Prerequisites to prevent extinction of the genus Dicerorhinus

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Dicerorhinus sumatrensis represents an equatorial rainforest form of an ancient and critically endangered mammalian genus. Popular media tend to lump all extant rhino species as a single group. Yet the prevailing situations for African rhinos and Dicerorhinus are as different as are those for gorillas and orang-utans. Work to save Dicerorhinus has become mired in cognitive bias. Some reasonable assumptions can be made: (1) fewer than 100 Dicerorhinus are alive today, (2) at best, only one wild concentration is potentially viable if left in situ, (3) the key threat is extreme Allee effect, rather than poaching or habitat loss, (4) the genus will drift to total extinction in the absence of a single program with the goal to boost rhino births. Relevant to a single program are the following facts : (1) captive husbandry of Dicerorhinus has advanced far beyond the disasters that occurred from 1980s to 2003, (2) Dicerorhinus have been bred successfully in captivity, (3) proven methods exist to safely capture and translocate wild Dicerorhinus, (4) female reproductive pathology is significant in some areas, (5) apart from keeping rhinos alive, the big need is to bring Dicerorhinus gametes together to boost potential for pregnancies, (6) profit motive has led to established systems that produce thousands of embryos annually from three mammalian families, (7) advanced reproductive technology work is underway on the rhino genus Ceratotherium. Key elements of the necessary Dicerorhinus rescue program are: (1) one meta-population, (2) capture of more rhinos and husbandry in excellent managed facilities, (3) increase births through natural breeding, (4) rapid experimentation and development of in vitro fertilization, embryo transfer and other advanced reproductive technology for Dicerorhinus, so that gametes are not wasted and can be transferred easily between facilities. Current constraints that need to be ameliorated in order to launch the necessary program to boost Dicerorhinus births include: (1) factions, at and between national, sub-national and institutional levels, which occasionally meet but do not budge from entrenched positions, (2) lack of leadership and support from international nature conservation organizations, (3) national decision-making in Indonesia is centered on a conservative forestry view, rather than a customized species view, (4) worries over lack of funding get in the way of focusing on making necessary policy decisions, (5) information on Dicerorhinus available in the media consists of misleading incidents and anecdotes that ignore the big picture, (6) unnecessary worries such as funding competition with other projects, "stakeholder" views, and availability of future habitat interfere with sensible debate.

Lessons learned from the decline of the Sumatran rhino (*Dicerorhinus sumatrensis harrissoni*) in Sabah

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Effective conservation of endangered species requires a thorough understanding of the population size, its ecological needs as well as the factors responsible for its decline. Yet, this information is still lacking for a variety of endangered species and the question arises of how to use these limited and uncertain data to

improve decisions for conservation management. The Sumatran rhino (*Dicerorhinus sumatrensis*) is a good example to illustrate the challenges in the conservation of a highly endangered species. Less than 100 Sumatran rhinos still exist in the wild. They are remnants of the two extant subspecies*, D. s. sumatrensis* in Sumatra, Indonesia, and *D. s. harrissoni* in Borneo in Kalimantan, Indonesia who live in very small and highly fragmented populations. Several conservation strategies have been proposed to stop the decline of the species and to increase its numbers. However data suitable and relevant for such measures hardly exist. Despite intensive research on Sumatran rhinos in the past, the exact number of the remaining individuals as well as their sex and age ratio are still unknown. This lack of data makes the conservation of the species challenging. The size of the population is easily overestimated and conservation measures such as the consolidation of isolated subpopulations to enhance the chance of mating are being delayed. We reviewed the literature on rhinos and assembled a comprehensive dataset on surveys of the Sumatran rhino subspecies (*D. s. harrissoni*) in the Malaysian state of Sabah on Borneo to chart the historical development of the population in Sabah and its exploitation until the present day. We ran a series of population viability analyses (PVAs) to extract the key demographic parameters most likely to affect population dynamics. The analysis revealed that unrestrained hunting between 1930 and 1950 drastically reduced the historical rhino population in Sabah and that the remnant population could have been rescued by combining the effort of total protection and stimulation of breeding activity. Two factors were identified as crucial parameters driving population dynamics: the percentage of breeding females and female lifetime reproductive period. In combination with total protection against poaching, even moderate improvements in these parameters could elevate population viability substantially. The experiences with the rhinos in Sabah illustrate that remnant populations with less than 15 individuals have a high chance of extinction if left to their own devices. We therefore recommend to translocate isolated individuals or small subpopulations to protected locations and to undertake measures to maximize conceptions. One possible option would be to run state-of-the-art reproductive management with assisted reproduction techniques to improve the reproductive performance of the female rhinos. The next few years are crucial for the survival of the species. Concerted efforts of the governments, NGO´s and scientists in terms of a one plan approach are needed to save the Sumatran rhino from extinction.

Saving the Sumatran rhino: Amalgamation in the Leuser Ecosystem

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The Leuser Ecosystem (LE) is one of four locations left in the world where Sumatran rhinos still exist in the wild. In LE there are at least four locations where the Sumatran rhino populations are relatively small: the western LE, Beutong, Samarkilang and Kappi. According to a PVA from 2015, there are at least 8-10 rhinos in Kappi, 3-5 in Samarkilang and 2-3 in Beutong. From our patrol reports over the last 3 years in Kappi, the last 2 years in Samarkilang, and from intermittent survey activities in Beutong, we could not find any indication that this critically endangered species is breeding in these 3 sites. Without intervention, there is a high chance that these populations will go extinct no matter how intensely we patrol and protect their habitat. One way to save these isolated individuals is by translocating them all to one location. After ascertaining population numbers and assessing the health and reproductive capability of these individuals, an appropriate breeding center should be built. This is the most viable option for conserving these small Sumatran rhino populations remaining in the eastern part of Leuser Ecosystem. Before we take the major step described above, we intend to conduct population surveys in these three locations using the occupancy method and camera trapping. Our next step would be capturing them and building a breeding center. The intensity of wildlife patrols would be concurrently heightened in the new