DISTRIBUTION, STATUS AND CONSERVATION OF REPTILIAN FAUNA IN THE COASTAL AREAS OF KARACHI WITH SPECIAL REFERENCE TO MARINE TURTLES

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Abstract

During the period from 2014 to 2017, distribution, status and conservation of reptilian fauna in the coastal areas of Karachi with special reference to marine turtles have been studied. In this study only Green turtle (*Chelonia mydas*) has been recorded from the selected study areas viz. Sandspit, Hawkesbay and Cape Monze. Nine species of lizards viz. Common tree lizard (*Calotes versicolor versicolor*), Spotted barn gecko (*Hemidactylus brookii*),Yellow belly common house gecko (*Hemidactylus flaviviridis*), Persian house gecko (*Hemidactylus persicus*), Blotched house gecko (*Hemidactylus triedrus*), Mediterranean house gecko (*Hemidactylus turcicus*), Blue tail sand lizard (*Acanthodactylus cantoris*), Spotted lacerta *(Mesalina watsonana*) and Bengal monitor (*Varanus bengalensis*) were recorded from Sandspit, Hawkesbay and Cape Monze. Five species of Sea snakes viz. Blotched diadem snake (*Sphalerosophis diadema diadema*), Blue green sea snake (*Hydrophis caerulescens*), Annulated sea snake (*Hydrophis cyanocinctus*), Yellow sea snake (*Hydrophis spiralis*) and Spotted small headed sea snake (*Microcephalophis cantoris*) were recorded from Sandspit, Hawkesbay and Cape Monze. Two species of terrestrial snakes viz. Cliff racer (*Platyceps rhodorachis*) and Saw scaled viper (*Echis carinatus*) were also recorded from Karachi coast. The population of reptilian species at Karachi coast is declining due to disturbance by anthropogenic activities, construction and developmental activities on beach front land, inappropriate management and fishing activities.

Keywords: Karachi coast, reptilian fauna, nesting, distribution, status.

INTRODUCTION

The coast of Pakistan is 1050 kilometers long extending from Sir Creek to Karachi coast in Sindh to Iranian border along with Makran coast in Balochistan province. In Sindh, the coast line is 250 km long and Balochistan coast is 850 km long (Khan *et al.*, 2010).

Climatic condition of the coastal areas of Sindh is the tail end of the Southwest monsoon and Balochistan is Mediterranean (IUCN, 2004). Average rainfall in the coastal areas is 10-20cm. Wind speed during Southwest monsoon (May-September) is about 25 nautical miles and during Northeast monsoon (November-March) is about 5-10 nautical miles. Temperature ranges from a minimum of 20^{o}C in December to maximum of 36.8^{o}C in May. The Hub River enters the Arabian Sea a few km North of Cape Monze (Khan *et al.*, 2010).

Reptiles form an important part of ecosystem. They are used as a source of protein in different parts of the world. Some species of reptiles are used for medicinal purposes to cure certain diseases. Skin of certain reptilian species is also used commercially for making different valuable items.

Karachi coastal area is the suitable habitat of reptilian fauna including marine turtle species, lizards and snakes. Manora, Sandspit, Hawkesbay and Cape Monze are the important habitats of reptilian fauna at Karachi coast. The topography of the coast is marine, muddy, sandy and rocky. Sandy beaches of the Karachi coast are the suitable nesting grounds of marine turtle species.

One hundred and seventy nine species of reptiles were found in Pakistan including turtles, tortoises, crocodiles, gavials, lizards and snakes (Rehman and Iffat, 1997). Marine turtle species, including Green turtle (*Chelonia mydas*), Olive ridley turtle (*Lepidochelys olivacea*), Hawksbill turtle (*Eretmochelys imbricata*), Loggerhead turtle (*Caretta caretta*) and Leatherback turtle (*Dermochelys coriacea*) were reported from the coast of Pakistan (Ghalib and Zaidi, 1976; Groombridge, 1982, 1987a, 1987b, 1989; Firdous, 1986, 1988; Kabraji and Firdous, 1984; Groombridge *et al*., 1988; Asrar,1999; Khan *et al.,* 2005; Khan and Ghalib, 2006; Iffat, 2009).

Six families of lizards found in Pakistan including Geckonidae, Agamidae, Chameleonidae, Scincidae, Lacertidae and Varanidae (Boulenger, 1890; Khan and Mirza, 1977; Ghalib *et al*., 1981; Iffat and Auffenberg, 1988; Auffenberg *et al*., 1989, 1991; Khan and Nazia, 2003; Khan *et al*., 2005; Khan, 2006).

Seventy four species of snakes were recorded from Pakistan, out of which 26 species are poisonous and 48 are non-poisonous snakes. Among 26 poisonous species of snakes there are 14 sea snake and 12 land snake species Khan *et al.* (2010).

Several studies related to herpetology of Pakistan contributed by Boulenger (1890), Minton (1966), Mertens (1969), Khan and Mirza (1977), Ghalib *et al*. (1981), Iffat and Auffenberg (1988), Auffenberg *et al*. (1989, 1991), Khan and Nazia (2003), Khan *et al*. (2005), Khan (2006).

The objective of present study is to investigate the distribution, status and conservation of the reptilian fauna in the coastal areas of Karachi with special reference to marine turtles.

MATERIALS AND METHODS

Study Site: Sandspit**,** Hawkesbay and Cape Monze areas with intertidal zone at the Karachi coast were selected as study sites (Fig. 1). Following methods were used for the observations.

DIRECT COUNTING METHODS

Transect method/ Habitat searching: This method was useful for the observation of marine turtle species, lizards and snakes. Most of the lizards were active at day time while the snakes were active both in day and at night. Female turtles visit the nesting ground at night for nesting. Tracks count and nesting pits along with direct observations of Green turtle (*C. mydas*) were made for the population status (Fig. 4 and 5). Lizards were found under the heap of waste material such as styrofoam, plastic material and debris usually thrown by people come to coastal areas for picnic (Fig. 2 and 3).

Incidental sightings: Incidental sightings were also helpful to determine the population status of different reptilian species at the coast of Karachi. Observations of animal sighting were recorded on a data sheet with name and number of species, date, time and habitat type. Green turtle (*C. mydas*) found in the sandy beaches of Sandspit and Hawkesbay for nesting while lizards were usually found basking on sand, stones or in potential habitat (Fig.3).

Sea snakes were seen near the edge of water and sometimes observed in backwaters of Sandspit.

Hand capturing: This method was used to capture lizards from micro habitat such as heap of litter in the form of bushes or sometimes from barks of trees (Fig. 3). A torch was used for seeing small lizards in cracks, holes and cervices. Hatchlings of Green turtle (*C. mydas*) were captured from marine turtle hatcheries and released into the sea (Fig. 6 and 7).

A venomous snake was caught with the help of two or three persons from the habitat by pinning behind its head, using a 'Y' shaped stick with some padding in the fork. A large forceps also manipulated in capturing a snake.

Noosing: In this method a long stick with a loop of string was used. The long stick is used to capture lizard species without getting close to it. The loop of string can be tightened around the neck of lizard and then catch it. This method was used to catch varanids and agamas when they bask or sleep in areas which are difficult to reach such as in the canopy and on large stones.

Trapping: This method is used to catch small terrestrial reptiles. In this method a pitfall trap was used consisting of a bucket sunk into the ground and its lip was covered with a layer of leaf-litter or some other waste material so that animals could fall in. The pitfall trap attracts small insects and other arthropods to trap, which could be used as a bait for lizard.

Lizards were also seen moving and resting on the ground. They became alert with a little movement of observer and ran away swiftly for hiding themselves. Snakes were also observed on rocks and in cervices.

INDIRECT COUNTING METHODS

Some other methods were also used for collecting the information about reptilian fauna of the coast of Karachi.

1. Information from different sources: Information about coastal reptilian species were collected from different sources such as Sindh Wildlife Department (SWD),WWF Pakistan, IUCN Regional office, Marine Biological Research and Laboratories, local fishermen, boatmen, members of local community and people of different villages residing near the coast of Karachi.

2. Presence of signs like footprints/ tracks: Footprints or tracks of reptilian species were also observed which show their existence, range and the population status (Fig. 5).

RESULTS

Marine Turtle Species: Karachi coastal sites viz. Sandspit, Hawkesbay and Cape Monze are the suitable nesting habitat of marine turtle species. During the whole study period, only Green turtle (*C. mydas*) has been recorded from all the study sites viz. Sandspit, Hawkesbay and Cape Monze. Olive ridley turtle (*L. olivacea*) and Hawksbill turtle (*E. imbricata*) were not observed in any of the study sites of Karachi coast throughout the study period.

In the present study population of Green turtle (*C. mydas*) was rated as 46% in year 2014 (Table 1), 46.98% in year 2015 (Table 2), 45.74% in year 2016 (Table 3) and 44.83% in year 2017 (Table 4) from all the study sites of Karachi coast.

A specimen of Loggerhead turtle (*C. caretta*) has caught by a fisherman in fishing net from off shore water of Pakistan. Leatherback turtle (*D. coriacea*) another rare species of marine turtle was found dead in Miani Hor lagoon near Sonmiani, district Lasbella, Balochistan. Leatherback turtle (*D. coriacea*) was also caught by fishermen when it was entangled in fishing gillnet at Khori Great bank near INDUS which was then gently released into the water. Hawksbill turtle (*E. imbricata*) has been reported from the coast of Balochistan.

Lizard species: Coastal habitat of Karachi supports different lizard species. The present study shows that in year 2014, population of Common tree lizard (*C. versicolor versicolor*) was rated as 2.77%, Spotted barn gecko (*H. brookii*) 5.02%, Yellow belly common house gecko (*H. flaviviridis*) 5.60%, Persian house gecko (*H. persicus*) 3.02%, Blotched house gecko (*H. triedrus*) 3.28%, Mediterranean house gecko (*H. turcicus*) 3.54%, Blue tail sand lizard (*A. cantoris*) 20.30%, Spotted lacerta (*M. watsonana*)5.66% and Bengal monitor (*V. bengalensis*) 1.74% from all the three study sites viz. Sandspit, Hawkesbay and Cape Monze (Table 1).

In the year 2015, population of Common tree lizard (*C. versicolor versicolor*) was rated as 2.82%, Spotted barn gecko (*H. brookii*) 4.94%, Yellow belly common house gecko (*H. flaviviridis*) 5.12%, Persian house gecko (*H. persicus*) 2.94%, Blotched house gecko (*H. triedrus*) 3.42%, Mediterranean house gecko (*H. turcicus*) 3.48%, Blue tail sand lizard (*A. cantoris*) 20.44%, Spotted lacerta (*M. watsonana*) 5.38% and Bengal monitor (*V. bengalensis*) 1.74% from all the study sites of Karachi coast (Table 2).

In the study period 2016,population of Common tree lizard (*C. versicolor versicolor*) was rated as 2.42%, Spotted barn gecko (*H. brookii*) 5.78%, Yellow belly common house gecko (*H. flaviviridis*) 5.22%, Persian house gecko (*H. persicus*) 3.11%, Blotched house gecko (*H. triedrus*) 3.52%, Mediterranean house gecko (*H. turcicus*) 3.27%, Blue tail sand lizard (*A. cantoris*) 20.37%, Spotted lacerta (*M. watsonana*) 5.82% and Bengal Monitor (*V. bengalensis*)1.79% from the selected study areas (Table 3).

During the study period 2017, population of Common tree lizard (*C. versicolor versicolor*) was rated as 2.70%, Spotted barn gecko (*H. brookii*) 5.72%, Yellow belly common house gecko (*H. flaviviridis*) 5.56%, Persian house gecko (*H. persicus*) 2.98%, Blotched house gecko (*H. triedrus*) 3.33%, Mediterranean house gecko (*H. turcicus*) 3.20%, Blue tail sand lizard (*A. cantoris*) 20.89%, Spotted lacerta (*M. watsonana*) 6.19% and Bengal monitor (*V. bengalensis*) 1.60% from all the three study sites (Table 4).

Snake Species: Five species of sea snakes and two species of terrestrial snakes have been observed and recorded during the study period from 2014-2017 from the selected coastal sites of Karachi. Among sea snake species, Blotched diadem snake (*S. diadema diadema*), Blue green sea snake (*H. caerulescens*), Annulated sea snake (*H. cyanocinctus*), Yellow sea snake (*H. spiralis*) and Spotted small headed sea snake (*M. cantoris*) were recorded from Karachi coast and rated as rare. Two species of terrestrial snakes viz. Cliff racer *(P. rhodorachis)* and Saw scaled viper (*E. carinatus*) were also recorded from the coastal sites of Karachi.

During the study period 2014, Cliff racer (*P. rhodorachis*) was only recorded from Cape Monze areas and rated as 0.13%. Saw scaled viper (*E. carinatus*) was found from Sandspit and Cape Monze areas and rated as 0.26% (Fig. 10). Blotched diadem snake (*S. diadema diadema*) rated as 0.29%, Blue green sea snake (*H. caerulescens*) 0.74%, Annulated sea snake (*H. cyanocinctus*) 0.39%, Yellow sea snake (*H. spiralis*) 0.77% and Spotted small headed sea snake (*M. cantoris*) 0.51% recorded from all the three study sites viz. Sandspit, Hawkesbay and Cape Monze (Table 1).

In year 2015, Cliff racer (*P. rhodorachis*) and Annulated sea snake (*H. cyanocinctus*) were only recorded from Cape Monze areas and rated as 0.16% and 0.25% respectively. Saw scaled viper (*E. carinatus*) was rated as 0.25%, Blotched diadem snake (*S. diadema diadema*) 0.32%, Blue green sea snake (*H. caerulescens*) 0.66%, Yellow sea snake (*H. spiralis*) 0.63% and Spotted small headed sea snake (*M. cantoris*) 0.47% recorded from all the study sites of Karachi coast (Table 2).

In year 2016, Cliff racer (*P. rhodorachis*) was only observed in Cape Monze and rated as 0.19%. Saw scaled viper (*E. carinatus*) was rated as 0.25%, Blotched diadem snake (*S. diadema diadema*) 0.35%, Blue green sea snake (*H. caerulescens*) 0.75%, Annulated sea snake (*H. cyanocinctus*) 0.35%, Yellow sea snake (*H. spiralis*) 0.63% and Spotted small headed sea snake (*M. cantoris*) 0.44%, from all the three study sites of Karachi coast (Table 3).

In year 2017, Cliff racer (*P. rhodorachis*) and Yellow sea snake (*H. spiralis*) were only recoded from Cape Monze areas and rated as 0.13% and 0.63% respectively. Saw scaled viper (*E. carinatus*) was rated as 0.35%, Blotched diadem snake (*S. diadema diadema*) 0.31%, Blue green sea snake (*H. caerulescens*) 0.69%, Annulated sea snake (*H. cyanocinctus*) 0.38% and Spotted small headed sea snake (*M. cantoris*) 0.50%, recorded from the study sites viz. Sandspit, Hawkesbay and Cape Monze (Table 4).

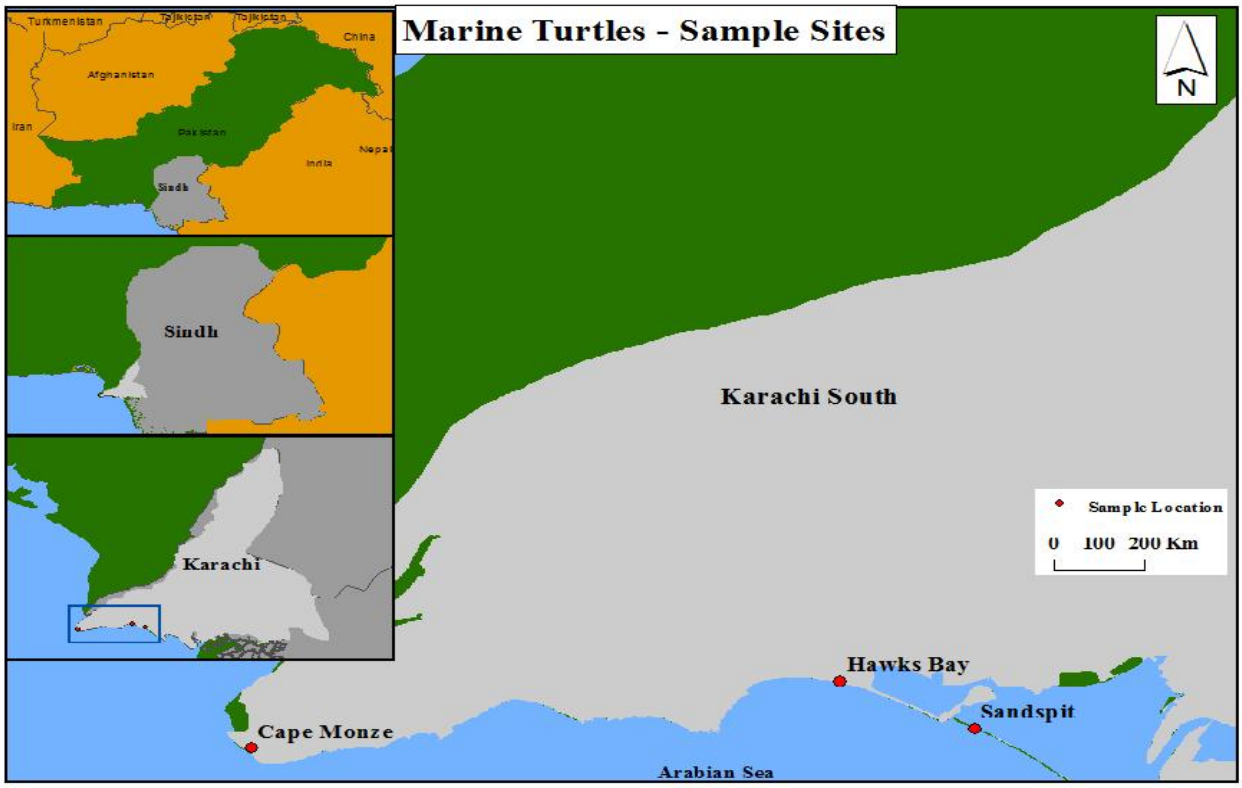

Fig. 1. Karachi Coastal sites Sandspit, Hawkesbay and Cape Monze.

Fig. 2. Common tree lizard.

Fig. 3. Potential habitat of lizards at Sandspit.

Fig.4. Nesting pit of Green turtle at Hawkesbay.

Fig. 5. Green turtle track at Sandspit.

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Fig. 6. Green turtle hatchling.

Fig.7. Hatchling collected from hatchery.

Fig. 8. Marine Turtle hatchery at Hawkesbay.

Fig. 9. Green turtle killed by fishing activity.

Fig. 10. Saw scaled viper (Courtesy Google).

Fig.11. Fencing around hut, a threat to female turtle.

Fig. 12. Marine Turtle Laboratory at Hawkesbay.

Fig. 13. Mangrove Forests at the coastal areas of Karachi.

Table 1. Reptilian Population in Year 2014.

S. No	Scientific Name	Common Name	Sandspit	Hawkes bay	Cape Monze	Total	%	Status
1	*Chelonia mydas*	Green Turtle	850	550	30	1430	46.00%	C
2	*Calotes versicolor versicolor*	Common Tree Lizard	3	3	80	86	2.77%	SC
3	*Hemidactylus brookii*	Spotted Barn Gecko	54	51	51	156	5.02%	SC
4	*Hemidactylus flaviviridis*	Yellow Belly Common House Gecko	65	70	39	174	5.60%	LC
5	*Hemidactylus persicus*	Persian House Gecko	32	31	31	94	3.02%	SC
6	*Hemidactylus triedrus*	Blotched House Gecko	34	34	34	102	3.28%	SC
7	*Hemidactylus turcicus*	Mediterranean House Gecko	34	42	34	110	3.54%	SC
8	*Acanthodactylus cantoris*	Blue Tail Sand Lizard	196	200	235	631	20.30%	C
9	*Mesalina watsonana*	Spotted Lacerta	56	35	85	176	5.66%	LC
10	*Varanus bengalensis*	Bengal Monitor	7	12	35	54	1.74%	Rare
11	*Platyceps rhodorachis*	Cliff Racer	0	0	4	4	0.13%	Rare
12	*Echis carinatus*	Saw Scaled Viper	1	0	7	8	0.26%	Rare
13	*Sphalerosophis diadema diadema*	Blotched Diadem Snake	1	1	7	9	0.29%	Rare
14	*Hydrophis caerulescens*	Blue Green Sea Snake	2	1	20	23	0.74%	Rare
15	*Hydrophis cyanocinctus*	Annulated Sea Snake	1	1	10	12	0.39%	Rare
16	*Hydrophis spiralis*	Yellow Sea Snake	2	2	20	24	0.77%	Rare
17	*Microcephalophis cantoris*	Spotted Small Headed Sea Snake	2	2	12	16	0.51%	Rare
	Total		1340	1035	734	3109	100.00%	

Legend: C=Common, LC=Less Common, SC=Scarce, Rare

Table 2. Reptilian Population in Year 2015.

S. No	Scientific Name	Common Name	Sandspit	Hawkes bay	Cape Monze	Total	%	Status
1	*Chelonia mydas*	Green Turtle	1000	454	31	1485	46.98%	C
2	*Calotes versicolor versicolor*	Common Tree Lizard	2	2	85	89	2.82%	SC
3	*Hemidactylus brookii*	Spotted Barn Gecko	56	50	50	156	4.94%	SC
4	*Hemidactylus flaviviridis*	Yellow Belly Common House Gecko	62	65	35	162	5.12%	SC
5	*Hemidactylus persicus*	Persian House Gecko	31	31	31	93	2.94%	SC
6	*Hemidactylus triedrus*	Blotched House Gecko	35	30	43	108	3.42%	SC
7	*Hemidactylus turcicus*	Mediterranean House Gecko	36	42	32	110	3.48%	SC
8	*Acanthodactylus cantoris*	Blue Tail Sand Lizard	202	199	245	646	20.44%	C
9	*Mesalina watsonana*	Spotted Lacerta	50	30	90	170	5.38%	SC
10	*Varanus bengalensis*	Bengal Monitor	8	10	37	55	1.74%	Rare
11	*Platyceps rhodorachis*	Cliff Racer	0	0	5	5	0.16%	Rare
12	*Echis carinatus*	Saw Scaled Viper	1	1	6	8	0.25%	Rare
13	*Sphalerosophis diadema diadema*	Blotched Diadem Snake	1	1	8	10	0.32%	Rare
14	*Hydrophis caerulescens*	Blue Green Sea Snake	2	1	18	21	0.66%	Rare
15	*Hydrophis cyanocinctus*	Annulated Sea Snake	0	0	8	8	0.25%	Rare
16	*Hydrophis spiralis*	Yellow Sea Snake	1	1	18	20	0.63%	Rare
17	*Microcephalophis cantoris*	Spotted Small Headed Sea Snake	2	2	11	15	0.47%	Rare
	Total		1489	919	753	3161	100.00%	

Legend: C=Common, LC=Less Common, SC=Scarce, Rare

Table 3. Reptilian Population in Year 2016.

S. No	Scientific Name	Common Name	Sandspit	Hawkes bay	Cape Monze	Total	%	Status
1	*Chelonia mydas*	Green Turtle	965	465	25	1455	45.74%	C
2	*Calotes versicolor versicolor*	Common Tree Lizard	1	1	75	77	2.42%	Rare
3	*Hemidactylus brookii*	Spotted Barn Gecko	64	60	60	184	5.78%	SC
4	*Hemidactylus flaviviridis*	Yellow Belly Common House Gecko	64	61	41	166	5.22%	SC
5	*Hemidactylus persicus*	Persian House Gecko	35	32	32	99	3.11%	SC
6	*Hemidactylus triedrus*	Blotched House Gecko	36	33	43	112	3.52%	SC
7	*Hemidactylus turcicus*	Mediterranean House Gecko	35	39	30	104	3.27%	SC
8	*Acanthodactylus cantoris*	Blue Tail Sand Lizard	198	210	240	648	20.37%	C
9	*Mesalina watsonana*	Spotted Lacerta	60	35	90	185	5.82%	LC
10	*Varanus bengalensis*	Bengal Monitor	9	9	39	57	1.79%	Rare
11	*Platyceps rhodorachis*	Cliff Racer	0	0	6	6	0.19%	Rare
12	*Echis carinatus*	Saw Scaled Viper	1	1	6	8	0.25%	Rare
13	*Sphalerosophis diadema diadema*	Blotched Diadem Snake	2	2	7	11	0.35%	Rare
14	*Hydrophis caerulescens*	Blue Green Sea Snake	2	2	20	24	0.75%	Rare
15	*Hydrophis cyanocinctus*	Annulated Sea Snake	1	1	9	11	0.35%	Rare
16	*Hydrophis spiralis*	Yellow Sea Snake	1	1	18	20	0.63%	Rare
17	*Microcephalophis cantoris*	Spotted Small Headed Sea Snake	2	2	10	14	0.44%	Rare
	Total		1476	954	751	3181	100.00%	

Legend: C=Common, LC=Less Common, SC=Scarce, Rare

Table 4. Reptilian Population in Year 2017.

S. No	Scientific Name	Common Name	Sandspit	Hawkes bay	Cape Monze	Total	%	Status
1	*Chelonia mydas*	Green Turtle	953	453	21	1427	44.83%	C
2	*Calotes versicolor versicolor*	Common Tree Lizard	2	2	82	86	2.70%	SC
3	*Hemidactylus brookii*	Spotted Barn Gecko	60	67	55	182	5.72%	LC
4	*Hemidactylus flaviviridis*	Yellow Belly Common House Gecko	67	72	38	177	5.56%	SC
5	*Hemidactylus persicus*	Persian House Gecko	35	30	30	95	2.98%	SC
6	*Hemidactylus triedrus*	Blotched House Gecko	32	32	42	106	3.33%	SC
7	*Hemidactylus turcicus*	Mediterranean House Gecko	32	38	32	102	3.20%	SC
8	*Acanthodactylus cantoris*	Blue Tail Sand Lizard	210	215	240	665	20.89%	C
9	*Mesalina watsonana*	Spotted Lacerta	62	40	95	197	6.19%	LC
10	*Varanus bengalensis*	Bengal Monitor	8	8	35	51	1.60%	Rare
11	*Platyceps rhodorachis*	Cliff Racer	0	0	4	4	0.13%	Rare
12	*Echis carinatus*	Saw Scaled Viper	3	1	7	11	0.35%	Rare
13	*Sphalerosophis diadema diadema*	Blotched Diadem Snake	1	1	8	10	0.31%	Rare
14	*Hydrophis caerulescens*	Blue Green Sea Snake	1	1	20	22	0.69%	Rare
15	*Hydrophis cyanocinctus*	Annulated Sea Snake	1	1	10	12	0.38%	Rare
16	*Hydrophis spiralis*	Yellow Sea Snake	0	0	20	20	0.63%	Rare
17	*Microcephalophis cantoris*	Spotted Small Headed Sea Snake	2	2	12	16	0.50%	Rare
	Total		1469	963	751	3183	100.00%	

Legend: C=Common, LC=Less Common, SC=Scarce, Rare

DISCUSSION

The present study reveals that the coastal sites of Karachi viz. Sandspit, Hawkesbay and Cape Monze have distinguished habitats comprise of sandy beaches, mudflats, rocky and muddy areas. Karachi coastal environment is highly suitable for reptilian fauna including Green turtle (*C. mydas*) species, lizards, sea snakes and some terrestrial snakes. Sandspit and Hawkesbay are the main nesting sites of Green turtle (*C. mydas*).

The present study shows that nesting of Green turtle (*C. mydas*) is affected due to activities like throwing litter around the breeding ground which may hamper nesting attempt of turtle, over exploitation of eggs and mortality due to fishing activities (Fig. 9). Deposition of different stones, sand particles and other construction material in the sandy beaches of Sandspit and Hawkesbay alter the composition of nesting sites which creates hindrance in making pits for nesting however, population of Green turtle rated as common throughout the study period.

Movement of different vehicles near nesting beaches also disturbs female turtle from nesting. Artificial lighting at the coast discourages female turtles from nesting and also distract the hatchlings as they move towards the brightest horizon of moonlit ocean after hatching but beach front lightening instead disorientate them and they wander inland and often die of dehydration or predation.

Nesting of Olive ridley turtle (*L. olivacea*) had been observed in years 2001, 2002, 2003 and 2004 from Sandspit while Hawksbill turtle (*E. imbricata*) was observed in years 2001 and 2003 from Cape Monze areas Khan *et al.* (2010). Habitat destruction might be the reason of non-nesting behavior of Olive ridley and Hawksbill turtles at Karachi coast.

In current study Common tree lizard (*C. versicolor versicolor*) was mainly observed from Cape Monze areas and rated as scarce in years 2014, 2015 and 2017 but rare in 2016.Spotted barn gecko (*H. brookii*) rated as scarce in study period from 2014-2016 and less common in 2017 from all three study sites viz. Sandspit, Hawkesbay and Cape Monze. Yellow belly common house gecko (*H. flaviviridis*) rated less common in 2014 and scarce in study period from 2015-2017. Persian house gecko (*H. persicus*), Blotched house gecko (*H. triedrus*) and Mediterranean house gecko (*H. turcicus*) have been rated scarce throughout the study period. Blue tail sand lizard (*A. cantoris*) rated common throughout the study period. Spotted lacerta (*M. watsonana*) rated as less common in years 2014, 2016 and 2017 while scarce in 2015 and Bengal monitor (*V. bengalensis*) mainly observed from Cape Monze areas and rated as rare. Mortality of Bengal Monitor during road crossing has also been reported.

In present study only five sea snake species viz. Blotched diadem snake (*S. diadema diadema*), Blue green sea snake (*H. caerulescens*), Annulated sea snake (*H. cyanocinctus*), Yellow sea snake (*H. spiralis*) and Spotted small headed sea snake (*M. cantoris*) were observed. Cliff racer (*P. rhodorachis*) and Saw scaled viper (*E. carinatus*) were also observed from the coastal sites of Karachi. All the observed snake species were rated as rare. Some snake species were found dead and some species of snake were not identified. Sometimes snake species were killed near road side while moving from back waters to coastal side.

Twelve sea snake species viz. Beaked sea snake (*Enhydrina schistosa)*, Blue green sea snake (*H. caerulescens*), Annulated sea snake (*H. cyanocinctus*), Persian sea snake (*H. lapemoides*), Broad band sea snake *(H. mamillaris),* Reef sea snake (*H. orantus*), Yellow sea snake (*H. spiralis*)*,* Pygmy sea snake (*Lapemis curtus*), Spotted small headed sea snake (*M. Cantoris*), Pelagic sea snake (*Pelamis platurus*)*,* Spotted viperine sea snake (*Praescutata viperina*) and Blotched diadem snake (*Sphalerosophis diadem diadem*) had been found from the coast of Karachi. Cliff racer (*P. rhodorachis*), Saw scaled viper (*E. carinatus*) and Black cobra (*Naja naja*) had also been reported Khan *et al.* (2010).

Sea snake species viz. Beaked sea snake (*E. schistosa*), Persian sea snake (*H. lapemoides*), Broad band sea snake (*H. mamillaris*), Reef sea snake (*H. orantus*), Pygmy sea snake (*L. curtus*), Pelagic sea snake (*P. platurus*) and Spotted viperine sea snake (*P. viperina*) were not observed throughout the study period due to habitat destruction and environmental effects.

CONSERVATORY MEASURES FOR REPTILIAN FAUNA AT KARACHI COAST: Reptilian fauna forms an important part of coastal food chain and food web therefore the sustainability and conservation of reptilian species is necessary for the stability of coastal ecosystem. Following conservatory measures have been taken for coastal reptilian species at Karachi coast.

- Marine turtle species have been protecting by Sindh Wildlife Department (SWD) under Sindh Wildlife Protection Ordinance 1972. There are three hatcheries at Sandspit and Hawkesbay working under Sindh Wildlife Department, Govt. of Sindh. This department protects the eggs and juveniles of Green turtle (*C. mydas*) from predators like dogs, crows, crabs and also from human activities. A Marine turtle laboratory has also been setup by Sindh Wildlife Department at Hawkesbay for the study of different aspects of the life of marine turtle species, such as feeding behaviour, digestive tract analysis, role in food chain and food web, effect of climate change in nesting behaviour (Fig.12).

- Awareness programs about the importance of reptilian fauna are usually organized by WWF Pakistan and IUCN Pakistan.
- Department of Zoology, Wildlife and Fisheries section, University of Karachi is also playing an important role in capacity building and awareness programs for the conservation of reptilian fauna by conducting several workshops and field visits in which students and experts of different fields of wildlife participate and share their experiences.
- Mangrove Forests play a significant role for different marine species. *Avicennia marina* is the most common species of mangroves in the coastal areas. They provide nursery for different marine species such as prawns, shrimps, crabs and fishes, also provide food for juveniles, fodder for different herbivores like cows, donkeys, camels and horses. Mangroves also provide fuel wood for the domestic use of local communities (Fig.13).

Recommendations: Following recommendations have been made for the conservation of reptilian fauna at Karachi coast.

- Developmental activities at the beach such as building of massive houses should be restricted in order to protect the nesting habitat of Green turtle (*C. mydas*).
- Careful driving should be assured as some snake species move across the road from mangroves towards the coast.
- Fencing around huts should be restricted to prevent the female turtles from being entangled during nesting activity (Fig. 11).
- Turtle Excluder Devices (TEDs) in fishing and trawl netting should be employed regularly so that marine turtle species present in coastal and offshore waters of Pakistan remain safe.
- Bycatch killing of turtle is common therefore training of fishermen for the use of Turtle Excluder Device should be properly organized and managed.
- Awareness programs for local community about the importance of reptilian fauna should be organized on regular basis.
- Conservatory measures for reptiles should be shared and discussed regularly with the policy makers for the sustainability of coastal ecosystems of Karachi.
- Workshops and other awareness programs based on conservation of reptiles organized for capacity building.
- Litterbins should be placed for throwing litter so that Green turtle may not deter the nesting attempt due to the waste material thrown at the nesting ground. This also prevents Green turtle from eating litter such as plastic bags, balloons, plastic pellets and save it from the severe consequences.
- Sign boards should be placed with instructions for people who visit the coastal beaches for picnic such as, use litterbins, don't kill animals, don't destroy the habitat of animals, don't catch the hatchlings of Green turtle when they hatch and move towards sea etc.
- Avoid excess use of artificial lighting at the beach which distracts juveniles of turtle while moving towards sea.

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