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A study of status and recent conservation measures of sindh province freshwater turtles

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Abstract

In Pakistan populations of freshwater turtles are extensively declining due to anthropogenic activities. In this study, seven districts of Sindh included Thatta, Sujawal, Badin, Dadu, Khairpur, Sanghar and Sukkur were selected for the study of distribution and population status of freshwater turtles. Data of one year i.e. 2017 collected from selected study sites. The mean percentage data from selected districts of Sindh for the year 2017 included *Hardella thurji* (15.33%), *Pangshura tecta* (14.86%), *Lissemys punctata* (14.19%), *Pangshura smithii* (15.36%), *Nilssonina hurum* (11.82%), *Nilssonina gangeticus* (9.30%), *Geoclemys hamiltonii* (10.44%), and *Chitra indica* (8.70%). *Pangshura smithii* (15.36%) found as most common while *Chitra indica* (8.70%) found as least sighted species. Illegal trade, poaching, over exploitation, habitat destruction and pollution found to be affecting their population status.

Keywords: freshwater turtles, sindh, hotspots

Introduction

Indus River system in Pakistan acts as the major habitat for freshwater fauna including turtles. All the rivers, canals, lakes, swamps, bogs, marshes, ponds, and reservoirs considered as tributaries of Indus river system. There are six genera and eight species of freshwater turtles are present in Pakistan.

Worldwide freshwater turtles are facing serious threats for existence. This similar condition occurs in Pakistan. Their population is most terribly affected by many factors like habitat degradation, urbanization, Developmental projects, illegal trading for food, pet and pharmaceutical industries, pollution, predators, parasites, human wildlife conflicts, human population extensions and modifications near riverbanks.

Sindh is also sharing the same number of species of Freshwater turtles as Pakistan. Six genera and Eight species have been recorded from different localities of Sindh. These comprise of two families Geoemydidae and family Trionchidae. Family Geoemydidae consists of Hard shelled turtles viz Spotted pond turtle (*Geoclemys hamiltonii*), Crowned river turtle (*Hardella thurjii*), Brown roofed turtle (*Pangshura smithii*), and Indian roofed turtle (*Pangshura tecta*). The second Family Trionychidae comprises of softshell turtles viz. Indian narrowheaded softshell turtle (*Chitra indica*), Indian softshell turtle (*Nilssonina gangeticus*), Indian peacock softshell turtle (*Nilssonina hurum*) and Indian flapshell turtle (*Lissemys punctata*)^[1] (Khan, 2006).

Large number of Chelonians are exposed to risk of international trade. The over exploitation of native species is exceeding up to its hazardous limits illegal wildlife trade is the main frightening factor for the existence of endangered species. Unsustainable wildlife trafficking is the most intimidating issue for wildlife biologist^[2] (Broad *et al.*, 2003).

High level of trade gives serious conservational concerns. Turtles and tortoises are traded worldwide^[3] (Georges *et al.*, 2006; ^[4]Turtle Conservation Fund, 2002).

Sindh is the main hub for illegal capturing and trading of Freshwater turtles because of presence of Sea Port at Karachi. Most of the illegal trading usually done through Karachi.

Specifically softshell turtles are captured, killed, and exported outside Pakistan, either in the form of body parts or as whole specimen. Unimplemented laws and lack of awareness is also a major cause for increasing trade and facilitating turtle traders to establish their business in Pakistan. Exploitation of these natural resources continues here because of flaws in wildlife ordinances and non-execution of laws and regulations.

Materials and Methods

In this study, seven districts of Sindh included Thatta, Sujawal, Badin, Dadu, Khairpur, Sanghar and Sukkur district were selected for the study of distribution and population status of

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Freshwater turtles. The study areas selected based on the reviewed literature, hotspots identification, and baseline data. Authenticated method and techniques used to carry out the surveys. Results of population diversity and population richness obtained from different districts.

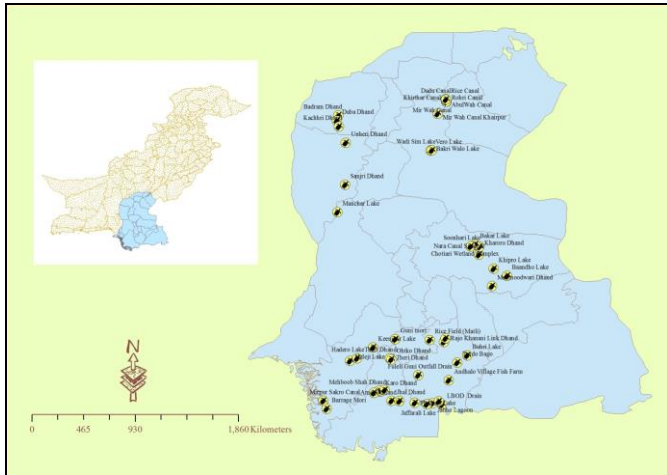


Fig 1: Study sites of freshwater turtles in selected districts of Sindh

There are several different methodologies used for study of freshwater turtles but most accepted and popular strategies are through the Direct and Indirect Observations.

1. Direct observations

The particular sites were visited and Line Transact method was adopted. Transact walks were made to observe the population status of turtles. Turtles have very sharp senses and they quickly jump into water by slight disturbance so high powered binoculars were used for their observations. Floating and Basking turtles were also observed. Surveys through Boats were also conducted for surveys through the lakes.

Incidental Sightings

Turtles have been sighted mostly during basking activity. In winter the temperature of water of rivers becomes very low. Due to cooler weather and cold water this cold blooded reptiles avoid to live in water and come outside for taking bath in sunshine which keep them warm.

Frequency and Day periods

The study areas were visited in much different timing mostly in early morning and in evening. It was recorded that sighting was higher in early morning and in late afternoon. In midafternoon the frequency of the sighting of turtles became low due to high temperature.

2. Indirect observations

Indirect observation is also called as secondary information. It includes secondary information from other sources like interviews from local communities, review of the published literature presence of signs and tracks, trails and fecal materials, traces, nests burrows and carcass of dead specimens.

Statistical analysis

Data has been analyzed by using Shannon-wiener" index of diversity (H). The formula used as: $H = - \sum p_i \ln p_i$ and Evenness Index also calculated by $(E) = -H / \ln(S)$.

Mapping and Locating Turtle's sightings

Global Positioning System (GPS) receivers were used to

record the geographical coordinates of the particular position of sighting of turtles. Maps of different districts pointing out the presence of turtles population has been developed by using a software named as Arc GIS version (10.1).

Results

The current status of freshwater turtles in Sindh in year 2017 by average percentages recorded as, *Hardella thurji* (15.33%), *Pangshura tecta* (14.86%), *Lissemys punctata* (14.19%), *Pangshura smithii* (15.36%), *Nilssonia hurum* (11.82%), *Nilssonia gangeticus* (9.30%), *Geoclemys hamiltonii* (10.44%), and *Chitra indica* (8.70%). *Pangshura smithii* (15.36%) found as most common while *Chitra indica* (8.70%) found as least sighted species.

The data of selected localities of Thatta district in year 2017 included Keenjhar lake (1.15%), Haleji lake (1.92%), Hadero lake (1.42%), Mehboob shah dhand (1.74%), Karo dhand (1.22%), Jubho lagoon (1.60%), Chabo mori (1.56%), Barrage mori (1.70%), Mirpur sakro canal (2.90%), Ghora bari fish farms (1.35%) and Deh Janghisar (0.47%). The maximum diversity of turtles were found in Mirpur sakro canal (2.90%) while lowest population richness shown in wetland of Deh Janghisar (0.47%).

The population distribution in Sujawal district for year 2017 as follows Theri dhand (4.20%) Thari dhand (1.76%), Ohtko dhand (2.40%), Amerji dhand (1.67%), Jhal dhand (1.98%), Guni mori (2.38%), Badh mori (2.18%) from previous year. Highest richness has observed in Theri dhand (4.20%) while lowest richness found from Amerji dhand (1.67%).

The data of population status of freshwater turtles in Badin district for year 2017 included Jaffarali lake (1.12%), Phoosna lake (0.91%), Tando Bago (1.29%), LBOD (Left Bank Fall Out Drain) (1.01%), Buhri lake (1.06%), Andhalo fish farm (1.35%), Laakhi dhand (1.43%), Fuleli guni drain (1.23%), Kadhan lagoon (1.72%), Rice field Matli (1.78%) and Rajo Khanani dhand (1.39%). Highest richness observed from Matli (1.78%) while lowest found from Phoosna lake (0.91%).

The data recorded from wetlands of Dadu district for year 2107 included Manchar lake (2.65%), Badram dhand (2.30%), Daba dhand (2.27%), Kacchri dhand (1.79%), Unheri dhand (1.83%), and Sanjri dhand (1.84%), Highest richness found from Badram dhand (2.30%) while lowest richness estimated in Kacchri dhand (1.79%).

The population diversity in Khairpur district for year 2017 resulted included Bakriwalo lake (2.19%), Vero lake (1.63%), Wadisim lake (2.66%) and Mirwah canal (2.50%). Highest richness found in Wadisim lake (2.66%) while lowest recorded from Vero lake (1.63%).

The population status of turtles from selected localities of Sanghar district for year 2017 included Nara canal (1.44%), Chotiari wetland complex (1.58%), Kharoro dhand (1.64%), Baandho lake (2.39%), Khipro lake (1.88%), Bakar lake (2.30%), Soonhari lake (0.98%) and Mehmoodwari dhand (2.63%). Highest richness found in Baandho lake (2.39%) whereas lowest recorded from Soonhari lake (0.98%).

The population status of freshwater turtles from Left Bank of Sukkur Barrage for year 2017 included Nara canal (1.52%), Mirwah canal (3.00%), Rohri canal (2.57%), and Abulwah canal (2.42%). Highest population richness obtained from Mirwah canal (3.00%), while lowest observed from Nara canal (1.52%).

The data of population diversity of turtles from Right Bank for year 2017 included Keerthar canal (1.87%), Dadu canal (2.49%), and Rice canal (1.72%). Slightly low richness found from Rice canal as compared to other two canals.

Hotspots

During the present study, wetlands, which were observed to have large population distribution of freshwater turtles, were considered as hotspots for distribution. Hotspots identified included Keenjhar lake, Haleji lake, Mirpur Sakro canal,

Mehboobshah dhand and Barrage mori from Thatta, LBOD, Manchar lake and Badram dhand from Dadu, Phoosna lake and Tandobago from Badin, Mirwah canal, Rohri canal, Kirthar canal, Dadu canal from Sukkur, and Chotiari wetlands from Sanghar.

Table 1: Population distribution of Freshwater turtles in selected localities of Sindh.

Population Distribution of Freshwater turtles in different districts of Sindh in 2017											
District	Location	P.S	P.T	L.P	H.T	N.G	N.H	C.I	G.H	Total	%
Thatta	Keenjhar Lake	34	5	12	4	6	4	3	33	101	1.15%
	Haleji lake	21	66	41	5	25	3	2	5	168	1.92%
	Hadero Lake	2	4	45	23	5	21	nil	24	124	1.42%
	Mehboob Shah Dhand	34	3	63	6	14	24	4	4	152	1.74%
	Karo Dhand	22	34	3	32	5	5	nil	6	107	1.22%
	Jubho Lagoon	12	25	34	5	6	21	5	32	140	1.60%
	Chabo Mori	33	23	24	24	24	4	nil	5	137	1.56%
	Barrage Mori	4	43	13	5	55	23	2	4	149	1.70%
	MirPur Sakro Canal	45	7	67	83	nil	8	1	43	254	2.90%
	Ghora Bari Fish Farm	32	44	21	13	2	3	nil	3	118	1.35%
Suajawal	Deh Janghisar	2	14	1	3	4	12	3	2	41	0.47%
	Theri Dhand	68	64	88	44	8	29	12	55	368	4.20%
	Thari Dhand	34	35	9	9	45	6	nil	16	154	1.76%
	Ohtko Dhand	66	9	18	38	8	24	3	44	210	2.40%
	Amerji Dhand	17	17	9	44	33	7	13	6	146	1.67%
	Jhal Dhand	8	26	8	9	9	87	nil	26	173	1.98%
	Guni Mori	34	21	35	35	16	46	7	14	208	2.38%
Badin	Fish Farm Badh Mori	11	45	8	9	38	40	2	38	191	2.18%
	Jaffarali Lake	5	5	7	34	6	29	7	5	98	1.12%
	Phoosna Lake	12	35	9	4	7	6	nil	7	80	0.91%
	Tando Bago	nil	7	3	26	6	35	32	4	113	1.29%
	LBOD	7	45	6	nil	5	8	9	8	88	1.01%
	Buhri Lake	24	7	35	8	4	4	7	4	93	1.06%
	Andhalo Fish Fram	6	36	9	6	9	36	9	7	118	1.35%
	Laakhi Dhand	11	8	18	7	36	4	4	37	125	1.43%
	Fuleli guni drain	28	36	8	6	3	9	13	5	108	1.23%
	Kadhan Lagoon	6	30	35	35	6	4	29	6	151	1.72%
Dadu	Rice field Matli	4	36	65	nil	35	1	7	8	156	1.78%
	Rajo Khanani Dhand	3	8	34	28	8	4	37	nil	122	1.39%
	Manchar Lake	47	45	7	45	nil	16	45	27	232	2.65%
	Badram Dhand	26	34	46	32	15	18	27	3	201	2.30%
	Daba Dhand	38	nil	27	29	8	28	33	36	199	2.27%
	Kachhri Dhand	52	34	12	46	5	4	4	nil	157	1.79%
Khairpur	Unheri Dhand	nil	4	27	25	44	39	17	4	160	1.83%
	Sanjri Dhand	9	16	15	33	nil	28	45	15	161	1.84%
	Bakriwalo Lake	23	29	7	38	8	38	4	45	192	2.19%
	Vero Lake	nil	31	34	nil	45	5	21	7	143	1.63%
Sanghar	Wadi Sim Lake	77	6	6	46	6	34	13	45	233	2.66%
	Mir Wah Canal	23	3	48	8	35	26	76	nil	219	2.50%
	Nara Canal	nil	1	7	37	7	9	34	31	126	1.44%
	Chotiari wetlands	6	34	35	46	1	4	4	8	138	1.58%
	Kharoro Dhand	63	9	8	26	15	8	8	7	144	1.64%
	Baandho Lake	75	17	34	7	7	9	27	33	209	2.39%
	Khipro Lake	79	43	nil	34	6	3	nil	nil	165	1.88%
	Bakar Lake	3	52	23	47	8	36	6	26	201	2.30%
Sukkur	Soonhari Lake	7	16	37	7	5	6	5	3	86	0.98%
	Mehmoodwari Dhand	43	35	9	56	6	34	nil	47	230	2.63%
	Nara Canal	4	15	35	25	4	34	3	13	133	1.52%
	MirWah Canal	34	36	34	34	12	55	35	23	263	3.00%
	Rohri Canal	24	42	24	31	34	22	22	26	225	2.57%
	Abul Wah Canal	55	23	6	23	14	22	45	24	212	2.42%
	Keerthar Canal	17	25	5	23	45	21	23	5	164	1.87%
Sukkur	Dadu Canal	24	nil	24	56	33	5	54	22	218	2.49%
	Rice Canal	31	13	4	43	23	24	nil	13	151	1.72%
	Total	1345	1301	1242	1342	814	1035	762	914	8755	100.00%
	%	15.36%	14.86%	14.19%	15.33%	9.30%	11.82%	8.70%	10.44%		

Key. HT (*Hardella thurjii*), PS (*Pangshura smithii*), PT (*Pangshura tecta*), GH (*Geoclemys hamiltonii*), LP (*Lissemys punctata*), NH (*Nilssonina hurum*), CI (*Chitra indica*), NG (*Nilssonina ganget icus*)

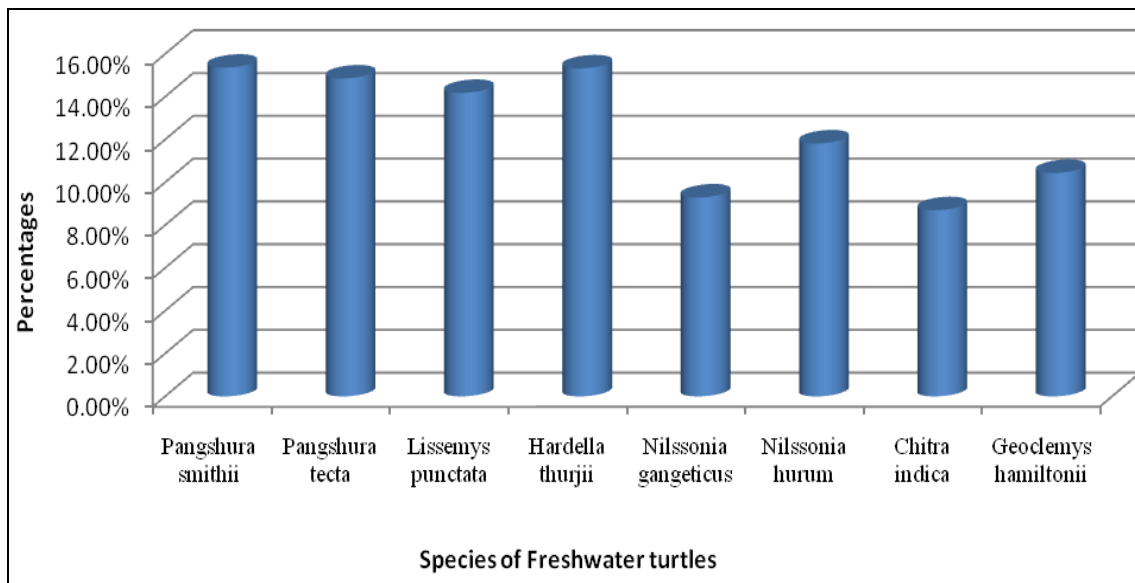


Fig 2: Percentages of Population of Freshwater turtles in Sindh in 2017.

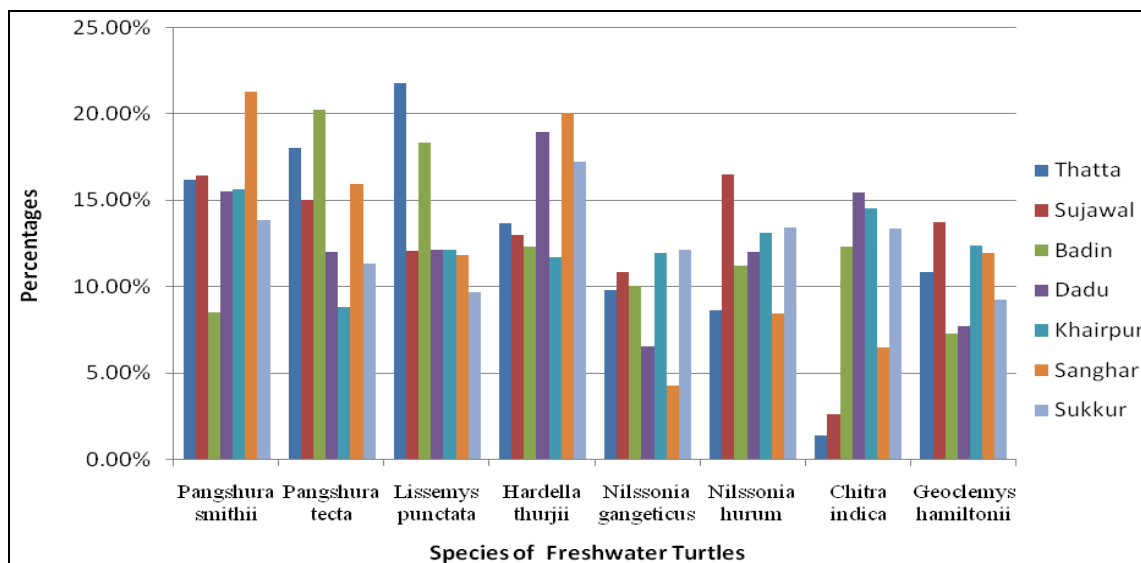


Fig 3: Percentage of Population Distribution of Freshwater Turtles in selected wetlands of Sindh for year 2017.

Statistical analysis

Data analysis of Thatta district mentions the highest species ratio of *Lissemys punctata* (0.217). Index-H calculated as 1.942 while Index-E estimated as 0.373.

In Sujawal, highest species ratio of *Nilssonia hurum* (0.1648) found. Index-H calculated as 2.004 while Index-E calculated as 0.386.

In Badin district, high relative count observed by population of *Pangshura tecta* (0.202). Index-H calculated as 2.024 while Evenness Index found as 0.402.

In Dadu district, highest species ratio estimated of the population of *Hardella thurjii* (0.189). Index-H found as 2.029 while Index –E estimated as 0.412.

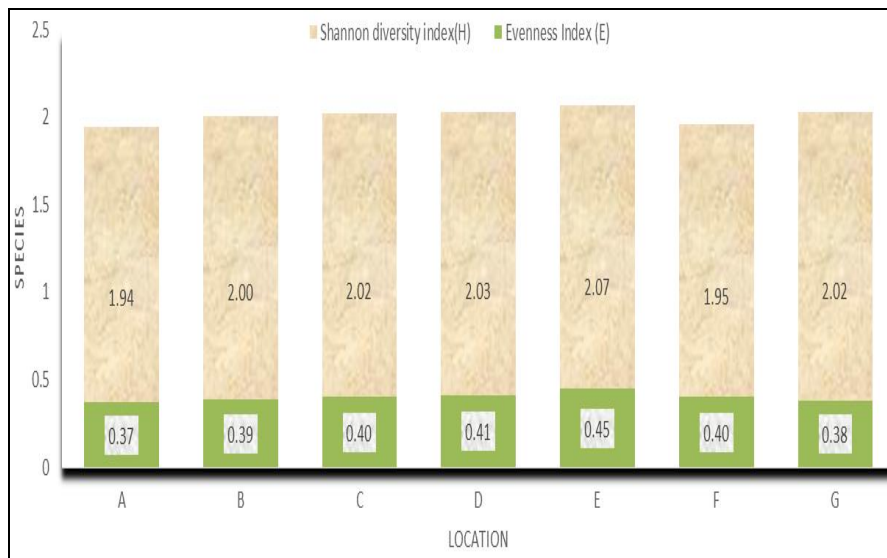
In Khairpur district, highest relative counts calculated of the

population of *Pangshura smithii* (0.156). Index-H found as 2.06 while Index –E estimated as 0.451.

In Sanghar district, high species ratio observed from the population of *Hardella thurjii* (0.240).Index-H calculated as 1.954 while Index-E found as 0.401.

In Sukkur District, highest species ratio calculated from the population of *Lissemys punctata* (0.231). Index –H estimated as 2.024 while Index –E calculated as 0.383.

All the data of different districts from 2017 show the highest level of species diversity Index i.e. (2.07) and Highest Evenness Index (0.45) found from the Khairpur district which demonstrates the most evenly distributed populations of Freshwater turtles in wetlands of Khairpur in 2017.



Key. A-Thatta District, B- Sujawal District, C-Badin District, D –Dadu District, E –Khairpur District, F- Sanghar District and G- Sukkur District.

Fig 4: Graph showing Shannon Diversity Index and Evenness Index of freshwater turtles Population estimated from different Districts of Sindh of year 2017.

Discussion

There are so many wetlands present in different districts of Sindh, which provides suitable habitat for Freshwater turtle's population. Due to lack of awareness and low literacy rate in rural areas of Sindh, it is the most difficult task to regulate the conservational efforts for turtles. Poverty is the main obstacle that results in illegal hunting and poaching of turtles by locally inhabited people for their livelihood.

^[5] Azam *et al.* (2005) recorded six species of turtle i.e. *Pangshura smithii*, *Pangshura tecta*, *Hardella thurjii*, *Chitra indica*, *Nilssonina gangeticus* and *Lissemys punctata* from Sukkur Barrage, Guddu Barrage and Jamaldin Wali. Whereas present investigation reports presence of eight species in seven districts of Sindh. This results differ may be because of the small scale in survey areas covered.

^[6] Baig (2006) mentioned the killing of two species of turtles i.e. *Chitra indica* and *Aspideretes gangeticus* by native community in Sindh for their carapace and plastron. The native people sold them for Rupees 50 to 250 to the agents of exporters. During current research, many hunters of freshwater turtles were interviewed in the localities of wetlands. They informed about the methods of capturing, supply, and trading of turtles to the middle agents of the exporters. Middle agents interact and bargain with the native hunters and then supply the parts or whole specimens to the exporters. The price of a single turtle found varied from 1500 to 2000 rupees. Many exporters are interested in only some particular parts, and then turtles are butchered and cut into pieces to obtain those particular parts. Remaining parts and viscera are put into water, which cause spoilage and bad smell from water that result in death of other turtles and fishes. Turtle hunting groups search for turtles not only in rivers but also in small canals, nearby watercourses and agricultural fields.

^[7] Noureen and Khan (2007) studied the status and illegal trade of turtles in Pakistan. Eight species found with high level of trade. Guddu Barrage area in Sindh was found to be a potential hotspot. Present investigation line up with them. Eight species recorded from different districts of Sindh. While During the present study, Hadero Lake, Haleji Lake, Karo Lake and Mahboob Shah Lake from Thatta District, Chotiari Wetland complex from Sanghar district, and Phoosna Lake

from Badin District noted as hotspots for illegal capture.

According to ^[8] Noureen (2009) eight species of freshwater turtles in Indus river system recorded from Sindh. Kotri, Guddu and Sukkur barrages were found to be the main hotspot for turtle capture. Current investigations support those findings.

^[9] Noureen *et al.* (2012) reported eight species of freshwater turtles in Pakistan. Illegal trade was recorded from various wetlands of Sindh. Karachi served as main hub for collection and export of turtles from Sindh. Present findings line up with those findings ^[10] Safi and Khan (2014) recorded seven species of freshwater turtles from Charsadda district of Khyber Pakhtunkhwa. While the previous data collected from Sindh and present findings, show the presence of eight species of turtles in seven selected districts of Sindh. Therefore, Sindh contains more rich turtle fauna as compared to KPK.

According to ^[11] Khan *et al.* (2015) status and distribution of freshwater turtles from four districts of KPK and from four districts of Sindh. *Geoclemys hamiltonii* was found as rare in Sindh while it was recorded only from a single district of KPK, while *Lissemys punctata* was found abundant in KPK and Sindh. Present investigations mention the decrease in population of *Geoclemys hamiltonii* during 2017. *Pangshura smithii* found abundant during current study

Illegal trade has been declared as a major threatening factor, which serves as a hurdle in conservational efforts by many researchers including ^[12] McNeely *et al.* (2009), and ^[13] Nijman (2010). Unsustainable trade leads to the main decline in the population of Asian freshwater turtles ^[14] Compton, 2000). Many other researchers also worked on the aspect of unmanaged trade of turtles ^[15] (Van Dijk *et al.*, 2000, ^[16] Gibbons *et al.*, 2000). Testudines are traded in Asia for food, traditional medicines and as pets ^[17] (Gong *et al.*, 2009; ^[18] Lyons *et al.*, 2013).

The Intensity of Illegal trade in Pakistan

In Pakistan, turtle trade is up to its peak, although several conservational efforts have been made by Government and nongovernmental organizations but due to increase in international demands, traders approach the native people to capture and sell turtles to them. This trade affects all the species of turtles but specifically the Softshell turtles face

decline in population due to overhunting. Soft shell turtles are more valuable because of their demand in food industry.

In the category of hardshell turtles, the most demanded species is *Geoclemys hamiltonii* (Black spotted turtle). Its export has increased in last few years. Pakistan is one of the main supplier of freshwater turtles along with Bangladesh and India while the major markets that receive these shipments are China, Thailand, Bangkok, and Indonesia ^[19] (Gong *et al.*, 2009).

Threats

The whole Indus river system is affected from illegal turtle trade by local communities. Many local tribes in Sindh use their flesh and eggs for edible purposes. Their flesh sold in markets in high prices due to great nutritious values and spiritual beliefs, which encourage their traders to continue this cruel business. Their body parts exported to South Asia and Central Asia ^[20] (Lyons *et al.*, 2013).

Climatic changes also reveal disastrous effects on the populations of freshwater turtles ^[21] (Cosentino *et al.*, 2010). It found during baseline study and current research, those different districts of Sindh adversely affected from extreme climatic conditions included floods, droughts, heavy rainfall and sea intrusions. Thatta and Badin districts are highly affected from flood, cyclones, and sea intrusion. Sea intrusion results in change of freshwater composition and ruins its quality. Extreme high temperature in summer also observed in Sanghar and Sukkur districts. The major causes of decline in population are high temperatures due to global warming and drought conditions in Sindh. Variable rainfall rate and regular flooding in some districts of Sindh are also causes of decline in population of turtles. Temperature is also having direct effect on developmental activity of eggs in freshwater turtles. ^[22] Vogt and Bull (1982) described that fluctuation in temperature of external environment results in sex determination in hatchlings.

Many other factors influencing on population density of turtles which leads them to hazardous decline includes prolonged drought, high by catch ratio, destruction of shoreline areas, spiritual beliefs, human interference in nature and sea water intrusion in inland water system. Some species has become vulnerable because of slow maturation rate and low fecundity level.

Other important cause of their loss is road mortality due to high traffic ratio near bank areas. High road mortality of turtles has observed by many researchers ^[23] (Proulx *et al.*, 2014; ^[24] Steen *et al.*, 2006). During the present study *Lissemys punctata* observed wandering on Sukkur barrage, which then rescued and released back into Indus river.

Wrong identification of species, Lack of awareness and less conservational efforts, Invasive species, poor implementation of regulations, deficient resources, traditional beliefs of local communities are also considered as major threats to turtle's survival.

Low productivity and delayed maturity are the also major factors for lower population richness in freshwater turtles ^[25] (Congdon *et al.*, 1993).

Predation is a major threat to hatchlings and eggs of freshwater turtles. Some important Predators are carnivorous mammals, otters, mink, raccoon, gray fox, coyote, heron, gulls, and some fishes like largemouth Bass ^[26] (Holland, 1994). In nesting season, turtles come outside water near bank areas and shoreline to construct nest. During nest building, they leave some prominent clues for predators so their nests are easily approachable and easily detected by predators like

coyotes, foxes, and wild dogs ^[27] (Campbell *et al.*, 2013). Similar investigation recorded by other researchers ^[28] (Browne and Hecnar, 2007; ^[29] Holcomb and Carr, 2014; ^[30] Mifsud, 2014; ^[31] Paterson *et al.*, 2012).

Prolonged developmental duration; high mortality ratio, lower adaptability and slower reproductive rate are the threatening limiting factors for existence of freshwater turtles ^[32] (Spencer, 2001).

Pollution is also a cause of mortality in turtles. It may be because of contaminated water with industrial chemical discharge, garbage, agricultural waste, pesticides, fertilizers, acid rain, and domestic wastages. These all factor leading the turtle's population to decline. Effects of contaminants, pesticides, and fertilizers on mortality of turtles investigated ^[33] (De Solla *et al.*, 2014).

During present study, high level of pollutants found in wetlands included the solid wastes like shopping bags, plastic bottles, and other garbage. Many local communities used to of throwing their domestic waste into wetlands. It observed that agricultural runoff water contains high levels of fertilizers and pesticides became the part of water body that results in increase of eutrophication. Sewerage water lines also observed in many areas that have outlets in wetlands that dump all their nitrogenous waste into water. Many wetlands serve as recreational area for tourists. They perform so many activities that increase pollutants in water like washing of their vehicles and clothes. Fuels and detergents added to water results in high mortality of fauna. Many industrial units also been noted, working near many different wetlands, which empty their effluents into water bodies with high level of toxic chemicals as well as acids. The whole biodiversity of wetlands can easily be ruined by these contaminants.

By Catch is a threat for turtle's survival ^[34] (Raby *et al.*, 2016). Use of inappropriate gears and improper mesh sizes results in high by catch ratio of turtles along with local fisheries. Use of suitable gears helps the escape of by catch from nets ^[35] (Lowry *et al.*, 2005). During present study, many fixed nets observed during surveys in different wetlands. Passive fishing mostly leads to capture of turtles as by catch in fixed nets that result in suffocation and finally death.

Another important factor of their mortality is the injuries due to boat propeller strikes during the fishing practices in rivers and canals. It is necessary to avoid high speeding of boats at areas of high turtle's populations. Many lakes and canals used as recreational sites for ecotourism. Boating practices for recreation have seen in different lakes and canals of Sindh included Keenjhar lake, Phoosna lake and canals near Sukkur barrage. These boats contain motor operated propellers with sharp edges. They can cause severe injuries to turtles as well as other fauna inside wetlands.

Habitat disintegration due to highways expansion projects became the major cause of decline in fresh water turtle's population ^[36] (Hamer *et al.*, 2016). During current study, many developmental activities seen in different localities of Sindh included the construction of poultry farms, cattle farms, agricultural units, bridges, tanneries, and other industrial units.

Sand mining has very devastating effects on ecological structure of turtles. Commercial sand mining causes soil erosion and disturb the nesting of turtles. The composition of water changes due to increase in turbidity which results in increased mortality.

Canal closure and de siltation also found as major factor for increasing mortality in turtles. In Sindh, there is a particular season for canal closure results in lower quantity of water in

canals. Due to shortage of water, turtles easily captured by local hunters in that particular season. Many turtles leave the wetlands and migrate to another water bodies but during the process most of them captured by native people and killed by road accidents.

Trade of Calipee

Calipee is the cartilaginous part present in plastron. It is the highly demanded part of turtles, which used to prepare the traditional medicines in China. Most of the turtles killed for their calipee. Many consignments seized by custom officials of Pakistan that actually containing calipee but tagged as buffalo horns or dried fish.

Internet Trade

A recent trend has developed by misuse the internet technology for sale and purchase of turtles as pets. Different dealers use different websites for advertising their wild caught species. Law enforcement agencies should have to keep an eye on internet trade protocols because both the trading parties remain unidentified to each other. Orders are booked on different websites for online purchase by just selecting them from displayed picture and then transactions has been made by using credit cards without any meeting of selling and purchasing parties. This trend has been increasing day by day.

Conservation Strategies

Pakistan is also playing an important role in conservation of freshwater turtles. It has joined CITES as an active member on July 19th, 1976. Four native species of turtles i.e. *Geoclemys hamiltonii*, *Pangshura tecta*, *Nilssonina gangeticus*, *Nilssonina hurum* are included in CITES Appendix I and three i.e. *Pangshura smithii*, *Lissemys punctata*, *Chitra indica* are included in CITES Appendix II.

IUCN included the turtles of Pakistan in its Red Listing categories. It declares *Geoclemys hamiltonii*, *Hardella thurjii*, *Nilssonina gangeticus*, *Nilssonina hurum* as vulnerable, *Pangshura smithii* as near threatened, *Pangshura tecta*, *Lissemys punctata* as Least concern while *Chitra indica* as endangered.

TurtleSAT, A Software

This application named as Turtle SAT is used to identify the species of turtles with a displayed picture guide and their location can be detected through GPS system for recording of sightings. This application is also useful to find out the hidden nesting areas of turtles.

Action Plan

Conservation plans and turtle conservation models can only be prepared when there is complete information and detailed inventory available, about the species, population density, status, distribution, habitat, breeding biology and threats. The following Action Plan for the conservation of turtles is suggested.

1. Regular monitoring of Local markets for investigating the turtle trade made possible.
2. Hotspots should be monitored regularly for illegal turtle capture and trade.
3. Some special protection areas should be designated for turtles.
4. International cooperation with other organization should be sort out and established.
5. Regular monitoring should be done at hotspots to determine threats.

6. Trade should be monitored.
7. Nesting areas should be protected.
8. Training should be given to custom officials for species identification.
9. Advanced technologies like software and mapping tools should be used.
10. Implementation of legislation should make possible.
11. Local communities should be aware about threatened species and their importance.
12. Alternative livelihood may be provided to the native communities to prevent turtle hunting.
13. Sindh Wildlife Department should be start technical cooperation with universities and wildlife institutions and scientific NGO's.

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