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Management of Green Turtle Eggs (*Chelonia mydas*) as one of the Supporting Aspects for its Sustainability in Pangumbahan Beach, Sukabumi Regency, West Java Province, Indonesia

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ABSTRACT

Pangumbahan Beach is one of the beaches suitable for green turtle nesting in Indonesia. Management of sea turtles including green turtle eggs is very important in maintaining its sustainability, because the eggs are a crucial part of population recruitment. One of the properties of the turtle is "homing orientation". This means that many eggs are hatched, many hatchlings are produced and then returned to the sea, and will thus improve the attendance rates of sea turtles nesting in the beach. According to data and information of the manager at the Pangumbahan Beach, the number of green turtle eggs collected during the 8-year period of 2001-2008 was about 626,115 eggs. Based on the results of *in situ* observations and interviews with local people, green turtle eggs produced from green turtles broodstock are moved from the nest to semi-natural nests for hatching. In the rainy season the semi-natural nest is placed indoors, while this is done outdoors in the dry season. Managing currently development of both the rainy season and dry semi-natural nests can be utilized to good. The management development of green turtle eggs in Pangumbahan Beach is making good progress over time as the knowledge of the officers improves. This may result in an increase in the number of hatched eggs. In 2009 the number of hatched eggs was about 142,609 eggs, and increased in 2010 to as many as 157,690 eggs. In 2011 a total of 131,211 eggs were hatched. Therefore, it is expected that this effort will increase the number of hatchlings returned to the sea, and that after they become adults they will continue to return to Pangumbahan Beach for nesting.

KEYWORDS: Management, Green Turtle Eggs, Pangumbahan Beach.

INTRODUCTION

Turtles are reptiles whose lives are dominated by the sea and migrate for long distances. There are seven species of sea turtles in the world, and six of these species of turtle occur in Indonesian waters. This includes two different families, namely Cheloniidae and Dermochelidae. One of the species of sea turtles belonging to Cheloniidae and found in Pangumbahan beach is the green turtle (*Chelonia mydas*). Pangumbahan beach is located in Sukabumi, West Java Province, Indonesia. The beach is an appropriate turtle nesting habitat, with a long beach about 2300 m. The management of the beach is divided into 6 posts (Figure 1). Since 2009, Pangumbahan beach has been set to become a "Centre for Turtles". This beach has a strategic value associated with the preservation of green turtles (*Chelonia mydas*). Indeed, Pangumbahan beach is one of three locations in Indonesia and 30 other locations where conditions of the green turtle population can be observed (Anonymous, 2011b).

According to Hirth in Nuintja (1992) turtles have a "homing orientation", which means that turtles instinctively have the ability to return to the beach where they were originally born. This is evidenced in the results of monitoring in coastal conservation areas managed by the Natural Resources Conservation Agency, Ministry of Forestry (BKSDA) in Citireum beach, which found that green turtles had previously come for nesting were found again in August of 2008 (Anonymous, 2008).

One of the problems that occurs in the Pangumbahan beach is a decrease in the number of green turtle eggs. The eggs decreased from 15,000 in 2001 to 10,000 in 2007. Management of green turtle eggs is an important factor, because the eggs are an important component and very decisive in recruitment. Turtle eggs represent the early stage in the life cycle that needs to be carefully maintained. The incubation time is a rather long period of 45-90 days, during which time hatchlings are produced (Anonymous, 2011a).

The objective of this study is to describe the current management of green turtle eggs in Pangumbahan beach, West Java Province.

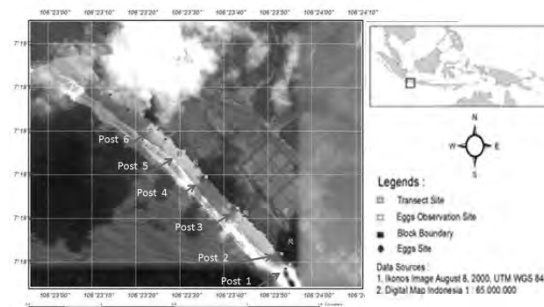


Figure 1. Green turtle (*Chelonia mydas*) observation site in the coastal area of Pangumbahan Southern, Sukabumi (Nastiti *et al.*, 2009).

MANAGEMENT OF TURTLE EGGS

The egg of the green turtle has a round or elliptical shape, and the outer surface is coated with a soft, supple and white shell having a diameter of 40-46 mm and a weight of 50-52 grams (Rebel, 1974). According to Bustard (1979) in Nuitja (1992), fertilization occurs internally in the turtles and *ovipar*. Turtles' nesting may take place 3-4 times with intervals of 14 days, in the spawning season.

Management of Green Turtle Nests

Since 1973 Pangumbahan beach has been managed as a green turtle habitat by the private sector (Anonymous, 2011a). The beach has a length of 2,300 m, and is divided into six observation posts. Each post is controlled by one guard person. The seasonal presence of female green turtles on beach of Pangumbahan as follows. In 2003, from January to July (included not spawning season) there were 2-3 turtles/night/month. In the spawning season, from August to December, there were 4-12 turtles/night/month. In 2004, there were 3-6 turtles/night/month (Yudha, 2004). Table 1 shows details regarding the presence of green turtles in 2008 during August (Nastiti *et al.*, 2010). Furthermore, according to information from the manager, the number of female turtles from 2008 to 2011 on the beach of Pangumbahan has decreased (Figure 2). It is thought that this is related to the green turtles' natural sensitivity to light and sound. Since 2009, the Pangumbahan beach has become a tourist area, and the number of visitors is increasing constantly. If there is no limitation of visitors, it is suspected that the number of female turtles could drop by about 40-50%. However, if there is a policy to limit the number of visitors, it is suspected that the number of female turtles will increase approximately 40-50%.

By comparing the data in Table 1 with those from Yudha (2004), we can see that the presence of green turtles has increased currently in Pangumbahan beach. This condition is supported by the good management practices implemented by the local government, which is the management authority for sea turtle conservation. The management activities carried out related to enhancing the nesting habitat, including re-planting of vegetation, improving surveillance, enhancing knowledge of human resource management and community awareness.

Table 1 shows that not all adult females spawned in the Pangumbahan beach. This is generally due to unsafe beach conditions (Nuitja in Bustard, 1992), such as the presence of predators, beach lights, unexpected sounds from motorbikes and randoms visitor entering to the beach. These conditions may cause the turtle broodstock to return to sea. Under conditions in which the turtles are very keen to nest, the turtles will look for another location.

Table 1. The presence of the green turtle on Pangumbahan Beach in August 2008 *).

Date	Total of green turtle at Pangumbahan beach	Total of spawning green turtle
01.08.2008	5	1
02.08.2008	5	2
03.08.2008	8	3
04.08.2008	12	5
05.08.2008	12	7
06.08.2008	6	2
07.08.2008	9	4
08.08.2008	5	2
09.08.2008	11	6
10.08.2008	8	4
11.08.2008	10	6
12.08.2008	12	6
13.08.2008	10	5
14.08.2008	10	5
15.08.2008	13	7
16.08.2008	14	7
17.08.2008	11	5
18.08.2008	12	7
19.08.2008	15	7
20.08.2008	16	8
21.08.2008	16	9
22.08.2008	13	6
23.08.2008	12	8
24.08.2008	13	8
25.08.2008	16	9
26.08.2008	14	8
27.08.2008	13	7
28.08.2008	36	15
29.08.2008	26	10
30.08.2008	27	14
31.08.2008	32	16

Sources: Department of Fisheries and Marine Resources, Sukabumi Regency in Nastiti *et al.*, 2010

Green turtle habitat management undertaken to date is as follows (Anonymous, 2011a,b):

1. Replanting coastal vegetation (*Pandanus tectorius*, *Terminalia cattapa* and *Calophyllum inophyllum*). According to Rebel (1974) *Pandanus tectorius* has strong roots and contributes to the maintenance of moisture in the sand, which is crucial to ensure that the nest built by the turtle does not collapse.
2. Building fences, to inhibit the theft of turtle eggs and its broodstock.
3. Zoning Pangumbahan into a core zone at Posts 1-2 and ecotourism zones for Posts 3-6.
4. Collaborating with relevant institutions such as the Ministry of Marine Affairs and Fisheries, the Sukabumi local government, Natural Resources Conservation Center (Ministry of Forestry), and local communities.
5. Improving field staff's knowledge of turtle conservation.
6. Preparing regulations and sanctions for turtle eggs poaching.

The realignment of technical activities and increased knowledge among staff in the field requires time, so the presence of turtles will not increase rapidly. In 2009, 2010 and 2011 the numbers of turtles was still lower than in 2008 (Figure 2). The decline in the number of turtles in related to green turtles' sensitivity to noise and light, therefore the managers have payed special attention to limiting the number of visitors.

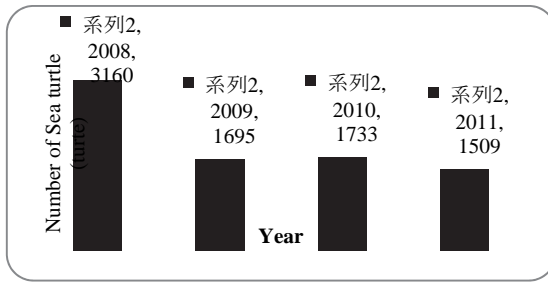


Figure 2. Presence of female green turtles on Pangumbahan Beach, 2008-2011.

Behavior of the Green Turtles During Nesting

The behavior of green turtles (*Chelonia mydas*) during the nesting process on Pangumbahan beach, is presented in Table 2.

Phase	Description	Photo
1. Searching	Green turtles appear together with the ocean waves, moving the head on the sea surface. After confirming safety, the turtle moves to the beach, looking for a place to spawn. The turtles travel in lines vertical to the beach. The direction of this movement can be seen from train of other turtles that have gone first, similar to “the tractor trail”. This phase takes 60-90 minutes.	
2. Digging	The front flipper is more than the back flipper, when digging a hole for the turtles' body \The excavation ends when it reaches the desired depth. The excavation an eggs hole by moving the back flipper with periodically if left back flippers to dig a hole. The movement of the back flipper is similar to a “shovel”, when the right front flipper is digging a hole, the left back flipper is throwing sand. After reaching a certain depth, the digging is stopped. This phase takes 20-40 minutes. The hole is shaped like a pumpkin, with a nest depth of ± 30 cm.	
3. Egg laying	Turtle will lay eggs even when they are disturbed. At the time of egg laying, both of the back flippers are attached to the back and cover the tail. The folded tail is inside the front tail and hangs over the egg hole (<i>cloaca</i>). The Entire the surface of the eggs is covered by <i>mucus</i> , and then the eggs come out of the <i>cloaca</i> one, two or three at once. This phase takes 20-25 minutes, depending on the number of eggs released.	
4. Covering the nest	After the eggs are out, the hole is closed by the back flipper. Once the eggs all have been deposited in the hole, it is filled with sand. Both back flippers are used to pat sand over the hole until it is dense. This phase takes 15-25 minutes	
5. Camouflaging the nest (Witherington et al, 2011)	The Green Turte then creates a false egg net so that the real nest is not found by predators> The movement is done randomly, occasionally revolves around the original nest. This phase takes 60-120 minutes.	
6. Return to the sea	After the spawning is finished, the turtle returns to the sea. The turtle stopped several times at the edge of the tide and wait for waves to help her return to the sea. This phase takes 10-20 minutes.	

Source : Nastiti et al, 2010.

Development of Green Turtle Egg

During 1973-2001, according to the management policy, management of the turtle eggs was done by the authority of the concession holder. In 2001-2005 30% of turtle eggs were incubated and the remaining 70 % were used for management, according to the management policy. In the period of 2005-2008, 50% of turtle eggs were incubated and the remaining 50% were used for management (Nastiti *et al.*, 2009). After the development of management began in August of 2008 all eggs were incubated (100%), meaning that none are currently utilized (Anonymous, 2011 a,b). At the peak of the spawning season a green turtle broodstock was capable of producing as many as 80-200 eggs in once spawning. The maximum number of eggs that could hatch was around only 60-93% (Anonymous, 2011 a,b), because of the poor quality of eggs, which tended to rot or were not fertile (infertile). On the Pangumbahan beach it was common that green turtle eggs were not fertile. For example, the data for February through May 2010 indicate that about 1-10% of green turtle eggs not fertile. The number of turtle eggs from post 1 until Post 6 is shown in Table 3.

Table 3. The number of green turtle eggs on Pangumbahan Beach

Year	Number of eggs hatched (eggs) based on policy manager	Total of eggs hatched (eggs)	Percent Hatching
2001	96401	17.497	18.15
2002	100822	6.695	6.64
2003	88859	21.095	23.74
2004	99199	29.571	29.81
2005	100789	13.949	13.84
2007	63623	30.361	47.72
2008	76422	16.568	21.68
2009	142609	142609	100
2010	157690	157690	100
2011	131211	131211	100

Sources : Anonymous (2011a,b)

Note : 2001-2005: 30% incubated and 70 % for operational costs,
 2005-2008 : 50% incubated and 50% for operational costs,
 2008- 2011 :100% incubated

Based on Table 3, starting in 2001 and continuing until 2007, only 6.64-47.72% of eggs produced from the green turtles broodstock hatched. This is not in accordance with the agreement, which stipulates that 30-50% of the eggs should have been hatched. The policy managers have determined that 50-70% of the eggs should be put towards operational costs, such as payment of employees, taxes, maintenance of the hatching eggs, hatchlings, administration offices and buildings. The year 2008 was a transition time in which the management was changed. In period of January to July, 50% of turtle eggs were still utilized, but starting in August all eggs were hatched. From Table 3, we can see that the number of eggs produced is not the same as the number of eggs hatched. However, starting in 2009 all eggs produced are hatched, a rate of 100%. This explains the increasing number of hatchlings. The current conditions of the green turtle eggs on Pangumbahan beach are shown in detail in Figure 3.

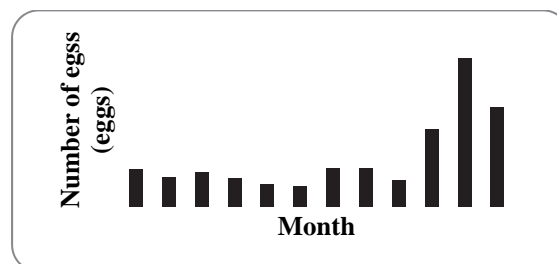


Figure 3. Total of green turtle eggs on Pangumbahan beach in 2011.

Figure 3 shows that there was an increase in the number of eggs starting in August and continuing until December, with a peak in November. August to December is the season of green turtles spawning on Pangumbahan beach. This situation is consistent with the observations of Yudha (2004).

Techniques Transfer and Hatching of Green Turtle Eggs

On Pangumbahan beach, the green turtle eggs hatching in natural nests are not safe. Therefore the eggs were removed from natural nests to semi-natural nests in indoor (in a temperature-controlled room where sand was replaced every two weeks) and outdoor (near the beach) systems. The depth of these nest was about 60-80 cm depending on the number of eggs (Anonymous, 2011 a).

In the indoor system, turtle eggs are hatched in rooms with two units of 8x5 m. Cylinder-shaped hatching containers are filled with sand, and the nest temperature is managed to a range of between 27-30°C. Indoor systems require a longer incubation time, 4-5 days, than the outdoor systems. This is consistent with the Nuitja's (1992) comment that turtle eggs in nests located in the shade require a longer incubation period. The percentage of turtle eggs hatched was not significantly different between the indoor and outdoor systems.

In the outdoor system, turtle eggs are hatched in two units of 15x7.5 m. Nest temperatures ranged between 29-31°C. The nests were located behind the beach vegetation approximately, at a distance of approximately 50 m from the beach, in order to prevent egg theft and damage from predators, as well as any negative influence from the tide. The outdoor system is operated even in times of rain. (Anonymous, 2011 a).

Officers carry out several steps in the transfer of green turtle eggs on Pangumbahan beach:

1. The officer takes the eggs one by one from the natural nest, places them in a bucket, but makes sure not to change the position of the eggs.
2. The eggs are laid into the semi-natural nests, and given a nest number. One nest contains turtle eggs from one broodstock, and are incubated for 45-90 days.
3. After a sufficient incubation period, hatchlings emerge and are then placed in a bucket that has been filled with sea water. The hatchling buckets are then stored in a treatment room a few hours to rest before returning to the sea. In the afternoon, hatchlings are ready to be restocked into the sea.

FACTORS AFFECTING THE HATCHING OF GREEN TURTLE EGGS

The recruitment success of green turtles on Pangumbahan beach is determined by the quality of turtle eggs, the physical condition of beaches, coastal vegetation, predators, human threats (theft of eggs), availability of field officers committed to supervision, care of eggs and knowledge of green turtle conservation.

Quality of Turtle Eggs

The bad quality of turtle egg is a non-fertile egg and rotten. The condition of non-fertile turtle eggs usually is inherited from its parent, while the cause of sea turtle eggs become rotten is suspected because of the ant or the intrusion of sea water into the nest egg. Ants which cover the entire surface of the egg would inhibit the process of egg metabolism. Rotten eggs in a nest of turtle eggs inundated due to sea water because of sea water intrusion through the nest (Nuitja, 1992).

The Physical Condition of Pangumbahan Beach

1. Slope of the beach

Beach slope is one of the factors that influences the occurrence of sea turtles laying eggs (Nuitja, 1992). The slope of Pangumbahan beach ranged from 2.60 to 3.66°, with an average of 3.05°. The sloping conditions allow turtles easy access to nesting locations. Observations indicate that nesting turtles choose sloping beaches about 100-200 m from the surf (Nastiti et al, 2009).

2. Size of sand

According to Nastiti *et al.*, (2009), Pangumbahan beach is dominated by the substrate composition of sand with grain size 0.25 - <0.50 µm. Based on the criteria of the USDA (1973), the size of sand grains on Pangumbahan beach is considered as fine sand, suitable for the green turtle. Sand grain size 0.25-<0.50 mm makes it easier for female green turtles to reach their nests, and also helps to maintain a stable temperature, which is important in the hatching process.

3. The temperature of the sand

Natural nest temperatures ranged from 28.30 to 30.60°C, with an average of 29.05°C (Nastiti *et al.*, 2009). Sangalaki, the island famous for its habitat for nesting sea turtles, the nest has a temperature range between 25-32°C (Rebel, 1974). Based on this fact, we know that Pangumbahan beach is a productive area for green turtle egg hatching. Temperature is a factor that affects the entire life cycle of turtles, including sex determination in the embryonic phase. The sex of turtles is determined by the temperature around the nest. At an average temperature of 29°C, male-female ratio is 50:50, but if the temperature increases, the female sex ratio will increase (Godfrey et al, 1999; Godfrey and Mrosovsky, 2001).

Coastal Vegetation

Observations in 2009 showed that the coastal region of Pangumbahan has long been disturbed, experiencing change to home garden, farmland, ranches and settlements. Damage to coastal vegetation is

one threat to turtle nesting areas, as this makes the nesting process more vulnerable to natural predators and theft of eggs by irresponsible humans. Coastal vegetation that can still be found in the area are *Pandanus tectorius*, *Terminalia cattapa* and *Calophyllum inophyllum* (Roemantyo *et al.*, 2011). According to Rebel (1974), *Pandanus tectorius* is an indicator for the presence of turtles on the beach. Observations have noted that because turtles prefer to lay eggs in a location easily accessible yet secure from interference, they generally tend to choose a places among vegetated coastal areas. (Roemantyo *et al.*, 2011). Management activities have included replanting of *Pandanus tectorius*, *Terminalia cattapa*, and *Calophyllum inophyllum*) (Anonymous, 2011a).

Predators

Egg hatching failure is influenced also by predators such as ants, lizards, snakes and boar. If ants cover the entire surface of an egg it will go rotten. For other predators (lizards, snakes, and boar), the threat is that they prey on the eggs in the nest. In their monitoring duties, the guards must ensure that the eggs are still in the nest and have not fallen victim to natural or semi-natural predators.

Theft of Green Turtle Eggs

According to the management practices, the area is divided into 6 observation posts, in order to ensure that the eggs are layed. Monitoring is done with a layered security system, in which there is a guard and supervisor present at every post. In addition to the surveillance system, the manager has built fences in the coastal areas, and is currently cooperating with the Natural Resources Conservation Center of the Ministry of Forestry (BKSDA). The latter institution has security units (forest police) and community group supervisors (Pokmaswas) who directly participate in the surveillance of illegal circulation and security of green turtle eggs (Anonymous, 2011 a ; [http://www.gatra.com / component / content.](http://www.gatra.com/component/content/))

Improvement of Knowledge among Staff

Training in the techniques of turtle conservation has been provided for employees, supervisors, tour guides and community groups (*Pokmaswas*) by WWF, in collaboration with the Department of Marine and Fisheries Sukabumi Regency and Directorate of Conservation Areas and Type of Fish, Ministry of Marine and Fisheries, on Pangumbahan beach during the period of December 6 to 10, 2010 (Anonymous, 2011a).

Facilities and Infrastructure

Management of green turtle eggs on Pangumbahan beach requires facilities and infrastructure. These include the availability of funds, egg hatching facilities, training, regulation and sanctions for violations (Local Regulation No. 5 of 2009) of the conservation of sea turtle in Sukabumi, and support from BKSDA (Conservation of Natural Resources-Ministry of Forestry and Community Supervision (*Pokmaswas*) (Anonymous,2011,b;[http://www.gatra.com/ component/content.](http://www.gatra.com/component/content/))

CONCLUSION

1. In the years between 1973-2001 concession holders because the main authority responsible for the turtle egg management system. According to the management policy for 2001-2005, 30% turtle eggs were incubated and the remaining 70% were used for management. According to the management policy for 2005-2008, 50% of turtle eggs were incubated and the remaining 50% used for management. Since August 2008, all eggs (100%) have been incubated.
2. Good management of turtle eggs may increase the number of adult female turtles, but further study is needed.
3. Activities conducted in support of improved management are: creation of nesting facilities in both indoor and also outdoor systems, replanting beach vegetation (*Pandanus tectorius*, *Terminalia cattapa* and *Calophyllum inophyllum*), fencing the area, zoning, improving knowledge of managers, supplying budget, cooperation with concerned institutions, formation of supervisor groups and development rules and sanctions for violation.

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