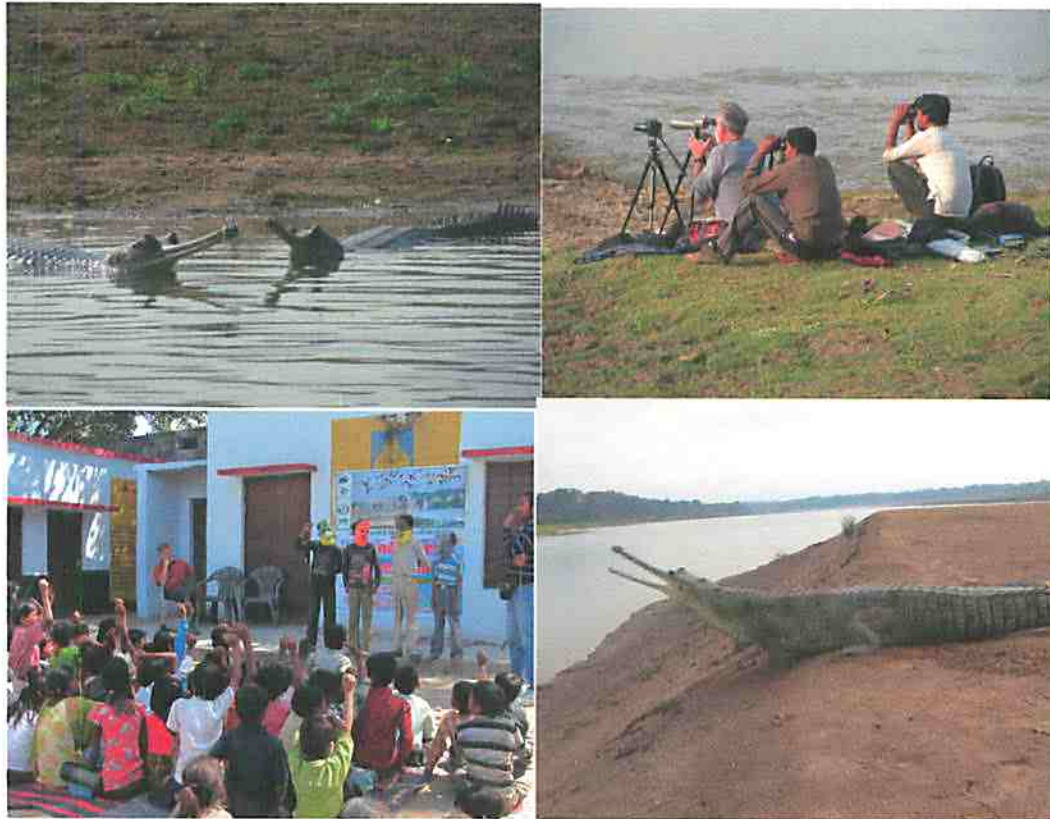


Gharial Telemetry Project, National Chambal Sanctuary

Progress/Activity Report Dec 2011-Dec 2012



A COLLABORATIVE PROJECT OF MCBT/GCA AND THE UTTAR PRADESH AND MADHYA PRADESH
STATE FOREST DEPARTMENTS

MADRAS CROCODILE BANK TRUST / GHARIAL CONSERVATION ALLIANCE, GARHAITA VILLAGE, ETAWAH
DISTRICT, UTTAR PRADESH, INDIA



January 25, 2013



Financial Support from San Diego Zoological Park, Zoo Praha, Cleveland Metroparks Zoo, Ocean Parks Conservation Foundation, Rufford Maurice Laing Foundation, IUCN Crocodile Specialist Group, the Gharial Conservation Alliance, and the Madras Crocodile Bank Trust.

Executive Summary

This activity/progress report covers the period December 2011 through December 2012, and briefly summarizes the Gharial Telemetry Project activities and preliminary results. It updates a previous progress report covering May 2010 through November 2011 (dated 15 December 2011) and earlier reports including an Interim Progress Report (dated June 2010), and also supplements periodic activity reports provided to FD offices, as well as granting agencies.

Earlier in this study, the ten gharial tagged with radios in 2008-09 were monitored until all radios ceased to function, the last in September 2011. The initial group of ten tagged gharial were marked near Chilonga and near Nachnouli in the lower Chambal segment of the National Chambal Sanctuary (NCS) between the Udi Bridge and Dinnpura, below Naangoan near Choti Mau. Overall, a total of 2321 animal-specific locations for these gharial were recorded over 38 months (Table 1). The average radio functioned for 2 years (24 months), and provided 152-311 location sightings per animal. The residency patterns of these gharial were restricted to 5-15 km of river length, and were well-defined and predictable, irrespective of season, as noted in prior reports, based on the first 14 months of tracking. The additional information collected during 2010-11 on these individuals confirms and expands on the earlier results and interpretations of spatial ecology. Because six of these individuals remained trackable during the last half of 2010 and the first half of 2011, tracking their movements overlapped with the tracking of a second group of ten gharial, tagged in late 2010.

In contrast to the first tagged group, the second group of gharial fitted with radios (in November 2010) resided at locations between the Udi Bridge and Sashon Ghat. These localities were approximately >40 km downstream of those of the first tagged group. Unlike the earlier tagged group, these recently tagged gharial from this lower section of the river exhibited several distinct residency patterns. Like the previous group, some gharial (primarily the smaller males; n=4) had restricted residencies, centered at or near their respective capture sites. These individuals tended not to move very far upstream or downstream (<15km), a spatial pattern similar to most of the previously tagged gharial from the initial study group. However, the other six gharial in the second group, including 3 larger females and three small males, made long-distance seasonal movements, up and downstream for distances > 80 km. These individuals ranged downstream below the Yamuna confluence to Pachnada, and upstream to rocky areas (Gohera, and Godha) above Naangoan. These movements were seasonal and predictable, and tended to occur within 1-2 weeks followed by a stable residency at the new location. Three of these long distance movers were adult females. One nested in 2011, and two nested in 2012. A third female may have nested in 2012, but not in 2011, but her nest site was not located because she moved out of range of telemetry monitoring during nesting/hatching.

In addition to the activities and preliminary results outlined above, selected topics are briefly discussed, including comments on radio attachment and function, seasonal capture scenarios, general comments on gharial seasonal activities and behaviors, and the relevance of this study to the 2007-2008 die-off of gharials in the lower Chambal River. The workplan for 2013 entails the continued monitoring of the second tagged group of gharial until these radios fail to function. The primary project personnel continues to be the two trackers working on motorbike and/or on foot, with periodic visits from MCBT/GCA staff and scientists, based at Sashon and Garhaita, UP.

Introduction

This activity/progress report briefly summarizes various activities carried out on the Gharial Telemetry Project, initiated in June 2008. This report covers the period from December 2011 through December 2012, and significantly updates the most recent report covering the previous year's activities (dated 15 December 2011, covering December 2010 through December 2011). This report also updates the Interim Progress Report, dated 28 May 2010, and supplements information presented in the Report on Phase II Tagging Operation, dated January 18, 2011, as well as in correspondence with State FD offices. In addition, the background from the telemetry component of this project, as well as the preliminary findings are outlined in a paper entitled "Application of Telemetry Techniques in Crocodilian Research: Gharial (*Gavialis gangeticus*) spatial ecology in the Chanbal River, India" published in a special ENVIS - Wildlife Institute of India Publication "Telemetry in Wildlife Science, Volume 12 (2012)". The ENVIS paper, a summary paper on the first group of tagged gharial, as well as presentations in 2012 and 2013 are referenced at the end of this report.

Preliminary Results: Telemetry Tracking Summaries

The preliminary results for the gharial tagged in 2008-09 were summarized in the previous interim report. In May 2010, all ten gharial from the initial group were still being tracked (14-22 months), and by September 2011, all of these radios had stopped broadcasting. The average broadcast life of a radio tag was 2 years, or 24 months, and ranged from a maximum of 1161 days to a minimum of 551 days. Only one radio was known to have detached, after approximately 500 days. This radio was subsequently recovered in shallow water near the riverbank frequented by the individual carrying this tag. This particular gharial (57) was recognizable because it had a broken snout, and it was later observed to be in good health and behaving normally after losing the radio tag.

During May through November 2010, a total of 426 animal-specific locations were recorded for the initial group of ten gharial. An additional 77 locations were recorded during December 2010 through May 2011, and a further 6 locations were added for the two remaining radios during May-September 2011. Overall, a total of 509 animal-specific locations were tallied for this group, in addition to the 1812 track locations recorded previously. Overall, for this group, a total of 2321 animal-specific locations were observed from June 2008 through September 2011, over 38 months. The majority of these individuals (n=7) were tracked through two monsoons of 2009 and 2010; two of these were followed through three monsoons (2009-2011); and one (59) was tracked through four monsoons (2008-2011).

The primary dry season (November-June) and monsoon season (July-October) locations of the initial tagged group of ten gharial are summarized for each individual in Table 1. The spatial ecology as evidenced by these additional records for 1-2 subsequent annual cycles reinforces the general patterns of river habitation outlined in the previous reports. In general, the gharial under study showed well-defined residence patterns, restricted to 5-15 km of river length, irrespective of season. During the monsoon months, a majority of tracked gharial moved downstream and monsoon residences increased in area/extent, but the areas frequented remained well defined and predictable for each tagged individual. Further comments on these preliminary results as they relate to the diep off are included in the discussion section.

Previous Project Activities: May 2010-November 2011

During May through November 2010, radioed gharial were tracked via telemetry by two experienced trackers, working together as previously described in detail, on motorbike and/or on foot patrols to locate, record, and observe tagged and marked individuals. During the 214 days from May through November 2010, the tracking team logged 130 days in the field ($130/214=61\%$), or an average 19 days per month for 7 months, including the monsoon period from July through September. A total of 426 animal-specific locations were recorded for the ten tagged gharial. At the end of this period, late October 2010, 6 tagged gharial were still being tracked by telemetry. One radio was recovered after becoming detached, apparently without injury to the gharial (57); the gharial was subsequently observed unharmed on a nearby riverbank. Three radios, presumably still attached to gharial, ceased emitting signals (2 in September=63, 69; and 1 in October=61). All three gharial were later sighted by visual identification with radios attached, but not functioning.

In November 2010, Phase II of capture and tagging was carried out at various localities between Sashon Ghat and the Udi Bridge, a section of the Chambal River selected below the site of the previous tagging and closer to the Yamuna confluence. An experienced field team with MCBT staff, representative Forest Department officials, and local trackers and fishermen captured and tagged ten additional gharial, ranging from 2.1m to 3.6m in length. These gharial were fitted with telemetry radios and visible tags from 18-28 November. The details of this operation are summarized in a previous report, Phase II tagging, dated January 18, 2011. This operation was carried out without incident, and no gharial were injured or died during any of the procedures. A summary of the gharial locations to date (thru Dec 2012) are shown in Table 2.

During December 2010 through May 2011, the tracking team spent a total of 122 days in the field ($122/182=67\%$ of total days during this six months; or an average of 20 days/month). The area of coverage ranged from Sashon Ghat to Godha, approximately 15 km above Naangoan, or >80 km of river. During most of this period, the team was able to track on a weekly/biweekly basis the 16 gharial that were radio-tagged, including 6 from the initial group, and 10 from the November 2010 tagging operation. All ten of the second group were successfully located during this period, and a major tracking effort was focused on these recently-tagged individuals, since their movement patterns were not yet documented. During this period, 4 additional radios for the first group stopped sending locatable signals (1 in March=75; 3 in May=49, 51, 53), leaving only two of the original group still trackable. During this time, three of the previously tagged gharial were observed and identified and photographed (61, 69, and 75) following the loss of radio function. Their radios were still firmly attached when they were subsequently observed, and there were no ill effects from radios.

From June through November 2011, the tracking team spent a total of 128 days in the field ($128/183=70\%$ of total days in 6 month period; or an average of 21 days/month). The area of coverage substantially increased during this period because the recently-tagged gharial ranged downriver to Pachnada and upriver to Gohera (~130 km river length) due to seasonal monsoonal movements. During this period, the last two gharial with radio tags from first capture were no longer trackable, but were observed with radios still attached. Thus, at least 7 of the original ten gharial tagged in the initial group were visually observed and photographed after the radios ceased broadcasting trackable signals, and some of these are still visually identified in early 2013.

Project Activities: December 2011-December 2012

Tracking of the second group of 10 tagged gharial (in November 2010) was initiated immediately upon release, and has continued to date (through January 2013). During the first year of tracking this second group (December 2010-December 2011), all ten individuals were monitored throughout the winter months, the pre-monsoon breeding season, the extensive monsoon of summer 2011, and the post-monsoon period. During the first half of 2011, as many as 16 radioed gharial were being tracked 1-3X weekly. During the second half of 2011, all ten gharial in the second group were monitored, but none of the initial group (tagged in 2008p 2009) were trackable after October (e.g., radios no longer functioning), although visual sightings were recorded for 7. A brief summary of the 2011 tracking data is included in the telemetry tracking summaries that follow, and referred to in this update, and shown in Table 1.

During December 2011 through December 2012, a total of 365 animal-specific locations were recorded for the second group of ten tagged gharial. Taken together with the previous year's records (538 locations, revised; mean=54 records per individual, range=17 to 75 locations), a total of 903 animal-specific locations were determined for these individuals, averaging 90 locations per animal, ranging from 147 to 17. Of the ten tagged in 2010, 7 gharial are still being tracked as of January 2013. For these, an average of 109 animal-specific locations have been determined for two years (continuously for 25 months through December 2012), ranging from 79 to 146 per individual. Importantly, these records represent weekly/monthly gharial locations throughout the entire annual cycle, including winter months, pre-monsoon, summer monsoon, and the post-monsoon period.

During this period (December 2011-December 2012), three radioed gharial were lost (25 male, 29 male, and 37 male). 29 male was tracked into March 2012, but 25 male and 29 male were not detected after December 2011. The radio attached to 25 male was relocated on the Yamuna bank in shallow water near Bawain village, approximately 2 km downstream from the Yamuna-Chambal confluence. The other two animals/radios were not recovered/relocated. For 25 male, a total of 17 radio locations were determined from March 2011 to October 2011. For 37 male, a total of 47 radio locations were determined from December 2010 through November 2011. For 29 male, a total of 79 radio locations were determined from December 2010 through March 2011.

For the second group of tagged gharial, preliminary examination of the tracking records reveals the general patterns of seasonal movements and activities/home range areas summarized in Table 2. These data are still being processed and analyzed, but the individual records indicate a number of distinct patterns of river residency. Four subadult males (27, 31, 37, and 39) exhibited relatively sedentary movement patterns, with well-defined, relatively small residencies. Three individuals (27, 31, and 37) were resident year-round with the same 5-15 km stretch of river; 27 and 31 for two years (2010-2012) and 37 for one year (2010-2011). Another subadult male, 39, shifted 15-20 km downstream during high water, from Chikni Tower to Sashon Ghat, in 2011 (heavy monsoon), and again in 2012 (light monsoon). All of these restricted residencies are located at or very close to the capture sites where these respective gharial were tagged. This seasonal pattern was similar to most of tagged gharial monitored earlier in 2008-2010 between Udi and Dinnpura, approximately 30 km upstream.

The other three subadult males (25, 29, and 35) exhibited stable seasonal residencies for most of the annual cycle, but all three males made seasonal long-distance river movements (>90-110 km) that punctuated extended periods of stationary residency at varied locations far downstream. In 2011, two subadult males (25 and 35) shifted upstream 60-70 km from the winter months and pre-monsoon period, then downstream 110-130 km to the Yamuna-Chambal confluence and/or Pachnada. 25 male was lost during the 2011 post-monsoon, and 35 male resided during 2012 near the Yamuna confluence (more on 35 later). The other adult male (29) resided near its capture site throughout 2011 pre-monsoon, shifted downstream 20-30 km to below Sashon Ghat during the monsoon, and then made a gradual long distance move of 60+ km to a breeding aggregation below Naangoan. In most instances these long distance movements were made in 1-2 weeks or less, particularly the downstream segments just as the high waters rose at the beginning of the monsoon. This movement was followed by a lengthy period of residence at the new locality, either upstream or downstream.

The residency pattern of subadult male 35 is particularly noteworthy because this individual resided in the Chambal upstream in 2011, shifted to the Yamuna-Chambal confluence and downstream during the 2011 monsoon, then took up residence in the lower stretches of the Yamuna (≥ 20 km upstream of confluence) for most of the 2012 pre-monsoon and monsoon. In November 2012, 35 male shifted back into the lower Chambal for residence, within 15-20 km of confluence where it is residing at present (January 2013). In short, 35 male resided for 6-8 months continuously during 2012 in the lower Yamuna. This area has been the focus of potential sources of pollution possibly related to one hypothetical scenario for the cause of the 2007-2008 dieoff in the Chambal below Udi, but to date, no ill effects are evident for 35 male.

Three subadult/adult females were tracked during 2011 and 2012. All have made long distance seasonal movements to breeding/nesting areas upstream during the post-monsoon months (October-December), then resided in these upstream locations (January-June), returning to downstream locations during the high water, monsoon months (July-September). The most detailed and extensive record is that of female 23. She nested at different locations in 2011 (Chikni Tower, 52 km upstream from the confluence) and in 2012 (Dinnpura, UP side, 87 km upstream from the confluence). Before nesting each year, this female traveled upstream to Gohera in 2011 (113 km upstream from Pachnada), and upstream to Maghera ka Pura in 2012 (101 km upstream from Pachnada). Downstream movements were rapid once water began rising in the beginning monsoon. In 2011, 23 female moved 50 km to the confluence within a week, and in 2012 moved 40 km to Chikni Tower in a few days in late July, and another 50 km further downstream to the confluence a week later.

Another female exhibited a similar seasonal pattern of long distance movements related to reproductive activities, and nested in 2012, but not the previous year (2011). From her capture point, 41 moved 90 km upstream to a breeding aggregation at Gohera where she remained until high water in 2011, returning as far downstream as Pachnada (113 km downstream, 11 km below the confluence). Post-monsoon (2011), she returned to Gohera in November, remained in residence through March, and shifted downstream 35 km to Dinnpura, MP side where she nested and remained until July 2012. With high water, she returned downstream to the confluence (87 km), returning to Gohera in November 2012 via stopovers near Sashon Ghat (30 km upstream from confluence). To date, 41 female has moved at least 541 km up and down river in two years.

The remaining female, 21, apparently did not nest in 2011, but may have nested in 2012. She moved upstream from her capture site 60 km to Gohera during the winter months and pre-monsoon 2011, returned to Sashon Ghat during the 2011 monsoon, and then moved back upstream to Gohera in 2012 from November 2011 through March 2012. She was conspicuously absent during the nesting/incubation/hatching period in 2012 at any locations surveyed, but this female reappeared downstream during high water of the 2012 monsoon, then returned upstream to above Gohera (77 km above Sashon Ghat) in December 2012. She may have nested upstream of the area monitored during nesting, because her disappearance coincided precisely with nesting. A brief summary table of gharial activities, by season/bimonthly, is shown in Table 3.

Selected Discussion Topics

1. **Radio Function and Attachment:** The method of radio attachment utilized in this study has proven effective for tracking, and was used successfully with no evidence of injury and/or harm to the gharial during the study or afterwards. Radios no longer functioning are observed visually.
2. **Monitoring Protocols:** The tracking methodology relies on high vantage points along the riverbank. Two local trackers move to the river on foot, and move between sites on motorbike and/or on foot. These procedures do not disturb gharial, which are habituated to people moving along the river. In contrast, boat travel routinely disturbs gharial, and interferes with tracking.
3. **Seasonal Timing of Capture/Tagging:** The best time of year to capture and tag gharial is the post monsoon period when water levels are relatively low, but seasonal breeding and nesting are not yet underway. On the lower Chambal, this period is October-December. The preferred time for capture/tagging when disturbance is minimized is from early October through mid November, when ambient temperatures are still seasonally mild prior to winter (Table 3).
4. **Population Profiles:** During this period of study, no adverse evidence of any ill health or abnormal behaviors were noted during the course of tracking and observing gharial in the NCS. The gharial population on the lower Chambal on all of the river stretches frequented by the trackers appeared to be healthy and relatively abundant, and comparable to the situation and/or condition observed in previous years. Nesting has been observed at the traditional nesting sites in 2010 thru 2012, and seasonal counts of gharial at selected sites have been similar to those observed at these sites in other years. Seasonal activities/behaviors are shown in Table 3.
5. **Relevance of Study to the 2007-08 Die-Off:** Previously, the initial group of tagged gharial resided along a 30 km stretch of the Chambal River, from Dinnpura to the Udi Bridge. The restricted residencies of this first group of tagged gharial suggested that the epicentre of the die-off, e.g., above and below Chikni Tower, was outside the seasonal boundaries they inhabited. The second group of tagged gharial were seasonal residents of the lower Chambal just above Sashon Ghat. It was suggested that these gharial may move down to the confluence during the monsoon.

In fact, this tracking study has shown that only some gharial move downstream, as far as the confluence with the Yamuna and even further downstream to Pachnada. Furthermore, these visits were seasonal and brief, with the notable exception of one subadult male that took up residence in the lower Yamuna during 2012. Four subadult males had stationary residencies close to their capture points, and either did not move downstream during the monsoon (3 individuals), or only moved 15-20 km downstream, but not downstream as far as the confluence. Actually, this group typically made directed movements upstream for long distances. The telemetry study suggests that seasonal exposure to Yamuna flow is confined to only a small subset of gharial living in the lower Chambal within 60 km of the confluence, near the die-off site.

WorkPlan for 2013--Gharial Telemetry Project

The current group of seven tagged gharial, marked in November 2010, will be monitored during 2013 until the radios cease to function, likely prior to the 2013 monsoon. The tracking team, consisting of two trained observers will monitor tagged gharial, and continue to make detailed observations on gharial activities and behaviors through the first half of 2013 (Jan-July). Representative staff and advisors at MCBT will be the primary project staff, in addition to the trackers, and will visit the project sites periodically and be resident at Garhaita, Sashon, and Etawah, and continue to access the river habitats within the NCS by jeep, on motorbike, and on foot. Boat patrols along selected stretches of river may be useful to document changes in river landscapes, and how gharial have responded to seasonal changes in river topography.

Continuance of the Gharial Telemetry Project is pending, depending on available financial support, operational and logistic planning, and the necessary permissions to continue. A tentative schedule for 2013 would be to plan a capture-tagging of another group of gharial to fit tracking devices for October-November when disturbance to social and breeding activities is low. The number and sizes of gharial to target remains to be determined, as well as specific locations. There may be benefit in tagging a small number of mugger crocodiles as well.

The long-term management and conservation of gharial within the National Chambal Sanctuary will require additional information on the ecology and behavior of the species as it relates to the suitability and stability of the riverine shoreline terrestrial habitats, as well as the water level and flow regimes available in the aquatic habitats. To date, the telemetry project has provided detailed data on the movements, activities, and behaviors of subadults and adults living in the lower Chambal, at distances from -10 km below the confluence with the Yamuna (Pachnada) to the Rajasthan boundary with Uttar Pradesh, ~130 km upstream from the Yamuna confluence. Monitoring of gharial in the upper segments of this stretch, as well as a select group of larger adults, including one or more large, breeding males will shed additional light on gharial ecology, and provide baseline data on the health and status of the resident gharial population in the NCS. Important management & conservation strategies should be based on gharial biology.

References to this project

Application of telemetry techniques in crocodilian research: Gharial (*Gavialis gangeticus*) spatial ecology in the Chambal River, India, pp. 161-171, in Sivakumar, K. and Habib, B. (Eds.) 2010 Telemetry in Wildlife Science, ENVIS Bulletin. Wildlife and Protected Areas, Vol 13 No. 1, Wildlife Institute of India, Dehradun 248001. INDIA

Spatial Ecology of *Gavialis gangeticus* in the Chambal River, India, pp. 183-196, in Crocodiles, (2010) Proceedings of the 20th Working Meeting of the Crocodile Specialist Group, IUCN, Gland, Switzerland and Cambridge UK.

Gharial Ecology on the Chambal River in north India, abstract for talk at World Congress of Herpetology (WCH7), 8-14 August 2012, University of British Columbia, Vancouver BC CANADA

Gharial Ecology on the Chambal River, plenary talk to be presented at the Gharial Session, CSG 22nd Working Mtg., 20-24 May 2013 to be held in Colombo, Sri Lanka.

Project Contact: This report prepared and written by Dr. Jeffrey W. Lang, jeff.w.lang@gmail.com
1385 Brompton St, St Paul, Minnesota 55108-1622 USA +1 651 646 0203 res; +1 651 269 5604 cell
Madras Crocodile Bank & Gharial Conservation Alliance, India; U. Minnesota and U. North Dakota

Table 1: Summary of Tracking Locations for Gharial tagged with radio transmitters in NCS. Abbreviations noted in legend below table. Trackable locations are tallied for the initial group of ten (49 thru 75) tagged in 2008-09, and for the second group (21-41) tagged in November 2010. During the first half of 2011, as many as 16 gharial were being tracked on a weekly/biweekly basis at Chambal locations ranging from Sashon to above Naangoan. Location notations as in Table 2. ***=visual observ; radio off ** denotes nesting for 23

ID	sex	tl(m)	2010 may- jun	2010 july- sept	2010 oct- dec	2011 jan- mar	2011 apr- jun	2011 july- sept	2011 oct- dec	loc10- 2011	total locat
49	F	2.9	KH	BD	KH	KH	KH			46	218
51	F	2.8	DN	CH	DN	DN	DN		***	49	246
53	F	2.3	DN	NK	DN	DN	DN		***	61	255
55	M	2.1	CH	CH	CH	CH	CH	CH	***	97	311
57	F	2.9	BD	BD	BD	***				38	228
59	M	2.0	KT	CH	KT	KT	KT	CH	***	62	174
61	F	2.9	CH	CH	CH		***		***	67	308
63	F	3.3	?	CH	CH					33	152
69	F	3.0	DN	CH			***		***	21	213
75	F	2.5	DN	NK	DN	DN	***		***	35	216
										=509	=2321
21	F	2.9			(PN)	GH	GH	SG	GH	72	
23	F	3.6			(PN)	GH	KH**	CF	SG	56	
25	M	2.6			(PN)	GD	GD	CF	SG	17	
27	M	2.2			(PN)	PN	PN	PN	PN	55	
29	M	2.2			(PN)	PN	PN	SG	PN	61	
31	M	2.3			(KH)	KH	KH	KH	KH	75	
35	M	2.3			(KS)	GD	GD	CF	SG	53	
37	M	2.1			(KS)	KS	KS	KS	KS	47	
39	M	2.3			(PN)	KH	KH	SG	KH	51	
41	F	3.1			(BR)	GH	GH	CF	GH	51	= 538

Table 2: Tracking Summary of Gharial with radio transmitters in National Chambal Sanctuary. Locations are noted for second group (ID 21n 41) tagged in November 2010. In 2011, most were tracked weekly/biweekly; 25 & 37 were lost by end 2011, and 29 by early 2012. Seven were tracked for 25+months, through Dec 2012. Total animal locations in 2010-2012 =903.

ID	sex	tl(m)		2010	2011	2011	2011	2011	2012	2012	2012	2012		
				nov-dec	jan-mar	apr-jun	july-sept	oct-dec	jan-mar	apr-jun	july-sept	oct-dec		total locat
21	F	2.9		(PN)	GH	GH	SG	GH	GH	?	SG	GH		99
23	F	3.6		(PN)	GH	KH**	PA	SG	GH	DN**	CF	MG		116
25	M	2.6		(PN)	GD	GD	CF	SG	---	---	---	---		17
27	M	2.2		(PN)	PN	PN	PN	PN	PN	PN	PN	PN		110
29	M	2.2		(PN)	PN	PN	PA	PN	MG	---	---	---		79
31	M	2.3		(KH)	KH	KH	KH	KH	KH	KH	KH	KH		146
35	M	2.3		(KS)	GD	GD	PA	SG	YM	YM	CF	MS		81
37	M	2.1		(KS)	KS	KS	KS	KS	---	---	---	---		47
39	M	2.3		(PN)	KH	KH	SG	KH	KH	KH	SG	KH		102
41	F	3.1		(BR)	GH	GH	PA	GH	GH	DN**	CF	GH		106

Chambal River loc: GD=Godha; GH=Gohera; MG= Maghera ka Pura; DN=Dinnpura; KT=Koroth NK=Nachnouli; CH=Chilonga; BD=Badpura; KH=Khera Ajab Singh; KS=Kasaua; PN= Pituwan ka Nagla (Philmunnagara); SG=Sashon Ghat; Mahua Sunda=MS; CF= Yamuma-Chambal confluence; YM= Yamuna; PA=Pachnada, below Y-C confluence (PN), (KH), (KS), (BR)=capture/release sites.

** =these females nested near DN in 2012, and 23 nested at Chikni Tower near Khera in 2011. In 2012, female 21 disappeared during the nest/hatch period, and may have nested elsewhere.

Table 3. Summary of Gharial activities and behaviors observed on the lower Chambal River (National Chambal Sanctuary) throughout the annual cycle (shown here bimonthly). Social interactions peak in late February/early March during the breeding period just prior to the formation of smaller groups of nesting females at nesting sites. Colonial nest sites are determined each year, based on available high sandbanks with adjacent side channels, but are also dependent on low levels of human and animal disturbances. In general, gharial of all size classes are most concentrated at late winter basking sites prior to breeding, and are most dispersed at high water levels during monsoonal rains when main channel flow is swift, and resting and basking sites along the shoreline are limited. Hatchlings remain together when water levels are low, but disperse into shallows and side channels when water levels are high. Basking groups/sites during monsoon are ephemeral. Capture and tagging should be restricted to October-November when animals move upstream and social interactions are minimal.

annual cycle		weather/season	size/age/sex distribution	spatial pattern	group size	dominant activities	river habitats
July-Aug		monsoon high water	all size classes	dispersed	1-5	feeding	shallows, edges, side channels
Sept-Oct		post monsoon receding water	all size classes	small, mixed grps	5-10	feeding basking	main channel, shallows, edges
Nov-Dec		early winter cool temps	all size classes	medium, mixed grps	10-30	basking	sand bars, river bends
Jan-Feb		late winter cool temps	adults – subadults multiple males ≥ 4	large grps breeding	30-90	basking, breeding	mid river bars, bends, rocks
Mar-April		early summer warm temps low water	nesting females egg incubation attendant male(s)	restricted to nesting locations	10-30	trial nests, nesting, incubation	river bends, high sand banks, w/ deep water
May-June		pre monsoon very high temps lowest water	nesting females hatchlings guarding male=1	restricted to nesting locations	10-30	incubation, egg hatch, creches	river bends, high sand banks, w/ deep water

GHARIAL ECOLOGY on the CHAMBAL RIVER in north INDIA

Following a die-off (>100 animals) of *Gavialis gangeticus* in winter 2007-08, ecological and behavioral studies were initiated on the resident breeding population in the lower Chambal River, near the Yamuna confluence. Over 4 yrs, individual gharial (11f:9m; 2-3.5m totl) have been tracked via radio telemetry at daily/weekly intervals, and the distribution and abundance of gharials of all size/age classes have been monitored weekly/monthly. Local observers, traveling by motorbike/on foot, have documented the seasonal movements and behavioral ecology, particularly during breeding, of free-living adults and subadults in an open, dynamic river system subject to monsoonal flooding and periodic drought. Individual gharial exhibited well-defined, predictable residency patterns that varied seasonally. Most frequented 5-15km of river length, inhabiting an upstream segment in low water/dry season, and a downstream area during the monsoon. Some made exceptional, long-distance seasonal movements (80-140km+), moving downstream with high water, and returning upstream 3-6 months later. To date, the resident population under study appears to be healthy, and the size/age distribution of animals indicate annual breeding and hatchling recruitment. Behavioral interactions of adults and young have been observed and photographed during hatching, immediately post-hatching, and throughout the first year for young. Male and female gharial guard and defend incubating eggs and newly hatched young from predators. Close associations of yearlings with each other (at 9 months of age) and with attending adults suggest that parental care continues through the first year of life. In gharial, biparental care, and in particular paternal defense of young, may be the usual condition for this unique crocodilian lineage. These studies are directly relevant to management /conservation strategies, and also of interest in understanding the ecology and evolution of parental care in crocodilians.

abstract for talk by Dr. Jeffrey W. Lang, Gharial Conservation Alliance & Madras Crocodile Bank Trust, Post Bag 4, Vadanemelli, Mamallapuram 603104 S. INDIA

World Congress of Herpetology (WCH7), 8-14 August 2012, Vancouver BC Canada