Evaluating Direct Incentive Initiatives for Sea Turtle Conservation: Insights from Egg Collectors in Bahía de Jiquilisco, El Salvador

By Emily Parker

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Abstract
The increased consumptive use of sea turtle eggs in the eastern Pacific rim in the past century has contributed to declines in several sea turtle populations. In El Salvador, the consumption of sea turtle eggs created a need for egg collectors, or *tortugueros*, who collect eggs from nesting sea turtles to meet demand. However, due to the increased need for sea turtle conservation measures in this region, a nation-wide ban on consumption and commercialization of sea turtle eggs and products was enacted in 2009. As a result, *tortugueros* have turned to local hatcheries for a legal alternative income source. These hatcheries are funded by federal programs and non-profit organizations to provide conservation incentive payments to egg collectors in exchange for sea turtle eggs, which are then incubated and released. This paper assesses the viability of hatchery programs and the effect the egg ban and the conservation programs has had on *tortuguero* populations in the Bahía de Jiquilisco region of El Salvador. One hundred and thirty-nine *tortugueros* were surveyed on their opinions and behaviors regarding sea turtle egg collection and sea turtle conservation. I found that this population feels very positively toward conservation and conservation awareness levels are high. I found that increased conservation awareness can be predicted by the increased experience a *tortuguero* has with egg collection. Due to these findings, I recommend continuation of the conservation awareness components of the current hatchery program. I also recommend the installation of a protected beach program in the Isla Montecristo community, where I believe the high rates of nesting and biodiversity these data show will result in a successful program. Finally, I recommend increased risk evaluation and efforts to provide alternative sources of income to *tortugueros* and their families.

Introduction
For thousands of years, human populations have had close and intimate connections with sea turtles (Barragán 2012). Whereas the human relationship with sea turtles may be one of reverence, it is also one of consumption and humans have targeted sea turtles for consumptive use for millennia. Dating back to prehistoric human communities, sea turtles have been hunted for their meat, eggs, skin, oil, shell and bones (Plotkin, et al. 2012). Human's first interactions with sea turtles were most likely on nesting beaches, at the interface between ocean and land, and the discovery of these easily-exploited reptiles resulted in the beginning of sea turtle egg collection that persists to this day (Cornelius et al. 2007). Consumptive use of sea turtle eggs has been documented across the globe, including areas in Southeast Asia, the Middle East and Central America (Campbell 2003) Turtle eggs are valued for their nutritional and economic value to families, and in Central American in particular, for their perceived aphrodisiac qualities (Campbell 2003).

The overexploitation of sea turtle eggs, particularly of olive ridley turtles (*Lepidochelys olivacea*), is believed to have contributed to the decline of sea turtle populations in the eastern Pacific in the past (Plotkin et al. 2012). In the eastern Pacific, the collection of eggs is considered to have had one of the most profound impacts on sea turtles (Seminoff et al. 2012). All species of sea turtles face many other threats, including subsistence collection of meat for consumption, incidental catch in both artisanal and industrial scale fishing operations, climate change related threats, and nesting and foraging habitat degradation (Gaos and Yañez 2012). These threats have led to collapses in the populations of the four species of sea turtles that nest in the eastern Pacific (Gaos et al. 2017). These four species, olive ridley, green (*Chelonia mydas*), leatherback (*Dermochelys coriacea*), and hawksbill (*Eretmochelys imbridcata*), are currently listed on the

International Union for Conservation of Nature (IUCN) Red List as Vulnerable, Endangered, or Critically Endangered. Massive overexploitation of sea turtle eggs in Central America and Mexico in particular is believed to have contributed to population declines of olive ridley turtles (Plotkin, et al. 2012), green turtles (Delgado-Trejo and Alvarado-Figueroa 2012), and leatherback turtles (Wallace et al 2012).

The decline of sea turtle populations has led some nations in the eastern Pacific region to take conservation measures, including the prohibition of sea turtle fisheries, enforcement of turtle excluder devices (TEDs) on shrimp trawlers to reduce incidental catch of sea turtles, and the ban of sea turtle egg collection and consumption. The nations of Latin America have implemented a wide variety of conservation programs to protect sea turtle nesting beaches and eggs (Campbell 2007). These programs and regulations range from fully protected beaches where collection is entirely banned to controlled sustainable use programs. For example, collection of sea turtle eggs for consumption is still permitted in Ostional, Costa Rica and the sale of those eggs is legal throughout the nation (Campbell 2007). In Nicaragua, indigenous communities still partake in legal subsistence hunting for green turtle meat (Campbell 2007). In recent decades, as a result of conservation programs, population growth has been noted for olive ridley turtles in much of the Eastern Pacific, but the full impacts of previous overexploitation of sea turtles and their eggs are still unknown (Plotkin et al. 2012).

Conservation Payments

One key method of sea turtle conservation is the use of "conservation payments". This method, used commonly in developing nations, encourages conservation and protection of natural resources and biodiversity through direct and indirect approaches (Ferraro and Kiss 2003). Conservation payment schemes for sea turtles can take many different forms. Sea turtle nesting performance payments, a method used in places such as Kenya, Tanzania and the Solomon Islands, uses direct payments to community members or elected beach patrollers who report a sea turtle or a nest, and some provide additional payment upon the successful hatching of that nest (Ferraro and Gjertsen 2009). In Nicaragua, a program that combines incentive payments, education and ecotourism promotes conservation by providing a monetary incentive to store owners who commit to abstain from the sea turtle egg trade (Ferraro and Gjertsen 2009). In Kenya and the Congo, sea turtle bycatch release programs are used to incentivize fishermen to release sea turtles caught incidentally during fishing activities and to participate in tag and recapture programs (Ferraro and Gjertsen 2009).

Conservation payments have been noted to be very successful when direct incentives are used, as is the case with the sea turtle egg hatchery system in El Salvador, where eggs are brought to a hatchery in exchange for a payment (Ferraro and Kiss 2003). Conservation payment schemes such as these have achieved substantial results for relatively low annual costs (Ferraro and Gjertsen 2009). However, the success of conservation payments rests in financial stability of the entities providing funds. Without direct monetary incentives, conservation payment schemes are not as successful.

Sea Turtle Egg Collection in El Salvador

El Salvador is no exception to the region-wide tradition of sea turtle egg collection and, like the rest of Central America, an economic demand for sea turtle eggs persists (Liles et al. 2015). In

coastal Salvadoran communities, sea turtle egg collectors known locally as *tortugueros* have made a living supplying this demand by collecting and selling sea turtle eggs for human consumption (Liles et al. 2015). *Tortugueros* are plentiful and skilled at their work and, in some areas of Central America, collect up to 100% of the eggs laid on particular nesting beaches (Campbell 2007). El Salvador is the smallest and most densely populated nation in Central America and both marine and terrestrial resources are often exploited (Gammage et al. 2002). As a low-income region, the use of natural resources such as sea turtles and their eggs remains a key component to the livelihood of much of the rural and coastal areas (Liles et al. 2015). In Bahía de Jiquilisco, a region in southeastern El Salvador, the collection and exploitation of natural marine resources such as fish, mollusks and sea turtle eggs represents a significant source of economic income for impoverished residents (Liles et al. 2015). Sea turtle eggs are a critical resource and are heavily exploited in this region of El Salvador and nearly 100% of all eggs laid on beaches are collected (Liles et al. 2015).

Sea Turtle Conservation in El Salvador

El Salvador is a participating party of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and has officially recognized the four species of sea turtles residing in their national waters as threatened or endangered (Acuerdo N 74, 2015). The Ministry of the Environment and Natural Resources (MARN) is the governing body of the Wildlife Conservation Law, which regulates sea turtle egg collection, the hatchery network and possession of hatchlings (Chacon 2002). The nation's ministry of Agriculture and Ranching governs the Fisheries Law, which regulates TEDs, bans the take of all sea turtles, and establishes product regulations (Chacon 2002). These two ministries passed a law prohibiting the consumption and commercialization of sea turtle eggs and products in 2009, making the sale and purchase of turtle eggs illegal (Chacon 2002). This ban represents one of the most significant advances for sea turtle protection, particularly for the hawksbill turtle, in the entire eastern Pacific region (Gaos and Yañez 2012).

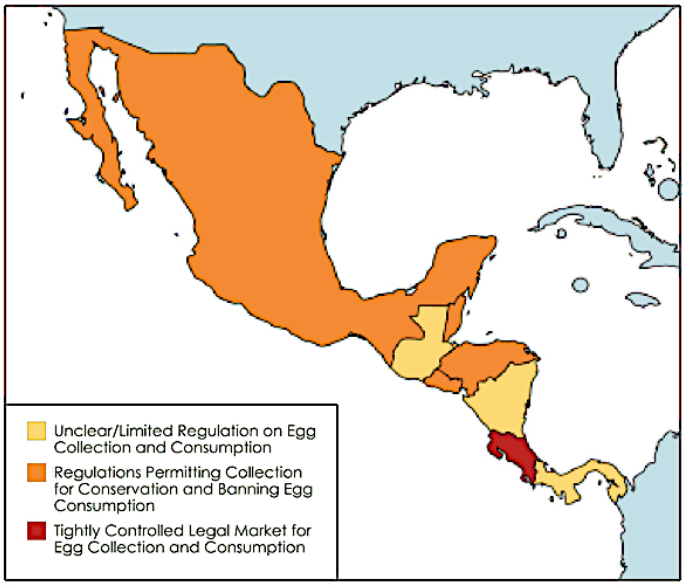

Figure 1. *Map displaying the differences in national regulation regarding sea turtle egg collection and consumption in Central America and Mexico*

El Salvador has enacted similar national regulations as other nations in Central America and Mexico by banning the consumption and commercialization of sea turtle eggs (Figure 1). El Salvador has tighter restrictions than Guatemala, Nicaragua and Panama, all nations that have unclear legislation regarding sea turtle egg collection (Chacon 2002). The current Salvadoran law makes an exemption for egg collection for the purpose of conservation or scientific research with the appropriate permits, allowing *tortugueros* the opportunity to continue to collect eggs and deliver them to a hatchery in exchange for payment. El Salvador has a large network of sea turtle hatcheries that, in places like Bahía de Jiquilisco, have become critical components to the conservation of sea turtles in the country and the economic foundation of local communities.

Hatcheries across the Salvadoran coast are supported and financed by both federal and non-governmental associations. In the Bahía de Jiquilisco region, the hatcheries are supported by the national organization Initiative for the Americas Fund (FIAES), the local organization Asociación Mangle, the international organization EcoViva, and other local and international organizations. While FIAES and EcoViva largely fund local efforts, the local organization Asociación Mangle supports local hatcheries with on the ground support and programming such as trainings and volunteer collection nights.

This region practices unique tactics as part of the conservation payment initiative, including a community fund, where a portion of the *tortugueros'* pay is deposited into a savings fund that is available at the end of each season to make large purchases (e.g. school building materials and fishing boats) for the entire community. Nationwide, hatcheries require that *tortugueros* donate two eggs for every dozen eggs that are bought. The hatcheries also conduct *noches de veda* or "nights of the ban". On these nights, which take place twice a month, hatcheries cannot purchase eggs and volunteers are encouraged to collect eggs and donate them to the hatcheries. These are popular volunteer events that encourage environmental awareness and conservation.

In 2008, a study conducted by the Monterey Institute of International Studies surveyed 88 individuals to profile four key stakeholders within the supply chain of turtle egg sale and purchase in the Bajo Lempa region of El Salvador. These stakeholders include sea turtle egg collectors, buyers, hatchery caretakers and retailers (Berner et al. 2009). This survey was conducted before the sea turtle egg consumption and commercialization ban of 2009. The structure of the market has since been overhauled and it is unclear how the market structure and stakeholder profiles have changed since this ban.

Objectives

Conservation efforts have expanded in El Salvador since enacting the ban on the consumption and commercialization of sea turtle eggs; however, an in-depth look at the effect these changes are having on the local *tortugueros* has not been conducted. In this paper, I examine the activities and opinions of the *tortugueros* living in the Bahía de Jiquilisco region of El Salvador through the use of surveys and interviews. I had three primary objectives: First, I developed a stakeholder profile of the *tortugueros* currently working in the Bahía de Jiquilisco region to better understand the demographic composition of this population. Second, using *tortuguero* survey responses of egg collection activities, I helped determine the most appropriate location for a protected beach pilot program. Finally, I analyzed the population's general thoughts and feelings on sea turtle

conservation and determined the key factors contributing to increased conservation awareness among the *tortugueros* of Bahía de Jiquilisco.

Methods

Study Site

Bahía de Jiquilisco, El Salvador is located on the southeastern coast of El Salvador in the Bajo Lempa region. The bay is 55 kilometers long with a total area of 63,500 hectares, making it the largest expanse of brackish water in all of El Salvador (Liles et al. 2011). The bay is part of the Xiriualtique-Jiquilisco UNESCO-MAB Biosphere Reserve that contains close to three-fourths of the country's mangroves, totaling 19,449 hectares of mangrove forest (Waitt Foundation 2018). This mangrove forest is not only the largest and most important expanse of mangroves in all of El Salvador, it also represents 46.82% of the mangroves of the dry north Pacific coast of Mesoamerica, an ecoregion that has been declared critically endangered by the World Wildlife Fund (Xiriualtique Jiquilisco | United Nations Educational, Scientific and Cultural Organization 2011).

Bahía de Jiquilisco provides critical nesting habitat for sea turtles, particularly the hawksbill turtle (*Eretmochelys imbricata*). A study of hawksbill nesting distribution along the eastern Pacific rim found that Bahía de Jiquilisco is one of three major mangrove nesting sites that together contain 80.6% of the documented hawksbill nesting in the eastern Pacific (Gaos et al. 2017). Another study focusing on hawksbill nesting distribution in El Salvador found that Bahía de Jiquilisco is the primary nesting site for hawksbill turtles in the country (Liles et al. 2011).

During the 2017–2018 nesting season, there were eight hatcheries operating within the Bahía de Jiquilisco region supplying economic income to dozens of communities. In this study, I focused on six hatcheries and the communities they serve: Isla Montecristo, Isla de Mendez, Ceiba Doblada, San Sebastian, El Espino and Corral de Mulas (Figure 2).

Figure 2. *The six hatchery study site locations on the coast of El Salvador (smaller photo shows entire country).*

Survey Design

The survey for this study was designed to gather information on the egg collection behavior and opinions of local egg collectors in the Bahía de Jiquilisco region. Based on the three main objectives, it was determined that the survey should be about 15-20 minutes in length and conducted using a combination of self-administered and interviewer-administered methods. The survey begins with quantitative questions regarding egg collection and income and is based on questions from a similar study conducted by Berner et al. (2009) before the sea turtle egg ban was enacted. The second set of questions are qualitative and focus on the thoughts, feelings and behaviors of the egg collectors regarding sea turtle conservation as a whole and the different conservation practices used in their communities, such as the *noches de veda* and the community fund. This section includes questions regarding whether or not egg collectors will continue bringing eggs to the hatchery without financial compensation. The survey concludes with a final section of demographic questions to establish the stakeholder profile and allow for comparative analysis between demographic variables and answers to qualitative questions. These demographics include age, family size, gender, religion, political party, and social movement or cooperative membership. The demographic questions are asked at the end of the survey due to the sensitive nature of certain questions, such as political and religious affiliation.

Survey Distribution

The target population of this study is the *tortugueros* of the Bahía de Jiquilisco region where the population of active *tortugueros* is estimated at approximately 800 individuals. To achieve an accurate sample size, this study aimed to reach as much of the target population as possible in a relatively short amount of time. There was no economically feasible method to employ a random sampling scheme, therefore, I used a grouping method to achieve a high sample size while still maintaining organized distribution. This method was achieved by hosting six events, one at each of the six hatchery study sites, and inviting the local egg collectors to participate in the event. These events were arranged by local contacts who have long-standing relationships with local *tortugueros*. By tapping into the network of cooperative and community leaders, I was able to hold all six events during our two-week research trip. During each event, collectors were divided into groups, and completed the surveys based on their literacy level. Those who had a sufficient literacy level completed the survey in writing whereas those who were not comfortable reading and writing were provided an interviewer and completed the survey orally. All attendees of each event were administered a survey using one of these two techniques.

During the events I used a variety of methods to improve accuracy, including triangulation and explanations of more complex questions, such as those involving mathematical principles that the respondent may not be familiar with. Surveys were then carefully translated and recorded with the assistance of native Spanish speakers. All activities were conducted in accordance with exempt approval status from UC San Diego Internal Review Board of the Human Research Protection Program.

Survey Analysis

Analysis of the surveys was conducted post-field trip at the Scripps Institution of Oceanography using Microsoft Excel, SPSS Statistics and Tableau programs. For each of the three objectives, a different analysis procedure was used to procure the best results.

Stakeholder Profile
The *tortuguero* stakeholder profile was built using simple descriptive statistics and charts to profile the demographic makeup of the population. Additionally, an analysis of the open-ended responses regarding opinions on conservation and egg donation is included to determine the overall view on conservation among this population (see *Feelings on Conservation* section below).

Collection Behavior and Biodiversity Analysis
Analysis of collection activity and biodiversity was conducted by calculating average and total egg collection at the six different hatchery locations. A measure of effort (for example, number of nights spent searching the beach for nesting turtles) was not collected, however it has been documented in the literature that low-income coastal communities, including Bahía de Jiquilisco collect nearly 100% of all nests laid (Liles et al. 2015). This study therefore operates under the assumption that that the number of eggs/nests collected by *tortugueros* reflect an accurate representation of the number of turtles nesting on that beach. The metric of "nests collected per person" is used as a measure of effort/collection behavior in place of "eggs collected per person" because, based on observations, collectors could more reliably recall the number of nests they collected. Additionally, a measure of species richness, referred to as the species index, was calculated based on the number of different sea turtle species reported by *tortugueros* in the surveys.

Feelings on Conservation
Respondents were asked to answer multiple series of yes/no and open-ended questions regarding their thoughts on sea turtle conservation, sea turtle egg donation and their opinions on specific conservation program elements such as the *noches de veda*. To analyze the open-ended questions, word clouds were used to determine approximate word frequencies within answers. These frequencies were then used to create appropriate bins to categorize open-ended responses. Each answer was then analyzed by hand and assigned bins based on specific words mentioned within their answer. Answers could be placed into more than one bin if their response contained words from more than one bin. Simple descriptive statistical analysis was then performed on binned responses to determine exact answer frequencies. Specific quotes from answers are also provided for additional insight.

Drivers for Conservation Awareness
This objective aims to determine the unique motives and drivers for increased conservation awareness among the *tortuguero* population of Bahía de Jiquilisco. This analysis is used to recommend any improvements or future actions that can be made in the conservation-payment program to increase awareness. To complete this analysis, I developed a "conservation index" as a measurement of conservation awareness based on the answer pattern for question 14 (multiple choice: why is sea turtle conservation important to you). Each respondent was given an index number representing two different groups: (1) the highly conservation aware group and (2) the not highly conservation aware group. These groupings were based on why the respondent considered the conservation of sea turtles important. Respondents were given three options for why conservation of sea turtles is important: (1) for the environment, (2) for their income/work and (3) for future generations. Multiple selections were allowed. Respondents who selected all three responses or those who prioritized the environment and future generations over income

were placed in the highly aware group. All other answer patterns were placed in the second group. This index was then used as a dependent variable in a series of statistical tests to determine any possible predictors for increased conservation awareness.

Statistical Analysis.
Testing for this objective was completed in Excel and SPSS Statistics. Before testing was completed, the data were scanned for answers that were discernibly calculated incorrectly by the respondent, indicating that the respondent did not understand the question and didn't answer accurately. Answers were removed based on the following process for four questions:

- For Question 5 regarding number of eggs collected, a calculation of number of eggs per nest was conducted for each respondent, and the responses that reflected numbers of eggs per nest that were far from biologically possible (answers over 200 eggs per nest) were removed from the dataset.
    - 1 case was removed from this variable
- For Question 6 regarding percentage of eggs brought to the hatchery, a common misconception of the question seen in the responses was an answer reflecting the number of eggs donated to the hatchery instead of the total number of eggs both donated and sold to the hatchery. Answers that clearly reflected this misconception (percentages that were abnormally low or that resembled the required donation rate of 2 eggs per dozen) were therefore removed from the dataset.
    - 14 responses were removed from this question
- For Question 7 regarding income received from collection of turtle eggs, a calculation of income per dozen was calculated and, if that number was extremely high (for example, higher than $5 per dozen), the response was removed from the dataset (the normal pay for a dozen turtle eggs is $1.25 in cash, $2.50 total including money to the community fund). It should be noted that for this question, some respondents may have indicated the amount received in cash (which was the desired response), while others may have indicated the total amount they received (including the money that went to the community fund). It is impossible to determine which amount the respondent is reporting, and therefore all amounts were analyzed together, however response error may be present.
    - 12 responses were removed from this question
- For Question 10 regarding percentage of annual income, an analysis of comparison was conducted, looking at whether or not the respondent indicated that sea turtle egg collection was their primary source of income and how many other sources of income they reported. If the comparison dictated that the percentage reported was clearly inaccurate (for example, the respondent reported that turtle egg collection was their primary source of income and only indicated one other source of income but reported a very low percentage of income from egg collection) the response was removed. Reponses such as these are thought to be due to low literacy and numeracy rates and a misunderstanding of the value of a percentage.
    - 11 responses were removed from this question.

Statistical analysis was conducted to complete the drivers for conservation awareness objective and the egg collection and biodiversity objective. A number of statistical tests were used to determine the factors that are driving conservation awareness level of the population, including

Chi-square analysis, boxplots, and t-tests. Trends were analyzed between the conservation index and ten other independent variables: age, collection frequency (number of nests/eggs collected), experience collecting (number of years collecting), family size, political affiliation, religious affiliation, social movement or cooperative membership, income, and financial dependency on the resource (percentage of annual income from egg collection). Certain factors were expected to have specific impacts on conservation awareness. The hypotheses for these expected outcomes are as follows:

1. Collectors who identify as religious have a lower level of conservation awareness
2. Collectors who identify with the FMLN (Farabundo Martí National Liberation Front) political party have a higher level of conservation awareness
3. Collectors who are members of *tortuguero* cooperatives have a higher level of conservation awareness
4. Collectors who are members of social movements have a higher level of conservation awareness
5. Collectors who have been collecting sea turtle eggs for longer have a higher level of conservation awareness
6. Collectors who collect more nests/eggs have a higher level of conservation awareness
7. Collectors who received more income from collecting turtle eggs have a higher level of conservation awareness
8. Collectors who are more financially dependent on income from turtle egg collecting (higher percentage of income from egg collecting) have a higher level of conservation awareness
9. Collectors who are older have a higher level of conservation awareness
10. Collectors with more children have a higher level of conservation awareness

For hypotheses 1-4, the conservation index is tested for dependence on the independent variables. A Pearson's Chi-Square test of independence is used to test the for statistically significant dependence because these four independent variables are ordinal, and a difference of means cannot be calculated. The independent variables containing more than 3 possible answers were categorically grouped to complete this test. Religion was categorized into two groups: religious or non-religious. Political Affiliation was categorized into three groups: members of the FMLN political party, members of the Arena political party, and neither/other. For hypotheses 5-10, the conservation index is tested for significant difference of means between the two groups of the independent variable. A t-test was used to determine the statistical significance of the difference of the means because these independent variables are nominal, and a difference of means can be calculated.

Statistical analysis was also used to create a geographical representation of biodiversity in terms of richness and biomass using the program Tableau. The number of nests collected on average per person was used as a measurement for biomass of nesting female turtles. This metric is based on the assumption that 100% of eggs laid on the beach are collected, therefore nest collection per person acts as an appropriate measure of biomass. To measure species richness, a species index was created from the mean number of species observed per person in each location. This analysis was used to determine the most appropriate location for a pilot program for a fully protected beach.

Results

Stakeholder Profile

During two weeks (data range), 139 sea turtle egg collectors were surveyed from the six different hatchery locations in the Bahía de Jiquilisco region. In total, 86% of the respondents identified as male and 9% identified as female, while 5% declined to respond. Age of egg collectors ranged from 15 to 84 years old (mean = 39 ± 1.33). Family sizes ranged from 0 children to 10 children (mean = 2.5 ± 0.2). In total, 38% of respondents reported being members of social movements (such as Asociación Mangle) and 69% reported being members of egg collector cooperatives. Respondents reported a range of political affiliations including Arena, FMLN, GANA, Nuevas Ideas or none. A range of religions was reported that included Christian, Catholic, Evangelical, Lutheran and others.

Table 1. *Demographic profile of respondents broken down by hatchery location.*

Location	*Number of Respondents*	*Male*	*Female*	*Mean Age*	*Mean Family Size*	*Cooperative Members*	*Social Movement Members*
Isla Montecristo	29	27	2	35	2	28	11
Isla de Mendez	26	19	3	50	3	21	12
Ceiba Doblada	31	26	5	38	3	28	20
San Sebastian	28	23	3	36	2	5	3
El Espino	18	17	0	36	2	10	3
Corral de Mulas	7	7	0	33	3	4	4
Total	139	119	13	39	2.5	96	53

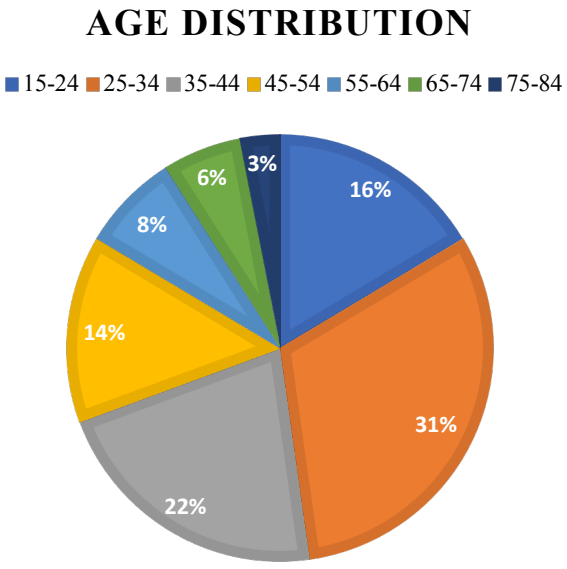

Figure 2a. *Pie chart of age range distribution across all hatchery locations. n=135*

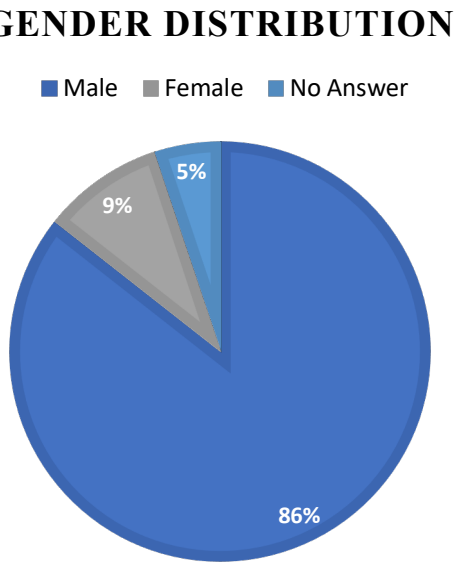

Figure 2b. *Pie chart of gender distribution across all hatchery locations. n=139*

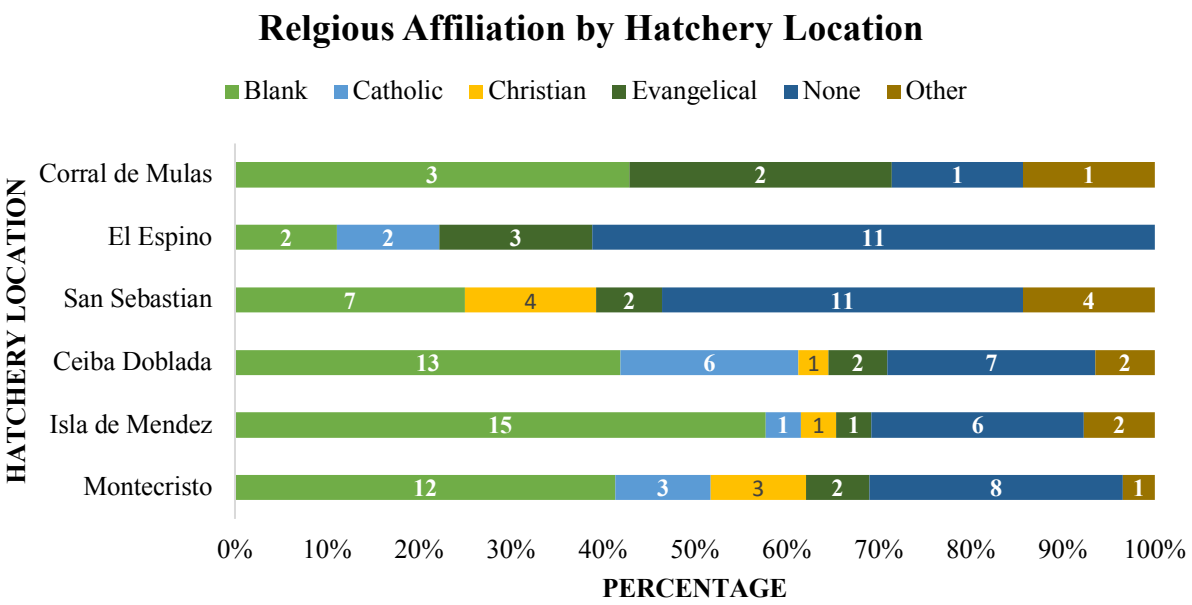

Figure 3. *Religious affiliation by hatchery location. Length of bar represents percentage within that location, color of bar represents source of income and number within bar represents the frequency. n=139*

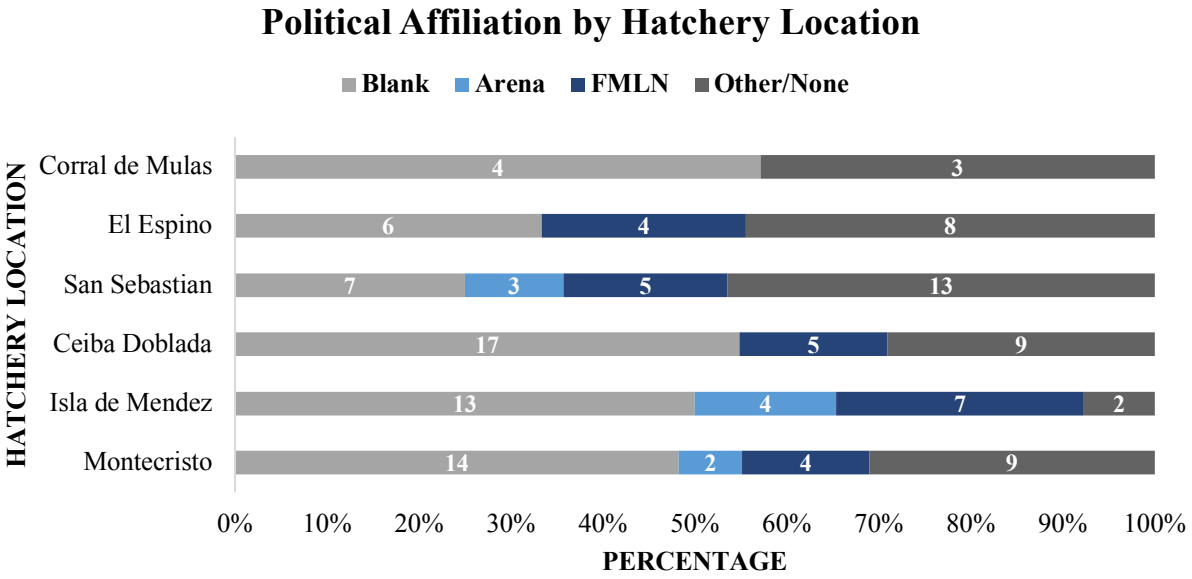

Figure 3. *Political affiliation by hatchery location. Length of bar represents percentage within that location, color of bar represents source of income and number within bar represents the frequency. n=139*

Income Distribution

Respondents were asked to report the amount of income they received during the 2017–2018 nesting season from sea turtle egg collection, the percentage of their total annual income that came from egg collection, whether or not egg collection is their primary source of income and their alternative sources of income other than egg collection. On average, an egg collector made $226 from collecting sea turtle eggs during the 2017–2018 nesting season (egg income ranged from $11.80 to $800). Of the 139 respondents, 73% reported egg collection as their primary source of income, and the average percentage of income received from egg collection across all locations was 49%. A wide variety of responses were collected for other sources of income, but most fell under the categories of "fishing" (which includes all types of fishing, crabbing and shellfish extraction), "agriculture" or "day-labor" (local terminology used for inconsistent work, usually in construction or agriculture). Respondents were able to list more than one alternate income. Of the 139 total respondents, 65% reported that they depended on fishing activities, 28% on agricultural activities, 8% on day-work and 8% reported other sources of income.

Table 2. *Income earned from sea turtle egg collection by hatchery location. Annual income was calculated using percentage of annual income from sea turtle egg collection and total income from sea turtle egg collection metrics "Primary" represent the percentage of respondents in that area that reported egg collection as primary source of income. "Dependency" represents the average percent of annual income that was reported to come from sea turtle egg collection.*

Location	*Mean Income from Egg Collection*	*Minimum*	*Maximum*	*Calculated Mean Annual Income*	*Primary*	*Dependency*
Isla Montecristo	$228.54	$100	$500	$768.09	59%	40%
Isla de Mendez	$327.08	$25	$800	$507.22	88%	68%
Ceiba Doblada	$242.51	$38	$700	$519.37	77%	49%
San Sebastian	$137.70	$11.8	$372	$461.71	68%	36%
El Espino	$160.26	$18	$430	$460.17	61%	46%
Corral de Mulas	$285.74	$100.20	$400	$441.09	100%	70%
TOTAL	$226.31	$11.80	$800	$544.59	73%	49%

Table 3. *Alternative sources of income received by egg collectors throughout the year, other than the collection of sea turtle eggs, by hatchery location. Percentages represent percent of respondents in that area.*

Location	*Seafood (fishing, shellfish collection)*	*Agriculture (cashews, corn, coconut)*	*Day-Work*	*Other (sales, housework, construction)*
Isla Montecristo	69%	59%	3%	3%
Isla de Mendez	42%	12%	15%	4%
Ceiba Doblada	65%	32%	19%	16%
San Sebastian	89%	14%	0%	4%
El Espino	61%	11%	0%	11%
Corral de Mulas	57%	43%	0%	14%
TOTAL	65%	28%	8%	8%

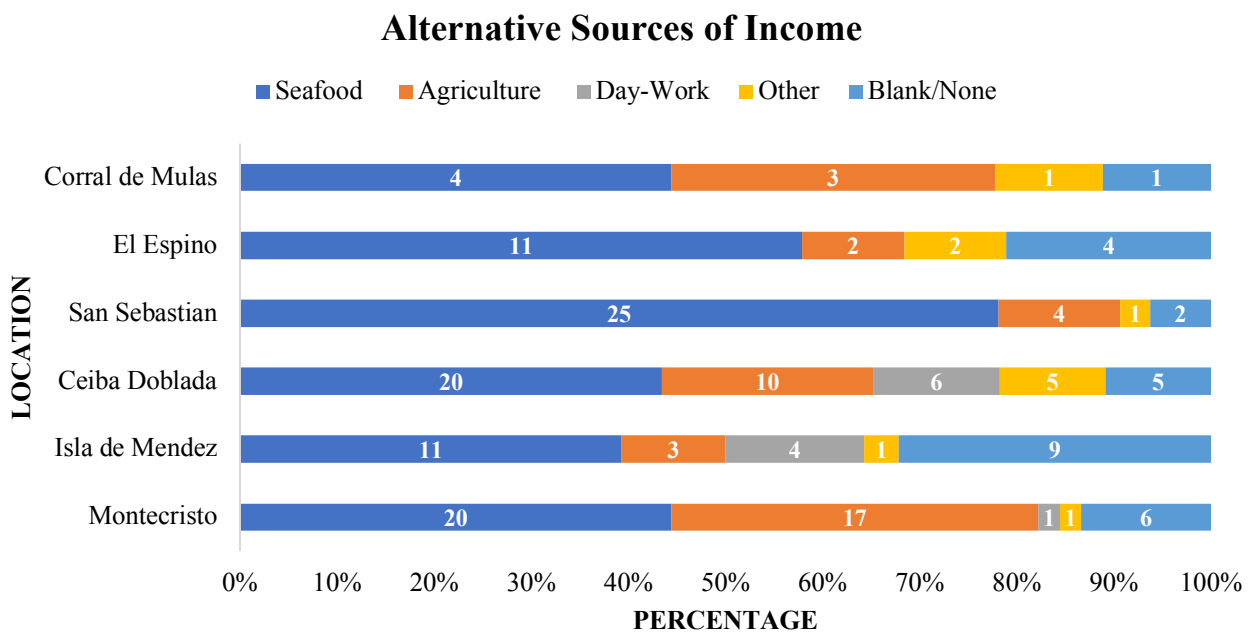

Figure 5. *Alternative sources of income by location. Length of bar represents percentage within that location, color of bar represents source of income and number within bar represents the frequency. n=139*

Collection Behavior and Biodiversity

On average, *tortugueros* reported collecting 42 nests per person and 2,776 eggs per person throughout the 2017–2018 nesting season. The number of nests collected ranged from none to 300 while the number of eggs collected ranged from none to 30,000. The total number of nests collected was 5,641 nests and the total number of eggs collected was 344,240. The rate of nests collected per person (the preferred metric over eggs collected per person) was highest in the Isla Montecristo community and lowest in El Espino. A completed distribution of nest collection across all hatchery sites can be seen in Figure 6. When asked about donation/sale to the hatcheries, the mean response was 96% of all collected eggs are brought to a hatchery. Responses ranged from a minimum of 49% to a maximum of 100% of collected eggs that are subsequently sold or donated to a hatchery.

Table 4. *Mean, minimum and maximum number of eggs and nests collected per person during the 2017–2018 nesting season by hatchery location.*

Location	*Mean Nests Collected Per Person*	*Minimum Nests Collected*	*Maximum Nests Collected*	*Mean Eggs Collected Per Person*	*Minimum Eggs Collected*	*Maximum Eggs Collected*
Isla Montecristo	71	15	300	4,711	800	30,000
Isla de Mendez	46	4	125	2,186	300	7,050
Ceiba Doblada	42	4	180	3,277	105	18,000
San Sebastian	25	0	100	1,647	0	10,000
El Espino	20	0	70	1,352	0	5,600
Corral de Mulas	39	15	50	2,964	1,500	6,000
TOTAL	42	0	300	2,776	0	30,000

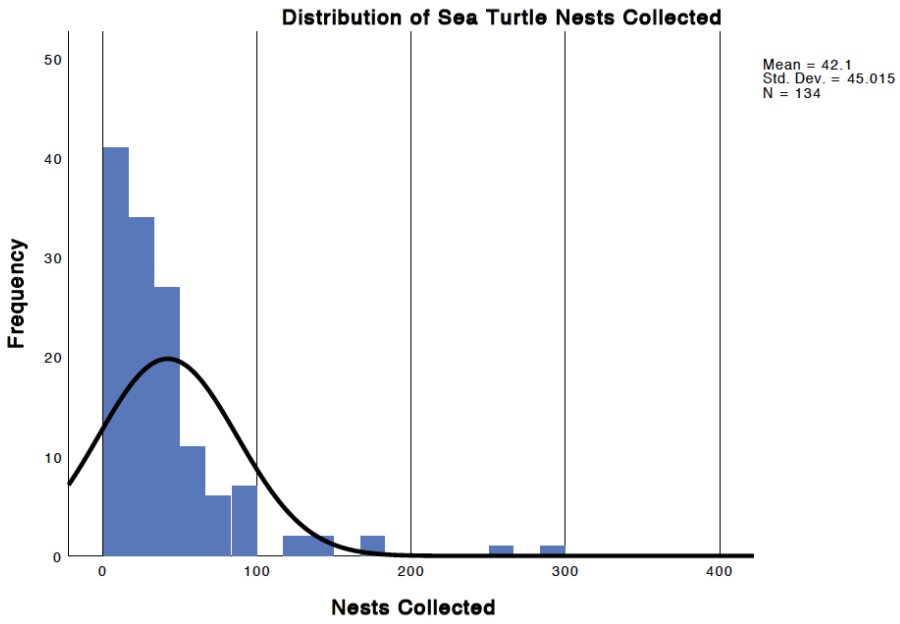

Figure 6. *Distribution of the number of sea turtle nests collected during the 2017–2018 season across all six hatchery locations.*

When asked what species they collected from, *tortugueros* reported olive ridley turtles the most, with 127 total reported sightings. Green turtles were the next highest with 104 sightings, following by hawksbill turtles with 56 sightings and leatherback turtles with 23 sightings. According to the average species index, the highest levels of species richness were observed in Isla Montecristo, where higher numbers of hawksbill and leatherback sightings were reported

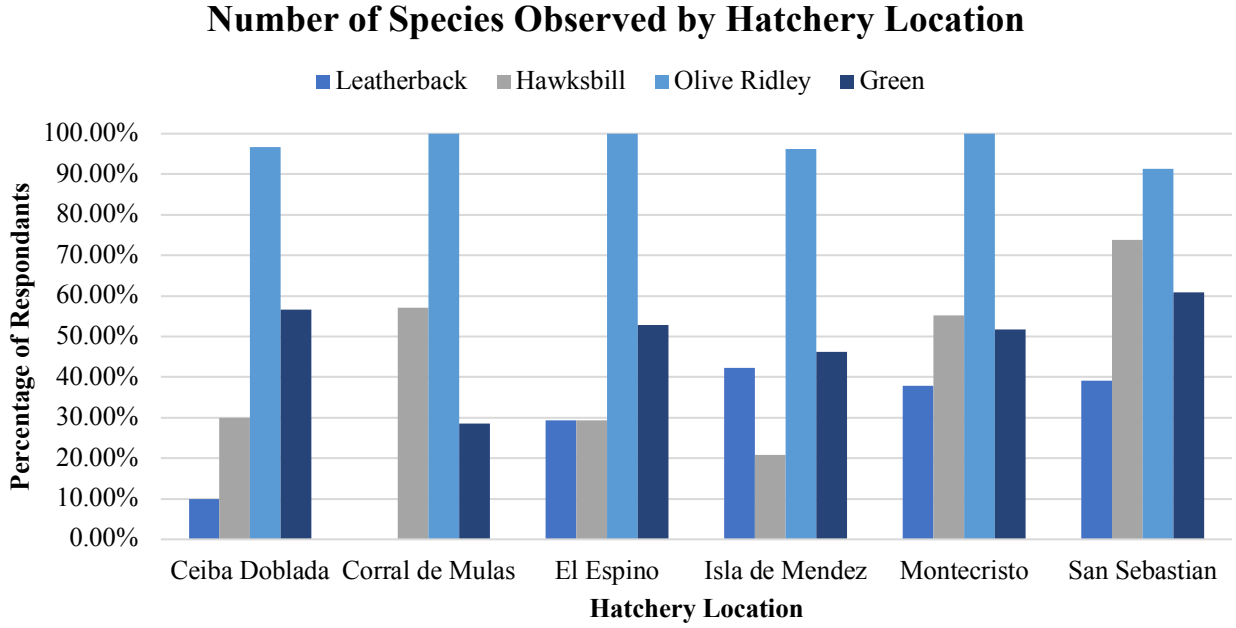

Figure 7. *Percentage of respondents per hatchery location who reported observing each species of sea turtle*

Figure 8. *Geographic distribution of average number of sea turtle nests collected per person and average number of different species sighted. Color represents species richness, with darker colors representing a higher average of species sightings. Circle size represents biomass, with larger circles representing higher number of nests collected per person, and therefore a greater biomass of nesting female sea turtles.*

Feelings on Conservation

Respondents were asked a series of open-ended questions, allowing for a varied level of response regarding opinions on conservation and specific local programs. The first of these was a question asking the respondent to provide his/her general feelings on sea turtle conservation. Of the 119 people that responded, 97% of the responses were determined to reflect a positive feeling toward conservation as a whole and none were determined to reflect a negative feeling. In their answers, 58% mentioned conservation and/or the species, 21% mentioned the future or their children, 13% mentioned the environment or natural resources, 28% mentioned production or economic income, and 17% mentioned human/community benefit. One *tortuguero* from the Ceiba Doblada hatchery commented:

> *For me, sea turtle conservation is very important because it helps our ecosystem and improves our quality of life because it generates income for my family and cares for our environment.*

Another respondent from the Isla Montecristo hatchery said:

> *Sea turtle conservation is important because turtles help maintain the health of the entire ecosystem and generate economic income through their conservation in the hatcheries.*

Some respondents mentioned the sea turtle egg ban in their responses, one going as far as to say that the hatcheries make them feel less threatened:

Supporting sea turtle conservation makes me feel safer and less afraid of the authorities because collecting for the hatcheries is permitted, whereas selling on the black market is not.

While not a majority response, 9% of people mention extinction of the species, indicating a portion of the population has an understanding of the vulnerability of local sea turtle populations and their endangered status. One respondent from the Isla Montecristo hatchery stated:

Conservation is the best thing you can do so that sea turtles are able to reproduce and won't go extinct.

Respondents were also asked to provide their opinion on the importance of donating sea turtle eggs. Answers showed similar patterns to previous questions, with 33% of responses mentioning production/reproduction, income or work, 66% mentioning the turtle/species itself, 56% mentioning the environment, conservation or awareness, and 24% mentioning the future or children in their responses. Of the 139 returned surveys, 97 respondents provided an answer for this open-ended question (these percentages are calculated using the number of completed answers, not total respondents). One egg collector from Isla Montecristo states that donating eggs is important because:

Not everything should be about money, we should demonstrate personal commitment and awareness. We are donating in order to provide a better future to our children.

Other responses focused more on the importance of the production of the resource or reproduction of the species, including this response:

Donating eggs is important because this way turtles can reproduce and there will no longer be species that are in danger of extinction.

The final open-ended question asked whether or not they would continue donating eggs even if their local hatchery runs out of funds and can no longer pay them. In total, 127 respondents said that they would continue to donate in some shape or form while only 5 said no.

***Table 5**: Responses for to question number 27, "If the hatchery were to run out of funds and couldn't pay you, would you continue to donate eggs?"*

	Yes		***No***	
Location	**Count**	**Percent of Total**	**Count**	**Percent of Total**
Isla Montecristo	24	92%	2	8%
Isla de Mendez	24	100%	0	0%
Ceiba Doblada	30	97%	1	3%
San Sebastian	24	92%	2	8%
El Espino	18	100%	0	0%
Corral de Mulas	7	100%	0	0%
TOTAL	127	96%	5	4%

When asked to provide reasoning for why they would continue donating eggs without pay in an open-ended response, respondents provided a wide variety of answers. Of the 127 respondents who said yes, 35% mentioned the turtle species itself, 23% mentioned conservation or protection and 20% mentioned production or reproduction. Additionally, 9% stated they felt the eggs would be better off at the hatchery than in the market or eaten, 7% of responses were conditional, saying they would only continue to donate a portion of their collection and 4% stated they couldn't or didn't want to sell eggs for a low price (a phenomenon that can be seen on the illegal black market when supply is greater than demand). Only 2% mentioned a monetary or economic reason for continued donation. Other responses included community or personal benefit (6%), future generations or children (4%), awareness or conscientiousness (2%) and duty or responsibility (3%).

One respondent from the Isla Montecristo community stated:

> *The work of sea turtle conservation should not stop. Even if there isn't as much impact, it is still important.*

Another collector from Ceiba Doblada stated:

> *It benefits me more to conserve sea turtle eggs in the hatchery than see them go to the market.*

Finally, a respondent from San Sebastian noted:

> *Sea turtles are a great benefit to our community. They have the right to live. If all the eggs are eaten, there will be fewer hatchlings, and we must ensure that there is reproduction in the future.*

Drivers for Conservation Awareness

To satisfy the second objective of this study, statistical analysis was performed to determine predicting factors for level of conservation awareness. Once divided into groups, it was found that 94 of the 139 respondents fell in the highly conservation aware group, making up 68% of the total responses.

Table 6. *Percentage of respondents in each of the two conservation awareness groups*

	Conservation Index	
Location	**Highly Conservation Aware**	**Not Highly Conservation Aware**
Isla Montecristo	69%	31%
Isla de Mendez	73%	27%
Ceiba Doblada	58%	42%
San Sebastian	61%	39%
El Espino	83%	17%
Corral de Mulas	71%	29%
TOTAL	68%	32%

For all hypotheses that involve a comparison between the conservation index (dependent variable) and a categorical/ordinal independent variable, a Chi-Square test of independence was used to determine if the variable was statistically different or independent between the two different conservation levels (highly aware versus not highly aware).

Table 7. *Results for Pearson's Chi-Square test of independence for the conservation index (dependent variable) and four independent variables*

Variable	*Pearson's Chi-Square Value*	*Degrees of Freedom*	*Asymptotic Significance (p-value)*	*Phi Value for Amount of Significance*
Religion	0.665	1	0.415	0.069
Political Affiliation	2.017	3	0.546	0.120
Cooperative Membership	1.943	1	0.163	0.125
Social Movement Membership	4.343	1	**0.037**	**0.187**

The Chi-Square analysis showed only one variable that the conservation index was statistically significantly dependent on. The null hypotheses for the religion, political affiliation and cooperative membership dependency tests failed to be rejected due to p-values of 0.415, 0.546 and 0.163 respectively. For the social movement membership independency test, the p-value = 0.037, therefore the null hypothesis is rejected, showing a statistically significant dependence of the conservation index on social movement membership. The phi value = 0.187 indicates a small to moderate dependence.

For all hypotheses that compare the conservation index with a scale variable, independent samples t-test was used to determine statistical difference in means between the two conservation index groups (highly conservation aware and not highly conservation aware).

Table 8. *Results for t-test of equality of means for six variables between the conservation index groups.*

	Levene's Test for Equality of Variances		*t-test for Equality of Means*	
Variable	**F**	**Significance Value (P-Value)**	**Degrees of Freedom**	**2-tailed Significance Value (p-Value)**
Number of Years Collecting	1.920	0.168	134	**0.015**
Nests Collected	9.965	0.002	128.769	**0.001**
Eggs Collected	7.558	0.007	117.041	**0.008**
Income Received	0.031	0.860	113	0.210
% of Annual Income from Egg Collection	1.578	0.212	64.408	0.078
Age	4.730	0.031	68.286	0.388
Number of Children	5.200	0.024	53.787	0.785

Of the seven variables tested using the t-test for equality of means, only three were found to have statistically significant means between the two groups. These variables were number of years collecting, number of nests collected, and number of eggs collected with p-values of 0.015, 0.001 and 0.008 respectively. For tests with a p-value greater than 0.05, the null hypothesis failed to be rejected. This outcome occurred for the income received, percent of annual income from egg collection, age and number of children dependent variables.

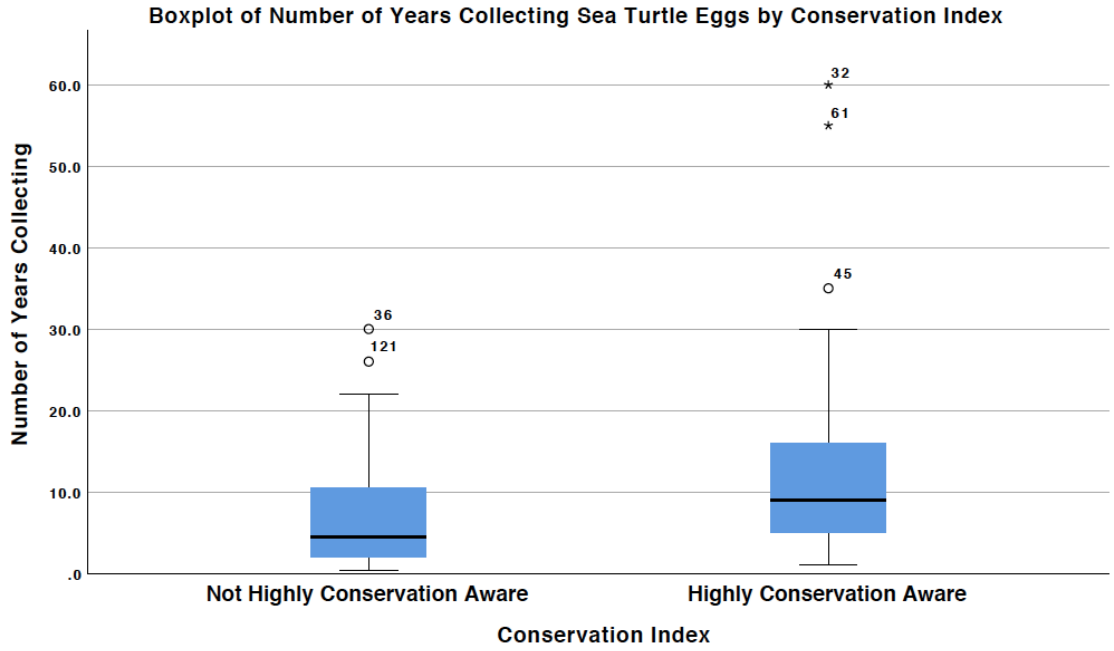

Figure 9. *Boxplot showing the statistically significant difference in the mean number of years collecting sea turtle eggs between the two conservation index groups. The average number of years spent collecting eggs is higher in the highly conservation aware group.*

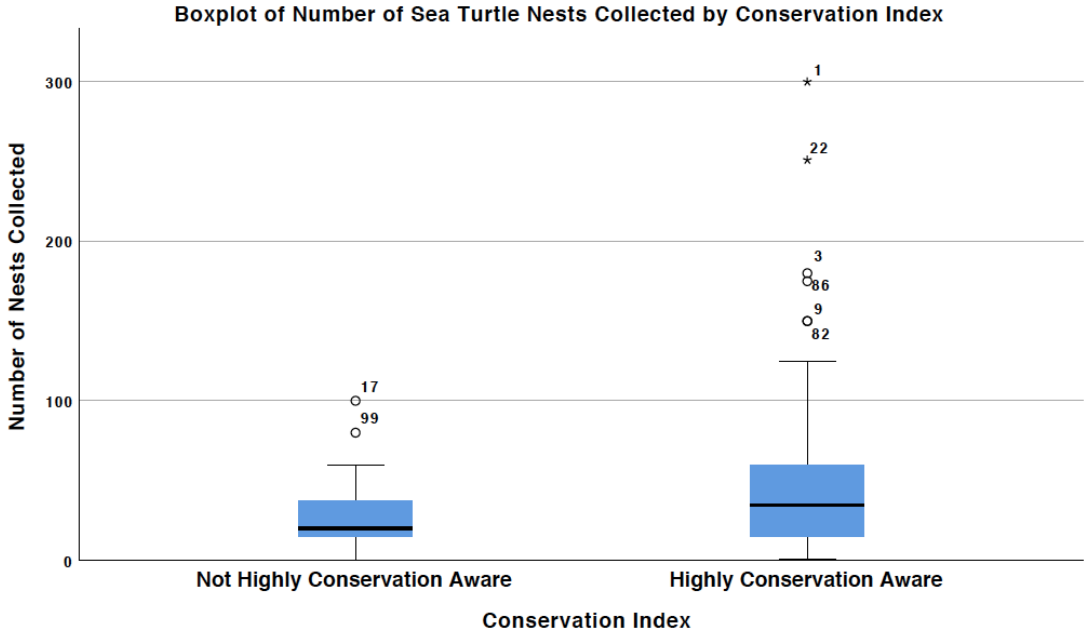

Figure 10. *Boxplot showing the statistically significant difference in the mean number of sea turtle nests collected eggs between the two conservation index groups. The average number of nests collected is higher in the highly conservation aware group.*

Discussion

Overall, respondents to this study showed a general positivity toward sea turtle conservation. Through both survey responses and anecdotal observations, I noted a passion for caring for and protecting sea turtle species in this population that was not expected. The desire to build awareness and protect natural resources exists within these communities and their willingness to donate sea turtle eggs to hatcheries for free without pay demonstrates their positive feelings toward conservation. Willingness to donate, however, does not make the hatchery systems financially viable into the future. On average, an egg collector living in the Bahía de Jiquilisco region receives nearly half of their annual income from the collection of sea turtle eggs. This income is invaluable, as most of these communities are living in extreme poverty. Even though *tortugueros* are willing to donate all or a portion of their income and time to the conservation of sea turtle species, they do not have the means to give up this source of income indefinitely. This program is not only conserving sea turtle eggs and hatchlings, but also providing vital support for coastal families that depend on this resource and whose income-generating options are extremely limited. Should funding be cut, the program is not financially sustainable in the long-run, regardless of egg collector's desire to conserve and donate. Should funding be cut for these hatchery programs, even if they can run on donation activities for a period of time, these programs cannot be sustained, and both the coastal communities and sea turtle populations will be negatively impacted.

Stakeholder Profile

The demographic profile of egg collectors reflects more or less what was expected and looks similar to the data from Berner et al. (2009). The population is male-biased and includes a wide range of ages, family sizes, political affiliations and religions. This population demographic differs from that of El Salvador as a whole. El Salvador is the 108th largest country in the world with a current population estimated at 6.41 million people, 47% of whom are male and 53% of whom are female versus the 86% male *tortuguero* population. Median age in El Salvador is 27; however, the median age of survey respondents is marginally higher at 35 (El Salvador Population 2018 (Demographics, Maps, Graphs) 2018). Half of the total Salvadoran population is reported to be Catholic and 36% as protestant, whereas among survey respondents in this study only 8% identified as Catholic and only 30% as religious (El Salvador ca. 2015).

Perhaps the largest disparity between the target population of egg collectors and El Salvador as a whole is average income. Calculated average income based on percentage annual income from egg collection and annual income received from egg collection responses indicated an average annual income of $545 and a maximum of $2,000 among the *tortuguero* population of Bahía de Jiquilisco compared to the national rural household average annual income of $4,3141 (Household Income Up 10% in El Salvador - CentralAmericaData :: The Regional Business Portal 2014). Literacy rates were also lower than the national average of 88% based on anecdotal observations of participants who could comfortably read and write (about one third of the respondents) versus those who could not (El Salvador ca. 2015). In summary, according to our data, *tortugueros* of the Bahía de Jiquilisco region exhibit lower literacy rates and lower income rates than national averages, are a male-dominated industry compared to the national population, are reportedly less religious and have a higher median age.

Collection Behavior and Biodiversity

Globally, methods of sea turtle conservation vary widely. Some nations and communities have employed strict legal regulations on the consumption of sea turtles and their eggs while other nations controlled consumptive use, such as the legal egg collection program in Ostional, Costa Rica (Campbell 1998; Campbell 2007). When it comes to sustainable use, however, sea turtle experts agree there is uncertainty and lack of information in the realm of controlled consumptive use of sea turtles (Campbell 2002). Unlike Costa Rica, El Salvador has adopted stricter regulations in the complete ban of consumption and commercialization of sea turtle eggs, however collection of nearly 100% of all eggs continues on the beach of Bahía de Jiquilisco as a result of the permitted collection of eggs when delivered to a hatchery (Liles, Peterson, Seminoff, et al. 2015). El Salvador currently does not have a fully protected beach where eggs are not permitted to be removed under any circumstance, allowing for in situ incubation and hatching. Based on observations from our team and local conservationists, the addition of a protected beach would allow for an alternate livelihood for egg collectors in the form of employed park rangers and would provide an extra layer of protection for sea turtle nests. Based on the collected data, it has been determined that Isla Montecristo would be the most ideally suited location for a protected beach pilot program.

Other communities where federal regulations such as national parks or protected beaches have been enacted have seen positive trends in the numbers of nesting turtles, such as the Tortuguero National Park in Tortuguero, Costa Rica (Troëng and Rankin 2005). The Tortuguero National Park was decreed in 1970 to protect the largest nesting site for green turtles in the western hemisphere, and all collection of eggs was banned on the protected nesting beach (Jacobson and Robles 1992). Data of nesting green turtles have shown signs of recovery, and this is likely due to the policy decisions made in this country, including the declaration of the Tortuguero National Park (Troëng and Rankin 2005). Additionally, training programs for ecotourism guides were developed to both control tourism and provide an economic resource to local community members (Jacobson and Robles 1992). I believe that a similar program in Bahía de Jiquilisco would provide extra protection nesting turtles, as well as foster an environment where alternate livelihoods in realms like ecotourism may become possible in the future.

Spatial Analysis Map for Protected Beach Program Location Recommendation

The spatial map of egg collection and species diversity (seen in Figure 6) shows that, according to survey responses, the highest average number of nests collected per person is in Isla Montecristo. Based on our assumption that this metric is a good indicator for female nesting biomass, the beaches surrounding this hatchery are receiving the greatest number of nesting females of all six study sites. Additionally, the data also shows that the average number of distinct species reported per person is also highest in Isla Montecristo, indicating a higher diversity of species in nesting females on this beach. In addition to the supporting evidence from this data, anecdotal observations from the research team and local conservationists demonstrates an ideal community environment for a protected beach program. This community is already well organized it its structure and takes great care in fairly distributing marine resources among the community members. Additionally, the community has strong and highly conservation aware leaders who are successfully implementing conservation awareness strategies in their communities. For these reasons, I suggest that a fully protected beach be put into place in the Isla Montecristo community.

Feelings on Conservation and Drivers for Conservation Awareness

Conservation awareness among the sea turtle egg collectors in the Bahía de Jiquilisco region may be shifting since the ban of sea turtle egg commercialization and consumption in 2009. Our data shows that 56% of respondents indicated conservation or the environment as a reason for the importance of donating sea turtle eggs, as compared to 15% mentioning sustainability and 12% mentioning conservation when asked their reason for donating eggs in a similar study conducted just before the ban was enacted (Berner et al. 2009). Our team wanted to determine the potential predictors of the conservation awareness levels of sea turtle egg collectors to better understand what makes an egg collector become more holistic in their thinking of sea turtle conservation. The statistical analysis of the correlation between ten different independent variables and the conservation index indicates three factors that may be contributing to the level of conservation awareness among the *tortuguero* population in Bahía de Jiquilisco: level of collection activity (number of nests/eggs collected), experience collecting (number of years spent collecting eggs) and membership in a social movement. The data also indicates marginal insignificance (statistical significance at a 90% confidence level) of one other factors: financial dependency on egg collection (percentage of annual income).

Experience with Egg Collection

These results indicate that a person who has more experience with egg collection is more likely to be highly conservation aware. Additionally, a person who collects more eggs/nests is more likely to be highly conservation aware and holistic in their views of conservation. A *tortuguero* who has had more experience walking beaches, collecting eggs and spending time with nesting turtles seems to develop a broader understanding of the need to protect the species and the resource it supplies for reasons beyond just an economic dependency. Additionally, a *tortuguero* who has been collecting for longer also has had more experience in the local conservation programs, such as the *noches de veda*. Collectors with more experience selling and donating eggs to a hatchery have been exposed to information regarding the importance of sea turtles in the marine ecosystem as a whole and have participated in more voluntary efforts to conserve the resource than someone who is just beginning their career as an egg collector. The awareness building component of the hatchery program may be having a meaningful impact on the egg collectors who are participating, and as collectors gain more experience, their conservation awareness increases as well. This component of the program may be critical to its overall success and it should be stressed that continued efforts to build awareness in egg collectors ought to be continued in the future.

Dependency on the Resource

Although less significant, the data indicates that financial dependency may be predictor of conservation awareness, with those who are more dependent financially on the resource being more likely to be highly conservation aware. This result was marginally insignificant and should therefore not be taken as being as significant as results with significance at 95% confidence levels, however I feel it is important to make note of this result. The percentage of annual income a *tortuguero* receives from collecting turtle eggs may be a good predictor for the level of conservation awareness that *tortuguero* has. A collector who is more financially invested in the resource may be more conscientious of the importance of conserving that resource. Sea turtle egg

collectors have an invested interest in the preservation of sea turtles because they hold a stake in that resource. They are a key group of stakeholders, and as beneficiaries, they are also critical stewards of the resource. The participation of stakeholders and beneficiaries in conservation practices is a necessity of successful community-based management programs because it is advantageous to them for the resource to endure (Frazier 1999). Stakeholders who depend on a resource have the responsibility of collaborating in conservation activities, a statement that is echoed in the answers of some respondents when asked why they would continue to donate eggs: it is a duty and a responsibility as someone who depends on the resource. In this unique situation, wherein the conservation program is heavily financially dependent on outside funding from federal and private sources, money may be playing an integral role in the success of the conservation program. The data from this study show that financial dependency may be driving conservation awareness levels, fostering an attitude of understanding and responsibility for the conservation for the turtle eggs that is critical for the success of a community-based conservation program like that of the hatchery system in Bahía de Jiquilisco.

Furthermore, the data reflect an unexpectedly large proportion of respondents who are willing to continue donating eggs to their local hatchery without pay should the hatchery find themselves without funding (a phenomenon that, according to local hatchery caretakers, is not uncommon). When a hatchery runs out of money and can no longer pay, a collector may continue to bring eggs for donation only, but financial dependency still may be playing a role in that collector's awareness of the importance of conserving the resource. Whether collectors are willing to donate eggs for free without payment or not, the level of conservation awareness among the population may still be correlated with monetary factors, and that dependency is critical in building and maintaining a successful community-based program.

Social Movement Membership

The data shows a relationship between the number of people with membership in social movements and the two conservation awareness groups. The possible reason behind this correlation is unknown, as the data shows a greater number of people who are *not* members of social movements in the highly conservation aware group. In this context, a social movement includes any social organization, such as unions, community groups, health organizations and conservation organizations. At this time, more data is needed to understand the correlation between these two factors.

Additional Recommendations

Threat Reduction Assessments and Hatchery Log Book Data Analysis

In addition to the creation of a protected beach pilot program in the Isla Montecristo community, I feel the hatchery system and associated conservation programs could benefit further from other added measures. A key component to any conservation effort is consistent evaluation and assessment (Trejo and Díaz 2012). In Colola, Mexico, a black sea turtle conservation project that utilizes a similar hatchery system to that of Bahía de Jiquilisco has been consistently collecting data over the past 20 years and has used that data to conduct a threat reduction assessment that measures program success based on the reduction of threats such as illegal egg harvest and habitat degradation (Trejo and Díaz 2012). I recommend that a similar assessment be conducted in Bahía de Jiquilisco to assess the threat reduction along nesting beaches as a means of evaluating success of the conservation program.

Currently, the hatcheries of our study region have already collected a wealth of data through the use of hatchery log books. These books keep track of all eggs that are delivered to the hatchery and every log book holds an enormous amount of data. In addition to a threat reduction assessment, I also recommend a thorough analysis of hatchery log book data to analyze both collection and nesting trends on the beaches of Bahía de Jiquilisco since the enactment of the nation-wide turtle egg ban.

Long-Term Financial Stability and Alternative Livelihood Options

Based on results from calculated *tortuguero* income and financial dependency variables, these communities are very dependent on the resource of sea turtle eggs. This population receives an average of half of their annual income from sea turtle egg collection. Although 96% of respondents reported that they would be willing to give up income to donate eggs, they do not have the means to do so long-term. Should funding become unavailable, this program is not financially sustainable. Even if hatcheries are willing to open and operate on a donation-only basis, other alternative income solutions need to be researched to supplement loss of income during times of financial hardship.

Alternative income solutions operate under the assumption that, should a more sustainable income solution be offered, the need and desire to exploit natural resources will be reduced and individuals will be more apt to choose the environmentally friendly option (Wright et al. 2015). When used for conservation, alternative income programs have been shown to be successful in some cases, however they can cause tension when income incentives are not evenly distributed amongst beneficiaries (Gjertsen and Niesten 2010). Alternative income programs have been used in Indonesia and Mexico to conserve sea turtles and marine mammals (Gjertsen and Niesten 2010). Great potential is seen when combined approaches are used, such as performance-based agreements that provide funding for alternative livelihood options and education (Gjertsen and Niesten 2010). A combined approach could be successful in Bahía de Jiquilisco, and the use of community funds in addition to direct incentive payments offer great promise.

The community funds do not always meet the specific needs of the communities of Bahía de Jiquilisco and therefore not all recipients of this incentive are in favor of the program. For example, respondents in some communities noted that, though their communities received items such as fishing boats or chicken coops, those purchases did not benefit them personally. In the literature, there is an evidence gap in the true success of alternative livelihood programs, so it should be stressed that should a program be implemented in this region, the planning process must involve all potential stakeholders. The program would also need to be very adaptive to meet the specific needs of each community, otherwise the costs would outweigh the benefits to many individuals. Alternative livelihood solutions often require long-term financing, which remains a challenge for most conservation interventions (Gjertsen and Niesten 2010). I recommend that additional research into increased alternative livelihood solutions such as ecotourism and nest monitoring positions is needed in this region to fully understand potential benefits.

Conclusions

Sea turtle conservation programs take many forms, and different nations and communities require unique solutions for the specific needs of both the turtle and human populations. Protecting sea turtles in rural and low-income areas such as Bahía de Jiquilisco is complex, and just as much a social justice concern as an ecological one. The egg collecting residents of this region have depended on sea turtles as an economic resource for generations, however a profound understanding and respect for the greater importance of the species is tangibly present within this population. While a great deal more research is needed to fully evaluate the complexity of sea turtle preservation in this region, I believe the insights and recommendations provided in this study have the potential to further improve the conservation program, the success of nesting sea turtles and the lives of local egg collectors.

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Appendices

Appendix 1: Questionnaire

1. How long have you been collecting sea turtle eggs?

    - If more than one year: _____years
    - If less than one year: _____ months

2. Can you identify specific species of turtles? YES NO

    If you answered YES, please move on to question 3. If you answered NO, please skip question 3 and move on to question 4.

3. If you can identify different species of turtles with confidence, what species of turtles did you collect eggs from this past nesting season? (Select all that apply)

    - ☐ Leatherback
    - ☐ Hawksbill
    - ☐ Olive Ridley
    - ☐ Green

4. How many nests did you collect eggs from this past nesting season?

    _____ turtles/nests

5. How many eggs did you collect this past nesting season?

    _____ eggs

6. What percentage of the eggs that you collected this past nesting season were donated or sold to a hatchery?

    _____ %

7. How much total income did you receive from turtle egg collection this past nesting season?

    $_____ (dollars)

8. Is collecting turtle eggs your primary source of income? YES NO

9. What are your other sources of income?

10. What percentage of your annual income comes from collecting turtle eggs?

_____ %

11. How do you feel about the conservation of marine turtles?

12. Why is the conservation of marine turtles important? (Select all that apply)

- ☐ Environmental conservation
- ☐ Protection of my livelihood
- ☐ Protecting the resource for future generations
- ☐ Other: _____

13. Are you aware of the activities of Association Mangle? YES NO

14. Have the activities of Mangle impacted how you feel about conservation?

YES NO

15. How?

16. On a scale of 1-5, how important is donating turtle eggs to you, with 1 being not important at all and 5 being very important? (Please circle a number)

1 2 3 4 5

Less important 17. Why? More important

18. Which of the following statements best describes how you feel about having to donate two turtle eggs per dozen?

a. I am happy to donate 2 eggs per dozen
b. I am not happy donating 2 eggs per dozen
c. I am indifferent

19. Which of the following statements best describes how you feel about the "noches de veda"?

a. I like the "noches de veda"
b. I do not like the noches de veda"
c. I am indifferent

20. Do you participate in the "noches de veda? YES NO

21. Why or why not?

22. Which of the following statements best describes how you feel about community fund?

    a. I like the community fund
    b. I don't like the community fund
    c. I am indifferent

23. Do you feel the community fund is beneficial to your community? YES NO

24. Why or why not?

25. Do you feel the community fund is beneficial to your cooperative group (if you are part of one)?

    YES NO

26. Why or why not?

27. If your local hatchery ran out of funds and was unable to pay you for your eggs, would you still donate them?

    YES NO

28. If you answered yes, why?

We would now like to know a few things about yourself. These questions are for research only. We are not associated with any institution (political, religious, etc.) other than Scripps Institution of Oceanography.

1. How old are you? _____ years old
2. What is your gender? (Please circle one) Male Female
3. How many children do you have? _____ children
4. What community do you live in? _____
5. What is your religious affiliation? _____
6. What is your political affiliation? _____
7. Are you a member of an egg collector cooperative? YES NO
8. Are you part of a social movement group (for example, Association Mangle)?
   YES NO