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Research Article

Feeding ecology of the green turtle *Chelonia mydas* in northern Peru

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ABSTRACT. Diet and food preferences of the green turtle *Chelonia mydas* were analyzed based on digestive tract contents of dead specimens caught incidentally by an artisanal gillnet fishery in Sechura Bay, northern Peru. We examined 27 digestive tracts and identified 35 prey items. The sampled turtles were all juveniles (CCL = 53.7 ± 1.2 cm, range 40.5-67.0 cm). The prey items were grouped into six categories: algae, cnidarians, mollusks, arthropods, chordates and garbage/anthropogenic debris. The items with the highest Frequency of Occurrence values (% FO) were: *Caulerpa filiformis* (77.8%), *Loligo gahi* (eggs) (51.9%) and *Rhodymenia corallina* (44.4%). By weight (% W), the most important items, were *L. gahi* (eggs) (33.3%), *Stomolophus* sp. (7.3%) and *Aphos porosus* (6.5%). According to the Preponderance Index (%IP), the preponderant item was *L. gahi* (eggs) with 6.1% and 61.2% during winter-spring and summer-autumn, respectively. According to the Resultant Weight index (Rw) of wet items, the most important items were: *C. filiformis* (13.1%), *L. gahi* (eggs) (10.5%), *R. corallina* (7.4%), plastic (7.5%), *Gigartina chamissoi* (5.1%). Garbage/anthropogenic debris was common in the digestive tracts analyzed. Plastic items had a frequency of occurrence of 44.4%. A greater diversity of food items was observed during summer and autumn. This study shows that juvenile *C. mydas* forage on a variety of resources. We recommend that conservation plans, land use planning and future management plans in the Sechura Bay include green turtles as a sentinel species for monitoring biodiversity of marine resources and the degree of pollution in the Bay.

Keywords: diet, *Chelonia mydas*, Sechura, Peru, small-scale fisheries.

INTRODUCTION

From their emergence as hatchlings through to their adult life, sea turtles experience ontogenetic changes in habitat use that includes nesting beaches and juvenile and adult feeding areas (FAO, 2011). Currently, multiple sea turtle populations are declining (Amorocho & Reina, 2007; Carrión-Cortez *et al*., 2010), due largely to anthropogenic activities including commercial overfishing, bycatch, destruction of critical habitat for feeding and nesting; and most recently, pollution (Gilman *et al*., 2006, 2010; Boyle & Limpus, 2008; Rodríguez, 2010).

The green turtle (*Chelonia mydas*) is a circumglobal species that is susceptible to overexploitation as a food resource, incidental mortality in fisheries (Alfaro-Shigueto *et al*., 2002), and coastal foraging habitat degradation, all of which have contributed to its listing as Endangered on the IUCN Red List (Lemons *et al*., 2011). The species is found year-round in shallow waters of coasts, bays and lagoons (Bjorndal, 1980; Plotkin *et al*., 1993), which are important habitats for growth and development (Musick & Limpus, 1997). *C. mydas* is distributed along the west coasts of North and South America (Marquez, 1990; Aranda & Chandler, 1989). Marquez (1990) reported coastal primary foraging areas from San Diego Bay, USA to Mejillones, Chile and more recently, the species' southward distribution was extended to Valparaíso, Chile (Troncoso-Fierro & Urbina-Burgos, 2007). Neritic habitats in Peru also form important feeding areas for the species (Alfaro-Shigueto *et al*., 2002, 2004; Velez-Zuazo *et al*., 2014).

The feeding ecology of this species has been studied throughout most of its distribution (Quiñones *et al*., 2015a). At their juvenile developmental habitats, green turtles can take on a herbivorous diet, feeding primarily on seagrass and algae (Plotkin *et al*., 1993; Seminoff *et al*., 2002a, 2003; López-Mendilaharsu *et al*., 2005; Sampson & Giraldo, 2014). Other studies have noted that *C. mydas* juveniles can also be carnivorous consumers, foraging mainly on cnidarians (Carrión-Cortez *et al*., 2010), sponges (Seminoff *et al*., 2002b), and tunicates (Amorocho & Reina, 2007, 2008). Additional studies have also identified an omnivorous diet, based mainly on algae but with an additional wide variety of animals, such as crustaceans, fish eggs, mollusks, and, to a lesser extent, jellyfish (Hays-Brown & Brown, 1982; De Paz *et al*., 2004; Kelez *et al*., 2004; Santillán, 2008; Quiñones *et al*., 2015a, 2015b).

The diet composition at different feeding grounds depends on the availability of resources (Bjorndal, 1980), and to some extent, by foraging preferences, especially for certain species of algae (López-Mendilaharsu *et al*., 2008). This feeding strategy, where juveniles are herbivorous/omnivorous, allows for accelerated growth of recruits (Quiñones *et al*., 2015a). In the Eastern Pacific Ocean (EPO), there is baseline diet information for some green turtle feeding grounds, including those located in the Baja California Peninsula (Mexico) (Seminoff *et al*., 2002a, 2003; López-Mendilaharsu *et al*., 2005), the Galapagos Islands (Seminoff *et al*., 2002b; Carrión-Cortez *et al*., 2010), and the Gorgona Island (Colombia) (Amorocho & Reina, 2007, 2008).

In Peru, *C. mydas* feeding grounds have been identified in Tumbes (Rosales *et al*., 2010), El Ñuro (Velez-Zuazo *et al*., 2014), Sechura Bay and Virrilá estuary (Santillán, 2008; De Paz & Alfaro-Shigueto, 2008; Paredes *et al*., 2015), Isla Lobos de Tierra (Quiñones *et al*., 2015a), Chimbote (Alfaro-Shigueto *et al*., 2004), Pisco (Hays-Brown & Brown, 1982; Quiñones *et al*., 2010), and the Paracas Bay area (Hays-Brown and Brown, 1982; De Paz *et al*., 2007; Paredes, 2015; Quiñones *et al*., 2010; Quiñones *et al*., 2015a, 2015b). Virrilá estuary and Sechura Bay are known to be important aggregation areas for juvenile and subadult green turtles (Santillán, 2008; Alfaro-Shigueto *et al*., 2011; Paredes *et al*., 2015; Ortiz *et al*., 2016). In addition to marine algae and seagrasses (Hays-Brown & Brown, 1982; Alfaro-Shigueto *et al*., 2004; Seminoff *et al*., 2002b; Amorocho & Reina, 2008), at many of these sites, green turtles consume large quantities of invertebrates (like scyphozoan jellyfish and sessile anemones) (Quiñones *et al*., 2010; Paredes, 2015), fish and mollusks.

Sechura Bay is also an important and traditional site of small-scale fishing (Alfaro-Shigueto *et al*., 2010; Morón *et al*., 2013) for demersal and benthic resources. More recently, the bay has seen the development of mariculture, mainly of *Argopecten purpuratus* (Mendo *et al*., 2008; Mendo, 2011). Small-scale fisheries (SSF) are often poorly managed and also have generated environmental problems such as pollution (IMARPE, 2011), and impacts on endangered species, including sea turtles (Alfaro-Shigueto *et al*., 2011; Ortiz *et al*., 2016).

The purpose of this research was to study the diet composition of juvenile and subadult green turtles in this bay, an area of particular importance as a foraging ground for the species in northern Peru, but also an area important for small-scale fisheries.

MATERIALS AND METHODS

Study area

Sechura Bay (05°12’ to 05°50’S and 80°50’ to 81°12’W) is delimited in the north by Punta Gobernador and Punta Aguja to the south, has an approximate extension of 89 km^2 (IMARPE, 2007; Morón *et al*., 2013), and is within the Piura Region (Fig. 1).

Turtle bycatch and sizes of individuals

The study was conducted between July 2013 and June 2014 as part of a program to monitor the small-scale fleet operating from the port of Constante (05°35’S, 80°50’W). Fishing vessels ranged in length from 6 to 10 m and each trip consisted of setting of bottom set gillnets. Gillnets were made of multifilament twine and were composed of multiple net panes that measured 56.4 m long by 2.8 m high, with a stretched mesh of approximately 24 cm. Nets were typically deployed in the late afternoon, soaked overnight and retrieved the following morning (Alfaro-Shigueto *et al*., 2010; Ortiz *et al*., 2016).

We collected digestive tract contents from dead specimens of *C. mydas* incidentally caught in this fishery. Each turtle was measured for the curved carapace length (CCL cm) from the anterior notch to the tip of the posterior-most marginal scutes (Bolten, 2000; Wyneken, 2001). Individuals with CCL < 69 cm. were considered as juveniles, individuals with $69 \leq$ CCL < 85 cm. were considered as sub-adults, and individuals with CCL $\geq$ 85 cm. as adults (Zárate *et al*., 2013).

Diet study

All digestive tract contents were collected and stored in 10% formaldehyde in seawater solution (Jacobson, 2000; Work, 2000; Wyneken, 2001). The identification of categories and items was made with the help of identification guides reaching the lowest possible taxonomic level. Prey species identification guides used included Chirichigno (1974), Mendez (1981), Alamo & Valdivieso (1997), Acleto & Zúñiga (1998), Chirichigno & Cornejo (2011), Moscoso (2012, 2013), Tume *et al*. (2012) and Guiry & Guiry (2015).

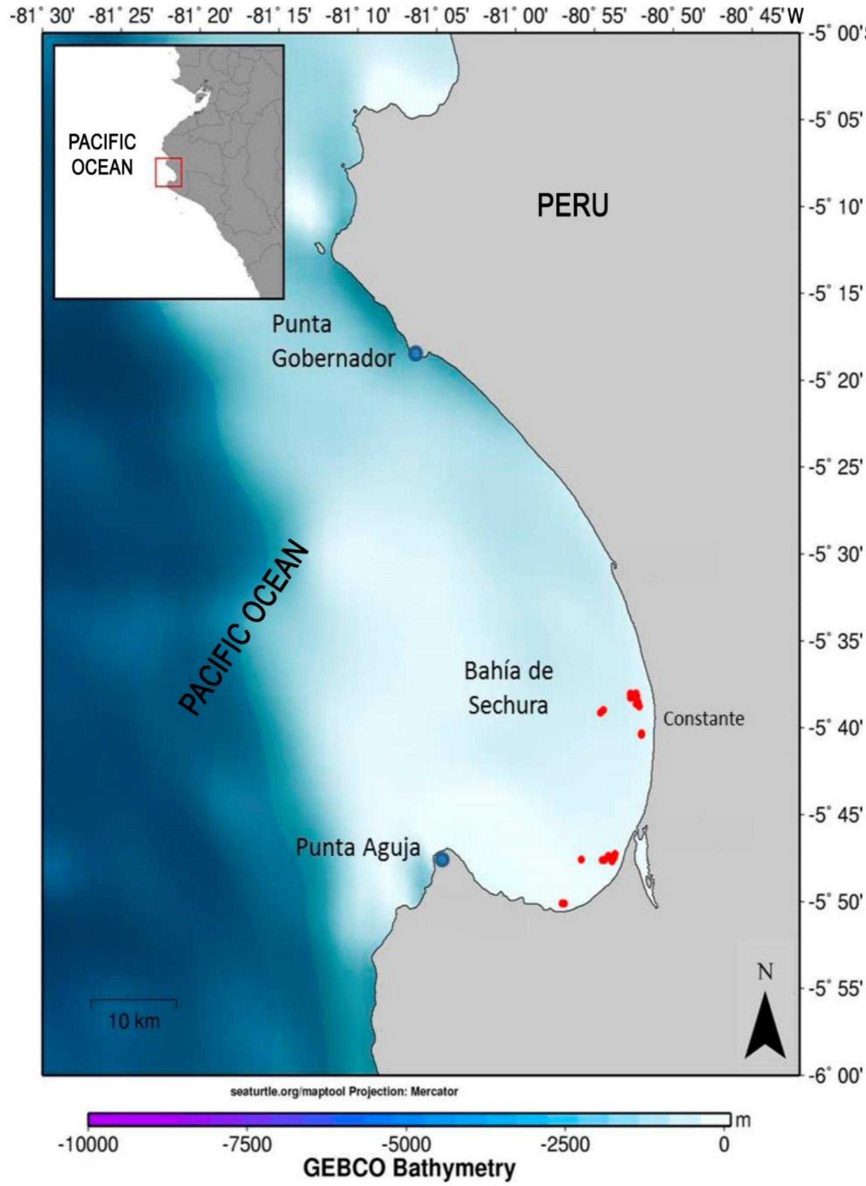

Figure 1. Sechura Bay, Piura, Peru, showing the geographical location of individuals of *C. mydas* caught incidentally during 2013-2014 (Seaturtle.org Maptool, 2002).

For all consumed items, we estimated the Frequency of Occurrence (%FO) and wet weight percentage (%W) (Carrión-Cortez, 2010), according to the following equation:

$$\%W = \frac{Pi}{Pt} \times 100$$

$$\%FO = \frac{Ni}{Nt} \times 100$$

where: Pi = total wet weight of diet item in all samples; Pt = total wet weight of all samples; Ni = number of samples containing diet item; Nt = total number of samples.

Frequency of Occurrence (%FO) and wet weight percentage (%W) were combined to calculate the Preponderance Index (%IP) (Mohan & Sankaran, 1988). Additionally, diet data were grouped into two seasonal groups: summer-autumn (January to June), and winter-spring (July to December) (Paredes, 2015), toward establishing the order of numerical dominance of items within the diet, according to the following:

$$\%IP = \frac{\%FO \times \%W}{\sum (\%FO \times \%W)} \times 100$$

where: %FO = frequency of occurrence percentage; %W = weight percentage.

To establish the order of importance for the entire array of foods ingested (Mohan & Sankaran, 1988; Carrión-Cortez, 2010), was also calculated the weighted resultant index (Rw), according to the following:

$$Rw = \frac{Q\,(\%W^2 + \%FO^2)^{\frac{1}{2}}}{\sum Q\,(\%W^2 + \%FO^2)} \times 100$$

$$Q = \frac{45 - |\theta - 45|}{45}$$

$$\theta = tan^{-1}\left(\frac{Wi}{FOi}\right)$$

where: %FO = frequency of occurrence percentage; %W = weight percentage.

The Resultant weight index (Rw) can be graphically represented as a function of the θº angle. This index allows one to interpret the importance of each item considering the values of %W and %FO. Items with a uniform representation of %W and %FO have angles close to 45º. The values of the Rw vary between 0 and 100. Items with values close to 100 represent the most important item in the diet (Mohan & Sankaran, 1988; Carrión-Cortez, 2010).

RESULTS

We examined 27 digestive tracts of *C. mydas*. The sampled specimens were 100% juveniles (CCL = 53.7 ± 1.2 cm, range 40.5-67 cm) (Fig. 3). The largest number of digestive tracts collected were in the summer (January-March) and autumn (April-June), with a total of 12 and seven digestive tracts, respectively. Four digestive tracts were collected in both the winter (July-September) and spring (October-December).

Thirty-five food items were identified and grouped into six categories: algae, cnidarians, mollusks, arthropods, chordates and garbage/anthropogenic debris (Table 1, Fig. 2). Of all items identified, five had the highest frequency of occurrence (% FO): *Caulerpa filiformis* "thread-like algae" (77.8%), *Loligo gahi* "common squid" (eggs) (51.9%), *Rhodymenia corallina* "rose seaweed" (44.4%), *Gigartina chamissoi* "tongue-weed" (29.6%), and *Ulva lactuca* "sea lettuce" and *Gelidium congestum* "jelly-weed" (22.2% each). By weight (% W), green turtles consumed mainly five food items: *L. gahi* (eggs) (33.3%), *Stomolophus* sp. jellyfish (7.3%), *Aphos porosus* "monkfish" (6.5%), *R. corallina* (5.1%), and *Sinum cymba* (eggs) (4.6%).

According the Preponderance Index (%IP), during winter-spring, the only preponderant item was *L. gahi* (eggs) (6.1%), while during summer-autumn the preponderant items were *L. gahi* (eggs) (61.2%), *R. corallina* (16.7%), *G. chamissoi* (12.8%), *C. filiformis* (11.5%) and *Stomolophus* sp. (10.5%) (Table 1).

Prey items found varied seasonally (Table 2). The three most important items by season according to the weighted resulting index (Rw) were: *L. gahi* (eggs), *Hexaplex* sp. "rock snail" (egg capsules) and *Hepatus chilensis* "crabs" in winter; *C. filiformis*, *L. gahi* (eggs) and *Cronius ruber* "blackpoint sculling crab" in spring; *C. filiformis*, *L. gahi* (eggs) and *R. corallina* in summer; and *L. gahi* (eggs), *R. corallina*, *G. chamissoi* and *Pseudosquillopsis lessoni* "mantis shrimp" in autumn. Debris from anthropogenic activities, such as nylon monofilament, rope, and plastic bags, was common in the digestive tracts analyzed (56%). Within these garbage/anthropogenic debris items, plastic bags were the most common, with a FO of 44.4%.

The degree of importance of preys consumed by *C. mydas* for the study period, according to the weighted resulting index (Rw) in decreasing order was *C. filiformis*, *L. gahi* (eggs), *R. corallina*, Plastic, *G. chamissoi* and *U. lactuca* (Fig. 4).

DISCUSSION

The green turtle uses the Peru coast mainly as a foraging ground (Hays-Brown & Brown, 1982; Santillán, 2008; Quiñones *et al*., 2010, 2015b; Paredes *et al*., 2015). Bays along the coast offer protection and food resources for juvenile green turtles (Hatase *et al*., 2006; Vander *et al*., 2013). Sechura Bay and Paracas Bay are two areas identified in past studies as green turtle foraging areas (De Paz & Alfaro-Shigueto, 2008; Santillán, 2008; Cáceres *et al*., 2013). These bays have similar characteristics, such as shallow water and abundant algae and seagrasses that provide habitat for invertebrates, fish and mollusks (Paredes, 2015).

The size distribution of green turtles captured in Sechura Bay in this study corresponded to an immature population consisting of juveniles (100%). Our results suggest that this bay is likely to harbor juveniles almost exclusively. This may indicate that small green turtles spend more time in nearshore areas than larger sized individuals (Carrión-Cortez *et al*., 2010). Smaller turtles have higher relative energy demands than adults (Koch *et al*., 2007; Carrión-Cortez, 2010), and have been shown to prefer sheltered areas where net energy expenditure during foraging activities is less than in high-energy oceanic zones (Seminoff *et al*., 2003; Koch *et al*., 2007; Santillán, 2008).

Research conducted in Baja California (Mexico) indicates that the green turtle has an herbivorous diet, feeding on red algae, green and seagrass (Seminoff *et*

Table 1. Frequency of occurrence (%FO), weight percentage (%W) and weighted resultant index (Rw) and preponderance index (%IP[a] = winter-spring; %IP[b] = summer-autumn) of prey groups recovered from digestive tracts of *C. mydas* caught from Sechura Bay, 2013-2014 (n = 35).

Category/ Phylum	Item/Components	N	%FO	%W	Rw	%IP[a]	%IP[b]
Plantae	*Codium peruvianum*	5	18.5	1.1	3.1	0.1	0.7
	Rhodymenia corallina	12	44.4	5.1	7.5	0.1	16.7
	Ulva lactuca	6	22.2	2.1	3.7	0.1	2.5
	Caulerpa filiformis	21	77.8	2.6	13.1	0.2	11.5
	Eisenia cokeri	1	3.7	0.1	0.6	-	-
	Gelidium congestum	6	22.2	0.9	3.7	0.1	0.8
	Gigartina chamissoi	8	29.6	4.5	5.1	-	12.8
	Porphyra sp.	1	3.7	1.5	0.7	-	0.5
Cnidaria	*Stomolophus* sp.	4	14.8	7.3	2.8	-	10.5
Mollusca	Mytilidae	2	7.4	0.1	1.2	-	-
	Aplysia sp.	1	3.7	3.3	0.9	0.3	-
	Loligo gahi (eggs)	14	51.9	33.3	10.5	6.1	61.2
	Loligo gahi (individuals)	3	11.1	1.3	1.8	-	0.9
	Hexaplex sp. (egg capsules)	2	7.4	0.9	1.2	0.2	-
	Tagelus peruvianus	1	3.7	0.2	0.6	-	-
	Octopus sp.	3	11.1	2.9	1.9	-	3.2
	Sinum cymba (eggs)	3	11.1	4.6	2.1	-	4.9
Arthropoda	Portunidae	5	18.5	0.9	3.1	-	0.8
	Penaeidae	1	3.7	0.1	0.6	-	-
	Hepatus chilensis	3	11.1	0.6	1.9	0.2	-
	Acanthonyx petiverii	1	3.7	0.1	0.6	-	-
	Cronius ruber	2	7.4	0.4	1.3	0.1	-
	Pseudosquillopsis lessoni	5	18.5	3.6	3.2	-	6.2
Chordata	Actinopterygii	4	14.8	1.4	2.5	0.1	0.7
	Ascidiacea	2	7.4	2.2	1.3	-	1.6
	Odontesthes regia (eggs)	1	3.7	1.3	0.7	0.1	-
	Pyrosoma sp.	1	3.7	0.6	0.6	-	-
	Engraulis ringens	4	14.8	2.7	2.5	0.4	0.4
	Ophichthus pacifici	5	18.5	3.5	3.2	-	6.2
	Aphos porosus	3	11.1	6.5	2.2	-	7.0
	Normanichthys crockeri	3	11.1	3.1	1.9	-	3.3
	Urotrygon sp.	1	3.7	0.6	0.6	-	0.2
Garbage / anthropogenic debris	Plastic	12	44.4	1.2	7.4	0.2	1.9
	Feathers	3	11.1	0.1	1.9	-	-
	Rope	6	22.2	0.2	3.7	-	0.2

al., 2002a, 2002b; Koch *et al*., 2007; López-Mendilaharsu *et al*., 2008). This trend toward algae and/or sea grasses has also been well documented in adult green turtles in the Caribbean (Bjorndal, 1980). On the Pacific coast of South America, direct observations in the Galapagos Islands of sub-adult and adult green turtles indicated that they predominantly fed on algae, including *Ulva*, *Padina*, *Gellidium* and *Gracilaria* spp. (Green, 1994). Sampson *et al.* (2013) found in esophageal lavages of *C. mydas* juveniles at Gorgona National Park that the most abundance items were *Povillopora damicornis*, rhodoliths, *Cladophora* sp. and algae mats. However, in coastal waters of Peru, Hays-Brown & Brown (1982) in Pisco, found a significant amount of animal prey items (mollusks, polychaetes, jellyfish, amphipods, sardines and anchovies) in the stomach contents of sub-adult and adult green turtles, in addition to algae. In San Andres (Pisco), Quiñones *et al*. (2010) found in the stomach and esophagus of *C. mydas* that jellyfish was the most consumed prey item, followed by mollusks and macroalgae. This feeding behavior is similar to the present study, where *C. mydas* shows an omnivorous diet, composed mainly of items of animal origin (68.6%).

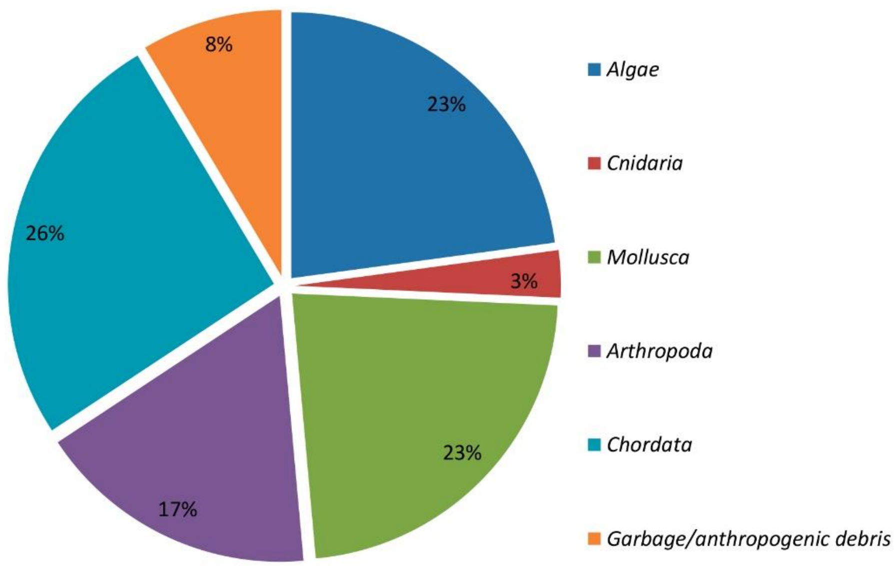

Figure 2. Proportion of items by taxonomic category (n = 35) present in 27 digestive tracts of *C. mydas* from Sechura Bay, 2013- 2014.

Table 2. The five most important food items found in digestive tracts of *C. mydas*, Sechura Bay, 2013-2014, represented by the frequency of occurrence percentage (% FO), weight percentage (%W) and weighted resultant index (Rw) by seasons. N = number of digestive tracts by seasons.

Season	Items	O	%FO	%W	Rw
Winter N = 4	*Loligo gahi* (eggs)	3	75	66.4	20.2
	Hexaplex sp. (eggs capsules)	2	50	7.2	10.1
	Plastic	2	50	3.5	9.9
	Hepatus chilensis	2	50	1.5	9.9
	Odontesthes regia (eggs)	1	25	9.7	5.4
Spring N = 4	*Caulerpa filiformis*	4	100	3	15.9
	Loligo gahi (eggs)	2	50	38.1	10.2
	Cronius ruber	2	50	2.5	7.9
	Gelidium congestum	2	50	2.4	7.9
	Plastic	2	50	0.7	7.9
Summer N = 12	*Caulerpa filiformis*	12	100	5.5	17.3
	Loligo gahi (eggs)	5	41.7	42.1	10.4
	Plastic	7	58.3	2.4	10.1
	Rhodymenia corallina	6	50	2.2	8.6
	Ophichthus pacifici	4	33.3	12.4	6.2
Autumn N = 7	*Loligo gahi* (eggs)	4	57.1	17.5	8.9
	Rhodymenia corallina	4	57.1	8.8	8.6
	Gigartina chamissoi	4	57.1	8.4	8.6
	Pseudosquillopsis lessoni	4	57.1	7.2	8.6
	Caulerpa filiformis	4	57.1	1.2	8.5

Early studies of the diet of *C. mydas* suggested macroalgae as their main prey item (Bjorndal, 1997), with the genus *Codium* and *Rhodymenia* extensively reported as diet components (López-Mendilaharsu *et al*., 2005; Rodríguez, 2010). In Paracas, De Paz *et al*., (2007) reported algae consumption of the genus *Ulva* in greater proportion. Our analysis reported algae consumption in all seasons, including *Caulerpa filiformis*, *Rhodymenia corallina*, *Codium peruvianum* and *Ulva lactuca*. The most important of these according to the Resultant Weighted Index was *C. filiformis* (Rw= 13.1%).

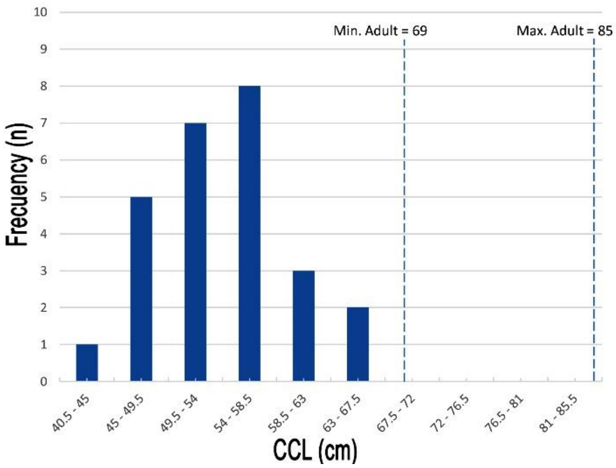

Figure 3. Size-classes of *C. mydas* captured in the Sechura Bay, 2013-2014. The dotted lines represent the minimum and average size reported for green turtle adults in the Galapagos Islands, the largest nesting colony of *C. mydas* near Peru (Source: Galapagos Islands size data).

Santillán (2008) analyzed 11 stomach contents from Sechura Bay and reported the highest values of frequency of occurrence for *Gracilaria* sp. (37.8%), *C. filiformis* (35.6%), *Codium* sp. (33.3%), and eggs of *Loligo gahi* (22.2%). Quiñones *et al*. (2010) found in 192 stomach and esophagus samples from San Andres (Pisco) that the most frequently consumed prey items were jellyfish (70.8%), mollusks (62%), crustaceans (47.4%) and macroalgae (37.5%). Our study also reports *C. filiformis* (74.2%) and *L. gahi* (eggs) (48.4%), but both at approximately twice the frequency reported by Santillán (2008).

Alfaro-Shigueto *et al*. (2004) examined 11 stomach contents from Chimbote Bay, and in seven found fish eggs, squids, *Engraulis ringens* "anchovy" and brachiopods. Hays-Brown & Brown (1982) analyzed 39 stomach contents and reported the occurrence of fish in 23% (mainly sardines, anchovies and fish eggs). Santillán (2008) also reported the presence of engraulids, especially serranids and carangids. In the Virrilá estuary in Sechura Bay, Quiñones (*Pers. comm.*) found great percentages of fish like *Mugil cephalus* "mullet" and a smaller percentage of *Anchoa nasus* "white anchovy" in stomach contents of green turtles. Our results indicate a %FO of 59.3% for fishes. This includes both bony fishes like *E. ringens*, elasmobranchs of the genus *Urotrygon* "round ray" and fish eggs from *Odontesthes regia* "silverside". This indicates that consumption of fish is important in the diet of *C. mydas*.

Invertebrates comprised 43% of the total abundance of items in the stomachs analyzed here. Some invertebrates were found only once (*Aplysia* sp. "sea slug" and *Tagelus peruvianus* "saltwater clams") and did not warrant consideration as a major diet item (Rw = 0.85 and Rw = 0.62 respectively). Hays-Brown & Brown (1982) found crustaceans in five of 39 stomach contents examined, representing a %FO of 13%. Likewise, Alfaro-Shigueto *et al*. (2004) found crustaceans (*Hyperia medusarum*, *Euphylax dovii*) in four of 11 stomach contents analyzed. In our study, Crustacea was reported for 14 digestive tracts (51.9%), consisting mainly of *Pseudosquillopsis lessoni* and Portunidae. This represents FO values of 18.5% each, but only *P. lessoni* had a value as weight (3.5%).

In another part of their investigation, Hays-Brown & Brown (1982) found mollusks (%FO = 64%), mainly *Nassarius*, *Mytilus* and *Semele* in 25 stomach contents. Alfaro-Shigueto *et al*. (2004), found Nudibranquia eggs, *Aplysia* sp., *Sinum cymba*, *Chione* sp., *Natica* sp., *Nassarius grayi*, *Mactra* sp., *Semimytilus algosus* and other mytilids in 10 of 11 stomach contents analyzed. In our research, mollusks were found in 18 digestive tracts (66.7%). High FO and weight values were found for eggs of *L. gahi* (51.9% and 33.3% respectively), followed by eggs of *S. cymba* (11.1% and 4.6% respectively).

A study in Magdalena Bay (Mexico) reported changes in prey diversity in juvenile turtle diets which coincided with seasonal changes in vegetal biomass (López-Mendilaharsu *et al*., 2008). Similary, Santillán (2008) reported that the herbivorous diet would predominate during spring and summer, while the carnivorous diet would increase during autumn and winter. Our results show that green turtles consumed *L. gahi* (eggs) throughout the year but, mainly during summer-autumn (%IP = 61.2%). This could be due to their seasonally high abundance in Sechura Bay (IMARPE, 2007) which in turn could be explained by the *L. gahi* (eggs) spawning seasons which peak in spring or early of summer and autumn (Villegas, 2001).

It has been suggested that the dominance of some food items over others could be related to increased algae abundance and that algae are the habitat of diverse organisms favoring their proliferation (Paredes, 2015; Gribben *et al*., 2009). Box (2008) stated that algae from the *Caulerpa* genus favors the growth of various organisms, mollusks in particular. Our work provides support for this assertion because *C. filiformis* and *L. gahi* (eggs) were mostly found in the same samples. Both items had high Resultant Weighted Index values (Rw) (*C. filiformis* = 13.1% and *L. gahi* (eggs) = 10.5%), and were the most important items in the *C. mydas* diet observed in our study.

During winter-spring, according the Preponderance Index (%IP), the only preponderant item was *L. gahi* (eggs) (6.1%), while during summer-autumn the prepon-

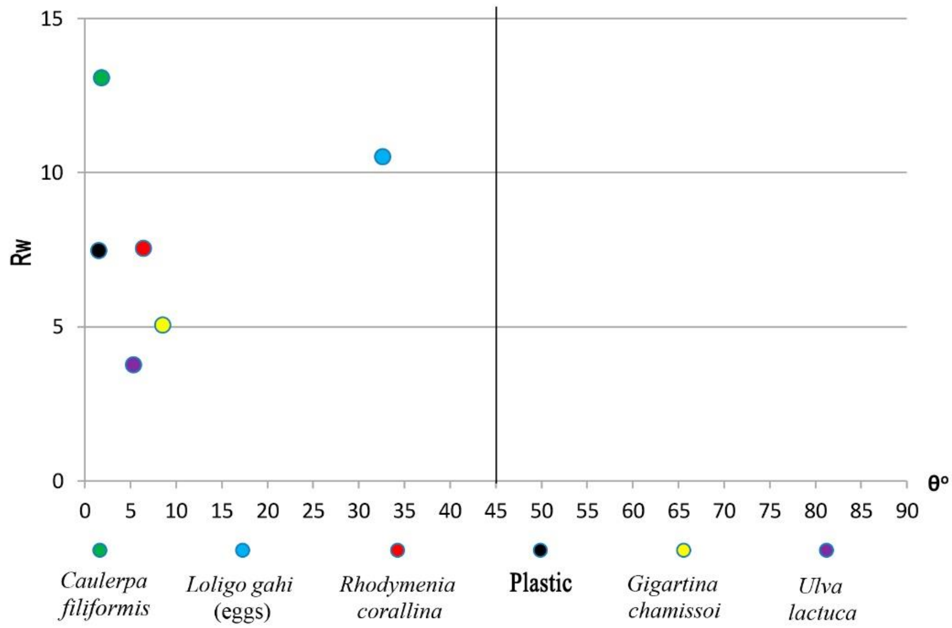

Figure 4. Weighted Resultant Index (Rw) plotted against the angle for food items in digestive tracts of *C. mydas* from Sechura Bay, 2013-2014. Food items with uniform representation in both values, %W and %FO fall around the 45°, whereas those with uneven representation spread on either side of the middle line (close to 0°: high %FO and less %W; close to 90°: high %W and less %FO).

derant items were *L. gahi* (eggs) (61.2%), *R. corallina* (16.7%), *G. chamissoi* (12.8%), *C. filiformis* (11.5%) and *Stomolophus* sp. (10.5%). This could be due, because during winter-spring the green turtle individuals go somewhere close like Virrilá estuary to feed on great percentages of *M. cephalus* "mullet", *Ulva* spp. and *A. nasus* "anchovy white" (Paredes, *unpubl. data*) whereas during summer-autumn go out of estuary to feed of mentioned items.

In the present study, 55.6% of digestive tracts analyzed contained garbage and/or anthropogenic debris. The materials found include: plastic (bags/ packing) and rope the majority of which was found in the final portion of the intestine. Marine debris is a growing problem for wildlife. It has been documented to affect more than 267 species worldwide (Schuyler *et al*., 2012) and can have lethal and sub-lethal effects on sea turtles and other wildlife (Schuyler *et al*., 2013). The occurrence of debris from anthropogenic activities (especially plastic bags) in digestive tracts of *C. mydas* has been reported since the 1980's (Schuyler *et al*., 2012). In Peru, a study from Chimbote reported plastic bags and traces of nylon in 91% of stomach contents analyzed (Alfaro-Shigueto *et al*., 2004). In Sechura, Santillán (2008) reported that green turtle stomach contents contained approximately 26.7% plastic debris. The high incidence of garbage and anthropogenic debris found in green turtles in our study may reflect the pollution of areas within the bay due to human presence and activities (*e.g.*, coastal community proximity, mariculture area, fisheries).

CONCLUSIONS AND RECOMMENDATIONS

Our results highlight the importance of neritic habitats, especially bays, as key habitats for the development of juvenile and sub-adult green turtles in the Eastern Pacific Ocean. Juvenile of *C. mydas* in Sechura Bay had an omnivorous diet and foraged on a variety of resources, but mainly on animal prey items like mollusks, arthropods and chordates. They did not appear to focus on any particular prey species. Future research could include a detailed assessment of the composition of species in the benthic areas of Sechura Bay, including their spatial and temporal distributions. Future use and development of bay areas, including of Sechura Bay, should take into account the vital role these habitats play in the development of juvenile green turtles. We recommend conducting complementary studies to characterize and quantify marine debris and formulating management plans toward reducing plastics pollution in Sechura Bay. Species like the green turtle can also be used as sentinels for biodiversity and pollution within bays and coastal areas.

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REFERENCES

Acleto, C. & R. Zúñiga. 1998. Introducción a las algas. Editorial Escuela Nueva, Lima, 383 pp.

Álamo, V. & V. Valdivieso. 1997. Lista sistemática de Moluscos Marinos del Perú. Instituto del Mar del Perú, Callao, 183 pp.

Alfaro-Shigueto, J., M. Van Bressem, D. Montes & K. Onton. 2002. Turtle mortality in fisheries off the coast of Peru. In: A. Mosier, A. Foley & B. Brost (eds.). Proceedings of the Twentieth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Tech. Memo. NMFS-SEFSC-477, 369 pp.

Alfaro-Shigueto, J., D. Montes, C. Acleto, R. Zuñiga & P. Huamán. 2004. Diet analysis from green turtle Chelonia mydas agassizii from central Peruvian Coast. In: M. Coyne & R. Clark (eds.). Proceedings of the Twenty-first Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-528, 368 pp.

Alfaro-Shigueto, J., J. Mangel, M. Pajuelo, P. Dutton, J. Seminoff & B. Godley. 2010. Where small can have a large impact: Structure and characterization of small-scale fisheries in Peru. Fish. Res., 106: 8-17.

Alfaro-Shigueto, J., J. Mangel, F. Bernedo, P. Dutton, J. Seminoff & B. Godley. 2011. Small-scale fisheries of Peru: a major sink for marine turtles in the Pacific. J. Appl. Ecol., 48: 1432-1440.

Amorocho, D. & R. Reina. 2007. Feeding ecology of the East Pacific green sea turtle *Chelonia mydas agassizii* at Gorgona National Park, Colombia. Endang. Species Res., 3: 43-51.

Amorocho, D. & R. Reina. 2008. Intake passage time, digesta composition and digestibility in East Pacific green turtles (*Chelonia mydas agassizii*) at Gorgona National Park, Colombian Pacific. J. Exp. Mar. Biol. Ecol., 360: 117-124.

Aranda, C. & M. Chandler. 1989. Las tortugas marinas del Perú y su situación actual. Bol. Lima, 62: 77-86

Bjorndal, K. 1980. Nutrition and grazing behavior of the green turtle *Chelonia mydas*. Mar. Biol., 56: 147-154.

Bjorndal, K. 1997. Foraging ecology and nutrition of sea turtles. In: P. Lutz & J. Musick (eds.). The biology of sea turtles. CRC Press, Boca Raton, pp. 137-164.

Bolten, A. 2000. Técnicas para la medición de tortugas marinas. In: K. Eckert, K. Bjorndal, F. Abreu-Grobois & M. Donnelly (eds.). Técnicas de investigación y manejo para la conservación de las tortugas marinas. Traducida al español. UICN/CSE Grupo Especialista en Tortugas Marinas, pp. 126-131.

Boyle, M. & C. Limpus. 2008. The stomach contents of post-hatchling green and loggerhead sea turtles in the southwest Pacific: an insight into habitat association. Mar Biol., 155: 233-241.

Box, A. 2008. Ecología de caulerpales: fauna y biomarcadores. Tesis Doctoral, Instituto Mediterráneo de Estudios Avanzados, Universidad Islas Baleares, Palma, 335 pp.

Cáceres, C., J. Alfaro-Shigueto & J. Mangel. 2013. Green turtle captured in net fisheries in the Port of Constante, Peru. In: J. Blumenthal, A. Panagopoulou & A. Rees (eds.). Proceedings of the Thirtieth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Tech Memo NMFS-SEFSC-640, 177 pp.

Carrión-Cortez, J., P. Zárate & J. Seminoff. 2010. Feeding ecology of the green sea turtle (*Chelonia mydas*) in the Galapagos Islands. Mar. Biol. Assoc. UK, 1: 1-9.

Chirichigno, N. 1974. Clave para identificar los peces marinos del Perú. Informe Instituto del Mar del Perú, Callao, Informe 44, 108 pp.

Chirichigno, N. & R. Cornejo. 2001. Catálogo comentado de los peces marinos del Perú. Instituto del Mar del Perú, Publicación especial, Callao, 314 pp.

De Paz, N., J. Reyes & M. Echegaray. 2004. Capture and trade of marine turtles at San Andres, Southern Peru. In: M. Coyne & R. Clark (eds.). Proceedings of the Twenty-First Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS–SEFSC-528: pp. 52-54.

De Paz, N. & J. Alfaro-Shigueto. 2008. Foraging grounds for sea turtles in inshore Peruvian waters. In: H. Kalb, A. Rohde, K. Gayheart & K. Shanker (eds.). Proceedings of the Twenty-Fifth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-582, 204 pp.

De Paz, N., J. Reyes, M. Echegaray, M. Ormeño & H. Anchante. 2007. Identificación y manejo de hábitats críticos de tortugas marinas en Perú: Paracas, estudio de caso. In: C. Guerra-Correa, A. Fallabrino, P. Bolados-

Díaz & C. Turner (eds.). VII Simposio sobre Medio Ambiente. Estado actual y perspectivas de la investigación y conservación de las tortugas marinas en las costas del Pacífico Sur-Oriental. [http://www.seaturtle.org/documents/VII_Simp_Medio_Ambiente.pdf]. Reviewed: 10 September 2016.

Food and Agriculture Organization (FAO). 2011. Directrices para reducir la mortalidad de las tortugas marinas en las operaciones de pesca. Food and Agriculture Organization, Roma, 132 pp.

Gilman, E., E. Zolett, S. Beverly, H. Nakano, K. Davis, D. Shiode, P. Dalzell & I. Kinan. 2006. Reducing sea turtle by-catch in pelagic longline fisheries. Fish. Fish., 7: 2-23.

Gilman, E., J. Gearhart, B. Price, S. Eckert, H. Milliken, J. Wang, Y. Swimmer, D. Shiode, O. Abe, S. Peckham, M. Chaloupka, M. Hall, J. Mangel, J. Alfaro-Shigueto, P. Dalzell & A. Ishizaki. 2010. Mitigating sea turtle bycatch in coastal passive net fisheries. Fish. Fish, 11: 57-88.

Green, D. 1994. Galapagos sea turtles: an overview. In: B. Schroeder & D. Witherington (eds.). Proceedings of the Thirteenth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFSC-SEFSC-341, Jekyll Island, GA, pp. 65-68.

Gribben, P., J. Byers, M. Clements, L. McKenzie, P. Steinberg & J. Wright. 2009. Behavioural interactions between ecosystem engineers control community species richness. Ecol. Lett., 12(11): 1127-1136.

Guiry, M. & G. Guiry. 2015. Algae Base. World-wide electronic publication, National University of Ireland, Galway. [http://www.algaebase.org]. Reviewed: 15 September 2016.

Hays-Brown, C. & W. Brown. 1982. Status of sea turtles in the South Eastern Pacific: emphasis on Peru. In: K. Bjorndal (ed.). Biology and conservation of sea turtles. Smithsonian Institution Press, Washington DC, pp. 235-240.

Hatase, H., K. Sato, M. Yamaguchi, K. Takahashi & K. Tsukamoto. 2006. Individual variation in feeding habitat use by adult female green sea turtles (*Chelonia mydas*): are they obligately neritic herbivores? Oecologia, 149(1): 52-64.

Instituto del Mar del Perú (IMARPE). 2007. Estudio de línea base del ámbito marino de la Bahía de Sechura, Perú. Instituto del Mar del Perú, Callao, 116 pp.

Instituto del Mar del Perú (IMARPE). 2011. Informe nacional sobre la conservación de las tortugas marinas en el Perú. Instituto del Mar del Perú, Callao, 72 pp.

Jacobson, E. 2000. Toma de muestras de tejidos y técnicas para la necropsia. In: K. Eckert, K. Bjorndal, F. Abreu-Grobois & M. Donnelly (eds.). Técnicas de investigación y manejo para la conservación de las tortugas marinas. Traducida al español. UICN/CSE Grupo Especialista en Tortugas Marinas, 4: 246-250.

Kelez, S., C. Manrique, X. Velez-Suazo & M. Williams. 2004. Green turtle (*Chelonia mydas agassizii*) diet differences in two Peruvian coastal localities. In: M. Coyne & R. Clark (eds.). Proceedings of the Twenty-First Annual Symposium in Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS SEFSC-528: 368 pp.

Koch, V., L. Brooks & W. Nichols. 2007. Population ecology of the green/black turtle (*Chelonia mydas*) in Bahia Magdalena, Mexico. Mar. Biol., 153: 35-46.

Lemons, G., R. Lewison, L. Komoroske, A. Gaos, C. Lai, P. Dutton, T. Eguchi, R. LeRoux & J. Seminoff. 2011. Trophic ecology of green sea turtles in a highly urbanized bay: insights from stable isotopes and mixing models. J. Exp. Mar. Biol. Ecol., 405: 25-32.

López-Mendilaharsu, M., S. Gardner, J. Seminoff, & R. Riosmena-Rodríguez. 2005. Identifying critical foraging habitats of the green turtle (*Chelonia mydas*) along the Pacific coast of the Baja California Peninsula, Mexico. Aquat. Conserv. Mar. Freshw. Ecosyst., 15: 259-269.

López-Mendilaharsu, M., S. Gardner, R. Riosmena-Rodríguez & J. Seminoff. 2008. Diet selection by immature green turtles (*Chelonia mydas*) at Bahia Magdalena foraging ground in the Pacific coast of the Baja California Peninsula, México. J. Mar. Biol. Assoc. UK, 88(3): 641-647.

Márquez, R. 1990. Sea Turtles of the World. An annotated and illustrated catalogue of the sea turtle species known to date. FAO Fisheries Synopsis. Rome, 125(11): 81 pp.

Méndez, M. 1981. Claves de identificación y distribución de los langostinos y camarones (Crustacea: Decapoda) del mar y ríos de la costa del Perú. Boletín Instituto del Mar del Perú, Callao, 172 pp.

Mendo, J. (ed.). 2011. Libro de Resúmenes del Seminario Bases Científicas para el Manejo y Repoblamiento de la Concha de Abanico en la Bahía de Sechura. Universidad Nacional de Piura (UNP) el día 11 de noviembre del 2010. Proyecto FINCYT-UNALM, 65 pp.

Mendo, J., M. Wolff, W. Carbajal, I. Gonzáles & M. Badjeck. 2008. Manejo y explotación de los principales bancos naturales de concha de abanico (*Argopecten purpuratus*) en la costa peruana. In: A. Lovatelli, A. Farías & I. Uriarte (eds.). Estado actual del cultivo y manejo de moluscos bivalvos y su proyección futura: factores que afectan su sustentabilidad en América Latina. Taller Técnico Regional de la FAO. Chile. FAO Actas de Pesca y Acuicultura, Roma, pp. 101-114.

Mohan, M. & T. Sankaran 1988. Two new indices for stomach content analysis of fishes. J. Fish. Biol., 33: 289-292.

Morón, O., F. Velazco & L. Beltrán. 2013. Características hidrográficas y sedimentológicas de la Bahía de Sechura. Inf. Inst. Mar Perú, 40(3-4): 150-159.

Moscoso, V. 2012. Catálogo de Crustáceos Decápodos y Estomatópodos del Perú. Bol Inst. Mar Perú, Callao, 27(1-2): 1-212.

Moscoso, V. 2013. Clave para identificación de crustáceos decápodos y estomatópodos del Perú. Boletín Instituto del Mar del Perú, Callao, Perú, 28(1-2): 1-135.

Musick, J. & C. Limpus. 1997. Habitat utilization and migration in juvenile sea turtles. In: P. Lutz, J. Musick & J. Wyneken (eds). The biology of sea turtles 1. CRC Press, New York, pp. 137-163.

Ortiz, N., J. Mangel, J. Wang, J. Alfaro-Shigueto, S. Pingo, A. Jiménez, T. Suarez, Y. Swimmer, F. Carvalho & B. Godley. 2016. Reducing green turtle bycatch in small-scale fisheries using illuminated gillnets: the cost of saving a sea turtle. Mar Ecol. Prog. Ser., 545: 251-259.

Paredes, E. 2015. Hábitos alimentarios de la tortuga verde del pacífico este *Chelonia mydas agassizii* (Boucort, 1868) en la Bahía de Paracas, Ica, Perú, durante el año 2010. Tesis Licenciatura, Universidad Nacional Mayor de San Marcos, Lima, 69 pp.

Paredes, E., J. Quiñones, S. Quispe & V. Bachmann. 2015. Black and hawksbill turtle strandings in estuarine waters in the peruvian Northern coast. In: Y. Kaska, B. Sonmez, O. Turkecan & C. Sezgin (eds.). Book of Abstracts of 35th Annual Symposium on Sea Turtle Biology and Conservation. Macart Press, Turkey, 250 pp.

Plotkin, P., M. Wicksten & A. Amos. 1993. Feeding ecology of the loggerhead sea turtle *Caretta caretta* in the Northwestern Gulf of Mexico. Mar. Biol., 115: 1-5.

Quiñones, J., V. Gonzales, J. Zeballos, S. Purca & H. Mianzan. 2010. Effects of El Niño-driven environmental variability on blackturtle migration to Peruvian foraging grounds. Hydrobiologia, 645: 69-79.

Quiñones, J., I. García-Godos, M. Llapapasca, F. Van Oordt, & E. Paredes. 2015a. The Black Sea turtle (*Chelonia mydas agassizii*) at Lobos de Tierra Island, Northern Peru: high densities in small areas. South Am. J. Herpetol., 10(3): 178-186.

Quiñones, J., E. Paredes, S. Quispe & L. Delgado. 2015b. Tortugas marinas durante el 2010 en Pisco, Perú. Inf. Inst. Mar Perú, 42(4): 516-525.

Rodríguez, J. 2010. Afinidad trófica a zonas de alimentación de la tortuga verde (*Chelonia mydas*) en la costa occidental de Baja California Sur, México. La Paz, Baja California Sur. Tesis Maestría, Instituto Politécnico Nacional, La Paz, 98 pp.

Rosales, C., M. Vera & J. Llanos. 2010. Varamientos y captura incidental de tortugas marinas en el litoral de Tumbes, Perú. Rev. Peru Biol., 17(3): 293-301.

Sampson, L. & A. Giraldo. 2014. Annual abundance of salps and doliolids (Tunicata) around Gorgona Island (Colombian Pacific), and their importance as potential food for green sea turtles. Rev. Biol. Trop., 62(1): 149-159.

Sampson, L., A. Giraldo & D. Amorocho. 2013. Diet, food availability and selectivity of *Chelonia mydas* juveniles at Gorgona National Park, Colombian Pacific. In: T. Tucker, L. Belskis, A. Panagopoulou, A. Rees, M. Frick, K. Williams, R. LeRoux & K. Stewart (eds.). Proceedings of the Thirty-third Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NOAA NMFS-SEFSC-645: 263 pp.

Santillán, L. 2008. Análisis de la dieta de *Chelonia mydas agassizii* "tortuga verde del Pacífico" en la Bahía de Sechura, Piura-Perú. Tesis de Magister, Universidad Agraria La Molina, Lima, 70 pp.

Schuyler, Q., B. Hardesty, C. Wilcox & K. Townsend. 2012. To eat or not to eat? Debris selectivity by marine turtles. PLoS ONE, 7: 7 pp.

Schuyler, Q., B. Hardesty, C. Wilcox & K. Townsend. 2013. Global analysis of anthropogenic debris ingestion by sea turtles. Conserv. Biol., 28: 129-139.

Seminoff, J., A. Reséndiz & W. Nichols. 2002a. Home range of the green turtle (*Chelonia mydas*) at a coastal foraging ground in the Gulf of California, México. Mar. Ecol. Progr. Ser., 242: 253-265.

Seminoff, J., A. Reséndiz & W. Nichols. 2002b. Diet of East Pacific green turtles (*Chelonia mydas*) in the Central Gulf of California, Mexico. J. Herpetol., 36(3): 447-453.

Seminoff, J., T. Jones, A. Reséndiz, W. Nichols & M. Chaloupka. 2003. Monitoring green turtles (*Chelonia mydas*) at a coastal foraging area in Baja California, Mexico: multiple indices describe population status. Mar. Biol. Assoc. UK, 83: 1355-1362.

Troncoso-Fierro, F. & B. Urbina-Burgos. 2007. Actualización del registro de tortugas marinas para el sur de Chile. In: C. Guerra-Correa, A. Fallabrino, P. Bolados-Díaz & C. Turner (eds.). Libro de Resúmenes VII Simposio Sobre Medio Ambiente. Estado Actual y Perspectivas de la Investigación y Conservación de las Tortugas Marinas en las Costas del Pacífico Sur Oriental, Antofagasta. Available at: [http://www.seaturtle.org/documents/VII_Simp_Medio_Ambiente.pdf]. Reviewed: 22 August 2016.

Tume, J., A. Ibaceta, M. Cortez & J. Santisteban. 2012. Recursos de la zona béntica de la bahía de Sechura. Ciencia y Desarrollo, 15(1): 50 pp.

Vander, H., K. Arthur, A. Bolten, B. Popp, C. Lagueux, E. Harrison, C. Campbell & K. Bjorndal. 2013. Trophic ecology of a green turtle breeding population. Mar Ecol. Prog. Ser., 476: 237-249.

Velez-Zuazo, X., J. Quiñones, A. Pacheco, L. Klinge, E. Paredes, S. Quispe & S. Kelez. 2014. Fast growing, healthy and resident green turtles (*Chelonia mydas*) at two neritic sites in the Central and Northern Coast of Peru: implications for conservation. PLoS ONE, 9(11): 1-12.

Villegas, P. 2001. Aspectos biológicos-pesqueros del "calamar común", *Loligo gahi* d'Orbigny, 1835 en el área del Callao durante 1996 y 1997. Tesis Biología, Universidad Nacional Mayor de San Marcos, Lima, 84 pp.

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Work, T. 2000. Manual de necropsias de tortugas marinas para biólogos en refugios o areas remotas. U.S. Geological Survey, National Wildlife Health Center. Hawaii. [https://www.nwhc.usgs.gov/hfs/Globals/Products/Turtle%20manual%20spanish.pdf]. Reviewed: 10 December 2016.

Wyneken, J. 2001. The Anatomy of sea turtles. U.S. Department of Commerce NOAA Technical Memorandum NMFS-SEFSC, 172 pp.

Zárate, P., K. Bjorndal, M. Parra, P. Dutton, J. Seminoff & A. Bolten. 2013. Hatching and emergence success in green turtle *Chelonia mydas* nests in the Galápagos Islands. Aquat. Biol., 19: 217-229. [http://www.int-res.com/articles/ab2013/19/b019p217pdf]. Reviewed: 20 August 2016.