Captive Breeding Specialist Group

Species Survival Commission
International Union for the Conservation of Nature and Natural Resources
U. S. Seal, CBSG Chairman

JAVAN RHINOCEROS

Rhinoceros sondaicus

POPULATION VIABILITY ANALYSIS

and

RECOMMENDATIONS

Captive Breeding Specialist Group

and

Asian Rhinoceros Specialist Group

Species Survival Commission IUCN

Prepared by

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with contributions from

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24 July 1989

(Based upon a population viability analysis workshop
held 5 - 7 June 1989 at Bogor, Indonesia)

12101 Johnny Cake Ridge Road, Apple Valley, MN 55124 tel. (612)431-9325

JAVAN RHINOCEROS

POPULATION VIABILITY ANALYSIS WORKSHOP

Problem Statement

June 5-7, 1989

Problem:

The Javan rhinoceros (Rhinoceros sondaicus) exists in the wild as single small populations in Ujung Kulon on Java and in Vietnam. A captive population has not been established. The rhinoceros population at Ujung Kulon numbers less than 70 animals and has not increased during the past 10-12 years. It fluctuated around 25 animals during the 60 preceding years. The basis for the current limited recruitment in the wild is not understood. These conditions favor continued loss of genetic diversity and potential extinction in the wild from random environmental events or catastrophe.

Goals:

(1) Conduct a population viability analysis for the Javan rhinoceros.

(2) Formulate quantitative strategies with risk assessments to prevent extinction and achieve the objective of developing viable, self-sustaining populations within the historic range of the species.

Objectives:

(1) Determine numbers of rhinoceroses and subpopulations required for various probabilities of survival and preservation of genetic diversity for specified periods of time (i.e. 50, 100, 200 years).

(2) Consider how possible interventions in the wild population might increase its rate of growth and decrease its loss of genetic diversity.

(3) Project the potential expansion or decline of rhinoceros population numbers under various management regimes.

(4) Outline metapopulation structure needed to establish viable populations of each species. Indicate management consequences of this approach.

(5) Formulate quantitatively and evaluate role of captive propagation as a component of the strategy for the Javan rhinoceros. In particular, consider how captive propagation can:

a) accelerate expansion of population,

b) enhance preservation of genetic diversity,

c) protect population gene pool against fluctuations due to environmental vicissitudes in wild, and

d) provide animals for reinforcement of wild populations and establishment of new populations.

(6) Develop goals for the captive populations to provide rhinos for release to the wild without compromising the genetic diversity and demographic stability of the captive population.

(7) Identify problems and issues that need continuing analysis and research.

(8) Recommend courses of action.

(9) Produce a document presenting the results of the workshop.

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JAVAN RHINOCEROS

Rhinoceros sondaicus

POPULATION VIABILITY ANALYSIS

RECOMMENDATIONS

1. Continue and intensify protection of the rhinoceros population at Ujung Kulon. The major threats are poaching and disease. Removal of 1 animal every 2 years is sufficient to prevent population growth and is a threat to survival of this small population. Disease threats to the wild population should be evaluated.

2. Establish a captive breeding program in 1990 with the objectives of collecting as full a genetic representation of the wild population as possible and expanding the total captive population to 150 animals as soon as possible.

   a. Establish 2 protected captive populations as soon as possible to protect against loss of the species and to assist expansion of numbers. One of these populations should be located near a site on Sumatra selected for eventual reintroduction into the wild. One population might be located on Java either in a zoo or a facility that can be expanded to hold 15-25 animals. It is essential that all captured animals be placed in groups in facilities designed for secure management and breeding. A captive population also should be located outside of Indonesia to provide maximum security for the species.

   b. Remove 18-26 animals from the population at Ujung Kulon to establish the captive populations. This should be done with continuing evaluation, according to the suggested guidelines, of the experiences with capture and postcapture management and mortality. The wild population appears to be at carrying capacity which is limiting further growth. It can recover from this removal within 10 years if growth rates increase to 3.5+% as occurred during 1971-1981.

3. Expand the total captive population to a minimum of 80 - 100 animals with an annual growth rate of 3.5% before beginning a release program. This is necessary to protect the species gene pool and to have sufficient animals to supply a release program without jeopardizing the demographic security of the captive population and the species gene pool.

4. Plan to restore the Javan Rhinoceros to reserves throughout its historical range to a total population of at least 2000 animals and manage the individual populations as a single metapopulation.

5. Initiate a field research program, using radiotelemetry, with the Ujung Kulon rhino population to provide information on the population dynamics and ecology of the species in preparation for future reintroduction programs. This will also provide additional protection for the population.

6. Initiate molecular genetic studies on all of the animals, as captured, to evaluate remaining levels of heterozygosity and to assist in identifying pedigree relationships among the animals as a guide to the captive breeding program. These studies will also allow comparison with samples to be collected from the Vietnamese population to evaluate the relationships of the two populations.

7. Initiate serological and laboratory studies on the rhinos as a guide to their health status and disease history. Samples should also be collected from banteng as a baseline for any future disease outbreaks in the rhinos and banteng.

8. Initiate reproductive studies of the species, including cryopreservation of semen, to assist in captive breeding management, preservation of genetic material, and to determine if the wild population is having reproductive problems.

9. Establish a collaborative species recovery and management program to develop a genetic and demographic masterplan for the captive and wild populations and to develop the necessary resources to undertake these programs.

Captive Breeding Specialist Group

Species Survival Commission
International Union for the Conservation of Nature and Natural Resources
U. S. Seal, CBSG Chairman

Date: 2 April 1990

Subject: Javan Rhinoceros Project

From: U. S. Seal, CBSG

1. Three major recommendations of the Javan Rhinoceros PVA were to (a) protect and enhance the Ujong Kulon reserve, (b) establish two captive populations of Javan rhino in Indonesia, and (c) identify and prepare new sites to establish wild populations of the Javan Rhinoceros. It was stated that at least one of the captive facilities should be located at the first proposed reserve for reintroduction of the rhinoceros. The report identified Way Kambas on Sumatra as a likely first site for reintroduction.

2. The New Zealand government through its Ministry of External Relations and Trade, Development and Assistance Division has an agreement with Indonesia to provide on site experts and assistance totaling NZ $400,000 towards the development of Ujong Kulon as a National Park. They appear responsive to information and suggestions concerning the protection of the Javan rhino as a part of the process. CBSG will keep in close contact with the New Zealand activity (they have made a tentative offer for me to serve on an advisory committee) as this proceeds and Tom Foose (executive officer of the CBSG) will follow up with the New Zealand Embassy in Jakarta in May during his tenure as an instructor in the National Zoo training workshop in Indonesia.

3. Santiapillai and Widdodo in their report to WWF on Ujong Kulon made a set of specific suggestions for immediate support of the wardens responsible for patrolling the Ujong Kulon park amounting to about US $26,000. The Minnesota Zoo has offered in writing to the PHPA (I hand delivered the letters to Sutisna and Effendi during the Bali Mynah PVA Workshop in March) to respond to these requests and to provide limited staff assistance. A curator at the Minnesota Zoo has 3+ years field experience in Indonesia and speaks the language.

4. The projects to capture, establish a captive propagation program, and eventually reintroduce rhinos into new reserves have a number of significant components to coordinate and manage.

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These include:

(a) collection of information and a process to review and select candidate sites for a reintroduction program with an associated captive breeding facility. This information needs to be based upon maps and inventories of the entire reserve system in Sumatra and perhaps other parts of Indonesia as well. It could serve as a basis for country wide planning for wildlife in Indonesia including the Sumatran rhino, elephant, tiger, Komodo lizards, and numerous primate, bird, reptile, fresh water fish, and other species.

It is my understanding that maps suitable for such a survey may be available at a cost of US $8-10,000. I am seeking detailed information. It will require 2 people with a suitable 80386 computer and the necessary software to do the Sumatran survey. Much of the information is available in reports but has not been integrated into a usable form. We estimate the first year costs of this project at $120,000 including maps, hardware, and software. We are planning at two additional years at a cost of $75,000 per year.

(b) a process to develop a capture program with the associated resources to hold, treat, and transport captured animals. This will include people, material resources, a temporary holding facility, veterinary capability, protocols for capture, examination, and selection of animals to retain or release, local transport to a holding facility, and transport to the captive breeding facility (we have substantial experience with the capture program for Sumatran rhinos on Sumatra). Using this experience as a guide, the capture program will cost about $250,000 per year. We feel that should be more easily completed than the Sumatran rhino project and thus suggest planning for a 2 year capture operation. This should be monitored on a continuing basis and carefully reviewed at the end of the first year.

Animals to be released back into Ujong Kulon should be radio collared and monitored by a field team. This project will provide essential information on the movements and location of the animals, biology of the species, the status of the population, and on factors limiting the growth of this population. The costs for telemetry equipment will be about $30,000 and the annual operating costs will be about $75,000. This project should be limited to 3 years and emphasis should be placed upon training an Indonesian team to run the project as quickly as possible.

(c) development, construction, and staffing of the first captive propagation facility in association with the proposed reintroduction site. This facility should be large enough to hold 10 wild caught rhinos and a minimum of 20 offspring. It should have the capability to be expanded to hold additional animals in a pre-release facility for reintroduction into the reserve. This facility would include paddocks, barns, support facilities, visitor quarters, staff quarters, and an interpretive visitors center. It should have access to road and air transport to allow movement of animals to other sites in Indonesia since it will be necessary to establish at least one additional large captive breeding facility as well as satellite sites. Precise estimation of these construction costs will depend upon site selection and its characteristics. We would estimate that they will cost from $250,000 to $500,000. This estimate should include necessary equipment for the facility. There will also be staffing costs of about $100,000 per year in the initial phases and operating costs of perhaps $50,000 per year when occupied by rhinos.

(d) development of the reserve for reintroduction program. This may include wardens and guard posts, restoration projects, resolution of local conflicts with people and domestic animals, monitoring capability of released animals, and a more detailed survey and inventory.

(e) conduct of at annual review and planning workshops on the progress and needs of the project. The first of these would need to held during the later phases of the information collection described in (a) and (b) above. Such workshops cost about $10,000 primarily for travel and per diem expenses.

There will be substantial preparatory activity necessary for the first stage of the project concerning selection of people to undertake the field aspects of the capture operation (there are few qualified trappers available and the prime candidate would be Parkinson or at least his participation as an advisor).

The first of these meetings might take place in September to November of 1990 with the direct objective of preparing for the capture program and preparation of the first captive breeding facility. The facility will need to be prepared to receive the first animals within a month or two after capture depending upon adaptation of the animals to captivity and substitute foods. It may be advisable to have completed a memorandum of agreement with the Indonesian

Government to undertake the project and use this meeting to develop the details of the project. This will require the formation of a Trust or other legal entity to enter into such an agreement. CBSG would provide a coordinating function. The costs of this coordinating function (person, travel, operating costs) would be about $100,000 per year for the first 2 years and decline thereafter with completion of the capture operation, the captive facilities, the surveys, and initiation of the captive propagation activity.

5. Ancillary projects include

(a) clinical, parasite, and serological studies on all of the captured rhinos and perhaps a survey of domestic livestock in the vicinity of Ujong Kulon and the new breeding facility. These studies (excepting the domestic animals) will cost about $5,000.

(b) genetic studies on each of the captured rhinos to estimate levels of heterozygosity, relatedness of the rhinos in Ujong Kulon, and possible phylogenetic separation form the recently discovered population in Vietnam. These studies will cost about $15,000 total.

(c) a substantial public information and education for the populations around the new reserve site and Ujong Kulon with a view to their establishing a proprietary involvement in the project, the species, and the reserve. There are suitable models to guide the development of this program. The costs for this project will range from $25,000 to $60,000 per year depending upon the scope.

(d) a training program for Indonesian field workers, biologists, and managers in all aspects of the project. This would include on the ground training in Indonesia, short sessions abroad, and support of a few people for graduate training in wildlife management and reproductive biology. A training workshop will cost $15,000 - $25,000. More precise cost estimates can be obtained from Chris Wemmer based upon their experience in May. Overseas training periods of 4-8 weeks will primarily involve travel and per diem costs of about $5,000 per trip per person. Perhaps 2 people per year would be involved. Graduate training overseas would be for 1-2 year periods and cost perhaps $40 - 50,000 per year per person. The training of a rhino team would be in country and as a part of the capture program.

6. Budget estimates are noted for each of the proposed projects. More detailed costing will need further information, more detailed analysis, and people with the appropriate local knowledge.

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POPULATION VIABILITY ANALYSIS DATA FORM - MAMMALS

Species: Rhinoceros sondaicus (Desmarest). Javan Rhinoceros.

Species distribution: *Ujung Kulon National Park (Java);*
Vietnam - 1989; Cambodia, Malaya, Burma? Historically in Malaya, Burma, Thailand, Indochina, Java, Sumatra, parts of northern India. Most unconfirmed until sightings in Vietnam.
Study taxon (subspecies): *R. s. sondaicus*
R. s. annamiticus in Vietnam, Cambodia, Laos. R. s. inermis in Assam.
Study population location: *Ujung Kulon National Park. 30,000 hectares = 300 km².*
Metapopulation - are there other separate populations? Are maps available?:
(Separation by distance, geographic barriers?)
Only one population known in Indonesia.

Specialized requirements (Trophic, ecological):
Browser. Prefers coastal forest zones and swamps in the park. 190 plants (179 dicots) with 4 comprising 44% of diet (Spondia pinnata, Amomum sp, Leea sambucina, & Dillenia excelsa).

Age of first reproduction for each sex (proportion breeding):

a)Earliest: *Female - 7 yrs; Male - 7;*
55 M in captivity. (Both Indian)
b)Mean: *Females 8 yrs in captivity (up to 20 yrs)*
Males 10 yrs
Gestation period (days or weeks): *16 months*

Litter size (N, mean, SD, range)(at birth?, weaning?): *1*

Birth Season: *Unlikely. None for Indians.*

Birth frequency (interbirth interval): *4-9 years for Javan.*
8 - 9 years suggested by Amman. Very long. 3-4 years for Indian with one at 18 months following loss of calf at a few days.
Reproductive life-span (Male & Female, Range):
30 yrs? G = 16 yr (F); = 19 yr (M) (Indians in captivity).
(G = generation time)
Life time reproduction (Mean, Male & Female): *4 - 8.*

Adult sex ratio: *.64 : 1 based upon 17 sexed animals (6:11).*

Adult body weight of males and females: *1500 kg.*

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Social structure in terms of breeding (random, pair-bonded, polygyny, polyandry, etc; breeding male and female turnover each year?):

Solitary, females with young to about 3 years. No pair bonding. Male territory may overlap several females.

Proportion of adult males and females breeding each year:

? .113 of adult females (4 calves per year; assuming 70 animals, 83% adults and sex ratio 0.64:1.0. Estimated from footprints - difficult and little validation. If this age structure is correct, this is a dying population.

Dispersal distance (mean, sexes): *May move 15-20 km in a day.*

Migrations (months): *Move between feeding areas. Area with 5 deaths reoccupied by a male and female.*

Territoriality (home range, season): *Said to not have a stable home range. Female territory said to be 2.6-13.4 km2 and males 12.5 to 21 km2.*

Birth sex ratio: *1:1*

Birth weights (male and female):

Ovulation - induced or spontaneous: *Probably spontaneous.*

Implantation - immediate or delayed (duration): *Probably immediate. (About 3 weeks).*

Estrous cycles (seasonal, multiple or single, post partum):

Probably multiple and non-seasonal. Post partum possible but inhibited by lactation.

Duration of lactation: *About 12-18 months (Indian).*

Post-lactational estrus: *Probably at about 18 months postpartum.*

Age of dispersal: *Males 39.4 ± 4.8 months; Females 34.1 (Indian). This would be shortly before birth of next calf.*

Maximum longevity: *35 - 40 years.*

Population census - most recent. Date of last census. Reliability estimate.: *About 50 (census)-70 (extrapolation) in Ujung Kulon. April 1984. 10-15%?* See attached tables. Census and extrapolation methods.

1989: 57 (52 - 62) with no young detected. (Santiapillai, Widodo, & Bambang).

Projected population (5, 10, 50 years).: *Population has been stable for about 10 years.* Would be difficult to detect a change of 10% in any one year (± 5 animals). No calves were detected this year.

Past population census (5, 10, 20 years - dates, reliability estimates):

1955 30-35 (Hoogerwerf, 1970). 13 killed 1955-65.
1967 21-28 (Schenkel)
1980 54-70 (PHPA; Ammann). 1984 50-54 (Sadjudin).

Population sex and age structure (young, juvenile, & adults) - time of year.:

Alternate scenarios:	0 - 1 =	2.2	0.0	1.1 (2.2)
	1 - 6 =	6.10	6.6	6.6
	Adult =	12.16	18.26	18.26

Fecundity rates (by sex and age class):
Adult females - 0.11 calf per year. This implies greatly reduced reproductive rates (about 1 calf per 8 years) as compared to the Indian and other rhinos protected and in good habitat. Capable of 1 calf every 3 years. An alternative scenario is 1 calf per 4 years but a high infant mortality rate.

Mortality rates and distribution (by sex and age) (neonatal, juvenile, adult);
Uncertain but: Infant = 5 - 20%
Juvenile = 2 - 4 %
Adult = 8 - 9%

Population density estimate. Area of population. Attach marked map.:
50 animals in 30,000 hectare (300 km²) Ujung Kulon Park. 1 per 600 hectare. However perhaps only 1/3 of habitat is suitable.

Sources of mortality-% (natural, poaching, harvest, accidental, seasonal?).:
Disease.
Poaching: 1 in 1985 and 1 in 1987.

Habitat capacity estimate (Has capacity changed in past 20, 50 years?).:
Banteng (Bos javanicus) population increasing.
Vegetation changes occurring.

Present habitat protection status.:
National Park.

Projected habitat protection status (5, 10, 50 years).:
Park to remain protected?

Environmental variance affecting reproduction and mortality (rainfall, prey, predators, disease, snow cover ?).:
5 bodies (4 adults and 1 calf) found in 1982. Diagnosis uncertain. Data on sex and ages?
Volcano activity. Poaching. Disease. Rainfall?
Is pedigree information available?:
NO

Attach Life Table if available. *See attached tables.*

Date form completed: June 6, 1989

Correspondent/Investigator:

Name: U. S. Seal

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Apple Valley, Minnesota 55124
USA

Telephone: 612-431-9325

Fax: 612-432-2757

References:

Nardelli, F., W.S. Ramono, & T. Foose. 1987. Project to conserve the Javan rhinoceros - Rhinceros sondaicus Desm.
Sadjudin, . 1987.

Schnekel, R. and H. Schnekel. 1969.

Amman, Hartman. 1985.

Laurie, A. 1982.

Indian Rhino SSP Analyses. Rockwell, R. 1989.

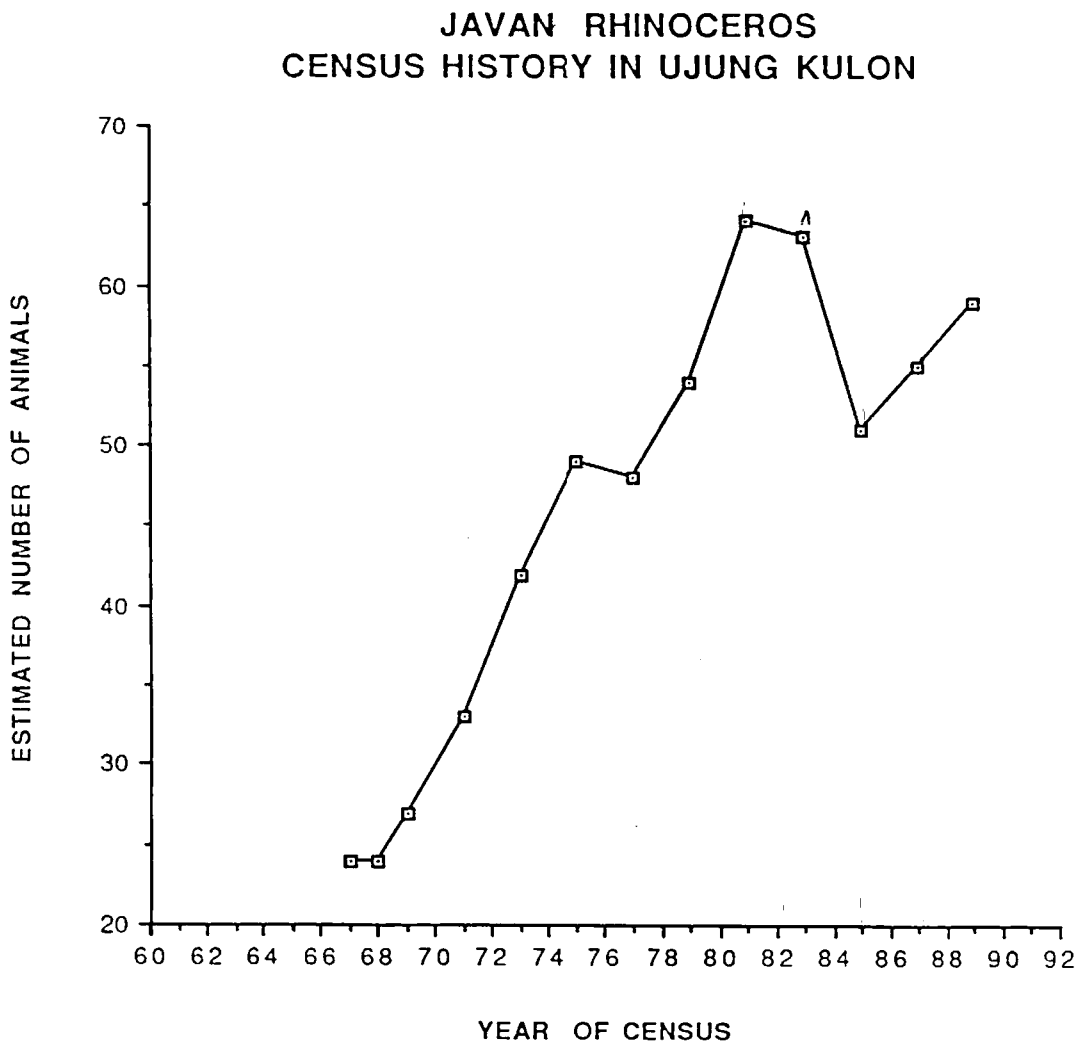
C. Santiapillai, S. R. Widodo, and P. D. Bambang. 1989.

Comments:

10 animals recorded in captivity during past 150 years (Reynolds, 1961). None now or in recent past. One lived 21 years.

Protected since the turn of the century in Ujung Kulon. Poachers and hunters took 16 in 1935-36, perhaps 20-25 in 1937. Estimated that 42 animals taken between 1930 and 1970, i. e. about 1 per year.

Population appears to have been stable in numbers for past 10 years. Interbirth interval is suggested to be about 8 years (would be 3 years in growing pop.),. Growth rate perhaps 4% now but was 10% from 1967 to 1974. Deaths in 1981-82 were in one area suggesting disease. These observations suggest that the population may be at carrying capacity of about 60 animals.


JAVAN RHINOCEROS
CENSUS HISTORY IN UJUNG KULON
ESTIMATED NUMBER OF ANIMALS
70
60
50
40
30
20
60 62 64 66 68 70 72 74 76 78 80 82 84 86 88 90 92
YEAR OF CENSUS

Population Projections if Ujung Kulon Not At Carrying Capacity

Year	If 52 Rhino in 1980 without '82 epidemic			If 52 Rhino in 1980 with '82 epidemic			If 60 Rhino in 1980 without '82 epidemic			If 60 Rhino in 1980 with '82 epidemic			If 110 Rhino in 1980 with 50% loss in '82		
	λ=7%	λ=5%	λ=3%	λ=7%	λ=5%	λ=3%	λ=7%	λ=5%	λ=3%	λ=7%	λ=5%	λ=3%	λ=7%	λ=5%	λ=3%
1980	52	52	52	52	52	52	60	60	60	60	60	60	110	110	110
1981	56	55	54	56	55	54	64	63	62	64	63	62	110	110	110
1982	60	57	55	55	52	50	69	66	64	64	61	59	55	55	55
1983	64	60	57	59	55	52	74	69	66	68	64	61	59	58	57
1984	68	63	59	63	57	53	79	73	68	73	67	63	63	61	58
1985	73	66	60	67	60	55	84	77	70	78	71	64	67	64	60
1986	78	70	62	72	63	56	90	80	72	84	74	66	72	67	62
1987	84	73	64	77	66	58	96	84	74	90	78	68	77	70	64
1988	89	77	66	83	70	60	103	89	76	96	82	70	82	74	66
1989	96	81	68	88	73	62	110	93	78	103	86	73	88	77	68
1990	102	85	70	95	77	63	118	98	80	110	90	75	94	82	70

If 52 Rhino in 1980
then rate of increase
from 1967 = 6% per year
or $\lambda = 1.06$

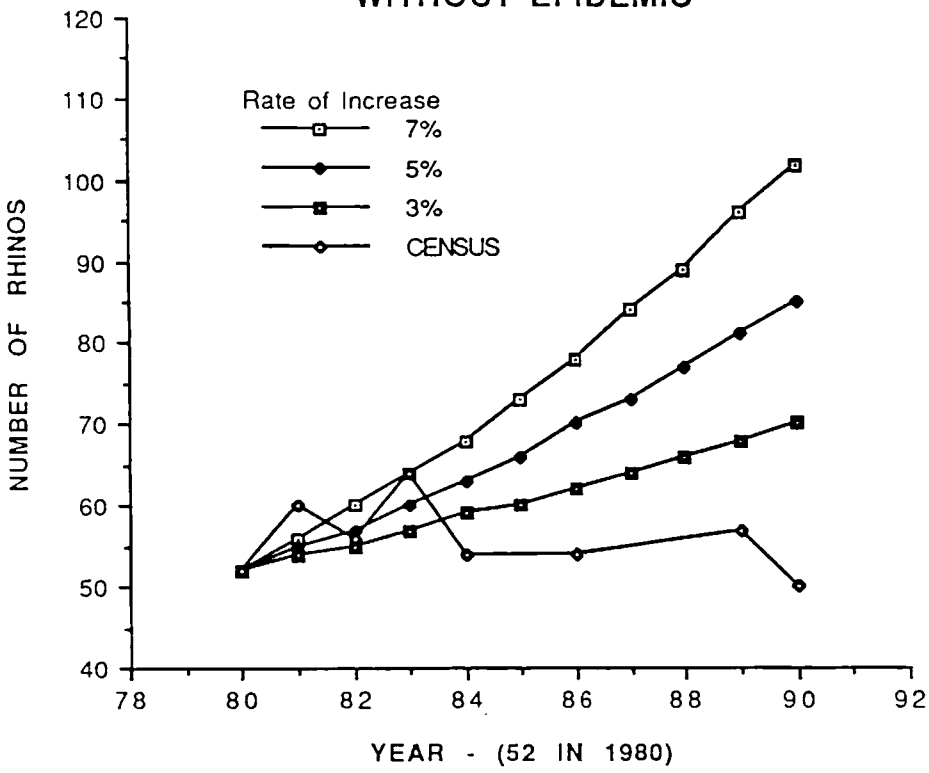
$\lambda^{T} = N_T/N_o$
$\lambda^{13} = N_{1980}/N_{1967}$
$\lambda^{13} = 52/25$
$\lambda = (52/25)^{1/13} = (2.08)^{.08}$
$\lambda = 1.06$

If 60 Rhino in 1980
then rate of increase
from 1967 = 7% per year
or $\lambda = 1.07$

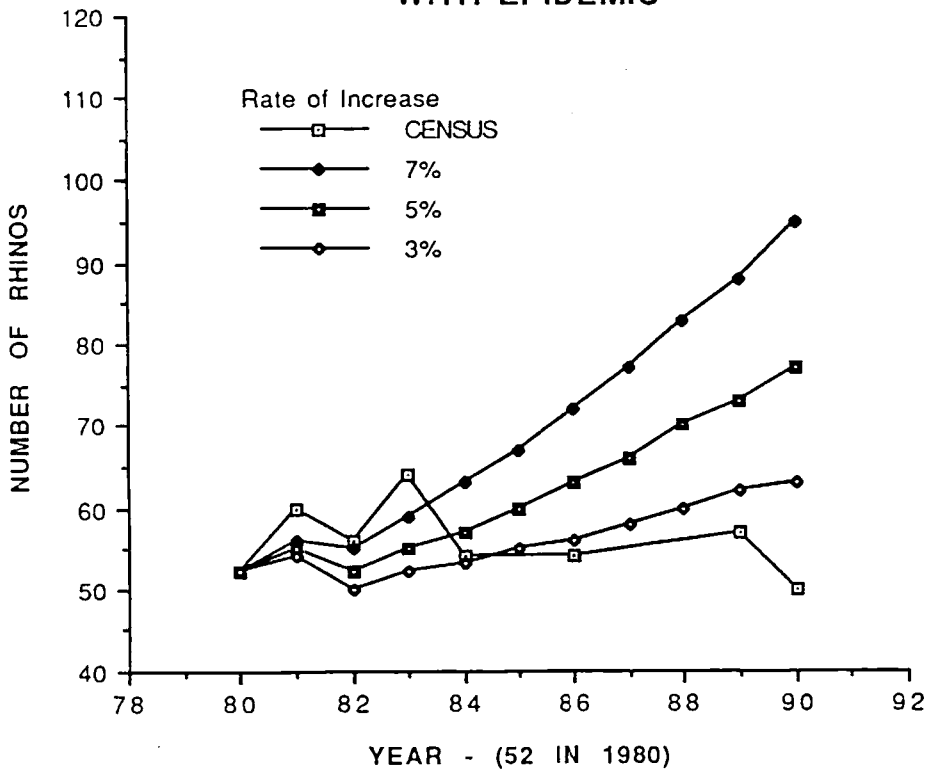
$\lambda^{T} = N_T/N_o$
$\lambda^{13} = N_{1980}/N_{1967}$
$\lambda^{13} = 60/25$
$\lambda = (60/25)^{1/13} = (2.4)^{.08}$
$\lambda = 1.07$

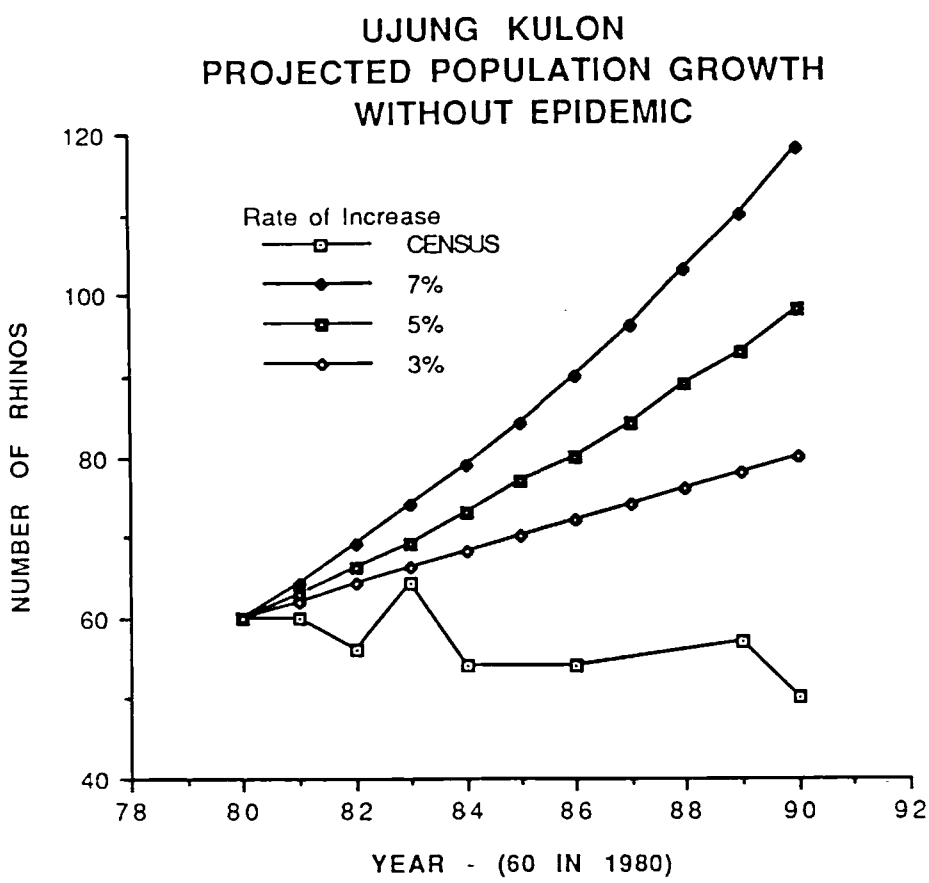
T. J. Foose
16 Aug. 91

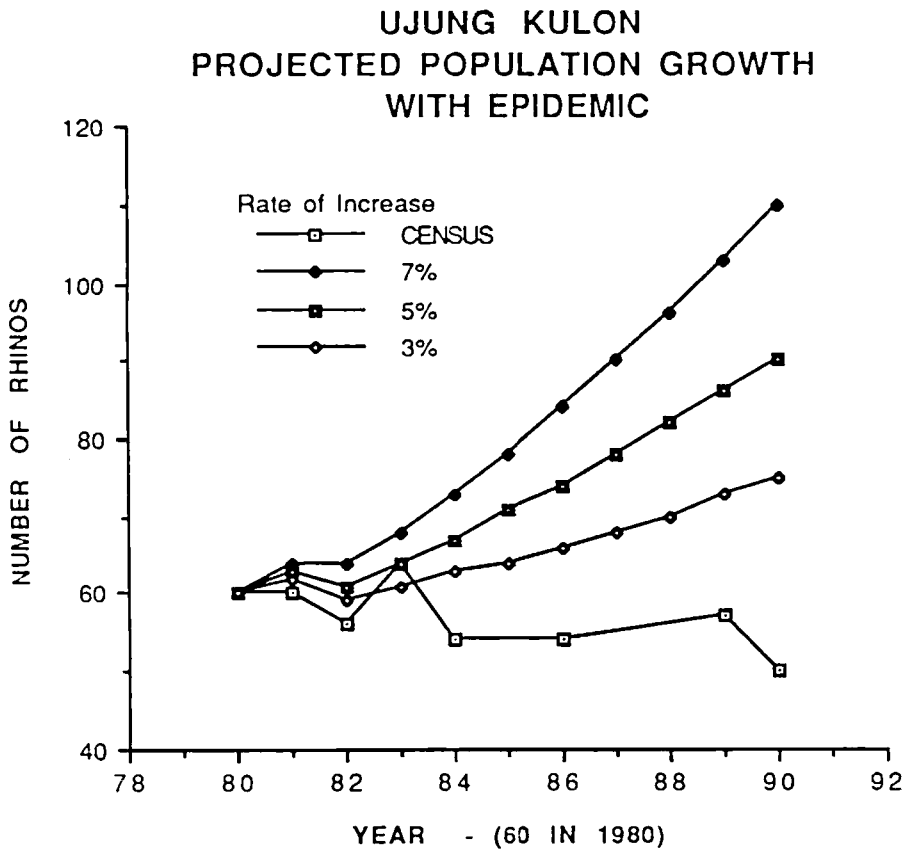
UJUNG KULON
PROJECTED POPULATION GROWTH
WITHOUT EPIDEMIC

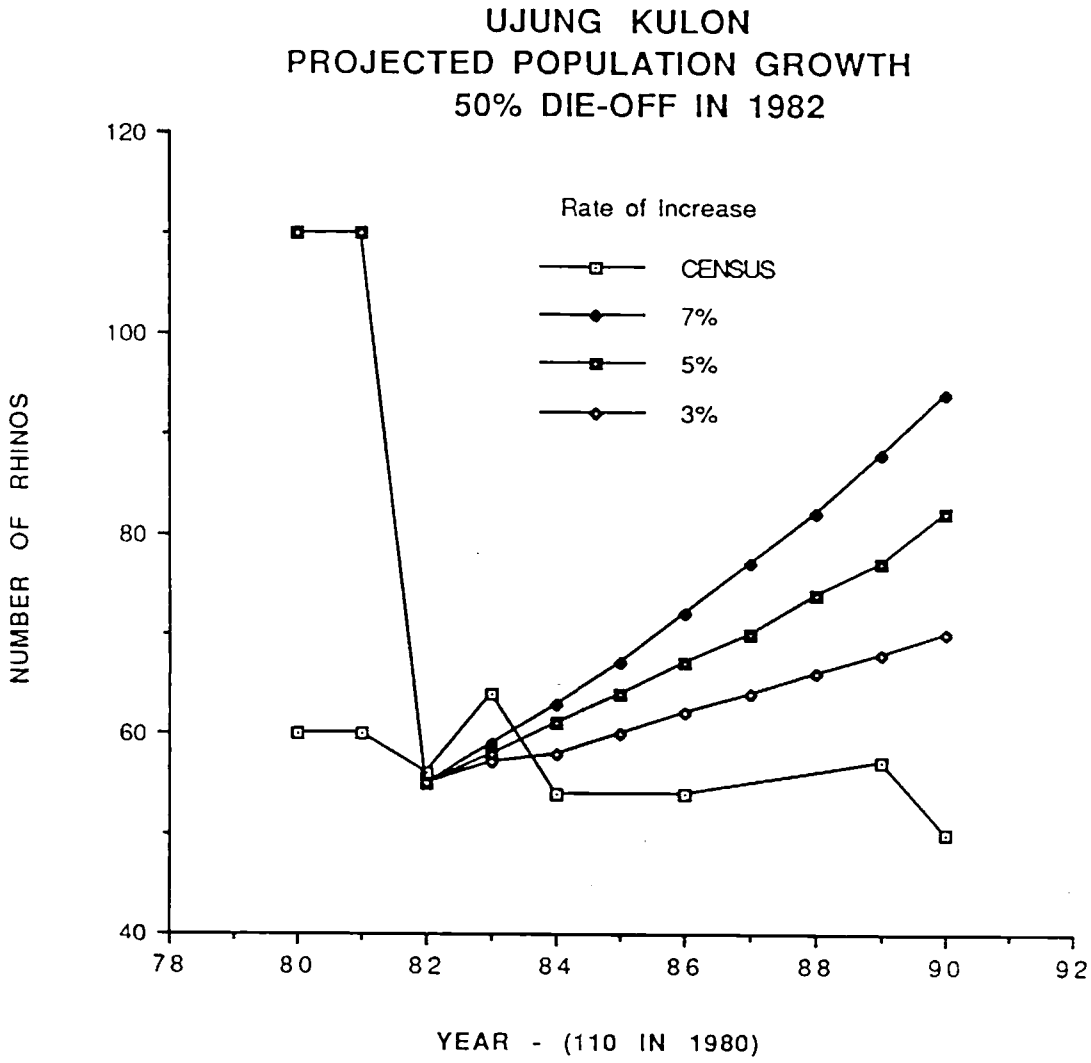


UJUNG KULON
PROJECTED POPULATION GROWTH
WITH EPIDEMIC




UJUNG KULON
PROJECTED POPULATION GROWTH
WITHOUT EPIDEMIC
Rate of Increase
CENSUS
7%
5%
3%
NUMBER OF RHINOS
120
100
80
60
40
78
80
82
84
86
88
90
92
YEAR - (60 IN 1980)


UJUNG KULON
PROJECTED POPULATION GROWTH
WITH EPIDEMIC
Rate of Increase
CENSUS
7%
5%
3%
NUMBER OF RHINOS
120
100
80
60
40
78
80
82
84
86
88
90
92
YEAR - (60 IN 1980)


UJUNG KULON
PROJECTED POPULATION GROWTH
50% DIE-OFF IN 1982
Rate of Increase
CENSUS
7%
5%
3%
NUMBER OF RHINOS
120
100
80
60
40
78
80
82
84
86
88
90
92
YEAR - (110 IN 1980)

EXPECTED LOSS OF GENETIC DIVERSITY

$$\Delta H = (1 - \frac{1}{2N_e})^G$$

ΔH = Fraction of Original Heterozygosity Surviving

N_e = Effective Population Size

G = Number of Generations

	If $N_e = 5$	If $N_e = 10$	If $N_e = 25$
Since 1955 i.e. 2 Generations	$\Delta H = (1 - \frac{1}{2(5)})^2$ $= (0.90)^2$ $= 0.81$	$\Delta H = (1 - \frac{1}{2(10)})^2$ $= (0.95)^2$ $= 0.90$	$\Delta H = (1 - \frac{1}{2(25)})^2$ $= (0.98)^2$ $= 0.96$
From 1955 to Year 2100 i.e. 7 Generations	$\Delta H = (1 - \frac{1}{2(5)})^7$ $= (0.90)^7$ $= 0.49$	$\Delta H = (1 - \frac{1}{2(10)})^7$ $= (0.95)^7$ $= 0.70$	$\Delta H = (1 - \frac{1}{2(25)})^7$ $= (0.98)^7$ $= 0.87$

T. J. Foose
15 Jan. 91