



InvestEGGator Pilot Study:
*Policy Analysis, Recommendations, and
Feasibility for Costa Rica*

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Project Abstract

Despite their protected status, a major threat to sea turtles is egg poaching for local consumption and commercial trade. In Costa Rica alone, as many as 100% of eggs are poached in some beaches (Fonseca et al, 2015). To help address this problem, our team partnered with Paso Pacífico who created the InvestEGGator—an artificial 3D printed egg containing a GPS tracker which resembles a real sea turtle egg.

The primary component of the project involved initiating a pilot study of the InvestEGGator. We aimed to understand whether conservation nonprofits could utilize this device to track poaching routes. Through semi-structured interviews we found that NGOs have unique monitoring protocols; different sea turtle species overlapped at some nesting grounds; cell tower signal availability was limited; and poaching activity varied across NGO locations. These site differences affected deployment of the InvestEGGators. NGOs successfully deployed 21 devices between October and December 2019. Only two were poached, and we were unable to retrieve positional data. Our findings support that InvestEGGators are capable of visually deceiving poachers, but require improved internal hardware to render them reliable in the future.

Second, we sought to understand the socioeconomic drivers of sea turtle egg poaching in Latin America, and potential policy interventions. We identified five primary reasons for high rates of continued poaching, including a strong cultural tradition of egg consumption and a lack of economic alternatives to poaching. We found that more governmental assistance is needed to ensure successful conservation outcomes.

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I. Executive Summary

Six out of the seven species of sea turtles are currently listed as endangered. Despite their protected status, their survival is under major threat from climate change, degradation of marine and nesting habitats, and poaching. More specifically, egg poaching for local consumption and commercial trade is a major land threat to these species. According to the State of the World's Sea Turtles 2015 report, illegal egg harvesting is close to 100% in nesting areas across Costa Rica despite their protected status nationwide (Fonseca et al. 2015). To address sea turtle egg smuggling the conservation organization Paso Pacífico developed the InvestEGGator—an artificial 3D printed egg containing a GPS tracker which resembles a real sea turtle egg and can be placed inside a turtle nest. The goal is to use this device to track stolen eggs and understand sea turtle poaching routes. To determine if the InvestEGGator can be used to reduce egg poaching, Paso Pacífico partnered with the University of Michigan Masters students to perform a beta test of the device and conduct a pilot study with Costa Rican organizations to use this new and creative technology.

With the objective of guiding the next round of InvestEGGator deployment in Costa Rica, and eventually other Latin American countries, the project team recommends the following strategies to Paso Pacífico. These recommendations are based on our beta testing, interviews with NGO partners, NGO directors, and community members, and our overall experiences during two field visits in summer 2019.

Summary of Key Recommendations

- **We recommend** that Paso Pacífico saves time, energy, and money in the InvestEGGator devices by leaving them unpainted, and not upgrading to a finer 3D printing material
- **We recommend** that InvestEGGator devices are deployed on beaches with nests from the *Lepidochelys olivacea* (olive ridley) and *Chelonia mydas* (green sea turtle) species
- **We recommend** that NGOs use the most battery-intensive setting of 10-minute GPS location interval, since interval settings do not impact battery life excessively
- **We recommend** that nonprofit partners are selected through extensive conversations to (1) understand how community relationships could be impacted if community members discovered the InvestEGGator and (2) gauge the level of commitment from the NGO to deploy the product
- **We recommend** that the InvestEGGator is not utilized by organizations with a hatching nursery or on beaches where nest relocation occurs
- **We recommend** that nesting grounds or beaches with moderate to high cell tower (LBS) signal should be prioritized and the InvestEGGator is deployed in nests located near the beach entrance
- **We recommend** the continued use of the ReachFar smartphone application for InvestEGGator device tracking, accompanied with substantial training to ensure autonomous NGO use
- **We recommend** that NGO partners are introduced to the ArcCollector application or another smartphone GPS platform to aid with nest recording, and InvestEGGator deployment and recovery

II. Introduction to the Problem & Project

Sea turtles around the world are continuously threatened by overexploitation (fishing, hunting, and poaching of wild species) and are currently undergoing large population declines due to bycatch and harvesting of adults and their eggs (Maxwell et al. 2016; Mazaris et al. 2017). Various conservation initiatives have been taken to address their decline including education and awareness programs, beach protection measures, and the establishment of marine and coastal protected areas. Nevertheless, researchers are concerned about populations that remain historically low despite these efforts. Major challenges to address poaching and illegal trade of wildlife and their parts is the constant surveillance required and the determination of trade routes.

To overcome this obstacle, many conservation organizations and institutions are utilizing new technologies. Examples of poaching detection and prevention technologies include perimeter-based, ground-based, aerial based, and animal tagging technologies (Kamminga et al. 2018). There are numerous success stories of using such devices and approaches to protect endangered species, in particular large carnivores and herbivores like lions and elephants. However, there is a need to develop similar innovative technologies to reduce sea turtle egg poaching in places like Central America and the Caribbean. The development and successful use of these technologies will allow conservationists to be one step closer to achieving healthy populations of all sea turtle species worldwide.

Paso Pacífico is a conservation non-profit working on community-based sea turtle conservation in Latin America. Recently, they developed the InvestEGGator, an artificial 3D printed egg embedded with a GPS tracking device. The device is designed to look and feel similar to real sea turtle eggs. In the last three years, Paso Pacífico collaborated with a researcher to test the first prototypes, and experienced varying degrees of success. The primary objective of our research is to conduct beta tests of the technology and pilot studies with on-the-ground NGOs to determine the feasibility and viability of the InvestEGGator. The main collaborators for this project are non-governmental conservation organizations including Equipo Tora Carey (ETC), Turtle Love, Comunidad Protectora De Tortugas De Osa (COPROT), The Leatherback Trust, and Centro de Rescate de Especies Marinas Amenazadas (CREMA).

III. Sea Turtle Egg Poaching in Costa Rica and Policy Analysis

A primary objective of our project is to understand what factors influence the continued poaching of sea turtle eggs and assess why current policies regarding sea turtle egg poaching may be failing to prevent such poaching. To achieve this goal, our group reviewed relevant literature from scientific journals, reports from organizations such as the Convention on International Trade in Endangered Species of Flora and Fauna (CITES), USAID, primary research articles, and other sources. Additionally, over the course of 2019 our team was able to engage in semi-structured interviews with several directors/founders of sea turtle conservation focused NGOs in Costa Rica.

The following section is broken into two parts; first, an examination of the factors that continue to contribute to sea turtle egg poaching, and second, main findings from conversations with these NGO directors as they paint a picture of what successful conservation of sea turtles looks like and how it can be accomplished.

A. Examination of Factors Contributing to Continued Egg Poaching

Background

Since July 1, 1975, when the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) treaty went into effect, all seven species of sea turtles have been protected under CITES Appendix I. Of the Central American countries, Costa Rica was an original signatory, while Nicaragua (1977), Belize (1987) El Salvador (1987) and other Central American countries came later. As of 2020, 178 countries are signatories restricting the international trade of turtle products, including all countries in Central America and even Latin America, combining Central and South America (Convention on International Trade in Endangered Species 2020).

CITES Appendix I includes species that are threatened with extinction, which are, or may be, affected by trade. Under CITES, international trade for commercial purposes is strictly prohibited for species listed under Appendix I. Although CITES prohibits international trade for species listed under Appendix I, individual nations must implement measures to regulate domestic trade. In Costa Rica, for example, which is the primary focus of this investigation, domestic trade in sea turtle parts has been banned since 1966, pre-dating CITES (Le Guern 2011). Furthermore, six of the seven species, excluding *Natator depressus* (flatback turtle), are listed under CITES Appendix II. Appendix II is reserved for species with a conservation status that indicates they are threatened with extinction and calls upon signatories to implement conservation measures to recover these species.

Despite these protections in place, illegal and unsustainable take (also known as poaching, or illegal harvest) of sea turtles and sea turtle eggs continues across Latin America (Sardeshpande 2019). Given the extremely low (estimated at 1%) survival of sea turtle hatchlings to adulthood, rampant overexploitation of sea turtle eggs, in particular, threatens to undermine the viability of future generations of sea turtles (Rafferty 2017).

Reviewing the primary literature to understand the factors that contribute to continued illegal harvest despite the measures to prevent it, we identified several factors behind this unsettling fact, discussed below.

Main Findings

(1) Legal harvest continues to be permitted in many countries

Although direct take or trade of sea turtles is prohibited throughout much, if not most of Latin America — El Salvador is the last documented Latin American country to ban any legal harvest, in 2008 following Mexico's complete ban in 1990 (Romanoff 2010) — notable exceptions exist. Wide-scale commercial exploitation has historically contributed to and continues to contribute to global declines in marine turtle populations and the problem seems to be especially common in Latin America's coastal communities. For example, it is estimated that Nicaragua accounts for some 22% of the global take in sea turtles due to few restrictions on the legal take. It is believed that it is legal in as many as forty-two countries across the world to directly harvest sea turtles and/or their eggs (Humber et al. 2014). What is more, other loopholes make harvesting of sea turtles or their eggs possible throughout Latin America. In addition to legal *C. mydas* fisheries in Nicaragua along its Caribbean coast; subsistence take and use of *L. olivacea* eggs are permitted in Isla Cañas Wildlife Refuge in Panama (CITES 2019).

In addition to economic opportunities, sea turtle fisheries provide an important source of protein and cultural identity for these coastal communities. Information on these activities can be hard to come by, but a most recent estimate suggests as many 42,000 marine turtles are caught each year legally, and more than 2 million since 1980. Over 80% of these harvested are *C. mydas* and much of the activity occurs in Latin America (Humber et al. 2014). Though current harvest levels are estimated at less than 60% of those in the 1980s, if sea turtles are to be preserved, a major part of the equation will be encouraging international cooperation to address current legal harvest practices.

(2) Hunting of sea turtles and consumption of sea turtle eggs is a long-established cultural tradition in many Latin American countries

Sea turtles have historically been an important food resource for many Latin American communities, especially coastal inhabitants. Today, the consumption of sea turtle meat and eggs continues in these nations despite well-documented legal protection and urbanization providing easier access to other more reliable protein sources (Senko 2009).

Sea turtle egg and meat consumption have traditionally been strongly associated with indigenous coastal communities who practice subsistence. For example, the Seri people off the Sonoran coast in the islands of the Gulf of California traditionally harvested sea turtles exclusively for food. In 1990 when Mexico enacted a ban on the harvesting of sea turtles or their eggs, the Seri were forced to focus on other fishing activities. The cultural tradition of consuming sea turtles has been passed down in material culture like artwork, songs, and legends over-time and as a result is a difficult tradition to break (Musick 2003). A 1995 investigation into the cultural importance of sea turtles in Latin American countries found that marine turtles contribute much to their overall cultural stability of various indigenous groups and provide a sense of independence from more modern societies. These groups described that "the source of protein is not nearly as important as this cultural role" played by sea turtles. The tradition of travel by dugout canoe, a subsistence economy, and ceremonies surrounding turtle hunts historically limited sea turtle harvest. However, the introduction

of a cash economy, government settlement programs that spread turtle fishing skills among islanders, and the erosion of traditional taboos have led to increased pressure on turtles. Although these local people see turtles as part of the sea and a "provider for all things," and they show little concern for evidence of decreasing populations (Musick 1996). As such, any interventions to stem the decline of sea turtle populations must address the long-standing tradition of harvest in these communities.

An additional reason for pressure on sea turtle populations because of egg consumption is the long-standing belief that sea turtle eggs are an aphrodisiac. In Ostional, Costa Rica, however, researchers have found that although some people recognized the aphrodisiac reputation of eggs, they emphasized their nutritional and economic value to families. Women were more likely to dismiss the aphrodisiac claim (Campbell 1997). Other studies found that in other parts of Latin America like Guatemala, eggs are primarily consumed for aphrodisiacal purposes and as such are "not a basic need." (Juarez and Muccio 1997).

There is growing evidence to suggest that consumption of sea turtle eggs and sea turtle meat comes with health hazards, however. Hazards associated with this consumption are due to the presence of bacteria, parasites, biotoxins, and environmental contaminants in sea turtle meat. Consuming sea turtle eggs is linked to conditions like diarrhea, vomiting, and extreme dehydration. Additionally, levels of heavy metals and organochlorine compounds can lead to toxic effects such as neurotoxicity, kidney disease, liver cancer, and developmental effects (Aguirre et al. 2006). Epidemiologists suggest the most damaging effects are likely cumulative because of the accumulation of heavy metals. This is relevant because it could deter the consumption of vast quantities of eggs, but only if communities have this knowledge (Cutlip 2016). Although this information portends health risks for communities consuming sea turtle eggs, it offers a persuasive public health argument that can be used in addition to or augmenting conservation education efforts, and hopefully will help reduce demand for sea turtle eggs.

(3) Lack of economic opportunity leads individuals and groups into illegal harvest

While Latin America is known for its spectacular biodiversity and eco-tourism it is also a region with some of the poorest countries in the Western Hemisphere that are also beset by civil and political conflicts. On a GDP-per capita basis, Nicaragua and Honduras, which both have miles of important nesting grounds for sea turtles, are amongst the poorest countries in the world (IMF 2019).

Even in wealthier countries such as Costa Rica, many communities, especially those receiving less eco-tourism, have few economic options available to them. In fact, in the 1990s researchers found that the seasonal legal Ostional harvest in Costa Rica provided the primary source of income for 70% of nearby households (Campbell 1998). Today, the number of households for whom it serves as a primary source of income may be closer to 30% (Sardeshpande 2019), but this is still illustrative of the lack of other options for this community. The original study found that just one nest of sea turtle eggs is equivalent to the wages that a farm laborer would earn in an entire week. An additional review of poaching practices in Baja California, Mexico, where options are more readily available, these jobs do not present the same profitability as sea turtle egg poaching. In Baja California Sur, the average weekly salary of a fisher in BCS is \$84 whereas the average price from poaching a single turtle nest was \$58 for each of eight poachers (Mancini 2011). Whether harvested legally or illegally, turtle eggs fill an economic need, and as the previous section makes clear, culture and economy are not so easily separated.

The legal harvest in Ostional, where residents have consistently expressed positive sentiments for the socio-economic benefits, support for community-based conservation as well as recognition of the importance of sea turtles as a resource to be preserved (Campbell 2007) provides an interesting counterpoint to trying to tackle illegal harvest year-round. The model in Ostional illustrates one possible solution to combating illegal harvest, which is to permit taking of sea turtle eggs during a very limited season throughout the year in designated areas. However, Ostional is a unique situation in that the impact on future populations of sea turtles is believed to be negligible. Ostional is one of the *arribada* (mass nesting) beaches where turtles come in droves for a mass nesting event. The number of nests is sufficiently high that turtles soon run out of free space to nest. Eggs that have already been laid are destroyed by subsequent waves of nesting turtles. (Le Guern 2011).

Even so, given that to obtain a permit to take eggs, locals must engage in conservation activities such as removing plastic pollution, assisting hatchlings or relocating nests as well as guarding/patrolling the beach, Ostional provides an interesting thought-experiment for how other municipalities or countries can devise a strategy to combat illegal harvest.

(4) Increased development has enabled poachers to access sea turtle nesting beaches

Three countries and their beaches in Latin America—Nicaragua, Costa Rica, and Panama—especially on the Caribbean side, as well as offshore foraging grounds, are considered by sea turtle experts as perhaps the most important collection of habitats and nesting grounds for sea turtles in the Western Hemisphere and perhaps the world (Seminoff 2012). Over the past three decades, increased development in terms of hotel and resort properties has eroded and destroyed sea turtle habitats and roads have provided greater access for poachers and smugglers of sea turtle eggs (Mazaris 2009).

Although analysis of illicit activities is hard to come by, it is believed that larger-scale illegal harvest often passes from local, community operations to middlemen who transport illegally taken sea turtle eggs for sale in clandestine markets, restaurants or to countries such as Nicaragua where sale and harvest of sea turtle eggs is legal (Smith 2009). Given this fact, roads connecting coastal communities and beaches to nearby centers make access to transfer points, city centers, other countries and the ability to transport sea turtle eggs by car far easier. Additionally, increased population density in these towns provides cover for sea turtle egg poachers than previous decades would have offered.

A case study of illegal harvest at the beach that now constitutes Las Baulas National Park on the northeast Pacific coast of Costa Rica and the rampant increase of illegal harvest that was initiated with development, illustrates this point. It is believed that poaching of sea turtle eggs at Las Baulas began in the 1950s. However, because only a few local families in the nearby vicinity occasionally went to the beach and took only 1-2 clutches of eggs for their consumption, effects were low. Researchers estimate at this time that only 1% of nests or less were removed. In the early 1970s however, a road opened that facilitated beach access, bringing individuals from nearby villages and even more distant locations such as Santa Cruz and San Jose, Costa Rica's capital. By 1975, just twenty-five years after poaching was negligible, a systematic system of poaching was well established. Poachers divided the beach into small sections and removed 90% of eggs, all of this happening at a time that of course, the activity was fully illegal. These local opportunistic poachers transferred the goods to wholesalers, who transported eggs by truck to big-city markets. Intense poaching lasted until 1991 when Las Baulas National Park was established (Tomillio 2009). Given that the

establishment of a National Park generally requires protection in the form of rangers and guards, as was the case for Las Baulas, poaching declined significantly after the establishment of the Park. Monitoring was thought to be fully implemented around 1993 and poaching was reduced to less than 1% of nests per year.

Even though only 1% of hatchlings are thought to survive to adulthood (and even a smaller percentage when considered on an egg basis), the effects of 90% removal of nests are considerable on sea turtle populations. The researchers studying the effects of poaching at Las Baulas found that in just one generation this rate of poaching would decrease the number of nesting turtles by 38% (Tomillio 2009).

It remains unclear whether there are ways to address the problem of poaching by scaling back development and roads directly. However, with the InvestEGGator project and other tools like it, gaining an understanding of where eggs go once they leave the nest can help conservation organizations and law enforcement allocate resources strategically to stop the flow into or out of these heavily hit beaches.

(5) Lack of regulatory enforcement and punishment for illegal harvest

As the details from conversations with Costa Rican NGO Directors in the following section make clear, for beaches that are important nesting grounds for turtles but not designated as National Parks, there is little if any enforcement of anti-poaching laws. Illegal harvest is often thought to occur at night in the darkest hours, where night cover and empty beaches provide cover for any individuals that might raise suspicion. This is why the NGO partners we worked with for this project almost exclusively conduct beach patrols in the late evening or early hours of dusk, from about 10 pm to 5 am. Without such patrols from sea turtle NGOs, however, poachers would be provided free reign on many beaches in the early hours.

An examination of the reasons behind illegal harvest practices in Baja California Sur, Mexico found that lack of law enforcement and ease of escape from or bribery of authorities were amongst the primary reasons poachers listed (Mancini 2011). Other prevalent reasons the study suggested were direct economic benefits and strong family tradition. The typical poacher profile from this study was male, age of 28-60, who had been born and spent most of the time in that community. On the topic of lack of law enforcement, one interviewee suggested "there is some law enforcement but most of the time you can easily escape. The inspectors from PROFEPA (Mexico's Environmental Ministry) have small boats they can't catch us, on the other hand, the marines are more efficient but most of the time they don't care about turtles. They look for guns and drugs. And sometimes when you get caught you just need to give them some money and there's no problem."

Beyond the calculus that chances of being caught are remote and the prospect of being able to bribe their way out of the situation, our conversations reveal that poachers in Costa Rica are not likely to face significant fines or jail terms unless they are apprehended was considering ceasing poaching if there was an increase in the presence of Navy and wildlife inspectors in his fishing area.

In the Baja California Sur study, poachers were concerned about the prospect of facing severely high fines, which were in place at the time of the study. In terms of punishment, the researchers found that a 6-month jail sentence proved to be a better deterrent than fines for two fishers caught illegally harvesting sea turtles. However, other research (Williams and Gulland 1993) indicates that a higher probability of detection (i.e. more resources allocated to patrolling) is a more effective deterrent than the actual penalty. One of the poachers in the Baja study report it will be necessary for governments to allocate more resources to enforce

existing laws, reduce social acceptance of sea turtle hunting throughout the region, aim to educate poachers on the ecological importance of sea turtles, and show these individuals the possibility direct economic benefits from non-consumptive use of sea turtles, such as ecotourism.

B. Conversations with NGO Directors

Over the course of 2019 our team engaged in semi-structured interviews with several directors/founders of sea turtle conservation-focused NGOs in Costa Rica. The focus of these conversations was on existing sea turtle egg poaching policy, where the problem of sea turtle egg poaching stems from, and where these directors believe more resources need to be dedicated in order to further address the problem. An additional focus of these conversations was the InvestEGGator technology and how NGO directors envision the tool could aid their conservation efforts. Out of these conversations and this research came several themes and insights, which are expanded upon below. Participating NGO members included Sea Turtle Conservancy, COPROT, and Turtle Love.

Background

In Costa Rica, with the exception of the legal harvesting in Ostional during certain *arribadas*, all harvesting of sea turtle eggs is illegal and has been so since 1966 (Le Guern 2011). However, there remains a significant black market for sea turtle eggs (Ankersen et al. 2015). A longstanding tradition in Costa Rica and across much of Central America of consuming sea turtle eggs in part because of their perceived qualities as an aphrodisiac, as well as the economic gains associated with selling the eggs, has contributed to this situation. Due to the many threats that sea turtles face during their life cycle, many of which are anthropogenic in nature, conservation and management of these species has become paramount for their continued existence.

Each country in Central America has a unique relationship to the sea turtle and to the coastal communities that interact with sea turtles. For example, while much of Nicaragua and Panama is inhabited by indigenous groups with varying degrees of self-governance over land and resources, and a longstanding cultural tradition of consumptive use of sea turtles, Costa Rica does not share this indigenous cultural and political overlay to the same degree, and recently moved to a non-consumptive approach to sea turtle use through ecotourism (Ankersen et al. 2015).

Main findings

1) NGO Directors feel their efforts have been effective at reducing poaching and increasing community awareness, however more data is needed

Although many of the organizations we spoke with have only recently initiated their efforts (COPROT was founded and began operations in 2018, Turtle Love in 2018, and Equipo Tora Carey in 2016), the founders feel that their conservation activities are already having a positive effect. The directors are optimistic that their efforts at community engagement, education, patrolling to prevent poaching and predation, along with other conservation activities, have been successful at increasing hatching rates and deterring poaching.

For example, Turtle Love estimates that on the beaches the organization now patrols, poaching rates of nests had been as high as 80-90%. Now, that rate has declined fourfold to approximately only 20-30% of nests. Likewise, for COPROT, because their beaches are more remote, they estimate the poaching rate of

nests was 20%-30% prior to beginning conservation activities, has been halved after a year. For Equipo Tora Carey, the patrollers approximate poaching has declined to 0% of nests being poached since the organization started three years ago. It is unknown how many nests were being poached before.

How much of this progress is due to patrolling activities to deter poachers and how much is due to other factors remains unclear. For example, in addition to patrolling activities, these organizations have increased educational efforts on the importance of sea turtles and their ecology within these communities. They have also been able to create jobs for those that might have poached before. Other extraneous factors include awareness about the plight of sea turtles, changing consumption habits, etc. However, it can be said almost with certainty that these NGOs are having a substantial effect in their areas by promoting conservation and reducing poaching pressures.

Some of the partners have seen mixed results. The Sea Turtle Conservancy, for example, is the partner that we spoke with that likely has the most robust data related to hatching and number of nests in the areas they patrol. The Sea Turtle Conservancy (STC) is a relatively larger NGO with projects in Tortuguero National Park in Costa Rica as well as the Big Bend region in Florida and four beaches in the Bocas del Toro province in Panama. STC has been recording data related to *C. mydas* and *Dermochelys coriacea* (leatherbacks) and their nesting rates in Tortuguero since 1986. In 2014, the most recent year for which data on poaching is available, between March 21 and May 5, seven *D. coriacea* nests were discovered to be poached and two *C. mydas* nests out of an estimated 200 *D. coriacea* nests (3.5%) and 130,000 *C. mydas* nests (.001%). However, while the estimated number of *C. mydas* nests in Tortuguero National Park have increased from 60,000 in 1986 to more than 130,000 today, *D. coriacea* nests have declined from an estimated 1,200 per year in 1986 to fewer than 200 today.

Sea Turtle Conservancy believes this is most directly related to erosion of beach shorelines during *D. coriacea* nesting seasons, particularly in the last several years. *D. coriacea* turtles previously would use open stretches of beach coastline to nest, primarily using areas with no vegetation. Because *D. coriacea* and *C. mydas* nest during different times of the year (*D. coriacea* primarily around March and *C. mydas* primarily around September), the beach ecology is completely different. During *D. coriacea* season the high tide line, in almost all the beach, is close to the vegetation due to erosion of the coastline, which means less space for *D. coriacea* to make nests. This is a key factor that could be affecting the number of *D. coriacea* that can successfully nest in Tortuguero.

2) In Costa Rica, NGOs, not governmental organizations, are primarily responsible for conservation efforts and enforcement of poaching restrictions

Patrolling beaches to deter poaching during peak nesting hours is a primary activity that Costa Rican sea turtle conservation NGOs engage in to protect sea turtles. Costa Rica encompasses more than 19,000 square miles in area and has more than 800 miles of coastline and 300 beaches, making it a huge area for sea turtle nesting and as such a huge area to protect (Jiménez 2017). Because of a decision long ago to invest in ecotourism, Costa Rica ranks relatively high in terms of the percentage of land area under protection (27%). In Central America, only Nicaragua ranks higher (37%). Protected areas are of less concern because national parks generally require admittance and have patrollers, park rangers and other governmental officials in these areas, which deters poachers. However, for the remaining 73% of the country is unprotected and has no official government presence.

According to NGO directors whose efforts span the Pacific and Caribbean coasts, assistance from and collaboration with law enforcement to deter poaching, protect nests and other activities is minimal at best and closer to nonexistent in actuality. Law enforcement presence is stronger in and around designated protected areas such as Tortuguero National park, however in adjacent beaches and especially in more remote locations, it is nearly lacking in entirety. Lack of collaboration or assistance from law enforcement means underfunded NGOs are left to do on-the-ground law enforcement.

In Costa Rica the governmental department that is responsible for the conservation of wildlife is the Ministry of Environment and Energy (MINAE). Within this ministry, the Vice President of Environment oversees the development of strategies, policies and plans that seek to conserve biodiversity, in situ and ex situ. However, presently the Ministry does not allocate any funds for law enforcement or ministry officials to patrol beaches or perform research on sea turtles, even those most in need of protection. As a result, organizations like Sea Turtle Conservancy, COPOROT, and others have stepped in to fill the void. According to several directors, if not for their presence and efforts, poaching rates of nests combined with predation would be extremely high, perhaps even 100% on beaches in close proximity to city centers.

3) Costa Rica government funds conservation, but sea turtle conservation only indirectly

The current administration of Costa Rica is very pro-conservation. Minister of the Environment Carlos Manuel Rodríguez is world-renowned for his conservation policies. He has indicated that he believes at least 1% of global GDP should be directed to conservation activities. The country raises 13% of its revenues from a carbon tax on gasoline; it has used these revenues in part to reforest the country and establish more than 300,000 hectares of reforestation in 2018 alone (Powlen 2019). A travel website for Costa Rica claims that “Costa Rican government also offers private companies and nonprofit organizations generous financial incentives to help repopulate the nation's forests,” (Go Visit Costa Rica 2018) however little information is available on these efforts or how sea turtle conservation organizations can take advantage of these funds. As a result, most organizations are left to find their own sources of funding, making applications for grants and building a network of donors and volunteers all the more important. Globally, over 80% of sea turtle nesting sites occur in developing nations and only 25% of these sites are in protected areas (Mazaris et al. 2017), underscoring the critical role that NGOs play in protecting the remaining 75% of nesting beaches.

Despite the Costa Rican government's commitment to conservation, there is a lack of financial commitment to helping sea turtle conservation NGOs. Still, one of the ways the government helps these organizations indirectly is The Blue Flag Ecological Program, launched in 1996. The program is a collaboration between the Ministry of Environment and other governmental agencies. The program is a certification scheme designed to protect the nation's diverse and fragile coastal ecosystems, to clean up current and prevent future beach pollution, to improve the health of Costa Rica's people and environment, and to safeguard Costa Rica's reputation as a world-class ecotourism destination. In order to achieve a “Blue Flag” certification, coastal communities must score a minimum 90% for all requirements. To do so, each beach and coastal community is rated on a scale of one to five stars, taking into account the following criteria: ocean water quality, potable water quality, quality of coastal sanitation areas, and environmental education. In 2013, 90 beaches were awarded with the distinction (Jiménez 2017). NGOs can proudly display on their website and with flags on the beach and street signs that they have received the distinction, which in theory

boosts revenue from tourism as well as heightened interest from research volunteers. However, it remains unclear how the government is helping with these efforts to boost water quality, maintain beaches, etc.

4) Despite challenges, NGO directors believe the model of NGO conservation is sustainable

Interviewed directors report that in Costa Rica, unlike in the U.S., there are no governmental funds available for NGO organizations to carry out sea turtle conservation. It is unclear as to whether or how much the Costa Rican government allocates for conservation from their yearly budget, as no such budget is publicly available. Although NGOs and government officials work closely with one another, sea turtle NGOs must obtain permission from the government in order to set up patrols on beaches and the environment ministry requests specific data sets and observations such as: number of observed nests in a monthly period; species type; disturbances observed, evidence of poaching (SINAC 2016).

NGOs are performing the majority, if not all, of the conservation work for sea turtles, with no financial assistance from the government, relying only on donations, private grants (such as from National Geographic, which helped to fund the InvestEGGator study) and volunteer research assistants. It is not clear this model of conservation will be sustainable in the long-term. However, the NGO directors I spoke with are optimistic that it is. They point to several trends – for one, an increasing awareness of the importance of sea turtle conservation within the country. The Directors are hopeful that the members of current younger generations, which have greater awareness of the negative impacts of turtle egg consumption, will pass these new values down to future generations. Over time, these directors hope that the cultural norm of consuming sea turtle eggs will disappear. Second, these directors point to the high amount of interest they receive from volunteer researchers across the world to join them in their efforts. As long as they have a steady supply of capable, diligent research volunteers to carry out these activities in exchange for room and board, they can keep costs down and continue their efforts. However, this comes with the downside that more international research volunteers may mean fewer jobs for locals. Creating economic opportunity for locals is not only an important part of these organizations' missions but also an important step to offset incentives to enter the illegal trade in sea turtle eggs (Campbell 2007).

A final factor that NGO Directors mention that gives them optimism about the model of NGO-driven conservation is their ability to find creative and novel revenue streams. For example, COPROT just launched a website (not common among new NGOs) where donors can sponsor a particular sea turtle, donate and purchase merchandise branded with sea turtles. The hatchery they recently completed on Playa Carate also serves as a tourist attraction, and they have formed partnerships with tour guides at Corcovado National Park to offer tours of the nursery as a part of the package. With new revenue streams, NGOs may be able to continue to fund their efforts, but there is certainly to be volatility.

5) Existing policies are adequate but lack enforcement

Given the extensive black market for sea turtle eggs and high rates of poaching in certain areas of Costa Rica (Ankersen, et al., 2015) the directors feel overall that the ban on sea turtle egg taking is helpful, but more enforcement is needed to ensure sea turtles have adequate protection. These directors are sympathetic to the significant challenge associated with patrolling the vast coastlines of Costa Rica, but also believe there is an opportunity for law enforcement to do more. Although it is illegal to take a sea turtle nest, it is still viewed as a minor crime. As a result, many of the directors had stories of poachers who had been caught, given a negligible fine and were back to poaching again shortly thereafter. When asked whether

more strict penalties could deter poaching, the directors had conflicted views. They thought that it could help some with more ‘opportunistic’ poachers, but for those who were doing this as a way of life and to make some income, it would likely not deter them significantly.

In terms of enforcement of existing laws, the NGO directors believe random stops of cars going into and out of national parks and at the border of Panama to the southeast, and Nicaragua to the north would be effective in reducing poached transport. However, on previous occasions when NGOs believed that poaching was occurring from certain individuals, they received little response from law enforcement.

Nevertheless, all NGO directors agreed that enforcement can only accomplish so much, and that when trying to deter all poaching across the country, which remains substantial, they are fighting a difficult, perhaps losing, battle. The strategies and help from the government that would have the greatest impact are:

- More direct funding of their environmental education initiatives
- Investing in targeted economic opportunities for low-income areas where poaching predominantly occurs
- Investing in youth programs to understand the values of turtles so that future poaching is not fueled by long-standing cultural consumption habits

6) More collaboration and leadership is needed from the U.S. and other developed countries

The final theme that emerged from conversations from NGO Directors is the sentiment that protecting Costa Rica’s beaches, some of the richest nesting grounds in the world for sea turtles, should not just be an imperative of local NGOs. Ideally, strong economies with heavy tourism into Costa Rica, such as the U.S. or international organizations like the United Nations. or IPBES (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services) could make funds available to support their work.

In an encouraging development, on November 11th 2019, the governments of Costa Rica and the United States signed a new agreement to further collaborate on important conservation initiatives throughout Costa Rica. The new agreement will help both countries further pool resources to protect Costa Rican national parks, reserves and other protected areas. The agreement also fosters coordination in conducting research, sharing expertise, cultivating local stewardship of resources and biodiversity and, last, collaborating with indigenous and forest communities. Perhaps most pertinent to this project, the countries agreed to focus joint efforts in combating illegal wildlife trafficking. The agreement recognizes that the illegal trade of animals and their parts, such as sea turtle eggs, places many species of concern on the path to extinction. potential extinction. The new agreement supports harsher penalties for those who are caught trafficking wildlife and efforts and best practices to rehabilitate rescued animals (Fish and Wildlife Service 2019).

IV. Recommendations to Paso Pacífico for Deployment

Based on our experiences during the summer 2019 field visits, including beta testing of the InvestEGGator, and collaborating with partner NGOs and local communities, we offer recommendations to Paso Pacífico regarding the InvestEGGator Device, NGO Selection, Deployment Strategy, and InvestEGGator tracking.

A. InvestEGGator Device

(1) Device Appearance

The design of the InvestEGGator was an important component of the discussions with NGOs about the continued use of the technology and its potential success. Based on feedback from the NGO staff, particularly with some of the community staff who were well-versed with the poaching activity, the eggs were quite realistic. Staff members appreciated the realistic softness that the 3D print design offered. They also confirmed that highly realistic painting to replicate color was not a critical factor, especially since poachers may use the same red lights the patrollers use (to not startle turtles), and with a red light any color will be distorted. Thus, we recommend that Paso Pacífico not expend energy painting the eggs in the future, which will streamline the process. The 3-D printing process is also sufficient, and once the eggs are covered in sand the fineness of the plastic and the ribbed lines on the device are obscured. Therefore, we recommend that Paso Pacífico produce eggs in whatever is the simplest and most economical process, without concerning themselves too much about achieving the most realistic appearance possible.

(2) Size & Weight

The size and weight of the InvestEGGator devices favor their use with only two turtle species. Once it was clear that poaching usually occurs at night in the dark, with either a red or white light flashlight, it was obvious that the feel, and especially the size and the weight of the false egg would be critical in going unnoticed. The egg size would have to be roughly similar to the other eggs in the nest, which vary based on species. Our interviews with community members and NGO staff made clear that the majority of poachers are quite knowledgeable about the several turtle species. In several of the communities there is even a perceived preference of egg species based on size, taste, and rarity. For example, rangers working in northwestern Costa Rica suggest poachers favor the *Eretmochelys imbricata* (hawksbill) due to their smaller size, allowing consumers to swallow the egg whole in one shot.

Based on the InvestEGGator diameter size of 45mm and weight average between 38-42g (each 3D printed egg is slightly unique; Table 1), we recommend that this current version is best used with NGOs that are working to protect nests from the *L. olivacea* and *C. mydas* species, with the weight adjusted to match the mean weight of the target species' eggs. The current size of the eggs are too small to camouflage as *D. coriacea* and too large to camouflage as *E. imbricata*, which limits their current use. However, given that the transmitter size sets only a lower limit on egg diameter, Paso Pacífico could design a second version matching the larger size and weight of *D. coriacea* eggs should the need arise.

Table 1. Egg size based on turtle species (Mortimer and Pritchard 1999).

Species	Diameter (mm)
<i>Eretmochelys imbricata</i>	32-36
<i>Lepidochelys olivacea</i>	37-42
InvestEGGator Device	45
<i>Chelonia mydas</i>	40-46
<i>Dermochelys coriacea</i>	51-55

(3) Device Settings

We conducted beta tests to determine the optimal settings to maximize battery life of the device. This is an important factor in the use of the InvestEGGator as the battery life will determine how many days the device is able to collect and transmit location information. Paso Pacifico believes the transmitters have ~7-8 days of battery life but is aware this may vary significantly based on how often it is programmed to send data. We tested three key settings: (1) the interval for device to turn on and attempt to take a GPS point, (2) the vibration sensitivity activation (device set to wake up when it detects movement or not), and (3) the level of vibration sensitivity (minimal sensitivity, medium sensitivity, and maximum sensitivity). These three components were tested under the assumption that we would like the device to attempt to take as many GPS points as possible and that this will deplete the battery quickly, which could be a concern.

Discussions with NGO staff informed us that most poachers work quickly and efficiently—arriving at the beaches at night, or during the early morning after the night patrol ends and before the morning census. We also learned that demand for turtle egg consumption correlates directly to the freshness of the eggs. Eggs are most likely to be sold directly to consumers or to bars in the local town or neighboring city in the first few days, as their quality quickly declines after that.

Although we were not able to do a robust analysis with the limited amount of InvestEGGator devices we had to work with, we were able to test 17 of the eggs at different settings. Based on visual analysis alone, the vibration setting on or off nor the vibration sensitivity level seem to impact battery life (Figure 1). We do see that interval setting (10/30/60 min) does make a difference, in that eggs with more frequent interval (10 minutes) run out of battery sooner (Figure 1). However, the mean difference in transmission time was less than 10 hours. Taking into account that eggs are consumed, sold, and bought quickly we can recommend that the life of the battery may not be a decisive factor for NGOs interested in using the InvestEGGator, particularly in situations where the eggs are sold in markets within a couple hours transport time of their poaching sites.

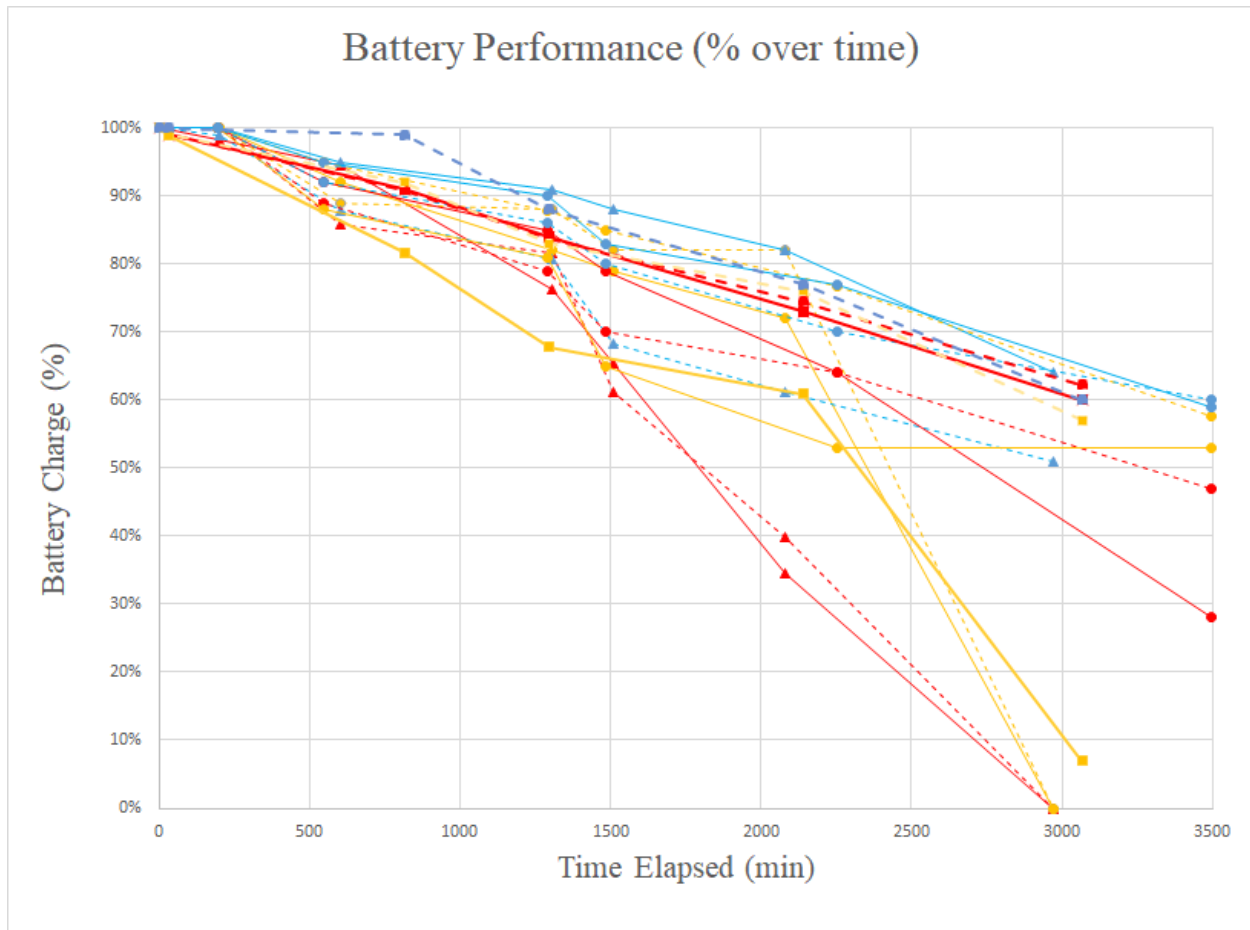


Figure 1. Battery performance of InvestEGGator device at three different interval settings. Color indicates interval settings (10 minute setting are in red, 30 minute setting are in yellow, and 60 minute setting are in blue). Vibration setting is either on (dotted line) or off (solid line). Vibration sensitivity setting is indicated by different symbols (level 2 is represented by circles, level 3 is represented by triangles, level 4 is represented by squares).

(4) Light Settings

The InvestEGGator devices have a setting option to keep a small indicator light on when the device is on and awake. Although this is helpful for the user to know that the egg is on and charging, we agree with Paso Pacífico that it should be turned off before deployed, as the light would be an obvious indicator to poachers that the egg is artificial. To avoid the potential deployment with the light still on we recommend that this light be turned off before the devices are given to the NGOs, or potentially find a way for the future design to not even have the lights on as an option as we experienced some difficulty on our second field visit trying to ensure all of the lights were off and would stay off. As a follow up from these results, Paso Pacífico’s next models are planned to include a speaker to play a tune when the device is turned on or off.

B. NGO Selection

(1) Community Relationship and Involvement with NGO

The relationships between NGOs and communities play an important role in determining the best strategy for NGO participation in the InvestEGGator project. It can help NGO leaders decide whether to work with this new device or even how much and what information they want to share with their staff about the InvestEGGators. For example, some NGO partners were careful about what they shared with community patrollers because of fear that this would ruin the relationship with the community members. In situations where the community was highly involved with patrolling, the concern was that local residents would lose trust in the NGO if they knew about the organization working with a GPS tracking device. Only one of the partner NGOs were not bothered by this concern. Based on these experiences, we suggest that interested partners carefully consider how their involvement with the InvestEGGators will affect their community relationships and or design a clear plan about who will be involved in the project. This will help NGOs select the ideal person for deployment and during which patrol shift this should occur. We think it is important for partners and Paso Pacífico to have this conversation, specifically for those who follow a community-based conservation approach. This might not be a major issue for NGOs that are less involved with the local residents or whose main staff consist of non-local research coordinators and assistants but who nonetheless may interact with members of the community.

(2) NGO Interest and Commitment to the Project

During our field site visits, the excitement of being able to work with the InvestEGGators was evident in all partners. However, the observed mutual interest and commitment from partners to the project was far more important because it made it easier for our team to determine how many InvestEGGators to leave for deployment. We suggest that in the initial conversations with potential partners, Paso Pacífico gauges this interest and commitment of the NGO before investing time in training them and more importantly before making the InvestEGGators for the partners. Once the NGO decides to work with Paso Pacífico and vice versa, we propose Paso Pacífico to establish a set of guidelines and expectations or an agreement to make sure the provided InvestEGGators are actually deployed during the nesting season. For example, once the partners have the InvestEGGators, Paso Pacífico could ask them to start and/or end deployment by a certain week or month. While the dates are not exact, it may create some accountability and effort in both parties.

(3) Patrolling Protocol and Shifts

Each NGO has a different monitoring and patrolling protocol which could affect when and how deployment happens. For example, NGOs that patrol at night or dawn can deploy the InvestEGGators without fear that poachers might see them place a fake egg inside the nest. Additionally, in some visited beaches, the time of poaching activity may vary by patrolling shifts. If patrolling happens one shift right after another and beaches are not left without attendance between shifts, we recommend deploying a fake egg after the last shift happens. However, if for example there is a break in between shifts, and there is a record of poachers taking advantage of this time when beaches are left unattended, then deployment can happen after the first shift and after the last shift. Still, we do not recommend deploying during shifts that are close to sunrise because poachers may be nearby waiting for patrollers to leave and may notice the deployment. Additionally, some NGOs may have morning census where they return to the beaches after sunrise or early in the morning to check on the nests laid that night. This is the perfect time to check on the nests with an InvestEGGator. If poaching has occurred patrollers can immediately check the egg status via the ReachFar app or communicate with the user that has access to the app.

(4) Relocation of Nests or Use of a Nursery

We understand that some NGOs relocate nests as a means of poaching deterrence and also to protect nests that have been laid too close to the water. Some NGOs may focus their conservation efforts in relocating nests to nurseries or hatcheries. If this is the case, the InvestEGGators may not be suitable for NGOs that follow this approach. This is because deployment and possible poaching of the real eggs along with the fake egg is more likely to occur if nests are undisturbed and left in their original state or location. We learned from NGO staff that poachers actually do not poach or open nests if they notice that they have been relocated by the patrollers. Some of the patrollers suggest that some poachers, specifically local ones, do not poach these nests “out of respect for the patrollers that saw the nest first.” If this is the case for some partners, then this could free up extra resources for NGOs to invest in InvestEGGators for beaches where relocation to nurseries does not occur. For this reason, we suggest that Paso Pacífico becomes aware of the patrolling approach and methods and whether they use nurseries before establishing a potential partnership with the NGO.

C. Deployment Strategy

(1) Selecting the right Beaches

Beach location and condition are critical when selecting where to deploy the InvestEGGator. If the organization patrols different beaches it is recommended to first check the general cellular signal. The InvestEGGator is equipped to take a location point with either cell-phone or GPS satellite signal. However, in order to communicate with the user and send that location status through the ReachFar app, gps123.org, and or SMS messaging it requires reception from a cellular tower. If there are several beaches that the NGO patrols, it is best to choose the beach with the strongest and most reliable signal for the actual deployment. Keep in mind that signal strength may vary if it is obstructed by tall infrastructure such as buildings, large trees, and mountains. However, if there are beaches with minimal to no signal, it is recommended to choose the beach that is nearest to a major city or a major road. In this case if the poachers take the eggs, the InvestEGGators would immediately pick up signal once they leave the beach. Although you may not see the exact start of the path taken from the beach, the route taken from a major road or highway to a major city will still provide useful information about the final destination of the eggs. In addition to signal, it is preferred to select the beach with the highest poaching activity (a beach with poaching rates of 20% or higher) to increase the chances that someone might take the InvestEGGators.

(2) Nest Selection for Deployment

Choosing the right location of where to deploy the InvestEGGator will increase the chances that a potential poacher will choose that nest when searching for sea turtle eggs. We recommend choosing nests located near a road, trail system, or even a nest on a part of the target beach that is facing in the general direction of the closest neighborhood or town or otherwise more accessible to potential poachers. If there are any nests near boats or fishing posts this may also be a good location since according to our interviews, some opportunistic poaching may be done by fishermen that see a nest near their favorite fishing spot. In many cases, poachers are most likely to enter the beaches from these trails, poach the nearest nest they find and immediately exit the beach through these pathways. Nests located near the high tide line should be avoided for chances of being destroyed by the water.

(3) Deployment Method During a Beach Patrol

Considering the nest selection process above, pay attention to the general direction of where the female turtle is heading to lay her eggs. If it appears that she might place her nest very close to the entrance of the beach or near a trail this might be the perfect home for the fake eggs. While waiting for the turtle to begin laying record the InvestEGGator ID number you plan to deploy in that nest. Once the turtle has laid about a quarter of the average number of eggs that are laid by that particular species, grab an InvestEGGator and place the decoy egg on top of the real eggs. The InvestEGGator will be covered by the real eggs that are still being laid. Place the second decoy egg in the top half of the egg clutch. If only one InvestEGGator will be deployed per nest, we recommend placing it in the middle of the egg mass. During a pilot study, patrolling staff followed the same process described above but in addition used some of the mucus secreted from the cloaca during oviposition. This cloacal mucus should be rubbed around the fake eggs and then covered with a bit of sand. Doing so will help the InvestEGGator look more realistic and decrease the chance of being detected by poachers.

(4) Deployment Time based on Turtle Species

In addition to the dimensions of the current InvestEGGator and how this corresponds to the actual size and weight of the real eggs, we also recommend paying attention to how each of the species varies in their nesting process. During our field visits, we were surprised to see that *L. olivacea* took less time to search for the right nesting location, excavate the nest, and then lay eggs (45min-1hour) versus *C. mydas* which took longer (about two hours for the whole process). For this reason, we recommend that nests of *L. olivacea* will make for a faster deployment than *C. mydas* if NGOs are under time constraints during the patrolling shifts. However, based on the dimensions of the InvestEGGators we still believe deployment in *C. mydas* nests is optimal. This approach works well in beaches where patrolling involves walking from one end of the beach and back. The patroller can make a note of the *C. mydas* that is starting to excavate, continue the walk, and then return by the time it has begun laying. Again, patrollers with extensive experience during our visit were well aware of this nesting process, their estimation of when egg laying would begin was very precise.

(5) Number of InvestEGGators to Deploy

The actual number of eggs to deploy will depend on the total number of eggs available for that season and on how prevalent poaching activity is. For example, if more poaching is occurring more than usual, it will make most sense to deploy at least two eggs or more each night, per nest (keeping in mind the nest selection process mentioned above). We suggest placing two eggs in each nest because poachers almost always take all the eggs from the nest and only leave one or two behind. We suggest placing one in the lower half of the egg clutch and one in the upper half. Placing two eggs per nest would maximize the use of the InvestEGGators if the organization decides to deploy in multiple beaches. We also recommend placing two devices based on our experience in working with them, there is a chance that some may stop working (presumably because of low quality). If the nests with the InvestEGGator inside were not poached at the end of the nesting season it will be ideal to try to retrieve the InvestEGGators and check them to see if they are still working to use them the following year.

(6) Adequate Training and Who Should Deploy

The InvestEGGators are relatively easy to deploy, requiring only one well-trained person to place it in the nest. After they undergo training, community staff patrollers would be the most adequate individuals to conduct the deployment because of their extensive experience with watching the entire oviposition process, assuming these individuals are trustworthy (i.e., unlikely to advise poachers of the project) and comfortable

using the technology. These experienced patrollers know when the turtles have laid the right number of eggs to begin the deployment process. As mentioned above, some patrollers were once poachers themselves and are quite aware of how poachers operate (which nests they would poach, what signs of nesting activity they look for). This knowledge was invaluable during the pilot study and we believe it is advantageous for NGOs. We suggest that whoever conducts the physical deployment they should be comfortable with handling the cloacal mucus as well as knowledgeable about how to approach a sea turtle during the egg laying process. In beaches where patrolling involves taking measurements of the sea turtle, the monitoring protocol can still occur and deploying the InvestEGGator will not hinder this process in any form.

However, we understand that this process may be unfamiliar and uncomfortable to many even after training for obvious reasons such as concerns for their security (if, for example poachers are violent and even armed) or the right way to handle the InvestEGGators. Nonetheless, during our interviews we quickly realized that the patrollers were fascinated by the InvestEGGators and wanted to at least try to deploy despite some of the technical difficulties. We believe it is important for all participating staff involved with the InvestEGGator project to undergo training and to communicate any concerns with a Paso Pacífico staff member during or after the training. This is especially important if Paso Pacífico has limited resources and is unable to visit every NGO and the beaches they patrol. With the deployment guidelines and the device manual, Paso Pacífico staff would only have to conduct a single training session with all participating NGOs within that country or an individual training through an online platform such as Skype.

D. InvestEGGator Tracking

(1) ReachFar Smartphone Application

As part of our two field visits, we trained over 20 NGO staff members, directors, research assistants, and volunteers on the use of the ReachFar application. It was very well-received, and trainees found it to be user-friendly, especially once we found that it could be downloaded in Spanish it became easier for Costa Ricans less comfortable with English. We recommend the continued use of the ReachFar Smartphone application. Based on our most successful training experiences during our second field visit, we recommend Paso Pacífico to hold a thorough workshop focused on the application use, particularly distributing an InvestEGGator to each trainee and allowing them to sign in to the application and practice tracking eggs and adjusting any settings as required. For NGOs to have more control over the InvestEGGator devices and autonomy from Paso Pacífico, we recommend that a key person from the NGO be set as the main ‘SOS1 phone number,’ so that they will be receive any SMS notifications instead of Paso Pacífico researchers (as was the case during the pilot study).

(2) Cellular Signal Limitations

Our two field visits confirmed the importance of cell phone signal when using the InvestEGGator device. Part of our difficulty in using the devices was due to the lack of cellular towers and cell phone signals on the remote beaches, both on the Caribbean and Pacific coasts.

If Paso Pacífico decides to expand their collaboration with NGOs to other beach areas of Costa Rica or other countries, we recommend that the beaches be tested for cell phone signal prior to the Paso Pacífico arrival, as this is a critical component for the success of the InvestEGGator. In addition to the application that Paso Pacífico already uses to test signal (Open Signal), we recommend explicit discussions with NGO staff to determine the quantity and quality of cell phone signal on the beaches they patrol, the local roads, and where they believe the eggs are being transported to.

In the case of the test deployment in Costa Rica, one problem we encountered was that the global SIM cards provided by the company Hologram did not work with the Kolbi ICE network, which was the only network available at two of the five deployment sites. Although the eggs did transmit once they were taken to nearby large towns with coverage from multiple carriers, this discovery precluded the ability of eggs to transmit within a few kilometers of the deployment beach, and came as a surprise to both the researchers and the company which produces the SIM cards. Hologram was later able to determine that the special SIM cards used with the transmitters (which have US numbers, unlike their standard IoT SIM cards) were incompatible with the Kolbi network. We therefore also recommend that end users either test Hologram SIM cards at their deployment site prior to purchase of InvestEGGators, or that they plan to use locally-available SIM cards, bearing in mind that they may face more technical difficulties since Paso Pacifico would not be able to test programming compatibility with the network prior to deployment.

(3) ArcCollector Application

After having the opportunity to patrol with staff members from all five NGOs on their respective protected beaches, we got a glimpse into the large number of detailed notes that are collected during night-time patrols, morning censuses, and turtle nesting and hatching. To help the collection, organization, and management of all of this nesting data, we recommend the use of the Collector Application (published by ArcGIS) for the NGOs. Using the Collector App will assist in recording the positional location of nests and monitoring their status, throughout the year. The Collector App could also be helpful in the deployment of the InvestEGGator devices, in recording where they are deployed, and also in recovering them from nests that do not get poached (after the real eggs hatch) to be reused in the next nesting season. (A more detailed description of the Collector can be found in the Appendix). Another application that may be of interest to NGOs for this same purpose is Avenza Maps. This application uses geospatial PDF maps and a phone's internal GPS hardware. The user can find their location on the map and even create new GPS points on the geopdf. The application requires no cellular signal or connection to the internet which could be most useful for NGOs working in remote areas.

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2020

INVESTEGGATOR USER MANUAL



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The InvestEGGator User Manual

Welcome

Thank you for your interest in the InvestEGGator. This manual shows how to operate the device and addresses the most frequently asked questions that may arise when using the product. We recommend reading the entire manual before using the device to avoid common issues or complications.

1. Introduction

Developed by [Paso Pacifico](#), the InvestEGGator is a GPS-enabled tracking device designed to look and feel similar to a sea turtle egg. The 3D printed egg is ideal for nonprofits, law enforcement, or other organizations that focus on the conservation and protection of sea turtles. The purpose of the InvestEGGator is to detect and deter sea turtle egg poaching activity as well as to provide an idea of the general poaching route used by poachers. Initial configurations and deployment of the device will depend on each NGO's unique conservation approach as well as the environmental conditions of the sea turtle nesting grounds.

1.1 Technical features

Each InvestEGGator device is associated with a unique 10-digit identification number, the last 4 digits of which are located in a small sticker above the USB port that is visible when the charging port door is opened. It may also be located on the outside surface of the device. If you have opted to use the Hologram IoT SIM cards, the SIM card inside is also associated with a chip identification number and a phone number. You should have received a spreadsheet with transmitter identification numbers, SIM card numbers, and their associated phone numbers from Paso Pacifico.

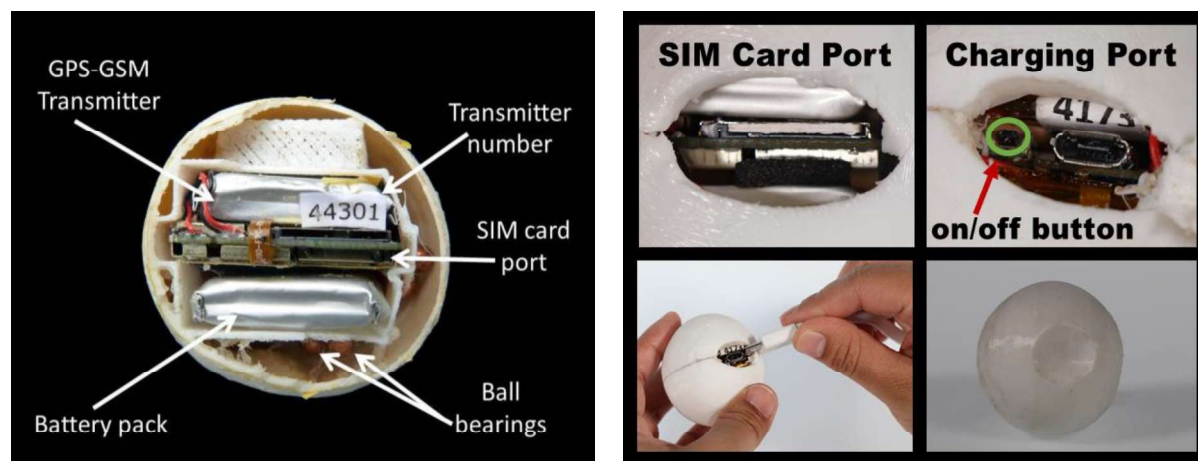


Figure 1.(a) Cross section of the InvestEGGator and its internal components (photo credit: Kimberly Williams). (b) External features of the InvestEGGator.

The following is a list of the InvestEGGator's key features and additional components to be familiar with (Fig.1)

- Charging port for access to the transmitter's USB port and off/on switch
- A USB port which enables connection to a computer or charging via USB cord
- Transmitter to relay real-time GPS location (based on satellite signal) or LBS location (based on cell phone tower signal).
- SIM Card for transmitting text messages to sos1 phone number
- USB cord for charging and manual programming
- USB Charging station with display screen and multiple USB ports
- Smartphone application: [ReachFar](#)
- Website platform: www.gps123.org

2. Programming

There are four different methods that can be used to program an InvestEGGator:

1. Smartphone application (ReachFar)
2. Web Platform (gps123.org)
3. Manual Programming with Txt file and a PC computer (see appendix)
4. SMS (text messaging) codes sent via cellphone (see appendix)

The smartphone application and web platform are explained in the next few pages.

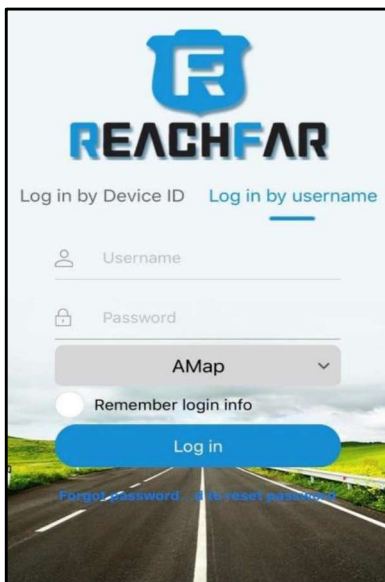


Figure 2. ReachFar log in screen. Log in by Device ID should be selected before entering username and password.

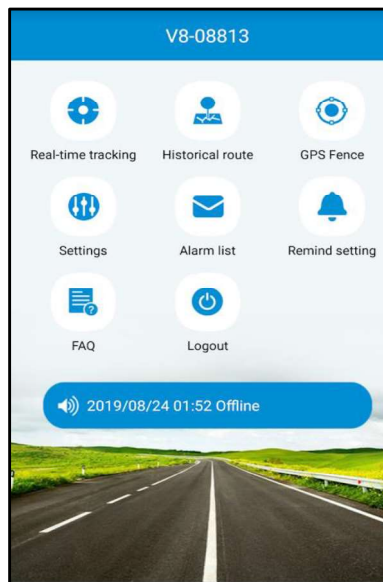


Figure 3. ReachFar home screen. These are the main items that you should see on the home screen.

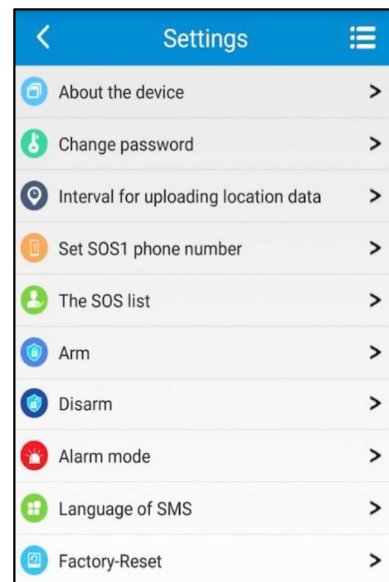


Figure 4. InvestEGGator settings that can be adjusted via the ReachFar App.

2.1 ReachFar Smartphone Application

The ReachFar Smartphone application offers an easily accessible, user friendly option for programming. To begin programming complete the steps below.

1. Download the ReachFar application from the Google or Apple app store.
2. Open the app and log in by using the **Log in by Device ID** option (*Fig. 2*)
3. Device ID is 210400 plus four-digit code. The only numbers that change are the last four digits, i.e., the entire 10-digit code would be:
210400 + 8821
4. As an example, use this information to log in
ID: 2104008821
Password: 123456
5. Once logged in, you should see the following options on the ReachFar main screen (*Fig. 3*):
 - Real-time tracking
 - Historical route
 - GPS fence
 - Settings
 - Alarm list
 - Remind setting
 - FAQ
 - Logout

2.2 ReachFar: Settings

There are many settings in the InvestEGGators that can be adjusted through the ReachFar App Settings window. Note that these settings can only be updated if the InvestEGGators are online and communicating with ReachFar via cellular network and with the data enabled on the phone with the app.

To adjust these complete the following steps:

1. Navigate to **Settings** by clicking on the icon
2. You will see the following prompts (*Fig. 4*):
 - About the Device
 - Change Password
 - Interval for uploading location data
 - Set SOS1 Phone number
 - The SOS List
 - Arm
 - Disarm
 - Alarm Mode
 - Language of SMS
 - Factory Reset
3. Ignore the first two and the last setting options. Changing the password and resetting the transmitter will prevent other users from logging in to ReachFar and the route history/data will be lost. Unless your research requires that your data be kept completely confidential, we recommend

that you not change the password. Keeping the same password will facilitate remote support from Paso Pacifico staff. Should you need to protect your data, make sure to change the password before data collection begins and inform those that may need (and have permission) to log in to see the information for that particular InvestEGGator.

4. In **Interval for uploading location data** you can change the interval at which the transmitter will take a GPS or LBS-based locations (depending on which signal it locates first, cellular tower or GPS satellite). The ReachFar App only has these time interval options: 1 minute, 10 minutes, 1 hour, 12 hours. Other time intervals must be programmed via the web platform, SMS message, or manually with the computer using the .txt file option. (*See Appendix for more information*)
5. In **Set SOS1 phone number** you can designate the master phone number that will receive the SMS alerts. For the purposes of this project, the SOS1 should be set to the principal investigator's phone number. You may also add additional numbers to receive messages under the **SOS list**. However, only the SOS1 number will receive SMS messages from the transmitter, should this option be enabled. The SOS numbers should be entered exactly as they would be dialed from the number associated with the phone. If you will be using a Hologram IoT SIM card, please see Appendix X, "Hologram SIM Cards"
6. The **Arm** setting will program the device to send alerts if it's set to detect noise or to detect movement or vibration. For the purposes of this project, the device can only be set to detect vibration. Every time the device detects a movement or vibration it will send an alert both to the SOS1 and to the ReachFar App if you have programmed it to do so. You can find the alerts under **Alarm list** (*Fig. 5*).
7. Use the **Disarm** settings to turn off the vibration and noise alerts.
8. If you select the vibration alerts, make sure to choose the method and platform where you wish to receive the alerts at by using the **alarm mode** setting. Ideally, the device should be programmed to send alerts to the platform (i.e., to gps123.org and to the ReachFar app); however, under certain circumstances it may be desirable to also send SMS messages, for example if the SOS1 number is not a smart phone.
9. The **Language of SMS** setting only has English, French, and Chinese options. However, when you download the app on your smartphone, the app will automatically be set to the main language that your phone is set to. Switching the language preference on your phone will also change the language on the app.

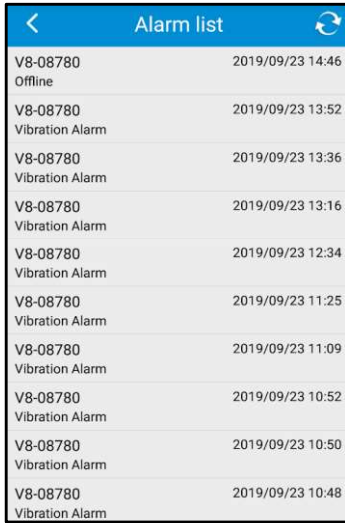


Figure 5. ReachFar Alarm list provides a list of notifications sent by the transmitter every time a vibration was detected.

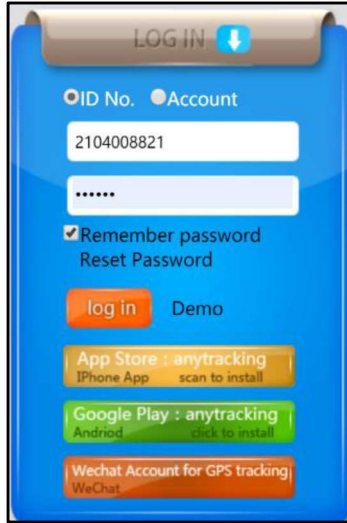


Figure 6. GPS123.org main login screen. Select ID No. before inputting username and password.



Choose the appropriate Language here to help you navigate the website.

2.3 GPS123.org Website Platform

Similar to the ReachFar App, the web platform, GPS123.org can also be used to program settings. The device needs to be online and able to transmit and receive data, and if it is not, the platform will not allow you to make changes.

To access GPS123.org use the following steps:

1. In a web browser navigate to GPS123.org (Fig. 6); if this is the first time using the site, use the flags at the top right-hand corner of the site to select your language.
2. Select **ID No.** and enter the Device ID and Password
 - DeviceID = 210400 + four-digit code
Example: 2104008821
Password: 123456
3. Once logged into the platform, choose the **Monitor** or the **Statistics** tab on the top options ribbon. Any settings programming will take place under the Monitor tab. From there, choose the drop down under Settings left-hand panel and select **Device Setting** (Fig. 7)



Figure 7. In the left-hand panel of GPS123.org is where the you can find the key settings and features that can be adjusted for the InvestEGGator.

4. Under **Device Setting**, you can make changes to many settings. The settings are divided into two categories (*Fig. 8*):

- **Control Command**
 - Remote Restart
 - Arm
 - Disarm
 - Version
 - Restore factory
 - Check device state
 - A single location
- **Set Command**
 - Upload Interval
 - master No. (SOS1)
 - SOS2
 - Set SOS number
 - Indicator setting
 - Alarm fashion
 - SMS language
 - Remote update

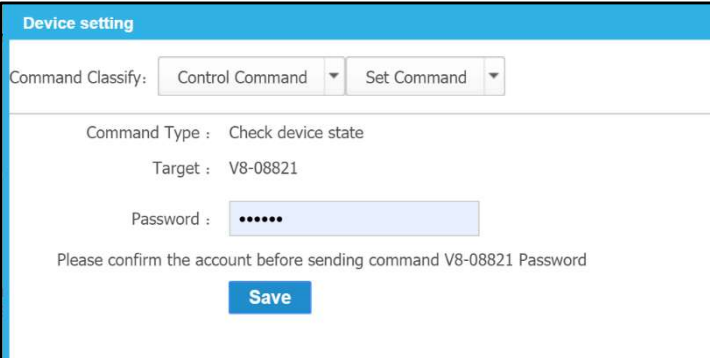




Figure 8. Device Settings in GPS123.org with two main categories.

Special Note: The settings options in GPS123.org are nearly identical to the setting options accessed through ReachFar. For each individual setting, you will need to “confirm account before sending command,” so it is advisable to have the password saved automatically on your smartphone in case you forget.

3. Monitoring Instructions (ReachFar and GPS123.org)

3.1 ReachFar: Real Time Tracking

Looking at Real Time Tracking image (*Fig. 9*):

- Blue Circle: Represents the user’s current location if the smartphone’s location setting is turned on.
- The compass arrow (pictured here in the color green) with the text box above is the location of the transmitter.
- A green arrow means the InvestEGGator is online and if you want to you can send different commands through the website, smartphone app platforms or via SMS messaging.
- A Gray Arrow means that the device is offline. Any commands you send will **NOT** go through.
- The Text box above the arrow allows you to see the last time the device submitted a reading of its location.
 - In *Figure 9* we see that the device (V8-08796) status is “Stationary”
 - The last reading of its location was at 06-06-2019 at 09:58:37
 - The current speed is 0.00 km/h as it has not moved.
 - Direction: East
 - Distance from current point: 3km
 - The  on an iPhone or  icon on an android in the upper-right corner allows you to do a single refresh, which should refresh the location to its most recent reading.

- The arrow icon facing northeast in the lower right-hand corner allows you to switch to other map options such as Apple maps if you have an iPhone.

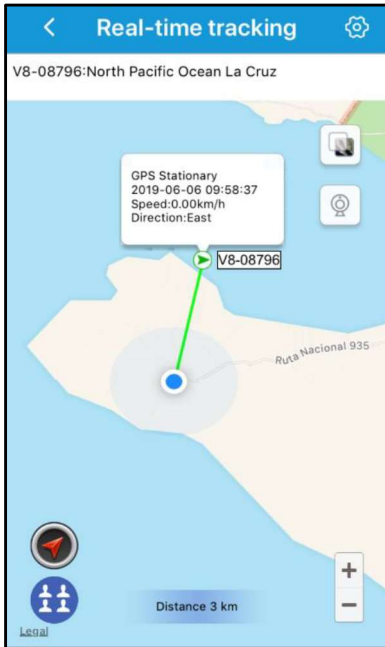


Figure 9. Use real-time tracking option to determine your current location and the location of the device.

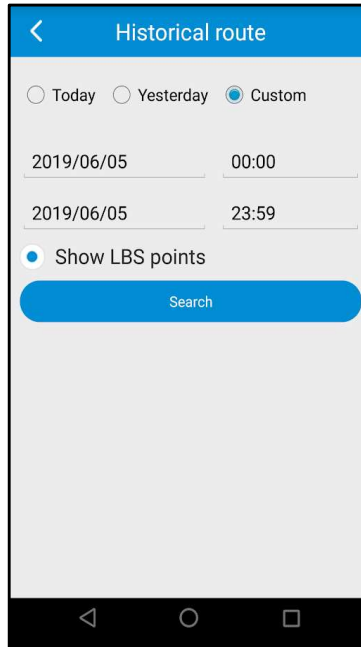


Figure 10. Customize your search to specific dates and times with Historical route.

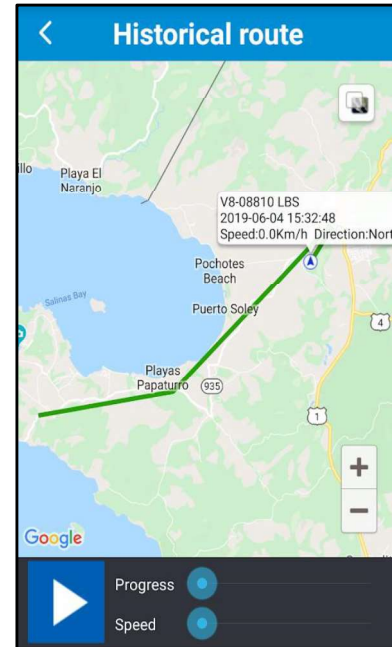


Figure 11. Historical route shows the general direction that the InvestEGGator took.

3.2. ReachFar: Historical Route

This feature allows the user to see the InvestEGGator’s route over a specified time period using the last LBS and/or GPS points it obtained. It is not an exact route since the program just approximates the route from the known points using Euclidean Distance (“as the crow flies” Distance).

- Click on the **historical route icon** to see a timeframe appear. There are three options (Fig. 10):
 - Today
 - Yesterday
 - Custom
- Make sure the **Show LBS points** option is always checked.
- **Custom** allows you to pick the desired dates and times. If error message indicating **No Data Obtained** appears this means that the InvestEGGator was not connected to a cellular network or GPS signal during the specified time frame and therefore it did not record any positional/location points.

Note that in the custom option you can only search the historical route within a 24-hour time period otherwise you will get an error message as well. (If you wish to see paths for a multi-day

period, or to download paths, this can be done on the gps123.org web platform under “Playback”, as described below.)

- The green lines as seen here indicate the approximate path that the InvestEGGator took during this time (Fig. 11).
- Use the **Progress** function to walk step by step through the InvestEGGator’s journey (Fig.11). The map will display the InvestEGGator’s location at the start of the time period specified. Slide along the progress bar to see specific points along the route, the direction that the InvestEGGator was taking, and the time of the reading
- Use the **Speed** function to adjust how fast the map shows the progress (Fig.11).
- Zoom in or out on the map to see the full extent of the route

3.3. GPS123.org: Monitor Tab

The monitor tab of the website platform allows you to see information about the InvestEGGator’s location in various ways. Similar to the ReachFar application, the text box on the home screen provides the following information (Fig. 12):

- Device: V8-08821
- Status is “Offline”
- The last reading of its location was on 06-07-2019 at 01:35:13



Figure 12a. Monitor tab on the website platform is similar to the app.

After clicking on the **Monitor**, head to the left-hand panel from which you can choose the **Tracking** or **Playback** options (Fig. 12a-12b).

- Click on the **Tracking** option to open a full screen map display with information about the last positional point that was taken. As seen in the image below, this includes.
 - Device: V8-08821
 - The last reading of its location was at 06-07-2019 at 01:35:13

- The device has mileage of 0 M.
- The latitude and longitude of the last location (11.03407, -85.72305)
- Direction and Speed are 0.00km/h as it has not moved

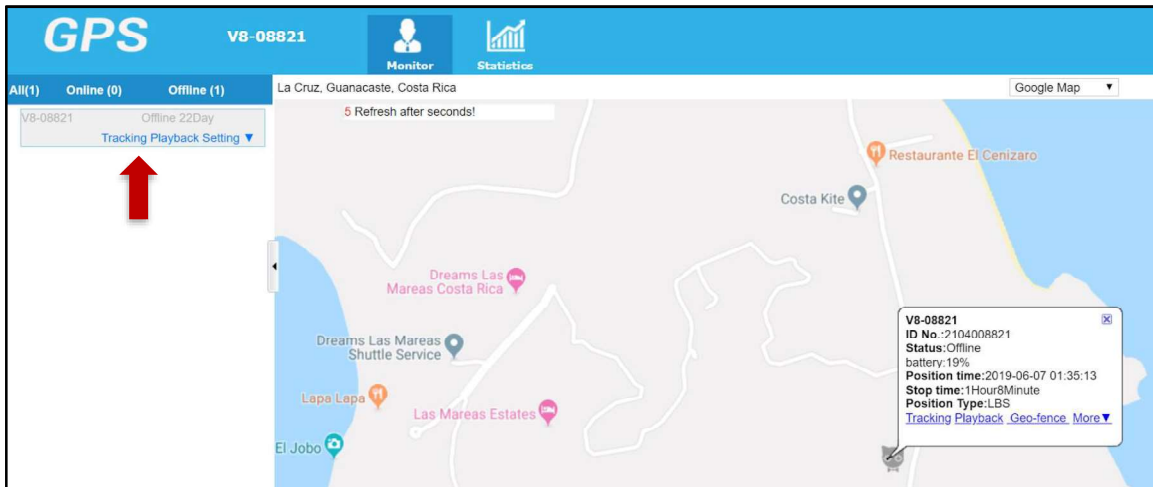


Figure 12b. The Tracking Playback Settings will appear after clicking on the Monitor tab on the website.

- Click on **Playback** on the left-hand menu to view the entire series of location points that have been recorded on the device. Because the transmitter packages are sourced from a Chinese company, the website automatically shows a map of Eastern China (Fig. 12b).

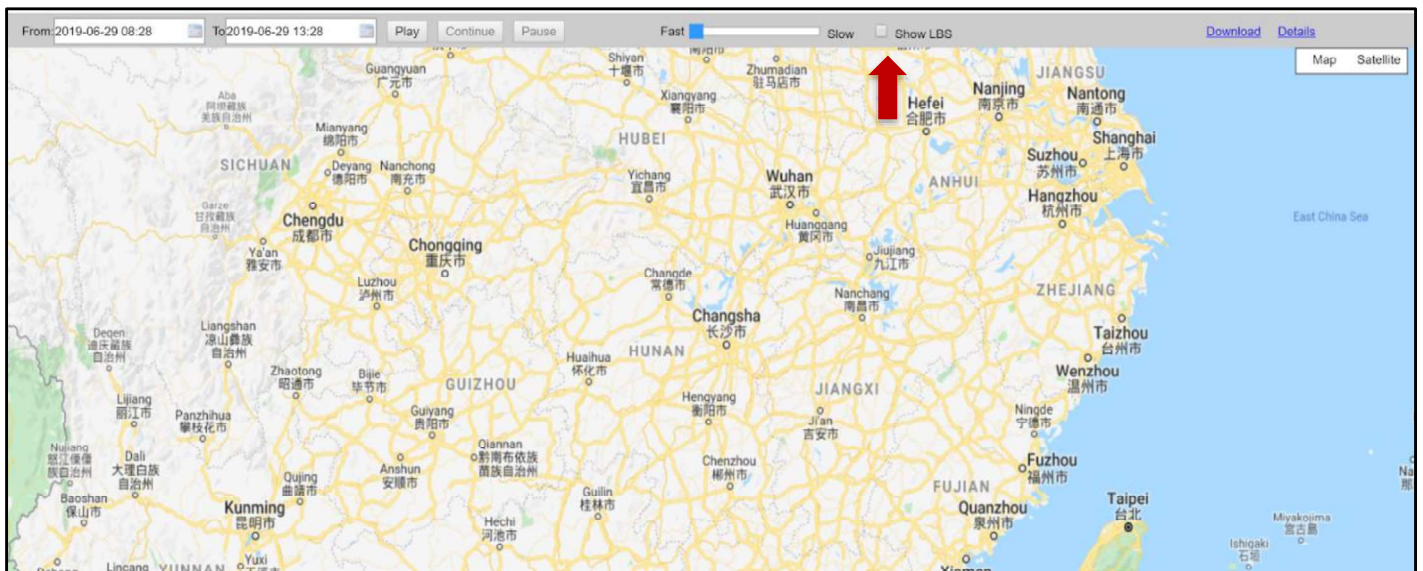


Figure 13. Make sure that **Show LBS** is always selected to get all the location points that the InvestEGGator to get a better estimate of the route taken.

- For a customized monitoring playback, you can make adjustments on the top ribbon to display the specific time and dates of location series. To do this:
 - Choose the date and time for when you would like to start the playback under the **From** drop down menu, and then choose the ending time under the **To** drop down menu (*Fig. 14*).
- Move the slide bar on the right from **Fast** to **Slow** to be able to view the points during Playback. Choose the **Slow** option to make it easier to see each location point.
- Click on **Show LBS** to display all points (include cell phone tower data locations, in addition to GPS location) (*Fig. 13 and Fig. 14*).
- You can now press the **Play** button and see a Playback of the locations recorded in the selected time period (*Fig. 14*).

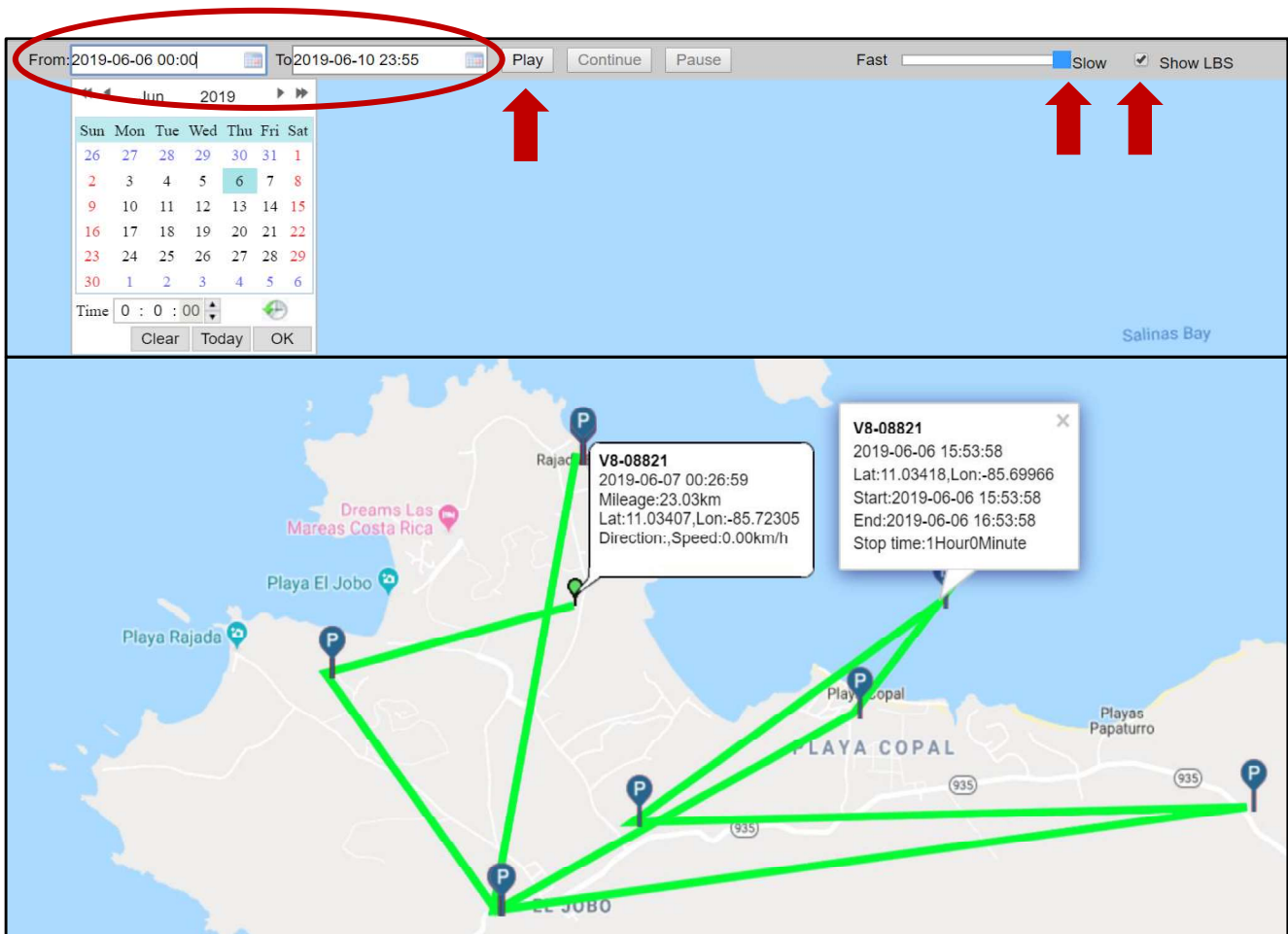


Figure 14. In GPS123.org, you can choose multiple dates and you are not limited to a 24-hour time period as you are in ReachFar App when choosing to do a customized monitoring playback.

4. Frequently Asked Questions

1. *How do I know the egg is working/moving?*

- Based on the vibration setting alarm, you should get at least one alert message through ReachFar. The person set as SOS1 will also receive an alert SMS message whenever it detects movement.

2. *Why does the InvestEGGator seem to be stuck in a single place for a long time?*

- This may be for a few reasons: 1.) The device has actually not moved 2.) It has been buried and cannot obtain a signal 3.) The device is “hung up” – especially when not receiving and GPS signals, occasionally a device shows as being in a previous location despite having moved 4.) The battery has died 5.) It has incurred some type of failure due to environmental conditions/damage.
- If you have the InvestEGGator with you, plug it into the charging port to see if this will help reactivate it. You can also take it for a drive to areas with more signal to get it back online.

3. *What is the best time interval setting to set it to?*

- We recommend a setting between 10 and 30 minutes; at a setting of 10 minutes, the device will last 5-8 days on a full charge. However, be aware that lower time intervals will provide more GPS/LBS points that will produce a better estimate of the route used if the InvestEGGator has been taken, but it may lose battery life a day or two earlier when set to a higher time interval.

4. *What is the best vibration setting?*

- The transmitters are already pre-programmed to setting #3 which is enough to detect when the transmitter is being picked up or if it’s being transported from one place to another. You should see the vibration alarms on the app under the “alarm list” option.

5. *What happens if the InvestEGGator stops sending me vibration alerts?*

- This may be for two reasons: 1.) If the InvestEGGator has been deployed into the nest, then it will not be able to receive any satellite or cell phone tower connection even if it comes on every X number of minutes based on the time interval it was set to. 2.) It may be that during transport or handling the SIM card came loose or some other hardware or software problem occurred that is preventing the transmitter from connecting to any signal at all.

6. *How do I know they are fully charged?*

- The InvestEGGators only require about 4-5 hours to be fully charged.
- If you have the lights active, you will see the lights flashing while charging but they will stay on constantly once fully charged.
- If you have the lights off and want to check the charging stats, after unplugging from the charging station and before deploying you can also log in to ReachFar or gps123.org with

the unique transmitter ID and password to get the latest status on battery life. Keep in mind this battery status was taken the last time the transmitter took a GPS/LBS location point. Therefore, it never hurts to charge it a few hours before deployment. However, avoid leaving the device plugged in charging overnight or for long periods, as this can decrease battery life.

7. *Will putting the InvestEGGators inside with the sea turtle eggs damage or negatively affect the biology or development of the hatchlings?*

- There is currently no evidence that the InvestEGGators will impact the development of the hatchlings. Based on initial observations and first deployment by Pheasey 2019, when the InvestEGGator remained inside the nest for the remainder of the incubation period there were no physical or visible developmental problems observed in the hatchlings.

8. *What is the difference between online and offline?*

- Online: when the InvestEGGator is online it means it can detect and connect to a cellular signal so it can communicate with the SOS1 and tracking platforms. Any commands that you send via SMS, ReachFar, and GPS123.org will be activated if the device is able to get cellular signal.
- Offline: the device is offline when it cannot find cellular signal. At this point it is in “sleep-mode.” This means that it’s still turned ON, but it’s not using battery and not connecting to GPS or cellular signals.

5. Common InvestEGGator Issues

The InvestEGGators can provide helpful information about the nearby location or route of the subject of interest. In this case, the goal is to estimate the trade route of poached sea turtle eggs. However, there may be some common hardware or programming issues that may arise when working with them and it’s important and helpful to be aware of these.

1. *SIM Card*

- In the process of handling the InvestEGGators the SIM card may become loose and this will cause the unit to stop sending alerts and go offline. This is a common problem if you press on the exterior of the egg to turn it on and off, rather than removing the tab and using a tool to press on the button to turn the egg on/off. If this happens, you can push in the SIM card in place after unplugging them from the charging station. If you have opted for the pre-installed Hologram cards, it is very rare that this will happen because they have been glued in to keep the card in place.

2. *Lights on and off when charging*

- The InvestEGGator has indicator lights that show the status of the cellular and GPS signals received; however, these indicator lights must be turned off before the egg is deployed into the nest. All the InvestEGGators used will be pre-programmed to have the lights on OFF Mode to prevent detection at night. The only issue with this is that it makes it difficult to know if the InvestEGGators are turned on. To help with this, charge the units at least 4 hours before taking them with you out into the field in case there is an

opportunity for deployment. Additionally, some transmitters may produce a slight flash of light when first plugging them into the charging station. This is normal, but afterward they should no longer show any lights.

- If at any point the lights do come on and are noticeable at night you can take them to a place with good cell phone connection and use the *text.file* to reprogram them (*See Appendix for more details*).

3. Correct Time Zone

- This setting can be useful to track the routes and see what time of day poachers are active. However, the time zone needs to be corrected to the right region which can be done through website platform. In gps123.org on the left-hand side panel click on **Settings** → **device info** → **Timezone** Because this setting resides in the web platform system, and not on the transmitter's internal programming, time zone can be set any time, even when the unit is off or not connected to cell phone signal.

4. Charging

- The InvestEGGator units should not be charged more than 4-5 hours as you risk damaging the overall battery life. Charging them a couple of hours before taking them to the field will be enough. If they are not charging, make sure the USB cable is pushed in tightly into the charging port.

5. Transmitter may stop sending SMS or becomes inactive

- If an InvestEGGator unit suddenly stops sending alerts through any platform (SMS, ReachFar, gps123.org) make sure to follow the above instructions. If the problem persists, it may be that the SIM card has become loose, or that it was discovered and destroyed. However, there are occasions where a unit may suddenly stop working altogether because of internal hardware issues, at this point you can contact Paso Pacifico's Kim Williams for further assistance to see if anything can be done remotely.

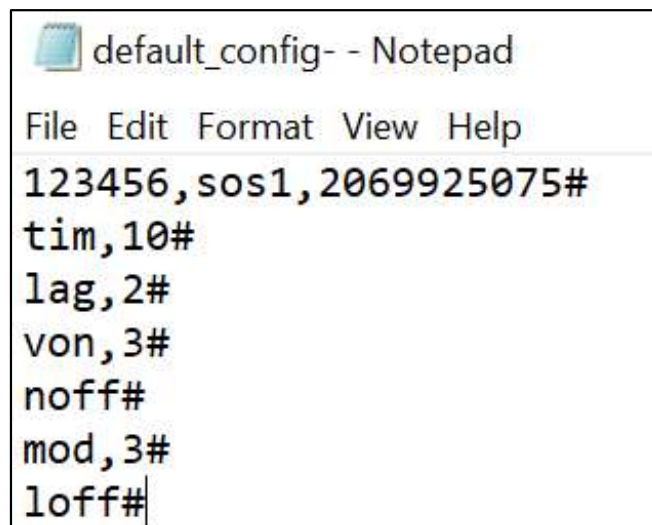
6. Appendix

In this appendix you will find additional information on the manual programming of the InvestEGGator as well as instructions on how to communicate with the transmitter via SMS text messaging.

Txt file Manual Programming

Follow the instructions below to program the InvestEGGator manually using a computer. Manual programming works best with a PC computer.

1. Turn the InvestEGGator unit OFF using toothpick-like tool by holding down on OFF/ON switch for three seconds. The OFF/ON button is a tiny black switch that is located inside the transmitter. The device is only programmable when in the OFF mode.
2. Ensure that the external drive folder shows up on File Explorer (as it would when you insert a USB flash drive); if it does not, it means the device is still ON.
3. Open notepad *txt.file* on PC and type in code in *txt.file* as shown in the picture below (Fig. 15).



```
default_config- - Notepad
File Edit Format View Help
123456,sos1,2069925075#
tim,10#
lag,2#
von,3#
noff#
mod,3#
loff#
```

Figure 15. Lines of code that are used for manual programming. Remember, all words need to be in lowercase letters and always have a # or pound sign at the end of each line.

4. Save As *txt.file* on desktop named “**default_config**”
5. Select “default.config” file and drop it into the general external drive folder that opens up when you insert the USB into the computer (not in the internal UpData folder). This needs to be done every time want to update the programing manually.
6. Right click on the external drive and click **Eject**. The InvestEGGator is now programmed. This step is crucial otherwise the InvestEGGator will not be programmed if the USB cable is removed without clicking on eject.

Textfile Codes for Manual Programming

The *txt.file* codes that you are able to program are (Fig. 15):

line1: Password, sos1, phone number followed by pound or hashtag

Example Code: **123456, sos1,2069925075#** (note that a country code is not required here)

- In order: this code provides the password, user number, phone number followed by pound or # to receive text message alerts
- Change the phone number to the phone you wish to receive alerts at. This is the designated SOS1 number.

line 2: tim: time interval followed by pound or hashtag

Example Code: **tim,10#**

- This line indicates the setting for the interval in minutes at which the device will update the user with its real-time GPS location as long as it is able to connect to cellular or GPS satellite signals.
- The above setting will update the user every 10 minutes about the device location.
- Options for time setting in manual programming: 1, 10, 30, 60 90 in minutes

line 3: lag: number designated to a specific language followed by pound or hashtag

Example Code: **lag, 2#**

- This line provides the language setting
- language setting options: 1= Chinese 2= English 3= French
- Example: to change to French it would be lag,3#

line 4: von: vibration level, followed by pound or hashtag

Example: **von3#**

- Changes the level of vibration sensitivity the device responds to. Every time it senses a vibration or movement, the device will send an alert to the SOS1 phone number.
- Options: von,1# von,2# von,3# voff
- For von, 1=most sensitive to vibration, 4= least sensitive
- For example, to change to least sensitive: von,4#
- In general, the highest setting (1) is not recommended because the user will receive alerts at every instance of vibration

line 5: noff: noise setting, followed by the pound sign. No comma is placed in between.

Example: **noff#**

- Change noise alarm setting to on or off
- It is important to keep this setting off to prevent poachers from detecting the InvestEGGator.

Line 6: mod: notification mode followed by the pound sign

Example: mode, 3#

- Indicates how the user wants to be notified
 - 1 = phone calls and messages
 - 2 = only phone calls
 - 3 = only messages

Line 7: lon: light in ON or OFF mode followed by the pound sign

Example: **lon#** for lights ON and **loff#** for lights OFF

- All InvestEGGators should be in lights OFF mode to prevent detection

Note: you can modify the txt.file to include just the command you desire to change by deleting the other commands; any commands not specified will remain as they are currently programmed.

Important Reminders for Manual Programing

- Always place a # at the end of the line of code
- Change the phone number after sos1 to the desired phone number to receive text messages/alerts, using the exact numbers necessary to make a call from the country of the transmitter’s SIM card to the country of the recipient’s cell phone number. For example, if you are using a Hologram card with a US number and want to send text alerts to a Costa Rican or another in-country number, the SOS1 number must be entered as 011506<cellphonenumber>. If using a Costa Rican SIM card, simply enter the number as if you were calling it from a Costa Rican number.
- A lower time interval setting will decrease the use of battery life (beta tests are ongoing to determine loss of battery life per hour and day.
- Before ‘deploying’ the InvestEGGator into the actual nest, make sure the light setting is set to loff# to prevent detection, especially at night
- Once you have changed all the above settings to your desired specifications, navigate to File → Save and follow the Txt File Manual Programming Steps above.

SMS Programming via Cellular Phone

Certain settings on the InvestEGGator can also be changed via an SMS command texted as a code through your phone. You can also use an SMS code to obtain information about the InvestEGGator once it has been deployed. If the InvestEGGator is online, it will make the changes or respond back to you based on the code you sent. Based on previous experience, it is usually the SOS1 designated number that can send SMS codes via messaging. Every command ends with a hashtag or pound sign and it’s possible that your phone may use autocorrect to capitalize the first letter of the code. Make sure the code is in all lowercase letters in order for the command to go through. Note that SMS commands can only be sent from numbers that are programmed as SOS1, SOS2, SOS3, and so on.

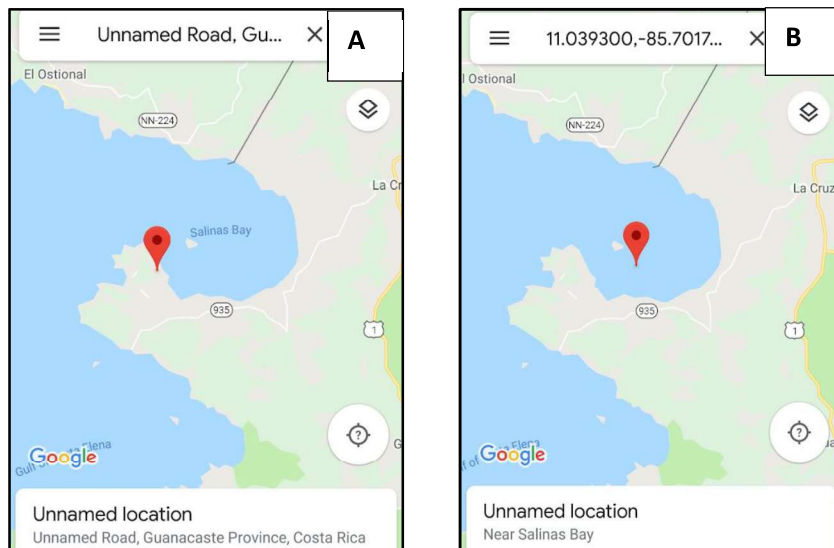


Figure 16. Difference in positional location between (A) GPS satellite signal and (B) Cellular tower signal or LBS.

Below are the main SMS commands needed for deployment:

- **dw#** provides the location of the InvestEGGator. With this command, the InvestEGGator will send a GPS location as a Google Maps link if it obtained a signal from a GPS satellite or an LBS location (also via a Google Maps link if the signal came from a cell tower.) You will notice that the LBS may be off or that the location may be a bit strange. This is because the InvestEGGator is estimating its location by the nearest cell tower signal it is receiving. In Figure 16, you can observe how the GPS point is a bit more accurate than the LBS.
- **dsp#** provides the individual InvestEGGator's ID number. It also updates you on its signal strength; whether it's in sleep mode or online based on its interval setting; percent battery life; whether the alarm is on (should be in silent monitoring); and its tracking setting (which should be on) (Fig. 16).

2020

MANUAL DE USUARIO DEL INVESTEGGATOR



PREPARADO Y PRESENTADO POR

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VERSIÓN MANUAL 1.0

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Manual de Usuario del InvestEGGator

Bienvenidos

Gracias por su interés en el InvestEGGator. Este manual muestra cómo operar el dispositivo y las respuestas a las preguntas más frecuentes que usted pueda tener al usar el producto. Asegúrese de leer el manual entero antes de usar el dispositivo para evitar problemas o complicaciones comunes.

1. Preámbulo

Desarrollado por [Paso Pacífico](#), el InvestEGGator es un dispositivo de localización GPS habilitado diseñado para verse y sentirse como un huevo de tortuga marina. El huevo, impreso en 3D, es ideal para las organizaciones sin fines de lucro (ONG), las autoridades del orden público, u otras organizaciones que se enfocan en la conservación y protección de tortugas marinas. El propósito del InvestEGGator es detectar y disuadir la actividad de la caza furtiva de huevos de tortugas marinas, así como proporcionar una idea de la ruta general de la caza furtiva usada por los cazadores furtivos (también conocidos como saqueadores o hueveros). Las configuraciones iniciales y el uso del dispositivo dependerán del acercamiento de conservación único de cada ONG así como las condiciones medioambientales de las zonas de anidación de la tortuga marina.

1.1 Características técnicas

Cada dispositivo InvestEGGator es asociado con un número de identificación único de diez dígitos, del cual los últimos 4 dígitos se encuentran en una calcomanía pequeña encima del puerto USB, la cual es visible cuando la puerta del puerto de carga está abierta. También se puede encontrar en la superficie exterior del dispositivo. Si usted optó por usar tarjetas SIM Hologram IoT, la tarjeta SIM dentro también está asociada con un número de identificación de chip y un número de teléfono. Usted debió haber recibido una planilla con números de identificación del transmisor, números de tarjeta SIM, y sus números de teléfono asociados de Paso Pacífico.

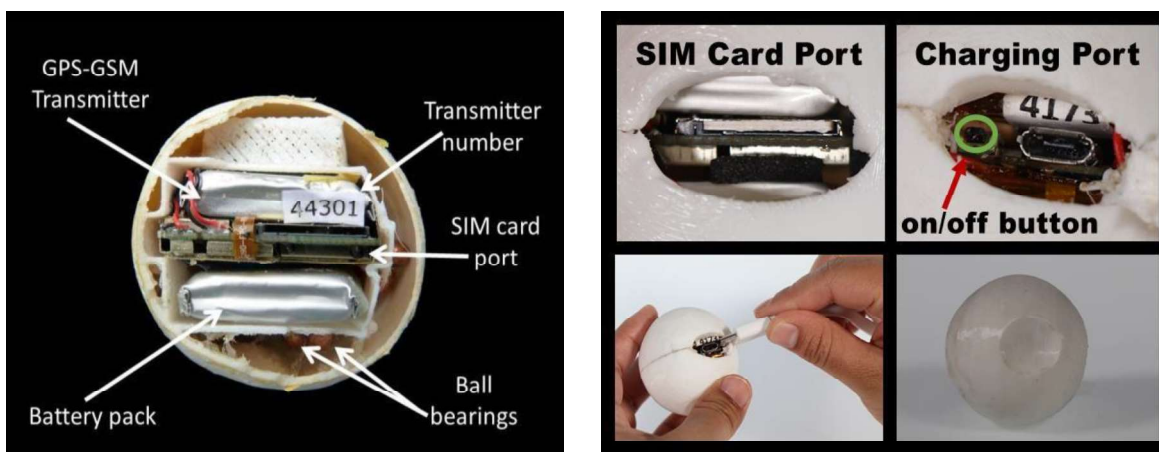


Gráfico 1. (a) Sección transversal del InvestEGGator y sus componentes internos (crédito de la fotografía: Kimberly Williams). (b) Funciones externas del InvestEGGator.

La siguiente es una lista de las funciones claves del InvestEGGator y de componentes adicionales con los cuales debe familiarizarse. (Gráf.1)

- Puerto de recarga para el acceso al Puerto USB del transmisor e interruptor off/on
- Un Puerto USB el cual habilita la conexión con una computadora y recarga a través de un cable USB
- Transmisor para enviar localización de GPS en tiempo real (basada en una señal satelital) o localización LBS (basada en una señal de una torre de teléfono celular)
- Tarjeta SIM para la transmisión de mensajes de texto a un número de teléfono sos1
- Cable USB para la recarga y programación manual
- Estación de recarga USB con pantalla de visualización y múltiples puertos USB
- Aplicación de teléfono inteligente: [ReachFar](#)
- Plataforma de página web: www.gps123.org

2. Programación

Existen cuatro métodos diferentes que se pueden usar para programar un InvestEGGator:

- Aplicación de teléfono inteligente (ReachFar)
- Plataforma Web (gps123.org)
- Programación manual con archive Txt y una computadora PC (véase apéndice)
- Códigos SMS (mensajes de texto) enviados a través de un teléfono celular (véase apéndice)

La aplicación de teléfono celular y la Plataforma web se explican en las siguientes páginas.

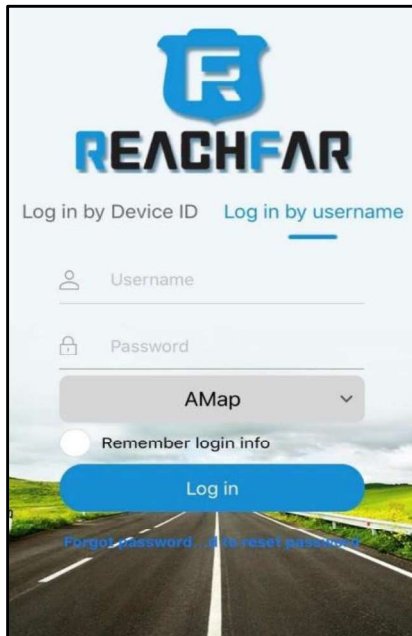


Gráfico 2. Pantalla de log in a ReachFar. Debería seleccionarse el ingreso por ID de Dispositivo antes de ingresar el nombre del usuario y la contraseña.

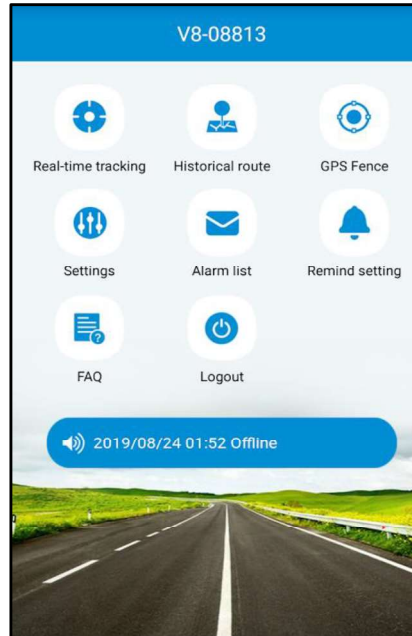


Gráfico 3. Pantalla principal de ReachFar. Estos son los artículos que usted debería ver en la pantalla de inicio.

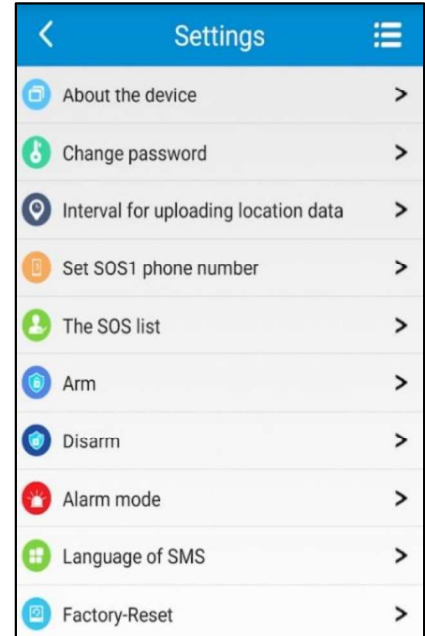


Gráfico 4. Configuraciones del InvestEGGator que se pueden ajustar a través de la aplicación ReachFar

2.1 Aplicación de Teléfono Inteligente ReachFar

La aplicación de Teléfono Inteligente ReachFar ofrece una opción intuitiva y fácilmente accesible para la programación. Para empezar a programar complete los pasos a continuación.

1. Descargue la aplicación ReachFar de las tiendas de aplicaciones de Google o Apple.
2. Abra la aplicación e ingrese usando la opción **Log in por ID de Dispositivo (Log in by Device ID)** (Gráf. 2)
3. ID de dispositivo es 210400 más un Código de cuatro dígitos. Los únicos números que cambian son los cuatro dígitos, ej., el código completo de 10 dígitos sería: 210400 + 8821
4. Como ejemplo, use esta información para ingresar
 - o ID: 2104008821
 - o Contraseña: 123456
5. Una vez ingresado, usted debería ver las siguientes opciones en la pantalla principal de ReachFar (Gráf. 3):
 - o Rastreo en tiempo real
 - o Ruta histórica
 - o Cerca de GPS
 - o Configuraciones
 - o Lista de alarma
 - o Configuración de recordatorio
 - o FAQ
 - o Logout

2.2 ReachFar: Configuraciones

Existen muchas configuraciones en los InvestEGGators que pueden ser ajustadas a través de la ventana de configuración de la aplicación ReachFar. Note que estas configuraciones solo pueden ser actualizadas si los InvestEGGators están en línea y comunicándose con ReachFar mediante una red celular y con data activada en el teléfono con la aplicación.

Para ajustar éstos complete los siguientes pasos:

1. Navegue a **Configuración (Settings)** al hacer clic en el ícono.
2. Usted verá las siguientes indicaciones (Gráf. 4):
 - o Acerca del Dispositivo
 - o Cambio de Contraseña
 - o Intervalo para carga de información de localización
 - o Configurar el número de teléfono SOS1
 - o La lista de SOS
 - o Activar
 - o Desactivar
 - o Modo Alarma
 - o Lenguaje de SMS
 - o Restablecer configuración de Fábrica
3. Ignore las dos primeras y la última opción de configuración. Cambiando la contraseña y

reconfigurando el transmisor prevendrá que otros usuarios ingresen al ReachFar y el historial/datos de ruta se perderán. A menos que su investigación requiera que su información sea completamente confidencial, nosotros recomendamos que usted no cambie su contraseña. Manteniendo la misma contraseña facilitará el soporte remoto del personal de Paso Pacífico. Si usted necesita proteger su información, asegúrese de cambiar su contraseña antes de que comience la recolección de datos e informe a aquellas personas que pueden necesitar (y que tengan permiso para) ingresar para ver la información de ese InvestEGGator en particular.

4. En **Intervalo para carga de información (Interval for uploading location data)** de localización usted puede cambiar el intervalo al cual el transmisor tomará localizaciones basadas en GPS o LBS (dependiendo de qué señal localice primero, torre de celular o satélite de GPS). La aplicación ReachFar solo tiene las siguientes opciones de intervalos de tiempo: 1 minuto, 10 minutos, 1 hora, 12 horas. Otros intervalos de tiempo deben ser programados mediante la plataforma web, mensaje SMS, o manualmente con la computadora usando la opción del archivo .txt. (*Véase Apéndice para más información*)
5. En **Configurar número de teléfono SOS1 (Set SOS1 phone number)** designe el número de teléfono principal que recibirá las alertas SMS. Para los propósitos de este Proyecto, el SOS1 debería ser configurado al número de teléfono del investigador principal. Usted también puede agregar números de teléfono adicionales para recibir mensajes bajo la lista de SOS. Sin embargo, solo el número SOS1 recibirá mensajes del transmisor, si esta opción está habilitada. Los números SOS deberían ser ingresados exactamente como serían tecleados desde un número asociado con el teléfono. Si usted va a usar una tarjeta SIM Hologram IoT, por favor vea el Apéndice X, “Tarjetas SIM Hologram”
6. La configuración **Activar (Arm)** programará el dispositivo para que envíe alertas si está configurado para detectar ruido o para detectar movimiento o vibración. Para los propósitos de este Proyecto, el dispositivo solo puede ser configurado para detectar vibración. Cada vez que el dispositivo detecte movimiento o vibración éste enviará una alerta tanto al SOS1 como a la aplicación ReachFar si usted lo ha programado para hacerlo. Usted puede encontrar las alertas bajo **Lista de alarmas (Alarm List)** (*Gráf. 5*).
7. Use las configuraciones de **Desactivar (Disarm)** para apagar las alertas de vibración y ruido.
8. Si usted escoge las alertas de vibración, asegúrese de escoger el método y la Plataforma donde usted desea recibir las alertas usando la configuración **modo alarma (alarm mode)**. Idealmente, el dispositivo debería ser programado para enviar alertas a la Plataforma (ej., a gps123.org y a la aplicación ReachFar); sin embargo, bajo ciertas circunstancias puede ser deseable enviar también mensajes SMS, por ejemplo, si el número SOS1 no es un teléfono inteligente.
9. La configuración de **Lenguaje de SMS (Language of SMS)** solo tiene las opciones de inglés, francés y chino. Sin embargo, cuando usted descargue la aplicación en su teléfono inteligente, la aplicación se configurará automáticamente al lenguaje en el cual su teléfono está configurado. Si se cambia la preferencia de lenguaje en su teléfono cambiará también el lenguaje en la aplicación.

Alarm list	
V8-08780	2019/09/23 14:46
Offline	
V8-08780	2019/09/23 13:52
Vibration Alarm	
V8-08780	2019/09/23 13:36
Vibration Alarm	
V8-08780	2019/09/23 13:16
Vibration Alarm	
V8-08780	2019/09/23 12:34
Vibration Alarm	
V8-08780	2019/09/23 11:25
Vibration Alarm	
V8-08780	2019/09/23 11:09
Vibration Alarm	
V8-08780	2019/09/23 10:52
Vibration Alarm	
V8-08780	2019/09/23 10:50
Vibration Alarm	
V8-08780	2019/09/23 10:48
Vibration Alarm	

Gráfico 5. La lista de alarmas de ReachFar provee una lista de notificaciones enviadas por el transmisor cada vez que se detectó una vibración.

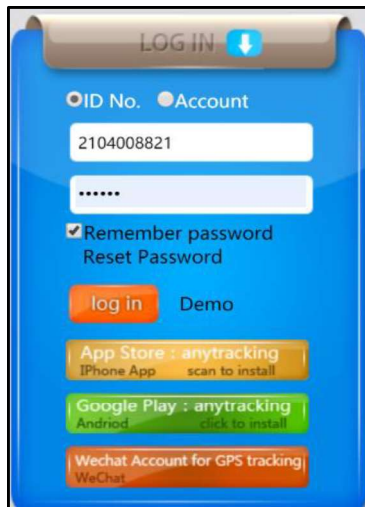


Gráfico 6. En la página principal de log in de GPS123.org. Seleccione ID no. antes de ingresar el nombre del usuario y la contraseña.



Selecione el Lenguaje apropiado aquí para ayudarle a navegar el sitio web.

2.3. Plataforma Sitio Web GPS123.org

Similar a la aplicación ReachFar, la Plataforma web, GPS123.org puede usarse también para programar configuraciones. El dispositivo tiene que estar en línea y habilitado para transmitir y recibir datos, y si no lo está, la plataforma no le permitirá hacer cambios.

Para acceder a GPS123.org use los siguientes pasos:

1. En un navegador de internet navegue a GPS123.org (*Gráf. 6*); si esta es la primera vez que usa este sitio, use las banderas en la esquina superior derecha del sitio para seleccionar su lenguaje.
2. Seleccione **ID No.** e ingrese la ID del Dispositivo y la contraseña
 - ID del dispositivo = 210400 + código de cuatro dígitos
 - Ejemplo: 2104008821
 - Contraseña: 123456
3. Una vez que haya ingresado a la Plataforma, escoja la pestaña de **Monitor** o la de **Estadísticas (Statistics)** en la cinta de opciones superior. Cualquier programación de configuraciones sucederá en la pestaña Monitor. Desde allí, seleccione el menú desplegable bajo el panel a mano izquierda de Configuraciones y seleccione **Configuración del Dispositivo (Device Setting)** (*Gráf. 7*).



Gráfico 7. En el panel a mano izquierda de GPS123.org es donde usted puede encontrar las configuraciones y características claves que pueden ser ajustadas para el InvestEGGator.

4. Bajo **Configuración del Dispositivo (Device Setting)**, usted puede hacer cambios a muchas configuraciones. Las configuraciones se dividen en dos categorías principales (*Gráf. 8*):

- **Control de Comando**
 - Re-Inicialización Remota
 - Activar
 - Desactivar
 - Versión
 - Restablecer configuración de fábrica
 - Chequear estado del dispositivo
 - Una localización singular
- **Configurar Comando**
 - Cargar intervalo
 - No. Máster (SOS1)
 - SOS2
 - Configurar el número SOS
 - Configuración del Indicador
 - Modo de Alarma
 - Lenguaje SMS
 - Actualización remota

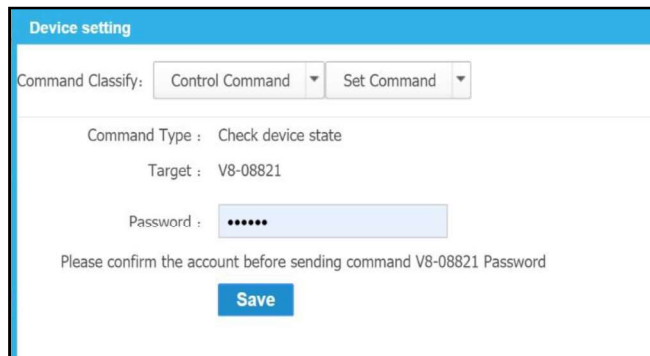


Gráfico 8. Configuraciones de Dispositivo en GPS123.org con dos categorías principales



Nota Especial: Las opciones de configuración en GPS123.org son casi idénticas a las opciones de configuración accedidas mediante ReachFar. Para cada configuración individual, usted tendrá que “confirmar la cuenta antes de enviar el comando,” entonces es recomendable guardar la contraseña automáticamente en su teléfono inteligente en caso de que se le olvide.

3. Instrucciones de Monitoreo (ReachFar y GPS123.org)

3.1 ReachFar: Rastreo en Tiempo Real

Viendo la imagen de Rastreo en tiempo Real (*Gráf. 9*):

- Círculo Azul: Representa la localización actual del usuario si la configuración de localización del teléfono inteligente está encendida.
- La flecha de la brújula (en la foto aquí en color verde) con el casillero de texto encima es la localización del transmiso

- Una flecha verde significa que el InvestEGGator está en línea y si usted quiere usted puede enviar comandos diferentes mediante el sitio web, plataformas de aplicaciones de teléfono inteligente o por mensajes SMS.
- Una flecha gris significa que el dispositivo no está en línea. Cualquier comando que usted envíe NO pasará.
- El casillero de texto encima de la flecha permite que usted vea la última vez que el dispositivo envió una lectura de su localización.
 - En el *Gráfico 9* vemos que el estatus del dispositivo (V8-08796) es “Estacionario”
 - La última lectura de su localización fue en 06-06-2019 a las 09:58:37
 - La velocidad actual es de 0.00 km/h porque no se ha movido.
 - Dirección: Este
 - Distancia al punto actual: 3km
 - El  en un iPhone o el ícono  en un androide en la esquina superior derecha permiten hacer una actualización singular, lo cual debería actualizar la localización de su lectura más reciente

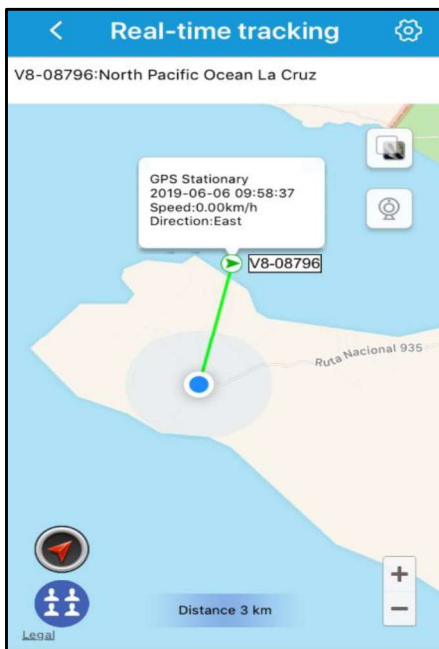


Gráfico 9. Use la opción de rastreo en tiempo real para determinar su localización actual y la localización del dispositivo.

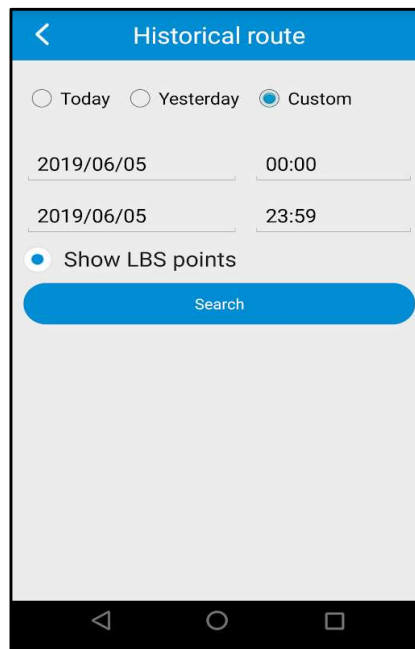


Gráfico 10. Personalice su búsqueda para fechas y horas específicas con ruta Histórica.

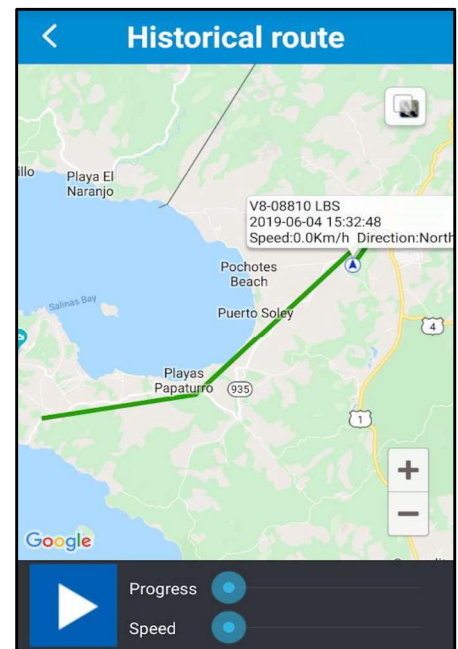


Gráfico 11. Ruta histórica muestra la dirección general que tomó el InvestEGGator.

3.2 ReachFar: Ruta Histórica

Esta característica permite al usuario ver la ruta del InvestEGGator sobre un período específico de tiempo usando los últimos puntos LBS y/o GPS que obtuvo. No es una ruta exacta porque el programa solo hace una aproximación de la ruta desde los puntos conocidos usando la Distancia Euclidiana (Distancia “a vuelo de pájaro”)

- Haga clic en el **ícono de ruta histórica (Historial Route)** para que aparezca un cronograma.

Existen tres puntos (*Gráf. 10*):

- Hoy
 - Ayer
 - Personalizado
- Asegúrese de que la opción de **Mostrar los puntos LBS (Show LBS points)** esté siempre marcada.
 - **Personalizado (Custom)** le permite escoger las fechas y horas deseadas. Si aparece un mensaje de error indicando **No se Obtuvo Información (No Data Obtained)** esto significa que el InvestEGGator no estaba conectado a una red de celulares o a una señal de GPS durante el período de tiempo especificado y por lo tanto no grabó ningún punto de posición/localización.
 - Note que en la opción personalizada usted solo puede buscar la ruta histórica dentro de un período de tiempo de 24 horas de otra manera usted también obtendrá un mensaje de error. (Si usted desea ver el camino para un período de múltiples días, descargar el camino, esto se puede hacer en la plataforma web gps123.org bajo “Reproducir”, como se describe a continuación.)
 - Las líneas verdes como se ven aquí indican el camino aproximado que tomó el InvestEGGator durante este tiempo (*Gráf. 11*).
 - Use la función **Progreso (Progress)** para caminar paso por paso por el recorrido del InvestEGGator (*Gráf.11*). El mapa mostrará la localización del InvestEGGator al comienzo del período de tiempo especificado. Deslícese a lo largo de la barra de progreso para ver puntos específicos de la ruta, la dirección que estaba tomando el InvestEGGator, y la hora de la lectura.
 - Use la función **Velocidad (Speed)** para ajustar qué tan rápido muestra el progreso el mapa (*Gráf.11*).
 - Haga un acercamiento o un alejamiento en el mapa para ver la extensión completa de la ruta.

3.3 GPS123.org: Pestaña del Monitor

La pestaña del monitor de la plataforma web le permite ver información acerca de la localización del InvestEGGator de varias maneras. Similar a la aplicación ReachFar, el casillero de texto en la pantalla principal provee la siguiente información (*Gráf. 12*):

- Dispositivo: V8-08821
- Estatus es “No está en línea”
- La última lectura de su localización fue en 06-07-2019 a las 01:35:13

Después de hacer clic en el Monitor, vaya al panel a mano izquierda del cual usted puede escoger las opciones de Rastrear o Reproducir (*Gráf. 12a-12b*).

- Haga clic en la opción Rastrear para abrir un mapa de pantalla completa con información acerca del último punto posicional que se tomó. Como se ve en la imagen debajo, esto incluye.



Gráfico 12a. La pestaña del Monitor en la plataforma del sitio web es similar a la de la aplicación.

- Dispositivo: V8-08821
- La última lectura de su localización fue en 06-07-2019 a las 01:35:13
- El dispositivo tiene un millaje de 0 M.
- La latitud y longitud de la última localización (11.03407, -85.72305)
- Dirección y Velocidad son 0.00km/h porque no se ha movido



Gráfico 12b. Las configuraciones de Reproducción del Rastreo aparecerán luego de hacer clic en la pestaña del Monitor en el sitio web.

- Haga clic en **Reproducir (Playback)** en el menú a mano izquierda para ver la serie completa de puntos de localización que han sido grabados en el dispositivo. Como los paquetes del transmisor provienen de una compañía china, el sitio web muestra automáticamente el mapa de la parte Este de China (*Gráf. 12b*).

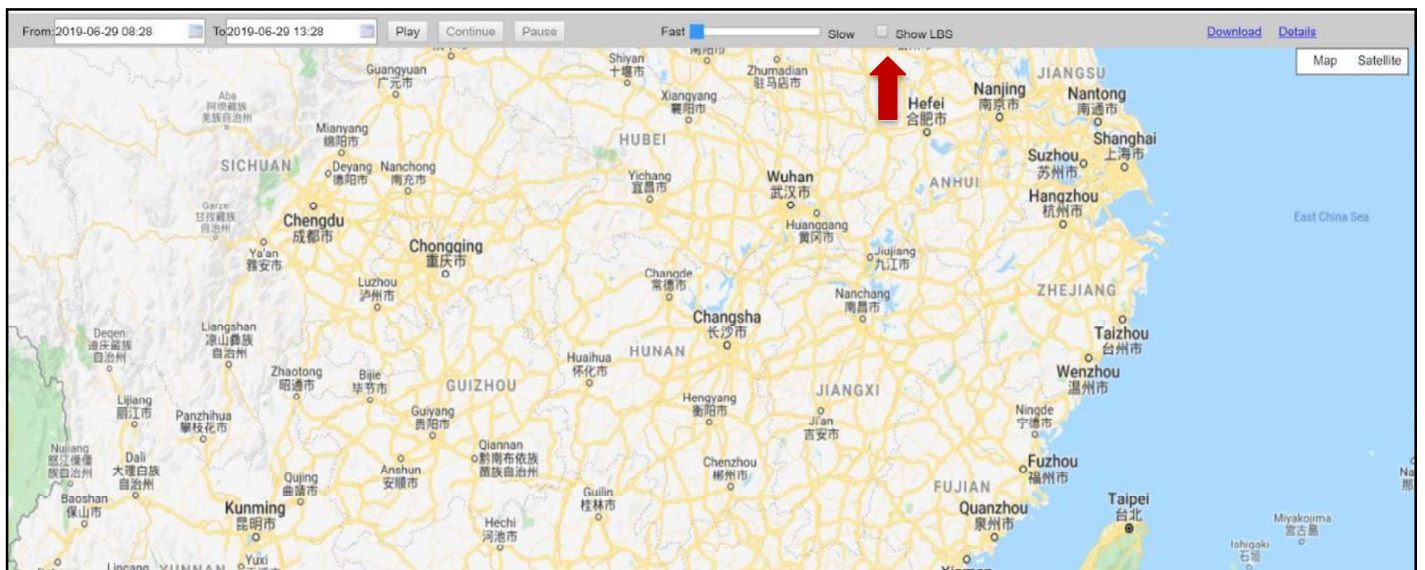


Gráfico 13. Asegúrese de que Mostrar LBS siempre esté seleccionado para obtener todos los puntos de localización del InvestEGGator para obtener una mejor estimación de la ruta tomada.

- Para una personalización de la reproducción del monitoreo, usted puede hacer ajustes a la cinta superior para que muestre las horas y fechas específicas de las series de localizaciones. Para hacer esto:
 - Seleccione la fecha y hora para cuando usted quisiera comenzar la reproducción bajo el menú desplegable **Desde (From)**, y luego seleccione la hora de finalización bajo el menú desplegable **Hasta (To)**. (Gráf. 14).
- Mueva la barra corredera a la derecha de **Rápido (Fast)** a **Lento (Slow)** para poder ver puntos durante la Reproducción. Seleccione la opción Lento para que sea más fácil ver cada punto de localización.
- Haga clic en **Mostrar LBS (Show LBS)** para mostrar todos los puntos (Incluyendo la información de localización de torres de teléfonos celulares, además de localizaciones de GPS) (Gráf. 13 and Gráf. 14).
- Ahora usted puede presionar el botón Play (Play) y ver una Reproducción de las localizaciones grabadas en el período de tiempo seleccionado (Gráf. 14).

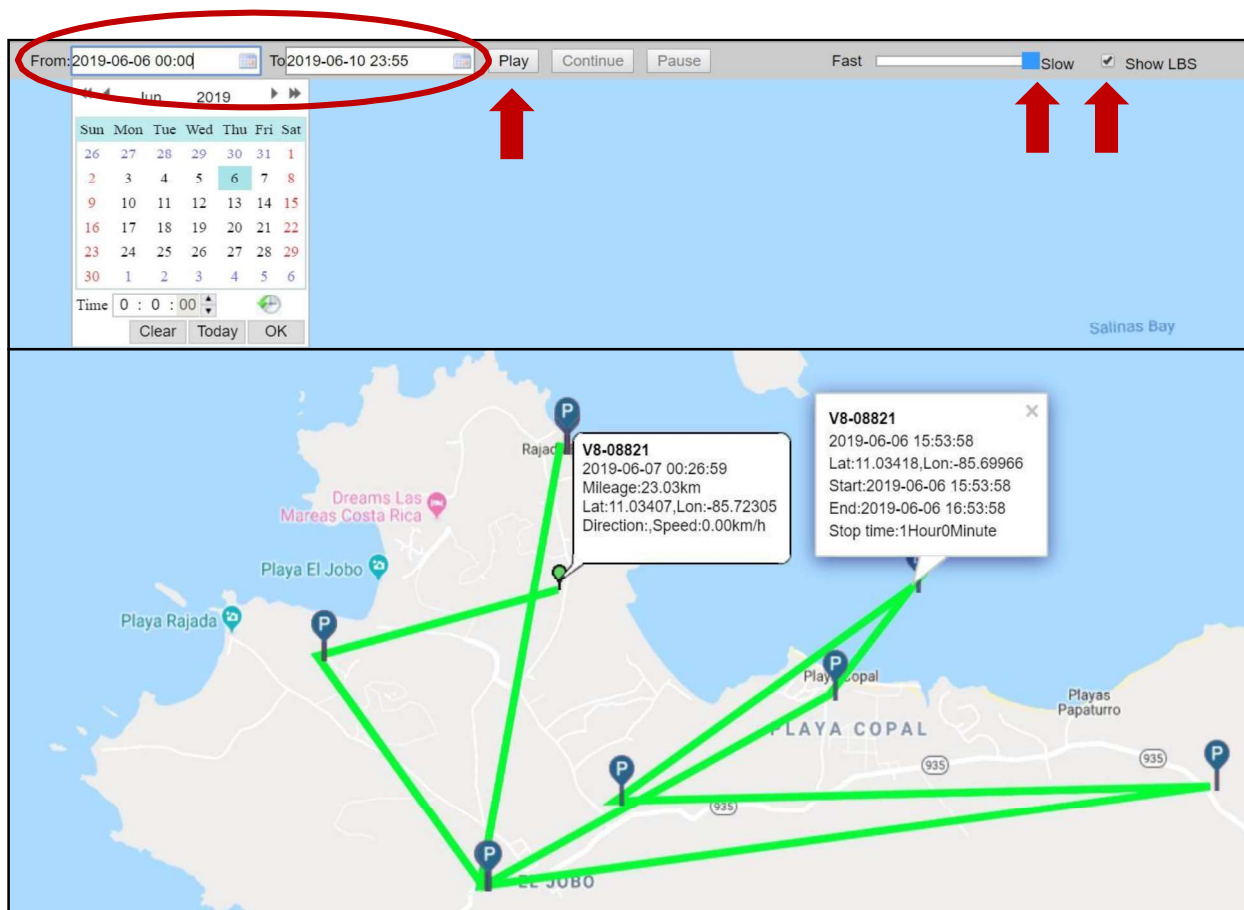


Gráfico 14. En GPS123.org, usted puede seleccionar múltiples fechas y usted no está limitado a un período de tiempo de 24 horas como lo está en la aplicación ReachFar cuando selecciona hacer una reproducción del monitoreo personalizada.

4. Preguntas Frecuentes

¿Cómo sé si el huevo está funcionando/moviéndose?

Basado en la configuración de la alarma de vibración, usted debería recibir por lo menos un mensaje de alerta mediante ReachFar. La persona configurada como SOS1 también recibirá una un mensaje de alerta SMS cada vez que se detecte un movimiento.

¿Por qué parece que el InvestEGGator está atascado en un solo lugar por un tiempo largo?

Esto puede ser por algunas razones: 1.) El dispositivo de hecho no se ha movido 2.) Ha sido enterrado o no puede obtener señal 3.) El dispositivo está “colgado” – especialmente cuando no recibe señales de GPS, ocasionalmente un dispositivo muestra como si estuviese en una ubicación previa a pesar de haberse movido 4.) La batería se ha agotado 5.) Ha incurrido en algún tipo de falla debido a condiciones/daños medioambientales.

Si usted tiene el InvestEGGator con usted conéctelo a un puerto de recarga para ver si eso ayuda a reactivarlo. También puede llevarlo a áreas con mejor señal para ver si regresa a estar en línea.

¿Cuál es la mejor configuración de intervalo de tiempo?

Nosotros recomendamos una configuración de entre 10 y 30 minutos; en una configuración de 10 minutos, el dispositivo durará de 5 a 8 días completamente cargado. Sin embargo, tenga en cuenta que los intervalos de tiempo más cortos proveerán más puntos de GPS/LBS que producirán un mejor estimado de la ruta por la cual el InvestEGGator ha sido llevado, pero puede perder la vida de la batería uno o dos días antes cuando está configurado a un intervalo de tiempo más alto.

¿Cuál es la mejor configuración de vibración?

Los transmisores son ya preprogramados a la configuración #3 la cual es suficiente para detectar cuando el transmisor está siendo levantado o si está siendo transportado de un lugar a otro. Usted debería ver las alarmas de vibración en la aplicación bajo la opción “lista de alarmas”.

¿Qué pasa si el InvestEGGator deja de mandar alertas de vibración?

Esto puede ser por dos razones: 1.) Si el InvestEGGator ha sido desplegado dentro del nido, entonces no podrá recibir ninguna señal de satélite o conexión a una torre de teléfono celular así se encienda cada X número de minutos basado en el intervalo de tiempo que se configuró. 2.) Puede ser que durante el transporte o manipuleo se aflojó la tarjeta SIM u ocurrió algún otro problema de hardware o software que está impidiendo que el transmisor se conecte a alguna señal.

¿Cómo sé si están completamente cargados?

Los InvestEGGators solo requieren de alrededor de 4-5 horas para estar completamente cargados. Si usted tiene las luces activadas, usted verá las luces parpadeando mientras se carga, pero estas estarán prendidas todo el tiempo cuando esté completamente cargado.

Si usted tiene las luces apagadas y quiere chequear el estado de la carga, luego de desconectar de la estación de carga y antes de desplegarlo usted puede ingresar a ReachFar o a gps123.org con la ID única del transmisor y la contraseña para obtener el ultimo estatus de la vida de la batería. Tenga en cuenta que este

estatus de la batería fue tomado la última vez que el transmisor tomó un punto de localización de GPS/LBS. Por lo tanto, nunca es malo recargarlo unas horas antes de desplegarlo.

Evite dejar el dispositivo conectado y recargándose toda la noche o por largos períodos de tiempo, porque esto puede reducir la vida de la batería.

¿Poner los InvestEGGators dentro con los huevos de tortuga dañará o afectará negativamente la biología o el desarrollo de las crías?

No hay actualmente evidencia de que los InvestEGGators impactarán el desarrollo de las crías. Basados en observaciones iniciales y el primer despliegue por parte de Pheasey 2019, cuando el InvestEGGator permaneció dentro del nido por el resto del período de incubación no se observaron problemas físicos o de desarrollo en las crías.

¿Cuál es la diferencia entre en línea y fuera de línea?

En línea: cuando el InvestEGGator está en línea significa que este puede detectar y conectarse con una señal de celular entonces puede comunicarse con el SOS1 y con las plataformas de rastreo. Cualquier comando que usted envíe mediante SMS, ReachFar, y GPS123.org será activado si el dispositivo puede obtener una señal celular.

Fuera de línea: el dispositivo está fuera de línea cuando no puede encontrar una señal celular. En este punto está en “modo-reposo.” Esto significa que todavía está encendido, pero no está usando batería y no se está conectando con señales celulares o de GPS.

5. Problemas comunes del InvestEGGator

Los InvestEGGators pueden proporcionar información útil acerca de una localización cercana o la ruta de un sujeto de interés. En este caso, la meta es estimar la ruta comercial de los huevos de tortuga robados. Sin embargo, puede haber algunos problemas comunes de programación o de hardware que pueden surgir cuando se trabaja con ellos y es importante y útil estar pendiente de estos.

1. Tarjeta SIM

- En el proceso de manipuleo de los InvestEGGators la tarjeta SIM puede aflojarse y puede causar que la unidad deje de enviar alertas e ir fuera de línea. Este es un problema común si usted presiona la parte de exterior del huevo para encenderlo y apagarlo, en lugar de remover la lengüeta y usar una herramienta para presionar el botón para encender o apagar el huevo. Si esto sucede, usted puede empujar la tarjeta SIM hacia adentro a su lugar luego de desconectarlos de la estación de carga. Si usted ha optado por las tarjetas Hologram preinstaladas, es muy raro que esto suceda porque ellas han sido pegadas para mantener la tarjeta en su lugar.

2. Luces encendidas y apagadas cuando se recarga

- El InvestEGGator tiene luces indicadoras que muestran el estatus de las señales de celular y de GPS recibidas; sin embargo, estas luces indicadoras deben estar apagadas antes de que se despliegue el huevo dentro del nido. Todos los InvestEGGators usados serán preprogramados para tener las luces en Modo OFF para prevenir la detección en la noche. El único problema

con esto es que hace difícil saber si los InvestEGGators están encendidos. Para ayudar con esto, recargue las unidades por lo menos por cuatro horas antes de llevarlas con usted al campo en caso de que haya una oportunidad para desplegarlas. Adicionalmente, algunos transmisores pueden producir un leve flash o luz al conectarlos en la estación de carga. Esto es normal, pero después ellos no deberían exhibir ninguna luz.

- Si en cualquier punto las luces se encienden y se notan de noche usted puede llevarlos a un lugar con una Buena conexión de teléfono celular y usar el *txt.file* para reprogramarlos. (Véase Apéndice para más detalles)

3. Zona horaria correcta

- Esta configuración puede ser útil para rastrear las rutas y ver a qué hora del día están activos los saqueadores de huevos. Sin embargo, la zona horaria debe ser corregida a la región correcta lo que se puede hacer mediante la plataforma del sitio web. En gps123.org en el panel lateral izquierdo haga clic en Configuraciones → información del dispositivo → Zona horaria. Como esta configuración reside en el sistema de la plataforma web, y no en la programación interna del transmisor, la zona horaria puede configurarse en cualquier momento, hasta cuando la unidad está apagada o no está conectada a una señal de teléfono celular.

4. Recargar

- Las unidades InvestEGGator no deberían recargarse por más de 4-5 horas porque se corre el riesgo de dañar la vida de la batería en general. Recargarlas un par de horas antes de llevarlas al campo será suficiente. Si no se están cargando, asegúrese que el cable USB esté empujado ajustadamente en el puerto de carga.

5. El transmisor puede dejar de enviar SMS o se vuelve inactivo

- Si una unidad InvestEGGator deja de repente de enviar alertas mediante cualquier plataforma (SMS, ReachFar, gps123.org) asegúrese de seguir las instrucciones de arriba. Si el problema persiste, puede ser que la tarjeta SIM se haya aflojado, o que fue descubierta y destruida. Sin embargo, hay ocasiones en las que una unidad puede dejar de trabajar completamente de repente por problemas de hardware internos, en este punto usted puede contactarse con Kim Williams de Paso Pacífico por ayuda adicional para ver si hay algo que se pueda hacer de manera remota.

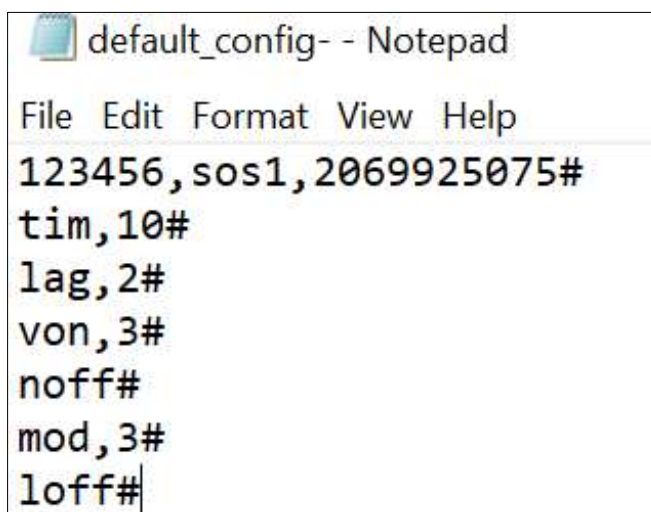
6. Sección Apéndice

En este apéndice usted encontrará información adicional con respecto a la programación manual del InvestEGGator, así como instrucciones de cómo comunicarse con el transmisor mediante mensajes de texto SMS.

Programación Manual del archivo Txt

Siga las siguientes instrucciones para programar manualmente el InvestEGGator usando una computadora. La programación manual funciona mejor con una computadora PC.

1. Apague la unidad InvestEGGator usando una herramienta como un palillo de dientes presionando el interruptor OFF/ON por tres segundos. El botón OFF/ON es un interruptor muy pequeño localizado dentro del transmisor. El dispositivo es programable solo cuando está en modo OFF.
2. Asegúrese de que la carpeta del drive externo aparezca en File Explorer (como sucederá cuando usted inserte un flash drive USB); si no lo hace, eso significa que el dispositivo todavía está encendido.
3. Abra notepad *txt.file* en la PC y escriba en Código en *txt.file* como se muestra en la fotografía abajo (Gráf. 15).



```
File Edit Format View Help
123456, sos1, 2069925075#
tim, 10#
lag, 2#
von, 3#
noff#
mod, 3#
loff#
```

Gráfico 15. Líneas de Código que se usan para la programación manual. Recuerde, todas las palabras deben estar en letra minúscula y siempre tener un # o signo de numeral al final de cada línea.

4. Grabe como *txt.file* en el desktop llamado “**default_config**”
5. Seleccione el archivo “default.config” y deposítelo en la carpeta del drive externo general que se abre cuando usted inserta el USB en la computadora (no en la carpeta interna UpData). Esto debe hacerse cada vez que se quiera actualizar manualmente.
6. Haga clic con el botón derecho del ratón en el drive externo y haga clic en **Eject**. El InvestEGGator está ahora programado. Este paso es crucial de otra forma el InvestEGGator no se programará si el cable del USB es removido sin hacer clic en eject.

Códigos Txtfile para la Programación Manual

Los códigos *txt.file* que usted puede programar son (Gráf. 15):

línea 1: Contraseña, *sos1*, número de teléfono seguido por numeral o hashtag

Código ejemplo: **123456, sos1,2069925075#** (note que un código de país no se requiere aquí)

- En orden: este Código provee la contraseña, el número de usuario seguido por numeral o # para recibir alertas por mensaje de texto
- Cambie el número de teléfono al teléfono en el cual usted desea recibir las alertas. Este es el número SOS1 designado.

línea 2: *tim*: intervalo de tiempo seguido por numeral o hashtag

Código ejemplo: **tim,10#**

- Esta línea indica el intervalo de tiempo en minutos en el cual el dispositivo actualizará al usuario con su localización de GPS en tiempo real mientras pueda conectarse a señales de celular o de GPS.
- La configuración anterior actualizará cada 10 minutos al usuario acerca de la localización del dispositivo.
- Opciones para la configuración de tiempo en la programación manual: 1, 10, 30, 60 90 en minutos

línea 3: *lag*: número designado a un lenguaje específico seguido por numeral o hashtag

Código ejemplo: **lag, 2#**

- Esta línea provee la configuración de lenguaje
- opciones de configuración de lenguaje: 1= chino 2= inglés 3= francés
- Ejemplo: para cambiar a francés sería lag,3#

línea 4: *von*: nivel de vibración, seguido por numeral o hashtag

Ejemplo: **von3#**

- Cambia el nivel de sensibilidad de vibración al cual el dispositivo responde. Cada vez que detecta una vibración o movimiento, el dispositivo enviará una alerta al número de teléfono SOS1.
- Opciones: von,1# von,2# von,3# voff
- Para von, 1=más sensible a vibración, 4= menos sensible
- Por ejemplo, para cambiar a menos sensible: von,4#
- En general, la configuración más alta (1) no se recomienda porque el usuario recibirá alertas en cada caso de vibración.

línea 5: *noff*: configuración de ruido, seguido por el signo de numeral. No se pone una coma entre ellos.

Ejemplo: **noff#**

- Cambiar la configuración de ruido de alarma a **on** o a **off**
- Es importante mantener esta configuración en off para prevenir que los saqueadores detecten el InvestEGGator.

línea 6: *mod*: modo de notificación seguido del signo de numeral

Ejemplo: **mode, 3#**

- Indica cómo quiere ser notificado el usuario
 - 1 = llamadas telefónicas y mensajes de texto
 - 2 = solo llamadas telefónicas
 - 3 = solo mensajes

línea 7: lon: luz en modo ON u OFF seguido por el símbolo de numeral

Ejemplo: **lon#** para luces ON y **loff#** para luces OFF

- Todos los InvestEGGators deberían estar en modo luces OFF para prevenir la detección.

Nota: usted puede modificar el txt.file para incluir solo el comando que usted desee cambiar borrando los otros comandos; cualquier comando no especificado permanecerá como está actualmente programado.

Recordatorios importantes para la Programación Manual

- Ponga siempre un # al final de la línea de código
- Cambie el número de teléfono después de sos1 al número de teléfono deseado para recibir alertas/mensajes de texto, usando los números exactos necesarios para hacer una llamada desde el país de la tarjeta SIM del transmisor al país del número de teléfono celular del receptor. Por ejemplo, si usted está usando una tarjeta Hologram con un número de Estados Unidos y quiere enviar alertas por mensajes de texto a un número costarricense o a otro número dentro del país, el número SOS1 debe ingresarse como 011506<número de teléfono celular>. Si está usando una tarjeta SIM costarricense, simplemente ingrese el número como si estuviera llamando desde un número costarricense.
- Una configuración de intervalo de tiempo menor reducirá el uso de la vida de la batería (pruebas beta están en curso para determinar la pérdida de vida de la batería por hora y por día.
- Antes de ‘desplegar’ el InvestEGGator dentro del nido propiamente dicho, asegúrese de que la configuración de la luz esté fijada a loff# para prevenir la detección, especialmente en la noche.
- Una vez que usted haya cambiado todas las configuraciones de arriba a sus especificaciones deseadas, navegue a Archivo → Grabar y siga los pasos de arriba para el Archivo Txt de Programación Manual.

Programación SMS mediante Teléfono Celular

Ciertas configuraciones en el InvestEGGator pueden ser cambiados también mediante un comando SMS texteadado como un código a través de su teléfono. Usted puede usar además un código SMS para obtener información acerca del InvestEGGator una vez que este ha sido desplegado. Si el InvestEGGator está en línea, hará los cambios o le responderá basado en el código que usted envió. Basado en experiencia previa, usualmente es el número designado SOS1 que puede enviar códigos SMS mediante mensajes. Cada comando termina con un hashtag o un signo de numeral y es posible que su teléfono use el corrector automático para escribir con mayúscula la primera letra del código. Asegúrese de que todo el código esté en letras minúsculas para que el comando proceda. Tome en cuenta que los comandos SMS solo pueden ser enviados desde números que están programados como SOS1, SOS2, SOS3, y así sucesivamente.

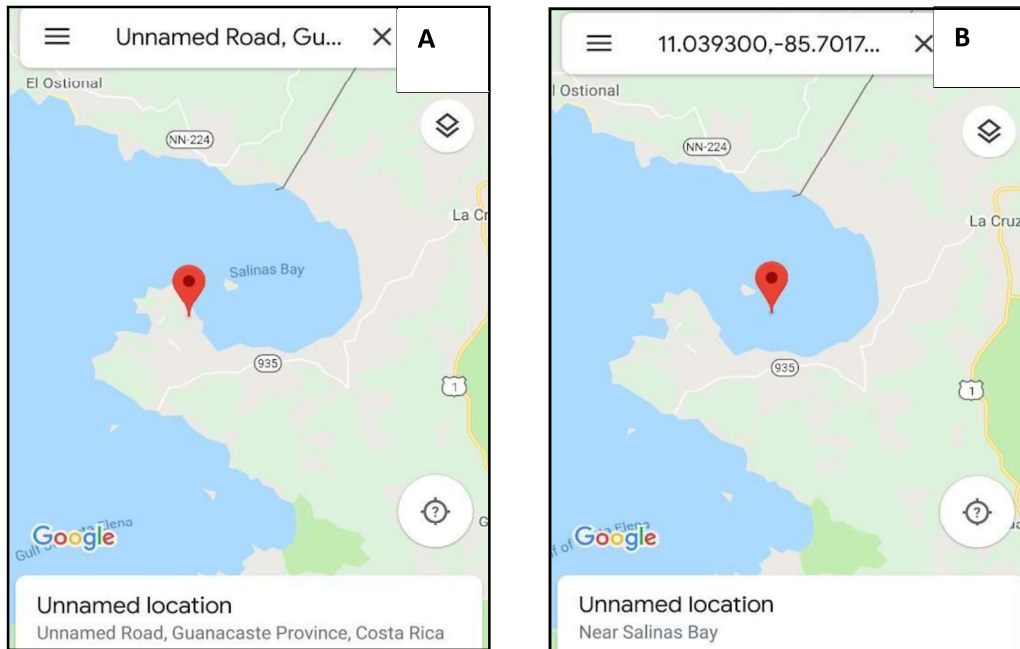


Gráfico 16. Diferencia en localización posicional entre (A) señal satelital de GPS y (B) Señal de torre de celular o LBS.

A continuación, están los principales comandos SMS necesarios para el despliegue:

- **dw#** provee la localización del InvestEGGator. Con este comando, el InvestEGGator enviará una localización de GPS como un enlace de Google Maps si obtuvo una señal de un satélite GPS o una localización LBS (también mediante un enlace de Google Maps si la señal vino de una torre de celulares.) Usted tal vez note que la LBS está errada o que la localización es un poco extraña. Esto es porque el InvestEGGator está estimando su localización por medio de la señal de la torre de celulares más cercana que este está recibiendo. En el Gráfico 16, usted puede observar como el punto de GPS es un poco más preciso que el de LBS.
- **dsp#** provee el número ID individual del InvestEGGator. También le actualiza de su potencia de señal; ya sea que esté en modo de reposo o en línea basado en su configuración de intervalos de tiempo; porcentaje de vida de la batería; si la alarma está activada (debería estar en monitoreo silencioso); y su configuración de rastreo (la cual debería estar encendida)



PASO PACIFICO SEA TURTLES PROGRAM UPDATE

About Paso Pacifico

Founded in 2005, Paso Pacífico's aim is to conserve and protect the unique forest and coastal ecosystems along Central America's pacific slope. These systems include seasonally dry tropical forests, mangrove wetlands, and coral reef communities.

To achieve these ends, Paso Pacífico works in-depth with local communities to address the ecological challenges at hand. Paso Pacífico's programs include environmental education in rural schools; restoration of forests and watersheds using native trees; and applied research focused on key wildlife species (i.e. sea turtles, amphibians, jaguars, parrots, primates).

Paso Pacífico's coastal and marine conservation programs integrate community development with ocean stewardship and marine wildlife protection. For example, Paso Pacífico builds capacity in ecotourism and at the same time employs local people to protect sea turtles and coral reefs. Currently, the sea turtle protection program provides permanent employment for eight sea turtle rangers who have received training in sea turtle monitoring and rescue techniques.



THREATS TO SEA TURTLE CONSERVATION

Sea turtles throughout the world's oceans are threatened. Among those are Central American species such as the leatherback (*Dermochelys coriacea*) and hawksbill (*Eretmochelys imbricata*), which are at risk of impending extinction. Recent assessments of risks to marine turtles have found that hawksbills and leatherbacks in the Eastern Pacific, where Paso Pacifico works, are among the most endangered populations in the world.

Sea turtles throughout the world face threats to their survival and conservation at every stage of their life cycles. Turtles in Central America's Pacific slope are no exception. The primary drivers over to sea turtles over the past several decades have included degradation of marine habitats, accidental by-catch by fishermen and widespread poaching of sea turtle eggs.

At sea, turtles increasingly face losses in availability of food resources due to rising sea temperatures as a result of climate change. By-catch is a persistent problem as turtles are often entangled in gill nets used by artisanal fisheries. Turtle reproductive success is suffering substantial declines due to the loss of nesting habitat to coastal development (i.e. hotels, roads) and erosion of beach lands. Those turtles that do manage to find suitable habitat to lay eggs often lose nests due to poaching and predation by domestic animals. Furthermore, the effects of global warming on sex ratios and longevity of nesting beaches are yet to be fully understood.

In addition to hawksbills and leatherbacks, Paso Pacifico works to protect the East Pacific green sea turtle (*Chelonia mydas agassizii*). This species is poorly known in Central America, and scientists are just beginning to document its migratory patterns and population genetics. It is crucial to perform research on this species to understand its lifecycle and life-history traits.





PASO PACIFICO'S SEA TURTLE CONSERVATION PROGRAM

Paso Pacifico has been committed to the recovery of sea turtle populations since its founding in 2005.

Our approach relies on interdisciplinary, multi-stakeholder engagement that reduces threats at sea, protects nesting resources, and reverses degradation of the key habitats used throughout sea turtles' life cycles.

Paso Pacifico's work is focused largely in the La Flor Wildlife Refuge in Nicaragua, whose main beach is an important mass nesting site for Olive Ridley sea turtles. Although the main beach receives regular patrols from Nicaragua's environmental ministry, remaining beaches were previously unprotected with poaching rates as high as 100%.

In 2008, Paso Pacifico's community-based turtle rangers began patrolling and protecting these small beaches, one of which has the largest documented nesting population of Pacific green sea turtles along Nicaragua's western coast.

Paso Pacifico's sea turtle program focuses on protecting nesting turtles by involving community members; education of youth and providing alternatives to income generated by egg poaching.

On this last point, an important aspect of Paso Pacifico's work is generating employment tied to sea turtle protection and promoting alternative economic activities through ecotourism.

Two Nicaraguan communities are highly involved in sea turtle conservation programs: Tortuga, an agricultural community inland from the La Flor Wildlife Refuge, and Ostional, just to the south of the refuge. Despite Paso Pacifico's efforts, community members continue to illegally harvest eggs from these beaches.

In the following pages, we will provide updates to our current initiatives to protect sea turtles. We'll also explain why your support is vital to achieving our sea turtle conservation goals.

SEA TURTLE CONSERVATION IN NICARAGUA

Despite a decade of work, challenges to conservation remain

Nicaragua's Pacific Coast represents a major opportunity for conservation of turtle nests for Olive Ridley, Hawksbill, Leatherbacks and Pacific Green turtles. This coast is long, dominated by sandy beaches, and at present, one of the least developed coastlines in the region.

For leatherbacks, the most endangered of turtle species, important nesting sites in Nicaragua, such as Playa Salamina (managed by Fauna & Flora International) persist in the region.

Paso Pacifico has identified potentially important Hawksbill, Leatherback, and Green nesting sites in the Rivas area (Medina et al. 2012) and has validated the national importance of the area for green turtles through its nest monitoring.

Despite important nesting beaches, nest poaching is a major threat on Nicaragua's Pacific coast. Solitary nests are nearly always destroyed by poachers at unprotected beaches.



CURRENT INITIATIVES



Paso Pacifico is taking a number of novel approaches to solve the extinction crisis facing turtles

Since its inception, Paso Pasifico has recognized that sea turtle conservation requires innovative approaches and inclusion of local communities.

We strongly believe that community members are our best allies for sea turtle conservation, which is why we established a community ranger program and recently a junior ranger program to patrol beaches and foster education of sea turtle conservation.

Our latest project is the InvestEGGator, a technology designed to mimic a real sea turtle egg, which is used to detect and deter sea turtle egg poaching. Developed by our very own Kim Williams-Guillen, this exciting breakthrough has the potential to expand our work into Latin America and even abroad with sea turtle conservation orgs as well as local governments.

In the following pages we will provide greater detail on some of these exciting initiatives.

JUNIOR RANGER PROGRAM

In 2008 Paso Pacífico recruited eight community members to receive training in sea turtle monitoring techniques. Since that time, rangers have been employed full time to protect three small nesting beaches around-the-clock.

Rangers are uniformed and equipped and treated as a professional team. They have traveled to international ranger courses and sea turtle meetings. Over the past five years, rangers have received training in nest monitoring techniques, data management, satellite transmitter placement, sea turtle first aid, and first aid. Rangers are also trained to use non-confrontational approaches to ask that egg poachers cease poaching on the beaches.

Over the past six years, rangers have successfully monitored and protected three small beaches located on the southern end of the La Flor Wildlife Refuge, bringing to light the presence of an important green sea turtle population. In 2007, there were only 7 Green Turtle nests reported for all of Nicaragua and similarly few Hawksbill nest sites.

When Paco Pacifico found numerous Green Turtles and several Hawksbill turtles at this beach, the organization was thrilled and became determined to maintain this program into the future.



THE INVESTEGGATOR

Developed by Dr. Kim Williams-Guillen in 2016 as a part of a competition for the USAID Wildlife Crime Tech Challenge, the InvestEGGator is a wildlife-tracking product designed to document the movement of illegally harvested sea turtles. The goal of the Investeggator is to combat illicit trade in sea turtle eggs by providing data into the burgeoning wildlife trade that is shrouded in secrecy.

The InvestEGGator is a low-cost “dummy” turtle egg with embedded with a GPS tracking device. It replicates the appearance, weight, and feel of a real turtle egg, is easily deployed at low risk to investigators, can be programmed and monitored remotely using web-based and smartphone applications, and is low cost, allowing for deployment of many units at once.

As part of the USAID challenge, Paso Pacífico was a winner in the "Detect Transit Routes" category and received \$10,000 and technical assistance to further their solutions. The InvestEGGator then competed with other winning projects for three Acceleration Prizes of \$100,000, awarded to those who made “truly remarkable progress in turning promising ideas into viable solutions positioned for scale and impact on the ground.” In September 2017, the Investeggator won the category.





THE INVESTEGGATOR

An initial beta test was performed in November 2016 in Costa Rica with Helen Pheasy, a PhD candidate from the United Kingdom, as the primary investigator. The test produced sufficient data to determine that the batter life of the InvestEGGator could last for as long as six days. Additionally, the technology reports its location even after being buried for more than two weeks and can come back online. One was even hauled over a very long distance (virtually all of Costa Rica!) without being detected. The details of its passage displayed on a digital map using an application the InvestEGGator connects to.

The InvestEGGator is currently the subject of a second beta test project with three University of Michigan graduate student researchers. As of April 2020 the group has worked with several conservation partners in Costa Rica across the Guanacaste, Punturanas and Limon provinces. The research study has produced promising results and we hope to use these results to market the InvesEEGator to other sea turtle conservation organizations.



REEF MONITORING PROGRAM

Coral reefs off the coast of Nicaragua provide critical ecosystem functions for sea turtles and all marine life

Paso Pacifico aims to conserve and protect the unique forest and coastal ecosystems along Central America's pacific slope. Amongst the most important of these are the coral reefs off the coast of Nicaragua.

With the purpose of building a base for long-term protection of reefs and turtle habitats, our marine-monitoring program has helped lay the groundwork to strengthen and expand the La Flor Wildlife Refuge's marine areas.

In the process we have been able to establish relationships with community members and youth, educating them on the importance of coral reefs for marine life.

In 2012, Paso Pacifico initiated our first reef life surveys and began three years of reef life monitoring.

Surveys were carried out in a period of five years and have established important baseline data for marine habitats in Paso Pacifico's Eastern Pacific.

This area provides a habitat for animals such as juvenile hawksbill sea turtles and overwintering humpback whales and displays the greatest diversity of soft corals and echinoderms found along the nearshore of Central America's Eastern Pacific

Appendix 4: InvestEGGator Beta Testing

An essential component of the first week of field work was to understand how different InvestEGGator settings could potentially impact the battery life of the devices. Due to time and material constraints, only 17 InvestEGGator devices were able to be tested.

Table 2. InvestEGGator devices that were used in beta testing during the first week of field work in El Jobo, Costa Rica, June 2nd-8th 2019. Each device was programmed to create a unique combination of interval setting (10, 20, or 30 minutes), vibration setting (on or off), and vibration sensitivity (2, 3, or 4).

Unique ID	Interval Setting	Vibration Setting	Vibration Sensitivity
V8-08804	10	On	3
V8-08821	10	Off	3
V8-08810	30	On	3
V8-08806	30	Off	3
V8-08808	60	On	3
V8-08822	60	Off	3
V8-08784	10	On	2
V8-08785	10	Off	2
V8-08786	30	On	2
V8-08787	30	Off	2
V8-08791	60	On	2
V8-08792	60	Off	2
V8-08803	10	On	4
V8-08800	10	Off	4
V8-08799	30	On	4
V8-08798	30	Off	4
V8-08796	60	On	4
V8-08793*	60	Off	4

*InvestEGGator device 8793 never recorded a location in Costa Rica. The device's last reading was 5/31/2019 in Michigan, USA. As a result we were not able to monitor battery.

Appendix 5: InvestEGGator Deployment Data



The 2019 Costa Rica pilot study resulted in InvestEGGator deployment on the Pacific and Caribbean coasts. The results are summarized below, as well as a description of continued research in other countries.

Summary of Deployment Data – Costa Rica, 2019

Each NGO was provided with at least a dozen InvestEGGators to deploy over the course of their nesting season in 2019. Table 3 and Table 4 show the number of devices that each NGO successfully deployed and the final status of each InvestEGGator. Together, the partner organizations successfully deployed 21 devices between October and December 2019 and only two were poached. All but one NGO deployed at least one InvestEGGator.

CREMA was unable to complete deployment because of hardware problems that kept the lights from turning off while the InvestEGGators were on. This light setting was meant to be turned off since deployment and poaching activity mostly occurs at night and the lights could alert poachers and possibly put patrollers in danger.

The Turtle Love Project was unable to complete deployment because they did not have the staff to check on the InvestEGGators for signs of poaching. They also did not have patrollers to retrieve those that were not poached after the 50-70 day incubation period for *C. mydas* (the species of turtles most commonly found in this area). They found evidence of poaching activity during their morning census and concluded that two nests, each with one decoy egg inside, were poached. They did not retrieve the stolen decoy eggs but community patrollers were approached by an individual asking if the device was theirs.

The Leatherback Trust shared photo evidence of one device that was found with wear and tear and could not be redeployed. This egg was found after the incubation period of 45-50 days for *L. olivacea*. Two of the InvestEGGators recovered were recharged and deployed again.

We do not have information on the reason why Equipo Tora Carey was unable to deploy any of the devices. We were unable to retrieve positional data for the stolen decoy eggs.

These findings show that the InvestEGGators are capable of deceiving poachers based on appearance but require improvements in their internal hardware to render them reliable for future deployment.

Table 3. InvestEGGator devices that were deployed and their final status as of March 2020. NGOs able to deploy include The Leatherback Trust (TLT), COPROT, CREMA, and Turtle Love (TL).

NGO	Egg Number	Final Status
TLT	V8-08768	N/A
TLT	V8-08780	N/A
TLT	V8-08781	recovered and redeployed
TLT	V8-08788	recovered and redeployed
TLT	V8-08794	N/A
TLT	V8-08795	damaged
TLT	V8-08802	N/A
TLT	V8-08807	N/A
TLT	V8-08819	N/A
TLT	V8-08823	N/A
COPROT	V8-08779	recovered
COPROT	V8-08854	recovered
COPROT	V8-08853	recovered
COPROT	Unknown	N/A
CREMA	V8-08778	N/A
CREMA	V8-08790	N/A
CREMA	V8-08801	N/A
CREMA	V8-08818	N/A
TL	V8-08792	poached and destroyed *
TL	V8-08825	N/A
TL	V8-08826	poached
Total	21	

Table 4. Final Status of the InvestEGGators that were deployed during the 2019 nesting season.

Status	Number of Devices
Poached	2
Recovered and redeployed	2
Recovered	3
Damaged	1
Status is unknown	13
Total	21

Ongoing Data Collection

The link is available for our ongoing data collection of which eggs have been deployed and their final fate, last updated March 2020.

https://docs.google.com/spreadsheets/d/1RJVz4Ug0fiF0lWHm_WuLR1VYtMoKotXWXE24Aeg6rg/edit?usp=sharing

Continued Research — Guyana, 2020

After the pilot study and summer field visits, Paso Pacífico established a new partnership with a sea turtle conservation organization in Guyana. This partnership solidified during the past month when the new partner obtained 30 InvestEGGators to begin deployment at a nesting site with a poaching rate of 10-12%. *C. mydas* is the most common species of sea turtle that arrives at this nesting ground. Using the information gathered from the field visits and pilot study over the summer, Paso Pacífico staff provided a virtual training session to the lead staff member on the use and tracking of the InvestEEGators. With this training, the lead staff trained his/her colleagues and together they designed a plan for deployment. The Guyana organization successfully deployed 27 InvestEGGators in less than a week in February 2020. According to the gps123.org tracking platform, there are currently no signs that any of the deployed devices have been taken by poachers, but monitoring will continue by Paso Pacífico and the Master Students. Overall, this project signals a continued interest in the InvestEGGator devices by organizations beyond Central America.

Appendix 6: Costa Rican Field Work with NGO Partners



Summer 2019 Field Visits

Paso Pacifico University of Michigan (UM) Master Project team visited each of the organizations during the summer of 2019. Below are summaries of interviews and field observations conducted with the nonprofit organizations that participated in the beta testing and deployment of the InvestEGGator devices. The Observations and interviews on their nesting protocols guided the development of the InvestEGGator Manual, deployment strategies, recommendations, and the deployment training workshop. Summaries include information regarding the NGO, turtle nesting, poaching behaviors, and patrolling activities, as well as the perceived impact on conservation.

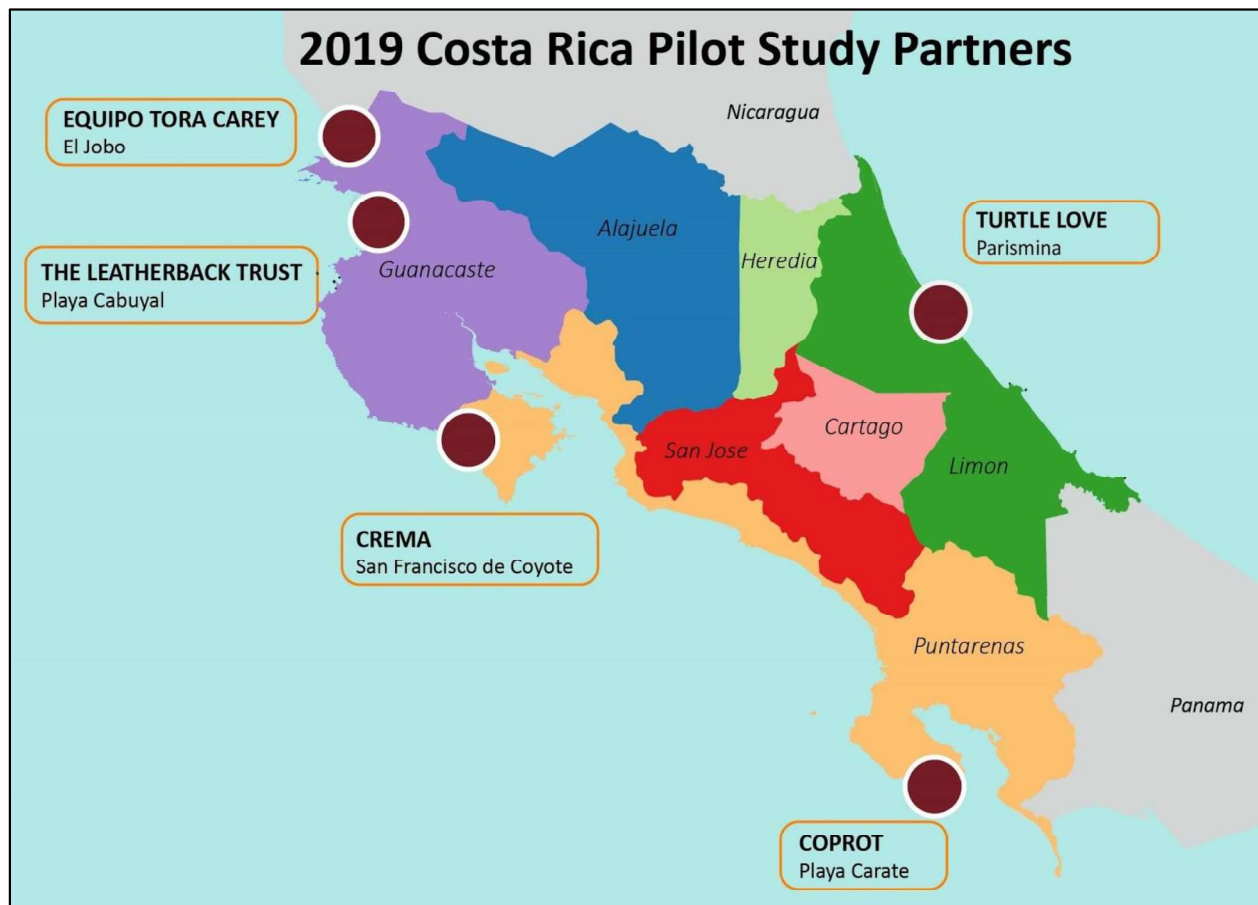


Figure 4. NGO partners in Costa Rica. Each organization participated in a beta testing and pilot testing of the InvestEGGator during field visits in Summer 2019 and continued deploying InvestEGGators devices over Fall 2019 and Winter 2020.

Table 5. List of turtle species and their nesting seasons at each of the beaches patrolled by the NGO partners.

Species Name	NGO Partner	Beaches Patrolled	Nesting Season
<i>Lepidochelys olivacea</i>	Equipo Tora Carey	Rajada, Rajadita, El Jobo, Coquito, Coyotera,	October-April
	CREMA	Bejuco, Corozalito	July-January
	Leatherback Trust	Zapotillal	December-January
	COPROT	Playa Carate	July-January
<i>Chelonia mydas</i>	Equipo Tora Carey	Rajada, Rajadita, El Jobo, Coquito, Coyotera,	January-March
	CREMA	Bejuco, Corozalito	July-January
	Leatherback Trust	Cabuyal	December-January
	Turtle Love Project	Playa Tres	July-October
	COPROT		July-January
<i>Eretmochelys imbricata</i>	Equipo Tora Carey	Rajada, Rajadita, El Jobo, Coquito, Coyotera,	Varies
	CREMA	Bejuco, Corozalito	July-January
<i>Dermochelys coriacea</i>	Leatherback Trust	Cabuyal	December-January
	Turtle Love Project	Playa Tres	February-June

Table 6. List of turtle species protected by the partner NGOs, including common names in English and Spanish

Species	Common Name (English)	Local Name (Spanish)
<i>Lepidochelys olivacea</i>	Olive Ridley	<i>Lora</i>
<i>Chelonia mydas</i>	Green Turtle, Black Turtle	<i>Negra</i>
<i>Eretmochelys imbricata</i>	Hawksbill	<i>Carey</i>
<i>Dermochelys coriacea</i>	Leatherback	<i>Baula</i>

Costa Rican NGO Partners

Equipo Tora Carey (ETC)

El Jobo, La Cruz, Guanacaste Province

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www.equipotoracarey.org

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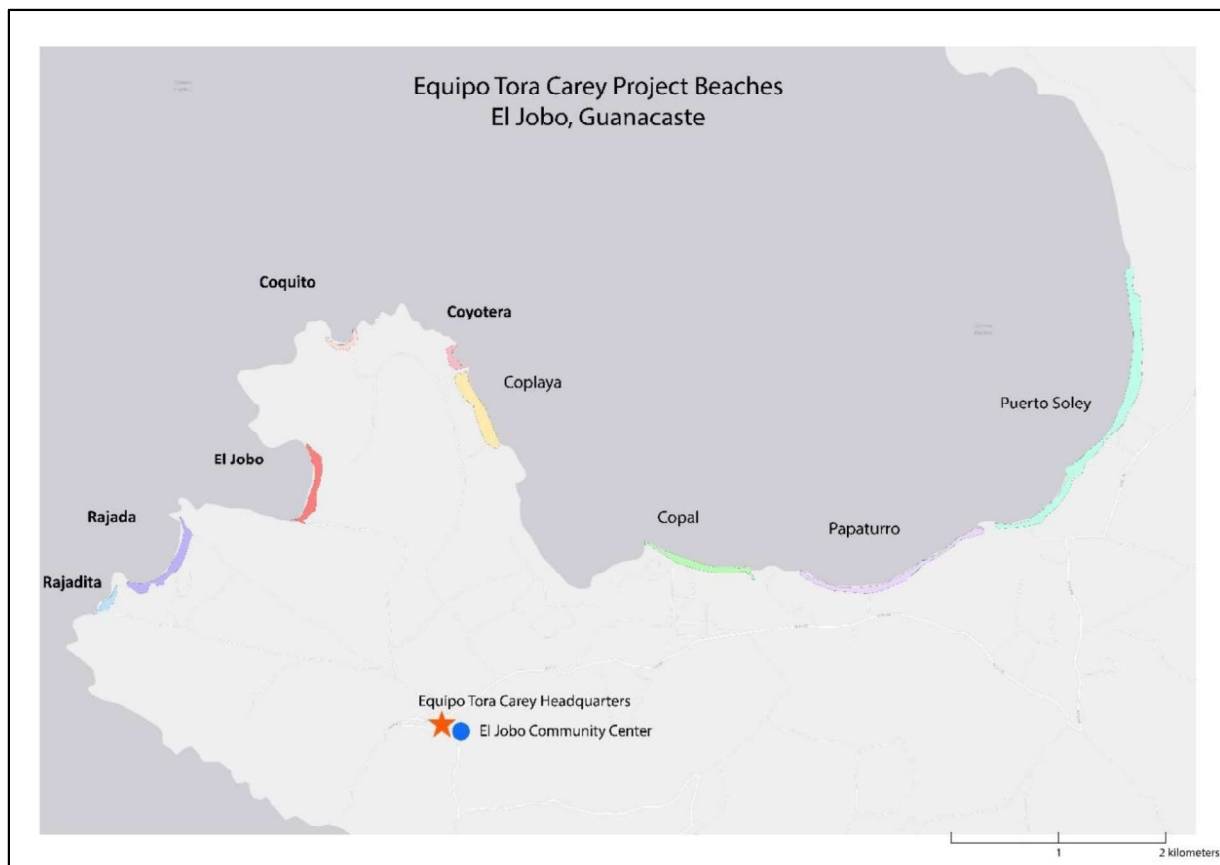


Figure 5. Map of El Jobo area, Guanacaste, Costa Rica showing the five beaches Equipo Tora Carey patrols each night in bold (Rajada, Rajadita, El Jobo, Coquito, Coyotera) and the four other beaches they monitor with less frequency in gray (Coplaya, Copal, Papaturre, Puerto Soley). The community center and ETC headquarters also appear.

Equipo Tora Carey (ETC) was founded in 2018 in a collaboration between El Jobo community members and a German biologist from the University of Costa Rica. ETC's mission is to empower and mobilize local coastal communities to conserve marine resources through education, conservation science, and community outreach. The inclusion of community leaders in the NGO's foundation speaks to the commitment to community leadership and is evident in every aspect of their work.

ETC was founded on a collaborative model, in which member families participate in a variety of ways--from being employed as a patroller, a host family for volunteers, or doing other ETC-related conservation work. There are currently 6-7 families involved. Participating families may not participate in poaching, and there is a disciplinary process if this is violated.

Sea Turtles & Nesting Seasons:

The 5 beaches that ETC patrols each night provide nesting grounds for *L. olivacea*, *C. mydas*, and the much rarer *E. imbricata*. *L. olivacea* tend to nest closer to the water, and the *C. mydas* nest 5 meters above the water line. For *Chelonia mydas* the peak nesting is usually January-March, and for *L. olivacea* usually October or December-April. February is nesting peak season due to cold waters and high winds, often with ~10 *L. olivacea* nesting each night.

Poaching Behaviors:

Within the community 2 older long-time poachers are well-known, poaching mostly when intoxicated. Most other poachers are opportunistic and occasional. According to community members, fishermen and divers passing the beaches in the early morning were historically the largest group of poachers. Poachers still tend to work alone and arrive after patrolling shifts end, around 4 a.m.

Members of ETC believe that the majority of poached eggs stay local in El Jobo, but some may travel to neighboring larger city La Cruz. For the most part they do not believe they would travel farther than La Cruz, but lack information to verify this. A dozen eggs go for about 1,000 CRC (~1.75 USD).

Nests of all species are poached, although there may be a local preference for *E. imbricata* eggs as they are smaller and more amenable to consumption. The Coyotera beach is often targeted, as it has easy access from the main road. Poaching behavior varies by species' nesting habits. For example, *L. olivacea* excavate and lay eggs relatively fast (less than an hour), while *C. mydas* take much longer (more than an hour). Patient poachers may sit and wait for the process to be completed to grab all of the eggs. Eggs are then usually stored in a bag in a backpack and brought to La Cruz by car where they are sold to bars, and potentially to Punto Soley or Nicaragua (very close to the border).

Patrolling/Projects:

ETC actively patrols 5 beaches: Rajadita, Rajada, El Jobo, Coquito, and Coyotera. Other beaches in the near vicinity are patrolled on occasion or in the day, including Coplaya, Copal, Papa Turro, and Puerto Soley. The majority of these have 2 shifts, from 8pm-12am, and then 12am-4am, while Coyotera has only 10pm-2am due to limited availability of patrollers. There are 7 full-time patrollers in El Jobo, who rotate with another pair and switch off for the beach they will patrol that night.

When patrollers are on duty, they walk the stretch of the beach they are assigned looking for signs of turtles and nesting. When a nest is located, patrollers first check for footsteps of any poachers already present. While they are patrolling, they look over the turtle to see if they have been tagged or not. They then record the location and relocate the eggs if necessary. There have been a few instances of encounters with poachers, in which patrollers may talk to them in a calm, non-confrontational matter and tell them that they are patrolling beaches to protect turtle nests, making sure to not put themselves in danger.

New patrollers are trained by one of the head patrollers/co-founders of ETC who is very knowledgeable and experienced. The job offers excellent benefits, including regular pay and paid training as well. Some of the newer patrollers have learned about the data collection and turtle ecology as well.

Community-Based Conservation Impact:

Since the formation of ETC, El Jobo has experienced a significant reduction in poaching. The patrollers we spoke with told us that patrolling is almost 100% effective, as all nearby communities know about ETC, and personally know the patrollers who are on the beaches.

Some of the positive results of the community-based conservation foundation of ETC were community buy-in to direct economic benefits to empowerment and capacity building. The community patrollers are paid, and there is also a system of collecting and organizing the monitoring data done by community members, before it is passed off to the researchers. This system builds on many roles for El Jobo residents

to be involved in and employed by ETC. As one patroller shared, although he was trained by a foreigner he is now able to train other local people. We were also impressed by the knowledge and autonomy of each patrollers style, using their beach-specific knowledge to best decide which nests should be moved, and where they should be moved to.

Although there is pay for patrollers, it is probably not the most well-paying jobs available in the area. Tourism (sport-fishing and hotel) related employment have created many opportunities nearby. However, patrollers told us that even if the income is not the highest, they really care about the conservation efforts and are doing it for future generations in their community. We met a few patrollers who have also trained their children and other family members on beach patrolling and overall encourage youth to respect their environmental resources.

Centro de Rescatee Especies Marinas Amenazadas (CREMA)

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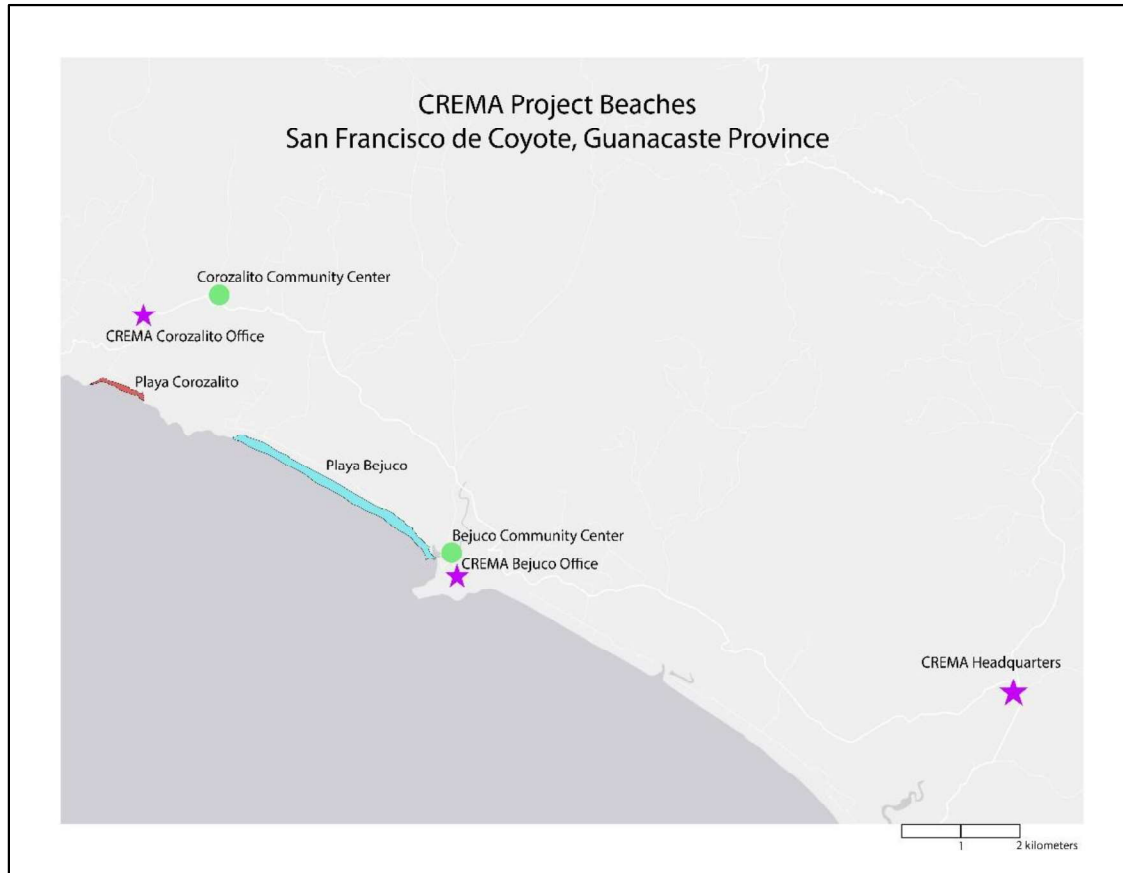


Figure 6. Map of CREMA project area in Guanacaste, Costa Rica. The headquarters is indicated in San Francisco de Coyote. There are two field offices, one at Playa Corozalito and one at Playa Bejuco. The community centers and patrolled beaches are indicated at both locations.

CREMA is a nonprofit organization in Costa Rica founded in 2012 to address the conservation of marine and terrestrial natural resources and to promote sustainable fisheries policies in Costa Rica and Central America (crema.org). Located in the southern region of the Nicoya Peninsula, CREMA coordinates various projects involving marine fauna conservation, education and community engagement, and sustainable marine resources policies. Sea turtle nesting monitoring projects occur in four main beaches in the region including Playa Corozalito and Bejuco (both of which were visited by the UM team). Playa Corozalito and Bejuco are distinct beaches with key differences in physical conditions and monitoring environment.

Sea Turtles & Nesting Seasons:

The sea turtle nesting season runs from July to early January in both Playa Corozalito and Bejuco. The NGO project coordinators report that solitary nesting peaks in October and September. However, peak nesting times do not necessarily align with poaching activity since rainy conditions during these months seems to deter poachers. The most common sea turtles that visit these beaches are *L. olivacea*. Rare individuals of *C. mydas* and *E. imbricata* species arrive during the season as well. Synchronized nesting

of hundreds of *L. olivacea* occurs every year in Playa Corozalito for several nights between August and October. These are often referred to as “mini-arribadas.”

Poaching Activity:

Coordinators in Corozalito and Bejuco describe most poaching activity as opportunistic, especially during the holidays and weekends when more people from larger cities travel to the coast for vacationing. Opportunistic poaching tends to happen between 7-10pm when families go to the beach. If they are there when a sea turtle starts nesting, they simply wait and grab the eggs as well as other things like crabs. Overall, poaching activity is most common when the presence of police decreases. The coordinator at Bejuco specifies that more poaching occurs during the weekends compared to Corozalito. In Corozalito, tourist access to the beach is regulated by an Environmental Committee and they report visitors that break the established beach rules. However, NGO project coordinators and assistants still encounter evidence of poaching activity and other prohibited beach activities, as well as predation by raccoons and dogs.

Patrolling/Projects:

Playa Corozalito is 1200 m stretch of open beach and located within 4 km of the small pueblo of Corozalito. An unpaved road facilitates easy access to the beach and visitors can easily walk to and from their parking spots to the beach area. In Corozalito, patrolling involves walking the 1200 m back and forth checking for signs of nesting turtles. There are two patrolling shifts; one at night in the early evening and one at dawn after 4 am. A transect and triangulation system is used to record nest location in Corozalito.

Playa Bejuco is a longer beach and only a certain section is monitored. Beach conditions prevent them from using a triangulation system because they lack immediate vegetation on the sandy beach to set up the transect locations. The fishing community in Bejuco participate in the monitoring and beach patrols and they also established a nursery where they relocate certain nests based on likelihood of poaching or getting washed away by the high tides. Playa Bejuco also has direct road access and a small neighborhood is located within walking distances to the beach. Research assistants in both sites conduct nightly beach patrols to track nesting sea turtles, tag individuals that nest, and overall deter poaching activity with their nightly presence during their shifts.

Community-Based Conservation Impact:

CREMA is well known among the community members around Playa Corozalito and Bejuco. In both beaches there is at least one community member that is part of the patrolling teams and works closely with the research coordinators to collect data on nesting turtles. CREMA’s involvement in community projects were obvious from the beginning. At Corozalito the research assistants and coordinators work closely with children from the community on environmental and education projects to promote sea turtle conservation. In Bejuco, CREMA’s community-based approach had a longer history. Here, they began working with a group of local fishermen who were fighting against large scale commercial fishing. CREMA’s initial work with the fishing community established what would become a long-term relationship to not only promote sustainable fishing but also establish a volunteer beach patrolling and community sea turtle hatchery.

Community members in Bejuco describe that attitudes toward wildlife and environment have “definitely” changed since they began working with CREMA. One of the members states that poaching is lower in Bejuco compared to years before CREMA initiated the community patrolling project there. The community members are grateful for the help that CREMA has provided their community such as building them a small house; fish biology and ecology educational resources; and for their assistance in creating Bejuco’s sustainable fishing NGO. The community of Bejuco has also had a great impact on CREMA. Community based patrollers volunteer to help the research assistants and the older generation fishermen are constantly training the community youth to become the next generation of sea turtle beach patrollers. Overall, the community members were happiest for the unique friendships that they had established with visiting CREMA volunteers from different parts of the world.

The Leatherback Trust (TLT)

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San José, Costa Rica

www.leatherback.org

Contact: Verónica Valverde, verovalcan@gmail.com



Figure 7. Map of The Leatherback Trust project area in Guanacaste, Costa Rica. The map indicates the two beaches patrolled, Playa Cabuyal and Playa Zapotillal, as well as the field office located at the Horizontes Experimental Forest Station. Also shown is the El Triunfo community center.

The Leatherback Trust (TLT) was founded in 2000 by two turtle biologists. They began with a central project in Las Baulas National Park, and then expanded to include the smaller site at Playa Cabuyal. The primary mission of TLT is research aimed at the protection of sea turtles, which requires very detailed scientific data and field measurements. This scientific focus presents a slight barrier to direct work with communities. The on the ground staff take care of the day-to-day activities and have significant autonomy, with the Directors mostly living abroad.

Sea Turtles & Nesting Seasons:

TLT monitors and protects *L. olivacea* (most common, and less in danger), *C. mydas* (about 60/season, usually between 25-90), and *D. coriacea* (12-15/season). At Playa Cabuyal the peak season is December-January, especially for green sea turtles as olive ridleys nesting is a little more constant (but also peaks then). TLT has observed that *L. olivacea* nest almost anywhere, while green sea turtles are more specific, often choosing spots with more vegetation such as the Southern area of Cabuyal beach. The heavier leatherbacks depend more on the state of the currents for their nesting times.

Poaching Behaviors:

Local poachers are now aware of the TLT beach patrols and altered their poaching behaviors accordingly. Poachers tend to come in small groups of 2-3 people from nearby towns often in the mornings (after the patrol and before the morning census) as they know TLT is patrolling at night, and target areas that tend to have more nests. In the past 5 years, TLT has only had 2-3 encounters with poachers. According to TLT's records, 4 *C. mydas* nests and 4 *L. olivacea* nests were poached in 2018.

TLT does not believe that poachers prefer a specific species of eggs, although *L. olivacea* nests tend to be poached more, as they are shallower and easier to see as the nesting bed is not camouflaged. *C. mydas* nests can be harder to see, and thus are usually targeted by more experienced poachers. TLT is not sure where the eggs go but hypothesize that the majority are sold directly to local buyers, where a dozen go for about 1,500 CRC (~2.50 USD), and may reach nearby Liberia. Profits supplement poachers' earnings but there is not a main source of income. According to TLT, poachers tend to take all of a nest's eggs, which they can gather in about 15 minutes and store them in a backpack, leaving by bicycle or car.

Patrolling/Projects:

There are 7 beaches that TLT is involved with, but only two are currently patrolled by the staff: Zapotillal (300m) and Cabuyal (1.5km). The coordinator and assistant researcher are responsible for directing the night patrols, which consist of 2 shifts (8pm-12am and 12am-4am) and are accompanied by trained assistants or volunteers. During patrols they take measurements of the turtles that nest, record nest temperature and flag the nest, before covering it with sand and camouflaging vegetation. The staff try to avoid relocating the nests, unless it is 100% necessary if it's too close to the shore or beach entrance. The team also conducts a morning census at 5:30am.

TLT has had moderate success collaborating with local authorities, including catching 2 poachers back in 2018. However, there is not much enforcement without direct denunciation. Additionally, they work with a beach guard in Cabuyal, who can support TLT, but not directly with police.

Community-based Conservation Impact:

According to discussions with staff members, people used to come from nearby city Liberia to camp on the beach for months at a time and poach eggs. People from the smaller local communities also regularly poached eggs. Since TLT was established, there has been a shift in public opinion, with people (especially children, from the school visits) respecting turtles more. Still, there is a need to transform this into protection of turtles.

Future TLT goals include building stronger and a larger amount of relationships with people in the community so they will join in turtle protection. They had success in the last few years of forming friendships with people in the 3 nearest houses, but not the larger nearby communities. TLT recognizes the importance of outreach and environmental education and have been trying to reach the communities who have historically poached. In 2017 they started holding classes in the El Triunfo local schools, and in 2018 started further outreach in Liberia. They are also interested in engaging communities through providing more direct benefits or involving them as patrollers which has not happened yet but is on their radar. That, too, would require trust to pay people and know they are not poaching at the same time. The future could also lead to new projects, expansions to other beaches or inclusion of other species.

Turtle Love Project (TL)

Parismina, Limon Province

www.turtleslove.org

Contact: Renato Bruno, renato.bruno@selu.edu



Figure 8. Map of the Turtle Love project area in Limon, Costa Rica. The NGO headquarters is displayed with a star, just outside of the Parismina Community Center. Across an outgoing river is the protected beach, Playa Tres.

Turtle Love is a newly-established nonprofit organization focusing on the conservation of sea turtles on the Caribbean coast of Costa Rica via community involvement, applied research, and partnerships with other environmental agencies. TL is based out of Parismina, a small coastal town a few miles south of Tortuguero National Park. While nesting populations of sea turtles has increased in the national park since its establishment in 1975, poaching activity still remains a major threat to nesting turtles in the areas immediately adjacent to the park. This includes Playa Tres—a 5 km stretch of beach where Turtle Love has concentrated its conservation efforts.

Playa Tres is immediately south of Tortuguero but at one point the entire beach was also part of the national park. After 15 years of being monitored by the environmental federal agency – SINAC and the community-based conservation organization ASTOP, Playa Tres was last patrolled in 1980. A community member and the NGO director first noticed the need for patrolling due to the high levels of egg poaching as well as evidence of turtle harassment and possibly killings for meat consumption. One of the NGO members reports that at one point the National Park guards (who occasionally patrol the 300 m of Playa Tres still owned by

the park) saw at least 14 sea turtles tied up on the beach. This prompted the NGO director and community members to garner support from the community for the establishment of the organization.

Sea Turtles & Nesting Season:

Turtle Love's patrolling activity takes place during two major seasons when *D. coriacea* and *C. mydas* sea turtles return to Playa Tres to nest. Nesting activity for *D. coriacea* occurs from February to June and the *C. mydas* sea turtle nests from July to late October.

Poaching Activity:

Most of the poaching is believed to be occurring in the southern end of the beach which is closest to the town of Parismina and a small hotel and restaurant. Two types of poaching may be occurring in the area; opportunistic for local consumption and commercial for sale, with most of the eggs sold at another town where middlemen pick them up to sell elsewhere outside of Parismina. In the year and half that TL has been patrolling, they believe poaching occurs during early dawn after their night patrol and after their morning census during the day. TL has a strict "no confrontation" policy if they encounter any poaching activity or poachers during their night and morning patrols. TL notes that evidence of poaching and the number of poached nests has decreased considerably since they created the organization, but it is still occurring. NGO staff report that religious and holiday dates are when more poaching activity is reported by the patrollers as well as during the weekends throughout the year.

Patrolling/Projects:

Playa Tres is a unique beach environment that supports both open sandy beach conditions as well as highly vegetated areas with large amounts of woody debris. During the site visit, we observed some nests in the flat sandy surface areas; others on the more vegetated areas; and very few nests were located near high concentrations of large woody debris. Nests that are laid too close to the water were relocated or those that patrollers believed to be in danger due to beach erosion are relocated. The 5 km of beach are extremely demanding with night patrolling taking place from 7pm to 2 or 3 am. Thanks to the availability of the vegetation, the monitoring protocol follows a transect and triangulation system to mark the nests. The turtles found are tagged and measured. A morning census takes place from 7-11 am, to monitor nests already censused, locate new ones, and check for signs of poaching or other human activity near the nests

Community-based Conservation Impact:

Turtle Love's work with community members was at the forefront since the initiation of the organization. As one of the community members describes, it was clear since the beginning that the organization would be one based on community involvement and that to start the NGO, they first sought the opinion of the people in Parismina. Additionally, the research assistants and director were very clear in letting us know how critical the community staff member was in the project. The community member was able to offer local ecological knowledge on sea turtle behavior as well as information on poaching behavior and attitudes of community members toward sea turtles and the environment.

TL believes that their work has made an impact in the community in the short period that they have been around. Their conservation efforts also extend outside of Parismina in nearby cities where they give school presentations on sea turtle conservation and foster environmental awareness and participation. In the past, Turtle Love have also organized beach clean-ups at Playa 3 where Parisima members participate. The community staff member asserts that since the beginning of the NGO he has observed less poaching in Playa 3. His goal is that people in the community (people he knows very well since childhood) learn to appreciate sea turtles and their contributions to ecotourism, because as he says "una tortuga viva siempre es mejor que una tortuga muerta (a living turtle is much better than a dead one)." This staff member also hopes TL continues their commitment to the community and that one-day beach patrollers will all be from Parismina, who could make a living giving tours and protecting sea turtles.

Comunidad Protectora De Tortugas De Osa (COPROT)

Carate, Osa Peninsula, Puntarenas Province

tortugasdeosa.org

Contact: Laura Exley, tortugasdeosa@gmail.com

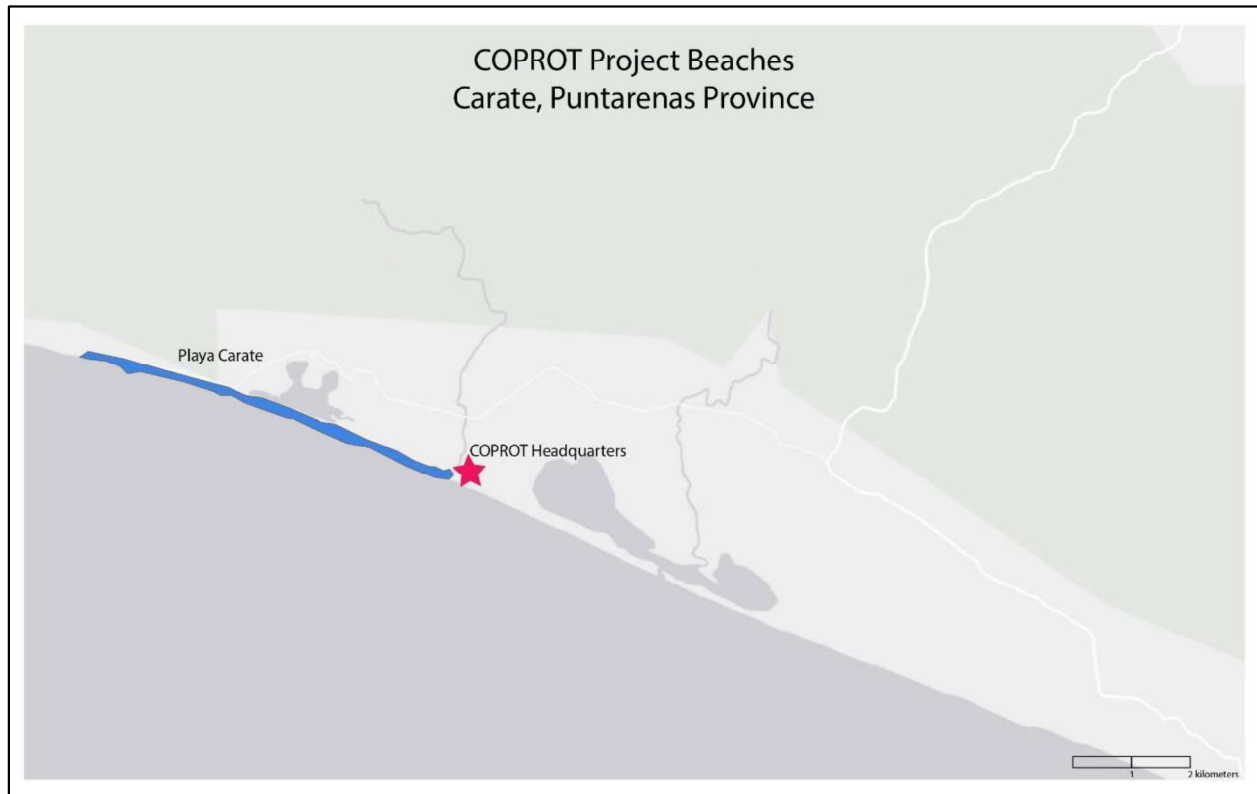


Figure 9. Map of the COPROT project area in Puntarenas, Costa Rica. The NGO headquarters is displayed with a star, and the largest of their protected beaches, Playa Carate, is displayed to the West.

COPROT was founded in 2017 by Head Biologist and Project Manager Laura Exley from the United Kingdom. The organization has collected substantial data on turtle nesting rates and hatching success in the area, which they hope to use to inform Costa Rican policy-making to provide more protections for sea turtles. COPROT collaborates closely with another U.K. conservation organization Frontier, which patrols on the northwest end of Playa Carate. By coordinating their efforts, these two NGOs have been able to double protections for sea turtles in a small area.

Sea Turtles & Nesting Season:

Tortugas de Osa primarily monitors for *L. olivacea* (most common, and less in danger), *C. mydas* (rarer, about 1 out of every 15 turtles) and very rarely *E. imbricata*. The beaches see high nesting around the new moon near the beginning of the month. There are no arribadas in the area, only solitary nesting events. At Playa Carate and Rio Oro, nesting season starts in July while the peak season is August-November especially for *C. mydas* as *L. Olivacea* nesting is a little more constant (but also peaks then).

Patrolling/Projects:

COPROT's three beaches cover approximately 2.5km in total: Rio Oro (1km) Carate (1km) and La Leona (0.5km), which borders Corcovado National Park. COPROT patrols beaches and protects nests with makeshift cages or sticks to prevent predation. They record new nests, monitor for hatching success, and translocate nests to either the nursery or a safer part of the beach. The NGO employs the help of community

staff and international seasonal research assistants. Patrolling occurs at night (10pm-2am) and morning (5am-9am) and it includes taking nest and sea turtle measurements in addition to recording for predation or signs of disturbance. The team also conducts a morning census at 5:00 am to check the status of previously discovered nests that night.

The primary threat to sea turtle hatchlings on COPROT's beaches is predation from local dogs and small mammals. To address this, in 2019 the NGO constructed a turtle nursery located on Playa Carate. Staff try to avoid relocating the nest unless there is an imminent need such as evidence of predation, if the nest is too close to the shore or too accessible to the National Park entrance. The team estimates that as few as 10% of nests are poached, a decrease from the 20-30% before the project started. On a few occasions early in the project, researchers had run-ins with poachers, although no one was hurt. Even so, since then, the researchers have instituted a rule that no one patrols alone

Poaching Activity

COPROT's activities border the popular Corcovado National Park, and staff believe tourists may be occasional takers of sea turtle eggs. The National Park was a place of profitable legal gold mining until it was banned in 2010, after which some locals turned to egg poaching for sustenance or to replace lost income from gold mining. The beaches are quite remote and were never heavily poached, but Rio Oro is poached most as it is most accessible from Puerto Jimenez, the closest major city and the likeliest transfer point for any poached eggs. Some poachers may come from Puerto Jimenez for supplementary income. Corcovado's proximity to the border with Panamá may also make it vulnerable to trans-border poaching/commerce, although the extent to which this happens is currently unknown.


Poachers in the area tend to prefer *C. mydas* eggs because they are larger, have a bigger clutch size, and are rare. *E. imbricata* eggs are also highly prized. Staff believe that the eggs are traveling either to Puerto Jimenez or across to Panama, where there is a more fervent market but less supply. The team believes that poaching generally occurs during their 10pm-2am shift as opposed to the early morning shift. They hypothesize that poachers travel down to the beach by vehicles from Puerto Jimenez and poach as many nests as they can since they can easily transport them by car.

Community-based Conservation Impact:

The COPROT lead coordinator is positive that poaching has dramatically decreased due to the employment of community members in the patrolling activities as well as through environmental education. In fact, they believe that by employing members of the community COPROT is showing the community their commitment to creating economic opportunity. While COPROT believes that their presence has made a significant change, they also account for the proximity to nearby NGOs and El Corcovado National Park in influencing the community's interest in sea turtle conservation for potential economic gain from tourism.

However, the NGO coordinator is also realistic about the overall change in attitude of the community towards marine resources including sea turtles. While the community has contributed a lot to the organization, the coordinator still believes that without the paid employment the community's participation in their conservation efforts would decrease. For this reason, among COPROT's goals are to develop an educational camp for people not interested in patrolling. Additionally, they want to create other economic opportunities such as permaculture, raising organic chicken, and other activities where people can learn how to grow or make organic products, etc. In regards to turtle conservation, they want to continue community-based patrolling and employ members that once worked in gold mining. Doing so, they hope to strengthen a sense of trust with the community.

Appendix 7: NGO Partner Exit Surveys



To learn more about the overall NGO experience in working with the InvestEGGators an online exit survey was provided to each partner organization to complete. In addition to the final report, the information gathered is meant to offer more guidance to Paso Pacífico in the overall product development, training, and deployment strategies for the device.

Survey Results Summary

In terms of the appearance of the InvestEGGators, the partners were generally impressed with one partner saying it was “really realistic, especially when put in sand.” Another NGO member noticed that the decoy egg had more of a “thicker” and “rough” texture compared to a real sea turtle egg but agreed with the size of the device. The partners believed that the training presentations were overall effective in teaching them how to use the decoy eggs but there was room for improvement. In a follow up question, of those partners that deployed at least one device, only one partner admitted feeling “not that confident” in using the InvestEGGators after the training.

Additionally, most of the partners expected to deploy more than a dozen decoy eggs; however, on average, partners deployed 4 InvestEGGators. It appears that safety concerns at the nesting beaches as well as issues with some of the devices were the main challenges that the partners faced when attempting to deploy. To track and monitor the movement of the decoy eggs, the NGO partners were somewhat satisfied with the website and app platforms. Furthermore, all partners believed that being able to communicate their questions about the device with the Master Student group during the deployment phase was “very helpful” and “very useful.” However, they noted that some issues with the eggs could not “be solved remotely.”

Our team was happy to hear that for all the NGOs, working with the InvestEGGators did not create conflict or negatively impact the relationship they had with the community. One partner described that this “was a positive collaboration that allowed [their] group to think about novel ways” to address poaching activity. Our team was eager to know if after this experience, the partners would want to continue working with the devices. To our surprise, of the responding partners all but one would like to use the decoy eggs again but acknowledge that the lack of signal and issues with using recovered devices need to be addressed before doing so.

Appendix 8: InvestEGGator NGO Training Protocol



Presentation Materials

- One or two InvestEGGator devices as examples
- Printed copy of entire InvestEGGator User Manual (English and Spanish)
- Presentation Slides or Printed Visuals

Training Outline

The following outline can assist in planning for effective, useful trainings with NGO partners, either in person during field visits or potentially remotely.

Introduction

- Introduce yourself/group and field of study and how happy and thankful you are for having the opportunity to work with their organization to tackle the issue of sea turtle egg poaching.
- Offer a short description of the InvestEGGator and its main purpose
 - *“Created by Paso Pacifico, the InvestEGGator is a GPS enabled tracking device that is designed to look and feel like a sea turtle egg. The goal is to use the InvestEGGator to prevent and track poaching activity by placing the device inside a turtle nest while the turtle is laying eggs. Disguised among the real eggs, the idea is for the InvestEGGator to track the route and destination of the stolen egg if someone does poach the nest with the device inside.”*
- The entire presentation can be done without a PowerPoint presentation, but it’s advised to have some visuals, such as printed pictures of the InvestEGGator’s key components and the different tracking platforms.

Deployment Strategy

- Following the introduction, explain the step-by-step process for deploying the InvestEGGators.
- Provide information on beach and nest selection and egg placement inside the nest (use the key points provided below). At the end ask, if as patrollers and experts out on the field, they have additional recommendations of how they would approach deployment differently. As an InvestEGGator trainer/presenter, always keep in mind that the community patrollers and those working directly with the sea turtles, are the ones who know their beaches and the sea turtles better than anyone else. Do not assume you know more about the ecology and behavior of turtles that arrive in these beaches.
 - *Beach and Nest Selection*
 - Deployment staff should prioritize beaches with the highest percentage of poaching activity and preferably those sites with a stronger cell tower signal

- Nests located near the entrance of the beach or those near areas with more signs of human activity such as fishing or trails should be selected for deployment
- *Egg placement inside the nest*
 - Once a sea turtle begins to nest near the suggested locations, the deployment staff should guard the turtle as she begins to lay her eggs
 - Patrollers should follow the protocol their team normally uses to approach sea turtles at night during their patrols
 - When a quarter of the eggs have been laid, deployment staff can use the cloacal mucus from the turtle to rub around the outer surface of the InvestEGGator (the idea to use this mucus actually came from a patroller during a training presentation). The mucus acts as a glue for the sand to stick to the device and will help to disguise it even more.
 - Record the number of the InvestEGGator that will be deployed in that nest and the approximate location if possible
 - Patrollers should slowly drop the InvestEGGator inside the nest. The fake egg will quickly blend in with the rest of the real ones as the turtle continues to lay eggs
 - Following these similar steps, a second egg can be placed inside the nest after half or two thirds of the eggs haven been laid

Tracking the InvestEGGator

- After introducing the two main methods of tracking the device allow the trainees to download the ReachFar application before beginning the App and website demonstration. If there is no signal in the area where the training is happening, it is a good idea to suggest to the trainees to come with the app already downloaded on their devices. This would significantly speed up the whole presentation and there will be more time to learn how to use the app. It is also a good idea to come with an extra phone or tablet that trainees can use during the presentation if they do not have a phone.
- Have them practice login in by breaking them into two separate groups. Provide them with the set of instructions from the Manual below and after about 3-5 minutes come back and ask 1) if they had any issues with accessing the app and 2) did they understand the manual instructions you provided. First explain the ReachFar application and if time permits continue to the GPS123.org website. During the app demonstration make sure to focus on the key aspects below. Also, remember to refer to the User Manual for more detailed explanations of the settings.
- *ReachFar Application*
 - Main Options on the main screen
 - ReachFar Settings and what they should be set to. Point out that they should never activate the Factory Reset or all data from the InvestEGGator will be lost.
- *GPS123.org*
 - Login in is similar to the ReachFar App
 - How to monitor through Real Time Tracking
 - How to access the Historical Route

Additional Resources

The following two sections will assist in conducting an effective training session.

Allow enough time for Q&A Session

- During the presentation, remind your audience to hold their questions for the end. They will have a lot of questions, particularly about the ReachFar settings and how the InvestEGGator is communicating with the application. Be prepared to repeat and re-explain. If they are asking a lot of questions, it's because they are really interested in the InvestEGGators!
- The most common questions about the InvestEGGators will be related to:
 - Battery life
 - Waterproof capabilities of device
 - Signal and lack of signal
 - What happens when the device is not poached?
 - What happens when the device stops working?
 - Do the fake eggs damage or harm the real ones?
- Answers to these and other possible questions are explained in the User Manual. Don't forget to refer to the Frequently Asked Questions section of the manual as well.
- At the end of the presentation, thank them for the time they took out of their busy schedules to participate in the training. If the training is happening at their specific NGO sites, remember that some participants may be patrolling later that night so be conscious of timing. Let them know you are available to answer any questions through email, text, etc. if they are still confused about the application and the InvestEGGators.

ReachFar App login Instructions

The ReachFar Smartphone application offers an easily accessible, user friendly option for programming. To begin programming complete the steps below.

1. Download the ReachFar application from the Google or Apple app store.
2. Open the app and login by using the **Log in by Device ID** option (*Fig. 2*)
3. Device ID is 210400 plus four-digit code. The only numbers that change are the last four digits, i.e., the entire 10-digit code.
Example: 2104008821
Password: 123456
4. Once logged on, you should see the following options on the ReachFar main screen (*Fig. 3*):
 - Real-time tracking
 - Historical route
 - GPS fence
 - Settings
 - Alarm list
 - Remind setting
 - FAQ
 - Logout

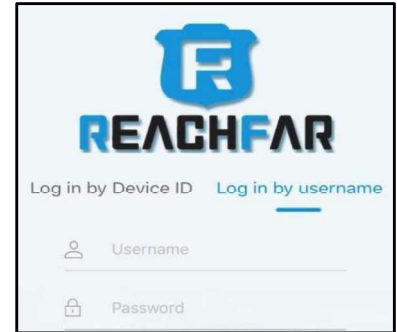


Figure 2. ReachFar login screen.

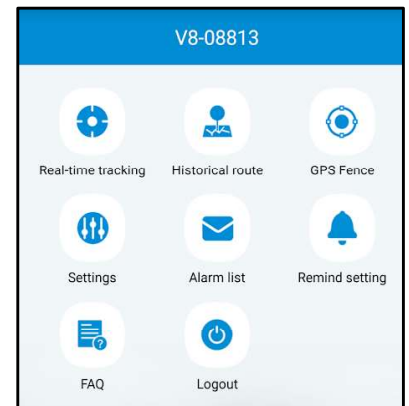


Figure 3. ReachFar home screen.

Appendix 9: Project Interview Questions



The following is a list of the questions used during the project's semi-structured interview portion. The questions are divided into two main sections: (A) questions designed to learn about the non-profit partners and their work as well as the characteristics of the poaching activity at the nesting sites and the presence of law enforcement and (B) questions to learn about each NGOs' community-based projects and how community members perceived the NGOs involvement and their conservation work in the region. The questions are not in any particular order. Many were designed as follow-up questions and or rephrased to gain as much information as possible.

Note: In different parts of Latin America, sea turtle egg poachers are referred to as “hueveros” or “saqueadores” in Spanish.

A) Questions for NGO partners and staff

NGO Background and Conservation Approach

- Tell us a little more about your position at the nonprofit organization (NGO)?

Cuéntenos un poco más sobre su posición en la organización.

- Can you describe your patrolling and monitoring approach/methods?

¿Puede describir los métodos de monitoreo que usan? ¿Puede describir el modo de patrullaje en cada playa?

- Do you relocate nests at the beach or move eggs to a different location different from the beach?

¿Reubican los nidos a otra parte en la misma playa o trasladan los huevos a una parte afuera de la playa?

Poaching Activity

- Are there any discernible patterns with regards to which nesting areas or beaches are most targeted by poachers?

¿Hay patrones distinguibles con respecto a qué áreas de anidación o playas están más dirigidas por los hueveros?

- What are the specific poaching behaviors you have observed in the years of working in the field?

¿Cuál es el comportamiento de los hueveros cuando saquean los nidos que ha observado en los años trabajando en el campo? ¿Por ejemplo, a qué hora del día? ¿Trabajan juntos o solo? ¿Son los mismos individuos o el mismo grupo?)

- Do you believe the NGO is effective in stopping the poaching activity?
¿Piensa que la organización es eficaz en detener el saqueo ilegal de los huevos de tortuga?
- What would you propose to help address the issue of illegal egg poaching?
¿Qué propone o sugiere como solución para afrontar el problema de saqueo de huevos ilegalmente?
- What are the typical characteristics of the nests that are more likely to be targeted by poachers?
¿Cuáles son las características típicas de los nidos que tienen más probabilidad de ser saqueados por los hueveros?
- When does peak nesting tend to occur? Does this influence the number of poachers or poaching activity in particular beaches?
¿Cuándo es el punto más alto de anidación? ¿Esto influye la cantidad de hueveros o actividad de saqueo en algunas playas?
- How long do the poachers typically spend collecting eggs at each nest?
¿Cuánto tiempo demoran los saqueadores en saquear cada nido?
- Do poachers remove all the eggs from the nest, or do they ever leave any behind?
¿Normalmente los hueveros recogen todos los huevos del nido o dejan algunos?
- What would you say is the profile/demographic of a typical poacher? Age, country of origin, gender, socioeconomic, etc.
¿Qué diría que es el perfil demográfico de un huevero o saqueador? O sea, sus edades, el país de origen, hombres o mujeres, estatus socioeconómico
- How specifically do the poachers transport the eggs? In what kind of containers do they transport them?
¿De qué forma transportan los huevos? ¿Por ejemplo, qué tipo de contenedores usan para distribuirlos?
- In what sort of road conditions do you believe they transport them? Through the main road system or through back roads/unpaved roads?
¿Cómo son las condiciones de transporte o distribución de los huevos? ¿Los mueven por las calles principales de la ciudad o usan otros caminos alternativos?
- What are the environmental conditions in the field like when poachers are active? Would this impact the number of eggs they are transporting or the condition of the eggs once they are excavated or even how many eggs are laid?

Nos puede contar más sobre las condiciones ambientales cuando los hueveros roban los huevos. ¿Esto afecta el número de huevos que recogen o transportan de un lugar para otro? ¿Estas condiciones ambientales pueden afectar la condición de los huevos una vez que sean excavados de los nidos?

- Is there an association between people who traffic and or poach turtle eggs and other illicit activities?

¿Hay una asociación entre las personas que trafican o saquean los huevos de tortuga y otras actividades ilícitas?

- Has poaching gotten worse over time?

¿Cómo ha cambiado la actividad de robo de huevos en estos últimos años?

Law Enforcement

- Do you believe law enforcement is effective in stopping the poaching?

¿Cuál es su opinión sobre la aplicación de la ley en cuanto a al saqueo de los nidos? (Follow-up Questions: ¿Piensa que esto funciona o es efectivo en detener el saqueo de nidos y robo de huevos? ¿Piensa que las autoridades están conscientes del robo de huevos?

- What kind of information do you think would be most helpful to both law enforcement and conservation NGOs to address illegal poaching?

¿Qué tipo de información piensa que sería más útil para las autoridades? ¿Qué tipo de información sería más útil para las organizaciones para enfrentar el problema de saqueo de huevo?

- Does law enforcement implement a fine for trafficking turtle eggs?

¿Hay una multa por parte del gobierno para aquellos que trafican huevos de tortuga?

- Are certain beaches or areas on the beach frequented more often by the local public, tourists, and law enforcement?

¿Hay algunas playas o áreas de las playas que son más frecuentadas por el público, los turistas, o las autoridades?

- Would law enforcement act on information given to them about poaching behaviors?

¿Qué harían las autoridades si reciben información de los hueveros y el saqueo ilegal de nidos?

B) Questions for NGO community member staff and external community members

- In your opinion, what is the most positive aspect of community-based conservation?

¿En su opinión qué es el aspecto más positivo sobre la conservación basada en la comunidad?

- What was the attitude toward wildlife and turtles before the NGO was established in the community?

¿Ha visto cambios en el comportamiento hacia la fauna y flora y el medio ambiente desde el inicio de la NGO en la comunidad?

- Based on your observations, how has the community-based NGO contributed to the conservation of sea turtles and their eggs?

¿Qué ha sido la contribución más grande de la comunidad hacia la NGO o cómo ha contribuido la comunidad a la NGO desde en cuanto a la conservación de las tortugas y sus nidos?

- In your experience working with the NGO, what has been the greatest success and what has been the greatest challenge?

¿En el tiempo que lleva trabajando con la organización, qué son los desafíos y éxitos más grandes?

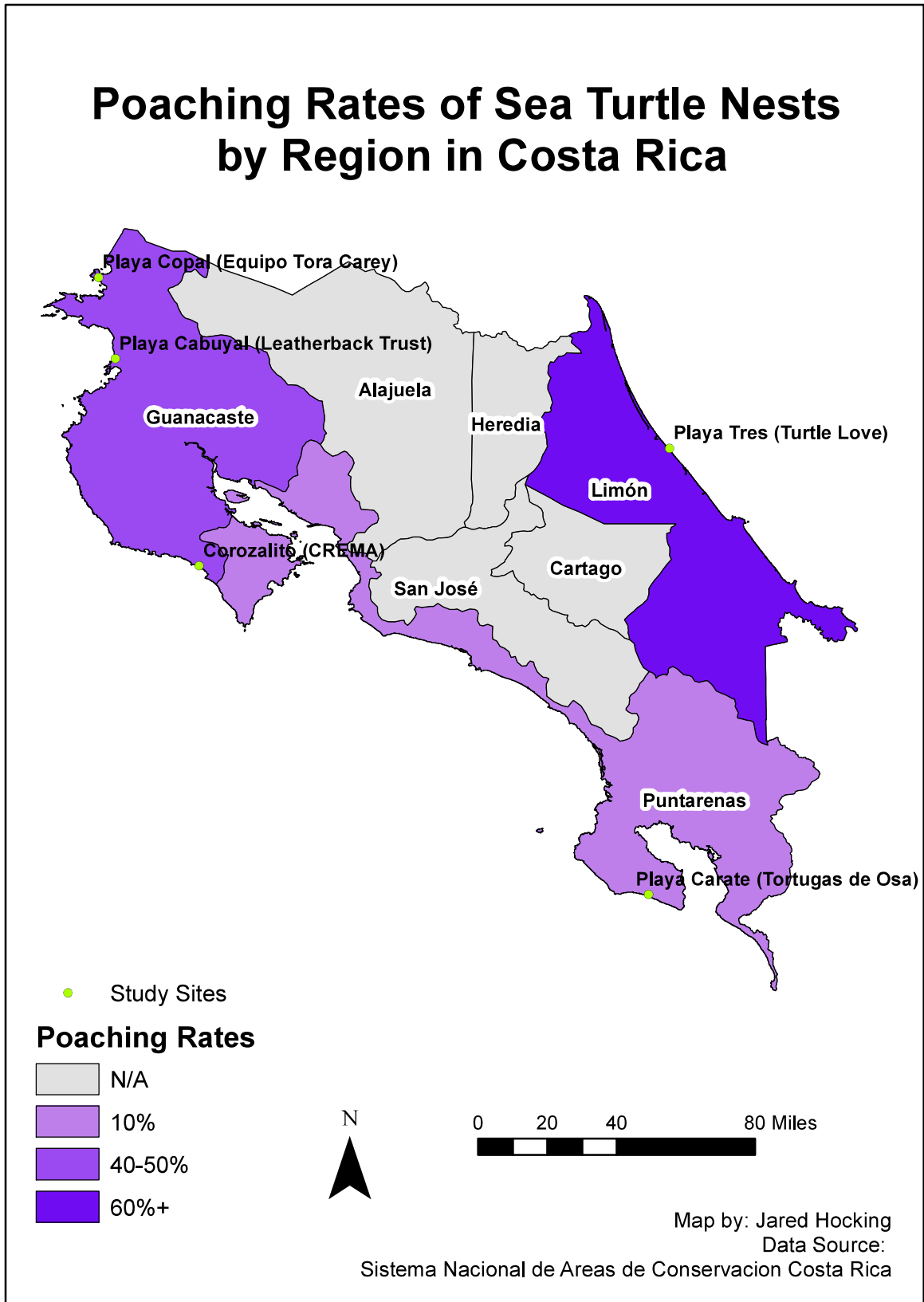
- What has been the greatest contribution of the NGO in this community?

¿Cómo ha contribuido la NGO a los miembros de la comunidad?

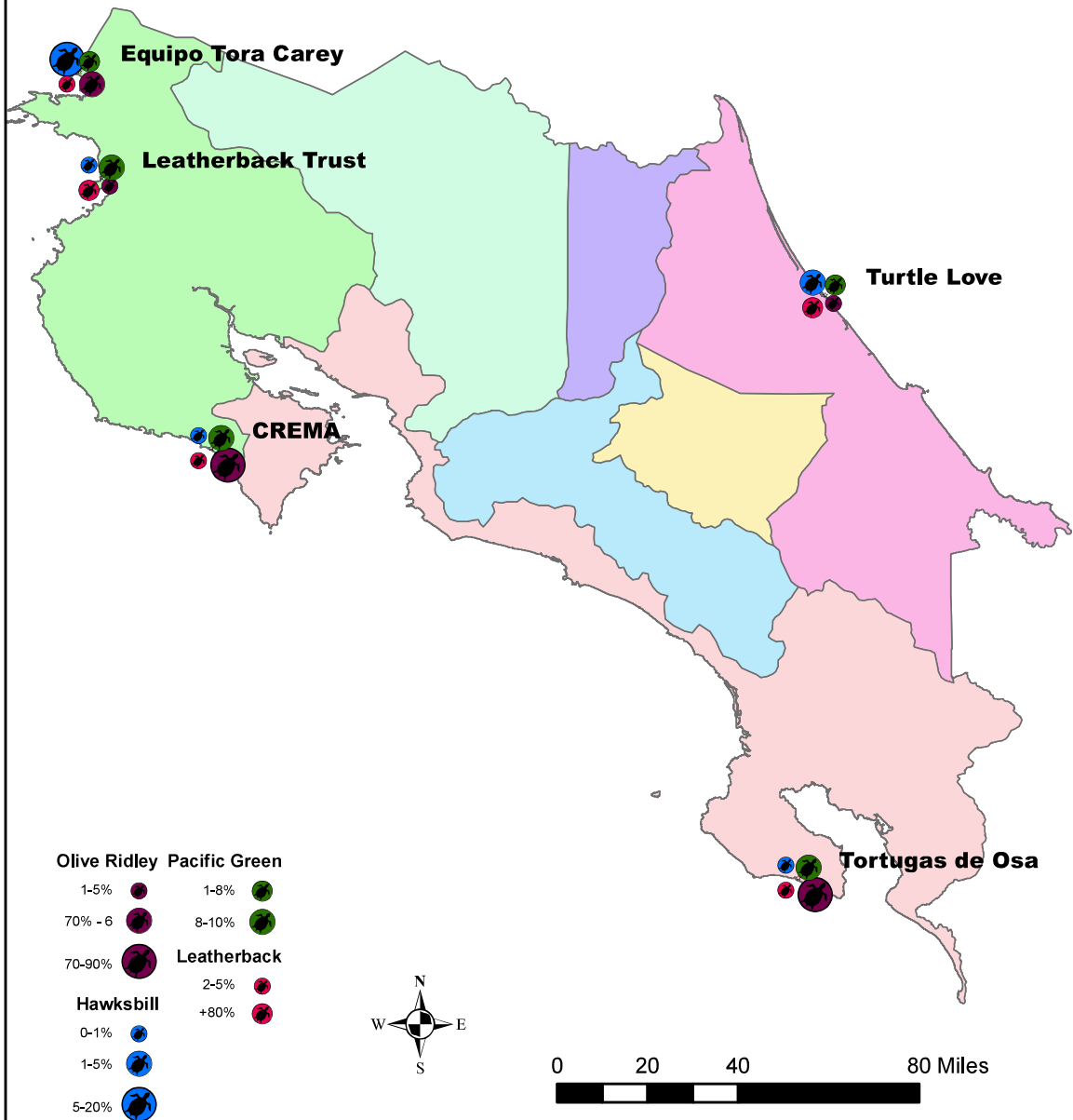
- How do you see the NGO working or contributing to the community in the next 5-10 years?

¿Cómo se imagina la organización contribuyendo a la comunidad de aquí a 5 o 10 años?

Appendix 10: Maps



Presence of Sea Turtle Species at Costa Rican Partner Sites



Map By: Jared Hocking

Data Source:

Turtle Love, Tortugas de Osa, CREMA, Equipo Tora Carey, Sea Turtle Conservancy

Attribution Page

The following group members participated in the writing of the Final Report: Zoe Fullem, Araceli Morales-Santos, and Jared Hocking. These are the group members that contributed to each of the following sections:

Main Report Sections

Section I – Z. Fullem and A. Morales-Santos

Section II – J. Hocking

Section III (A, B) – J. Hocking

Section IV (A, B, C, D) – Z. Fullem & A. Morales-Santos

Section V – All Group Members

Appendices Sections

Appendix 1,2 & 4, 5, 6, 7, 8, 9 – Z. Fullem & A. Morales-Santos

Appendix 3 & 10 – J. Hocking