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**USAID REGIONAL PROGRAM FOR THE MANAGEMENT
OF AQUATIC RESOURCES AND ECONOMIC ALTERNATIVES**



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PROTECTION FINAL REPORT

DELIVERABLE 1.2

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EXECUTIVE SUMMARY

Hawksbill (*Eretmochelys imbricata*) turtles are on the brink of extinction in the eastern Pacific Ocean. Estero Padre Ramos in Nicaragua and Bahía Jiquilisco in El Salvador are the most important remaining nesting aggregations for the species, harboring more than 90% of the nesting by the species in entire eastern Pacific. ICAPO, with the support from USAID, conducted hawksbill turtle nest conservation and research activities at these two sites between the months of May and October, 2011. Local community members were hired as program staff and the successful collaboration of community members in locating hawksbill nests led to a nest protection rate of >85%.

A total of 250 hawksbill nests were documented by the program, leading to the production and release of 14,874 hawksbill hatchlings. Scientific research was carried out that will facilitate increased hatchlings success in future seasons and improve overall conservation efforts. Through the use of flipper tagging techniques, a total of 44 hawksbill turtles were tagged. Turtles ranged between 66cm and 95cm in length, had an average clutch size of 169 eggs and nested an average of 2.2 times during the season. These figures indicate an adult female hawksbill population size of approximately 114 turtles used the shorelines of Estero Padre Ramos and Bahía Jiquilisco for nesting during the 2011 season. The 2011 nesting totals were approximately 50% lower than totals recorded during 2010 at both sites, which is likely attributable to natural fluctuations in annual nesting rates due to the 2-3 year nesting cycle of hawksbills.

The critical nest protection and hatchling recruitment provided via ICAPO's efforts are the single most important conservation action on behalf of the species in the eastern Pacific. The ongoing realization of the program is fundamental to survival and recovery the population.

INTRODUCTION AND BACKGROUND

Hawksbill turtles (*Eretmochelys imbricata*) play a critical role in maintaining healthy coastal marine ecosystems around the globe. Nonetheless, populations have been reduced by more than 80%, threatening the future viability of the species and limiting their ability to serve their ecological function (Mortimer & Donnelly 2008). Nowhere is this more apparent than in the Eastern Pacific Ocean (EP), where hawksbills were once common from Mexico to Ecuador, but today are considered among the world's most endangered sea turtle populations (Wallace et al. 2011). Protection of hawksbills was recently cited as the most pressing sea turtle conservation issue in the EP; only 200-300 female hawksbills are estimated to nest along the entire region's coastline (Gaos et al., 2010). These low nesting numbers suggest that the species is unlikely to survive without coordinated conservation actions to protect eggs, increase hatchling production, generate biological information and conserve coastal marine ecosystems that serve as critical habitat for the species. Furthermore, to ensure long-term success of recovery efforts, conservation actions must be socially, financially and ecologically sustainable.

Before 2008 and the inception of the Eastern Pacific Hawksbill Initiative (ICAPO), encountering a hawksbill in the EP was a rare if not impossible occurrence. Conservation efforts and especially recovering the population, was beyond the imagination of even the most optimistic researcher. In 2008, ICAPO pioneered activities to seek out information on the species, leading to discovery of several key nesting and foraging sites. These findings completely changed the conservation outlook for hawksbills in the EP and provided hope for recovery. Since the initial discoveries, ICAPO has established numerous local conservation projects, consolidated an important body of scientific literature, and brought EP hawksbill turtles to the forefront of the global marine turtle conservation agenda. ICAPO is now a strong, diverse network of individuals and organizations that work to protect and recover hawksbill turtles and their habitat in countries throughout the EP through close collaborations with coastal community members, private interest holders, scientists, management authorities and policy makers.

ICAPO identified Bahía Jiquilisco in El Salvador and Estero Padre Ramos in Nicaragua, as the two most important hawksbill nesting areas in the EP (Figure 1). Located at the mouth of the Gulf of Fonseca (GOF), together these sites host approximately 90% of the known hawksbill nesting in the entire EP. ICAPO partnered with local community members to establish research and conservation programs at Bahía Jiquilisco and Estero Padre Ramos in 2008 and 2010, respectively. With key support from USAID's Regional Program, ICAPO solidified and expanded the reach of these programs during 2011. By working directly with the traditional egg 'poachers' to find, collect and protect hawksbill eggs, we provided critical recruitment of the species while also supporting impoverished members of local communities that often have limited employment options to provide for themselves and their families. By working in close collaboration with members of local community groups, fishing cooperatives, non-governmental organizations (NGOs) and government agencies, we optimized conservation activities and advanced conservation efforts towards long-term sustainability. This report summarizes conservation activities and data collected through ICAPO's program in Bahía and Padre Ramos, during the 2011 nesting season.

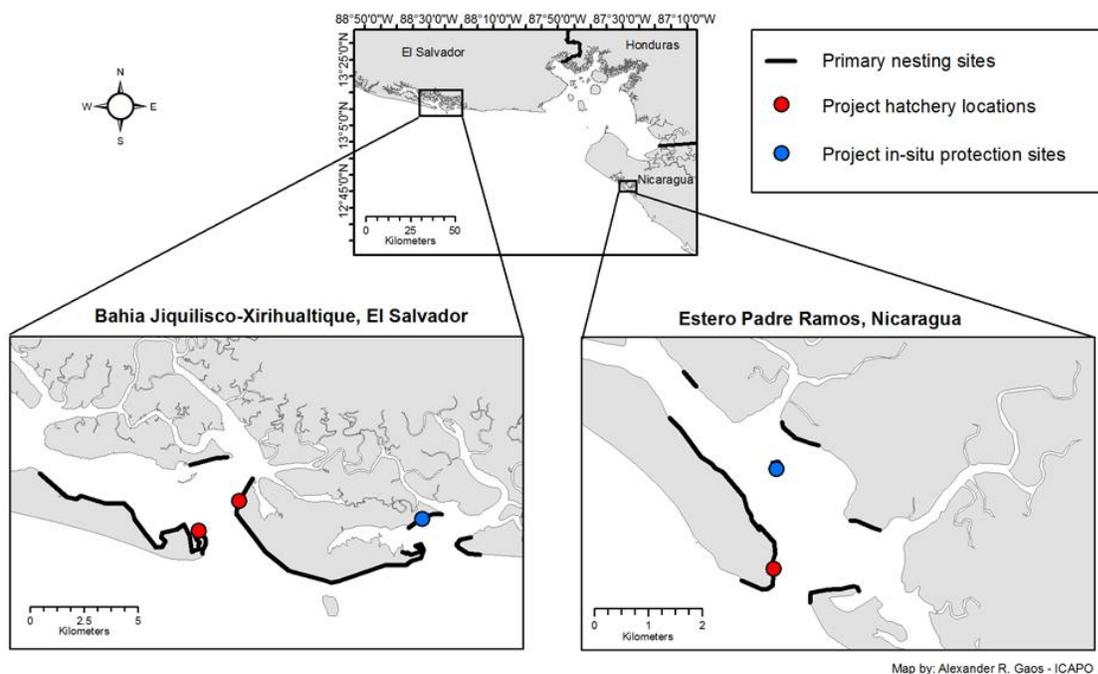


Figure 1. ICAPO's hawksbill nest conservation program located in the Gulf of Fonseca.

OBJECTIVES

1.1. Overall objective:

- Carry out hawksbill research and conservation in the Bahía Jiquilisco Biosphere Reserve and the Estero Padre Ramos Natural Reserve to promote the recovery of hawksbill turtles in the eastern Pacific Ocean.

1.2. Specific objectives:

- Generate information on the hawksbill population size and status at Bahía and Padre Ramos.
- Protect nesting females and their nests in the program areas via standardized procedures.
- Maximize hatching success and hawksbill hatchling recruitment.
- Assist national and international efforts to reduce marine turtle mortality.
- Improve our scientific understanding of hawksbill biology and ecology to improve protected area management at these sites.
- Improve economic conditions and generate income for local community members.
- Work with key national stakeholders (community members and local organizations) to develop effective management and conservation strategies.
- Highlight the international importance of Bahía Jiquilisco and Estero Padre Ramos for the survival of hawksbills in the EP.

METHODOLOGY

From May – October, 2011, project personnel and an extensive network of local egg collectors patrolled the beaches at Estero Padre Ramos and Bahía Jiquilisco each night from 6:00 pm to 6:00 am in search of nesting hawksbills. For all hawksbills encountered, data was collected on morphometrics and flipper tags were applied following established protocols. Physical data at time of nesting were documented.

Hatcheries were constructed and operated between May and November, 2011, on the primary hawksbill nesting beaches at each site to incubate hawksbill eggs and ensure maximum hatchling recruitment. Due to the disperse (e.g. 1 nest per 2 km) and low density (e.g. 1-5 nests per night) nesting characteristics exhibited by hawksbills, field technicians worked in partnership with local egg collectors to encounter all nests.

Since 1970's, high population density and acute poverty have evoked the use of hatcheries as the primary method used to protect sea turtle nests along the Salvadoran and Nicaraguan coasts. By purchasing eggs from local egg collectors, hatcheries provide an alternate economic incentive to sale for consumption and thus have gained acceptance among coastal communities; eggs not purchased by hatcheries are sold for consumption.

During the 2011 program timeframe ICAPO continued to operate a local incentive program, established in previous seasons, that ensured local participation in and economic benefits from hawksbill research and conservation efforts. Incentives were provided in three forms. Individuals were first provided an incentive for collecting, transporting and protecting eggs in project hatcheries. In order to tag and collect biological information on the maximum number of adult nesting turtles, an additional incentive was provided for locals that ensured program staff encountered hawksbills. Lastly, to promote the careful handling of eggs during transport and reburial, as well as ongoing program engagement, a second incentive was given for each hatchling that emerged from the nest. This approach continued to prove highly successful, leading to a nest protection rate >85% at both sites. The incentive program was also financially feasible when compared to directly hiring sufficient personnel to achieve similar conservation results. Furthermore, this approach empowered local ownership of the project and enhanced community involvement and support. Incentives were paid via a bond system routed through local markets (pulperias) located in key local communities. In this way the program also built alliances with small businesses and made incentives easily accessible to local participants, which is necessary for the bond system to work.

Approximately 90% of all hawksbill nests encountered were relocated to project hatcheries, while the remaining 10% were protected *in-situ*, the latter as a means to evaluate hatching success under natural conditions. Two rotating local hatchery and *in-situ* site managers provided 24-hour vigilance of nests and were responsible for: burying all eggs attained by the projects; conducting post-hatching nest excavations; and recording data such as hatching success rates, embryonic development of failed eggs, and number of hatchlings released. Managers also monitored hatchery temperatures and

ensured release of hatchlings at different locations along the beach, the latter to avoid the establishment of predator ‘feeding stations’.

RESULTS AND DISCUSSION

Beach Monitoring and Nesting Levels

Period: May – October 2011

Staff and roles

A total of 11 and 9 program staff managed the activities in Bahía Jiquilisco and Estero Padre Ramos, respectively. These included one local project coordinator, one biologist and nine field technicians in the former and one local project coordinator, one biologist and seven field technicians in the latter. Working roles for field technicians included beach patrollers, hatchery managers, and in-situ protection site management. At both sites the working roles of the field technicians rotated to guarantee sharing of responsibilities and capacity building within each of the different program phases.

Beach patrols and nesting levels

Estero Padre Ramos Natural Reserve, Nicaragua -

Nightly beach patrols to document hawksbill nesting and protect nests at Estero Padre Ramos in Nicaragua, were conducted between 07 May and 15 October, 2011, for a total of 154 patrol days (Table 3). These night patrols included shifts from 18:00-23:00 and from 23:00-04:00. Boat patrols starting at 05:30 were also conducted on a daily basis to visit all nesting areas within the estuary and collect any nests that had been missed during night patrols. As nesting dropped off significantly towards the end of the season and as a result, beginning on 10 September 2011 nightly patrols were reduced to one shift at daybreak.

A large hatchery measuring 10m x 18m, with a capacity to protect 360 nests, was constructed prior to the start of the season. The hatchery was located on the Venecia Peninsula (Figure 1), approximately 200 meters from the location used in 2010. La Tigra island was used as a refuge to house and protect all in-situ nests (Figure 1). Nest protection, including hatchery and in-situ site management, continued until the end of October 2011, by which time all nests had hatched.

A total of 150 successful hawksbill nesting events were recorded at Estero Padre Ramos during the 2011 season, with 4 (2.7%) occurring in April, 21 (14.0%) in May, 54 (36.0%) in June, 55 (36.6%) in July, 14 (9.3%) in August and 2 (1.3%) in September (Table 1). Of the total 150 nesting events, 105 (70.0%) occurred on Venecia, 16 (10.7%) on La Tigra, 9 (6.0%) on Padre Ramos, 7 (4.7%) on El Almendro, 7 (4.7%) on El Tintal, 3 (2.0%) on Los Zorros, 2 (1.3%) on La Muerta and 1 (0.7%) on La Palma (Figure 2).

Estero Padre Ramos	
Month	Nesting events
April	4
May	21
June	54
July	55
August	14
September	2

Table . Hawksbill nesting by month at Estero Padre Ramos, Nicaragua

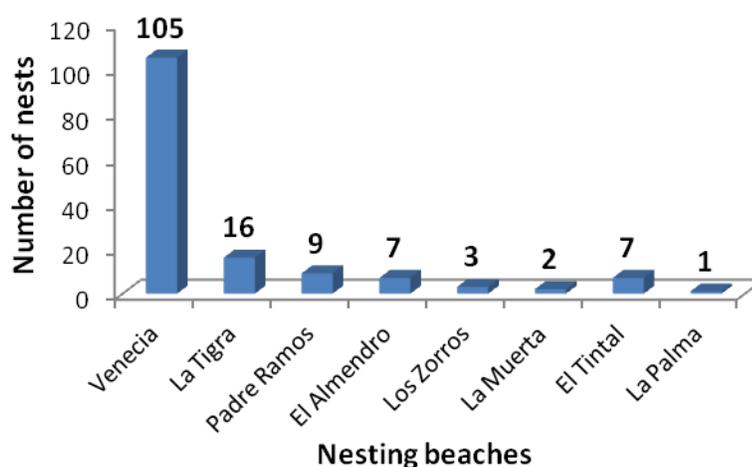


Figure 2. Hawksbill nests by beach within Estero Padre Ramos Natural Reserve, Nicaragua.

Bahía Jiquilisco Biosphere Reserve, El Salvador -

Nightly beach patrols to document hawksbill nesting and protect nests at Bahía Jiquilisco in El Salvador, were conducted between 21 May and 31 October, 2011, for a total of 163 patrol days (Table 3). These night patrols included shifts from 18:00-23:00 and from 23:00-04:00. As nesting dropped significantly towards the end of the season, beginning on 15 August 2011 nightly patrols were reduced to one shift at daybreak.

Two large hatcheries measuring 10m x 10m, with a capacity of 200 nests each, were constructed prior to the start of the season. The hatcheries were located on the San Juan del Gozo Peninsula at Punta San Juan and on the outskirts of the community of La Pirraya on Isla San Sebastian (Figure 1). The former hatchery was relocated more than one km from the site used last season toward the mouth of the estuary in an effort to improve hatching success, and the latter located approximately 5 meters from the site used the previous season. Las Isletas beach served as a refuge to house and protect all in-situ nests and nests relocated from nearby beaches (Figure 1). Nest protection, including hatchery and in-situ site management, continued until the end of October 2011, by which time all nests had hatched.

A total of 100 successful hawksbill nesting events were recorded at Bahía Jiquilisco during the 2011 season, with 3 (3.2%) occurring in April, 13 (14.1%) in May, 53 (57.6%) in June, 25 (27.2%) in July and 6 (6.5%) in August (Table 2). Of the total 100 nesting events, 61 (61.0%) occurred on Punta San Juan, 16 (16.0%) on Isla Madresal, 1 (1.0%) on Isla Pajarito, 2 (2.0%) on Las Isletas, 8 (8.0%) on El Casco, 7 (7.0%) on El Bajon and 5 (5.0%) on La Pirraya (Figure 3).

Bahia Jiquilisco	
Month	Nesting events
April	3
May	13
June	53
July	25
August	6
September	0

Table 2. Hawksbill nesting by month at Bahía Jiquilisco, El Salvador.

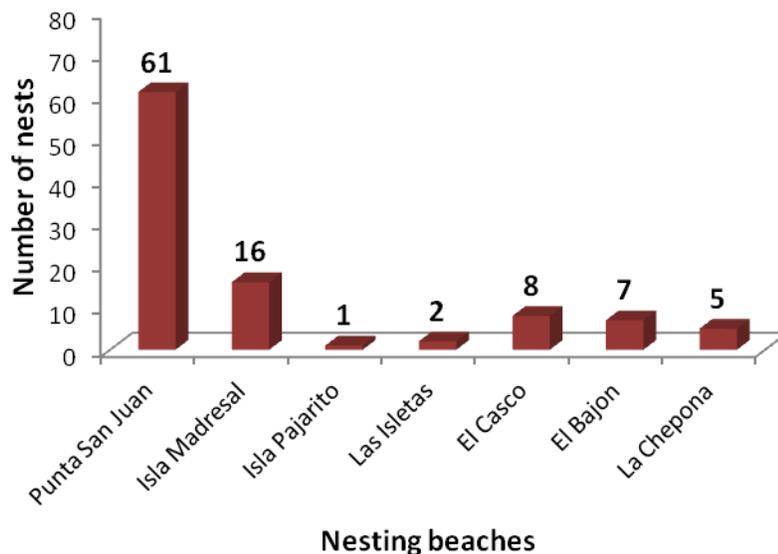


Figure 3. Hawksbill nests by beach within Bahía Jiquilisco, El Salvador.

Combined Totals -

Hawksbill monitoring was carried out for a combined total of 317 patrol days at Padre Ramos and the Bahía (Table 3). During that time, a total of 250 successful hawksbill nesting events were recorded, with 150 (60.0%) occurring at Padre Ramos and 100 (40.0%) at the Bahía (Figure 4). Of the 250 successful nesting events, 7 (2.8%) occurred in April, 34 (13.6%) in May, 107 (42.8%) in June, 80 (32.0%) in July, 20 (8.0%) in August, and 2 (0.8%) in September (Figure 5). The greatest number of nests were recorded in June (107) and July (80), respectively, representing the peak of the hawksbill nesting season in the GOF.

Table 3. Beach monitoring effort (days) at Bahía Jiquilisco and Estero Padre Ramos during the 2011 season.

Month	Monitoring Days		
	Bahia Jiquilisco	Estero Padre Ramos	Total
May	10	17	27
June	30	30	60
July	31	31	62
August	31	31	62
September	30	30	60
October	31	15	46
Total	163	154	317

The nesting levels at both Padre Ramos and Bahía were considerably lower than those documented during the previous season. A total of 250 nests were recorded during the 2011 season, compared to 454 in 2010 (Figure 6). It is also important to note that the hawksbill conservation program in the Bahía began late in 2010 and locals reported that numerous additional nests were laid prior to the start of conservation efforts. Hawksbills nest on 2-3 year cycles and the fact that substantially fewer nests were documented in 2011 likely represents a natural fluctuation in the nesting cycle. Nonetheless, considering these areas host more than 90% of the hawksbill nesting known to occur in the entire eastern Pacific, the 2011 results highlight the low population numbers and the precarious state of hawksbill turtles in the region.

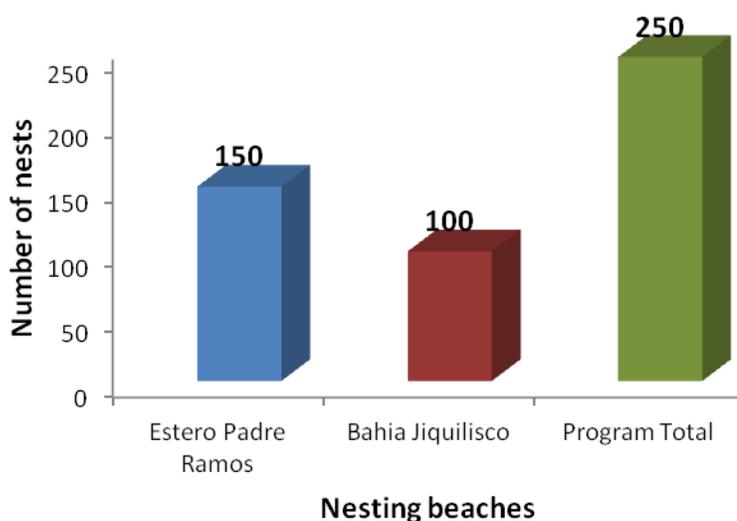


Figure 4. Comparison of hawksbill nests at Estero Padre Ramos, Bahía Jiquilisco and combined totals.

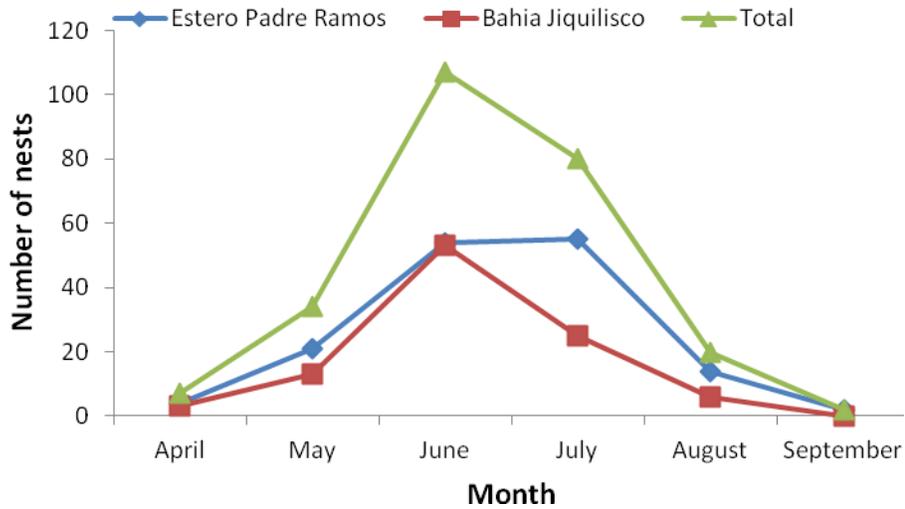


Figure 5. Comparison of hawksbill nests by month at Estero Padre Ramos, Bahía Jiquilisco and combined totals.

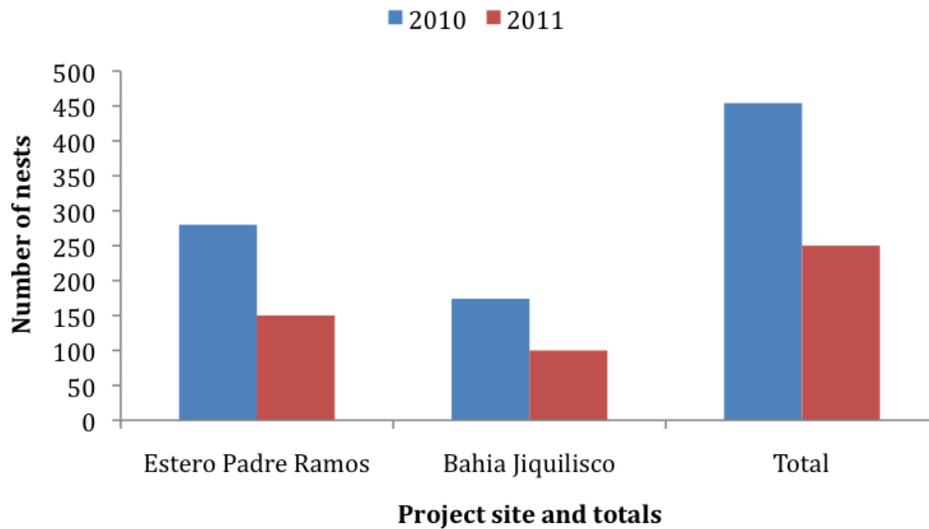


Figure 5. Comparison of hawksbill nesting during the 2010 and 2011 seasons at Estero Padre Ramos, Bahía Jiquilisco and combined totals.

Number of Nests, Eggs and Hatchlings

Period: May – October 2011

Estero Padre Ramos Natural Reserve, Nicaragua -

We established one hatchery and one in-situ nest protection site in Estero Padre Ramos. Of the 150 nests recorded at the site, 21 (13.8%) were poached, 24 (15.8%) were protected in-situ (i.e. natural environment), and 107 (70.4%) were protected in the program hatchery (Figure 7). It is important to note that 11 of the 21 poached nests were poached prior to the start of conservation efforts (i.e. prior to 07 May 2011). Further discussion on egg poaching is provided in the “Combined Totals” section below.

The 129 nests protected in the project hatchery and in-situ represent a total of 19,145 eggs and resulted in the production of a total of 11,489 hatchlings, for an overall hatching success rate of 60.0% (Table 4). The 107 nests protected in the project hatchery represent a total of 10,172 hatchlings, with a hatching success rate of 62.0%, while the 22 nests protected in-situ represent a total of 1,317 hatchlings, with a hatching success rate of 47.9%. The hatching success achieved is slightly higher than that attained during the previous 2010 season (57.3%). Further discussion on hatching success is provided in the “Combined Totals” section below. Of the 11,489 hatchlings that were released, 820 (7.1%) hatched in July, 2,577 (22.4%) in August, 6024 (52.4%) in September and 2,068 (18.0%) in October. Hawksbill eggs require approximately 60 days to develop and hatch and because the majority of nests were deposited in July, September was the peak month for hatchling production.

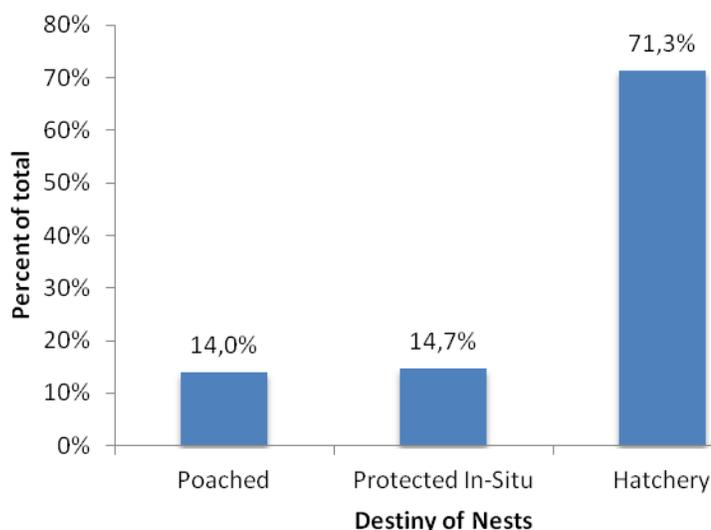


Figure 7. Percentage of nests poached, protected in-situ or relocated to the project hatchery in Estero Padre Ramos, Nicaragua.

	Estero Padre Ramos		
	Hatchery	In-situ	Total
Nests	107	22	129
Eggs	16396	2749	19145
Hatchlings	10172	1317	11489
Hatching success	62.0%	47.9%	60.0%

Table 4. Nests, eggs, hatchlings and hatching success rates for hatchery and in-situ protection sites in Estero Padre Ramos, Nicaragua.

Bahía Jiquilisco Biosphere Reserve, El Salvador -

Two hatcheries and one in-situ nest protection site were established in Bahía Jiquilisco. Of the 100 nests recorded in Bahía Jiquilisco, 15 (15.0%) were poached, 20 (20.0%) were protected in-situ (i.e. natural environment), and 65 (65.0%) were protected in the project hatcheries (Figure 8). It is important to note that 8 of the 15 poached nests were poached prior to the start of conservation efforts (i.e. prior to 21 May 2011). Further discussion on egg poaching is provided in the “Combined Totals” section below.

The 85 nests protected in the project hatcheries and in-situ represent a total of 15,278 eggs and resulted in the production of 3,385 hatchlings, for an overall hatching success of 22.2% (Table 5). Nests protected in the project in-situ had a slightly higher hatching success than those protected in hatcheries, with 25.7% and 21.0%, respectively. The relatively low hatching success rates in the program hatcheries were largely due to the results of the hatchery in Punta San Juan, which was relocated to a new site at the start of the season. Unfortunately, a site that was chosen that overly exposed to the sun and a spike in temperatures in the second month of the program rendered the majority of nests/eggs unviable. If we consider only the hatchery in La Pirraya, hatching success was a respectable 52.1%, a rate higher than that achieved in-situ. A new site has already been selected for the 2012 season that will provide abundant shade and more closely reflect natural hawksbill nesting habitat in an effort to improve hatching rates during the upcoming season. Further discussion on hatching success is provided in the “Combined Totals” section below. Of the 3,385 hatchlings that were released, 484 (13.7%) hatched in July, 2,265 (66.9%) in August, 404 (11.9%) in September and 252 (7.4%) in October. Because hawksbill eggs require approximately 60 days to develop and hatch and because the majority of nests were deposited in July, we would expect September to be the peak month for hatchling production. Nonetheless, the majority of nests in the La Pirraya hatchery were collected early in the season and thus nests hatched in July, while the high temperatures mentioned previously caused fatalities and reduced hatching during August and September.

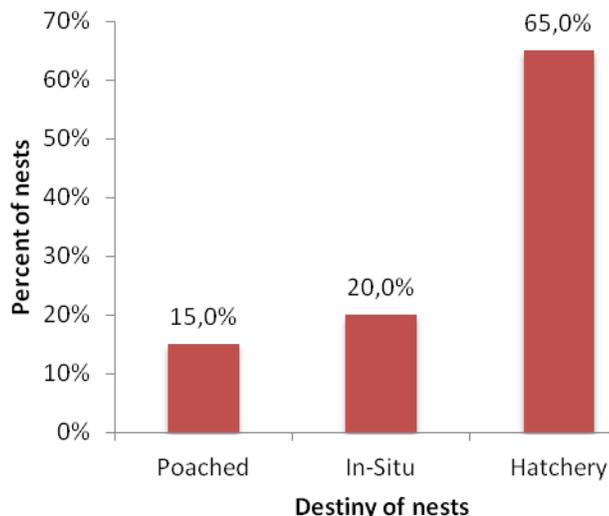


Figure 8. Percentage of nests poached, protected in-situ or relocated to the project hatchery in Bahía Jiquilisco, El Salvador.

	Bahia Jiquilisco		
	Hatchery	In-situ	Total
Nests	65	20	85
Eggs	11570	3708	15278
Hatchlings	2431	954	3385
Hatching success	21.0%	25.7%	22.2%

Table 5. Nests, eggs, hatchlings and hatching success rates for hatchery and in-situ protection sites in Bahía Jiquilisco, El Salvador.

Combined Totals-

A total of three hatcheries and two in-situ nest protection sites were established in Estero Padre Ramos and Bahía Jiquilisco. Of the 250 nests recorded, 36 (14.4%) were poached 42 (16.8%) were protected in-situ (i.e. natural environment) and 172 (68.8%) were protected in project hatcheries (Figure 9). If we consider strictly protection rates, 214 (85.6%) were protected and only 36 (14.4%) were poached (Figure 10). Prior to the establishment of hawksbill conservation programs in Estero Padre Ramos and Bahía

Jiquilisco, 100% of the nests laid were collected for consumption or sale. A combined nest protection rate of >85% at both program sites is a phenomenal achievement.

Poaching of eggs occurred in the past (and continues today at low levels) primarily due to high levels of poverty in the program areas, largely the result of few employment options and low levels of pay in these regions. A hawksbill nest can typically fetch between \$20 and \$30 on the black market, a sum of money equivalent to several days of work, thus nests represent an invaluable source of income to many community members, the majority of whom are trying to meet the basic necessities to their families. Without sufficient incentives and employment alternatives, egg poaching will continue indefinitely. The Program has achieved considerable success in this respect, providing direct employment to numerous local community members –many former egg poachers turned conservationists - and economic incentives to traditional egg collectors throughout the program region, allowing them to work for conservation. This approach has fueled unprecedented local support of the program, as evidenced by the high protection rates and strong community involvement at both Estero Padre Ramos and Jiquilisco.

The 214 nests protected in program hatcheries and in-situ represent a total of 34,423 eggs, resulting in the production of a total of 14,874 hatchlings, for an overall hatching success of 43.2% (Table 6). Of particular importance is that nests protected in the project hatcheries had a higher hatching success than those protected in-situ. This indicates that nest management and manipulation by program staff is not the cause of a somewhat low hatching success. The relatively low natural in-situ hatching success rates indicate that hatching success is likely due to either biological factors (e.g. low fecundity, lack of genetic diversity, etc.) of the species or physical factors at the nesting sites (e.g. gas exchange, tidal inundation, etc.). An in-depth hatching success study will be conducted during 2012 in an effort to better understand the factors affecting hatching success at both Estero Padre Ramos and Bahía Jiquilisco.

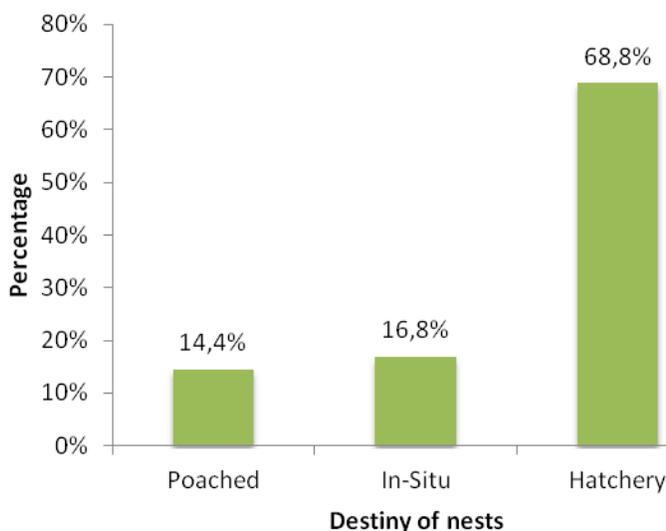


Figure 9. Combined percentages of nests poached, protected in-situ or relocated to project hatcheries at Estero Padre Ramos and Bahía Jiquilisco.

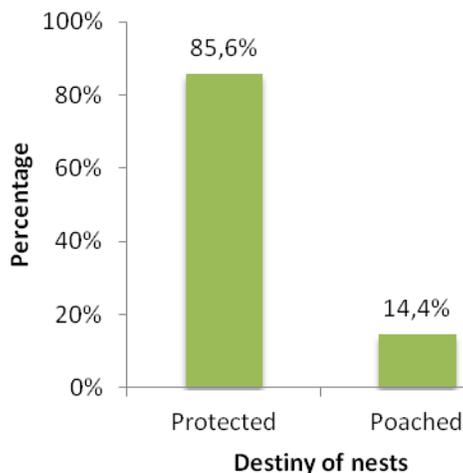


Figure 10. Combined percentages of nests protected and poached at Estero Padre Ramos and Bahía Jiquilisco.

	Combined Totals		
	Hatchery	In-situ	Total
Nests	172	42	214
Eggs	27966	6457	34423
Hatchlings	12603	2271	14874
Hatching success	45.1%	35.2%	43.2%

Table 6. Combined nests, eggs, hatchlings and hatching success rates for hatchery and in-situ protection sites in Estero Padre Ramos and Bahía Jiquilisco.

Data on Nesting Females

Turtle tagging, re-nesting and clutch frequency

A total of 32 individual hawksbill turtles were observed and tagged while nesting in Padre Ramos, while an additional 12 turtles were observed and tagged at Bahía Jiquilisco, for a grand total of 44 tagged turtles. All turtles were tagged with Inconel tags, while 30 turtles in Estero Padre Ramos and 12 turtles in Bahía Jiquilisco were also equipped with PIT (Passive Integrative Transponder) tags to increase likelihood of tag retention over time.

All tagging and observations in Estero Padre Ramos were of turtles that had never been tagged before, with none of the individuals recorded re-nesting from the previous 2010 season. Similarly in Bahía Jiquilisco, nearly all turtles were individuals that had never been tagged before. This is not particularly surprising as hawksbills typically nest on 2-3 year cycles in other regions of the world. It is important to note that 2011 represents the

first season that a specific effort was made to tag nesting female turtles at Jiquilisco, as previous years of the program focused solely on egg protection. Despite this fact, one and two turtles that were originally tagged in 2009 and 2010, respectively, as part of a pilot tagging effort in Bahía Jiquilisco were documented re-nesting in 2011, providing evidence for a 2-3 year nesting cycle for hawksbills in the program sites. Considering these findings to date, it is expected that turtles originally tagged during the 2010 season, the first year of monitoring in Estero Padre Ramos, to begin returning during the upcoming 2012 season, while those tagged during the 2011 season at both sites to begin re-nesting in 2013.

While hawksbills appear to nest on a bi-annual basis in the program sites, intra-seasonal re-nesting occurs frequently. Via the tagging program it was possible to confirm that while the majority of hawksbills were observed laying only one nest, several individuals were documented nesting several times per season, with an average of 2.2 clutches per female (max = 5 nests) (Figure 11). These figures indicate an adult female hawksbill population size of approximately 114 turtles used the shorelines of Estero Padre Ramos and Bahía Jiquilisco for nesting during the 2011 season

As indicated in Figure 14, the majority of turtles observed during the first months (May and June) of the nesting season were new recruits, while those same turtles were re-observed nesting during the latter half of the season (July and August) (Figure 12). The observed re-nesting interval for nesting hawksbills turtles varied between 13 and 30 days at both sites. The majority of tagged hawksbills were re-observed after a period of 17 days. The turtles that re-nesting at intervals greater than 17 days had likely nested prior to the second nesting event, but went unobserved.

Indeed, not all nesting hawksbills are observed and tagged at the program sites (55.3% in Estero Padre Ramos and 12.4% in Bahía Jiquilisco). Hawksbills nest on small sections of beach dispersed throughout the estuaries in both Bahía Jiquilisco and Estero Padre Ramos, often in intervals of less than one hour, making it difficult to encounter female turtles while in the process of nesting. While specific efforts will be made to increase the percentage of turtles observed and tagged in 2012, particularly at Bahía Jiquilisco, it will likely take several seasons to achieve tagging saturation at these sites. Nonetheless, once achieved the program will have the capacity to provide increasingly accurate information on inter and intra-seasonal nesting intervals, clutches frequency and total nesting population size at both Estero Padre Ramos and Bahía Jiquilisco.

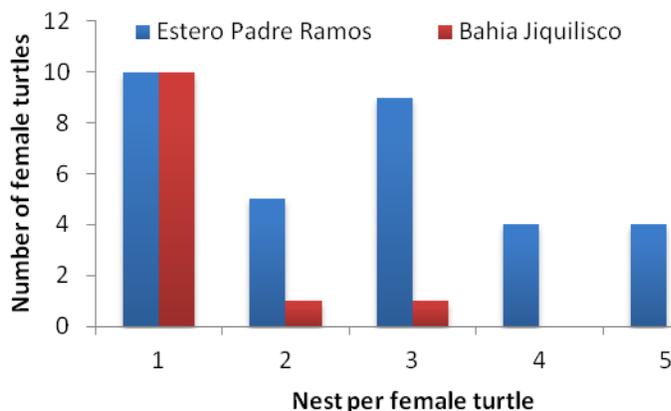


Figure 11. Number of clutches laid per individual hawksbill at Estero Padre Ramos and Bahía Jiquilisco

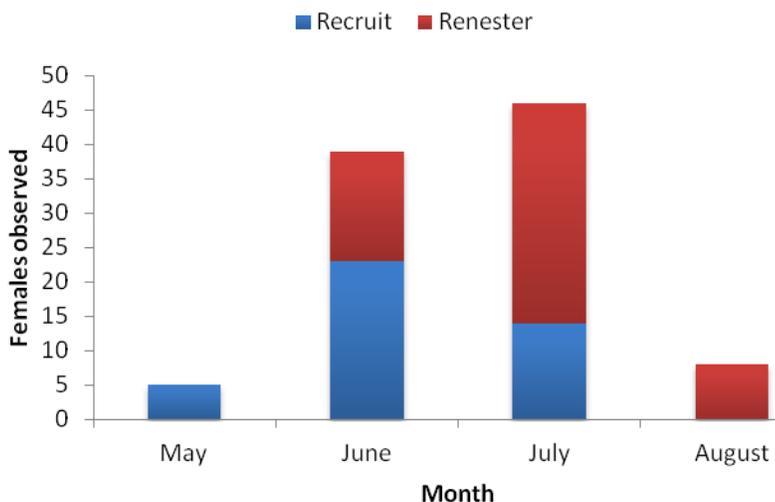


Figure 12. Total female hawksbill recruits and re-nesters by month at Estero Padre Ramos and Bahía Jiquilisco.

The nesting hawksbills in Bahía Jiquilisco tended to be larger than those nesting in Estero Padre Ramos during the 2011 season, with the largest percentage having a Curved Carapace Length (CCL) of 76-80cm in the former and 81-85cm in the latter (Figure 13). Turtles in Bahía Jiquilisco also laid larger average size clutches than those in Estero Padre Ramos, with 179.7 and 148.4 eggs per clutch, respectively (Table 7). However, the difference in CCL and clutch size may be an artifact of small sample size in Bahía Jiquilisco. Nevertheless, the correlation between these two parameters suggests that larger turtles lay larger clutches of eggs.

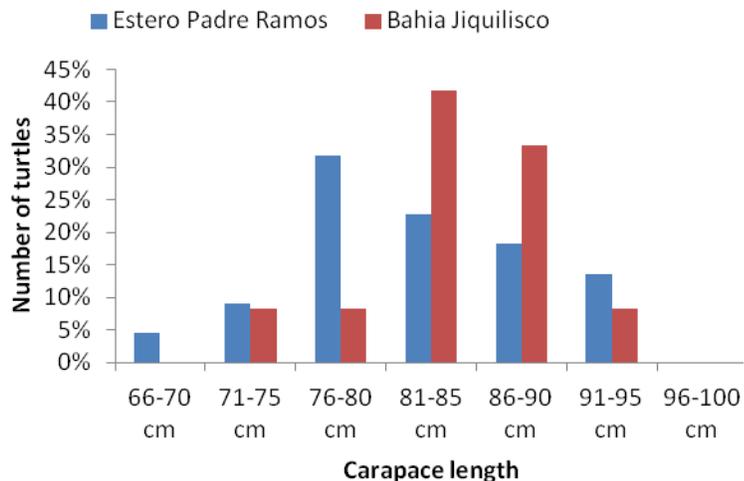


Figure 13. Size distribution of nesting turtles in Estero Padre Ramos and Bahía Jiquilisco.

Site	Nests	Eggs	Average Clutch Size
Estero Padre Ramos	129	19,145	148.4
Bahía Jiquilisco	85	15,278	179.7

Table 7. Nests, eggs and average clutch size for turtles at Estero Padre Ramos and Bahía Jiquilisco.

Throughout the season data was collected on the vegetation present in the areas of nest deposition. The overwhelming majority of nests (99.2%) were laid under vegetation, while almost no nests (0.8%) were deposited on the open berm (i.e. sand with no vegetation (Table 8). In contrast to other sea turtle species such as the olive ridley (*Lepidochelys olivacea*), which almost always nest on the berm of the beach with full exposure to the sun, hawksbills are known to often nest under vegetation in other parts of the world. Nonetheless, the extent of use of nesting sites located under vegetation documented via this study underscore the importance of maintaining intact vegetation at both Estero Padre Ramos and Bahía Jiquilisco. Unfortunately, the mangrove and native vegetation stands along several sections of shoreline at both sites have been removed or degraded over the years and activities detrimental to these habitats continue to take place. Considering the importance of vegetation for hawksbill nesting it is imperative that these shorelines are fully protected and that efforts are initiated to restore coastal vegetation in degraded areas.

Habitat	Estero Padre Ramos	Bahia Jiquilisco	Average
Vegetation	98.4%	100.0%	99.2%
No vegetation	1.6%	0.0%	0.8%

Table 8. Location of hawksbill nests in relation to coastal vegetation in Estero Padre Ramos and Bahía Jiquilisco.

Employment, incentive program and local economic benefits

Via direct employment and conservation incentives, the hawksbill program represents a critical employment opportunity and source of income for numerous locals in the impoverished coastal communities surrounding the program sites.

Estero Padre Ramos Natural Reserve, Nicaragua.-

Nine local program staff members were hired to manage all on-site research and conservation activities in Estero Padre Ramos (Annex 1). These jobs generated a total of \$9,825 for local program staff. A total of 43 locals participated in the incentive program at Estero Padre Ramos, generating a total of \$2,870 (Annex 2). Combined, a total of \$12,695 was generated for community members in Estero Padre Ramos via direct employment and the incentive program (Table 9).

Bahía Jiquilisco Biosphere Reserve, El Salvador -

Eight local program staff members were hired to manage all on-site research and conservation activities in Bahía Jiquilisco (Annex 3), generating a total of \$6,650 in salaries. A total of 36 locals participated in the incentive program, generating a total of \$2,956 (Annex 4). Combined, a total of \$9,606 was generated for community members in Bahía Jiquilisco via direct employment and the incentive program (Table 9).

Combined totals -

A combined total of 17 local program staff members were hired to manage all on-site research and conservation activities via the hawksbill program, generating a total of \$16,475 for local program staff. A total of 79 locals participated in the incentive program, generating a total of \$5,826. Combined, a total of \$22,301 was generated for community members via direct employment and incentives associated with the hawksbill conservation program (Table 9).

Site	Employment		Incentives		Total \$ generated
	# Staff	\$ Generated	# Beneficiaries	\$ Generated	
Estero Padre Ramos	9	\$9,825	43	\$2,870	\$12,695
Bahía Jiquilisco	7	\$6,650	36	\$2,956	\$9,606
TOTAL	16	\$16,475	79	\$5,826	\$22,301

Table 9. Number of local staff and salaries, as well as the number of participants with the incentive program and the amount of funds generated in Estero Padre Ramos, Bahía Jiquilisco and combined totals.

CONCLUSIONS AND RECOMMENDATIONS

Considering the data collected during the first years of ICAPO's hawksbill conservation programs in Estero Padre Ramos and Bahía Jiquilisco, these areas represent the first and second most important hawksbill nesting sites, respectively, in the entire eastern Pacific.

Hawksbill nesting in 2011 was approximately 50% lower than levels recorded for 2010. This is likely attributable to natural fluctuations in annual nesting rates due to the 2-3 year nesting cycle of hawksbills. Despite this fact, a total of 250 nests were documented at the two sites, representing >95% of the hawksbill nesting documented in the eastern Pacific during 2011.

Using data from 2010 and 2011, a rough estimation of the female hawksbill population present in Estero Padre Ramos and Bahía Jiquilisco for these two years can be made of approximately 292 individual turtles. These totals are less than those reported annually at each of several small islands around the Caribbean, demonstrating the precarious state of the population in the eastern Pacific and highlighting the importance of conservation efforts in the region.

Compared to previous years, in 2011 hawksbill nesting began earlier in the season at both Estero Padre Ramos and Bahía Jiquilisco. The causes of this behavior remain unclear, but could include factors such as large-scale environmental changes or particular behavioral characteristics of the 2011 nesting assemblage.

Coastal vegetation within the first 50 meters of the shoreline is fundamental for hawksbill nesting in Estero Padre Ramos and Bahía Jiquilisco. It is crucial that measures be taken to protect intact areas and to reforest shorelines that have been degraded. Locals reported that hawksbills previously nested along several coastal areas where they no longer do as a result of their present condition. Initial reforestation efforts should focus on these sites.

The hatchery in Punta San Juan, Bahía Jiquilisco, had extremely low hatching success due to its location during the 2011 season. A new location has been identified and will be utilized in the 2012 season to maximize hatching success. Nonetheless, when considering even natural hatching success rates, those demonstrated by hawksbills at both Estero Padre Ramos and Bahía Jiquilisco are lower than rates for the species in other parts of the world. It remains unclear whether it will be possible to improve hatching success to the degree seen in other ocean basins, or whether there is some biotic or abiotic limitation to doing so in the eastern Pacific.

ICAPO's efforts have brought extensive socio-economic and natural resource benefits to both Estero Padre Ramos and Bahía Jiquilisco. The incentive program has been extremely effective in garnering local support and achieving high protection rates. It is also economically viable, particularly when compared to the costs that would be required to employ alternative conservation measures to achieve the same results, such as the hiring of sufficient protected area personnel (i.e. rangers, wardens, etc.) to patrol and control these areas, which would likely generate conflict and discourage local

participation in program activities. Considering its effectiveness and economic viability, the continued use of the incentive program is essential and highly recommended.

Hawksbill nest protection rates have been >85% across all years, demonstrating the effectiveness of ICAPO's conservation program, as well as the strong buy-in from local community members. These efforts have led to a release of approximately 15,000 hatchlings during the 2011 season and approximately 50,000 over the program's lifetime. The ongoing implementation of the program will be fundamental to the survival and recovery of hawksbill turtles in the eastern Pacific.

Annex 4. Program photos



Photo 1. Program staff at the project hatchery in Venecia Peninsula, Estero Padre Ramos, Nicaragua.



Photo 2. Program staff at the project hatchery in La Pirrarya, Bahía Jiquilisco, El Salvador



Photo 3. Hawksbill laying a clutch of eggs at Estero Padre Ramos, Nicaragua.



Photo 4. Local program staff with a nesting hawksbill encountered during night patrols at Bahía Jiquilisco, El Salvador.



Photo 5. Participant of the community egg incentive program in Estero Padre Ramos, Nicaragua.



Photo 6. Local program staff preparing a nest chamber prior to depositing eggs in Bahía Jiquilisco, El Salvador.



Photo 7. Recently hatched hawkbill turtle prior to release in Bahía Jiquilisco, El Salvador.



Photo 8. Hatchlings making their way to sea shortly after hatching at Estero Padre Ramos, Nicaragua.