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Varanus salvator AS AN INDICATOR OF TURTLE NESTING SEASON AT NGAGELAN BEACH, ALAS PURWO NATIONAL PARK (TNAP), INDONESIA: A CONSERVATIOM EFFORT

Varanus salvator SEBAGAI INDIKATOR MUSIM PENYU BERTELUR DI PANTAI NGAGELAN, TAMAN NASIONAL ALAS PURWO (TNAP), INDONESIA: UPAYA KONSERVASI

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Abstract

Various turtle conservation efforts continue to be carried out, including protecting the eggs from predators. The study aimed to describe the behavior of turtles laying eggs using *Varanus salvator* as an indicator. The research was conducted at Ngagelan Beach, Alas Purwo National Park (TNAP), and around the Semi Natural Turtle Hatchery (PPSA), Banyuwangi, Indonesia. The research was conducted from January to December 2019. The type of research is quantitative and qualitative. The study results indicated that *Varanus salvator* visited this area only during the turtle nesting season. *Lepidochelys olivacea* dominates the types of turtles that land in TNAP. 1,056 *L. Olivacea*, 6 *Chelonia mydas*, *Eretmochelys imbricata*, and *Dermochelys coriacea* landed only one animal to lay eggs. Landing occurs from April to August, with peak landing in June. *Varanus salvator* was found roaming the area starting April, peaking in the second week of August and decreasing in October. Differences in landing time and arrival behavior of *Varanus salvator* are related to the incubation period of 40–50 days of turtle eggs. The smell of turtle eggs and dead hatchlings beckons *V. salvator* to this area. This behavior is because *Varanus salvator* has a strong sense of smell, detected by frequent tongue flicking.

Keywords: Indicators; Turtle; *Varanus salvator*

Abstrak

Berbagai upaya konservasi penyu terus dilakukan, salah satunya melindungi telur dari pemangsa. Tujuan penelitian untuk mendeskripsikan perilaku penyu bertelur menggunakan Varanus salvator sebagai indikator serta upaya konservasii. Penelitian dilakukan di Pantai Ngagelan, Taman Nasional Alas Purwo (TNAP), dan di sekitar Penangkaran Penyu Semi Alami (PPSA), Banyuwangi, Indonesia. Penelitian dilakukan bulan Januari-Desember 2019. Jenis penelitian adalah kuantitatif dan kualitatif. Data yang diperoleh dianalisis secara deskriptif kulitatif dan korelasi. Hasil penelitian menginformasikan bahwa V. salvator mengunjungi daerah ini hanya pada musim penyu bertelur; mereka melakukan perjalanan ke daerah lain ketika bukan musim penyu bertelur. Lepidochelys olivacea mendominasi jenis penyu yang mendarat di TNAP. Sebanyak 1.056 L. Olivacea, 6 Chelonia mydas, Eretmochelys imbricata, dan Dermochelys coriacea masing-masing hanya satu satwa mendarat untuk bertelur. Pendaratan terjadi pada bulan April hingga Agustus, puncak pendaratan pada bulan Juni. V. salvator ditemukan berkeliaran di daerah ini mulai bulan April, memuncak pada minggu kedua Agustus dan menurun bulan Oktober. Perbedaan waktu pendaratan dan perilaku kedatangan V. salvator berkaitan dengan masa inkubasi telur penyu berkisar antara 40–50 hari. Bau telur penyu dan tukik mati mengundang V. salvator ke kawasan ini. Perilaku ini karena V. salvator memiliki indera penciuman yang kuat, terdeteksi oleh lidah yang sering dijentikkan.

***Kata Kunci**: Indikator; Penyu; Varanus salvator*

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INTRODUCTION

Learning about wildlife directly in the open will get authentic information. Someone will naturally learn about the nature and behavior of the animal being observed without any intervention from anyone (Aziz, 2017). Learning animal behavior directly in their habitats will allow someone to get a good experience about the animal they are observing (Buchanan et al., 2012). However, some wildlife in habitats rarely visited by humans has a very high self-protection behavior. Simply by watching the movement of foreign objects, they rush away. Moreover, seeing the existence of humans, they run away very quickly (Hikamah, 2021).

As in humans, animals can respond to various events, either through instinctive reactions or by responses to experiences they experience and achieve through their learning abilities (Cam et al., 2018). Living things in the wild cannot stand alone. They constantly interact and depend on other creatures and their natural surroundings (Sumartono & Koneri, 2016). They can survive by eating each other, thus forming food chains and food webs (Mandeville et al., 2017).

Varanus salvator (Water monitor lizard) has a habitat along the Ngagelan Coast; they eat eggs and turtle hatchlings (Hikamah, 2021). *Varanus salvator* has the behavior of coming to this area to hunt animals for prey in certain seasons. Another study found that at Chagar Hutang Beach, Redang Island in Malaysia, Asian water monitor lizards (*Varanus salvator*) are predators of Green turtles (*Chelonia mydas*) nests (Rusil et al., 2020). In Tanjung Natural Tourism Park, Belimbing, Sambas Regency, it was found that the *Varanus salvator* was eating turtle eggs (Manurung et al., 2016).

There are seven species of nesting turtles in the world's oceans (Ario et al., 2016; Higgins, 2018; Mazaris et al., 2017). Six species landed in the Indonesian oceans (Ario et al., 2016; Fitriani et al., 2021) four of the six species landed on the Ngagelan Coast of TNAP to nest during the spawning season, along 18 km of the South Coast, Indonesia (Albab, 2018; Fanani, 2017; Hughes & Brooks, 2006). The four species are the Olive ridley turtle (*Lepidochelys olivacea*), the Green turtle (*Chelonia mydas*), the Hawksbill turtle (*Eretmochelys imbricata*), and the Leatherback turtle (*Dermochelys coriacea*) (Fanani, 2017). Based on the International Union for Conservation of Nature (IUCN) Red List: *Lepidochelys olivacea* is vulnerable (VU) (Abreu-Grobois & Plotkin, 2008); *C. mydas* as endangered (EN) (Seminoff, 2004); *E. imbricata* as critically endangered (CR) (Mortimer & Donnelly, 2008); *D. coriacea* is vulnerable (VU) (Wallace et al., 2013). Sea turtles have played an essential role in maintaining the health of the world's oceans for more than 100 million years (Wilson et al., 2018). This is an indication of the importance of turtle survival in the ocean.

Efforts to save turtles hatching in situ at TNAP are carried out by moving nests. After more than two years of observation, no ex-situ nests survived due to very high predation or predation, especially by *V. salvator*, so eggs were relocated to hatcheries as a conservation strategy (Maulany et al., 2012; 2017). The turtle breeding process in TNAP is divided into five phases: “lalar” (finding and collecting turtle eggs), preparation and construction of a semi-natural nest, egg incubation, rearing, and releasing hatchlings (baby turtles). This conservation effort shows a positive impact; it can increase the turtle population and increase the percentage of successful hatching of eggs into new turtle individuals (Sulaiman & Wiadnyana, 2017).

Varanus salvator has a keen sense of smell (Hikamah, 2021; Rahman et al., 2017). They are predicted to be able to detect the smell of turtles laying eggs from a distance, so they come to the location where the turtle nests are located. These animals visit a location based on the availability of food, which they can detect by sticking out their tongues (Frýdlová et al., 2017; Pathak et al., 2015). Therefore, activities are mainly hunting for food (Rahman et al., 2017).

Excessive turtle nest predation is a problem for turtle population conservation management (Rusil et al., 2020). Conservation science helps maintain biodiversity (Kopnina et al., 2018; Sterling et al., 2017). However, there is a gap between the importance of learning wildlife naturally in the wild and the difficulty of encountering wild animals such as turtles and Varanus salvator. The solution offered is to submit an article about Varanus salvator as an indicator of turtle nesting season. Varanus salvator is attracted to the area because of the smell of turtle eggs. This is because animals belonging to the Squamata family, including V. salvator, have a detection device, namely a

tongue that is often stuck out. Varanus salvator's tongue's forked tip enhances the ability to follow scent trails (Ford & Low, 1984). The primary role of the tongue in detecting and identifying prey is a sampling of chemicals from the environment for analysis by vomerolfaction (Cooper & Burghardt, 1990). The tongue is extended beyond the mouth, at this point, in contact with the chemicals in the air and on the substrate it touches. These molecules stick to the wet tongue and are transported to the mouth when the tongue is pulled. They reach the vomeronasal duct in the roof of the mouth by an unknown mechanism and pass through the duct to the vomeronasal epithelium, where they contact vomerolfactory chemoreceptor cells (Cooper, 1995; Young, 1990).

MATERIALS AND METHODS

Map of the Ngagelan Beach TNAP Banyuwangi, Indonesia

This research was conducted in the sea turtle landing area to lay eggs and hatchlings in Ngagelan TNAP Banyuwangi, Indonesia. Observations of the behavior of *V. salvator* were mainly carried out around the Semi Natural Turtle Hatchery (PPSA) enclosure, which is located in front of the Ngagelan Regional Unit Office. This Ngagelan Beach map is presented in Figure 1.

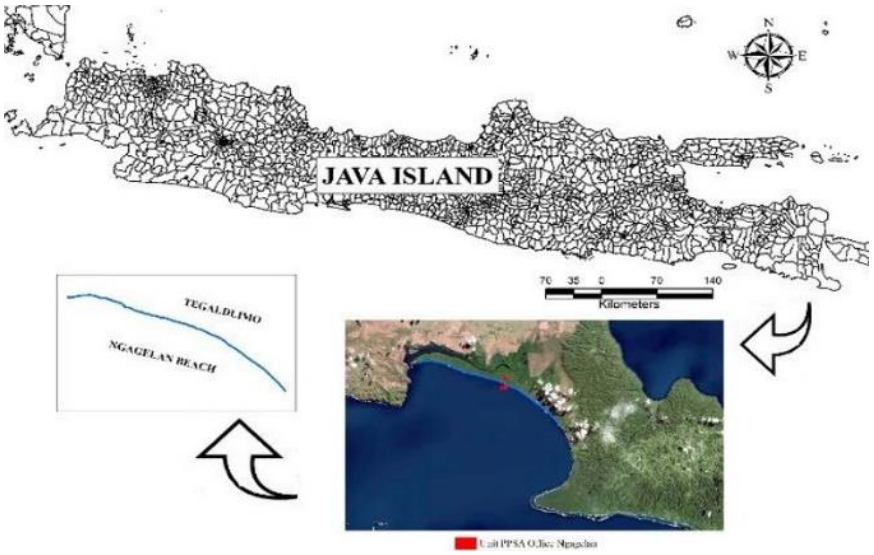

Figure 1. Blue Lines Show Research Areas at Ngagelan Beach TNAP Banyuwangi, Indonesia

The reason for choosing Ngagelan Beach TNAP as the research location is that this area is a landing site for nesting and laying eggs for four sea turtle species from six sea turtle species that enter Indonesia. Thus, making Ngagelan Beach a representative sample that can represent the territory of Indonesia as a whole as a nesting and laying place for four sea turtle species from a total of 7 sea turtle species in the world.

Data Collection and Analysis

Data collection was carried out in two steps: observation. Observations were made by observing the presence activities, and departure at the hatchery of *Varanus salvator* for several days every month for one year. The study was conducted for one year, from January to December 2019. Researchers made observations from January 31 to August 27, 2019. Observations were made once a month, and observations were carried out for one week. Researchers came to the location of turtles laying eggs at night starting at 23.00–05.00. The complete egg-laying data was obtained from PPSA officers' records. Researchers find turtle nests based on footprints.

This observation was carried out by making hiding places and aiming at *Varanus salvator* with a camera. This method is done because *V. salvator* is susceptible to other creatures. When *Varanus salvator* notices a foreign object's movement that is not from nature, they very quickly run away from the object (Hikamah, 2021).

Interviews were conducted with five PPSA officers to obtain the required information. The information that was asked to PPSA officers is how many turtles land on the beaches one year in

2019 in what month they land, what to do with the eggs that have been found, and how are the hatched hatchlings treated, what PPSA officers do during the turtle nesting season, and what conservation activities are being carried out to save eggs on the coast of TNAP Ngagelan. This type of question is an open-ended interview which allows the questions to evolve to produce the information needed by the researcher. The collected data is then analyzed qualitatively and described descriptively to produce an overview of the conditions in the original environment. Statistical analysis using a correlation test to see the relationship between turtle nesting season and the arrival of *V. salvator* on the coast of TNAP Banyuwangi and descriptive analysis to describe the conservation conditions that occur on the beach.

RESULTS

Presence of *Varanus salvator*

Reported by PPSA officers, when interviewed informed that *Varanus salvator* roam around this area only during the turtle nesting season. They come to hunt turtle eggs and hatchlings hen turtles do not lay eggs, they do not come to this territory. Table 1 informs the behavior of *V. salvator* hunting turtle eggs and hatchlings around PPSA in 2019. Table 1 shows that *Varanus salvator* came around PPSA during turtle nesting season. August showed high intensity with *Varanus salvator*, with 169 sightings. This condition can be related to the season when turtles lay eggs and hatch because the months between April and August are when turtles lay their eggs.

Table 1. Presence number of *Varanus salvator* around PPSA

V. salvator	Month											
	Jan	Feb	Mar	April	May	June	July	Agus	Sep	Oct	Nov	Dec
Total	0	0	0	19	77	92	133	169	103	0	0	0

Data on Turtles Landing

Turtles land on the Ngagelan Beach TNAP beach just to lay their eggs. Data The results of a survey on the names of turtle species and the number that landed to lay eggs along the Ngagelan Coast, TNAP Banyuwangi, Indonesia during 2019, are presented in Table 2.

Table 2. Data of turtle landing per month at Ngagelan Beach TNAP, Indonesia in 2019

Name turtle	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Number
L. olivacea	1	17	28	100	159	305	275	147	20	4	0	0	1056
C. mydas	0	0	0	0	0	0	1	0	1	1	1	2	6
E. imbricata	1	0	0	0	0	0	0	0	0	0	0	0	1
D. coriacea	0	0	0	0	0	0	0	0	0	0	0	1	1
Total number	2	17	28	100	159	305	276	147	21	5	1	3	1064

Table 2 informs that *L. olivacea* is the most common turtle species that land to lay eggs along the 18 km coast of Ngagelan TNAP. The highest egg-laying time is from April to August, and the highest number of turtles land to lay eggs in June. The species *C. mydas* lands six times a year in July, September to December, while *E. imbricate* and *D. coriacea* is the only animal that lands to lay eggs for one year.

Correlation of *Varanus salvator* with Landing Turtles

The behavior of the arrival of *Varanus salvator* to TNAP indicates the turtle nesting season. Therefore, there is a correlation between the number of *V. salvator* that come and the number of turtles landing to lay eggs in this area. The correlation between the number of *V. salvator* that came to the coast of TNAP to the number of eggs that came to lay eggs is shown in Table 3.

Based on Table 3, it can be concluded that there is a correlation between the number of *Varanus salvator* that came and the number of turtles laying their eggs. the data from the correlation analysis showed the value of Sig. (2-tailed) between the number of *Varanus salvator* and the

number of turtles laying eggs is 0.01 <0.05. These results indicate a significant correlation between the number of *Varanus salvator* that comes and the number of turtles laying eggs on the coast of TNAP Banyuwangi.

The turtle nesting season correlates with *Varanus salvator* hunting for food along the Ngagelan Coast. The more turtles land to lay their eggs, the more *Varanus salvator* present; conversely, the fewer turtles lay eggs, the less *Varanus salvator* was present. When no turtles land to lay eggs, no *V. salvator* is present in this territory. The graph of the behavior of *Varanus salvator* is showed in Figure 2. Predatory behavior of *Varanus salvator* against dead turtle eggs and hatchlings in the PPSA Ngagelan TNAP area, Indonesia, can be seen in the following video (Figure 3).

Table 3. The correlation between the number of *V. salvator* that came to the coast of TNAP

		Turtle landing	*V. salvator*
Turtle landing	Pearson Correlation	1	.710**
	Sig. (2-tailed)		.010
	N	12	12
V. salvator	Pearson Correlation	.710**	1
	Sig. (2-tailed)	.010	
	N	12	12

**. Correlation is significant at the 0.01 level (2-tailed)

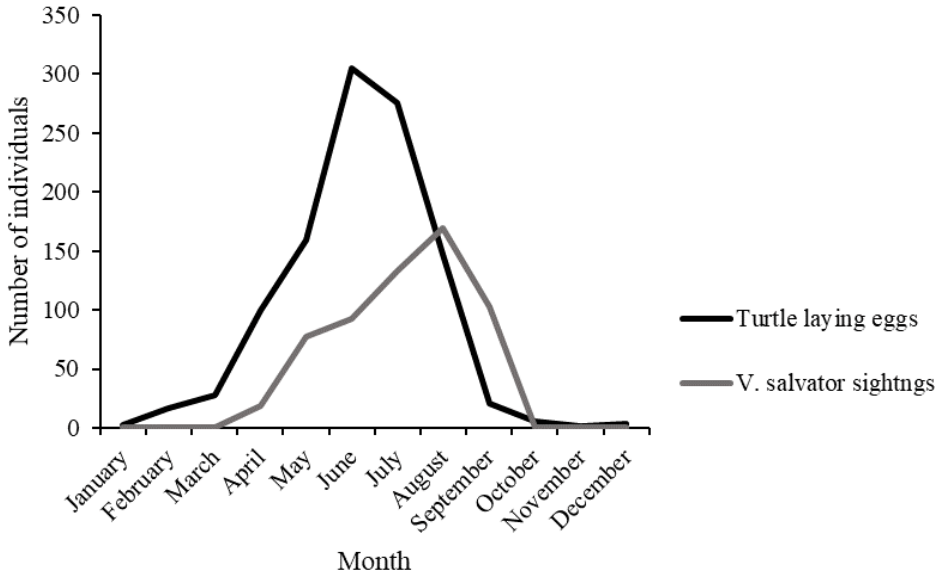

Figure 2. Comparison graph of the presence of *Varanus salvator* with egg-laying turtles in Ngagelan, TNAP Banyuwangi, Indonesia

Figure 3. Barcode of Predatory behavior of *V. salvator* against dead turtle eggs and hatchlings in the PPSA Ngagelan TNAP area, Indonesia (Hikamah, 2021)

DISCUSSION

Behavior of *Varanus salvator* on Turtle Eggs

When turtles lay their eggs, not all of the eggs can hatch. Some are damaged and rotten, which may attract *Varanus salvator*, known for its keen sense of smell (Hikamah, 2021; Rahman et al., 2016). In addition to the smell of rotten eggs, dead hatchlings (baby turtles) also contribute to attract of this species.

Figure 2 shows that the presence of the *Varanus salvator*, in line with the highest number of turtles landed, the difference in time is influenced by the incubation period of eggs, which ranges from 40 to 50 days. Variations in the incubation period depend on weather and temperature. Cold weather inhibits incubation. Hot weather and higher temperatures accelerate the incubation period. However, if the temperature and weather are too hot, it can cause the hatchlings to die (Maulany et al., 2012).

Behavior *Varanus salvator* on turtle eggs wildlife of *Varanus salvator* is a carnivore and scavenger, so it is often referred to as a scavenger animal (Ardiantiono & Udeya, 2014; Bennett, 2015; Hikamah, 2021; Kulabtong & Mahaprom, 2015; Losos & Greene, 1988). *V. salvator* acts as a secondary or tertiary predator in the ecosystem, namely at trophic level III or IV. They came to the PPSA area and Ngagelan Beach TNAP to hunt for food. Their keen sense of smell can lead them to areas with much prey for food. They can detect the smell of food and carrion from a distance because they have a strong and highly developed sense of smell (Hikamah, 2021; Rahman et al., 2017).

Animals *Varanus salvator* life is solitary. They hunt for food independently without intervention and cooperation with others. When they find the same prey, the larger animal repels, the smaller one. However, these smaller animals dodge and do not leave their prey location. They can consume food together even though the larger animal becomes the social ruler (Frýdlová et al., 2017; Hikamah, 2021).

Varanus salvator as an Indicator of Turtle Laying Season

Based on the results of the correlation test analysis in Table 3, it was found that there was a significant relationship between the number of *Varanus salvator* that came to the beach and the number of turtles laying eggs. The behavior of *Varanus salvator* roaming in this area can be used as an indicator for PPSA officers to be more alert to the safety of turtle eggs. This is very useful in the context of conserving turtles whose population is decreasing day by day (Maulany et al., 2017).

Varanus salvator found roaming the Ngagelan Coastal area starting in April, peaking in the second week of August and declining until October. They come to this area to hunt for dead turtle eggs and hatchlings; therefore, their arrival is by the season for turtles to lay eggs and hatch. The previous research results revealed that the main activity of *Varanus salvator* is hunting for food (Frýdlová et al., 2017; Hikamah, 2021; Kulabtong & Mahaprom, 2015; Rahman et al., 2016). The presence of *Varanus salvator* in this area indicates the turtle nesting and hatching season.

Even globally, *L. olivacea* is the most abundant sea turtle on the Ngagelan Coast and has a pantropical distribution (León et al., 2019). In November, this species is also commonly found in the waters near Gahirmatha Heboh, Odisha, India, and begins to breed in the first week of December (Behera et al., 2019). At Ngagelan Beach TNAP, Indonesia, this species is abundant from the second week of April to the fourth week of August every year. Hatchlings begin to hatch at the end of May until the first week of October. The arrival of *V. salvator* is closely related to when turtles lay their eggs, so the presence of these wild animals can be a marker or indicator of when it is time for turtles to lay eggs and when the turtle eggs are incubated.

Minimizing *Varanus salvator* as a Turtle Conservation Effort

To prevent predation of turtle eggs by *Varanus salvator* on Ngagelan Beach, the eggs have been moved to the Semi Natural Turtle Hatchery (PPSA) location. However, *Varanus salvator* may still be attracted to the smell of eggs laid by the mother in the nest, so officers have to rush to collect them as soon as the mother oviposits the eggs. *L. olivacea* turtles are known for their mass nesting behaviour (arribadas). Such behaviour retains the body's energy for use during egg-laying (Behera

et al., 2014). Turtle eggs develop into hatchlings without parental care. Parent turtles can choose a nesting site that increases the survival of their offspring (Hughes & Brooks, 2006). This selection is based solely on temperature and location, with no natural predators.

Turtle conservation may include managing nests on shore, translocation of nests to protected hatcheries, initiation, reduction, elimination of natural predators, and protection against hunting (Behera et al., 2013). Continuing conservation and monitoring efforts are essential to support successful turtle conservation globally (Mazaris et al., 2017).

Thus, turtle conservation can be carried out immediately to preserve, the turtle community by looking at indicators of the arrival of predators, namely *Varanus salvator*. So that the presence of these wild animals becomes a unique marker for officers. To immediately carry out in situ conservation of the eggs produced by turtles so that they can continue to preserve turtles in Indonesia. This is because seeing the appearance of *Varanus salvator* is more accessible than seeing the appearance of turtles laying eggs. Turtles come to the beach to lay eggs at night. After laying their eggs, they bury their eggs and return to the sea again, while *Varanus salvator* lives on land and carries out activities during the day so that its emergence is more accessible to observe than the appearance of turtles. PPSA officers who are usually in the office or who travel around this area often find *Varanus salvator* roaming around, they are an indicator that the turtle nesting season has arrived, so the officers will walk along the beach at night to relocate turtle eggs.

CONCLUSION AND SUGGESTIONS

The main activity of *Varanus salvator* is hunting for food. They are always roaming from Region to Region, providing them with food. If during the day, many *Varanus salvator* is roaming along the coast of Ngagelan TNAP, this can be used as an indicator that this is the season for turtles to land to lay their eggs. The peak of turtle landing is in June, while the peak of *Varanus salvator* is in August. This time difference is related to the incubation period of turtle eggs. The arrival of this wildlife is stimulated by the smell of rotten eggs and dead hatchlings. The presence of eggs and hatchlings occurred during the egg season, so that at that time also became the season for many *Varanus salvator* passing by.

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