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Literature citations should read as follows:

For individual articles:

[Author/s] 2004. [Article title]. pp. [number]. *In*: Crocodiles. Proceedings of the 17th Working Meeting of the Crocodile Specialist Group, IUCN - The World Conservation Union, Gland, Switzerland and Cambridge UK.

For the volume:

Crocodile Specialist Group. 2004. Crocodiles. Proceedings of the 17th Working Meeting of the Crocodile Specialist Group, IUCN - The World Conservation Union, Gland, Switzerland and Cambridge UK: xxvi + 530 p.

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ISBN: 1 876248 94 7

Published by: IUCN/SSC Crocodile Specialist Group

Recent Reversals in the Population Trends in the Population of Gharial in the National Chambal Sanctuary in North India; Implications and a Suggested Strategy for the Conservation of One of the World's Most Endangered Crocodilians

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Introduction

The gharial *Gavialis gangeticus* was critically endangered in 1975 with a world population numbering less than 300 individuals (Behler 1975). This resulted in conservation action through a Government of India/FAO-UNDP Crocodile Conservation Project comprising of a head-start program with captive reared animals and the creation of the National Chambal Sanctuary, which encompasses 425 km of the Chambal River flowing along the borders of the three north Indian states of Rajasthan, Madhya Pradesh and Uttar Pradesh. These steps enabled the gharial to recover from its critically endangered condition. The Gharial population of the Chambal that had numbered 150-175 before the initiation of the project was monitored regularly and showed steady growth reaching a figure of 1289 individuals in 1998, Sharma (1999). Because of the positive trend of the gharial population in the Chambal River, it was accepted in many quarters that the status of gharial had 'stabilized' and the species did not require proactive conservation efforts for its survival.

Recent Reductions of Gharial Population in the Chambal River; its Nature and Extent

After 1998, the Chambal was surveyed in 2003 following a gap of four years and then again in 2004. These surveys were conducted in the months of February/March, when conditions are favorable for gharial enumeration, using methods identical to those of earlier workers. Year wise summarized results of these surveys, along with the results of surveys conducted by previous workers are given in the following table.

The population decreases were first noticed during a survey of dolphins conducted by the first author in 2001 when intense clandestine fishing operations were observed in a particular section of the river. However, in that year the survey did not extend over the entire length of the National Chambal Sanctuary and the population decreases could not be comprehensively assessed.

There is no plausible cause for the observed decrease of gharial population other than mortality due to accidents in nets of fish poachers that operate in the sanctuary. Many fishing nets were confiscated and destroyed by burning in the course of the surveys. The smallest age class of gharials showed maximum decrease in the latest surveys. This is possibly because this age class also routinely disperses downstream beyond sanctuary limits and is also the one most susceptible to mortality from accidents in nets of the mesh size most commonly used in fishing. That the mortality rate due to fishing nets can be extremely high was revealed in 2003, when 8 gharials were found dead during a survey lasting only 15 days. The observed decrease of 30-40% in the populations of adult and sub-adult gharials, in the five years between 1998 and 2003, works out to 6-8% annual reduction.

The Current Management Status of the Sanctuary

Three different management systems and hierarchies are in force in the three states in which the sanctuary lies, encompassing areas of a total of twelve administrative districts.

Rajasthan

The sanctuary in Rajasthan has no separate machinery or staff for administration of the sanctuary. This is the responsibility of the District Forest officers of five districts viz. Kota, Bundi, Sawai Madhopore, Kaila Devi and Dholpur. There are apparently no special budget allocations for the administration, nor any field-staff deployed exclusively for protection or maintenance of the sanctuary and neither is there any management plan.

Table 1. Population of Gharial in the Chambal River differentiated into 3 size classes. (To facilitate comparison of populations between years, crude population densities per river km are shown, since river stretches surveyed in different years were not identical). SA+J = sub-adults and juveniles; H+Y= hatchlings and yearlings. References: 1= Singh (1978); 2= Singh (1985); 3= Rao (1988); 4= Hussain and Choudhury (1991); 5= R.K. Sharma (unpublished information).

Year	Section of River Surveyed	Length of River Surveyed (km)	Details of Enumerated Gharials								Ref.
			Total Adults	Adult Density (gh/km)	Total SA+J	SA-J Density (gh/km)	Total H+Y	H+Y Density (gh/km)	Total Population	Total Population Density (gh/km)	
Pre-1979	Sections near major breeding sites	~250	30	0.120	43	-	34	-	107		1
1983-84	Rahuka Gaon to Pachnada**	315	37	0.117	369	1.171	45	0.143	451	1.432	2
1984-85	Pali*** to Pachnada	425	49	0.115	491	1.155	65	0.153	605	1.424	2
1985-86	Pali to Gyanpura/Jagtauli	385	66	0.171	391	1.016	170	0.442	627	1.629	3
1988	Pali to Pachnada	425	114	0.268	536	1.261	170	0.400	820	1.929	4
1990	Pali to Pachnada	425	113	0.266	727	1.711	142	0.334	982	2.311	4
1993	Pali to Pachnada	425	186	0.438	305	0.718	407	0.958	898	2.113	5
1994	Pali to Bhare	415	202	0.487	418	1.007	488	1.176	1108 (*1026)	2.670	5
1995-96	Pali to Bhare	415	212	0.511	445	1.072	557	1.342	1214 (*1042)	2.925	5
1996-97	Pali to Bhare	415	226	0.545	459	1.106	554	1.335	1241 (*1078)	2.993	5
1997-98	Pali to Bhare	415	0	0.000	0	0.000		0.000	1289 (*1121)	3.106	5
2003	Pali to Chakarnagar	395	150	0.380	265	0.671	99	0.251	514	1.301	5
2004	Pali to Chakarnagar	395	158	0.400	276	0.699	118	0.299	552	1.397	5

*** Pali is the upstream-most point of National Chambal Sanctuary

** Pachnada is the downstream-most point of National Chambal Sanctuary

* Total population corrected for the river section from Palito to Chakarnagar

Madhya Pradesh

The sanctuary is under the financial and administrative control of the Divisional Forest Officer, Morena Forest Division, while the executive officer is the Sanctuary Superintendent, National Chambal Sanctuary, who is an officer

of the rank of Assistant Conservator of Forests. The Sanctuary Superintendent is assisted by three Forest Rangers, one Research Ranger and sanctioned staff strength of about 28 subordinate field staff. The effective strength of executive subordinate cadre field staff, as computed in the draft management plan, works out to single personnel for guarding 40 km of river. The sanctuary being situated in non-forest areas of civil districts necessitates the involvement of the staff with the revenue and civil authorities of 3 very large districts Sheopur, Morena and Bhind of Madhya Pradesh.

The sanctuary has experienced a financial crunch for the past several years with very little available resources for so-called plan expenditure through which budget allocations are made for development works of the sanctuary. Even the 'non-plan' budget allocated has fallen short of the requirements for meeting expenditure on salary which has had to be supplemented with budget appropriations from financial heads that are not earmarked for the sanctuary. As a result, there has been hardly any available budget for meeting the maintenance expenditures of the sanctuary including fuel, lubricant and expenditures for regular and effective patrolling of the sanctuary that is estimated at Rs 5 lakhs (~\$12,000) per annum. It will however be noticed that between 2003 and 2004 there has not been any decrease to the gharial population and in fact there is a slight improvement in the gharial populations of all age classes. This, in all probability, is because of the action taken by the MP authorities to intensify patrolling of the sanctuary with additional budget being made available for this. This step was taken in view of the abrupt and alarming decrease in the sanctuary gharial population noticed in 2003. Also river patrolling for all echelons of field staff for stipulated periods was made mandatory by the higher authorities of the Forest Department.

A management plan has been drafted for the MP sector by the MP Forest Department. The draft management plan is well focused on the problems of conservation of aquatic biodiversity in the sanctuary and contains some innovative approaches to long term solutions to some of the problems faced by the sanctuary. However, whether the Government of MP will have political support to carry out the far reaching reforms required for implementation of the draft management plan, even if the plan is formally approved, cannot be said with any certainty at this stage. The estimated cost of implementation of this plan over a ten year period from 2003 to 2013 is Rs 777 lakhs (or \$US1.8 million) so the total cost of implementation of similar plans in all the three states comprising the sanctuary would be about \$US5-6 million.

Uttar Pradesh

The sanctuary is under the control of the Divisional Forest Officer, National Chambal Sanctuary. Because of some changes in the administrative structure of the Forest Department, the controlling officer and field staff have been burdened with the protection of certain forest areas lying within the sanctuary boundaries whereas formerly the management and protection of gharial and river biodiversity was their exclusive responsibility and concern.

Nature and Intensity of the Various Threats being faced by the Sanctuary

Agriculture

Agriculture is the most serious of long-term threats because it damages habitat and alienates wildlife off it: When the river recedes in summer growths of riverine succession of *Tamarix* on the exposed islands, which now become accessible, are hacked down to reclaim the areas for agriculture and gharial, mugger and turtle nesting sites may also be destroyed in the process. Shrinkage of stream due to reduced discharge of the river (see water abstraction below) increasingly exposes sandy riverbanks that are utilized for cultivation of cucurbit crops such as gourds and melons. As a result, increasing human activity on the river banks alienate gharial of all size classes from basking habitats and lead to permanent emigration of animals from these areas, as has occurred in the Yamuna and many other north Indian rivers, where ever riparian cucurbit cultivation is practiced. Although not quantified, it can safely be said that agricultural activity on riverbanks has steadily increased over the years.

Water Abstraction

Water abstraction for agriculture through a lift irrigation scheme in Uttar Pradesh within the last decade would definitely have impacted stream flow in downstream sections of the river. A second, major lift irrigation scheme has been approved, which is meant to supply the nearby town of Dholpur in Rajasthan with drinking water. During the recent surveys increasing numbers of small diesel pump sets were noticed being used for local agricultural irrigation. Certain midstream rocks, formerly submerged, that seem to have become exposed to heights of up to 2 m during the surveys in 2003 and 2004. There are unconfirmed reports about the planned construction of a hydroelectric dam

Rahughat. If this dam is eventually constructed, the hydrological regime of the river may be radically transformed with serious implications for gharial habitat. Apart from causing stream shrinkage, water abstraction also exposes more sand banks for potential, large-scale cucurbit horticulture with adverse impact on gharial because of reason already discussed. Unsustainable water abstraction is likely to severely and adversely impact gharial habitat to the extent that Chambal River may eventually be rendered uninhabitable for gharial.

Fishing

During the survey, fishing on commercial scale was observed in most of the stretches. Fishermen were seen using nylon gill nets and other advanced fishing gear. Fishing activity was recorded from 60-75% of the Chambal River flowing within the sanctuary. Interrogation of fishermen in the upper stretches revealed that they worked for fish contractors who resided in Rajasthan where planned sanctuary management is yet to come into force because of this state's non-participation in the National Chambal Sanctuary Project. Illegal fishing is rampant and occurs on a scale, which apart from directly causing mortality of gharial in net accidents is likely to affect the food availability for gharial and reduce the carrying capacity of the river for piscivorous aquatic vertebrates like gharial, mugger, dolphin and otters. The most serious implication of fishing arises from the fact that the fishing regime has changed from the pre sanctuary notification period to that in the current time. Previously, fishing was carried out by different contractors who acquired fishing rights auctioned by the district authorities. The contractors used the services of fishermen from outside the sanctuary areas who were forced to discontinue fishing activity and leave when the contract fishing system was scrapped. Today the local residents of the area are gradually discovering the economic benefits of fishing and once this becomes incorporated into the local economy, as is happening at present, curbing and regulating fishing will become more and more difficult if not impossible. The lawlessness of the area is well documented and fishing in certain stretches has come under the control of criminal elements making control of fishing an uphill task requiring large investments on enforcement. Fishing pressures have also become acute at the upstream and downstream most extremities of the sanctuary.

Sand Mining

During the survey in 2004, sand mining on the Madhya Pradesh side of the river, was recorded only on 5 sites. However, large-scale sand mining was recorded in all the 11 survey zones on the Rajasthan side. Intensive mining of building stone from the riverbed was also recorded in Zone 1 (Rameshwar-Khirkiree) at Solghata near Adavasipura. Over the years, the financial implications of sand mining at Rajghat, the only mining site that is actually auctioned by the government owned Mining Corporation, have magnified manifold. Today this site generates an annual revenue of Rs 23 crores (\$5.35 million) for the state. Due to reduced river discharge most of the upper stretches of the river have shrunk to a very narrow and shallow stream, easily fordable on foot and tractors, enabling activities like sand and stone mining from the bank as well as the riverbed. These are reaching a level when they are bound to become serious threats for the biodiversity of the sanctuary. Not only is human presence at the mining sites leading to the exclusion of wildlife from these areas, but mining activity is also probably altering the geomorphology and adversely affecting wildlife habitats in unknown ways. Apart from the Rajghat site mentioned earlier, sand mining occurs clandestinely at several points along the river on a scale which is drastically and irreparably altering several important nesting and basking sites for gharial like Banwara, Ajbapura, Pureni, Barendra, Gyanpura. Sand mining in Chambal sanctuary has reached an industrial scale and feeds the building construction business of several big cities of the region including the country's capital, Delhi. While directives of India's Apex Court go against any exploitation, whatsoever, of the natural resources of any PA, the ground reality is that the economic value of Chambal building sand is too large for its exploitation to be prevented by simple legal protection. The industry is labor intensive and a major income generator in the local economy as well, so the illegal syndicate which controls this unorganized industry, will go to great lengths to prevent any impediment to it, for which it has not only its own financial base but also local socio-political support.

Firewood Collection

Harvesting of fuel wood and denudation of tree cover from bordering ravenous areas leads to catchment erosion and increased stream turbidity as well as silt deposition with a resultant shrinkage of stream.

A Strategy for the Conservation of Gharial

The gharial, because of its great and unique scientific value, requires conservation action guaranteeing its indefinite survival. The lessons learnt from the successes and more importantly the failures of the first conservation action to

save the gharial in the Chambal and North India are as follows:

- i) The permanence of political support for gharial and biodiversity conservation in any protected area cannot be taken for granted as the conservation concept still remains detached from the socio-economic aspirations of the common people.
- ii) The characteristics of dispersal/migration of younger age/size classes of gharial are such that the success rate of supplementation of captive reared gharial within any localized river stretch is low, necessitating protracted and sustained supplementation to successfully restore populations.
- iii) Gharials do not become permanent residents of unprotected river stretches where there is conflict and disturbance due to people.
- iv) The biotic pressures on gharial are increasing at rapid rates exacerbating the complexities and dimensions of the problem of gharial conservation.

In view of the political mutability of India, any strategy to conserve the gharial should therefore be independent of anticipated permanent and sustained political support for its implementation. The following strategy is proposed for international adoption and support to save the gharial from extinction and guarantee its demographic health.

Continual and Definite Monitoring of all Surviving Gharial Populations

As seen in the Chambal, gharial population declines can be quite rapid. So, there is the need for continually updated accurate information on the status of all surviving gharial populations. So far, this information has been available due to efforts of a few devoted workers who appreciate the significance of scientific population monitoring. But this is not yet an institutional activity undertaken by the main agencies responsible for gharial conservation in the Chambal viz. the state Forest Departments. The practice of survey and census at regular intervals along with all financial and other support to conduct these requires to be ensured, so that status of different gharial populations is monitored without break and gharial population reductions become known at the earliest.

Extension of Gharial Population Restoration through Head Start Programs, in all Existing Parks with the Potential for Population Restorations

Presently, apart from the Chambal River, only the Girwa River in the Katerniaghat Sanctuary in northern Uttar Pradesh and the Ramganga River in the Corbett National Park in the state of Uttaranchal has breeding populations of gharial. Of these two populations, the Katerniaghat WLS encompasses a river section less than 5 km in length that forms prime gharial habitat. In nearly three decades, this population has not been observed to expand and colonize adjacent river sections. As such, the Girwa River in the sanctuary is a fragile and vulnerable gharial habitat where long-term conservation does not appear to be viable. Precise information about the breeding status of the Ramganga population is not available and the extent of prime gharial habitat is also believed to be extremely limited. Considering therefore, the immensity and complexity of the problems faced by the Chambal sanctuary a worst case scenario exists in which, wild gharial populations can once again decline to the level of extirpation or critical endangerment as had occurred in 1975 if conditions in this sanctuary continue to deteriorate.

A safeguard against such a situation needs to be developed by restoring the gharial populations in the two other potential gharial conservation areas, viz. the Ken and the Sone Rivers, to breeding status. Both these areas have been legally protected for over a decade or more but it has not been possible to restore their populations to breeding status (Sharma, unpublished information). This is mainly due to lack of sustained supplementation of the population with captive reared gharial. In this respect the Sone Sanctuary notified in 1981, which includes a section of the Sone River some 200 km in length and some prime gharial habitat, has the best potential for consolidated population restoration. The Ken Sanctuary, which is much smaller than the Sone and includes a relatively small river section comprising prime gharial habitat, presents a situation like the Girwa River in the Katerniaghat Sanctuary already mentioned, but considering the precarious situation confronted by the species every opportunity for developing buffer populations should be exploited to the maximum. Potential gharial conservation areas in other states such as Assam and in northeastern India and West Bengal where reintroductions of gharial in former habitats have been attempted also need to be vigorously followed up. Husbandry know-how for the captive rearing of gharial exists in north India and may be used to extend ex-situ operations wherever necessary.

Sustained Research on Dispersal and Migration of Gharial and Refinements of Supplementation Techniques

Because of the linear nature of gharial habitats the species, especially the younger size classes that are used in

supplementation programs, are disposed to rapid and extensive emigration that is believed to occur pre-dominantly in the down stream direction. However, there have been almost no sustained studies of the phenomenon by either mark-recapture or telemetric methods that will facilitate refinement of supplementation techniques and aid higher retention rate of released animals in sanctuaries. Many aspects of gharial biology and ecology remain largely unknown and research is required to acquire more elaborate knowledge of these as well.

Research on River Water Management and Impact of Water Abstraction

The impact of water abstraction needs quantification and study to determine the extent and rate of habitat degradation. Also the potential and implications of rainwater harvesting and storage in the Chambal catchment may be a potential solution to prevent the ultimate inhabitability of the river for gharial. This information is also extremely important for all gharial conservation areas.

Research on Environmental Impact of Different Biotic Pressures on the Chambal River as well as other Gharial Habitats and Conservation Areas

Such research is required for making management decisions that are not arbitrary and therefore do not lead to avoidable conflict with human populations residing in or on the periphery of gharial conservation areas.

Innovative Eco-Development to Raise Standards of Living of Important Target Groups of Local Residents and Eliminate their Dependence on Natural Resources required for Gharial Conservation

Eco-development is a key tool for reducing dependence of stakeholders residing in and around core gharial conservation areas on resources occurring in gharial habitats. Eco-development has not yet been an unqualified success where experimentally initiated but the impedimental problems can be identified and solved if the implementing agencies are adequately motivated have the required resources at their disposal.

Sustained and Adequate Awareness Campaigns for Different Target Groups and Stakeholders in Resources Required for Conservation of Gharial

Although the effectiveness and feasibility of awareness programs may be questioned, it is vital that every north Indian stakeholder know about the highly endangered state of the gharial and appreciates the participatory role that has to be played in conserving this species. So far efforts at increasing awareness about these issues have been opportunistic, sporadic and grossly inadequate at best. There is need to carry out a well planned, well designed campaign using all potential, formal as well as non-formal media to achieve this, and of sustaining the campaign until this has been achieved.

Mobilization of Resources to Achieve the Above

Very little financial resources, either indigenous or foreign have been forthcoming to support conservation of gharial unlike that made available for charismatic mammalian wildlife like the tiger. The quantum of funds required to exhaustively implement all the above strategies in letter and spirit, will probably require international financial assistance. Even if the international community shows willingness to contribute the necessary resources, the modalities of this assistance will require a great amount of careful consideration and reflection by both the donors and the acceptors and should have foolproof safeguards to ensure that the resources are efficiently and effectively utilized.

Acknowledgements

The second author is grateful to Rom Whitaker for a travel grant and encouragement to go to Gwalior and write this paper in collaboration with RKS. We are grateful to our respective Forest Departments for the support of our work.

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