

**ABSTRACTS
SPECIAL SYMPOSIUM**

**The Ecology of Large Woodpeckers
History, Status, and Conservation
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PRESENTATIONS

Rediscovery of the Ivory-billed Woodpecker (*Campephilus principalis*)

Scott Simon, The Nature Conservancy, Arkansas Field Office, Little Rock, ssimon@tnc.org

The rediscovery of the Ivory-billed Woodpecker in the Arkansas Big Woods came about through a chain of remarkably fortuitous events. First, on 11 February 2004, kayaker Gene Sparling made a sighting of a perched Ivory-billed Woodpecker at short range on Bayou DeView. Then, on 27 February 2004, at nearly the same spot, Tim Gallagher of the Cornell Laboratory of Ornithology and Bobby Harrison of Oakwood College, Alabama, together observed an Ivory-billed Woodpecker in flight. For the first time in 60 years an Ivory-billed Woodpecker sighting had been confirmed. Finally, on 25 April 2004, again not far from the site of the first sighting, David Luneau of the University of Arkansas at Little Rock obtained 4 seconds of an Ivory-billed Woodpecker departing from a tree trunk. The video contributes crucial documentation of the existence of the Ivory-billed Woodpecker in Arkansas Big Woods. Due to technical imperfections, the woodpecker in the Luneau video offers a challenging identification puzzle but comparisons with images of Pileated Woodpecker in flight and a reenactment with models of Ivory-billed Woodpecker and Pileated Woodpecker demonstrate the videoed bird is indeed an Ivory-billed Woodpecker. Sound recordings by the Cornell Laboratory of Ornithology indicate the existence of at least several individuals. The rediscovery was published in *Science* on 3 June 2005. The forest area under conservation management in the Arkansas Big Woods has been drastically expanded during the past 30 years and the story of this conservation effort is also remarkable. Further conservation is underway led by a partnership of government agencies and NGOs. A recovery team for the Ivory-billed Woodpecker was established in August 2005. The current symposium aims to exchange information on species ecologically similar to the Ivory-billed Woodpecker to improve the knowledge required for conservation of the world's largest woodpeckers and their forests.

Status of what we know and what we need to know about the Ivory-billed Woodpecker (*Campephilus principalis*)

Ken Rosenberg, Cornell Laboratory of Ornithology, kvr2@cornell.edu

The remarkable rediscovery of the Ivory-billed Woodpecker has led to perhaps the largest search effort ever for a single species, as well as one of the highest-profile endangered species recovery efforts ever in the United States. Determining the status of the current population and recovering the Ivory-billed Woodpecker to some sustainable future level will require us to synthesize and interpret what we already know about the species, make many assumptions based on what we think we know, acknowledge the critical gaps in our knowledge, and develop an innovative and efficient plan for acquiring new knowledge. We *know* that the

Ivory-billed Woodpecker was a noble inhabitant of pre-European settlement southeastern forests, both bottomlands and upland pine savannahs; that it was a specialist on large beetle larvae that attacked recently dead and dying trees; that its behavior and biology were inexorably tied to large cavities for roosting and nesting. We also *know* that the noble Ivory-billed Woodpecker is not extinct, based on a body of evidence from the Luneau video, several sight records, and recorded sounds from eastern Arkansas in 2004-2005. Based on the extensive work of James Tanner at Louisiana's Singer Tract in the 1930s, we have a detailed understanding of the biology of that specific remnant Ivory-bill population, including size of territories and home range, preferred feeding, roosting, and roosting sites, and use of specific microhabitats. We *think we know*, therefore, the basic habitat requirements of the Ivory-bill, at least in the Mississippi Delta bottomlands, focusing our modeling and search efforts in the maturing hardwood forests along the edges of the wetter cypress-tupelo swamps. To successfully locate, study, and ultimately recover a population of Ivory-billed Woodpeckers, however, we still *need to know*: how many birds exist in the Big Woods? Are they successfully reproducing? Is sweetgum-Nuttall's oak really the preferred habitat association? What are the birds feeding on and how far do they range? How much dead wood and other habitat features is required for a sustainable population? And perhaps most importantly, can we manage the southeastern forests to promote and maintain conditions suitable for Ivory-bills to flourish over the next century or more. To fill these critical gaps in our knowledge, we are launching a massive search effort, combined with detailed forest inventories, and habitat and population modeling. An intriguing supplement to these efforts is the prospect of using other large woodpeckers, including the sympatric Pileated Woodpecker, congeneric *Campephilus* species, and other ecological counterparts around the world, as surrogates for studying and understanding the biology of the elusive Ivory-bill – indeed this is the impetus for the present symposium.

Ecology of the four largest woodpeckers: similarities in requirements and threats

Martjan Lammertink, Cornell Laboratory of Ornithology, jml243@cornell.edu

Insights into the ecology of the Ivory-billed Woodpecker (*Campephilus principalis*) can be derived from comparisons with similarly sized woodpeckers and from contrasts with smaller woodpeckers. Among the world's ca. 210 woodpecker species, there are only four taxa that reach body masses over 400 g: Ivory-billed Woodpecker, Imperial Woodpecker (*C. imperialis*), Great Slaty Woodpecker (*Mulleripicus pulverulentus*), and Korean White-bellied Woodpecker (*Dryocopus javensis richardsi*). These four largest woodpeckers all forage predominantly in large old trees, have large home ranges, require mature forests, and consequently are threatened with extinction. At least three of the four frequently live in groups, probably to allow optimal exploitation of localized or ephemeral concentrations of food resources. Their grouping increases area demands and aggravates the impact of hunting. In contrast, smaller woodpeckers in all three genera are less social, have smaller home ranges, persist in disturbed forest, and are not threatened. In a community of 14 woodpecker species in Borneo, several aspects of foraging behavior correlated with body mass, but the largest woodpecker, Great Slaty Woodpecker, diverged from most of these correlates. The type of substrates that the correlates predicted to be most suited for a woodpecker the size of a Great Slaty Woodpecker (large diameter branches and trunks with rough bark) are scarce in primary forests and become rarer in disturbed forests. Whereas gigantism is frequently observed in fossils of many vertebrate lineages, no woodpeckers larger than Imperial Woodpecker occur in the fossil record. The four largest woodpeckers appear to be at the limit of ecological possibilities, rendering these species highly vulnerable to disturbance and fragmentation of forests. The 'big four' in the woodpecker family are among the vertebrates best suited to gauge quality and integrity of forest ecosystems and deserve to be the focus of conservation studies and actions.

Current and desired habitat conditions in the Big Woods

Tom Foti, Arkansas Natural Heritage Commission, tom@arkansasheritage.org

The “Big Woods” of Arkansas is the corridor of bottomland hardwood forest along the White River and its tributaries Cache River and Bayou De View, the lower Arkansas River and its tributary Bayou Meto, and the Mississippi River near the mouths of the White and Arkansas rivers. At approximately 500,000 acres, it is the largest block of forest remaining in the northern Mississippi Alluvial Valley or “Delta”, but is only a small remnant of the original 8,000,000 acres of forest in the Arkansas Delta alone. Forest types in the Big Woods range from semi-permanently inundated cypress-tupelo swamp through overcup oak–water hickory forest on sites with long-duration flooding to forests dominated by Nuttall oak, willow oak, sugarberry and ash on sites with less frequent flooding. In general, forests along the Arkansas and Mississippi rivers are dominated by riverfront cottonwood, sugarberry, ash and pecan with sweetgum more common in the presettlement forest than today. Oaks are dominant along the White River. In the original Arkansas Delta, there were substantial areas (now mostly cleared) of both hardwood and pine forest and woodland that were seldom or never flooded. Therefore habitat then was more diverse than today. Habitat conditions vary by land ownership; over 300,000 acres are publicly owned, with about 70,000 acres owned by forest industry and the remainder by private, non-industrial landowners, many of which are hunting clubs. Substantial additional acreage of farmland has been planted in the last two decades, primarily through USDA Wetland Reserve Program and Conservation Reserve Program. On public lands, volume of dead wood, important for Ivory-billed Woodpecker (IBWO) food resources, is thought to be substantial because the forests are relatively mature and dead/dying trees are retained for wildlife purposes. Public lands in the Big Woods are currently being inventoried to better estimate IBWO habitat conditions. Industrial forest land is managed more aggressively than are public lands and volume of dead wood is generally lower. In response to reports of IBWO, a principal industrial forest owner, Anderson-Tully Company, has implemented a policy of leaving some older trees in harvested stands near the White River National Wildlife Refuge. Management and condition of non-industrial timberlands varies widely; assistance and incentive programs can play important roles in encouraging appropriate management of these lands. Forests in the Big Woods are being stressed by a number of landscape changes, including modification of White River hydrology by operation of flood-control reservoirs that increase low flows in the summer. Drainage of adjacent agricultural lands and release of irrigation water (which also increases beaver activity) has made many areas wetter. Channel instability with increased erosion and altered hydrology has resulted from construction of navigation improvements. Proposed and existing irrigation and navigation projects will further alter the natural system. Conservation of Ivory-billed Woodpecker habitat in the Big Woods will require comprehensive protection and management actions at multiple scales.

Ranging behavior of Pileated Woodpeckers (*Dryocopus pileatus*) in Missouri based on radio telemetry studies

Rochelle Renken, Missouri Department of Conservation, Rochelle.Renken@mdc.mo.gov

Pileated Woodpeckers were radio-tagged during 1985-1987 in central Missouri, USA, to estimate territory size and determine what forest habitat features were related to territory size. The telemetry data has subsequently been used to estimate movement rates (in meters/hour) of successfully breeding and failed breeding Pileated Woodpeckers, and to examine movements and home range of woodpeckers in relation to nest site location. Successfully breeding and failed breeding Pileated Woodpeckers had similar movement rates. Pileated Woodpeckers that were incubating eggs and feeding chicks still in the nest ranged over less area than Pileated Woodpeckers with fledged chicks or failed nests. For about half of the successfully breeding woodpeckers, nests were located near the center of their home range. Other aspects of the use of telemetry in the study of Pileated Woodpeckers will be discussed in the presentation.

Woodpecker densities and dead wood volumes in the Arkansas Big Woods habitats of the Ivory-billed Woodpecker (*Campephilus principalis*)

Utami Setiorini, Martjan Lammertink, Elliott C. H. Swarthout, Peter H. Wrege, and Ron Rohrbaugh, Cornell Laboratory of Ornithology, usetiorini@hotmail.com

In the only detailed study on the ecology of the Ivory-billed Woodpecker (*Campephilus principalis*), Tanner (1942) reported that this species preferred mature bottomland hardwood forests dominated by sweet gum, oaks and green ash. Characteristics of Ivory-billed Woodpecker habitats included a high density of other woodpecker species, particularly of Pileated Woodpecker (*Dryocopus pileatus*) and Red-bellied Woodpecker (*Melanerpes carolinus*), and a high volume of standing dead wood. Ivory-billed Woodpeckers were generally absent, and other woodpeckers less abundant, in cypress-tupelo swamp forests (Tanner 1942). In contrast, all sightings of Ivory-billed Woodpecker in Bayou DeView in the Arkansas Big Woods in 2004-2005 were in a cypress-tupelo swamp. We assessed woodpecker densities and dead wood volumes in the sightings area and other forest types in the Arkansas Big Woods to evaluate Tanner's findings. Twelve transects of 2.4 (1.5 mi) or 3.0 km (1.9 mi) in length were each surveyed 12 times in April 2005. Dead wood volumes were assessed in a 20-m (66-ft) wide strip along the transects. Four transects were in mature cypress-tupelo swamp forests in the sightings area, two transects were in nearby hardwood forests with a history of recent logging, and six transects were in mature bottomland hardwood forests in the southern part of White River NWR. Six resident and one migratory species of woodpecker were recorded during the transect surveys with a total of 4875 detections. Pileated Woodpeckers and Red-bellied Woodpeckers reached their highest densities (up to 16 and 61 individuals/km² respectively, or 41.4 and 158.0 individuals/sq mile) in the cypress-tupelo swamps where the Ivory-billed Woodpecker was seen. Total woodpecker density and biomass were highest in the mature hardwood forests, and only slightly lower in mature cypress-tupelo swamps. Woodpeckers were significantly less abundant in the younger hardwoods. Woodpecker biomass showed a significant correlation with the available volume of standing dead wood. For an Ivory-billed Woodpecker core home range to encompass 14,908 m³ (526,471 ft³) of standing dead wood (Shoch 2005) it would have to measure 24.5 km² (9.5 sq mile) in the Bayou DeView cypress-tupelo swamps, 61.3 km² (23.7 sq mile) in managed hardwood forests and 27.4 km² (10.6 sq mile) in mature hardwoods in the White River NWR, compared to only 10.4 km² (4.0 sq mile) in the Singer Tract (Tanner 1942). Further searches in Arkansas and elsewhere for Ivory-billed Woodpecker should focus on cypress-tupelo swamps at least as much as on bottomland hardwood forests.

Ecology and status of the Korean White-bellied Woodpecker (*Dryocopus javensis richardsi*)

Jürgen Fiebig, Museum of Natural History Berlin, juergen.fiebig@museum.hu-berlin.de

Although there is only scarce information on its present situation, I attempt to outline the status and survival chances of the Korean White-bellied Woodpecker (*Dryocopus javensis richardsi*) which is endemic to the Korean Peninsula. The taxon *richardsi* is distinguished from other forms in the *Dryocopus javensis* complex by its very large size, more purely black and white plumage, and lack of red in the head plumage of the female. The smaller, tropical southeast Asian forms persist in disturbed forests but *richardsi* requires mature stands of oak, chestnut and pine trees and is now critically endangered. From 1987 to 1990 I traveled through most of the North Korean provinces for ornithological studies. In 1996 I visited the last breeding place in South Korea, from 1981, of the Korean White-bellied Woodpecker there, which is in Gwangneung Forest, north of Seoul. On two occasions, in May 1989 and May 1990, I observed this woodpecker in a North Korean reserve near Pongtanri village, North-Hwanghae Province, that was especially established for this woodpecker. One breeding pair was photographed at the nest hole and sound recordings were made of calls and drumming, of which sonograms are presented. A reconstruction is presented of the former area of distribution of *richardsi* based on data given in the (historical) literature as well as data on the ecology and breeding biology in Korean literature. The current

global population of *richardsi* is restricted to North Korea and is presumed to number between 10 and 30 individuals.

Ecology and social behavior of the Magellanic Woodpecker (*Campephilus magellanicus*) in temperate Patagonian forests

Valeria Ojeda, Universidad Nacional del Comahue, Argentina, campephilus@bariloche.com.ar

The Magellanic Woodpecker (*Campephilus magellanicus*) is endemic of the Austral Temperate Forests of South America (Chile and Argentina), where it resides year-round. Through the excavation of large holes, it is a potential keystone habitat modifier in these ecosystems. It is categorized as vulnerable (*sensu* IUCN) in Chile and of “special concern” for the National Parks staff in Argentina. Besides, it is threatened of extinction in several Chilean provinces where recovery plans based on reliable biological data are needed. Here, I summarize data on the social and breeding biology of this woodpecker, based on several territories monitored and >30 active nests located from 1998–2004 in forests from northwestern Argentine Patagonia. Woodpeckers normally traveled in pairs or family parties (2-4 individuals) which, on average, used 100-200 ha of continuous old-growth forest throughout the year, although home ranges were much larger in winter, when territorial behavior was greatly depressed and two or more family groups could gather at optimum foraging sites. In early Austral spring, pairs became territorial and actively defended large forest areas, both around prospective nests or actual foraging sites far from nesting spots. Breeding occurred between mid- to late spring and early to mid-summer, and took about 65 days. Monogamous parents shared duties in nest excavation, incubation and young rearing. Incubation took roughly 18 days. Clutch size was two eggs, occasionally one, and only one or no nestling survived at any nest, despite the number of hatchlings initially produced. Nestlings were altricial and remained at the nest for 45-48 days. Young remained with their family group for up to 2 years or more, and were fed by adults frequently during their first year; this dependence was related to pairs that bred every second year. Nest predation and helpers at the nest were not recorded. Nest-reuse was observed only once in a highly disturbed site lacking mature trees. A pair excavated a new nest and several roosting holes each year. To accommodate a completed cavity 25.6±3.7 cm wide (horizontally) and 32.3±5.3 cm deep (vertically), a tree at least 32 cm in diameter at nest height was required, and most (>90%) completed cavities were excavated in trees larger than 35 cm DBH. Holes were placed between 4-12 m high, but mean height at any site depended greatly on the average height of the forest and other stand characteristics. Nest hole dimensions were very stable among sites, while roosting holes (mostly old cavities) were more variable in size. Nest entrances (±SD) were 8.92±0.46 cm wide and 15.59±2.54 cm high and mostly oval in shape. Peculiarities of the breeding biology and social behaviour of this species are analyzed in comparison with those known for other *Campephilus* spp., especially *C. principalis*. Remarkably, in addition to considerations on habitat requirements, life history traits such as reduced brood size, very high parental investment and low survival of nestlings/juveniles seem to be limiting population numbers in these species and should be included as relevant issues in the delineation of recovery plans.

The status of the Imperial Woodpecker (*Campephilus imperialis*) habitats in Western Mexico and recent reports

Jorge Necedal¹, Xico Vega, Miguel A. Cruz, Alberto Lafón and Adolfo Navarro, ¹Instituto de Ecología, Durango, Mexico, necedal@prodigy.net.mx

Although in the last 10-15 years there have been several attempts to determine the status of the Imperial Woodpecker or Pito Real, as it was known in northern Mexico, in its natural habitat, the surveys carried out throughout the Sierra Madre Occidental have been rather isolated in time and space. The most recent record, well documented is for the State of Durango (Fleming and Baker 1963) from the late 50's. Its

present status, according to the Red Data Book, is that of a species in serious risk of extinction (King 1981), whereas more recently it is considered as Critically Endangered (BirdLife International 2000). This status is formally and widely accepted because of the lack of recent sightings despite intensive searches and because habitat availability has decreased in recent decades mostly owing to the logging of mature pine forests. In 2000 one of us (JN) did a survey in the northern Sierra Madre Occidental, particularly in the states of Chihuahua and Durango. At localities selected based on their isolation from roads and the type of forest cover, as determined from aerial photographs, land surveys were carried out first, to determine the structure of pine and pine-oak forests, so the existence and status of mature old-growth pine and pine-oak forests was documented, not presumed. Although none of the sites selected sheltered old-growth forests, a clear outcome was the need for more surveys to sites that might fulfill the habitat requirements of this species. Field surveys and interviews with local people have been carried out in the states of Sonora, Chihuahua, Durango, Zacatecas, and Jalisco by one of us (MAC) for more than ten years and although some of the interviewed people claim to have seen the species these records must be evaluated very carefully in terms of their certainty. Also working in the sierra in the state of Chihuahua, one of us (AL) had support from the US Fish and Wildlife to search for this species in the western part of the state and the northern part of Durango. And one more of us (XV) has been surveying the southern part of the sierra in the states of Nayarit and Jalisco. We firmly believe that there is a little chance that this magnificent bird may still roam the largest and widest mountain range in Mexico.

Molecular evidence for the phylogenetic position of the genus *Campephilus* in the woodpecker family

William S. Moore¹, Martjan Lammertink and Kathleen J. Miglia¹, ¹Department of Biological Sciences, Wayne State University, Detroit, wmoore@biology.biosci.wayne.edu

The “true woodpeckers” comprise the subfamily Picinae in the family Picidae (Piciformes). The diminutive piculets in the paraphyletic subfamily Picumninae are sister to the woodpeckers and the wrynecks (subfamily Jynginae) are sister to the woodpecker-piculet clade. The most widely cited classifications of woodpeckers are substantially based on plumage characteristics. However, DNA-sequence-based phylogenies indicate that convergence in plumage patterns has been common in woodpecker evolution and as a consequence, earlier classifications are substantially incorrect. Phylogenetic analyses based on the mitochondrial cyt b, COI and 12S rRNA genes and intron 7 of the nuclear gene β -fibrinogen infer three major lineages of woodpeckers: Malarpicini (*Colaptes*, *Piculus*, *Celeus*, *Dryocopus*, *Mullerpicus*, *Dinopium*, *Meiglyptes*, *Picus*, *Campethera* and *Geocolaptes*), Megapicini (*Campephilus*, *Chrysocolaptes*, *Reinwardtipicus* and *Blythipicus*) and Dendropicini (*Picoides*, *Veniliornis*, *Dendropicos*, *Melanerpes*, *Sphyrapicus*, *Xiphidiopicus* and *Sapheopipo*), which diverged from a common ancestor over a short period of time early in the evolutionary history of woodpeckers. Remarkably, the Antillean Piculet, is not a piculet but rather the basal woodpecker (B.W. Benz, A.T. Peterson and M. B. Robbins; G. F. Barrowclough, personal communication). The Pileated and Ivory-billed Woodpeckers are not closely related and their similarity, which poses problems for the ivory-billed search project, is the result of convergent evolution. Other more striking examples of convergent plumage patterns include the Hairy and Downy Woodpeckers, the Lineated and Crimson-crested Woodpeckers in South America and the *Dinopium-Chrysocolaptes* complex in southeast Asia. Relative to other major radiations (e.g., passerines), the woodpeckers are not very old. Based on molecular clock estimates, the base of the woodpecker radiation is estimated to be 7-8 MY old, but the separation from the piculets is considerably older, 8-15 MYA. Although the woodpeckers are most species-rich in South and Central America, the distribution of extant species and higher taxa (genera and tribes) in context of the DNA-sequence tree suggest that woodpeckers originated in Eurasia.

The role of human depredations in the decline of the Ivory-billed Woodpecker (*Campephilus principalis*)

Noel F.R. Snyder, Portal, Arizona, nfrs16426@vtc.net

In virtually all modern accounts, the endangerment of the Ivory-billed Woodpecker has been attributed mainly to (1) extreme foraging specialization, leading to a crucial dependency of individuals on vast areas of pristine woodlands to obtain sufficient food, and (2) the logging of nearly all virgin forests in the species' original range. However, rigorously persuasive evidence for the ivory-bill being an extreme foraging specialist appears to be lacking, and the numerous reports of early abundance of the species across its original range are difficult to reconcile with a dependency of individuals on vast areas of mature forests. Although the ivory-bill did exhibit sparse populations and a frequent close association with remnant virgin forests as it approached extinction, these characteristics may have been due mainly to factors other than food stress. In particular, direct human depredations may have been more important than habitat modification and food scarcity in producing the species' decline. The loss of certain Florida populations to zealous specimen collecting has long been acknowledged. But in addition, there are other populations for which evidence plausibly suggests extirpation mainly due to subsistence, curiosity, and sport killings. The high vulnerability of the ivory-bill to human depredations was often noted in historical accounts, and no substantial regions are known that were free of such threats. In many regions major ivory-bill declines clearly took place before logging operations were initiated, suggesting that habitat destruction was at most a secondary stress, whatever the primary stress may have been. Logging must surely have greatly lowered the carrying capacity of most woodlands for the species, but not necessarily to the point where food supplies were inadequate to support any ivory-bills. Instead, logging's most significant detrimental role may have been the facilitation of human depredations on remnant populations, especially by providing much improved access to formerly remote regions, a role increasingly recognized as crucial in the current disappearance of vulnerable wildlife species from tropical forests around the world.

Status of the acoustic search for Ivory-billed Woodpecker (*Campephilus principalis*) in the U.S

Russ A. Charif¹, Kathryn A. Cortopassi, Harold K. Figueroa, Ken V. Rosenberg, and John W. Fitzpatrick,
¹Cornell Laboratory of Ornithology, r.charif@cornell.edu

As part of the 2004-2005 search for Ivory-billed Woodpecker (*Campephilus principalis*) in eastern Arkansas, we collected over 17,000 hours of acoustic data from 153 sites in the Cache River and White River National Wildlife Refuges. Data were recorded by programmable digital audio recorders deployed for two to six weeks at each site. Audio files were initially screened using a spectrogram correlation based algorithm that detected sounds similar to templates of known Ivory-bill vocalizations and double-knock display drums recorded from other *Campephilus* woodpeckers. Sounds selected by this automated process were further screened by human experts through spectrographic and aural examination. Several sequences of "kent-like" notes similar to those of Ivory-bills, and numerous double-knock display drums have been found. Quantitative comparison of kent-like notes to recordings of known Ivory-billed Woodpecker, Blue Jay (*Cyanocitta cristata*) and White-breasted Nuthatch (*Sitta carolinensis*) indicates that they are most similar to Ivory-bill notes. However, several observers have reported hearing Blue Jays in this area produce atypical notes that are similar to those of Ivory-bills. We are presently unable to rule out Blue Jay as a possible source of these sounds. One objective of the upcoming field season will be to record the full range of vocalizations of Blue Jays in this area, in order to improve our ability to discriminate between unusual Blue Jay notes and Ivory-bill notes. Apparent double-knock display drums were concentrated in a few locations, and occurred most frequently around sunrise and sunset.

The demise of the Imperial Woodpecker (*Campephilus imperialis*): known specimens, historic range, and reasons for extinction

David E. Brown¹ and Kevin B. Clark,¹ Arizona State University, Tempe, Bosco069@aol.com

We assessed the historical distribution, specimen history, and current prospects for the Imperial Woodpecker (*Campephilus imperialis*). On the basis of ±160 specimens in museum collections, we mapped the historical range of this species as having been restricted to Madrean Conifer Forest in 6 states in western Mexico. Range limitations may have been correlated with the distribution and abundance of prey items, specifically *Oropyrodes maculicollis* (Cerambycidae). Habitat assessments and overflights of key areas of historic range, together with descriptions of other investigators, implicate direct exploitation as the primary cause of extirpation, with timber harvest a contributing factor in most areas. Even though localized areas of suitable habitat remain, the possibility of any populations persisting is remote, and any surviving individuals are threatened by shooting.

Habitat use and threat status of the Great Slaty Woodpecker (*Mulleripicus pulverulentus*)

Martjan Lammertink¹, Dewi M. Prawiradilaga, Thet Zew Naing, and Will Duckworth,¹ Cornell Laboratory of Ornithology, jml243@cornell.edu

Asia's largest woodpecker, the Great Slaty Woodpecker, has a large distribution range that includes 13 countries, stretching from Nepal and northern India in the west, eastward to Vietnam and southern China and south to Java and Borneo. This large range, and variation in ecology among its two subspecies complicates obtaining a grasp on the global population trend of the Great Slaty Woodpecker. The southern subspecies *M. p. pulverulentus* is restricted to lowland rainforests below 200 m of elevation in peninsular Thailand, Malaysia and Myanmar; Palawan, Borneo, and Java. Whether or not it occurs on Sumatra, even historically, is unclear. Throughout the range of *pulverulentus* the required lowland forests are being cleared for agriculture, oil palm plantations, and urban development. Areas within the range still under forest cover are heavily impacted by industrial logging, widespread illegal hand logging, and forest fires. Great Slaty Woodpeckers forage predominantly in large trees, where groups of 3-6 individuals search for and exploit nests of social insects. Population density of this woodpecker is reduced by an average 83% in once-logged forests compared to primary forests. Primary lowland forests in protected areas in the range of *pulverulentus* are all under 100 km² in size and are generally not secure from degradation. The southern subspecies thus is certainly endangered. The northern subspecies *M. p. harterti* occurs in the remainder of the range of the species in continental Asia. It ranges higher into hills than *pulverulentus*, to 500 m and rarely up to 1000 m elevation. The larger elevational amplitude and distribution range of *harterti* may make its status slightly more secure. Nevertheless, even historically *harterti* was local and scarce throughout most, if not all, of its range; it, too, is associated with mature forests and suffers from logging and forest clearing. Countries in the range of *harterti* generally have little forest remaining below 500 m elevation, except for Cambodia and Myanmar. The still extensive lowland forests in these two countries are logged at a rate and in a manner that is not ecologically sustainable and has resulted in a marked reduction in the area of mature forest in recent decades. In Nepal, *harterti* was recently listed as Nationally Endangered and this situation is likely indicative for the status of *harterti* elsewhere. Overall, the available information indicates the global status of the Great Slaty Woodpecker is Vulnerable and possibly Endangered.

Use of camera traps at trees with foraging sign of large woodpeckers

David Luneau, Department of Engineering Technology, University of Arkansas, Little Rock, mdluneau@ualr.edu

Autonomous motion-detecting cameras (camera traps) were deployed in the Bayou DeView river swamp of eastern Arkansas in 2004 and 2005 in the search for the Ivory-billed Woodpecker. These cameras were aimed at trees that had extensive bark scaling similar to descriptions of scaling from earlier literature. Automatic cameras were used to monitor feeding trees because the woodpeckers are known to have large home ranges, so visits to any one feeding site would be too infrequent for human monitoring to be practical. Eight cameras of two different styles were aimed at approximately 35 different trees over the 13 month period. These cameras were purchased by The Nature Conservancy for use in the search for the Ivory-billed Woodpecker. Extensive testing was done to determine an appropriate range of distances over which the passive infrared detection would be effective on a bird the size of an Ivory-billed Woodpecker. The cameras were tested on smaller birds, and estimates were made of the effective range on large woodpeckers. Cameras were deployed at a distance greater than the distance at which small birds would be detected and less than the estimated maximum distance at which the large woodpeckers would be detected. Custom mounts and locking mechanisms were designed to enhance the efficacy and security of the units. A custom laser pointer was constructed to aim the camera accurately at the target. A standard set of data was collected at each site, which included GPS location data, camera elevation and azimuth, distance to the target, height above the water of both camera and target, and still pictures of the scaling before and after the camera was deployed. The cameras captured pictures of both Pileated Woodpeckers and gray squirrels, but no Ivory-billed Woodpeckers. There was no indication that the Pileated Woodpeckers or squirrels added to the type of scaling that was initially found on the trees. Additionally, there were no cases where the cameras failed to get pictures when additional scaling was done on a monitored tree. No smaller woodpeckers or other birds were photographed in the field. Trees with fresh scaling proved to be more likely to have return visits by large woodpeckers than trees with older, weathered scaling. The author has continued to deploy and monitor camera traps, and will use additional cameras in the upcoming fall and winter search season. Cameras with time lapse capability will also be used for situations where motion detection is not practical.

Longhorned beetles (Coleoptera: Cerambycidae) in bottomland hardwood forests of the southern United States

Michael D. Warriner , Arkansas Natural Heritage Commission, michael@arkansasheritage.org

One factor listed as contributing to the decline of the Ivory-billed Woodpecker is decreased availability of insect prey, specifically the larvae of certain xylophagous beetles. It has been suggested that the ivory-bill is a foraging specialist, primarily feeding on insects found just below the bark of dying and recently dead trees. With such a dependence upon a specific stage of tree mortality, it is thought that widespread forest clearing decreased suitable foraging habitat for this species. A reduction in volume of dying/dead wood could have lead to a real decline in insect prey. Longhorned beetles are cited as an important dietary component of the ivory-bill and are dependent upon suitable dying/dead wood resources for reproduction. As larvae are legless, choice of larval host is up to egg-bearing adult females. Adult beetles are known to exhibit distinct preferences when it comes to oviposition sites. Preferences are based upon a number of factors including tree species, host condition, and structural affinity. Typically, longhorned beetles that feed on healthy woody plants have the most specific host requirements, while those feeding on dead, decaying wood tend to be more generalized. With such close ties to living trees and dead wood, longhorned beetles could provide useful information about the forests in which they occur. Although potentially insightful from such a standpoint, longhorned beetles have been little studied from that respect in North America. Thus far, most research on longhorned beetles in the U.S. has been devoted to the pest status of a few species, rather than the group's potential to serve as indicators of forest condition. It has only been relatively recently that work investigating the impact of forest management on these insects has even appeared in this country. An understanding of longhorned beetle diversity and ecology in bottomland ecosystems is needed to guide forest management decisions in areas where the Ivory-billed

Woodpecker is found to occur. An introduction to the biology of longhorned beetles will be presented, along with specific details regarding common species found in bottomland hardwood forests. Pertinent research regarding the importance of dead wood and the impact of forest management on this group will also be discussed.

Finding the Ivory-billed Woodpecker: where should we look and why?

Jerome A. Jackson, Whitaker Center, Florida Gulf Coast University, Ft. Myers, Florida,
jjackson@fgcu.edu

Since the reported rediscovery of the Ivory-billed Woodpecker in flood-plain forests along the Cache and White rivers in eastern Arkansas, there has been renewed impetus to locate remaining Ivory-bills throughout their range and to look ahead to potential habitat for recovery of the species. Over a period of three decades I have examined Ivory-bill specimens and their associated data, reviewed the scientific and anecdotal literature for the species, and searched potential habitats for evidence of the birds. Between 1986 and 1989, with the support of the U.S. Fish and Wildlife Service, I followed leads provided by anecdotal reports and guidance provided by James Tanner and Lester Short in searching what Tanner, Short, and I felt were the habitats of greatest potential for Ivory-bills in the Southeast. In this presentation I will discuss the results of these efforts. Future searches should begin with known or probable 20th century Ivory-bill locations. Prioritization of sites for searching should include compilation of the history and extent of associated habitat and habitat corridors that might have served as dispersal routes, levels and timing of human and natural disturbances, and the frequency and quality of anecdotal Ivory-bill reports in the region.

Managing bottomland hardwood forests for Ivory-billed woodpecker (*Campephilus principalis*)

David Shoch, Winrock International, Arlington, Virginia, dshoch@winrock.org

The recent rediscovery of one or more individuals of Ivory-billed Woodpecker (*Campephilus principalis*) in the delta region of Arkansas presents one of the greatest conservation opportunities and challenges ever faced. Existing forest management practices can be adapted and applied as tools in the conservation of this species on both protected areas and private landscapes managed for economic ends. Private lands, which make up 84% of the oak-gum-cypress forest type in the Mississippi delta region, are an essential resource base for the Ivory-billed recovery effort. Because tree death tends to occur in events, conservation in the long-term requires a shift in focus from the stand to the landscape level and an effort to foster public-private partnerships that can coordinate forest management activities at that scale (e.g. incentive payments for variable retention practices that allow “over mature” trees to persist in commercial stands). Through direct intervention, forest stands can be manipulated to advance through development stages faster and produce big trees sooner. Snag volume and density have been demonstrated as functions of forest productivity. The dead wood Ivory-billeds depend on is ultimately a product of forest growth; not surprisingly, the “ridge” sites that Ivory-billeds apparently preferred tend to also display the greatest forest productivity within bottomlands. Management can also reduce the incidence of stand-replacing disturbances and generate and maintain age structures and stem densities determined to be most advantageous to Ivory-billeds. Though existing information is sufficient to define habitat in which Ivory-billeds can survive, further study is required to correlate reproductive success with home range sizes and density of foraging substrates to better refine management actions.

Habitat enhancement: management for the recovery of the Ivory-billed Woodpecker (*Campephilus principalis*)

Douglas Zollner¹, Tom Foti, Kenny Ribbeck, Mike Melnechuck, Martjan Lammertink, and Michael Warriner. ¹The Nature Conservancy, Arkansas Field Office, Little Rock, dzollner@tnc.org

We evaluated literature on the availability of standing, recently dead and dying trees in Ivory-billed Woodpecker (IBWO) home ranges, assessed the current availability of standing, recently dead and dying trees in the Cache River ecosystem, and initiated an experiment to enhance the availability of suitable trees. Tanner (1942) found that resident, breeding IBWO on the Singer Tract in NE Louisiana spent most of their time in areas four square miles (2,500 acres) in size. Optimal areas contained 7 or more recently dead or dying trees per acre. The Singer tract in northeast Louisiana (now Tensas NWR) experienced a wildfire in the decade before Tanner's study which may have been the reason for the elevated level of dead and dying trees and the presence of the IBWO. The current Big Woods landscape is short of large tracts of forest with seven or more trees per acre showing significant decline or recently dead. Recent collection of forest data on public and private lands, in and adjacent to the area of initial and subsequent sightings, found 2-3 dead and dying trees per acre. Few of these trees were in the 12" - 21" dbh size classes. The diet of IBWO consists of both animal and plant material. Wood-boring beetle larvae of the families Cerambycidae, Buprestidae, and Elateridae are particularly important. Once the resistance mechanisms of a tree are compromised, beetles move in rapidly to mate and oviposit eggs. Most wood-boring species are attracted to new hosts through volatiles released by the stressed and weakened tree in the form of terpenoids and ethanol. Trees that have been scarred by windstorms, struck by lightning, or mechanically treated (girdled, scorched, injected, burned) will release such volatiles. It takes the beetles several hours to a day to find injured trees. In order to increase the amount of standing, recently dead and dying trees for the enhancement of IBWO foraging resources, target trees could be wounded or killed by means of girdling, scorching, injection, or prescribed burns and be left standing. We initiated an experiment to provide a preliminary evaluation and guidance for implementation of an habitat enhancement strategy for IBWO. Four enhancement areas (4-acre each) were established on the west side of Bayou Deview and at Robe Bayou south of Dagmar WMA. The enhancement areas were inventoried using permanent transects (one in each 2 acres) with regularly spaced, circular plots. All woody stems greater than 2" dbh were measured, assigned to a decrepitness class, and tallied to species. Based on the inventory, various treatments were implemented in June and July of 2005. Each enhancement had specific objectives relating to species treated, dbh of treated trees, number of each species treated, desired outcome of treatments, and desired future condition for the four-acre site. The treatments included variable rates of girdling using hand tools and chainsaws on two sites and variable rates of injection of glyphosphate in pellet form on two sites. A series of malaise traps were established at each enhancement site to begin inventory of the local beetle fauna.

Future directions and priorities for large woodpecker research and conservation

Hans Winkler, Konrad Lorenz Institute for Ethology, Vienna, Austria, H.Winkler@klivv.oeaw.ac.at

In my contribution I will try to summarize the presentations and results of the discussions of this symposium, and add some thoughts about woodpecker biology that may be relevant for the conservation of large woodpeckers. If we define "large woodpeckers" as species that, on average, weigh more than 160g we get a set of species that also forms a more or less phylogenetically related group (exceptions are some species of the genera *Colaptes* and *Picus*). Thanks to the efforts of William Moore and others we know more about woodpecker phylogenetic relationships than ever before and we are entering a new era of comparative research. Comparisons among families have already shown that woodpeckers are most successful birds. Their radiation is young and there are quite a few examples of species that have survived for long periods in what appears to be small populations on the one hand, and species that have

substantially increased their ranges within the last 100 years. Armed with these new insights about the past, we can tackle some of the problems that puzzled scientists for a long time and which are relevant for the future conservation of the “big four” as well. Take the interactions between what Cody (1969) had dubbed the logcocks (*Meiglyptes*, *Micropternus*, *Dinopium*, *Dryocopus*) and the ivory-bills (*Hemicircus*, *Blythipicus*, *Chrysocolaptes*, *Campephilus*). The former are ant eaters, and the latter predominantly feed on beetle larvae. Are sympatric species from either group competing with each other for resources other than food? Do the striking examples of similar appearance comprise adaptations (mimicry) in response to frequent aggressive interactions, or are they convergent features related to some common (and unknown) environmental factors? Answers to these questions have obvious consequences for interpreting habitat quality and species management. The fact that the different clades of large woodpeckers can be characterized by several ecological variables (such as food) hints at a certain inertia and inflexibility. On the other hand, woodpeckers are large brained birds and are endowed with remarkable cognitive skills. These aspects are related to migratory behavior and seasonal movements about which we know little with regard to most large woodpeckers. Large woodpeckers react quite differently to habitat alterations. Some species cope with secondary forests quite well, yet others seem to be rather sensitive. This view may be rather superficial at closer look as the excellent work of Martjan Lammertink on the Great Slaty Woodpecker has shown. This flexibility may misguide conservation efforts. Analyses of historical distributions may give us clues about the true nature of the primary habitats. Dispersal behavior and long distance need also to be considered when we are talking about habitat corridors which may benefit the spread of specialized predators and diseases more than our target species. Other issues that should have high priority in future research are important life history components, such as longevity and clutch size, and how they are controlled in large woodpeckers. Besides food, the size of suitable forest patches is certainly a key factor and regular surveys based on satellite data may greatly help conservation biologists and managers to take appropriate action. Large Woodpeckers are ideal flagship species. They are attractive, threatened by forest destruction, and hard to sink. I hope they sail into a bright future and will once serve as the prime example for the successful cooperation between science and wildlife management.

POSTERS

Significance of ancient American uses of the Ivory-billed Woopecker

Alex W. Barker, Milwaukee Public Museum, Wisconsin, Barker@mpm.edu

Archaeological evidence indicates that ancient Americans encountered Ivory-billed Woodpeckers with greater frequency than their current reclusiveness might suggest. Depictions of what appear to be ivorybills are prominent in the iconography of southeastern groups, particularly during the Mississippian period (AD 900-1500); the use of ivorybill skulls and plumage in ceremonially important objects from the region suggests that these iconographic depictions are of ivorybills rather than Pileated Woodpeckers. Evidence for familiarity with ivorybills in ancient America assumes three main forms: 1) Skeletal elements of ivorybills-most often crania-are known from both protohistoric and prehistoric contexts; 2) iconographic depictions of ivorybills are widespread, and particularly associated with the Southeastern Ceremonial Complex (SECC), an artistic and religious horizon of the Mississippian period dating to AD1050-1400; and 3) plumage and skulls of ivorybills are used as prominent elements of ceremonially-significant pipestems by a variety of protohistoric and ethnographically-documented groups. These lines of evidence may be related, however. Skeletal elements of ivorybills have been identified at all of the largest Mississippian-period mound centers associated with the SECC. Ivorybills appear to be one of the core motifs in SECC iconography; for example, a minimum of four different kinds of engraved shell gorgets featuring ivorybills are known from the SECC--along with iconographic depictions in several other media. And thematic evidence suggests that the iconographic referents depicted in SECC images are closely related to more recent Siouan cosmologies and beliefs. Most of the ethnohistoric or

ethnographic groups using ivorybills as pipestem elements are either Siouan groups sharing these beliefs or groups having close historical connections with these Siouan communities.

Fungal inoculations to promote establishment of woodpecker cavity and forage trees in managed and protected forests

James C. Bednarz¹, Martin J. Huss, Dana Ripper, Daniel E. Varland, and Troy Brader, ¹Department of Biological Sciences, Arkansas State University, Jonesboro, JBEDNARZ@astate.edu

Managed forests contain fewer trees suitable for use by cavity-using wildlife than are generally found in old-growth forests. Because of short timber-harvest rotations, relatively few trees in managed forests are infected with the heart-wood decaying fungi which softens wood, enabling primary cavity-nesters, such as woodpecker species (e.g., *Dryocopus* spp.), to excavate cavities. A lack of woodpecker activity and resulting deficiency of available nest and roost cavities limits the diversity and abundance of many wildlife species. Beginning in 1996, we have implemented a long term experiment to evaluate an innovative management approach wherein a wood-decaying fungus, the red-belted conk (*Fomitopsis pinicola*) was introduced into selected trees in order to enhance the suitability of managed forests in western Washington for woodpeckers. In 1997 and 1998, we inoculated 330 trees with fungus in 33 stands and 320 trees with a sterile control in 32 stands. In 2002, we visited all 650 trees that were experimentally inoculated and found that significantly higher proportions of treatment trees displayed *F. pinicola* conks (0.173) and mycelia (0.063) than did control trees (0 conks, 0 mycelia, $P < 0.001$). The nature of the experimental design we have implemented in studies of creating suitable nest cavity trees for western hemlock (*Tsuga heterophylla*) trees and Douglas-fir trees (*Pseudotsuga menziesii*) in western Washington, may provide a good model for developing concurrent studies and strategies in other ecosystems. For example, establishment of decaying trees in this manner could provide foraging and nesting niches for Ivory-billed Woodpeckers (*Campephilus principalis*) in Arkansas and Louisiana to enhance habitat and to help insure the continued survival of this and other sensitive wildlife species.

Can winter woodpecker populations predict good habitat for Ivory-billed Woodpeckers?

Paul B. Hamel¹, Robert P. Ford, and G. Edward Alexander, Jr.¹ Center for Bottomland Hardwoods Research, Stoneville, Mississippi 38776, phamel@fs.fed.us

Rediscovery of Ivory-billed Woodpecker (*Campephilus principalis*) by Fitzpatrick et al. (2005) underscores the urgency to determine good methods to screen potential search areas. Woodpecker populations in the Singer Tract, Madison Parish, LA, were believed by Tanner (1942) to indicate suitable habitat for Ivory-billed Woodpeckers, namely the presence of suitable, i.e., large, numbers of dead and dying trees (25-35/ha). He believed that a relative abundance of 126 Red-bellied Woodpeckers (*Melanerpes carolinus*) to 36 Pileated Woodpeckers (*Dryocopus pileatus*), which occurred within the home range of 1 Ivory-billed Woodpecker, would indicate such habitat. His published values reflect 19 Red-bellied Woodpeckers and 3.9 Pileated Woodpeckers per 100 ha. Ivory-billed Woodpecker density was 0.27/100ha within home ranges, and 0.047/100ha for the entire 31 km² Singer Tract. These data present a standard for comparison of existing woodpecker populations to address the hypothesis that existing populations in certain areas are not large enough to indicate habitats capable of supporting Ivory-billed Woodpeckers. We present evidence of relative abundance of woodpeckers from published and unpublished sources. We evaluated Winter Bird Populations Studies (WBPS) from the South from 1948-1979 (Hamel 1992). We conducted WBPS on 11 ha of mature second-growth bottomland hardwood forests at Leroy Percy State Park, Mississippi, 1971-2003. We conducted line transect surveys of woodpecker abundance in three areas: Congaree Swamp National Monument, South Carolina, old-growth bottomland forests surveyed 1981-1983; 32 upland sites in middle Tennessee, surveyed 1988-1989

(Hamel et al. 1993); 59 bottomland sites in west Tennessee, surveyed 1985-1987 (Durham et al. 1988). We summarized these data by the method of Jarvinen and Vaisanen (1975). All sites were mature hardwood forests. Differences in sampling methodology complicate density comparisons. Obvious differences exist in abundance of both Red-bellied Woodpecker and Pileated Woodpecker between upland and bottomland sites, regardless of methodology. Bottomland forests contain more birds of each species than do upland forests. Among bottomlands, Red-bellied Woodpecker numbers similar to those suggested by Tanner occur in numerous maturing and mature stands. For Pileated Woodpeckers, the situation is similar; perhaps numbers in old-growth forests of Congaree Swamp in 1980s were even higher than in Singer Tract; small data sets impede statistical precision. We conclude that while search for especially high numbers of woodpeckers would be one alternative screening method for potential Ivory-billed Woodpecker habitats, a direct approach involving cruising timber for the presence of very large diameter trees in decadent or dying condition would probably be more effective.

A preliminary report on the use of large woodpecker foraging sign as a possible method to suggest presence of Ivory-billed Woodpeckers (*Campephilus principalis*): a forensic approach

Paul W. Sykes¹, Steve Holzman, Carl Perry, Joan J. Sykes, James Peterson, and Pierre Howard¹ USGS Patuxent Wildlife Research Center, University of Georgia, Athens, paul_sykes@usgs.gov

The bill marks made by large woodpeckers in the course of foraging (bark scaling and furrow and pit excavation) have been widely reported at the White River and Cache River National Wildlife Refuges of eastern Arkansas over the past two years. At this time, some of this work is suspected to be that of the Ivory-billed Woodpecker (*Campephilus principalis*). We have measured bill tips of both Ivory-billed and Pileated Woodpeckers (*Dryocopus pileatus*) in museum collections, and measured bill markings on standing dead and living trees. We suggest the two species can be distinguished by some but not all of the sign. If this technique is found to be reliable, it will be a useful method to suggest the presence of Ivory-bills in both the Big Woods of eastern Arkansas as well as elsewhere in the southeastern United States.

Modeling bottomland hardwood forest structure – past, present, and future

Maria Melnechuk¹, Douglas Zollner¹, and Ayn Shlisky The Nature Conservancy, Arkansas Field Office, Little Rock, dzollner@tnc.org

Natural disturbance plays a large role in structuring bottomland hardwood forests and providing habitat for a host of species, including the ivory-billed woodpecker. Current management practices vary depending on ownership and land use objectives. However, timber harvesting and fire suppression along with habitat fragmentation have greatly altered the impact of disturbance in these forest systems. Using vegetation models created through the LANDFIRE project, we model the structure of bottomland hardwood forests under current management practices and compare to a reference condition derived from historical data. Models for current and historic forest structure were developed using the Vegetation Dynamics Development Tool (VDDT, ESSA Technologies). These models are designed to demonstrate the effect of fire suppression, diameter harvests at 15, 50, and 100 year intervals, and limited clearcutting (every 100 years). Other natural disturbances (wind, weather, insect outbreak, and disease) remain in the model to demonstrate the role management alone has had on these communities. The results indicate a drastic reduction in older closed canopy forests and an increase in younger forests. The shift to a younger, “healthier,” forest suggests a canopy with smaller trees as well as fewer dead and dying trees. The lack of older trees results in a reduction of suitable habitat for disturbance-dependent species like the ivory-billed woodpecker. Vegetation dynamics models are a useful tool for determining appropriate

strategies for maintaining and enhancing habitat for species and measuring the long-term impacts of current management.