CONVENCIÓN SOBRE EL COMERCIO INTERNACIONAL DE ESPECIES AMENAZADAS DE FAUNA Y FLORA SILVESTRES

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Trigésima primera reunión del Comité de Fauna
Ginebra (Suiza), 13-17 de julio de 2020

Cuestiones de interpretación y aplicación

Reglamentación del comercio

Dictámenes de extracción no perjudicial

PUBLICACIÓN DE UN INFORME DE GESTIÓN DEL VARANO ACUÁTICO *(VARANUS SALVATOR)* EN MALASIA PENINSULAR

1. El presente documento ha sido presentado por las Autoridades Administrativas de Malasia Peninsular (Ministerio de Energía y Recursos Naturales y Departamento de Vida Silvestre y Parques Nacionales de Malasia Peninsular)[*].

Antecedentes

2. En los últimos 50 años, Malasia ha mantenido un comercio de pieles de varano de dos bandas (*Varanus salvator*), especie que figuran en el Apéndice II desde 1975. De conformidad con el párrafo 3 del Artículo IV, las exportaciones de especímenes de las especies del Apéndice II deben ser objeto de una vigilancia continua y se deben adoptar medidas apropiadas para limitar esas exportaciones a fin de conservar la especie concernida, a través de su hábitat, en un nivel consistente con su papel en los ecosistemas donde se halla y en un nivel suficientemente superior a aquel en el cual esa especie sería susceptible de inclusión en el Apéndice I.

3. Las Autoridades Científicas y Administrativas CITES de Malasia Peninsular se comprometieron a mejorar los sistemas de vigilancia y gestión de *Varanus salvator* en Malasia, lo que ha dado lugar al sistema de gestión que se presenta aquí (anexo).

Objetivos y visión general del sistema de gestión para *Varanus salvator*

4. En el informe sobre la gestión se proporciona información sobre las características biológicas de *V. salvator*, las recientes constataciones sobre los datos de la población en Malasia Peninsular y los sistemas de supervisión y gestión utilizados para garantizar su comercio sostenible.

5. Los principales objetivos específicos del informe de gestión son:

    a) Proporcionar una herramienta para apoyar a las Autoridades Administrativas de vida silvestre en Malasia en la aplicación de las disposiciones de la CITES, tales como los dictámenes de extracción no perjudicial (DENP).

[*] *Las denominaciones geográficas empleadas en este documento no implican juicio alguno por parte de la Secretaría CITES (o del Programa de las Naciones Unidas) para el Medio Ambiente sobre la condición jurídica de ninguno de los países, zonas o territorios citados, ni respecto de la delimitación de sus fronteras o límites. La responsabilidad sobre el contenido del documento incumbe exclusivamente a su autor.*

b) Fomentar la explotación sostenible de las poblaciones de *Varanus salvator* en Malasia a fin de asegurar que los beneficios obtenidos por los ciudadanos de Malasia sean sostenibles y al mismo tiempo proteger la especie de la sobreexplotación.

c) Permitir la normalización de la supervisión y de la recopilación de datos en todo el país.

d) Proporcionar un modelo que pueda ser reproducido por otros países del área de distribución de la especie, y para otras especies en diferentes regiones.

c) Generar impresiones y observaciones de las Partes interesadas en relación con la solidez del sistema de gestión a fin de asegurar la sostenibilidad del comercio de 120 000 pieles al año, y ayudar a mejorar el sistema de gestión para asegurar una explotación sostenible en el futuro.

6. El informe sobre la gestión consta de cuatro capítulos:

a) En el capítulo I se presentan los antecedentes sobre la historia del uso, los marcos jurídicos que rigen el uso y el comercio, y se describen los objetivos de Malasia en relación con la gestión de esta especie.

b) En el capítulo II se describen la distribución, las características biológicas generales, la dinámica de la población y el estado de conservación de *Varanus salvator* en Malasia y en Asia Suroriental.

c) En el capítulo III se ofrece información sobre los tamaños estimados de las poblaciones, la supervisión de las poblaciones sobre el terreno, la vigilancia de las extracciones y el control del comercio en Malasia Peninsular.

d) En el capítulo IV se ofrece información sobre las restricciones a las extracciones, los instrumentos de gestión, los avances tecnológicos y el comercio ilegal y la aplicación de la ley en relación con la gestión y el comercio de *Varanus salvator* en Malasia.

Recomendaciones al Comité de Fauna

7. Se invita a los miembros del Comité de Fauna a:

a) Tomar nota del *Informe sobre la Gestión de los Varanos de Dos Bandas* (*Varanus salvator*) en Malasia Peninsular;

b) Pedir a la Secretaría que publique el Informe sobre la Gestión en la sección sobre los DENP del sitio web de la CITES;

c) Invitar a las Partes y a otros interesados pertinentes a que examinen el Informe de Gestión y ofrezcan un análisis sobre si los sistemas establecidos proporcionan fiabilidad en cuanto a la sostenibilidad del cupo propuesto (120 000 pieles/año);

d) Invitar a las Partes y a otros interesados pertinentes a que examinen el Informe sobre la Gestión y ofrezcan ideas fundamentadas para mejorar los sistemas de gestión de Malasia; y

e) Transmitir impresiones y observaciones a la Autoridad Científica de Malasia: CITESMalaysia@ketsa.gov.my; khadiejah@wildlife.gov.my.

PERHILITAN

Ministry of Energy
and Natural Resources





MANAGEMENT AND TRADE IN ASIAN WATER MONITORS (*Varanus salvator*)

IN PENINSULAR MALAYSIA

Ministry of Energy
and Natural Resources

Published by:
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Acknowledgements

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General introduction

The reptile Family Varanidae is comprised of about 80 species of "Monitor Lizards" (0.2 - < 3.0 m in total length) that occur naturally in Africa, Asia and Oceania, but now occur as an invasive species within the Americas.

For millennia monitor lizards have been used by local people and traded domestically throughout their range, for food, medicines and skins (Das 1989; Luxmoore and Groombridge 1990; Klemens and Thorbjarnarson 1995). Traditional uses were primarily centred on meat, but skins and other body parts were also valued for decorative and medicinal purposes. Over the last 100 years, significant international trade in the skins of larger *Varanus* species, for leather, has occurred (Jenkins and Broad 1994). Trade in live *Varanus* specimens for exhibition, research and keeping (including as pets) has grown over the last 50 years. It involves a diversity of *Varanus* species, with trade typically in small volumes, with sharp species-specific increases and decreases matching trends in demand.

As a precautionary and safeguard measure, when the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) came into force (1975), it included a generic listing of all *Varanus* spp on its Appendices. Today there remain 78 species of *Varanus* on the CITES Appendices, mostly on Appendix II where trade is subject to compliance with Article IV, but with 5 species (at least in parts of their range), on Appendix I, where trade in wild caught specimens is prohibited.

Asian Water Monitors (*Varanus salvator*) are the second largest of all *Varanus* species, with adults reaching 1.5 to > 2 m and weighing up to 25 kg (Pianka et al. 2004). They are the most widespread of all *Varanus* species, ranging from India and Sri Lanka in the west across Southeast Asia to the Philippines in the east and to western and central Indonesia in the south (Böhme 2003). Most range states exported *V. salvator* skins historically, but trade in compliance with CITES is now largely restricted to Indonesia and Malaysia (Khadijah et al. 2019). The IUCN Red List review (2009) of the status of *V. salvator* in the wild, across its range, confirmed *V. salvator* was not an endangered species ("Least Concern") despite both harvest and trade.

The Government of Malaysia is committed to protecting and preserving its natural resources, for the benefit of all Malaysians. When Malaysia became the 38th Party to CITES in 1978, it did not lodge any reservations concerning trade in *V. salvator*, and accepted its obligations to ensure ongoing international trade in *V. salvator* complied with Article IV of the CITES Convention. *Varanus salvator* is a ubiquitous and common vertebrate species within Peninsular Malaysia (land area: 132,339 km^2), in both rural areas, and in more densely settled areas. In many human-modified environments its generalist biological and ecological traits has allowed *V. salvator* to benefit from human-induced resource subsidies; its population densities in these areas appear to have increased appreciably. But an unintended cost of such flexibility is that *V. salvator* is considered a pest species by many people, because it eats domestic livestock, becomes both bold and aggressive in contact areas with people, and each year attacks some people, which attracts media attention. Against these negative values are the

General introduction

positive values generated by harvesting, use and trade, which for some people are direct financial benefits, but for others, the perceived value of short-term reductions in abundance.

This report describes the management context, strategy and program being implemented in Peninsular Malaysia, to ensure wild *V. salvator* populations are both conserved and valued, despite different goals of management in different areas. It describes the indices used for evaluating objectively the degree to which the national conservation and management goals are being achieved.

The report is structured as follows

Chapter I: Management context

- History of use,
- Legal frameworks governing use and trade,
- Management goals.

Chapter II: Biological parameters of *Varanus salvator* germane to management

- Distribution,
- General biology,
- Population dynamics;
- Conservation status in Malaysia and Southeast Asia.

Chapter III: Monitoring indices for ensuring sustainable use

- Estimating population sizes,
- Population field monitoring
- Harvest monitoring
- Trade Monitoring

Chapter IV: Trade and management controls in Peninsular Malaysia

- Harvest restrictions
- Management tools
- Technological advances
- Illegal trade and enforcement

Conclusion

CHAPTER I

Management context

1.1 History of use

Monitor lizards have been utilized as a renewable resource by the people of Peninsular Malaysia from pre-history to the present time. Traditional and customary uses include meat for consumption, skins for various decorative and utility purposes, and fat and other products for medical purposes (Das 1989; Klemens and Thorbjarnarson 1995). In historical times the human population was much lower than today, and both urban and rural development much less.

Today, *V. salvator* is one of the most common large vertebrate species in Peninsular Malaysia. They are found throughout the country and in most habitat types. Reasons for their prevalence are various, but important triggers may include:

a) Availability of food (e.g., human waste and agricultural rodent pests),

b) Increased habitat (e.g., channeled water resources and agri-forestry)

c) Reduced predation and competition from less-adaptable species (e.g. large raptors and carnivores)

The historical abundance of *V. salvator* relative to today is unknown, and the possibility that human landscape changes and food subsidies have resulted in increased abundance cannot be rejected on available data. In some parts of their range, the species occurs at very high densities and are recognized as a pest species (PERHILITAN 2020), although even single *V. salvator* in some locations cause public concern.

The use of lizard skin as a fashion leather started in the 1920's. Demand declined during WWII, but increased significantly from the 1950's onward (Jenkins and Broad 1994). To supply this demand, local people in Malaysia began to harvest *V. salvator* for trade, and developed baited traps as a primary capture method, which are still used today. Most harvesting is done by rural people, with the animals sold to processing facilities, which on-sell the skins, meat and other body parts domestically and internationally.

Although the skins of *Varanus salvator* are the most valuable product, the market increasingly covets skin quality. Large adult *V. salvator* engage in combat with conspecifics, and as a consequence, are often heavily scarred and of low value. This distortion in prices has been independently verified by PERHILITAN as directing the harvest to smaller individuals (< 5 kg), relatively free of scarring (Khadiejah et al. 2019). This results in many larger lizards captured being released and not sold into trade. In addition, lizards smaller than 25 cm in snout-vent length (~1 kg) are not taken for trade, because their skins are too small to be manufactured into leather goods (PERHILITAN 2020).

Lizard meat is consumed by some people in Peninsular Malaysia in low volumes, but there is no available evidence that people trap and sell lizards exclusively for meat. The meat of lizards captured and brought to processing facilities for their skins is used, with some sold domestically and some exported to China and Hong Kong.

No harvesting is allowed in protected areas (22.5% of land area) and lizards are rarely harvested in natural habitats (natural forest comprises 44% of land area), so PERHILITAN considers that the species' role in the ecosystem has not been impacted by trade in these habitats (see Chapter III). The habitats with the most lizards (and therefore most intense harvests) are disturbed areas (e.g., oil palm plantations; see Chapter III) where densities are highest. Within these habitats, harvesting in Peninsular Malaysia is concentrated in coastal areas where the largest human populations (and thus most harvesters) are located.

1.2 International trade

1.2.1 Skins

Skins are imported for manufacture of leather goods, mainly in Europe, USA, Mexico, China, throughout Asia, and in the Middle East (CITES Trade Database, 2020). In the early 1990's and 2000's, Malaysia exported around 200,000 *V. salvator* skins annually but reduced to 100,000 over the last decade, as demand has declined (**Fig. 1a**). Annual variation in exports in both Malaysia and Indonesia reflects changes in demand within the fashion industry from year to year, and a general reduction in demand over the last decade (Khadiejah et al. 2019; **Fig. 1b**).

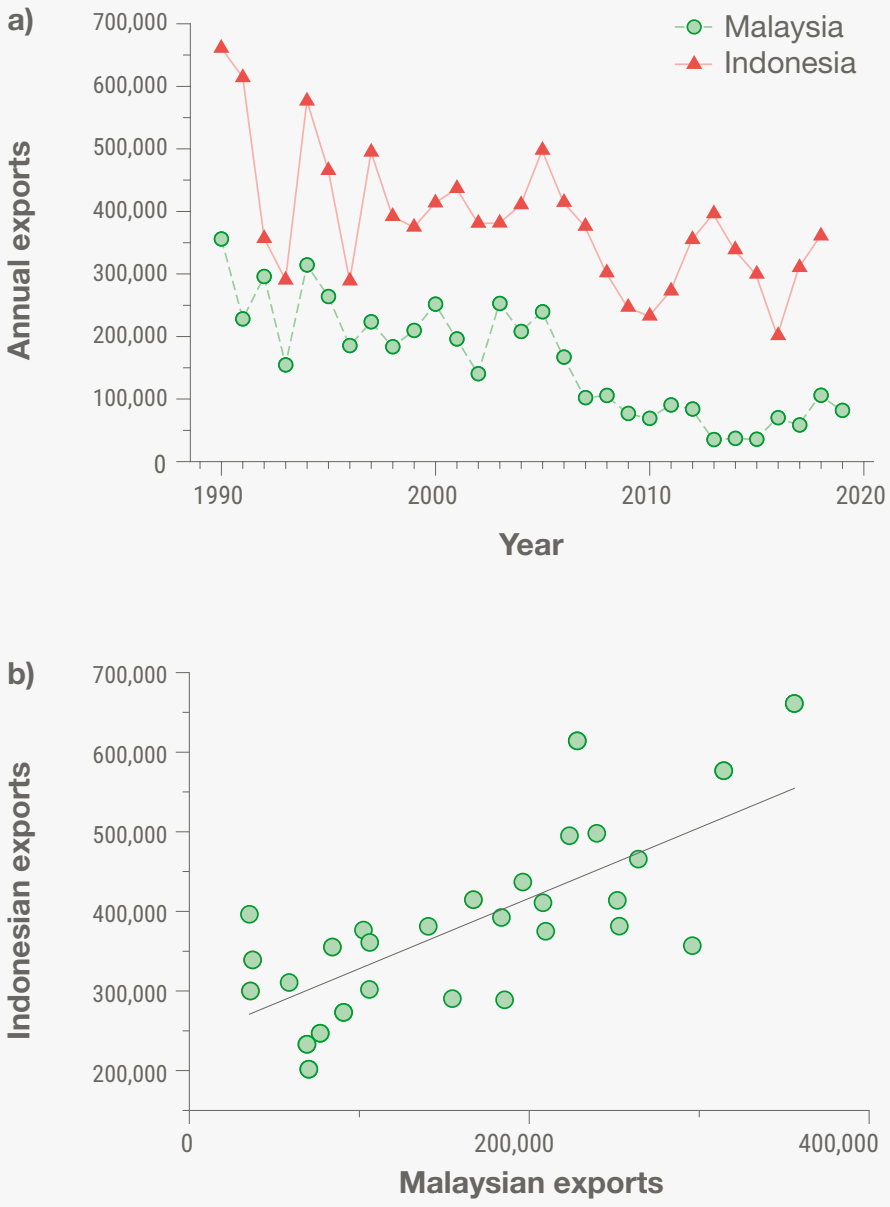


Fig. 1. (a) Annual exports of Asian water monitor (*Varanus salvator*) skins from Malaysia and Indonesia between 1990 and 2019, and (b) correlations between yearly export volumes of those two countries.

1.2.2 Meat

Malaysia has a single reptile meat processing and export facility. However, annual exports of *V. salvator* meat over the last 10 years have fluctuated greatly, ranging from 0 to 20 tonnes (CITES Trade Database, 2020). No major meat exports have occurred since 2013.

1.2.3 Live animals

Exports of several thousand live animals has occurred over the past decade. Exports have been to China and Hong Kong, and are suspected to be for human consumption.

1.2.4 Other Products

The majority of other byproducts utilized from *V. salvator* are tissues for traditional medicines, but these are typically sold domestically rather than exported. However, some exports of gall bladders have taken place (latest exports in 2011). Exports of some finished leather goods occur each year, but the numbers are exceptionally small (CITES Trade Database, 2020).

1.3 Domestic utilisation and trade

Varanus salvator skins are used within Peninsular Malaysia to make leather products, sold locally, but total volumes are exceptionally small (e.g., 100 skins/year; estimated by local traders; PERHILITAN 2020). Meat from animals captured for the international skin trade is consumed domestically, mainly by local Aboriginal (Orang Asli) populations. The most common domestic use of abattoir byproducts are organs (hemipenes, tongues, gall bladders) for traditional medicines. All are byproducts of the more significant trade in skins (PERHILITAN 2020).

1.4 Legal frameworks

1.4.1 International

The generic listing of all monitor lizards (*Varanus* sp.) by CITES, before the first Conference of Parties and without reference to listing criteria, species-specific trade nor status data, was clearly a well-intentioned precautionary measure, but not one based on hard science. Malaysia was well aware of this situation, and accepted the obligations to comply with Article IV in order to continue legal and sustainable trade, in a responsible manner. The primary requirements of Article IV, that all Parties to CITES address when exporting CITES-listed species on Appendix II, are embodied within Paragraph 2:

> a) [Exports will not be] *detrimental to the survival of the species in wild*, and;
> b) [Exports will not be] *in contravention of the laws of that State*

However, additional requirements are in Paragraph 3:

> a) [Exports will be] *limited in order to maintain that species throughout its range at a level consistent with its role in the ecosystems in which it occurs*, and;
> b) [The population will be maintained] *well above the level at which that species might become eligible for inclusion in Appendix I*

All four of these conditions are satisfied for *V. salvator* in Malaysia, which has:

a. Introduced management of the harvest and trade at levels commensurate with the local context and risks of extinction;
b. Derived monitoring indices for the harvest, trade and status of the wild population;
c. Ensured compliance with regulations designed to ensure sustainable levels of offtake from the wild; and,
d. Undertakes targeted researches to ensure assessments are science-based.

1.4.2 Domestic

Trade in *Varanus salvator* is regulated by the Department of Wildlife and National Parks (DWNP) Peninsular Malaysia (Jabatan Perlindungan Hidupan Liar dan Taman Negara; PERHILITAN), which is the Malaysian CITES Scientific Authority. Together with the Malaysian Ministry of Energy and Natural Resources (KeTSA), PERHILITAN also acts as the CITES Management Authority. *Varanus salvator* is a protected species in Peninsular Malaysia, but harvesting is permitted by the Wildlife Conservation Act 2010 (Act 716) if subject to strict regulations (see Chapter IV for further information on trade controls and management).

1.5 Jurisdiction

Malaysia is divided into 13 states (and 3 federal territories). All but two States are located in Peninsular Malaysia, which forms part of mainland Asia. The other two States (Sabah and Sarawak) are located on the island of Borneo. Sabah and Sarawak are semi-autonomous States, with separate wildlife management authorities and regulations that are different to Peninsular Malaysia. For example, Sabah and Sarawak implement their own harvest quotas for *Varanus salvator* and manage those harvests differently. This report and the management system presented here relate to *V. salvator* in Peninsular Malaysia, implemented by PERHILITAN, and does not concern the Malaysian Borneo States of Sabah or Sarawak.

1.6 Importance of sustainable use in Malaysia

PERHILITAN's primary mandate is to ensure the conservation of Malaysia's unique biodiversity for the benefit of Malaysian people. For some species and habitats considered vulnerable and in need of special measures (e.g., elephants, tigers, primary forest reserves, etc), strict prohibition of harvest and trade is implemented. However, the Malaysian Government and the public are also committed to deriving benefits from the use of wild species, where that use is demonstrably sustainable. This applies to species that are common and widespread and to habitat types at low risk – it requires management interventions to ensure sustainable use. The benefits derived from sustainable use change public perceptions of species like *V. salvator*, to ensure that those who live alongside wildlife perceive it as an integral component of rural development and livelihood upliftment. Responsibility for implementing both protection and sustainable use is vested in PERHILITAN.

Varanus salvator is a protected species, but because it is common and widespread, it can be utilized with authorization from PERHILITAN (see Chapter IV). The harvesting and benefits derived go mostly to lower income, rural Malaysians, particularly the local Aboriginal people (Orang Asli) who are traditional hunters and gatherers. Much like other wildlife harvests at the artisanal level, in most cases the harvest itself does not provide a sole source of livelihood. However, the ability to utilize common and freely available resources provides significant food security and income resilience in times of hardship (Nossal et al. 2016).

The harvest and trade of *V. salvator* in Peninsular Malaysia is conducted in line with several biodiversity conventions and international agreements. For example:

(1) The Convention on Biological Diversity (CBD): *conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources*.

(2) The Addis Ababa Principles and Guidelines: *the needs of indigenous and local communities who live with and are affected by the use and conservation of biological diversity, along with their contributions*

to its conservation and sustainable use, should be reflected in the equitable distribution of the benefits from the use of those resources, and, the costs of management and conservation of biological diversity should be internalized within the area of management and reflected in the distribution of the benefits from the use.

(3) UN Sustainable Development Goals: ....*to end poverty, targeting the most vulnerable, increasing basic resources and supporting communities affected by conflict and climate related disasters... and ...action to reduce loss of natural habitats and biodiversity and support food security, climate change mitigation and adaptation....sustainable use of terrestrial ecosystems to halt and reverse land degradation.*

1.7 Management goals: sustainable trade and mitigation of wildlife conflict

PERHILITAN's management goals for a species are tailored to the social, economic and biological context within which that species exists, is being used by people, and is likely to need conservation action in the short- or long-term. *Varanus salvator* is one of four common species (including: reticulated pythons *Python reticulatus*, macaques *Macaca fascicularis*, and wild pigs *Sus scrofa*) that are considered "wildlife conflict" species, in different parts of their range, to which the public attributes negative values. Conservation management for these species in Malaysia involves both culling (which reduces negative values) and sustainable use (which creates positive values).

In the case of *V. salvator*, this species is abundant throughout much of the country and despite their large size, are common even in densely populated areas. They readily grow accustomed to people and learn to associate human activities with food subsidies (Uyeda 2009; Khadiejah et al. 2019). Larger individuals are capable of becoming obnoxious food scavengers and audacious predators. This is true for many parts of Southeast Asia (Traeholt 1998; Shine et al. 1996; Shine et al. 1998b; Gaulke et al. 1999; Amarasinghe et al. 2009; Uyeda 2009; Cota 2011; Khadiejah et al. 2019).

In rural areas, water monitors regularly consume domestic pets and household livestock (mainly ducks and chickens). This species can also be dangerous to humans, inflicting serious bites (**Fig. 2**). PERHILITAN has no record of the number of Asian water monitor attacks on humans each year, but the number is expected to be low. Nevertheless, such instances gain media attention, resulting in negative opinions about monitor lizards in Malaysia. E.g.:

https://www.nst.com.my/news/nation/2019/10/528071/boy-gets-30-stitches-after-monitor-lizard-attack-tioman

https://www.hmetro.com.my/mutakhir/2017/03/211365/biawak-20kg-sesat-masuk-rumah

https://www.freemalaysiatoday.com/category/bahasa/2019/07/05/viral-buaya-kecil-panjat-rumah-orang-di-johor/

For these reasons, many Malaysian people are not prepared to tolerate this species. In some instances, local people poison, capture and kill monitor lizards, because they are considered vermin (**Fig. 2**). Because of the lack of oversight and possible animal welfare issues, PERHILITAN is required to undertake costly, targeted, culling programs for *V. salvator* in a number of sites in Peninsular Malaysia.

Fig. 2. Although rare, monitor lizard bites on people do occur (left and centre panel). Asian water monitors (*Varanus salvator*) also attack and consume pets and poultry in Peninsular Malaysia. Local people often kill monitor lizards themselves (right panel), or request PERHILITAN to initiate formal culling programs.

Hence the use and trade in *V. salvator* not only generates commercial benefits for harvesters, processors, their families and communities, but it reduces densities in areas where they are considered pests. Active harvesting also behaviorally conditions lizards to become more wary of humans, which reduces conflict, and lowers public expenditure on management through PERHILITAN.

Thus, PERHILITAN's management goals are twofold:

1) In areas of sustained conflict or high lizard density near human habitation, to significantly reduce short-term abundance; and,
2) In areas where commercial harvesting takes place, ensure lizard abundance does not decline to levels likely to threaten high and sustainable levels of offtake.

1.8 Compliance with CITES Article IV

The non-detriment provisions of CITES [Article IV. Paragraph 2(a)], are a significant safeguard for species in which excessive harvesting for trade could threaten the survival of the species, in accordance with Article II (Fundamental Principles), Paragraph 2(a): *all species which although not necessarily now threatened with extinction may become so unless trade in specimens of such species is subject to strict regulation in order to avoid utilization incompatible with their survival*.

In the case of *V. salvator*, it is assumed this was the rationale for listing (based on trade levels alone), although many species in the generic listing have never been traded in high volumes, and may have been listed for "look-a-like" reasons – difficulties in identifying species in trade [Article II Paragraph 2(b)].

Regardless, what constitutes evidence that trade in a common and abundance species like *V. salvator* is not causing extreme populations declines, likely to cause extinction, needs to be resolved by the range state. Implicit within this decision for Malaysia, is that a high harvest level has been sustained over multiple lizard generations, which is consistent with harvesting for trade resulting in high and positive rates of population increase (Sinclair et al. 2006) - the opposite to trade that is increasing the risk of extinction.

PERHILITAN accepts that the sustainability of the wild harvest, over generations, and now indicated by trade records, provides unequivocal evidence of compliance with Article IV Paragraph 2 (a) (*not detrimental to the survival of the species*). *Varanus salvator* is not at risk of extinction in Peninsular Malaysia due to trade.

Article IV Paragraph 3(a)(*maintain … species … at a level consistent with its role in the ecosystems in which it occurs)* is ecologically challenging for many species, but the situation in Peninsular Malaysia is relatively simple. *Varanus salvator* is rarely harvested in natural habitats and ecosystems, where their ecological role is not adversely affected by harvesting. Most harvesting of *V. salvator* occurs in disturbed and altered habitats, such as palm oil plantations, where much of their original biodiversity has been lost (e.g. Yue et al. 2015; Pardo et al. 2018), and no historical ecosystem role benefiting other native species can be re-established. Observational evidence suggests this large and voracious predator may reduce the abundance of feral species, such as rats, assisting other native species in the altered habitats. However, high densities of lizards in these anthropogenically-altered ecosystems may result in lower levels of biodiversity through direct predation. For example, the simple linear geography of oil palm drainage canals combined with monitor lizard foraging behavior may preclude a number of threatened water birds from capitalizing on this ubiquitous, pseudo-wetland habitat. Irrespective, PERHILITAN considers that the species' role in the ecosystem is not being impacted by harvest and trade (see Chapter III), which complies with Article IV Paragraph 3(a).

Article IV Paragraph 3(b) requires species to be maintained at levels well above what is needed for inclusion in Appendix I. *Varanus salvator* is on Appendix II because of the generic listing in 1975 – it has not been assessed objectively against present or past listing criteria. Importantly, it does not, and is unlikely to ever comply with, the listing criteria for Appendix I [Resolution Conf. 9.24 (Rev. CoP17) Annex 1]. Hence exports of *V. salvator* comply with Article IV paragraph 3(b).

1.9 Buy-in by industry

The sustainable use management programs implemented by PERHILITAN have been significant, and can be difficult to understand for industry people who were in operation for decades prior to implementation of conservation-based management. Therefore, requested changes need to be "fair and reasonable", undertaken for sound reasons, respect commercial confidentiality under Malaysian law, and not engender animosity between the industry and the Department. This limits the ability to publish some data publicly (e.g., export volumes for specific identified facilities), but allows such data to be assembled and used by the regulators to better monitor trade and harvest levels

CHAPTER II

The Asian Water Monitor

2.1 Background

In order to manage use and trade in *Varanus salvator* efficiently, it was important for PERHILITAN to review the literature on the species' biology. This chapter details what is known about *V. salvator*, both throughout its range and within Peninsular Malaysia. Data sources include peer-reviewed scientific research and various data and results PERHILITAN researchers and others have access to, some of which is published in peer-reviewed journals and some of which is not.

2.2 Nomenclature

The Asian water monitor (*Varanus salvator*) was first described by Josephus Nicolaus Laurenti in 1768 as *Stellio salvator*. Cantor (1847) was the first to use the name *Varanus salvator*. Mertens (1942) distinguished six subspecies in his study (*V. s. salvator, V. s. togianus, V. s. cumingi, V. s. nuchalis, V. s. marmoratus*, and *V.s. scutigerulus*). Taxonomic studies of the *V. salvator* complex were neglected for several decades until the discovery of new species and colour varieties in the genus *Varanus*. These discoveries lead Böhme (2003) to develop a standard reference for monitor lizards, at the request of the CITES Nomenclature Committee. This standard reference was developed to assist with communication about monitor lizards in the CITES domain, as previously there was confusion surrounding trade records of this family group. Böhme's (2003) list comprised 58 species and 28 subspecies. These taxa were to be adopted by the World Conservation Monitoring Centre, Cambridge (WCMC) and incorporated into the database Checklist of CITES species. Böhme (2003) detailed eight subspecies of the *V. salvator* complex (*V. s. salvator, V. s. andamanensis, V. s. bivittatus, V. s. cumingi, V. s. komaini, V. s. marmoratus, V. s. nuchalis, V. s. togianus*). Koch et al. (2007) re-elevated three recognised subspecies from the Philippine Archipelago (*V. s. marmoratus, V. s. nuchalis, V. s. cumingi*), as well as the Sulawesian taxon (*V. s. togianus*), which were elevated to full species status due to significant morphological differences. At the same time, the nominotypic subspecies *V. s. salvator* was restricted to the designated type locality of Sri Lanka, while the name *macromaculatus* was resurrected from synonymy for the populations of mainland Southeast Asia, as well as Borneo and Sumatra.

In 2010, the *V. salvator* complex was reviewed by Koch et al. (2010a) and revised to include eight subspecies:

- *V. s. andamanensis* Deraniyagala 1944
- *V. s. bivittatus* Kuhl 1820
- *V. s. cumingi* Martin 1838
- *V. s. komaini* Nutaphand 1987
- *V. s. macromaculatus* Deraniyagala 1944
- *V. s. marmoratus* Wiegmann 1834
- *V. s. salvator* Laurenti 1768
- *V. s. ziegleri*

These subspecies were divided based upon morphological characteristics. While these morphological analyses aid with understanding geographic variation in the *V. salvator* complex, phylogenetic analyses of morphological and molecular genetic data would be required to further understand the genealogical relationships among *V. salvator* lineages. Bennett et al. (2012) assessed the *V. salvator* complex for the IUCN Red List of Threatened Species, but only included four recognised subspecies; *V. s. salvator, V. s. andamanensis, V. s. bivittatus, V. s. macromaculatus.*

The subspecies recognized from Peninsular Malaysia and the subject of this management system is *Varanus salvator macromaculatus*, which is also the most geographically widespread.

Detailed ecological comparisons among the different subspecies of *V. salvator* have not been conducted to the best of PERHILITAN's knowledge, though the basic ecology and life history patterns are consistent for the entire species. Nevertheless, the majority of the information gathered within this

report is based on research on the widespread *Varanus salvator macromaculatus*, which is also the species mostly heavily harvested for skin and meat throughout its range.

2.3 Distribution

Varanus salvator is the most widespread varanid lizard (Böhme 2003; Gaulke and Horn 2004). It is widely distributed throughout Southern and Southeast Asia and the Indo-pacific region, from Sri Lanka in the west to the Philippines and Sulawesi in the east (Gaulke 1991b; Gaulke and De Silva 1997; De Silva 1998; Gaulke and Horn 2004; Grismer et al. 2006; **Fig. 3**). *Varanus salvator* is absent from northeastern Myanmar, northern and northeastern Thailand, all but coastal Cambodia, and all of Laos PDR except for the ranges on the Viet Nam border (Cota et al. 2009). This species is also absent from northwestern Viet Nam, Yunnan (China), all but coastal south China adjacent to Hainan, as well as Timor and Seram (Bennett et al. 2012). Examination of the distribution of *V. salvator* complex shows a continuous coastal and near coastal pattern, following permanent water sources and riparian habitat.

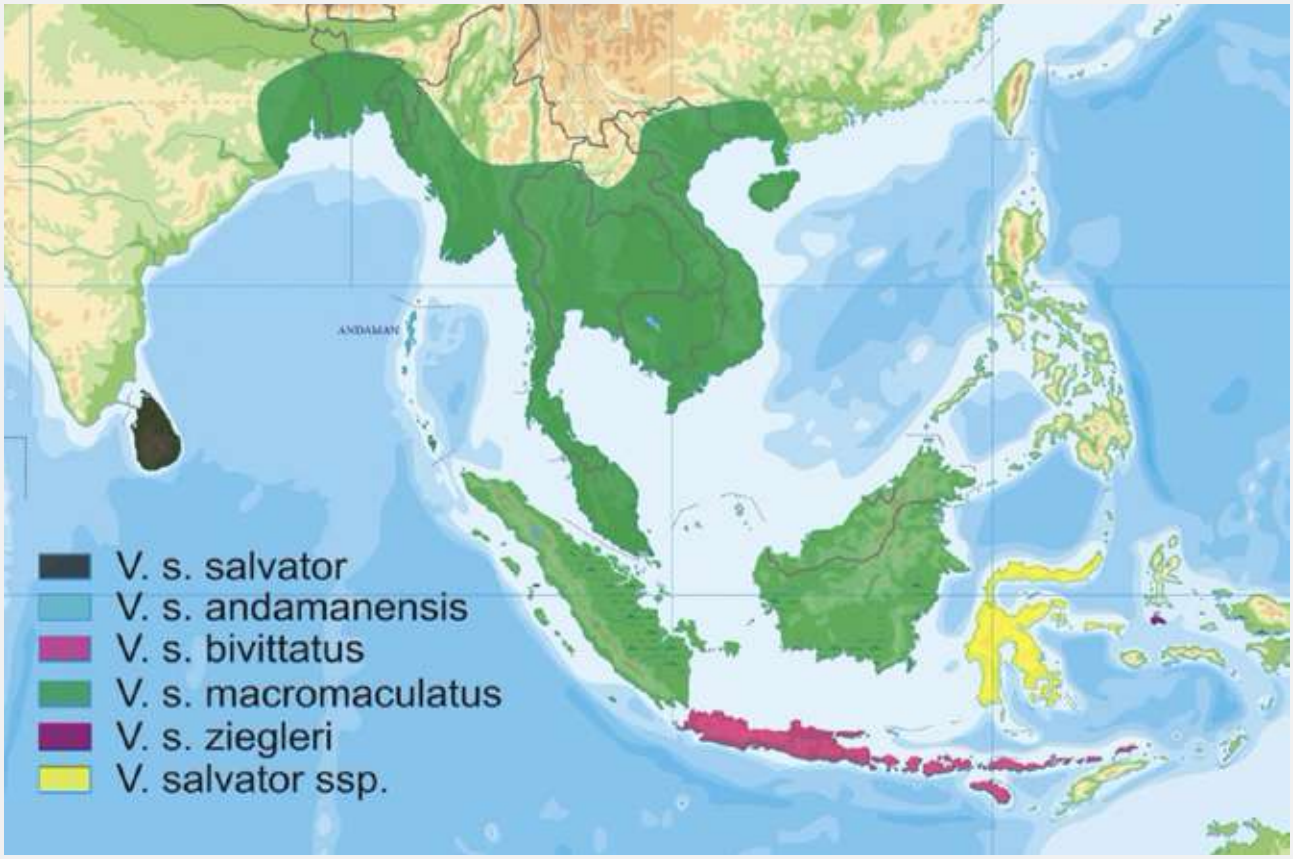


Fig. 3. Distribution of the Asian water monitor (*Varanus salvator*) and its subspecies (adapted from Koch et al. 2007).

2.4 Distribution in Peninsular Malaysia – past and present

Management in Peninsular Malaysia focuses on the subspecies ***V. s. macromaculatus***, which is distributed throughout the Southeast Asian mainland, Sumatra, the island of Borneo, and smaller associated offshore islands (Koch et al. 2010a). This species is common in Peninsular Malaysia, and is distributed in all habitats in this region, including urban areas (and indeed large cities, where they are common; Guerrero-Sanchez 2019; PERHILITAN 2020). *Varanus salvator* is uncommon above 1000 m sea level (Gaulke and Horn 2004), and are thus considered absent from these sites for the purpose of management (see Chapter III). Excluding this area of extent generates a potential distribution range of 115,629 km^2. There are probably some sites within this predicted distribution where *V. salvator* may not occur, for various reasons.

2.5 Habitat use and spatial ecology

The Asian water monitor, as its name suggests, is semi-aquatic and is observed most frequently near rivers, drainage canals in oil palm estates, estuaries, and other water bodies. They are generally found at altitudes below 1000 m (Gaulke and Horn 2004), in a variety of habitats such as rainforests, mangrove swamps and coastal zone wetlands (Traeholt 1998; Amarasinghe et al. 2009; Weijola 2010). Being an ecologically flexible species, *V. salvator* also thrives in agricultural areas (e.g., rice and oil palm), canal systems within cities (Gaulke et al. 1999), and second-growth forest (S. Sweet [IUCN] pers. comm.). At Malaysian sites, Twining et al. (2017) found higher occupancy of water monitors in areas of intense land use (oil palm plantations) and Guerrero-Sanchez (2019) found that lizards preferred oil palm plantations rather than forested areas. Both studies link increased food resources, higher occupancy rates and smaller home ranges to oil palm plantations (Twining et al. 2017; Guerrero-Sanchez 2019). In Malaysia, an upsurge in the management and control of freshwater resources associated with land reclamation, agricultural expansion, road construction and flood mitigation may have altered monitor lizard ecology in disturbed habitats and conferred significant benefits to the individuals occupying those habitats. An extensive network of open drainage canals and irrigation networks provide a mosaic of open water foraging habitats whilst the natural connectivity of water flow facilities unhindered movement and dispersal.

Radio-tracking in Peninsular Malaysia demonstrated *V. salvator* has clearly defined home ranges, consisting of a core area, in which a burrow would often be the centre for adults and a basking site as a centre for hatchlings (Traeholt, 1997). There is overlap among individual's home ranges, which appear to be variable in size. Vogel (1979) estimated the typical home range size was 1.5 km^2, which was considerably larger than the size given by Gaulke (1989) at 0.09 km^2. Uyeda (2015) reported a home range between 0.0055 and 1.12 km^2. Guerrero-Sanchez (2019) estimated mean home range sizes of *V. salvator* in Sabah, Malaysia, to be 1.56 km^2 in oil palm plantation and 3.91 km^2 in forested sites. Traeholt (1997) estimated home range of a population of *V. salvator* from an island and an oil palm plantation in Peninsular Malaysia to be between 0.02 and 0.31 km^2.

It is not known whether home range sizes differ between males and females, but it is likely that males have larger activity areas (Traeholt 1997). Wikramanayake and Dryden (1993) report that *V. salvator* is active between 0700 – 1700 h, and studies by Dryden and Wikramanayake (1991) and Gaulke et al. (1999) found the highest level of activity peaked at the hottest time of the day.

2.6 Morphological characteristics

Varanus salvator is the second largest monitor lizard species in the world after the Komodo dragon (Shine et al. 1998a). It can attain total lengths (TL) of up to 250 cm and weigh up to 25 kg (Shine et al. 1996; Traeholt 1995), despite individuals of this size being rare (Pianka et al. 2004). Studies in west Kalimantan, Indonesia, found the largest of 60 *V. salvator* had a total length of 224 cm, an average length of 143 cm, with the heaviest individual weighing 12.7 kg (Auilya and Erdelen 1999). Studies by Shine et al. (1996) on a population of *V. salvator* in southern Sumatra, Indonesia, found that males are larger, heavier bodied, and have longer tails, than females. *Varanus salvator* hatchlings are 18 to 30 cm long (Das 2006). In Peninsular Malaysia, *V. salvator* larger than 5 kg, if captured, are seldom sold into the skin trade because their skin quality is unsuitable (due to scarring and other age-related blemishes). Hence, the vast majority of *V. salvator* captured for trade are smaller than 5 kg.

2.7 Reproductive characteristics

Varanus salvator grow quickly to sexual maturity in 2 or 3 years depending on food availability, habitat type and geographic variation (e.g., Andrews and Gaulke 1990). Data compiled from captive *V. salvator* suggests that maturation is attained at the end of the second year of life (Andrews 1995). In Indonesia, males reach sexual maturity at around 40 cm SVL (approximately 100 cm TL, 1 kg) and females slightly larger at around 47 cm SVL (approximately 120 m TL; Shine et al. 1996). The largest immature male measured was 44 cm SVL and the largest immature female was 57 cm SVL. Embryonic sex-determination is genetically determined, hence biases in population sex ratio are not linked to the temperarture-dependent sex determination mechanisms in many other reptiles (Janzen and Paukstis 1991).

2.8 Timing of reproduction

Varanus salvator can reproduce year round in captivity and in the wild (Khan bin Khan 1969; Biswas and Kar 1981; Andrews and Gaulke 1990; Andrews 1995). Heavy rains preceding the monsoon appears to trigger the mating season in *V. salvator macromaculatus* (at least for populations in Bangkok and the Chao Phraya flood basin, see Cota 2011). Shine et al. (1996) found that adult males in southern Sumatra, Indonesia, had larger testes in April than October. Females were reproductively active in August and April, but with some reproductive activity also evident in October. It is thought that the egg-laying season extends from at least April to October, and that most females lay multiple clutches each year (Shine et al. 1996).

2.9 Reproductive output

Shine et al. (1996) found that clutch size ranges from 5 to 22 (mean 13) and is positively correlated with maternal body size (Shine et al. 1996), but can be much larger as Erdelen (1989) found 40 eggs in the oviducts of a mature *V. salvator* female. Data on clutch size of captive *V. salvator* (n = 6) were gathered by Mendyk (2012); six clutches were produced by five female *V. salvator* between 1977 and 1986. Clutch size ranged from 2 to 10 eggs (mean = 4.2 ± 3:1; n = 6). *Varanus salvator* nest and lay eggs in sandy soils along riverbanks, at the base of trees or bamboo clumps, in termite mounds, burrows, or in rotten or hollow trees (Boonratana 1989). Incubation times depend on clutch temperature (Pianka et al. 2004) and vary from 180 to 327 days in different locations (Das 2006).

2.10 Longevity

There are no data on the lifespan of wild *V. salvator*. In captivity, *V. salvator* is expected to live for 10.6 to 15.7 years (Flower 1925; Snider and Bowler 1992). Böhme (2003) recorded the age of a male *V.*

salvator kept in captivity between 1973 and 1999 in a school terrarium in Bonn, Germany. Due to its size when purchased, Böhme (2003) concluded that the specimen could have attained an age of 28 years, which represents the second oldest age ever reported in a member of the Varanidae.

2.11 Diet

Varanus salvator is a generalist carnivore that opportunistically feeds and scavenges. They are also active hunters (Gaulke 1991a; Traeholt 1993) that may travel more than 4 km a day in search of food. Prey items include insects, rodents, crustaceans, molluscs, reptiles, amphibians, mammals, carrion and, sometimes, human corpses and faeces (Gaulke 1989b; Gaulke 1991a; Traeholt 1993; Traeholt 1994a; Traeholt 1994b; Bundhitwongrut et al. 2008; Uyeda 2009; Stanner 2010). Shine et al. (1996) obtained records of prey from nine *V. salvator* from southern Sumatra; two contained fiddler crabs; one contained a large beetle; three contained rice-field rats (*Rattus argiventer*); one contained a long tailed giant rat *(Leopoldamys sabanus*); one medium sized male contained a conspecific monitor lizard not much smaller than itself (approximately 40 cm SVL); and one contained feathers of a domestic chicken and a large fishhook. In Sabah, Guerreo-Sanchez (2019) found that *V. salvator* from oil palm plantations fed predominately on rats, but that animals foraging in forest contained a much greater diversity of prey. Twining and Koch (2018) record human-refuse and a porcupine (*Hystrix brachyura*). Gut contents of *V. salvator* from oil palm plantations in Peninsular Malaysia reveal a range of prey, but with a predominance for rats, fish, and small individuals of the same species (i.e., cannibalism; PERHILITAN, 2020). *Varanus salvator* is clearly an opportunistic, generalist predator and scavenger whose diet is influenced strongly by habitat and prey availability.

2.12 Population sizes and density

Densities of *V. salvator* are recorded as being highly variable, depending on region and habitat type, and survey methodology (**Table 1**). Asian water monitors occur in the highest densities on islands and near human habitation, which are not representative of other sites. Perhaps the most in-depth population study on *V. salvator*, undertaken at discrete sites along the Kinabatangan River in Sabah, Malaysia, revealed high densities in both forest habitats and oil palm plantations (Guerrero-Sanchez 2019).

Table 1. Density estimates for *V. salvator* populations throughout Southeast Asia. Density estimates for sites in Peninsular Malaysia from PERHILITAN's studies are listed in **Table 3**.

STUDY (YEAR)	LOCATION	HABITAT	ESTIMATED DENSITY (lizards/km^{-2})
Vogel (1979)	Ujung Kulon, Java, Indonesia	Forest	4.5
Djasmani and Rifani (1988)	Kalimantan, Indonesia	Forest	10
Luxmoore and Groombridge (1989)	Calauit Island, Philippines	Forest	24 – 50
Traeholt (1997)	Tulai Island, Peninsular Malaysia	Forest and urban	224
Traeholt (1997)	Timor plantation, Peninsular Malaysia	Oil palm	33
Riquier (1998)	Sibau Island, Kalimantan, Indonesia	Forest	12
Cota (2011)	Bangkok, Thailand	Urban	144
Uyeda (2012)	Tinjul Island, Indonesia	Forest and urban	200 – 2,400
Mahaprom et al. (2015)	Samutprakran, Thailand	Forest	26
Guerrero-Sanchez (2019)	Kinabatangan, Sabah, Malaysia	Forest	136 - 212
Guerrero-Sanchez (2019)	Kinabatangan, Sabah, Malaysia	Oil palm	51 - 106

2.13 Susceptibility to anthropogenic disturbance

As already mentioned several times, *V. salvator* is widespread around human-modified areas and commonly encountered in anthropogenic habitats (Shine et al. 1998a; Das and De Silva 2005; Stanner 2010; PERHILITAN 2020). This species has a high reproductive rate (i.e., early maturation, frequent reproductive events and large clutch size) and a generalist diet. These life history traits make it well-suited to anthropogenic disturbance (Traeholt 1994b; Traeholt 1997a; Traeholt 1997b; Traeholt 1997c; Traeholt 1998; Shine et al. 1996; Shine et al. 1998a; Shine et al. 1998b; Gaulke et al. 1999; Amarasinghe et al. 2009; Uyeda 2009). This is the case in Peninsular Malaysia, where *V. salvator* is common in some of Malaysia's largest cities, such as Kuala Lumpur (**Fig. 4**). Although robust data on historical abundance are unavailable, in many parts of the range habitat conversation has likely increased lizard abundance – not reduced it. Given numerous research results and observational evidence, PERHILITAN does not consider habitat conversion to be a major threat to this species.

Fig. 4. A small water channel nearby to human settlement. Asian water monitors (*Varanus salvator*) thrive in habitats like this throughout Peninsular Malaysia.

2.14 Conservation status

Varanus salvator is listed as Least Concern on the IUCN Red List of Threatened Species (IUCN Red List, 2020). This is a global categorization, which includes Peninsular Malaysia. Claims by Koch et al (2013) that *V. salvator* populations are declining in Indonesia and Malaysia are poorly substantiated. They use export data and personal observations as evidence for decline of this species and do not report any analyses that can be used to assess sustainability of the harvest of Asian water monitor lizards. While claiming the off-take is too much, they also concluded, "it remains difficult to ascertain whether current exploitation levels impact local *V. salvator* populations, or if other factors such as specific land use practices not in favor of this semi-aquatic monitor lizard species also add to these declines." Koch et al. 2013 p.38). Below we present more thorough analyses of the trade in *V. salvator* from Malaysia.

2.15 Threatening processes unrelated to harvesting

2.15.1 Habitat loss

Varanus salvator thrives in many habitats that have replaced natural forest. Creation of drainage canals in oil palm plantations appears to have increased the availability of suitable habitat for this species in Peninsular Malaysia (**Fig. 5**). Coupled with high prey densities in these agroforestry systems, abundance of *V. salvator* is likely to be higher today relative to historical levels (see Chapter III). Therefore, habitat loss does not appear to be a significant threat.

Fig. 5. The creation of drainage canals in this resource rich habitat (an oil palm plantation, pictured) appears to have increased the availability of suitable habitat for *Varanus salvator* in Peninsular Malaysia. Monitor lizard densities are highest in this habitat type (see Chapter III).

2.15.2 Road kill

Varanus salvator are commonly observed as road kill on Malaysia's roads. Based on observations made while conducting routine activities throughout Peninsular Malaysia (i.e., data not collected in a standardized way) PERHILITAN estimates that perhaps thousands of individuals are killed each year, which reflects their high abundance in many areas. The impact of roadkill on *V. salvator* populations is unknown. PERHILITAN suspects it is not a driver of population dynamics and for this reason roadkill mortality is not factored into population estimates and sustainability of offtake.

CHAPTER III

The basis for sustainable utilisation

3.1 Introduction

PERHILITAN synthesizes a broad range of information to provide confidence that harvesting of *V. salvator* is sustainable in Peninsular Malaysia. This process of assessment is designed to be robust and inherently conservative. For example, where uncertainty in results and possible weaknesses in interpretation exist, PERHILITAN will apply information using the lowest estimates available.

3.2 Offtake rate

As the basis for sustainable utilisation of Asian water monitors, PERHILITAN considers that an annual harvest rate of 10% of the total population is likely to be indefinitely sustainable, despite the current harvest being well below that. A 10% harvest rate is well within harvest rates of other wildlife utilized for commercial purposes (Sinclair et al. 2006). For example, sustainable offtake rates of European hares are 20-40% (Marboutin et al. 2003); saltwater crocodiles are 4.0-60% (Bradshaw et al. 2006), wild pigs are 20-40% (Gentle and Pople 2013) and red deer are 10-40% (Milner-Gulland et al. 2000). Considering the biological attributes of this species (rapid growth, high fecundity; summarized in Chapter II), PERHILITAN considers *V. salvator* to have a life history approaching an r-selected strategy. R-selected species typically have high density-dependent population regulation, greater population growth rates, and can recover faster from stochastic shocks (e.g., harvesting; Williams 2013). Importantly, *V. salvator* occurs throughout a vast area in Malaysia and uses many types of habitat. Its distribution is much larger than the area where it is harvested. In fact, 99% of harvesting occurs in the states of Kedah, Pahang, Perak, Selangor but Asian water monitors occur throughout Malaysia. These characteristics make species like *V. salvator* capable of sustaining offtake (Khadiejah et al. 2019).

3.3 Decision-making steps

To establish a level of offtake that is sustainable, based on extraction of 10% of the standing population, PERHILITAN follows a series of 5 decision-making steps (**Fig. 6**).

1) Estimate the size of the harvestable *V. salvator* population in Peninsular Malaysia,

2) Based on a harvest rate of 10%, establish a precautionary quota based on results of population field monitoring and density estimates for the States and habitats in which harvesting occurs,

3) Conduct field surveys at harvested and unharvested sites to continually assess the area of occupancy, extent of area, and abundance of *V. salvator* in Peninsular Malaysia. This is done to document whether this species is disappearing from some areas and/or whether abundance is remaining stable. It also generates additional data to improve density estimates in key habitats,

4) Conduct continuous monitoring of trade dynamics to ensure no major changes in population demographics or catch per unit effort (CPUE) are taking place, and

5) Review results of monitoring activities and, if necessary, adapt harvest and trade regulations (permit numbers, harvesting areas, and quotas). Use results from field monitoring to recalibrate population size estimates.

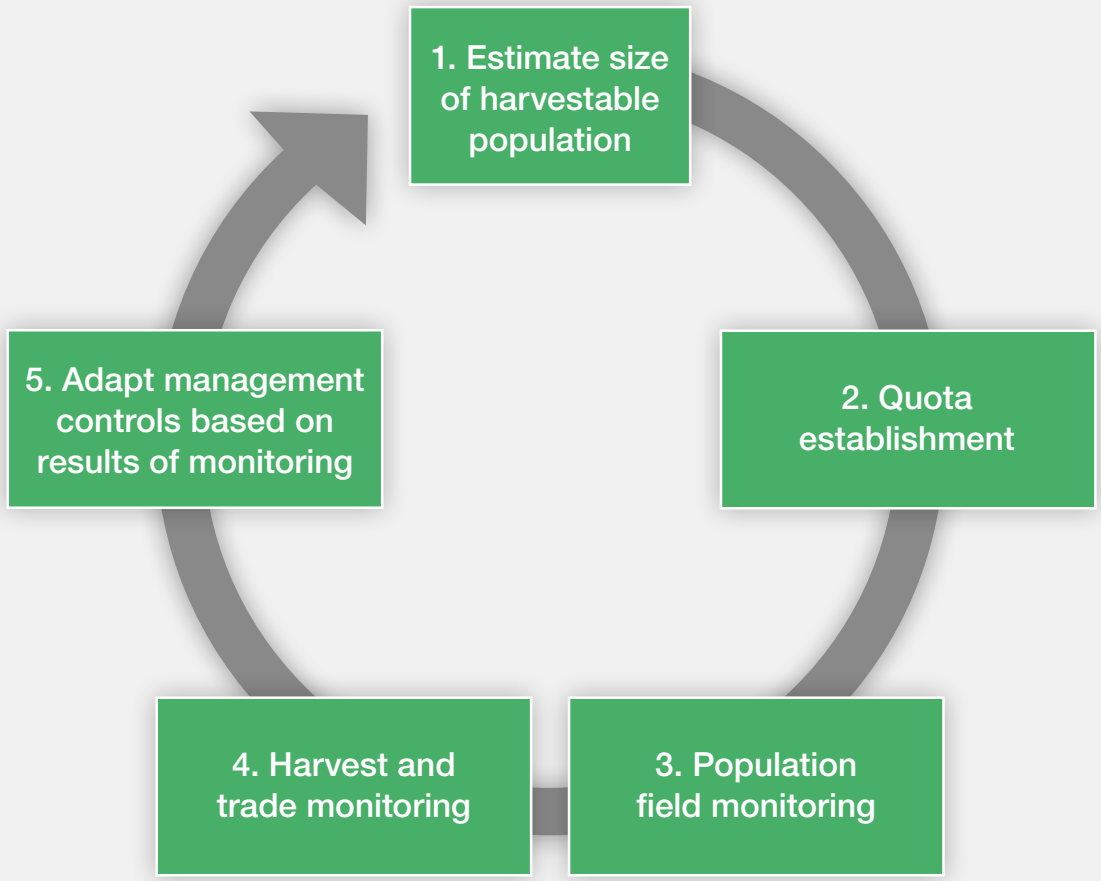


Fig. 6. Steps taken by PERHILITAN to inform decision-making for sustainable harvesting of *Varanus salvator in* Peninsular Malaysia.

3.4 Population field monitoring

3.4.1 Locations

Most harvesting in Peninsular Malaysia (99%; **Fig. 7**; see Section 3.8.2 for greater detail) occurs in four States: Kedah, Pahang, Perak and Selangor. Nevertheless, PERHILITAN has conducted trapping surveys at sites throughout Peninsular Malaysia to build understanding of population and harvest dynamics. For example, PERHILITAN's initial field monitoring (years 2010, 2011, 2012, 2018, 2019) was focused on sites and habitats known to be heavily harvested, as well as sites where little harvesting occurs. The purpose of this monitoring was to better understand the following:

1) Are there differences in abundance and density between sites and habitats of high and low harvest intensity?
2) Does relative abundance of lizards change over time depending on whether sites are harvested or not?
3) What are densities of monitor lizards in a range of sites and habitats across the Malay Peninsular?

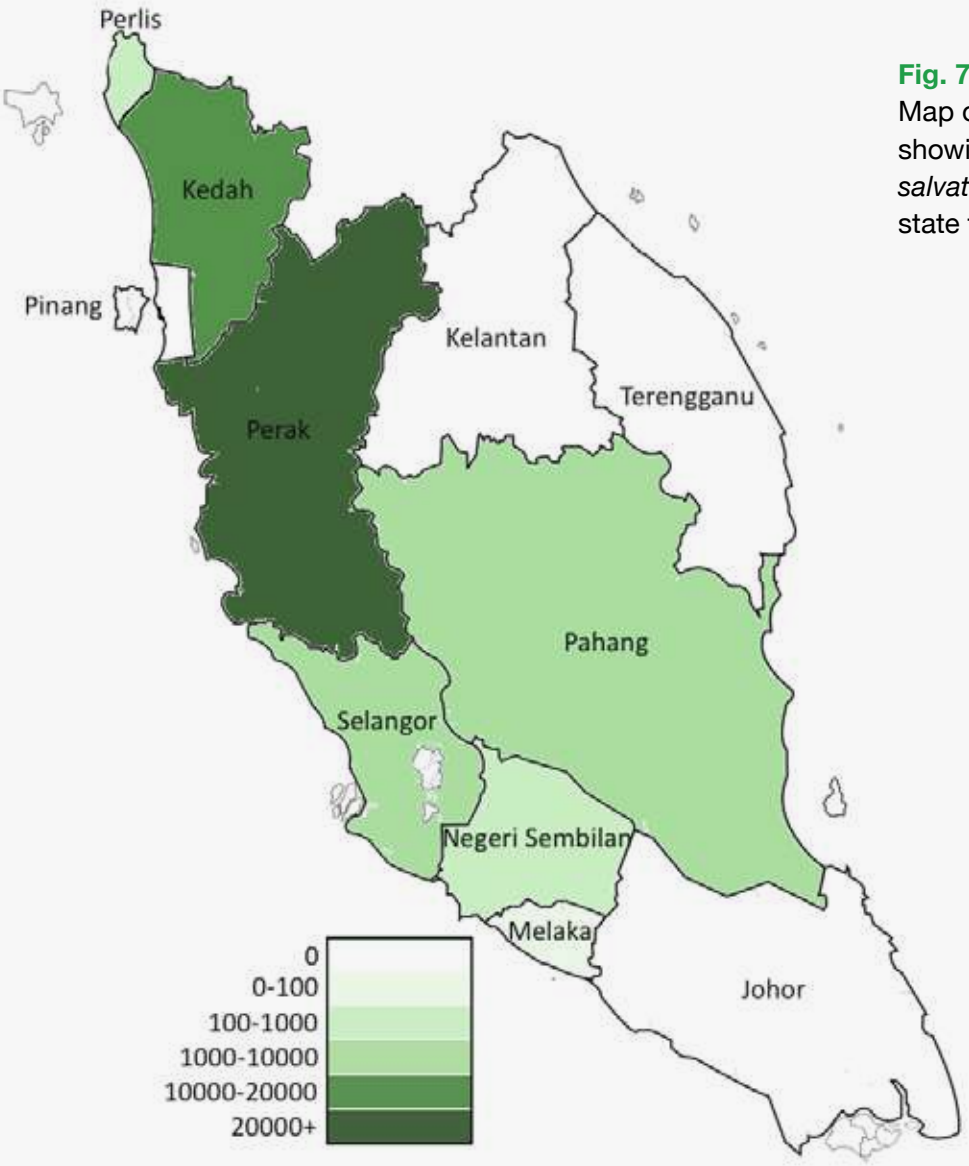
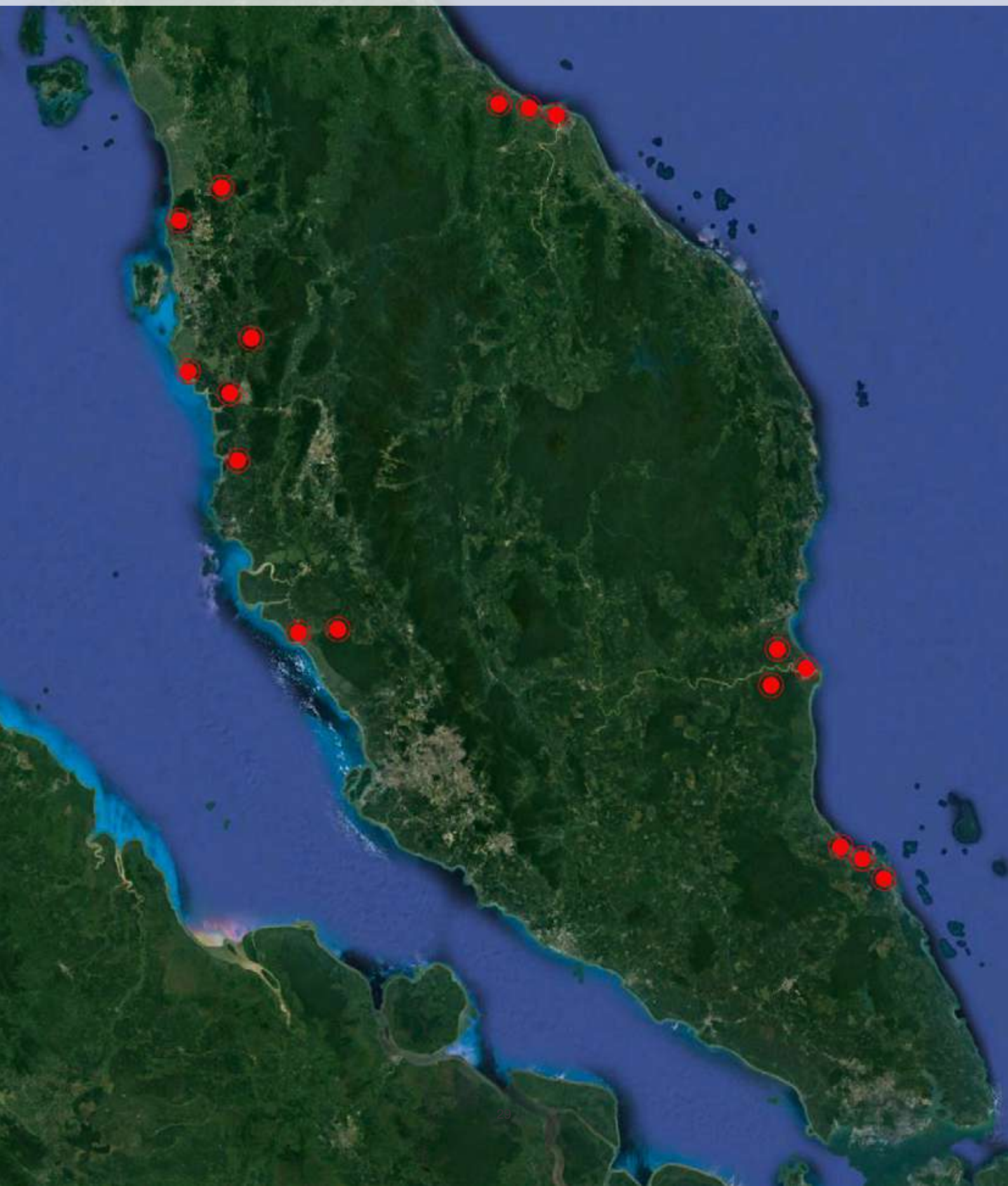


Fig. 7.
Map of Peninsular Malaysia showing the extent of *Varanus salvator* harvesting in each state from 2019 data.

To date, PERHILITAN has surveyed *V. salvator* in six states in Peninsular Malaysia between October 2010 and October 2019 (**Fig. 8**). Sites were chosen because they are either the main harvesting areas for *V. salvator* in Peninsular Malaysia, or because they represent sites of little or no harvesting against which comparison can be made (PERHILITAN 2020). All sites experience a tropical equatorial climate, with high year-round temperatures and rainfall, but with a minor 'drier period' from April to October. All surveys were conducted during drier months (May–October), and when completed at one site, the survey team moved immediately to another site, to minimize seasonal biases. Some sites were surveyed once; to establish a general index of abundance in different areas, with others surveyed in two successive years to better understand the confidence around that index. PERHILITAN conducted no trapping surveys between 2013 and 2017. For details of survey sites and dates see **Table 3** (below).

Fig. 8. Population monitoring survey sites for *Varanus salvator* in Peninsular Malaysia. Survey sites were concentrated in coastal areas because (1) most harvesting licenses are issued to harvesters living in coastal sites, who confirmed that most harvesting occurs in these areas, and (2) so to survey as many different habitat types as possible (specifically, mangroves; see **Table** 3 for further detail).



At each site PERHILITAN surveyed lizards in four habitat types: rainforests; oil palm plantations; mangroves and surrounding swamps; and rice paddies (**Fig. 9**). Within each state, all habitats were within 25 km of one another – close enough to limit confounding environmental effects, yet far enough to preclude migration of lizards between sites (based on home-range sizes; Traeholt 1998a). Natural forest habitats were all within protected areas, where harvesting is strictly prohibited. Although illegal hunting may occasionally take place at these sites, difficulty of access coupled with the ready availability of Asian water monitors at other locations suggests that harvesting pressure was relatively low. The other habitat types are all subject to harvesting in the states where harvesting occurs (as stated by local traders and harvesters; PERHILITAN 2020). Survey sites were concentrated in coastal areas because (1) most harvesting licenses are issued to harvesters living in coastal sites, who confirmed that most harvesting occurs in these areas, and (2) so to survey as many different habitat types as possible (specifically, mangroves).

Fig. 9. Examples of the four main habitat types regularly surveyed for *Varanus salvator* in Peninsular Malaysia. Natural forest (top left), oil palm plantation (top right), swamp/mangrove (bottom left), and rice paddy (bottom right).

3.4.2 Survey Protocol

The survey method was adapted so that local harvesters, with experience and equipment, could be integral parts of the survey team in each different area. When population surveys are planned, PERHILITAN suspends all other harvesting at survey sites. Harvesters modify their trapping protocols, to establish a single line (transect) of 20 snares in each survey habitat, which was replicated without harvesters involved at subsequent sites (**Fig. 10**). This single transect became the trapping survey line (i.e. a single replicate per habitat type; **Table 3**). The length of each trap line varied with habitat type and logistical constraints, but the distance between adjacent traps never exceeded 350 m (mean trap line length = 3.51 ± 0.19 km; **Table 3**). Transect lines at the same sites in multiple years also attempted to recapture marked individuals (see **Table 3**). Traps are nylon snares, used traditionally to capture monitor lizards in Peninsular Malaysia (Traeholt 1998b). Snares were set in sheltered sites, with vegetation cleared 1–2 m around the snare location to ensure proper functioning and minimise possibility of entanglement of lizards (*sensu* Traeholt 1998b; **Fig. 11**). Snare sites were baited with poultry or snake offal and checked twice per day (late morning and afternoon). The sex of most lizards was determined when males everted hemipenes directly after capture and, if not everted, by checking with palpation. We reconfirmed sex upon recapture, and excluded specimens of uncertain sex from some analyses (N = 42). Snout–vent length (hereafter SVL) and body mass were measured using a flexible tape and spring scales, respectively (Figs. 12 & 13). Before release at the site of capture, a passive integrative transponder (PIT) tag was implanted in each lizard to identify individuals on subsequent encounters (**Fig. 14**). Toenails were also clipped in a specific pattern to allow identification. Finally, coloured pastels were used to mark individuals for short-term encounters (2-3 days; **Fig. 15**). Trap lines were operated for approximately 1 week (mean = 8.3 days; s.e. = 0.21; range 8–9). During surveys in successive years, normal harvesting was allowed to occur during the intervening period.

Fig. 10. PERHILITAN staff sets a noose traps together with local harvesters.

Fig. 11.
A noose trap with hanging bait
set in an oil palm plantation.

Fig. 12.
Measuring the total length of a captured lizard before release.

Fig. 13.
Measuring body mass of a captured lizard before release

Fig. 14. Uniquely marking a captured *Varanus salvator* with a passive integrated transponder tag to allow the individual to be identified on subsequent encounters.

Fig. 15. Uniquely marking a captured *Varanus salvator* with a coloured pastel to allow easy identification after short periods (2-3 days; toenail clipping lasts several weeks, while PIT tags last for years).

3.4.3 Frequency

PERHILITAN has monitored *V. salvator* populations since 2010. Surveys were conducted in 2010, 2011 and 2012. Surveys began again in 2018, were conducted in 2019, and will be conducted annually for the foreseeable future (**Table 3**). Surveys in each habitat typically last for an average of one week (one month of surveying in total). Based on the results of earlier surveys and knowledge of harvest locations, future surveys (2020 onwards) will be focused in the states where 99% of harvesting occurs (Kedah, Pahang, Perak, Selangor; see Section 3.8.2 of this Chapter).

3.5 Landscape scale assessment of *V. salvator* population sizes in Peninsular Malaysia

3.5.1 Extent of habitats

Peninsular Malaysia has a land area of 132,339 km^2. The largest single land cover type in Peninsular is natural forest, which accounts for approximately 44% of the total land area (**Table 2; Fig. 16**). Of this natural forest area, 83% is protected within national parks or state forest reserve. With the exception of mangroves, swamps and open water bodies and urban areas, the majority of the remaining land use in Peninsular Malaysia is comprised of various agricultural crops (most notably, oil palm plantations; **Table 2**).

Table 2. Land use cover (in km^2) for each state in Peninsular Malaysia (Malaysian Ministry of Forestry).

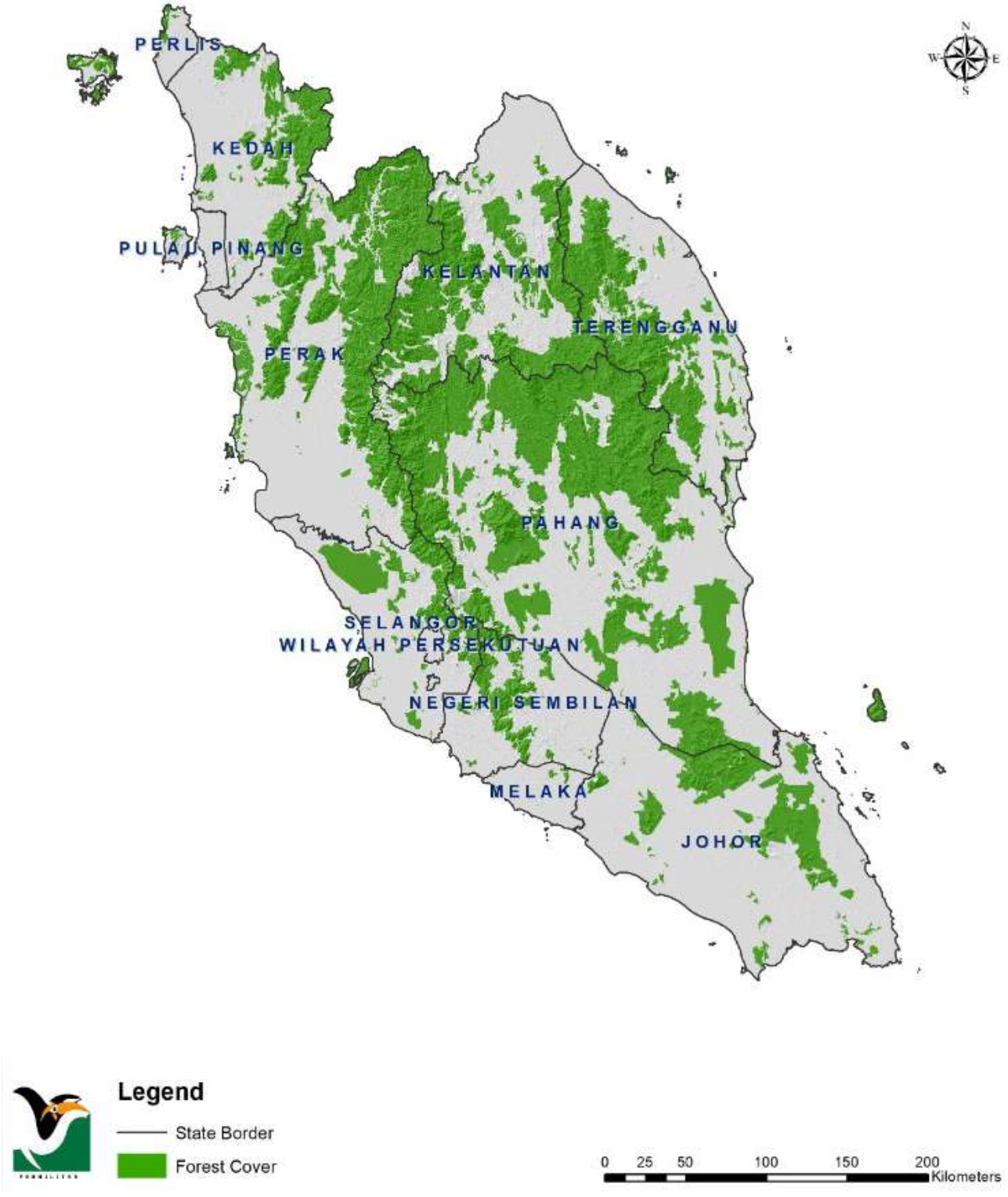
STATE	NATURAL FOREST	MANGROVES/ SWAMPS	OIL PALM	RICE	OTHER AGRICULTURE[1]	URBAN AREAS	OTHER[2]	TOTAL
Johor	5613	835	6368	11.6	5820	398	163	19210
Kedah	3608	330	1032	1387	2900	229	12	9500
Kelantan	7912	103	1190	508	5291	86.7	6.3	15099
Melaka	199	16	404	17.4	867	150	8.6	1664
Negeri sembilan	2107	23	1982	11.2	2286	178	97	6686
Pahang	18958	1812	8596	28.1	6375	113	254	36137
Perak	11576	1142	4842	527	1910	351	685	21035
Perlis	74	1.72	57.8	288	368	27.6	1.91	821
Pulau Pinang	143	57	217	171	166	288	3.9	1048
Selangor	2085	1224	2059	246	1164	975	349	8104
Terengganu	7190	664	2304	146	2148	101	479	13035
Wilayah Persekutuan	11.7	1.73	1.01	0	45.2	227	5.23	292
Peninsular	**59469**	**6212**	**29054**	**3345**	**29299**	**2897**	**2059**	**132339**

[1]"Other agriculture" category includes rubber, mixed fruits, livestock, and unknown.

[2]"Other" category includes water bodies, scrubland and sparse vegetation.

https://www.forestry.gov.my/en/component/flippingbook/book/49/1?page=98&Itemid=1188

Fig. 16. Location of natural forest habitat within Peninsular Malaysia. Primary forest covers 44% of Peninsular Malaysia's land area (**Table 2**). Eighty-three percent of that forest is under formal protection from harvesting and habitat clearance (national parks, etc).



3.5.2 Estimating the population of *Varanus salvator* throughout Peninsular Malaysia

PERHILITAN estimates population sizes of *V. salvator* at each survey site using a combination of open-population and closed-population models in the program MARK (White and Burnham 1999). For sites surveyed only once over a short time period, a full likelihood closed-capture model is employed (Otis et al. 1978), where the probabilities of first and subsequent captures were equal to one another (M_0). This model is used because capture probability is unlikely to vary with time (because of the short duration of our surveys), an assumption that may be violated if lizards become trap shy after their first capture. However, allowing capture probability to vary does not improve model fit and typically produces unrealistic parameter estimates (e.g., population estimates several orders of magnitude higher than what is considered possible). The M_0 model is used to estimate the number of individuals that remain unmarked (f_0) at the end of the sampling period and thus calculate population size (Otis et al. 1978). Closure of each population is assumed because of the brief (1-week) sampling period. For the sites surveyed in successive years, data are combined from both years and the number of days between each sampling interval is included in an open population Jolly–Seber model to estimate population size (White and Burnham 1999). Outputs of both open and closed modeling are used to estimate the density of *V. salvator* at each survey location, by dividing the estimated population sizes by the area of each habitat type surveyed. Traeholt (1998a) estimated the home range of *V. salvator* at an island (forest) site and mainland (oil palm) site in Peninsular Malaysia to be between 0.014 and 0.31 km^2. Thus, we conservatively used the largest home-range sizes calculated by Traeholt (1998a) to assume that we would capture lizards up to 0.31 km from each baited trap (the maximum linear distance between a trap and the edge of a lizard's home range). This method allowed us to derive a survey area for each trap line from the following equation:

Survey area =
([transect distance + (2 x 0.31 km)] x [2 x 0.31])

The home range estimates of Traeholt (1998a) were used because they are the only estimates available for Peninsular Malaysia. The largest figure of 0.31 km^2 was derived from an oil palm plantation, where most harvesting occurs (PERHILITAN 2020). Therefore, the estimate of *V. salvator* home-range size used to determine densities was the best available to us, but other studies from other parts of the species' range report home range estimates both smaller and larger (Vogel 1979; Erdelen 1991; Guererro-Sanchez, 2019; **Table 1**). Most comparable studies of *Varanus* densities estimate the effective area covered by each trap (i.e. trap influence area) as half the radius of the mean distance between all recapture sites (Krebs, 1999; Ciofi et al., 2007; Uyeda, 2009; Jessop et al., 2012; Purwandana et al., 2014). Applying this technique to our study sites would have yielded smaller total survey areas, and thus higher densities. In an attempt to reduce possible bias associated with home range estimates, naïve densities, which are based on the total number of individual lizards captured within the sampling area, were calculated for the period of trapping survey. Trapping effort was standardized using the number of captures per trap day.

Table 3. Summary of survey effort for water monitors (*Varanus salvator*) in four habitats in six States in Peninsular Malaysia. Where possible, naïve, closed-model and open-model population estimates (see text) are provided, together with associated density estimates.

Study area	Year of survey	Habitat	Survey dates	Transect length (km)	Survey area (km^2)	Monitors captured	Monitors recaptured (from previous years)	Population estimate	Naïve density estimate (km^{-2})	Estimated density (km^{-2})
Terengganu	2010	Rainforest	27.10.10-4.11.10	1.6	1.4	10	0		7.1	
		Oil palm	27.10.10-4.11.10	2.5	1.9	59	5	288±119	28.4	151.6±62.6
		Mangrove	27.10.10-4.11.10	3.8	2.7	41	3	238±129	14.4	88.1±47.8
		Rice paddy	27.10.10-4.11.10	4.3	3.1	30	2		9.0	
	2011	Rainforest	24.5.11-31.5.11	1.6	1.4	16	0 (2)		11.4	
		Oil palm	24.5.11-31.5.11	2.5	1.9	40	1 (16)	*123±48	20.5	64.7±25.3
		Mangrove	24.5.11-31.5.11	3.8	2.7	19	0 (3)		7.0	
		Rice paddy	24.5.11-31.5.11	4.3	3.1	34	2 (3)		10.3	
	2018	Rainforest	11.7.18-19.7.18	1.6	1.4	3	0 (0)		2.1	
		Oil palm	11.7.18-19.7.18	2.5	1.9	77	14 (0)	156±34	33.2	82.1±17.9
		Mangrove	11.7.18-19.7.18	3.8	2.7	30	2 (0)		10.4	
		Rice paddy	11.7.18-19.7.18	4.3	3.1	53	1 (0)		16.8	
Selangor	2010	Rainforest	1.10.10-9.10.10	4.1	2.9	25	0		8.6	
		Oil palm	1.10.10-9.10.10	1.9	1.6	13	1		7.5	
		Mangrove	1.10.10-9.10.10	2.5	1.9	25	2		12.1	
		Rice paddy	1.10.10-9.10.10	5.9	4.0	16	0		4	
	2011	Rainforest	28.6.11-6.7.11	4.1	2.9	12	1 (4)		3.8	
		Oil palm	28.6.11-6.7.11	1.9	1.6	26	1 (0)		15.6	
		Mangrove	28.6.11-6.7.11	2.5	1.9	53	1 (0)		27.4	
		Rice paddy	28.6.11-6.7.11	5.9	4.0	22	0 (0)		5.5	
	2018	Rainforest	10.8.18-17.8.18	4.1	2.9	38	5 (0)	110±43	11.4	37.9±14.8
		Oil palm	10.8.18-17.8.18	1.9	1.6	30	2 (0)		17.5	
		Mangrove	10.8.18-17.8.18	2.5	1.9	49	0 (0)		25.8	
		Rice paddy	10.8.18-17.8.18	5.9	4.0	21	1 (0)		5	
Perak	2010	Rainforest	24.10.10-1.11.10	1.2	1.1	6	2		3.5	
		Oil palm	24.10.10-1.11.10	4.5	3.2	33	0		10.4	
		Mangrove	24.10.10-1.11.10	2.2	1.7	64	3	633±353	34.9	372.4±207.6
		Rice paddy	24.10.10-1.11.10	5.1	3.5	25	1		6.8	
	2019	Rainforest	18.10.19-22.10.19	2.0	1.6	10	0		6.2	
		Oil palm	17.10.19-24.10.19	2.7	2.0	113	3	1847±1042	55.0	923±521
		Mangrove	17.10.19-22.10.19	2.1	1.7	29	0		17.1	
		Rice paddy	16.10.19-24.10.19	5.2	3.6	58	3	479±264	15.3	133.1±73.3
Pahang	2012	Rainforest	15.5.12-22.5.12	5.2	3.6	6	0		1.7	
		Oil palm	15.5.12-22.5.12	2.9	2.2	24	0		11.0	
		Mangrove	15.5.12-22.5.12	2.9	2.2	17	0		5.3	
		Rice paddy	15.5.12-22.5.12	5.9	3.1	10	0		3.3	
	2018	Rainforest	27.7.18-3.8.18	5.2	3.6	24	1 (0)		6.4	
		Oil palm	27.7.18-3.8.18	2.9	2.2	53	4 (0)	287±134	22.3	130.4±60.9
		Mangrove	27.7.18-3.8.18	2.9	2.2	13	0 (0)		5.9	
		Rice paddy	27.7.18-3.8.18	5.9	4.0	33	0 (0)		8.3	
Kedah	2012	Rainforest	11.7.12-18.7.2012	3.5	2.6	7	1		2.3	
		Oil palm	11.7.12-18.7.2012	3.4	2.5	3	0		1.2	
		Mangrove	11.7.12-18.7.2012	3.6	2.6	33	0		12.6	
		Rice paddy	11.7.12-18.7.2012	5.9	4.0	7	0		1.7	
	2019	Rainforest	3.10.19-10.10.19	3.5	2.6	15	1		5.4	
		Oil palm	3.10.19-11.10.19	2.0	1.6	14	1		8.1	
		Mangrove	4.10.19-10.10.19	3.6	2.6	41	0		15.8	
		Rice paddy	4.10.19-11.10.19	6.1	4.2	44	1		10.5	
Johor	2019	Rainforest	20.9.19-24.9.19	2.8	2.1	5	1		1.9	
		Oil palm	22.9.19-26.9.19	1.9	1.6	6	1		3.1	
		Mangrove	19.9.19-27.9.19	2.3	1.8	38	5	84±32	18.3	46.7±17.8
		Rice paddy	21.9.19-25.9.19	5.1	3.5	5	0		1.4	

Population sizes for *V. salvator* could only be estimated at 10 of 52 sites surveyed, because few had recapture rates high enough for modelling (**Table 3**). Nine estimates were derived from closed-capture models and one from an open-population Jolly–Seber model.

To estimate habitat specific densities, the following assumptions were made:

- Altitudes greater than 1,000 m (17,093 km^2) were not occupied by *V. salvator* (*sensu* Gaulke and Horn, 2004). Nearly 100% of this area is comprised of natural forest.
- Habitat types not included in population surveys (**Table 3**), which included other agriculture, urban areas, and other (water bodies, scrubland and sparse vegetation; **Table 4**) (34,590 km^2) were considered for analytical purposes to have zero *V. salvator* and were excluded, leaving 81,083 km^2 (61% of Peninsular Malaysia's land area).

Table 4. Extent of available habitats and mean densities (and ranges) from the surveys. Peninsular Malaysia contains 17,093 km^2 of land above 1,000 m (nearly 100% of which is natural forest) where *V. salvator* is assumed not to occur; E = excluded from analyses and assumed to have zero density, until estimates can be obtained. Range totals are calculated based on lowest or highest estimates where they are available, together with single estimates where they are not.

HABITAT TYPE	AREA	MEAN DENSITY	DENSITY RANGE	MEAN ESTIMATED POPULATION SIZE	RANGE ESTIMATED POPULATION SIZE
Natural forest	$59,115.2	E	-		-
Natural forest available	42,022.2	37.9	-	1,607,157	-
Mangrove/swamp	6,232	169	46.7 - 372.4	1,053,214	291,036 – 2,320,812
Oil palm	29,055.5	270.3	64.7 - 923	7,855,447	1,879,891 – 26,818,236
Rice	3,345.6	133.1	-	445,299	-
Other agriculture	29,379.2	E	-	0	-
Urban areas	3,141.3	E	-	0	-
Other	2,070.1	E	-	0	-
Total	**132,339**	**152.59**		**10,961,119**	**4,223,384 – 31,191,505**

An estimated 81,083 km^2 of habitat in Peninsular Malaysia is available for *V. salvator*, and within these areas the wild population of *V. salvator* is estimated to be 10,961,120 individuals for the purposes of management (**Table 4**). If the lowest and highest density estimates for each habitat type are used, it would range from 4,223,384 to 31,191,505 individuals.

3.5.3 Offtake calculations

Offtake rates of 10% applied to the total population estimate for *Varanus salvator* in Peninsular Malaysia would result in a harvest quota of more than 1 million lizards (**Table 4**). Given worldwide demand for lizard skins has been significantly less during more than two decades, PERHILITAN does not consider such offtake to be realistic. Moreover, a country-wide population estimate does not take into account the geographic distribution of harvesting, and PERHILITAN is interested in managing the populations that are harvested. Therefore, rather than using 10% of the national population size to set harvest quotas, a different, more realistic, approach to establish allowed offtake is applied.

Data on the spatial distribution of harvesting (**Fig. 7 and Fig. 23**) shows that 99% of Asian water monitors harvested in Peninsular Malaysia come from just four states: Kedah, Pahang, Perak, and Selangor. Therefore, annual offtake quotas are based on estimates derived for available habitats in those states only. This helps ensure that populations are not being over-exploited where harvesting is taking place.

Within these states, only the habitat types that are most targeted by harvesters are included in the population estimate. Through work with local harvesters during population surveys and direct questioning, it appears harvesters rarely target unprotected forest habitats because it is easier to collect from modified landscapes. Additionally, most forested habitats are protected from harvesting (83%). To make offtake estimates and quotas even more conservative and more directly related to areas where the species is actually targeted, population estimates were restricted to include only mangroves/swamps, oil palm plantations, and areas under rice cultivation. Though lizard density estimates in these habitats in these states were higher than other states (**Table 3**), a precautionary approach was taken whereby estimates were based on mean values for habitats across Peninsular Malaysia. These criteria all tend to produce population estimates that likely under-estimate the real population size. Using this approach, the total estimated population size for these three habitats in those four states is 5,516,434 lizards (**Table 5**).

It is further taken into account that because population size in monitors, and all lizards, is so difficult to estimate, any estimates carry broad confidence intervals (Rodda 2012). Because of uncertainty and wide confidence limits, population sizes in these states were recalculated based on the lowest density (rather than the mean) estimates obtained in each habitat across all sites in Peninsular Malaysia (**Table 6**). This resulted in a very conservative estimated population size of 1,571,625 individual lizards.

Based on an annual offtake of 10%, the harvestable proportion of the estimated population in these states equates to 157,162 individual lizards. Based on current evidence available to the department, this number is considered a conservative assessment of sustainable offtake for this species in Peninsular Malaysia. However, based on interviews and correspondence with Malaysian stakeholders trading in this species, there is not demand for this number of skins each year. Therefore, at this time Malaysia intends to set the annual quota and exports for this species at 120,000 skins/year. Should demand increase, or decrease, the quota will be adapted accordingly to reflect market demand. However, until more precise estimates and more data are available to justify an amendment, the annual harvest and export quota for Peninsular Malaysia will not be increased beyond 157,000 skins.

Table 5. Habitat area and estimates of population sizes in four states in Peninsular Malaysia where 99% of *Varanus salvator* harvesting occurs. Population estimates are based on **mean** densities recorded for each habitat type across Peninsular Malaysia.

STATE	MANGROVE/SWAMP (density = 169km^{-2})		OIL PALM (density = 270.4km^{-2})		RICE (density 133.1km^{-2})		TOTAL ALL HABITATS	
	Area	Population size	Area	Population size	Area	Population size	Area	Population size
Kedah	330.2	55,800	1,032.1	278,667	1387.9	184,590	2,750.2	519,058
Pahang	1,812	306,228	8,596.6	2,321,082	28.1	3,737	10,436.7	2,631,047
Perak	1,142.5	193,084	4,842	1,307,340	527.9	70,210	6,512.4	1,570,634
Selangor	1,224.6	206,952	2,059	555,930	246.7	32,811	3,530.3	795,693
Total	**4509.26**	**762,064**	**16,529**	**4,463,019**	**2,190**	**291,349**	**23,229**	**5,516,433**

Table 6. Habitat area and estimates of population sizes in four states in Peninsular Malaysia where 99% of *Varanus salvator* harvesting occurs. Population estimates are based on **minimum** densities recorded for each habitat type across Peninsular Malaysia.

STATE	MANGROVE/SWAMP (density = 46.7km^{-2})		OIL PALM (density = 64.7km^{-2})		RICE (density 133.1km^{-2})		TOTAL ALL HABITATS	
	Area	Population size	Area	Population size	Area	Population size	Area	Population size
Kedah	330.2	15,420	1,032.1	66,777	1387.9	184,729	2,750.2	266,927
Pahang	1,812	84,620	8,596.6	556,200	28.1	3,740	10,436.7	644,561
Perak	1,142.5	53,355	4,842	313,277	527.9	70,263	6,512.4	436,896
Selangor	1,224.6	57,189	2,059	133,217	246.7	32,836	3,530.3	223,242
Total	**4509.26**	**210,584**	**16,529**	**1,069,472**	**2,190**	**291,569**	**23,229**	**1,571,625**

3.5.4 Additional considerations

Extrapolation of density estimates to the total area of Peninsular Malaysia suggests a population of approximately 11 million lizards, which is not unreasonable. In all studies of lizards and snakes conducted world-wide that have been able to compare survey methods with known population sizes, the actual population size is always under-estimated by about one order of magnitude (Smolensky and Fitzgerald 2010; Rodda 2012). This happens because in reptiles with highly variable activity periods, detectability and availability biases result in low population estimates. In terms of setting guidelines for management of exploited species such as Asian water monitors in Malaysia, these biases work in favor of creating conservative population estimates and conservative conservation measures.

A strong positive correlation between predicted absolute densities and relative densities based on captures (naïve densities) provides confidence that the trends in predicted absolute densities are real (**Fig. 17**). Comparison with the most robust population study completed on this species to date (in the Malaysian state of Sabah) corroborates that our estimates are well within the estimated densities they derived (Guererro-Sanchez 2019).

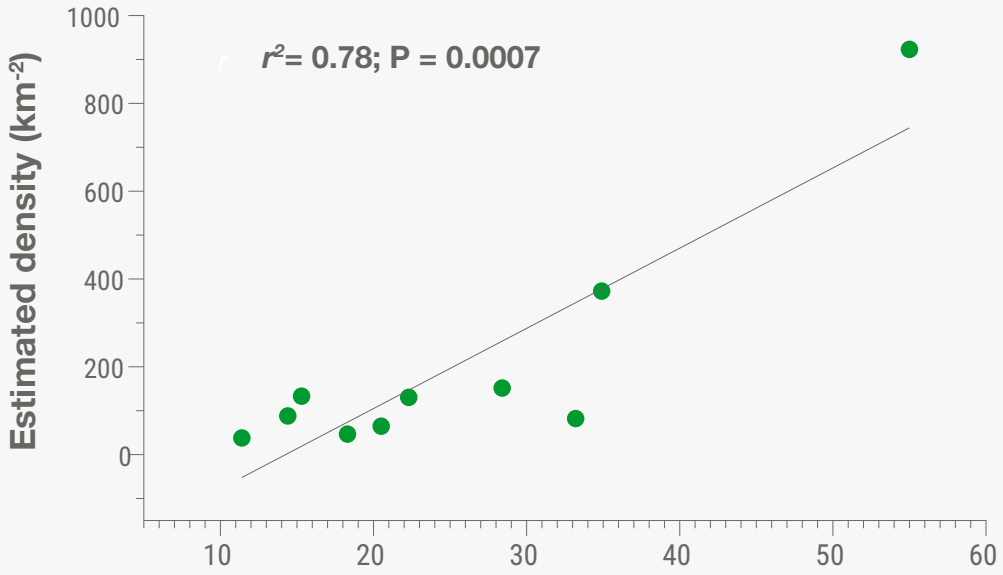


Fig. 17. Positive correlation between naïve density estimates and model-derived density estimates for *Varanus salvator* at sites throughout Peninsular Malaysia. The strength and significance of the correlation are presented.

There are clearly numerous assumptions and potential biases involved in such calculations, which are recognized. Using density alone (and impacts of harvesting on density) to evaluate harvest sustainability is challenging. Densities of lizards doubtless vary at the microhabitat and macrohabitat scale, and vary through time depending on food supply (and subsidies), predation, density dependence and population size structure, habitat alteration and harvesting (Khadiejah et al. 2019). These are all aspects of monitor lizard population biology that must be studied to better understand and refine estimates.

Because of the importance of recapture rates, making precise population estimates requires many years of almost perfect data. Even then, the effects of harvest are almost impossible to detect (Fitzgerald 1994; Ryberg et al. 2013). In reality, all these factors could never be fully accounted for in field-based population estimates. In summary, while population estimates do provide useful information despite assumptions, they should not be the sole source for making concrete decisions about harvest sustainability for wide ranging species like *V. salvator*

For all the above reasons, harvestable population estimation has been restricted to the four states and habitats from which most lizards are harvested (17.5% of Peninsular Malaysia's land area), which is a highly precautionary approach in applying the results to management. Other important considerations include:

1) Most of *V. salvator* in Peninsular Malaysia are not subject to harvest – 99% of the harvest is restricted to four states (Kedah, Pahang, Perak and Selangor; **Fig. 7 & Fig. 23**), occupying 57% of Peninsular Malaysia's land mass. No harvesting occurs in Johor State (due to State Enactment, see section 4.8 of Chapter IV) and less than 1% of the harvest is spread between the other 6 states and 2 Federal Territories (43% of the land mass; **Table 2**).

2) In the States most heavily harvested, 42% of land area is under strict protection (national parks, State parks, etc) – no harvesting can occur. Little harvesting takes place within forested areas of any state, which provides vast areas of safeguard refuges, buffering the species from extinction

3) The absolute estimates of population size included only three habitat types in four states, and excluded the population known to exist outside those areas in land used for other purposes, including urban areas and agricultural plantations other than oil palm.

4) Surveys of *V. salvator* in different habitats showed that capture rates and densities of lizards were higher in harvested vs non-harvested sites. This indicates that despite harvest taking place, no discernable effects were observed on the population size and structure. This could occur because the harvest rate is very small in relation to the population size.

5) No account of density-dependent compensation responses has been made yet it is highly likely that *V. salvator* effectively increase population rates of increase in harvested areas relative to non-harvested areas.

6) The population estimates are restricted to a population demographic of larger individuals, because the capture method selects for them. Juveniles less than 30 cm SVL were never captured, despite them being a significant proportion of the population age- and size-structure, as revealed by observation and stomach contents analysis.

7) Despite the most conservative estimate of sustainable offtake being calculated (157,000 lizards), the annual harvest quota will be set at 120,000 (24% lower).

8) The ongoing commitment to monitoring and assessment (see Section 3.6.4, below) provides a further science-based safeguard favouring sustainable use.

3.6 Ongoing population research and monitoring

3.6.1 Population demography

The 1,400+ *Varanus salvator* captured to date during the monitoring research program confirm the wild population has a sex ratio of 1:1 (53% male). The mean SVL of males was greater than that of females ($F_{1,1371}$ = 19.2, P > 0.0001). The largest male captured was 118 cm SVL whereas the largest female was 105 cm SVL. Body mass relative to SVL was similar between the sexes ($F_{1,1357}$ = 1.28, P = 0.258). Within the size range not used for commercial purposes (< 5 kg), the sex ratio (56% males) is slightly but significantly biased (χ^2 = 13.5 d.f. = 1, P = 0.0002).

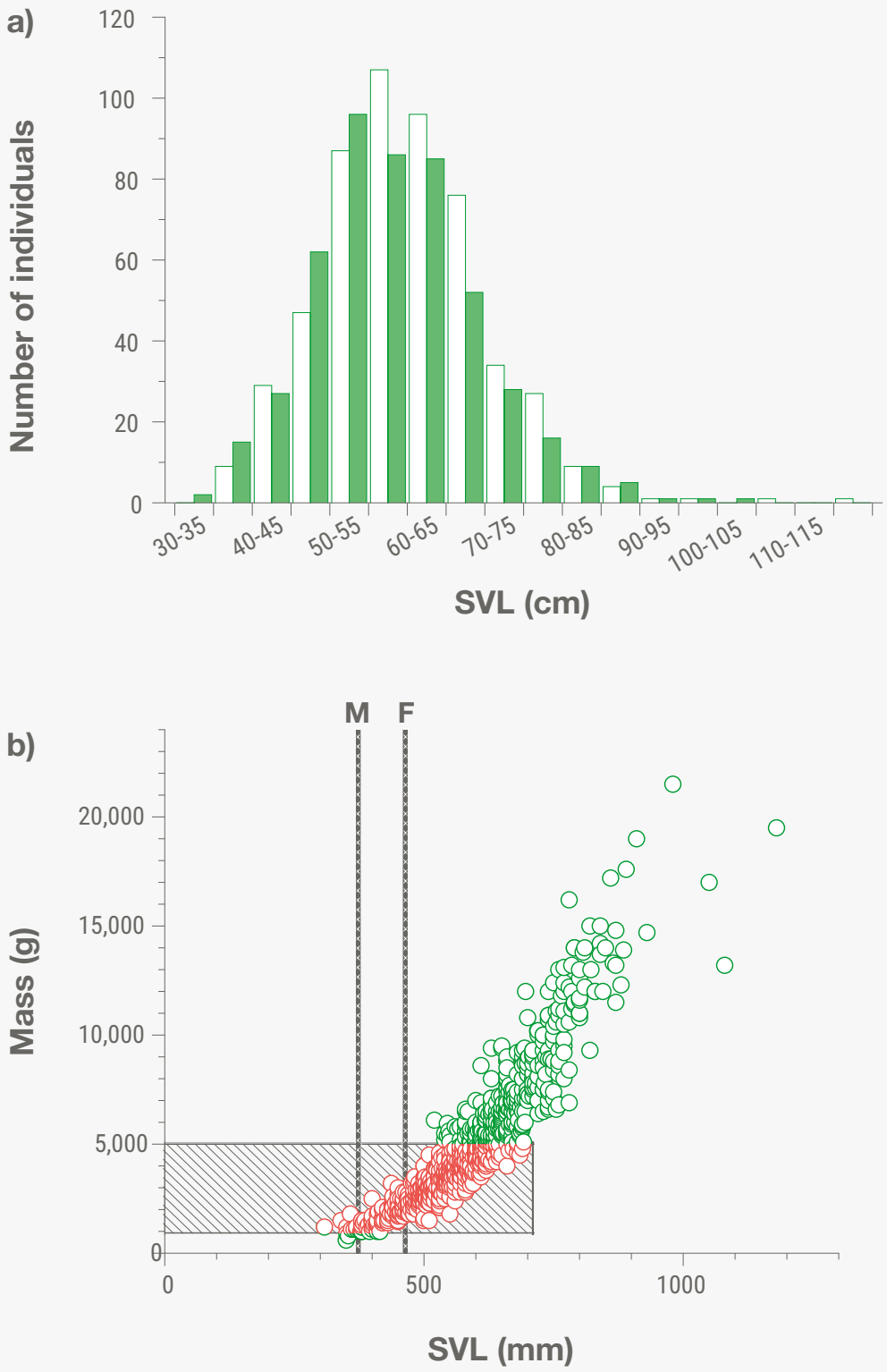


Fig. 18. Size frequency histogram of wild male (shaded) and female (unshaded) *V. salvator* captured during monitoring (a), and the relationship between length (SVL) and body mass for all animals captured (b), with the vertical lines indicating size at which maturity is attained (after Shine et al. 1996, 1998). The shaded box indicates the preferred commercial size (in red), with most captured specimens outside this range being released.

Varanus salvator in natural forest habitats were larger than those in other habitats, which may be a consequence of habitat-specific harvest (Jasmi and Amin 1987; Traeholt 1998b; Auliya 2006; Khadiejah et al. 2019). Numerous other differences exist in sex ratios, body sizes and body mass between sites and among habitats. However, no consistent patterns emerge that would be attributable to effects of harvesting. For broader discussion on these results see the publication by Khadiejah et al. (2019).

That mean body sizes increased significantly in all sampling areas over the 7-9 year period of sampling (ANOVA: $F_{4,1356}$ = 9.0, P > 0.0001) is consistent with harvest rates being sustainable. However, an important caveat to this conclusion is that different sites were surveyed in different years and interannual effects and area effects could confound the result. Within site analysis, with 2-3 years data per site, confirmed the earlier result, with larger body sizes over time, but did not reach statistical significance (all P > 0.05; **Fig. 19**). The most important take-home from these analyses is there is no indication of decreasing size.

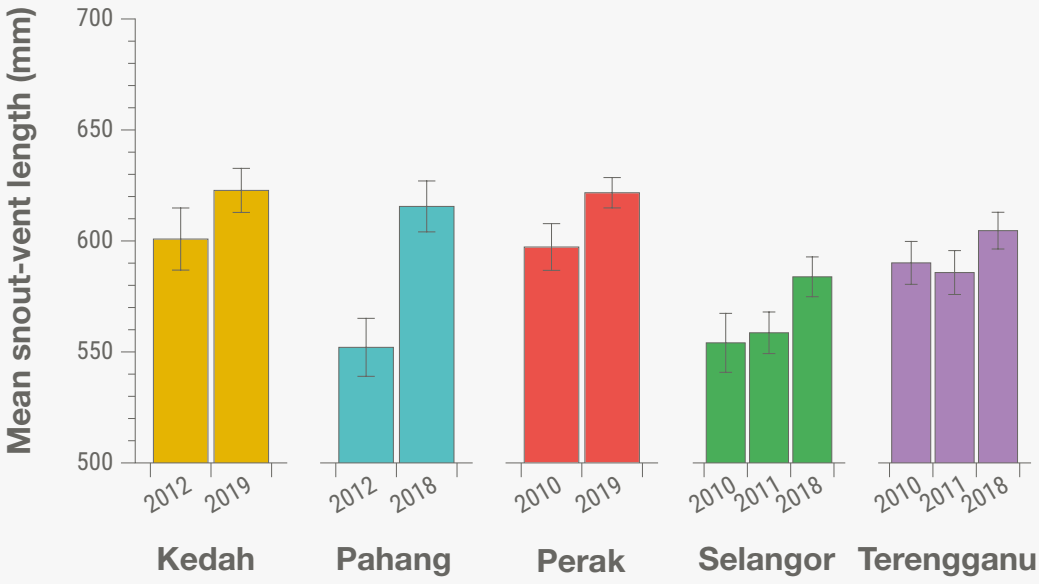


Fig. 19. Mean snout-vent length of *Varanus salvator* between years at five States in Peninsular Malaysia subject to harvest.

3.6.2 Relative abundance

Density estimates for *V. salvator* reported in other studies vary widely over time and by site, and presumably are dependent on a range factors (**Table 1**). The estimates for Peninsular Malaysia reported in this study are equally variable, but in most cases have increased rather than declined over time. Current densities are similar to those reported from the same Malaysian states 15–20 years previously (Traeholt 1998b), despite temporal and methodological differences.

Analysis of naïve density estimates over time (ln tansformed), with site, habitat and year as potential factors, revealed:

1) Densities of *V. salvator* were highest in the sites where most harvesting occurs and lowest where no harvesting occurs ($F_{5,51}$ = 2.94, P = 0.024).

2) Densities of *V. salvator* were highest in harvested habitats of oil palm and mangrove/ swamps, intermediate in rice paddies, and lowest in forested sites where no harvesting occurs ($F_{3,51}$ = 9.65, P < 0.0001)

3) Densities of *V. salvator* increased over time (from 2010 to 2019; $F_{4,51}$ = 3.05, P = 0.028).

That densities of *V. salvator* are higher in mangrove and oil palm plantations than in natural forests adds support to the species adapting to disturbed habitats with higher resource subsidies (Traeholt 1998b; Uyeda 2009; Twining et al. 2017). Rodents can reach extraordinary abundances in oil palm plantations (Stuebing and Gais 1989; Puan et al. 2011) and form a major dietary item of *V. salvator* in these systems (Traeholt 1994a; Guererro-Sanchez 2019; PERHILITAN 2020). Mangroves are an equally resource rich environment. Densities of monitors at these sites may be further increased by a lack of competition from mammalian carnivores, which tend to decline in such plantations (Yue et al. 2015; Pardo et al. 2018).

That selective harvesting can stimulate population rates of increase, to the extent that densities in harvested populations exceed those in non-harvested populations, also occurs in wild caiman (*Caiman crocodilus*) populations subject to selective harvesting (Velacso et al. 2003). It is probably a reflection of density-dependent population processes, deserving of study. When the naïve density estimates were analysed site by site, the same trend was apparent, but with the restricted sample sizes (2-3 year) did not reach statistical significance (all P > 0.05; **Fig. 20**).

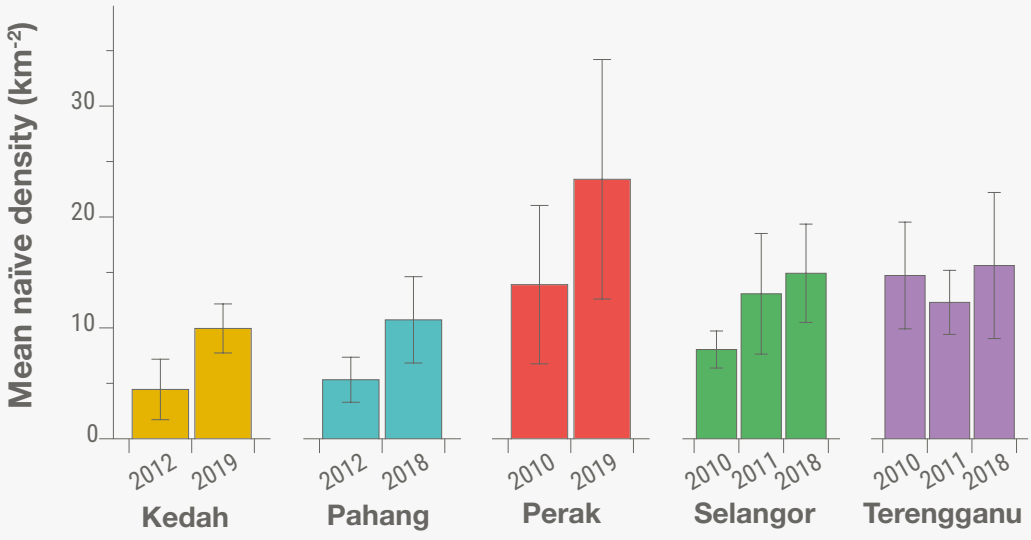


Fig. 20. Mean naïve density estimates of *Varanus salvator* between years at five sites in Peninsular Malaysia subject to harvest.

3.6.3 Population trends

The population research conducted to date has resulted in the capture of large numbers of *V. salvator* over long periods of time, across a wide range of regions and habitats. Notwithstanding capture biases against the smallest individuals, the population structure clearly contains large numbers of reproductive adults, which is the opposite of populations in steep decline because of excessive harvesting (Fitzgerald 2012; Sinclair et al 2006). There is no evidence of any long-term biological problem that would represent a survival risk. That the commercial harvest reduces densities in harvested areas in the short-term is to be expected (Sinclair et al. 2006), but the population demonstrably has the ability to compensate for that decline, and indeed has been doing so for the last 60 years. Our results indicate the wild population has demonstrated a positive rate of population increase during the last decade, perhaps an adjustment to reduced demand and harvesting, which is to be expected. This is clearly the first time that detailed population data have been used to quantify status in Peninsular Malaysia, and it indicates that precautionary concerns about adverse impacts of the harvest, based on anecdotal evidence (Auliya 2006; Koch et al. 2013), can be rejected.

3.6.4 Population monitoring into the future

Future monitoring of *V. salvator* populations in Peninsular Malaysia will continue to focus on the four states where most harvesting occurs, which will provide a longer time series for investigating the ongoing status of the wild population, the impacts of harvesting, and population processes involved in adapting to, and compensating for, harvest. Future mark-recapture and relative abundance monitoring at known harvesting sites, in cooperation with harvesters, offers a reliable and cost-effective method for responsible management. Increases and declines in abundance are to be expected in the survey results over time (due to many potential biases involved), but levels of decline likely to threaten sustainability will be readily detected. New research data may well lead to more refined estimates of population density over time.

3.7 Monitoring harvested animals

In addition to monitoring the harvest of *Varanus salvator* in the field, PERHILITAN scientists undertake annual surveys of lizard processing facilities, to gather data on the attributes of harvested individuals. The methodologies and results of this monitoring program are described below, together with a discussion of its applicability to ensuring sustainable offtake of *V. salvato*r in Peninsular Malaysia.

3.7.1 Location

Data are collected from facilities that harvest and trade the largest number of lizards. Because of fluctuations in demand, the facilities visited vary from year to year, but typically account for 90% of trade taking place each year (and are typically located in Johor and Selangor States). In some years, data are also collected from smaller facilities to test if the harvested population demographics are similar among all facilities.

3.7.2 Protocol

At each facility PERHILITAN staff examine samples of freshly killed monitor lizards before and after skinning (Fig. 21). Snout–vent length and body mass are recorded (using a steel measuring tape and electronic scales, respectively), and then the lizard's carcass is examined to determine sex and reproductive condition (by visual inspection of gonads). Females are considered to be mature if they possess either thickened, muscular oviducts, primary ovarian follicles >8 mm, vitellogenic secondary follicles, oviducal eggs, or corpora albicantia indicative of previous reproductive events (sensu Natusch et al. 2019). Clutch size is determined by counting eggs within the oviducts of gravid females. Males are considered to be mature if they possessed thick turgid testes and convoluted efferent ducts indicating the presence of sperm.

Fig. 21. PERHILITAN rangers collecting biological data from specimens of *Varanus salvator* brought to a processing facility in Peninsular Malaysia

3.7.3 Frequency

Monitoring of *V. salvator* typically takes place between March and May annually. Because *V. salvator* reproduce several times per year, without a definitive reproductive season (Shine et al. 1996; PERHILITAN, 2020), the timing of inspections are not critical.

3.7.4 Insights from the processing facilities

Data collected from *V. salvator* within the processing facilities include:

Size of animals processed

Mean SVL of males (mean = 55.5 ± 0.7 cm; range 41 – 72 cm) and females (mean = 55.6 ± 0.6 cm; range = 37 – 76 cm) was essentially identical. Females (mean 3.5 ± 0.13 kg) are slightly but not significantly heavier than males (mean 3.4 ± 0.14 kg), which could reflect reproductive condition: there was no significant difference in body condition between sexes ($F_{1,300}$ = 0.66, P = 0.42). The animals examined within processing facilities included more smaller individuals than those examined in specific sites during the field monitoring program (two-way ANOVA with sites and sex as factors and SVL as the dependent variable; $F_{1,1676}$ = 4.15, P = 0.041; **Fig. 22a**).

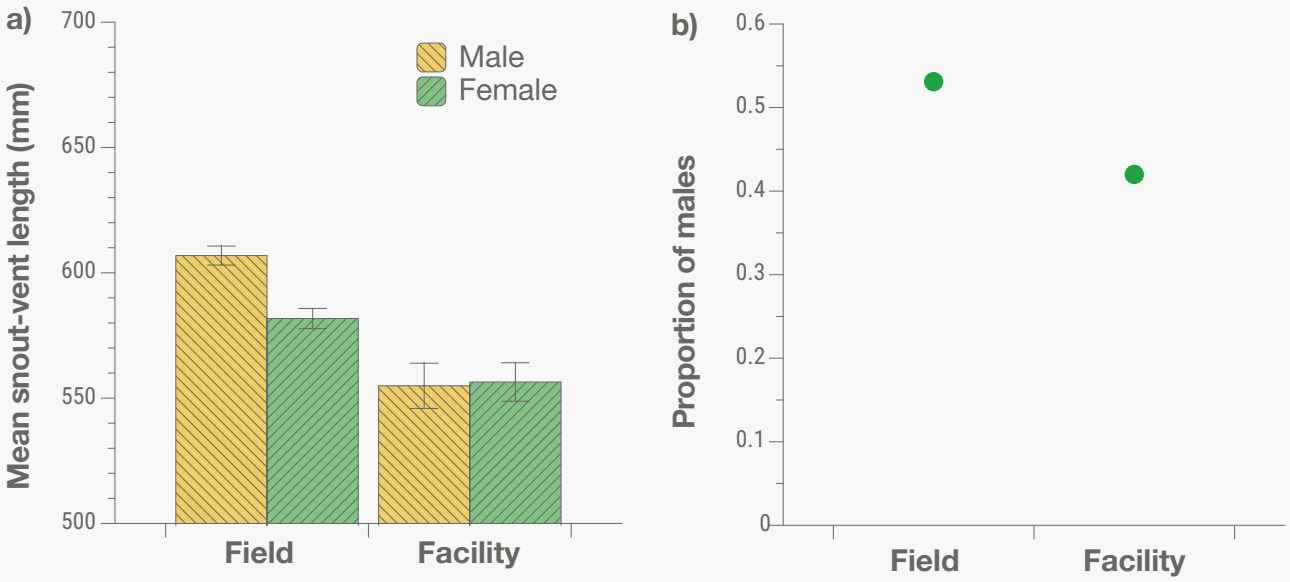


Fig. 22. (a) Mean snout-vent length (mm) of male and female *Varanus salvator* and (b) the proportion of male lizards captured in the field versus those brought to processing facilities.

Sex ratios

The sex ratio of animals in the processing facility was more biased towards females (contingency table analysis: χ^2_1 = 12.4, P = 0.0004; **Fig. 22b**) than the samples examined in the survey program: 42% males versus 53% males, respectively.

Reproductive biology

Seasonal sampling has not yet been undertaken, so the exact timing and peak in reproduction remains unknown. Between March and May, when sampling occurred, all males (N = 208) were deemed sexually mature, with the smallest

being 30 cm SVL and weighing 1.2 kg. Amongst females (N = 277), 80% were deemed sexually mature. The smallest mature female was 43 cm SVL with a body mass of 1.5 kg.

Diet

Diet was mainly of commensal rodents, with land crabs, smaller monitor lizards and invertebrates making up the remainder of most stomach contents. A detailed analysis has not yet been undertaken.

3.7.5 Insights into monitoring

The data from processing facilities:

1) Allow independent corroboration and cross-checks of harvest data provided by traders;

2) Provide potential indices and correction factors that can be used to improve the population estimates over time; and,

3) Provide definitive information on population parameters, and variation within them annually and over time, that have direct application to harvest sustainability (eg mean body size, mass, sex ratios and sizes at sexual maturity).

The IUCN has incorporated information from PERHILITAN scientists in their guide to monitoring of snakes (https://portals.iucn.org/library/sites/library/files/documents/SSC-OP-065-En.pdf), with direct application to achieving sustainability. At this stage, only two years of monitoring within processing facilities has been conducted, but it establishes definitive status reference points for quantification of future trends. Conclusions that can be drawn now from this monitoring research are:

1) The mean body size of lizards harvested is generally lower than the mean size in the field monitoring program, which is consistent with the demand for smaller animals (**Fig. 22a**).

2) There is no sexual dimorphism in the size of animals harvested generally;

3) Sex ratio of lizards harvested generally has a female bias (58% female), which is greater than detected in the field-monitoring program.

4) The trade's focus on specimens with undamaged skins (typically those <5 kg) and those above 30 cm SVL effectively acts as industry-imposed size limits that protects most large, and thus highly fecund, adults and small juveniles (Shine et al. 1998).

5) Most lizards captured are adults (**Fig. 18b**) which have reproduced at least once before capture;

3.8 Trader monitoring

The third tier of monitoring by PERHILITAN examines trader information.

3.8.1 Protocol

Harvesters capturing and selling *V. salvator* are required to purchase permits from local PERHILITAN offices, provided on demand. Traders and processing facility operators are required to maintain log books (provided by PERHILITAN) and in future will be required to engage in online reporting (see Chapter IV). In addition, PERHILITAN assists and encourages Malaysian industry to design and implement their own verification systems. Data from any systems developed are used by PERHILITAN to monitor and cross-check against the department's own systems to gather important data for monitoring and ensure compliance.

3.8.2 Locations and Extent of Harvest

Analysis of the number of harvesting permits and where they were issued provides important information on the intensity of the harvest of *V. salvator* in Peninsular Malaysia. At present, the main harvesting areas, which provide 99% of the harvest, have been consistent from year to year **(Fig. 23)**. Little harvesting occurs in other states (<~1%), and none in Johor or Kelantan (**Table 7; Fig. 23**). The number of lizards captured per harvesting license issued remained stable over the five years of data collection.

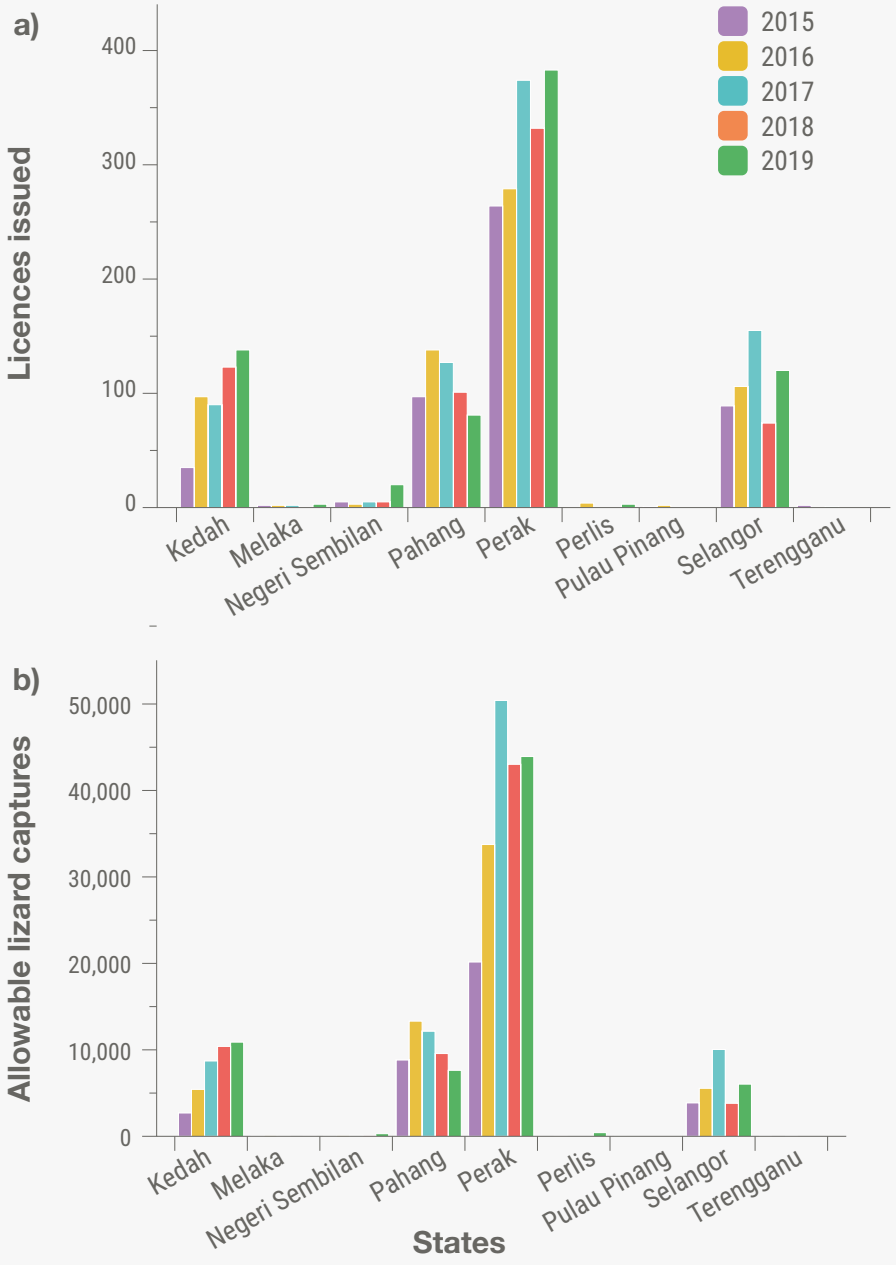


Fig. 23. The number of (a) harvesting licenses issued and (b) *Varanus salvator* captured in each state in Malaysia from 2015 until 2019. The States with the most harvesting all continue to sustain a high abundance of lizards.

Table 7. Number of licenses issued and *Varanus salvator* captured in each state in Peninsular Malaysia from 2015 until 2019.

STATES	2015		2016		2017		2018		2019	
	Licences	Lizards	Licences	Lizards	Licences	Lizards	Licences	Lizards	Licences	Lizards
Kedah	35	2717	97	5428	90	8733	123	10400	138	10900
Melaka	2	30	2	61	2	25	0	0	3	29
Negeri Sembilan	5	24	3	75	5	120	5	78	20	302
Pahang	97	8845	138	13330	127	12170	101	9571	81	7636
Perak	264	20180	279	33747	374	50414	332	43030	383	43925
Perlis	0	0	4	29	0	0	0	0	3	421
Pulau Pinang	1	2	2	4	0	0	0	0	0	0
Selangor	89	3880	106	5556	155	10049	74	3822	120	6044
Terengganu	2	2	0	0	1	1	0	0	0	0
Totals	**495**	**35680**	**631**	**58230**	**754**	**81512**	**635**	**66901**	**748**	**69257**

3.8.3 Harvest Dynamics.

a. Yield.

Yield is defined as the number of *V. salvator* taken within a particular harvesting context. A range of environmental, social and economic factors alter yield from any given population annually, and from states as a whole (**Table 7**), hence it is not a direct measure of population abundance although correlated with it to some extent.

b. Catch Per Unit Effort (CPUE)

An index of CPUE is the number of *V. salvator* caught per license issued. At the national level, yield and CPUE are highly correlated ($r2 = 0.97$, $P > 0.0001$; **Fig. 24**), supporting the idea that the take per license is a good measure of CPUE. CPUE is potentially able to detect any changes in the harvest due to population status, although it is also driven by changes in demand.

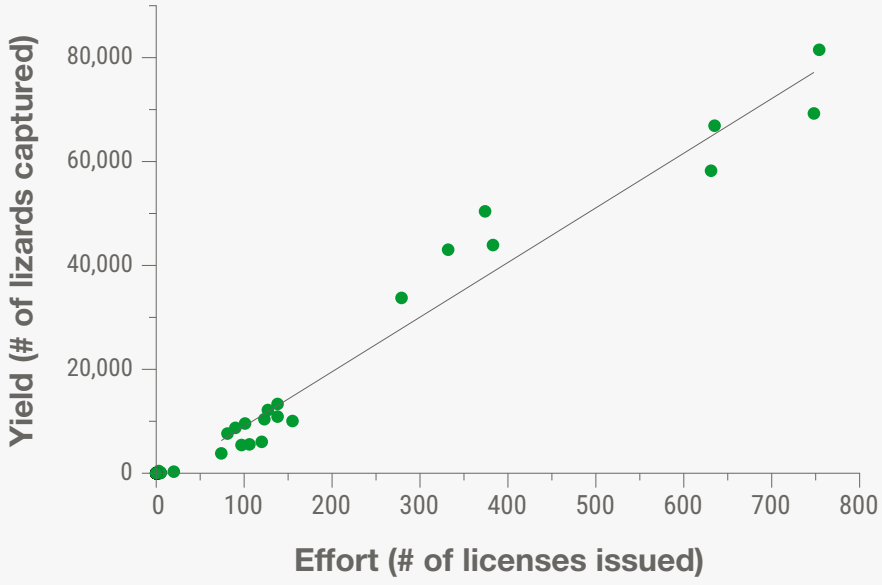


Fig. 24. Relationship between state effort (number of licenses issued) and state yield (number of lizards captured) in Peninsular Malaysia (2015-2019).

c. Analysis

When examined at the level of resolution of lizards captured per license issued, at the national level, there was a variable but positive correlation between effort (licenses issued) and CPUE ($r2$ = 0.55, P = 0.0006; **Fig. 25a**). As the number of licenses issued increased, so to did the number of animals caught per license. CPUE generally increased since 2015, but counter to expectation did not generally decrease as the number of licenses issued increase (**Fig. 25b**).

A more robust mechanism for gaining further insights into effort and CPUE utilised data for five years from a tagging and traceability system implemented by Malaysian industry (see Section 4.7 in Chapter IV), in which the number of *V. salvator* captured by individual harvesters over time is recorded, and provides a much greater sample size. Effort was still positively correlated with CPUE ($r2$ = 0.55, P < 0.0001; **Fig. 26a**). Analysis using a linear mixed model, with a Tukey's post-hoc test, demonstrated that CPUE was lower in 2015 than for all other years (2016-2019; $F_{4,280}$ = 228, P < 0.0001), but the very significant extent of variation explained by harvester ID (P < 0.0001) confirmed that some harvesters consistently capture more lizards than others, and exert a strong influence on mean CPUE.

Thus two independent measures (catch per licence, and catch per individual harvester) confirm CPUE increases as more harvesters are licenced, which is the opposite to what would be expected from a population whose abundance was being regulated by harvesting. It is much more consistent with an abundant population in which yield is dictated by economic factors (demand and price), rather than by biological factors (abundance and intrinsic rates of increase).

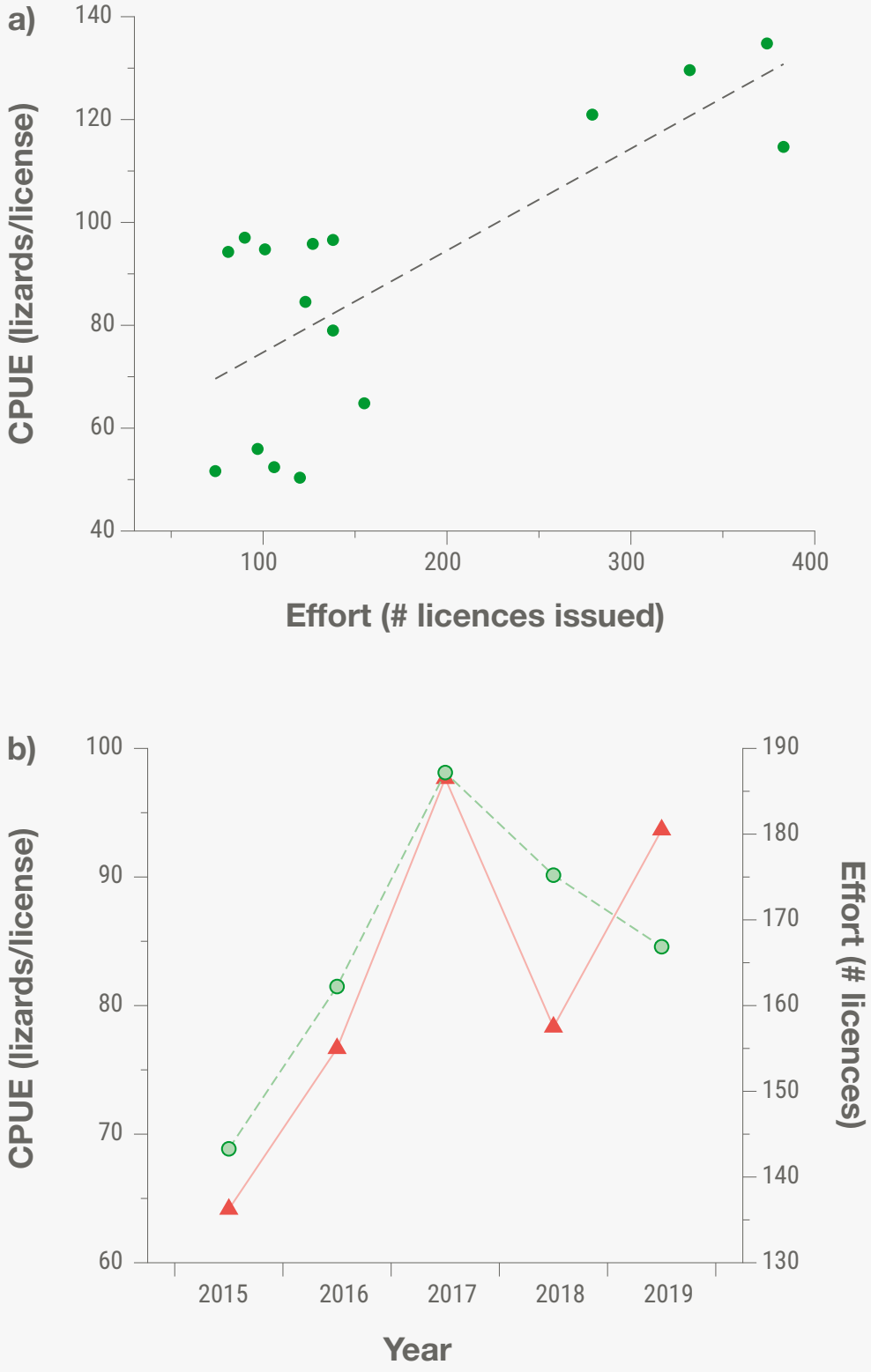


Fig. 25. Relationship between (a) catch per unit effort (CPUE; lizards caught per license) and effort (# licenses issued) and (b) year on year changes in effort (triangle, solid line) and catch per unit effort (CPUE; hollow circles, dashed line) based on licenses issue for capture of *Varanus salvator* at the national level.

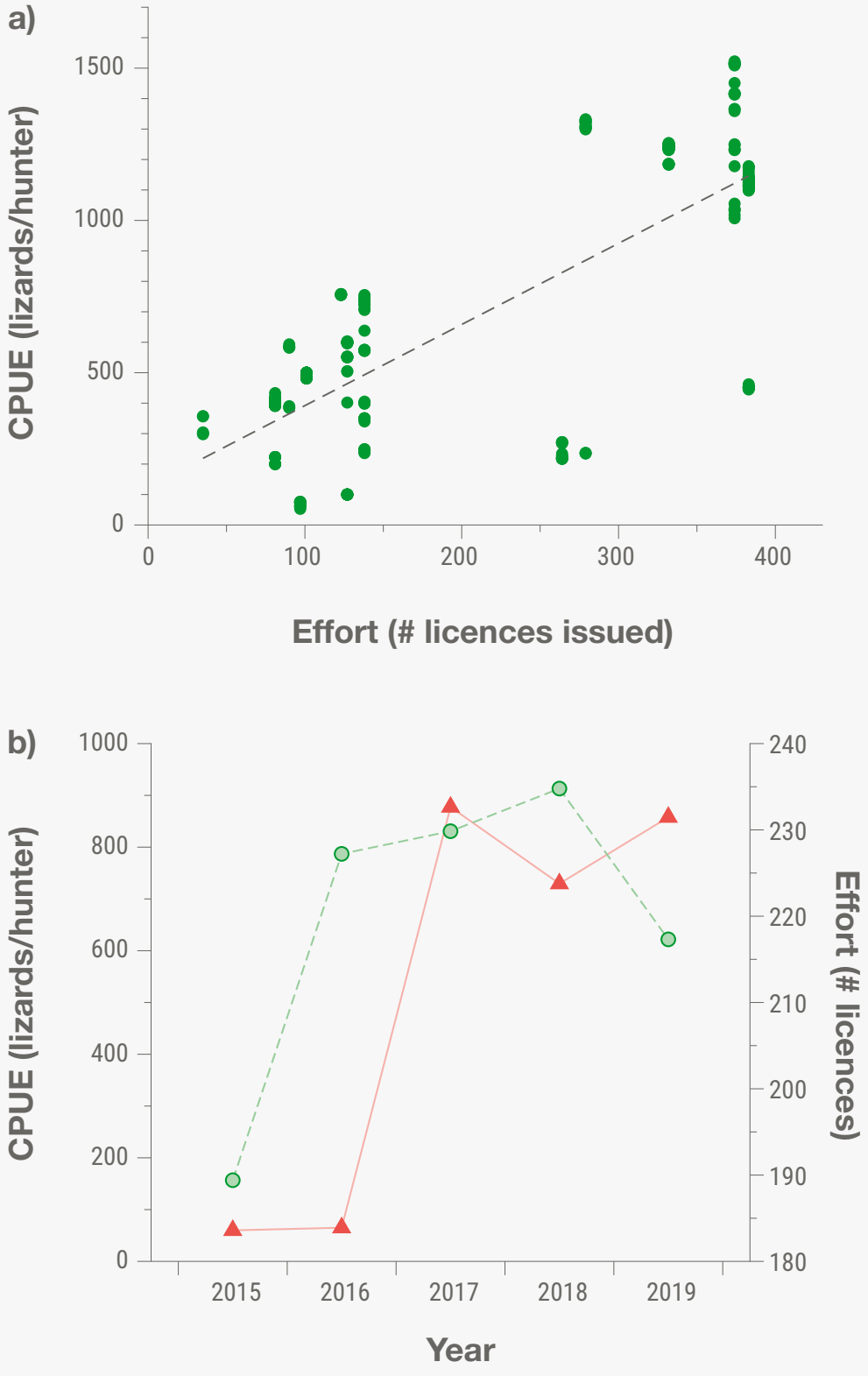


Fig. 26. Relationship between (a) catch per unit effort (CPUE; lizards caught per harvester) and effort (# licenses issued) and (b) year on year changes in effort (triangle, solid line) and catch per unit effort (CPUE; hollow circles, dashed line) based on an industry tagging and traceability initiative. Data reflect mean values for data pooled from 2015-2019 for the four states where 99% of lizard harvesting occurs (Kedah, Pahang, Perak, Selangor).

3.9 Decision-making process revisited: adaptive management

Implicit within the current management system is the ability to reduce harvests, reducing the number of licenses and harvesters, should evidence establish that population declines or other indices of unsustainable harvest are occurring. No evidence to date suggests harvesting is causing long-term declines in the abundance of *V. salvator*. Section 3.3 of Chapter III describes the management steps undertaken by PERHILITAN to ensure sustainable use of *Varanus salvator* in Peninsular Malaysia. Figure 27 below describes this process using information generated through PERHILITAN's monitoring protocols.

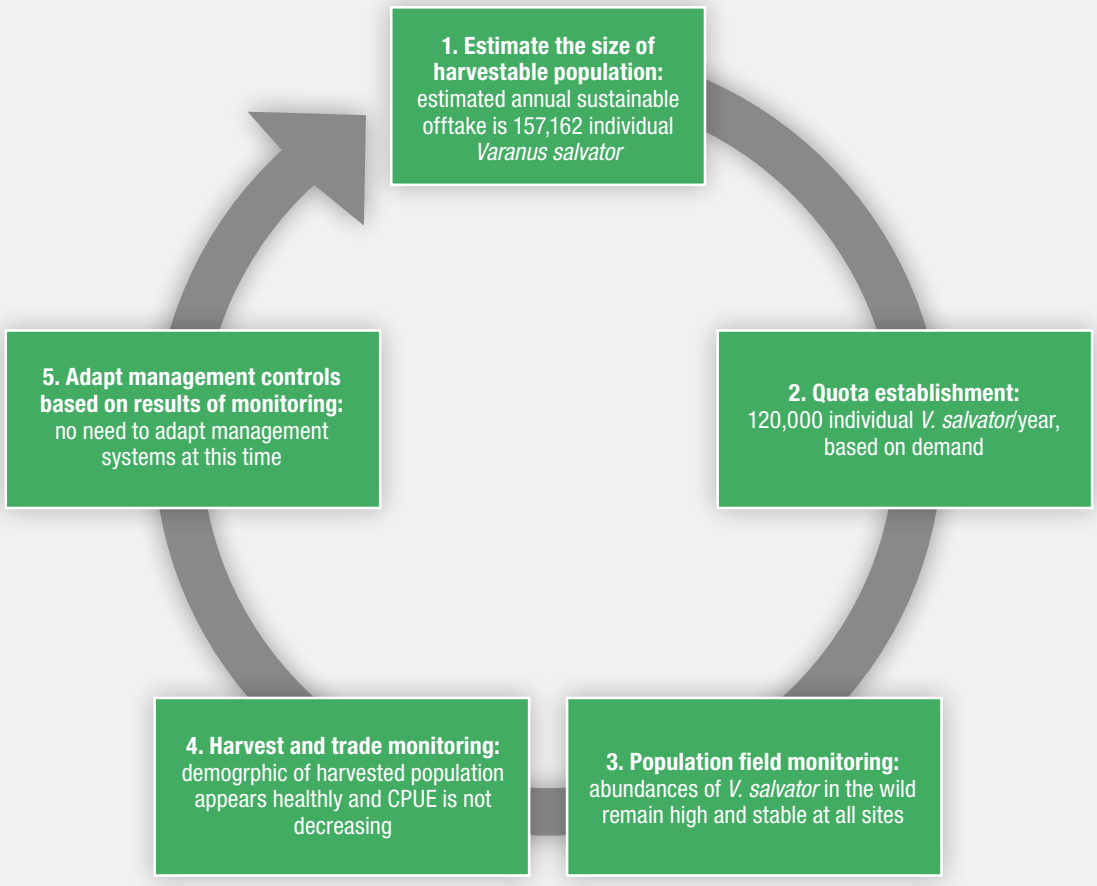


Fig. 27. Decision-making process for annual management of *Varanus salvator* harvest and trade in Peninsular Malaysia, based on information gathered from monitoring systems. Conclusions presented in the figure are elaborated in Chapter III of this report.

CHAPTER IV

TRADE CONTROLS AND MANAGEMENT

4.0 Background

The ability to monitor and ensure trade remains within sustainable levels depends on sound management practices and trade controls, which within Malaysia are becoming increasingly more effective. The management tools described below allow PERHILITAN to effectively monitor harvesting and trade, and exert and adapt controls on harvesting and trade should evidence of unsustainable use become available.

4.1 Quotas

4.1.1 Annual quotas

Malaysia imposes annual harvest and export quotas on the number of *Varanus salvator* that can be legally captured and exported from Peninsular Malaysia. This quota was established in the early 2000's in response to the need to set species-specific quotas that matched annual levels of harvest (**Table 8**). Since then, new biological data on *V. salvator*, and the results of periodic population monitoring, has revealed a high level of biological capacity to withstanding harvest offtake at the level occurring in Malaysia. The global demand for *V. salvator* skins has decreased over the last decade, to which Malaysia has adapted (**Fig. 1**). Over the last six years, annual exports of *V. salvator* skins fluctuated between 33,000 and 85,000 (**Table 8**), which matches levels of harvest variability historically. For 2020, Malaysia wished to raise the quota back to 165,000 skins, in accordance with its abundance, but this has resulted in the EU forming a "negative opinion" on skin imports, which has had severe impacts on the trade, on Malaysian businesses, and on the ability to benefit from natural resources. In response to this loss of confidence in Malaysia's program, Malaysia has since reduced the harvest quota in 2020 again, to 83,000 skins, despite no evidence of unsustainable use, or use likely to impact negatively on the species' status in Malaysia.

4.1.2 Annual Quotas and the probability of detriment to the wild population

Based on the most conservative estimate of population abundance, and the best science available, PERHILITAN has established that a harvest quota of 157,162 individuals is a precautionary and safe level. The proposed harvest level of 120,000, which matches likely demand, is even more conservative, precautionary and safe (see detail within Chapter III). The annual harvest quota is based on a "first come, first serve" basis, and is divided into two 6-month slots (50% released at the beginning of the year, and 50% release halfway through the year). The quota is verified in several ways, which are described below in Sections 4.2 – 4.5 on harvest and trade licenses, CITES permits, and inspection and verification. If a portion of the quota remains unused in one year, it is not carried forward into the next.

Table 8. Quota and numbers of *V. salvator* skins exported from Peninsular Malaysia from 2011 until 2020. The proposed 2021 quota of 120,000 skins is also included.

Year	Quota	Exports
2011	165,000	72,258
2012	165,000	85,127
2013	165,000	33,316
2014	165,000	45,189
2015	165,000	35,850
2016	165,000	70,233
2017	165,000	58,712
2018	165,000	106,113
2019	83,000	81,998
2020	83,000	?
2021	120,000	?

4.2 e-license system

PERHILITAN uses an e-license system to regulate the capture and harvest of *Varanus salvator* in Peninsular Malaysia. Under the Malaysian Wildlife Conservation Act 2010 (Act 716) only licensed harvesters are legally permitted to catch *V. salvator* using traps or by hand. No shooting or destructive capture methods are permitted. Harvesting licenses are valid all year with allowable hunting periods between the hours of 0700 to 1900 (Federal Government Gazette: Wildlife Conservation (Open Season, Methods and Times of Hunting) Order 2014). Harvesting licenses issued by a state are only applicable for hunting activities within that respective state. A harvester catching *V. salvator* from Selangor and Perak States requires two licenses. Licenses are issued by the relevant PERHILITAN field office, in each state, and can only be issued by the licensing officer in charge. The location of wildlife offices issuing harvesting permits in each state can be found at www.wildlife.gov.my/index.php/bahagian/69-perlesenan.

Licenses are issued for the capture and sale of a set number of lizards (typically 50 – 200 specimens; mean = 96.3 ± 1.3; N = 2515; see example license in Appendix I). Harvesters can apply for multiple licenses each year (and regularly do). The cost of each license is dependent on the quantity of lizards to be captured, at RM2 ($US0.5)/lizard (or RM 200 for 100 lizards, etc). Each license is fitted with a unique QR code and since 2013 data for each license issued is uploaded by the relevant permitting officer into a national database accessible by State offices but administered by PERHILITAN Headquarters in Kuala Lumpur. As the harvest reaches the national quota allocated for the year, PERHILITAN Headquarters contacts the relevant State wildlife offices and informs the permitting officers of the exact number of lizards that can be harvested before all harvesting is ceased for the year.

4.3 Trade licenses

Licensed traders are allowed to source *V. salvator* from licensed harvesters or other licensed traders only. Every trade transaction is recorded in a logbook provided by PERHILITAN. Date of transaction, number of *V. salvator*, source person (with license number), and remaining stock are all recorded. Enforcement officers check logbooks regularly. Trading licenses are issued to processing facilities and exporters. A separate license is required to buy live lizards, trade in skins, and trade in meat, each of which costs RM 300. Therefore, each processing facility in Peninsular Malaysia pays an annual fee of RM 900 ($US 225) to operate under Malaysian law.

4.4 Harvest size limits

No restrictions are imposed on the size of lizards that can be legally harvested for trade. The main target for the commercial trade at present is specimens < 5 kg in body mass, although some above this limit are captured if they have high quality skins (Khadiejah et al. 2019). The market effectively sets the size limits, and records from processing facilities confirm *V. salvator* < 30 cm SVL (approximately 1 - 1.2 kg) are not captured. Harvesting of lizards 1.2-5 kg in body mass has no obvious deleterious effects. Therefore, there is a self-imposed slot size in place, where lizards outside of 1.2 - 5 kg body size range (small immature and large highly fecund individuals) are protected from harvesting. Such a slot size arrangement is known to promote sustainable management of fisheries (Ahrens et al. 2020). PERHILITAN rightly see little utility in imposing additional restrictions on harvest size, for cosmetic rather than scientific reasons.

4.5 CITES Export permits and traceability verification process

CITES export permits are issued by CITES registered offices in Kuala Lumpur, Penang or Johor Bahru. When an application for export is submitted, the exporter is required to make the stock available for examination by PERHILITAN inspection officers. Officers travel to the processing facility and count and record every skin destined for export. The skins are boxed with the PERHILITAN inspection officer present who seals and stamps the export boxes with unique identifiers held by the department. Traders are then allowed to transport the skins to the designated ports where they are inspected once more by PERHILITAN officers at Malaysian borders. If the seal provided by PERHILITAN is tampered with or broken, the shipment is seized by PERHILITAN, customs, MAQIS or aviation security officers, and investigated. Numbers of *V. salvator* purchased, and skins sold or kept in stock are balanced and verified by PERHILITAN enforcement officers during regular inspections and logbook reconciliation.

4.6 Stockpiling

In some years, the allowable number of lizards that can be captured is lower than the number exported, whereas in other years the reverse occurs. PERHILITAN accepts that traders need to stockpile skins from one year to the next. Such stockpiling has been raised as a regulatory challenge for reptile trade many times (e.g., Kasterine et al. 2012), but it is a normal and acceptable part of any animal production industry. Through its systems of annual balances and checks (harvesting licenses, transaction logbooks, and industry tagging and traceability systems), PERHILITAN is sufficiently confident that stocks of skins of *V. salvator* are being adequately monitored and managed

4.7 Skin tagging and traceability

Varanus salvator skins are not required by law to be individually tagged. At a national level, PERHILITAN implements batch traceability, through its inspection verification system (see Section 4.5). However, to complement the other management practices implemented for trade in this species, PERHILITAN encouraged and assisted one Malaysian business to invest in the development of a tagging and traceability system. This system was piloted in 2015, has been implemented since that time, and is based on radio frequency identification (RFID) technology.

The RFID tagging and traceability system has four principle benefits:

1) To cross-check against other records in place (e.g., harvesting permits, log books, quotas) and assist enforcement.

2) To better understand the geographic focus of harvests

3) To generate better data on catch per unit effort,

4) To improve knowledge of trade chain intermediaries, and

5) To better understand opportunities to improve animal welfare

The traceability system adopted includes the following elements:

1) Harvesting occurs in three states: Kedah, Pahang and Perak.

2) Licensed harvesters are assigned plastic cable ties containing unique information about the license issued by PERHILITAN (**Fig. 28**).

3) Monitor lizards are captured alive and placed into breathable mesh bags. The tag is attached to the top of the mesh bag containing the live monitor lizard.

4) Agents registered with PERHILITAN are allowed to collect the monitor lizards from the harvesters. Collection occurs daily, either on the same day the lizards are captured or the day after. Bagged monitor lizards are kept cool within plastic crates and are provided with water by gently spraying on a regular basis.

5) Live animals are transported to a single processing facility where key information is transferred using RFID technology (**Fig. 28**).

6) After cooling and de-stressing, the live monitor lizards are humanely euthanized and skinned.

7) Skins are then dried and exported to Europe. The RFID tags remain on the skins until the point of tanning in Europe.

Fig. 28. Staff at a Malaysian *Varanus salvator* processing facility registers information into the RFID traceability system. Clearly seen is the yellow plastic tag on a bag containing a monitor lizard, the RFID chip, and the RFID scanner.

Data collected from the traceability system includes:

- Tag number
- Origin country
- Species
- CITES source code
- Capture area
- Capture date
- Harvester name
- Plastic tag colour
- Harvester license number
- Date of sale to collector
- Collector license number
- Date of sale to processing facility
- Processing facility license
- Skinning date
- Dry skin length
- Dry skin width

The system has been piloted since late 2015 in three of the four main states where harvesting occurs (**Fig. 23**). In those three states, 83% of all lizards harvested are now tagged (**Fig. 29**).

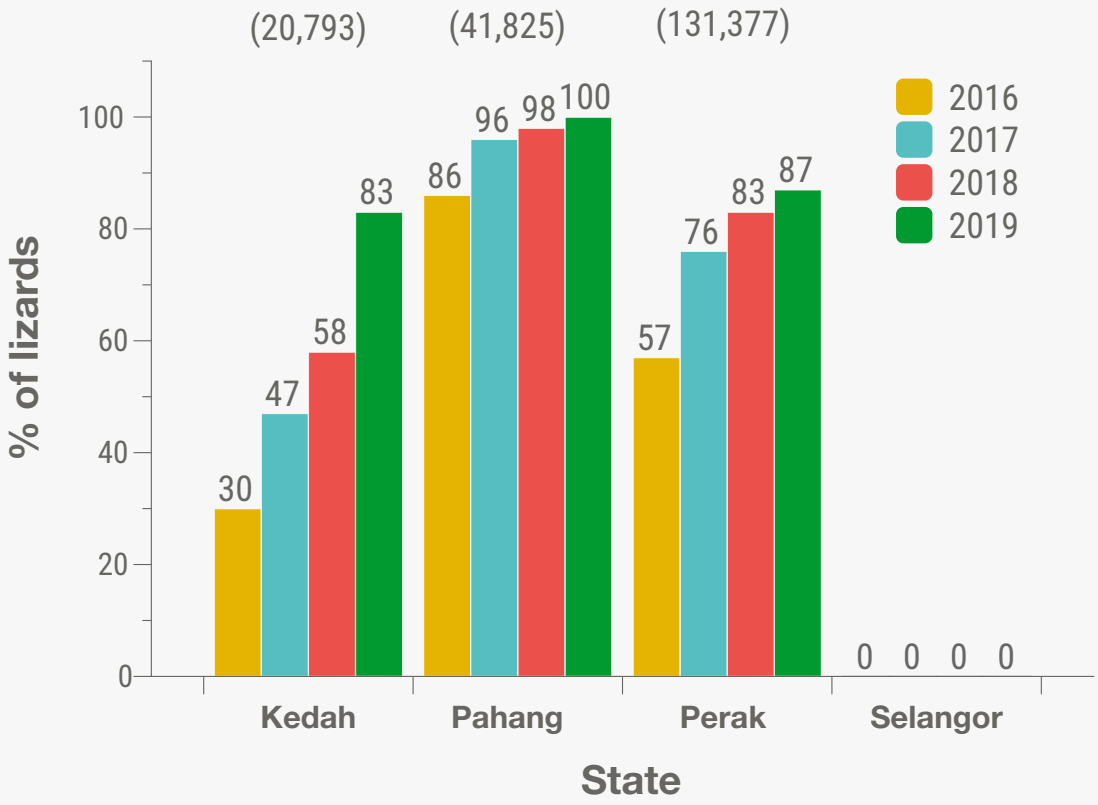


Fig. 29. The RFID-based tagging and traceability system has been rolled out in three of the four Malaysian states where most harvesting of *Varanus salvator* occurs. Columns show the percentage of lizards captured in each state that tagged were between 2016 and 2019. Numbers in parentheses indicate the total number of lizards tagged in each state.

4.8 State regulations

In Malaysia, natural resources are legally State-owned, and State governments have the right to impose additional regulations via State Enactments. Such an enactment has been implemented by the Sultan of Johor, which has forbidden harvesting of all animals except feral pigs (*Sus scrofa*) in the state of Johor. Hence, this state remains a refuge for *V. salvator*, where no harvesting is permitted.

4.9 Harvesting areas and tenure

The vast majority of harvesting that occurs in Peninsular Malaysia occurs on state or privately owned land. Oil palm plantations and the outskirts of urban areas are the main targets for harvesters, because lizard densities are often highest in these sites (see Chapter III). Harvesting by Orang Asli people often occurs in land granted as reservation, which may include a variety of land use types. Most private landowners allow harvesters on their land to capture monitor lizards and other species, and support reducing densities of species such as feral pigs, pythons and monitor lizards. Some plantation owners recognize the value of large reptiles in rodent control, and do not allow harvesting on their estates (PERHILITAN 2020). In other cases, plantation owners recognize the value of these animals, but allow harvesting to keep favour with local communities (who are the mainstay of labour in these plantations). Engagement with harvesters suggests that hunting without permission is rare, because of the availability of sufficient harvesting areas, and the poor skin quality of animals collected from populations with the highest densities (in sites with resource subsidies where harvesting is forbidden; PERHILITAN 2020).

4.10 Protected areas

Much of Peninsular Malaysia's land area is protected from harvesting of *Varanus salvator*. Data from harvesting licenses and from the tagging and traceability system confirm that 99% of harvesting occurs within only four States (Kedah, Pahang, Perak, Selangor; **Fig. 23**; **Table 7**). This effectively safeguards populations in the remainder of country from harvest.

In terms of formally gazetted protected areas, 22.5% of Peninsular Malaysia's land area is under formal protection (National Parks, State Parks, etc), which prohibits harvesting and land clearing. Critically, 4.8 million hectares of protected land in Peninsular Malaysia is primary rainforest. These are habitats and reserves that protect tigers, elephants, bears and tapir. They are subject to continuous anti-poaching patrols and high levels of political will and enforcement is focused on these sites. For the benefit of *V. salvator*, the State of Johor (14.5% of Peninsular Malaysia) is also protected from harvesting through State Enactment.

4.11 Illegal trade

Despite some illegal trade in reptile skins occurring within Southeast Asia (Kasterine et al. 2012; Natusch et al. 2016), there is little evidence available to PERHILITAN indicating illegal trade in the meat or skins of *Varanus salvator* from Malaysia is taking place at significant levels. Malaysian customs and enforcement authorities are well-briefed on the importance of wildlife crime and have been involved in numerous high profile seizures of pangolin scales, elephant ivory, and other illicit wildlife products. There are incidents where Malaysian customs has seized illegal shipments of python and lizard skins entering Malaysia (e.g., https://www.bernama.com/en/region/news.php?id=1814311), but traders indicate these skins were destined for Singapore in transit through Malaysia.

The opportunity for illegal trade exists within the harvesting program, such as harvesters capturing

V. savlator without a license, harvesting where harvest is prohibited, or manipulating permits etc., but PERHILITAN has not detected any significant abuse, partly because legal trade is so readily available.

4.12 Penalties for non-compliance

The Malaysian Wildlife Conservation Act 2010 (Act 716) has specific sections to ensure trade of *V. salvator*, which is a protected species under this Act, is regulated properly:

37(1) A licensed dealer shall keep and maintain a record consisting of the following particulars:

(a) the number and species of wildlife (live or dead), the number of parts or derivatives of wildlife and the number of articles manufactured from any wildlife or part or derivative of any wildlife, which were purchased, acquired or sold;

(b) the name, address and license number, of the person from whom the wildlife, parts or derivatives of wildlife or articles were purchased or acquired;

(c) the name, address and license number, if any, of the person to whom the wildlife, parts or derivatives of wildlife or articles were sold;

(d) the receipt number issued for any sale or purchase; and

(e) the date of any purchase, acquisition or sale.

(2) Any licensed dealer who contravenes subsection (1) commits an offence and shall, on conviction, be liable to a fine not exceeding ten thousand ringgit or to imprisonment for a term not exceeding six months or to both.

40(1) A licensed hunter shall sell protected wildlife hunted or taken by him only to a licensed dealer or licensed taxidermist.

(2) Any licensed hunter who contravenes subsection (1) commits an offence and shall, on conviction, be liable to a fine not exceeding twenty thousand ringgit or to imprisonment for a term not exceeding one year or to both

44(1) A licensed dealer, licensed taxidermist or birds' nest collector shall, at the time of each sale, issue a receipt of sale to the purchaser.

(2) Any licensed dealer, licensed taxidermist or birds' nest collector who contravenes subsection (1) commits an offence and shall, on conviction, be liable to a fine not exceeding ten thousand ringgit or to imprisonment for a term not exceeding six months or to both.

60(1) Any person who –

(a) hunts or keeps any protected wildlife (other than immature or female), or

(b) takes or keeps any part or derivative of any protected wildlife, without a license commits an offence and shall, on conviction, be liable to a fine not exceeding fifty thousand ringgit or to imprisonment for a term not exceeding two years or to both.

61. Any person who hunts or keeps an immature protected wildlife without a license commits an offence and shall, on conviction, be liable to a fine not exceeding one hundred thousand ringgit or to imprisonment not exceeding five years or to both.

62. Any person who hunts or keeps the female of a protected wildlife without a license commits an offence and shall, on conviction, be liable to a fine not exceeding one hundred thousand ringgit or to imprisonment for a term not exceeding five years or to both.

63. Any person who carries out business of dealing or taxidermy business without a license commits an offence and shall, on conviction, be liable to a fine not exceeding fifty thousand ringgit or to imprisonment for a term not exceeding two years or to both.

65. Any person who imports, exports or re-exports any protected wildlife or any part or derivative of a protected wildlife without a license commits an offence and shall, on conviction, be liable to a fine of not less than twenty thousand ringgit and not more than fifty thousand ringgit and to imprisonment for a term not exceeding one year.

International trade in V.salvator is also regulated under the Malaysian International Trade In Endangered Species Act 2008 (Act 686). V.salvator is classified as an Appendix II species in Schedule Three of this Act.

10. Any person who imports or exports any scheduled species without a permit commits an offence and shall, on conviction, be liable –

(a) where such person is an individual, to a fine not exceeding one hundred thousand ringgit for each animal, plant, or readily recognizable part or derivative of the animal or plant, of the scheduled species but such fine shall not exceed in the aggregate of one million ringgit, or to imprisonment for a term not exceeding seven years or to both;

(b) where such person is a body corporate, to a fine not exceeding two hundred thousand ringgit for each animal plant, or readily recognizable part or derivative of the animal or plant, of the scheduled species but such fine shall not exceed in the aggregate of two million ringgit

4.13 Technological developments to aid data gathering

PERHILITAN has collaborated with industry to develop and pilot an online data collection application to aid data gathering from *V. salvator* brought to processing facilities. The application is downloadable from the Google and Apple store onto both Apple and Android tablets and mobile phones. The Application is called *ReptileTradeMonitor* and has two main purposes:

1) To streamline self-collection and allow instant online upload of key data from processing facilities trading in *Varanus salvator*, and

2) To simplify data collection for PERHILITAN scientists and allow instantaneous download of data for statistical analysis.

For trader monitoring, each trader is registered to use the application as a facility user by PERHILITAN staff. Each trader is given a unique identifier so data collected is linked to their permit and business registration numbers (**Fig. 30**). The application and trader details are managed through an administrative platform accessible only by PERHILITAN staff.

Data collected and submitted by the traders includes the following:

- Name, address and permit details of harvesters selling lizards
- Sale date
- Number of lizards sold
- State and specific location of capture
- Habitat of capture
- Snout-vent length of captured lizards
- Mass of captured lizards

These data are entered manually by the processing facility owners and are uploaded to the online database, where they are viewable at PERHILITAN's administrative dashboard (**Fig. 31**). The data can be downloaded in csv. file format and can be imported into a statistical analysis program for rapid analysis and reporting. Importantly, the information gathered allows PERHILITAN to crosscheck against other available information and ensure compliance in real-time. PERHILITAN is currently working with partners to pilot-test the application in *V. salvator* processing facilities.

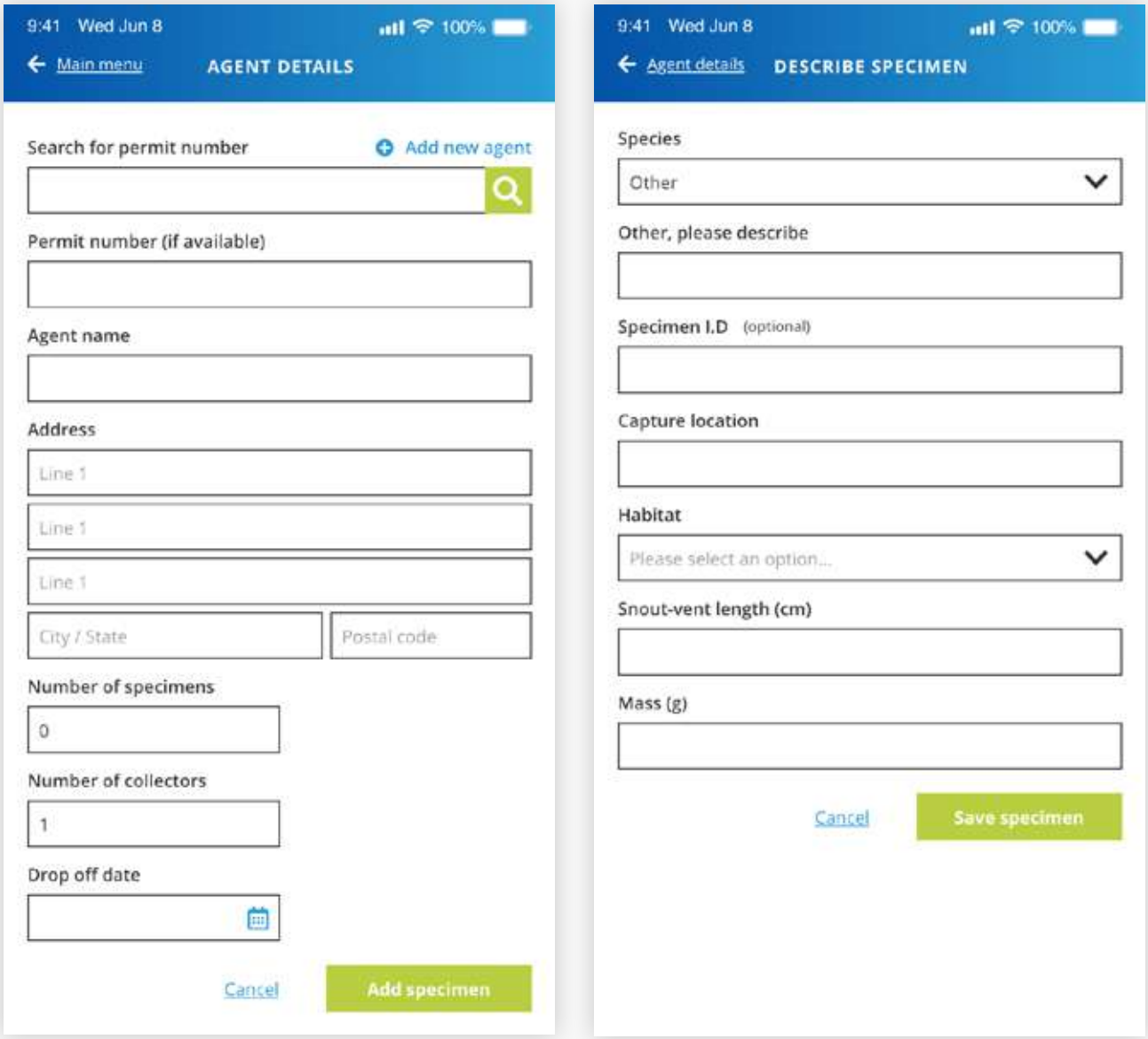


Fig. 30. Data collection application and information self-recorded by traders collecting *Varanus salvator.*

Fig. 31. The online dashboard accessible by PERHILITAN from which data collected from traders and science teams can be viewed and downloaded.

In addition to trader self-reporting, PERHILITAN scientists use this same application to collect data while surveying registered facilities trading *V. salvator*. The system works in the same way, except that PERHILITAN scientists are registered as science-users and are taken to a separate science portal when they sign-in to the application. From there, scientists can collect data on basic specimen details, harvest locations, morphometrics, and reproductive attributes (**Fig. 32**). Data are instantaneously uploaded to an online database accessible by PERHILITAN. The application is available in English, Indonesian and Malaysian.

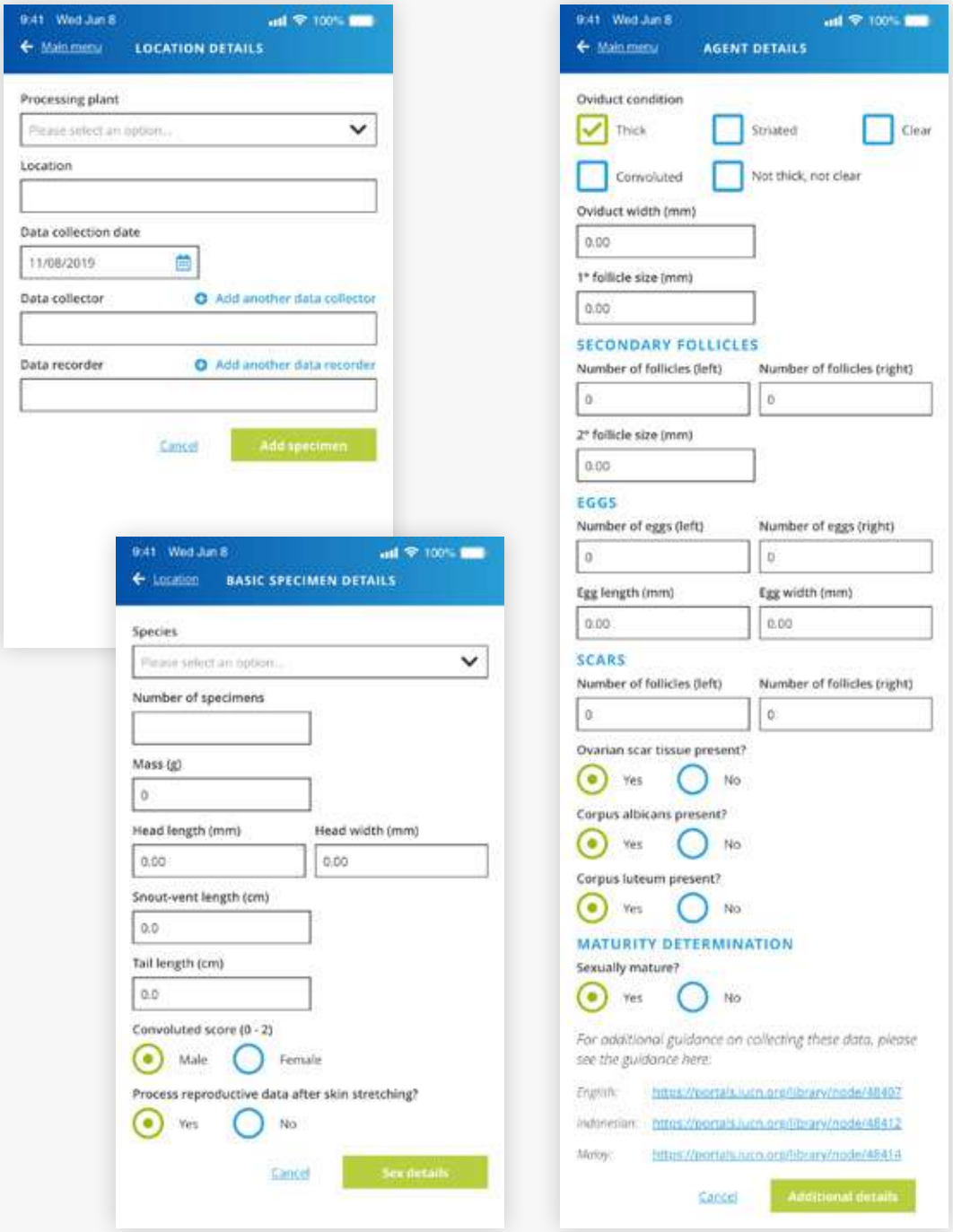


Fig. 32. Data collection application and information recorded by PERHILITAN science teams collecting data on *Varanus salvator* harvested for trade.

4.14 Capacity development

In collaboration with industry stakeholders, PERHILITAN undertakes regular capacity development exercises with *V. salvator* harvesters, processing facility owners and exporters. PERHILITAN staff visits processing facilities every month to ensure compliance with national regulations and ensure compliance with those regulations.

Fig. 33. Examples of workshops on humane treatment of reptiles (including *Varanus salvator*) conducted with trade participants in Peninsular Malaysia

In addition, PERHILITAN has undertaken several rounds of training workshops to improve animal welfare outcomes for monitor lizards and other reptile species traded for meat and skins (**Fig. 32**). For example, in 2017 PERHILITAN visited all reptile-processing facilities to ensure humane methods of handling, restraint, holding and killing were being implemented. Hands-on training was undertaken for all processing facility owners and their staff. In 2019, PERHILITAN held several workshops involving hundreds of harvesters, agents, and processing facility staff (**Fig. 32**). During both workshop series, three key resource documents were disseminated to reptile trade stakeholders in order to improve capacity related to animal welfare. All of these documents were disseminated in the local Malay language and provide science-based assessment of current knowledge related to reptile welfare from the point of capture to humane killing.

4.15 Assurance of animal welfare

PERHILITAN keeps abreast of developments in our understanding of animal welfare for reptiles. For example, as noted above, PERHILITAN has carried-out trainings for industry stakeholders to improve capacity in animal welfare based on recently published guidance from the World Organisation for Animal Health (OIE). All facilities processing *V. salvator* are implementing humane methods of euthanasia based on OIE guidelines. Under Section 86 of the Wildlife Conservation Act 2010 (Act 716), it is an offence to treat wildlife inhumanely. This provision states that any person who –

(a) Beats, kicks, infuriates, terrifies, tortures, declaws or defangs any wildlife;
(b) Neglects to supply sufficient food or water to any wildlife which he houses, confines or breeds;
(c) Keeps, houses, confines or breeds any wildlife in such manner so as to cause it unnecessary pain or suffering including the housing, confining or breeding of any wildlife in any premises which is not suitable for or conducive to the comfort or health of the wildlife;
(d) Uses any wildlife for performing or assisting in the performance of any work or labour which by reason of any infirmity, wound, disease or any other incapacity it is unfit to perform;
(e) Uses, provokes or infuriates any wildlife for the purpose of baiting it or for fighting with any other wildlife or animal, or manages any premises or place for any of these purposes; or
(f) Willfully does or willfully omits to do anything which causes any unnecessary suffering, pain or discomfort to any wildlife,

Has commited an offence and shall, on conviction, be liable to a fine of not less than five thousand ringgit and not more than fifty thousand ringgit or to imprisonment for a term not exceeding one year or to both.

PERHILITAN strongly encourages the improvement of infrastructure designed to improve the welfare outcomes of monitor lizards in trade. Two Malaysian processing facilities are state-of the art establishments designed to maximize animal welfare. Data from the RFID tagging and traceability systems reveals that, on average, it takes 48 hours from the time of capture to the time of euthanasia (range ~24-78 hours). During this period in confinement, lizards are provided water, and transportation occurs within specialized climate-controlled transport vehicles. Although not all facilities employ the same standards of animal welfare, the majority of lizards in trade are part of this system. For the other facilities, active engagement and improvements are ongoing. Finally, together with industry, PERHILITAN is providing expertise and assistance in the development of third-Party certification to independently verify animal welfare within Malaysian *V. salvator* supply chains.

4.16 Levies and funding for ongoing trade management

Ensuring monitoring and management procedures are themselves sustainable requires a dedicated source of funding. Each year, approximately $US 35,000 is spent on directly monitoring the sustainability of trade in *Varanus salvator* and *P. reticulatus* in Peninsular Malaysia. Of this, approximately $US 15,000 is spent on monitoring processing facilities for pythons and monitors lizards, and $20,000 is spent undertaking population field studies on *V. salvator* only. In addition, a minimum of $US 70,325 is spent each year by local Malaysian industry on the RFID tagging and traceability from which PERHILITAN gathers important information to monitor trade.

Therefore, each year a minimum of $US 105,000 is directly spent on management of trade in *Varanus salvator* in Peninsular Malaysia. In addition to this hard cost, intangible or in-kind costs and salaries of PERHILITAN staff engaged in wildlife management issues, logbook purchases, vehicle and equipment use, and sundry other tasks, are not estimated.

Table 9. Breakdown of government revenue obtained from the trade in *Varanus savlator*. This estimate does not include customs goods taxes (dependent on value and quantity of export).

Levy	Cost per unit (RM)	Units	Total revenue (RM)	Notes
Harvesting licenses	2	70,917 skins	141,834	Based on mean lizard skin exports 2015-2019
Trading license	300	15	4500	5 facilities, with 3 trading licenses each
CITES and export permits	50 per permit + 5 per skin	70,917 skins; 28 permits	355,985	Based on skins exported and mean shipments (mean/year = 28 ± 3)
MAQIS Export permit	5 per permit	28	140	Malaysian Quarantine and Inspection Services (Fees and Charges) Regulations 2013. For permit issuance; mean 28 shipments per year.
Total			**502,459 US$115,281**	

Based on the results of **Table 9**, management costs are equivalent to 91% of taxes levied from the sale of *V. salvator* skins. Based on the mean value of *V. salvator* skins in Peninsular Malaysia ($US15) and mean exports from 2015 until 2019 (70,917 skins), direct management costs for this species amount to approximately 10% of the value of this trade to Malaysian businesses ($105,000/$1,063,755). It should be noted that the value of the trade in other products (meat, and other tissue) is not taken into account.

In terms of a per skin value, approximately US$1.6 is levied from the trade of which US$1.5 is

dedicated to management. PERHILITAN considers this management cost to be significant, especially considering that this species remains so common throughout all habitats in Malaysia. This cost is partly justified because harvesting reptile species is one of few employment activities that can be undertaken by the Orang Asli (aboriginal) people of Peninsular Malaysia. Furthermore, *Varanus salvator* is considered a pest species in several areas of its Malaysian range and harvesting can offset the costs of eradication management by the department (see Section 1.6 in Chapter I).

4.17 Further research

As is typical of biological field studies, the data collected during PERHILITAN's extensive research and monitoring program has raised many questions and opportunities for further research. Important questions to be answered to better improve our knowledge of harvesting include:

- How do lizard populations respond to harvesting? For example, does removal of large lizards increase abundance of smaller lizards? What is the recovery rate of populations to carrying-capacity following depletion?

- How do lizard capture rates differ among lizards of different sexes, sizes, and reproductive status?

- The claim that skin quality is lower in sites with high lizard density, and that those sites are therefore avoided by harvesters, requires independent analysis and verification.

- There is observational evidence that this large and veracious predator may also limit the occupancy and abundance of other biodiversity in some habitats (e.g., oil palm plantations). It is plausible that reducing the abundance of this species in certain habitats may increase biodiversity.

Intensive mark-recapture studies at spatially limit sites could usefully answer some of these questions. The determination of non-detriment is not dependent on obtaining results from the research suggested above. Although the studies above will be of significant interest, and will help to clarify how and why *Varanus salvator* is able to withstand harvesting, and perhaps shed light on how management can be improved, they will not improve our understanding of whether harvesting is sustainable or not. Long term trend analysis from ongoing monitoring of wild populations, harvested lizards, and harvest metrics, will achieve this.

Conclusion

Conclusion

Despite the decades-long (and ongoing) harvesting of Asian water monitors in Peninsular Malaysia, populations remain stable in a variety of habitats at all survey sites. Recorded densities are highest in the most heavily harvested sites.

Expansion of human-modified environments, coupled with the ecological flexibility of *Varanus salvator*, has benefitted this species. In particular, although historical data are not available, data from natural versus human-modified sites strongly suggests that land use changes to oil palm plantations (with high densities of prey species and channeled water resources) has increased the habitat available for this species in Malaysia.

The available evidence thus suggests that harvesting until now has been sustainable. A very conservative and thus precautionary offtake of 157,162 individuals, based on 10% offtake of minimum estimated population sizes, is considered to be sustainable.

- The above estimate is based on the States, habitats, altitudes, and unprotected areas where harvesting can occur, and accounts for only 17.5% of Peninsular Malaysia's land area. The remaining land area (82.5%) is effectively protected from harvesting.
- A significant proportion of Peninsular Malaysia's land area (22.5%) is formally protected from harvesting and habitat loss (e.g., National Parks).
- Most lizards captured for trade are within a specific size range (1.2 - 5kg), protecting both immature individuals and large fecund adults.
- Despite the most conservative estimate of sustainable offtake being accepted (157,162 lizards), the annual harvest quota will be set at 120,000 (24% lower).

In addition, Malaysia's monitoring and management system provides sufficient failsafe provisions to both detect and reverse declines or indications of unsustainable harvesting. Nevertheless, Malaysia's management system for *Varanus salvator* is not perfect. Research and monitoring is continuing, and management protocols will be refined and adapted as more and better information becomes available. For the time being, however, PERHILITAN firmly believes that sufficient information is available to confidently conclude that harvests of *V. salvator* in Peninsular Malaysia are sustainable and that adequate management and monitoring procedures are in place to ensure the sustainability of offtake into the future.

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Appendix

Example: *Varanus salvator* hunting license

JABATAN PERLINDUNGAN HIDUPAN LIAR DAN TAMAN NEGARA
DEPARTMENT OF WILDLIFE AND NATIONAL PARKS

C-00510-11-20

LESEN MEMBURU / MENGAMBIL/ MEMUNGUT

LICENSE TO HUNT/ TAKE/ COLLECT

AKTA PEMULIHARAAN HIDUPAN LIAR 2010 [AKTA 716] WILDLIFE CONSERVATION ACT 2010 [ACT 716]

BUTIRAN PEMILIK *OWNERS PARTICULARS*

NAMA PEMILIK *OWNER'S NAME* : BRAHIM A/L AH WA

NO MYKAD / PASPORT *MYKAD NO / PASSPORT* : 780709065507

No. Telefon Bimbit *Mobile Number* : 011-16534231

PEKERJAAN *DESIGNATION* : SENDIRI

ALAMAT *ADDRESS* : KAMPUNG PETAH, KUALA ROMPIN
26810-KUALA ROMPIN, PAHANG

SPESIES *SPECIES* : *VARANUS SALVATOR* / BIAWAK AIR

KUANTITI *QUANTITY* : **100** EKOR

JENIS LESEN *TYPE OF LICENSE* : *MENGAMBIL*

TEMPOH SAH *VALIDITY*

05/02/2020 - 04/05/2020

Syarat - Syarat Lesen Memburu / Mengambil / Memungut

1. Lesen hendaklah dipulangkan dengan merekodkan bilangan, jenis dan jantina hidupan liar yang dibunuh atau dilukakan. Jika tiada hidupan liar yang dibunuh maka perkataan “Tiada” hendaklah ditulis di dalam lesen itu.
2. Menjadi kesalahan jika kaedah menyuluh (jacking) digunakan untuk menembak, membunuh atau melukakan mana-mana hidupan liar kecuali bagi spesies-spesies katak, serangga atau labah-labah.
3. Penjualan hidupan liar yang ditangkap atau diambil hanya dibenarkan kepada peniaga atau ahli taksidermi yang berlesen sahaja.
4. Lesen ini hendaklah dipulangkan kepada pegawai pelesen dalam tempoh empat belas (14) hari selepas tarikh habis tempoh sah.
5. Setiap penjualan yang dibuat hendaklah dikeluarkan resit seperti format yang ditetapkan.
6. Menjadi kesalahan jika memburu di kawasan atau dalam lingkungan 400 meter dari jenut.
7. Hanya hidupan liar yang dinyatakan di dalam lesen sahaja dibenarkan diburu/diambil/dipungut.
8. Menjadi kesalahan jika memburu dari atas mana-mana pengangkut.
9. Lesen ini hanya sah di dalam negeri yang mengeluarkan lesen ini.
10. Hidupan liar yang telah diburu hendaklah ditandakan.
11. Menjadi kesalahan jika memburu menggunakan racun.
12. Lesen ini tidak boleh dipindah milik.
13. Pemegang lesen memburu ular sawa hanya dibenarkan untuk Memburu/memungut/mengambil ular sawa (Python reticulatus) yang mempunyai saiz snout-vent length (panjang daripada muncung hingga anus) sekurang-kurangnya 240 sentimeter sahaja

Nama Pegawai : MOHD HAFIZ BIN MOHD ZAIN
No Lesen: C-00510-11-20

Ini adalah cetakan komputer dan tidak perlu ditandatangani

JABATAN PERLINDUNGAN HIDUPAN LIAR DAN TAMAN NEGARA
DEPARTMENT OF WILDLIFE AND NATIONAL PARKS

LESEN MEMBURU / MENGAMBIL/ MEMUNGUT

LICENSE TO HUNT/ TAKE/ COLLECT

AKTA PEMULIHARAAN HIDUPAN LIAR 2010 [AKTA 716] *WILDLIFE CONSERVATION ACT 2010 [ACT 716]*

BUTIRAN HIDUPAN LIAR *WILDLIFE PARTICULARS*

SPESIES : *VARANUS SALVATOR* / BIAWAK AIR

KUANTITI : **100** EKOR

JENIS LESEN *TYPE OF LICENSE* : Mengambil

Tarikh	Kuantiti	Jantina	Tempat

Ini adalah cetakan komputer dan tidak perlu ditandatangani

Nama Pegawai : MOHD HAFIZ BIN MOHD ZAIN
No Lesen: C-00510-11-20

MANAGEMENT AND TRADE IN ASIAN WATER MONITORS (*Varanus salvator*)

IN PENINSULAR MALAYSIA





PERHILITAN

Ministry of Energy
and Natural Resources