

Prospek Keberlanjutan Penangkaran Rusa Jawa (*Rusa timorensis* Blainville, 1822) Skala Kecil di Jawa

Intisari

Rusa Jawa merupakan salah satu satwa liar yang mempunyai potensi nilai ekonomi tinggi. Populasi rusa Jawa di alam mengalami penurunan karena perburuan liar yang tidak terkendali dan rusaknya habitat. Upaya menghindari kepunahan dan bisa memanfaatkan rusa secara optimal dan berkelanjutan dapat dilakukan melalui penangkaran. Sampai saat ini, perkembangan penangkaran rusa Jawa yang ada belum menunjukkan hasil mengembirakan. Informasi keberhasilan penangkaran rusa Jawa masih terbatas. Suatu review terhadap keberhasilan penangkaran rusa Jawa yang telah ada sangat dibutuhkan dalam rangka memberikan gambaran variasi pengelolaan penangkaran rusa Jawa yang sudah dilakukan serta informasi kendala dan masalah yang dihadapi dalam mengelola penangkaran rusa Jawa. Selain itu, sebagian besar kepemilikan lahan oleh masyarakat pedesaan di Indonesia kurang dari 5 ha, sehingga penangkaran rusa Jawa di pulau Jawa harus menghadapi tantangan terhadap kecilnya kepemilikan lahan ini. Oleh karena itu, penting untuk merancang penangkaran skala kecil, yang dapat diadopsi oleh masyarakat lokal untuk memenuhi kepentingan ekonomi mereka, dan konservasi spesies ini. Tujuan penelitian yaitu (1) review variasi pengelolaan dan problema berbagai penangkaran rusa Jawa yang telah dilakukan, (2) membuat model penangkaran rusa Jawa skala kecil yang dimulai dari mengkaji kelayakan lokasi yang diperuntukkan bagi penangkaran rusa Jawa dengan sistem *semi intensif* skala kecil, menyusun perencanaan pengelolaan penangkaran rusa Jawa dengan sistem *semi intensif*, dan melakukan evaluasi keberlanjutan penangkaran rusa Jawa skala kecil.

Penelitian untuk menjawab tujuan/permasalahan 1 dilakukan di beberapa penangkaran rusa Jawa yaitu penangkaran rusa Jawa Maliran, KPH Blitar dan KPH Ngawi (BUMN). Penangkaran rusa Jawa Bunder (BKSDA Yogyakarta) dan penangkaran rusa Jawa Dawe, Margorejo, Kudus (CV. Bahtera Satwa). Metode pengumpulan data dilakukan dengan pendekatan triangulasi, yaitu dengan cek dokumen (data sekunder), pengamatan di lapangan, dan wawancara. Metode triangulasi ini diterapkan pada setiap verifikasi sehingga informasi yang diperoleh bisa seakurat mungkin. Selanjutnya dari data-data tersebut dilakukan analisis komparatif terhadap aspek-aspek yang telah ditentukan dan dilakukan analisis deskriptif kualitatif terhadap pengelolaan yang dilakukan untuk mendapatkan kendala-kendala yang dihadapi. Sedangkan untuk tujuan 2 adalah menilai suatu lokasi yang merupakan bagian dari area PERUM PERHUTANI di Jawa Timur yang didedikasikan untuk pengembangan model penangkaran. Penilaian merupakan pertimbangan penting untuk mengeksplorasi kelayakan lokasi dan merancang alokasi ruang yang tersedia secara optimal. Pengumpulan data dilakukan untuk mengetahui kondisi bio-fisik kawasan dengan menggunakan metode nested sampling, circular plot, dan diagram profil. Ketersediaan pakan rusa Jawa diperoleh dengan mengidentifikasi jenis rumput dan menghitung produktivitasnya. Data yang terkumpul kemudian dianalisis dan dibandingkan dengan kebutuhan rusa Jawa. Lokasi yang terpilih kemudian dibuat desain penangkaran untuk alokasi ruang berdasarkan kebutuhan pengelolaan dan kebutuhan dasar Rusa Jawa. Rancangan manajemen penangkaran ditujukan untuk pengaturan populasi dan pemantauan kebutuhan pakan. Evaluasi keberlanjutan penangkaran ditekankan pada aspek populasi melalui perkembangan pertumbuhan populasi yang terjadi, peluang untuk melakukan pelepasliaran dan kemampuan untuk melakukan pembiayaan dan profit yang diperoleh dari analisis *cashflow* yaitu perbandingan antara hasil penerimaan atau penjualan kotor (*gross-sales*) dengan jumlah biaya-biaya pengeluaran (*total cost*).

Hasil penelitian tujuan 1 menunjukkan bahwa rancangan penangkaran dan fasilitas penangkaran sudah mempunyai peralatan yang memadai. Pencatatan data logbook/studbook telah dilakukan. Pengelolaan populasi menunjukkan perkembangan populasi yang mengalami peningkatan dari jumlah populasi awal. Pakan yang diberikan rata-rata sudah merupakan kombinasi antara hijauan dan pakan tambahan. Hanya satu penangkaran rusa Jawa yang sudah memanfaatkan hasil penangkaran. Kendala dan permasalahan yang dihadapi adalah permasalahan populasi seperti seringnya terjadi kematian, rendahnya produktivitas, dan rasio jenis kelamin yang mendekati tidak ideal. Sumber daya manusia dan sistem baru masih perlu meningkatkan upaya digitalisasi dalam pencatatan dan pelaporan. Sistem permohonan perizinan harus beradaptasi dengan *One Single Submission* (OSS) yang baru diperkenalkan. Biaya operasional pengelolaan masih terbatas. Terdapat variasi pengelolaan penangkaran rusa Jawa yang telah dilakukan. Beberapa kendala dan permasalahan masih sering ditemui dalam pengelolaan penangkaran rusa Jawa. Beberapa permasalahan kemudian dapat dicari solusinya melalui inovasi pengelolaan. Hasil penelitian tujuan 2 menunjukkan bahwa lokasi di RPH Malo dapat dinyatakan layak untuk dikembangkan sebagai kawasan penangkaran rusa Jawa. Pengembangan desain penangkaran yang diusulkan adalah sistem terbuka atau *mini ranching*. Desain penangkaran



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ini terdiri dari dua blok: blok pengelolaan dan blok perkantoran. Penyeleksian asal bibit rusa dan pengaturan sex rasio sangat diperlukan untuk mengurangi terjadinya *inbreeding* dan meningkatkan reproduksi secara optimal. Kebutuhan pakan rusa jawa di penangkaran kurang mencukupi sehingga perlu dibuatkan lokasi pakan rusa jawa di luar area penangkaran. Evaluasi keberlanjutan penangkaran rusa jawa menunjukkan dari dimensi ekologi, pertumbuhan populasi yang cenderung meningkat. Sementara dari dimensi ekonomi, berdasarkan perhitungan NPV, BCR, PP dan BEP menunjukkan kurang layak diteruskan. Walaupun demikian penangkaran ini perlu dipertahankan karena dari aspek konservasi dapat dikatakan berhasil karena rusa jawa berhasil dikembangkan dan dilestarikan. Agar penangkaran rusa mencapai kelayakan secara finansial maka perlu dilakukan peningkatan penerimaan, yaitu dengan melakukan inovasi untuk mengoptimalkan sumber-sumber potensial. Sementara kalau menggunakan skema memasukkan CSR, menunjukkan penangkaran rusa jawa skala kecil di RPH Malo, KPH Parengan secara finansial sudah layak, dan dari dimensi ekologi dapat dikatakan berhasil dimana rusa jawa berhasil dikembangkan dan dilestarikan.

Kata kunci: Rusa Jawa, Penangkaran, Keberlanjutan, Skala kecil, Jawa.

Prospects for the Sustainability of Small-Scale Javan Rusa (*Rusa timorensis* Blainville, 1822) Captive Breeding in Java

Abstract

Javan deer is one of the protected wild animals and has the potential for high economic value. The population of Javan deer in nature has decreased due to uncontrolled poaching and habitat destruction. To avoid extinction and to be able to optimally and sustainably utilize deer, this can be done through captive breeding. Only now, the existing captive Javan deer development has shown encouraging results. For that, we need a review of an overview of the variations in captive management of Javan deer that have been carried out and obtain information on various obstacles and problems faced in managing captive Java deer. Most land ownership by rural communities in Indonesia is less than 5 ha, so captive breeding for Javan deer on Java island has to face the challenge of small land ownership. It is, therefore, essential to design small-scale captive breeding, which local people can adopt to fulfill their economics and the conservation of this species. The objectives of the research were: (1) to provide the variations in managing Javan deer captive breeding and to obtain various problems encountered in managing Javan deer captive breeding, (2) to assess the feasibility of locations designated for Javan deer captive breeding with a small-scale, semi-intensive system, (3) prepare management plans for Javan deer captive breeding with a semi-intensive system, and (4) evaluating the sustainability of small-scale Javan deer captive breeding.

The research of objective 1 will be carried out in several captive Javan deer, namely the Javan deer captivity KPH Blitar, and KPH Ngawi (Perhutani). Bunder Javan deer captivity (BKSDA Yogyakarta) and CV. Bahtera Satwa (Private Javan deer captivity). The data collection method used a triangulation method, which collects secondary data, interviews, and field observations. Secondary data includes documents related to deer population regulation and management. The interview was conducted using a semi-structured questionnaire. Field Observation is intended to verify and obtain more detailed information about the verifier to be assessed. Furthermore, a comparative analysis was carried out on the aspects that had been determined, and a qualitative descriptive analysis obtaining the constraints faced. Meanwhile, for objective 2, we assessed a site, part of the PERUM PERHUTANI area in East Java, dedicated to model development of captive breeding. The assessment is an essential consideration in exploring the feasibility of the location and designing the optimal allocation of available space. Data collection was carried out to determine the bio-physical conditions of the area using a nested sampling, circular plot, and profile diagram method. The availability of Javan deer food was obtained by identifying the types of grass and calculating productivity. The collected data is then analyzed and compared with the needs of Javan deer. The selected location is then made for a site design. The captive management design is focused at regulating the population and monitoring food requirements. Evaluation of the sustainability of captive breeding emphasizes the population aspect through the development of population growth, opportunities for reintroduction and the ability to carry out financing and profits obtained from cashflow analysis.

The result of objective 1 showed that there are variations in the management of Javan deer captivity that have been carried out. Some problems are often encountered in managing Javan deer captivity. Some problems can then be sought for solutions through innovations in captive management. The result of objective 2 showed that the location in RPH Malo can be declared feasible to be developed as a Javan deer captive breeding area. The proposed captive site design development is an open system or mini ranching. This ranch consists of two blocks: the management block and the office block. Selecting the origin of deer breeds and regulating the sex ratio is very necessary to reduce the occurrence of inbreeding and increase optimal reproduction. The food requirements for Javan deer in captivity are insufficient, so it is necessary to create a feeding location outside the breeding area. Evaluation of the sustainability of Javan deer captive breeding showed that from the ecological dimension, population growth tends to increase. Meanwhile, from the economic dimension, based on NPV, BCR, PP and BEP calculations, it showed that it is not feasible to continue. However, this captive breeding needs to be maintained because, from a conservation aspect, it can be successful because Javan deer have been increased and conserved. For captive breeding to achieve financial viability, it is necessary to increase revenue, namely by carrying out innovations to optimize potential sources of revenue. Meanwhile, we use the CSR inclusion scheme. In that case, small-scale Javan deer breeding at RPH Malo, KPH Parengan, is financially feasible. From an ecological dimension, it can be successful because Javan deer have been successfully bred and preserved

Key words: Javan deer, Captive breeding, Sustainability, Small-scale, Java

1.2. Pembahasan

Secara keseluruhan sarana dan prasarana kandang penangkaran rusa jawa di lokasi yang diteliti sudah memenuhi ketentuan yang dipersyaratkan. 3 penangkaran rusa jawa yaitu penangkaran rusa jawa KPH Ngawi, BKSDA Yogyakarta dan CV. Bahtera Satwa termasuk penangkaran rusa jawa kategori skala kecil (*small scale*) karena memiliki luasan kurang dari atau sama dengan 1 hektar. Sementara penangkaran rusa jawa KPH Blitar termasuk dalam kategori skala besar karena memiliki luasan lebih dari 5 hektar.

Penangkaran satwaliar dengan skala kecil yang merupakan 90% dari *wildlife farming* telah dilakukan berbagai negara. Sebagai contoh, di Brasil yang menggunakan sistem produksi semi intensif, menggunakan area berpagar, dengan luasan mulai 5.000 m² (0,5 ha) hingga 40.000 m² (4 ha) yang dikelilingi oleh vegetasi arboreal (Nogueira-Filho 2004). Sementara di Oklahoma, *deer farming* dengan skala kecil menggunakan luasan area sekitar sekitar 1 ha yang terdiri atas *paddock-paddock* yang disusun dalam satu blok dengan gang di tengahnya (DeVuyst, 2017).

Setiap unit penangkaran wajib membuat buku induk (*Stud Book*) dan buku catatan harian (log book) mengenai pencatatan perkembangan seluruh stok jenis yang ada di dalam penangkaran. Buku catatan harian (*Log Book*) tersebut harus terbuka bagi petugas dalam rangka pembinaan dan kontrol serta bagi auditor atau tim penilai keberhasilan penangkaran dalam rangka penilaian pemenuhan standar kualifikasi.

Pengelolaan populasi di penangkaran satwa meliputi: pemilihan bibit rusa, pengelompokan rusa, perkembangan populasi rusa, monitoring sex ratio, pemeliharaan kesehatan, pencegahan inbreeding (Takandjandji, 2015). Perkembangbiakkan satwa dalam suatu usaha penangkaran merupakan hal yang sangat penting karena indikator keberhasilan usaha penangkaran dapat dilihat dari keberhasilan pengelola dalam mengembangkan satwa yang ditangkarkannya. Dalam suatu perkembangbiakkan perlu diperhatikan garis keturunan satwa yang akan dibiakkan, jangan sampai perkawinan *inbreeding*.

Salah satu komponen penting dalam pengelolaan satwa di penangkaran adalah ketersediaan tumbuhan pakan baik di dalam atau di luar areal penangkaran, yang menentukan daya dukung habitat. Pentingnya kualitas dan kuantitas pakan pada satwa yang dipelihara dalam penangkaran adalah karena pakan merupakan faktor pembatas, di mana rendahnya kualitas dan kuantitas pakan seringkali menjadi faktor kendala utama dalam penangkaran untuk tujuan produksi (Kwatrina et al, 2011).

Manfaat yang diperoleh dari penangkaran, selain aspek konservasi adalah objek eko-wisata (keunikan dan keindahannya) dan pemenuhan kebutuhan protein hewani serta hasil ikutan lainnya (keturunan ke-2/F2 dan seterusnya). Ditinjau dari dimensi ekonomi adalah usaha penangkaran dapat tetap memberikan keuntungan dan peningkatan pendapatan bagi penangkar sehingga usaha penangkaran dapat terus berjalan dan ditingkatkan kapasitasnya.

Resiko kematian akibat perkawinan antar pejantan dapat dikurangi dengan melakukan pengaturan sex ratio jantan dan betina yang ideal yaitu 1 : 4. Cara lain yang dilakukan adalah mengurangi jumlah jantan yang banyak dengan melakukan pengurangan untuk penjualan atau

menempatkan pada ruang/kandang baru sehingga tidak terjadi penumpukkan jumlah jantan dalam satu kandang yang sama.

Upaya untuk mempermudah administrasi dengan sistem digitalisasi meng-upgrade kemampuan SDM agar bisa menyesuaikan dan mengikuti sistem yang baru melalui pelatihan-pelatihan tertentu. Tenaga pengelola yang terbatas bisa diatasi dengan menambah tenaga pengelola dan dibuat system shift sehingga akan menghemat dalam biaya operasional pengelolaan. Kandang juga harus dibersihkan secara teratur tiap hari dan dijaga agar tetap kering. melakukan perbaikan kandang penangkaran dan secara bertahap melakukan perbaikan terhadap sarana pendukung yang rusak serta melengkapi sarana pendukung penangkaran yang diperlukan. melengkapi persyaratan yang diperlukan dalam mendapatkan ijin edar dan melakukan komunikasi intensif dengan instansi yang berwenang (BKSDA) agar bisa memberikan pendampingan dalam mendapatkan ijin edar. Penggalan sumber dana bisa dilakukan dengan mempercepat peluang mendapatkan dana melalui penjualan hasil penangkaran dengan mendapatkan ijin edar satwa terlebih dahulu. Menggandeng mitra untuk mengembangkan penangkaran rusa sebagai salah satu ikon pengembangan edukowisata.

2. Membuat model pengelolaan penangkaran rusa jawa skala kecil yang dapat diimplementasi

2.1. Mengkaji kelayakan lokasi yang diperuntukkan bagi penangkaran rusa jawa dengan sistem *semi intensif* untuk skala kecil.

2.1.1. Hasil

Kondisi fisik di lokasi RPH malo adalah aksesibilitas menuju lokasi mudah dijangkau baik pada musim kemarau maupun hujan, iklim termasuk tropis kering dengan curah hujan 1670 mm/tahun, suhu 26,5-30°C, kelembaban 51-71%, topografi Relatif datar, kelerengan 0.5-7,75 % dan sumber air berasal dari sumur tanah. Sedangkan kondisi fisik di RPH Parengan Utara adalah aksesibilitas menuju lokasi mudah dijangkau, tetapi berbatasan dengan jalan raya dan jalan desa. iklim termasuk tropis kering dengan curah hujan 1483 mm/tahun, suhu 27,5-30,5°C, kelembaban 54-65%, topografi Relatif datar, kelerengan 3,57-6,75 % dan sumber air berasal dari sumur musiman.

Kondisi bio-ekologi di lokasi RPH Malo adalah memiliki 5 jenis pada tingkat semai, 3 jenis pada tingkat pancang, 3 jenis pada tingkat tiang, 5 jenis pada tingkat pohon, dan 20 jenis tumbuhan bawah. Dari 20 jenis rumput dan tumbuhan bawah yang ditemukan di lokasi Malo, 15 jenis di antaranya merupakan tumbuhan yang dimakan Rusa Jawa. Tutupan tajuk cukup terbuka berkisar antara 8,33 hingga 50%, sedangkan tutupan tumbuhan bawah berkisar antara 16,67 hingga 83,33%. Hasil pengamatan tutupan semak berkisar antara 0 – 5,83%, sedangkan tutupan pancang, tiang, dan pepohonan sebesar 0. Perhitungan produktivitas pakan seluruh jenis rumput dan tumbuhan bawah sebesar 253,6 Kg. sedangkan produktivitas pakan jenis tumbuhan bawah dan rumput yang dimakan rusa adalah 174,5 Kg.

Kondisi bio-ekologi di lokasi RPH Parengan Utara adalah diperoleh 26 jenis rumput dan tumbuhan bawah, serta 1 jenis pohon yaitu Jati (*Tectona grandis*). Dari 26 jenis rumput dan tumbuhan bawah yang ditemukan, 8 di antaranya merupakan jenis tumbuhan pakan rusa. Tutupan tajuk berkisar antara 0-8,33%, sedangkan tutupan tumbuhan bawah antara 8,33-6,66%. Kisaran

tutupan semak adalah 0-10%. Perhitungan produktivitas seluruh jenis rumput dan tumbuhan bawah yang telah dilakukan adalah sebesar 186,5 kg. Sedangkan produktivitas hijauan jenis tumbuhan bawah dan rumput yang dimakan rusa adalah 64,47 kg.

Hasil gap analisis komponen fisik dan bio-ekologi kawasan menunjukkan bahwa lokasi di RPH Malo dapat dinyatakan layak untuk dikembangkan sebagai kawasan penangkaran rusa jawa.

2.1.2. Pembahasan

Kondisi Bio-Ekologis di RPH Malo menunjukkan bahwa tutupan vegetasi di kawasan tersebut cukup terbuka, dan hanya sedikit saja yang tertutup vegetasi. Kondisi vegetasi pada lokasi yang ada menggambarkan bahwa kawasan tersebut tidak terlalu tertutup oleh vegetasi sehingga pertumbuhan dan perkembangan tumbuhan bawah yang merupakan sumber makanan tidak terhambat. Kondisi pohon, tiang, dan pancang untuk cover dan fungsi shelter sebagai tempat berlindung (bersembunyi), cukup baik dan aman terutama pada saat melahirkan dan menyusui anak rusa.

Kondisi Bio-Ekologis di RPH Parengan Utara menunjukkan bahwa tutupan vegetasi pada kawasan tersebut terbuka dan sangat sedikit yang tertutup oleh vegetasi. Kondisi vegetasi pada lokasi tersebut memberikan gambaran bahwa kawasan tidak tertutup oleh vegetasi. Begitu pula dengan kondisi pohon, tiang, dan pancang sebagai cover dan fungsi shelter sebagai tempat berteduh (bersembunyi) sangat kurang sehingga kurang aman dan nyaman sebagai tempat terutama pada saat melahirkan dan menyusui anak rusa.

Komponen fisik di Malo memiliki curah hujan yang lebih tinggi dibandingkan Parengan Utara. Hal ini sangat bermanfaat bagi pertumbuhan dan perkembangan hijauan. Hu dkk. (2021) mengatakan informasi curah hujan dan jumlah hari hujan mempengaruhi arah penggunaan lahan. Kondisi iklim yang demikian menyebabkan air permukaan dan air tanah selalu tersedia, serta produktivitas tanah lebih baik sehingga pertumbuhan dan perkembangan vegetasi dan hijauan makanan tidak terhambat.

Komponen fisik dan bio-ekologi lokasi Malo dapat dinyatakan layak untuk dikembangkan sebagai kawasan penangkaran rusa jawa. Terdapat 15 jenis rumput dan tumbuhan bawah yang bisa dimakan oleh Rusa Jawa (*Rusa timorensis*). Lima jenis tumbuhan yang dapat berfungsi sebagai tempat berlindung, dan produktivitas jenis tumbuhan bawah dan rumput yang dimakan rusa mencapai 174,51 Kg. Selain itu, dari aspek satwa liar lain yang berada di lokasi penangkaran juga tidak ditemukan jenis hewan peliharaan yang dapat mengganggu keberadaan rusa.

2.2. Menyusun perencanaan penangkaran rusa jawa dengan sistem *semi intensif* yang meliputi perancangan tapak penangkaran dan rancangan manajemen penangkaran

2.2.1. Perancangan tapak penangkaran rusa jawa dengan sistem *semi intensif* untuk penangkaran skala kecil

2.2.1.1. Desain Tapak Penangkaran Rusa Jawa

Berdasarkan analisis lokasi dan penentuan alokasi lokasi pada berbagai unit pengelolaan, maka desain lokasi penangkaran rusa jawa terdiri dari 2 zona yaitu zona perkantoran dan zona penangkaran.

Zona perkantoran, merupakan areal yang berfungsi sebagai pusat pengelolaan dan pelayanan administrasi. Jenis bangunan yang terdapat di dalam zona perkantoran yang merupakan sarana dan prasarana penunjang kegiatan penangkaran rusa yang antara lain berupa kantor, pos jaga, gudang pakan atau obat-obatan, jalan kontrol, menara air, papan petunjuk dan informasi.

Zona Penangkaran, merupakan areal yang berfungsi untuk pengembangbiakan dan pembesaran serta pemeliharaan satwa untuk tujuan perkembangan populasinya. Sarana dan prasarana yang perlu ada di zona penangkaran ini adalah areal pemeliharaan, areal pembesaran, areal transit, bak air, menara/instalasi air, bangunan peneduh, dan jalan inspeksi.

Blok penangkaran/pengelolaan merupakan inti dari kegiatan penangkaran yang mempunyai fasilitas seperti tempat melahirkan, penyapihan, kandang jepit, shelter, tempat makan/minum, dan saluran air. Pierce dkk. (2015) mengatakan bahwa penentuan zona penangkaran rusa perlu mempertimbangkan persyaratan teknis, ekonomi, dan lingkungan.

2.2.2. Rancangan manajemen penangkaran

2.2.2.1. Pengelolaan populasi

Awalnya bibit rusa jawa yang didatangkan berasal dari satu lokasi yaitu penangkaran rusa jawa di Maliran, KPH Blitar. Jumlah rusa yang didatangkan sebanyak 11 ekor rusa jawa yang terdiri dari 4 rusa jawa betina dan 7 rusa jantan. Keberadaan bibit rusa yang hanya berasal dari satu lokasi akan menimbulkan beberapa permasalahan terutama menyangkut permasalahan genetika dan *performance* (tampilan) rusa. Problema tersebut diatasi melalui upaya untuk memperkaya keragaman genetik dengan melakukan penambahan rusa-rusa baru yang berasal dari lokasi yang berbeda dengan asal rusa yang sudah ada.

Dilakukan penambahan rusa baru yang berasal dari daerah Kudus, Jawa Tengah sebanyak 9 ekor yang terdiri dari 2 jantan dan 7 betina serta 1 rusa jawa betina dari penangkaran rusa KPH Ngawi. Setelah penambahan rusa – rusa baru ini maka jumlah populasinya menjadi 21 ekor dengan komposisi 12 rusa betina dan 9 rusa jantan dengan sex rasio 1 : 1,3.

Seleksi adalah segala hal menyangkut pemilihan hewan unggul yang akan dijadikan sebagai tetua untuk generasi berikutnya. Proses ini terjadi pula di alam bebas yang sering disebut sebagai seleksi alami. Di dalamnya individu-individu yang paling mampu beradaptasi dengan lingkungan (*the fittest*) akan dapat bertahan hidup untuk kemudian berkembang biak, sedangkan yang lainnya akan mati. Dengan demikian hanya materi genetik dari individu-individu terbaiklah yang diteruskan ke generasi berikutnya.

2.2.2.2. Pengelolaan Pakan Rusa Jawa

Rata-rata tingkat konsumsi pakan harian Rusa Jawa (*Rusa timorensis*) di penangkaran KPH Parengan adalah 5,5 kgBB/individu/hari. Tingkat konsumsi tersebut lebih rendah dari hasil yang diperoleh Teddy (1998) yang memperoleh rata-rata tingkat konsumsi harian sebanyak 5,88 kg BB/individu/hari. Rendahnya tingkat konsumsi dalam penelitian ini dapat dipengaruhi oleh dua hal. Pertama, adanya perbedaan jumlah dan spesifikasi rusa yang digunakan. Kedua, perbedaan terhadap kandungan air pada hijauan di kedua tempat. Berdasarkan tingkat konsumsi pakan harian

sebanyak 5,5 kg/individu/hari, maka kebutuhan pakan Rusa Jawa (*Rusa timorensis*) selama setahun sebanyak 2.008 kg/individu/tahun.

Mengingat ketersediaan pakan rusa di lokasi RPH Malo sangat sedikit, maka perlu dilakukan pengayaan dan penanaman jenis rumput dan semak yang dapat dimakan rusa jawa. Jenis rumput dan perdu yang dapat ditanam di area penangkaran rusa jawa. Biasanya ketersediaan pakan rusa di area penangkaran kurang mencukupi. Perlu dirancang untuk membuat lokasi pakan di luar area penangkaran yang dapat digunakan untuk menyuplai pakan bila diperlukan.

2.3. Evaluasi keberlanjutan penangkaran rusa jawa skala kecil

2.3.1. Dimensi Ekologi

Dimensi ekologi menekankan pada perkembangan populasi rusa di penangkaran. Pada pendugaan pertumbuhan populasi rusa jawa di Penangkaran rusa jawa Malo, KPH Parengan, nilai No yang digunakan adalah jumlah populasi rusa di penangkaran pada tahun 2014 yaitu 13 ekor dengan laju pertumbuhan populasi sebesar 27,3%. Selama jangka waktu 8 tahun menunjukkan pertumbuhan populasi yang cenderung meningkat (baik yang dipengaruhi faktor penjualan rusa, pemindahan, pengambilan maupun yang tidak).

Peraturan Menteri Kehutanan No. 19 tahun 2005 pasal 71 menyatakan bahwa Setiap penangkar yang melakukan penangkaran sebagaimana dimaksud dalam Pasal 4 ayat (1) huruf b dan huruf c, dan ayat (2) huruf a, wajib melakukan pengembalian ke habitat alamnya dari spesimen tumbuhan dan satwa hasil penangkaran dari jenis yang dilindungi yang telah memenuhi standar kualifikasi penangkaran sedikitnya 10% (sepuluh persen) dari hasil penangkaran.

Penangkaran rusa jawa di Malo, KPH Parengan berkewajiban melakukan pelepasliaran rusa jawa hasil penangkaran yang dikelola selama ini. Jumlah rusa jawa yang harus dilepasliarkan sebanyak 10% dari populasi yang ada sesuai peraturan menteri kehutanan. Kalau dihitung berdasarkan perkembangan populasi pada tahun 2017 yaitu 39 ekor maka akan diperoleh jumlah rusa jawa yang akan dilepasliarkan yaitu $10\% \times 39 = 3,9 \sim 4$ ekor. Penangkaran rusa jawa KPH Parengan berhasil melakukan pelepasliaran satwa hasil penangkaran sekaligus sebagai pemenuhan kewajiban pengembalian satwa hasil penangkaran ke habitat alamnya.

Terbitnya PermenLHK No. 18 tahun 2024 tentang Pemanfaatan Jenis Tumbuhan Dan Satwa Liar Dalam Bentuk Penangkaran, Pemeliharaan Untuk Kesenangan, Perdagangan, Dan Peragaan mengatur bahwa pelepasliaran satwa hasil penangkaran sudah tidak bersifat wajib lagi bagi penangkar.

2.3.2. Dimensi Ekonomi

Salah satu cara untuk melihat kemampuan pembiayaan dan profit bisa dilakukan melalui analisis kelayakan finansial. Analisis kelayakan finansial merupakan salah satu cara untuk menentukan sumberdaya finansial yang dibutuhkan untuk mendapatkan laba yang diharapkan (Kusmayadi dkk, 2017). Analisis finansial yang dilakukan pada dihitung berdasarkan realita bisnis yang terjadi di penangkaran rusa jawa Malo, KPH Parengan.

Hasil analisis finansial berdasarkan variabel pendapatan dan pengeluaran diperlukan analisis lebih lanjut mengenai analisis kelayakan finansial menggunakan perhitungan NPV, BCR, PP dan BEP. Nilai NPV penangkaran rusa ialah Rp. (382.560.750) atau negatif. Menurut Kusuma

(2012), nilai NPV yang positif menunjukkan bahwa proyek atau industri tersebut layak untuk dilaksanakan sementara nilai NPV negatif berarti proyek tidak layak dilakukan. Hasil analisis, BCR adalah 0 (nol) maka usaha tersebut tidak layak (*unfeasible*) sebab dalam sebuah usaha BCR harus > 1 . nilai Payback Period mencapai 26,2 tahun melebihi umur ekonomis penangkaran rusa yang hanya 20 tahun. Suatu usaha menjadi layak dan optimis jika Payback Period lebih singkat atau dibawah umur ekonomis (Kusuma, 2012; Arwati, Sedana, & Artini, 2016). Investasi penangkaran rusa ini menjadi tidak layak sebab waktu pengembalian modal terlalu lama dibandingkan umur ekonomis. Hasil analisis menunjukkan bahwa BEP jumlah rusa yang terjual seharusnya 69 ekor, sehingga kalau yang terjual hanya 20 ekor maka untuk mencapai BEP harga rusa Rp 29.220.000/ekor. Secara finansial, BEP sulit tercapai dikarenakan beban biaya awal pembangunan sangat tinggi.

Walaupun demikian penangkaran ini perlu dipertahankan karena dari aspek konservasi dapat dikatakan berhasil karena rusa jawa berhasil dikembangkan dan dilestarikan. Agar penangkaran rusa mencapai kelayakan secara finansial maka perlu dilakukan peningkatan penerimaan, yaitu dengan melakukan inovasi untuk mengoptimalkan sumber-sumber potensial penerimaan.

Sementara kalau menggunakan skema dengan memasukkan sumber pendanaan dari CSR Pertamina EP 4 Cepu maka hasil yang diperoleh menunjukkan perbedaan. Hasil analisis finansial menggunakan perhitungan NPV, BCR, PP dan BEP menunjukkan nilai NPV penangkaran rusa ialah Rp. 41.564.250. Menurut Kusuma (2012), nilai NPV yang positif menunjukkan bahwa proyek atau industri tersebut layak untuk dilaksanakan. Hasil analisis, BCR adalah 1,08 maka usaha tersebut layak (*unfeasible*) sebab dalam sebuah usaha BCR harus > 1 . Nilai *Payback Period* mencapai 7,8 tahun tidak melebihi umur ekonomis penangkaran rusa yang hanya 20 tahun. Suatu usaha menjadi layak dan optimis jika *Payback Period* lebih singkat atau dibawah umur ekonomis (Kusuma, 2012; Arwati, Sedana, & Artini, 2016). Investasi penangkaran rusa ini menjadi layak sebab waktu pengembalian modal tidak lama dibandingkan umur ekonomis. Hasil analisis menunjukkan bahwa BEP jumlah rusa yang terjual seharusnya 16 ekor (rusa jawa yang terjual 20 ekor), sehingga sudah mencapai BEP.

D. KESIMPULAN

Kesimpulan yang bisa diambil dari kajian penelitian adalah sebagai berikut :

1. Terdapat variasi pengelolaan penangkaran rusa jawa pada penangkaran rusa jawa KPH Blitar, KPH Ngawi, BKSDA Yogyakarta dan CV. Bahtera Satwa dari aspek Kondisi umum penangkaran, Pengelolaan Administrasi, Pengelolaan Populasi, Pengelolaan Habitat (pakan), dan Pemanfaatan hasil penangkaran. Kendala dan permasalahan yang dihadapi adalah permasalahan populasi seperti seringnya terjadi kematian, rendahnya produktivitas, dan rasio jenis kelamin yang mendekati tidak ideal. Sumber daya manusia dan sistem baru masih perlu meningkatkan upaya digitalisasi dalam pencatatan dan pelaporan. Sistem permohonan perizinan harus beradaptasi dengan *One Single Submission* (OSS) yang baru diperkenalkan. Biaya operasional pengelolaan masih terbatas. Terdapat variasi pengelolaan penangkaran rusa jawa yang telah dilakukan. Beberapa kendala dan permasalahan masih sering ditemui dalam



pengelolaan penangkaran rusa jawa. Beberapa permasalahan kemudian dapat dicari solusinya melalui inovasi pengelolaan penangkaran.

2. Terciptanya model penangkaran rusa jawa skala kecil dengan luas kurang dari 1 hektar dengan tahap pembuatan, rancangan pengelolaan penangkaran rusa jawa sampai evaluasi keberlanjutannya sebagai berikut;
 - a. Lokasi yang terpilih sebagai model penangkaran rusa jawa skala kecil memiliki kelayakan bio-fisik untuk dijadikan sebagai lokasi penangkaran rusa jawa skala kecil;
 - b. Pengelolaan rusa jawa skala kecil memerlukan perancangan tapak untuk mengatur alokasi ruang dan penataan sarana-prasarana yang diperlukan untuk penangkaran rusa jawa. Perancangan manajemen penangkaran juga diperlukan untuk pengelolaan penangkaran rusa jawa yang terdiri dari Pengaturan Populasi yang meliputi seleksi bibit rusa jawa dan pengaturan sex rasio, Pengaturan Pakan yang meliputi tingkat konsumsi pakan dan pembuatan lokasi hijauan pakan, dan Pengelolaan kebutuhan dasar lain rusa jawa yang meliputi pemeliharaan vegetasi penanung, pengelolaan air minum, pengelolaan *hygiene* dan sanitasi lokasi penangkaran;
 - c. Prospek keberlanjutan pengelolaan penangkaran rusa jawa untuk skala kecil menunjukkan penangkaran rusa jawa skala kecil di RPH Malo, KPH Parengan secara finansial belum layak, namun usaha penangkaran rusa jawa tersebut sebaiknya masih terus berlanjut karena dari dimensi ekologi dapat dikatakan berhasil dimana rusa jawa berhasil dikembangkan dan dilestarikan.
 - d. Sementara kalau menggunakan skema memasukkan CSR, menunjukkan penangkaran rusa jawa skala kecil di RPH Malo, KPH Parengan secara finansial sudah layak, dan dari dimensi ekologi dapat dikatakan berhasil dimana rusa jawa berhasil dikembangkan dan dilestarikan.

LAMPIRAN

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The importance of regulatory compliance in wildlife captive breeding: Case study from deer captive breeding in Indonesia

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Abstract. Subeno, Pudyatmoko S, Imron MA, Widi TSM. 2022. *The importance of regulatory compliance in wildlife captive breeding: Case study from deer captive breeding in Indonesia. Biodiversitas 23: 6128-6136.* Indonesia has five deer species that the Indonesian government protects. Among these deer, Javan deer (*Rusa timorensis*) and sambar deer (*Rusa unicolor*) have received conservation attention through captive breeding. Despite this conservation approach being applied for these two species, a review on captive breeding implementation is still lacking. This research aimed to assess the management of captive breeding of two deer species, which will support the natural population of endangered species in Indonesia. A triangulation method is used to collect secondary data (documents), interviews, and field observations in Parengan of East Java for Javan deer and Dumai of Riau for sambar deer. Then we assessed the management aspect and the ability of captive breeding to contribute to the release program using descriptive qualitative analysis. The Pertamina RU 2 Dumai sambar deer captive breeding has been carried out since 2016. However, during four years of management, the documents required for captive management, assessed by the Nature Resources Conservation Agency (Balai Konservasi Sumber Daya Alam/BKSDA), were not fully available. Consequently, the population increment in captive breeding could not participate in the release program. The Parengan Javan deer captive breeding was built in 2014. Management documents, population and habitat management were carried out intensively. As a result of the assessment by BKSDA East Java, this captive breeding received an excellent value (A). The population development showed an increasing trend. The results of this population development are then taken 10% to be released into the wild. In 2018, 4 captive-breed Javan deer were released in their natural habitat of Tahura R. Soeryo, East Java. The implication is that captive breeding, which is managed through proper management of population, habitat, and infrastructure, can contribute to supporting the addition of wildlife populations in their natural habitats.

Keywords: Assessment, captive breeding, Javan deer, Sambar deer, triangulation method

INTRODUCTION

The sambar deer (*Cervus unicolor*) and Javan deer (*Rusa timorensis*) are native species of Indonesian deer protected by law. Their population numbers continue to decrease due to illegal hunting and increasing habitat degradation (Krisna et al. 2020; Giarat et al. 2021). Many efforts can be made to protect endangered animals under human pressure or change their habitat to conserve natural resources. To avoid extinction and simultaneously utilize deer optimally and sustainably, this can be conducted through captivity (ex-situ conservation) (Rasyidi et al. 2020). Captive breeding is a technique of breeding animals that are managed in a particular place to increase the population, and then they can be released back into nature (Ralls and Ballou 2013). The government carries out efforts to protect and make

sustainable use of the potential of sambar deer (*Cervus unicolor*) and Javan deer (*Rusa timorensis*) as protected animals in Indonesia through captive breeding (Semiadi and Jamal 2015). To ensure that captive activities can run properly and correctly, the Government of the Republic of Indonesia has issued a Government Regulation No. 8 of 1999 concerning the use of wild plant and animal species, and captive breeding is a form of ex-situ conservation and utilization justified by the regulation (Kasso and Balakhrisnan 2013; McCleery et al. 2014; Hutapea et al. 2021).

Wildlife captivity is one of the conservation and utilization programs for conservation and economic purposes (Skonhoft et al. 2013). Individuals, legal entities, cooperatives, or conservation organizations can carry out captive breeding. The results of captive deer also have the



prospect of being developed on a commercial cultivation scale to fulfill the function of the forest as a food source (Adji 2015; Miller and Miller 2016). In the formula to obtain the optimal solution for the development of captive deer, it is necessary to consider carrying capacity and still pay attention to development for conservation purposes (Broom 2019; Krisna et al. 2020). The habitat's carrying capacity components include cover, water, and space used to obtain food, shelter, water, and breeding area (Noonan and MacFarlane 2012; McComb 2016). The space in the habitat depends on the size of the animal species (Frynta et al. 2013; Landaa et al. 2017).

Regarding the utilization of the area for captive breeding, there are at least two choices of captive systems that can develop, namely ranching and farming (Takandjandi 2015; Taylor et al. 2015; Ho et al. 2018; Krisna et al. 2020). One of the essential considerations that must be done first is the design of the optimal allocation of available space to suit the functions and needs of the site in the development of a captive deer unit (Yang et al. 2016; Selvarajah et al. 2022). The facilities and infrastructure used in captive deer follow SEAZA (Southeast Asian Zoos and Aquariums Association) standards (SEAZA 2019).

Pertamina RU 2 Dumai (A state-own enterprise produces a variety of fuel oil and non-fuel oil to meet domestic and foreign needs, including to meet the fuel needs of Riau and northern Sumatra as well as southern parts. Doing business in the oil and petrochemical processing sector that is managed professionally and with an environmental perspective) has started to make efforts to conserve the sambar deer through deer breeding activities that had carried out since 2016 (Imron et al. 2021). Meanwhile, Pertamina EP 4 Cepu (An upstream subsidiary of PT. Pertamina (Persero) is engaged in upstream oil and gas business activities with a mining working area in the Cepu Block and commits to responsible operating activities through Social and Environmental Responsibility activities) has started to make efforts to conserve the Javan deer through deer breeding activities that had carried out since 2014 (Subeno and Mukhlison 2016). The Sambar and Javan deer are protected animals, so in captivity, they need permission from the authorized institution. Applying for a captive permit must meet the requirements for the legality of bred animals, infrastructure, documents, and management institutions. After at least two years, the manager can submit a captive assessment to the authorized institution (Anugrah 2018). The assessment results will determine whether improvements still needed or get an opportunity. If a breeding permit is obtained, there is an opportunity to take advantage of the obtained derivatives for Edu-ecotourism or commercial development while simultaneously carrying out the obligations that must be fulfilled, namely conducting releases to support deer populations in the wild (Tensen 2016; Arini et al. 2020).

Methodological triangulation or mixed-methods research uses more than one kind of method to study a phenomenon. Triangulation method is a data collection technique that combines various data collection techniques and existing data sources (Mertens and Hesse-Biber 2012).

Methodological triangulation has been found to be beneficial in providing confirmation of findings, more comprehensive data, increased validity, and enhanced understanding of the studied phenomenon. With triangulation, researchers can use two research methods to decrease the weaknesses of an individual method and strengthen the outcome of the study. Data triangulation using different sources of data. This includes different times for data collection, difference places from which to collect the data, and different people who could be involved in the research study. Triangulation can be used in quantitative and qualitative research, and it even seems as though triangulation is just another term for mixed-methods research. The Journal of Mixed Methods Research has a special issue devoted to analyzing and exploring the various ways triangulation is used in mixed.

Deer captive breeding at Pertamina RU 2 Dumai and Pertamina EP 4 Cepu has been running for almost five years. It is appropriate to start submitting an assessment or audit to determine the success of the breeding. Therefore, this study is essential to assess the management of captive breeding of two deer species, which will serve as crucial management measures for captive breeding of endangered species in Indonesia and supporting the natural population of endangered species in its habitat.

MATERIALS AND METHODS

Study area

Locations of area study were Parengan of East Java for Javan deer captive breeding and Dumai, Riau for Sambar deer captive breeding. Both captive breedings received support for establishment and earlier management assistantship by state-own enterprises of Pertamina EP 4 Cepu for the Parengan captive breeding and Pertamina RU II Dumai for the Sambar deer captive breeding in Dumai, Riau province. Pertamina RU 2 Dumai has started the sambar deer captive breeding since 2016. Meanwhile, Pertamina EP 4 Cepu has started the Parengan Javan deer captive breeding since 2014. KPH Parengan is part of PERUM PERHUTANI (the state-own forest company) area in Bojonegoro, East Java which is dedicated to the development of captive breeding.

Data collection

A triangulation method is used to collect secondary data (documents), interviews, and field observations (Thamhain 2014; Hopf et al. 2016; Moleong 2018; Shin et al. 2022). Secondary data includes captive licensing documents, documents related to deer population regulation and management (origin of deer, genealogy, marking/tagging, and population development reports), captive management institutional documents, and captive assessment documents by the authorized institution (BKSDA). The interview was conducted using semi-structured question and answer with the management and staff of the deer breeding management, which was guided by questions as the topic of conversation and a control direction. Key persons were chosen by

purposive sampling (Etikan et al. 2016). Field Observation is intended to verify secondary data/document information and interview results and obtain more detailed information related to the verifier to be assessed (Natow 2020). Direct observation was conducted to see captive facilities and

infrastructure, supporting facilities built in the cage area, forage planting areas, supporting buildings: guard house/guard post, feed and tool warehouse, and availability of experts. This triangulation method is applied to each verifier so that the information obtained can be accurate.

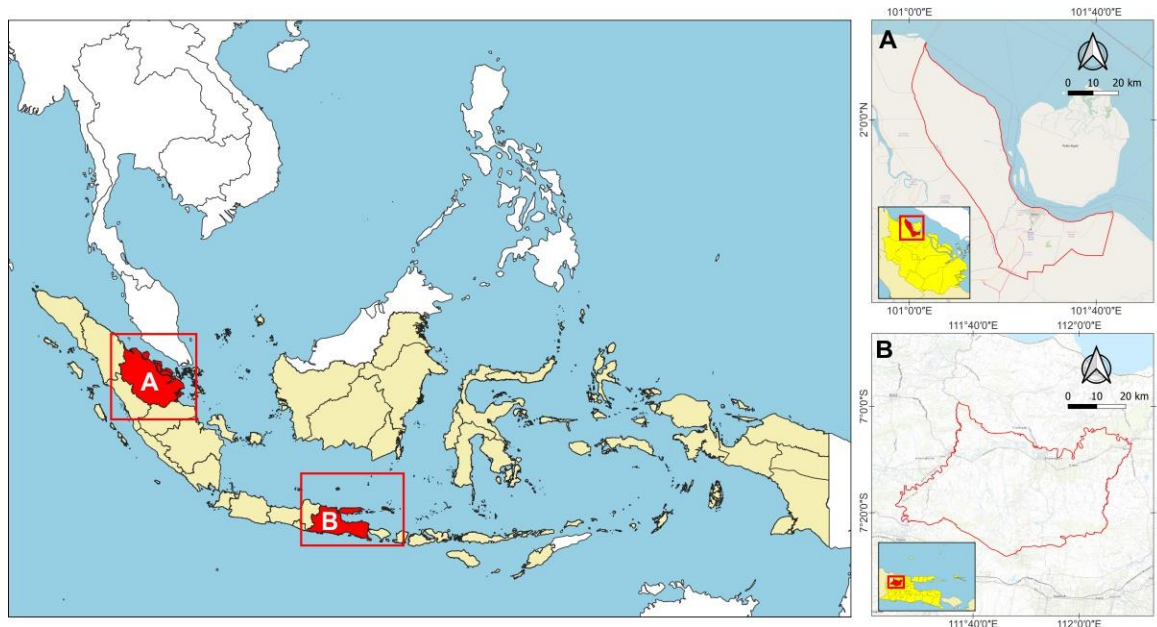


Figure 1. Study area. A. Sambar deer captive breeding at Pertamina RU II Dumai, Riau, Indonesia; B. Javan deer captive breeding at Malo, Parengan, East Java by Pertamina EP 4 Cepu, Central Java, Indonesia

Data analysis

To see the suitability of Java deer captivity that has been managed following captive management standards, the data obtained then carried out a comparative analysis of the aspects that have been determined, such as availability of documents needed in captivity, deer captive breeding infrastructure, population management of deer captive breeding, and habitat management of deer captive breeding. After that, an assessment of the management aspect and the ability of captive breeding to contribute to the release program used descriptive qualitative analysis.

RESULTS AND DISCUSSION

A captive assessment by an authorized institution (BKSDA) was conducted on a captive activity to determine the success of the captive management. This assessment was a means to carry out guidance by the authorized institution (BKSDA) and, simultaneously, could provide incentives for successful captive managers. Captive success could be achieved if, in the assessment carried out, the predicate is A or B (Perdirjen PHKA Number P. 6/IV-SET/2011).

Availability of documents needed in captivity

Based on the search for important documents needed in the implementation of a captive activity at the captive

sambar at Pertamina RU 2 Dumai and the captive Javan deer at Pertamina EP 4 Cepu, the following results were obtained Table 1.

One of the requirements needed in applying for a captive breeding permit is proof of the legality of the origin of the bred wildlife. Meanwhile, in captivity of the sambar deer at Pertamina RU 2 Dumai, there is no legal document on the origin of the sambar deer. So, in the future, it is necessary to strive for the availability of legal documents of the origin of this wildlife to strengthen further the deer breeding permit that Pertamina RU 2 Dumai obtained.

Deer captive breeding infrastructure

The following results were obtained based on direct observations of the existing infrastructure in captivity for sambar and spotted deer at Pertamina RU 2 Dumai and the captive Javan deer at Pertamina EP 4 Cepu and interviews with managers, as presented in Table 2.

Population management of deer captive breeding

The manager of Javan deer captive breeding Pertamina EP 4 Cepu did this activity by recording the development of the population through a studbook. Every birth or death that occurs is recorded in the document. The genealogy of the individual Javan deer clarify by every birth of an individual that can survive is marked by tagging. Meanwhile, no document on population development could be found at



Sambar deer captive breeding the Pertamina RU II Dumai based on documents, interviews, and field observations. Until 2020, we can see the development of the Javan deer population in the Pertamina EP 4 Cepu Javan deer captivity, as presented in the following Table 3.

Habitat management of deer captive breeding

Habitat management is necessary to realize deer captivity that can provide environmental conditions close to their natural habitat. This activity should the manager do so that the deer feel comfortable, and their welfare fulfilled so they can grow and develop optimally and have good reproductive abilities. Until 2020, habitat management done by Javan deer captive breeding of Pertamina EP 4 Cepu is presented in the following Table 4.

Table 1. Availability of documents needed in captive breeding

Secondary data	Pertamina RU II Dumai		Pertamina EP 4 Cepu	
	Completeness of data		Completeness of data	
	Yes	No	Yes	No
Captive permit document,	√		√	
Document Legality of parent origin		√	√	Yes
Document Availability Master Book (Stuudbook)/Log Book		√	√	Yes
Document marking or tagging of species in captivity		√	√	Yes
Population development document:		√	√	Yes
a. Growth of tillers				
b. Mortality Rate				
Reporting and planning documents:		√	√	Yes
a. Monthly report				
b. The annual work plan				
Captive Management Institutional Documents		√	√	Yes, so far the management is under the responsibility of HSSE and KPH Parengan assisted by 2 keepers.
Captive assessment document by the authorized institution (BKSDA).		√	√	Yes



Table 2. Captive Breeding Infrastructure in captive breeding

Type	Pertamina RU II Dumai			Pertamina EP 4 Cepu		
	Availability		Eligibility (condition and quality)	Availability		Eligibility (condition and quality)
	Yes	No		Yes	No	
Captive breeding facilities and infrastructure, including :						
a. Main cage						
b. Weaning/enlargement cage	√		• Not have a transit enclosure to carry newly-imported deer	√		• Already have a transit enclosure to carry newly-imported deer
c. Handling/treatment cage		√	• The handling cages are not suitable for captive standards	√		• The handling cage is suitable for captive breeding standards
d. Quarantine cage	√		• Shade vegetation is quite good	√		• Shade vegetation is quite good
e. Shade vegetation	√					
Supporting facilities that need to be built in the captive area:						
a. Water installation	√		Many former playground buildings such as tables, benches, and toilets should be dismantled or removed.	√		• Almost all supporting facilities for deer captive breeding are available
b. Shade building (shelter)	√			√		
c. Puddle	√			√		
d. Drinking water tub	√			√		
e. Corridor road		√		√		
Forage planting area		√		√		• Already available with odot grass, lamtoro, sweet potato and papaya
Supported building:			It still uses the former stage building from the playground.			• Already have a guardhouse and warehouse which are usually occupied by the keeper
a. Guard house/guard post	√			√		
b. Feed and tool warehouse.		√		√		
Availability of Experts						
a. Experts in the field of captivity and or animal health		√	The available staff are 2 keeper on duty with the shift system	√		• Collaborate with veterinary medical personnel with the district livestock office
b. Experienced captive technical personnel	√			√		• The existing staff are 2 keepers on duty with the shift system
c. Administration staff		√		√		

Table 3. Deer population development in deer captive breeding Pertamina EP 4 Cepu, Central Java, Indonesia

Year	Initial number	Addition	Reduction	Total
2014	11	3	0	14
2015	14	4	1	17
2016	17	10 (new breeder) + 2 (birth)	0	29
2017	29	13	0	42
2018	42	12	2 (die in a fight) + 2 (sold)	50
2019	50	6	4 (releasing) + 3 (sold) + 2 (requested by divre)	47
2020	47	5	3	49

Table 4. Habitat management activities in Javan Deer Captivity by Pertamina EP 4 Cepu, Central Java, Indonesia

Year	Management activities	Description
2015	Addition of shelters, puddles and provision of protective vegetation	Protective vegetation in captivity is provided with protection at the bottom of the tree to avoid disturbance so that the tree bark is not peeled off due to eating or rubbing with deer antlers.
2016	Addition of facilities for handling cages and maintenance cages.	
2016, 2018	Making a place for providing forage	To support the lack of feed, especially in the dry season
2018	Addition of the main cage	This is done through the main enclosure to avoid fights between adult male parents, especially during the breeding season

While in Sambar deer captivity for the Pertamina RU II Dumai, habitat management, mainly feed, tends to still rely on the availability of natural food. Natural food for this deer is quite widely available around the captivity area. The existence of former playground equipment such as tables, benches, and toilets has not been moved from the captive cage.

Releasing Javan deer from captive breeding

Based on proper management of population, habitat, and infrastructure, the population development of Javan deer captive breeding of Pertamina EP 4 Cepu shows an increasing trend from the initial population of 20 individuals within four years became 50 individuals. The Regulation of the Minister of Forestry No. 19 of 2005, article 71 states that every breeder who conducts captivity must return to his natural habitat from captive-bred specimens of plants and animals of protected species. That have met the qualification standards for captive breeding of at least 10% of captivity results (Willoughby and Christie 2019; Webb 2020). The results of this population development took 10% to be released into the wild. Pertamina EP 4 Cepu succeeded in releasing 4 Javan deer (*Rusa timorensis*) from captive breeding of Javan deer located in KPH Parengan. In 2018, 4 captive-breed Javan deer were released in their natural habitat of Tahura R. Soeryo, East Java. Meanwhile, the Pertamina RU 2 Dumai sambar deer captive breeding during four years of management, the documents required for captive management assessed by the Nature Resources Conservation Agency (BKSDA) were not fully available. Consequently, the population increment in captive breeding could not participate in the release program.

Discussion

A captive permit document from the government is essential in a deer captive breeding activity because deer have registered in the Decree of the Minister of Forestry No. 305/Kpts-11/1991, dated June 19, 1991, and Government Regulation No. 7/1999 concerning Preservation of Plant and Animal Species as protected animal species. In the IUCN (International Union for Conservation of Nature), the Sambar and Javan deer are categorized as threatened species (Vulnerable) due to their declining population (IUCN 2018; Zerbini et al. 2019).

Protection and utilization of deer as a protected species has been carried out based on Government Regulations 7 and 8 of 1999 concerning the Preservation and Utilization of Wild Plant and Animal Species. One form of protection and utilization can be in the form of captive breeding. Permits for captive breeding wild plants and animals that are protected or not protected are granted for 5 (five) years. They can be extended by applying for an extension no later than 3 (three) months before the expiry of the captive breeding permit. The management of captive breeding permits is regulated in the Minister of Forestry Regulation Number 69/Menhut-II/2013 concerning the Captive Breeding of Wild Plants and Animals.

One of the requirements needed in applying for a captive breeding permit is proof of the legality of the origin of the wildlife bred. The sambar deer captive breeding at Pertamina RU 2 Dumai does not yet have a legal document on the origin of the sambar deer. So, in the future, it is necessary to strive for the availability of legal documents of the origin of this wildlife so that it will further strengthen the deer breeding permits that have been obtained.



In managing wildlife captivity, under the mandate of government regulations, there are obligations for the breeder to carry out captive activities (Government Regulation No. 8 of 1999), namely: (i) Make a parenting book about wild plants or animals in captivity; (ii) Implement a system of marking and certification of breed individuals in captivity; (iii) Prepare and submit periodic reports to the government; (iv) Maintaining the purity of protected wildlife species until the first generation.

From the search for documents, the mandatory documents are Documents of Availability of a Parent Book (Studbook)/Logbook, Documents of marking or tagging of species in captivity, Documents of population development (Growth of fawn and Mortality rate), and Reporting and planning Documents (Monthly Report and Annual Work Plan) not yet available. The captive deer breeding at Pertamina RU 2 Dumai only received a captive permit in 2019, so it has only been running for 2.5 years. It can be prepared for the preparation of these documents. In particular, no documents show the existence of a management agency appointed by the company to manage the sambar deer captive breeding at Pertamina RU 2 Dumai. The existing management is still under the responsibility of the HSSE head, who is assisted by 2 or 3 field workers (keepers).

Meanwhile, Pertamina EP 4 Cepu's Javan deer captive breeding already has legal documents on the origin of the Javan deer. The availability of documents on the legality of the origin of these animals will further strengthen the deer breeding permits that have been obtained. The mandatory documents such as Documents of Availability of a Parent Book (Studbook)/Logbook, Documents of marking or tagging of species in captivity, Documents of population development (Growth of tillers and Mortality rate), and Reporting and planning documents (Monthly Report and Annual Work Plan) are available. Javan deer captive breeding by Pertamina EP 4 Cepu got a captive permit in 2015 and received a distribution permit for animals starting in 2017. Some documents show the company appoints a management agency to manage the Javan deer breeding at Pertamina EP 4 Cepu.

The Javan deer captive breeding at Pertamina EP 4 Cepu has been conducted intensively, including population and habitat management (Subeno and Mukhlison 2016). Population management emphasizes setting the composition of the population, which is very important in supporting the reproductive process (Christie et al. 2012; Zakaria et al. 2016; Kaumanns et al. 2020). At the same time, habitat management is emphasized by providing the availability and adequacy of deer feed at all times (Dahlan and Dawend 2013; Khattak et al. 2021). This feed is vital in supporting the growth and performance of deer in captivity so that deer in captivity have reproductive capabilities according to the developmental age of the deer (Hutapea et al. 2021). It can be seen that the deer population development in Pertamina EP 4 Cepu deer captivity shows a significant increase from time to time. Khan et al. (2017) reported the population trends of captive animals showed the enormous increase in population.

Minister of Forestry Regulation No. 19 of 2005 article 71 states that every breeder who conducts captivity, as referred to in Article 4 paragraph (1) letters b and c, and paragraph (2) letter a, is obliged to return to their natural habitat from captive-bred plant and animal specimens of this type. They are protected species that have met the captive qualification standards of at least 10% of the captive yields. The return of captive-bred plants and animals, as referred to in paragraph (1), is carried out if they meet the requirements, among others: (1) have high genetic value, which is close to the parent or origin seed; (2) the population of this species is low so that restocking will help restore the population; (3) free from disease; (4) not physically disabled; (5) predicted to be able to survive in natural habitats; (6) release habitat is a natural distribution area, or it known in its life history, the species has existed in the area; (7) the release habitat is technically adequate and able to accommodate the life of animal specimens to be released; and (8) Pay attention to/consider animal behavior. Based on this regulation, Javan deer captive breeding held by Pertamina EP 4 Cepu in KPH Parengan and Sambar deer captive breeding by Pertamina RU 2 Dumai are obliged to release Javan deer from captive breeding that has been managed.

The Pertamina RU 2 Dumai sambar deer captive breeding has been carried out since 2016, starting with the construction of a breeding cage and its facilities, including bringing in broodstock of sambar deer. However, during four years of management, the documents required for captive management assessed by the Nature Resources Conservation Agency (BKSDA) were not fully available. Consequently, the population increment in captive breeding could not participate in the reintroduction program. Whereas the Pertamina EP 4 Cepu Javan deer captive breeding built captive cages and facilities in 2014, followed by bringing in broodstock of Javan deer. Management documents, population management, and habitat management were conducted intensively, and as a result, during the captive breeding assessment by BBKSDA Jawa Timur, this captive breeding received an excellent value (A). The population development shows an increasing trend from the initial population of 20 individuals within four years became 56 individuals. The results of this population development took 10% to be released into the wild. Four years since the captive deer breeding was established, Pertamina EP 4 Cepu succeeded in releasing 4 Javan deer (*Rusa timorensis*) from captive breeding of Javan deer located in KPH Parengan. The release was carried out to coincide with the National Flower and Wildlife Love Day, which fell on November 5, 2018. In 2018, 4 captive-breed Javan deer were released in their natural habitat of Tahura R. Soeryo, East Java. This Javan deer release activity is the first carried out in Indonesia. In conclusion, Javan deer captive breeding of Pertamina EP 4 Cepu, managed through proper management of population, habitat, and infrastructure, can support the addition of Javan deer populations in their natural habitats. While The Pertamina RU 2 Dumai sambar deer captive breeding has not managed the population and habitat properly, its population growth has yet to be able to support release in nature. For this reason, Javan deer captive

breeding of Pertamina EP 4 Cepu needs to maintain the management that has been carried out in terms of population, habitat, and infrastructure. While The Pertamina RU 2 Dumai sambar deer captive breeding must be carried out to complete the documents needed in captive management must complete the deer captive infrastructure and complete habitat management so that it follows management standards.

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Site assessment for a small-scale Javan rusa (*Rusa timorensis*) captive breeding in East Java, Indonesia

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Abstract. Subeno, Pudyatmoko S, Imron MA, Widi TSM. 2023. Site assessment for a small-scale Javan rusa (*Rusa timorensis*) captive breeding in East Java, Indonesia. *Biodiversitas* 24: 4568-4576. Javan deer (*Rusa timorensis* Blainville, 1822) is a protected wild animal with high potential economic value; captive breeding can be done to avoid extinction and sustainably utilize it. Most land ownership by rural communities in Indonesia is less than 5 ha; therefore, it is essential to design small-scale captive breeding, which local people can adopt to meet economic interests and species conservation. We assessed a site part of the Perum Perhutani area in East Java dedicated to developing captive breeding models. Assessment is an essential consideration in exploring location feasibility and designing optimal allocation of available space; data collection on bio-physical conditions used nested sampling, circular plots, and profile diagrams. Feed availability is obtained by identifying the grass type and calculating its productivity. The collected data were then analyzed and compared with the needs of the Javan deer. The selected location was then made a captive design for space allocation based on the management and basic needs of the Javan deer. The results showed that the location at RPH (Resort Pemangku Hutan=Forest Management Resorts) Malo (Bojonegoro District, East Java, Indonesia) could be declared feasible to be developed as a Javan deer breeding area. The captive site design is mini ranching; this captive design consists of the breeding/management and office blocks.

Keywords: Biophysical, captive breeding, Javan deer, mini ranching, site assessment

INTRODUCTION

Captive breeding has been recognized as one of the important ex-situ conservation measures, which goes hand in hand with in-situ conservation (Braverman 2014). Captive breeding recognizes people's need for protein and other products (Kuba et al. 2015). It becomes an alternative for both protection and economic support of rural people in tropical countries (Krisna et al. 2020). Captive breeding, sometimes called wildlife farming, can have various aims of products including meat, velvet, fur, and others (Kuba et al. 2015).

Captive breeding has been applied on various scales, from small to large. Small-scale wildlife breeding, which accounts for 90% of wildlife farming, has been carried out by various countries (Nogueira-Filho and Nogueira 2018). For example, Brazil uses a semi-intensive production system, using fenced areas ranging from 0.5 to 4 ha surrounded by arboreal vegetation (Nogueira-Filho and Nogueira 2018). Meanwhile, in Oklahoma, small-scale deer farming uses an area of about 1 ha consisting of paddocks arranged in one block with an alley in the middle (De Vuyst 2013).

The Javan rusa (*Rusa timorensis* Blainville, 1822) is among the native deer species of Indonesia (Ali et al. 2021), which is also protected by national law (Semiadi and Jamal 2015). Despite being legally protected by the Indonesian government by stipulates as a protected animal and prohibits

hunting in nature, the perspective of local communities on Javan rusa has been playing an important role in their faith in nature, affecting population numbers that continue to decrease due to illegal hunting and increasing habitat degradation (Krisna et al. 2020). Therefore, to avoid extinction and accommodate sustainable utilization, this species was proposed to be under a captive breeding program (Rasyidi et al. 2022).

Despite the Javan rusa being promoted for captive breeding, current research is limited to assessing the spatial distribution of habitat (Hedges et al. 2015; Rahman et al. 2020) and studies on captive breeding of this species on their roles to climate change mitigation (Krisna et al. 2020). However, we have imperfect knowledge of any studies to explore various sizes and site conditions affecting captive breeding management. In Indonesia, land ownership for agricultural activities is relatively low, less than 5 ha (Susilowati and Maulana 2012; Liu and Yamauchi 2014). On Java Island, the world's most highly populated island, the land ownership is 0.25 ha on average (Antriandarti 2018; Prasada et al. 2022). One of the important aims of captive breeding is to balance the captive population and locals' economics to reduce illegal activities. Therefore, to ensure the adaptation of captive breeding by the wider communities to support economic and conservation, captive units in Java Island should be carried out through semi-intensive breeding

systems (Khan et al. 2016), which can later be a model for a small-scale area.

Captive breeding generally tries to mimic natural conditions brought into confines to provide various needs of the captive species (Braverman 2014). The smaller the scale of captive breeding, the more intensive animal care (Rizzolo 2020). It is important to assess local conditions to establish a good captive breeding site available for breeding. This stage is very crucial to identifying gaps in resources in captive areas and possible intervention for captive breeding designing optimal allocation of available space to ensemble the function and site requirements of the captive deer unit (Janiszewski et al. 2016; Urošević et al. 2018). This process is essential because it affects the management design needed to achieve captive success. We aim to assess two potential areas for the captive breeding of Javan rusa in East Java of Indonesia. The assessment involves evaluating the areas' bio and physical aspects and developing suitable designs for captive breeding.

MATERIALS AND METHODS

Study area

We assess a site in East Java Province of Indonesia under the management of PERUM PERHUTANI, the state-owned forest enterprise on Java Island. The research was carried out in two locations that had been prepared by KPH (*Kesatuan Pemangkuan Hutan*=Forest Management Units) (Forest management area according to its main function and designation, which manager can manage efficiently and sustainably) Parengan based on a letter from Adm/KKPH Parengan No. 554/045.1/PRG/II. The two locations are (i) RPH/*Resort Pemangkuan Hutan*=Forest Management Resorts (the smallest forest area management unit) Malo, and (ii) RPH Parengan Utara. The prospective location in the RPH Malo (or Malo) has an area of 0.425 ha, and the prospective location in the RPH Parengan Utara (or Parengan Utara) has an area of 0.35 ha. The reason for choosing the two locations is because Perum Perhutani's working area is one of the areas that is the habitat of Javan deer and is dedicated to model development of captive breeding. The two areas are adjacent to the Forest Management Resorts office area to ensure the area's security because there are always officers on guard every day.

Data collection

Biophysical condition

We collected physical conditions of the locations, such as rainfall, temperature, humidity, topography, water sources, and accessibility through secondary data from the Meteorology and Geophysics Agency for the Bojonegoro and Tuban Regions and direct observations in the field. In contrast, we collected biological data on the location, including the type and number of vegetation (seedlings, saplings, poles, and trees), covers of understorey and canopy, understory foliage volume, and the vertical structure of vegetation. We employed the nested sampling method, commonly used to collect data on vegetation (Prayoga and

Imron 2022). The sample plot is 50% of the total area analyzed (<0.5 ha), with 5 or 6 sample plots for each location. The data are the type and number of individuals of each vegetation (seedlings, saplings, poles, and trees). 6 nested samplings were used to collect vegetation data at Malo, and 5 nested samples at Parengan Utara.

The circular plot method (Prayoga and Imron 2022) measured other habitat characteristics, including canopy and understory cover, leaf volume closure, temperature and humidity, and slope. The circular plot is placed overlapping the nested sampling plot. A profile diagram method (Kastuari et al. 2020) assessed the vertical structure of the vegetation in each of the selected locations. The data taken includes species name, diameter breast height (dbh), height, width of canopy, height of the crown, and spatial position of trees.

Feed productivity

Feed productivity was collected by measuring vegetation productivity in a systematic 1x1 m sampling plot (Stendardi and Karlson 2016); 5 measuring plots were placed in each nested sampling plot. In total, 30 plots were laid in Malo, and 25 plots were in Parengan Utara. In each plot, we cut all potential feed vegetation above ground. The removed feed grass in the sample plots grew for 20 days without intervention. After that, we cut the vegetation again and weighed the gross weight (mass) to calculate the feed's growth.

Data analysis

Physical and biological condition location

We calculated the relative density of each vegetation stage. The formula for calculating relative density is as follows (Nguyen et al. 2014):

$$\text{Relative density} = \frac{\text{Density of a species}}{\text{Total density of all species}} \times 100$$

$$\text{Density} = \frac{\text{Number of a species}}{\text{Total area sampled}}$$

We computed canopy and understory covers following Noon (1981) as follows:

$$C = \frac{p}{n} \times 100\%$$

Where,

C: Canopy and understory cover

P: Number of green vegetation at the intersection point of the cross hairs (+)

n: Total of 20 (10 each transect) plus or minus readings

Understory foliage volume closure is calculated using the formula according to Noon (1981) as follows:

$$\text{PVD (Penutupan Volume Daun)} =$$

$$\frac{\text{the number of squares within each height interval at least 50 percent obscured}}{\text{Total number of squares per height interval}} \times 100\%$$

$$\text{PVD} = \text{Understory foliage volume closure}$$

The profile diagram to determine the vertical structure of the vegetation at the site was analyzed using the Sexi-FS program (Kastuari et al. 2020). The Sexi-FS program allows the researcher to simulate a plot's horizontal and vertical structure visually.

Forage productivity

Forage productivity can be calculated using the formula (Setiawan and Haryanto 2018):

$$P = \frac{L}{B} \times l$$

Where,

P: Forage productivity

L: Grass area (m²)

B: Sample average natural grass biomass production (kg/day)

l : Sample area (m²)

Feasibility analysis

The description of the locations' bio-physical conditions was compared with the Javan rusa's life requirements. Furthermore, to find out the deer's life needs, including food, water, and habitat for Javan deer, literature studies from various sources.

Site plan

From the location that has been selected, a site design is carried out for the division of space based on the needs for management and captive breeding of Javan deer by taking into account aspects of the basic needs of Javan deer.

Table 1. Criteria for eligibility assessment of Javan rusa captive breeding for each aspect

Aspects	Criteria for eligible	Reference
Accessibility	Relatively easy to reach from the road or main road have the higher eligibility of the area.	Pierce et al. (2015)
Climate	Low to high, according to Schmidt and Fergusson	Kissinger et al. (2021); Saputra et al. (2021)
Temperature	24-32°C	Pairah et al. (2014)
Humidity	65-92%	Pairah et al. (2014)
Topography	Relatively sloping to slightly hilly so that the area's development does not damage the site	Pairah et al. (2014); Pierce et al. (2015)
Slope	0-45°	Kissinger et al. (2021); Saputra et al. (2021)
Water Source	Always available, both quality and quantity	Pierce et al. (2015); Khattak et al. (2019)
Vegetasi	Tend not to be close	Saputra et al. (2021)
Shelter	Medium canopy closure for shelter. There are some shade trees (cover)	Khattak et al. (2019); Kissinger et al. (2021); Saputra et al. (2021)
Food	Have sufficient types of forage plants (>8 species)	Saputra et al. (2021)

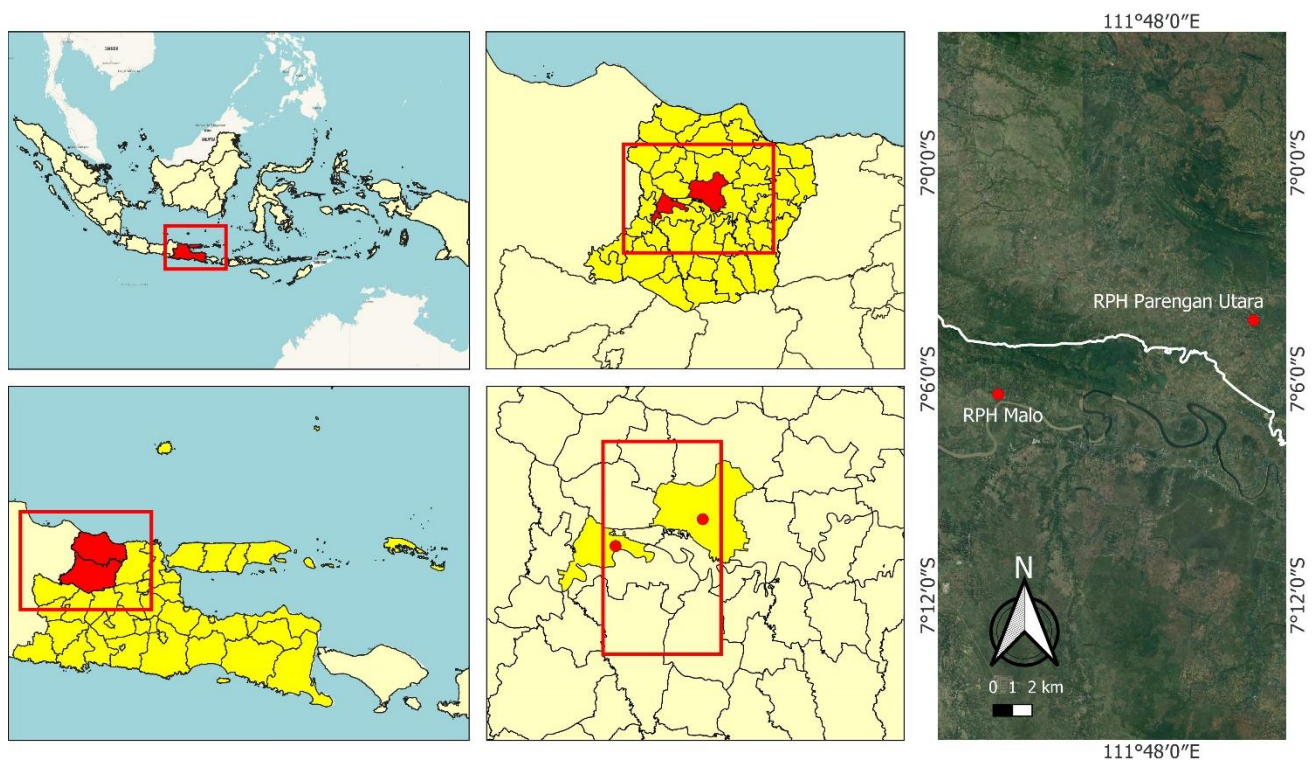


Figure 1. Map of the study area in RPH Malo, Bojonegoro District and RPH Parengan Utara of KPH Parengan, Tuban District of East Java Province, Indonesia

RESULTS AND DISCUSSION

Bio-ecological condition of Malo location

The observations obtained five species at the seedling level, three species at the sapling level, three types at the pole level, five species at tree level, and 20 species of understorey. The highest relative density at the seedling level is teak (*Tectona grandis*), with a value of 48%. The relative density at the sapling level is teak (75%), banana (*Musa acuminata*) (12.5%), and chinaberry (*Melia azedarach*) (12.5%). The relative density at the pole level is teak (81.25%), johar/kassod tree (*Senna siamea*) (12.5%) and mango (*Mangifera indica*) (6.25%). The relative density at the highest tree level is teak (*Tectona grandis*) (57.9%) and kassod tree (*Senna siamea*) (15.7%). Of the 20 types of grass and understorey found at Malo, 14 are plants eaten by Javan deer (*Rusa timorensis*).

The canopy cover at Malo was quite open, ranging from 8.33 to 50%, while the understorey cover ranged from 16.67 to 83.33%. The observations of bush cover ranged from 0 to 5.83%, while the cover of saplings, poles, and trees was 0. Meanwhile, the complete condition of the vegetation structure in Malo can be seen in the profile diagram presented in Figure 2.

The forage productivity calculation of all types of grass and understorey that has been carried out is 253.6 kg. At the same time, the forage productivity of understorey and grass species eaten by deer was 174.51 kg. The highest forage productivity was arrowleaf sida (*Sida rhombifolia*) at 49.42 kg, cogon grass (*Imperata cylindrica*) at 19.36 kg, and bermuda grass (*Cynodon dactylon*) at 16.40 kg.

Bio-ecological condition of Parengan Utara

Based on the observations at the Parengan Utara, 48 types of grass and understorey were obtained, and 1 type of tree, namely Teak (*Tectona grandis*). Of the 48 types of grass and understorey found, eight are plant species that feed deer.

Two individual teak trees were found from observing seedlings, saplings, and trees. The canopy cover in the observation area shows that the cover condition ranges from 0-8.33%, while the understorey cover is between 8.33-6.66%. The range of bush cover in the observation area is 0-10%. Meanwhile, the complete condition of the vegetation structure in the Parengan Utara can be seen in the profile diagram presented in Figure 3.

The forage productivity calculation of all types of grass and understorey that has been carried out is 186.5 kg. At the same time, the forage productivity of understorey and grass species eaten by deer was 64.47 kg. The highest forage productivity was carpet sedge (*Carex jackiana*) at 19.96 kg, tick weed (*Cleome viscosa*) at 13.61 kg, and bermuda grass (*Cynodon Dactylon*) at 12.51 kg.

Physical components of Malo and Parengan Utara

The results of the physical condition of the location at the Malo and Parengan Utara can be seen in Table 5.

Location feasibility analysis

Several requirements that must be considered in determining the location of deer captive breeding, among others, are outside the nature reserve area, located in a quiet place, safe from interference, easily accessible in the rainy and dry seasons, and plenty of water available all year round for drinking.

Site plan of captive breeding

Deer breeding site design should be reviewed from the technical aspects of deer breeding. Considering the bio-physical conditions and considerations of limiting factors and management efficiency, the area that needs to be developed in the Javan deer captive breeding consists of 2 zones: the office zone and a captive breeding zone. The site design for Javan deer captive breeding is shown in Figure 4.

Table 2. Types of grass and understorey in Malo, Bojonegoro District, East Java Province, Indonesia

Local name	English name	Scientific name	Type of deer feed	Reference
Alang-alang	Cogon grass	<i>Imperata cylindrica</i>	Yes	Firdaus et al. (2023)
Otok	Arrowleaf sida	<i>Sida rhombifolia</i>	No	
Rumput Grinting	Bermuda grass	<i>Cynodon Dactylon</i>	Yes	Firdaus et al. (2023)
Rumput kabek-kabekan merah	Centipede grass	<i>Ischaemum timorensis</i>	Yes	Pattiselanno (2012)
Rumput kabek-kabekan putih	Bowgrass	<i>Cyrtococcum patens</i>	Yes	Tewari and Rawat (2013)
Kacang-kacangan	Wild grout nut	<i>Calopogonium mucronata</i>	Yes	Suarna et al. (2019)
Lamuran	Nadi blue grass	<i>Dichanthium caricosum</i>	Yes	Azwar et al. (2019)
Patikan putih	Garden spurge	<i>Euphorbia hirta</i>	No	
Rawadan	Cape gooseberry	<i>Physalis peruviana</i>	No	
Rondo moprol	Tridax daisy	<i>Tridax procumbens</i>	No	
Rumput jarum	Golden false beard grass	<i>Chrysopogon aciculatus</i>	Yes	Pattiselanno (2012)
Rumput lulangan	Crowfoot grass	<i>Eleusine indica</i>	Yes	Sudibyo (2015)
Sogok telik	Rosary pea	<i>Abrus precatorius</i>	No	
Rumput teki	Coco grass	<i>Cyperus rotundus</i>	Yes	Firdaus et al. (2023)
Wedusan	Billy goat weed	<i>Ageratum conyzoides</i>	Yes	Suarna et al. (2019)
Saruni laut	Beach sunflower	<i>Wedelia biflora</i>	No	
Rumput udang	Chinese love grass	<i>Eragrostis unioides</i>	Yes	Suarna et al. (2019)
Rumput jejaringan	Swollen Finger Grass	<i>Chloris barbata</i>	Yes	Suarna et al. (2019)
Waderan	Swamp millet	<i>Isachne globosa</i>	Yes	Sudibyo (2015)
Putihan	Sweet pitted grass	<i>Bothriochloa pertusa</i>	Yes	Suarna et al. (2019)

Table 3. Forage productivity of all types of grass and understorey in Malo, Bojonegoro District, East Java Province, Indonesia

English name	Scientific name	Forage productivity (kg)	Forage productivity for type of deer feed (kg)	References
Cogongrass	<i>Imperata cylindrica</i>	19.36	19.36	Firdaus et al. (2023)
Arrowleaf sida	<i>Sida rhombifolia</i>	49.42	-	
Bermuda grass	<i>Cynodon Dactylon</i>	16.40	16.40	Firdaus et al. (2023)
Centipede grass	<i>Ischaemum timorense</i>	13.26	13.26	Pattiselanno (2012)
Bowgrass	<i>Cyrtococcum patens</i>	14.15	14.15	Tewari and Rawat (2013)
Wild grout nut	<i>Calopogonium mucronata</i>	11.60	11.60	Suarna et al. (2019)
Nadi blue grass	<i>Dichanthium caricosum</i>	3.62	3.62	Azwar et al. (2019)
Garden spurge	<i>Euphorbia hirta</i>	9.93	-	
Cape gooseberry	<i>Physalis peruviana</i>	3.19	-	
Tridax daisy	<i>Tridax procumbens</i>	3.30	-	
Golden false beard grass	<i>Chrysopogon aciculatus</i>	14.82	14.82	Pattiselanno (2012)
Crow-foot grass	<i>Eleusine indica</i>	13.55	13.55	Sudibyo (2015)
Rosary pea	<i>Abrus precatorius</i>	2.13	-	
Coco grass	<i>Cyperus rotundus</i>	10.28	10.28	Firdaus et al. (2023)
Billy goat weed	<i>Ageratum conyzoides</i>	9.38	9.38	Suarna et al. (2019)
Beach sunflower	<i>Wedelia biflora</i>	11.13	-	
Chinese love grass	<i>Eragrostis unioloides</i>	12.48	12.48	Suarna et al. (2019)
Swollen Finger Grass	<i>Chloris barbata</i>	10.64	10.64	Suarna et al. (2019)
Swamp millet	<i>Isachne globosa</i>	9.38	9.38	Sudibyo (2015)
Sweet pitted grass	<i>Bothriochloa pertusa</i>	15.60	15.60	Suarna et al. (2019)
Total		253.60	174.51	

Table 4. Forage productivity of all types of grass and understorey in Parengan Utara, Tuban District, East Java Province, Indonesia

English name	Scientific name	Forage productivity (kg)	Forage productivity for type of deer feed (kg)	Type of deer feed	References
Billy goat weed	<i>Ageratum conyzoides</i>	5.10	5.10	Yes	Suarna et al. (2019)
Musk basil	<i>Basilicum polystachyon</i>	6.50	-	No	
Purple amaranth	<i>Amaranthus blitum</i>	7.06	-	No	
Erect spiderling	<i>Boerhavia erecta</i>	8.29	-	No	
Creeping panic grass	<i>Brachiaria reptans</i>	6.19	6.19	Yes	Suarna et al. (2019)
Carpet sedge	<i>Carex jackiana</i>	19.96	-	No	
Tick weed	<i>Cleome viscosa</i>	13.61	-	No	
Coco grass	<i>Cyperus rotundus</i>	2.83	2.83	Yes	Firdaus et al. (2023)
Cane grass	<i>Eragrostis</i> sp.	4.68	-	No	
Chinese love grass	<i>Eragrostis unioloides</i>	5.19	-	No	
Bermuda grass	<i>Cynodon dactylon</i>	12.51	12.51	Yes	Firdaus et al. (2023)
Madras carpet	<i>Grangea maderaspatana</i>	5.40	-	No	
Centipede grass	<i>Ischaemum timorense</i>	7.36	7.36	Yes	Pattiselanno (2012)
Tropical kudzu	<i>Pueraria phaseoloides</i>	7.67	-	No	
Soybeans	<i>Dolichos soja</i>	9.68	-	No	
Sweet potato	<i>Ipomoea batatas</i>	5.67	-	No	
Little hogweed	<i>Portulaca oleracea</i>	4.53	-	No	
Nadi blue grass	<i>Dichanthium caricosum</i>	3.40	3.4	Yes	Azwar et al. (2019)
Water pimrose	<i>Ludwigia adscendens</i>	9.44	-	No	
Indian goosegrass	<i>Eleusine indica</i>	3.40	3.4	Yes	Sudibyo (2015)
Rice	<i>Oryza sativa</i>	5.67	-	No	
Knotgrass	<i>Paspalum distichum</i>	8.68	8.68	Yes	Suarna et al. (2019)
King begonia	<i>Begonia rex-cultorum</i>	7.64	-	No	
English ivy	<i>Hedera helix</i>	6.23	-	No	
Purple needlegrass	<i>Stipa pulchra</i>	9.25	-	No	
Ironweed	<i>Vernonia</i> sp.	0.57	-	No	
Total		186.50	64.47		

Table 5. Physical components of the candidate for Javan rusa captive breeding in Malo and Parengan Utara, East Java, Indonesia

Aspects	Malo	Parengan Utara
Accessibility	very easy to reach both in the dry season and the rainy season	Easy to reach, bordering the highway and village roads
Climate	Dry tropics, rainfall 1670 mm/year	Dry tropics, rainfall 1483 mm/year
Temperature	26.5-30°C	27.5-30.5°C
Humidity	51-71%	54-65%

Topography	Relatively flat	Relatively flat
Slope	0.5-7.75	3.75-6.75
Water source	Ground well	Seasonal well

Table 6. Location feasibility analysis of the candidate for Javan rusa captive breeding in Malo and Parengan Utara, East Java, Indonesia

Aspects	Malo		Parengan Utara	
	Site condition	Remarks	Site condition	Remarks
Accessibility	very easy to reach both in the dry season and the rainy season. (only there is one main road from location and the distance is enough far so that the location remains convenient for deer in captivity)	Eligible	Easy to reach, bordering the highway and village roads. (it will cause the location to become busy and noisy and this will make the deer in captivity uncomfortable).	Not eligible
Climate	Dry tropics, rainfall 1,670 mm/year	Eligible	Dry tropics, rainfall 1,483 mm/year	Eligible
Temperature	26.5-30°C	Eligible	27.5-30.5°C	Eligible
Humidity	51-71%	Eligible	54-65%	Eligible
Topography	Relatively flat	Eligible	Relatively flat	Eligible
Slope	0.5-7.75	Eligible	3.75-6.75	Eligible
Water source	Ground well	Eligible	Seasonal well	Not eligible
Vegetasi	Tend not to be close	Eligible	Tend to be open	Not eligible
Shelter	Medium canopy closure for shelter. There are some shade trees (cover)	Eligible	Low canopy closure for shelter. There are little shade trees (cover)	Not eligible
Food	Have sufficient types of forage plants (> 8 species)	Eligible	Have little types of forage plants (< 8 species)	Not eligible

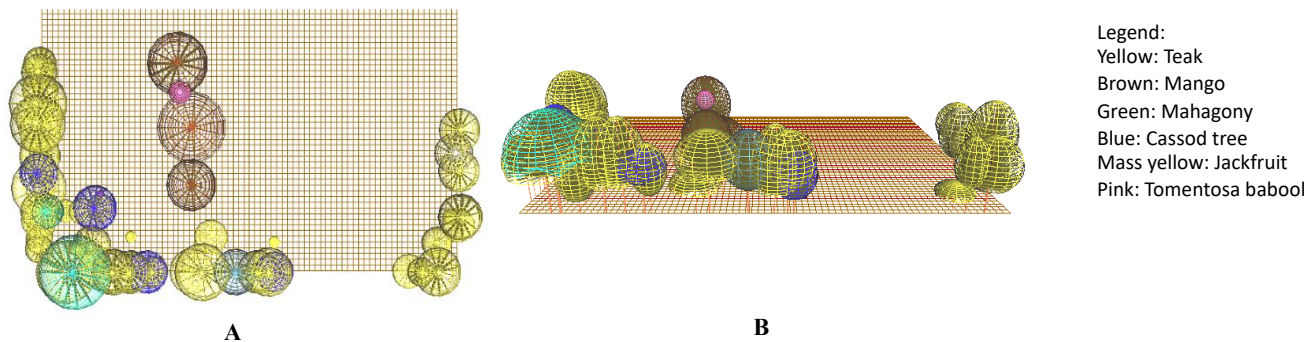


Figure 2. Tree profile diagram at Malo, East Java, Indonesia seen from above (A) and viewed from behind (B)

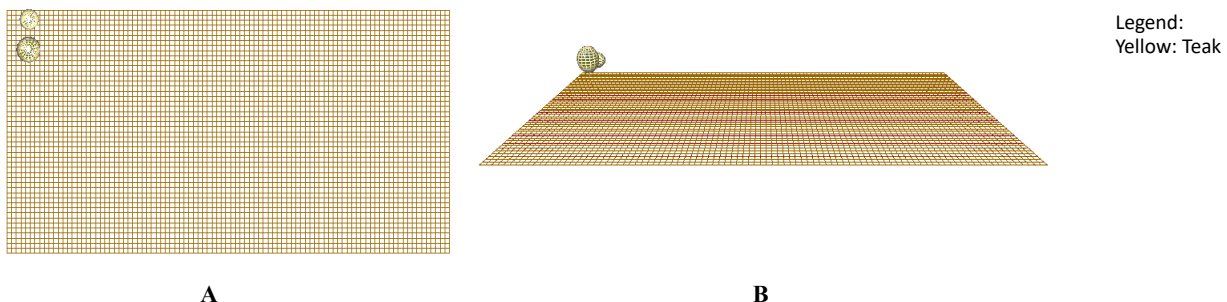


Figure 3. Tree profile diagram in the Parengan Utara, East Java, Indonesia, seen from above (A) and from the front (B)

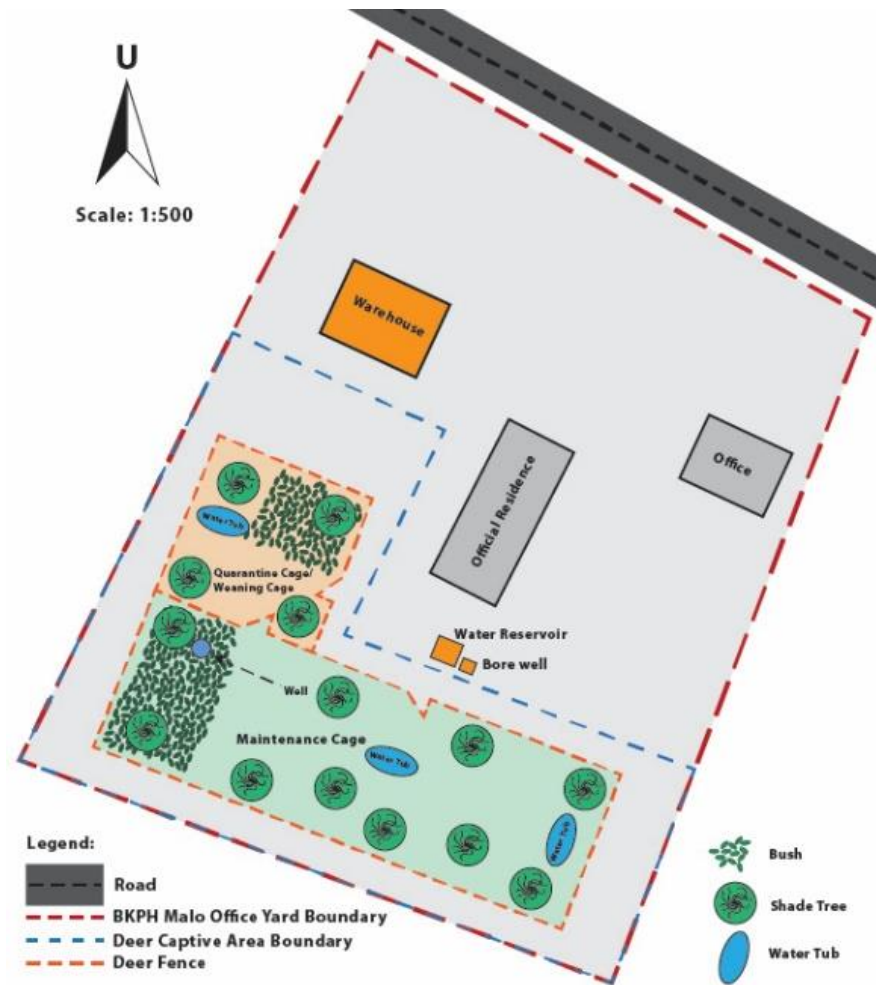


Figure 4. Design of the Javan deer breeding site at Malo, East Java, Indonesia

Discussion

The Bio-Ecological condition in Malo showed that the vegetation cover in the area is quite open, and only a few areas are covered by vegetation. The vegetation condition in the existing location illustrates that the area is not too covered by vegetation so that the growth and development of the understorey, a food source, is not hampered. The condition of trees, poles, and stakes for cover and shelter functions as a place of shelter/hiding, is quite good and safe, especially during childbirth and breastfeeding fawn.

During rut, the stag always rubs the antlers on the trees, so the captive area needs trees (Charco et al. 2016). If sufficient trees are in the breeding area, the male deer will tend to rub their antlers against the fence posts. In addition, in terms of animal movement and access to management, the condition of dense trees can cause limited deer movement, which can reduce access and affect the layout. Therefore, it is necessary to manage and regulate to achieve optimal tree conditions.

The Bio-Ecological condition in Parengan Utara showed that the vegetation cover in the area is open, and the minimal area is covered by vegetation. The vegetation condition in the existing location illustrates that vegetation does not

cover the area. Likewise, the condition of trees, poles, and stakes for cover and shelter functions as a place of hiding is very lacking, so it is not a safe and comfortable place, especially when giving birth and breastfeeding fawn.

The physical components in Malo has higher rainfall than Parengan Utara. It is very beneficial for the growth and development of forage. Hu et al. (2021) said that information about rainfall and the number of rainy days affect the direction of land use. Such climatic conditions cause surface water and groundwater to always be available, as well as better soil productivity so that the growth and development of vegetation and forage are not hampered. Javan deer can adapt to various environmental conditions, where deer can live and breed at altitudes ranging from 200-500 m above sea level (Pairah et al. 2014). There is even a claim that the Javan deer can live up to an altitude of 2600 m above sea level (Widjaja and Utomo 2021).

The physical components in the Parengan Utara have lower rainfall than Malo location. It is less favorable for the growth and development of forage. Zhao and Wu (2018) and Martins et al. (2016) said that information about rainfall and the number of rainy days affect the direction of land use. Existing climatic conditions cause surface water and

groundwater to not always be available in sufficient quantities so that soil productivity becomes less good, which causes the growth and development of vegetation and forage to be hampered.

The analysis results of the area's bio-physical components indicate that Malo can be declared feasible to be developed as a Javan deer breeding area. Bio-ecological conditions showed that the location of Malo has better potential than Parengan Utara. Malo location had 20 types of grass and undergrowth found, of which 14 species were eaten by Javan deer (*Rusa timorensis*). Five plant species can function as shelters, and the productivity data of all types of grass and understorey that have been carried out was obtained at 253.6 Kg. In contrast, the productivity of understorey and grass species eaten by deer was 174.51 Kg. In addition, from the aspect of other wildlife in the captivity location, there were also no domestic animal species that could interfere with the presence of deer.

The determination of development zones in captive locations is based on considerations: (a) management intensity; (b) utilization intensity; and (c) the feasibility of the available area. These considerations are crucial so captive deer management's objectives can be achieved effectively and efficiently. First, the Office Zone is an area that functions as a regional administration and management services center. The determination of the office zone is carried out considering the following requirements of location: (1) The topography is relatively flat to light hilly so that the construction of the building will not damage the site; (2) Availability of easy-to-use water sources to meet water needs for daily management activities; and (3) The road accessibility must be easy to reach (Krisna et al. 2020; Kissinger et al. 2021). Types of buildings in the office zone are facilities and infrastructure to support deer breeding activities. These buildings include offices, guard posts, feed or medicine warehouses, control roads, water towers, signage, and information.

Second, the Captive Zone is an area for breeding, rearing, and maintaining animals to develop their population. The location determination is based on the following requirements of location: (1) Flat topography, sloping to mild hilly so that deer can explore well; (2) It provides the availability of food, water, and cover as the main components of the needs of the deer's life; (3) The ecosystem must provide the minor possible technical intervention options to change the existing physical and vegetation conditions to become a suitable habitat for deer; and (4) The allocation of the area is adjusted to the projected development of deer captive breeding that will be developed in the future (Krisna et al. 2020; Kissinger et al. 2021). The facilities and infrastructure in this captivity zone are the maintenance area, enlargement area, transit area, water tank, water tower, shade building, and inspection road.

The captive/management block is the core of the captive activity, which has facilities such as a location for giving birth, weaning, clip-on cages, shelters, places to eat/drink, and waterways. Pierce et al. (2015) said that determining deer breeding zones needs to consider technical, economic, and environmental requirements. The breeding block that

has been established is very strategic and follows its designation so that it can function as a center for the development of deer breeding technology to produce deer breeds, utilize deer, and provide educational and training facilities.

Captivity has many facilities, so the primary consideration in building design is to provide facilities that can be used effectively (Khattak et al. 2019). The design of deer breeding facilities must consider the type of deer to be bred, the budget, and the available resources (bio-ecological and physical location). Janiszewski et al. (2016) said that the principles that must be considered in designing deer breeding facilities include (1) deer like to move around outer circles or corners; (2) the site should be well-drained; and (3) Avoid visual contact with other animals outside of captivity.

Facilities should be considered, enabling easy access to deer transport, feed, equipment, and medicines. Deer breeding should also consider avoiding low trees that interfere with road access in transportation (Janiszewski et al. 2016). The facilities and infrastructure contained in the captive breeding location are as follows: cage, fence, drinking place or water tub, road control/inspection, waterways, water tower, warehouse and equipment, guardhouse, and deer feed location. In addition, it is also necessary to support captive breeding facilities and infrastructure in the form of harmonica bulkheads, portable bulkheads, clip cages, and electrical installations. In Conclusion, the bio-ecological conditions in the Malo area showed this location has better potential than Parengan Utara. The physical condition of the two areas showed that all physical components in the Malo area were more eligible than Parengan Utara. Based on the results of the bio-physical components analysis of two areas, it is shown that the location in the Malo can be declared feasible to be developed as a Javan deer captive breeding area. The captive breeding site design is mini ranching, consisting of the breeding/management and office blocks.

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CV. KANDIDAT DOKTOR



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Saat ini penulis sedang tertarik untuk mengembangkan salah satu cabang ilmu konservasi yaitu konservasi ek-situ khususnya di bidang *captive breeding*. Bidang yang masih perlu digarap agar bisa memberikan sumbangsih bagi kepentingan mendukung konservasi in-situ dan menjadi alternatif dalam turut bisa memberdayakan sosial ekonomi masyarakat.