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Suiform Soundings

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IUCN
The World Conservation Union

SSC
Species Survival Commission

Photo front page: Collared peccaries, *Pecari tajacu,* in the Tehuacan-Cuicatlan Biosphere Reserve in Mexico. Read more about the development of habitat suitability indices (HSI) to evaluate habitat quality for this species, on page 14. *Photo credit: IBUNAM/RBTC-CONANP*

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Editorial

There has been a lot written in popular scientific websites lately about the need to share discoveries and findings, making information readily available to all, thus avoiding the 'reinvention of the wheel' and helping countries to implement conservation strategies that work. I find this particularly relevant in the situation within which I operate, where regulations, red tape and uncertainty can be somewhat overcome by providing examples of similar undertakings elsewhere. I would imagine that these situations exist in many parts of the world, where researchers and conservationists are trying to move forward with implementing projects, and where the ready availability of information on previous work, successful or not, can make the difference to the project getting the go ahead.

Hopefully newsletters such as *Suiform Soundings* can contribute to this process of information sharing, and can play a part in the dissemination of findings relevant to the future conservation of the Suiformes. So I encourage readers to send in their contributions, letters, comments and feedback, and to help distribute the newsletter to a wider audience.

This edition of the newsletter highlights some interesting findings with regards to the distribution of *Sus scrofa* in Iran, as well as the behaviour of giant forest hogs in west Ethiopia. We also read about the methods used to capture and transport Nile hippopotamus (not an easy job!), as well as the development of habitat suitability indices to evaluate collared peccary habitat. Such articles provide us with valuable information on tried and tested techniques that might be applicable to our own work.
I hope you enjoy reading this issue of *Suiform Soundings*, and I look forward to your contributions for the next newsletter.

Happy holidays!

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Infanticide in Giant Forest Hog, *Hylochoerus meinertzhageni*

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In April 2010 I spent three days in the Jibat forest in Ethiopia.

The Giant Forest Hog (*Hylochoerus meinertzhageni*) is relatively widespread in Ethiopia. It occurs in the south-western forests, where it seems to be quite common. It also occurs east of the Rift Valley in the Bale massif, where it is not so easily found. The best place to encounter the Giant Forest Hog is the Jibat forest.

Jibat is located around 200 km west of the capital Addis Ababa and lies close to the upper tributaries of the Gibe River. The majority of the forest is at 2,000–3,000m asl, with a lower south-western portion, which is partly cleared and settled. In the centre of the forest there is a ruined palace believed to have belonged to an Ethiopian king in the 15th century. The forest has been heavily logged in more recent years for commercial timber production, but the sawmill has now closed. Illegal logging and deforestation of some areas by settlers still occurs. The forests of Jibat are dense, cut by deep ravines and streams and difficult to penetrate.

I knew that Giant Forest Hogs are normally quite secretive, but I was told that in Jibat they are so plentiful that sightings are common. We walked a lot in the forest the first day and saw plenty of spoor and signs, but no hog, though we heard some in the dense undergrowth. We also encountered signs of bushbuck and bushpig and saw many black and white Colobus monkeys. The second day in the afternoon my local guide placed me with my camera in a lovely meadow, around 300m long and 100m wide, seamed with dense forest on three sides and the main gravel road on the fourth. I sat quite sheltered under the low hanging branches of a tree.

Around 16:30 a sounder of forest hogs appeared on the far side of the meadow and went to a salt lick consisting of an old termite mound, now a shallow whole in the ground. The group consisted of a boar, a mother with five little piglets, another grown female, obviously related to her, and a couple of yearlings. After having licked the salty earth for a while they started to cross the meadow at a distance of approximately 150 m from me. At the same time, on the other end of the meadow, a local herder appeared with some cows. The hogs started to run back across the meadow in the direction they had come from. The sow, who kept the piglets very close to her the whole time I had been observing her, now ran ahead of them. The boar, taking up the rear immediately seized the opportunity to catch one of the piglets and crushed it. The sow immediately rushed back, followed by the remaining four piglets and her sister, and attacked the boar, even though the herder was now quite close. There was a struggle for about 20 seconds, after which the sow left the boar and ran back to the forest, followed by piglets, sister and boar.

I managed to take a lot of photos during the hog's visit, but unfortunately the distance was quite large and the light not optimal.

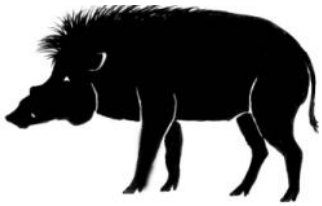
I then went to retrieve the piglet und saw that it was a male. When I asked the villagers in the evening whether they had observed events like this, they all nodded and confirmed that infanticide was quite common among Giant Forest Hog. They also stated categorically that the boar kills only male piglets. They had seen many incidences of infanticide, but never was a female piglet killed.

My cursory check of Giant Forest Hog' behavior on the internet showed no records of such infanticide, even though there seem some instances reported from warthog. I would be glad to hear more about this from experts.

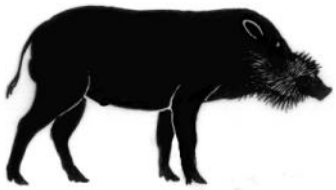
Forest hog females with the piglets at the clearing in Jibat forest

Adult forest hog male killing the piglet that it managed to catch.

The adult females immediately returned to the clearing, confronting and fighting with the male. The remaining four piglets stayed close to the females.



Papers and communications



Sus scrofa subspecies of Iran

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Taxonomic Background

Sus scrofa or the Eurasian Wild Pig is the most widespread species of naturally occurring wild pig. Many of the more distinctive regional forms of these animals were originally described as full species, e.g., *vittatus*, *cristatus*, *leucostymax*, *moupinensis*, and *meridionalis*, from Sumatra, India, Japan, China, and Sardinia respectively. More recent and comprehensive taxonomic reviews have combined many of these taxa into one species, mostly on the recognition that the different forms of *S. scrofa* formed a stepped cline extending from western Europe to the far east and insular South-East Asia. This gradual change in morphological characteristics allowed the combination of the extreme forms on either side of the range (*scrofa* and *vittatus*) into one species.

Sus scrofa is characterized by significant levels of naturally occurring geographic variation. An astonishingly large number of subspecies have therefore been proposed and recognized in the literature. Colin Groves of the Australian National University undertook the most comprehensive review when proposing the recognition of at least 16 morphologically distinct populations of *S. scrofa* on the basis of external as well as craniometric characteristics (Groves 1981; Groves and Grubb 1993). This is not the final word on the species taxonomy, however. Groves and Grubb (in press) recently proposed recognition of two species, previously considered subspecies of *S. scrofa*, namely: *S. chirodontus* (Heude, 1888) from south-central China (including Kienté, Ningkua, Zhejiang, Shaanxi, Anhui, and also Korea), and *S. ussuricus* (Heude, 1888) from Heilongjiang and Far East China and Russia.

The taxonomic discussion about *S. scrofa* continues because the morphology and genetics of the species in parts of its range are poorly known, making it difficult to determine subspecies boundaries. Iran is one such area. Several subspecies could potentially occur in the country, but it is largely un-

known where the subspecific boundaries lie. Potential subspecies in Iran include *S. s. attila*, *S. s. nigripes*, *S. s. davidi*, and *S.s. lybicus*.

Figure 1. Map of southwest Asia

S. s. attila Thomas, 1912, occurs in eastern Europe, southern Russia towards the northern flank of the Caucasus, but not including the Transcaucasian countries of Georgia, Armenia, and Azerbaijan (for countries see Fig. 1) (Groves 1981). The range possibly extends as far south as the Mesopotamian Delta in Iraq, in which case it would likely include western and southwestern Iran, and possibly the eastern parts of Turkey and Syria. This subspecies may also extend into central Asia and include western Kazakhstan. Further south, in Uzbekistan and Turkmenistan, *S. s. nigripes* occurs, but it is unclear where the boundary between the subspecies lies. *S. s. attila* is a very large subspecies, with skull length in males over 450 mm. It is usually light yellow-grey, with hair tips long and straw-yellow, copious brown underwool, and a long mane which extends to the loins.

S. s. lybicus Gray, 1868, occurs to the west and south-west of *S. s. attila* in Turkey, Syria, Jordan, Israel, Palestine, Egypt, but also parts of southern Europe. The boundary between *S .s. lybicus* and *S. s. attila*

is on the Caucasus area around Georgia and Armenia, but it is unclear where in Iran the boundaries lie, as the range of *S. s. attila* extends east and possibly south of the Caspian Sea. *S. s. lybicus* is described by Groves as pale brindled straw-colour or grey, with mane short or absent. Based on skull measurements (Groves 1981) it is somewhat smaller than *S. s. attila*.

S. s. nigripes Blanford, 1875, occurs along the flanks of the Tianshan mountains in Kyrgyzstan and northwestern China (Xinjiang autonomous region), while specimens from Uzbekistan and southern Kazakhstan are also allocated to this subspecies. It is unclear whether its range potentially extends from there to include Uzbekistan, Turkmenistan, Tajikistan, Afghanistan, and possibly Iran. *S. s. nigripes* is a light-colored subspecies with dark legs—usually paler behind, a nearly white face and no mane. It has a very broad skull. Weights of boars from Uzbekistan and Kazakhstan are given as 220–240 kg.

Finally, *S.s s. davidi* Groves, 1981, occurs in the arid zone from eastern Iran to Gujarat, India, including Pakistan and NW India, and perhaps north to Afghanistan, as well as Tajikistan. *S. s. davidi* is a small, light brown pig, with a long thick mane, and without any black on legs. Weights of boars from Tajikistan, which might belong to this subspecies, were reported as 74–144 kg, and occasionally up to 158 kg for males, and 71–123 for females. This subspecies belongs to the low-crowned pigs of the western part of S*. scrofa*'s distribution range, rather than to the eastern pigs of India, China and the rest of east and south-east Asia.

Review of new information

Figure 2. Map and photo from Anguran Wildlife Refuge in north-western Iran

We recently received a set of photographs from different parts of Iran from the Iranian Cheetah Society. This provided an excellent opportunity to shed more light on the boundaries of *S. scrofa* subspecies in the country. We discussed the photographs with Colin Groves, and below we summarize the

findings.

One camera trap photo came from the Anguran Wildlife Refuge (36°29–43'N, 47°42–47'E), Zanjan, in north-western Iran (Figure 2). It shows a large pig with a shaggy coat and shortish face. Legs and ears appear dark but this might be because of the angle of the light. There is no apparent mane, or if it occurs it does not run along the length of the back. Several other photos from Anguran, however, do not fully fit this description (Figs. 3, 4 and 5). The animal in Fig. 3 is grey with a short, brownish dorsal mane, and darker legs. The animals in Fig. 4 have an obvious, long mane that extends half-way down the back. Finally, the animals in Fig. 5 also have a mane, half-way down the back, and an overall brownish-grey colour, brindled with yellowish-brown, and dark legs. These animals look very similar to *S. scrofa* from Azerbaijan (not shown here).

Figure 3 (above left), **4** (above right), and **5** (left) indicate the morphological variation among pigs from north-western Iran

The evidence from these photos suggests that pigs from north-western Iran generally appear brownish-grey with darker legs and often a mane that extends at least half-way down the back. Based on overall colouration they conform more to the type of *S. s. attila* than *S. s. lybicus*.

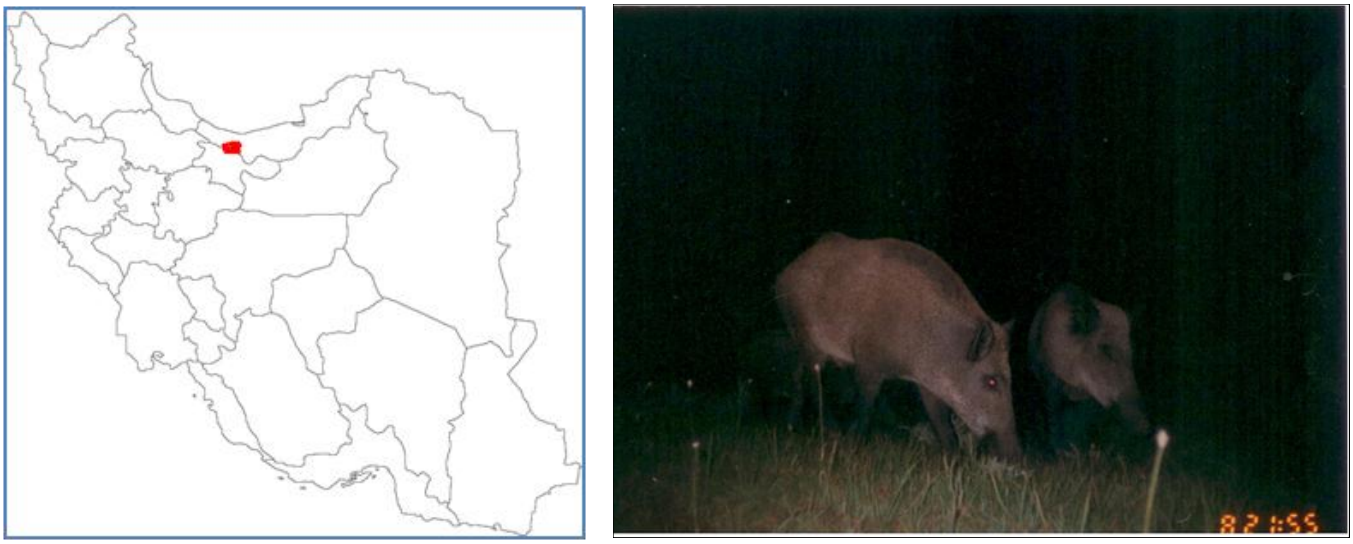

Figure 6. Map and photo from Central Alborz Protected Area

A second area from which we obtained photos is the Central Alborz Protected Area (35°45'-36°35'N, 51°00'-36'E) in northern Iran, directly south of the Caspian Sea (Fig. 6). The light is not very good, but it appears to show brownish, relatively long-snouted pigs with black legs. Colin Groves mentioned that the animals look very different from the other photos in this article, especially the contrast between the black legs and the rest of the body". Based on this, he suggested that this might *S. s. nigripes*. This would suggest that the range of this subspecies extends from Uzbekistan and Kyrgyzstan into northern Iran. We are not convinced, however, that these animals are clearly different from those in Anguran (Figs. 3, 4, and 5), and suggest that additional photos should be obtained from this area to better understand morphological variation.

The third area from which we obtained photos is the Sarigol National Park (36°55'-37°8', 57°34'-47'), North Khorasan, in northeastern Iran (Fig. 7). This photo could potentially have confirmed whether indeed *S. s. nigripes* is the subspecies of north-central and north-east Iran, but the evidence is again inconclusive. It shows a light-coloured pig in winter coat. Legs appear to be darker, but it may have quite a distinct mane, which should be absent in *S. s. nigripes*. The animal looks more like the description Groves (1981) gives for *S. s. attila* (see above)

A photo of a group of killed pigs from Mahin, also in north-western Iran (Fig. 8), helps to resolve the subspecies status of *S. scrofa* in northern Iran. The animal in the bottom right of the picture clearly shows a longish mane, suggesting that it is neither *S. s. lybicus* nor *S. s. nigripes*—the latter also excluded because these animals do not appear to have black legs. We do not know to what extent the absence of a mane is fully diagnostic for determining the difference between *S. s. attila* and *S. s. lybicus*, but if indeed a reliable character, it would suggest that *S. s. attila* occurs in north-western and possibly northern-eastern Iran.

Figure 7. Eurasian Wild Pig from Sarigol National Park in northeastern Iran

Figure 8. Killed Eurasian Wild Pig from Mahin, north-western Iran

A photo from Fars Province in Southwest Iran (Fig. 9) shows a very large pig, with overall grayish colouration and a short mane. This again fits the characters in previous pictures, although the animal appears greyer and its mane is shorter and does not extend as far back as in the pigs from north, north-west and north-east. The length of the mane however changes with age as their hairs are abraded. The evidence is inconclusive regarding the sub-specific status of *Sus scrofa* in this part of the country.

Figure 9. Adult pig from Fars Province.

Finally, a photo from the vicinity of Borou'eeyeh Wildlife Refuge (30°5'N, 54°8'E), Yazd, in Central Iran (Figure 10) provides insight into the subspecific status of *S. scrofa* there. A farmer had killed 3 pigs (1 adult female, 1 young male, 1 young female). Colin Groves considered these pigs to be *S. s. davidi*, based on size, overall colouration, and presence of mane.

The overall conclusion from the analysis of various photographs is that the subspecies in northwest, and north, of Iran is most likely to be *S. s. attila*. *S. s. nigripes* may occur further east, in the area south of the Caspian Sea, but a photo from north-eastern Iran does not support this and suggests that this is also *S. s. attila*. Overall this suggests that the range of *S. s. attila* extends around the eastern side of the Caspian Sea. Finally, *S. s. davidi* seems to be the subspecies in central and presumably southern and eastern Iran, possibly adapted to the desert conditions in this part of the country. Whether or not *S. s. lybicus* occurs in the west or south-west of Iran requires further study.

Figure 10. Eurasian Wild Pig killed in Harat, central Iran.

Admittedly, evidence from these photos is tentative and direct analysis of skins, skulls, or DNA would be needed to accurately map the subspecies status of *S. scrofa* in Iran. But at least it provides a start. There are likely many more photos available of pigs killed in this poorly studied region. We specifically suggest to check whether the numerous camera trapping programmes in the country for large carnivores and other conservation target species include useful pictures of *S. scrofa.* We call on western Asian biologists to assist us in the task of unravelling subspecies boundaries of *S. scrofa* in the region by sending us additional photographic material. What is also needed is to reassess information from the museum specimens and check the original descriptions of the different subspecies.

Finally, there is a significant amount of information on the internet, mostly from hunter accounts, that could further be used in this study. A few examples include:

This video shows a Eurasian Wild Pig hunt in Qazvin, north-central Iran. This appears to be a smaller pig, with fully grown canines suggesting an adult animal. It appears to be *S. s. davidi*. http://www.youtube.com/watch?v=jemkz7gnUyk
This video shows a large number of Eurasian Wild Pigs killed in Iran, http://www.youtube.com/watch?v=GHyfSEE1twE&feature=related, indicating considerable morphological variation. Unfortunately, no localities are given and I am presently trying to contact the person who posted the photos to see if any geographic information is available.
This shows pigs from western Iran: http://isdle.ir/news/index.php?news=6661

Further work is needed on these pig populations, not just to determine their taxonomic status but also to determine their present conservation status. Pigs used to be abundant in Iran, especially in the

Caspian forests and occurred throughout the country apart from the driest deserts (Lay 1967), and are still considered as occurring throughout the country (Solaymani-Mohammadi et al. 2005; Ziaie 1996). It is unclear however how much these populations have been reduced by hunting and whether any subspecies are presently threatened with extinction.

Acknowledgements

We thank Colin Groves for providing input into the morphological analysis.

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Modelando la calidad del hábitat para el pecarí de collar en una Reserva de Biosfera de México

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Abstract

We developed habitat suitability indices (HSI) to evaluate the habitat quality of the collared peccary in the Tehuacan-Cuicatlan Biosphere Reserve (RBTC for its Spanish initials) in Mexico. According to three environmental variables and one anthropogenic variable, we classified the habitat quality of the total area (490,186 ha) in four categories: very low, low, medium and high. We found that 40.3 % of the RBTC area presented medium to high habitat quality and the rest was classified as low to very low.

Data collected in the field and analyses of habitat use (preference/availability) from collared peccary support this classification. Collared peccary showed preferences for sites classified as high quality. Anthropogenic activities are having a great impact on the habitat by drastically decreasing its quality. The results and maps generated in this study will be use to support informed decisions regarding conservation and management of the collared peccary in the RBTC. We suggested trying the HIS in other tropical areas to verify its generality and improve its predictions.

Resumen

Se desarrollaron modelos HSI ("habitat suitability index") para evaluar la calidad del hábitat del pecarí de collar en la Reserva de la Biosfera de Tehuacán-Cuicatlán (RBTC), México. Considerando tres variables de hábitat y una de tipo antropogénica, se clasificó la superficie total (490,186 ha) en 4 categorías de calidad: muy baja, baja, media y alta. Se encontró que el 40.3% del área de la RBTC presentó hábitat de calidad media a alta; en contraparte con el 59.7% del área representado por calidades baja y muy baja. Empleando datos de campo y análisis de disponibilidad-preferencia en el uso por parte del pecarí de collar, se sustenta la clasificación de la calidad de hábitat de los modelos propuestos. Los pecaríes de collar tienen preferencia hacia los sitios clasificados como de alta calidad. Las actividades antropogénicas están teniendo un alto impacto en el hábitat al disminuir drásticamente su calidad. Los resultados y mapas generados en este estudio servirán para apoyar la toma de decisiones en materia de conservación y aprovechamiento sustentable del pecarí de collar en la RBTC. Además, sugerimos probar el modelo HSI aquí propuesto en otras regiones tropicales para probar su generalidad y/o mejorar sus predicciones.

Palabras clave: Conservación, manejo, modelo de idoneidad de hábitat, HSI, *Pecari tajacu.*

Introducción

Cada especie requiere un hábitat particular para satisfacer sus necesidades de espacio, alimento, cobertura y otros requerimientos para su sobrevivencia. El hábitat ha sido definido como el lugar ocupado por una población dentro de una comunidad de poblaciones (Smith, 1974), y frecuentemente puede ser caracterizado por un tipo vegetal dominante o por algunas características físicas **(**Ricklefs, 1973**)**. También se define al hábitat como los recursos y condiciones presentes en un área que producen ocupación, incluyendo sobrevivencia y reproducción, por un organismo dado (Hall, 1997).

El uso de hábitat se define como la forma en la cual un animal usa o consume un conjunto de recursos (Johnson, 2007). En este sentido los animales seleccionan el hábitat a través de procesos jerárquicos en la escala espacial (Hall, 1997). De acuerdo con Johnson (1980) la selección ocurre primero a nivel del rango geográfico; luego a nivel de donde los animales llevan a cabo sus actividades diarias (ejemplo: ámbito hogareño); después a nivel de sitios o componentes específicos dentro de sus ámbitos hogareños; y finalmente acorde a como usan los recursos dentro de estos micrositios (Johnson, 1980; Hall, 1997). Por lo tanto entender las relaciones entre el hábitat y los animales requiere que tanto la disponibilidad de los recursos del hábitat como los requerimientos de las especies sean conocidos (Moen, 1973). Asimismo se entiende que los organismos que ocupan hábitats que maximizan su éxito reproductivo a lo largo de su tiempo de vida contribuirán

mayormente a las siguientes generaciones (Block y Brennan, 1993).
La calidad de hábitat es la habilidad del ambiente de proveer las condiciones apropiadas para la persistencia de los individuos y poblaciones (Krausman, 1999). Se distinguen dos tipos de calidad de hábitat: la fundamental, en la que existe ausencia de competencia, y la realizada, la actualmente experimentada con la presencia de competidores (Johnson, 2007). Esta calidad puede ser medida y cuantificada acorde a los recursos disponibles y puede ser explícitamente relacionada con parámetros demográficos tales como la abundancia y la densidad (Hall, 1997). Se han propuesto modelos para evaluar y categorizar la calidad de hábitat mediante índices, como por ejemplo, el índice de idoneidad de hábitat.

Los modelos de Índice de Idoneidad o calidad del hábitat (Habitat Suitability Index, HSI) fueron desarrollados por la U.S. Fish and Wildlife Service en un intento por caracterizar la calidad del hábitat para algunas especies de vida silvestre (Schamberger *et al*., 1982). El HSI es un índice numérico que va de 0, representando un hábitat no adecuado, a un máximo valor de 1, indicando el hábitat óptimo. Se asume que el índice tiene una relación linear positiva con la capacidad de carga potencial del hábitat (U.S. Fish and Wildlife Service, 1981). El proceso consta de seleccionar a una especie o grupo de especies para representar el o los hábitats de interés. Los requerimientos de hábitat para estas especies son obtenidos a partir de la literatura publicada determinada a través de investigaciones directas o basada en la experiencia y conocimiento profesional. Esta información es resumida y las variables de hábitat son construidas, frecuentemente basadas en las categorías de alimento, cobertura y agua (Thomasma *et al*., 1991). Un modelo HSI es desarrollado combinando las variables en una serie de ecuaciones simples. Las variables importantes o limitantes son frecuentemente las de mayor peso cuando se analiza el valor en conjunto del HSI. Los modelos HSI son usados frecuentemente en estudios de impacto ambiental para evaluar la calidad del hábitat para la vida silvestre (Rho, 2005; Traill y Bigalke, 2006; Montgomery, 2009).

El pecarí de collar (*Pecari tajacu*) es un artiodáctilo que está ampliamente distribuido; desde el sur de los Estados Unidos, hasta el norte de Argentina (Sowls, 1997). Ocupa una amplia variedad de hábitats, desde bosques tropicales hasta desiertos. Puede mantener poblaciones viables en áreas donde la temperatura nocturna invernal es menor a los 0° C. La tolerancia de esta especie a las bajas temperaturas estacionales es excepcional para un animal que también vive en los trópicos. Debido a que el pecarí de collar es una especie con alta capacidad para habitar un amplio rango de ambientes, desde húmedos hasta desérticos, la complejidad de determinar los requerimientos esenciales de hábitat para la especie se incrementa. Numerosos estudios en los Estados Unidos y en Sudamérica han mostrado que los pecaríes de collar poseen una considerable flexibilidad en el tipo de hábitat que ellos seleccionan, desde los desiertos áridos o semiáridos de Texas y Arizona (Sowls, 1997) hasta los bosques tropicales del Amazonas en Brasil (Peres, 1996), pasando por un sinnúmero más de ambientes. En éstos, tanto las condiciones abióticas tanto bióticas difieren y el uso que le dan a éstas también difiere. La especie se ha adaptado a una gran variedad de comunidades de plantas, diversas condiciones climáticas y a una topografía variada. El pecarí de collar es menos vulnerable que el pecarí de labios blancos (*Tayassu pecari*) a la fragmentación del hábitat y a la presión de caza (Altrichter y Almeida, 2002), además puede mantener poblaciones saludables incluso en áreas altamente degradadas (Reyna-Hurtado y Tanner, 2007; Beck *et al*., 2008). Las mayores amenazas para la sobrevivencia del pecarí de collar es la sobre caza por su carne y piel, y la excesiva destrucción de su hábitat natural (Peres, 1996; Altrichter y Boaglio, 2004). Estos factores ya han resultado en una

extensiva fragmentación de sus poblaciones y en su extirpación sobre grandes partes de su distribudistribución (March y Mandujano, 2005). Tanto el pecarí de collar como el pecarí de labios blancos son importantes recursos para la subsistencia de cazadores. Actualmente, ésta especie está situada en el Apéndice II del CITES (Beck *et al*., 2008).

En México, el pecarí de collar se encuentra en una gran parte del territorio nacional a excepción de la Península de Baja California y de una gran parte de la Altiplanicie Central (March y Mandujano, 2005). Se presenta en un amplio espectro de tipos de vegetación que incluyen al bosque tropical perennifoperennifolio, subcaducifolio y caducifolio, bosque espinoso, matorral xerófilo, pastizales, bosque de encino, bosque de coníferas, bosque mesófilo de montaña y en áreas transformadas o con vegetación secundaria. Se ha encontrado desde el nivel del mar hasta 3 000 msnm. Son muy pocos los estudios de esta especie en México y más aún aquellos relacionados con su hábitat (Mandujano, 1999; Bolaños y Naranjo, 2001 y 2002; Reyna-Hurtado y Tanner, 2005 Reyna-Hurtado y Tanner, 2007). Ninguno de éstos involucra la evaluación de la calidad de su hábitat. Inclusive, ésta falta de información no está restringida solamente a la escala nacional, si no que también a nivel de todo su rango de distribución. El objetivo del presente estudio fue estimar la calidad de hábitat potencial para el pecarí de collar dedentro de la Reserva de la Biósfera de Tehuacán-Cuicatlán (RBTC) a través de la generación de un momodelo de evaluación del hábitat espacialmente explícito. La RBTC constituye una muestra excepcioexcepcional de los ecosistemas semiáridos del trópico mexicano. Su importancia radica en la alta didiversidad biológica, geológica y cultural que contiene (Dávila *et al*., 2002), además de que dentro del área ocupada por la RBTC confluyen un sinnúmero de comunidades indígenas tanto fuera como dedentro de sus límites, las cuales desde tiempos ancestrales han utilizado al pecarí de collar como un recurso básico en su sustento alimenticio. La RBTC está afectada por las actividades antropogénicas principalmente por la fragmentación del hábitat, la cacería no controlada, el excesivo pastoreo, la disdisminución de las fuentes acuíferas y la construcción de vías de comunicación. Estos factores afectan el estado poblacional y la distribución del pecarí de collar dentro de la zona, así como la calidad de hábitat para el mismo. Por lo tanto el generar información básica de la especie permitirá generar estrategias para su conservación, manejo sustentable y recuperación. Se espera que esta información sirva en los planes de manejo de acuerdo a las necesidades ecológicas, sociales y culturales de la región.

Área de estudio

El estudio se realizó en la Reserva de la Biosfera Tehuacán-Cuicatlán (RBTC) la cual forma parte de la Sierra Madre del Sur y ocupa la zona noroccidental de la subprovincia de la Meseta de Oaxaca. Se localiza en el extremo sureste del estado de Puebla y noreste de Oaxaca entre las latitudes 17° 39' y 18° 53' N y longitudes 96° 55' y 97° 44' W. La superficie que cubre es de 490,186 ha, y su altitud varía de los 600 a los 2,950 msnm (Fig. 1). La temperatura media anual en el valle de Tehuacán varía entre los 18° a 22°C, y aumenta a 24.5°C en Cuicatlán (CONANP, 2008). El clima árido es controlado en gran parte por la Sierra de Zongolica que se encuentra entre el valle y el Golfo de México, ya que los vientos húmedos y las nubes cargadas de agua son interceptados por las montañas. El promedio anual de precipitación en la región del valle varía desde los 250 a 500 mm, y se presenta principalmente de mayo a octubre, con mayores posibilidades de precipitación entre junio y septiembre. La reserva ocupa las cuencas altas de las regiones hidrológicas del Balsas y del Papaloapan. Las aguas superficiales permanentes comienzan cerca de Coxcatlán, donde varios cursos de aguas convergen incluyendo al río

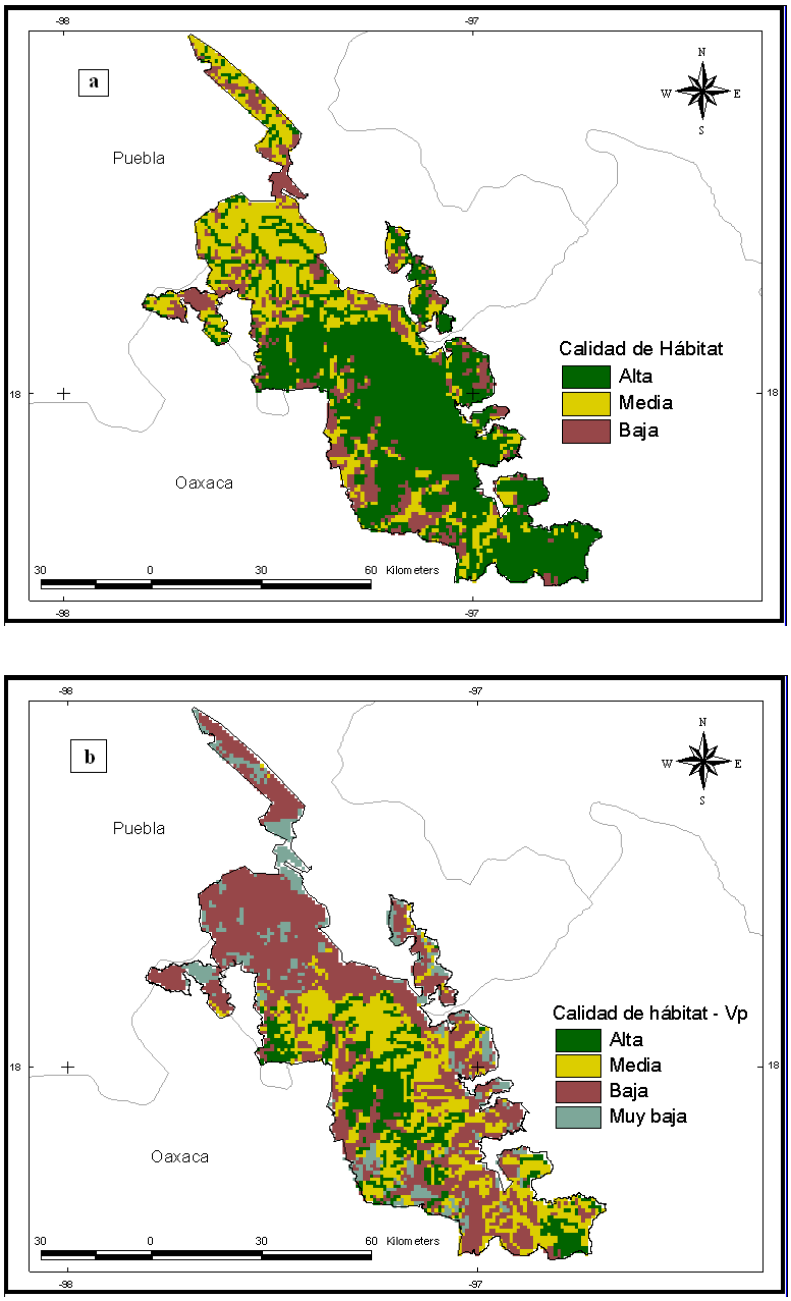

Figura 1. Calidad de hábitat para el pecarí de collar en la RBTC (a) considerando únicamente los atributos esenciales para la especie y (b) añadiendo el factor de presión humana.

La región tiene una gran variedad de hábitats relacionados con las variaciones en la topografía, altitud, substratos geológicos y clima, lo que propicia formaciones y asociaciones de vegetación. Los principales tipos de vegetación y uso de suelo en la región son la selva baja caducifolia con un 29% del territorio de la reserva; terrenos dedicados a la agricultura, crianza de ganado, y de explotación forestal con el 22%; el bosque de encino y pino con 21%; el matorral desértico rosetófilo con predominancia de arbustos espinosos y una presencia importante de cactáceas con el 10%; el matorral crasicaule con

vegetación dominada por cactáceas de gran tamaño con el 8%; y otros tipos de vegetación con el 10% (CONANP, 2008). Los grupos étnicos presentes en la zona están conformados por mixtecos, popolocas, mazatecos, chinantecos, nahuas, chocholtecas y cuicatecos (CONANP, 2008).

Métodos

Para obtener el modelo espacialmente explícito de la calidad de hábitat se aplicó el Modelo de Evaluación del Hábitat para fauna propuesto por Cole y Smith (1983) y modificado por Delfín-Alfonso *et al*. (2009) mediante la obtención del HSI el cual se complementó con el uso de un Sistema de Información Geográfica (SIG). Para obtener el HSI, el cuál está en una escala de 0 a 1, se analizaron tres atributos del hábitat indispensables para la permanencia de la especie y una fuente de presión antropogénica como amenaza. Estos atributos fueron la cobertura de protección (Bock y Bock, 1973; Sowls, 1997; Gabor *et al*., 2001; Ticer *et al*., 2001), las fuentes de agua disponibles (Sowls, 1997; Elder, 1956) y el suelo. (Sowls, 1997; Ticer *et al*., 2001) (Tabla 1). El primer paso fue asignar un "Valor de Importancia" (VIC) a cada clase de acuerdo con la relevancia que presenta cada atributo para la especie. Posteriormente se obtuvo el "Índice de Importancia del Atributo" (IIA), dividiendo el VIC asignado entre "n" clases del atributo y normalizado a 1 con el valor más alto que resulte. El 1 significa el índice más alto de importancia, por lo que el atributo será de "Alta calidad" y el valor de 0 representa el atributo de "Baja Calidad" o "Inapropiado". Se generó una carta temática para cada atributo a la cual se le asignaron los valores de los atributos correspondientes del VIC, IIA y además la distribución espacial de cada clase de atributo. El tamaño del píxel fue de 1 km^2. El procesamiento se hizo con el software ArcView 3.2. (ESRI, 2000). Los modelos espaciales fueron generados y obtenidos a partir de diferentes fuentes de información nacionales: Uso de suelo y vegetación, Edafología-Tipo de suelo e Hidrografía.

Con esta información se generó un primer modelo HSI considerando únicamente los requerimientos esenciales para la especie. La cobertura de protección fue ponderada por dos al considerarse uno de los atributos más importantes en el paisaje para la presencia del pecarí de collar (Sowls, 1997) como**:** $HSI_e = (a_1+a_2+2a_3) / \sum a_n$ donde a_1 = Fuentes de agua, a_2 = Suelo, a_3 = Cobertura de protección, a_n = Número de atributos evaluados.

Posteriormente, a este modelo se le añadió un "Valor de presión (*Vp*)" derivado de las actividades antropogénicas ejercidas dentro de la Reserva para evaluar el efecto de cambio en la calidad del hábitat. Con esto se obtuvo un segundo modelo (HSI-Vp). El Valor de presión es un valor cualitativo que va de 0 (hábitat conservado) a 1 (Hábitat no conservado), el cual se obtuvo a partir del modelo de Huella Humana (Human footprints, HF por sus siglas en inglés) derivado del Global Human Footprint Database of the Last of the Wild Project, Version 1, 2002 (LWP-1) (http://sedac.ciesin.columbia.edu/wildareas/maps.jsp) desarrollado por The Wildlife Conservation Society (WCS) y the Center for International Earth Science Information Network (CIESIN) de la Universidad de Columbia. El modelo de HF es el Índice de Influencia Humana (HII por sus siglas en inglés) normalizado por tipo de bioma. El HII es una base de datos global de 1km^2 por píxel, creado a partir de nueve capas globales de datos. Éstas incluyen la presión de la población humana (densidad poblacional y asentamientos humanos), el uso humano de la tierra e infraestructura (áreas urbanizadas, luces nocturnas y uso del suelo/cobertura del suelo) y el acceso humano (costas, carreteras, ferrocarriles y ríos navegables). Los rangos de valores del HF van de 1 a 100, donde 1 significa que el pixel con ese valor es parte del 1% de área menos influenciada en ese bioma (Sanderson *et al*., 2002). Por lo tanto, al primer modelo HSI se le restó el *Vp*

para obtener así el modelo: $HSI\text{-}Vp = [(a_1+a_2+2a_3) / \sum a_n]- Vp$. Finalmente, la clasificación del modelo en calidades de hábitat Baja, Media y Alta se realizó agrupando los valores del HSI en intervalos. La distribución de los valores determinó que intervalos correspondieron a cada categoría.

A partir del último modelo generado (HSI-Vp) se evaluó la presencia del pecarí de collar en cada una de las categorías de calidad de hábitat aplicando la prueba de Chi-cuadrada. Se utilizaron registros de la especie obtenidos a través de transectos, fototrampas y entrevistas. En el caso de encontrar diferencias significativas se obtuvieron los intervalos de Bonferroni (intervalos de confianza) para evaluar el uso y/o preferencia por categoría de calidad de hábitat por parte del pecarí de collar de acuerdo a su disponibilidad (Byers *et al*., 1984).

Tabla 1. Atributos del hábitat esenciales para la sobrevivencia del pecarí de collar. Asignación del valor de importancia (VIC) y cálculo del índice de importancia (IIA) para cada clase por tipo de atributo.

Atributo	**Intervalos**	**VIC**	**Clases de atributo**	**IIA**	**Calidad del atributo**
Cobertura de protección	Densa: Arbóreo-arbustivo (Selva baja caducifolia)	4	5	1	Alta
	Densa: Arbóreo (Bosques)	3		0.75	Alta
	Media: Arbustivo (Matorrales, chaparral, palmar, mezquital)	2		0.5	Media
	Baja; Herbácea (Pastizales)	1		0.25	Baja
	Sin cobertura aparente (zonas urbanas y agrícolas)	0		0	Inapropiada
Fuentes de agua	Perenne	3	3	1	Alta
	Intermitente	2		0.67	Media
	Sin agua	1		0.33	Baja
Suelo	Textura media: Limo	3	3	1	Alta
	Textura fina: Arcilla	2		0.67	Media
	Textura gruesa: Arena	1		0.33	Baja

La obtención de los registros de la especie fue a través de la selección sistemática de 16 localidades dentro de la RBTC. En 9 de ellas, se ubicaron 8 transectos en franja de 500m de largo por 2m de ancho con una separación mínima de 500m entre ellos por localidad (Burnham *et al*., 1980; 1985). Los transectos fueron recorridos por equipos de 3 personas, una de las cuales era un campesino conocedor de la zona. Se registró la presencia y/o ausencia de la especie mediante métodos indirectos (huellas, heces, echaderos y/o comederos), los cuales fueron geoposicionados. Debido a que el pecarí forma

manadas de varios individuos, se consideró el conjunto de rastros u observaciones como un solo registro por grupo de rastros. Los recorridos se llevaron a cabo durante la época de secas (Abril-Junio) del 2010 y 2011, periodo donde se encuentran las condiciones menos favorables para la especie y donde la permanencia de los rastros es alta. En las otras 7 localidades, se realizaron entrevistas abiertas a los pobladores con mayor conocimiento y/o edad de la zona para reconocer así sitios de avistamiento y/o de caza del animal para posteriormente geoposicionarlos. Todo aquel registro previo de la especie dentro de la RBTC fue igualmente considerado.

Resultados

En el modelo HSI, del área total de la RBTC (490,186 ha), el 56.9% se clasificó como de calidad alta para el pecarí de collar, ubicándose principalmente en la parte central de la reserva en la zona conocida como la Cañada; el 25.7% se clasificó como calidad media y se presentó con mayor frecuencia en la parte norte; mientras que el 17.4% se clasificó como de calidad baja y se encontró primordialmente en las zonas aledañas a los límites de la misma (Figura 1a).

Al considerar los factores humanos que afectan la calidad del hábitat para el pecarí de collar (modelo HSI-Vp), los porcentajes de cada categoría de calidad de hábitat cambian significativamente (Tabla 2; $\chi^2 = 2981.27$, gl = 3, $P < 0.05$).. El área de calidad alta presentó un drástico descenso a 14.9% de la totalidad de la RBTC; mientras que en contraparte, la calidad de hábitat baja y muy baja en conjunto incrementaron y sumaron el 59.7%. A la par de los cambios en los porcentajes de área de cada categoría de calidad de hábitat para el pecarí de collar, se tienen cambios en la distribución espacial de las mismas en la RBTC (Fig. 1b).

Como una medida para verificar la clasificación de hábitat generada por el modelo HSI-Vp, de las 16 comunidades humanas visitadas y de aquellas con registros previos (2 comunidades más), únicamente en ocho se registró la presencia del pecarí de collar. En estas comunidades se obtuvo un total de 46 registros (huellas, excrementos, echaderos, avistamientos, foto-trampeo y entrevistas con cazadores) de la presencia de esta especie. Se encontró diferencia significativa en el uso de cada una de las categorías de calidad de hábitat por parte del pecarí de collar (Tabla 2; $\chi^2 = 36.69$, gl = 3, $P < 0.05$). Los intervalos de confianza de Bonferroni indicaron que existió un uso preferencial hacia los sitios con calidades media y alta (Fig. 2).

Tabla 2. Categorías de calidad de hábitat y su área relativa dentro de la RBTC (490, 186 ha) para ambos modelos. Intervalos de confianza de Bonferroni para determinar el uso de cada una de las categorías de calidad por parte del pecarí de collar de acuerdo a la disponibilidad de área dada por el modelo HSI-Vp (-uso negativo, +uso positivo).

Intervalo	Categoría	Modelo HSI	Modelo HSI-Vp					
		Área relativa	Área relativa	Número de registros observados	Proporción de uso observado	Proporción de uso esperado	Intervalos de confianza	
-0.046-0.165	Muy baja	0	0.11	0	0	0.11	0 <p< 0	-
0.165-0.499	Baja	0.17	0.49	8	0.17	0.49	0.03 <p< 0.31	-
0.499-0.666	Media	0.26	0.25	21	0.46	0.25	0.27 <p< 0.64	+
0.666-0.9	Alta	0.57	0.15	17	0.37	0.15	0.19 <p< 0.55	+
	Total	1	1	46				

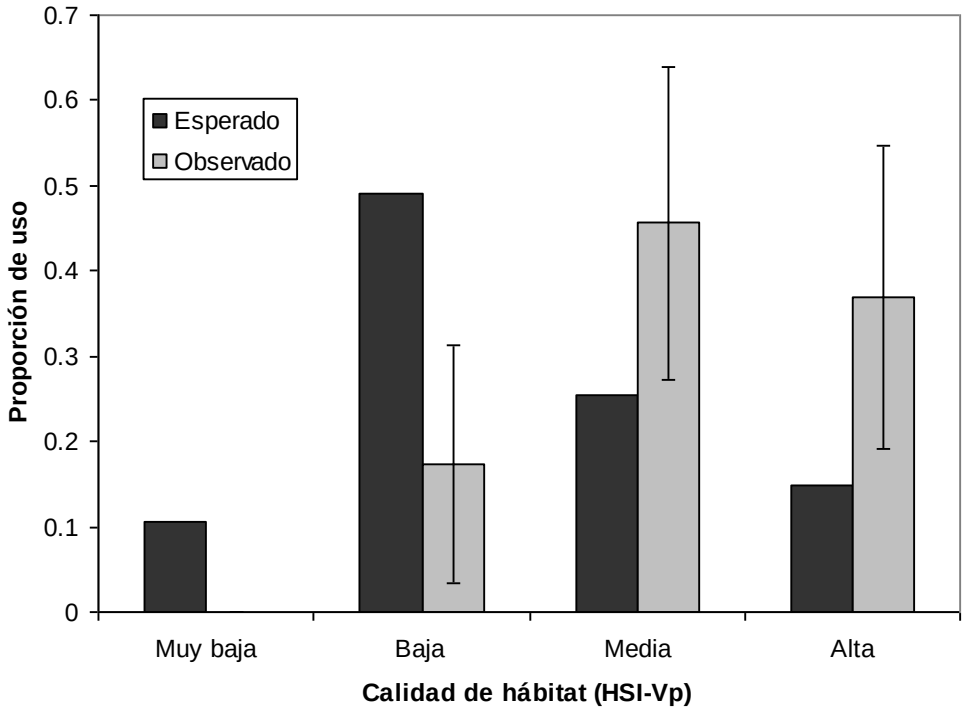

Figura 2. Proporciones de uso observadas y esperadas para cada una de las categorías de calidad de hábitat según los registros encontrados de la especie y el área ocupada por cada categoría en el modelo HSI-Vp.

Discusión

Los resultados de nuestro estudio sugieren que, considerando únicamente los atributos del hábitat esenciales para la sobrevivencia del pecarí de collar (modelo HSI), el 56.9% del área de la RBTC cuenta con las condiciones de idoneidad de hábitat óptimas para la presencia de poblaciones de esta especie, lo cual contrasta con el 17.4% del área que fue clasificado como de idoneidad baja. Este modelo apunta a que un porcentaje alto del área total de la RBTC podría estar manteniendo poblaciones viables del pecarí de collar.

El tipo de vegetación predominante en los sitios categorizados como de calidad alta fue la selva baja caducifolia, seguida por una menor representación del bosque de encino y del bosque de coníferas. Las áreas de calidad baja estuvieron principalmente asociadas a sitios sin vegetación aparente o perturbada. La cobertura vegetal alta es un determinante de la calidad de hábitat para el pecarí de collar al otorgarle protección contra el clima y depredadores (Sowls, 1997). Las selvas bajas caducifolias y los bosques templados, por su constitución vegetal, constituyen un buen sustento de éste recurso favoreciendo la presencia de manadas del pecarí de collar (Mandujano, 1999).

Sin embargo, las comunidades humanas y las actividades relacionadas con éstas y su desarrollo tienen gran influencia en la modificación de la calidad del hábitat para el pecarí de collar. En el segundo modelo generado (HSI-Vp), donde además de los atributos de hábitat esenciales para la especie se incluyó el factor de presión humana, los porcentajes de área de cada categoría de calidad para la RBTC cambiaron en comparación con el primer modelo generado (HSI). El área de calidad alta presentó un drástico descenso mientras que en contraparte, la calidad de hábitat baja y muy baja en conjunto incrementaron, la parte media se quedo casi sin cambios

Para este segundo modelo, la calidad de hábitat alta estuvo representada mayoritariamente por el bosque de encino y por pequeñas secciones de bosque de coníferas. Esto reduce las posibilidades del pecarí de collar para encontrar una cobertura vegetal de buena calidad dentro de la RBTC, ya que estos tipos vegetales están escasamente representados dentro de los límites de la misma (CONANP, 2008). Muchas de las zonas de selva baja caducifolia que en el modelo anterior habían sido consideradas de calidad alta disminuyeron en idoneidad, trasformándose así en calidad media. El incremento tan alto en la categoría de calidad baja y el surgimiento de una categoría aún más baja (muy baja calidad) denotan un bajo grado de conservación del ecosistema y una alta presencia de comunidades humanas, las cuales están ejerciendo una fuerte presión sobre el paisaje y, por ende, sobre el hábitat de pecarí de collar y otras especies de fauna silvestre.

El uso de las zonas de calidad alta y media por parte del pecarí de collar, categorizadas a partir del modelo HSI-Vp, mostraron preferencia al contener un número de registros alto de la especie. Esto soporta nuestra ideal inicial, que a mayor idoneidad de hábitat, mayor será la presencia del pecarí de collar. Comprobamos que efectivamente, a través de la aproximación de evaluación del hábitat utilizada, el animal está prefiriendo los sitios donde encuentra mejores condiciones de hábitat (cobertura vegetal, agua disponible y suelo) sobre aquellos en donde las condiciones y recursos son de menor calidad aunque éstos estén presentes en el ambiente.

Nuestros modelos fueron generados considerando la cobertura vegetal, el agua disponible y el tipo de

suelo, pero cabe destacar que un atributo importante para la sobrevivencia de los pecaríes en ambientes desérticos es la presencia y abundancia de cactáceas del género *Opuntia spp.* Este atributo no se considero en este estudio debido a que la disponibilidad ecosistémica en la RBTC no es exclusivamente de ambientes cálidos secos. En zonas áridas, una alta abundancia de Opuntias es indicadora de una alta calidad de hábitat ya que éstas los proveen de alimento, agua y cobertura (Theimer y Bateman, 1992**;** Ticer *et al*., 2001). Modelos que incluyan información de la distribución y abundancia del recurso alimenticio crítico para el pecarí de collar proporcionarán una mejor aproximación a su calidad de hábitat.

Alcanes y limitaciones del modelo

Aunque los modelos de calidad de hábitat representen una aproximación a los requerimientos de hábitat de las especies y a la distribución espacial de los mismos, son muchas las limitaciones que aquejan la buena predicción. En primer lugar, la biología de la especie en sí misma es un factor limitante, ya que se debe tener suficiente conocimiento de la misma para poder determinar cuales son sus requerimientos de hábitat básicos. Esto conlleva a una dificultad mayor cuando se trata de especies generalistas, tal como es el caso del pecarí de collar. Segundo, la escala a la cual existe y se maneja información espacial de cada uno de los requerimientos es generalmente a nivel nacional y global. Difícilmente las capas informativas se encuentran a escalas menores de pixel de $1km^2$, a menos que éstas sean generadas particularmente a través de datos y trabajo de campo en específico lo que implica un gasto mayor en tiempo y dinero. Tercero, son modelos estáticos que no representan cambios en el tiempo ni en el espacio. Cuarto, las diferencias en la selección y uso de hábitat por edad o sexo no son detectables cuando se trabaja con registros indirectos de animales tales como huellas. Y finalmente, la calidad de la información utilizada sobre la especie y sobre las condiciones del ecosistema/paisaje para generar los modelos, redundará en la calidad de la predicción.

Por otra parte, muchos de los modelos de idoneidad de hábitat que se han reportado para otras especies (Anadón *et al*., 2007; Delfín *et al*., 2009) han sido generados conjuntando en una misma ecuación y proceso tanto los requerimientos biológicos propios de la especie como la información de presiones antropogénicas. Sin embargo, en este sentido y particularmente para este estudio, el proceso de incluir factores humanos a la generación del modelo presidió de la generación de un primer modelo donde únicamente se observara la calidad de hábitat para la especie en cuestión bajo un supuesto de "no" actividad humana con la finalidad de notar si existía un efecto de cambio entre un primer modelo y el segundo. Se percibió que efectivamente existió una reducción en las áreas de mejor calidad y por ende el aumento en aquellas de menor. La comparación de ambos modelos generados denota que aunque en gran parte de la RBTC se pueden encontrar los requerimientos básicos que la especie necesita, las comunidades humanas y su desarrollo tienen una marcada injerencia en delimitar la disponibilidad de estos.

Implicaciones en el manejo y conservación de la especie

La presión antropogénica mostró un efecto en la categorización de los tipos de calidad de hábitat. Los sitios de mejor calidad y donde se encontraron más rastros fueron aquellos donde los valores de la huella humana fueron bajos. Sin embargo, se ha observado que el pecarí de collar tiene la capacidad de hacer uso de hábitats degradados en su calidad, incluso tienden a usar sitios de vegetación secun-

daria (Reyna-Hurtado y Tanner, 2007) y cercanos a zonas urbanas y agrícolas (Bellantoni y Krausman, 1993; Romero-Balderas, 2006). El pecarí de collar no solo ha mostrado una gran adaptabilidad a varios climas y tipos vegetales, si no que también ha mostrado la habilidad a adaptarse a cambios en el hábitat hechos por el hombre. A pesar de que puede prosperar en vegetación prístina, también puede hacerlo en vegetaciones secundarias y áreas agrícolas. En zonas agrícolas puede prosperar bien si es que existe una cobertura adecuada y disponible para ocultarse (Sowls, 1997). Las poblaciones del pecarí de collar pueden presentar menor vulnerabilidad a los declines relacionados al deterioro de su hábitat debido a que tienen ámbitos hogareños y tamaños de manada más pequeños en comparación con otras especies de ungulados (Keuroghlian *et al*., 2004).

Por otra parte durante el trabajo en campo, aunque no fueron evaluados, se observó que la ganadería extensiva y la cacería furtiva son otros dos factores importantes dentro de la RBTC que probablemente podrían estar afectando la presencia del pecarí de collar a una escala menor de hábitat. Ambos factores van muy de la mano con el desarrollo de las comunidades humanas. Debido a que la información obtenida por la Huella Humana (HF) no contiene a éstas amenazas, sería importante evaluarlas para determinar cual es su impacto sobre las poblaciones de ésta especie y sobre su hábitat en la región. Hay que considerar que el hábitat es más que solo vegetación y los recursos que rodean a un animal y que igualmente importante son las limitaciones ecológicas que podrían restringir el uso de esos recursos (Morrison *et al*., 2006).

Los modelos generados en este estudio son una herramienta muy útil en la generación de información básica para el conocimiento del pecarí de collar en la zona y de las condiciones de hábitat actuales en la región para el mantenimiento de poblaciones viables de la misma. Fue notable que a pesar de considerar a la RBTC como un sitio con una gran diversidad biológica y como una entidad destinada a la conservación de ésta, la presencia de actividad antropogénica dentro de sus límites está ocasionando deterioro en las condiciones del hábitat para el pecarí de collar y, muy probablemente, para otras especies. Entonces, en conjunto con las restricciones del área y a las amenazas directas (por ejemplo: la caza) los factores relacionados a la calidad del hábitat y a la diversidad pueden estar afectando la persistencia de las poblaciones del pecarí de collar en la región. Es primordial, hacer planes de manejo y conservación sustentables para la especie considerando las condiciones de su hábitat y las amenazas presentes para evitar su futura extinción local en la zona.

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Boma and Chemical capture of the Nile Hippopotamus *(Hippopotamus amphibious kiboko)* for translocation in Kenya.

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Introduction

The common or Nile River hippopotamus (*Hippopotamus amphibious)* and the pygmy hippopotamus *(Choeropsis liberiensis)* are the only two species in the family hippopotamidae. The common hippo is a gregarious social animal inhabiting wetlands, rivers and lakes in at least 29 countries in sub-Saharan Africa.

Demand for hippo meat, trophies, and fatal consequences following retaliatory human-hippo conflicts are major threats to their viability (IUCN, 2004), which probably led to the species being listed as vulnerable in 2006 (Miller, 2003). In Kenya there are about 5000 common hippos, a population size regarded as stable but relatively sparse compared to 40 000 hippos in Zambia (IUCN, 2004). Across several African countries human-hippo conflicts are on the increase, which are often exacerbated by drought conditions (IUCN, 2004). Human-hippo conflicts result in human injuries and deaths exceeding those caused by crocodiles annually (Morris *et al.,* 2001) and therefore calls for strategic interventions to manage the populations. Capture and translocation of wild animals, especially of elephants, have been used in Kenya and Uganda to alleviate human-wildlife conflicts (Gakuya *et al.,* 2003; Wambwa *et al.,* 2001) and it is predictable that the strategy is plausible and can be applied in the conservation management of hippos. Capture and translocation of free-ranging hippos is rare in Africa, supposedly due to the amphibious nature and aggressiveness of the species. During prolonged drought in 2009 in Kenya, frequent reports of human–hippo conflicts led to the decision to capture and translocate a hippo population from the high conflict site as a mitigation measure. The aim of this study is to describe the outcome of the translocation exercise of hippos captured by either chemical or physical methods.

Study area

The site of the human-hippo conflict was the Ruai sewage treatment plant, which is on the outskirts of Nairobi, approximately 50 km from Nairobi National Park. A rapid census survey suggested that 27 hippos were in the sewage plant. The hippos had colonized the ponds from nearby rivers following prolonged drought. Coincidentally over the years, human settlement and crop farms had extended near the sewage area. This led to continuous human-hippo conflicts, to the extent of being a threat to human life. Hippo presence also hampered planned expansion and maintenance activities at the sewage site.

Boma Capture

The boma system of capture was recommended because it was possible to habituate the animals due to the prevailing scarcity of food. A circular-shaped crush (boma) was constructed with poles all round and inlet and exit sliding doors made of thick metal, located opposite each other. The poles were 3 m (sunk 1m deep and 2 m above the ground). The poles were joined together by cross-bar poles tied by high tensile wires (Fig. 1). The inner wall near the doors was lined with thick conveyor belt to prevent hippos biting on the walls. The boma was located 5 meters from the ponds. A fresh supply of cut maize stalks, vegetables and hay sprinkled with molasses was supplied every evening in the boma. The habitual feeding continued for two weeks without a capture attempt. When capture began, it was done at night after every two days, though habitual feeding continued. When the animals entered the boma to feed, the sliding inlet door was pulled using a long, high-tensile wire to close them in. The exit door on the opposite side of the inlet was slid opened. The exit door was attached to the opened door of a transportation truck. The trapped animals were then coerced through the exit door into the truck where they stayed calm throughout the journey.

Chemical Capture

Chemical immobilization was used in two cases: the first involved a translocated hippo from Ruai that had strayed out of Nairobi National Park, just hours after release. The second incident involved three hippos that were already in the boma, but mud hindered the access of the transportation truck to the boma.

Case 1:

The hippo (Hippo 1) was sighted in a residential compound, 30 km from the release pond. Chemical restraint was opted for to achieve quick translocation because the animal posed a risk to the public. There was also no adjacent mass of water that could potentially lead to drowning after neuroleptoanalgesia. The animal was approached by a slow moving vehicle and seemed unperturbed until it was darted on the right gluteus maximas muscle. The animal then reacted by moving slightly away from capture team but remained calm. The animal was an adult with an estimated weight of 1500 kg. It was darted using a combination of 3mg etorphine hydrochloride (M99®, Norvatis PTY, South Africa) and 80 mg azaperone (Kyron Laboratory, PTY, Limited, South Africa). The dart, which was fitted with a 60 mm-long needle, was delivered by a Dan-inject dart gun. The induction time and narcosis effects were recorded.

After recumbency, tetany of the forelegs was noticed and the animal was given a dose of 5cc doxapram (Dopram®, Kyron Laboratory, PTY, Limited, South Africa) sublingually and a further maintenance dose of 10 cc intramuscularly to reverse the narcosis effects. The animal was drenched with copious amounts of water to reduce hyperthermia. As a precautionary measure against hypoxemia, 10mg of nalophine® (Laboratoires Pharmaceutiques, Paris) was administered sublingually. High tension straps were tied on the fore-limbs above the carpal joint and above the hock joint of the hind limbs and the animal was hoisted by a crane onto the back of the truck. The animal was positioned on a lateral recumbency on the truck but the head was slightly raised by pillow of rags. It took about 35 minutes to relocate the animal back into the release site within the National Park. The animal was

off-loaded from the truck and placed on the ground near a pond in lateral recumbency. Neuroleptoanalgesia was reversed, by a combination of 15 mg diprenophine (M5050®, Norvatis, PTY, Limited. South Africa) and 10 mg naltrexone (Kyron Laboratory, PTY, Limited, South Africa), administered sublingually.

Case 2:

The second incidence of chemical restraint was of three hippos (Hippos 2, 3 and 4) inside the capture boma. Heavy rain after the animals were already trapped in the boma caused the terrain to be muddy and hinder entry of the transportation truck to the boma. As such, the option was to chemically immobilize the animals and place them in a smaller truck, which would then transport them to the larger transportation truck (Fig 1). The animals were also immobilized using a combination of etorphine hydrochloride and azaperone. The animals were pushed to lateral recumbency. As a result of the mud and rain, the limbs of the hippos were slippery to fasten straps on for lifting. Alternatively, straps were placed around the shoulder and another fastened over the inguinal region of the animal. This process took longer than expected and Hippo 4 showed signs of neuroleptoanalgesic reversal and a supplemental dose of etorphine was administered intramuscularly. The animals were lifted from the boma onto the back of smaller truck using a crane, and moved 1.2 km away. The animals were then transferred from the smaller truck to the transportation truck where neuroleptoanalgesia was reversed using diprenorphine and naltrexone as above. The animals were transported to Nairobi National park and released into ponds.

Figure 1. Trapped hippos inside a boma where they were chemically immobilized and slings/ropes fixed to lift them out. Mud hindered the transportation truck from reaching the boma, which necessitated the decision to immobilize the trapped animals. Note the wall of the boma.

Results

Out of 27 hippos, 18 hippos were successfully relocated into ponds within Nairobi National Park. Of the four animals that were chemically restrained, three were successfully relocated into the park while one died. The drugs and doses administered on the hippos and periods of induction and reversal are summarized in table 1. Hippo 1 was still standing eight minutes post-darting, obviously alert but saliva drooling from its gaping mouth. By 12 minutes post-darting, the animal assumed a squatting position, stargazing with the mouth wide open. The animal was approached by the 20th minute, but with great caution and a blindfold was fitted over the eyes. The animal was then gently positioned on sternal recumbency. Recovery from neuroleptoanalgesia was very slow but rate and depth of respiration was observed to increase followed by slight head movement and ear twitching. By 15 minutes the animal was alert and assumed sternal recumbency. The animal then staggered into the nearby pond and was able to remain afloat as the head was maintained above the water surface. This hippo was released into a different pond occupied by only one mature hippo and after a week of monitoring, it was considered settled. In the second case, darting of Hippos 2 and 3 was uneventful. All assumed the dog -sitting position and star-gazing posture as the drug took effect. They maintained these positions for up to 40 minutes when they were forced on lateral recumbency by ropes. A sub adult (Hippo 4) was given a supplemental dose of 1mg etorphine after it showed signs of neuroleptoanalgesic reversal but it developed breathing difficulty and died suddenly. The time of induction for the four hippos was mean ± SD = 28.25 ± 5.7 while time of reversal for the three hippos was mean ± SD = 8.33 ± 5.8. Hoisting hippos strapped just above the hocks, or using straps fastened just behind the forelegs and another just in front of the hind legs were both considered effective methods.

Discussion

The physiology, biology and behavior are just some of the factors that have made captures of wild Nile hippos a challenge (Harthoorn *et al.,* 1960; Van Niekerk & Pienaar, 1962). Physical methods of hippo capture in the wild such as the boma system, or dual systems involving chemical restraints and netting (Pienaar, 1967) or chemical methods alone (Harthoorn *et al.,* 1960) have been tried with variable outcomes and success rates. From our work, we recommend dual systems of physical and chemical restraints as they increase success rates.

However, previous capture exercises based on chemical immobilizations suggest challenges. An attempt to reintroduce hippos into Addo National Park, South Africa was initially frustrated when a combination of flaxedil and scoline became fatal (Van Niekerk & Pienaar, 1962). It was suggested that scoline is of high risk due to its narrow safety margin and not recommended when the correct weight of the animal cannot be assessed, when hippos are under water or at a distance. Van Niekerk & Pienaar, (1962) tried a combination of morphine hydrochloride, hyoscine hydrobromide and chlorpromazine with success despite the fact that initial drug effect took as long as 30 minutes while recumbency was only after two hours. Combinations of thiambutene, phencyclidine and hyoscine have been tried but with poor outcomes (Buck *et al.,* 1963). A combination of phencyclidine and acetylpromazine were recommended when darting hippos in water as it allows for netting the hippos in water and relocating on land (Pienaar, 1967). Several workers have used etorphine hydrochloride in combination with azaperone in the capture of wild hippos and they seem to recommend it (Henwood & Keep, 1989; Maritz, 1993; Burroughs *et al.,* 2006) but there is still a lack of consensus on dose regime to be

used on hippos in the wild.

In this work we used etorphine combinations and doses (Table 1) that are in agreement with that recommended by Harthoorn (1976). Using narcotic combinations and doses that have been tried before is important for guiding future immobilization exercises. In the wild, a 1.5 – 2.0 mg etorphine dose has resulted in 67.6% successful captures (Henwood & Keep, 1989), which is almost comparable to the outcome of this work (75%). The etorphine doses used in restraint of wild hippos are relatively low compared to those recommended in captivity (Jarofke, 1993; Burroughs *et al.,* 2006). In the present work we observed the effects of the drugs on the hippos, which included squatting, dog-sitting posture, star-gazing, wide open mouth and drooling (Fig.2). Other effects observed in previous reports include grunts (Van Niekerk & Pienaar, 1962), prostration, chewing and paddling movements (Burroughs *et al.,* 2006).

Table 1. Summary of chemical restraint and dose data of hippos sedated by a mixture of Etorphine hydrochloride and Azaperone

Key: F – Female; M – Male; Ad – adult; W – estimated weight; E – etorphine; Az – azaperone; IT – Induction time; Dox – doxapram; Dip- diprenorphine; Nal - naltrexone

Hippo data				Narcotization				Reversal		
No.	**Sex**	**Age**	**W**	**E**	**Az**	**IT (Min)**	**Dox**	**Dip**	**Nal**	**RT**
H1	M	Ad	1500	3	80	20	15	15	10	15
H2	M	Ad	1200	3	200	31	200	15	10	4
H3	F	Ad	1000	3	200	29	200	15	10	6
H4	F	Sub-Ad	550	1.5	80	33	200	Died	_	_

It is advisable to pour large amounts of water on the recumbent animal and administer doxapram as a precautionary measure against respiratory complications (Ramsay *et al.,* 1998). Parasympatholytic drugs and atropine which reportedly block the sweating reflex of the hippos ought to be avoided as they result in fatal hyperthermia (Pienaar, 1967). The head of recumbent hippos should be raised and supported by a pillow or rags to allow free breathing. The animal may be lifted while on a flat sled as used for rhinos (Burroughs *et al.,* 2006) or hoisted by straps tied above the hock-knee joints of the hind- and fore-limbs (Fig. 3) or slings strapped under the shoulders and another above the inguinal area.

Suitable sites for administering drugs on hippos are one of the challenges to their chemical restraint (Ramsay *et al.,* 1998), due to their thick layer of subcutaneous fat. Skin folds or areas near the neck are likely to be less thick and are therefore suitable especially for recumbent animals, but may be quite a challenge when darting from a distance. In this work, narcotics and other adjunct drugs were administered through the gluteal muscle (Fig. 2), a site that had also been used by Ramsay *et al.,*

(1998) in captive hippos. However, for analgesic reversals, a sublingual route was quite effective and recommended.

Figure 2. The Nile hippo was chemically immobilized for translocation. The characteristics associated with effects of narcosis (squatting, star-gazing and open mouth) are displayed.

Figure 3. The picture shows positions for tying the slings and lifting of the neuroleptoanalgesic hippo onto the back of a truck. The Nile hippo was being captured for translocation to Nairobi National Park.

In conclusion, an etorphine-azaperone combination provided sufficient narcotization. A dual system of physical and chemical methods for hippo capture is suitable as they are likely to result in more success. Since hippos are increasingly in conflict with humans, translocation is a plausible intervention.

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The Javan Warty Pig – A Sparring Partner for Hunting Dogs

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Introduction

The Javan Warty Pig *Sus verrucosus* is an endangered pig species of Indonesia and is endemic to Java and associated offshore islands. It probably evolved on Java since the Early Pleistocene, or almost two million years ago. Hardjasamita (1987) traces its ancestry back to several older species found on Java, while Randi *et al.* (1996) found that it split off from its nearest living relative, the Bearded Pig *S. barbatus* from elsewhere in the Greater Sunda Islands between 2 and 5 million years ago. The species is therefore relatively ancient, and is a good example of the unique Javan fauna. The two recognized subspecies are *S. v. verrucosus* from Java and Madura—although Blouch (1993) and Semiadi & Meijaard (2006) thought it to be extinct on Madura—and *S. v. blouchi* from Bawean Island, 150 km off the northeast coast of Java (Groves 1981).

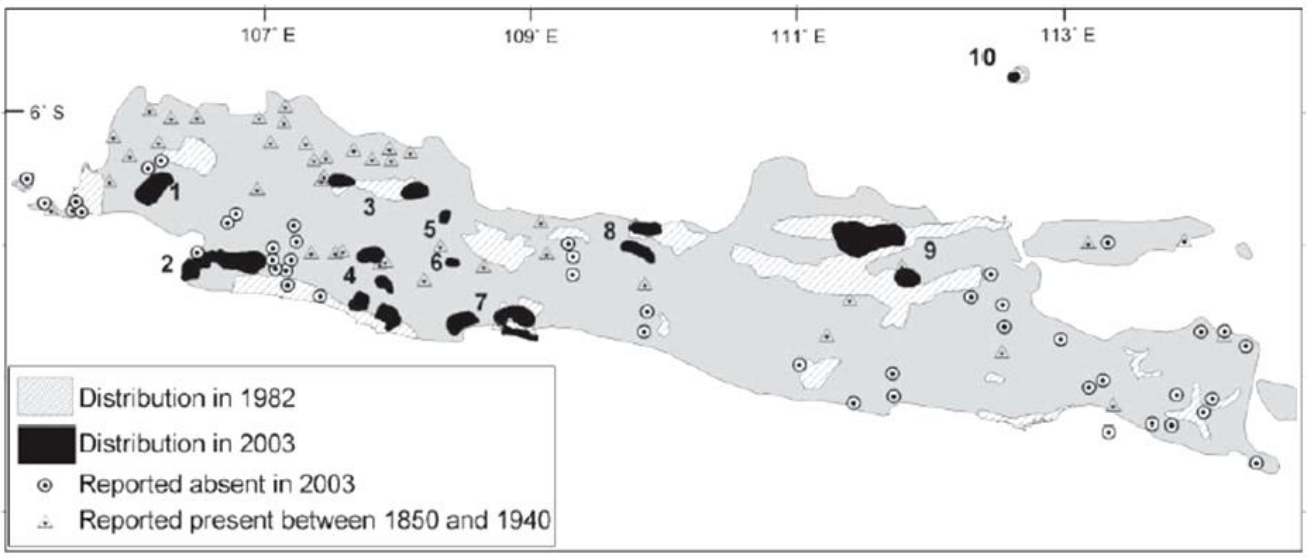

Figure 1: The distribution of *Sus verrucosus* between 1850 to 2003 (Semiadi and Meijaard 2006).

On Java, *S. verrucosus* is sympatric with the Indonesian wild pig or 'banded pig, *S. scrofa vittatus*, which is widely distributed elsewhere in the region. Olivier (1925) mentions that in West Java *S. verrucosus* and *S. scrofa* were both common, and that they occurred in similar habitats from coastal to montane forests, though van Balen (1914) stated that they occurred only on lower slopes. However, more recent studies, for example, Blouch (1988; 1993) indicate that the two species avoid each other

and attained their highest densities where the other species was absent. Olivier (1925) also suggested that *S. verrucosus* was the more common species away from human habitation.

Blouch (1988) conducted a wide-ranging survey of *S. verrucosus*, which also included Bawean Island, but excluded Madura where the species was already presumed extinct owing to the virtual denudation of that island (J. MacKinnon, pers. comm.). He noted that *S. verrucosus* was not found above 800 m., and its preferred habitat was extensive areas of lowland secondary vegetation, particularly teak plantations in Central Java characterizes by a mixture of trees and grasslands with clumps of bush and heavily disturbed forest. Blouch (1988) also found that it frequented coastal forest, thereby largely confirming the earlier descriptions of Olivier (1925) and Franck (1936). *S. scrofa* on the other hand can be found at all altitudes in most habitats, and seems to be far more adaptable than *S. verrucosus*.

Conservation Status

S. verrucosus was feared to be nearly extinct in the late 1970s, but a small population was found in 1981 on the forested slopes of Mt. Penanggungan near Tretes, East Java (Whitten *et al*. 1996). The 1982 survey by Blouch located several more populations across Java, and he reported diverse threats to the species' survival, such as hunting and poisoning. Still, Blouch (1988) concluded that the future of *S. verrucosus* was relatively safe. However, Blouch and Groves (1990) pointed out that hybridisation between *S. verrucosus* and *S. scrofa* posed an unknown, but potentially serious threat, primarily

to the survival of the former species.

Since the political upheaval in Indonesia between 1996-1998, the forests of Java, which are prime *S. verrucosus* habitat have come under increasing threat from illegal logging. It is yet unclear how this timber poaching has affected the *S. verrucosus* populations, but the few available data indicate the likelihood of continued decline and severe fragmentation of the few remaining wild populations.

In 2000, *S. verrucosus* was listed as Endangered based on an inferred population decline, the fragmentation of habitat, and the levels of exploitation (IUCN 2000). The IUCN/SSC Action Plan (Oliver, 1993) accorded the species very high conservation priority, and stressed the urgency of implementing relevant conservation measures – including this survey. Until now, there has been no follow-up to the conservation recommendations given by Blouch (1988) and Oliver (1993).

A report by Semiadi & Meijaard (2006) indicated that hunting, mainly as means of controlling agricultural pests, and the loss of suitable habitat are the major threats. The report indicates that loss of habitat, in particular in production forest (teak plantation), is by far the more serious problem at this time. The situation at present indicates that the population contains only a small number of individuals in a very fragmented habitat, with little data existing on exact population numbers or demography.

The first phase of the programme (2003-2004) produced a "Rapid Assessment of the Current Conservation Status and Future Management Needs of the Endangered Javan Warty Pig (*Sus verrucosus*)" and was followed by a 'Rapid Assessment on Prospective Habitat for a Re-introduction Programme'.

In March 2006 a meeting was held in Cibinong to discuss priority conservation actions. Key points raised at the meeting included: (a) the establishment of Verrucosus Breeding Centre (VBC) was seen as a priority, and proper facilities have already been established in Cikananga; (b) molecular profile of pure and hybrid *Sus verrucosus* and *Sus scrofa* should be established, with first samples taken from pigs that are available in Indonesian Zoos; (c) the protocol being developed during the molecular study will be used as a standard protocol for identification on any wild pigs that are captured for the Verrucosus Breeding Center.

Current Threats

Additional surveys in September 2010, in Banjar village (West Java; Fig 1, No 6), the area where *verucosus* was already known to be present and being heavily hunted, showed that the Javan Warty Pigs are not being hunted because of their perceived status as an agricultural pest, but mainly for two other reasons: first for traditional dog-pig fighting in arenas in the nearby Pangandaran village area (Fig 1, No 7), mainly during the Islamic holidays, and secondly to train the hunting dogs which specialize in pig hunts. These are mainly pitbulls.

The first activity has been known for years, but it turns out that the Javan Warty Pig is much more wanted than the Eurasian Wild Boar (*Sus scrofa*) as the former species seems to be much more aggressive, and lasts longer during the fights with several dogs.

The second activity has not been reported before, but seems to have a much greater negative impact on the natural populations, especially in the surroundings of Banjar village. Local farmers catch the Warty Pigs and sell them for Rp 150,000-500,000 (US$ 17-60) to the dog-fighting mafia. When the time comes, the pigs are placed in an arena, and hunting dogs get their turn in biting the pig – every bite resulting in a fee of Rp 30,000 (ca. US$ 4) to the pig owner. When the pig is completely exhausted and almost dying, the animal is killed with spears and the meat sold to non-muslims. In this way, a Javan Warty Pig can fetch up to Rp 1 milion (USD 120) per animal, making this activity a very lucrative business for the locals. According to reliable sources, every week a few pigs are caught for this purpose, adding up to probably more than a hundred animals per year in this particular area.

Future Conservation Measures

For the continuous survival of this extremely rare and heavily threatened pig species, several actions will need to be undertaken:

- Secure remaining habitats and protect the species within these habitats
- Continue the Captive Breeding efforts which are presently running in the Cikananga Conservation Breeding Center in West Java to establish insurance colonies, and obtain more insight on the species' genetics, behaviour, and ecology
- Reintroduction of the species into empty (former) habitats which are secure, with trial projects on offshore islands near the Ujong Kulon National Park

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Indigenous pig management in West Papua (Highland Vs Coastal sites)

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Why farm with pigs?

The indigenous communities living in the West Papua commonly rely on the "blessings of nature". The climate is tropical and humid and the mountains in the area are mostly covered with primary and secondary rainforests rich in biodiversity. Local communities strongly depend on the forest: it provides bushmeat, fuel wood, fruits, vegetables and medicinal plants. People also practice slash-and-burn agriculture and grow crops for own consumption such as tuber crops, maize, peanuts, beans, red pepper and cucumber. Traditionally, they keep small numbers of livestock. Local breeds of chicken, kept for meat and egg production, range freely in and around the house. Families own few heads of cattle, which are left to graze on public areas in and around the village. They also own a small number of pigs, which are kept around the house or taken to the fields. (Fig. 1) All family members are involved in taking care of their animals.

Farmers acknowledge the value that livestock in general and pigs in particular offer. They require relatively low labor inputs, feed on and recycle tree leaves, grass and crop residues, and (household) waste products, provide fertilizer for home gardens and act as a capital investment that can be used in emergencies. Pigs are particularly valuable because they are very fertile, give families social status

and play an important role in cultural and traditional rituals. They are frequently offered as "bride price" and valued as a barter object. Pigs also play an important role in the communities' farming system (Pattiselanno, 2004[b]).

Figure 1: Pigs are kept around the household.

Raising pigs is generally an additional alternative source of income for farmers in the coastal areas. A previous study by Ropa (2001) indicated that the demand for pork in Manokwari was met by other parts of West Papua (Bird Head and Gelvink Bay regions). Statistical data from the Livestock Office in Manokwari regency cited that there is an increase in pork supply from Nabire, Serui, Biak and Jayapura. Warastuti (2001) esimated that income generated from swine husbandry along the coastal area of Manokwari was about Rp. 1,204,134.38 (approximately (120 US $) annually (n=41).

Extensive pig management in the highlands

Most households let the pigs range freely around the house and garden and some allow the animals to stay in the house, particularly near the cooking area. Pregnant sows receive priority attention; they are often kept in the house and given good quality food (Pattiselanno, 2004[a]). Sometimes pigs are kept in small pens near the house, built from wood or bamboo. They are fed with cooked and uncooked kitchen and household leftovers such as rice and vegetables, or they are given sweet potato, cassava or other tuber crops (Randa, 1994). Women and children are usually responsible for feeding pigs.

Disadvantages of this method of housing pigs is that zoonosis cases may spread widely though the area. One common diseases found in the area is cysticercoids, because the feeding sites of pigs are also surrounded by human latrines. In the remote highland areas in West Papua, humans defecate freely around the house. Even though the government has built public toilets, this has not changed behaviour. Therefore, while searching for food, it is possible that the pigs may also ingest human faeces that contain infective eggs, thereby maintaining the cycle for the development of *Taenia solium*.

Households living near the forest or village families that temporarily move to non-permanent houses near the slash-and-burn areas keep their pigs in simple pens in the field, the reason being that they perform several functions in slash-and-burn agriculture. Slash-and-burn farmers clear new forest plots, or return to old fields that have been kept under fallow for some years and make them ready for cultivation. Crops such as maize, beans, peanuts and root crops are planted. While harvesting, some parts of the crops (the crop residues, such as stalks and leaves, or also part of the harvest, e.g. maize cobs) are left in the field and pigs are allowed to feed on them.

After one or two years of cropping, the land is left fallow and pigs are allowed in. Farmers construct a live fence of *gamal* (*Gliricidia sepium*) around these plots to keep the pigs in and to obtain fuel wood and fodder for ruminants (Fig. 2). While searching for food, the pigs carry out extensive digging on the fallow land – hence the name "pig-dozer" – thereby improving the soil structure (Pattiselanno, 2004[b]). Simultaneously, the pig manure improves the chemical soil fertility of the land. After a 2-3 year fallow period, the plot is made ready again for planting. Farmers know that plots prepared by pigs are very suitable for planting root crops, so they plant their cassava and sweet potato in those fields (Fig. 3).

Figure 2: Live fence constructed around plots

Figure 3: Pigs are used to prepare plots for planting

Intensive management around the coastal areas

In contrast to the highland farmers, farming groups along the coast apply a more intensive management style. For their entire lives, pigs are kept inside small pens suspended above the water, and as a consequence the diet, water and other production needs of the animals must be provided by the farmers.

The main construction material used by the farmers is "kayu buah" (*Macaranga* sp) for a semi-permanent, open-style pen (Fig.4). During the night when temperatures decrease, metal sheets cover the top of the pen to keep the animals warmer. Locally, the pen style is known as "*kandang berlabuh"* – floating pens.

Feed comprises the highest cost associated with pig production, which is why some farmers try to find alternative diets that are inexpensive and regularly available. Utilization of waste from the vegetables

market and restaurant leftovers are an alternative source of food provided by the farmer to their animals. Numerous different foods (household leftovers, tofu residue, waste from fish markets or waste from banana and cassava vendors) are mixed and cooked for feeding the pigs. Not only does this benefit the farmer economically as it is efficient and low in cost, but it reduces waste around the city.

Figure 4: Open-style pens suspended above the water

Anecdotal information obtained from farmers is that pigs that constantly drink sea water produce less body fat. Sea water does play an important role in keeping the pen clean and maintaining pig health as well. Apparently sea water consumption also provides pigs with adequate mineral requirements, and at the same time seems to reduce the aggressiveness of the animals - they do not chew the bamboo and wood used for pen construction.

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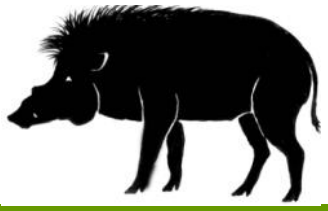
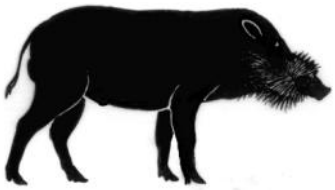


News in Brief



Pigs Susceptible to Virulent Ebolavirus Can Transmit the Virus to Other Animals.

http://www.sciencedaily.com/releases/2011/05/110513064355.htm

ScienceDaily (May 13, 2011) — Canadian investigators have shown that a species of ebolavirus from Zaire that is highly virulent in humans can replicate in pigs, cause disease, and be transmitted to animals previously unexposed to the virus. The findings are published in The *Journal of Infectious Diseases* and are now available online.

In order to prevent human outbreaks of Ebola hemorrhagic fever, it is important to identify animal species that replicate and transmit the virus to other animals and, potentially, people. Zaire ebolavirus, one of several species of the virus, has a fatality rate as high as 90 percent in humans. Antibodies to another species not associated with human disease, known as Reston ebolavirus, have been found in pig farmers in the Philippines, suggesting pigs may be able to transmit virulent ebolavirus to humans as well.

This study, led by Gary P. Kobinger, PhD, of the Special Pathogens Program, National Microbiology Laboratory, Public Health Agency of Canada, and Hana Weingartl, PhD, of the National Centre for Foreign Animal Disease at the Canadian Food Inspection Agency, investigated whether Zaire ebolavirus, like Reston ebolavirus, could replicate and cause disease in pigs and be transmitted to other animals. Using domesticated pigs, the researchers first evaluated virus replication, pathogenicity, and shedding.
Following mucosal exposure to Zaire ebolavirus, the pigs replicated the virus in high amounts, mainly in the respiratory tract. Shedding of the virus from nasal mucosa was detected for up to 14 days post-infection, and severe lung disease was observed. The study also showed that the virus was transmitted to all previously unexposed pigs co-habiting with the infected animals.

The study authors suggest that domesticated pigs are susceptible to Zaire ebolavirus through mucosal infection and that the pigs' accompanying severe respiratory disease is associated with shedding of high viral loads into the environment, exposing uninfected pigs to the infection. In contrast to the systemic syndrome affecting multiple organs that often leads to shock and death in primates, they noted, the respiratory syndrome that develops in pigs could be mistaken for other porcine respiratory diseases.

In an accompanying editorial, Daniel G. Bausch, MD, MPH & TM, of the Tulane School of Public Health and Tropical Medicine in New Orleans, noted that the study's findings raise important questions for additional research on ebolavirus. The results described in the study are "cause for consideration, for further scientific study" but are not cause for panic, Dr. Bausch wrote.

Background information

1. Zaire ebolavirus, one of several species of ebloavirus, has a fatality rate as high as 90 percent in humans.
2. Antibodies to Reston ebolavirus, a species of the virus not associated with disease in humans, have been found in pig farmers in the Philippines.
3. In this study, pigs exposed to Zaire ebolavirus became infected and transmitted the infection to previously unexposed pigs.

Amazon's Biodiversity: Clearing Up Doubts as to the Benefits of Ecotourism

http://www.sciencedaily.com/releases/2011/11/111122112123.htm

ScienceDaily (Nov. 22, 2011) — Ecological tourism has no effect on the presence of large mammals in the Amazon, according to a study that for the first time compares the biological diversity of ecotourism zones with that of protected areas. Furthermore, it can help to protect the biodiversity of areas that are not officially protected yet are vital in the ecological framework.

Since the UN began to promote ecological tourism at the end of the 1980's as a way of protecting the environment without resorting to its economic exploitation, the debate as to whether ecotourism is really beneficial has remained alive.

Aiming to answer such questions, two Spanish researchers spent four months in the middle of the Amazon to assess the presence of large mammals in Bonanza, a private estate used for ecotourism within the Manu Biosphere Reserve. The results of their study show that not only is ecotourism harmless to the biological richness of the area but it could even have a positive effect on the biodiversity of surrounding areas.

The study by Salvador Salvador (University of Gerona) and Miguel Clavero, (Doñana Biological Station-CSIC), in collaboration with Renata Leite from Duke University's Center for Tropical Conservation, has been published in the Mammalian Biology journal.

In their analysis of the Bonanza estate, the researchers found 41 species of large mammal out of the 48 species that have been documented in the whole reserve. According to Salvador, "we could not find any way in which the richness of species has been affected. No species sensitive to the presence of humans was lacking and although we were unable to calculate population density, species like the tapir (Tapirus terrestris) or the huangana (a local way of referring to another type of wild boar, the Tayassu peccary) were abundant, even compared to virgin forest areas.

As the study lasted for four months, the researchers were also able to compare the presence of fauna during the dry and wet seasons.

When we talk about ecotourism, Salvador warned that "we have to understand the difference because a [photographic] safari in Kenia is not the same as what we studied in the Amazon rainforest." The importance of the study lies in the fact that never before has the biodiversity of ecotourism zones been contrasted with that of protected areas, at least in the Amazon.

"The size of the ecotourism areas bears little significance in relation to the size of the extensive Amazon's ecosystem and yet some species had been found to be affected," said Salvador. One of them was the giant otter (Pteronura brasiliensis), which is native to the Amazon and considered endangered by the International Union for Conservation of Nature. The expert pointed out that "these were some cases but no real comparison had been made until our study." Inadequate ecotourism practices that negatively affected the otter were mainly linked to river transport. For example, the boats used to transport tourists would come too close to the dens of the otters.

After four months of field work and interviews with the locals, the results show that Bonanza has "at least 85% of species." The expert added that "the species from pristine areas that were not found in Bonanza are likely to appear there, given that despite their rarity they are not considered particularly sensitive to human presence."

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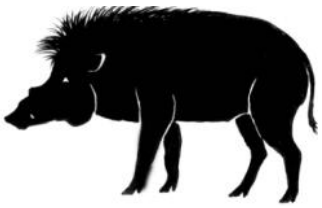
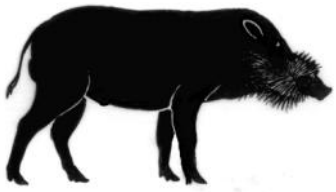
Salvador Salvador, Miguel Clavero, Renata Leite Pitman. Large mammal species richness and habitat use in an upper Amazonian forest used for ecotourism. *Mammalian Biology - Zeitschrift fur Saugetierkunde*, 2010; DOI: 10.1016/j.mambio.2010.04.007



New Literature on Suiformes



Abstracts of new papers from our regular contributors and members

Obanda VO, Lekolool I, Munyao M, Chege SM, Manyibe T and Gakuya F. 2011. New distribution records for the desert Warthog (*Phacochoerus aethiopicus delamerei* - Pallas 1766). *African Journal of Ecology* 49(3): 373-376.

In Africa, there are two species of warthogs (Suiformes, Phacochoerinae), the common warthog (*Phacochoerus africanus* Gmelin, 1788) and the desert warthog (*P. Aethiopicus* Pallas, 1766) (Grubb, 1993; Randi et al., 2002).The two species diverged genetically some 3 million years ago (Randi et al.,

2002) and differ in morphology (d'Huart & Grubb, 2005) and anatomy (Ewer, 1956; Grubb, 1993). Common warthog is widely distributed in Africa, and numerous studies on its ecology and behaviour have been published. The distribution of desert warthog is discontinuous with the extinct Cape warthog (*P. aethiopicus aethiopicus*) restricted to the south-western part of the Cape Province of South Africa and the extant desert warthog (*P. aethiopicus delamerei*) confined to the horn of Africa (d'Huart & Grubb, 2001). Little is known of the biology of desert warthog, and its distribution is poorly described although the species is regarded as of least concern (IUCN, 2010). The abundance of the species is equivocal (d'Huart & Oliver, 1993; Grubb, 1993). Some of the locations that d'Huart & Grubb (2001) confirmed the presence of desert warthog are in highly insecure regions of Kenya and Somalia. The continued civil war in Somalia is a factor that could influence distribution and persistence of wildlife. It has not been ascertained that the species still occurs in these ranges, and therefore the objective of this study is to provide locations where the species was present, captured and positively identified.

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Taber A, Altrichter M, Beck H and Gongora J. 2011. Family Tayassuidae (Peccaries). In: *Handbook of the Mammals of the World. Vol 2, Hoofed Mammals.* Wilson DE and Mittermeier RA (eds.) Barcelona: Lynx Edicions. Pp. 292-307.

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Biondo C, Keuroghlian A, Gongora J and Miyaki CY. 2011. Population genetic structure and dispersal in white-lipped peccaries (*Tayassu pecari*) from the Brazilian Pantanal. *Journal of Mammalogy*. 92: 267-274.

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Nascimento FF, Gongora J, Tristem M, Lowden S and Moran C. 2011. Distinctive differences in long terminal repeat sequences between γ1 endogenous retroviruses of African and Eurasian suid species.

Infection, Genetics and Evolution 11: 686-693.

Diversity Assessment

Gongora J, Reyna-Hurtado R, Beck H, Taber A, Altrichter M and Keuroghlian A. 2011. *Pecari tajacu*. In: IUCN 2011. IUCN Red List of Threatened Species. Version 2011.2. www.iucnredlist.org

Veterinary, Genetic and Physiological Studies

Abe M, Ito N, Sakai K, Kaku Y, Oba M, Nishimura M, Kurane I, Saijo M, Morikawa S, Sugiyama M and Mizutani T. 2011. A novel sapelovirus-like virus isolation from wild boar. Virus Genes 43(2): 243-248.

A novel sapelovirus-like virus was isolated from a wild boar (*Sus scrofa*). In this study, partial viral genomic nucleotide sequences were determined using the rapid determination system of viral nucleic acid sequences (RDV) ver. 3.1, which we recently developed for discovering novel viruses. Phylogenetic analysis of VP1 and 3A proteins and their encoding nucleotide sequences of enteroviruses and sapeloviruses indicated that the isolated virus was closely related to porcine sapelovirus. RT-PCR detected viral sequences in six of 48 wild boar fecal samples.

Castro-Hermida JA, Garcia-Presedo I, Gonzalez-Warleta M and Mezo M. 2011. Prevalence of Cryptosporidium and Giardia in roe deer (*Capreolus capreolus*) and wild boars (*Sus scrofa*) in Galicia (NW, Spain). Veterinary Parasitology 179(1-3): 216-219.

Faecal samples from 224 roe deer (*Capreolus capreolus*) and 381 wild boars (*Sus scrofa*) shot during the 2008-2009 hunting season (August-January) in Galicia (NW Spain) were examined to determine the presence and intensity of infection by Cryptosporidium and Giardia. Analysis of a single sample from each of the roe deer revealed that the prevalence of cryptosporidiosis and giardiosis was 1.3% and 5.3% respectively. The prevalence of Giardia infection was significantly higher in juvenile female roe deer than in adult females, but no other significant differences were found in relation to age and sex. In wild boars, the prevalence of cryptosporidiosis and giardiosis was 7.6% and 1.3% respectively. The prevalence of Cryptosporidium infection was significantly higher in juvenile male wild boars than in adult males, but no other significant differences were found in relation to age or sex. In both groups of wild animals, the number of Cryptosporidium oocysts per gram of faeces (OPG) ranged from 5 to 200 and the number of Giardia cysts per gram of faeces (CPG) was between 5 and 47; there were no significant differences between the two groups with respect to number of infections. This is the first large study of Cryptosporidium and Giardia in roe deer and wild boars in hunting areas in Spain and the results demonstrate a low, but widespread prevalence of Cryptosporidium and Giardia in these animals.

Closa-Sebastia F, Casas-Diaz E, Cuenca R, Lavin S, Mentaberre G and Marco I. 2011. Antibodies to selected pathogens in wild boar (Sus scrofa) from Catalonia (NE Spain). European Journal of Wildlife Research 57(4): 977-981.

environment without resorting to its economic exploitation, the debate as to whether ecotourism is really beneficial has remained alive.

Aiming to answer such questions, two Spanish researchers spent four months in the middle of the Amazon to assess the presence of large mammals in Bonanza, a private estate used for ecotourism within the Manu Biosphere Reserve. The results of their study show that not only is ecotourism harmless to the biological richness of the area but it could even have a positive effect on the biodiversity of surrounding areas.

The study by Salvador Salvador (University of Gerona) and Miguel Clavero, (Doñana Biological Station-CSIC), in collaboration with Renata Leite from Duke University's Center for Tropical Conservation, has been published in the Mammalian Biology journal.
In their analysis of the Bonanza estate, the researchers found 41 species of large mammal out of the 48 species that have been documented in the whole reserve. According to Salvador, "we could not find any way in which the richness of species has been affected. No species sensitive to the presence of humans was lacking and although we were unable to calculate population density, species like the tapir (Tapirus terrestris) or the huangana (a local way of referring to another type of wild boar, the Tayassu peccary) were abundant, even compared to virgin forest areas.

As the study lasted for four months, the researchers were also able to compare the presence of fauna during the dry and wet seasons.

When we talk about ecotourism, Salvador warned that "we have to understand the difference because a [photographic] safari in Kenia is not the same as what we studied in the Amazon rainforest." The importance of the study lies in the fact that never before has the biodiversity of ecotourism zones been contrasted with that of protected areas, at least in the Amazon.

"The size of the ecotourism areas bears little significance in relation to the size of the extensive Amazon's ecosystem and yet some species had been found to be affected," said Salvador. One of them was the giant otter (Pteronura brasiliensis), which is native to the Amazon and considered endangered by the International Union for Conservation of Nature. The expert pointed out that "these were some cases but no real comparison had been made until our study." Inadequate ecotourism practices that negatively affected the otter were mainly linked to river transport. For example, the boats used to transport tourists would come too close to the dens of the otters.

After four months of field work and interviews with the locals, the results show that Bonanza has "at least 85% of species." The expert added that "the species from pristine areas that were not found in Bonanza are likely to appear there, given that despite their rarity they are not considered particularly sensitive to human presence."

Journal Reference:
Salvador Salvador, Miguel Clavero, Renata Leite Pitman. Large mammal species richness and habitat use in an upper Amazonian forest used for ecotourism. *Mammalian Biology - Zeitschrift fur Saugetierkunde*, 2010; DOI: 10.1016/j.mambio.2010.04.007

feral pigs. Twelve adult male free-ranging feral pigs were captured, sedated, and orchidectomized, and then were released and observed to complete recovery and return to their natural environment. Fragments of the testes were embedded in plastic resin and used to prepare slides for histometric analysis. Characteristics investigated included cell populations in the seminiferous epithelium in stage 1 of the cycle of the seminiferous epithelium, intrinsic rate of spermatogenesis and Sertoli cell index. The efficiency coefficient of spermatogonial mitosis was 7.59, the meiotic index was 3.03, the overall yield of spermatogenesis was 23.97 and the cell loss ratio during the meiotic prophase was 1.04. Each Sertoli cell supported an average of 0.92 type A spermatogonia, 7.01 primary spermatocytes in preleptotene/leptotene, 7.30 primary spermatocytes in pachytene and 22.16 round spermatids. In conclusion, the results of the present study indicate that the supporting capacity of Sertoli cells in free -ranging feral pigs is among the greatest values reported for most domestic animals, and the overall yield of spermatogenesis is comparable to that reported in wild boars.

Costa DS, Santos MD and Paula TAR. 2011. Kinetics of spermatogenesis in the white-lipped peccary (*Tayassu pecari*). Animal Reproduction Science 124(1-2): 98-103.

This study aimed to characterize the stages of the seminiferous epithelium cycle by the tubular morphology method, and to determine the number of differentiated spermatogonia generations in the adult white-lipped peccary. Twenty adult white-lipped peccaries, obtained from commercial slaughterhouse, were used. Fragments of the testicular parenchyma were fixed in 3% glutaraldehyde and embedded into a methacrylate resin. The number of germ and Sertoli cells was estimated by the analysis of cell populations in 50 transversal sections of seminiferous tubules in different stages of the cycle. The tubular morphology method allowed the identification of cellular associations characteristic of the eight stages of the seminiferous epithelium cycle in white-lipped peccaries. The results showed the presence of six generations of differentiated spermatogonia in white-lipped peccaries, and that the cell composition of the eight stages of the seminiferous epithelium cycle in this species is very similar to that described for collared peccaries.

Di Francesco A, Donati M, Morandi F, Renzi M, Masia MA, Ostanello F, Salvatore D, Cevenini R and Baldelli R. 2011. Seroepidemiologic Survey for *Chlamydia suis* in Wild Boar (*Sus scrofa*) Populations in Italy. Journal of Wildlife Diseases 47(3): 709-712.

We used serology to estimate the prevalence of exposure to chlamydiae in Italian populations of wild boars (*Sus scrofa*). Sera from 173 hunter-killed wild boars harvested during the 2006-2009 hunting seasons in three Italian regions were tested for antibodies to *Chlamydia suis*, *Chlamydophila pecorum*, *Chlamydophila abortus*, and *Chlamydophila psittaci* by the microimmunofluorescence test. Antibody titers to chlamydiae >= 1.:32 were detected in 110 of the 17:3 samples tested (63.6%). Specific reactivity could be assessed only in 44 sera with antibody titers to *C. suis* that were two- to threefold higher than antibody titers against the other chlamydial species; the other 66 sera had similar reactivity against all the chlamydia species tested. Antibody to *C. suis* was detected in sera from wild boar populations with rare or no known contact with domestic pigs. These results suggest that the wild boar could be a chlamydia reservoir and may acquire chlamydiae independent of contacts with the domestic pig.

Everett H, Crooke H, Gurrala R, Dwarka R, Kim J, Botha B, Lubisi A, Pardini A, Gers S, Vosloo W and Drew T. 2011. Experimental Infection of Common Warthogs (*Phacochoerus africanus*) and Bushpigs (*Potamochoerus larvatus*) with Classical Swine Fever Virus. I: Susceptibility and Transmission. Transboundary & Emerging Diseases 58(2): 128-134.

An incursion of classical swine fever virus (CSFV) into the domestic pig population in South Africa, identified in 2005, raised the concern that infection might spread to wildlife species and be maintained in these hosts. This study sought to determine whether two wildlife Suidae species present in South Africa, the bushpig (*Potamochoerus larvatus*) and the common warthog (*Phacochoerus africanus*), could support productive CSFV infection. Both species could be infected with CSFV and transmitted infection to in-contact animals of the same species. Viral antigen and RNA genome were detected in blood/serum and animals that survived initial infection seroconverted approximately 10-14 days post-inoculation. Viral RNA remained detectable in nasal and saliva secretions for prolonged periods until monitoring ended at 42-44 days after initial challenge. These data suggest that both Suidae species could serve to spread circulating CSFV within wild populations, with implications for disease control.

Gallardo C, Okoth E, Pelayo V, Anchuelo R, Martin E, Simon A, Llorente A, Nieto R, Soler A, Martin R, Arias M and Bishop RP. 2011. African swine fever viruses with two different genotypes, both of which occur in domestic pigs, are associated with ticks and adult warthogs, respectively, at a single geographical site. Journal of General Virology 92(2): 432-444.

The role of the ancestral sylvatic cycle of the African swine fever virus (ASFV) is not well understood in the endemic areas of eastern Africa. We therefore analysed the ASF infection status on samples collected from 51 free-ranging warthogs (*Phacocherus africanus*) and 1576 *Omithodorus porcinus* ticks from 26 independent warthog burrows at a single ranch in Kenya. Abattoir samples from 83 domestic pigs without clinical symptoms, originating from specific locations with no recent reported ASF outbreaks were included in this study. All samples were derived from areas of central Kenya, where ASF outbreaks have been reported in the past. Infection with ASFV was confirmed in 22% of *O. porcinus* pools, 3.22% of adult warthog serum samples and 49% of domestic pig serum samples by using p72-based PCR. All of the warthog sera were positive for anti-ASFV antibodies, investigated by using ELISA, but none of the domestic pig sera were positive. Twenty 0. porcinus-, 12 domestic pig- and three warthog-derived viruses were genotyped at four polymorphic loci. The ASFV isolates from ticks and domestic pigs clustered within p72 genotype X. By contrast, ASF viruses genotyped directly from warthog sera, at same locality as the tick isolates, were within p72 genotype IX and genetically similar to viruses causing recent ASF outbreaks in Kenya and Uganda. This represents the first report of the coexistence of different ASFV genotypes in warthog burrow-associated ticks and adult wild warthogs. The data from this and earlier studies suggest transfer of viruses of at least two different p72 genotypes, from wild to domestic pigs in East Africa.

Garcia G, Vergara J and Lombardi R. 2011. Genetic characterization and phylogeography of the wild boar *Sus scrofa* introduced into Uruguay. Genetics & Molecular Biology 34(2): 329-NIL_315.

sex. In wild boars, the prevalence of cryptosporidiosis and giardiosis was 7.6% and 1.3% respectively. The prevalence of Cryptosporidium infection was significantly higher in juvenile male wild boars than in adult males, but no other significant differences were found in relation to age or sex. In both groups of wild animals, the number of Cryptosporidium oocysts per gram of faeces (OPG) ranged from 5 to 200 and the number of Giardia cysts per gram of faeces (CPG) was between 5 and 47; there were no significant differences between the two groups with respect to number of infections. This is the first large study of Cryptosporidium and Giardia in roe deer and wild boars in hunting areas in Spain and the results demonstrate a low, but widespread prevalence of Cryptosporidium and Giardia in these animals.

Closa-Sebastia F, Casas-Diaz E, Cuenca R, Lavin S, Mentaberre G and Marco I. 2011. Antibodies to selected pathogens in wild boar (Sus scrofa) from Catalonia (NE Spain). European Journal of Wildlife Research 57(4): 977-981.

From 2004 to 2007, blood samples from 273 healthy wild boars (*Sus scrofa*), culled during the hunting season, were obtained in three areas of Catalonia (NE Spain): Pyrenees, Sant Lloren double dagger del Munt i l'Obac Natural Park (SLM), and Ports de Tortosa i Beseit National Hunting Reserve (PTB). We investigated the presence of antibodies against classical swine fever virus (CSFV), African swine fever virus (ASFV), porcine vesicular disease virus (PVDV), porcine respiratory and reproductive syndrome virus (PRRSV), Aujeszky's disease virus (ADV), porcine influenza A virus (PIV), porcine circovirus type 2 (PCV2), porcine parvovirus (PPV), *Mycoplasma hyopneumoniae*, *Erysipelothrix rhusiopathiae*, *Salmonella* spp., and *Toxoplasma gondii*. Four wild boars were suspicious for CSFV, but the infection was discarded with a virus neutralization test, and infection with a border disease virus was confirmed. Negative results were obtained against ASFV and PVDV. Antibodies were detected against PRRSV (3%), ADV (0.8%), PIV (6.4%), PCV2 (64.6%), PPV (54.7%), *M. hyopneumoniae* (26.6%), *E. rhusiopathiae* (5.3%), *Salmonella* spp. (11.3%), and *T. gondii* (43.5%). In SLM, we detected a higher seroprevalence for PIV and *M. hyopneumoniae* and a lower seroprevalence for *E. rhusiopathiae* than in the other two areas. In PTB, seroprevalence was higher for PPV, *Salmonella* spp., and PCV2. Adult wild boar displayed higher seroprevalence for PPV, PIV, and *M. hyopneumoniae*, whereas presence of antibodies for Salmonella spp. was higher in juveniles compared with adults and piglets.

Cooper JD, Waser PM, Hellgren EC, Gabor TM and DeWoody JA. 2011. Is sexual monomorphism a predictor of polygynandry? Evidence from a social mammal, the collared peccary. Behavioral Ecology & Sociobiology 65(4): 775-785.

Sexual dimorphism is common in polygynous species, and there is clear evidence that both intrasexual competition and female preferences can drive the evolution of large body size in males. In contrast, sexual monomorphism is often argued to reflect a relaxation of male mate competition or an intensification of resource competition among females. Alternatively, it might imply opportunities for females to circumvent or counteract male mate competition in a polygynandrous mating system. We test the prediction that sexual monorphism is associated with polygynandry in the collared peccary (*Pecari tajacu*, Tayassuidae), a social ungulate closely related to the old-world suids. The genetic mating system in the Tayassuidae is unknown, but its sexual monomorphism presents a striking contrast to the strong size dimorphism found in most Suidae, so that a departure from the polygy-

We analysed 74 wild boars from Tunisia with respect to patterns of genetic differentiation and diversity based on sequences of the mitochondrial control region and genotypes at eight nuclear microsatellite loci. Analysis of molecular variance for both marker systems and Bayesian structure analysis of our microsatellite data revealed a clear break between northern and southern populations. Southern wild boar were monomorphic for one of three mtDNA haplotypes; the other two (one of which only occurred in three individuals) were confined to the north. A comparison with published sequences showed all three haplotypes to belong to the major European clade E1. Microsatellite diversity was similar to that found in earlier studies of wild boar (expected heterozygosity of 0.695 and 0.597 for the north and south, respectively). Contrary to the mtDNA results, we did not find unequivocal evidence of a bottleneck in Tunisian wild boar based on our microsatellite data. The clear distinction between northern and southern populations may be due to an Algerian origin of the southern animals.

Lavelle MJ, Vercauteren KC, Hefley TJ, Phillips GE, Hygnstrom SE, Long DB, Fischer JW, Swafford SR and Campbell TA. 2011. Evaluation of Fences for Containing Feral Swine under Simulated Depopulation Conditions. Journal of Wildlife Management 75(5): 1200-1208.

Populations of feral swine (*Sus scrofa*) are estimated to include >2 million animals in the state of Texas, USA, alone. Feral swine damage to property, crops, and livestock exceeds $50 million annually. These figures do not include the increased risks and costs associated with the potential for feral swine to spread disease to domestic livestock. Thus, effective bio-security measures will be needed to quickly isolate affected feral swine populations during disease outbreaks. We evaluated enclosures built of 0.86-m-tall traditional hog panels for containing feral swine during 35 trials, each involving 6 recently caught animals exposed to increasing levels of motivation. During trials, fences were 97% successful when enclosures were entered by humans for maintenance purposes; 83% effective when pursued by walking humans discharging paintball projectors; and in limited testing, 100% successful when pursued and removed by gunners in a helicopter. In addition to being effective in containing feral swine, enclosures constructed of hog panels required simple hand tools, took <5 min/m to erect, and were inexpensive ($5.73/m excluding labor) relative to other fencing options. As such, hog-panel fences are suitable for use by state and federal agencies for rapid deployment in disease response situations, but also exhibit utility for general control of other types of damage associated with feral swine.

Lessa SS, Paes RCS, Santoro PN, Mauro RA and Vieira-da-Motta O. 2011. Identification and antimicrobial resistance of microflora colonizing feral pig (*Sus scrofa*) of the Brazilian Pantanal. Brazilian Journal of Microbiology 42(2): 740-749.

Antimicrobial resistance of bacteria is a worldwide problem affecting wild life by living with resistant bacteria in the environment. This study presents a discussion of outside factors environment on microflora of feral pigs (*Sus scrofa*) from Brazilian Pantanal. Animals had samples collected from six different body sites coming from two separated geographic areas, Nhecolandia and Rio Negro regions. With routine biochemical tests and commercial kits 516 bacteria were identified, with 240 Gram-positive, predominantly staphylococci (36) and enterococci (186) strains. Among Gram-negative (GN) bacteria the predominant specimens of Enterobacteriaceae (247) mainly represented by Serratia spp.

Baldelli R. 2011. Seroepidemiologic Survey for *Chlamydia suis* in Wild Boar (*Sus scrofa*) Populations in Italy. Journal of Wildlife Diseases 47(3): 709-712.

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Gallardo C, Okoth E, Pelayo V, Anchuelo R, Martin E, Simon A, Llorente A, Nieto R, Soler A, Martin R, Arias M and Bishop RP. 2011. African swine fever viruses with two different genotypes, both of which occur in domestic pigs, are associated with ticks and adult warthogs, respectively, at a single geographical site. Journal of General Virology 92(2): 432-444.

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European Journal of Wildlife Research 57(3): 443-448.

Lawsonia intracellularis, *Brachyspira hyodysenteriae*, and *Brachyspira pilosicoli* are important pathogens in domestic pig production, responsible for porcine intestinal adenomatosis, swine dysentery, and porcine intestinal spirochetosis, respectively. They are widely distributed among pig-producing units around the world, and transmission is accomplished by relatively weak immunity, long shedding intervals, sequential shedding, and actual environmental survival. Little information is available on occurrence, prevalence, and quantity of these pathogens in free-ranging wild boars. The aim of the present study was to evaluate *L. intracellularis*, *B. hyodysenteriae*, and *B. pilosicoli* infections in wild boars in Germany. Tissue samples from ileocaecal mucosa of 165 wild boars from 18 hunting grounds situated in 14 of the 16 federal states of Germany were examined by conventional PCR and quantified by multiplex real-time PCR. None of the wild boars did show any gross pathological signs of enteritis. The overall prevalence for *L. intracellularis*, *B. hyodysenteriae*, and *B. pilosicoli* was 20.6%, 2.4%, and 12.1%, respectively. None of the three agents was detected in 68.5% of the wild boars and in 11.1% of the hunting grounds. Numbers of bacteria per sample were below the limit of quantification (100 cells/PCR reaction). This is the first study on *L. intracellularis* and *Brachyspira* spp. in free-ranging wild boars. The study revealed colonised animals without signs of disease. The meaning of these findings remains unclear, and we do not know whether and to what extent these three pathogens are exchanged between wild boars and domestic pigs. Further research is needed to get insight into the epidemiological impact of the results.

Scandura M, Iacolina L and Apollonio M. 2011. Genetic diversity in the European wild boar *Sus scrofa*: phylogeography, population structure and wild x domestic hybridization. Mammal Review 41(2): 125-137.

Despite the vast literature on genetic variation in the domestic pig *Sus scrofa*, little is known about genetic differentiation in wild boar populations. Here we present an up-to-date review of published data on the past and recent history of the European wild boar, its genetic diversity and the spatial distribution of genetic variation throughout the continent. The phylogeography of the species seems to be shaped mostly by past large-scale events (like postglacial recolonization) rather than by more recent human manipulation. Genetic differentiation is observed both on a continental and a regional scale, and non-intuitive barriers to gene flow occur. From an indirect estimate, hybridization between wild boar and domestic pigs is seemingly a minor source of genetic variation for wild boar populations, yet risks are still linked to the release of captive hybrids in some areas. Finally, we present future perspectives concerning the development of powerful molecular tools and their possible application to the study and management of this species.

Scandura M, Iacolina L, Cossu A and Apollonio M. 2011. Effects of human perturbation on the genetic make-up of an island population: the case of the Sardinian wild boar. Heredity 106(6): 1012-1020.

Game species are often manipulated by human beings, whose activities can deeply affect their genetic make-up and population structure. We focused on a geographically isolated wild boar population (Sardinia, Italy), which is classified, together with the Corsican population, as a separate subspecies (*Sus scrofa meridionalis*). Two hundred and ten wild boars collected across Sardinia were ana-

times subtle. Three individuals, including one in-contact control, developed distinct lympho-plasmacytic cuffing in their brains. Subtle lesions included scant lympho-plasmacytic infiltration of various organs, occasionally accompanied by perivascular cuffing. In contrast, the bushpigs developed overt clinical signs similar to CSF in domestic pigs. Four of six animals, including two in-contact controls, died or were euthanized during the trial. On postmortem examination, intestinal necrosis and ulceration, purulent rhinitis and pneumonia were present. Affected animals developed lymphoid necrosis and depletion whilst surviving individuals showed perivascular cuffing in multiple organs. From the present work, we conclude that these wild Suidae are susceptible to CSF virus and intra-species transmission under experimental conditions can occur.

Hajji GE and Zachos FE. 2011. Mitochondrial and nuclear DNA analyses reveal pronounced genetic structuring in Tunisian wild boar *Sus scrofa*. European Journal of Wildlife Research 57(3): 449-456.

We analysed 74 wild boars from Tunisia with respect to patterns of genetic differentiation and diversity based on sequences of the mitochondrial control region and genotypes at eight nuclear microsatellite loci. Analysis of molecular variance for both marker systems and Bayesian structure analysis of our microsatellite data revealed a clear break between northern and southern populations. Southern wild boar were monomorphic for one of three mtDNA haplotypes; the other two (one of which only occurred in three individuals) were confined to the north. A comparison with published sequences showed all three haplotypes to belong to the major European clade E1. Microsatellite diversity was similar to that found in earlier studies of wild boar (expected heterozygosity of 0.695 and 0.597 for the north and south, respectively). Contrary to the mtDNA results, we did not find unequivocal evidence of a bottleneck in Tunisian wild boar based on our microsatellite data. The clear distinction between northern and southern populations may be due to an Algerian origin of the southern animals.

Lavelle MJ, Vercauteren KC, Hefley TJ, Phillips GE, Hygnstrom SE, Long DB, Fischer JW, Swafford SR and Campbell TA. 2011. Evaluation of Fences for Containing Feral Swine under Simulated Depopulation Conditions. Journal of Wildlife Management 75(5): 1200-1208.

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lite loci isolated from *T. pecari* and their cross-amplification in collared peccaries, *Pecari tajacu*. In 30 individuals of *T. pecari*, a total of 32 alleles were found in ten polymorphic loci, ranging from 2 to 8 alleles per locus with a mean of 3.2. The expected and observed heterozygosity ranged from 0.143 to 0.802 and from 0 to 0.704, respectively. Two loci deviated from Hardy-Weinberg equilibrium. In *P. tajacu*, nine loci were polymorphic with a mean of 3.2 alleles per locus. These molecular markers will be useful to study the genetic status of peccary populations and, consequently, to help their conservation.

Baker SR, O'Neil KM, Gramer MR and Dee SA. 2011. Estimates of the seroprevalence of production-limiting diseases in wild pigs. Veterinary Record 168(21): NIL_56-NIL_57.

Pluhacek J and Bartosova J. 2011. A case of suckling and allosuckling behaviour in captive common hippopotamus. Mammalian Biology 76(3): 380-383.

Taxonomic, Morphological, Biogeographic and Evolutionary Studies

Boisserie JR, Fisher RE, Lihoreau F and Weston EM. 2011. Evolving between land and water: key questions on the emergence and history of the Hippopotamidae (Hippopotamoidea, Cetancodonta, Cetartiodactyla). Biological Reviews 86(3): 601-625.

The fossil record of the Hippopotamidae can shed light on three major issues in mammalian evolution. First, as the Hippopotamidae are the extant sister group of Cetacea, gaining a better understanding of the origin of the Hippopotamidae and of their Paleogene ancestors will be instrumental in clarifying phylogenetic relationships within Cetartiodactyla. Unfortunately, the data relevant to hippopotamid origins have generally been ignored in phylogenetic analyses of cetartiodactyls. In order to obtain better resolution, future analyses should consider hypotheses of hippopotamid Paleogene relationships. Notably, an emergence of the Hippopotamidae from within anthracotheriids has received growing support, leading to reconciliation between genetic and morphological evidence for the clade Cetancodonta (Hippopotamidae and Cetacea). Secondly, full account needs to be taken of the Hippopotamidae when studying the impact of environmental change on faunal evolution. This group of semi-aquatic large herbivores has a clear and distinct ecological role and a diverse and abundant fossil record, particularly in the African Neogene. We examine three major phases of hippopotamid evolution, namely the sudden appearance of hippopotamines in the late Miocene (the "Hippopotamine Event"), the subsequent rampant endemism in African basins, and the Pleistocene expansion ofHippopotamus. Each may have been influenced by multiple factors, including: late Miocene grass expansion, African hydrographical network disruption, and a unique set of adaptations that allowed Hippopotamus to respond efficiently to early Pleistocene environmental change. Thirdly, the fossil record of the Hippopotamidae documents the independent emergence of adaptive character complexes in relation to semiaquatic habits and in response to insular isolation. The semiaquatic specializations of fossil hippopotamids are particularly useful in interpreting the functional morphology and ecology of other, extinct groups of large semiaquatic herbivores. Hippopotamids can also serve as models to elucidate the evolutionary dynamics of island mammals.

Ludovisi A, Pozio E and Capelli G. 2011. First reports of *Trichinella pseudospiralis* in wild boars (*Sus scrofa*) of Italy. Veterinary Parasitology 178(3-4): 370-373.

Trichinella *pseudospiralis* is a non-encapsulated species infecting both mammals and birds. In Italy, this parasite was reported only in two night-birds of prey of Central Italy. In January 2010, *Trichinella* larvae were detected in three wild boars (*Sus scrofa*) of two regions of Northern Italy by enzymatic digestion. The parasites were identified as *T. pseudospiralis* by multiplex-PCR. The first infected wild boar was hunted in the Emilia Romagna region and the other two infected wild boars were bred outdoors in a small family farm of the Friuli Venezia Giulia region. These new epidemiological data reinforce the role of the wild boar as the main reservoir of *T. pseudospiralis* in Europe.

Reiner G, Winkelmann M and Willems H. 2011. *Prevalence of Lawsonia intracellularis, Brachyspira hyodysenteriae*, and *Brachyspira pilosicoli* infection in hunted wild boars (*Sus scrofa*) in Germany. European Journal of Wildlife Research 57(3): 443-448.

Lawsonia intracellularis, *Brachyspira hyodysenteriae*, and *Brachyspira pilosicoli* are important pathogens in domestic pig production, responsible for porcine intestinal adenomatosis, swine dysentery, and porcine intestinal spirochetosis, respectively. They are widely distributed among pig-producing units around the world, and transmission is accomplished by relatively weak immunity, long shedding intervals, sequential shedding, and actual environmental survival. Little information is available on occurrence, prevalence, and quantity of these pathogens in free-ranging wild boars. The aim of the present study was to evaluate *L. intracellularis*, *B. hyodysenteriae*, and *B. pilosicoli* infections in wild boars in Germany. Tissue samples from ileocaecal mucosa of 165 wild boars from 18 hunting grounds situated in 14 of the 16 federal states of Germany were examined by conventional PCR and quantified by multiplex real-time PCR. None of the wild boars did show any gross pathological signs of enteritis. The overall prevalence for *L. intracellularis*, *B. hyodysenteriae*, and *B. pilosicoli* was 20.6%, 2.4%, and 12.1%, respectively. None of the three agents was detected in 68.5% of the wild boars and in 11.1% of the hunting grounds. Numbers of bacteria per sample were below the limit of quantification (100 cells/PCR reaction). This is the first study on *L. intracellularis* and *Brachyspira* spp. in free-ranging wild boars. The study revealed colonised animals without signs of disease. The meaning of these findings remains unclear, and we do not know whether and to what extent these three pathogens are exchanged between wild boars and domestic pigs. Further research is needed to get insight into the epidemiological impact of the results.

Scandura M, Iacolina L and Apollonio M. 2011. Genetic diversity in the European wild boar *Sus scrofa*: phylogeography, population structure and wild x domestic hybridization. Mammal Review 41(2): 125-137.

Despite the vast literature on genetic variation in the domestic pig *Sus scrofa*, little is known about genetic differentiation in wild boar populations. Here we present an up-to-date review of published data on the past and recent history of the European wild boar, its genetic diversity and the spatial distribution of genetic variation throughout the continent. The phylogeography of the species seems to be shaped mostly by past large-scale events (like postglacial recolonization) rather than by more recent human manipulation. Genetic differentiation is observed both on a continental and a regional

cation, that initial confusion was spread in many scientific works and has important taxonomical consequences. Thus, in 1902, CJF Major described under the name *H. madagascariensis* Guldberg, 1883 a new Malagasy skeleton which is quite different from *H. lemerlei*. But because *H. madagascariensis* is no more than a replacement name for *H. lemerlei*, it is not usable. We then propose the new name *Hippopotamus guldbergi* to designate the species described in 1902 by CJF Major.

Gommery D, Ramanivosoa B, Faure M, Guerin C, Kerloc'h P, Senegas F and Randrianantenaina H. 2011. Oldest evidence of human activities in Madagascar on subfossil hippopotamus bones from Anjohibe (Mahajanga Province). Comptes Rendus Palevol 10(4): 271-278.

The colonization of Madagascar by man is an active subject of scientific debate. Until recently the oldest evidence of humans on the island dated to a few centuries BC or AD from sites located in the South-West of Madagascar. The discoveries at Anjohibe, about 1500 years older, indicate an early colonization of the North-West of the island. This region is closer than two of the shortest routes from Africa or Asia. The discoveries are not archaeological artefacts but cut marks on bones of subfossil dwarf hippopotami. These observations indicate that the coexistence of humans with extinct subfossil faunas has been much longer than previously thought.

Kneepkens AFLM and Macdonald AA. 2011. Vertebral Column, Rib and Sternal Muscles of Sulawesi Babirusa (*Babyrousa celebensis*). Anatomia, Histologia, Embryologia: Veterinary Medicine Series C. 40(2): 149-161.

The muscular anatomy of the vertebrae, ribs and sternebrae of the Sulawesi Babirusa (*Babyrousa celebensis*) is described. There are many similarities to the anatomy of the domestic pig (*Sus scrofa*). However, unlike other pigs, the M. spinalis et semispinalis cervicis et thoracis has an origin from the twelfth thoracic mamillary process. Similarly, the Babyrousa does not have the lumbar part of the M. obliquus internus abdominis which is found in other pigs. The M. sacrocaudalis dorsalis medialis of the Babyrousa is not fused to the Mm. multifidi, and the origin of the M. obliquus externus abdominis in the Babyrousa does not include rib 4 or the fascia thoracolumbalis. In the Babyrousa, the M. longissimus atlantis is clearly separated from the M. longissimus capitis, whereas in Sus the two are fused and have a more caudal origin (up to the second thoracic vertebra). The M. longissimus cervicis of the Babyrousa has a less extensive origin and insertion than is found in the domestic pig which may be related to differences between each species in its ability to dig with its nose.

Yeh KD and Popowics T. 2011. Molecular and Structural Assessment of Alveolar Bone During Tooth Eruption and Function in the Miniature Pig, *Sus scrofa*. Anatomia, Histologia, Embryologia: Veterinary Medicine Series C. 40(4): 283-291.

The development of alveolar bone adjacent to the tooth root during tooth eruption is not well understood. This study tested the hypothesis that predominantly woven bone forms adjacent to tooth roots during tooth eruption, but that this immature structure transitions to lamellar bone when the tooth comes into function. Additionally, bone resorption was predicted to play a key role in transitioning

phological and functional skull variation. Subadult females displayed greater skull robustness, and their force indexes indicate an enhancement on bite strength and in head elevation. This could suggest ecomorphological dissimilarities between subadult male and female *T. pecari*. The sexual precocity of the females reported in the literature could be the main determinant of the marked morpho-functional variation among the *T. pecari* subadults. These sexual differences in skull morphology seem to become reduced as males mature.

Vecchia ACD, Biondo C, Sanches A, Keuroghlian A, Miyaki CY, Galetti M and Galetti PM. 2011. Isolation and characterization of microsatellite loci for white-lipped peccaries (*Tayassu pecari*) and cross-amplification in collared peccaries (*Pecari tajacu*). Conservation Genetics Resources 3(1): 151-154.

White-lipped peccaries, *Tayassu pecari*, are neotropical ungulates whose populations have been declining in numerous locations within their geographical distribution. Here we describe 16 microsatellite loci isolated from *T. pecari* and their cross-amplification in collared peccaries, *Pecari tajacu*. In 30 individuals of *T. pecari*, a total of 32 alleles were found in ten polymorphic loci, ranging from 2 to 8 alleles per locus with a mean of 3.2. The expected and observed heterozygosity ranged from 0.143 to 0.802 and from 0 to 0.704, respectively. Two loci deviated from Hardy-Weinberg equilibrium. In *P. tajacu*, nine loci were polymorphic with a mean of 3.2 alleles per locus. These molecular markers will be useful to study the genetic status of peccary populations and, consequently, to help their conservation.

Baker SR, O'Neil KM, Gramer MR and Dee SA. 2011. Estimates of the seroprevalence of production-limiting diseases in wild pigs. Veterinary Record 168(21): NIL_56-NIL_57.

Pluhacek J and Bartosova J. 2011. A case of suckling and allosuckling behaviour in captive common hippopotamus. Mammalian Biology 76(3): 380-383.

Taxonomic, Morphological, Biogeographic and Evolutionary Studies

Boisserie JR, Fisher RE, Lihoreau F and Weston EM. 2011. Evolving between land and water: key questions on the emergence and history of the Hippopotamidae (Hippopotamoidea, Cetancodonta, Cetartiodactyla). Biological Reviews 86(3): 601-625.

The fossil record of the Hippopotamidae can shed light on three major issues in mammalian evolution. First, as the Hippopotamidae are the extant sister group of Cetacea, gaining a better understanding of the origin of the Hippopotamidae and of their Paleogene ancestors will be instrumental in clarifying phylogenetic relationships within Cetartiodactyla. Unfortunately, the data relevant to hippopotamid origins have generally been ignored in phylogenetic analyses of cetartiodactyls. In order to obtain better resolution, future analyses should consider hypotheses of hippopotamid Paleogene relationships. Notably, an emergence of the Hippopotamidae from within anthracotheriids has received growing support, leading to reconciliation between genetic and morphological evidence for the clade Cetancodonta (Hippopotamidae and Cetacea). Secondly, full account needs to be taken of the Hip-

which are commonly kept in enclosures in Sweden and Finland for meat and recreation hunting. We studied the behaviour of wild boars in one enclosure during three reproductive seasons. Non-maternal infanticide was documented in 14 out of 22 litters, causing the deaths of all piglets in all but 1 affected litters. Infanticide was typically performed during or shortly after parturition by a sow which was older ($P < 0.05$) and tended to be larger ($P = 0.068$) than the victimised sow, and was not affected by whether or not the involved females were mother-daughter pairs. A questionnaire sent to 112 owners of a total of 116 enclosures in Sweden and Finland resulted in 62 valid responses. Non-maternal infanticide was reported to be the most common cause of piglet pre-weaning mortality, which in total (including all causes) was estimated to be 29.1%. The occurrence of infanticide was unrelated to size of enclosure (less or more than 20 ha) and to variations in supplementary feeding routines (less or more than once a week) ($P > 0.05$), which may suggest that the behaviour could be a part of the normal behavioural repertoire in European wild boars. The observed levels of infanticide constitute a major welfare problem in captive wild boars.

Ballesteros C, Vicente J, Carrasco-Garcia R, Mateo R, de la Fuente J and Gortazar C. 2011. Specificity and success of oral-bait delivery to Eurasian wild boar in Mediterranean woodland habitats. European Journal of Wildlife Research 57(4): 749-757.

Eurasian wild boar (*Sus scrofa*) is an important reservoir host for pathogens affecting humans and domestic animals. The eradication of these diseases may require the development of control strategies that reduce pathogen transmission between wildlife and domestic animals. Baiting for oral vaccine delivery is often considered for wildlife disease control. The effective and efficient field vaccination of wildlife requires species-specific baits as delivery vehicles for oral vaccines and designing appropriate baiting strategies. The objective of this study was to determine the proportion of young and adult wild boar and non-target animals that consumed baits containing a chemical marker, iophenoxic acid (IPA), in delivery trials conducted in summer in four different sites in the Mediterranean region of Spain where wild boar are abundant. The proportion of wild boar showing IPA markers in serum in autumn ranged from 11.5% to 56.4%. When attending to age classes, 12.6% to 72.7% of young individuals presented IPA. The results evidenced that the percent of wild boar that ingested the baits varied among study sites and age classes. Placing baits inside selective cages (for juveniles) and under heavy pavel stones (for adults) contributed to improve age specificity in bait consumption. We suggest ways for improving the age specificity of bait delivery systems used for young and adult wild boar.

Bengsen AJ, Leung LKP, Lapidge SJ and Gordon IJ. 2011. Target-specificity of feral pig baits under different conditions in a tropical rainforest. Wildlife Research 38(5): 370-379.

Context. The mitigation of feral pig (*Sus scrofa*) impacts in north Queensland's World Heritage tropical rainforests is constrained by the lack of an effective and target-specific poison baiting method.
Aims. This study aimed to determine whether easily implemented bait presentation methods or seasonal variation in bait acceptability could be used to selectively reduce the consumption of feral pig baits by non-target species.
Methods. We exposed manufactured feral pig baits to pigs and non-target species in the field, and

Fovet W, Faure M and Guerin C. 2011. *Hippopotamus guldbergi* n. sp.: revision of the status of *Hippopotamus madagascariensis* Guldberg, 1883, after more than a century of misunderstanding and taxonomical confusions [French]. Zoosystema 33(1): 61-82.

Hippopotamus guldbergi n. sp.: revision of the status of *Hippopotamus madagascariensis* Goldberg, 1883, after more than a century of misunderstanding and taxonomical confusions. After a short notice upon its author, whose scientific works are presently rather unknown, we publish the first complete translation in French language of the original description of the extinct Holocene. *Hippopotamus madagascariensis* Guldberg, 1883, which was published in Riksmaal, an ancient Norvegian language incomprehensible for most palaeontologists. We provide a mammalogical comment of that description, showing that the Guldberg's specimen actually pertains to the other small species of Holocene Malagasy hippo, *Hippopotamus lemerlei* Grandidier, 1868. Since Guldberg's publication, that initial confusion was spread in many scientific works and has important taxonomical consequences. Thus, in 1902, CJF Major described under the name *H. madagascariensis* Guldberg, 1883 a new Malagasy skeleton which is quite different from *H. lemerlei*. But because *H. madagascariensis* is no more than a replacement name for *H. lemerlei*, it is not usable. We then propose the new name *Hippopotamus guldbergi* to designate the species described in 1902 by CJF Major.

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community level we found that rooting homogenized soil seed banks by increasing seed abundance and species richness in species-poor communities, while decreasing seed species dominance in nitrophilous communities. These results suggest a deep alteration of the structure of seed banks by wild boar rooting, which in turn, may not represent a real chance for colonization from soil seed banks.

Collen B, Howard R, Konie J, Daniel O and Rist J. 2011. Field surveys for the Endangered pygmy hippopotamus *Choeropsis liberiensis* in Sapo National Park, Liberia. Oryx 45(1): 35-37.

Conservation of a threatened species is reliant upon good quality monitoring information to provide population estimates and trends to inform management practices. Surveying to establish such data can be costly and difficult, particularly for cryptic species in forest habitats. We therefore used remotely triggered cameras to survey for the presence of the pygmy hippopotamus *Choeropsis liberiensis* in Sapo National Park in Liberia. In 1,247 trap days we obtained seven camera-trap photographs, the first photographic records of the species in Liberia. Habitat destruction, principally from illegal gold mining, is the greatest threat to the persistence of the pygmy hippopotamus within the Park. A range-wide survey of the pygmy hippopotamus is required to establish a robust baseline from which future conservation efforts can be developed. Understanding how this species is able to cope with the effects of habitat fragmentation across its range, and controlling commercial hunting, will dictate how it is able to survive the ongoing pressures of land conversion in West Africa.

Desbiez ALJ, Keuroghlian A, Piovezan U and Bodmer RE. Invasive species and bushmeat hunting contributing to wildlife conservation: the case of feral pigs in a Neotropical wetland. Oryx 45(1): 78-83.

An unusual combination of two major conservation threats, invasive species and bushmeat hunting, has had a positive outcome for wildlife conservation in the Brazilian Pantanal. The Pantanal is a wetland and one of the few non-protected areas in the Neotropics where people live but rarely hunt native wildlife. To understand why wildlife hunting is not a major conservation issue in the Pantanal an exploratory survey, semi-structured interviews, skull collection and tooth wear analysis of feral pig *Sus scrofa*, white-lipped peccary *Tayassu pecari* and collared peccary *Pecari tajacu* were conducted, and hunting registers distributed, in the central region of the Pantanal. The results showed that feral pigs are the main hunting target. Feral pigs are effectively acting as a replacement species for hunting of native wildlife because the pigs provide a constant, culturally acceptable, readily available and free source of meat and oil to remote ranches. We cannot evaluate, however, if the buffer from hunting that feral pigs provide to native wildlife outweigh this species' potential negative ecological impacts.

Dunkell DO, Bruland GL, Evensen CI and Litton CM. 2011. Runoff, Sediment Transport, and Effects of Feral Pig (*Sus scrofa*) Exclusion in a Forested Hawaiian Watershed. Pacific Science 65(2): 175-194.

Browsing and trampling by nonnative feral pigs (*Sus scrofa*) negatively impact native flora and fauna in forested ecosystems and cause soil compaction. However, their impact on runoff and erosion is largely unknown. This study addressed this knowledge gap by investigating effects of feral pigs on runoff volume and total suspended solids (TSS) in runoff from the upper forested area of a Hawaiian watershed. Correlations between TSS, runoff, and other environmental variables were also examined.

vivors. Piglet weight at day 1 and growth until weaning also declined with increasing litter size. Sows in parity four had higher piglet mortality due to starvation, but the number of surviving piglets was not affected by parity. In conclusion, piglet mortality caused by maternal crushing of piglets, many of which had no teat success, and starvation caused by sibling competition, increased with increasing litter size for most sow parities. The constant number of surviving piglets at the time of weaning suggests that 10 to 11 piglets could be close to the upper limit that the domestic sow is capable of taking care of.

Andersson A, Valros A, Rombin J and Jensen P. 2011. Extensive infanticide in enclosed European wild boars (*Sus scrofa*). Applied Animal Behaviour Science 134(3-4): 184-192.

Infanticidal behaviour, behaviour with wide welfare implications, is wide-spread among animals of various taxonomic groups, but has not previously been systematically studied in European wild boars, which are commonly kept in enclosures in Sweden and Finland for meat and recreation hunting. We studied the behaviour of wild boars in one enclosure during three reproductive seasons. Non-maternal infanticide was documented in 14 out of 22 litters, causing the deaths of all piglets in all but 1 affected litters. Infanticide was typically performed during or shortly after parturition by a sow which was older ($P < 0.05$) and tended to be larger ($P = 0.068$) than the victimised sow, and was not affected by whether or not the involved females were mother-daughter pairs. A questionnaire sent to 112 owners of a total of 116 enclosures in Sweden and Finland resulted in 62 valid responses. Non-maternal infanticide was reported to be the most common cause of piglet pre-weaning mortality, which in total (including all causes) was estimated to be 29.1%. The occurrence of infanticide was unrelated to size of enclosure (less or more than 20 ha) and to variations in supplementary feeding routines (less or more than once a week) ($P > 0.05$), which may suggest that the behaviour could be a part of the normal behavioural repertoire in European wild boars. The observed levels of infanticide constitute a major welfare problem in captive wild boars.

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National Reserve and the adjoining pastoral ranches in 2006 using foot counts along 155.3 km of the main rivers. We counted 4,170 hippopotamuses in 171 schools. Comparisons with earlier surveys suggest that this population increased by 169.6% between 1971 and 1980 within the reserve and, although it did not increase within the reserve during 1980-2006, it increased by 359.4% outside the reserve during this period against a background of deteriorating habitat conditions. The overall density in 2006 was 26.9 hippopotamuses km(-1) of river, equivalent to a biomass of 26,677 kg km of river. The ratio of calves to 100 adults was 9:100 inside the reserve, 10:100 outside the reserve and 6:100 along tributaries of the Mara River, implying that the population is either increasing or that its spatial distribution is being compressed because of range contraction. The apparent increase in the hippopotamus population contrasts with marked contemporaneous declines in the populations of most other large mammalian herbivore species in the Reserve. We discuss possible reasons underlying the increase in the hippopotamus population.

Kendall CI. 2011. The spatial and agricultural basis of crop raiding by the Vulnerable common hippopotamus *Hippopotamus amphibius* around Ruaha National Park, Tanzania. Oryx 45(1): 28-34.

Categorized as Vulnerable on the IUCN Red List, the common hippopotamus *Hippopotamus amphibius* is under considerable pressure from habitat degradation and hunting. Although human-hippopotamus conflict is known to increase retaliatory killing and culling of hippopotamuses, the issue has been little examined. Using interviews I investigated various spatial, ecological and agricultural factors that influence the vulnerability of farms to crop raiding by hippopotamuses in three villages to the south-east of Ruaha National Park, Tanzania. There was a positive correlation between these crop-raiding events and a farm's proximity to the river and to hippopotamus access points (places where hippopotamuses leave and enter the river). Results from this study provide insights for management and conservation of hippopotamuses, including a need to identify key habitat areas to mitigate future conflict.

Licona M, McCleery R, Collier B, Brightsmith DJ and Lopez R. 2011. Using ungulate occurrence to evaluate community-based conservation within a biosphere reserve model. Animal Conservation 14 (2): 206-214.

Conservation areas in tropical forests protect the most diverse and threatened ecosystems on the planet. In the Amazon, ungulates are important determinants of forest structure and plant diversity, as well as being a resource for rural communities. Using occupancy-based methods, we estimated the occurrence of white-lipped peccary *Tayassu pecari*, collared peccary *Pecari tajacu*, lowland tapir *Tapirus terrestris* and red brocket deer *Mazama americana* in and around protected areas reserve in Tambopata, Peru, to evaluate how different management designation, anthropogenic influences and habitat type influenced the occurrence of each species. We used a combination of track surveys (n=258) and camera surveys (n=256) to estimate ungulate presence at 55 sites in a national reserve, a native community and adjacent buffer areas from May 2008 to March 2009. We found that prediction of the occurrence of white-lipped peccary, lowland tapir and red brocket deer was best accomplished using travel time from the nearest city (a measure of an area's accessibility). The occurrence of ungulates differed little between buffer and reserves, but community lands managed by indigenous peo-

Wild boar rooting is considered one of the main large soil disturbances affecting the structure and composition of plant communities in alpine grasslands. While direct consequences on plant community have been widely studied, their effects on soil seed banks have received little attention although rooting is assumed to determine the successional processes and ultimately the ecological recovery of the communities. The aim of this study is to assess the effect of wild boar rooting on species and community soil seed banks. The rooting effect was studied in terms of seed abundance and diversity in the most disturbed plant communities by wild boar in Pyrenean alpine grasslands. Two hundred soil core samples were collected at two depths to account for (short/long term) persistent and transient seed banks within and outside wild boar rooting in those grasslands. The 'seedling emergence method' was used to identify and quantify seeds from the germinable seed bank. The soil seed bank found within disturbances was smaller than expected. At the species level, the main type of seed bank represented in these grasslands was long-term persistent, comprising 75% of the seeds found. Rooting turned long-term persistent seed bank into short-term persistent and transient, by exposing seeds from the deepest part of the soil to germination conditions at the surface of disturbed areas. At the community level we found that rooting homogenized soil seed banks by increasing seed abundance and species richness in species-poor communities, while decreasing seed species dominance in nitrophilous communities. These results suggest a deep alteration of the structure of seed banks by wild boar rooting, which in turn, may not represent a real chance for colonization from soil seed banks.

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showed more behaviour towards, and a higher consumption from, the feeder where the sow was eating, while this was not true for mismatch piglets, suggesting a role of both local and stimulus enhancement. Observation, participation, local and stimulus enhancement thus all seem important for piglets to learn from the sow.

Plhal R, Kamler J, Homolka M and Adamec Z. 2011. An assessment of the applicability of photo trapping to estimate wild boar population density in a forest environment. Folia Zoologica 60(3): 237-246.

Wild boar is an autochthonous animal species of the Czech Republic that has significantly increased its population density in recent years. There are concerns that there is an associated negative impact upon agricultural crop production however, objective methods for sustainable management of wild boar, especially for estimation of its population density and intensity of regulation are still lacking. Wild boar differs markedly from the other free-living ungulates in its spatial activity and food selection, which limits applicability of the experiences and methods used for other species. Two methods of wild boar population censusing in a forest environment were tested in this study. The density of wild boar was evaluated in an area of 2256 ha, circumscribed by both natural and man-made barriers that restrict wild boar migration. Wild boar abundance was estimated using traditional snow-track counting and photo trapping data analysis. Both field methods were used in the winter season 2009-2010. Wild boar abundance as assessed by snow-track counting was 6.3 ind./km(2) and by phototrapping 6.8 ind./km(2). The results have revealed that if correctly performed, both of the tested methods are applicable to estimate wild boar abundance. Photo trapping seems to be more accurate; it requires special equipment and is time-consuming, however, it provides additional information on the structure of the population and requires less experience to undertake. Combination of several methods is advisable.

Reidy MM, Campbell TA and Hewitt DG. 2011. A Mark-Recapture Technique for Monitoring Feral Swine Populations. Rangeland Ecology & Management 64(3): 316-318.

Techniques to monitor populations of feral swine (*Sus scrofa*) relative to damage control activities are needed on rangelands. Our objectives were to describe and assess a mark recapture technique using tetracycline hydrochloride (TH) for monitoring feral swine populations. We established bait stations at study sites in southern and central Texas. During 1 d, we replaced normal soured corn bait with bait containing TH and counted the number of feral swine that consumed bait with observers. We conducted feral swine removal using box-style traps and helicopters, at which time we collected teeth for TH analysis. In southern Texas, we estimated population reduction to be 43%. In central Texas, we estimated population reduction of 31%. Our mark recapture population monitoring technique would complement programs to manage feral swine populations and damage through lethal control.

Saito M, Momose H and Mihira T. 2011. Both environmental factors and countermeasures affect wild boar damage to rice paddies in Boso Peninsula, Japan. Crop Protection 30(8): 1048-1054.

Populations of wild boar (*Sus scrofa* Linnaeus, 1758) and reports of crop damage by them have in-

lighter and younger to heavier and older wild sows. Foetal sex ratio was biased towards males (1.3:1). Observed intrauterine mortality rate (9.7%) and postnatal mortality (6.3%) were among the lowest recorded in European wild boar populations. The productivity rate of the Central Portuguese wild boar population was calculated as 1.1 young per individual in the population. Conception and birth periods did not differ significantly between the considered 4 years. Birth synchronisation was pronounced in all the years, with a peak of births occurring in March.

Kanga EM, Ogutu JO, Olff H and Santema P. 2011. Population trend and distribution of the Vulnerable common hippopotamus *Hippopotamus amphibius* in the Mara Region of Kenya. Oryx 45(1): 20-27.

The common hippopotamus *Hippopotamus amphibius* can significantly influence the dynamics of ecosystems and engender serious conflicts with people but, in Kenya, one of the species strongholds, it has been little studied or monitored. We surveyed the hippopotamus population in the Masai Mara National Reserve and the adjoining pastoral ranches in 2006 using foot counts along 155.3 km of the main rivers. We counted 4,170 hippopotamuses in 171 schools. Comparisons with earlier surveys suggest that this population increased by 169.6% between 1971 and 1980 within the reserve and, although it did not increase within the reserve during 1980-2006, it increased by 359.4% outside the reserve during this period against a background of deteriorating habitat conditions. The overall density in 2006 was 26.9 hippopotamuses km(-1) of river, equivalent to a biomass of 26,677 kg km of river. The ratio of calves to 100 adults was 9:100 inside the reserve, 10:100 outside the reserve and 6:100 along tributaries of the Mara River, implying that the population is either increasing or that its spatial distribution is being compressed because of range contraction. The apparent increase in the hippopotamus population contrasts with marked contemporaneous declines in the populations of most other large mammalian herbivore species in the Reserve. We discuss possible reasons underlying the increase in the hippopotamus population.

Kendall CI. 2011. The spatial and agricultural basis of crop raiding by the Vulnerable common hippopotamus *Hippopotamus amphibius* around Ruaha National Park, Tanzania. Oryx 45(1): 28-34.

Categorized as Vulnerable on the IUCN Red List, the common hippopotamus *Hippopotamus amphibius* is under considerable pressure from habitat degradation and hunting. Although human-hippopotamus conflict is known to increase retaliatory killing and culling of hippopotamuses, the issue has been little examined. Using interviews I investigated various spatial, ecological and agricultural factors that influence the vulnerability of farms to crop raiding by hippopotamuses in three villages to the south-east of Ruaha National Park, Tanzania. There was a positive correlation between these crop-raiding events and a farm's proximity to the river and to hippopotamus access points (places where hippopotamuses leave and enter the river). Results from this study provide insights for management and conservation of hippopotamuses, including a need to identify key habitat areas to mitigate future conflict.

Licona M, McCleery R, Collier B, Brightsmith DJ and Lopez R. 2011. Using ungulate occurrence to evaluate community-based conservation within a biosphere reserve model. Animal Conservation 14

brate density and leaf litter cover, but not in soil pH, soil conductivity, invertebrate diversity, vegetation diversity, tree density, canopy cover or fallen log cover. Mean seedling density was lower in the fenced damaged plots than the fenced undamaged plots in 1994 but not in 2006. Other response variables also did not differ significantly between these two plot types, indicating that any damage caused by feral pigs to soil, soil biota or vegetation before 1994 was fully recovered within 12 years.
Conclusions. Our findings suggest that reductions in soil invertebrate density, seedling density, and leaf litter cover should be monitored regularly to inform feral pig management programs, and that these variables should be measured for objective assessment of the outcome of any feral pig control program. These declines may continue and be translated into the decline of trees and other keystone species or processes into the future.
Implications. The efficacy of feral pig control programs can be assessed using the quantitative analysis of the aforementioned variables. The results of such monitoring programs, in conjunction with baseline data, can provide an indication of ecosystem recovery and therefore the level of success achieved by the applied control measures.

White AM and Cameron EZ. 2011. Fitness consequences of maternal rearing strategies in warthogs: influence of group size and composition. Journal of Zoology 285(2): 77-84.

Cooperatively breeding species are defined by the presence of individuals who help in rearing the offspring of others. This seemingly altruistic behaviour has been difficult to define and the help provided has not always resulted in a reproductive advantage to the recipient. We examine maternal rearing strategies in the common warthog, *Phacochoerus africanus*, a facultative, cooperative breeder that displays variation in the number of reproductive and non-reproductively aged individuals in a group. We compare rearing strategies in adult females to assess whether group size or group composition increases the production and survival of group offspring. We found that although the number of offspring observed in groups with multiple adult females was larger than the number of offspring observed in groups with only one adult female, the average number of offspring observed per female was similar. Additionally, maternal rearing strategy had no effect on the survival of dependant offspring and variation in offspring survival could not be explained by either the number of reproductive or non-reproductive individuals per offspring. Taken together, these results suggest that the differences in maternal rearing strategies may not benefit dependent offspring, but we suggest that grouping between reproductive females may increase the survival of yearlings through group augmentation.

White AM and Cameron EZ. 2011. Evidence of helping behavior in a free-ranging population of communally breeding warthogs. Journal of Ethology 29(3): 419-425.

Cooperative breeding societies are defined by the presence of helpers. Defining helping behavior in cooperatively breeding mammals has been difficult because lactation limits the ability of individuals to provision non-genetic young. As a consequence, "helping" behavior has frequently included predator and conspecific defense and thermoregulation. However, these behaviors are often associated with the benefits of group living and their expression may not warrant a species' classification as a cooperative breeder (e.g., many ungulates and pinnipeds). In this study, we examine cooperative

503-511.

We investigated which mechanisms of learning about foraging from the mother are important in piglets, *Sus scrofa*. The first experiment compared observation of the sow versus participation during eating. Piglet pairs could observe (observation piglets) or participate (participation piglets) with the sow while she was eating a flavoured feed in a test room for 10 min/day for 5 days. Piglet pairs that could eat food without cues from the sow and control piglets that had neither cues nor food were also exposed to the test room with their sow present but unable to eat. Piglets were tested over 3 days for 90 min/day and could choose between the sow's food and another flavoured food. Observation and participation piglets showed shorter latencies to eat and higher consumption of, and preference for, the flavour eaten by the sow than control and no-cue piglets. The second experiment compared local versus stimulus enhancement. Piglets observed the sow eating a flavoured feed from one of two feeders on different sides of the room for 10 min/day for 5 days. During the test phase there was a match or mismatch between location and the flavoured food eaten by the sow. Match piglets showed more behaviour towards, and a higher consumption from, the feeder where the sow was eating, while this was not true for mismatch piglets, suggesting a role of both local and stimulus enhancement. Observation, participation, local and stimulus enhancement thus all seem important for piglets to learn from the sow.

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capture rate for corral traps was >4 times that of box traps. Our data suggest that corral traps are temporally and economically superior to box traps with respect to efficiency; that is, corral traps effectively trap more pigs per trap night at a lower cost per pig than do box traps.

Wirthner S, Frey B, Busse MD, Schutz M and Risch AC. 2011. Effects of wild boar (*Sus scrofa* L.) rooting on the bacterial community structure in mixed-hardwood forest soils in Switzerland. European Journal of Soil Biology 47(5): 296-302.

Soil disturbances are known to influence the soil bacterial community structure and therefore have the potential to affect forest ecosystem functioning and productivity. Whereas most studies have focused on how disturbances originating from forest management practices alter these communities, almost nothing is known about the effects of biotic natural disturbances, especially the ones caused by large animals. Our goal was to determine how European wild boars (*Sus scrofa* L.) affect soil microbial biomass carbon and bacterial community structure by rooting (grubbing) in the soil when searching for food. We sampled microbial biomass carbon immediately and 24 months after the rooting event and determined bacterial community structure immediately, 11, 14 and 18 months after rooting on paired rooted and non-rooted study plots in four hardwood forest stands. In addition, we measured plant available total nitrogen, soil moisture and soil temperatures for each sampling interval. Wild boar rooting had no significant effect on microbial biomass carbon or soil bacterial community structure, diversity, richness and evenness. However, we found that the bacterial community structure varied significantly with the sampling date. Correlations between bacterial community structure and different environmental parameters, namely plant available total nitrogen, soil moisture, and soil temperature were found to be responsible for these seasonal differences. Thus, seasonal changes in bacterial community structure seem to override rooting effects of wild boars at our study sites.

Oliveira-Santos LGR, Dorazio RM, Tomas WM, Mourao G and Fernandez FAS. 2011. No evidence of interference competition among the invasive feral pig and two native peccary species in a Neotropical wetland. Journal of Tropical Ecology 27(5): 557-561.

Wilbroad C and Milanzi J. 2011. Population status of the hippopotamus in Zambia. African Journal of Ecology 49(1): 130-132.

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The newsletter of the IUCN/SSC Wild Pigs, Peccaries and Hippos Specialist Groups (previously Asian Wild Pig News)

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The IUCN/SSC Wild Pigs, Peccaries and Hippos Specialist Groups (WPSG, PSG and HSG) are three of several Specialist Groups of the Species Survival Commission (SSC) developed by the IUCN to foster conservation, research and dissemination of information for species of conservation concern.

These groups consist of technical experts focusing on the conservation and management of wild pigs, peccaries and hippos.

The broad aim of the these groups is to promote the long-term conservation of wild pigs, peccaries and hippos and, where possible, the recovery of their populations to viable levels.

Pigs, peccaries and hippopotamuses are non-ruminant ungulates belonging to the Suborder Suiformes of the Order Artiodactyla (the even-toed ungulates).

Within the Suborder Suiformes, pigs belong to the Family Suidae, peccaries to the Family Dicotylidae and hippopotamuses to the Family Hippopotamidae.

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