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Trends in threat status and priorities in conservation of the woodpeckers of the world

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Abstract. Taking the first IUCN Red List from 1988 as a starting point, I review trends in the threat status of the woodpecker species of the world, the geographical distribution of (near-) threatened woodpecker species, threat factors affecting these species, and the research output about them. Between 1988 and 2013 the number of genuinely Red Listed woodpeckers (categories Near Threatened and up) increased from 20 to 28 species and the number of species in the categories Vulnerable and up from 8 to 12. As percentage of recognised woodpecker species in the different years, the increase in Red Listed woodpecker species was even sharper. The geographical distribution of Red Listed woodpeckers stayed constant between 1988 and 2013, with over half of the species in Latin America, about one quarter in Asia, and none in Europe. A taxonomic reappraisal adopted by IUCN in 2014 raised the total number of recognised woodpecker species to 254 and of Red Listed woodpecker species to 42, of which 40% occur in Asia. Nearly all Red Listed woodpecker species on the 2013 list are threatened by deforestation. Out of 28 species, 10 are also threatened by selective logging, and these 10 are in higher threat categories. Woodpecker conservation research should focus in particular on the species sensitive to selective logging, to assess their within-habitat requirements and thresholds. The output of research on Red Listed woodpeckers in the past 25 years was heavily skewed to three North American species: Red-headed Woodpecker *Melanerpes erythrocephalus*, Red-cockaded Woodpecker *Picoides borealis* and Ivory-billed Woodpecker *Campephilus principalis*. I identify 10 priority species to focus woodpecker conservation research on, four from Latin America: Speckle-chested Piculet *Picumnus steindachneri*, Fernandina's Flicker *Colaptes fernandinae*, Black-bodied Woodpecker *Dryocopus schulzi*, Helmeted Woodpecker *Dryocopus galeatus*; and six from Asia: Okinawa Woodpecker *Dendrocopos noguchii*, Korean White-bellied Woodpecker *Dryocopus richardsi*, Great Slaty Woodpecker *Mulleripicus pulverulentus*, Red-collared Woodpecker *Picus rabieri*, Yellow-faced Flameback *Chrysocolaptes xanthocephalus* and White-rumped Woodpecker *Meiglyptes tristis*.

Key words: IUCN Red List, old-growth forest, selective logging, threat factors, conservation, woodpeckers

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INTRODUCTION

Woodpeckers are a near-cosmopolitan family of birds occurring on all continents except Australia and Antarctica. Most species in the family live in forests or woodland ecosystems but some are adapted to open areas with few or no trees. Some woodpecker species are rather flexible in their habitat requirements and can live in intensively managed forests or in tree plantations, whereas other species are closely dependent on natural or old-growth forests (Winkler & Christie 2002). When an old-growth specialist woodpecker species occurs in a restricted geographical range and there is considerable deforestation and forest modification in its range, it is usually globally threatened, and a worrisome number of woodpecker species are now in this situation. Even so, the proportion of threatened species in the woodpecker family is relatively low, whereas it is markedly high in such bird families as pigeons or parrots (Bennett & Owens 1997). The difference in the proportion of threatened species between bird families is to a large extent related to the proportion of island endemic species in each family, which is rather low in woodpeckers. Independent from the family average of threatened species, woodpecker species that are old-growth or natural forest specialists are often among the most sensitive and visible vertebrates affected by changes

in forest ecosystems. As such, these woodpeckers make valuable indicators and umbrella species (Martikainen et al. 1998, Mikusiński et al. 2001, Kumar et al. 2011). Furthermore, as forests are the major reservoirs of biodiversity globally (Myers et al. 2000), conservation efforts for woodpecker species carry weight in biodiversity conservation beyond these single species.

A first perspective on the conservation of the woodpeckers of the world was presented by Short & Horne (1990). They discussed the taxonomy of the family, the distinction between specialised and generalised species and genera, the ecological attributes of woodpeckers including cavity excavation and foraging, woodpecker communities with high species diversity, and made recommendations for forest management supportive of the conservation of the European woodpecker diversity. They stressed that closely related woodpeckers may differ in their needs and demands on their environment. They did not identify the most threatened woodpeckers at the time or present a priority list of woodpecker species that needed research and conservation action. However around the same time, Collar & Andrew (1988) published the first Red List of threatened bird species of the world, which included 7 threatened and 10 near-threatened species of woodpeckers, partially following recommendations from Short (1982).

Taking Collar & Andrew (1988) as a starting point, I examine trends in the conservation status of the woodpecker species of the world over the past quarter century. I tally changes in the number of woodpecker species in different threat categories on iterations of the IUCN Red List during this period, and discuss the impact of taxonomic changes on recent and future lists. I examine the geographical distribution of Red Listed woodpecker species, the threat factors that affect these species, and patterns in the research effort on Red Listed woodpeckers. I identify priority species for conservation research and discuss options to increase the research output on these species.

METHODS

I reviewed woodpecker species listed on all 12 iterations of the IUCN Red List between 1988 and 2014. In Table 1 I present only the genuine category changes of Red Listed woodpecker species between years, those that reflect a change in threat situation rather than improved knowledge of an unchanged situation, as indicated in the species accounts by BirdLife International in subsequent years. In order to be able to examine numerical trends over time, I included the status that I estimated for four newly recognised species on one to four early iterations of the list, before the recognition of these species. These species are Sulu Woodpecker *Dendrocopos ramsayi*, first recognised in 2000 and formerly considered a subspecies of Philippine Woodpecker *D. maculatus*; Choco Woodpecker *Veniliornis chocoensis*, first recognised in 1994 and formerly considered a subspecies of Red-stained Woodpecker *V. affinis*; Kaempfer's Woodpecker *Celeus obrieni*, first recognised in 2007 and formerly considered a subspecies of Rufous-headed Woodpecker *C. spectabilis*, and Andaman Woodpecker *Dryocopus hodgei*, first recognised in 1994 and formerly considered a subspecies of White-bellied Woodpecker *D. javensis*. In all four cases, the best available information indicated that the status between 1988 and the first evaluation was equal to the status at first evaluation. I treated the 2014 Red List separately as it is based on an expanded species list of del Hoyo & Collar (2014) and there is no information on past Red List status of newly recognised species, at least not in sufficient detail to estimate when in the past 26 years list category changes might have occurred. I then tallied the changes of woodpecker species in threat categories over the 26 year period, both as the number of species as well as the percentage of woodpecker species recognised by the IUCN in each list year. Following Collar (2013), the number of all recognised woodpecker species in 1988 was based on Morony et al. (1975), in 1994, 2000 and 2004 it was based on Sibley & Monroe (1990), and from 2007 onward it is based on yearly taxonomic checklists issued by BirdLife International. I define “Red Listed woodpeckers” as those that are in the categories Near-Threatened and up, and “threatened woodpeckers” as those that are in the categories Vulnerable and up. I reviewed the threat factors that affect Red Listed woodpeckers by scoring key words in the “Threats” sections in on-line species fact sheets (BirdLife International 2014b) and grouping these into broad and finer categories. I made no distinction between past or current threats but instead included all threats that affected a species during the 25 year window. I scored the number of publications on Red Listed woodpecker species by running a search for the scientific name of each species in the online Web of Science database, with "all years" and "all databases" filters. This

includes Zoological Record. The threat factor and research output analyses only include the 28 species Red Listed between 1988 and 2013, because information is too scant for species newly recognised and Red Listed in 2014. All statistical tests were performed in R (version 3.1.0, The R Foundation for Statistical Computing).

RESULTS AND DISCUSSION

Changes in woodpecker species and status on IUCN Red Lists 1988–2013

Between 1988 and 2013 eleven iterations of the IUCN Red List of birds of the world were published (Collar & Andrew 1988, Collar et al. 1994, BirdLife International 2000, 2004, 2007, 2008, 2009, 2010, 2011, 2012, 2013). During that period 35 woodpecker species were on one or more iterations of the list. There were 43 changes in the threat categories of these species. However, most of these category changes reflect improvements in the knowledge of the status of species rather than actual changes in the threat situation of species. Based on such improved knowledge, seven woodpecker species that figured in various iterations of the Red List were removed in revisions of the list: Rusty-necked Piculet *Picumnus fuscus*, Ochraceous Piculet *Picumnus limae*, Fine-barred Piculet *Picumnus subtilis*, Antillean Piculet *Nesoctites micromegas*, Ground Woodpecker *Geocolaptes olivaceus*, White-winged Woodpecker *Dendrocopos leucopterus*, and Robust Woodpecker *Campephilus robustus*.

There are 13 genuine changes in the Red List status of 28 genuinely listed woodpecker species during 1988–2013 (Table 1). Of the 13 changes, 12 involved a change to a higher threat category, and only one, the Red-cockaded Woodpecker *Picoides borealis*, showed an improvement from Vulnerable to Near-Threatened status. Of the 28 Red-Listed species, 16 remained in a constant threat category over the 25-year period, with most of these in the Near-Threatened category. One species, the Speckle-chested Piculet *Picumnus steindachneri* went through two changes, first from Near-Threatened to Vulnerable in 2000 and then from Vulnerable to Endangered in 2013. The remaining 11 species showed one category change.

The total number of woodpecker species on the Red List (categories Near-Threatened and up) steadily climbed from 20 to 28 species between 1988 and 2013 (Table 1). The number of threatened woodpeckers (categories Vulnerable and up) climbed from 8 to 13 species between 1988 and 2012, then lowered to 12 species in 2013 with the downlisting of Red-cockaded Woodpecker. The number of woodpecker species in the highest threat categories of Endangered to Critically Endangered/Possibly Extinct stayed at a constant of 4 during 1988–2011, then climbed to 6 in 2012–2013 with the inclusion of Speckle-chested Piculet and Varzea Piculet *Picumnus varzeae*, following a model of future deforestation in the Amazonian basin by Bird et al. (2011). One species, Imperial Woodpecker *Campephilus imperialis*, is in the category Critically Endangered/Possibly Extinct as of 2012. By these measures, the number of Red Listed woodpeckers and their mean Red List status have sharply increased over the past quarter century.

Changes in woodpecker taxonomy and impact on Red List trends

The appearance of four newly split woodpecker species on the IUCN Red List between 1994 and 2007 (with asterisk in earlier years in Table 1) is representative of a increasing tendency in ornithology to elevate former subspecies (particularly allopatric and distinctive subspecies) to species level (Hazevoet 1996, Tobias et al. 2010, Gill 2014). The number of recognised species in the woodpecker family has increased from 198 species in Short (1982) to 219 species in BirdLife International (2013), and to 234 species in Gill & Donsker (2014). A large increase in recognised woodpecker species to 254 came with del Hoyo & Collar (2014), adopted by BirdLife International (2014a) (Table 2). Additional splits are recommended by Del-Rio et al. (2013) and Winkler et al. (2014). To examine trends in the number of Red Listed woodpecker species over time, one approach is to make an estimate of the Red List status of species on year iterations of the list before their elevation to species level, as I did in the previous section, so that trends can be examined among a constant suite of species. Another approach is to take the number of woodpecker species on a year iteration of the Red List and the total number of recognised woodpecker species in that year, and calculate the proportion of these numbers. Taking this approach (Table 3), the percentage of Red-Listed woodpecker species increased from 7.8% of recognised woodpecker species in 1988 to 12.8% in 2013, an increase by a factor of 1.6x. The percentage of threatened woodpecker species increased from 2.9% to 5.5%, a factor of 1.8x. These are even sharper increases than

Table 1. Red List categories of 28 woodpecker species genuinely appearing on 11 iterations of the IUCN Red List between 1988 and 2013, showing a total of 13 genuine changes. Cells are colour coded with increasing threat category. LC — Least Concern, NT — Near Threatened, VU — Vulnerable, EN — Endangered, CR — Critically Endangered, CR/PE — Critically Endangered/Possibly Extinct. * — Threat status of species estimated by the author for early years when taxa were not yet recognised as species and hence were not evaluated.

Common name	Scientific name	IUCN Red List Category (year)										
		1988	1994	2000	2004	2007	2008	2009	2010	2011	2012	2013
White-bellied Piculet	*Picumnus spilogaster*	LC	LC	LC	LC	LC	LC	LC	LC	LC	VU	VU
Guianan Piculet	*Picumnus minutissimus*	LC	LC	LC	LC	LC	LC	LC	LC	LC	NT	NT
Speckle-chested Piculet	*Picumnus steindachneri*	NT	NT	VU	VU	VU	VU	VU	VU	VU	VU	EN
Varzea Piculet	*Picumnus varzeae*	LC	LC	LC	LC	LC	LC	LC	LC	LC	EN	EN
Tawny Piculet	*Picumnus fulvescens*	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
Mottled Piculet	*Picumnus nebulosus*	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
Guadeloupe Woodpecker	*Melanerpes herminieri*	LC	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
Red-headed Woodpecker	*Melanerpes erythrocephalus*	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
Knysna Woodpecker	*Campethera notata*	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
Stierling's Woodpecker	*Dendropicos stierlingi*	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
Sulu Woodpecker	*Dendrocopos ramsayi*	VU*	VU*	VU	VU	VU	VU	VU	VU	VU	VU	VU
Arabian Woodpecker	*Dendrocopos dorae*	NT	NT	VU	VU	VU	VU	VU	VU	VU	VU	VU
Okinawa Woodpecker	*Dendrocopos noguchii*	CR	CR	CR	CR	CR	CR	CR	CR	CR	CR	CR
Red-cockaded Woodpecker	*Picoides borealis*	VU	VU	VU	VU	VU	VU	VU	VU	VU	VU	NT
Choco Woodpecker	*Veniliornis chocoensis*	NT*	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
White-browed Woodpecker	*Piculus aurulentus*	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
Fernandina's Flicker	*Colaptes fernandinae*	VU	VU	VU	VU	VU	VU	VU	VU	VU	VU	VU
Kaempfer's Woodpecker	*Celeus obrieni*	EN*	EN*	EN*	EN*	EN	EN	EN	EN	EN	EN	EN
Helmeted Woodpecker	*Dryocopus galeatus*	VU	VU	VU	VU	VU	VU	VU	VU	VU	VU	VU
Black-bodied Woodpecker	*Dryocopus schulzi*	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
Andaman Woodpecker	*Dryocopus hodgei*	NT*	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
Guayaquil Woodpecker	*Campephilus gayaquilensis*	LC	LC	NT	NT	NT	NT	NT	NT	NT	NT	NT
Imperial Woodpecker	*Campephilus imperialis*	CR	CR	CR	CR	CR	CR	CR	CR	CR	CR/PE	CR/PE
Ivory-billed Woodpecker	*Campephilus principalis*	CR	CR	CR	CR	CR	CR	CR	CR	CR	CR	CR
Red-collared Woodpecker	*Picus rabieri*	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
Olive-backed Woodpecker	*Dinopium rafflesii*	LC	LC	NT	NT	NT	NT	NT	NT	NT	NT	NT
Buff-necked Woodpecker	*Meiglyptes tukki*	LC	LC	NT	NT	NT	NT	NT	NT	NT	NT	NT
Great Slaty Woodpecker	*Mulleripicus pulverulentus*	LC	LC	LC	LC	LC	LC	LC	VU	VU	VU	VU

Table 2. Woodpecker species newly added to the IUCN 2014 Red List after taxonomic reappraisals by del Hoyo & Collar (2014).

Common name	Scientific name	2014 IUCN Red List category	Formerly subspecies of	
			Common name	Scientific name
Splendid Woodpecker	*Campephilus splendens*	NT	Crimson-bellied Woodpecker	*Campephilus haematogaster*
Javan Flameback	*Chrysocolaptes strictus*	VU	Greater Flameback	*Chrysocolaptes lucidus*
Red-headed Flameback	*Chrysocolaptes erythrocephalus*	EN	Greater Flameback	*Chrysocolaptes lucidus*
Yellow-faced Flameback	*Chrysocolaptes xanthocephalus*	EN	Greater Flameback	*Chrysocolaptes lucidus*
Spot-throated Flameback	*Dinopium everetti*	NT	Common Flameback	*Dinopium javanense*
White-rumped Woodpecker	*Meiglyptes tristis*	EN	Buff-rumped Woodpecker	*Meiglyptes tristis*
Chequer-throated Yellownape	*Chrysophlegma humii*	NT	Chequer-throated Yellownape	*Chrysophlegma mentale*
Javan Yellownape	*Chrysophlegma mentale*	NT	Chequer-throated Yellownape	*Chrysophlegma mentale*
Sumatran Woodpecker	*Picus dedemi*	NT	Grey-faced Woodpecker	*Picus canus*
Ringed Woodpecker	*Celeus torquatus*	NT	Ringed Woodpecker	*Celeus torquatus*
Atlantic Black-breasted Woodpecker	*Celeus tinnunculus*	VU	Ringed Woodpecker	*Celeus torquatus*
Northern Sooty Woodpecker	*Mulleripicus funebris*	NT	Sooty Woodpecker	*Mulleripicus funebris*
Southern Sooty Woodpecker	*Mulleripicus fuliginosus*	VU	Sooty Woodpecker	*Mulleripicus funebris*
Amami Woodpecker	*Dendrocopos owstoni*	NT	White-backed Woodpecker	*Dendrocopos leucotos*

the increases outlined in the previous section among a constant suite of species: an increase of Red Listed woodpecker species from 20 to 28 (factor 1.4x) and of threatened species from 8 to 12 (factor 1.5x). Nevertheless, the more conservative increase figures from trends in species numbers in the constant suite are arguably a fairer index of trends, because as more subspecies are lifted to species level, average global range size of species drops, hence global populations are smaller, and this increases the probability of species meeting Red List criteria. This issue is exacerbated by the taxonomic approach by del Hoyo & Collar (2014) which adds many small-range species to the list. Their splits are welcome as an improved recognition of actual biodiversity and the improved focus they provide on taxa of conservation concern. However, changes in woodpecker taxonomy do complicate assessments of status trends over time among Red Listed woodpecker species.

As part of further re-evaluations of species status of woodpecker taxa, including with molecular techniques, priority should be given to clarifying the potential species status of taxa that are threatened or probably threatened, including *Dryocopus javensis richardsi* of North Korea (Sonobe & Izawa 1987), *Piculus chrysochloros polyzonus* of coastal Atlantic Forest in southern Brazil, and *P. c. paraensis* of northeast Brazil (Del-Rio et al. 2013).

Red List trends in woodpeckers compared to other birds

Bennett & Owens (1997) reported that on the IUCN Red List of Collar et al. (1994) the woodpecker family had a lower proportion of threatened species than birds in general. The same is true for the 1988 and 2013 iterations of the Red List. In 1988, of all woodpecker species 3.4% were threatened and 8.3% were Red Listed (these numbers are as they appeared on the 1988 list and are not corrected to genuinely listed species based on later insights, thus numbers differ from those in Tables 1 and 3), compared to 11.6% threatened species and 18.7% Red Listed species among all other birds (Collar & Andrew 1988). In 2013, of all woodpecker species 5.5% were threatened and 12.8% were Red Listed, compared to 13.2% threatened species and 22.0% Red Listed species among all other birds. The number of woodpecker species of conservation concern appears to have increased faster between 1988 and 2013 than the comparable number of other birds: the number of threatened woodpecker species increased by a

Table 3. Total number of recognised woodpecker species, number of species in IUCN Red List Categories, and percentage of Red Listed woodpecker species relative to recognised species during 1988–2013. Numbers from the 2014 Red List are based the different taxonomy of del Hoyo & Collar (2014) and are added for comparison. The increase factors were calculated over the years 1988 versus 2013.

	year												increase factor
	1988	1994	2000	2004	2007	2008	2009	2010	2011	2012	2013	(2014)	
Number of recognised species	204	216	216	216	218	218	218	218	218	219	219	(254)	
Near-Threatened species	10	13	14	14	14	14	14	14	14	15	16	(24)	
Vulnerable species	3	3	6	6	6	6	6	7	7	8	6	(9)	
Endangered species	0	0	0	0	1	1	1	1	1	2	3	(6)	
Critically Endangered sp.	3	3	3	3	3	3	3	3	3	2	2	(2)	
Critic. End/ Possib. Ex. sp	0	0	0	0	0	0	0	0	0	1	1	(1)	
Percentage (%) of													
Red Listed (NT+) species	7.8	8.8	10.6	10.6	11.0	11.0	11.0	11.5	11.5	12.8	12.8	(16.5)	1.6x
Threatened (VU+) species	2.9	2.8	4.2	4.2	4.6	4.6	4.6	5.0	5.0	5.9	5.5	(7.1)	1.8x
(Cri.) Endangered/PE (EN+) species	1.5	1.4	1.4	1.4	1.8	1.8	1.8	1.8	1.8	2.3	2.7	(1.2)	1.8x

factor of 1.6x (1.1x in other birds) and Red Listed woodpecker species by 1.5x (1.1x in other birds). However the differences in these increase rates are not significant (Fisher exact test, p = 0.73 for threatened species and p = 0.65 for Red Listed species).

Threat factors affecting Red-Listed woodpecker species

Three broad categories and 10 finer categories of threats drive population declines in the 28 species of woodpecker on the 2013 IUCN Red List (Table 4). In broad categories, habitat loss is the most important threat factor, affecting all Red Listed species except one. The exception is the Imperial Woodpecker for which ca. 80% of original forest cover in its range still exists, although nearly all of that has been strongly modified by logging of large timber and extraction of dead trees for paper pulp (Lammertink et al. 1996). Habitat modification affects 18 species, and increased mortality from unnatural causes affects 4 species. Specifically, hunting affects or affected the two largest *Campephilus* woodpeckers, and predation by introduced species affects two woodpecker species that are small island endemics, Guadeloupe Woodpecker *Melanerpes herminieri* and Okinawa Woodpecker *Dendrocopos noguchii*. Also in finer categories, within habitat loss, the main factor is deforestation for large scale agriculture and urbanization, affecting 25 species. Within habitat modification, the main threat factor is selective logging, affecting 10 species. In other words, these are the species that are dependent on old-growth or near-natural forests. Given the often repeated emphasis on the importance of old-growth or near-natural forests for conservation of woodpeckers (Tanner 1942, Mikusiński & Angelstam 1998, Czeszczewik & Walankiewicz 2006, Virkkala 2006), it is surprising that only 10 out of 28 globally threatened woodpeckers depend on such habitats. Nevertheless, the 10 Red Listed woodpeckers that are affected by selective logging are on average in higher threat categories than the 18 that are not (Wilcoxon W = 46, p= 0.02), underlining the importance of conservation of old-growth and natural forest for the most threatened woodpeckers. The higher threat categories of old-growth dependent woodpecker species can be explained in part by the scarcity of such habitats world-wide (FAO 2010, Lindenmayer et al. 2014), and in part by these species being negatively affected both by deforestation as well as by habitat modification

Table 4. Threat factors affecting 28 woodpecker species on the 2013 IUCN Red List. Source: BirdLife International (2014b) species fact sheets.

Threat factor	N species affected by factor	Species
Habitat loss	27	all species except *Campephilus imperialis*
Deforestation, for industrial agriculture and urbanisation	25	
Deforestation, small holder forest clearance	15	
Artificial lakes	3	*Picumnus varzeae, P. nebulosus, Celeus obrieni*
Habitat modification	18	
Selective logging	10	
Grazing	4	
Forest fire damage	4	
Suppression of forest fire	1	*Picoides borealis*
Destruction of nest trees by parrot trappers	1	*Colaptes fernandinae*
Increased mortality	4	
Hunting	2	*Campephilus imperialis, C. principalis*
Predation by exotic species	2	*Melanerpes herminieri, Dendrocopos noguchii*

through selective logging in the remaining forests; that is, nearly everywhere in their global ranges. The 10 Red Listed woodpecker species that are affected by selective logging are: Speckle-chested Piculet, Okinawa Woodpecker, Red-cockaded Woodpecker, Fernandina´s Flicker, Helmeted Woodpecker, Black-bodied Woodpecker, Imperial Woodpecker, Ivory-billed Woodpecker, Red-collared Woodpecker, and Great Slaty Woodpecker (BirdLife International 2014b).

Geographical distribution of Red Listed woodpeckers

In 2013, Red Listed woodpecker species were distributed as follows over the world: Latin America and Caribbean 57%, Asia 21%, North America 11%, Africa 11%, Europe 0% (Table 5). This is not different from the distribution of all woodpecker species in 2013, nor from the distribution of Red Listed woodpeckers in 1988 (Fisher exact test, $n = 21$, $p = 1$ and $p = 0.93$, respectively). Both in 1988 and 2013, Latin America had the largest number of Red Listed woodpecker species followed by Asia. In both years, in Latin American the percentage of Red Listed species was higher than the percentage of all woodpecker species, whereas in Asia the percentage of Red Listed species was below the percentage of all woodpecker species. After the reappraisals in 2014 of woodpecker taxonomy and Red List status of woodpeckers, 11 Asian woodpecker species were added to the Red List (Table 2). In 2014, Latin America remains ahead over Asia in overall woodpecker species richness (45% versus 29%) as well as in Red Listed woodpeckers (47% versus 40%). However, in 2014 for the first time, the percentage of Red Listed woodpeckers in Asia (40%) is higher than would be expected based on its overall woodpecker species richness (29%), whereas Latin America now has a percentage of Red Listed woodpeckers (47%) similar to its overall woodpecker richness (45%). The relatively high number of threatened woodpecker species in Asia in 2014 reflects both high deforestation rates in Asia (Hansen et al. 2013) as well as an under-recognition of woodpecker species richness in Asia in previous decades.

The number and percentage of threatened woodpecker species in Africa have been consistently modest between 1988 and 2013 and the percentage is even lower in 2014 (Table 5). The low woodpecker species richness and a low number of sympatric woodpecker species anywhere on the continent could mean less niche stacking among

Table 5. Geographical distribution of all recognised woodpecker species and of Red Listed (RL) woodpecker species in 1988, 2013 and 2014. The 2014 numbers are based on the new taxonomy of del Hoyo & Collar (2014).

	1988				2013				2014			
	All species		RL species		All species		RL species		All species		RL species	
	N	%	N	%	N	%	N	%	N	%	N	%
Latin America	100	46	11	52	114	47	16	57	126	45	20	47
Asia	59	27	4	19	66	27	6	21	81	29	17	40
North America	22	10	3	14	23	10	3	11	24	9	3	7
Africa	28	13	3	14	28	12	3	11	35	13	3	7
Europe	10	5	0	0	10	4	0	0	11	4	0	0

the species and hence more flexibility to forest disturbance. Furthermore, most of Africa´s woodpeckers are medium sized; there are few small species and no large species, whereas small and large species are more frequent than expected among Red Listed woodpecker species (Mikusiński 2006). Finally, the rate and extent of deforestation in Africa is lower than that in Latin America and Asia (Hansen et al. 2013).

Europe has no globally threatened woodpecker species: despite population declines and local extinctions of several species in western and northern Europe these same species have large or stable populations in eastern Europe and/or in parts of Eurasia (Mikusiński & Angelstam 1998). The Middle Spotted Woodpecker *Dendrocopos medius*, a European near-endemic and mature forest specialist, may have gone through a rapid global decline in the decades before the first Red List evaluation in 1988, but currently it has a stable or increasing global population (BirdLife International 2014b).

Research output on Red Listed woodpecker species

Although there has been a considerable output of 693 papers on 28 Red Listed woodpeckers between 1988 and 2013, this production is heavily skewed towards three North American species that account for 86% of these papers, with Red-cockaded Woodpecker alone accounting for 435 papers (Table 6). Outside of North America, Kaempfer´s Woodpecker was most intensively published about with 14 papers. Seventeen species had between one and ten papers, and 7 species had no publications about them since 1988. For most Red Listed woodpecker species, information on their ecology and habitat requirements remains scant (Winkler & Christie 2002), and much research remains to be done to facilitate informed measures for improving the situation of these woodpeckers.

PRIORITY SPECIES FOR RESEARCH AND CONSERVATION PROJECTS

To set priorities for research among Red Listed woodpecker species, I argue that the species that are affected by selective logging are most in need of research, to assess their within-habitat and landscape requirements and thresholds, and to so derive measures to stabilise and recover populations of these species. This as opposed to woodpecker species that are affected primarily by deforestation, but that can tolerate considerable within-habitat modification. Such species are best helped not with detailed research but with conservation projects aimed at maintaining forest cover through sustainable use within their areas of occurrence, actions that typically would not be aimed solely at these woodpeckers but at forest biodiversity in general. Nevertheless, some research on woodpecker species on the outside of this dichotomy remains necessary, especially on those that are in the Endangered threat category: Varzea Piculet and Kaempfer´s Woodpecker.

The 10 Red Listed woodpecker species that are affected by selective logging are often in the higher threat categories, an additional reason to prioritise these species for research. Two of the 10, Imperial Woodpecker and Ivory-billed Woodpecker, are at the verge of extinction if not extinct. Despite occasional reports of both species, organised searches to locate surviving individuals in recent decades have been fruitless (Lammertink & Estrada 1995, Lammertink et al. 1996, Rohrbaugh et al. 2007, 2009, Lammertink et al. 2011, Moskwik et al. 2013). If credible reports of either of these two species would again emerge, efforts for documentation, research and recovery would be the top priority in woodpecker conservation, but until then no practical research programme can be executed for these two species. A third species, Red-cockaded Woodpecker, is the only of the Red Listed woodpecker species which

Table 6. The number of papers published on 28 Red Listed woodpecker species prior to 1988 and since 1988, and the threat category of the species on the 2013 IUCN Red List.

Common name	Scientific name	IUCN (2013)	Region	N papers	
				pre-1988	post-1988
White-bellied Piculet	*Picumnus spilogaster*	VU	Latin America	2	0
Guianan Piculet	*Picumnus minutissimus*	NT	Latin America	1	0
Speckle-chested Piculet	*Picumnus steindachneri*	EN	Latin America	2	0
Varzea Piculet	*Picumnus varzeae*	EN	Latin America	1	3
Tawny Piculet	*Picumnus fulvescens*	NT	Latin America	1	4
Mottled Piculet	*Picumnus nebulosus*	NT	Latin America	1	4
Guadeloupe Woodpecker	*Melanerpes herminieri*	NT	Latin America	3	6
Red-headed Woodpecker	*Melanerpes erythrocephalus*	NT	North America	120	73
Knysna Woodpecker	*Campethera notata*	NT	Africa	3	6
Stierling's Woodpecker	*Dendropicos stierlingi*	NT	Africa	3	1
Sulu Woodpecker	*Dendrocopos ramsayi*	VU	Asia	0	0
Arabian Woodpecker	*Dendrocopos dorae*	VU	Africa	2	2
Okinawa Woodpecker	*Dendrocopos noguchii*	CR	Asia	3	4
Red-cockaded Woodpecker	*Picoides borealis*	NT	North America	98	435
Choco Woodpecker	*Veniliornis chocoensis*	NT	Latin America	4	0
White-browed Woodpecker	*Piculus aurulentus*	NT	Latin America	2	6
Fernandina's Flicker	*Colaptes fernandinae*	VU	Latin America	3	2
Kaempfer's Woodpecker	*Celeus obrieni*	EN	Latin America	1	14
Helmeted Woodpecker	*Dryocopus galeatus*	VU	Latin America	2	10
Black-bodied Woodpecker	*Dryocopus schulzi*	NT	Latin America	1	3
Andaman Woodpecker	*Dryocopus hodgei*	NT	Asia	0	0
Guayaquil Woodpecker	*Campephilus gayaquilensis*	NT	Latin America	1	0
Imperial Woodpecker	*Campephilus imperialis*	CR/PE	Latin America	4	8
Ivory-billed Woodpecker	*Campephilus principalis*	CR	North and Latin America	46	88
Red-collared Woodpecker	*Picus rabieri*	NT	Asia	2	2
Olive-backed Woodpecker	*Dinopium rafflesii*	NT	Asia	2	5
Buff-necked Woodpecker	*Meiglyptes tukki*	NT	Asia	10	7
Great Slaty Woodpecker	*Mulleripicus pulverulentus*	VU	Asia	10	10

has improved in conservation status during the past 25 years (Table 1), after intensive research and recovery efforts (Conner et al. 2001). This species remains dependent on appropriate management and restoration of its habitat. Additional research to monitor and guide these continued efforts is welcome, but given the extensive body of knowledge on this species, such research is not an international priority. Excluding these three species, and including two recent additions from the 2014 IUCN Red List and one likely future split, results in the following list of ten woodpecker species for which conservation research is urgent.

Speckle-chested Piculet (EN) has twice moved up in Red List category over the past 26 years while there was no research dedicated to this species during that period (Tables 1 and 6). It is endemic to a small range of about 160 by 60 km in two valleys in northern Peru, where it occurs in tropical and lower montane forests at 1100–2200 m elevation and is known from a few locations only (Schulenberg & Sedgwick 2012, BirdLife International 2014b). It is threatened by deforestation for agriculture and pasture and by selective logging and intrusion into remaining forest areas by an expanding human population. Research is needed into its exact geographic range, habitat requirements and disturbance tolerance, and identification of sites with population strongholds.

Okinawa Woodpecker (CR) is restricted to a range of about 55 by 12 km in the northeast of Okinawa Island, Japan, where an estimated population of 100 to 390 mature individuals survives (BirdLife International 2014b) although this may be an underestimate considering the size of the range. It frequents old-growth forest, particularly for foraging, and it is threatened by deforestation, selective logging, and predation by introduced mongoose and feral cats. Research is needed into its population density in forests of different ages and structures, movements and dispersal between old-growth forest remnants, and rates of predation by introduced mammals, all topics best examined in a radio telemetry study. Approximately 14% of the range area of the bird is on U.S. military bases on the island (http:// en.wikipedia.org/wiki/File:

US_military_bases_in_Okinawa.svg) and although this adds complexity to research and conservation actions, it also means there may be opportunities to fund research into this species through U.S. Department of Defense grants.

Fernandina´s Flicker (VU) of Cuba has a total population of 400–530 mature individuals (BirdLife International 2014b) divided between five widely separated sub-populations that probably have little exchange between one another. It is a bird of open palm savannahs and it is threatened by clearance for agriculture, logging, and the cutting of cavity trees by parrot trappers. The main population in Zapata Swamp appears to have declined at least 20% between 1998 and 2007 (BirdLife International 2014b). A doctorate study by A. Serrano is under way of a community of cavity nesting birds including Fernandina´s Flicker in the Delta del Cauto Protected Area in Granma province (E. Iñigo-Elias pers. comm.). Research that is needed includes periodic transect counts to monitor population trends in all of the sub-populations.

Helmeted Woodpecker (VU) of the southern Atlantic Forest has a global population of between 2,500 and 10,000 individuals (BirdLife International 2014b). Generally scarce, it reaches its best densities in mature forest stands. It is threatened by deforestation and selective logging. Its population strongholds are in the Serra de Paranapiacaba, São Paulo, Brazil, and in Misiones Province, Argentina, where I am making a radio-tracking study of this species since 2012. The goals of this research are to assess density, landscape use, nesting ecology and foraging ecology of Helmeted Woodpecker in logged and mature forests, as well as its co-existence with two large woodpecker species, Lineated Woodpecker *Dryocopus lineatus* and Robust Woodpecker *Campephilus robustus*.

Black-bodied Woodpecker (NT) of xeric woodlands in the Chaco region of north-central Argentina, southern Bolivia, and western Paraguay has a tentative global population estimate of ca. 7,000 mature individuals (BirdLife International 2014b). It is threatened by selective logging and deforestation for agriculture. The rate of deforestation in its range has increased since 2000 and is among the highest deforestation rates globally (Hansen et al. 2013). Research is needed to assess its degree of tolerance to selective logging, improve estimates of its global population status and trends, and to assess to what extent the Chaco areas that are currently being cleared, overlap with stronghold areas of this woodpecker species.

Red-collared Woodpecker (NT) of lowland forests in Laos, Vietnam and Cambodia is generally scarce and is declining due to forest loss and degradation. Research is needed into its tolerance to habitat disturbance, population trends, and nearly all basic aspects of its biology (Winkler & Christie 2002).

Great Slaty Woodpecker (VU) is the largest woodpecker in Southeast Asia. It uses large trees for both foraging and nesting and shows marked population declines with selective logging of mature forests (Lammertink et al. 2009, Baral 2011, Kumar & Shahabuddin 2012). It is threatened by rapid rates of deforestation and logging of old-growth forest including in its strongholds in Myanmar, Cambodia and Borneo (Lammertink et al. 2009, Hansen et al. 2013). Research is needed to assess the reproductive rate and the long-term viability of reduced populations in disturbed forests, and to assess priority sites for conservation of old-growth habitat, particularly in Myanmar.

Yellow-faced Flameback of the Philippine islands Panay, Negros, Guimaras and Masbate has suffered from deforestation and hence habitat loss of between 92% and 100% on the four islands (Curio 2002, and http://www.google.com/earth/), and the only recent records come from Negros. Its total population may be below 500 mature individuals, and research is needed to assess its current distribution, densities, reproductive success, and habitat requirements. The other recently Red Listed splits from the Greater Flameback complex (Javan Flameback and Red-headed Flameback, Table 2) are also of research interest but are better known than Yellow-faced Flameback, and both occur in several protected areas.

White-rumped Woodpecker of Java appears to be extremely rare and, as all Javan forest endemics, contends with the effects of extensive deforestation and fragmentation, pressure from a dense human population on remaining forests including in protected areas, and indiscriminate large scale bird trapping. Whereas the sister taxon Buff-rumped Woodpecker *Meiglyptes grammithorax* is common and tolerant to forest disturbance elsewhere in the Sundaic region (Lammertink 2004, Styring & Hussin 2004), White-rumped Woodpecker has not been recorded in intensive surveys of forest birds in Java (van Balen 1999) and there appear to have been only two sightings in the past 50 years, both by D. Liley at Gunung Halimun in 1994 (S. van Balen and D. Liley pers. comm.). Surveys are needed to clarify the current status and distribution of White-rumped Woodpecker, perhaps using playback initially of sounds

of Buff-rumped Woodpecker as there are no known recordings of White-rumped Woodpecker. **Korean White-bellied Woodpecker** *Dryocopus* [*javensis*] *richardsi*: if species level status is confirmed for this taxon it would rank among the most critically endangered woodpecker species. It is extinct in South Korea and on Tsushima island (Japan) and is now down to a population of probably less than 40 individuals in North Korea, if still extant (Fiebig 1993). Surveys and protective measures for this taxon are very urgent but also highly challenging given the political situation and socio-economic pressures in North Korea.

For each of the priority species, recommended research actions should be accompanied by, or followed up by, conservation actions. This includes communication of results to land managers and governments, a search for solutions with local stakeholders, and an inclusion of desired improvements in environmental education, as well as strategic alignment with conservation efforts for other biodiversity.

CONCLUDING REMARKS

An emphasis in research priorities on woodpeckers that are affected by selective logging, including globally and regionally threatened species, puts a spotlight on the importance of the protection of old-growth forests in the ranges of each of these species. Old-growth forests are usually the habitats where specialist woodpeckers reach their best densities and best reproductive rates (Tanner 1942, Carlson & Aulén 1992, Lammertink et al. 2009) and these forests are indispensable as reference sites in research and as population strongholds. Globally, conservation strategies have moved away from the total protection of habitats to the development of sustainable, multiple uses by community stakeholders (Naughton-Treves et al. 2005). There is a lot of merit to this current approach and it is often the only viable option for the conservation management of large landscapes. Nevertheless, the strict protection of generally small and few old-growth remnants in forest ecosystems must remain in focus. There is an important role for biologists working with specialist woodpecker species in advocating the importance of old-growth protection and the restoration to old-growth conditions in select, formerly logged areas.

Up to the present, the bulk of woodpecker research is concentrated in North America and Europe (Mikusiński 2006), and is often aimed at regionally threatened species that have secure populations elsewhere, or at common species in behavioural or ecological research. While there are valid motivations for these research avenues, it is imperative that woodpecker researchers dedicate more of their expertise and resources to globally threatened woodpecker species, to help prevent an erosion of woodpecker diversity from global extinctions. Research groups working with woodpeckers should include more PhD and student projects about globally threatened woodpeckers. Researchers with main projects in the northern hemisphere could dedicate field research on threatened woodpeckers outside their main field seasons. For some threatened species, information is so scant that even a short project of several weeks can yield important new information. Woodpecker conservation research would further be stimulated by the creation of a grant fund dedicated to this family, similar to existing funds for raptors, cranes, and parrots.

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STRESZCZENIE

[Zmiany w ocenie stopnia zagrożenia wyginięciem oraz priorytety w ochronie dzięciołów]

Posługując się Czerwoną Listą Gatunków Zagrożonych Międzynarodowej Unii Ochrony Przyrody i Jej Zasobów (IUCN) z 1988 r. jako punktem odniesienia, opisano zmiany, jakie zachodziły w ciągu ostatnich 25 lat w ocenie statusu zagrożenia dzięciołów na świecie, w rozmieszczeniu geograficznym gatunków z Czerwonej Listy i czynnikach wskazywanych jako odpowiedzialne za zmiany ich liczebności. Przeanalizowano także liczbę publikacji dotyczących zagrożonych gatunków dzięciołów.

W okresie pomiędzy 1988 a 2013 r. zostało opublikowanych 11 wydań Czerwonej Listy IUCN. Uwzględniając zmiany związane ze wzrastającą liczbą informacji o statusie i liczebności gatunku, wśród 28 gatunków zanotowano w tym okresie 13 zmian w kategorii stopnia zagrożenia, 12 z nich dotyczyły zwiększenia stopnia zagrożenia i tylko w przypadku dzięcioła skromnego status zmienił się z „narażony" na „bliski zagrożenia" (Tab. 1). Liczba gatunków dzięciołów wykazywanych na Czerwonej Liście tj. w kategoriach począwszy od „bliskie zagrożenia" i wyższej wzrosła z 20 do 28 gatunków, zaś w grupie zagrożonych wyginięciem tj. kategoriach począwszy od „narażone" i wyżej — z 8 do 12 (odpowiednio wzrost o 1,6 i 1,8 raza — Tab. 3). Rozmieszczenie geograficzne gatunków dzięciołów wykazywanych w Czerwonej Liście nie zmieniło się od 1988 r. — połowa tych gatunków zasiedla Amerykę Łacińską, a jedna czwarta Azję. W Europie nie ma obecnie gatunku, który mógłby być zaliczony do którejś z kategorii zagrożenia (Tab. 5). W związku ze zmianami taksonomicznymi, zwłaszcza z podniesieniem do rangi gatunku wielu podgatunków (Tab. 2), liczba gatunków dzięciołów wzrosła do 254. Zmiany te spowodowały wzrost liczby gatunków dzięciołów na Czerwonej Liście do 42, z których 40% zasiedla Azję (Tab. 5).

Utrata i zmiany zachodzące w siedliskach, oraz wzrost śmiertelności to główne grupy zagrożeń dla analizowanych 28 gatunków dzięciołów. Wśród nich 10 jest zagrożonych przez selektywne pozyskiwanie drewna — są to gatunki klasyfikowane w kategoriach „zagrożone wyginięciem" (Tab. 4).

Badania naukowe i działania ochronne powinny koncentrować się przede wszystkim na gatunkach wrażliwych na wyrąb selektywny. Dotychczas badania naukowe prowadzone na zagrożonych gatunkach dzięciołów skupiały się przede wszystkim na trzech gatunkach północnoamerykańskich — dzięciurze krasnogłowym, dzięciole skromnym i dzięciole wielkodziobym (Tab. 6). Autor przedstawia listę 10 priorytetowych gatunków, które wymagają jak najszybszych badań i zabiegów ochronnych: 4 zasiedlających Amerykę Łacińską i 6 — Azję.