JAVAN RHINO
Population & Habitat Viability Assessment

11 – 13 February 2015
Taman Safari, Cisarua, West Java, Indonesia

Population and Habitat Viability Assessment
For the Javan Rhino

Workshop Report

Editors:
Muh. Haryono, P.S. Miller, C. Lees, W. Ramono, A. Purnomo, B. Long, Sectionov, M. Waladi Isnan, B.D. Aji, B. Talukdar, and S. Ellis

Compiled by the Workshop Participants

Workshop Organizers:
International Rhino Foundation
World Wildlife Fund
IUCN-SSC Asian Rhino Specialist Group

Workshop Sponsors:
United States Fish and Wildlife Service
Taman Safari Indonesia

Cover photo courtesy of Stephen Belcher.

A contribution of the IUCN/SSC Conservation Breeding Specialist Group, in collaboration with the International Rhino Foundation, World Wildlife Fund, PHKA, YABI, Taman Safari, the IUCN/SSC Asian Rhino Specialist Group, and workshop participants.

Workshop support provided by The United States Fish and Wildlife Service.

Suggested Citation:
Haryono, Muh., Miller, P.S., Lees, C., Ramono, W., Purnomo, A., Long, B., Sectionov, Waladi Isnan, B.D., Aji, B.D., Talukdar, B., and Ellis, S. (Eds.) 2016. *Population and Habitat Viability Assessment for the Javan Rhino.* Apple Valley, MN: IUCN/SSC Conservation Breeding Specialist Group.

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Executive Summary

Introduction

The Javan rhino formerly occurred from Bangladesh, Myanmar, Thailand, Lao PDR, Cambodia, Viet Nam, and probably southern China through peninsular Malaya to Sumatra and Java (Grubb, 2005). The species' precise historical range is not known; early accounts failed to distinguish rhinos to specific level, due to partial sympatry with the other two Asian rhino species (*Rhinoceros unicornis* and *Dicerorhinus sumatrensis*). Beginning in the middle of the 19th century, the species was extirpated from most of its historical range.

The subspecies *Rhinoceros sondaicus inermis* formerly occurred in northeastern India, Bangladesh, and Myanmar, but is now extinct (Nowak, 1999). The subspecies *Rhinoceros sondaicus annamiticus* formerly occurred in Viet Nam, Lao PDR, Cambodia, and eastern Thailand. The last individual of this subspecies was poached in May 2010 in the Cat Loc part (Dong Nai province) of Cat Tien National Park in Viet Nam (Brook et al 2011).

The subspecies *Rhinoceros sondaicus sondaicus* formerly occurred from Thailand through Malaysia, to the Indonesian islands of Java and Sumatra. The Javan rhino now only occurs at one site, in Indonesia's Ujung Kulon National Park (UKNP) in the very westernmost portion of the island of Java (Figure 1).

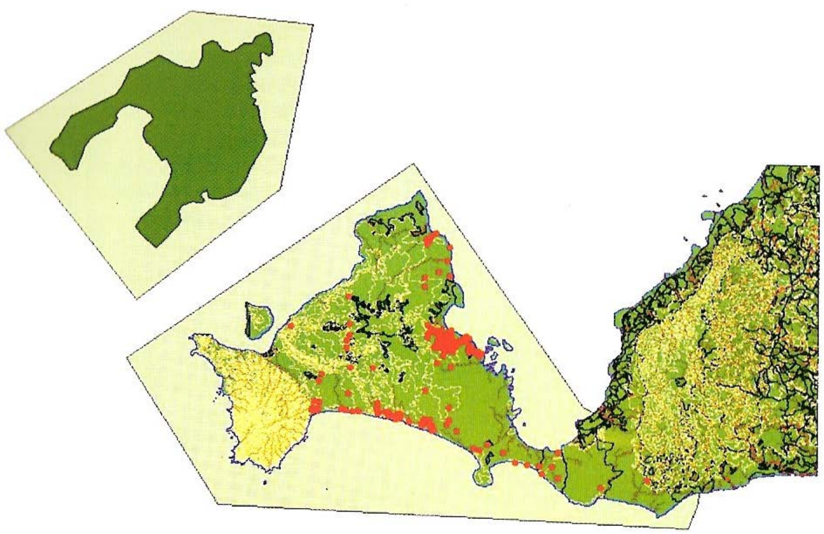

Figure 1. Map of Java's Ujung Kulon National Park with Javan rhino distribution indicated by red areas (from *Strategy and Action Plan for the Conservation of Rhinos in Indonesia 2007-2017,* Ministry of Forestry of the Republic of Indonesia).

Ujung Kulon National Park

The area now known as Ujung Kulon National Park (UKNP) was declared as a Hunting Reserve in 1910, has been a protected area since 1921 and was gazetted as a national park in 1980. In 1992, the park, along with the Krakatau archipelago, was declared Indonesia's first UNESCO World Heritage Site. Ujung Kulon represents the largest remaining tract of lowland tropical forest on the island of Java, and home to the last surviving population of the Critically Endangered Javan rhino (*Rhinoceros sondaicus*) as well as many other threatened species (Appendix I).

Javan Rhinos in Ujung Kulon

The first report of a rhinoceros in the peninsula of Ujung Kulon dates from 1857; rhinos were occasionally reported from the area afterwards (van Strien and Rookmaaker, 2010). There is no indication from the available estimates and sightings that rhinos were exterminated in the area, even from the eruption of Krakatoa in 1883 (van Strien and Rookmaaker, 2010). The population of *Rhinoceros sondaicus* has been restricted to Ujung Kulon since the 1930s. Rhino numbers have hovered at about 40 or 50 individuals for several decades. The Javan rhino is a lowland species that typically occurs up to 600 m (Sectionov and Isnan, pers. comm.), but has been recorded above 1,000 m (Nowak, 1999).

Javan rhinos have been monitored and protected by the UKNP park authority, the World Wildlife Fund - Indonesia (WWF - Indonesia) and/or Yayasan Badak Indonesia (YABI or the Rhino Foundation of Indonesia) over a period spanning 3 decades, using foot patrols and more recently, video camera traps. During this time, there have been no recorded rhino poaching events. (The last rhino poaching incident was reported in the early 1970s.)

The population appears to be stable, perhaps even increasing, based upon the most recent field research results. Recent video camera trap data analyzed by the UKNP authority indicates that there are at least 60 animals in the population, including three relatively young calves. These data were verified by an independent team from the IUCN/SSC Asian Rhino Specialist Group. However, the park probably is nearing carrying capacity and the rhino population is unlikely to increase without more intensive management efforts. Available rhino habitat is limited by two major factors: (1) human encroachment and (2) the predominance of an invasive palm (*Arenga obtusifolia*), known locally as *langkap* and which is rampant in UKNP, that dominates the forest canopy in many locations and inhibits the growth of rhino food plants.

Ujung Kulon also is home to an estimated 25 other threatened mammals, birds, reptiles and amphibians (Appendix 1), including the Javan gibbon (*Hylobates moloch)*, ebony leaf monkey or Javan lutung (*Trachypithecus auratus*), Javan leopard (*Panthera pardus melas*), and Javan banteng (*Bos javanicus*), a species of wild cattle.

UKNP is bordered by water to the north, west and south (Figure 1). Its eastern boundary adjoins agricultural lands and one of Indonesia’s most heavily populated regions in Banten Province (the 2014 estimated population was more than 11.8 million), which results in continuous human pressure on protected lands and wildlife.

Several years ago, the Indonesian government removed more than 300 illegal settlers living within UKNP’s eastern boundary in the Gunung Honge area. This reduced, but has not eliminated, threats due to a low level of illegal activities engaged in by communities, largely for subsistence reasons, i.e., fishing, small-scale timber extraction, and the gathering of forest products.

Javan rhinos have persisted in UKNP because they are carefully monitored and guarded around-the-clock by a combination of Rhino Protection Units (RPUs) and Indonesian government personnel working in the park.

Javan Rhino Study and Conservation Area

In May, 2008, as the *Strategy and Action Plan for the Conservation of Rhinos in Indonesia* (Directorate General of Forest Protection and Nature Conservation, Ministry of Forestry of the Republic of Indonesia, 2007) was beginning implementation, the IUCN Asian Rhino Specialist Group convened a meeting to discuss conservation action progress for the Javan rhino in UKNP and to set immediate goals and actions.

Whereas it was formerly believed that Ujung Kulon had the holding capacity for more than 100 Javan rhino, it was then suggested that the park's carrying capacity may have diminished to as low as 70 due to habitat changes and possible food competition with Javan banteng.

One of the strategies outlined in the 2007 action plan was to translocate a subset of population to another area in its historic range to to increase carrying capacity and to sustain overall health of the population. At the March 2009 meeting, it was agreed that habitat surveys, along with a rhino and banteng census, were an immediate priority (Talukdar et al., 2009). An independent expert was enlisted to lead habitat assessments for both UKNP and possible second habitat-relocation sites outside Ujung Kulon peninsula to ensure critical information would be unbiased. Field surveys were conducted on the Ujung Kulon peninsula and proposed relocation sites on the island of Java in Gunung Honje, Gunung Halimun, Masigit Kareumbi and Leuweung Sancang.

These results (Ramono, et al., 2009) were presented to a board of reviewers comprised of the Indonesian Ministry of Forestry, the Indonesian Rhino Task Force, the Indonesian Institute of Sciences (*Lembaga Ilmu Pengetahuan Indonesia* –LIPI) and rhino NGOs (the Indonesian Rhino Foundation or *Yayasan Badak Indonesia* – YABI, the World Wide Fund for Nature - WWF, the International Rhino Foundation - IRF, and BirdLife Indonesia or *Burung Indonesia*).

Javan rhino habitat preference is governed by a wide variety of biophysical site factors including sensitivity to human activity. While vegetation and elevation are clearly important determinants of rhino habitat, their influence is strongly modified by proximity to water, to mineral salt and especially to site conditions that favor the maintenance of long-term wallows (Ramono et al., 2009). In times of drought, water scarcity can become problematic as indicated in the history of UKNP and may severely restrict rhino movement.

Historic patterns of both natural and human disturbance in Ujung Kulon have generated a mosaic of successional stages of vegetation regeneration in which the early to mid-pioneer stages were valuable sources of food-plants and where patches of mature forest provided cover (Ramono et al., 2009). Examination of vegetation cover on ground and via remote-sensing suggest that these mosaics are becoming increasingly homogeneous as succession moves toward closed forest. As a result, it was concluded that food-plant availability may be decreasing, especially where closed forest is being invaded by *Arenga* (Ramono et al., 2009).

In Gunung Halimun, Masigit Kareumbi and Leuweung Sancang, where human activity has greatly restricted access to favorable habitat, rhino food plant resources are extremely minimal. Taking into account the various biophysical elements, including the influence of human activity, it was concluded that while conditions in UKNP and adjacent Gunung Honje were not entirely optimal for sustained management of the Javan rhino, they were considerably better than those offered in Gunung Halimun National Park or the other two areas, where translocation would almost certainly lead to failure (Ramono et al., 2009).

In 2010, Yayasan Badak Indonesia (YABI or the Rhino Foundation of Indonesia), the International Rhino Foundation (IRF), the UKNP authority and local partners launched the 5,000-ha Javan Rhino Study and Conservation Area (JRSCA) in the Gunung Honje region on the eastern side of the park. This project includes constructing an electric fence intended to reduce the entry of domestic cattle into the park from surrounding villages, as well as habitat restoration efforts involving the removal of the invasive *Arenga obtusifolia*. The JRSCA area is planned to be a staging ground for translocation of a subset of the population to a suitable site in the species' historic range.
As of early 2015, YABI had hired more than 120 local people to clear 78 ha of *Arenga* palm in the JRSCA. Nine rhinos (roughly 15 percent of the population) now are regularly using the area, which

bodes well for further *Arenga* palm management within the park and its positive effects on rhinos. Additional funding is being sought for more extensive *Arenga* management.

The PHVA Workshop

From 11-13 February 2015, a Javan Rhino Population and Habitat Viability Assessment workshop was convened at Taman Safari in Cisarua, West Java. The workshop was collaboratively organized by the Ministry of Environment and Forestry, Yayasan Badak Indonesia (YABI or the Rhino Foundation of Indonesia, WWF-Indonesia, the International Rhino Foundation, the IUCN Asian Rhino Specialist Group, the US Fish & Wildlife Service and other partners. The IUCN Conservation Breeding Specialist Group (CBSG) facilitated the workshop, which was generously hosted by Taman Safari and funded by a USFWS grant to WWF. The CBSG facilitated an earlier PVA workshop for Javan rhinos in 1989 (Seal & Foose, 1989).

The purpose of the Workshop was utilize available biological data and expert knowledge to assess the risks of extinction for the critically endangered Javan rhino, which is now found only in UKNP. Stochastic simulation models incorporating this information were used to assess the risk of extinction, to identify critical factors through sensitivity analysis, and to examine the effectiveness of suggested management scenarios in reducing the risk of extinction. Additionally, specific activities, whereby domestic and international cooperation and assistance can be mobilized to assist in the efforts to prevent the extinction of the Javan rhino, have been identified.

The initial task of the workshop participants was to assemble and evaluate the biological and ecological data needed for the Population Viability Analyses (PVA) of the species. The focus was on data needed to estimate the risk of extinction over the next 50 -100 years.

Javan Rhino Conservation Challenges

The group began by elucidating various challenges to Javan rhino conservation. These were:

<u>Javan Rhino Population Management</u>

- Lack of population growth
- Disease
- Low reproductive rate
- Inbreeding depression
- Future poaching threat
- Insufficient population management
- One location that doesn’t support growth
- Lack of a long-term vision for population management
- Lack of quick action to reduce extinction risk

<u>Javan Rhino Habitat Management</u>

- Climate change
- Natural disasters, e.g., tsunami, Krakatau
- Arenga palm invasion
- Limited habitat availability (carrying capacity) in UKNP
- Improper census methodology
- Competition with banteng
- Competition with wild dogs

- Forest succession
- Insufficient habitat management in park, JRSCA

Additional Rhino Habitat Identification and Management

- Difficulties in identifying optimal Javan rhino habitat
- Funding the identification and management of a second habitat site
- Poor communication with local people about the idea of a second habitat in the area around the National Park (e.g., Pandeglang)
- District authorities support a second population but don't have a clear plan forward (Pandeglang)
- Difficulty in identifying a second habitat for Javan rhino
- There is not a clear process for identifying a second habitat site
- Uncertainty about the perceptions of local people regarding need for translocation outside Banten Province
- Habitat availability outside Banten provicnce that could support a population of Javan rhinos

Local Stakeholder Engagement for Javan Rhino Conservation

- Conflict between rhinos and humans in their use of the park
- Lack of good, alternative livelihoods for local people - they rely too heavily on resources from within the park
- Competition between people and rhinos for space – human settlements
- Lack of support amongst local communities for any translocation outside Banten Province
- Lack of knowledge amongst local people of the Javan rhino's conservation needs
- Too little emphasis on developing Javan rhinos as an icon - a source of pride amongst local communities
- Human population growth around UKNP
- Too little emphasis on encouraging local people instilling the potential value of this
- Conservation not well enough understood among the clerics who are a potentially valuable source of information and influence in their communities – for example the recent Fatwa on wildlife has not been distributed and explained adequately
- Local people do not perceive rhinos as being of value
- Lack of stakeholder involvement and integration into the protection and conservation of Javan rhinos – the local communities are not sufficiently mobilized towards common goals
- Political and bureaucratic challenges

Four working groups were set up around these themes. The groups were: Javan Rhino Population Management; Javan Rhino Habitat Management; Population Modelling; and Stakeholder Engagement. Each working group began by developing goal statements.

Conservation Goal Statements

Once the working groups had developed all of their goals (see working group reports on the following pages for details), they presented and discussed these goals with the rest of the workshop participants in plenary so that all participants were able to have input into all issues and goals. Goals were examined across the three working groups and, if necessary, were consolidated, split, or otherwise refined to equalize the level of action and to increase clarity. This resulted in a total of 11 goals endorsed by the workshop participants, all of which are recommended to improve the long-term viability of the Javan rhino in Indonesia.

An overall prioritization of all workshop goals helps to guide working groups in developing recommended actions, especially if resources (funding, time, personnel) are limited, and can help focus attention on the primary issues of concern. Once the goals were finalized, the participants were asked to consider the importance of each goal in terms of its expected impact on Javan rhino conservation management.

The goals were displayed on flip charts, and participants were asked to prioritize these goals with respect to a common criterion: The greatest immediate positive impact on Javan rhino conservation in Indonesia.

The goal statements presented below are listed in order of priority as determined by the workshop participants, with the number of votes given for each following the statement. It is again important to recognize that all conservation goals have been endorsed and seen as important to achieve within the larger context of Javan rhino conservation. The relative ranking presented here gives a sense of the urgency and/or priority of all goals when compared as a whole. The goal statements were:

- The Javan rhino population is managed to achieve genetic and demographic viability through increasing the abundance of rhino to at least 80 individuals, in at least two sites, by 2025. [31]

- The habitat quality for Javan rhino is improved in Ujung Kulon National Park, and additional habitat in a second site is identified and managed to accommodate growth of the Javan rhino population to at least 80 individuals by 2025. [30]

- By 2025, all relative stakeholders are fully supportive of the Javan rhino conservation program because they are empowered to be involved in the most appropriate way. [23]

- By 2025, there is improved understanding and management of the ecological factors limiting Javan rhino population growth. [17]

- By 2025 and beyond, zero poaching of Javan rhino is maintained. [15]

- Regulations are revised on habitat management in the core zone of Ujung Kulon National Park to control the spread of *Arenga* palm. By 2025, 10,000 hectares of *Arenga* palm are removed to expand the suitable habitat available to Javan rhino and to increase the Park's carrying capacity. 13
- By 2025, there are no illegal activities by local communities inside Ujung Kulon National Park because of a close, trusting and mutually beneficial partnership between those communities and the National Park. [8]

- By 2025, all communities champion the Javan rhino conservation program due to active involvement in (50% of the 2 adjacent villages) and high knowledge of (100% of 19 buffer zone villages) of conservation program activities. [8]

- By 2025, human encroachment, poaching threat, human disturbance, and risk of disease transmission are reduced by at least 50%. [8]

- By 2025, communities no longer extract natural resources from the rhino zone within Ujung Kulon National Park through the implementation of a government-wide green economic development masterplan across the Park buffer zone that increases local livelihoods. [4]

- By 2025, the Javan rhino conservation program is implemented in full and on time. [1]

Creating a Vision for Javan Rhino Conservation in Indonesia

Near the start of the workshop, the participants were asked to identify the key components of a vision statement for Javan rhino conservation in Indonesia. A vision is a short statement that outlines the desired future state of the species. It is meant to be ambitious and inspire all those reading it to clearly understand the ideal future condition for the species.

After a plenary discussion on identification of key themes, a smaller group of participants were selected to create a draft vision statement. Over the next 2 days of the workshop, the team requested feedback from all workshop participants and ultimately presented a final statement that the participants could support. The Vision Team was composed of:

- Widodo Ramono (YABI)
- Moh. Haryono (Ujung Kulon National Park, PHKA)
- Yuyun Kurniawan (WWF)
- Ofat Sofatudddin (Friends of the Rhino)
- Enah Suhenah (Dishutbun Propinsi Banten)
- M. Agil (FKH IPB/YABI)

The final vision statement was:

Secure the habitat and develop three well-managed sites for in situ populations to ensure an increase to at least 150 Javan rhinos by 2040. The Javan rhino will be the "Icon" flagship species of the pride of Indonesia, providing benefits to communities and to knowledge/science.

Javan Rhino Population Management Working Group Report

Threats to Javan rhino populations

The group first identified threats to Javan rhino population, which included:

- Lack of population growth
- Disease
- Low reproductive rate
- Inbreeding depression
- Future poaching threat
- Insufficient population management
- Lack of a long-term vision for population management
- Lack of quick action
- Lack of carrying capacity for population
- Risk of natural disaster
- Risk of sea level rise and drought as a result of climate change versus risks that can be mitigated through management
- Competition with Banteng
- Increasing human population around the park (domestic cattle, disease transmission, disturbance, activity = increased stress)
- Insufficient ecological information (population demographics, birth rate/interval, lifespan, density dependent effects)
- Stress
- Food scarcity
- We do not know the root cause of the population abundance problem

Prioritization of Threats

The group then prioritized the most significant threats (number of participant votes in parentheses), resulting in the following ranking:

1. Disease (4)
1. Inbreeding depression (4)
3. Insufficient population management (3)
4. Lack of population growth (2)
5. Poaching threat (1)
5. Increasing human population around the park (1)

Prioritized threat statements

1. Javan rhino population abundance is believed to be at a standstill due to insufficient habitat and population management, inbreeding depression, limited carrying capacity and disease.
2. There is inadequate management capacity to respond to the increased risk to the rhino population (e.g., from disturbance, disease, poaching, habitat degradation, stress) caused by an increasing human population.

3. The ever-present risk of poaching due to the rising demand for rhino horn in Asia is not sufficiently addressed by current protection and conservation management.
4. Global warming and severe environmental conditions (such as rising sea levels, drought, food scarcity), result in additional pressure on the rhino population.

Data Assembly

Following the identification and prioritization of threats, the group characterized each threat by clearly identifying known information (facts), assumptions, and information gaps.

Threat 1: Javan rhino population abundance is believed to be at a standstill due to insufficient habitat and population management, inbreeding depression, limited carrying capacity and disease.

Facts	Assumptions	Information Gaps
Population abundance is stagnant: Population size = 55-58 Previous population size fluctuated	Survey methods accurately depict current population size and trends Habitat and population management has been insufficient to stimulate increased population abundance.	• The cause of the stagnant population abundance trend: are inbreeding depression, limited carrying capacity, and disease impacting population growth?
The population contains breeding rhinos.	Young rhinos are surviving to reproduce.	• Are all rhinos of breeding age actually breeding? • Is there any reproductive pathology among adult females that is reducing their breeding potential?
Rhino deaths have been recorded.	All deaths have been detected and recorded.	• Cause of death • Average longevity in the wild
Demographic information / age structure / sex ratio is known in the wild.	Age class / structure has been correctly defined.	• Inter-birth interval • Age of reproductive maturity • Youngest/oldest breeding age • Social structure / mating relationships • Intra- and interspecific competition

Threat 2: There is inadequate management capacity to respond to the increased risk to the rhino population (e.g., from disturbance, disease, poaching, habitat degradation, stress) caused by an increasing human population.

Facts	Assumptions	Information Gaps
Human population increase in the UKNP buffer zone is higher than the national average.	Human population will continue to increase and, as a result, threats to rhinos and their habitat will also increase.	There is no mapping of encroachment (area, people)
Many people are involved in illegal harvesting of forest products in and around the UKNP.	There is inadequate and ineffective local law enforcement to combat illegal harvesting.	
Domestic cattle grazing exists in the National Park	Domestic cattle carry and transmit diseases to rhinos.	Incidence of disease in cattle, and risk of disease transmission to rhinos.
There is poor local knowledge and awareness of the National Park, as well as a general negative attitude among local people towards the Park.	Community education and awareness-raising about the National Park is limited.	Socio-economic factors defining the local human populations are not well understood.
The local National Park management authorities and the local government are reluctant to address encroachment and resource extraction problems.		
The Special Zone within the National Park is not properly managed.	Proper management of this Zone will alleviate identified problems.	

Threat 3: The ever-present risk of poaching due to the rising demand for rhino horn in Asia is not sufficiently addressed by current protection and conservation management.

Facts	Assumptions	Information Gaps
The rate of rhino poaching has increased globally, but the level of protection in UKNP has not changed to addreess this threat.	The current level of anti-poaching effort is adequate to prevent poaching in the face of increased poaching risk. Currently, there are no rhino poachers in the area of the National Park.	We don't know if the area around the National Park is targeted by organized poaching gangs (an unquantified threat) because there is no intelligence network in place around the Park.
The global demand for rhino horn has increased.	The demand for rhino horn will stay the same or increase in the future.	Is Asian rhino horn really in demand in the markets?
The price of rhino horn has increased.	The price of rhino horn will stay the same or increase in the future.	How will the price of rhino horn affect Javan rhino populations?
Organized crime syndicates focusing on rhino poaching are targeting rhino populations around the world.	UKNP will almost certainly be targeted at some point in the future.	Level of anti-poaching staffing needed to adequately protect Javan rhinos in UKNP.
Any kind of disruption in poaching protection efforts immediately leads to increased levels of poaching and human encroachment (examples of this seen in South Africa, Bukit Berasan Selatan in Sumatra)	Community engagement in wildlife conservation and Park management could help to mitigate the threat of rhino poaching.	Level of interest from local communities in wildlife conservation.

Threat 4: Global warming and severe environmental conditions (such as rising sea levels, drought, food scarcity), result in additional pressure on the rhino population.

[This threat was not addressed in this exercise as the group believed it was outside their manageable interests and scope of expertise.

Identification of Conservation Goals

For each of the problem statements described earlier in this section, the working group participants developed management goals to address these problems. Finally, the group placed these goals in order of priority in terms of their effectiveness in advancing Javan rhino conservation in Indonesia.

1. The Javan rhino population is managed to achieve genetic and demographic viability by increasing population abundance to a total of at least 80 individuals in at least two sites by the year 2025.
2. Local authorities work to maintain zero poaching of Javan rhino through 2025 and beyond.
3. Encroachment, poaching, human disturbance and risk of disease transmission from domestic cattle are reduced by at least 50% by 2025.

Identification of Conservation Actions

Threat 1
Javan rhino population abundance has stagnated due to insufficient habitat and population management, inbreeding depression, limited carrying capacity and disease.

Goal 1
The Javan rhino population is managed to achieve genetic and demographic viability by increasing population abundance to a total of at least 80 individuals in at least two sites by the year 2025.

Action 1: <u>Identify home range and relatedness of individual rhinos in Ujung Kulon via dung collection/genetic analysis/camera-trapping.</u>

Responsible Parties: Coordinator: Director UKNP
Camera-trap: AOM - UKNP
Genetic analysis: Dadan Subrata - YABI .

Timeline: May – Sept 2015, 16 sample collection; Oct - Feb 2015, 16 sample analysis.

Outcome: All individuals in the population have been identified, sex, genetic relatedness and breeding status is understood, and home ranges of each individual mapped .

Collaborators: <u>Genetics</u>
Eijkman - Prof Herawati
LIPI - Dr Zen
University - Dr Dedi Duryadi
Forda - Pujo
<u>Camera - trapping</u>
YABI - Waladi
WWF - Ridwan

Obstacles: 1. No genetic primer available to conduct the DNA analyses.
2. Uncertainty how to select animals for moving to the 2nd population

Important considerations: We should not wait for the genetic information to move animals and establish a 2nd population. Genetic information can be layered in later.

Action 2: Survey and select a second habitat for translocation.

Responsible Parties: YABI as coordinator

Timeline: Survey by November 2015; site selection by April 2016.

Outcome: Suitable habitat identified for establishing a second population.

Collaborators: WWF – Indonesia

Obstacles: Difficulty in finding habitat of sufficient size to support a wild population.

Action 3: Develop a plan for capture and translocation of the animals and obtain government permission.

Responsible Parties: WWF – Indonesia: Anwar Purwoto

Timeline: 1 May 2016.

Outcome: Plan produced and submitted to the Government.

Collaborators: Eijkman - Prof Herawati
LIPI - Dr Zen
University - Dr Dedi Duryadi
Forda - Pujo
YABI – M. Waladi Isnan
WWF - Ridwan

Obstacles:

Important considerations: We should not wait for the genetic information to move animals and establish a 2nd population. Genetic information can be layered in later. Local government in Banten province and districts as well as in the receiving province/district must be receptive to the translocation.

Action 4: Officially demarcate the boundaries of the second habitat site.

Responsible Parties: YABI

Timeline: 1 May 2016.

Outcome: Second habitat boundaries are clearly identified and recognizable.

Collaborators: WWF – Indonesia; IRF

Obstacles:

Important considerations:

Action 5: Establish protection protocol at the second habitat site.

Responsible Parties: YABI: M. Waladi Isnan

Timeline: 1 May 2016.

Outcome: Plan for adequate protection is in place.

Collaborators:

Obstacles:

Important considerations:

Action 6: Capture ten rhinos (at random), choose four for translocation based on analysis of blood samples (not siblings), DNA and fertility assessment; ear tag/collar the remaining six and release.

Responsible Parties: Trained capture / veterinary team.

Timeline: 2017.

Outcome: Four rhinos translocated to second site. Health / reproductive evaluations conducted on ten animals, six identified animals to remain in UKNP.

Collaborators: YABI; IPB; IRF; WWF-Indonesia; ALERT; UKNP; Local veterinary bureau; Cincinnati Zoo

Obstacles: There is little institutional knowledge remaining in Indonesia for rhino capture. No experienced capture team is in place at present; it would be useful for capture training to take place elsewhere, with trusted advisors who possibly could assist the capture in UKNP, well in advance of the capture. Experienced and trained veterinary, reproductive, and husbandry personnel are critical to the success of the capture and translocation. There is currently no funding for capture and translocation.

Important considerations: There is no room for error with this first translocation. Every precaution must be taken and every problem anticipated to ensure the translocation's success.

Action 7: Carry out the translocation of animals to the second site.

Responsible Parties: WWF: Anwar Purwoto

Timeline: 2017.

Outcome: New population of Javan rhinos is established.

Collaborators: YABI; IPB; IRF; WWF; UKNP; Local veterinary bureau; Cincinnati Zoo

Obstacles: Adequate monitoring of the population.

Action 8: Set up and agreed methodology and monitor the released animals using GPS collars and/or other devices.

Responsible Parties: YABI.

Timeline: 2017 – 2025.

Outcome: Standardized monitoring methods in place and documenting the outcome of the translocation.

Collaborators:

Obstacles: Finding appropriate devices that will function well in a rainforest environment with no detrimental effects on rhinos.

Important considerations: There is no room for error with this first translocation. Every precaution must be taken and every problem anticipated to ensure that animals are monitored 24 hours per day, seven days per week, to document the translocation's success.

Action 9: Habituate released animals to regular handling for veterinary examinations, including reproductive assessments.

Responsible Parties: Cincinnati Zoo – Dr. Monica Stoops and Dr. Terri Roth; Translocation site staff.

Timeline: 2017.

Outcome: Translocated animals can be monitored for health and reproduction. This facilitates regular evaluation of how animals are doing in their new environment.

Collaborators:

Obstacles: New habitat may not be conducive to training for health evaluation.

Important considerations: The ability to evaluate the health and well-being of translocated animals is an important tool to facilitate future efforts of this kind.

Action 10: Continued population monitoring.

Responsible Parties: UKNP – designated staff

Timeline: Annually.

Outcome: Understanding of dispersal, health, reproduction, etc. of translocated population.

Collaborators: WWF- Indonesia

Obstacles:

Important considerations: Adequate, multi-faceted monitoring methods need to be in place, including collars or other means, and also good camera trap coverage and fecal DNA monitoring (e.g. for female hormone cycles).

Threat 2
There is inadequate management capacity to respond to the increased risk to the rhino population (e.g., disturbance, disease, poaching, habitat degradation, stress) caused by an increasing human population.

Goal 1
Encroachment, poaching, human disturbance and risk of disease transmission from domestic cattle are reduced by at least 50% by 2025.

Action 1: Maintain activity of Rhino Protection Units (RPUs).

Responsible Parties: YABI.

Timeline: Begin 1 August 2017, then ongoing

Outcome: Zero poaching maintained within UKNP as reflected by the number of days patrolled and patrol coverage by RPUs.

Collaborators: UKNP; IRF; WWF-Indonesia

Obstacles: Securing long-term funding for RPU activities.

Important considerations: Protection audit and security assessment will determine strategies for dealing with encroachment and other threats.

Action 2: Map and monitor encroachment by local human populations.

Responsible Parties: YABI – RPUs RPUs,

Timeline: Ongoing.

Outcome: Regular maps and quarterly reports. Human encroachment into UKNP understood.

Collaborators:

Obstacles:

Important considerations: Protection audit and security assessment will determine strategies for dealing with encroachment and other threats.

Action 3: Conduct conservation education activities targeting a variety of audiences, primarily in local communities.

Responsible Parties: YABI

Timeline: As funding is available; planned to begin in 2016.

Outcome: Local communities understand Javan rhino conservation activities. Javan rhino constituency built in local communities.

Collaborators: WWF-Indonesia

Obstacles: Sustainable funding for education activities. Conducting education activities takes RPU time away from anti-poaching patrolling.

Important considerations: Need to engage professional educators to conduct environmental / conservation education. Also need to properly document impact of conservation education activities for donors.

Action 4: Activate Rhino Health Unit to continue disease surveillance and mitigation.

Responsible Parties: UKNP authority (Fire)

Timeline: Ongoing

Outcome: Annual report on disease surveillance will allow understanding of disease dynamics in the population (if present).

Collaborators:

Obstacles: Sustainable funding for health monitoring.

Important considerations:

Action 6: Develop guidelines for management of the Special Zone and submit to UKNP.

Responsible Parties: UKNP – M. Haryono

Timeline: By 31 December 2015

Outcome:

Collaborators:

Obstacles:

Threat 3
The ever-present risk of poaching due to the rising demand for rhino horn in Asia is not sufficiently addressed by current protection and conservation management.

Goal 1
Local authorities work to maintain zero poaching of Javan rhino through 2025 and in perpetuity.

Action 1: Law enforcement expert to undertake a protection audit and security assessment to develop a comprehensive protection plan for UKNP and the second habitat site.

Responsible Parties: Coordinators: IRF-Susie Ellis / WWF-US-Barney Long
Local coordinator: YABI-Widodo Ramono, M. Waladi Isnan

Timeline: Contract: 1 January 2016
Assessment: May-Sept 16
Results: 31 Dec 2016

Outcome: Zero poaching maintained within UKNP. Also, the number of days patrolled and patrol coverage by RPUs.

Collaborators: UKNP; WCS; Local government; WPS; SOS-Rhino

Obstacles: Securing long-term funding to expand RPU activities, especially to second site.

Important considerations: Protection audit and security assessment will determine strategies for dealing with encroachment and other threats.

Action 2: Increase the number and intensity of patrols in Ujung Kulon National Park.

Responsible Parties: YABI – M. Waladi Isnan

Timeline: Beginning January 2016 and ongoing

Outcome: All Javan rhino areas are adequately protected.

Collaborators: UKNP; IRF; WWF-Indonesia

Obstacles: Securing long-term funding to expand RPU activities, including to second site.

Important considerations: Including marine patrols to protect incursions by water.

This and the following actions are ideas of what might be required; while we shouldn't wait for the plan to improve law enforcement efforts, the below may differ depending on assessment outcome.

Action 3: Hire, train, and institute anti-poaching patrols at the second habitat site.

Responsible Parties: YABI, WWF-Indonesia

Timeline: 2017

Outcome: Adequate protection in place at second habitat site.

Collaborators:

Obstacles: Securing long-term funding to expand RPU activities to second site.

Important considerations: Animals cannot be moved to a second site until a sufficient, well-functioning protection system is in place.

Action 4: Increase the number of staff in resorts (to at least 64, from 40) in Ujung Kulon National Park.

Responsible Parties: UKNP Authority

Timeline: As soon as possible and ongoing

Outcome: Adequate joint patrols (RPUs and UKNP guards) in place to continue zero poaching of Javan rhinos and to prevent other illegal activities, e.g., bird collection and illegal fishing

Collaborators:

Obstacles:

Important considerations: Sustainable funding from the Government of Indonesia is needed for increased staffing in UKNP.

Action 5: Use SMART tools to monitor law enforcement efforts.

Responsible Parties: YABI – M. Waladi Isnan / W. Ramono

Timeline: As funding becomes available; ideally 2016-2017

Outcome: UKNP, including the Javan Rhino Study and Conservation Area (JRSCA) and coastline are adequately protected, enabling continued zero rhino poaching.

Collaborators: UKNO; IRF

Obstacles: Sustainable funding for expanded RPU staffing.

Important considerations: Many perpetrators of illegal activities access the park through the coastline. Establishing establish marine patrols to protect coastal access is important.

Action 6: Establish an informant network to support intelligence-led enforcement.

Responsible Parties: YABI – M. Waladi Isnan / W. Ramono

Timeline: 2016, pending funding

Outcome: Information system utilizing local informants will help to decrease poaching incidents (non-rhino) in park.

Collaborators: UKNP; IRF

Obstacles: Sustainable funding for intelligence unit.

Important considerations:

Action 7: Build capacity and provide capacity continued education of protection staff (RPUs, Park, police, and collaborative agencies).

Responsible Parties: YABI – M. Waladi Isnan
Timeline: 20167 and ongoing, pending funding
Outcome:
Collaborators:
Obstacles: Funding for continued education for RPU, park staff, and collaborators.
Important considerations:

Javan Rhino Habitat Management Working Group Report

Threats to Javan rhino habitat

The group first identified threats to Javan rhino habitat, which included:

- **Climate change -** Changes in precipitation, temperature changes, and unpredictable seasons due to climate change impact upon the forest ecosystem. The impact of climate change can already been seen in Ujung Kulon. It affects the movement of rhinos, the availability of wallows and food which results in rhino mortality. In addition sea-level rises due to climate change could also reduce rhino habitat and threaten the survival of the species.

- **Natural disasters -** Ujung Kukon National Park is located south of Anak Krakatoa. This volcano is still active. Given its proximity to Anak Krakatoa, the Javan rhino population is at risk from a number of catastrophic events, including volcanic activity, and resultant tsunamis. This, combined with its small population size and single site distribution, makes the Javan rhino population extremely vulnerable to the risk of extinction.

- ***Arenga* Palm invasion** – the suitability of the habitat in Ujung Kulon for Javan rhinos is deteriorating because of the spread of the invasive and dominant *Arenga* palm (*Arenga obtusifolia*). It is thought that the fertility of the soil improved following Krakatau's eruption; this may have led to the rapid growth of *Arenga* palm in the area. Due to its fast growing nature, *Arenga* palm now dominates other plant species that provide vital food sources for the rhino. National regulations currently prohibit the removal of *Arenga* palm in the core zone of UKNP.

- **Limited habitat availability** – The population is believed to have reached its maximum level in the current habitat and probably cannot grow any larger without intervention. The optimum population that can be supported by the habitat is still unknown.

- **Competition with Javan banteng -** The existence of the endangered Javan banteng (*Bos javanicus*) within Ujung Kulon reduces the availability of space and food for rhino. Lack of banteng population estimates means it is difficult to quantify the level of competition between the two species.

- **Forest succession** – Forest succession leads to tree growth which creates a dense forest canopy that reduces light to the forest floor, and limits the growth of secondary forest and the availability of rhino food.

- **Habitat encroachment -** Human encroachment will reduce the size of the habitat which will negatively impact the carrying capacity of the park. In addition, other illegal activities negatively impact the habitat.

The group then identified and prioritized the three top threats to Javan rhino habitat:

1. **Limited habitat availability**
2. **Arenga palm invasion**
3. **Competition with Javan banteng**

Data Assembly

Following the identification and prioritization of threats, the group characterized each threat by clearly identifying known information (facts), assumptions, and information gaps.

Threat 1: Limited habitat availability – The population is believed to have reached its maximum level in the current habitat and probably cannot grow any larger without intervention. The habitat carrying capacity for UKNP is still unknown.

Facts	Assumptions	Information Gaps
• Population abundance has remained relatively unchanged. • Rhino occupancy data indicate that not all of the National Park is used by Javan rhino.	• The carrying capacity of the park has been reached. • The rhino habitat in Ujung Kulon is limited. Not all the habitat is suitable for rhinos because of food/water availability etc	• No comprehensive data to estimate the carrying capacity of the park.

Threat 2: *Arenga* Palm invasion – the suitability of the habitat in Ujung Kulon for Javan rhinos is deteriorating because of the spread of the invasive and dominant *Arenga* palm (*Arenga obtusifolia*). It is thought that the fertility of the soil improved following Krakatau's eruption; this may have led to the rapid growth of *Arenga* palm in the area. Due to its fast growing nature, *Arenga* palm now dominates other plant species that provide vital food sources for the rhino. National regulations currently prohibit the removal of *Arenga* palm in the core zone of UKNP.

Facts	Assumptions	Information Gaps
• Over 60% of the peninsula of UKNP is dominated by *Arenga* palm. • *Arenga* palm suppresses the growth of rhino food. • There is some research on *Arenga* palm eradication.	• The distribution of *Arenga* palm has significantly increased year by year. • Reduced food availability due to *Arenga* palm limits population growth.	• Lack of data and information on *Arenga* palm density and distribution time-series • Lack of regulation for controlling *Arenga* palm in core zone area.

Threat 3: Competition with Javan banteng - The existence of the endangered Javan banteng (*Bos javanicus*) within Ujung Kulon reduces the availability of space and food for rhino. Lack of banteng population estimates means it is difficult to quantify the level of competition between the two species.

Facts	Assumptions	Information Gaps
• There is research on competition between banteng and rhino using space and food. • There is some research on banteng populations. In 1997, 800 individuals were recorded. In 2002, there was less than 100 using the concentration count method. In 2013, the number is 124 with a similar method. • There is less grazing areas for banteng. • The population of banteng is increasing at a faster rate than rhino.	• The feeding behaviour of banteng is changing, moving from grassland to more forested areas	• There is comprehensive data series on banteng population using a consistent method • There is a lack of comprehensive research on competition between banteng and rhino.

Identification of Conservation Goals

For each of the problem statements described earlier in this section, the working group participants developed management goals to address these problems. Finally, the group placed these goals in order of priority in terms of their effectiveness in advancing Javan rhino conservation in Indonesia.

1. The habitat quality of Javan rhino is improved in Ujung Kulon National Park, and additional habitat in a second site is identified and managed to accommodate growth of the Javan rhino population to at least 80 individuals by 2025.
2. By 2025, there is improved understanding and management of ecological factors limiting Javan rhino population growth.
3. Regulations are revised on habitat management in the core zone of Ujung Kulon National Park to control the spread of *Arenga* palm. By 2025, 10,000 hectares of *Arenga* palm are removed to expand the suitable habitat available to Javan rhino and to increase the Park’s carrying capacity.

Identification of Conservation Actions

Threat 1
Limited habitat availability – The population is believed to have reached its maximum level in the current habitat and probably cannot grow any larger without intervention. The habitat carrying capacity for UKNP is still unknown.

Goal 1
The habitat quality of Javan rhino is improved in Ujung Kulon National Park, and additional habitat in a second site is identified and managed to accommodate growth of the Javan rhino population to at least 80 individuals by 2025.

Action 1: Collect baseline data on habitat conditions and rhino ecology in UKNP and identify priority areas for enrichment.

Responsible Parties: UKNP-Daryan and WWF-Indonesia-Yuyun.

Timeline: 2016.

Outcome: Habitat baseline data are available to support management decisions.

Collaborators: Local communities / YABI

Obstacles:

Action 2: Enrich habitat within Ujung Kulon National Park by improving the availability of wallows, food, water, minerals, etc.

Responsible Parties: UKNP-Daryan and WWF-Indonesia-Yuyun.

Timeline: 2017.

Outcome: Improved rhino occupancy rates in enriched areas.

Collaborators: Local communities; YABI; UKNP

Obstacles: Funding for habitat improvement.

Important considerations: Inclusion of local communities is important, but must be done in a way that does not disturb the rhinos nor lead to an increased potential for poaching.

Action 3: Conduct second habitat assessments for potential translocation sites, using a multidisciplinary team in promising areas (Cikepuh, Cikeusik, Cikamurang).

Responsible Parties: WWF-Indonesia-Yuyun; IRF-Inov

Timeline: 2015/2016.

Outcome: Field assessment studies of promising sites in Cikepuh, Cikeusik, Cikamurang.

Collaborators: UKNP; WWF; IRF; YABI; IPB; UNTIRTA; local government and communities both in Banten province and at similar translocation sites

Obstacles: Areas surveyed may not be of sufficient size to support a wild rhino population. Additionally, political support from local government/local communities may be a challenge. Finally, two priority second habitat sites are not formally gazette as protected area

Important considerations: Are we aiming for a wild population or one that is in a sanctuary-type setting? This will be an important consideration when choosing a site.

Action 4: Conduct second habitat assessments by a multidisciplinary team in three additional sites (Way Kambas, Harapan Forest, Bukit Barisan Selatan and others to be determined).

Responsible Parties: WWF-Indonesia-Yuyun; YABI/IRF-Sectionov

Timeline: 2016.

Outcome: Field assessment studies of Way Kambas, Harapan Forest, Bukit Barisan Selatan and others TBD (must be within the species' historic range). Evaluation report with site comparisions.

Collaborators: IRF, YABI, IPB, UNTIRTA, local government and communities both in Banten province and at similar translocation sites

Obstacles: Endorsement from Director General for site not in Java. Political support from local government/local communities.

Important considerations: We do not want to translocate Javan rhinos to a site where they might compete with Sumatran rhinos. If no site is large enough to accommodate a wild population of Javan rhinos, and the conclusion is to set up a captive population, perhaps expanding the Sumatran Rhino Sanctuary to accommodate Javan rhinos is a cost-effective solution since expertise and infrastructure are already there. Alternatively an SRS-like facility could be constructed for Javan rhinos.

Action 5: Identify and implement habitat improvement measures in second habitat to improve suitability for Javan rhinos.

Responsible Parties: WWF-Indonesia-Yuyun; YABI/IRF-Sectionov; Dr. Rahmat

Timeline: 2018.

Outcome: Habitat management plan for the second habitat of Javan rhino.

Collaborators: IPB, UNTIRTA, Local government & local communities near translocation site

Obstacles: Assessment reports may identify only initial improvements to be required.

Important considerations: Are we aiming for a wild population or one that is in a sanctuary-type setting? This will be an important consideration when choosing a site and identifying its habitat improvement needs.

Goal 2
By 2025, there is improved understanding and management of ecological factors limiting Javan rhino population growth.

Action 1: Analyse existing camera and video trap data on the interaction between rhino and other wildlife species as a potential competitor for resources.

Responsible Parties: UKNP-Aom, WWF-Indonesia-Rois

Timeline: 2015.

Outcome: Report on relationship patterns between Javan rhinos and other wildlife species to support park management decisions.

Collaborators: YABI; IRF

Obstacles: Availability of data to allow analysis.

Action 2: Research to analyse information gaps on the interaction between wildlife species (competition/disease) to inform future management plans.

Responsible Parties: UKNP, FORDA
Timeline: 2016.
Outcome: Research plan developed, based on information gaps.
Collaborators: IPB; YABI; WWF; IRF
Obstacles: Not all data on wildlife competition and/or disease are published or available.

Threat 2
***Arenga* palm invasion** – the suitability of the habitat in Ujung Kulon for Javan rhinos is deteriorating because of the spread of the invasive and dominant *Arenga* palm (*Arenga obtusifolia*). It is thought that the fertility of the soil improved following Krakatau's eruption; this may have led to the rapid growth of *Arenga* palm in the area. Due to its fast growing nature, *Arenga* palm now dominates other plant species that provide vital food sources for the rhino. National regulations currently prohibit the removal of *Arenga* palm in the core zone of UKNP.

Goal 1
Regulations are revised on habitat management in the core zone of Ujung Kulon National Park to control the spread of *Arenga* palm. By 2025, 10,000 hectares of *Arenga* palm are removed to expand the suitable habitat available to Javan rhino and to increase the Park's carrying capacity.

Action 1: Complete a legal review of the national regulations to allow the control of *Arenga* palm in the core zone of Ujung Kulon.

Responsible Parties: WWF

Timeline: 2015.

Outcome: Legal review document to inform the Ministry of Environment and Forestry decision concerning removal of *Arenga* zone within UKNP.

Collaborators:

Obstacles:

Action 2: Obtain agreement on the methodology for controlling *Arenga* palm, following a workshop between stakeholders. Share the results with the Directorate General, Ministry of Environment and Forestry, and lobby for a decree allowing *Arenga* removal throughout the park using agreed-upon methods.

Responsible Parties: UKNP-Haryono, IPB-Haryanto

Timeline: 2015.

Outcome: Agreement between stakeholders on the methodology for controlling *Arenga* palm. Additionally, an official decree from the Directorate General, Ministry of Environment and Forestry.

Collaborators: YABI; IRF; FORDA

Obstacles:

Action 3: Lobby the Directorate General, Ministry of Environment and Forestry to issue a decree to allow habitat management actions to take place throughout UKNP.

Responsible Parties: UKNP-Haryono, WWF-Indonesia-A. Purwoto

Timeline: 2015.

Outcome: Decree issued by Ministry of Environment and Forestry allowing habitat management throughout UKNP.

Collaborators: YABI; IRF; FORDA

Obstacles: Securing political support may be difficult, but it is critical.

Action 4: Map the distribution and population density of *Arenga* palm in UKNP.

Responsible Parties: WWF-Indonesia-Rois

Timeline: Ongoing – complete by end of 2015.

Outcome: Map of *Arenga* palm distribution and density. Design of *Arenga* palm control plan.

Collaborators:

Obstacles:

Action 5: Develop a strategy for *Arenga* palm control to include:

- Identification of priority areas for control
- How many hectares need to be controlled per annum
- Frequency of maintenance
- Engagement with local communities on the importance of *Arenga* palm control

Responsible Parties: UKNP-Daryan, WWF-Indonesia-Rois

Timeline: 2016.

Outcome: Arenga palm control implementation plan is designed.

Collaborators: Local communities; YABI

Obstacles:

Action 6: Implement the *Arenga* Palm Management Strategy.

Responsible Parties: UKNP

Timeline: 2017.

Outcome: Carrying capacity of UKNP is increased. *Arenga* palm is controlled within the park (amount to be determined by Strategy).

Collaborators: YABI; local communities

Obstacles: Weather, resources.

Action 7: Monitoring and maintenance of the *Arenga* palm removal program.

Responsible Parties: UKNP

Timeline: 2017 – ongoing.

Outcome: Carrying capacity of UKNP is maintained.

Collaborators: YABI; WW; local communities

Obstacles: Weather, resources.

Javan Rhino Population Viability Analysis Report

Working Group members:
Caroline Lees
With assistance from:
Widodo Ramono (YABI)
Philip Miller (CBSG)
Barney Long (WWF)
Susie Ellis (IRF)
And workshop participants

Working Group Summary

- *Vortex* population simulation models were built to inform a Javan Rhino conservation planning workshop, using the following baseline data.
  - Javan rhinos persist as a single population of 58-61 individuals, within Ujung Kulon National Park (UKNP) in Banten Province, West Java. Census data suggest that the population has been oscillating around its current size for some time.
  - It is assumed that the current carrying capacity of the park has been reached.
  - The Javan rhino population at UKNP is potentially threatened by: encroachment of *Arenga* palm reducing available habitat; diseases transmitted by cattle (Javan banteng and domestic cattle that graze in the park) such as anthrax and brucellosis; environmental catastrophes; inbreeding depression and the possibility of resumed poaching.
- At the rates modelled all of these threats put downward pressure on the population but none resulted in extinction except for poaching.
- To improve population resilience to all threats the population needs to grow. Two options for this were considered: (1) increasing carrying capacity at UKNP and (2) establishing a second population elsewhere by translocating rhinos from UKNP.
- Models indicate that in absence of other threats, the UKNP population would be likely to recover from a harvest of 12 individuals, though a precautionary approach would see fewer removed initially and the results monitored carefully before any additional harvest. Understanding more about the number of actively breeding females at the UKNP site would help refine model estimates.
- Models also indicate that in the absence of external threats, five females and three males should be sufficient to found a new population provided that supplementation downstream from UKNP remains possible. Any second site where a wild population would be established would ideally be large enough to support at least 50 rhinos to provide for long-term stability.
- Modelled translocation strategies should be revisited once more details have been agreed with regard to the logistics, health/injury and behavioural challenges, of capturing, translocating and integrating rhinos into a second site.
- Once two sites are established, strategic exchanges of animals would be expected to benefit gene diversity within each sub-population and to slow inbreeding accumulation.

There is much uncertainty concerning the biology of Javan rhinos and the environmental pressures at Ujung Kulon National Park; model parameters were based on recent and past survey data, estimates used in previous population viability analyses and the views of experts present during the workshop. Model outputs should be reviewed as more information becomes available.

Introduction

There remains uncertainty around the biology of Javan rhinos and the impact of environmental and human-mediated threats on the population. However, to prevent further decline of the species, management decisions need to be made urgently and in the context of this uncertainty. Computer simulation models, though not expected to be an accurate depiction of wild rhino populations, can inform decisions by: identifying key aspects of life history that correlate with performance; clarifying the relative impact of different threats; and comparing the likely performance of alternative management strategies.

Computer modelling is a valuable and versatile tool for quantitatively assessing risk of decline and extinction of wildlife populations, both free ranging and managed. Complex and interacting factors that influence population persistence and health can be explored, including natural and anthropogenic causes. Models can also be used to evaluate the effects of alternative management strategies to identify the most effective conservation actions for a population or species and to identify research needs. Such an evaluation of population persistence under current and varying conditions is commonly referred to as a population viability analysis (PVA).

The software used in these analyses is the simulation program *Vortex* (v10.0.7.9) (Lacy & Pollack, 2014). *Vortex* is a Monte Carlo simulation of the effects of deterministic forces as well as demographic, environmental, and genetic stochastic events, on small wild or captive populations. *Vortex* models population dynamics as discrete, sequential events that occur according to defined probabilities. The program begins by either creating individuals to form the starting population, or by importing individuals from a studbook database. It then steps through life cycle events (e.g., births, deaths, dispersal, catastrophic events), for each individual and typically on an annual basis. Events such as breeding success, litter size, sex at birth, and survival are determined based upon designated probabilities that incorporate both demographic stochasticity and annual environmental variation. Consequently, each run (iteration) of the model gives a different result. By running the model hundreds of times, it is possible to examine the probable outcome and range of possibilities. For a more detailed explanation of *Vortex* and its use in population viability analysis, see Lacy (1993, 2000) and Lacy et al. (2015).

Baseline Models

Few species-specific data were available to inform the development of models for Javan rhinos; therefore, baseline model parameters were initially based on:

- limited data from previous population viability analyses;
- real data on other rhino species, mainly from captive populations of Asian one-horned rhinoceros, *Rhinoceros unicornis*.

In addition, the following revisions were made during the workshop, based on expert judgment.

- Participants at the meeting considered the current population (58-61 individuals) to have reached the carrying capacity of the environment. This represents a reduction in previously estimated carrying capacity from 70 to 60 individuals.
- Model mortality was reduced from 6% to 4% in the adult age-classes to align more closely with the rate of observed adult deaths in Ujung Kulon (though this may also be influenced by the difficulty of locating carcases).
- Initial population size was increased from 56 to 58 (to reflect the lower end of the 2014 estimate).
- Average kinship in the population was set to an initial vale of 0.0255 (the average in modelled populations run from 1970, for 45 years, beginning with 30 unrelated founders)

Further information about model input parameters is provided in Appendix 1.

Deterministic characteristics

In the absence of probabilistic effects (stochastic fluctuations in demographic rates and environmental impacts; inbreeding depression; limitations on mates) the baseline model grows at approximately 4% each year (see Table 1.) and the generation time (average age at breeding) is approximately 16.5 years. The stable age-structure that emerges from the vital rates modelled is illustrated in Figure 1.

Characteristic	Value
r (instantaneous growth rate)	0.0408
λ (lambda – annual growth rate)	1.0416
Ro (growth per generation)	1.9952
T (generation time in years)	16.525

Table 1. Deterministic characteristics of the baseline model for Javan rhinos.

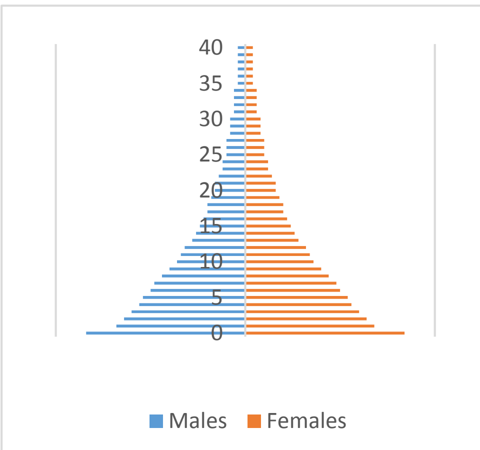

Figure 1. Illustration of stable age-structure for the vital rates specified in the baseline Javan rhino model.

Stochastic characteristics

The inclusion of probabilistic effects (stochastic fluctuations in demographic rates and environmental impacts; inbreeding depression; limitations on mates) reduces instantaneous growth in the models from r=0.041 to r=0.035.

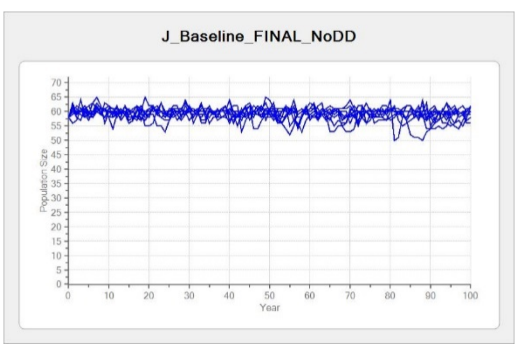

Figure 2. Performance of the baseline model with stochastic effects included.

Model validation

The models were run retrospectively, from a 1970 starting point, at which time the population is thought to have numbered around 30 individuals. Model behaviour was compared to available field estimates of the actual population over the same period. To take account of participants' current working hypothesis, that the Ujung Kulon population has reached carrying capacity, the models used in this analysis were modified from the baseline to include a density dependent relationship between carrying capacity (estimated at K=60) and breeding rate (set at 16% at high density and at 33% at low density). The results of the comparison are depicted in Figure 3. It should be noted that survey methods at Ujung Kulon have changed over time and the older survey estimates are considered less reliable than more recent estimates (Widodo Ramono, pers. comm). Despite this, and though the models are not expected to provide either accurate or precise estimates of wild population behaviour, the analysis supports their further (though cautious) use as a reasonable working representation of Javan rhino population dynamics at the Ujung Kulon site.

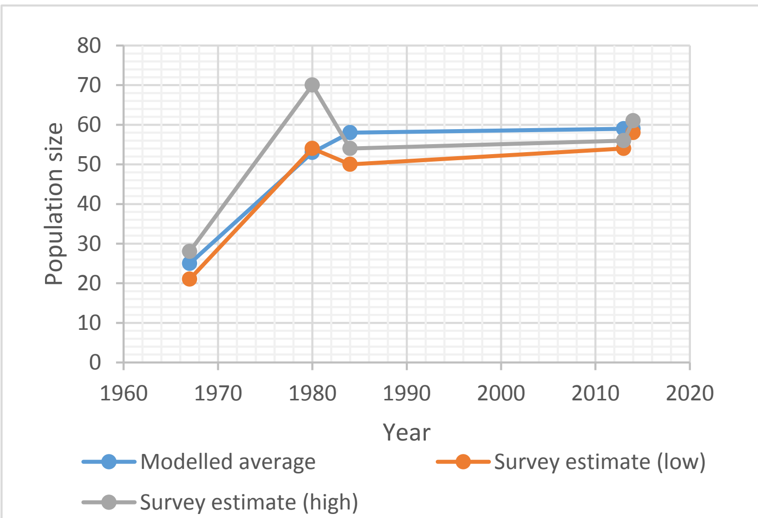

Figure 3. Comparison of retrospective model projections with estimated numbers from field surveys.

Date	Model	Est-low	Est-high	Source
1967	25	21	28	Schenkel
1980	53	54	70	PHPA; Amann
1984	58	50	54	Sadjudin
2013	59	54	56	Pre-PHVA est.
2014	59	58	61	YABI 2015

Sensitivity testing

With so few species-specific data there remains much uncertainty around the values used in the models. Some model parameters are more influential than others in shaping population performance and understanding which these are can help us to determine priorities for future action, for research and for monitoring. *Vortex* can help by providing a simple and quick way to test the sensitivity of the baseline models to uncertainty in each individual parameter.

One parameter at a time was selected in the baseline model (e.g. age at first breeding, inter-birth interval, sex-ratio etc.) and was varied across a plausible range of values, keeping all other parameters constant. The size of the impact of this variation on key performance indicators was recorded and compared to that of other parameters. The values tested are shown in Table 2 and the main results illustrated in Figure 4.

Across the range of values considered, shifts in adult mortality rate had the largest impact on growth rate, closely followed by female annual breeding rate. Inbreeding and carrying capacity also show an effect but this is milder across the range of values considered.

Table 2. Values used to test the sensitivity of the models to parameters uncertainty

Parameter	Values tested
Female breeding rate (%)	25, **33,** 40
First year mortality rate (%)	10, **15,** 20
Adult mortality rate (%)	**2, 4,** 6, 8
Inbreeding depression (Lethal equivalents per genome)	3.14, **6.29,** 9.00
Carrying capacity (Maximum number of individuals able to be maintained)	40, 50, **60,** 70, 80

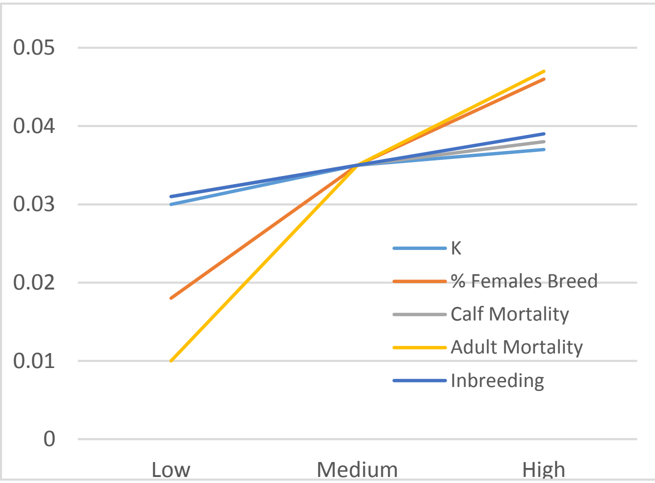

Figure 4. Illustration of the potential impact of parameter uncertainty on growth rate estimation, for four key model parameters.

Threat-based scenarios

The following section explores the likely resilience of a population conforming roughly to the density dependent model described, to a range of potential additional risks: *Arenga* palm encroachment on available habitat; banteng-mediated disease; environmental catastrophe; and poaching. Each risk is explored in isolation and then in combination with others.

Arenga palm

The encroachment of *Arenga* palm reduces habitat quality for Javan rhinos. To give an indication of the potential threat that this could pose to rhino population viability at UKNP, *Arenga* palm encroachment was modelled as a reduction in carrying capacity over the next 20 years, of 1% and 2% per year, from a starting point of K=70.

The modelled risk of extinction remained low across both encroachment scenarios (P(Ex) at 100 years < 0.01) suggesting that the population could withstand a threat of this magnitude. However, average population size over time is reduced from that of the baseline and average growth rate is negative, potentially increasing vulnerability to threats not considered here. [*Note that the mechanism through which* Arenga *palm interacts with rhinos is likely to be more complex than that modelled here and more information on the impact of its removal in recently cleared areas should help clarify this*].

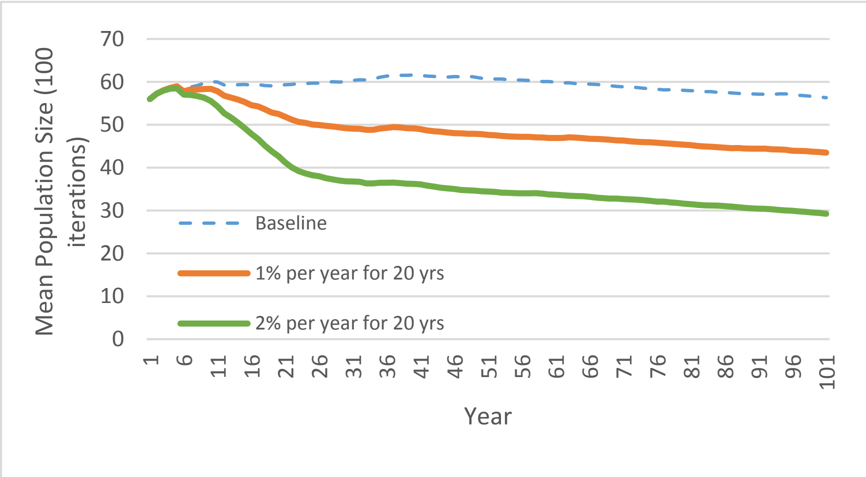

Figure 5. Modelled impact of *Arenga* palm encroachment in Ujung Kulon.

Table 3. Summary statistics for models exploring the impact of further *Arenga* palm encroachment at Ujung Kulon

***Arenga* palm encroachment**	**Stoch-r**	**P(Ex)@100yrs**	**N-all @100 yrs**	**GD @ 100yrs**
Baseline	0.001	0.000	56.31	0.9044
Arenga: 1% per year, 20 yrs	-0.001	0.001	43.50	0.8858
Arenga: 2% per year, 20 yrs	-0.004	0.009	29.26	0.8457

Disease

The baseline models include a level of mortality, some unspecified proportion of which would be expected to be attributable to “normal” low-level disease in the population. However, the models do not include “disease outbreaks”; occasional disease events that result in mortality rates outside the “normal” range.

Javan banteng (*Bos javanicus*) are known to be present in significant numbers in UKNP. Direct competition with rhinos may operate but this remains uncertain. However, several disease agents are known to be transmissible between bovids and rhinos and two of these (anthrax and bovine tuberculosis) are potentially fatal. A number of recorded deaths of Javan rhinos in 1981-1982 were attributed to anthrax (Ramsay and Zainuddin 1993) and this was used as the basis for exploring additional disease-related risks.

The 1981-82 Anthrax outbreak resulted in five deaths; approximately 10% of the rhino population at that time. Assuming that this has been the only outbreak in the past 50 years, and in the absence of further information, this was ascribed a 2% probability of occurrence, with no impact on reproduction and a 10% reduction in survival. The results of including this in the baseline model are shown in Figure 6.

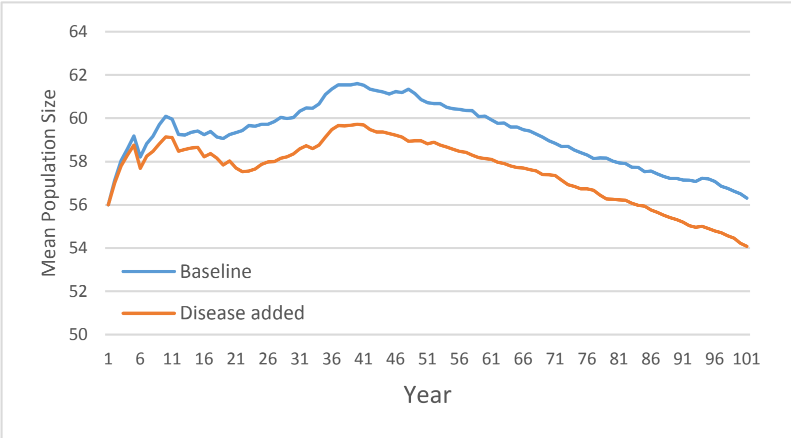

Figure 6. Modelled impact of a hypothetical cattle-mediated disease causing periodic outbreaks.

In this hypothetical disease scenario likelihood of extinction remains zero, suggesting that the population could weather a risk of this frequency and magnitude. However, as illustrated, this kind of event could depress average population size.

Environmental catastrophes

Participants registered concern about the potential impact of an environmental catastrophe on the population of rhinos at UKNP, such as a tsunami or earthquake. The park is low-lying and vulnerable to inundation. The likely impact of these potential catastrophes on the resident rhino population was not discussed in detail. However, for illustration, a generic environmental catastrophe was added to the models. In absence of Ujung Kulon-specific data, the parameters included were based on a rule of thumb proposed by Reed *et al*. (2003) generated from a study of 100 vertebrate species. The study found that species will occasionally undergo severe die-offs (i.e. loss of at least 50% of individuals) with a frequency that relates to their generation length. The risk measured is approximately 15% per generation, which for Javan rhinos in this case was interpreted as a roughly 1 in 100 year chance of a 50% die-off in the population. The results of this are illustrated in Figure 7. Risk of extinction was 3.6% in this scenario (that is, 3-4 populations out of every 100 went extinct over the 100 year period when a catastrophe of this magnitude was included) and average growth shifted from positive (r= 0.0408) to slightly negative (r=-0.003). Once again the models suggested that the population could cope with a risk of this frequency and magnitude.

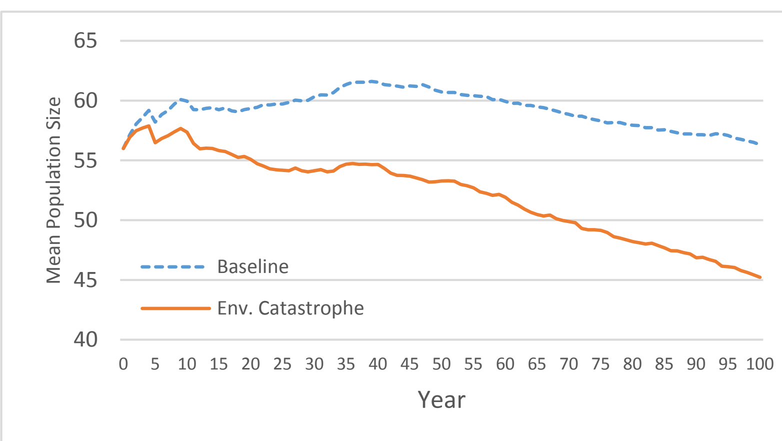

Figure 7. Modelled impact of a hypothetical environmental catastrophe (1 in 100-year chance of occurrence, resulting in 50% mortality).

Poaching

Though the UKNP population has been protected from poaching for many years, poaching remains a potential threat to wild rhino populations everywhere. Models were constructed to explore the potential resilience of the UKNP population to low levels of poaching. Following the approach taken for the 1989 PVA models (Seal and Foose 1989) poaching was treated as frequency-dependent; that is, the rate of poaching was assumed to increase with increasing population size. The 1989 PHVA records 15 animals killed over a 10 year period. Over the period considered this was roughly 2-3% of the population each year. Poaching rates of 2 and 3% per year were modelled from year 1. The results are illustrated in Figure 8.

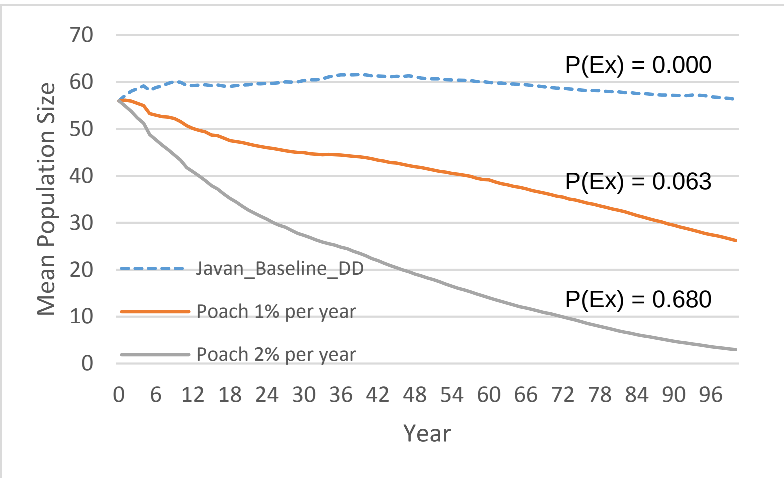

Figure 8. Modelled impact of historic poaching levels on the current population.

The impact of this level of extraction is not sustainable over the long-term at current population size. Average growth rates are negative (r= -0.010 at 1% and r= -0.031 at 2%) and 100-year extinction risks are elevated, especially at the 2% rate (P(Ex) at 100 years = 0.063 at 1% and 0.680 at 2%).

Combined risks

So far each of the threats has been considered in isolation. A series of scenarios were also run to explore the impact of multiple threats operating on the population; threats are added one at a time to the baseline and the results tracked. In these scenarios each threat is included at the more conservative end of the range of values considered, as follows:

1. *Arenga* palm encroachment (at 1% per year, for 20 years).
2. Disease risk (once every 50 years causing 10% mortality)
3. Environmental catastrophe (once every 100 years causing 50% mortality)
4. Poaching (1% harvested per year)

As illustrated in Figure 9, the modelled populations are sent into decline (negative growth) over the 100 year period in all cases. Extinction risk over the 100-year period is low in the presence of only *Arenga* palm and disease (P(Ex)=0.001), but increases where an occasional catastrophe is included to P(Ex)=0.062 and again to P(Ex)=0.354 with the addition of 1% poaching per year.

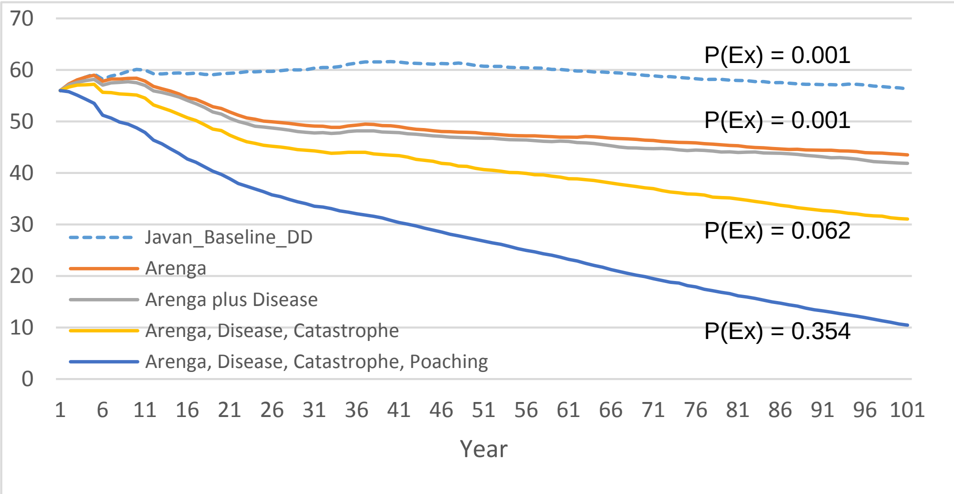

Figure 9. Modelled impact of multiple threats on the Ujung Kulon population.

Inbreeding depression

The population at Ujung Kulon has been small for several decades and, as a result, could be suffering from inbreeding depression; an increase in mortality, reduction in fertility or increased expression of rare genetic disorders typically presenting in the offspring of close relatives. As described previously, to estimate the current degree of inter-relatedness in the population models were run from a 1970 starting point when there were estimated to have been approximately 30 individuals in the population. In the models, these founding 30 were assumed to be unrelated. Models were run for 45 years and the average level of relatedness (F=0.0255) recorded and applied as the starting point for kinships in the 2015 models.

As illustrated in Figure 10, from this starting point of relatedness, and with inbreeding depression included, the baseline model declines over the 100 year period from 58 individuals to around 53 individuals, with a steady downward trend visible from around year 40 onwards. This steady downward trend is corrected once inbreeding depression is removed, with the net result of an average population decrease of only one individual over the period considered. The results suggest that inbreeding depression could put downward pressure on the population in Ujung Kulon if it remains at its current size over the coming decades.

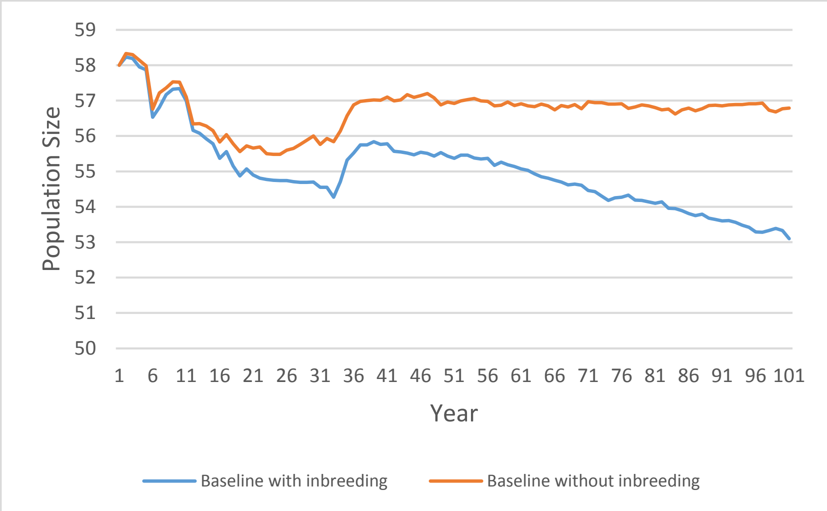

Figure 10. Comparison of the baseline model with and without inbreeding depression.

It is possible that rhinos are more closely related than predicted from the retrospective models. For example, some of the 30 animals thought to exist in Ujung Kulon at that time may have been related; or some of the males in that populations may have been disproportionately successful breeders, leading to a higher than expected level of relatedness in the following generation. A series of models were run to consider this possibility. Starting levels of relatedness were set as follows:

- 0.0255 (relatedness generated from retrospective models)
- 0.0625 (equivalent to relatedness between first cousins)
- 0.1250 (equivalent to relatedness between half-siblings)
- 0.2500 (equivalent to relatedness between full-siblings)

The impact on population performance of applying these starting levels of relatedness is illustrated in Figure 11.

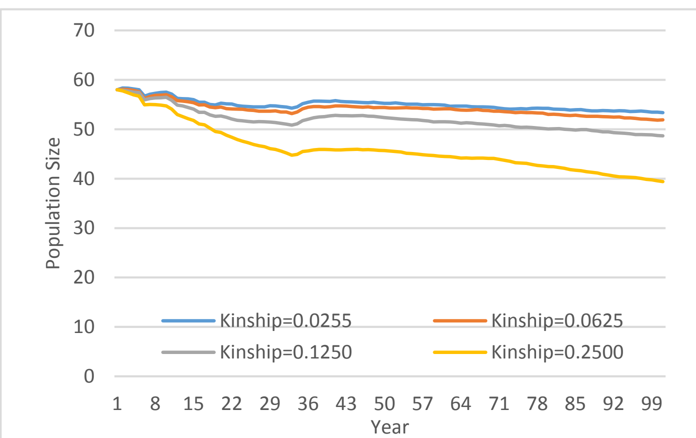

Figure 11. Impact on population performance of elevating the relatedness of the starting population.

As shown in the Figure, population performance declines as starting relatedness increases. Extinction probability is zero for the 0.0255 and 0.0625 starting levels, increasing to P(Ex) = 0.001 and 0.005 for the 0.125 and 0.2500 levels respectively. Based on what is known about the Ujung Kulon population, relatedness seems more likely to be sitting at the more optimistic end of this range but this is an area of uncertainty.

In other contexts, three broad strategies might be considered for reducing the accumulation of inbreeding in a population: 1) increasing population size; 2) introducing unrelated rhinos from outside the population; and 3) manipulating breeding within the population to favour less related pairings. In the Javan rhino context options 2) and 3) are not real options at this time; UKNP hosts the only population of this species so no unrelated animals are available, and intensive management of pairings is not currently an option. This leaves only increasing population size as a potential strategy for mitigating inbreeding depression and this is considered in the next section.

In summary, at its current size and with the likely constraints on further growth, the population of rhinos at UKNP is vulnerable to a range of threats potentially operating in the park. Participants discussed potential strategies for reducing this vulnerability and these are described below.

Strategy-Based Scenarios

Participants considered strategies for reducing the vulnerability of the remaining population at Ujung Kulon. Maintaining full protection against poaching and increasing the current population size were the two highest priorities identified. Increasing population size could be achieved by one or both of the following:

1) Increasing the carrying capacity at UKNP through:
    a. reducing *Arenga* palm encroachment; or
    b. otherwise improving habitat quality for Javan rhinos.
2) Establishing a second site for Javan rhinos outside UKNP.

Impact of increasing carrying capacity at UKNP

Figure 12. Illustrates the impact over 100 years on the modelled populations, of increasing carrying capacity on year 1 from 60 (current estimate) to 65, 70, 75, and 80.

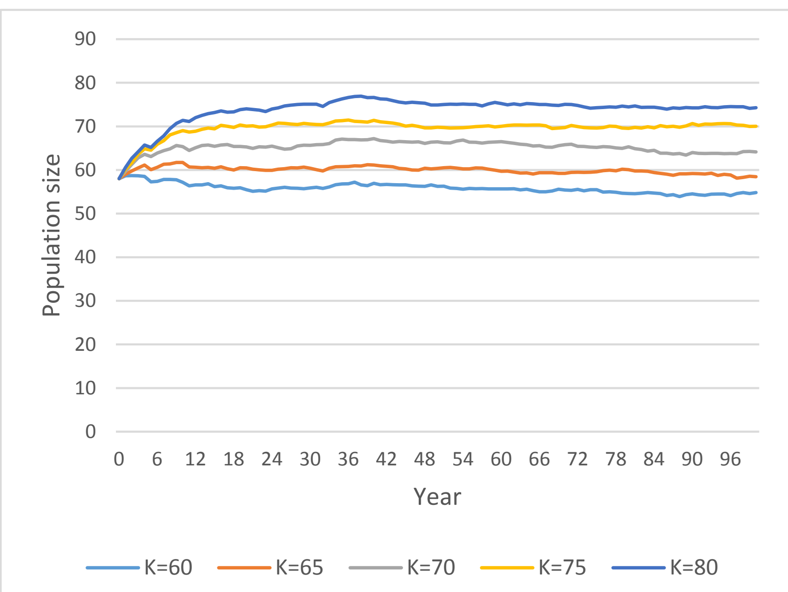

Figure 12. Modelled impact over 100 years, of increasing carrying capacity on year 1 (e.g. by clearing *Arenga* palm or improving habitat). Growth, gene diversity and population statistics shown in table below.

K	GD@ 100yrs	N@50 years
K=60	0.9043	54.83
K=65	0.9125	58.46
K=70	0.9185	64.16
K=75	0.9221	70.04
K=80	0.9272	74.28

The increase in population size is expected to increase the amount of gene diversity retained and, related to this, decrease the rate of inbreeding accumulation.

Establishing a second population

The establishment of a second population of Javan rhinos at a site outside of UKNP would be a formidable undertaking with multiple challenging dimensions including security, logistics, funding and sustainability. This analysis is confined to the following questions that relate to population viability:

- How many rhinos can we safely remove from UKNP to found a second population?
- How many founders do we need to give a second population a good chance of establishment?

How many rhinos can we remove from Ujung Kulon?

Factors likely to impact on the number of rhinos able to be removed safely from Ujung Kulon, that is, without threatening its viability, include the following:

- The **age and sex-ratio of the individuals removed** relative to the source population. For example, if the UKNP population is short of females, or is short of reproductively capable females, it will be less able tolerate female-biased harvest of breeding age individuals.
- **The timing of removals**. For example, the population may be more able to tolerate two smaller harvests spread several years apart, than a single, large harvest which could leave the population particularly vulnerable to demographic and genetic uncertainty.
- **The mechanism underpinning the current lack of growth in the population**. This is assumed to be density related due to the proximity of current population numbers to the Park's (estimated) carrying capacity. If this is the case, the removal of some individuals should provide space that will allow growth to resume. If this is not the case, growth may not resume and the population will be left even more vulnerable than before.

Single harvest, year 1

Figure 13 below illustrates the impact on modelled populations of harvesting for translocation groups of 2, 4, 6, 8, 10, or 12 adults of even sex-ratio, on year 1 of the program.

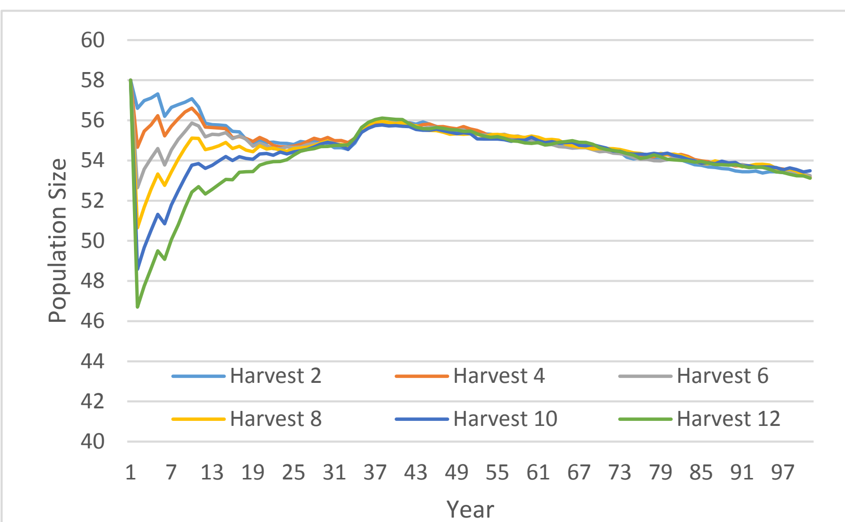

Figure 13: Impact of harvesting 2, 4, 6, 8 or 10 adults, of even sex-ratio, from UKNP in Year 1.

As can be seen, in the absence of threats (e.g. further *Arenga* palm encroachment, disease outbreaks, catastrophes, poaching) modelled populations eventually recover from all of these harvest levels and return to roughly the same trajectory as they would be expected to have followed in absence of any harvest. However, the larger the harvest, the longer the period of recovery and, therefore, of increased vulnerability to other threats; harvests of 2, 4, and 6 return to a common trajectory around year 15, whereas harvests of 8, 10 and 12 take 5-10 years longer to "catch up". However, overall in terms of the numbers of individuals involved the differences are small and all five scenarios returned an extinction risk of zero for the period considered. **However, it should be stressed that this is in the absence of human-mediated threats and environmental catastrophes and it assumes that growth will increase immediately following harvest because of the increase in habitat availability.**

Multiple smaller harvests

Figure 14 explores the impact of spreading the harvest across years. Two harvest sizes are considered: one of 8 individuals in total and one of 12 individuals in total. For N=8, one scenario involves taking all 8 rhinos out in year 1, the other takes 4 in year 1 and 4 more in year 3. For N=12, one scenario takes all 12 rhinos out in year 1, the other takes 4 individuals in year 1, 4 in year 3 and 4 more in year 8. All of the scenarios considered take the same average trajectory from approximately year 30. As might be expected, scenarios involving removal of 12 rhinos result in the maintenance of a lower population size at Ujung Kulon, for longer than those in which only 8 animals are removed. Due to the growth in between removal events, scenarios involving several smaller harvests maintain larger average sizes throughout.

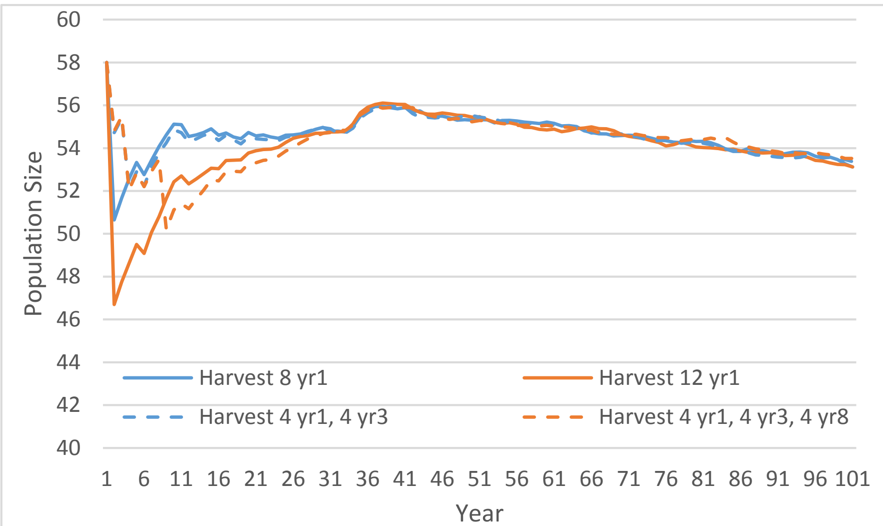

Figure 14: Comparison of model performance under a single harvest on year 1 versus the same-sized harvest spread across multiple harvest events, for harvests of 8 and 12.

In addition to the slightly larger average population size expected, taking multiple smaller harvests has the advantage of a precautionary approach, in which the impact of the smaller harvest can be assessed before further animals are taken, and translocation protocols can be tested and refined.

Female-biased harvest

We expect that any population translocated to a second site will grow faster if it carries more females. For a harvest of a given size, increasing the number of females implies biasing the sex-ratio of animals taken towards females. However, harvesting more females from Ujung Kulon would be expected to reduce productivity there, potentially exposing the population to additional risk. Figure 15 compares the relative impact on the UKNP population, of three translocation scenarios with biased sex-ratios, all of which involve the movement of 8 rhinos spread across two translocation events, spaced 2 years apart. The ratios considered were as follows (Figure 15):

1) 4 males and 4 females (blue line)
2) 3 males and 5 females (orange line)
3) 1 male and 7 females (grey line)

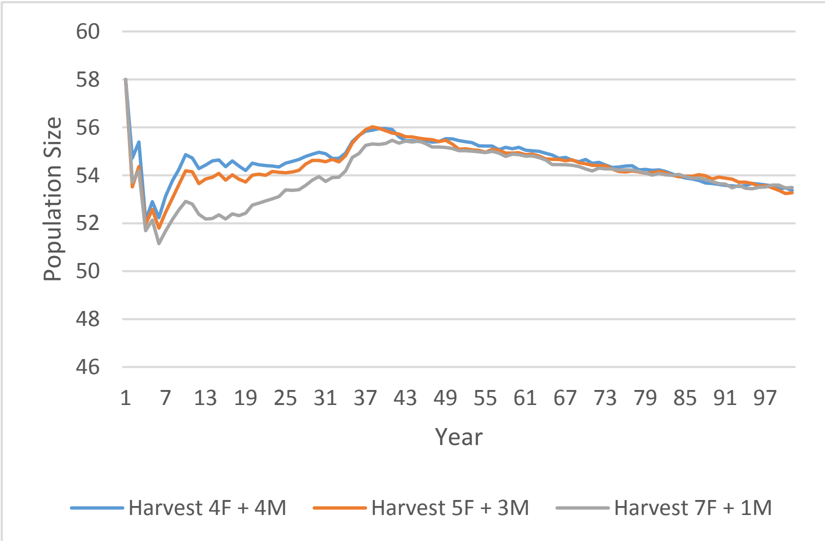

Figure 15: Impact on the model populations of applying a female bias to the sex-ratio of rhinos harvested for translocation.

As illustrated, taking extra females out of the population has a small but visible impact on the average trajectory of modelled populations, with the scenario in which 7 females are removed taking noticeably longer to recover than those in which 4 and 5 are removed.

Note that the models may underestimate this impact as all females in the model are assumed to be in the breeding pool. If in reality only a proportion of the females in Ujung Kulon are capable of breeding then the removal of any of those could have a disproportionate impact on the population's ability to recover post-harvest which is not illustrated here. This could be further explored using the models if relevant data become available.

<u>How many rhinos do we need to establish a new population?</u>

A newly formed population founded with 8 rhinos would be expected to grow more quickly with a larger proportion of females than males. However, the larger the skew, the greater the chance of losing all breeding males in the early years of the program due to chance demographic events, and the faster the accumulation of inbreeding due to the high level of relatedness expected in the first generation. The three harvesting scenarios considered in the previous section were reconsidered from the perspective of their suitability for founding a new population and the results are illustrated in Figure 16:

1) 4 males and 4 females (blue line)
2) 3 males and 5 females (orange line)
3) 1 male and 7 females (grey line)

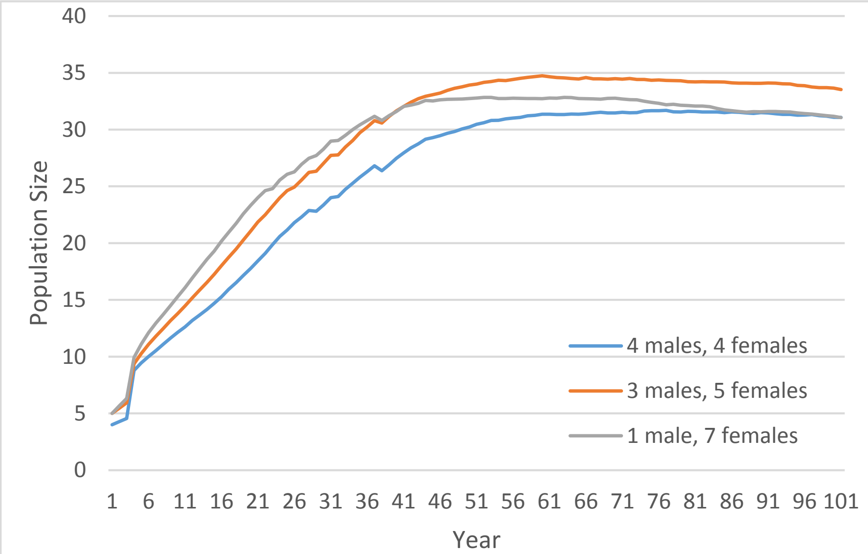

Figure 16: Impact on the NEW population of a female-biased founder base.

Sex-ratio (M.F)	P(Ex)	Inb @ 100yrs
4.4	0.120	0.176
3.4	0.071	0.167
1.7	0.115	0.189

The population founded with 5 females and 3 males (orange line) performs best all round, showing a lower extinction risk, higher average population size over the longer term and lower inbreeding accumulation at 100 years. The faster early growth of the population founded with 5 females appears to offset any genetic (inbreeding-related) advantages of the population founded on an even sex-ratio (blue line). The population founded with 7 females (grey line) performs better for the first few decades but begins to decline, on average, around year 40 primarily due to inbreeding which accumulates faster because of the close relationships amongst all first generation offspring.

In reality it may be possible to low inbreeding accumulation at a second site by periodic movement of individuals from UKNP. However, the extent of mitigation possible would be influenced by a number of factors including feasibility, logistical difficulty, social and behavioural obstacles and health/injury implications in the context of capture, translocation and integration of wild Javan rhinos. These aspects of founding and managing a second site were not discussed in detail at the workshop but models could be revisited with additional scenarios once more boundaries have been set around these considerations.

The impact of carrying capacity on the performance of a second population is illustrated in Figure 17, for the more optimistic of the founding strategies considered (5 females and 3 males). Carrying capacities of 10, 20, 50 and 100 are considered.

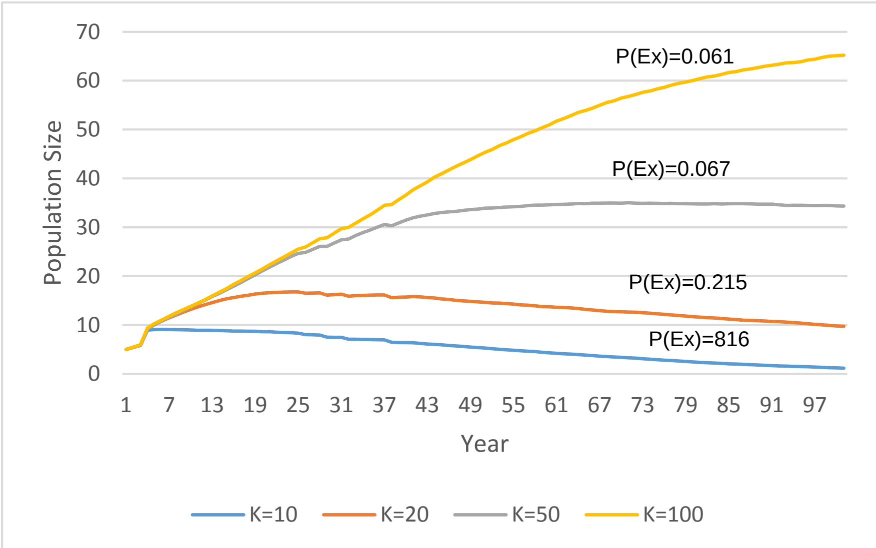

Figure 17: Impact of carrying capacity on performance of a second population founded with 5 females and 3 males.

For carrying capacities of 10 and 20 the modelled populations show, on average, a brief period of initial growth followed by a steady decline. Extinction risks for these populations are 0.816 and 0.215 respectively. A carrying capacity of 50 allows growth to continue for approximately 40 years before plateauing and a carrying capacity of 100 allows growth to continue throughout the 100 year period. Extinction risk for these two scenarios are relatively low and would be reduced further by periodic supplementation from Ujung Kulon.

The second population scenarios described above may be optimistic as they do not include threats such as poaching, disturbance, habitat degradation, or disease outbreak. No specific sites were discussed during the workshop but should potential sites be identified it might be useful to revisit the models with additional information about site-specific conditions.

Poaching tolerance at second site

Figure 18 illustrates the response of the modelled second population to poaching at a rate of 0-4 adult rhinos every year. Carrying capacities of 10, 20, 50 and 100 are considered but as can be seen, populations are driven to extinction too quickly to expand into the space available. All populations go extinct, with average times to extinction of 10-11 years.

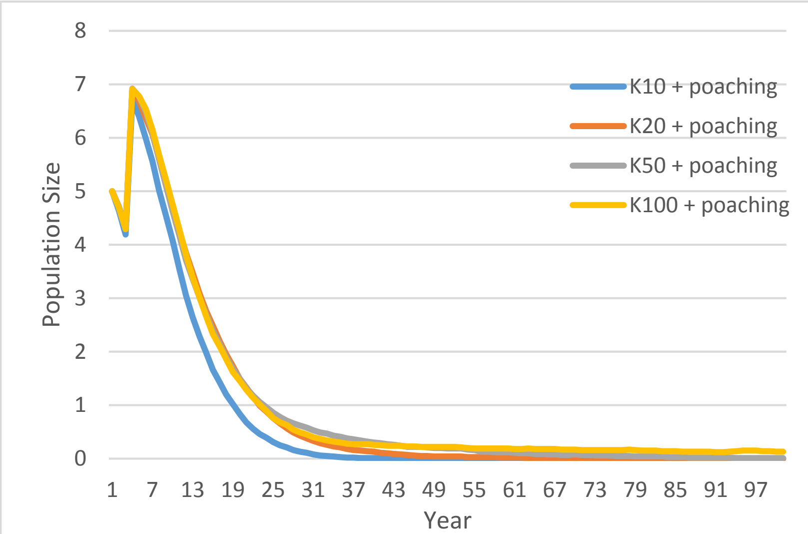

Figure 18: Impact of poaching on a second population founded with 5 females and 3 males and with carrying capacity varied (K=10, 20, 50 and 100)

Summary

Javan rhinos are potentially at risk to a number of threats: *Arenga* palm encroachment, cattle-mediated disease outbreaks, environmental catastrophes, inbreeding depression and poaching. At the impact levels simulated, poaching was the greatest threat to the modelled populations.

Increasing population size would be expected to increase resilience to all of the threats considered. Options for achieving this are: 1) increasing carrying capacity at Ujung Kulon (through, for example, clearing Arenga Palm or otherwise improving habitat) and 2) establishing rhinos at a second site outside UKNP.

Assuming that the lack of growth observed at UKNP over the past decades is the result of the population having reached carrying capacity, removing animals to seed another site should restore growth, allowing the population to recover from the harvest.

Models indicate that in the absence of other threats the population could withstand a harvest of 12 individuals, though a precautionary approach would remove fewer until the expected impact on growth was confirmed. The population would be expected to take 20-30 years to recover from a harvest of this size.

A population of around 8 individuals, 5 females and 3 males, should be sufficient to seed a new population successfully provided that additional supplementation downstream remains an option. A new site expected to provide long-term stability would ideally provide space for at least 50 individuals and would need to be completely protected from poaching to secure establishment and growth.

Constraints around site-specific risks, logistics, rhino behaviour, health/injury risks and general feasibility would be major influences in any project aiming to capture, translocate and establish rhinos at a new site. These issues were not discussed in detail at the workshop. Models should be re-worked to take these issues into account.

Appendix I: Summary of Modeling Results

Scenario	stoch-r	SD(r)	PE	N-extant	SD(Next)	N-all	SD(Nall)	GeneDiv	SD(GD)	AlleIN	SD(A)	MeanTE
Baseline	0.001	0.045	0.000	56.31	9.16	56.31	9.16	0.9044	0.0220	17.48	2.50	0.0
Arenga encroaching: 1% per year, 20 yrs	-0.001	0.049	0.001	43.55	8.73	43.50	8.82	0.8858	0.0286	14.44	2.52	81.0
Arenga encroaching: 2% per year, 20 yrs	-0.004	0.057	0.009	29.51	8.31	29.26	8.67	0.8457	0.0489	10.61	2.26	86.8
Cattle-mediated disease	0.000	0.048	0.000	54.03	10.41	54.03	10.41	0.9012	0.0247	16.80	2.73	0.0
Environmental catastrophe	-0.003	0.086	0.036	46.88	16.61	45.23	18.42	0.8787	0.0534	14.66	4.09	74.8
Poaching: 1% per year	-0.010	0.063	0.063	27.88	13.40	26.21	14.50	0.8369	0.0756	10.58	3.29	84.7
Poaching: 2% per year	-0.031	0.098	0.682	8.49	6.53	2.97	5.31	0.6972	0.1402	5.20	2.30	75.7
Arenga (1%) plus disease	-0.002	0.052	0.001	41.91	9.23	41.88	9.28	0.8808	0.0341	13.89	2.58	100.0
Arenga (1%), disease & catastrophe	-0.007	0.093	0.062	33.04	14.30	31.05	15.87	0.8465	0.0685	11.31	3.37	77.4
Arenga (1%), disease, catastrophe % poaching (1%)	-0.021	0.107	0.354	15.94	10.11	10.46	11.01	0.7682	0.1140	7.36	2.91	74.9
Kinship=0.0255, No inbreeding	0.008	0.043	0.000	56.99	3.42	56.99	3.42	0.9047	0.0210	17.56	2.26	0.0
Kinship=0.0255	0.003	0.043	0.000	53.36	5.64	53.36	5.64	0.9064	0.0195	17.50	2.33	0.0
Kinship=0.0625	0.002	0.043	0.000	51.90	6.56	51.90	6.56	0.9041	0.0214	17.23	2.44	0.0
Kinship=0.1250	0.000	0.044	0.001	48.70	8.08	48.66	8.21	0.9000	0.0246	16.56	2.64	89.0
Kinship=0.2500	-0.004	0.047	0.005	39.61	11.18	39.42	11.47	0.8842	0.0358	14.61	3.14	81.2
Harvest 2, year1	0.003	0.043	0.000	53.15	6.18	53.15	6.18	0.9056	0.0210	17.55	2.45	0.0
Harvest 4, year 1	0.003	0.043	0.000	53.20	5.85	53.20	5.85	0.9045	0.0216	17.46	2.43	0.0
Harvest 6, year1	0.003	0.044	0.000	53.25	5.70	53.25	5.70	0.9049	0.0199	17.36	2.28	0.0
Harvest 8, year 1	0.003	0.046	0.000	53.12	6.17	53.12	6.17	0.9041	0.0221	17.34	2.52	0.0
Harvest 10, year 1	0.003	0.047	0.000	53.49	5.68	53.49	5.68	0.9034	0.0224	17.26	2.45	0.0
Harvest 12, year 1	0.003	0.049	0.000	53.12	6.07	53.12	6.07	0.9035	0.0208	17.07	2.34	0.0

Scenario	stoch-r	SD(r)	PE	N-extant	SD(Next)	N-all	SD(Nall)	GeneDiv	SD(GD)	AlleIN	SD(A)	MeanTE
Harvest 4 yr 1, 4 yr 3	0.003	0.044	0.000	53.37	5.66	53.37	5.66	0.9047	0.0195	17.26	2.38	0.0
Harvest 2.3 yr 1, 1.2 yr 3	0.003	0.044	0.000	53.27	6.07	53.27	6.07	0.9024	0.0224	17.21	2.38	0.0
Harvest 1.4 yr 1, 3 yr3	0.003	0.044	0.000	53.49	5.46	53.49	5.46	0.9032	0.0215	17.14	2.35	0.0
Harvest 4 yr 1, 4 yr 3, 4 yr 8	0.003	0.045	0.000	53.52	5.63	53.52	5.63	0.9035	0.0207	17.19	2.32	0.0
NEWpop 2.2 yr 1, 2.2 yr 3	0.020	0.101	0.120	35.27	11.42	31.07	15.62	0.7738	0.1013	7.53	2.18	56.6
NEWpop 2.3 yr 1, 1.2 yr 3	0.019	0.085	0.071	36.06	11.30	33.52	14.25	0.7853	0.0827	7.79	2.11	56.9
NEWpop 3.5, K10	0.004	0.128	0.816	5.02	2.09	1.17	2.15	0.4949	0.1848	2.77	0.84	60.2
NEWpop 3.5, K20	0.009	0.102	0.215	12.22	4.79	9.75	6.37	0.6666	0.1334	4.65	1.38	70.6
NEWpop 3.5, K50	0.019	0.085	0.067	36.76	11.24	34.33	14.16	0.7863	0.0763	7.80	2.02	63.4
NEWpop 3.5, K100	0.024	0.081	0.061	69.43	26.13	65.22	30.25	0.8045	0.0806	8.80	2.49	57.1
NEWpop, K10, POACH	-0.042	0.245	1.000	0.00	0.00	0.00	0.00	0.0000	0.0000	0.00	0.00	10.0
NEWpop, K20, POACH	-0.037	0.231	1.000	0.00	0.00	0.00	0.00	0.0000	0.0000	0.00	0.00	11.9
NEWpop, K50, POACH	-0.035	0.228	0.999	7.00	0.00	0.01	0.22	0.7143	0.0000	6.00	0.00	11.5
NEWpop, K100, POACH	-0.035	0.231	0.997	44.33	11.24	0.13	2.48	0.7798	0.0405	7.33	1.53	11.4
Baseline K65	0.005	0.042	0.000	59.13	5.46	59.13	5.46	0.9128	0.0174	19.03	2.39	0.0
Baseline, K70	0.006	0.041	0.000	64.33	5.29	64.33	5.29	0.9193	0.0161	20.51	2.61	0.0
Baseline K75	0.006	0.039	0.000	69.62	5.35	69.62	5.35	0.9218	0.0173	21.52	2.54	0.0
Baseline, K80	0.007	0.039	0.000	74.16	5.69	74.16	5.69	0.9275	0.0132	23.07	2.63	0.0

Appendix II: *Vortex* Parameters for the 2015 Javan Rhino PVA

Vortex Parameter	2015 Javan Rhino PHVA	2015 Notes (Values are those used in the 1989 PVA unless stated otherwise).
# of populations	1	Management scenarios will consider a second population.
Inbreeding depression included?	6.29LEs	Based on O'Grady *et al.* 2006. Applied in the model as a decrease in first year survival though note that inbreeding can also impact life-time survival and fertility.
Concordance of environmental variation (EV) and reproduction	No	
EV correlation among populations	N/A	
Breeding system	Polygynous	
Age of first reproduction (♂ / ♀)	7 years	
Maximum age of reproduction	35 years, longevity = 40 years	
Annual % adult females breeding	33% and in the density dependent model, ranging from 33-16, A=1 ; B=4 ;	Equates to an average inter-birth interval of 3-4 years plus a scenario where birth rate drops off to roughly 1 birth per female in 6 years as the population approaches either capacity or n=0.
Density dependent reproduction?	YES	Not included here
% males in breeding pool	80%	
Litter size	1	
Offspring sex ratio	50-50	
EV in breeding and mortality	20% of mean	
% annual mortality (♀)		
0-1 years	15%	
1-7 years	2%	
8+ years	4%	
% annual mortality (♂)		
0-1 years	15%	
1-7 years	2%	
7+ years	4%	

Vortex Parameter	2015 Javan Rhino PHVA	2015 Notes (Values are those used in the 1989 PVA unless stated otherwise).
Initial population size	33.25 (58 in total)	Data made available by Ujung Kulon via WWF-YABI: starting age structure includes 25.18 adults (aged >8 distributed amongst adult age classes weighted to younger ages) and 6.4 animals aged <8yrs and distributed evenly amongst younger age-classes. This excludes two other known individuals residing in the connected area of forest on the mainland (JRSCA).
Carrying capacity (K)	70 & 60	K=70 based on Ramono et al., 2009. K=60 agreed by workshop participants as likely current capacity representing a further reduction resulting from habitat changes and competition with other species.
Breeding pair selection	Random	Can include genetic management but unlikely to be a practical intervention.
Harvest/Poaching	None	Added into scenarios but not included in the baseline.
Catastrophes	None in baseline. Included elsewhere as: Frequency: 1% (1 in 100 yrs). Severity: 50% mortality in year of occurrence, no impact on reproduction.	Based on a rule of thumb proposed by Reed et al (2003), generated from a study of 100 vertebrate species.

Javan Rhino Stakeholder Engagement Working Group Report

Working Group members:

Challenges to stakeholder engagement for Javan rhino conservation

The group first identified the following challenges to stakeholder engagement for Javan rhino conservation:

1. Human population growth without the availability of alternative livelihoods, combined with a lack of integration, participation and synergies amongst all stakeholders in economic development of the buffer zone, increases pressure on UKNP and increases the conflict between the national park and the local communities. This increased level of conflict leads to a degradation of support for Javan rhino conservation.

2. Lack of knowledge and perception in the local community creates low support of the local community for Javan rhino conservation as it creates resistance to the implementation of the Javan rhino conservation program.

3. Communities are not supportive of Javan rhino conservation because they are not involved and empowered in the program. This leads to a low level of support for Javan rhino conservation efforts amongst local stakeholders.

4. Slow policy decision making due to many and often conflicting interests leads to delays in implementing the Javan rhino conservation program which needs to be implemented fast as the situation is critical for the species.

Data Assembly

Threat 1: Human population growth without the availability of alternative livelihoods, combined with a lack of integration, participation and synergies amongst all stakeholders in economic development of the buffer zone, increases pressure on UKNP and increases the conflict between the national park and the local communities. This increased level of conflict leads to a degradation of support for Javan rhino conservation.

Facts	Assumptions	Information Gaps	Regional Specificity	Bibliography
Human population growth in 4 villages; a) Ujung Jaya (4,59), Cibadak (1,15)	Many villages are marginalized		• Rancapinang • Cibadak • Cimanggu • Ujung jaya • Taman jaya	• Ramono et al. 2009 • Statistic Data BPS (2010)
50-81% of local communities not yet economically prosperous				
46% of communities dependent on forest resources				
Ujung jaya (2010) 997 household (3.877 people) Ranca pinang 3696 people (1098 household)		Investigate community activity in between agriculture		
Low agricultural productivity (1 ton/ha).				
90% of people in local communities are farmers (55.64% own land)	Conversion in profession of local community			

Proportion of farmers has increased 129% in local communities	Productive age has increased	Investigate why the number of farmers has increased		
There is no program integrating conservation and regional economic development				

Threat 2: Lack of knowledge and perception in the local community creates low support of the local community for Javan rhino conservation as it creates resistance to the implementation of the Javan rhino conservation program.

Facts	Assumptions	Information Gaps	Regional Specificity	Bibliography
91% of local people understand that rhino is protected	Low prosperity levels in local community (78% not prosperous yet)			• Ramono et al. 2009 • National Park data
78% of local people know that Ujung Kulon is the only habitat with Javan Rhino				
46% of local people know that encroachment will create disturbance among rhino				
46% of local community shows support for JRSCA, while 24% oppose it				

Factors influencing attitudes on rhino conservation: • Profession • Perceived value of Javan rhino				
Data on community involvement in Javan rhino conservation	Communities currently involved in conservation have not successfully influenced other communities to support rhino conservation			

Threat 3: Communities are not supportive of Javan rhino conservation because they are not involved and empowered in the program. This leads to a low level of support for Javan rhino conservation efforts amongst local stakeholders.

Facts	Assumptions	Information Gaps	Regional Specificity	Bibliography
District Regulation No. 3/2014 (has just been issued)	• Regulation has not yet been socialized • Master plan of development in buffer zone area as a mandate of Perda has not been formulated	• Have other stakeholders been informed about the Regulation? • What is the level of acceptance of the Regulation among stakeholders?	District	Perda No. 3/2014

Threat 4: Slow policy decision making due to many and often conflicting interests leads to delays in implementing the Javan rhino conservation program which needs to be implemented fast as the situation is critical for the species.

Facts	Assumptions	Information Gaps	Regional Specificity	Bibliography
Delayed response to conservation program			District and province	
Low financial support to program	No other financial resources exist	List of funding resources		
The province has a budget but is has not yet been allocated for rhino conservation	Gap of information regarding Javan rhino conservation among stakeholders	Policy of budget allocation in the province		

Identification of Conservation Goals

For each of the problem statements described earlier in this section, the working group participants developed management goals to address these problems. Finally, the group placed these goals in order of priority in terms of their effectiveness in advancing stakeholder engagement for the purpose of Javan rhino conservation in Indonesia.

1. By 2025, no illegal activities by local communities inside UKNP and the second habitat occur due to a close, trusting and mutually beneficial partnership between communities and the park authorities.
2. By 2025, communities no longer extract natural resources from the rhino zone within UKNP due to the implementation of a whole-of-government green economic development masterplan across the park buffer zone that increases local livelihoods.
3. By 2025, all communities champion the Javan rhino conservation program due to active involvement in (50% of the 2 adjacent villages) and high knowledge of (100% of 19 buffer zone villages) the conservation program activities.
4. By 2025, all relevant stakeholders are fully supportive of the Javan rhino conservation program because they are empowered to be involved in the most appropriate way.
5. The Javan rhino conservation program is implemented in full and on time.

Identification of Conservation Actions

Action 1: Design and conduct a study to investigate the level of stakeholder support and involvement in conservation.

Responsible Parties: UKNP Natural Resource Management Committee.

Timeline: 2015, then every 2 years afterwards.

Outcome: Understanding of current level of stakeholder support and involvement in rhino conservation.

Collaborators:

Obstacles:

Action 2: Conduct a series of facilitated "Problems and Needs" meetings with all villages and community groups.

Responsible Parties: UKNP community staff.

Timeline: Method development and training, 2016. First meetings, 2016.

Outcome: Understanding of problems facing communities and which communities need to become part of the Javan rhino conservation program.

Collaborators: YABI; WWF-Indonesia; IRF

Obstacles:

Action 3: Develop a master plan for UKNP buffer area through public consultation under district regulation 2/2013.

Responsible Parties: Head of Planning and Coordination Department (BAPEDA).

Timeline: 2017.

Outcome: Buffer zone plan created and in compliance with district regulations.

Collaborators:

Obstacles:

Action 4: Establish a Buffer Area Management Committee.

Responsible Parties: Head of Planning and Coordination Department (BAPEDA).

Timeline: 2017.

Outcome: Collaborative management system in place for buffer area.

Collaborators:

Obstacles:

Action 5: Implement the UKNP Buffer Area Master Plan.

Responsible Parties: Buffer Area Management Committee.

Timeline: 2017, then ongoing.

Outcome:

Collaborators:

Obstacles:

Action 6: Socialization of the Buffer Area Master Plan.

Responsible Parties: Buffer Area Management Committee and Director, UKNP Director.

Timeline: 2017, then annually.

Outcome: Community support is built for Buffer Area management.

Collaborators:

Obstacles:

Action 7: Build community support for the Javan rhino conservation plan through education, awareness, pride campaigns and creation of a fatwa MUI.

Responsible Parties: UKNP community staff.

Timeline: Beginning in 2017, then annually.

Outcome: Communities feel “ownership” of the Javan rhino conservation program.

Collaborators: YABI; WWF-Indonesia; UNAS – Fachruddin Mangunjaya

Obstacles:

Action 8: Develop a “Rhino Hero Recognition Award” program.

Responsible Parties: UKNP Director.

Timeline: 2018.

Outcome: Community members and/or UKNP staff are recognized for contributions to Javan rhino conservation.

Collaborators:

Obstacles:

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Appendix I

Threatened Terrestrial Vertebrates of Ujung Kulon National Park

Scientific Name	Common English Name	Assessment
Huia masonii	Javan torrent frog	Vulnerable
Kalophrynus minusculus		Vulnerable
Limnonectes macrodon	Fanged River frog	Vulnerable
Ophiophagus hannah	King cobra	Vulnerable
Python bivittatus	Burmese python	Vulnerable
Centropus nigrorufus	Javan coucal	Vulnerable
Leptoptilos javanicus	Lesser adjutant	Vulnerable
Lophura erythrophthalma	Crestless fireback	Vulnerable
Mulleripicus pulverulentus	Great slaty woodpecker	Vulnerable
Pavo muticus	Green peafowl	Endangered
Sturnus melanopterus	Black-winged starling	Critically Endangered
Aonyx cinerea	Asian small-clawed otter	Vulnerable
Arctictis binturong	Binturong	Vulnerable
Lutrogale perspicillata	Smooth-coated otter	Vulnerable
Niviventer cremoriventer	Dark-tailed tree rat	Vulnerable
Nycteris javanica	Javan slit-faced bat	Vulnerable
Rusa timorensis	Javan deer	Vulnerable
Trachypithecus auratus	Javan leaf monkey	Vulnerable
Bos javanicus	Javan banteng	Endangered
Cuon alpinus	Dhole	Endangered
Hylobates moloch	Silvery gibbon	Endangered
Manis javanica	Malayan pangolin	Endangered
Nycticebus javanicus	Javan slow loris	Endangered
Presbytis comata	Javan surili	Endangered
Panthera pardus melas	Javan leopard	Critically Endangered
Rhinoceros sondaicus	Javan rhinoceros	Critically Endangered

Appendix II
Workshop Participants

Name	Organization	E-mail
Haerudin Sadjudin	YABI	sadjudin_haerudin@yahoo.co.id
Waladi	YABI	w_isnan@yahoo.com
Dadan D. Subrata	YABI	dadansubrata@yahoo.com
Yusep Hardiana	YABI	yusephardiana@gmail.com
Deddy Wardhana	YABI	deddywardhana@yahoo.co.id
Diky Wahyudi	YABI	diky.ainur@gmail.com
Nasrul Ikhram	YABI	rmofking@gmail.com
Moh. Haryono	BTNUK	moh_haryono@yahoo.com
Asep Yayus F	TNUK	f.yayus@gmail.com
Aom Muhtarom	TNUK	aom.muhtarom@gmail.com
Ofat Sofatudddin	TNUK	ofatbadak@yahoo.com
Rusdianto	TNWK	rhiyanto99@gmail.com
Harijoko SP	PHKA	harijoko.prasetyo@gmail.com
Drajat Dwi H	KKH	drajatdh@gmail.com
Fajria Novari	KKH	novarifajria@gmail.com
Desy Satya	KKH	desysatyac@gmail.com
U. Mamat Rahmat	KKH	umat_rahmat@yahoo.com
Febriany	KKH	febry.iskandar@gmail.com
M. Agil	FKH IPB/YABI	rhinogil@indo.net.id
Bertha L.U	Eijkmen	bertha@eijkmen.go.id
Indra Arinal	Copenhagen Zoo	
Facrudin Mangunjaya	UNAS	fmangunjaya@civitas.unas.ac.id
Enjat Sudrajat	YUKINDO	
Keni Sultan	TSI	keni.s@tamansafari.net
Sharmy Prastiti	TSI	amicurator@tamansafari.net
Ulum	Dishutbun Prov.Banten	ulum.ganten@yahoo.com

Name	Organization	E-mail
Sugandjar	Dishutbun Prov. Banten	ganda73@yahoo.co.id
Aa. Deny Budiarna	Dishutbun Prov. Banten	forester_sai@yahoo.com
Enah Suhenah	Dishutbun Prov. Banten	
Fikron	Dishutbun Kab. Pandeglang	fikronrahman@gmail.com
Pujo Setio	Puskonser	desetio@yahoo.com
Reny S	Puskonser	renysavitri@gmail.com
R. Garsetiasih	Puskonser	8161819630
Hendra Gunawan	Puskonser	hendragunawan64@yahoo.com
Sunarto	WWF	s.sunarto@yahoo.com
Ridwan Setia	WWF	padol67@yahoo.com
Kurnia O.KH	WWF	kurnia_okh@yahoo.com
Rois Mahmud	WWF	rois@mail.ugm.ac.id
Yuyun Kurniawan	WWF ID	ykurniawan@wwf.or.id
Arnaud Lyet	WWF	arnaud.lyet@wwfus.org
Nicola Lowete	WWF UK	nlowete@wwf.org.uk
Barney Long	WWF US	barney.long@wwf.us.org
Susie Ellie	IRF	s.ellis@rhinos.org
Inov	IRF	
Bibhab Talukdar	IRF	b.talukdar@rhinos.org
Sarah Brook	WCS	sarahmbrook@gmail.com
Terri Roth	Cincinnati Zoo	terri.roth@cincinnatizoo.org
Karen K. Dixon	SOS Rhino	kkdixon@sosrhino.org
Caroline Lees	Conservation Breeding Specialist Group	caroline@cbsgaustralasia.org
Philip Miller	Conservation Breeding Specialist Group	pmiller@cbsg.org