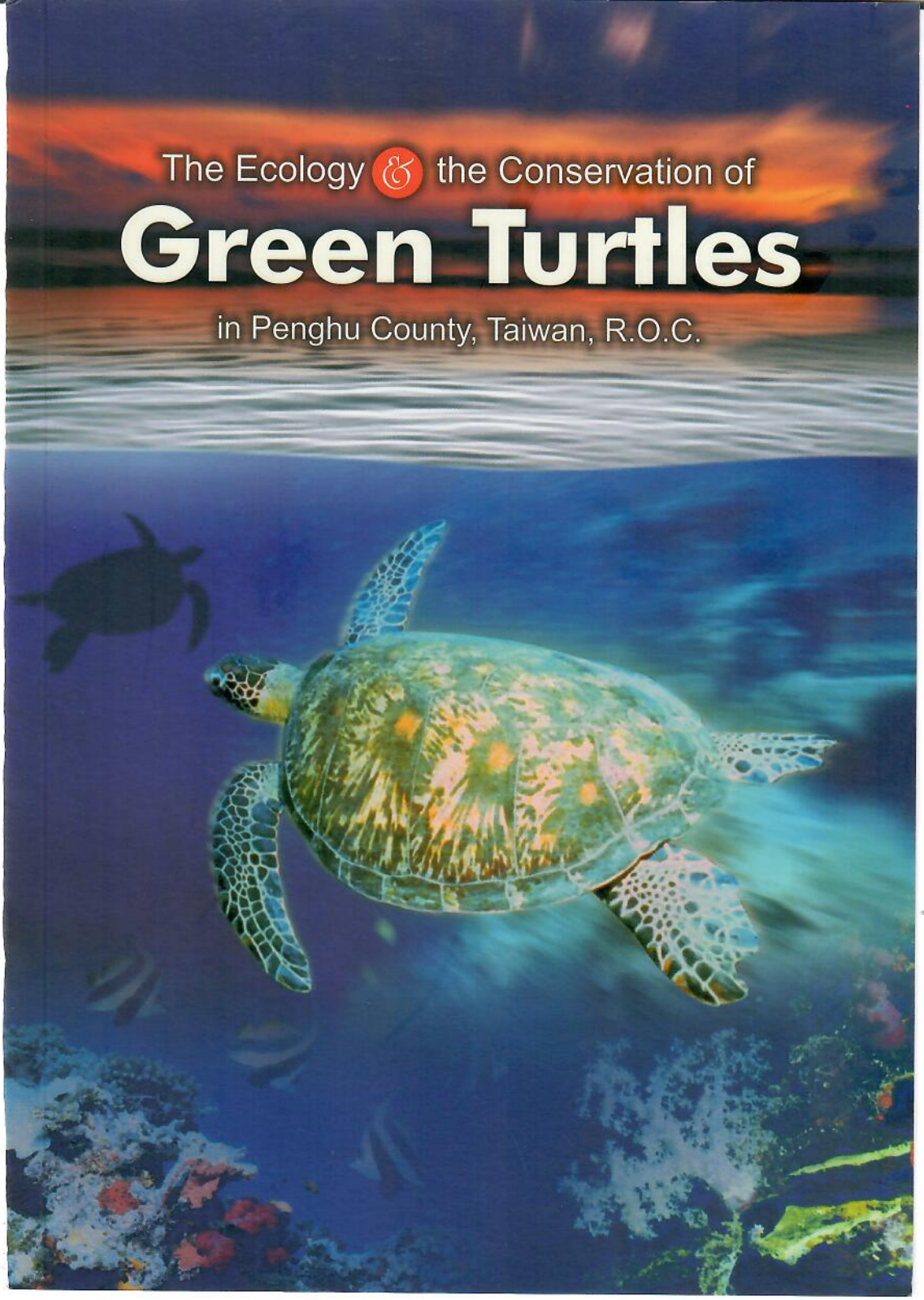

The Ecology & the Conservation of
Green Turtles
in Penghu County, Taiwan, R.O.C.

Table of content

Preface

Wan-an Island is located of the west coast of Taiwan, south of Makung City in the Penghu Archipelago. It has a low resident population and one of the most exceptional sceneries in Taiwan, all along its breath-taking zigzagging coastline. The erosion topography of the basalt rocks in the north of Wan-an Island is very obvious. To the south, the topography is mainly of the pile-up style. The sand accumulated by the waves form sandy beaches thousands of meters long. These beaches are the nesting sites of the famous green turtles in Taiwan.

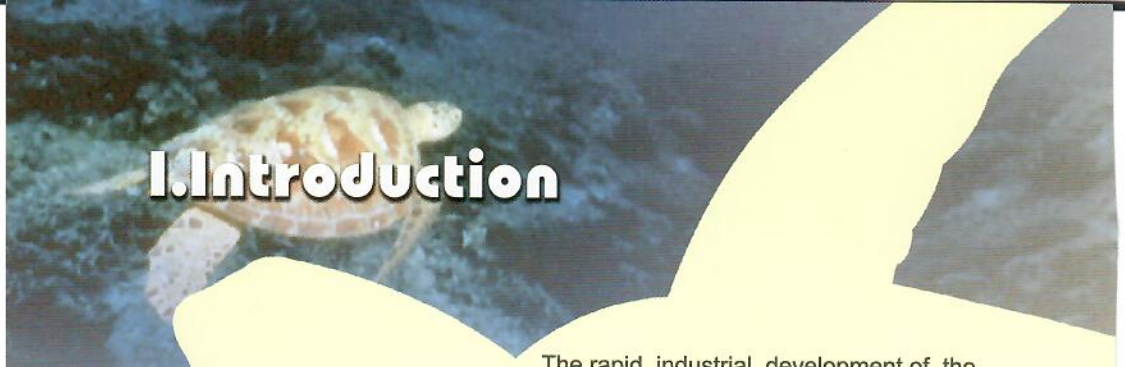
The green turtle is a medium to large size sea turtle. It is on the endangered species list and is protected by international conservation laws. Once upon a time these sea turtles could be found nesting all along the west coast of Taiwan. Marine pollution, hunting, and destruction of their nesting sites have resulted in a dramatic decline of the green turtle population. Currently, its only nesting sites are a few beaches on Wan-an Island, as well as Makung and Hu-Se in the Penghu Archipelago.

In order to protect this precious rare natural resource, the Penghu County Government has declared these beaches a "Wan-an Green Sea Turtle Refuge Site of Penghu County" on January 17, 1995. With these active conservative practices in place, green turtles can now also be found nesting on beaches other than the protected areas. This result demonstrates the obvious success, and shows what can be accomplished when conservation policies and promotion of public awareness are put in place.

The publication of this book would not have been possible without the editing and photos being made available by Professor I-Jiunn Cheng, of the National Taiwan Ocean University, Section Supervisor Mrs. Shu-Lin Liu, and staff Gen-En Sha, the Conservation Section of Penghu County Government. Also, the information from the " Green Sea Turtle Tourism and Conservation Center " in Penghu National Scenic Area Administration is highly appreciated.

Wang, Chien-Fa

Prefect of Penghu County



I.Introduction

The rapid industrial development of the last few decades has destroyed many forests and has eliminated numerous ecologically valuable wetlands by filling them in for development purposes.

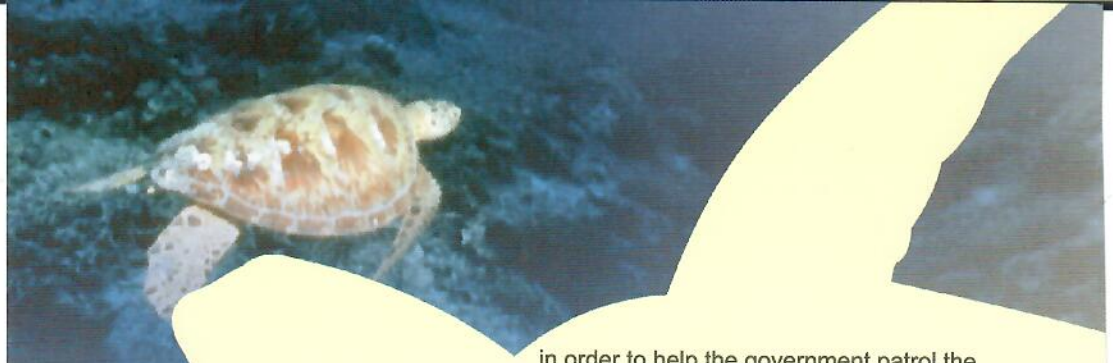
Environmental degradation has a very negative impact on the fauna and flora of the ecosystem. The air, water and soil pollutions are resulting in a rather grim situation. Therefore, based on the "Wildlife Conservation Law", in May of 1995, the Penghu County Government established the first wildlife refuge site on the Big Cat Islands southwest of Penghu Island. The second wildlife refuge site, the "Wan-an Green Turtle Nesting Reserve", was established on January 17, 1995.

The establishment of a protected area does not simply mean barricading the area with yellow caution tape and installing a few signs declaring the site a protected area and listing the appropriate regulations. The protected area has three missions; to protect the critical natural environment , to protect the

biodiversity, and to protect the genetic diversity within the protected area. These conservation efforts can not, should not, and must not depend solely on the government. They need the participation from local and communities to support the various conservation policies. Then the local community can be proud of having at least done something to protect the ecosystem, and they may even reap financial benefits from the establishment of a protected area. Furthermore, they should take the responsible of preserving these precious natural resources for the enjoyment of their children and their children's children. Therefore, under the supervision of the Penghu County Government, local communities established the NGO, "Wan-an Green Sea Turtle Conservation Association". The members of this association received substantial training from and were certified by the government,

Researchers trained the local people with basic beach patrol skills.

The green turtle on Wan-an Island.



in order to help the government patrol the nesting beach and carry out relevant management duties. The Wan-an District Office also has a program to reduce any negative impacts on the nesting females and hatchlings.

The green turtle is a mid-to large-size sea turtle. It is one of the endangered wildlife species, and is protected by the wildlife conservation law of Taiwan, R.O.C.. Wan-an Island in Penghu County is one of the few remaining nesting sites in Taiwan, and even these were seriously damaged over the years. In addition, there has been a decrease in the trend of nesting females in recent years. Therefore, in order to protect the green turtle, their eggs, and their environment

A green sea turtle is swimming on the coral reef (courtesy of Taitung Diving Club).

on this island, the government announced the nesting beaches as a "Wildlife Protection Site" and enhanced the management policies accordingly. Thus, the green sea turtles and their nesting habitats can be protected properly.

With these active conservation practices, the green turtles have made a come-back, and even found nesting places on non-protected beaches other than Wan-an Island in the Penghu Archipelago. These sites include San-Shu beach of Makung City, So-Li marine recreation beach, I-Men beach of Lake Western County, Je-ba beach of White Sand County, and Great Lake Beach of Western Islands County. These phenomena are very encouraging and demonstrate the success of the gradual implementation of conservative policies, and help to upgrade the concepts

The green turtle nesting site -- Wan-an Island of Penghu Archipelago. The island is marked with red circle.

Researchers conducted satellite telemetry studies.

The large-size notice board for the protection of green sea turtles by the harbor.

The large-size notice board for the protection of green sea turtles on the nesting beach.

of conservation among local communities. However, in order to have a sustainable management of our natural environment, we must conduct conservation practices constantly. Nor can we rest and be satisfied with the current achievements. The green turtle conservation practices needs the participation and efforts from all the people in the community. The Penghu County Government has not only invited the research team from the Institute of Marine Biology, National Taiwan Ocean University to conduct basic biological researches at the green turtle refuge sites, but it hired local people as beach patrols. The government has also set up large-size notice boards at the ferry docks, the airport, and at various sites outside the protected beaches to announce the regulations, prohibitions and the maps of the protected areas of the green turtles. The purpose of these public announcements is to make local residents and tourists alike, aware of the fact that it is forbidden to enter the

protected beaches during the nesting period (in the night) and disturb the nesting females, to poach green turtles, or to conduct sand mining activities. Each year, the government also conducts several patrol training workshops, and awareness campaigns for the local schools and communities. Furthermore, the government prepares many multi-media audio-video products and a green turtle ecology manual as supplementary teaching material for the wildlife and environmental courses in the schools, as well as a guide book for the ecotourists.

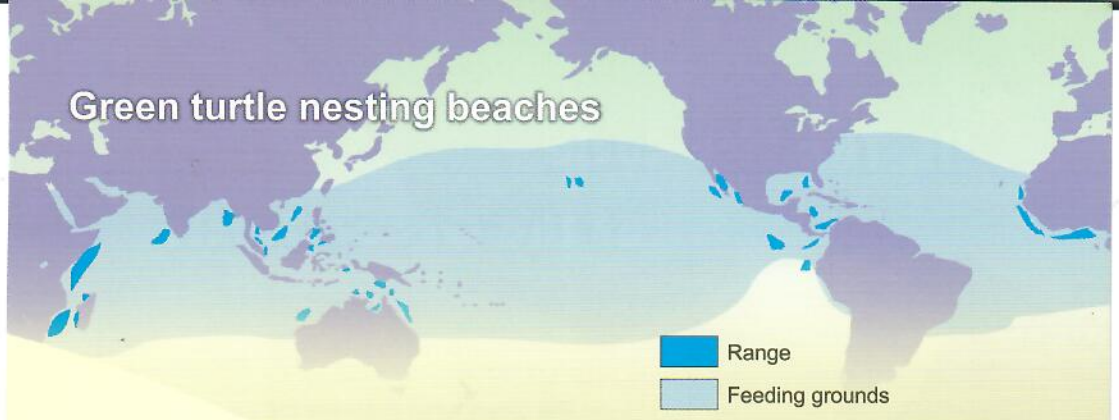
The green turtle conservation awareness materials.

Researchers use the results of satellite telemetries to conduct a regional and international workshop to discuss how to protect the green turtles that nest on Wan-an Island.

II. Taxonomy and Distribution of the Green Turtle

The scientific name of the green turtle is *Chelonia mydas* (Linnaeus, 1758). In China, it is called "green turtle", or "sea turtle". The common name in Taiwan is "stone turtle", "black turtle",or "meat turtle". It belongs to the Class Reptilia, Order Testudines, Family Cheloniidae, and Genus *Chelonia*. Green turtles are a cosmopolitan species. Their distribution ranges from 55ºN to 46ºS , mainly in the tropical and subtropical oceans.

The green turtle has an elongated ellipse shape. The dorsal carapace has four pairs of lateral scutes, 5 central scutes. The rear side is bold-round. There is one pair of scales in front of the eyes. The body color ranges from brown to black, sometimes embedded with big flower marks on the dorsal carapace. It takes 20 to 50 years for the hatchlings to reach maturity. The mature turtle can grow up to 1 meter in straight carapace length, and weigh more than 100kg. Green turtles are the most abundant of all sea turtles species. Their total number is estimated at more than 200 000 turtles. However,



Global distribution of the green turtles.

most of them are concentrated in only a few areas. In addition, only in a very few sites, such as in Florida and Hawaii in the USA, the populations are on the increase due to effective conservation measures, however, most of the populations of green turtles are seeing a decreasing trend. One of the main issues being that their nesting sites are disappearing continuously. Thus, in Taiwan the Council of Agricultue has listed all species of sea turtle as endangered wildlife, in order to protect these precious natural resources. The green turtle is not green at all, but rather it is black to brown as noted earlier. Because the main food sources of the green turtle are the macroalgae and seaweeds, it deposits the ingested chlorophyll in the lipid reserves (i.e. their body fat) giving it a green color. From there the English name of "green turtle".

III. The Life Cycle of the Green Turtle

The green turtle is a large marine reptile. It spends most of its life in the ocean. Due to the fact that during the course of their evolution, sea turtles actually lived most of that time on land, so all sea turtles still nest on land. This special characteristic shows the unique life style of the sea turtle, and this fact alone is worthy of advanced study.

Green turtles are distributed widely in tropical and subtropical oceans. They only emerge to nest on beaches with a water temperature higher than 25° C. A sea turtle breathes air and has lungs. Even though green turtles are excellent swimmers, they rarely dive below one to two hundred meters in depth.

The sea turtle is a timid animal, and usually only emerges to nest on a remote beach. It has high nest site fidelity. Once it has picked a beach, it will return to that same nesting beach no matter how far or how long it takes to travel to it. However,

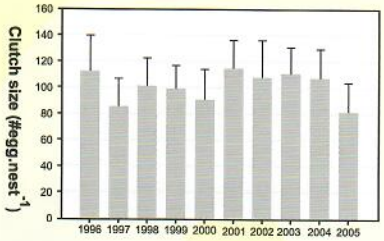
once the nesting site has been seriously altered or has disappeared, a sea turtle will abandon the nest site and select a new one. Also, many researches have demonstrated that about 5 % of the nesting females will nest on another island without any reasonable explanation.

Mature female green turtles do not nest every year. According to the available research, the average interval between nesting events ranges from 3 to 5 years. Because the initiative to start a reproductive migration depends on the degree of fat reserves, the interval varies from one individual to another. Thus, the size of the nesting population can vary greatly. Prior to the beginning of the nesting season, both the adult females and adult males swim from their foraging ground to the vicinity of the nesting sites to mate.

Male green turtle
(courtesy of Taitung Diving Club).

Female green turtle
(courtesy of Taitung Diving Club).

Every female will mate with several males, and store their sperms in the abdomen. After each ovulation, the eggs are fertilized with the stored sperms, and the female emerges to nest on the beach. This is the reason why gravid females emerge several times to nest during the nesting season. After the mating season, the male turtle returns to his foraging habitat alone, or remains in the vicinity and leaves with the female turtles after the nesting season. On Wan-an Island, the mating season occurs in March and April, and the nesting season lasts from May to October, with the peak nesting period in July and August. Each female deposits one to nine nests (with the mean value being 4 nests) each year. The clutch size is about 110 eggs.



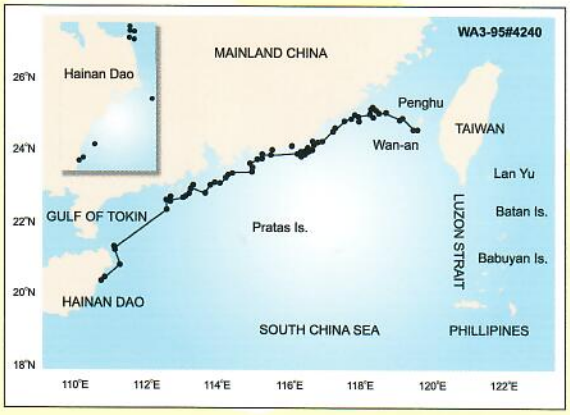
The average clutch size ranged from 80 to 120 eggs.

After 60 days of incubation, the hatchlings emerge from the nest. Because the embryo needs to exchange air and absorb water from the substratum media through numerous amorphous pores in the shell, the hatching condition is influenced by the air temperature and the amount of precipitation during the incubation period. Similar to some other reptiles, the sex of the hatchling is determined by the sand

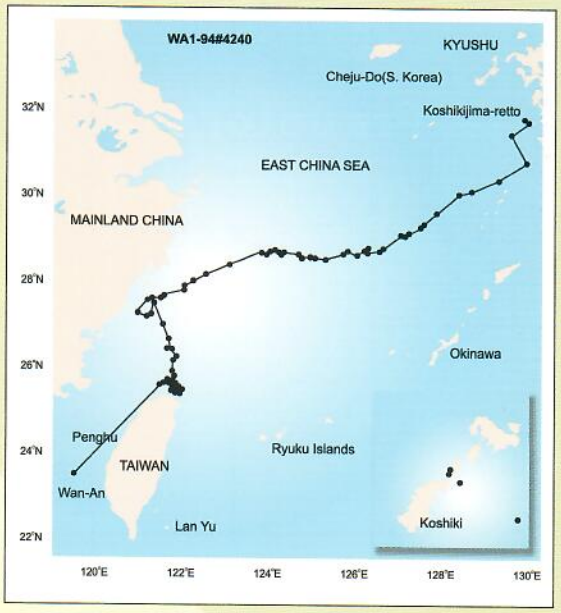
temperature during the first third of the incubation period. According to the literature, when the incubation temperature rises above 30.3°C, the hatchlings are all female. However, when the incubation temperature drops below 28°C, all the hatchlings are male. Only when the incubation falls between these two extremes does the hatching contain both sexes. The size of the hatchling is about 4 to 5 cm in straight carapace length, smaller than the size of an adult human palm. The color of the dorsal carapace is dark blue, with the margin and the ventral carapace being white. Most hatchlings hatch within the same time period. It takes about 3 to 7 days to emerge from the nest. In order to avoid predators, the hatchlings usually emerge when the temperature is lowest, during the very early morning hours, crawling quickly towards the bright ocean. Once they reach the edge of the water, they follow the sound of the breaking waves and rush into the ocean. They swim vigorously in an offshore direction for at least 24 hours so as to decrease the chance of being caught by predators in the nearshore waters.

Hatchlings emerged
from the nest simultaneously.

Until recently no one has ever found hatchlings after they enter the waters of the ocean before they re-appear in the coastal waters. By that time they have a carapace length of 20 to 30 cm. In the past with limited technologies, no one really knew where they went during this period. Thus, the term"the lost years" was used to describe the green turtle's early life history. However, recently, with more advanced technologies in navigation and oceanography, researchers found that the green turtle hatchlings live beneath the floating Sargassum and feed on plankton. However, we are still not quite sure how they get there. Maybe they drift with the surface currents, or... There are still many questions that remain unanswered.



Satellite telemetry showed that after the nesting season, the green turtle migrated southwest and arrived at Hainan Dao.



Satellite telemetry showed that after the green turtle finished her nesting season on Wan-an Island, she migrated northward and reached the nearshore waters of Southern Kyushu.

As mentioned above, the hatchlings spend their early lives in the open ocean, under floating masses of Sargassum (a brown algae), and do not return to the coastal waters until they are 20 to 30 cm in carapace length. Afterwards, they will select areas rich in macroalgae or seaweeds to settle, and switch from a planktonic to a benthic life style. Because many seaweed or macroalgae pastures are located near coral reefs, they can be easily found there. Green turtles may stay in one area until they mature, or they may move to a different area at a different age. No matter what life style they choose, they will return to their birthplace to nest and produce the next generation. The mature size of a green turtle is at least 80 to 90 cm in carapace length.

IV. Predators of the Green Turtles

Their large size, hard shell and fast swimming speed, allows the green turtles to be free from most predators except some sharks and human beings. An encounter with a shark may result in the loss of a flipper or may leave some bite marks, but it is rarely seen.

Hatchlings, however, have many more predators. On land, many predators wander around on the nesting beaches, such as livestock, sand crabs, raccoons, fire ants, snakes, raptors, and of course humans. In the ocean, various carnivorous fishes, such as shark and marlins are the major predators. Since they have no

A hatchling is emerging from the shell.

defense with soft shell and relative slow speed, the hatchlings are easy prey. As a result the mortality of the green turtle is highest in the first year of their life. It is estimated that only one in a thousand hatchlings survives into adulthood.

In addition, the poaching and collection of hatchlings, sand mining for various purposes turns the sandy beaches into gravel beaches, resulting in a loss of nesting sites for gravid females , and the inability of hatchlings to cross the large gravel stones after their emerge. The light pollution from nearby street lights and houses close to the nesting beaches will also attract the hatchlings, resulting in disorientation and misorientation and failure to find their way back to the sea. They will die from lack of food, or by being food for predators. All of these unnatural disturbances will further increase the mortality rate of the hatchlings and makes the possibility of the survival of the green turtle that much more difficult.

Natural predator of the green turtle hatchling -- sand crab.

V. Hometown of the Green Turtles

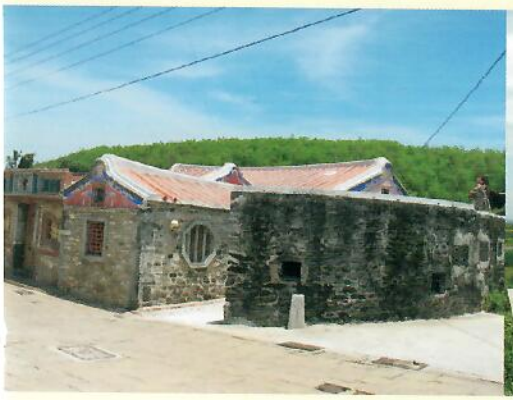
i. Wan-an Island and its natural resources

Originally Wan-an Island was called "Ba-Jau", a local dialect meaning "covers 8 ", because on a sunny day one could see the 8 nearby islands, allowing the government to keep an eye on them all . The island changed name in the 16th century, when a navy commander saw the island from a distance. Somehow looking at the island made him feel comfortable and at ease and it made him regain his confidence for the next battle. Thus he renamed the island " Wan-an ", meaning " *feeling comfortable just by looking at.* "

Wan-an Island is located in the southern Penghu Archipelago. It lies between Makung and Chiemei Island, and is about 18 miles from Makung and 11 miles from Chiemei. Wan-an is the fourth largest island of the Penghu Archipelago. The island is about 4 km long and 1.8 km wide. It has an area of about 7.17 square kilometers.

Wan-an Island being situated south of the Tropic of Cancer (23°22'N, 119°30'E),

has a subtropical climate. Due to its special geomorphology and being modulated by the ocean, the summers (June till September) are influenced mainly by the southwest monsoons. The average air temperature is about 27°C.

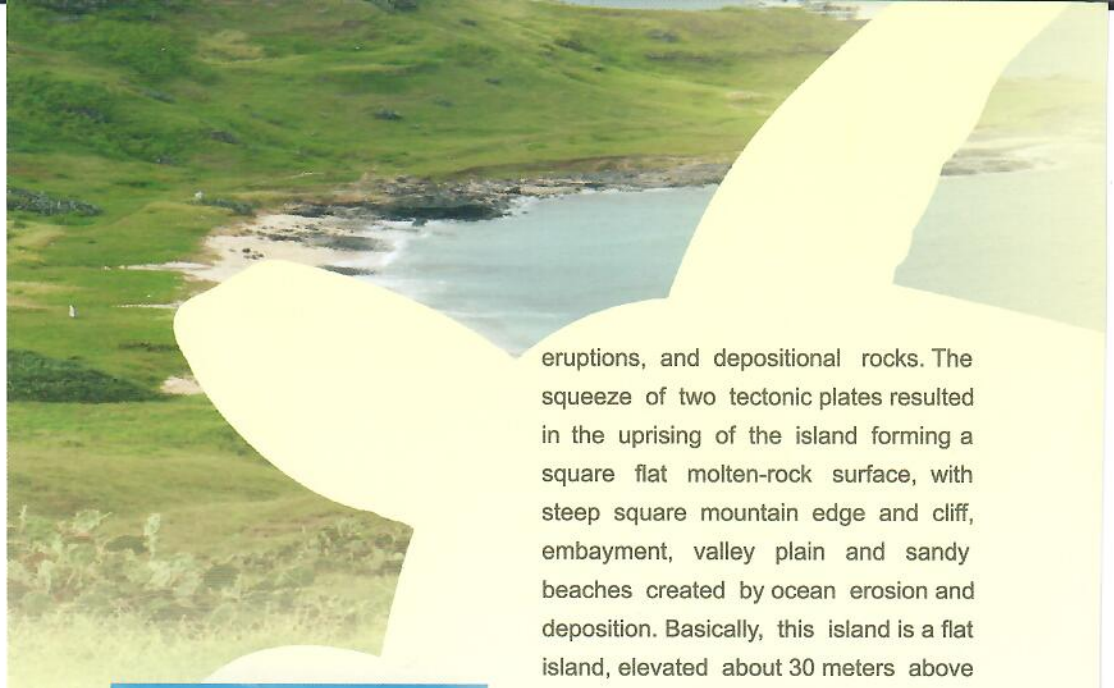


The traditional stone house on Wan-an Island

Summer scenery on Wan-an Island.

In spite of the influence in the winter from the cold fronts from Siberia, the ocean modulation results in mild winters. The average air temperature in the winter is 17°C. The average annual air temperature on Wan-an Island is 22°C, and the average annual precipitation is 14 mm.

Because Wan-an Island is a volcanic island, the substratum is composed mainly of basaltic rock from volcanic



eruptions, and depositional rocks. The squeeze of two tectonic plates resulted in the uprising of the island forming a square flat molten-rock surface, with steep square mountain edge and cliff, embayment, valley plain and sandy beaches created by ocean erosion and deposition. Basically, this island is a flat island, elevated about 30 meters above sea level. The highest point on the island, Heavenly Gate Mountain, is only 54.2 m. The coastline of Wan-an Island consists mainly of a rocky coast formed from basaltic rock. On top of these basaltic rocks are thousands of meters long sandy beaches made from fine quartz sand and fine debris from shells and the coral reefs. These beaches make perfect nesting sites for the green turtles. In addition there are extensive rock outcroppings between some of the beaches and the ocean, allowing the turtles to reach these beaches only during high tide.

Look far into the distance of one nesting beach on Wan-an Island--Tan-Ta-San Beach.

Traditional stone fishing trap on Wan-an Island.

ii. The fauna and flora on Wan-an Island

In addition to the endangered green turtle, there are also the unique land crab (*"Cardisoma carnifex"*) to be found

on the island. Other important fauna include grey heron, oriental skylark, green stink snake, grass hopper, various insects, terns, and fishes, mollusks such as bivalves, squids, crustaceans, corals, other invertebrates such as sponges and crustaceans such as hermit crab, planktons. The biodiversity is very high.

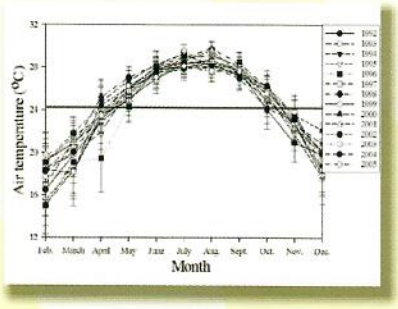
The main flora on Wan-an Island includes Polynesian iron wood (*Casuarina equisetifolia* Forst.), Scaevola (*Scaevola sericea* Vahl.), white popinac (*Leucaena leucocephala*), linden hibiscus (*Hibiscus tiliaceus*), white oleander (*Nerrium indicum* Mill.), *Aloe vera chinensis*, pandanus odortissimus (*L.f.var. sinensis* 《 Warb.》 Kanehira) , tequila (*Agave americana* L), Chinese banyan (*Ficus Reusa* Linn.). Common introduced flora includes *Terminalia catappa*, *Clerodendrum inerme* (L.) Gaertn. papaya, rose-ring gaillardia (*Gaillardia pulchella* Foug), *Wedeliatrilobata*, On the beaches you can find *Ipomoea pescaprae* (L.) Sweet. In the ocean, there exist various planktonic and benthic microalgae and macroalgae as well as seaweeds.

The traditional cow wagon still exists on Wan-an Island

VI. The Nesting Characters of the Green Turtles

I. Distribution of the nesting sites

The nest sites of the green turtles are distributed mainly throughout the regions where the water temperature remains above 25°C. In the other words, their nesting sites are for the most part distributed throughout the tropics and subtropics, and they rarely occur in the temperate regions. In Taiwan and nearby islands, the nesting sites of the green turtles are located mainly in the east, northeast and south of mainland Taiwan, the Penghu Archipelago, Kinmen Island, Lanyu Island, Dongsha Island and the Nansha Archipelagos. However, due to the human harvesting, death by accidental ingestion of artificial debris or garbage, caught in abandoned fishing nets, wounded or killed due to the accidental captures, sickness due to the marine pollution, alterations in their marine and terrestrial habitats areas as a result of human interference, insufficient hatchlings due to mass poaching, all results in the decline of the sea turtle populations. Most of their



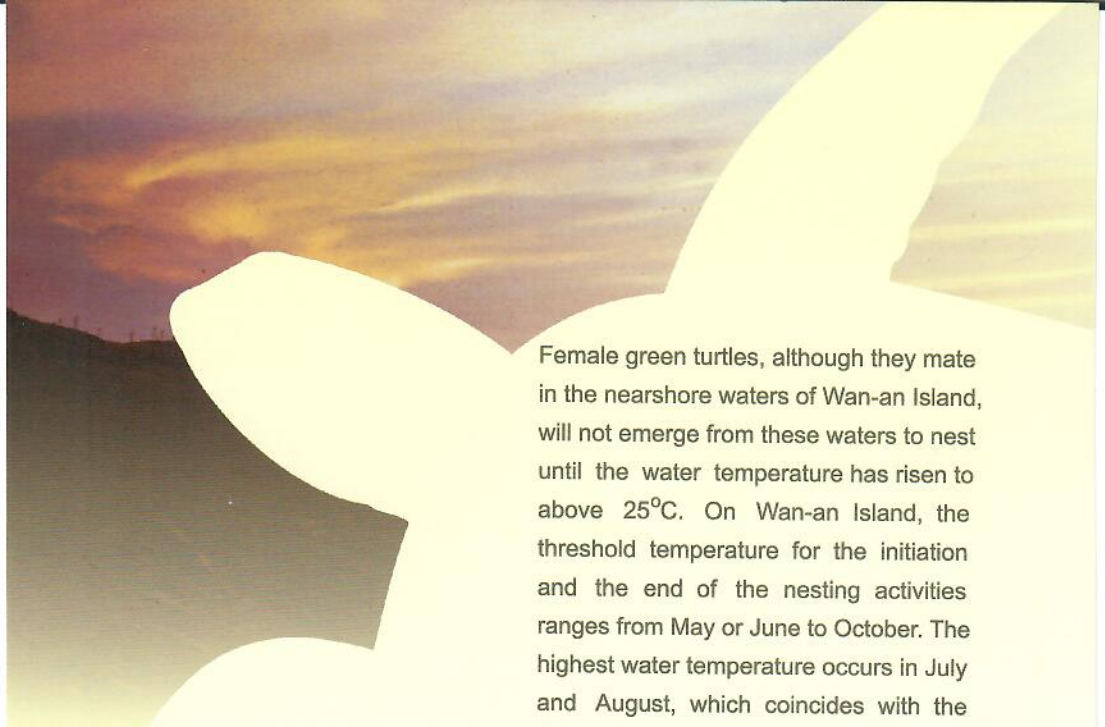
Monthly air temperature from 1992 till 2005. The green turtles initial their nesting seasons when the temperature rises above 24°C.

nesting sites have disappeared in the last few decades. Only a few places on the offshore islands, such as the Penghu Archipelago, Lanyu Island in Taitung County, and the Nansha Archipelago remain as a nesting site for sea turtles, and the only known species to nest here is the green turtle.

ii. The necessary conditions for nesting

If sea turtles have access to a suitable beach environment, it will not only enable them to construct their nests successfully, but it also will increase the hatching rate. However, in order to achieve this goal, the following conditions must be met, and they are : the sand of the beach must have the correct grain size and the right compactness, suitable water content, the sand layer must be of a sufficient thickness, the sand and air temperature must be within certain criteria, and the amount of human disturbance must be kept to zero, or at least very low.

The gravid female was searching for the nest site on Wan-an Island.



Female green turtles, although they mate in the nearshore waters of Wan-an Island, will not emerge from these waters to nest until the water temperature has risen to above 25°C. On Wan-an Island, the threshold temperature for the initiation and the end of the nesting activities ranges from May or June to October. The highest water temperature occurs in July and August, which coincides with the peak of their nesting season.

The onset of Northeast monsoon in September decreases the water temperature. As a result the females finish their nesting activities and leave Wan-an Island to migrate to their overwintering / feeding ground.

On the nesting beaches, the gravid females climb over the first slope after they emerge from the water, and search for a nesting site on the beach/grass interface or grass zone. The physical characteristics of the beaches determine whether the females can construct their nests successfully or not. Among all characters, grain size, compactness, thickness of sand layer, and pore water

content, are the most important influential factors. When the beach contains too much coarse sands or gravels, the gravid females may abandon these sites because they fail to dig through it. When the particles are too fine or the vegetation coverage is too dense, despite being able to create a body pit, the female turtles may abandon these sites also because they cannot dig deep enough. When the sand layer is too thin, female cannot also dig enough depth. When the pore water content is too low, female will abandon this site because the pits will collapse too easily.

Sunset on Wan-an Island.

A suitable nesting site must,

(i) have sand with a grain size that ranges from moderately fine to very coarse (i.e. sand particles with a mean diameter of 0.2 to 1.0 mm). Generally speaking, the nesting environment ranges from fine to coarse sands composed of debris derived from coral reefs and shells. The suitable grain size helps to maintain the proper substratum compactness.

(ii) The sand layer should be at least 50 to 60 cm in depth so as to reduce the influence of the weather during the embryogenesis. This will increase the hatching success.

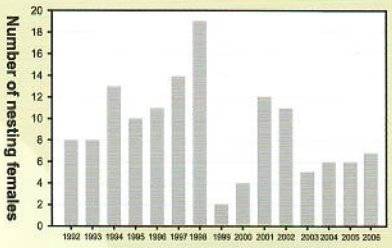
(iii) The pore water content should range between 2% to 17%.

The nesting beach on Wan-an Island.

On Wan-an Island in the Penghu Archipelago, the sand layer of the nesting beaches for green turtles is at least 1m deep. The sand is mainly composed of quartz and debris from coral reefs and shells. The sand characteristics are moderate to well sorted coarse sands (mean grain size ranges from 0.61 to 1.01 mm). Thus, except for a few sites where there are some rocky outcroppings or

where the sand layer is too thin, the sand beaches on Wan-an Island provide good nesting grounds for green turtles.

Despite these good conditions, green turtles will not nest on all beaches. Most of them will nest only in areas where human activities are low. This is because the sea turtle is a very shy animal, and sensitive to human disturbance. As a result they will not come to beaches that are near a village and that are frequently accessed by human beings. This is one more reason why it is critical that we maintain the original characteristics of the nesting beaches. The best rule is : no building of artificial structures, no disturbances of any kind, in order to avoid damaging the nesting beaches.



The number of nesting females on Wan-an Island from 1992 till 2006.

iii. Nesting behavior of the green turtles

Mature male and female green turtles will aggregate in the nearshore waters of Wan-an Island to mate during March and April each year. Females emerge to nest in May or June when the water temperature has risen to above 25°C.

The nesting tracks on the beaches of Wan-an Island.

Although the female turtles are excellent swimmers in the ocean, they are slow and cumbersome on land. They also have no way to defend themselves. Thus, they are easily attacked by predators when they are on the beach. Female turtles usually emerge to nest on remote beaches away from the human in middle of the night. There are fairly large rock outcroppings on several nesting beaches. Most females only emerge during high tide. Based on the studies, the female turtles can climb over most beaches on Wan-an Island, except for a few places where the beach slope is too steep (the angle is more than 30°C), and the females failed to climb over and returned to the sea. However, most females still select their nest sites on remote beaches as far away as possible from human activities.

The female turtle remains in the water and observes the beach for a while before emerging. She is very sensitive and aware during that time. Any activities from large creatures, such as humans or large animals will scare her away, and she will not come ashore. Only after she

feels there is no threat on the beach will she emerge. Most females will start searching for a nest site after they reach the vegetation line. Very few females start digging body pits before reaching the foreshore.

After walking around for about 20 to 30 minutes to search for a possible nest site. Research has shown that the turtle prepares to make a nest by first removing the debris from the potential nest site. After the area has been chosen, the female will use her front flippers to dig a body pit (so called the "big hole"). This takes about 10 to 30 minutes. Then the female will use her rear flippers to dig a 70 cm deep and 50 to 60 cm wide nest chamber (so called "small hole"). The female is still very alert at this stage and extremely sensitive and any disturbance will discourage her from finishing the nesting activities and she'll return to the sea. The nesting activities can also be hampered by the collapse of the nest chamber due to low pore water content. Or, the nest chamber may be too shallow because there are large stones in the gravels, or plastic or other foreign

The nesting beach on Wan-an Island.

The night falls, and the green turtles are ready to emerge on the beach.

A nesting green turtle is digging the body pit.

A researcher is reading the PIT tag number from a nesting green turtle.

materials, or the sand layer is too thin. Sometimes, the female will abandon the body pit without any explainable reason. All these activities will leave several bombed-shape body pits on the beach. Providing the turtles are not disturbed, they usually crawl around on the beach for a while, keep on digging or search for another suitable nest site. On Wan-an Island, one turtle was found to have spent at least 7 to 8 hours to dig 11 pits without laying any clutch. She emerged again the second night, this time to finish her job.

However, if the turtle returns to the sea because of a disturbance, she will stay in the water at least a day before she'll emerge again. In the worst case scenario she may move to another beach or a different island to nest.

A female turtle needs 20 to 60 minutes to construct her nest chamber. After completing the construction of the nest chamber, she will spend 10 to 15 minutes

to lay about 100 pin-pong ball shaped leathery eggs. During the egg-laying period the female falls into a semi-sleeping state due to hormonal changes. The disturbances will force the turtle to abandon her nesting activities and return to sea.

The turtle egg is about the size of a pin-pong ball.

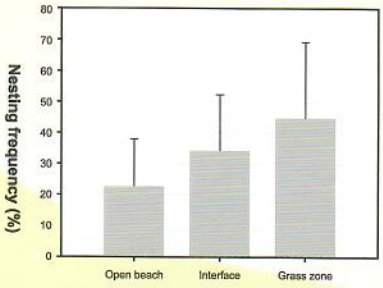
After a female has finished her nesting activities, she will spend 5 to 10 minutes to cover up the nest with her rear flippers. Then, she will spend about 1 to 2 hours throwing sand backwards to cover the nest as she moves forward towards the sea. This will form a crescent-shape nest cover. The female wakes up gradually and increase her sensitivity. Because the fluctuation in temperature will be dampened with the increase in sand depth, the turtle's sand covering activities will increase the nest depth and will provide the eggs with a relatively stable incubation environment. After this stage, the female turtle is exhausted and climbs straight back to the ocean. She will return to lay another clutch of eggs approximately two weeks later.

After laying her nest, exhausted female climbed back to sea, and wait for two weeks to emerge again for another nest.
(courtesy of Information Office, R.O.C.)

A green turtle is laying her eggs.

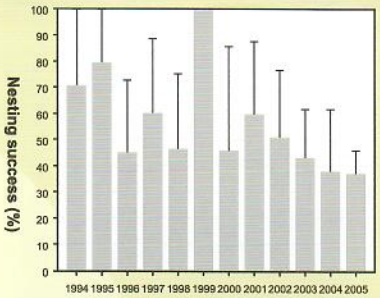
Research indicates that most nests on Wan-an Island are distributed in the interface zone, followed by the grass zone, with very few on the open beach. This may be related to the fact that in the vegetation zone, the grass roots stabilizes the sand layer. This allows the females to construct their nests relatively easily. On the open beach, the low water content in the sand layer may cause the chamber to collapse more easily during the nest construction. This suggest that the protection measures of the nesting green turtles that are in effect presently should not only include minimizing the

The green turtles left bomb-shape body pits on the nesting beach.



The average nest site distribution in different zones on the nesting beaches from 1992 till 2005.
Data suggests that the green turtles preferred to nest where the vegetation exist.

disturbance of the nesting female, but should also include maintaining the original geomorphologic characters of the beach. None of the vegetation should be allowed to be removed. Any permanent artificial building, such as bath / toilet combination, should be banned on the nesting beaches in order to prevent loss of beach areas. Any artificial illumination such as street lights on these beaches and any flashlights on the beaches should also be banned or minimized so as not to frighten the nesting females.



The nesting success from 1994 till 2005 on Wan-an Island.

iv. Hatching of the baby turtles and their trip to the sea

Baby turtles hatch after 50 days of incubation. The hatchling uses its piping tooth, the hard spot on the front of it beak, to break through the egg shell. This tooth will fall off after the hatchling is released from the egg. Most hatchlings in the same nest hatch simultaneously, and they work together to climb out of their nest. During the ascending phase, sand from above falls into the empty shells, and forms a ladder for the hatchling to climb out of

A hatchling is emerging from the nest.

the nest. Meanwhile, shallow pits were formed on the surface above the nest, suggests that the hatchling is ready to emerge from the nest. The hatchlings emerge within 3 to 7 days after hatching. In order to avoid high temperature and predation, hatchlings usually emerge just before dawn, when the sand temperature is at its lowest.

Emerged hatchlings
climb their best towards the sea

After emerging the hatchlings crawl towards the ocean based on three environmental characters : first it the brightest horizon, second it is down slope, and third is its dark silhouette. Because the female turtle will select her nest site in a remote location of the beach, the ocean will look brighter than the land. To the hatchling, climbing towards the brightest direction means traveling to the ocean. Also, because the nests are deposited on the beach above the ocean, climbing in the down slope direction means that this is the road to home (i.e. ocean). The dark silhouettes on a beach represent forest or sand dunes on the back of the beach. Thus, the hatchlings

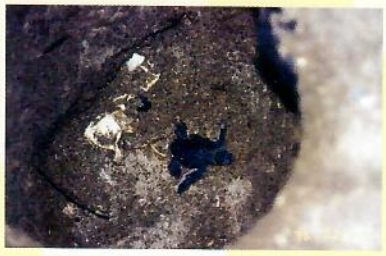
avoids going towards dark silhouettes. After they reach the water line, they run directly into the waves. Hatchlings seem to know instinctively that their best chance to avoid predators and reach the deep ocean as soon as possible is to swim rigorously and continuously for one to two days. When they reach the deep ocean, they will drift with the surface currents and reach their nursery grounds in the middle of the ocean.

Because the hatchlings have a positive phototaxis characteristic, avoid dark silhouettes and climb down slope after emergence, we must be very careful that we :

(i) do not use flash lights on their beaches. We should decrease the number of street lights close to their beaches, or turn the light direction away from the beach, or use low pressure sodium yellow light, or eliminate streetlights close to their nesting beaches altogether. This will prevent the gravid females from being frightened away, and prevent the hatchlings from becoming disorientated or misorientated on their way to the sea.

(ii) Do not litter or construct permanent structures of any kind on the beach, especially not things like cement walkways, and under no circumstance drive vehicles on the beach. This will prevent hatchlings being blocked on their way to the sea by these artificial " obstacles " or being killed by a vehicle driving over them.

Researcher examining the hatchling.



The hatchlings that fail to emerge from the nest.

Hatchlings are attacked by many predators on their short trip to the ocean. In addition to poaching, animals on the beach, such as sand crabs, green stink snakes, raccoons, raptors, ants, even the livestock from nearby villages will also attack the hatchlings. In the ocean, many carnivorous fishes wait in the nearshore waters for the big hatchling festival. Because hatchlings have no defense ability, their shells are soft, and they move slowly, they usually enter the ocean in the dark night. Even so, the mortality rate of the hatchling is still very high.

On Wan-an Island, the establishment of a protected area has decreased poaching to a minimum. On the beaches, except for sand crabs, the natural predators of the hatchlings are rare. Even though there are sea birds sanctuary islands (the Cat Islands) located nearby, not a single attack from sea birds has ever been recorded. The percentage of sand crab predation is also not very high. Thus, the major predators of the hatchlings produced from Wan-an Island should be the carnivorous fishes.

Natural predator of the green turtle hatchling -- sand crab.

The predator of the hatchling-- green stink snake.

VII. Threats to the Green Turtles

The main reason why green turtles have become an endangered species is due to the actions from human beings. In spite of the increasing awareness of the need for sea turtle conservation, the green turtles have not escaped from the threat of being in danger of extinction. These threats include:

i. Human slaughter

for meat to produce " turtle soup " to sell for profit, and the consumption of their eggs. Chinese medicine uses the bond, ventral carapace, blood, flippers, liver, stomach, bile and eggs of the green turtle. They are used to make lucky ornaments, decorations (such as pen pot), eyeglass frames, jewelry (such as ring), combs, musical instruments etc. In addition, turtle skins are used for making purses or shoes.

Mass slaughtering of sea turtle is one of the major causes for the extinction of sea turtle population. (Courtesy of P. Pritchard)

ii. Fisheries bycatches,

such as the accidental capture by gill nets, setnets, trawlers (especially the shrimp trawlers). Bycatches causes

On Wan-an Island, the establishment of a protected area has decreased poaching to a minimum. On the beaches, except for sand crabs, the natural predators of the hatchlings are rare. Even though there are sea birds sanctuary islands (the Cat Islands) located nearby, not a single attack from sea birds has ever been recorded. The percentage of sand crab predation is also not very high. Thus, the major predators of the hatchlings produced from Wan-an Island should be the carnivorous fishes.

Natural predator of the green turtle hatchling -- sand crab.

The predator of the hatchling-- green stink snake.

wounded animals, excessive shock, suffocation, physiological malfunction and relevant survival problems. Many fishermen cut the turtle's head off to decrease net repair costs, or to keep for human consumption. The bycatch on the feeding and breeding grounds causes mass reductions of the turtle populations. The fate of the bycatch turtles are: being slaughtered, released to temples where they are reared for religious purposes. In the temples turtles are treated inhumanely, and are kept in very poor captive environments. "Religious release" of turtles is equal to a death sentence for the turtle. Often money is involved, and the problem becomes even worse...

A stranded sea turtle by the discarded fishing net. (Courtesy of D. Allen)

iii. Destruction of habitat,

(i) destruction of their terrestrial habitat. This includes,

a. sand mining of the nesting beaches for such purposes as house and road constructions. This causes loss of nesting habitats.

Sand mining in the protected area is an illegal behavior.

b. The construction of buildings on or by the nesting beaches, such as public facilities like dykes, walkways and washroom facilities. These structures decrease the size of the nesting beaches and block the routes of the hatchlings to the sea.

c. Human activities on or near the nesting beaches, such as campfires on the beach, direct illumination on the beach from street lights, airport, harbor, etc. all will create light pollution for the sea turtles, and direct or indirect disturbance (such as riding the turtles, poaching, driving and boating activities) which frightens the nesting female and causes the hatchlings to lost their way home.

d. Garbage, large amounts of littering, and livestock from nearby villages such as dogs and pigs also influences the ability / willingness of the gravid females to find a nest site, and it decreases the chances of the hatchlings to return to the sea. Livestock are known to dig up the nests and attack the hatchlings.

The construction of bathroom-toilet combination not only increase the beach erosion, but block the entrance of the tourists to the beach, results in more beach erosion.

Dynamite and poisoning fishing are illegal fishing methods, destroy the nearshore marine ecosystem. (courtesy of Information Office, R.O.C.)

(ii)Destruction of the marine habitats.

This includes

a. The use of dynamite and electric fishing may kill or wound the turtles, while the use of poison will destroy the food source of the sea turtles and threaten their survival.

b. The use of illegal fishing gears and methods, such as the chain-roller bottom trawlers, destroying critical marine habitats such as coral reefs.

c. Abandoned fishing nets and ropes, causing turtles to trapped in the nets or srope where they are stranded and die.

d. Unregulated marine dumping, destroying the important growth and reproductive nearshore habitats of the sea turtles.

e. Uncontrolled dumping of garbage and discharge of polluted waters into the ocean.They cause marine pollution, destroy the integrity of the marine ecosystem, and cause incurable diseases of sea turtles such as fibropapilloma. In addition there is death caused by ingestion of indigestible garbage, such as plastic materials.

Sea turtle starve to death by ingest the plastic materials, because it cannot egests them.

Littering not only damage the coastal ecosystem but bite off their own heads.

VIII. Wan-an Green Sea Turtle Tourism and Conservation Center

The " Wan-an Green Sea Turtle Tourism and Conservation Center " was constructed in response to the ever increasing tourists visiting Wan-an Island since the establishment of the protected area in 1995. The sea turtles give the island a unique character. In order to promote conservation to the tourists, researchers and local residents strongly recommend the construction of this center as a site for ecological and environmental education for the tourists.

Sea turtle ecotourism activities.

A meeting was held in the Wan-an County Office on September 24, 1998 where it was decided that the Tourism Bureau of the Transportation Department, Penghu National Scenic Area Administration would be responsible for the construction of the " Wan-an Green Sea Turtle Tourism and Conservation Center ". The building was constructed in 2002.

It is located north of Tan-mon Harbor on Wan-an Island. The center is a 2-story building, and occupies 3.8 acres. The exhibit areas include a sea bird introductory area, green sea turtle display area, a display area for the fauna of the southern part of the Penghu Archipelago, as well as a display area of the geological and mineral resources. The research and administrative units are located on each side. The center not only provides tourism information, but facilitates conservation research and promotes education on conservation.

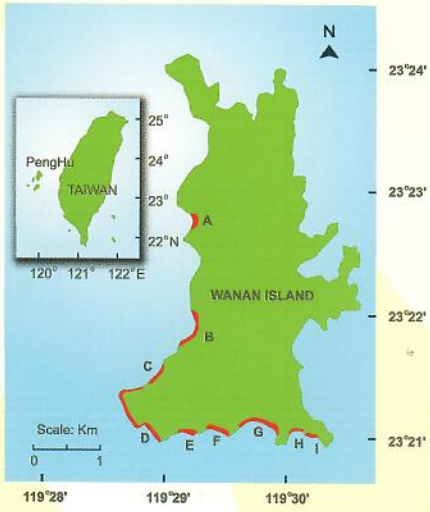
This center combines such multiple functions as tourism, conservation, research and management, with the intention of fulfilling the goals of both conservation and tourism.

Green Sea Turtle Tourism and Conservation Center on Wan-an Island.

IX. Conservation Practices for the Green Turtles

In order to protect the nesting habitat of the green turtles, the Penghu County Government declared the nesting beaches on the island as protected areas on January 17, 1995. The law prohibits entering the protected area without permission during the green turtle nesting season.

The nesting beaches on Wan-an Island has been declared as the protected area since 1995.



Map of Wan-an Island, Penghu Archipelago, with nesting beaches labeled from A to I .

Protected site	Area (acre)
A. Beach and vegetation sites south of Tan-Ta-San (A1)	0.75
B. Beach and vegetation sites east of She-An Dam (A2)	3.4691
C. Beach and vegetation sites south of Tu-De Temple (A3) (from Tu-De Temple vie Da-La-Ja, Chuan-La-Ja. till Je-Be-Wai)	12.4141
D. Beach and vegetation sites south of Sha-La-Ja (A4) (from Be-Wei till west of Middle Temple)	3.996
E. Beach and vegetation sites east of Wan-an-Kuo (A5) (from Don-an Community Center till Hu-To-Jew)	1.24
F. Beach and vegetation sites south of Wan-Shan Temple (A6)	1.4591
Total area	23.3283
Note: for the protected range, please refer the island map	

Size of green turtle protected sites on Wan-an Island, Penghu Archipelago

Green turtles are an endangered species. Therefore, it is necessary to take proper conservation and rehabilitation measures to sustain their nesting populations. In addition to declaring the important nesting and nearshore habitats as protected areas which will provide the nesting females and hatchlings with proper legislative protection, we should also promote a long-term ecological research project to further and strengthen the study on the nesting ecology of sea turtles. Because sea turtles are a long-lived species and do not nest annually, establishing a long-term project appears to be very important. It will help us to understand the long-term trend of the nesting population, and provide early identification of any positive or negative factors that may influence the green turtles, allowing us to take the appropriate actions in a timely fashion.

Date	Time
Lunar Calender 1st day and 16th day of the month	9 pm. till 3 am. next day
Lunar Calender 2nd day and 17th day of the month	10 pm. till 4 am. next day
Lunar Calender 3th day and 18th day of the month	11 pm. till 5 am. next day
Lunar Calender 4th day and 19th day of the month	0 till 6 am. next day
Lunar Calender 5th day and 20th day of the month	1 till 6 am. next day
Lunar Calender 6th day and 21th day of the month	2 till 6 am. next day
Lunar Calender 7th day and 22th day of the month	7 to 9 pm. and 3 till 6 am. next day
Lunar Calender 8th day and 23th day of the month	7 to 12 pm.
Lunar Calender 9th day and 24th day of the month	7 to 12 pm.
Lunar Calender 10th day and 25th day of the month	7 to 12 pm.
Lunar Calender 11th day and 26th day of the month	7 to 12 pm.
Lunar Calender 12th day and 27th day of the month	7 pm. till 1 am. next day
Lunar Calender 13th day and 28th day of the month	8 pm. till 2 am. next day
Lunar Calender 14th day and 29th day of the month	9 pm. till 3 am. next day
Lunar Calender 15th day and 30th day of the month	10 pm. till 4 am. next day

The restricted entrance date and time of the month during the nesting seasons on Wan-an Island (calculated based on the lunar calendar).

Researches conducted on the nesting beach.

included in the curriculums of primary and middle schools compete with relevant teaching materials. We must also strengthen the involvement of conservation through various extra-curriculum activities, such as summer camps, environmental experience / education camps, ecotourism, and others. This will allow students as well as the general public to get a feel of the correct concepts of wildlife conservation and environmental protection through textbooks, and leisure activities. Conservation must start in the family, where parents and children influence each other , so that they learn together and understand the importance of how wildlife conservation and natural habitat protection not only helps with the survival of the wildlife but it also adds to the quality of the lifestyle of the entire family.

There has been a relationship between the sea turtle and Chinese culture since time immemorial. Without the green sea turtle we will have lost this part of our culture forever!

The satellite telemetry work initiated from 1994 under the cooperation of the US expert, researcher and local helper.

Local kids join the hatchling release activities in the late afternoon.

Researches conducted on the nesting beach

Sea turtle exhibit picture outside the wall of Wan-an Junior High School.

Local people worship the coin turtle offering at home for peace and prosperity.

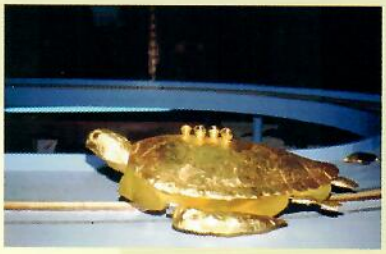
Sea turtle stone carving by the main road on Wan-an Island.

The marine habitats of the green turtles that nest at Wan-an Island are distributed throughout the continental shelves off East China, In order to protect the green sea turtle of Wan-an Island, we must not only protect their nesting beaches, we also their marine habitats. In order to accomplish that, cooperation among East Asian international agencies and researchers is urgently needed. International cooperative sea turtle research and international conservation activities including international workshops on sea turtle research and conservation, exchange of scholars and students, volunteers and the participation of regional and global conservative organizations, are all urgently needed to sustain the survival and rehabilitation of the green sea turtle population.

In the 21 Century, people must learn to coexist with nature. In order to achieve this we must encourage people to pay more attention to their environment. It is only after the whole nation, but especially the local residents, pay more attention to the integrity of their own resources and

the protection of their environment, that we can hang on to our natural resources. If we do not, we risk losing it all, forever. Education and community participation must play a pivotal role in the implementation of sea turtle conservation. Whether the green turtle can survive in the waters of Taiwan, and whether they can nest on the beaches of the Penghu Archipelago will be the touchstone of our will as a people to protect and conserve our environment and the earth we live on. Let us maintain the nesting environments of green turtles, allow them to flourish for many generations to come, so that they may stay forever on this beautiful island.

Sea Turtle Sacrifice Festival activities on Penghu County.



The golden turtle offering used in Sea Turtle Sacrifice Festival activities.

TEDs can not only reduce the sea turtle by-catchment,but not influence the shrimp yields during the fishing activities (Courtesy of NMFS, U.S.).

Sun rise on Wan-an Island.

Appendix

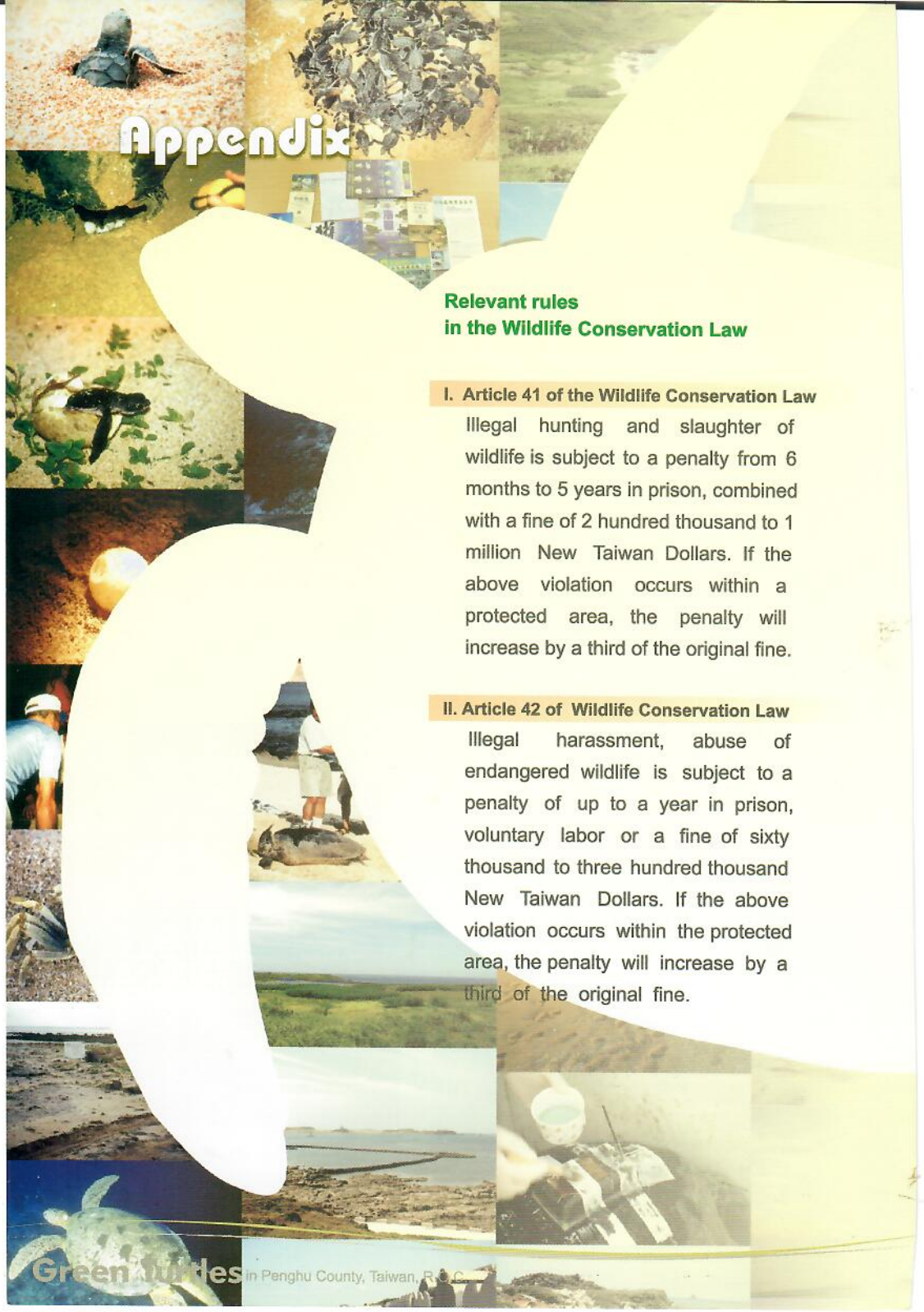
Relevant rules in the Wildlife Conservation Law

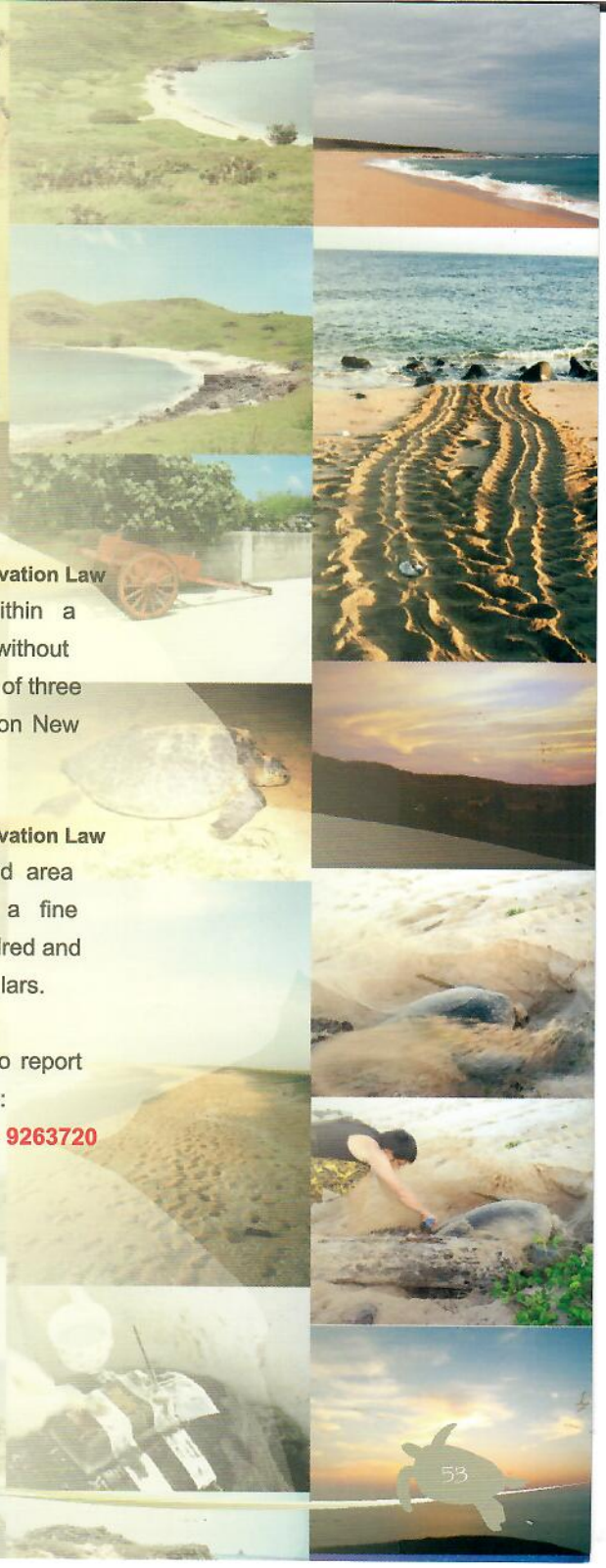
I. Article 41 of the Wildlife Conservation Law

Illegal hunting and slaughter of wildlife is subject to a penalty from 6 months to 5 years in prison, combined with a fine of 2 hundred thousand to 1 million New Taiwan Dollars. If the above violation occurs within a protected area, the penalty will increase by a third of the original fine.

II. Article 42 of Wildlife Conservation Law

Illegal harassment, abuse of endangered wildlife is subject to a penalty of up to a year in prison, voluntary labor or a fine of sixty thousand to three hundred thousand New Taiwan Dollars. If the above violation occurs within the protected area, the penalty will increase by a third of the original fine.





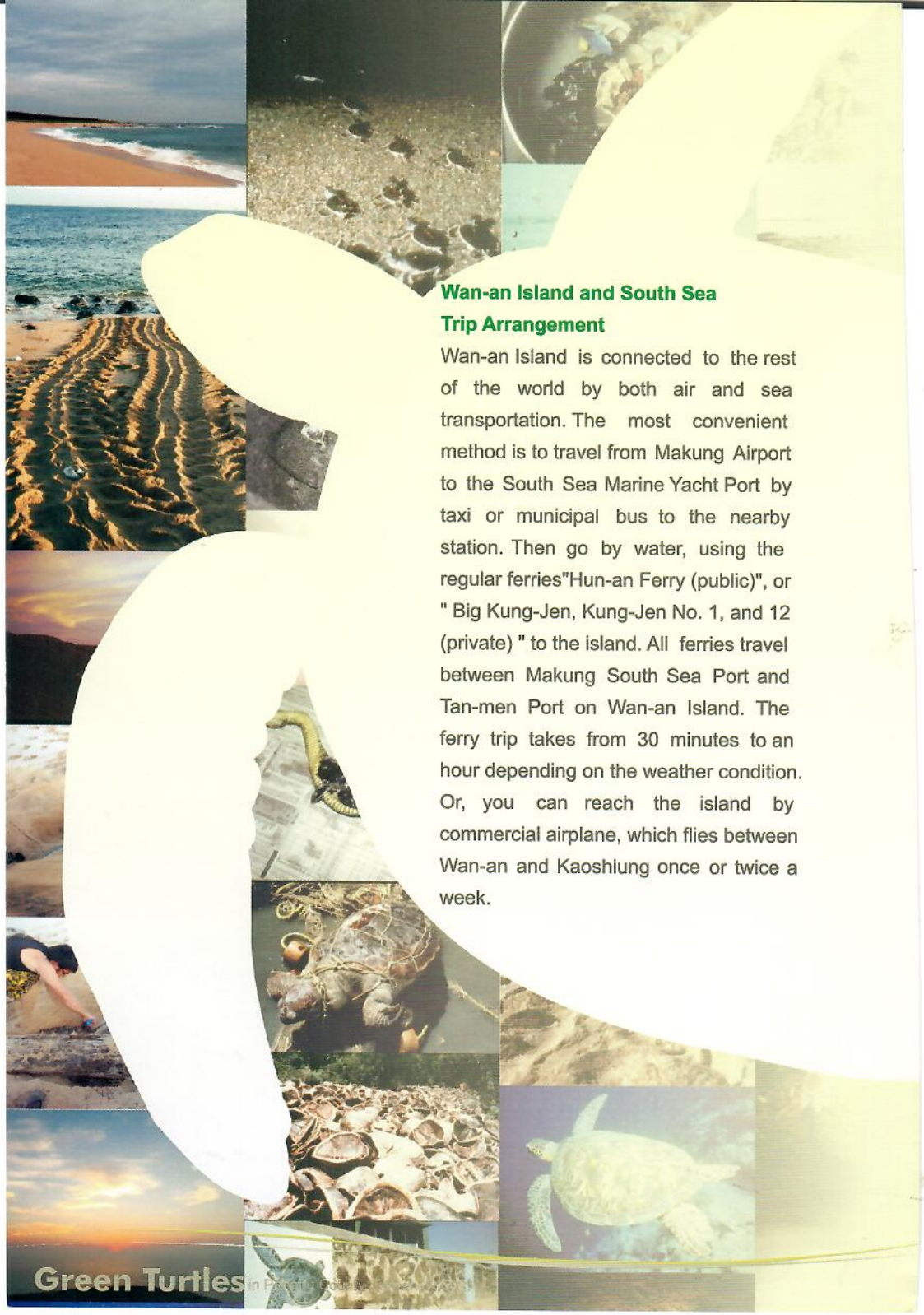
III. Article 43 of the Wildlife Conservation Law

Commercial development within a known wildlife habitat without permission is subject to a fine of three hundred thousand to 1.5 million New Taiwan Dollars.

IV. Article 50 of the Wildlife Conservation Law

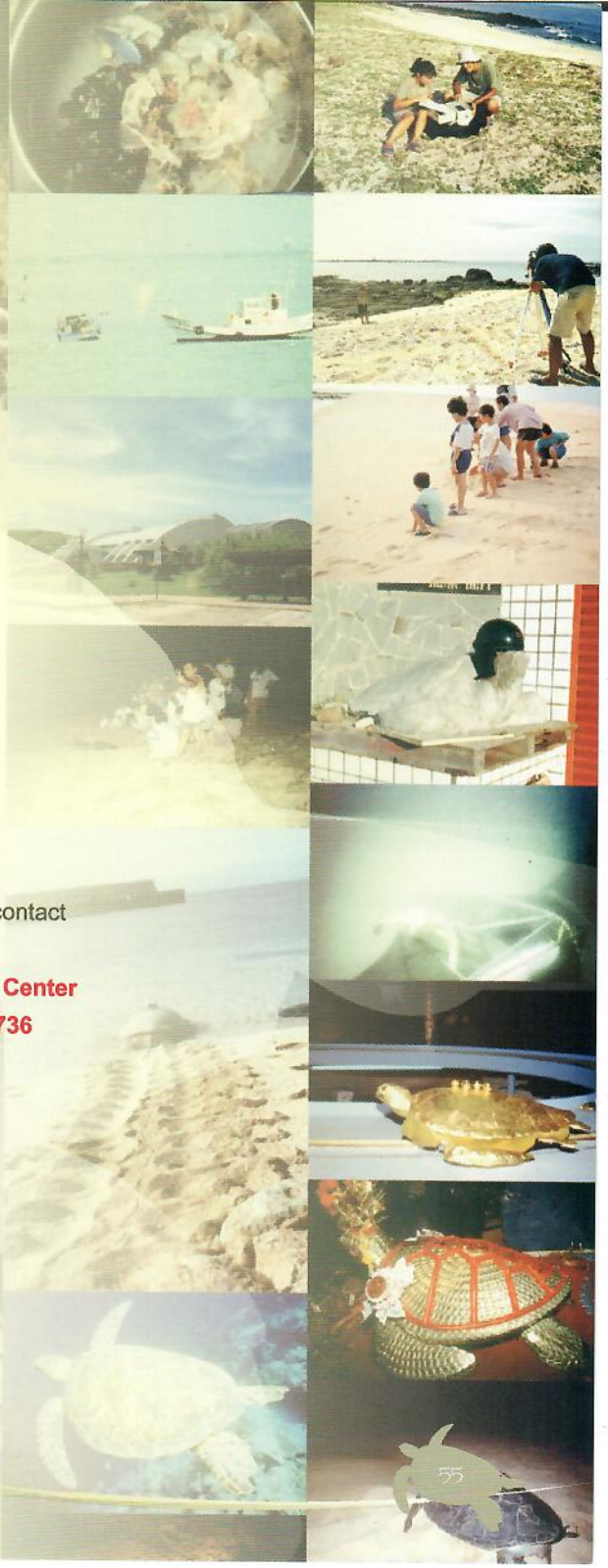
Violation any of the protected area declarations is subject to a fine of fifty thousand to two hundred and fifty thousand New Taiwan Dollars.

The dedicated phone number to report any violations to the authorities is:
+886 - 6 - 9262620, or +886 - 6 - 9263720



Wan-an Island and South Sea Trip Arrangement

Wan-an Island is connected to the rest of the world by both air and sea transportation. The most convenient method is to travel from Makung Airport to the South Sea Marine Yacht Port by taxi or municipal bus to the nearby station. Then go by water, using the regular ferries"Hun-an Ferry (public)", or " Big Kung-Jen, Kung-Jen No. 1, and 12 (private) " to the island. All ferries travel between Makung South Sea Port and Tan-men Port on Wan-an Island. The ferry trip takes from 30 minutes to an hour depending on the weather condition. Or, you can reach the island by commercial airplane, which flies between Wan-an and Kaoshiung once or twice a week.



For detailed information, please contact

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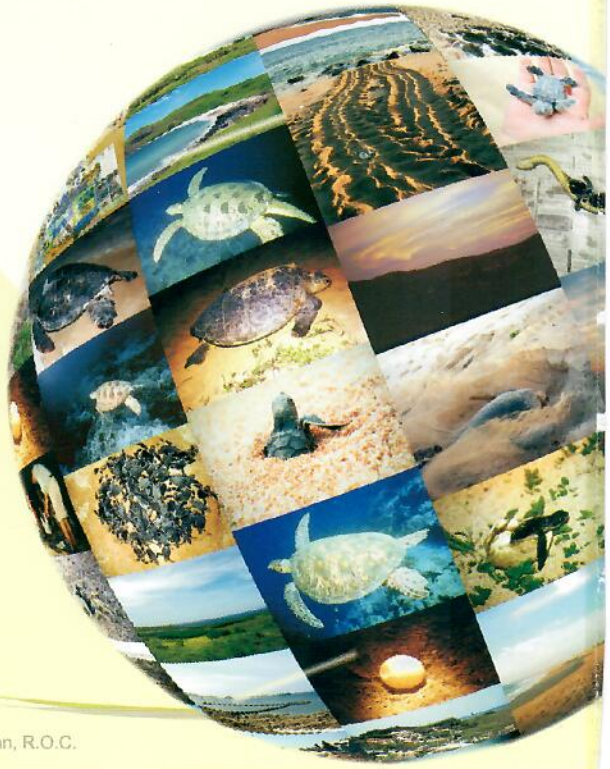

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