

Economic Incentives, Perceptions and Compliance with Marine Turtle Egg Harvesting Regulation in Nicaragua

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Abstract

La Flor Wildlife Refuge and nearby beaches on the Pacific coast of Nicaragua are important nesting sites for various species of endangered marine turtles. However, illegal harvesting of turtle eggs threatens the survival of marine turtles. In this study, we analysed the different motivations of local villagers for complying with a ban on harvesting marine turtle eggs in a context, in which government authorities do not have the means to fully enforce existing regulations. We also analysed the effectiveness and the participation of locals in an incipient performance-based nest conservation payment programme to protect turtle eggs. The analysis of survey-based data from 180 households living in Ostional, the largest village near La Flor Wildlife Refuge, indicates remarkable socio-economic differences between harvesters and non-harvesters. Our findings suggest that harvesters are associated mainly with a lack of income from other activities and the absence of productive assets, such as land for cattle and/or agriculture. In addition, the lack of legitimacy of prevailing institutions (i.e., actual regulations) also seems to perpetuate illegal harvesting. The performance-based payments programme is an effective option for protecting nests on isolated beaches, however, it is not clear if it changes harvesting behaviour overall. Normative motivations to protect the turtles are important determinants of participation in this programme, although the financial reward is also an important incentive, particularly since most participants who are egg harvesters depend on this activity as their main source of income.

Keywords: La Flor Wildlife Refuge, marine conservation, performance-based payments

INTRODUCTION

The direct consumption and selling of marine turtle eggs, shells and meat as well as the non-consumptive uses of turtles (eco-tourism) provide important economic and cultural benefits to inhabitants of Nicaragua's coastal areas. These could be important components of the livelihoods of some local

households, in a context where poverty and limited income-generating activities are widespread (Guillén et al. 2007; INIDE 2008). Despite the legal ban on turtle egg harvesting, established in 2005 by the Nicaraguan government (Urteaga and Díaz 2006), commercialisation and consumption are very common in Nicaragua.¹ Although there is variation among species, one sea turtle nest may provide up to ten dozen eggs. Harvesters sell eggs (USD 0.20–3.00 per dozen eggs, depending on supply and demand) to four to six local brokers (most of them women), who then bring the eggs, for the most part, to illegal urban markets and restaurants.² Beyond these local benefits, marine turtles are considered a flagship species for conservation because of their importance for the health of marine ecosystems, as well as for the existence value that societies attach to them (Troëng and Drews 2004; Campbell 2010; Wilson et al. 2010).

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In one of the major nesting beaches for Olive ridley sea turtles *Lepidochelys olivacea*, located in south-western Nicaragua and within La Flor Wildlife Refuge, government officers, police, and the army have made an effort to enforce the prohibition and associated sanctions established by the Nicaraguan government against harvesting marine turtle eggs. However, the existence of illegal harvesting and associated commercialisation, documented by multiple interviews that we conducted in the area (explained in detail below), as well as conflicts between local communities and those trying to enforce the prohibition (Smith and Otterstrom 2009), call into question the conservation effectiveness and social desirability of this policy. Interestingly though, as complement to the traditional ‘fines and fences’ approach followed by the Nicaraguan government, an NGO named Paso Pacifico³ is promoting a ‘payments for conservation’ programme to incentivise local people to protect marine turtle nests instead of harvesting them for commercial gains. Nevertheless, this programme faces questions regarding its long-term sustainability and capacity to alter behaviour of local harvesters.

Most literature related to marine turtles comes from the biology side (Campbell 2010).⁴ The lack of related socio-economic scholarship, and the inherent complexity of the issue, limits our understanding and capacity to inform policies aimed at discouraging egg harvesting. With this in mind, the principal objective of this article is to understand the different motivations local villagers in Ostional, the largest community near La Flor Wildlife Refuge, report in deciding whether or not to comply with rules protecting sea turtle nests. In particular, we explore the roles of livelihood structure and normative perceptions in the allocation of time and effort to harvest eggs. In addition, we offer an analysis of local participation in the performance-based nest conservation payment programme (PPP) run by Paso Pacifico. We consider identifying socio-economic characteristics and motivating factors associated with local villagers enrolled into this programme. This analysis provides insights into the importance of economic and non-economic factors to promote the participation of local villagers in this type of conservation strategy, as well as the potential of this programme to become an effective tool to reduce harvesting behaviour significantly. Further, we also explore the potential behavioural changes on harvesting that this participation might have influenced.

Context information

The Community of Ostional belongs to the municipality of San Juan del Sur, located in the Rivas province, south Pacific of Nicaragua (see Figure 1). This community is located approximately 5 km south of La Flor Wildlife Refuge, and is the second-largest population centre of the municipality, with 160 houses and 675 inhabitants (Guillén et al. 2007). Its economy is based on traditional fishing, while agriculture and animal husbandry also exist on a small scale, mainly for local household consumption (Guillén et al. 2007). Currently, community tourism, including homestays and guided ‘eco-

tours’ around natural spots, has become a source of additional income for some families in the community (Guillén et al. 2007).⁵ In addition, although limited to a few people, according to interviews with local leaders, some villagers are allowed to act as guides for spotting nesting turtles within La Flor. However, the overall economic situation continues to be characterised by few opportunities to generate income, largely due to low agricultural production and the increasing scarcity of marine resources (e.g., thereby making fishing a more difficult source of revenue). Some authors suggest that these difficult economic realities are encouraging the unsustainable patterns of exploitation of marine fauna and land-based resources, or migration to Costa Rica (Guillén et al. 2007). Poverty is an important consideration in this area, as the National Institute of Development Information of Nicaragua (INIDE 2008) suggests that 29.9% and 11.6% of the population is listed as ‘Poor’ and ‘Extremely Poor’, respectively.

La Flor Wildlife Refuge was established to protect one of the region’s most important nesting beaches for the Olive ridley sea turtle. Hundreds of thousands of Olive ridley turtles lay eggs on La Flor beach, and nesting takes place simultaneously over three to seven days in a natural periodical phenomenon that occurs five to seven times per year on average, particularly during the rainy season (June through November) (Hope 2002). These mass nesting events are known to locals as an *arribada* (or arrival, its literal meaning in English). Rangers from MARENA (Nicaragua’s Ministry of Environment) patrol the beach at La Flor, with support from the Nicaraguan police and army. However, due to alleged lack of funding, protective activities and patrols are limited to a single beach where the *arribadas* occur (Smith and Otterstrom 2009). Nevertheless, even on this beach, enforcement is limited due to scarce human and financial resources that would enable regular patrols.

In 1993, MARENA established a system of regulated exploitation and distribution of eggs in La Flor that favoured

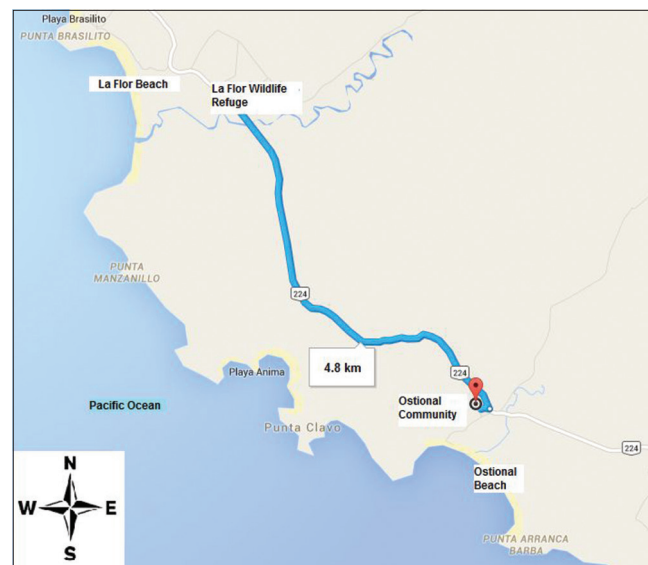


Figure 1
Location of Ostional community

nearly communities who constantly pressed to have consumption rights at the beach (Campbell 2007). This system allowed the legal collection of eggs by the community members for household consumption, but only during the first three days of a nesting period (Urteaga and Diaz 2006; Campbell 2007).⁶ The reason given for this government decision was that, due to high density of nesting activities during the *arribada*, turtles arriving later in the nesting period destroy existing nests, and therefore there was no compelling reason to protect the nests established during the initial days, as they were likely to be dug up and destroyed by later arrivals (Urteaga and Diaz 2006).

This new egg collection system was managed in cooperation with Cocibolca Foundation (Campbell 2007). However, by 2005, this system was suspended by MARENA in response to various allegations questioning the achievement of conservation and socio-economic goals. Among the most important reasons reported for this decision are continuing problems of illegal extraction and marketing (Urteaga and Diaz 2006; Campbell 2007), allegations of physical abuse against harvesters (Urteaga and Diaz 2006; Campbell 2007), and nonconformity of local villagers on the general management of the harvesting and protection project by Cocibolca (Campbell 2007). From 2005 until now, MARENA has established an indefinite closure and prohibition on harvesting and marketing marine turtle eggs (or any other turtle parts) in all of Nicaragua, in the interest of improving marine turtle conservation in the country (Urteaga and Diaz 2006).⁷

The prohibition on harvesting eggs in La Flor Wildlife Refuge has promoted conflicts between local people and the MARENA's rangers and army that patrol the main *arribada* beach (Smith and Otterstrom 2009). For example, some local people believe that the rangers and military personnel are finding ways to enrich themselves (e.g., some suspect them of engaging in private harvest and selling). Additionally, in the past, the army has shot harvesters, and there have been serious injuries (Smith and Otterstrom 2009). Finally, in our visits to the field, villagers also expressed annoyance because government authorities refused to share money collected from entrance fees paid by tourists entering La Flor with local communities, and moreover, they do not make available opportunities for more locals to work as tour guides who spot nesting turtles within the Refuge boundaries.

Although the Olive ridley is the primary species nesting at La Flor, other critically endangered species of marine turtles nest solitarily along the southern beaches at La Flor, such as Ostional. These species include Hawksbill *Eretmochelys imbricata*, Leatherback *Dermochelys coriacea*, and Green *Chelonia mydas* (Smith and Otterstrom 2009). At these southern beaches, where governmental surveillance is much lower than that in La Flor, nearly 100% of nests are lost due to harvesting by local people (Ferraro and Gjertsen 2009). However, this harvest rate has decreased through the participation of local villagers in the PPP and other conservation activities run by Paso Pacifico, targeted mostly at Ostional beach (Smith and Otterstrom 2009).

The performance-based conservation payments programme

The PPP has been managed and funded by Paso Pacifico since 2008, but the villagers have also participated in its design and implementation. Since its inception the programme has been modified, mostly to accommodate changes in the amount, timing, and vehicle of payment. The main goal of the programme is to protect nests in beaches next to La Flor, particularly Ostional. This is complemented by other conservation efforts, such as educational campaigns.

At the beginning of the payments programme, each person enrolling a nest⁸ in the programme received a payment that varied according to the black market price of eggs (during an off-*arribada* period, the price could be three to four times higher due to low egg availability) and turtle species (the more threatened ones receiving the highest payment). Taking these factors into account, payments during the off-*arribada* months for Hawksbill *Eretmochelys imbricata* nests were set around NIO 500 (about USD 20), followed by Green *Chelonia mydas* at NIO 350 (about USD 15) and Olive ridley *Lepidochelys olivacea* at NIO 250 (about USD 10). Payments were made via gift certificates that could be redeemed for food or other products in local authorised stores (Smith and Otterstrom 2009). However, in 2012 Paso Pacifico simplified the payments scheme. Payments were delivered in cash and nests were paid at around USD 3, no matter the turtle species. Even though this price is usually below the illegal market price (which ranges from USD 10-18 per nest in the off-season, while during the *arribada* ranges from USD 2-5), Paso Pacifico wants to promote the idea that delivering a nest to the programme is mostly about protecting the turtles instead of receiving a monetary reward.

Some enrolled nests, particularly those located in the most vulnerable areas of the beach, are re-located to hatcheries monitored by an independently organised group of nine local women.⁹ Each of these women received a fixed payment of NIO 3,000 (around USD 120) to protect all nests enrolled during the incubation period (around two months). At the beginning of the programme these women also received a variable payment per hatchling born, ranging from three to five Nicaraguan córdobas (USD 0.13-0.20 respectively) depending on turtle species. However, due to problems in monitoring the number of emerging hatchlings, this type of variable payment was abandoned in 2012.

According to our in-depth interviews with local leaders and Paso Pacifico personnel (details on methods for collecting data are described below), the programme results are positive in terms of the protection of nests and hatchlings in solitary nesting beaches, as these nests probably would have been harvested in the absence of payment. Similar findings were previously reported by Ferraro and Gjertsen (2009).¹⁰ In addition, Paso Pacifico reports that protecting activities on the nests and hatchlings reduces natural mortality (e.g., from vultures, dogs) significantly. At the beginning, harvesters complained about the amount, timeliness and mode of payment

(i.e., cash preferred over bonds to be redeemed in local stores). However, in the opinion of local leaders and local people interviewed, these problems have receded in recent years.

Theoretical background

Marine turtles provide, directly and indirectly, a wide array of local and global benefits to human well-being (Tröeng and Drews 2004; Campbell 2010). Unfortunately, when high demand for eggs and open access exists, the predictions of the Tragedy of the Commons (Hardin 1968) play out, unless different policies and/or local collective action are in place to increase conservation outcomes. In this regard, governments, NGOs and communities, among others, have been trying to implement different initiatives focusing on protecting nesting sites. For instance, many countries have implemented a top-down approach that focuses on legal restrictions or bans on the harvesting, sale, and other uses of marine turtle products and eggs. However, the effectiveness of these policies are questioned by conservation scholars and practitioners because of budgetary, logistical and geographical challenges in enforcing regulations, as well as a general understanding that excluding people in this way may not provide the desired conservation results, and may, in fact, limit local trust in or engagement with conservation efforts (Campbell et al. 2009; Osmond et al. 2010; Rands et al. 2010; Strange et al. 2011).

As an alternative and complement to legal restrictions, some innovative institutional arrangements such as co-management approaches, the promotion of alternative livelihoods, and performance-based payments, have been developed with various degrees of success (Campbell et al. 2009; Ferraro and Gjertsen 2009; Madrigal et al. 2013). Such approaches build on local knowledge and incentives to better define community involvement, as well as expected community roles and benefits, and improve understandings of enforceable rules for the conservation of turtles and the sustainable use of their eggs, whether by conservation authorities alone, or by more diverse or alternative groups (Hauck and Sowman 2001; Coelho et al. 2010; Grayson et al. 2010). The conditions under which these approaches succeed in sustaining both, conservation and livelihoods, over time require more study from a social and economic perspective (Ferraro and Gjertsen 2009, Campbell 2010).

The biological and social impact of policies and programmes on egg harvesting are likely influenced by how local people perceive and respond to their implementation. Conservation critiques and scholarship have shown that regulations for coastal and marine environments, and the management of such areas, will falter if they incorporate simplistic assumptions about human responses to regulations (Suuronen et al. 2010; Lédée et al. 2012). Oversimplifying uses and users of marine environments will lead to failed predictions with respect to both the ecological impact of regulations and the economic impact on fishers and other users of the environment. To create appropriate conservation schemes, managers need a strong and nuanced understanding of people's decisions and responses

to regulation and other stimuli (Suuronen et al. 2010; Lédée et al. 2012). In this regard, analysing the role of economic incentives and perceptions of their impacts on compliance with regulations becomes a crucial aspect of those efforts dedicated to improving conservation outcomes and policy implementation.

Scholars have addressed what is seen as the puzzle of compliance from different perspectives. One explanation of individual rule compliance comes from the economics perspective (Becker 1968). According to this approach, deterrence can be enhanced by increasing sanctions and/or the probability of detecting rule violators. In fact, some studies in fisheries find some support regarding the effectiveness of external sanctions for increasing individual compliance with extraction quotas (Kuperan and Sutinen 1998; Eggert and Lokina 2009). However, the empirical validity of this argument as the sole explanation for rule compliance has been contested in other studies of fisheries (Kuperan and Sutinen 1998; Eggert and Lokina 2009) and marine turtle co-management (Madrigal et al. 2013) to cite a few. These studies advance the possibility that normative perceptions held by individuals also play a role in fostering compliance, as described in the following lines.

Normative factors (e.g., social norms, morality, and legitimacy) are often cited as additional explanations for the traditional economic approach to compliance (Hauck 2008). For instance, evidence suggests that the decision whether to follow or break a rule depends not only on formal sanctions (e.g., monetary fines) but also on social norms¹¹, which lead to a cost or a benefit of breaking a rule (Ostrom 2005). The perception of the legitimacy of the rules is one of the core normative determinants of compliance. Legitimacy can be understood as being affected by whether or not an individual or group views rules, laws, or desired behaviours as fair or appropriate. In the area of natural resources, Ostrom (1990) suggests that this is a key ingredient for avoiding the Tragedy of the Commons (Hardin 1968). Hence, in successful locally-devised institutions for managing common pool resources such as forests and pastures, those affected by rules must participate in their design. Empirical and experimental evidence suggest that regulations imposed by an external agent may fail or lack efficacy, compared to rules endogenously devised by local resource users, for related reasons (Ostrom 1990; Ostrom et al. 1994; Cárdenas et al. 2000; López et al. 2012). In fisheries scholarship, some have also noted the influence of local perceptions of procedural justice (i.e., perceptions of fairness in related processes, procedures, and resulting outcomes) on rule compliance (Kuperan and Sutinen 1998; Raakjær et al. 2003; Eggert and Lokina 2009).

On the other hand, some studies analyse human use of marine turtles and the reasons motivating people to engage in harvesting of turtle eggs. The main results in this regard include the lack of developing alternative livelihood opportunities (Campbell 2007); the existence of contested property rights and transaction costs that weaken incentives to manage the resource collectively (Hope 2002); and demographic conditions and cultural characteristics (Garland and Carthy

2010). Similarly, Mancini et al. (2011) analysed economic and social factors contributing to fisher engagement with illegal sea turtle hunting in Mexico. They found that direct economic benefits, lack of law enforcement, ease of escape from authorities (e.g., bribery to reduce or eliminate penalties), and strong family tradition as the most important factors associated with turtle hunting.¹² Other studies in fisheries have shown the relevance of livelihood characteristics in compliance as well. For instance, Ahmed et al. (2010) have analysed the enforcement of harvesting bans for a prawn (*Macrobrachium rosenbergii*) in Bangladesh, and they found that the lack of compliance with this regulation was mainly due to the lack of alternative livelihoods. Similar conclusions on the role of livelihood diversity for the compliance with fishing regulations have been found in Ecuador and Vietnam (Bucaram and Hearn 2013; Phung Ha and van Dijk 2013).

In addition, the misalignment of incentives between coastal communities and worldwide society is one of the core problems for the enforcement, effectiveness, and fairness of the most common turtle marine conservation policies (e.g., closures, fines and penalties) (Gjertsen and Niesten 2010). These initiatives tend to impose opportunity costs or income losses due to reduced or prohibited access. By contrast, the global benefits from conservation, largely in the form of existence values and indirect use values, accrue to people who have not incurred any such costs. Performance payments, or payments by results, programmes have been used in some turtle marine conservation initiatives around the world to reward coastal villagers for the achievement of conservation goals associated with the protection of nests and hatchlings (Ferraro and Gjertsen 2009). In principle, this type of approach reduces trade-offs between conservation (or global benefits) and local livelihoods (or local costs), and often shows high cost-effectiveness gains (Ferraro and Gjertsen 2009).

Similar market-based approaches, labelled as payments for environmental services (PES), are common in terrestrial landscapes for forest conservation (Pattanayak et al. 2010); however, some initiatives have also been developed for livestock holders to encourage refrain from hunting the damage-causing carnivores (Zabel and Engel 2010). However, the incipient nature of performance-based payments schemes for wildlife conservation, and turtles in particular, has led to important questions that need to be solved in relation to the conditions that determine their long-term success (Ferraro and Gjertsen 2009), such as: 1) leakage, occurring when payments do not inhibit harmful actions on the aggregate, but just relocate them from one area to another (Robertson and Wunder 2005; Zabel and Engel 2010); 2) the magnet effect, when payments attract new people into egg harvesting activities (Zabel and Engel 2010); and 3) when payments only provide short-term behavioural changes due to an emphasis on monetary incentives rather than ethical and motivational changes (Ferraro and Gjertsen 2009).

Other compensation programmes in marine settings have also experienced some drawbacks. For instance, as reported by Ávila-Forcada et al. (2012), the voluntary compensation

programme promoted by the Mexican government for protecting Vaquita *Phocoena sinus* suffered from a lack of participation due to demographic characteristics of fishers and the low payments. As a complement, the existing studies on the participation of people in a payment programme for the conservation of terrestrial ecosystems shed some light on the main drivers for enrolment in similar programmes for marine turtle egg protection. Zbinden and Lee (2005) found that participation in the Costa Rican PES programme is associated with an individual's farm size, human capital, other household economic factors, and access to information. Wunder (2006) emphasizes that farmer participation in PES schemes is influenced by the overall ranking of PES as a contribution to household income and the opportunity costs associated with land dedicated to conservation. However, Kosoy et al. (2008) suggest that motivations for enrolment go beyond purely monetary incentives, because environmental values (e.g., importance of forests as providers of ecosystem services) interact with other motivations (e.g., sacred values and intergenerational concerns). Similarly, Fisher (2012) found that payments are the main motivation for involvement for farmers in a particular programme (Trees for Global Benefit) in Uganda, but that some people are also motivated by aesthetic and existence values.

METHODOLOGY

Data gathering

We collected data from villagers from Ostional in October 2012¹³ using different methods. First, we did six in-depth interviews and focus groups with local leaders, chief government officers, and Paso Pacifico collaborators. The purpose of all in-depth interviews and focus groups was to explore the feasibility of conducting a study on egg harvesting (knowing that it is an illegal activity), to have a general profile of local harvesters and market functioning, the conflicts and limitations on the implementation of the ban on harvesting, and the operative details on the PPP, among other relevant topics. Second, we did 180 structured household surveys, covering all households identified in the community. We interviewed the head of each household (individuals who self-identified as head of households). In 95% of the cases, the heads of households were men. No individual rejected the survey. We did not include two houses in this study due to absentee property owners. We designed this questionnaire based on field observations and four extra in-depth interviews with key informants (including local leaders and head personnel from MARENA and Paso Pacifico) during August 2011. The household survey instrument included questions regarding normative and economic motivations to comply with the existing ban on harvesting, and questions about general characteristics of local livelihoods and demographics. We also included a section on the participation in the PPP.

It is worth mentioning that, when rule-breaking behaviour is investigated ex-post via inter-personal surveys, people may

have incentives to lie or they may simply have poor memory recall (Eggert and Lokina 2009; Agarwal 2010). This could be a potential threat to identifying illegal behaviour accurately in our context. Although there are no formal ethical protocols to guide ‘informed consent’ by research participants at our home institutions, we exert all the precautionary measures that we could to minimise untruthful responses and to respect villager privacy and security. In the following paragraphs we explain some of the major considerations in this regard.

First, we carefully recruited and trained enumerators. We followed useful guidelines provided by Whittington (2002) on rules for good interview practice to gather reliable information using individual surveys in developing countries. Among other things, this includes ‘dos and don’ts’ for enumerators related to neutrality to sensitive questions, minimisation of improvisation during survey, and privacy issues. These elements were critical for collecting information in a professional manner, including abiding by ethical considerations.

Second, the enumerators clearly identified themselves as university personnel (providing the name of the university, location, and contacts), with no relationship with the Nicaraguan government, police, Paso Pacifico or any other organisation aiming to judge or prosecute those infringing upon the law on harvesting. Enumerators explained that the purpose of the survey was to inform a research project aiming to understand the relationship between local villagers and marine turtles. They also indicated that the information will be used exclusively for research purposes (including a publication with aggregated results, never revealing private information), that individual data would be kept private and in a safe place, and that no government agency or NGO would have access to it in a way that could identify survey respondents. After this, we explicitly asked informants about their willingness to continue with the interview. This initial introduction, in addition to the training of enumerators based on Whittington (2002), was key to gaining initial trust. Additionally, all surveys were conducted in privacy to avoid any type of peer pressure or external biases.

Third, the vast majority of local people interviewed admitted openly that they have been harvesting eggs as part of their daily livelihoods for many years. They also clearly identified other people in the community who have similar behaviours. During our conversations with key informants, focus groups and household interviews, it was clear that no strong stigmatisation of harvesting exists on the part of members of this community. The reasons why this is happening in Ostional are beyond our understanding, but they might be associated with a perception of low enforceability of existing penalties, and the fact that such ‘illegal’ behaviour has been widespread in the area for many years. Without these particularities, conducting a study on illegal behaviour would be extremely challenging and with dubious validity. The lack of stigmatisation on harvesting activities and the fact that the field work team lived in the community for one month, which helped it to gain trust (e.g., team members shared places to eat with villagers, and stayed in local accommodations) and mutual knowledge, were extremely useful for research purposes. This allowed us to

cross-check and determine the reliability of survey responses. In fact, by comparing a list of egg-harvesters provided by local leaders, our own observations on the field during harvesting and the surveys responses, we identified five individuals who were very likely providing untruthful responses regarding their participation in harvesting activities. We removed these persons from the dataset during the process of data editing and, hence, they were not included in the analysis of the results.¹⁴ However, we never told or suggested to anybody in the community that we had found these untruthful answers.

Fourth, we tested an initial version of this survey in a nearby coastal community (San Juan del Sur) where some locals engaged occasionally in egg harvesting. The two enumerators who participated in this trial were also responsible for conducting the survey in Ostional. This pilot test helped to detect and correct potential sensible topics, and improve enumerators’ skills as well as the overall quality of the survey instrument.

Sample characteristics

Table 1 reports some key attributes of the surveyed villagers.

From the group of 180 interviewed individuals, 74 (41%) were egg harvesters and 106 (59%) were non-harvesters.¹⁵ The non-harvesters’ group includes villagers who have never harvested eggs (39% of the ‘non-harvester’ subsample) and people who quit this activity at least five years ago (61% of the subsample). The main reason for ceasing egg harvesting activities, according to participants, was government-initiated legal bans (53%). The second most common reason was the appearance of an alternative source of income (20%). As discussed below, there are also important relationships between having fishing as the main income-generating activity and being an egg harvester.

Methods of analysis

To characterise the socio-economic attributes associated with harvesters and non-harvesters, we used two complementary approaches. First, we did simple statistical analyses comparing averages of key socio-economic variables characterising the livelihoods of the two groups. We supported this with some excerpts from the surveys to enrich the qualitative analysis of data. Second, the information collected using the household survey helped to inform Probit models¹⁶ (Wooldridge 2002). These models, or statistical regressions, are used to model dichotomous or binary outcome variables (the dependent variable can be only one or zero) in a variety of fields. The

Table 1
Key sample demographics (n=180)

Average age	36
Average number of years living in Ostional	32
Fishing as the main income generating activity	49%
Actual egg harvesters	41%
High school unfinished	37%

purpose of this econometric model is to estimate the probability that an observation (i.e., individual) with particular socio-economic characteristics (e.g., age, education, land tenure) will fall into one of the two categories of the dependent variable. In our context, these variables indicate if the person is a harvester or a non-harvester.

For the case of determining differences in perception towards regulations between harvesters and non-harvesters, as well as the participation in the PPP, we relied on basic descriptive statistics and cross tabulations to analyse data from a more qualitative oriented perspective. The information gathered through in-depth interviews and excerpts from the surveys also helped us to reinforce this type of analysis.

RESULTS

Socio-economic factors associated with egg harvesters

There are socio-economic attributes that differ between the group of egg harvesters and villagers who do not participate in harvesting activities. Table 2 presents some prominent differences related to age, number of years living in Ostional, education level, number of income-generating activities, and land tenure.

As indicated in Table 2, egg harvesters in our sample were, on average, younger than those who do not harvest eggs. The reason for this is still unknown but it could be potentially associated with different factors. For instance, in our surveys, older individuals indicated that the difficulties in overcoming harvesting challenges from the physical perspective (e.g., the effort at the beach and hauling efforts, plus avoidance of guards and police monitoring) contributed to abandoning this activity. Some excerpts from the surveys help to illustrate this:

Nowadays we do not gain anything from harvesting because the only ones benefiting are the young people, the ones who can run with something that once was our way of living. (Informant #130)

For me it is not easy being awake the full night, I am not young anymore. (Informant #93)

On the other hand, some distinctions exist in the education levels of both groups. The non-harvesters seemed to have a higher rate of education beyond high school, mostly technical/professional degrees and certificates. One hypothesis is that this might eventually lead to better employment opportunities. Nevertheless, a significant proportion (70%) of harvesters have formal schooling at some level of high school. The reason why some relatively educated individuals dedicate their time to egg harvesting is intriguing. It might be plausible that structural imperfections in the labour market might reduce opportunities for relatively educated individuals to find jobs in the formal market, though this is a topic that deserves further exploration in future research. In general, the relationship between education and the illegal use of natural resources (e.g., in protected areas) is not clear in the literature. While some argue

higher levels of education are associated with positive attitudes towards conservation areas (Mehta and Heinen 2001), other studies present mixed results (MacKenzie and Hartter 2013).

Egg harvesters tend to have a larger amount of income-generating activities compared to that of non-harvesters.¹⁷ In fact, 27% have three income-generating activities (including egg harvesting) and 56% have two. These activities tend to be occasional (e.g., opportunities in the construction sector), while non-harvesters depend on few but relatively stable sources of income. Similarly, only 10% of egg harvesters have land for cattle and agriculture, whereas 43% of non-harvesters have land for these purposes. The latter observation reinforces the idea that non-harvesters could have more stable sources of income, and probably more profitable, and assets that might reduce the dependence on temporary and uncertain income from selling turtle eggs.

The above results complement and inform a Probit model that explores the socio-economic factors that increase the probability of being a turtle egg harvester. Table 3 summarises these results. The dependent variable assumes values of 1 for harvesters and 0 for non-harvesters.

As indicated in Table 3, increasing age seems to be negatively correlated with the (reported) probability of being an

Table 2
Socio-economic characteristics of villagers

	Egg harvesters	Non-harvesters
Number of individuals	74	106
Age (<i>average years</i>)	28	42
Years living in Ostional (<i>average years</i>)	24	37
Education level		
None (%)	1	7
Primary incomplete (%)	7	14
Primary completed (%)	12	17
High school incomplete (%)	51	27
High school completed (%)	19	19
Other education above high school (%)	10	35
Number of income generating activities		
One (%)	16	47
Two (%)	57	39
Three (%)	27	14
Owns property for cattle/ agriculture (%)	10	43

Table 3
Probit model (marginal effects) Factors associated with poaching behaviour

Variables	
Age	-0.01317*
Education	-0.038818
Only one income-generating activity (besides egg harvesting)	-0.26532*
Owns property for cattle or/and agriculture	-0.23205*
Fishing as their main income generating activity	0.13750*

Notes: Observations 179; * $p < 0.01$, + $p < 0.05$; Prob > $\chi^2 = 0.0000$; Log likelihood = -83.49978; Pseudo $R^2 = 0.3100$

egg harvester in this community. As argued before, the reasons for this could be associated with the capacity to manage the physical efforts of harvesting and the limited existing local income-generating activities for younger people. In addition, other studies suggest that older generations in resource-dependent communities tend to comply more with regulations due to normative motivations (e.g., Madrigal et al. 2013; Velez and López 2013).

As indicated by Probit model results, the attributes associated with the structure of livelihoods are strongly associated with the decision to harvest eggs. In particular, having only one income-generating activity (excluding egg poaching) reduces the probability of harvesting by 27% while formal ownership of land for cattle and/or agriculture reduces the probability by 23%. This suggests that those with only one economic activity have a more stable and significant flow of income that reduces the need for harvesting or, alternatively, increases the opportunity cost of dedicating time to harvesting. Similarly, those who have land for commercial purposes might have fewer economic incentives to dedicate time to egg harvesting. Finally, if fishing is a person's main economic activity, that increases the likelihood of harvesting eggs by 14%. According to our interviews, fishing tends to be seasonal, unpredictable in terms of catches, and dependent on market prices. This could create important financial gaps in fisher income that need to be covered, in this case apparently by egg harvesting. Similar to other studies (e.g., Campbell 2007), our results suggest that lack of outside economic opportunities strongly influence people to harvest and sell eggs. Some excerpts from our surveys help to support the above statements:

We need employment. You know, if employment would be available people forget about eggs. (Informant #113)

I do harvesting because I have no other job and I have a child. Because I am very young I cannot find a job. (Informant #78)

If I had other options to generate income I will not go to La Flor risking myself. We have no work and harvesting eggs is a way of living. (Informant #86)

Given this dependency and incentives of local villagers on harvesting, a complicated and costly scenario arises for the enforcement of existing ban regulations. Further, it might also raise fairness and equity concerns in the distribution of costs and benefits regarding the provision of conservation goals. In other words, and in absence of any compensation scheme, local people are assuming the costs of providing global benefits of protecting nesting sites.

Perceptions on regulations protecting turtles

Interesting similarities and discrepancies exist between egg harvesters and non-egg harvesters regarding their perceptions about regulations to protect turtles, as presented in Table 4. Both groups agree on the necessity of protecting turtles. In

addition, they perceive that the main responsibility for such protection should rely on the local community of villagers, instead of the central government or an NGO (more than 40% of people held this belief, as presented in Table 4). According to villagers, they want to have a greater say in defining and enforcing the rules of access and extraction that could lead to more sustainable harvesting over the long run. Further, some argued in favour of putting back in place the system of regulated exploitation on the part of the community that existed in 1993 (described in subsection 1.1 of context information).

The preference for a more community-based approach for conservation is reinforced by the perception of villagers that the central government, by means of the army, police officers and park rangers, has been incapable of deterring overharvesting and minimising conflicts between the community and law enforcement, particularly in La Flor. In addition, there is a general perception that the effectiveness of the government in monitoring and enforcing the prohibition is relatively low. 54% of non-harvesters and 69% of harvesters stated that just a few harvesters (one to four out of 10) are caught by the governmental surveillance (see Table 4). These statements are reinforced by different MARENA officials, who argued in our interviews that budget and personnel for enforcing regulations are insufficient in relation to the relevant geographical area under protection.

Villagers also expressed a relatively low perception of the fairness of government officials in sanctioning culprits (see Table 4). In this regard, villagers argued that most officials receive bribes from harvesters to avoid sanctions, use excessive force, and treat friends differently when it comes to sanctioning, among other complaints. For instance, some of our informants expressed the following:

MARENA and the army give eggs to whomever they want. (Informant #169)

We are doing a great effort to make a living and it is not fair that they (the government/the police) take our eggs to give them to their families and friends. (Informant #140)

The policemen beat me in La Flor, it wasn't necessary, I swore not to go back there. (Informant #92)

On the other hand, similarly to one of the general principles that characterise successful local institutions for the management of common-pool resources (Ostrom 1990), procedural justice (i.e., perceptions of fairness in related processes, procedures, and resulting outcomes) seems to be relevant in the context of Ostional. This element cannot be isolated from the process of rulemaking, particularly the participation of those affected by the regulation and the resulting adherence of rules to local reality and interests. We found that non-compliance with actual ban on harvesting was also associated with the fact that villagers perceive they were not included in the process of regulation design (see Table 4 on participation of community in defining ban). In line with the empirical evidence about fishing (e.g., Eggert and Lokina

Table 4
Perceptions towards regulations (harvesters vs non-harvesters)

		Harvesters	Non-harvesters
Necessity of nest protection	Affirmative	97.3%	99.1%
Main responsibility for protecting nests	Community	42.5%	48.1%
	Government/MARENA	20.6%	22.1%
	NGOs	20.6%	11.5%
Monitoring effectiveness perception. Out of 10 harvesters, # of individuals who will be caught by authorities	None	11%	5.7%
	Few (1 to 4)	68.5%	53.8%
	Most (6 to 9)	19.2%	29.3%
	All	1.4%	11.3%
Perceptions about	Fairness of governmental officials to sanction culprits	2.0*	2.1*
	Participation of community in defining ban	2.3*	2.5*
Main opinion on harvesters	Doing a wrong thing	10.8%	25.5%
	Doing a subsistence activity	89.2%	74.5%

Notes: *All respondents answered using a Likert scale of 4 levels, with 1 representing the lowest score or degree of agreement with the statement and 4 representing the highest level of agreement. The number presented in the table is the average score provided by all respondents

2009) and turtle marine management (Madrigal et al. 2013), among other examples, this low perception on participation in institutional design might negatively affect the legitimacy of rules, and hence, could further reduce the incentives for villagers to comply with the ban.

In addition, according to surveys, villagers do not have a strong stigmatisation toward egg harvesting based on moral grounds. As presented in Table 4, only 11% of harvesters and 26% of non-harvesters believed that egg harvesting is a “wrong thing.” On the contrary, 89% of harvesters, compared to 75% of non-harvesters, perceive that this activity is similar to any other income-generating activity for subsistence (such as fishing). This suggests a dichotomy in the perception of benefits and costs associated with conservation between the worldwide conservation community and the local villagers. The former is likely to be against harvesting because they attach a high existence value to eggs and turtle conservation, while the local community primarily perceive the direct-use benefit from harvesting the eggs. Solving the potential trade-off between these two perspectives is central to conservation policies and constitutes one of the main arguments for promoting schemes for turtle eggs conservation payments.

Participation in the PPP

There are some differences in socio-economic characteristics between participants and non-participants in the PPP. Due to the large fraction of harvesters participating in PPP, these differences seem to mimic those that exist between the group of harvesters and non-harvesters (as presented in Table 2). That is, fishing tends to be a main source of income for participants in PPP, who depend upon a larger menu of income-generating activities and in addition, lack of productive assets such as land for cattle or agriculture.

As indicated in Table 5, a total of 49 villagers have participated in PPP over the years 2010-2012. From that number, 37 (76%) are egg harvesters. Considering that

Table 5
Distribution of participation in PPP according to sample

	PPP participants	Total interviewed
Harvesters	37	74
Non-harvesters	12	106
Total	49	180

approximately 74 harvesters exist in Ostional (according to Table 2), this means that 50% of all egg harvesters have participated in PPP (37 out of 74). Interestingly, 12 non-harvesters were persuaded to participate in the programme over the same period. Nevertheless, the main reason for the participation of this group is to protect the nests (75%), instead of reaping the financial reward. Interestingly, in the case of harvesters, 60% stated that the main reason to participate is the protection of turtles, while 40% participated for the financial reward.

One could expect that in this context the main motivation of harvesters to participate in PPP would have been the financial reward. However, prices paid by local brokers in illegal markets and payments from PPP were similar around 2012. Since harvesters have the freedom to choose where to sell the eggs (to our knowledge there is no coercion from local brokers), it is very likely that those selling the eggs to PPP tend to show higher normative values towards conservation. This suggests that PPP implementation and success depended on the degree to which conservation payments competed with illegal markets, but enhancing normative values towards conservation cannot be ruled out completely as part of the strategy to recruit participants.

However, one could argue that in the absence of strong environmental values of local villagers towards turtle protection, the success in enrolling nests into the programme would depend heavily on the ability of the PPP to compete against the local brokers. This could eventually lead to the generation of potential adverse negative effects, such as pressure on illegal market prices (increasing the incentives to

harvest) and attracting new people to egg harvesting. Some quotations from our interviews might provide the reader with some testimonies that suggest these effects could have occurred, at least in the very short-term:

When the payments from Paso Pacifico started, people who did not usually harvest started to go the beach because prices were better. (Informant #71)

I harvest regularly but when Paso Pacifico pays for nest I prefer to sell eggs to them because I get a better profit. (Informant #90)

Nevertheless, it is difficult to assess whether the programme reduces harvesting in the aggregate or displaces it (leakage effect reported by Robertson and Wunder 2005; Zabel and Engel 2010) or, instead, attracts new people into the illegal activity (magnet effect reported by Zabel and Engel 2010). Assessing such impacts with precision is very challenging from a methodological point of view, especially because the decision to harvest depends on a myriad of factors difficult for the researcher to control. For instance, 57% of villagers reported their harvesting levels decreased after participation in PPP, while 23% reported an increase. However, most changes in behaviour are likely influenced by external factors (e.g., new outside economic alternatives or the market price of turtle eggs) rather than a change motivated by the PPP.

On the other hand, the overall effectiveness of PPP in achieving long-term conservation goals depends in part on its capacity to induce behavioural changes in the short- and long-term. As villagers indicated in our surveys, PPP is highly effective at protecting nests in isolated beaches because eggs in these cases are very likely to be harvested in absence of the PPP. To a greater extent, the monitoring efforts of Paso Pacifico minimise the likelihood that human interference and predators could affect nests and hatchlings on these beaches. The conservation value of this strategy increases because most of these turtles are Hawksbill, Leatherback, and Green. These species are more threatened than the Olive ridley, which uses La Flor as its main nesting place.

CONCLUSION

This study suggests that economic factors might be the most important drivers motivating local villagers to violate government regulations that prohibit harvesting and selling marine turtle eggs. The lack of productive assets, stable sources of income and economic opportunities in general could perpetuate the pressure on locals to harvest eggs for their own selling and consumption. In addition, the lack of legitimacy expressed by locals regarding prevailing institutions (i.e., rules in use related to harvesting prohibition) due to low participation in its design and implementation could also play a role in generating more incentives to allocate labour to egg harvesting. The efforts to enforce regulations have to overcome these strong motivations, as well as the limited budgets from

the government and the complex biophysical characteristics of nesting sites (e.g., extension of the beach and variability in nesting periods) that reduce the effectiveness of monitoring efforts.

These results might have important implications for the role of the central government in generating the enabling conditions that predict conservation policies for sea turtles acknowledging the socio-economic conditions of a developing country. In particular, it seems that a general governmental prescription, based on a top-down approach, could not generate appropriate incentives for local communities to be involved in the provision of global public goods (conservation of an important and emblematic marine species). The inadequate adaptation of rules to the peculiarities of communities explains why some policy blueprints might not be an effective solution for local problems (Ostrom 2007). This suggests that the government policies need to account for local user particularities in order to reduce conflicts and excessive costs, and to guarantee the successful enforcement of wildlife conservation strategies. Unless the basic needs and economic opportunities of local villagers are at least partially fulfilled, the success of conservation policies aiming to exclude local people from accessing a natural resource important for their livelihoods is extremely limited, costly, and controversial on ethical and equity grounds.

Our field work accords with Ferraro and Gjertsen (2009), in that it suggests that the PPP seems to be an effective option for protecting nests in isolated beaches. Normative motivations to protect the turtles are important as determinants of participation in this programme, although the financial reward also plays a significant role, particularly because most participants who are egg harvesters depend on this activity as their main source of income. The extent to which these incentives could affect market structure, the spatial distribution of effort along the nesting beaches, the overall harvesting rates and the budgetary needs to run the programme deserve further study, since the incipient nature of this programme and our lack of data limited our capacity to draw conclusions on these critical issues for Ostional and other nesting sites aiming to implement or improve similar programmes. Interestingly, though, recent changes in the programme that emphasise the action of delivering a nest to the conservation initiative is mainly to protect the turtles, rather than for the monetary reward (along with modifications in the timing and vehicle of payment) might indicate that the long-term success of these types of initiatives depends on their flexibility and capacity to minimise the generation of perverse incentives for conservation goals and the attention of villagers needs and preferences.

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NOTES

1. Nicaraguans express a preference for the flavour of sea turtle eggs and a belief that they have superior nutritional value over chicken eggs (Smith and Otterstrom 2009).
2. We did not analyse the market structure of the egg selling but it is likely that incentives for harvesting and improvements for management depend to some extent on this particular structure. Hope (2002) analyses market structures for Olive ridley in nesting sites of Nicaragua and Costa Rica.
3. Paso Pacífico is an NGO founded in 2005 to restore and conserve the natural ecosystems of Central America's Pacific coast. For details, see <http://www.pasoPacifico.org/> or Smith and Otterstrom (2009). One of its areas of focus is protecting endangered sea turtles in partnership with local communities.
4. Some exceptions in recent years include Garland and Carthy (2010), Mancini et al. (2011), and Madrigal et al. (2013).
5. In 2007 a group of local villagers established a community organisation for promoting ecotourism in the region and for capacity building of local villagers to provide services such as lodging and guided tours (Guillén et al. 2007). According to our interviews with local leaders, this organisation is still working with around 20 members, but only six homestays. Local leaders related that the lack of capital to invest in improving infrastructure (food and lodging) is the main restriction to expand this activity further.
6. A similar management exists in one beach in Costa Rica. This system was legally established in 1984 and provides exclusive rights to a local village to harvest eggs under certain technical criteria. It is often cited as a successful co-management model between the central government and a local community; however, some external disturbances threaten the long-term survival of this initiative. For details see Campbell (1998) and Madrigal et al. (2013).
7. This ban applies to all of Nicaragua. However, communities in Caribbean Nicaragua have traditional rights that allowed them to use natural resources for subsistence. This opens the possibility of harvesting turtles for meat consumption (Garland and Carthy 2010).
8. Harvesters usually protect nests during a night and do personal markings in the sand in order to identify them with the Paso Pacífico team as "their nests." On very few occasions there are conflicts among harvesters over 'ownership' of nests.
9. Eggs are relocated in order to protect them from natural predators and/or harvesters. Relocation of eggs is contested by some authors; see for instance Spanier (2010). The participation of women as guards was mostly to increase their economic opportunities and also because they were a well-organized group within the community. This group received training from Paso Pacífico in protecting the nests and the hatchlings.
10. This is consistent with evidence around the world on sea turtle incentive payment initiatives. Most of these initiatives have achieved substantial results on protecting nests for a very low annual cost (Ferraro and Gjertsen 2009).
11. These are defined as shared understandings about actions that are obligatory, permitted, or forbidden (Ostrom et al. 1994).
12. As a complement, a study in Baja California Sur (Mancini and Koch 2009) associated consumption of sea turtle meat with cultural factors, while illegal trade was facilitated by the involvement of the authorities and the lack of law enforcement.
13. There was no particular reason to choose October for this fieldwork.
14. Overall results do not vary significantly with the exclusion of these five observations from the original sample of 185 villagers. Although it is not standard practice in survey research, Kish (1965) suggests that survey objectives and practical difficulties in data editing can determine deliberate and explicit exclusion of surveys. Data screening is commonly recommended as part of the data analytic process in order to have a "clean" or unbiased dataset (Tabachnick and Fidell 2007). For the identification and elimination of untruthful responses, different methods may be used. For instance, see Kontour (2011) on the use of a consistency score for such purpose, assuming that the questionnaire is well constructed.
15. 95% of harvesters were men. Focus groups with local leaders confirmed that this activity is largely done by men. The reason for such an acute gender division of labour goes beyond our current understanding of local harvesting dynamics, and is also beyond the focus of this paper. This is an interesting matter for future research.
16. According to Wooldridge (2002), these models have some advantages over the linear probability model: fitted probabilities are between zero and one, and the partial effects diminish. The principal challenge with Probit is that it is harder to interpret.
17. We could not assess if on the aggregate, total income differs between the two groups. Similarly, given that we do not have reliable information on income per activity, it might be feasible that the type or quality of the activity might matter more than its quantity. This is an important issue for further research.

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