

Marine Turtle Newsletter

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Stranded olive ridley sea turtle found on Boavista Island, Cape Verde Archipelago; see pages 25-26 (photo: D. Cejudo).

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Reports

Green Turtle (*Chelonia mydas*) Mortality in the Galápagos Islands, Ecuador During the 2009 – 2010 Nesting Season

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Four sea turtle species, *Chelonia mydas*, *Dermochelys coriacea*, *Eretmochelys imbricata*, and *Lepidochelys olivacea*, are found in the Galápagos Biological Reserve of Marine Resources (GMR) (Green & Ortiz-Crespo 1981; Hurtado 1984; Pritchard 1971; Seminoff 2004). However, *C. mydas* is the only species that occurs in high numbers and is known to routinely nest in the archipelago, with an estimated 1,800 nesting events from two monitored beaches in 2008 (Zárate 2009a). *Chelonia mydas*, like all species of sea turtles, are susceptible to morbidity and mortality caused by anthropogenic impacts. These impacts include intentional and illegal egg collection and harvesting of adults, accidental fisheries related by-catch, pollution, disease, and coastal development (George 1997; Lutcavage *et al.* 1997; Seminoff 2004).

In the eastern Pacific Ocean, the most important nesting site for *C. mydas* historically was Michoacán, Mexico (Alvarado & Figueroa 1990; Seminoff 2004). However, the exploitation of eggs and adults led to a population decline of 90% of this nesting colony

(Alvarado & Figueroa 1990; Seminoff 2004). Today, the Galápagos Islands is one of the most important nesting sites for green turtles in the Eastern Pacific, with the population currently classified as stable over time (National Marine Fisheries Service & U.S. Fish and Wildlife Service 1998; Seminoff 2004).

Regulations on fishery activities and patrolling of marine habitats and nesting beaches ensure protection of sea turtles within the 138,000 km² GMR (Heylings *et al.* 2002). However, due to the extensive area involved, it has proven difficult to enforce environmental laws. For example, a pilot study on threats to *C. mydas* in the archipelago demonstrated that the main causes of mortality were due to anthropogenic interactions, including collision with vessels and interactions with fishing gear (Zárate 2009b).

We investigated the causes of mortality in stranded green turtles recovered from three nesting beaches in Galápagos during the 2009–2010 nesting season, and compared causes of mortality between the sites.

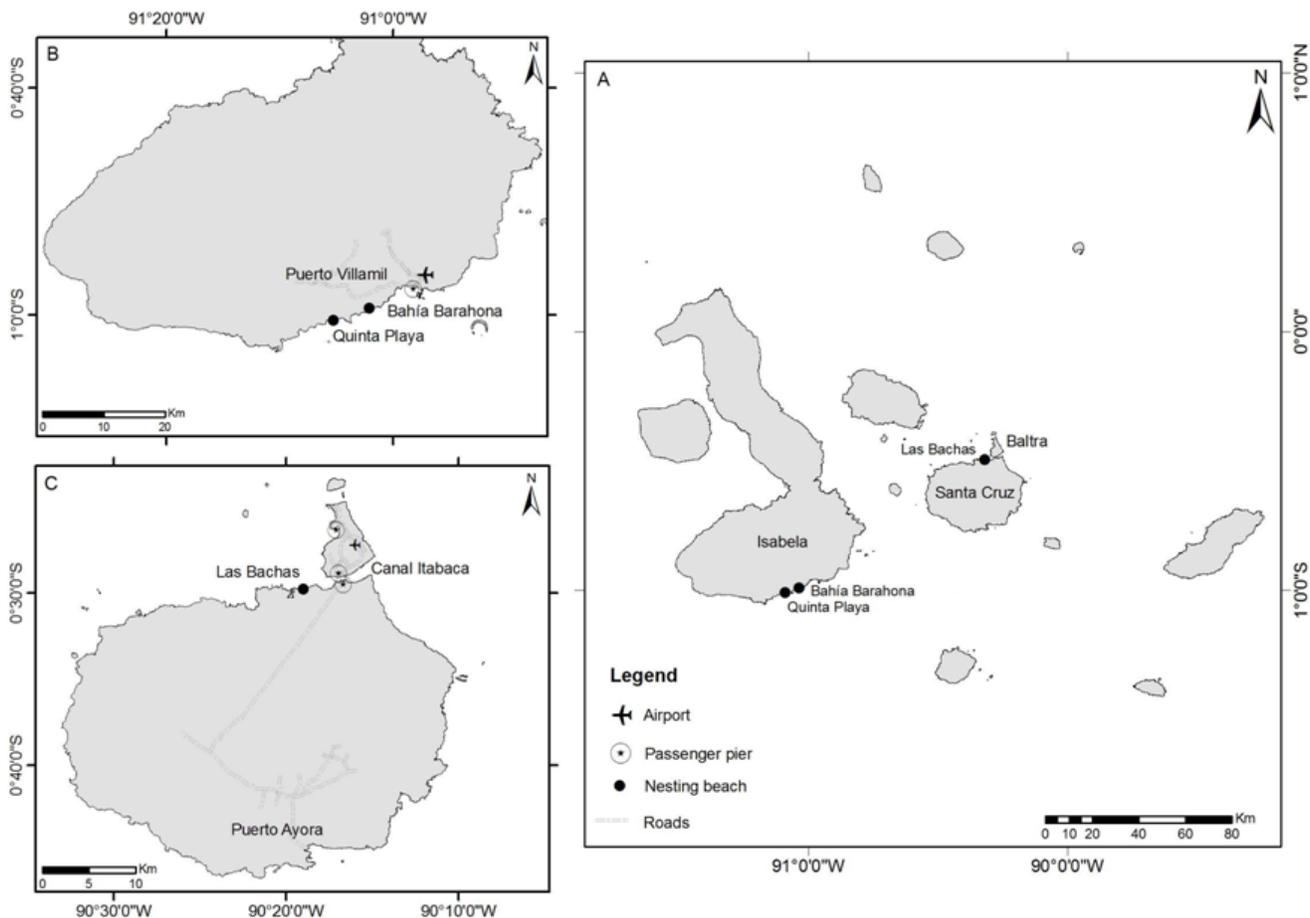


Figure 1. Map of the Galapagos Islands indicating the three study sites of Las Bachas on Santa Cruz Island, and Bahía Barahona and Quinta Playa on Isabela Island.

Site	Age	Sex	Anthropogenic				Possible anthropogenic	Natural	Unknown	Total
			Fisheries Interaction	Boat collision	Human consumption	Debris ingestion				
Quinta Playa	Adult	Male	1	2	none	none	none	1	5	
Quinta Playa	Adult	Femlae	7	3	none	1	1	none	5	
Quinta Playa	Adult	?	6	none	none	none	none	1	8	
Quinta Playa	Juvenile	?	1	1	none	none	none	none	none	
Quinta Playa	?	?	1	none	none	none	none	none	none	44
Bahía Barahona	Adult	Male	none	1	none	none	none	none	1	
Bahía Barahona	Adult	Female	2	none	none	none	none	none	none	
Bahía Barahona	Adult	?	2	none	2	none	none	none	none	
Bahía Barahona	Juvenile	?	none	none	none	none	none	none	none	
Bahía Barahona	?	?	none	none	none	none	none	none	none	8
Las Bachas	Adult	Male	none	none	none	none	none	none	none	
Las Bachas	Adult	Femlae	none	none	none	none	none	none	1	
Las Bachas	Adult	?	none	none	none	none	none	none	none	
Las Bachas	Juvenile	?	none	none	none	none	none	none	none	
Las Bachas	?	?	none	none	none	none	none	none	none	1
All sites	Adult	Male	1	3	none	none	none	1	6	
All sites	Adult	Femlae	9	3	none	1	1	none	6	
All sites	Adult	?	8	none	2	none	none	1	8	
All sites	Juvenile	?	1	1	none	none	none	none	none	
All sites	?	?	1	none	none	none	none	none	none	53
All turtles			20	7	2	1	1	2	20	53

Table 1. Stranded green turtles in Galapagos, Ecuador found during the nesting season of 2009-2010 and classified by location, age, sex, and cause of death.



Figure 2. Sea turtle mortality caused by anthropogenic impacts: (a) evidence of collision with vessel based on carapace longitudinally lesion; (b) clean cut of head and flippers indicative of interaction with fisheries; (c) human consumption based on all soft tissues removed from the turtle with evidence of sharp dissection; (d) marine debris with rope in the esophagus that exited through the oral cavity.

Data were collected from all stranded turtles observed during annual tagging and monitoring of nesting females at three beaches, Quinta Playa and Bahía Barahona on Isabela Island, and Las Bachas on Santa Cruz Island (Fig. 1). Quinta Playa, located in southwest Isabela (1°0'19,56"S, 91°4'49,36"W) is 2 km in length. This beach is free of obstructions except for rocky areas at the extreme ends, and is largely backed up by a salt lagoon. This is one of the best turtle nesting beaches in the archipelago and located approximately 15 km from Puerto Villamil, a town of 2700 (Emmanuel Cléder, personal communication; Pritchard 1975). People from the town may access the beach by foot (approximately 5 hr), or boat (approximately 30 min). Bahía Barahona, 1.2 km in length and also located in southwest Isabela (0° 59'20,77"S, 91° 01'52,07"W), is the second most important nesting site for green turtles in Galápagos (Hurtado 1984; Pritchard 1975). This beach is located approximated 9 km from Puerto Villamil and can be accessed from town, either by walking 2 hr or by boat. Hunting, surfing, and tourism are especially common at this beach due to its close proximity to Puerto Villamil. Las Bachas, located on northern Santa Cruz (0° 29'39,91"S, 90° 20'32,19"W), is 43 km from Puerto Ayora a town of 21,233 people (Emmanuel Cléder, personal communication) and divided into two nesting beaches of approximately 1 km length. The only access is by boat and can easily be reached from nearby Canal Itabaca, an area with heavy boat activity for local transport and tourism as it is the only access to the main airport in the islands. All three nesting sites are located within the GMR, a management category that covers out to 40 nautical miles to sea and which indicates their use

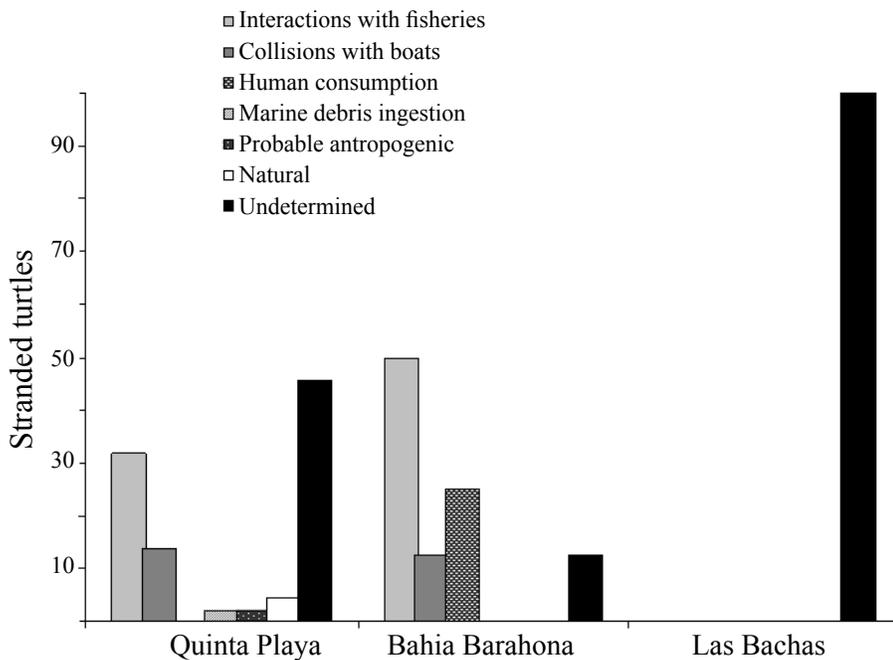


Figure 3. Causes of mortality for stranded green turtles recovered at three sites in the Galapagos Islands during the 2009-2010 nesting season. Quinta Playa (n = 44), Bahía Barahona (n = 8), and Las Bachas (n = 1).

for conservation and extractive (e.g., fishing) and non-extractive uses (Heylings *et al.* 2002). Additionally, Las Bachas is a favorite tourist site, receiving an average of 3 boats and approximately 50 tourists daily (Zárate & Dutton 2002).

For each stranded turtle, we recorded sex based on tail length, morphometrics including curved carapace length (CCL) and width (CCW), and causes of mortality based on gross external lesions, and in nine turtles based on complete necropsies (Work 2000). Photographs were taken of the majority of the turtles and the remains of all individuals were buried in the sand to avoid double counting of turtles.

Causes of mortality were classified into four main categories, including anthropogenic, possible anthropogenic, natural, and undetermined. Anthropogenic impacts were further divided into (1) interaction with fisheries, (2) collision with boats, (3) human consumption, and (4) marine debris ingestion. Lesions supportive of each of these categories were (1) marks consistent with fishing

line, sharp dissection of flippers, and / or head and in some cases evidence of drowning based on airway hyperemia, foam and froth in airways, and seawater in the digestive and respiratory systems (Koch 2006; Zárate 2009b; Work & Balazs, 2010), (2) linear fractures in the carapace or head indicative of propeller or hull impact (Phelan & Eckert 2006), (3) carapace and plastron cleaned of all musculature, and (4) marine debris such as plastic, fishing line, hooks, aluminum foil, rubber or tar found within a turtle (Bjorndal *et al.* 1994), respectively.

The second category, possible anthropogenic impact, was based on severe damage to the flippers and / or carapace suggestive of sharp dissection, but due to an advanced state of decomposition cause of death could not be determined with certainty. The third category, natural causes, included those turtles that appeared to have succumbed to hyperthermia and dehydration after having been mis-oriented away from the ocean. Also included in this category were turtles that had evidence of severe parasitism. The fourth category included turtles in which the cause of death could not be determined either due to the

advanced state of decomposition or the lack of any gross lesions.

Prevalence was defined as the number of stranded turtles with an attribute (e.g., site, month, cause of stranding) over all stranded turtles and 95% confidence intervals are provided (Thrusfield 2007). Chi-square tests or Fisher's exact tests were used to compare number of stranded turtles by site, category of mortality, and cause of anthropogenic related mortalities. Results were analyzed using a commercial statistical software package (NCSS, Kaysville, Utah; SPSS, version 13.0, Chicago, IL., USA).

Fifty-three stranded green turtles were recorded during the 2009-2010 nesting season and included 44 (83%; 70.8-90.8) on Quinta Playa, 8 (15.1%; 7.9-27.1%) on Bahía Barahona, and 1 (1.9%; 0.3-9.9%) on Las Bachas (Table 1). There were significantly more stranded turtles on Quinta Playa than the other two beaches (chi-square test; $P < 0.001$), although we spent 7 and 58 more days monitoring on Quinta Playa than on Bahía Barahona and Las Bachas, respectively. Anthropogenic causes accounted for 56.6%

	Quinta Playa		Bahía Barahona		Las Bachas		Source
	Start date	End date	Start date	End date	Start date	End date	
2002	14-Dec-01	29-Apr-02	10-Dec-01	29-Apr-02	7-Jan-02	28-Apr-02	Zárate 2002
2003	17-Feb-03	17-May-03	18-Feb-03	15-May-03	26-Jan-03	9-May-03	Zárate 2003 a,b
2004	15-Dec-03	14-May-04	15-Dec-03	14-May-03	18-Jan-04	14-May-04	Zárate 2004; Páez & Zárate 2004
2005	14-Dec-04	16-May-05	18-Dec-04	15-May-05	9-Jan-05	16-May-05	Zárate & Chasiluisa 2005; Zárate 2005
2006	15-Dec-05	16-May-06	22-Dec-05	16-May-06	12-Feb-06	19-Feb-05	Zárate 2006 a,b
2007	10-Jan-07	12-Jun-07	17-Jan-07	9-Jun-07	Not monitored in 2007		Zárate <i>et al.</i> 2007
2008	9-Feb-08	10-Apr-08	12-Mar-08	31-Mar-08	14-Apr-08	17-Apr-08	Zárate 2009a
2010	6-Dec-09	4-Jun-10	13-Dec-09	5-Jun-10	11-Jan-10	10-May-10	This study

Table 2. Period of green turtle monitoring on Isabela Island (Quinta Playa and Bahía Barahona) and Santa Cruz Island (Las Bachas) in the 2002 to 2010 nesting seasons in Galapagos.

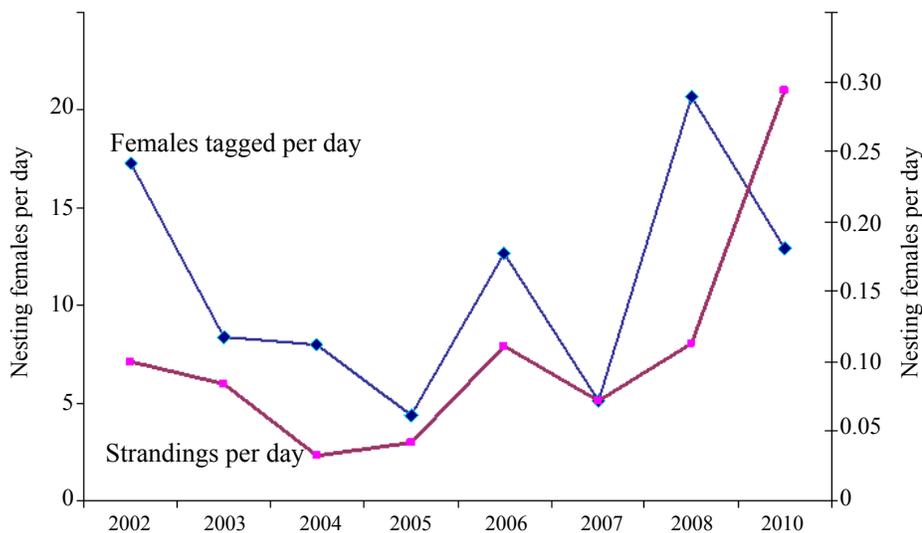


Figure 4. Number of green turtles tagged per day and number of stranded turtles recorded per day at three sites in the Galapagos Islands during the nesting seasons of 2002-2010 (see Table 2 for data sources).

(43.3-69.0%) of all stranded turtles, with the other 47.4% divided into possible anthropogenic causes (1.9%; 0.3-9.9%), natural causes (3.8%; 1.0-12.7%), and unknown causes (37.7%; 25.9-51.2%) (Table 1, Fig. 2 and Fig. 3). Stranded turtles were categorized with an anthropogenic cause of mortality significantly more than the three other causes (chi-square test; $P < 0.001$). Further division of the anthropogenic related mortalities demonstrated that interactions with fisheries (66.7%; 48.8-80.8%) were significantly more common than other causes of anthropogenic interactions including collision with boats (23.3%; 11.8-40.9%), human consumption (6.7%; 1.8-21.3%), and ingestion of marine debris (3.3%; 0.6-16.7%) (chi-square test; $P < 0.001$). Three of the seven turtles with evidence of fisheries interactions we categorized consistent with drowning based on airway hyperemia, foam and froth in airways, and seawater in the digestive and respiratory systems (Work & Balazs 2010). The two turtles categorized as natural causes of death included one that was found alive but subsequently died and appeared hyperthermic, dehydrated, exhausted and located far from the ocean, and a second turtle that had massive barnacle infestation throughout the entire gastrointestinal tract and a brown discolored liver.

Morphometrics from 21 of the stranded turtles were $81 \text{ cm} \pm 9.4$ with range of 58 – 93 cm for CCL and $75 \text{ cm} \pm 8.7$ with range 55 – 87 cm for CCW. Based on the previously established CCL values of 60 - 66.7 cm for adult (e.g., the smallest nesting female recorded in Galápagos was 60 cm) and 40-50 cm for juvenile green turtles in Galápagos (Green 1994), we determined that 94% of stranded turtles were adults ($n = 50$), 4% juvenile ($n = 2$), and 2% unknown age (e.g., between 50 and 60 cm) ($n = 1$) (Table 1). For the adults, 38% were females ($n = 19$), 22% male ($n = 11$) and 40% undetermined sex ($n = 20$). Four stranded females were confirmed oviparous at the time of death and three of the females had metal flipper tags, including two from 2009-2010 and one from the 2002-2003 nesting seasons.

A significantly higher number of stranded turtles were recorded in December (49.1%; 36.1-62.1%) than in any of the other months; January (26.4%; 16.4-39.6%), February (13.2%; 6.5-24.8%), March (5.7%; 1.9-15.4%), April (1.9%; 0.3-9.9%), and May (3.8%; 1-12.8%) ($P < 0.001$).

The presence of stranded sea turtles is often used as an index of mortality at sea (Murphy & Hopkins – Murphy 1989; Epperly *et al.* 1996) and as a supplementary source for a better understanding of the health status of marine animal populations (Kreuder *et al.* 2003). However, this is believed to be an underestimation of population mortality due to the loss of many turtles at sea (Hillestad *et al.* 1978).

The number of stranded green turtles we report during the 2009-10 season is the highest number recorded when compared to all previous data collected from the monitoring seasons since the program began in 2001 (Zárate 2009b) (Fig. 4). This is of note since although the time spent monitoring on the beaches was longest in this season compared to previous years, the cumulative time was greater for these 7 seasons (Table 2). Additionally, on a per day basis the number of females tagged (and thus

nesting) was much higher in 2002 and 2008, than the 2009-2010 season although the numbers that stranded per day were much lower (Zárate 2009b, Fig. 4).

Fifty-three percent of the cases in this study corresponded to mortality caused by anthropogenic impacts with the majority of the stranded turtles discovered on Quinta Playa, an area with the highest human presence among the different nesting beaches monitored. Artisanal fishing and tourism are common in this area with high boat traffic. Additionally, it should be noted that Quinta Playa and Bahía Barahona are located in areas of increased inflow of ocean currents and winds while, Las Bachas is in a calmer region and presumably there is less chance of turtles drifting on to the beach (Banks 2002).

The highest category of mortality was associated with interactions with fisheries, similar to other studies (Parnell *et al.* 2007; Zárate 2009b). Although fishing activities are regulated and methods such as gillnet and shark finning are illegal, evidence exists that these modes of fishing are still commonly practiced in the GMR (Reyes & Murillo 2007).

Boat strikes were the second most common cause of mortality in this study, similar to findings from other regions of the world, and emphasizes the importance of boat traffic on sea turtle morbidity and mortality (Chaloupka *et al.* 2008; Schroeder *et al.* 1987; Sobin & Tucker 2008; Zárate, 2009b). In the Galápagos, there has been an exponential rise in tourists in the last two decades which in turn has led to increased marine traffic (Epler 2007). This increase in tourism has been most evident in the less populated islands such as Isabela which has tripled the number of hotels in Puerto Villamil during the past 15 yr (Epler 2007). Additionally, the recent development of sport fishing and “pesca vivencial” a form of fishing in which tourists use methods of the local fishermen to gain an appreciation of Galápagos culture have increased boat activity and the number of fishermen in the waters of the GMR (Macarena Parra, personal observation). Boat collision is known to be a major cause of sea turtle mortality in developed areas of the world, such as Florida and Hawaii, USA (Chaloupka *et al.* 2008; Schroeder *et al.* 1987). With the increase in boat traffic in Galápagos, the number of sea turtles that suffer the same fate may also rise.

Two of the stranded turtles were taken for human consumption. These two turtles were found on Bahía Barahona, the most accessible beach for local people, at just a 2 hr walk from Puerto Villamil. Previously, this site is where other green turtles have been recorded with evidence of human consumption, including signs of being roasted on the beach (Zárate 2009b). One stranded turtle in this study was confirmed with marine debris based on a 4 mm diameter string that passed from the mouth to cloaca (Fig. 2d). Marine debris including items such as plastics, balloons, monofilaments, and oil are a major cause of mortality in sea turtle populations globally (Barreiros & Barcelos 2001; Bjorndal *et al.* 1994; Bugoni 2001; Mascarenhas *et al.* 2004). The turtle in this study is the first confirmed green turtle to die from the ingestion of marine debris in Galápagos waters. Additionally, it is interesting to note that in the 2009-2010 field season we found two live turtles on the beach with nylon wrapped around flippers, and in both cases there was severe muscle damage associated with the nylon tourniquets. One additional turtle was identified with nylon protruding from the cloaca which supports ingestion. The lack of previously diagnosed cases of interaction with marine debris suggests that the waters around the archipelago have until now been relatively marine debris free and that debris appears to be increasing in the region (Sharon L. Deem & Macarena Parra, personal observations).

We recorded the highest number of stranded green turtles in the 2009-2010 turtle nesting season since monitoring began in 2001. The average number of stranded turtles identified during the seven previous years was 11 per year, with 0.08 turtles stranded per day, based on monitoring effort (Zárate 2009b). Therefore, there was a 300% increase in the 2009-2010 season. In previous years, there appears to have been a correlation between number of nesting females and number of stranded turtles (Fig. 4). However, in 2009-2010 there was an increase in the number of stranded turtles, with no corresponding increase in the number of nesting females (Fig. 4), although as discussed previously the monitoring effort was longer for this season (Table 2).

The number of stranded green turtles in Galápagos is lower than other parts of the world, although data currently available is only for 3 of the nesting beaches in the archipelago, even though the population size is believed to be one of the largest. For example, in Magdalena Bay, Mexico, greater than 600 turtles strand each year because of fisheries interactions (Gardner 2001; Koch 2006). However, we must be vigilant to a possible increasing trend in sea turtle mortality in Galápagos, especially as an increase in human population size and tourism in the region continues (Epler 2007). The Galápagos National Park must strive to enforce laws and to penalize offenders that perform illegal activities in the GMR and that threaten sea turtles and other wildlife in this iconic site (Reyes & Murillo 2007). If implemented, a regulation to decrease boat traffic and boat speeds near important foraging and nesting sites during December-February, the peak of the nesting season and the months with the most recorded stranded turtles, may significantly lower the number of stranded green turtles (Sobin & Tucker 2008).

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- ALVARADO, J. & A. FIGUEROA. 1990. The ecological recovery of sea turtles in Michoacán, México. Special Attention: the black turtle *Chelonia agassizii*. Final report 1989-1990, U.S. Fish and Wildlife Service, Albuquerque, New México. 97 pp.
- BANKS, S. 2002. Ambiente Físico. In: E. Danulat & G.J. Edgar (Eds.). Reserva Marina de Galápagos. Línea base de la Biodiversidad. Fundación Charles Darwin/Servicio Parque Nacional galápagos, Santa Cruz, Galápagos, Ecuador. pp. 22-37.
- BARREIROS, J.P. & J. BARCELOS. 2001. Plastic ingestion of Leatherback turtle *Dermochelys coriacea* from Azores (NE Atlantic). Marine Pollution Bulletin 42: 1196 – 1197.
- BJORNDAL K.A., A.B. BOLTON & C.J. LAGUEUX. 1994. Ingestion of marine debris by juvenile sea turtles in coastal Florida habitats. Marine Pollution Bulletin. 28:154 -158.
- BUGONI, L., L. KRAUSE & M.V. PETRY. 2001. Marine debris and human impacts on sea turtles in Southern Brazil. Marine Pollution Bulletin 42: 1330-1334.
- CHALOPUKA, M., T.M. WORK, G.H. BALAZS, S.K. MURAKAWA & R. MORRIS. 2008. Cause-specific temporal and spatial trends in green sea turtle strandings in the Hawaiian Archipelago (1982–2003). Marine Biology 154: 887–898.
- EPLER, B. 2007. Turismo, Economía, Crecimiento Poblacional y Conservación en Galápagos. Para la Fundación Charles Darwin. Traducción al español: Graciela Monsalve. 82 pp.
- EPPERLY, S.P., J. BRAUN, A.J. CHESTER, F.A. CROSS, J.V. MERRINER, P.A. TESTER & J.H. CHURCHILL. 1996. Beach strandings as an indicator of at-sea mortality of sea turtles. Bulletin of Marine Science 59:289-297.
- GARDNER, S.G. & W.J. NICHOLS. 2001. Assessment of sea turtle mortality rates in the Bahía Magdalena region, Baja California Sur, México. Chelonian Conservation & Biology 4:197–199.
- GEORGE, R.H. 1997. Health problems and diseases of sea turtles. In: P.L. Lutz & J.A. Musick (Eds.). The Biology of Sea Turtles. CRC Press, Boca Raton, Florida. pp. 363-385.
- GREEN, D. 1994. Galápagos Sea Turtle: an overview. In: B.A. Schroeder & B.S. Witherington (Comps.), Proceedings of the 13th Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-314, pp 65-68.
- GREEN, D., & F. ORTIZ-CRESPO. 1995. Status of sea turtle populations in the Central Eastern Pacific. In: K.A. Bjorndal (Ed.) Biology and Conservation of Sea Turtles, Smithsonian Institution Press, Washington D.C. pp. 221-233.
- HEYLINGS P., R. BENSTED-SMITH & M. ALTAMIRANO. 2002. Zonificación e historia de la Reserva Marina de Galápagos. In: E. Danulat & G.J. Edgar (Eds.). Reserva Marina de Galápagos. Línea Base de la Biodiversidad. Fundación Charles Darwin/Servicio Parque Nacional Galápagos, Santa Cruz, Galápagos, Ecuador. pp. 10 -21.
- HILLESTAD H.O., J.I. RICHARDSON & G.K. WILLIAMSON. 1978. Incidental capture of sea turtles by shrimp trawlers in Georgia. Proceeding of the Annual Conference of the Southeast Association of Fish and Wildlife Agencies 32:167-178.
- HURTADO, M. 1984. Registro de la anidación de la tortuga negra, *Chelonia mydas* en las islas Galápagos. Boletín Científico y Técnico 4: 77-106.
- KOCH, V., W.J. NICHOLS, H. PECKHAM & V. DE LA TOBA. 2006. Estimates of sea turtle mortality from poaching and bycatch in Bahía Magdalena, Baja California Sur, Mexico. Biological Conservation 128: 327 –334.
- KREUDER, C., M. MILLER, D. JESSUP, L. LOWENSTINE, M. HARRIS,

- J. AMES, T. CARPENTER, P. CONRAD & J. MAZET. 2003. Patterns of mortality in southern sea otters (*Enhydra lutris nereis*) from 1998–2001. *Journal of Wildlife Diseases* 39: 495–509.
- LUTCAVAGE, M.E., P. PLOTKIN, B. WITHERINGTON & P.L. LUTZ. 1997. Human impacts on sea turtle survival. In: P.L. Lutz & J.A. Musick (Eds.). *The Biology of Sea Turtles*. CRC Press, Boca Raton, Florida. pp. 387–409.
- MASCARENHAS, R., R. SANTOS & D. ZEPPELÍN. 2004. Plastic debris ingestion by sea turtle in Paraiba, Brazil. *Marine Pollution Bulletin* 49: 354–355.
- MURPHY, T.M., & S.R. HOPKINS-MURPHY. 1989. Sea turtle and shrimp fishing interactions: a summary and critique of relevant information. Center for Marine Conservation, Washington, D.C. 52 pp.
- NATIONAL MARINE FISHERIES SERVICE & US FISH AND WILDLIFE SERVICE 1998. Recovery Plan for US Pacific Populations of the East Pacific Green Turtle (*Chelonia mydas*). National Marine Fisheries Service, Silver Spring, Maryland. 50 pp.
- PARNELL, R., B. VERHAGE, S.L. DEEM, H. VAN LEEUWE, T. NISHIHARA, C. MOUKOULA & A. GIBUDI. 2007. Marine turtle mortality in southern Gabon and northern Congo. *Marine Turtle Newsletter* 116: 12–14.
- PÁEZ, D. & P. ZÁRATE. 2004. Segundo informe de avance sobre la anidación de la tortuga verde *Chelonia mydas*, en playas de Galápagos durante la temporada 2003 - 2004. Fundación Charles Darwin. Presentado al National Marine Fisheries Service y Parque Nacional Galápagos. 11 pp.
- PHELAN, S.M. & K.L. ECKERT. 2006. Marine Turtle Trauma Response Procedures: A Field Guide. Wider Caribbean Sea Turtle Conservation Network (WIDECAS) Technical Report No. 4. Beaufort, North Carolina 71 pp.
- PRITCHARD, P.C.H. 1971. Galápagos sea turtles: Preliminary findings. *Journal Herpetology* 5: 1–9.
- PRITCHARD, P.C.H. 1975. Galápagos sea turtle study. Progress report on WWF project number 790. Charles Darwin Research Station, Santa Cruz, Galápagos. 23 pp.
- REYES, H. & J.C. MURILLO. 2007. Esfuerzos de control de pesca ilícita en la Reserva Marina. In: Informe Galápagos 2006 – 2007. Parque Nacional Galápagos/Fundación Charles Darwin/Ingala. 60 pp.
- SCHROEDER, B.A. & N.B. THOMPSON. 1987. Distribution of the loggerhead turtle, *Caretta caretta*, and the leatherback turtle, *Dermochelys coriacea*, in the Cape Canaveral, Florida areas: Results of aerial surveys. In: W.N. Witzell (Ed.). *Ecology of East Florida Sea Turtles: Proceedings of the Cape Canaveral, Florida Sea Turtle Workshop*, Miami, Florida, February 26 -27, 1985. NOAA Technical Report NMFS 53.
- SEMINOFF, J.A. 2004. Global Status Assessment: green turtle (*Chelonia mydas*). *Marine Turtle Specialist Group review* 71 pp.
- SOBIN, J.M. & T.D. TUCKER. 2008. Diving Behavior of Female Loggerhead Turtles (*Caretta caretta*) During Their Internesting Interval and an Evaluation of the Risk of Boat Strikes. Authorized licensed use limited to: Colorado State University. Downloaded on March 25, 2010 at 12:19:03 EDT from IEEE Xplore. Restrictions apply.
- THRUSFIELD, M. 2007. *Veterinary Epidemiology: third edition*. Blackwell Publishing, Oxford, UK. 610 pp.
- WORK, T.M. 2000. Manual de tortugas marinas para biólogos en refugios o áreas remotas. U.S. Geological Survey National Wildlife Health Center. Hawaii Field Station. 25 pp.
- WORK, T.M. & G.H. BALAZS. 2010. Pathology and distribution of sea turtles landed as bycatch in the Hawaii-based North Pacific pelagic longline fishery. *Journal of Wildlife Diseases* 46: 422–432.
- ZÁRATE, P. 2002. Evaluación de la actividad de anidación de la tortuga verde *Chelonia mydas*, en las islas Galápagos durante la temporada 2001–2001. Fundación Charles Darwin. Presentado al Parque Nacional Galápagos. Ecuador 35 pp.
- ZÁRATE, P. 2003a. Primer informe de avance sobre la anidación de la tortuga verde *Chelonia mydas*, en playas de Galápagos durante la temporada 2003. Fundación Charles Darwin. Presentado al National Marine Fisheries Service y Parque Nacional Galápagos. 11 pp.
- ZÁRATE, P. 2003b. Segundo informe de avance sobre la anidación de la tortuga verde *Chelonia mydas*, en playas de Galápagos durante la temporada 2003. Fundación Charles Darwin. Presentado al National Marine Fisheries Service y Parque Nacional Galápagos. 10 pp.
- ZÁRATE, P. 2004. Primer informe de avance sobre la anidación de la tortuga verde *Chelonia mydas*, en playas de Galápagos durante la temporada 2003 - 2004. Fundación Charles Darwin. Presentado al National Marine Fisheries Service y Parque Nacional Galápagos. 13 pp.
- ZÁRATE, P. 2005. Segundo informe de avance sobre la anidación de la tortuga verde *Chelonia mydas*, en playas de Galápagos durante la temporada 2004 - 2005. Fundación Charles Darwin. Presentado al National Marine Fisheries Service y Parque Nacional Galápagos. 16 pp.
- ZÁRATE, P. 2006a. Primer informe de avance sobre la anidación de la tortuga verde *Chelonia mydas*, en playas de Galápagos durante la temporada 2005 - 2006. Fundación Charles Darwin. Presentado al National Marine Fisheries Service y Parque Nacional Galápagos. 12 pp.
- ZÁRATE, P. 2006b. Segundo informe de avance sobre la anidación de la tortuga verde *Chelonia mydas*, en playas de Galápagos durante la temporada 2005 - 2006. Fundación Charles Darwin. Presentado al National Marine Fisheries Service y Parque Nacional Galápagos. 14 pp.
- ZÁRATE, P. 2009a. Informe final: Actividad de Anidación de la Tortuga Verde *Chelonia mydas*, durante la temporada 2007–08. Fundación Charles Darwin. Presentado al Parque Nacional Galápagos. Ecuador. 39 pp.
- ZÁRATE, P. 2009b. Amenazas para las tortugas marinas que habitan el archipiélago de Galápagos. Fundación Charles Darwin. Presentado al Parque Nacional Galápagos. Ecuador. 50 pp.
- ZÁRATE, P. & C. CHASILUISA. 2005. Primer informe de avance sobre la anidación de la tortuga verde *Chelonia mydas*, en playas de Galápagos durante la temporada 2004 - 2005. Fundación Charles Darwin. Presentado al National Marine Fisheries Service y Parque Nacional Galápagos. 10 pp.
- ZÁRATE, P. & P. DUTTON. 2002. Tortuga verde. In: E. Danulat & G.J. Edgar (Eds.). *Reserva Marina de Galápagos. Línea base de la Biodiversidad*. Fundación Charles Darwin/Servicio Parque Nacional Galápagos, Santa Cruz, Galápagos, Ecuador. pp 305 – 323.
- ZÁRATE, P., M., PARRA & J. CARRIÓN. 2007. Informe final proyecto anidación de la tortuga verde *Chelonia mydas*, en playas de Galápagos durante la temporada 2006 - 2007. Fundación Charles Darwin. Presentado al Parque Nacional Galápagos. 68 pp.