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To prevent extinction of Endangered Large Mammals : Changing perceptions and practices, 1960-2020, and proposals for a future approach

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Abstract : Protected areas are a necessary basis to sustain wild species but, in the absence of new, targeted interventions, will be insufficient to prevent the extinction of large terrestrial mammal species categorised as "endangered". Prevailing prescriptions for interventions are the same as those proposed more than sixty years ago. In addition to establishment of protected areas, they tend to focus on "conservation" (rather than management or population recovery), public awareness (rather than governmental policy decisions) and anti-poaching (reducing death rate yet not increasing birth rate). This paper suggests that human cognitive biases, rather than technical limitations, represent major constraints to prevention of large mammal extinctions. Six optional interventions are proposed which, if applied together with protected areas, may yet thwart some otherwise inevitable large mammal extinctions in Malaysia.

Keywords : perceptions, practices, extinction, endangered, large mammals, Malaysia

INTRODUCTION

Since the 1970s, I have been involved in wildlife conservation in Malaysia, starting in Krau Wildlife Reserve, Pahang (Chivers, 2021 this issue), from which the two largest-bodied mammal species (Asian elephant *Elephas maximus* and seladang Bos *gaurus hubbackii*) have since gone extinct, and a third (Malayan tiger Panthera *tigris jacksoni*) is now functionally extinct there. The evident failure of prevailing approaches to prevent extinctions, and realisation that those approaches are becoming little more than background noise, have forced me to step away from simply enjoying the last fragments of the pre-twentieth century ecosystem. My imperatives have widened, to imagine and try to promote new approaches. These include seeking means to boost carrying capacity of endangered large mammals at population and landscape scales, to seeing emerging opportunities presented by recent advances in reproductive biology at cell level, which can help sustain the living genomes of individual animals that are dying without contributing to births. As a contribution to this commemorative Special Issue of the *Malaysian Nature Journal*, I have reviewed critical events and drawn on my personal experience to analyse failures, to evaluate obstacles, and to propose constructive measures that could assist future decision-making in this challenging field.

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PAST

Here are two comments from papers included in the 1961 "Nature Conservation in Western Malaysia" *Malayan Nature Journal 21st Anniversary Special Issue* (Wyatt-Smith & Wycherley, 1961): 'The States of Selangor and Negri Sembilan have seen fit to afford the tiger protection under the game laws and are to be commended for the foresight' (Kitchener, in 'The Importance of protecting the Malayan tiger'). And: 'Nor should sanctuaries be chosen without a very close study of the beat of any particular herd. We must learn to limit them to these carefully chosen protected areas by improving living conditions therein and preventing overabundance' (Foenander, in 'The conservation of the Malayan elephant'). There is much on which ponder contained within those few words, relevant to preventing extinctions of endangered large mammal species in Malaysia today.

By 1920, all literature on Sumatran rhinoceroses *Dicerorhinus sumatrensis* already pointed to the existence of many small, isolated clusters. Centuries of hunting to supply the traditional medicine market had presumably led to this situation, but by then, poaching was no longer the only driver towards extinction. Instead, the non-existence of any large populations, wide scatter of the survivors and insufficient reproduction would have been the issues to address. As explained by Payne *et al* (2019) and Schaffer *et al* (2020), the impending extinction of the Sumatran rhino has very little to do with habitat loss or poaching, and everthing to do with inbreeding and reproductive pathology arising from chronic insufficient breeding in the last remaining wild clusters. In 1920, Sumatran rhino was probably already within its 'extinction debt' phase (Tilman *et al.,* 1994), whereby extinction was inevitable in the absence of targeted interventions, although another century would be needed for the last ones to die. Captive breeding within the context of a managed international meta-population programme and application of assisted reproductive technology could have prevented the extinction of the Sumatran rhino.

Immediately after the deaths of the last two Sumatran rhinos in Malaysia in May and November 2019, the global response was of sympathy, touching to those close to the rhinos, but demonstrating no understanding that the species' current situation is the end-stage of centuries of contributory history. Over the decade preceding the extinction of this rhinoceros in Malaysia, the government as well as people caring for the rhinos in Sabah had advocated frequently and waited, ultimately in vain, for IUCN and the Government of Indonesia to endorse a single, collaborative meta-population programme with rapid capture and application of in vitro fertilization for reproductively compromised individuals (Payne *et al.,* 2019).

The European bison *Bison bonasus*, extinct in the wild by 1927, was bred up by a few dedicated citizens in several countries, from only 54 alive at that time, all in zoos, to thousands of individuals today, mostly living wild (Pucek *et al.*, 2004). The idea of doing the same for Sumatran rhino was raised seriously within wildlife conservation circles only in 1982, by Thomas Foose of the American Association of Zoological Parks and Aquariums (Foose, 1982). But the chance to reverse the extinction process by establishment of a single, managed breeding programme was subverted at an IUCN-convened meeting in Singapore in October 1984. A fatal compromise was reached between those arguing to leave Sumatran rhinos in the forest and those arguing for a captive breeding programme, whereby fertile rhinos would remain in the forest, and only 'doomed' (mainly solitary, infertile, sub-fertile or old) individuals would be brought into fenced facilities (Seal, 1984). As a result, the entire conservation programme was doomed along with the individual rhinos. Strong and well-reasoned arguments in favour of managing rare large animals in the wild rather than through conservation breeding have been made (Balmford *et al.*, 1995) but, twenty-five years later, this approach seems to be failing, at least for some of the currently most endangered large mammals in Malaysia.

Figure 1: Puntung, the very last Sumatran rhino in Tabin Wildlife Reserve, down from an estimated 12 or more in the 1980s, a few days after her capture in December 2011. Note the front left foot is missing, torn off in a poacher's snare when she was still an infant.
(**Credit :** Azrie Alliamat, Institute for Tropical Biology and Conservation, Universiti Malaysia, Sabah)

PRESENT

All commonly-heard recommendations to prevent extinctions were already being proposed in Malaysia in the 1930s (Kathirithamby-Wells, 2005) and 1960s (Wyatt-Smith & Wycherley, 1961) : the need for a change in attitudes, reducing habitat loss, reducing poaching, stronger legislation and enforcement, new protected areas, and education and awareness. Empirically, we see that those recommendations have been insufficient. The overall numbers of all large mammals have declined drastically, and are still declining. We must imagine the fate of the Sumatran rhino repeating for other species, as remaining numbers have become isolated into clusters too small to be viable. Fresh, specific and practical recommendations are needed urgently.

There are at least three basic biogeographical constraints that limit action to help prevent extinctions of large mammals. Firstly, there is the species-area curve (Figure 1). The main message from this graph is that there is a limit to how many species can be sustained within a given area. If 50% of the original habitat (tropical rainforest, in the case of Malaysia) is removed for human purposes, we can expect that about 10% of species formerly there will go extinct, even though it may take a long time before the last individuals die. Secondly, habitat loss is not a recent phenomenon. Vast areas of lowlands of the Sunda shelf, that would have contained populations of the region's large mammal species, were lost to Early Holocene sea level rise between about 18,000 to 6,000 years ago (Sathiamurthy & Voris, 2006). From 1920 to 2020, we have witnessed subsequent human-made habitat loss layered on top. Thirdly, during that century, people have removed not just a certain percentage of what was present, but disproportionately removed the most important areas for large mammals, mainly lowlands. Figure 2 shows a specific example. The Forest Reserves and Parks of Sabah that were legislated in 1984 (shown in fine lines) bore no relationship to the population centre of wild orangutans *Pongo pygmaeus* but, instead, consisted mainly of land that could not support permanent agriculture. This is not to say that policy decisions were wrong, but that the protected areas were not chosen to conserve

endangered large animals. Ironically, one exception, Tabin Wildlife Reserve, was included in the 1984 gazettements specifically in order to 'save' the Sumatran rhino. The reality was that the numbers of breeding female rhinos there was already too small to be viable. Now, fortuitously Tabin does contain the largest known Bornean population of banteng *Bos javanicus* (Payne *et al.*, 2021. This issue).

I believe that the single biggest threat to endangered species in 2020 lies more in the array of human emotions, cognitive biases and bureaucracies, rather than habitat loss and illegal killing. Two points need to be accepted. Firstly, people will determine the fate of all endangered species. Long gone are the days of leaving the last clusters of individuals in their natural habitat, hoping that nature will cause them to get together and reproduce. What has happened to the Sumatran rhino will happen again to other species. Secondly, the precise nature of steps to be taken to prevent extinctions is best left to experienced field practitioners who know the situation. Linked to that, implementation of the agreed steps is best delegated to dedicated teams, who might or might not be government employees. Even if those points can be accepted, remaining challenges are great. These stem from the existence of cognitive biases - the widespread patterns of deviation from rational thinking that are common to all humans (e.g. https://www.verywellmind.com/what-is-a-cognitive-bias-2794963). There are similar biases which are fundamental and widespread, and which result in failures to identify what is needed to prevent extinction of endangered species. This is a universal problem in nature conservation. Individual biases then extend to institutional, national and international levels. Here are some of the major ones.

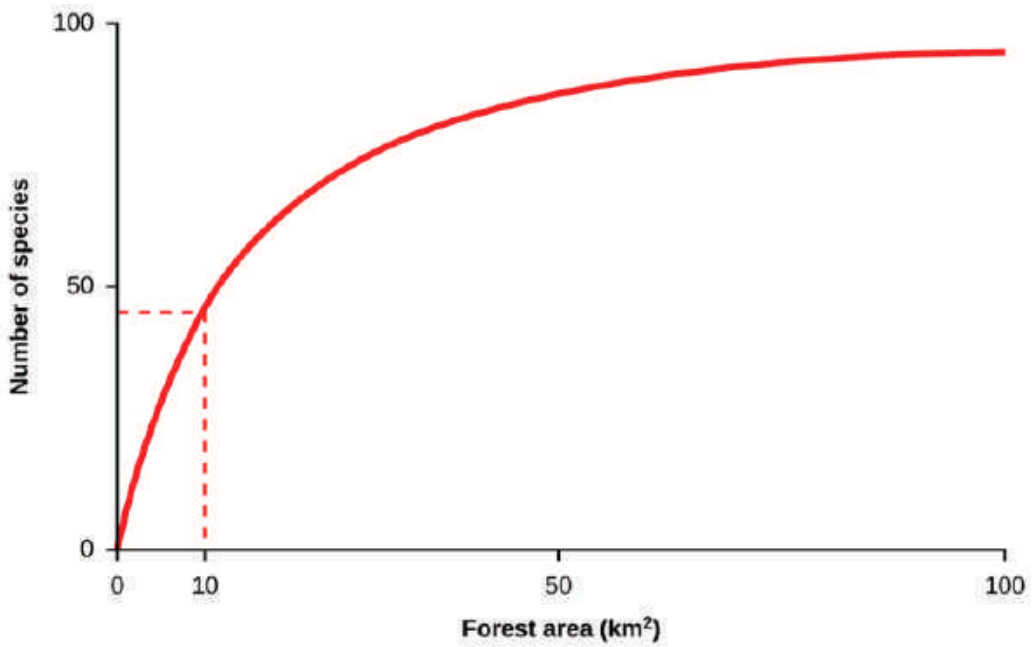

Figure 2: Species-area curve

Avoidance bias Actions that are currently unfashionable or uncomfortable are avoided before they can be opened for discussion. Captive breeding is one example. Another example concerns species that have become super abundant in some localities, and no-one is willing to raise the possible need for action to reduce those numbers.

Availability bias This means the tendency to overestimate the significance of something that has the greatest "availability" in memory. All of us are bombarded with the habitat loss, fragmentation and poaching mantra, to the extent that these drown out all other key issues.

'Boiling frog' syndrome With an imaginary frog in a saucepan of cold water placed on a cooker, a very gradual change in temperature is tolerated up to a point of inevitable death, even though the option of jumping out had been present over a long time. Similarly, we watch as numbers of a rare species decline over the decades until there are too few breeding animals left to sustain a viable population. We continue to blame habitat loss and poaching, but that damage had been done many years earlier. For wildlife, small but inadequate steps may be taken over many years, whereas a single big change was necessary to achieve the desired outcome.

Can see bias Vital aspects of an endangered species that cannot be seen, including those at molecular and cell levels, and those at entire population level, as well as those which need to be imagined over long periods, are ignored in favour of actions that can be applied to a few individual living animals that can be seen, even if only in photos or captivity.

Confirmation bias This is the tendency to seek, interpret and prefer information that confirms or supports one's prior belief. Thus, the habitat loss, fragmentation and poaching mantra is reinforced, while other key issues remain ignored.

Emotionalization of wildlife Photos of distressed and dead large mammals can bring money to organisations that aspire to 'save' them. The sincerity and dedication of the people involved is admirable, and many distressed mammals are indeed relieved with human help. But this work is largely animal welfare rather than breeding population management and, if the animals are moved to a location other than where they originated, they may or may not reproduce.

Everyone is an expert Most people accept that lawyers, accountants and medical doctors are experts in their field. It is a characteristic of wildlife conservation, however, that most people believe that their opinions on wildlife are based on self-evident facts and are therefore a valid contribution to decision-making. But their opinions might be wrong. For example, African rhino numbers have increased significantly over the past century. Poaching is an issue of concern but, contrary to popular belief, not one that will determine whether or not African rhinos go extinct.

Global media reporting The deaths of the last three Sumatran rhinos in Malaysia were all reported in the news media globally. These events that happened on certain dates were fluffed up as hooks on which to hang an incorrect story, that the near-extinction of the species is a result of poaching and habitat loss. Given that international wildlife conservation authorities provided the underlying misinformation, it is not surprising that the reported story was wrong. By virtue of being reported in iconic global news outlets, ordinary people in Malaysia, and perhaps even senior public officials, have their confirmation bias re-enforced.

Human benefit irony Since around year 2000, stakeholder consultations on wildlife conservation projects tend to bring in a wider variety of people than previously, and many wildlife projects now bizarrely require that the beneficiaries be human, rather than the wildlife that the project is intended to help.

Institutional rule tyranny Big institutions can slow processes that need quick decisions and actions, albeit not deliberately. In the case of Sumatran rhino, the Malaysian government facilitated many necessary policies and actions. But failure to issue CITES import permits for rhino gametes by the intended partner, attributed to failure of a draft Memorandum of Understanding (MOU) to adequately incorporate the provisions of the Nagoya Protocol on Access to Genetic Resources, when in any case no MOU was required under any laws, ensured that gametes could not be sent to that intended partner nation in order to initiate in vitro fertilization attempts.

Law of triviality This cognitive bias means that people give disproportionate weight to trivial issues, thereby avoiding having to confront the important but difficult issues.

Location bias There is a widespread view that all wildlife should stay in areas designated as protected, even if those areas are suboptimal ecologically and insufficient in extent. Vast forested mountain ranges will not be sufficient to sustain a viable elephant population in the long term, whereas a few large oil palm plantations probably would be so.

Misleading leaders In September 2015, the Chair of IUCN's Species Survival Commission, in text still available in public domain at time of writing this paper, stated "With the ongoing poaching crisis, escalating population decline and destruction of suitable habitat, extinction of the Sumatran rhino in the near future is becoming increasingly likely."

Nation states We live with the existence of a relatively new phenomenon, a global array of human management units with precise borders, known as countries or nation states. The case of the Sumatran rhino suggests that nationalistic sentiments will continue to have a profound and usually negative impact on species where only a few are still alive and live in more than one human management unit. The collaboration between non-governmental individuals and zoos in several countries in the 1920s and 30s, that prevented the extinction of the European bison by management of a captive metapopulation of the last individuals, is unlikely to be possible again.

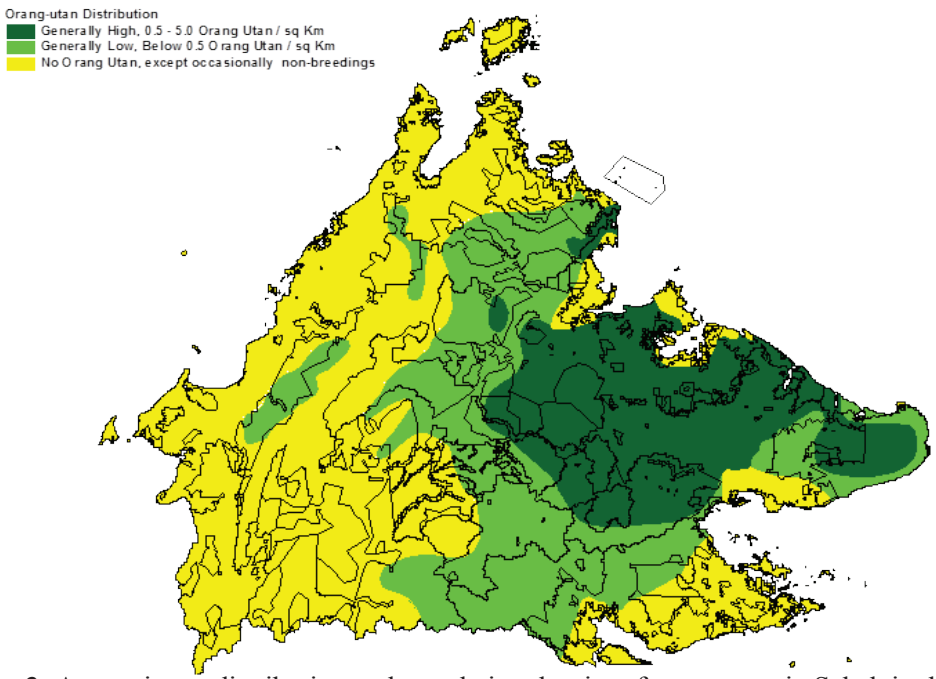

Figure 3: Approximate distribution and population density of orangutans in Sabah in the early 1980s, superimposed on Forest Reserve and Park boundaries (from Payne, unpublished, 1988).

Figure 4: Forest patches in oil palm landscapes can be enriched with primate food plants in order to help boost long term carrying capacity for orangutans in a mixed forest plantation landscape. (**Credit** : John Payne)

NGO influence Governments are to be credited for listening to non-governmental organisations (NGOs) and academic researchers when formulating policies on endangered species. But they need to be aware that NGOs, like all of us, are not immune from using opinions, and even academic researchers whose published papers influence NGO views, may be unaware of important aspects of the species other than the aspects that they have been studying.

No system Human health and survival can be viewed at two levels. At the individual level, we can imagine someone being brought into an emergency room. But we can also imagine a national health delivery system that is already in place. This is a simile for endangered wildlife. Every Sumatran rhino that has died in captivity in the past few decades drew sympathy and the last few were reported in the media as a tragedy, but without global context. Every time an individual rhino or other rare animal is 'rescued' or dies, the tragedy is never that these animals were displaced or died (everything dies) but that there is no systeme stablished to manage the population.

Numbers obsession People always want to know the number of individuals of rare species. Much time can be wasted trying to find out and, whatever is the result, it does not help in deciding the best intervention. It does not matter, for example, that there were probably about 40 Javan rhinos *Rhinoceros sondaicus* in Ujung Kulon, Java, in the 1960s, and over 500 Sumatran rhinos alive in Sumatra at that time. Javan rhino numbers have increased since then to about 60, but they all descend from the same tiny number of founder animals and, moreover, have reached the carrying capacity of their designated habitat. On the other hand, those 500 or so Sumatran rhinos were too scattered to form a breeding population without human intervention and so the numbers have declined to a few tens.

Opinion-based decision-making Stakeholder consultation is appropriate when there is discussion of proposals that, if implemented, will affect people. In relation to the Sumatran rhino, the most damaging fashion in recent decades was to bring too many people into discussions, to the extent that the small number of experienced practitioners in the room were outnumbered by multiple participants who determined policy based on their opinions.

Photo anecdotes In recent years, it has become fashionable to publish images of endangered wild species, with particular fondness for animals in a place where the species is known to be extremely rare or where it was previously absent. These images come with texts that normally use the word 'hope'. These can be dangerously misleading. A photo of a wild female with a baby reveals nothing about the status of the species.

Prioritisation error Up to around 1970, captive breeding was considered by wildlife biologists to be the most urgent intervention when a species reaches very low numbers, and this view was supported by proven success in preventing the extinction of European bison, Arabian oryx, Californian condor and other species. After the 1970s, 'expert' fashion instead provides arguments as to why captive breeding is a last resort, most commonly that there will not be enough habitat to support released captive-bred animals in the future, and that captive-bred animals cannot adjust to life in the wild. This conveniently ignore the cases of European bison and Arabian oryx, in which zoo-born calves were released into the wild and populations increased thereafter. When captive breeding has become necessary - as it was with Sumatran Hairy rhino since the 1950s - the 'last resort' situation has already arrived. The priority is not to worry about some future unknown scenario, but to make sure every last individual contributes to the gene pool and to boosting number of births.

Probablity presented as nationality Global reporting on the deaths of Tam and Iman highlighted that the Sumatran rhino was now extinct in Malaysia, but not in Indonesia. This represents a political, rather than biological viewpoint. The main reason why the species is not yet extinct in Indonesia is that the combined land area of Kalimantan and Sumatra is 2.8 larger than the combined land area of Peninsular Malaysia, Sarawak and Sabah. That the species disappeared first from the land area controlled by Malaysia is a function of probability in relation to land under Malaysian control, not of differential competence between nations.

Shifting baseline syndrome This is perhaps the greatest bias affecting wildlife conservation. In the absence of past information or personal experience of historical conditions, people of each new generation accept the situation in which they were raised as being normal (Soga & Gaston, 2018). In 1984, for example, many 'experts' were aware that, during their own lives, only a few, scattered Sumatran rhinos were left, and had lulled themselves into thinking that this was normal. They were unable to imagine concentrating rhinos under a managed meta-population programme because, to them, their baseline was a tiny, sparse scatter of rhinos.

Time is not expertise In the wildlife world, as in the worlds of politicians, lawyers and scientists, "experts" tend to be people who have spent many years doing the same things on the same subject. Their views are not necessarily wrong, but may need to be treated as a partial contribution because their knowledge of a species is not necessarily related to time spent studying a few aspects of that species.

Umbrella species This is the assumption that there can be one species whose conservation is expected to confer protection to a large number of naturally co-occurring species (Roberge & Angelstam, 2004). The arguments for designating Taman Negara, Tabin Wildlife Reserve, and Endau-Rompin Park, all included that of being a 'refuge' for Sumatran rhinoceros. Once the protected areas had been established, people believed that the job was done: by virtue of being 'protected' the endangered species should start breeding and reverse its decline. Once that thinking had been established unchallenged, the subsequent need to remove the rhinos for a managed breeding programme was challenged. I do not assert that endangered species should be removed willy-nilly from protected areas. The problem is that the 'umbrella species' concept may be used to get a decision to preserve a forest area, but those same advocates might then argue against interventions to prevent the extinction of that endangered species.

'We' politeness Out of politeness, civil society commentators in the nature conservation sphere often couch their arguments for necessary actions in the form of 'We need to …'. In fact, usually there are only three people who can make the decisions to initiate necessary

actions: the head of the relevant governmental department, the senior civil servant to whom he reports, and the relevant Minister. Unless civil society commentators can convince any of those three individuals on what constitute necessary policy decisions, then the actions will not happen. To recover endangered species, honesty is more important than politeness.

Wishful thinking This is a shorthand way of saying that people prefer to believe that they want to believe instead of what is true. For example, false records of the presence of Sumatran rhinos abound in many unpublished reports up to the present day. Marks in the soil which resemble a rhino footprint, or wild pig wallows are written down as 'rhino signs'. Most cases represent desperate attempts to find rhinos where the last one has already died many years ago.

Zero deforestation commitments and high carbon stock Based on exhortation by environmentalists, many corporations have made commitments to not deal in products that have involved deforestation. The high carbon stock approach is an associated methodology that identifies high carbon stock forests and allows lands with degraded vegetation to be developed for plantation commodities. The intent is sincere and the methodology probably helps to secure forests. However, it is not so much the amount of carbon stored in a forest at the present time that is important for endangered large animals, but the location of the land, its topography, geology, the fertility of the soil and the prospects of keeping that land uncultivated that are more important.

Figure 5: (Left) Restoration of orangutan habitat inside an oil palm plantation in eastern Sabah; **(Right)** The living diversity of wild Bornean fig species is being preserved in the Sabah Ficus Germplasm Center.
(**Credit** : John Payne)

PROSPECTS

I have outlined some of the ways in which individual humans tend to think, which drive the institutions and audiences that they influence. Due the ways in which the human mind operates, none can be changed in any major way, yet all of them are strongly influencing endangered wildlife conservation policy. I also believe that it is clear that recommendations dating from the 1930s are now proven to be insufficient. While protected areas (Parks, sanctuaries, protection forests etc) are necessary to sustain wild species, I believe that, in the absence of targeted human interventions, they will be insufficient to prevent the extinction of large terrestrial mammals categorised as 'Endangered'. What can be done that will not render most current efforts a waste of resources? I suggest six approaches by which prospects to prevent the extinction of endangered large mammals might be enhanced. Not all need to be applied for any one species, but one or more of them applied together with retention and management of protected areas, may yet thwart otherwise inevitable extinctions in Malaysia.

Targeted habitat improvement inside protected areas
Underlying thinking: Protected areas ought to be managed to sustain populations of species they are intended to protect. For most species in Malaysia, that will likely be retaining and in some cases restoring closed-canopy forest. But other habitat modification targeted to favour the most endangered of those species may be beneficial.

Challenges: There are few practical ways to modify rainforests on any meaningful scale that might boost carrying capacity or breeding success of target large mammal species. For example, the natural carrying capacity of Sunda clouded leopards *Neofelis diardi* is very low, but it is not possible to boost the population density of its presumed favoured food animals. For the Malayan tapir *Acrocodia indica* regenerating logged lowland forest is probably an ideal habitat. Sustainably managed production forests may be a superior habitat than closed canopy forest, as long as forest blocks are large enough to sustain a viable tapir population. Wild cattle (both seladang and Bornean banteng), Asian elephants and sambar deer *Rusa unicolor* seek grasses as an important component of their diet.
Possible treatment: develop and maintain mixed grass and forb species as pastures on damaged sites in protected areas (e.g. on former logging roads, burned areas).

Periodic moving of young mature males between protected areas
Underlying thinking: in most mammal societies, young males disperse from their natal area on reaching sexual maturity; their priority is to seek mating opportunities elsewhere. This phenomenon differs from females, as well as their young, and old males, which generally stay where they are. Dispersing males tend to move long distance from their natal area and eventually choose a permanent home range. Unlike the translocation of large animals that cause problems for humans, intended to relieve human complainants but not to serve the interests of the animals involved, moving young sexually-mature male animals from one area to another could potentially serve their individual interest and that of their species in terms of reducing inbreeding risks inherent in small populations confined to one area.

Challenges: Locating, selecting and safely capturing the target animals will be extremely difficult, and to some extent will depend on luck. Post-translocation monitoring might also be challenging, not least in terms of removing a satellite tracking device before the battery expires.
Examples that might be helpful: all wild cat species, Malayan tapir.
Possible treatment: try with an example species in a well-thought-out situation.

Establish new populations in appropriate protected areas
Underlying thinking: hunting might not be the sole cause of disappearance of a species from a given area. It might be that the current small clusters of animals are in sub-optimal habitat or on infertile soils. Despite prevailing concerns over poaching, past hunting might have wiped out a species in places where it could now survive and breed. It is in general safer to have several separate populations of endangered species rather than just one or two.

Challenges: local human concerns if the species is considered as dangerous or destructive; availability of source animals; risk of inbreeding if the founder group is too small; only some individuals of some species can adapt well to a new habitat; the details and logistics of the operation; post-translocation monitoring.
Examples that might be helpful: wild cattle, Malayan tapir.
Possible treatment: try with an example species in a well-thought-out situation.

Big land-owners contribute space for wildlife
Underlying thinking: historically and globally, farmers want to keep wildlife out of their property; but farms could help sustain populations of those wild species that cause minimal damage to crops (or where the potential for damage could be mitigated) by providing space for

feeding and for moving between protected areas; this might apply in the Malaysian context to oil palm, rubber and industrial tree plantations; the locations of these plantations tend to be where large-bodied wildlife used to thrive, due to fertile soils and high productivity of food plants.

Challenges: changing perceptions of big land-owners; implementation will be voluntary. Examples that might be helpful: there is a sparse population of orangutans *Pongo pygmaeus* in the Kinabatangan region of Sabah, where 90% of the land is under oil palm plantations, and male orangutans travel through the landscape to mate with females in scattered forest patches. Possible treatment: already underway in Kinabatangan, Sabah (Payne & Oram, 2020).

Conservation breeding

Underlying thinking: if long-term survival of a species in natural habitat areas is untenable or is becoming implausible, bring individuals together in managed (usually fenced) facilities to recover numbers with a goal of maximising birth rate. The priority should be to prevent extinction before overall numbers and breeding reach a point of no return, and not to debate unduly at the present time over future release programmes.

Challenges: prevailing opinion that wildlife should not be kept in fenced conditions; insistence by some parties that the release programme be planned in advance (even though that will be decades from the present time).
Examples that might be helpful: Not only European bison, but also American bison *Bison bison*, Arabian oryx *Oryx leucoryx*, Californian condor *Gymnogyps californianus* and Black-footed ferret *Mustela nigripes* would now be extinct if this approach had not been applied.
Possible treatment: initiate with relatively amenable species in Malaysia, such as the wild cattle.

Advanced (assisted) reproductive technology

Underlying thinking: in vitro fertilization and embryo transfer into healthy females is done routinely in some livestock species but not, so far, for wildlife; culture of living mammal cells is routine in some laboratories; it is now technically possible to create gametes (sperm and egg cells) from mammal somatic cell cultures, and to create embryos; cell cultures can be preserved indefinitely in liquid nitrogen; it is better to establish a programme to maintain gametes and cultures of the cells of all individuals of endangered species from which samples can be taken before they die, sooner rather than later.

Challenges: outside USA, there is no established system in place to preserve the living genomes of the last individuals of very endangered species; sustained interest and funding to proceed with advanced reproductive technology in Malaysia; some wildlife biologists remain negative on this approach, believing that it will not only distract attention from traditional approaches but might never be of any value.
Examples that might be helpful: it will be a relatively simple matter to take semen samples from the 20 or more living male Malayan tigers *Panthera tigris tigris* currently in captivity in Malaysia, and cryo-preserve the samples in liquid nitrogen; tiger lifespan is normally 20 years maximum; most will die without mating, and their genomes lost forever; Reproductive Innovation Centre for Wildlife and Livestock (RICWL) has been established in Faculty of Sustainable Agriculture, Universiti Malaysia Sabah, in Sandakan, and has a collection of cryopreserved gametes of several endangered wildlife species. International Islamic University Malaysia maintains living cell cultures of the last three Malaysian Sumatran rhinos.

Possible treatment: maintain cryo-preserved materials in current facilities for potential future opportunities.

REFERENCES

Balmford, A., Leader-Williams, N. and Green, M. J. 1995. Parks or arks: where to conserve threatened mammals? *Biodiversity & Conservation* 4: 595–607.

Chivers, D.J. 2021. Krau Game Reserve, Pahang, from 1968-1985: a personal narrative and a review of primate research. *Malaysian Nature Journal 81st Anniversary Special Issue*: 35-48

Foose, T. J. 1982. *In pursuit of the Sumatran rhino.* Unpublished proposal to the American Association of Zoo Parks & Aquariums, Wheeling, WV, USA

Kathirithamby-Wells, J. 2005. Nature and Nation. Forests and Development in Peninsular Malaysia. University of Hawaii Press.

Payne, J., Ahmad, A. H and Zainal, Z. Z. 2019. Urgent appraisal needed of Sumatran rhino conservation efforts. *Pachyderm* 60: 138-141.

Payne, J. and Oram, F. 2020. Oil palm and Orangutans: A Fresh Look and a New Idea. *The Planter* 96 (1129): 247-253.

Payne, J., Ahmad, A.H., Abu Hassim, H., Saad, M.Z., Abdullah, P. & Zainuddin, Z.Z. 2021. Endangered wild cattle of Malaysia: past, present and prospects. *Malaysian Nature Journal 81st Anniversary Special Issue* : 27-34

Pucek, Z., Belousova, I.P., Krasiñska, M., Krasiñski, Z.A. and Olech, W. (compilers) 2004. *European Bison. Status Survey and Conservation Action Plan.* IUCN/SSC Bison Specialist Group. IUCN, Gland, Switzerland and Cambridge, UK.

Roberge, J-M. and Angelstam, P. 2004. Usefulness of the Umbrella Species Concept as a Conservation Tool. *Conservation Biology* 18(1):76–85.

Soga, M. and Gaston, K. 2018. Shifting baseline syndrome: causes, consequences, and implications. *Frontiers in Ecology and the Environment* 16(4): 222-230.

Tilman, D., May, R., Lehman, C. and Nowack, N. 1994. Habitat destruction and the extinction debt. Nature 371:65–66.

Sathiamurthy, E. & Voris, H. K. 2006. Maps of Holocene Sea Level Transgression and Submerged Lakes on the Sunda Shelf. *Tropical Natural History* 2: 1-44. Retrieved from https://li01.tci-thaijo.org/index.php/tnh/article/view/102930

Schaffer, N. E., Muhammad Agil & Zainal Z. Zainuddin. 2020. Ramifications of reproductive diseases on the recovery of the Sumatran Rhinoceros *Dicerorhinus sumatrensis* (Mammalia: Perissodactyla: Rhinocerotidae). *Journal of Threatened Taxa*.12(3): 15279–1528.

Seal, U. S. 1984. Ad hoc meeting on the Sumatran rhinoceros, Singapore, 3-4 October 1984. Unpublished minutes of the meeting, prepared by the Chair of the IUCN Captive Breeding Specialist Group. International Union for Conservation of Nature and Natural Resources.

Wyatt-Smith, J. and Wycherley, P. R. (Eds). 1961. Nature Conservation in Western Malaysia. *Malayan Nature Journal 21st Anniversary Special Issue*.

Figure 6: Close-up of the eye of a Sumatran rhinoceros
(**Credit :** Charles Ryan)

Figure 7: Harvest of egg cells from female Sumatran rhino, Iman, by a multinational specialist team from Italy, Germany, USA and Malaysia (**Credit :** John Payne)

Figure 8: Collection of semen from Tam, the last male Sumatran rhinoceros in Malaysia, by an all-Malaysian veterinary team (**Credit** : John Payne)