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Unexpected threat from conservation to endangered species: reflections from the front-line staff on sea turtle conservation

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This study described the paradox created by the efforts of a conservation organization, which caused an emerging threat to the survival of an endangered species, as well as proposed recommendations to mitigate this paradox. In-depth interviews were conducted to investigate the problems encountered during the implementation of conservation practices by green sea turtle conservation workers (volunteers) in Lanyu, Taiwan. The staff believed that the implementation of the green sea turtle conservation measures violated the traditional cultural beliefs of the local residents (Tao/Yami ethnic group), which caused resentment by the residents towards the organization. Consequently, the residents did not cooperate with the organization and even discouraged conservation activities. In addition, green sea turtle ecotourism promoted by the conservation organization in recent years violated local customs of not having contact with green sea turtles or entering their habitats.

Keywords: Tao/Yami ethnic group; cultural taboos for conservation; volunteers; economic benefits; impact of conservation stations

1. Introduction

Sea turtles are a keystone species in marine ecosystems (Stringell *et al.* 2016). Their diet includes seaweed, algae (Moran and Bjorndal 2007), sponges (Bell 2013), and jellyfish (da Silva *et al.* 2016). Sea turtles can facilitate the ecological stability of coral reefs and seabeds, as well as protect marine fish resources. Their migratory activities may promote nutrient transfer and exchange between different ecosystems (especially marine and terrestrial ecosystems) (Vander Zanden *et al.* 2012). However, sea turtles have long been classified as an endangered species because of their unique and complex lifecycle and human disturbance. In recent years, global climate change has further threatened their survival (Butt, Whiting, and Dethmers, 2016; Almpandou *et al.* 2016).

Sea turtles spend most of their lives in the ocean, but return to land, where they hatched, for egg laying. Once a year, females come ashore to lay their eggs. Nest site selection, nesting success, hatching success, hatchling emergence success, and so on depend on the nesting environment (Hays, Mazaris, and Schofield 2014; Mazaris, Matsinos, and Margaritoulis 2006). Beach width affects nest site selection (Mazaris, Matsinos, and Margaritoulis 2006). Nighttime light reduces the number of sea turtle nests (Brei, Pérez-Barahona, and Strobl 2016). Temperature affects the hatching rate of eggs and the sex ratio of the hatchlings (Hays, Mazaris, and Schofield 2014). Any change to the abovementioned habitat variables reduces sea turtle reproduction. However, sea

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turtles exhibit a high degree of habitat fidelity, which makes it difficult for them to change nesting sites in response to environmental change (Bowen and Karl 2007).

Human disturbance is the main cause of the decline in sea turtle numbers. A large number of sea turtles are captured for their meat and eggs, as well as their shells (Guebert, Barletta, and Costa 2013). Bycatch also directly endangers individual sea turtles (Senko *et al.* 2014). Habitat degradation, fragmentation, and the reduced number of turtles have affected turtle reproduction (Mazaris, Matsinos, and Pantis 2009). Artificial light sources (e.g., street lights, car lights, flashlights) have hindered the return of sea turtles to land for egg laying (Johnson, Bjørndal, and Bolten 1996). In addition, light interferes with the movement of young hatchlings towards the sea, thereby increasing their mortality rate (Johnson, Bjørndal, and Bolten 1996).

Many conservation measures have been implemented to protect green sea turtles. Ecological monitoring and observations (Grand and Beissinger 1997) have facilitated the elucidation of sea turtle community dynamics. Habitat restoration (Rumbold, Davis, and Perretta 2001) measures have been applied to improve their habitat. Nest migrations (Grand and Beissinger 1997; Pike 2008) have improved the likelihood of eggs hatching and the survival of hatchlings. The development of ecotourism for sea turtles has created economic benefits (Walter and Reimer 2011; Pegas and Stronza 2010; Wilson and Tisdell 2003; Rattan, Eagles, and Mair 2011), thereby reducing poaching of sea turtles and improving the willingness of the local community to implement conservation measures (Stacey *et al.* 2012). These conservation strategies for sea turtles have also been implemented in Taiwan.

Taiwan's sea turtle population faces a serious threat to its survival. Sea turtles have been observed laying eggs on the beaches of Taiwan's main island and on many offshore islands. However, because of excessive long-term poaching, combined with habitat destruction caused by construction projects (e.g., construction of bulwarks, ports, coastal roads), the number of sea turtles has declined sharply. Turtle nesting habitats have also been limited to a few locations. Of all the sea turtle species observed in Taiwan's coastal waters (i.e., *Chelonia mydas* (green sea turtle), *Caretta caretta* (loggerhead sea turtle), *Eretmochelys imbricata* (Hawksbill sea turtle), *Lepidochelys olivacea* (Olive ridley sea turtle), and *Dermochelys coriacea* (leatherback sea turtle)), only the green sea turtle comes ashore for egg laying. Nesting habitat is limited to the Wangan and Lanyu islands offshore from mainland Taiwan. The environments of the Wangan and Lanyu islands are different; therefore, the evolutionary paths of the green sea turtles from these two habitats also differ. Thus, the genetic structure of adult female turtles, their egg laying and diving behaviors, the physiology of egg hatching, and the size and weight of hatchlings differ between these two distinct turtle populations (Cheng 2015).

Because the green sea turtles in Lanyu Island can affect the behavioral evolution¹ of terrestrial organisms in this region, it is more important to study their evolutionary biology than that of green sea turtles in other areas. Huang *et al.* (2011) observed unique behaviors of *Oligodon formosanus* in Lanyu. Most notable is their propensity to burrow near the nests of green sea turtles to mark their territory and their unique way of ingesting eggs via a 'food can opening' approach. Furthermore, the observation of females defeating males to take possession of turtle eggs differs from the male-dominated survival mode of most organisms. Huang *et al.* (2013) and Pike *et al.* (2016) observed that green sea turtles caused the evolution of parental care behavior by *Mabuia longicaudata* in Lanyu. These studies confirm that marine organisms can affect the behavioral evolution of terrestrial organisms, and this is the first discovery of this phenomenon in Taiwan. Similar cases are rare worldwide. Therefore, this phenomenon

has important value for behavioral evolution studies of reptiles, as well as the unique ecological impacts of Lanyu green sea turtles.

Lanyu green sea turtles are affected by loss of habitat, which has led to a significant reduction in their numbers and diversity. Green sea turtles have not been observed laying eggs along Taiwan shores for a long time. To protect this endangered species in Lanyu, the Green Turtle Conservation Organization (Marine Ecology and Conservation Research Laboratory, National Taiwan Ocean University, hereafter referred to as the conservation organization) has moved to Lanyu to implement conservation measures with the assistance of the government. The conservation organization monitors the numbers and activities of green sea turtles, rescues injured turtles, and shifts turtle nests to more suitable local habitats. In addition, the organization engages in various forms of educational and promotional activities aimed at raising local awareness about the project and obtaining support from the local communities. These activities include planning and promoting green sea turtle ecotourism, training tour guides, and employing local residents to assist with ecological restoration-related projects (Cheng *et al.* 2009). This work is performed by volunteer workers recruited by the conservation organization. After recruitment, volunteers undergo a short-term training with the organization and travel to Lanyu Island to perform the assigned tasks. Their primary working hours are during the night, when the green sea turtles come to lay eggs. For the remaining time, the volunteers are free to travel around the island and engage in tourism activities.

Although the conservation organization has been promoting green sea turtle conservation in Lanyu for nearly two decades, they have not yet been able to obtain sufficient support from the local communities (Cheng 2006). They have even encountered hostile reactions (Cheng 2010). During this program, frontline green sea turtle conservation workers (i.e., volunteers, hereafter referred to as 'staff') from the conservation organization based in Lanyu were interviewed to determine conservation initiatives and their implementation process. In addition, implementation problems encountered by the staff and their interpretation of possible causes were also documented. These data were collated to clarify why effective conservation practices, which have been successfully implemented in other countries for several years, have not been effectively implemented in Taiwan and have even caused detrimental effects.

The academic contributions of this study are mainly twofold. The first is the exploration of conservation issues for green sea turtles, which have special evolutionary ecological significance. The green sea turtle is an endangered species recognized worldwide, and their populations and habitats require conservation. Although the Lanyu green sea turtle population and its habitats account for less than one-thousandth of the worldwide population (supplementary table A1 in Mazaris *et al.* (2014)), they have impacted the behavioral evolution of terrestrial organisms. Thus, they are crucial in reptile behavioral evolution. The second contribution is the analysis of the failure in successful implementation of international programs in Lanyu and the proposal of recommended changes. This was in response to the reports by Broderick *et al.* (2006) and Patrício, Diez, and van Dam (2014), who proposed the adoption of practices and standards that were consistent with regional characteristics for the conservation of the green sea turtle. Under the growing threat of climate change, the existing habitats of green sea turtle populations are valuable. Regardless of size and scale, conservation efforts for each habitat should be strengthened (Mazaris *et al.* 2014). Obstacles that are detrimental to the conservation of green sea turtles should be addressed appropriately (Almpanidou *et al.* 2016). Although this study covered few research locations and subjects, and the research location is not well known internationally, the results could

still improve planning and management of Lanyu green sea turtles (hereafter referred to as ‘green turtles’) conservation efforts. The application of conservation practices that are consistent with Lanyu’s local culture and customs could facilitate the protection of a unique green turtle population, which has facilitated the behavioral evolution of terrestrial organisms.

2. Lanyu, the Tao/Yami ethnic group, and green turtles

Lanyu Island is located off the southeastern coast of Taiwan (Figure 1). The local residents of the island belong to the Tao/Yami ethnic group. Tao/Yami’s cultural customs include the flying fish festival, Yami boats, and underground houses, which are unique to this ethnic group and distinct from other Taiwanese aboriginals. This group cultivate taro as a staple diet, and other important dietary items include coral reef and migratory fish (mainly flying fish). Their fishing methods include diving and capturing fish with spear guns (coral reef fish), use of torchlights at nighttime to attract flying fish, which are then captured with hand-held nets,² and the use of flying fish as bait to catch larger migratory fish.

The Tao/Yami ethnic group has developed a variety of taboos in their daily lives. For example, based on consumption suitability, fish are divided into three groups, ‘male fish,’ ‘female fish,’ and ‘elderly fish.’ Of these, ‘female fish’ can be eaten by everyone, whereas ‘male fish’ can only be consumed by men. ‘Elderly fish’ are only suitable for consumption by the elderly and are not suitable for consumption by younger men, women, or children. In the surrounding environment, tribal members were prohibited from accessing or disturbing local plants and animals because of evil spirits. For

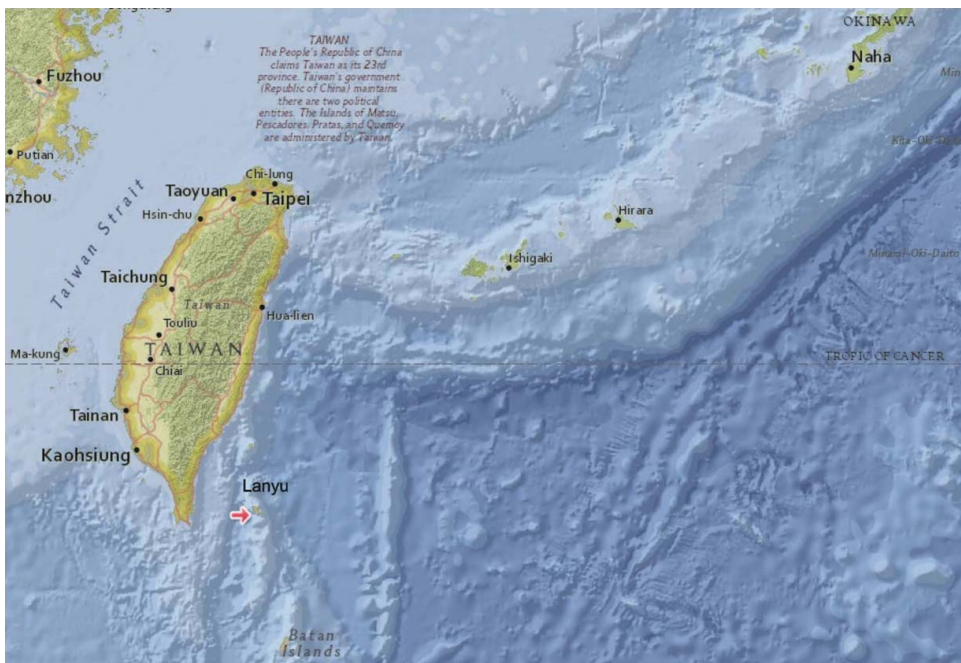


Figure 1. Location of Lanyu (Map data source: *National Geographic*, <http://mapmaker.nationalgeographic.org/g4LW2Dlp7VaqfEqN4xAoNh/>).

example, a subspecies of *Otus*, the Lanyu scops-owl, which is unique to Taiwan and whose habitat is limited to Lanyu, is regarded as the incarnation of an evil spirit. Tao/Yami tribal members are forbidden from discussing Lanyu scops-owl in their place of residence. In addition, even approaching the habitat of the Lanyu scops-owl is considered a violation of the taboo. The Magellan birdwing (*Troides magellanus*) is the largest butterfly in Taiwan and only occurs in Lanyu. The Tao/Yami people refer to it as 'pahapahad no anito' meaning the familiar, or servant, of the evil spirit. They believe that approaching the butterfly, or attempting to capture it, would lead to possession by evil spirits and provoke misfortune. The coconut crab is known as 'mipeyso' in the Tao/Yami tribal language, which means 'back away.' This name is meant to act as a warning for pregnant women and their families against ingestion of coconut crabs. If the taboo is broken, it could lead to birth difficulties, or the baby could be born with impaired mobility (Liu and Lu 2014).

Green turtles are considered evil spirits by the Tao/Yami ethnic group. The habitat of the green turtles is also located within a taboo area. Because the nesting beaches of green turtles are located close to, or overlapping, the traditional graveyard of the Tao/Yami tribe, the area is considered home to evil spirits. The nighttime flowering *Barringtonia racemosa* is regarded as the devil's tree, and *Barringtonia racemosa* forests are chosen as graveyards. The organisms in these forests, such as the Magellan birdwing, are believed to have the devil's spirit, and Lanyu scops-owl is believed to be the devil's servant. This community believes that disasters and illnesses originate from the devil. Thus, all things related to the devil, such as graveyards or organisms within *Barringtonia racemosa* forests, cannot be mentioned or approached. Interactions with taboo objects or areas, or even grains of sand, are believed to lead to disaster. These cultural taboos prohibited interference with, and poaching of, green turtles. Thus, the main threats to the survival of green turtles, such as commercialized poaching (Van Houtan and Kittinger 2014), bycatch³ (Senko *et al.* 2014; Koch, Brooks, and Nichols 2007), and consumption of eggs and meat (Van Houtan and Kittinger 2014; Tröng and Rankin 2005; Seminoff *et al.* 2003; Aguirre *et al.* 2006), do not apply to Lanyu Island.

The threats to the survival of green turtles are primarily from the loss of habitat and disturbance of eggs caused by ecotourism. The construction of tourist facilities used up large quantities of sand and gravel (Liu and Lu 2014), which sharply reduced the nesting areas for green turtles. The constructed sightseeing roads with intense light affect the turtles (Liu and Lu 2014). The intense lights along roads have disturbed egg-laying processes and lowered the hatching rate of eggs (Bourgeois *et al.* 2009; Cheng *et al.* 2009).

Green turtle conservation initiatives started in 1996. The Forestry Bureau, Council of Agriculture, supported the conservation activities in Lanyu. The conservation organization has openly recruited volunteers as staff, whose work includes habitat patrol, physiological status measurements of green turtles, marking turtles, and migration of nests to suitable beaches (King *et al.* 2013). In addition, the conservation organization has collaborated with the Marine National Park to promote ecotourism activities, such as training local residents (Tao/Yami people) as tour guides and setting up ecological information boards (Cheng 2010).

3. Research methods

First, we applied participatory observation methods to understand the operational mode of the conservation organization and its interaction with the local residents, as well as the

issues encountered during implementation of conservation measures. Based on the observed results, we formulated in-depth interview questions. Participatory observations were conducted from October 2011 to May 2014 and eight observations were conducted. One observation was conducted for a 30-day period and other observational periods were from five to 15 days. During the observational stage, we actively participated in the daily life and work of the conservation staff, which included participating in internal meetings, assisting with the development of conservation workshops, monitoring the green turtle egg-laying process on the beach, measuring the physical status of turtles and nests, and participating in nest migrations. Participatory observations were recorded as field notes, supplemented by audio and video recordings to ensure the integrity of the data records.

Because this study was conducted in the Aboriginal Township, the locals were consulted with regard to the legal requirements outlined in the 'Statutory Provision for Indigenous People' for academic research conducted on the lands of the indigenous people. In addition, their consent for participation in the project had to be obtained. Thus, during this period, we reported the content of this study to the Lanyu Township Administration, Lanyu Community Committees, and Tao/Yami People's Literature and History Society members, and acquired the consent of these organizations and individuals. Although the interviewees in this study were volunteers of non-Tao/Yami ethnic origin, the interview contents, analysis, and interpretation were still related to the culture of the Tao/Yami ethnic group. Consequently, it was necessary to follow the legislation outlined in the 'Statutory Provision for Indigenous people' for academic research and to re-establish a communication channel with local authorities and individuals to obtain their consent. This time-consuming administrative procedure was not part of the study, but had to be completed prior to the study as part of the statutory requirements.

In this study, the conservation experiences of the staff were used as case studies to understand the problems encountered by the staff during the implementation of conservation strategies and to explore possible solutions. We used extensive interviews, including face-to-face, semi-structured, and open interviews, to collect data; 10 staff members were interviewed from August to October 2013. The interviews were conducted in Chinese without the need for an interpreter.

The interviewees included the conservation staff aged between 20 and 26 years, with education levels of a university degree or above. These volunteers were from Taiwan and not of local origin. The staff received short-term training from the conservation organization after enrollment. After completion of training, the staff arrived in Lanyu during June to October to monitor and survey the ecological status of green turtles. Staff members were selected each year. In 2013, 10 volunteers participated in the conservation activity, nine of whom were first-time participants. It was the second time the final staff member had volunteered for the conservation organization. Although we interviewed only 10 staff members, this represented the entire volunteer team for 2013.

We did not interview local residents because the main purpose of this study was not green turtle conservation. Instead, the study focused on volunteer tourism in Taiwan and the research emphasized the characteristics of volunteer tourism participants, participation motivation, difficulties encountered, and the need for assistance. The goal was to promote and improve Taiwan's volunteer tourism program. The staff openly revealed the challenges met during the conservation project and clearly detailed the causes of conflicts. In particular, the topic of conservation activities violating local taboos and possible improvements for the conservation organization were worthy of further discussion. Thus, it was worthwhile to explore cultural and conservation conflicts in this

context, and further analyses were performed. The interviewees did not completely blame the residents for the conflicts and considered their cultural background and its influences. Thus, the interview content was not biased towards either party (local residents or the conservation organization). Therefore, this case study was completed prior to interviews with local residents to ensure the timeliness of conservation measures. In the future, another study will be conducted, in which the local residents will be interviewed and their views considered.

4. Research results

From the analysis of the interview data, we documented the operational methods of the conservation organization in Lanyu, the Tao/Yami's social culture, and interactions between the conservation organization and the Tao/Yami ethnic group.

4.1. Green turtle-related cultural taboos

Staff members perceived that local residents considered green turtles as evil spirits, and their nesting beaches as homes to evil spirits. In addition, they observed the effect of this taboo on local residents entering the turtles' habitat.

"The locals were very sensitive regarding bringing sand into the house. Because their graveyard is located next to the beach, they consider everything on the beach to be a taboo, including sand." VS001

"The local residents very rarely visit the beach." VS002

Because the beach is located next to the graveyard, the beach is regarded as the devil's home. If objects from the beach were brought home, it was equivalent to inviting the devil into the house. This action would bring misfortune and injury to the family. Sand was no exception. Therefore, the Tao/Yami tribal culture prohibited their access to the beach where turtles laid their eggs. This taboo has become the strongest and most powerful cultural practice for the conservation of the green turtle's habitat, because it protected their habitat and prevented disturbance to egg-laying turtles.

In addition to the habitat protection created by its taboo status, the staff also mentioned that residents regarded the sea turtles themselves as evil spirits. Thus, the Tao/Yami people avoided any contact with the turtles.

"They (the Tao/Yami people) feel that the turtles are evil spirits. Because turtles lay eggs where the evil spirits are active, so they believe the turtles are also a type of evil spirit." VS003

"They (the Tao/Yami people) feel that the turtles are ominous beings, they (the Tao/Yami people) believe that they are evil spirits." VS002

The staff pointed out that green turtles in the Tao/Yami traditional culture lay eggs in a location considered the devil's home. All objects in this area are considered to be related to the devil. Thus, the turtles are considered evil spirits, given their activities on the beach. With regard to dealing with evil spirits or related objects, the Tao/Yami people's main coping strategy is one of avoidance. Thus, the Tao/Yami people's traditional cultural taboo is actually a conservation measure for green turtles.

4.2. *Conservation workers breach of taboos during work and resulting conflicts*

Green turtle conservation staff calculated the number of turtles that swam ashore and the number of nests [38] on the beach. They installed a transmitter on the turtles' shells [43], and migrated eggs as part of the conservation initiative [44]. Because each activity violated the cultural taboo of the Tao/Yami people, the staff members were met with varied degrees of resistance. Light resistance, such as dissuasion, was often encountered.

"They (the Tao/Yami people) don't like us patrolling the beaches. They (the Tao/Yami people) often tell us "the turtles have returned to the sea, you (the staff) don't need to go to the beach." VS003

"An elderly man always tells us, you (the staff) shouldn't go down to the beach." VS004

When the residents see the conservation staff patrolling beaches, they often try to dissuade the staff, hoping the staff would not approach the turtles.

In addition to dissuasion, the staff members were often subjected to verbal abuse.

"We were scolded continuously after running into Tao/Yami people on the beach." VS001

"The Tao/Yami people took pictures of the staff and reprimanded us for making contact with the turtles on the beach." VS005

Because the green turtle conservation work continued, the violation of taboos also continued. Consequently, growing discontent by the local residents led to more aggressive actions towards the staff. Verbal dissuasion and abuse escalated to more threatening actions, such as throwing bottles at the conservation team.

"One of our researchers was on the beach observing the sea turtles coming ashore to lay eggs, and some residents started to throw bottles at him." VS001

4.3. *The conflict between the economic benefits of ecotourism and traditional cultural taboos*

The conservation organization implemented green turtle ecotourism in Lanyu with the goal of creating economic benefits from tourism activities. They hoped to use this economic incentive to attract local residents and change their way of utilizing green turtles as a resource [21]. Thus, the organization actively promoted a training camp for ecological tour guides and trained hundreds of guides [29]. However, the development of sea turtle tour guide services has not been effective to date. At present, there are less than 10 local residents working as tour guides. The ineffective promotion of green turtle ecotourism could be attributed to the tribe's traditional concept of evil spirits.

"They (the Tao/Yami people) believed that green turtles are the incarnation of evil spirits. So, local residents will not take someone to see the turtles." VS002

The Tao/Yami people who have retained the traditional concept of taboos tended to reject activities associated with the green turtles. They tended to resist participation in green turtle ecotourism in areas they considered taboo.

The local Tao/Yami residents who were engaged in green turtle ecotourism had worked in Taiwan for a time, and recently returned to Lanyu. When they were with a

tour group, they tended to ignore the conservation workers' instructions to turn off flashlights. Some of them even used intense flashlights, thereby disturbing the egg-laying process.

"The tour guide was very angry. He started to take photos of the turtle with a strong flashlight, as well as continued to curse the conservation staff. He then stormed off with the tour group." VS006

The conservation organization attempted to solve these issues through various methods of communication. However, the local tour guides remained unconvinced and believed that:

"They (local tour guide) have been residents of Lanyu for many decades. Why should they (tour guide) follow the instructions outlined by us (conservation staff)?" VS005

To attract a steady supply of tourists, each tour guide wanted to establish their own unique style of tours.

"The guides wanted to establish their own unique style of tours, and refused to follow our instructions. We would explain to the guides what they should avoid, which was often ignored." VS005

Even the simplest issue of light interference reduction could not be solved with communication.

"We requested they (guides) not use flashlights. Yet, they still used flashlights the next time we saw them with a group." VS001

4.4. Tao/Yami people wished green turtles to be undisturbed

The conservation staff patrols tended to be perceived by the local residents as interference with the green turtles.

"The local residents are unhappy with the staff for either observing or following the turtles. The older generation felt that these turtles should be left undisturbed." VS007

"Whenever the local residents find us on the beach, they believed we are disturbing the turtles." VS008

"The local residents would tell us not to disturb the turtles." VS001

The residents also questioned the migration of green turtle eggs from nests.

"A tour guide noticed we were migrating a turtle egg nest. He told us that he felt our action was very bad. We explained the need to migrate the nest. He felt it was better to leave the nest where it was and questioned the migration." VS010

"Several local residents have said that green turtles have lived in Lanyu for hundreds of years, and were able to live well with their ancestors. The turtles are still alive today, why would we interfere with the turtles or move their nests?" VS010

Staff experience showed that local residents maintained an attitude of suspicion and noncompliance with conservation activities, such as turtle tracking or nest migration.

4.5. Location of work camps and collaboration with locals

Because of the restrictions of rental agreements, the location of the work camp varied from year to year. It could either be located in Hontou or Yeyin (Figure 2). If the camp was in Yeyin, it was located within the tribal village. If the camp was in Hontou, it was distant from the tribal village and near the sea.

“Previously, the Yeyin work camp was located in the village. The neighbors (local residents) would chat with them (staff). There was more opportunity to interact with the locals.” VS007

“When we were stationed in Yeyin, we could run into the locals and chat with them.” VS001

“When we lived in Yeyin, the more talkative people (local residents) would ask us about our work activities or inform us about the turtles coming ashore. Their attitudes were pretty good.” VS007



Figure 2. Location of Hontou and Yeyin (Map data source: *National Geographic*, <http://mapmaker.nationalgeographic.org/fWd9RTLhhePDA5DRS60Wy0/>).

The staff noticed that when the green turtle conservation work camp was located in the Yeyin village, they often met the local residents by chance at locations where the locals conducted their daily business. The discussion topics tended to be centered around their daily lives. The residents also regarded the staff as part of their daily surroundings. Thus, the progression of discussions from daily lives to green turtle-related topics could occur more naturally and without triggering knee-jerk reactions. The residents would even initiate discussions regarding the movement of green turtles with the staff. However, the opposite reaction was observed when the work camp was stationed in Hontou.

(When we live in Hontou) Compared with the Yeyin residents, the Hontou residents are not nearly as familiar with us. We don't have any neighbors near our current residence (Hontou work camp), whereas we had neighbors in Yeyin (Yeyin work camp). We are more likely to interact with local residents in Yeyin. Whereas in Hontou, it is less likely to run into the locals. VS002

"Where we live now (Hontou), the residents are more likely to see us on the beach." VS007

When the green turtle conservation work camp was located in Hontou, the tribal village was distant. Thus, interactions with the locals were less likely to occur. The staff were more likely to be spotted by the locals on the beach, where turtles nest. Because the beach itself is considered a forbidden area, it is not a suitable place for casual conversation. Therefore, this made it difficult for the staff to interact with the locals.

5. Discussion

The Lanyu green turtle conservation workers detailed the challenges in the implementation of the conservation project. They illustrated the conflicts between conservation activities and local residents, as well as the existing cognitive differences. Yet, they were able to understand the cultural influences that caused these conflicts and differences. The staff explained that the Lanyu residents regarded green turtles as the incarnation of evil spirits; therefore, the turtles and their eggs should not be disturbed. They also explained that the residents considered that the natural habitats of green turtles were possessed by evil spirits; therefore, they should not enter these areas. The residents even avoided contact with sand from the habitat, which could not be brought into the house.

In the traditional cultural norm, the Tao/Yami ethnic group regarded green turtles as a source of misfortune. Thus, they tried to avoid close contact or interactions with the turtles to avoid calamities. These taboos prohibited interference and poaching of green turtles. However, the conservation organization believed that human disturbance of green turtles was very severe in Lanyu. In addition, turtle eggs were easily discovered and consumed by the natural predator, *Oligodon formosanus*. Therefore, artificial conservation measures, such as shifting of egg nests, must be conducted to preserve the eggs. For the purpose of green turtle conservation, the conservation organization shared a common understanding with the local residents. However, in terms of conservation measures, the views of the conservation team differed from those of the local residents.

The various measures used by the organization have often been applied by conservation organizations worldwide to protect green turtles. Green turtle conservation measures such as, ecological monitoring (Grand and Beissinger 1997), habitat restoration (Rumbold, Davis, and Perretta 2001), and egg nest migration (Grand and Beissinger 1997; Pike 2008) are all standard operating procedures. In addition, the data could be

used for the purpose of global conservation of green turtles (Supplementary Table A1 in Mazaris *et al.* (2014)). However, these methods are considered taboo violations by the local community, which generated conflicts, and even resulted in attacks on conservation workers.

The application of these conservation measures is necessary; however, it led to conflicts. The conservation organization should continue to implement these conservation measures and strengthen their communication with local residents. The location of work camps in the village is an effective way to facilitate communication. The staff members noticed that when the work camp was located in the village, they interacted frequently with the residents. There were more opportunities for discussion and information exchange. They could even discuss the subject of green turtles being taboo. If the work camp is located outside the tribal village, an opposite reaction can be expected. Thus, the location of the work camp in the tribal village is a priority task to promote effective communication.

The economic incentive chosen by the conservation organization included the development of green turtle ecotourism, which was not suitable for Lanyu. First, as part of their cultural taboo, the Tao/Yami ethnic group prohibited interaction with green turtles. For most of the local residents, green turtle ecotourism was not an attractive incentive. When the conservation organization promoted green turtle ecotourism, it was regarded as an effort to force local residents to comply with the devil (evil spirits) and became a reason for the locals to resist the conservation organization. Thus, promotion of green turtle ecotourism was a futile exercise that wasted resources and caused conflicts between the two sides.

The tour guides who accepted green turtle ecotourism started to ignore the taboo of green turtles. Because of the lack of cultural constraints, the ecological tours conducted by these tour guides caused even more damage to green turtles. The guides would lead a large number of tourists into the habitat and cause damage to the habitat, as well as the egg nests. The frequent and casual usage of flashlights by the tour guides hindered the green turtles' egg laying process. The guides ignored instructions from the staff and conducted the tours. This type of conduct often resulted in conflicts.

Green sea turtle ecotourism caused emerging threats to the survival of the green turtle population. The traditional Tao/Yami tribal culture of non-contact and non-interference with green turtles was disrupted by the promotion of ecotourism. This resulted in a small number of tribal members ignoring the constraints of the traditional cultural taboo. This represented a gap in the taboo culture of green turtles, which may further reduce the restraints of the green turtle cultural taboo. The reduction of this cultural constraint will increase the likelihood of green turtle interference by the Tao/Yami ethnic group. The Lanyu green turtle ecotourism did not exist previously and generated habit disturbances by tourists, created light pollution, and lowered the likelihood of green turtles coming ashore to lay eggs. In addition, these new activities damaged egg nests, and reduced the hatching rate. This emerging threat has been caused by the idea of the conservation organization to generate economic incentives for ecotourism in order to protect green turtles.

Currently, there is a lack of data to evaluate whether green turtle ecotourism is a substantial threat to the survival of green turtles. The existing observations suggest that green turtle ecotourism created disturbances and threats that did not exist previously. For example, some tribal members were not constrained by the cultural taboo and they used strong flashlights that disturbed green turtles. They also conducted tours on the beach without permission, interfering with the nest building process of turtles and destroying

their nests. They did not adhere to the instructions of conservation workers. These issues are not conducive to the reproduction of green turtles. If these emerging disturbances are not managed, the survival of green turtles in Lanyu will encounter even more challenges.

6. Conclusion

This study was based on interviews with conservation workers to analyze the challenges encountered in the conservation of green turtles. We found that the local residents and conservation organization were both aligned with the goal of protecting green turtles. However, they maintained different attitudes with regard to conservation practices. This attitude was because of the local cultural taboos, which were effective in prohibiting the tribe members from disturbing green turtles. However, this taboo culture was hostile towards green turtle conservation measures. Green turtle ecotourism was weakened by this taboo culture, which resulted in new threats and disturbances to the turtles. Consequently, it increased the challenges of green turtle reproduction in Lanyu.

We recommend that the conservation organization continue to use scientific guidelines for the conservation of green turtles. However, it is worth adjusting the priority of different conservation measures and the strength of communication with local residents. Ecological monitoring (Grand and Beissinger 1997) and habitat restoration (Rumbold, Davis, and Perretta 2001), as well as the effort to communicate with local residents need to be continued. Shifting of nests (Grand and Beissinger 1997; Pike 2008) should be minimal and based on habitat conditions with a careful evaluation of the number and location; in addition, shifting of turtle nests should be avoided near local residential areas. Communication with the tribe will be a lengthy and complex process; therefore, it was not included in this paper. However, we noted that the location of the work camp had a profound impact on communication between the two parties. If the work camp could be located in the tribal village, it could greatly improve the relationship between the locals and the conservation staff, and facilitate discussion on conservation measures, including ecological monitoring, habitat restoration, and nest migrations.

The economic incentive of green turtle ecotourism created detrimental and far-reaching consequences. Although there have been many successful international cases of ecotourism that have effectively protected sea turtles (Walter and Reimer 2011; Pegas and Stronza 2010; Wilson and Tisdell 2003; Rattan, Eagles, and Mair 2011), this approach disrupted the local cultural taboo in Lanyu and created new disturbances for the turtles. Therefore, the conservation organization should consider the suspension, or even termination, of the green turtle ecotourism program. The results indicate that local cultural factors should be taken into account for the implementation of incentive measures.

There are two serious limitations to our study. First, the sample contained only 10 respondents. Second, Lanyu Island is only one of several islands in the Pacific region. It is neither particularly special nor unique. However, the results of this study were highly significant and practical. In terms of practical applications, terminating the promotion of green turtle ecotourism and locating conservation work camps in villages are feasible solutions that could be implemented immediately. In terms of significance, the Lanyu green turtle is a unique example of evolutionary behavioral ecology. The conservation effect of Lanyu's taboo culture on the protection of green turtles is also unique. The integration of cultural taboo with conservation techniques in regional conservation is a special example, which is in line with the initiative to apply a regionally specific approach (Broderick *et al.* 2006; Patrício, Diez, and van Dam 2014) and reinforce

existing effective measures (Mazaris *et al.* 2014) to protect green turtles globally. In addition, we also found that conservation volunteers (staff) had a keen ability to understand and interpret the Tao/Yami culture, which could be used as a reference for volunteer workers in conservation.

Our subsequent studies will include interviews with local residents and management staff from the conservation organization. The perspectives of the local residents will be used to conduct a detailed examination of the points raised in this study, to determine whether these conclusions were sufficient. Interviews with the conservation organization's decision makers and managers will be conducted to determine whether the organization is aware of the findings of this study, and whether they have implemented appropriate measures. The results of the follow-up research will aid in addressing the issues presented in this study.

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Notes

1. It is extremely difficult to study and validate the 'behavioral evolution' of species. The readers should refer to the cited literature and other papers for the conclusion.
2. Tao/Yami fishermen use single-handed nets to catch flying fish as they leap out of the sea.
3. Although the Tao/Yami tribe uses the gillnetting method for fishing, they have caught green turtles as bycatch. Tao/Yami fishermen check the net several times a day and draw the net in at dusk. They also believe that nets that catch green turtles become cursed and are unable to catch fish. Thus, they often avoid placing nets in seas with green turtles.


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