes, the last one is a subjective judgment of the likelihood that conservation actions in favour of a species may succeed. By grouping higher priority species according to their geographical distribution within Venezuela, we generate a list of the top priorities to save the country's threatened birds, both species-based and bioregion-based. Our approach is relatively simple, and readily applicable or adaptable to other taxa and regions.

Methods

We focus on 36 species whose range includes Venezuela, listed as threatened (i.e. Critically Endangered, Endangered or Vulnerable) either in the *Red Data Book of the Animals of Venezuela* (Rodríguez & Rojas-Suárez, 1999) or in the *2003 IUCN Red List of Threatened Species* (IUCN, 2003). As national and global assessments do not always perfectly match (Rodríguez *et al.*, 2000), considering both lists together is more conservative as it ensures that we include a larger number of species in our analysis.

The species selected were assessed according to four attributes: extinction risk, degree of endemicity, taxonomic uniqueness, and public appeal, where each attribute was awarded a score of 1–3. A combined 'priority score,' calculated by multiplying the value assigned to each attribute, was then generated. Therefore, the priority score has a value in the range 1–81; the higher the score, the higher the rank and the importance of each species in our scheme. We multiplied, rather than added, the attribute scores in order to give greater relative weight to taxa that ranked highest within any attribute. Species were assessed using the criteria described below.

Extinction risk This attribute reflects the urgency of the extinction threat (IUCN, 2001). Taxa classified as

Table 1 Principal characteristics used in the definition of sub-global (regional, national or local) priorities for threatened species conservation, in a series of selected studies from around the world.

	Characteristics*					
Taxon, Region (Reference)	A	B	C	D	E	F
Freshwater crabs, Chile (Pérez-Losada *et al.*, 2002)	X	X		X	X	X
Butterflies, Britain (Warren *et al.*, 1997)	X	X			X	
Fish and wildlife, Florida, USA (Millsap *et al.*, 1990)		X	X	X	X	
Birds, Britain (Avery *et al.*, 1995)	X	X			X	
Birds, East Africa (Bennun *et al.*, 2000)	X	X			X	X
Birds, USA (Carter *et al.*, 2000)	X	X			X	X
Birds, Canada (Dunn *et al.*, 1999)	X	X			X	X
Birds, Switzerland (Pearman, 2002)	X	X			X	X
Birds, mammals and reptiles, USA (Breininger *et al.*, 1998)	X	X			X	
Mammals, Russia (Polishchuk, 2002)			X		X	
Terrestrial vertebrates, Italy (Pinchera *et al.*, 1997)	X	X			X	
Terrestrial vertebrates (native), Australia (Lunney *et al.*, 1996)	X	X	X		X	
Vertebrates, Argentina (review of 60 studies) (Grigera & Ubeda 2002)	X	X	X	X	X	X

*A, national and/or global extinction risk category (includes magnitude of threat); B, population or range size (mainly degree of endemicity or relative importance of the geographical unit considered, but also includes absolute numbers and trends); C, life history variables; D, phylogenetic uniqueness; E, priorities defined in terms of target species; F, priorities defined in terms of target geographical areas.

https://doi.org/10.1017/S0030605304000730 Published online by Cambridge University Press

Vulnerable, Endangered of Critically Endangered were assigned scores of 1, 2 and 3, respectively. Species Extinct or Extinct in the Wild were not considered. As in most cases the categories assigned nationally and globally differed, we adopted a precautionary approach (*sensu* CBD, 1992); the value assigned to each species corresponds to the highest of the national and global category. As eight of the species analysed are listed nationally but not globally, their score was always that of the national list.

Degree of endemicity This attribute reflects the relative importance of the Venezuelan populations with respect to the global range of each species. Wide ranging taxa were assigned a score of 1, species distributed across more than one country but within a single Neotropical zoogeographic region (Stotz *et al.*, 1996; e.g. Northern Andes, Tepuis) were assigned 2, and species that are endemic to Venezuela or of which >50% of the global population falls within Venezuela were assigned 3.

Taxonomic uniqueness This attribute reflects the evolutionary significance of the species in terms of its divergence from its closest extant relatives (*sensu* Vane-Wright *et al.*, 1991). Species belonging to a large genus (>11 species) were assigned a score of 1, those belonging to a medium-sized genus (2–10 species) were assigned 2, and those belonging to a monospecific genus were assigned 3. Sibley & Monroe (1990) is the basis of our generic treatment, except for *Ara* where we follow Sick (1993), as do Juniper & Parr (1998). We disregarded extinct species.

It is important to point out that the size of a genus is an imperfect measure of taxonomic uniqueness. The only way to correctly quantify evolutionary significance is to estimate the divergence time using a phylogeny. For example, it is possible that a diversified genus be old and thus have numerous old species, or that a relatively young genus has not diversified greatly and thus has only one or two species. The problem is that most species do not have their phylogenetic relationships well resolved (Mace *et al.*, 2003). But as complete phylogenies become available, efforts should be made to improve the quantification of taxonomic uniqueness.

Public appeal Conservation actions are more likely to succeed if the public supports them. Although the preferences of the public are not always straightforward to predict (Carvell *et al.*, 1998; Balmford, 2000), there are taxa that tend to be more effective for the communication of a conservation message. We assigned a score of 3 to species most likely to become conservation symbols within Venezuela (Butler, 1992) because they are already highly valued by the human population. This includes species that are frequently used as pets, are hunted for food or commercial purposes, or are part of significant cultural traditions (regardless of whether these traditions could affect the population positively or negatively). A score of 2 was assigned to species that may be the object of similar human attention, but would be preferred only if the higher ranking species were not available (e.g. in general, parrots are more sought after than parakeets as pets, so the former rank higher than the latter). A score of 1 was assigned to species that do not particularly attract the interests of people.

The geographical distribution of each species within Venezuela was determined by assessing their presence/absence in the following bioregions (modified from MARN, 2000): Andean Cordillera, Caribbean Islands, Central Coastal Cordillera, Guyana Highlands and Lowlands, Lara-Falcón Arid Lands (excludes montane species, which are considered part of the Andean Cordillera), Maracaibo Lake Basin, Northern Orinoco Lowlands (known locally as the Llanos), Paria Peninsula-Turimiquire Massif Complex, Sierra de Perijá, and Orinoco Delta (Fig. 1). The number of threatened birds was determined for each bioregion, and mean priority scores were calculated by averaging the scores of the species present. On the basis of their scores, the top species-based and bioregion-based priorities were identified for recommendations of future conservation action.

Results

Table 2 summarizes the scores assigned to each species for each of the four attributes, as well as the resulting priority scores. National assessors have a slight tendency

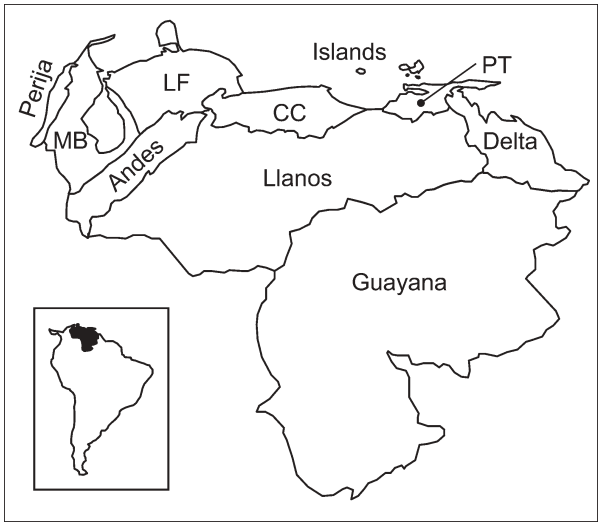

Fig. 1 Bioregions of Venezuela. Andean Cordillera (Andes), Caribbean Islands (Islands), Central Coastal Cordillera (CC), Guayana Highlands and Lowlands (Guayana), Lara-Falcón Arid Lands (LF), Maracaibo Lake Basin (MB), Northern Orinoco Lowlands (Llanos), Paria Peninsula-Turimiquire Massif Complex (PT), Sierra de Perijá (Perijá), and Orinoco Delta (Delta). Based on map in MARN (2000). The inset shows the location of Venezuela in South America.

https://doi.org/10.1017/S0030605304000730 Published online by Cambridge University Press

Table 2 Threatened species categories, ranking attributes, and priority scores for the species included in this analysis.

Species	Category[1]		Attribute scores[2]				Priority Score
	N	G	Risk	DE	TU	PA	
Tawny-breasted tinamou *Nothocercus julius*	VU	–	1	1	2	2	4
Sharp-tailed ibis *Cercibis oxycerca*	VU	–	1	1	3	1	3
Northern screamer *Chauna chavaria*	VU	LR/nt	1	3	2	2	12
Torrent duck *Merganetta armata*	EN	–	2	1	3	2	12
Andean condor *Vultur gryphus*	CR	LR/nt	3	1	3	3	27
Harpy eagle *Harpia harpyja*	VU	LR/nt	1	1	3	3	9
Wattled guan *Aburria aburri*	EN	LR/nt	2	1	3	3	18
Northern-helmeted curassow *Pauxi pauxi*	EN	VU	2	3	2	3	36
Black-fronted wood-quail *Odontophorus atrifrons*	LR/nt	VU	1	3	1	2	6
Rusty-flanked crake *Laterallus levraudi*	VU	EN	2	3	2	1	12
Plain-flanked rail *Rallus wetmorei*	EN	EN	2	3	2	2	24
Scaly-naped pigeon *Columba squamosa*	VU	–	1	1	1	1	1
Scarlet macaw *Ara macao*	VU	–	1	1	2	3	6
Military macaw *Ara militaris*	EN	VU	2	1	2	3	12
Saffron-headed parrot *Pionopsitta pyrilia*	VU	VU	1	1	2	2	4
Rusty-faced parrot *Hapalopsittaca amazonina*	EN	EN	2	2	2	2	16
Yellow-shouldered parrot *Amazona barbadensis*	EN	VU	2	3	1	3	18
Scaly-naped parrot *Amazona mercenaria*	VU	–	1	1	1	2	2
Buff-fronted owl *Aegolius harrisii*	VU	–	1	1	2	1	2
Scissor-tailed hummingbird *Hylonympha macrocerca*	LR/nt	VU	1	3	3	2	18
Perijá metaltail *Metallura iracunda*	DD	VU	1	3	2	1	6
Powerful woodpecker *Campephilus pollens*	VU	–	1	1	1	1	1
White-throated barbtail *Premnoplex tatei*	VU	VU	1	3	2	1	6
Perijá thistletail *Schizoeaca perijana*	LR/nt	VU	1	3	2	1	6
Orinoco softtail *Thripophaga cherriei*	VU	VU	1	3	2	1	6
Recurve-billed bushbird *Clytoctantes alixii*	EN	EN	2	2	2	1	8
Táchira antpitta *Grallaria chthonia*	EN	EN	2	3	1	1	6
Great antpitta *Grallaria excelsa*	DD	VU	1	3	1	1	3
Hooded antpitta *Grallaricula cucullata*	DD	VU	1	2	2	1	4
Urich's tyrannulet *Phyllomyias urichi*	DD	EN	2	3	1	1	6
Slaty-backed hemispingus *Hemispingus goeringi*	VU	VU	1	3	1	1	3
Grey-headed warbler *Basileuterus griseiceps*	LR/nt	EN	2	3	1	1	6
Paria whitestart *Myioborus pariae*	VU	EN	2	3	1	1	6
Venezuelan flowerpiercer *Diglossa venezuelensis*	VU	EN	2	3	1	1	6
Red siskin *Carduelis cucullata*	CR	EN	3	3	1	3	27
Yellow-faced siskin *Carduelis yarrellii*	EN	VU	2	1	1	1	2

[1]N, national; G, global; DD, Data Deficient; LR/nt, Lower Risk near threatened; VU, Vulnerable; EN, Endangered; CR, Critically Endangered; –, not included in IUCN (2003).
[2]Risk, extinction risk; DE, degree of endemicity; TU, taxonomic uniqueness; PA, public appeal.

to believe that the risk of extinction of a species within Venezuela is higher than at the global level (in 47% of cases national assessment is higher than global, in 22% they are equal, in 31% global is higher than national). This is consistent with the general notion that smaller populations are more likely to go extinct than larger ones (Terborgh, 1974; Soulé, 1983; Lande, 1993; Caughley, 1994; Beissinger, 2000). However, the national assessments used precede recent guidelines for the application of IUCN Red List criteria at sub-global levels (Gärdenfors *et al.*, 2001).

Three groups of species were identified: highest, high and medium priority (Table 3). Highest priority species are those whose priority score is >20 points. The highest priority species of all is the northern-helmeted curassow *Pauxi pauxi*, a bird that has received some, but certainly not enough, conservation attention (Strahl *et al.*, 1997; Silva, 1999). High priority species are those whose score is >10 but ≤ 20 points; eight species fall in this category. The remaining 24 species are considered medium priority with a score of ≤ 10 points.

From the perspective of our analysis, northern Venezuela should receive priority conservation attention (Fig. 2). The Andean Cordillera is the bioregion with the largest number of threatened birds, and the Lara-Falcón Arid Lands have the highest mean priority scores. However, the Central Coastal Cordillera and Sierra de Perijá are the only two bioregions among the top three

https://doi.org/10.1017/S0030605304000730 Published online by Cambridge University Press

Table 3 Classification of species according to their priority scores.

Priority level			
Highest (>20 points)	High (>10 points ≤20)	Medium (≤10 points)	
Northern-helmeted curassow	Wattled guan	Harpy eagle	Venezuelan flowerpiercer
Andean condor	Yellow-shouldered parrot	Recurve-billed bushbird	Tawny-breasted tinamou
Red siskin	Scissor-tailed hummingbird	Black-fronted wood-quail	Saffron-headed parrot
Plain-flanked rail	Rusty-faced parrot	Scarlet macaw	Hooded antpitta
	Northern screamer	Perijá metaltail	Sharp-tailed ibis
	Torrent duck	White-throated barbtail	Great antpitta
	Rusty-flanked crake	Perijá thistletail	Slaty-backed hemispingus
	Military macaw	Orinoco softtail	Scaly-naped parrot
		Táchira antpitta	Buff-fronted owl
		Urich's tyrannulet	Yellow-faced siskin
		Grey-headed warbler	Scaly-naped pigeon
		Paria whitestart	Powerful woodpecker

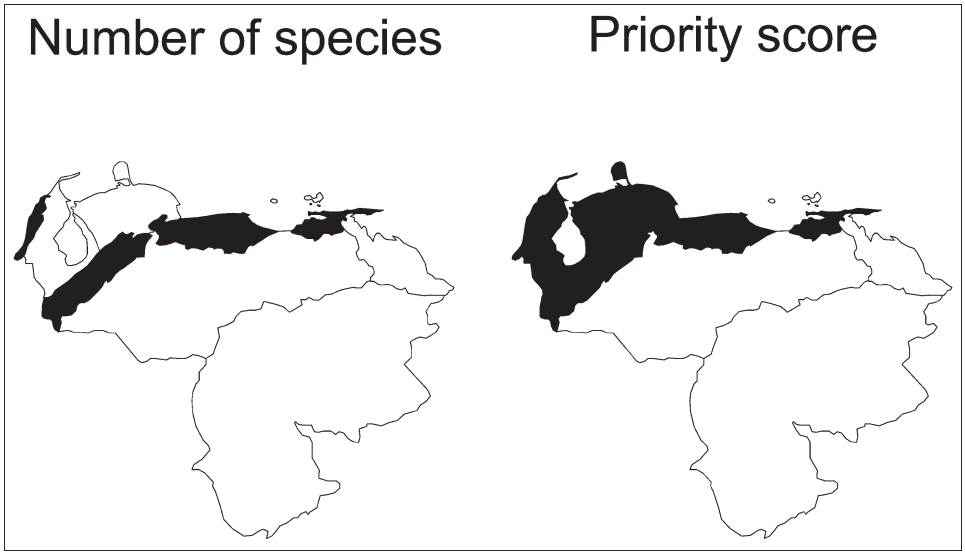

Fig. 2 Top ranking bioregions of Venezuela, shaded, in terms of the number of threatened bird species present (5 or more), and their mean priority scores (10 or higher). See Fig. 1 for details of the bioregions.

both in terms of their number of species and priority scores (Table 4). We classified Venezuela's bioregions into three groups: highest, high and medium priority.

The highest priority bioregions are those that rank amongst the top both in terms of number of threatened birds present (≥5) and their mean priority scores (≥10). There are four: Andean Cordillera, Central Coastal Cordillera, Paria Peninsula-Turimiquire Massif Complex, and Sierra de Perijá. High priority bioregions are those that rank amongst the top either in terms of number of threatened birds present (≥5) or their mean priority scores (≥10). Two bioregions are in this category, Lara-Falcón Arid Lands and Maracaibo Lake Basin. Medium priority bioregions are the four that remain: Caribbean Islands, Guayana Highlands and Lowlands, Llanos, and Orinoco Delta.

A final set of combined priorities was determined by integrating the highest and high priority subsets from both the species-based and bioregion-based priorities (Fig. 3). All top ranking species and bioregions are included.

Discussion

Priority species as conservation symbols

Three of the four highest priority species (northern-helmeted curassow, Andean condor *Vultur gryphus*, and red siskin *Carduelis cucullata*) have significant potential for becoming national or regional conservation symbols. For example, the northern-helmeted curassow is endemic to the branches of the Andes located in northern and western Venezuela; it inhabits forest patches located within a heavily modified matrix of urban and agricultural areas (Silva, 1999). Most remnant populations are within existing national parks, and are thus a symbol of the pristine habitats that remain in the region.

https://doi.org/10.1017/S0030605304000730 Published online by Cambridge University Press

Table 4 Presence of Venezuela's threatened birds in the country's major bioregions, with the number of species in each bioregion and their mean priority scores (bioregion abbreviations follow Fig. 1).

	Bioregion									
Species	Andes	Islands	CC	Guayana	LF	Llanos	MB	Delta	PT	Perijá
Tawny-breasted tinamou	X									
Sharp-tailed ibis						X				
Northern screamer							X			
Torrent duck	X									
Andean condor	X									X
Harpy eagle			X	X				X		
Wattled guan	X									X
Northern-helmeted curassow	X		X							X
Black-fronted wood-quail										X
Rusty-flanked crake	X				X					
Plain-flanked rail			X		X					
Scaly-naped pigeon		X								
Scarlet macaw				X		X		X		
Military macaw	X		X							X
Saffron-headed parrot	X									X
Rusty-faced parrot	X									
Yellow-shouldered parrot		X			X				X	
Scaly-naped parrot	X									X
Buff-fronted owl	X		X	X						
Scissor-tailed hummingbird									X	
Perijá metaltail										X
Powerful woodpecker	X									
White-throated barbtail									X	
Perijá thistletail										X
Orinoco softtail				X						
Recurve-billed bushbird										X
Táchira antpitta	X									
Great antpitta	X		X							X
Hooded antpitta	X									
Urich's tyrannulet									X	
Slaty-backed hemispingus	X									
Grey-headed warbler									X	
Paria whitestart									X	
Venezuelan flowerpiercer									X	
Red siskin	X		X		X				X	X
Yellow-faced siskin			X							
Number of species	17	2	8	4	4	2	1	2	8	12
Mean priority score	11.1	9.5	14.4	5.8	20.3	4.5	12.0	7.5	11.6	12.9

As is the case throughout the tropics, even weakly enforced protected areas confer some degree of protection to the species in them (Bruner *et al.*, 2001); the fact that curassows are more-or-less restricted to national parks is a demonstration of this. Hunting is still a major problem for this species, however, and although it is prohibited by Venezuelan law (Venezuela, 1996), illegal poachers exert direct and severe pressure on populations even in protected areas (Silva & Strahl, 1994, 1996). Within the family Cracidae, the IUCN/SSC Cracid Specialist Group (Brooks & Strahl, 2000) assign the highest conservation priority (Immediate) to the northern-helmeted curassow. At a subspecies level they rank the Sierra de Perijá subspecies *Pauxi pauxi gilliardi* as the highest priority of all taxa.

Five factors make the northern-helmeted curassow an ideal candidate for a regional conservation symbol: (1) it is endemic or nearly endemic to Venezuela, (2) it is a habitat specialist and thus can be associated with a particular type of environment or location, (3) it is charismatic and of interest to humans, (4) it is highly threatened, and (5) its future survival is dependent on already established protected areas. A conservation strategy for this species could be based on strengthening regional pride (Butler, 1992) by integrating education and research initiatives in human settlements in and around protected areas. The successful conservation of northern-helmeted curassows would indirectly benefit other species that inhabit montane forests in northern Venezuela.

https://doi.org/10.1017/S0030605304000730 Published online by Cambridge University Press

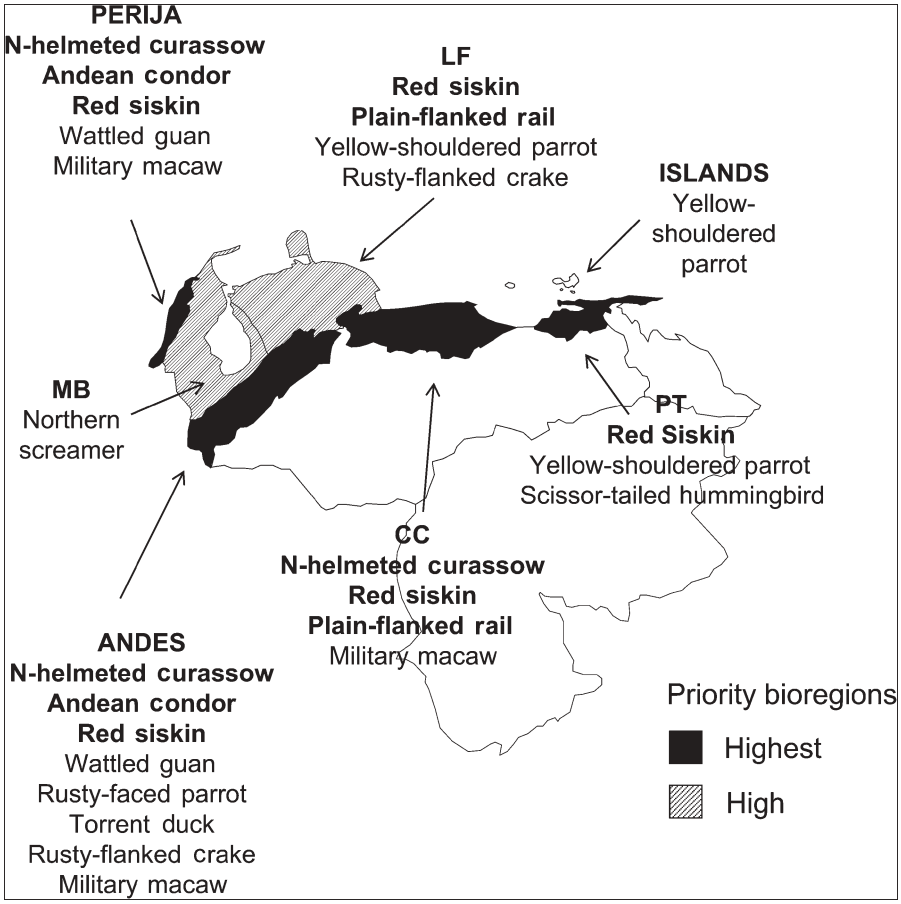

Fig. 3 Combined species-based and bioregion-based conservation priorities for Venezuelan threatened birds. Map displays the presence of the 12 highest (bold, and at top of each list) and high priority species in the bioregions of Venezuela. Highest and high priority bioregions are also indicated (bioregion abbreviations follow Fig. 1).

The red siskin and Andean condor also have high potential for becoming national conservation symbols. The siskin inhabits humid foothill forests in arid areas in northern Venezuela (Coats & Phelps, 1985; Rodríguez & Rojas-Suárez, 1999), and the condor is found in mountain areas in western Venezuela. They are both associated with specific habitats or regions and are charismatic. The plain-flanked rail *Rallus wetmorei* is more cryptic, although perhaps of sufficient interest to act as a flagship for the mangroves of the central section of the Caribbean coast to which it is confined. Despite their significant threat level, however, these species are not currently the object of any national conservation programme in Venezuela; the condor is the focus of a local educational campaign, captive breeding, and a reintroduction effort by Fundación BioAndina in Mérida State.

We highlight these four species because they are at the top of the list of priorities identified by our study, but we are not suggesting that they be the beneficiaries of all available conservation resources. As a minimum, conservation initiatives should be launched for all medium and high priority species. Some may work well as regional conservation symbols (e.g. northern screamer *Chauna chavaria*, yellow-shouldered parrot *Amazona barbadensis*), and some may require alternative strategies (e.g. recurve-billed bushbird *Clytoctantes alixii* and Urich's tyrannulet *Phyllomyias urichi*). By focusing on the species listed in Table 3 it would be possible to directly or indirectly advance the conservation of Venezuela's avifauna as a whole (1,382 species; Hilty, 2003).

Comparison with other priority-setting exercises

Financial resources for conservation of tropical species tend to come from outside the region and this is the case in Venezuela, where national investment in conservation and science, as well as support for governmental organizations responsible for environmental matters, have declined severely in the last decades (Sharpe, 1994; Markandya *et al.*, 1996; Requena, 2003). International donors, however, do not necessarily take into consideration national priorities when defining their conservation investments, and thus sometimes impose research and conservation agendas that do not correlate with local realities and needs.

For example, consider the case of a hypothetical international aid agency or non-governmental organization interested in supporting bird conservation in Venezuela.

https://doi.org/10.1017/S0030605304000730 Published online by Cambridge University Press

After evaluating the information available, they may decide to invest preferentially in endemic bird areas (Stattersfield *et al.*, 1998), globally threatened species (IUCN, 2003) or the conservation priorities of Parker *et al.* (1996). We explore how different those priorities would be to the ones that we identify in the present study by comparing targets identified by BirdLife International, American Bird Conservancy (which bases its priorities on IUCN, 2003), and Parker *et al.* (1996).

In the 1990s BirdLife developed an international habitat-based conservation priority system focused on Endemic Bird Areas (EBAs): small regions of the world ($<50{,}000$ km^2) that entirely encompass the overlapping breeding ranges of two or more restricted-range bird species (Stattersfield *et al.*, 1998). Venezuela includes seven EBAs, with a notable degree of correspondence with our top ranking bioregions (Fig. 1): Caribbean Colombia and Venezuela (partially overlaps with LF, CC, PT and Islands), Caripe-Paria region (entirely contained within PT), Colombian East Andes (Venezuelan portions inside Perijá and Andes), Cordillera de la Costa Central (falls within CC, Andes and LF), Cordillera de Mérida (entirely within Andes), Orinoco-Negro white-sand forest and Tepuis.

There are two principal differences between BirdLife's scheme and our proposal. BirdLife's analysis highlights two EBA's in southern Venezuela, both located in Guyana (Fig. 1), Orinoco-Negro white-sand forest and Tepuis. These are areas that harbour numerous restricted-range species (12 and 38, respectively), but only one threatened species. These EBAs form part of the world's largest tropical wilderness area (Bryant *et al.*, 1997); there is no road access to the former EBA and only one road to a portion of the latter. In addition, both areas are well represented within strict protected areas. Thus, most of the endemic species that occur in this region are amongst the most secure populations of any species in the world. Therefore, their low rank in our priority-setting exercise is due to the relatively small risk that they face.

Secondly, BirdLife's ranking of habitat-based conservation priorities places the Caripe-Paria region and Colombian East Andes at the top (Critical Priority), followed by Caribbean Colombia and Venezuela, Cordillera de Mérida, and Tepuis (Urgent Priority), and then Cordillera de la Costa Central and Orinoco-Negro white-sand forest (High Priority). An important difference with our ranking is the relatively low priority given by BirdLife to the Central Coastal Cordillera. It is unclear why its current threat level is considered to be relatively low, comparable to the Tepuis and Orinoco-Negro white-sand forest, as north-central Venezuela has experienced more extensive habitat modification than anywhere else in the country (Bisbal, 1988). The Central Coastal Cordillera is one of the highest ranking bioregions in our analysis.

American Bird Conservancy administers a small grants programme devoted specifically to the conservation of 'birds and their habitats throughout the Americas' (ABC, 2004). Their focus is on species categorized globally as Critically Endangered or Endangered. For Venezuela, their priorities are four Endangered birds: grey-headed warbler *Basileuterus griseiceps*, Venezuelan flowerpiercer *Diglossa venezuelensis*, Paria whitestart *Myioborus pariae* (listed also by its alternative common name, Paria redstart), and Urich's tyrannulet. These are four of the 24 birds listed as Critically Endangered or Endangered for Venezuela (IUCN, 2003), and all are restricted to the Paria Peninsula-Turimiquire Massif Complex (Fig. 1). The reasons for focusing exclusively on this specific set of species or region are not indicated, but ABC's priorities fall within those that we also identified.

Parker *et al.* (1996) assigned conservation priority rankings to all neotropical bird species based on the authors' and collaborators' experience with each species. The values assigned are Urgent, High, Medium and Low. Their rankings coincide broadly with our own except that both the plain-flanked rail and the Paria Peninsula-Turimiquire endemics are considered lower (Medium) priority. Urgent priority is assigned to the red siskin.

The priorities identified by BirdLife International, American Bird Conservancy and Parker *et al.* (1996) are approximately consistent with those proposed by ourselves, although the species and regions of interest differ in their relative importance. We believe that country-based priority-setting exercises, which explicitly consider the public's preferences, not only target species that are more likely to receive local support, but also have the key advantage that they take into account the political unit where conservation implementation is carried out (i.e. a nation). In other words, species do not respect political borders, but the people based at local conservation institutions do, regardless of whether they are academic, governmental or non-governmental. A priority-setting exercise must therefore integrate the biological reality of threatened species with the institutional reality of those working to protect them. We encourage international conservation organizations to promote country-based priority-setting exercises to optimize the impact of their conservation investments.

The problem of incomplete data

In assessing the risk of extinction of a species, there is no good substitute for peer-reviewed field data. The species accounts for Venezuelan birds listed in the *2003 IUCN Red List of Threatened Species* (the actual accounts can be found in BirdLife, 2000) often rely on *in litt.* references,

https://doi.org/10.1017/S0030605304000730 Published online by Cambridge University Press

information contributed informally by amateur and professional ornithologists. Despite the fact that birds are probably the best studied taxon of all of the world's species, much of what is known remains unpublished and therefore cannot be validated by the scientific community. Although the collation of data by the listing authorities is a monumental effort, investment in basic research on the distribution and abundance of organisms, particularly in the tropics, is still a key requirement for conservation (Rodríguez, 2003).

Acknowledgements

We are grateful to Thomas M. Brooks for his valuable suggestions in the initial stages of this work, and Stuart Butchard and two anonymous reviewers for their helpful comments on an earlier version of this manuscript. Provita is a member of the Wildlife Trust Alliance.

References

ABC (2004) *American Bird Conservancy.* Http://www.abcbirds.org [accessed 24 July 2003].

Ando, A., Camm, J., Polasky, S. & Solow, A. (1998) Species distributions, land values, and efficient conservation. *Science*, **279**, 2126–2128.

Avery, M., Gibbons, D.W., Porter, R., Tew, T., Tucker, G. & Williams, G. (1995) Revising the British Red List for birds: the biological basis of U.K. conservation priorities. *Ibis*, **137**, S232–S239.

Balmford, A. (2000) Separating fact from artifact in analyses of zoo visitor preferences. *Conservation Biology*, **14**, 1193–1195.

Beissinger, S.R. (2000) Ecological mechanisms of extinction. *Proceedings of the National Academy of Sciences*, **97**, 11688–11689.

Bennun, L.A., Njoroge, P. & Pomeroy, D. (2000) Birds to watch: a Red Data List for East Africa. *Ostrich*, **71**, 310–314.

BirdLife (2000) *Threatened Birds of the World*. Lynx Edicions, Barcelona, Spain and BirdLife International, Cambridge, UK.

Bisbal, F.J. (1988) Impacto humano sobre los hábitat de Venezuela. *Interciencia*, **13**, 226–232.

Breininger, D.R., Barkaszi, M.J., Smith, R.B., Oddy, D.M. & Provancha, J.A. (1998) Prioritizing wildlife taxa for biological diversity conservation at the local scale. *Environmental Management*, **22**, 315–321.

Brooks, D.M. & Strahl, S.D. (eds) (2000) *Curassows, Guans and Chachalacas. Status Survey and Conservation Action Plan for Cracids 2000-2004.* IUCN, Gland, Switzerland.

Bruner, A.G., Gullison, R.E., Rice, R.E. & da Fonseca, G.A.B. (2001) Effectiveness of parks in protecting tropical biodiversity. *Science*, **291**, 125–128.

Bryant, D., Nielsen, D. & Tangley, L. (1997) *The Last Frontier Forests: Ecosystems and Economies on the Edge*. World Resources Institute, Washington, DC, USA.

Butler, P.J. (1992) Parrots, pressures, people, and pride. In *New World Parrots in Crisis: Solutions from Conservation Biology* (eds S.R. Beissinger & N.F.R. Snyder), pp. 25–46. Smithsonian Institution Press, Washington, DC, USA.

Carter, M.F., Hunter, W.C., Pashley, D.N. & Rosenberg, K.V. (2000) Setting conservation priorities for landbirds in the United States: the Partners in Flight approach. *Auk*, **117**, 541–548.

Carvell, C., Inglis, N.F.J., Mace, G.M. & Purvis, A. (1998) How Diana climbed the ratings at the zoo. *Nature*, **395**, 213.

Caughley, G. (1994) Directions in conservation biology. *Journal of Animal Ecology*, **63**, 215–244.

CBD (1992) *Convention on Biological Diversity*. United Nations Conference on Environment and Development, Rio de Janeiro, Brazil.

Coats, S. & Phelps Jr., W.H. (1985) The Venezuelan red siskin: case history of an endangered species. In *Neotropical Ornithology* (eds P.A. Buckley, M.S. Foster, E.S. Morton, R.S. Ridgely & F.C. Buckley), pp. 977–985. Ornithological Monographs No. 36, American Ornithologist's Union, Washington, DC, USA.

Collar, N.J. (1996) The reasons for Red Data Books. *Oryx*, **30**, 121–130.

Dunn, E.H., Hussell, D.J.T. & Welsh, D.A. (1999) Priority-setting tool applied to Canada's landbirds based on concern and responsibility for species. *Conservation Biology*, **13**, 1404–1415.

Gärdenfors, U., Hilton-Taylor, C., Mace, G.M. & Rodríguez, J.P. (2001) The application of IUCN red list criteria at regional levels. *Conservation Biology*, **15**, 1206–1212.

Grigera, D. & Ubeda, C. (2002) Una revisión de los trabajos sobre categorizaciones y prioridades de conservación de los vertebrados de Argentina. *Ecología Austral*, **12**, 163–174.

Hilty, S.L. (2003) *Birds of Venezuela.* 2nd Edition. Princeton University Press, Princeton, USA.

IUCN (2001) *IUCN Red List Categories and Criteria: Version 3.1.* IUCN, Gland, Switzerland [http://www.redlist.org/info/categories_criteria2001.html, accessed 22 July 2004].

IUCN (2003) *2003 IUCN Red List of Threatened Species*. IUCN, Gland, Switzerland and Cambridge, UK [http://www.redlist.org, accessed 22 July 2004].

Juniper, T. & Parr, M. (1998) *Parrots: A Guide to the Parrots of the World*. Pica Press, East Sussex, UK.

Lamoreux, J., Akçakaya, H.R., Bennun, L., Collar, N.J., Boitani, L., Brackett, D., Brautigam, A., Brooks, T.M., da Fonseca, G.A.B., Mittermeier, R.A., Rylands, A.B., Gärdenfors, U., Hilton-Taylor, C., Mace, G., Stein, B.A. & Stuart, S. (2003) Value of the IUCN Red List. *Trends in Ecology and Evolution*, **18**, 214–215.

Lande, R. (1993) Risks of population extinction from demographic and environmental stochasticity and random catastrophes. *American Naturalist*, **142**, 911–927.

Lunney, D., Curtin, A., Ayers, D., Cogger, H.G. & Dickman, C. (1996) An ecological approach to identifying the endangered fauna of New South Wales. *Pacific Conservation Biology*, **2**, 212–231.

Mace, G.M. (1994) Classifying threatened species: means and ends. *Philosophical Transactions of the Royal Society of London B*, **344**, 91–97.

Mace, G.M., Gittleman, J.L. & Purvis, A. (2003) Preserving the Tree of Life. *Science*, **300**, 1707–1709.

Markandya, A., Yero, L., Cariola, C., Lacabana, M., Velasco, F.J., Caraballo, A., Fajardo, V., Castellanos, H., Herrera, F., Rodríguez, I., Sharpe, C., Giordiani, J., Laplace, Y., Maingon, T., Pucci, R., Prato, N., Pirela, A., Mata, L. & Lacabana, P. (1996) Case study for Venezuela. In *Structural Adjustment, the Environment, and Sustainable Development* (ed. D. Reed), pp. 201–224. Earthscan, London, UK.

MARN (2000) *Primer Informe de Venezuela sobre Diversidad Biológica*. Ministerio del Ambiente y los Recursos Naturales, Caracas, Venezuela.

McIntyre, S., Barrett, G.W., Kitching, R.L. & Recher, H.F. (1992) Species triage – seeing beyond wounded rhinos. *Conservation Biology*, **6**, 604–606.
Millsap, B.A., Gore, J.A., Runde, D.E. & Cerulean, S.I. (1990) Setting priorities for the conservation of fish and wildlife species in Florida. *Wildlife Monographs*, **111**, 1–57.
Parker III, T.A., Stotz, D.F. & Fitzpatrick, J.W. (1996) Ecological and distributional databases for neotropical birds. In *Neotropical Birds. Ecology and Conservation* (eds D.F. Stotz, J.W. Fitzpatrick, T.A. Parker, III & D.K. Moskovits). University of Chicago Press, Chicago, USA.
Pearman, P.B. (2002) Developing regional conservation priorities using Red Lists: a hypothetical example from the Swiss lowlands. *Biodiversity and Conservation*, **11**, 469–485.
Pérez-Losada, M., Jara, C.G., Bond-Buckup, G. & Crandall, K.A. (2002) Conservation phylogenetics of Chilean freshwater crabs *Aegla* (Anomura, Aeglidae): assigning priorities for aquatic habitat protection. *Biological Conservation*, **105**, 345–353.
Pinchera, F., Boitani, L. & Corsi, F. (1997) Application to the terrestrial vertebrates of Italy of a system proposed by IUCN for a new classification of national Red List categories. *Biodiversity and Conservation*, **6**, 959–978.
Polishchuk, L.V. (2002) Conservation priorities for Russian mammals. *Science*, **297**, 1123.
Possingham, H.P., Andelman, S.J., Burgman, M.A., Medellin, R.A., Master, L.L. & Keith, D.A. (2002) Limits to the use of threatened species lists. *Trends in Ecology and Evolution*, **17**, 503–507.
Requena, J. (2003) Venezuela: crisis puts major institutions at risk. *Nature*, **422**, 257–257.
Restani, M. & Marzluff, J.M. (2002) Funding extinction? Biological needs and political realities in the allocation of resources to endangered species recovery. *BioScience*, **52**, 169–177.
Rodríguez, J.P. (2003) Challenges and opportunities for surveying and monitoring tropical biodiversity – a response to Danielsen *et al. Oryx*, **37**, 411.
Rodríguez, J.P., Ashenfelter, G., Rojas-Suárez, F., García Fernández, J.J., Suárez, L. & Dobson, A.P. (2000) Local data are vital to worldwide conservation. *Nature*, **403**, 241.
Rodríguez, J.P. & Rojas-Suárez, F. (1999) *Libro Rojo de la Fauna Venezolana, Segunda Edición*. PROVITA, Fundación Polar, Caracas, Venezuela.
Scott, P., Burton, J.A. & Fitter, R. (1987) Red Data Books: the historical background. In *The Road to Extinction* (eds R. Fitter & M. Fitter), pp. 1–6 . IUCN, Gland, Switzerland and UNEP, Nairobi, Kenya.
Sharpe, C.J. (1994) *The Effects of Structural Adjustment on the Venezuelan National Parks System*. Report to Centro de Estudios del Desarrollo, Universidad Central de Venezuela (CENDES-UCV), Caracas, Venezuela.
Sibley, C.G. & Monroe Jr., B.L. (1990) *Distribution and Taxonomy of Birds of the World*. Yale University Press, New Haven, USA.
Sick, H. (1993) Notes on the taxonomy of Brazilian parrots. *Ararajuba*, **1**, 111–112.
Silva, J.L. (1999) Notes about the distribution of *Pauxi pauxi* and *Aburria aburri* in Venezuela. *Wilson Bulletin*, **111**, 564–569.
Silva, J.L. & Strahl, S.D. (1994) Usos folclóricos de la fauna silvestre en nueve parques nacionales al norte de Venezuela. *Vida Silvestre Neotropical*, **3**, 100–107.
Silva, J.L. & Strahl, S.D. (1996) La caza furtiva en los parques nacionales al norte de Venezuela. *Vida Silvestre Neotropical*, **5**, 126–139.
Soulé, M.E. (1983) What do we really know about extinction? In *Genetics and Conservation* (eds C. Schonewald-Cox, S. Chambers, B. MacBryde & W. Thomas), pp. 111–124. The Benjamins/Cummings Publishing Company, Reading, USA.
Stattersfield, A.J., Crosby, M.J., Long, A.J. & Wege, D.C. (1998) *Endemic Bird Areas of the World: Priorities for Biodiversity Conservation*. BirdLife International, Cambridge, UK.
Stotz, D.F., Fitzpatrick, J.W., Parker III, T.A. & Moskovits, D.K. (1996) *Neotropical Birds. Ecology and Conservation.* University of Chicago Press, Chicago, USA.
Strahl, S.D., Rojas-Suárez, F. & Herrera, A.M. (1997) En peligro: el pauji copete de piedra (*Pauxi pauxi*) un programa de concientización ambiental. In *The Cracidae: Their Biology and Conservation* (eds S.D. Strahl, S. Beaujon, D.M. Brooks, A.J. Begazo, G. Sedaghatkish & F. Olmos), pp. 197–200. Hancock House Publishers, Washington, DC, USA.
Terborgh, J. (1974) Preservation of natural diversity: the problem of extinction prone species. *BioScience*, **24**, 715–722.
UNEP-WCMC (2004) *UNEP World Conservation Monitoring Centre*. Http://www.unep-wcmc.org/ [accessed 22 July 2004].
Vane-Wright, R.I., Humphries, C.J. & Williams, P.H. (1991) What to protect? – Systematics and the agony of choice. *Biological Conservation*, **55**, 235–254.
Venezuela (1996) *Decreto 1485: Animales Vedados para la Caza*. Gaceta Oficial No. 36.059 - 7 de octubre de 1996, Caracas, Venezuela.
Warren, M.S., Barnett, L.K., Gibbons, D.W. & Avery, M.I. (1997) Assessing national conservation priorities: an improved Red List of British butterflies. *Biological Conservation*, **82**, 317–328.
WCMC (1994) *Biodiversity Data Sourcebook*. World Conservation Press, Cambridge, UK.

Biographical sketches

Jon Paul Rodríguez is a founder and the current President of Provita, a Venezuelan conservation NGO. His work focuses on understanding patterns in the spatial distribution of threatened species and habitats, as well as the underlying causes of these patterns, and the development of policy guidelines for biodiversity conservation.

Franklin Rojas-Suárez has spent most of his career leading conservation projects among Venezuelan NGOs. He is presently responsible for establishing alliances with key scientists and organizations in Venezuela, targeting conservation action for the country's threatened species, biodiversity hotspots, wilderness areas, and national parks.

Christopher J. Sharpe has worked with birds and protected area management throughout the Neotropics. He is an ornithologist specializing in the use of vocalizations in bird identification and the conservation of threatened species. He has worked for the governments of several Neotropical countries as well as for UNEP, UNDP, World Conservation Monitoring Centre, Conservation International and Flora & Fauna International. His most recent work has been a reassessment of the conservation status of Venezuela's threatened birds for Provita.