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From Extinction to Extension: Rediscovery of Gavial (*Gavialis gangeticus*) in Pakistan

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ABSTRACT

Gavial (Gavialis gangeticus), the critically endangered species, has long been extinct from Pakistan. Since the 1990s there has been no confirmed significant sighting in Pakistan; however, a local fisherman in the Ganda Singhwala region of the Satluj River accidentally captured a Gavial in 2023. This sparking renewed the wildlife experts' interest in the species' existence in Pakistan and led to subsequent field investigations conducted by experts from the Punjab Wildlife & Parks Department and Pakistan Wildlife Foundation that aimed to confirm the presence of Gavial in the Satluj River. A 5 km stretch of the river was surveyed along the river channel in Pakistan by using a combination of direct and indirect observation methods. A total of five potential Gavial habitats, including two breeding sites, were identified in the whole study area. The presence of the species in Pakistan marks a significant ecological rediscovery after three decades of absence that might be due to potential cross-border migration from India, where extensive conservational efforts have been conducted. This study emphasizes the ecological importance of Gavial reappearance and underscores the need for transboundary conservation collaboration. The present finding also highlights the ongoing threats to the Gavial which should be addressed for the long-term survival of species in Pakistan.
Keywords: Ganda Singh Wala, Gavial, Gharial, Satluj River

INTRODUCTION

The Gavial or Gharial (Gavialis gangeticus) is a critically important apex predator of running freshwater ecosystems. Currently, it is categorized as Critically Endangered (CR) under criteria A2bce with an increasing population trend (IUCN, 2023) and listed in Appendix I of the CITES. Historically, Gavialis gangeticus has been reported since the Indus Valley Civilization, and it was common in freshwater river systems throughout the northern Indian subcontinent. In the Indus River system, they thrived with Marsh crocodiles (Crocodylus palustris) and once they were more numerous than the crocodiles (Martin, 2019; Burnes, 1973). But around three decades ago, in the 1990's, the Gavial population experienced a drastic decline leading to extinction in Pakistan. According to Zafar and Malik (2018) and Chaudhry (1993), only a few individuals of Gavialis gangeticus were left in the Sindh region. During extensive surveys undertaken by WWF-Pakistan under the "Indus for All Programme" and "Pakistan Wetlands Programme" in 2008 and 2009, Gavial was not significantly sighted in Pakistan. So, the species was considered virtually extinct by 2008 in Pakistan.

Gavialis gangeticus extinction in Pakistan was attributed to an alteration in the ecological dynamics of Gavial habitats due to anthropogenic pressures and the degradation of essential breeding grounds (Lang *et al*., 2019). Additionally, illegal poaching, habitat encroachment, incidental death in fishing nets, and human disturbance are also declining factors (Lang *et al*., 2019). Since the last five years, there have been reports of the existence of crocodiles (Crocodylus palustris) in the River Satluj from Ganda Singh Wala in District Kasur to Sulemanki Headworks in District Okara, Punjab, Pakistan.

An anecdotal report from a local fisherman has suggested the Gavial's presence in the region. In May 2023, unexpectedly, a local fisherman caught a crocodile in his fishing net at Ganda Singh Wala that was initially identified as a crocodile, but subsequent viral footage and video on social media revealed that it was a Gavial (Gavialis gangeticus) and not the crocodile. This igniting news

renewed interest in the possible reappearance of Gavial in Pakistan. In response, the Director General of the Punjab Wildlife & Parks Department, Government of Punjab, Pakistan, constituted a team of experts to investigate the issue and confirm the existence of Gavial in the Satluj River. The team consisted of experts from the Punjab Wildlife & Parks Department, Pakistan Wildlife Foundation, and WWF-Pakistan. The team conducted a field visit of the River Satluj at Ganda Singh Wala in June 2023 with the active cooperation of the Pakistan Army and Punjab Rangers. The 2023 expedition to the Satluj River in District Kasur, Pakistan, confirmed the rediscovery of Gavial. The field survey confirmed the species' resilience and highlights the potential for cross-border conservation initiatives. The findings can be used for future conservation efforts and understanding the species' resilience. The study also underscores the importance of preserving Gavial in the region.

MATERIALS AND METHODS

In Pakistan, the study was conducted along a 5-kilometer stretch of the Satluj River, starting from the Pak-India border at Ganda Singh Wala, District Kasur, Punjab, Pakistan. The surveyed area was systematically divided into five key sites: Nagar Amin, Ferozpur Bridge, Badhian Usman Wala, Kothi Fateh Muhammad, and Head Sulemanki (Figure 1). The selected study area encompasses a wide range of suitable habitats for the species, including extensive sandy riverbanks and densely vegetated riparian zones. Due to the deep-water channels, relatively undisturbed sandy banks and minimal human influence, these study areas were prioritized to serve as critical habitat of Gavial.

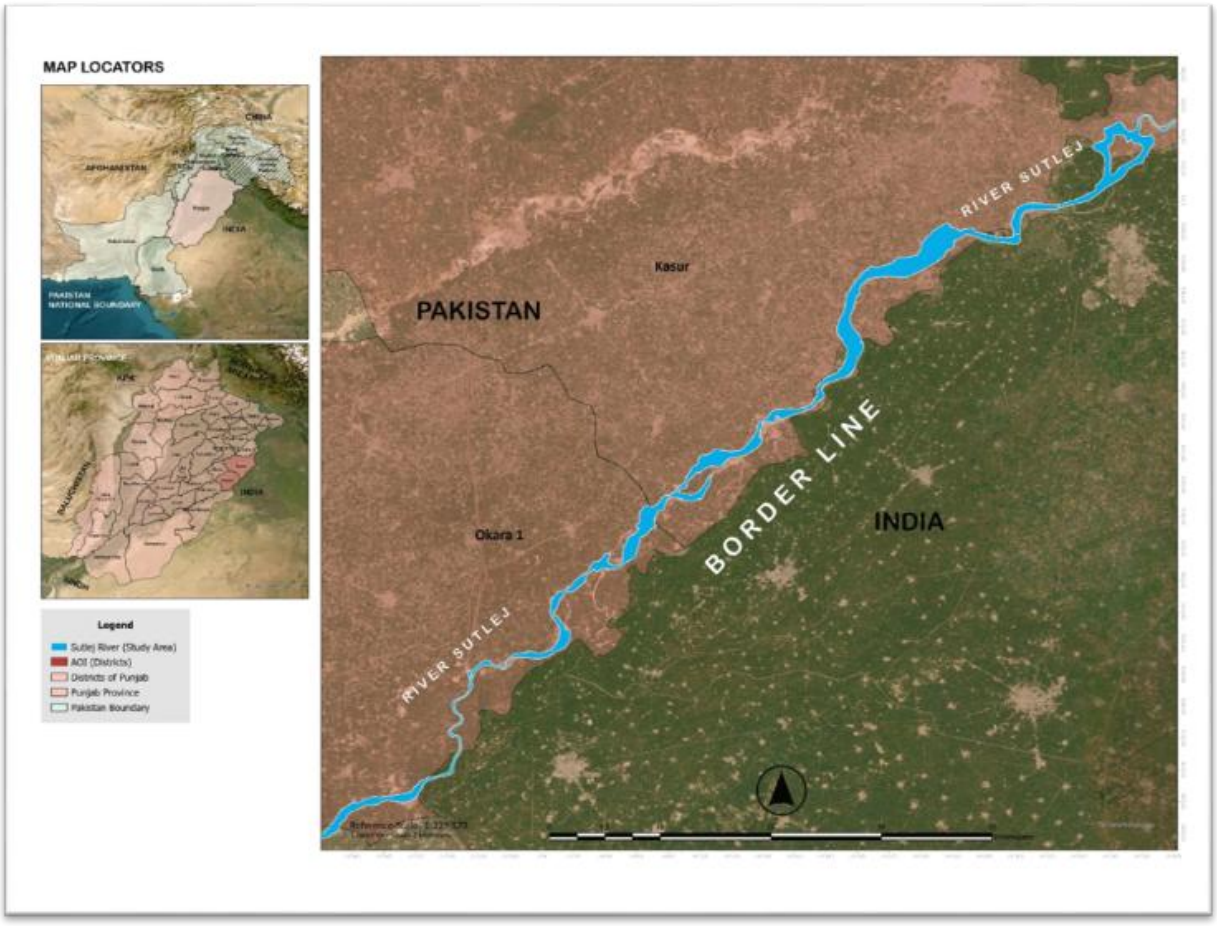

Figure 1: Study area for Gavial distribution in Pakistan

From June to July 2023, field surveys were conducted with daily observation between 07:00 am and 11:00 am to maximize the likelihood of direct sighting as Gavials bask on exposed sandy riverbanks. Both direct and indirect methods were applied to investigate the existence of Gavial

in the study area (Bohara *et al*., 2022). Key sections of the riverbank were systematically scanned for direct observation. For the direct observation, high-power binoculars and spotting scopes from vantage points at distances of 200 to 300 meters were used. For the detailed visual search of basking adults, juveniles, and other visible signs of Gavial underwater or in no-access areas, the latest DJI Mavic 3T Thermal drone was also used (Katdare *et al*., 2011).

In addition to direct sightings, indirect evidence of Gavial's presence was also collected. For this sandy riverbanks were carefully searched for tracks, trails, and nests indicative of recent gavial activity. All the species' presence signs, such as drag marks, footprints, or tail impressions left in the sand, were documented. Special attention was given to dense vegetation areas, as these vegetated sections provide cover for juveniles. GPS coordinates of each potential habitat were collected for study area distribution map development, and all the direct and indirect evidence of gavials was photographed as pieces of evidence of their existence with a digital camera with a 150-600 mm lens. Officials of the Pakistan Army, Punjab Rangers, and local fishermen were interviewed, and their observations were recorded. Local authorities, including the Pakistan Army and Punjab Rangers, fully cooperated during the study period. Considering the ethical and legal guidelines, special care was taken to minimize the habitat disturbance.

RESULTS

An area of over 170 km2 along the Satluj River was investigated through a field survey. The field survey yielded crucial findings regarding Gavial's rediscovery in Pakistan after more than three decades. The survey identified five key sites as potential habitats for the Gavial. The field visits mainly focused on assessing population, distribution, habitat viability, breeding activity, and anthropogenic pressures. Based on field surveys and interview-based investigations, a total of five sites were identified as potential habitats of Gavial along the Satluj River in Pakistan, with varying population estimates across these sites (Table 1).

Table 1: Gavial Sightings and Population Estimates

Site Name	GPS Coordinates	Breeding Activity	Sightings No.	Estimated Population
Nagar Amin	74°40'43" E, 31°04'46" N	Active	6	8 (6 adults, 2 juveniles)
Ferozpur Bridge	74°32'32" E, 30°59'35" N	Active	4	4 (1 adult, 3 juveniles)
Badhian Usman W	74°26'49" E, 30°58'13" N	Inactive	1	2 adults
Kothi Fateh Muhammad	74°05'49" E, 30°38'34" N	Inactive	1	1 adult
Head Sulemanki	73°52'21" E, 30°23'16" N	Inactive	6	12 adults

From these five potential habitats, two sites (Nagar Amin and Ferozpur Bridge) were found as the breeding sites for the species, while the other sites showed sporadic Gavial activity. Sandy riverbanks and minimal human interference support successful breeding and rearing of juveniles in these breeding sites (Table 2). Despite the disturbed habitat due to human influences and fishing activities, the population is viable at Head Sulemanki. While at Badhian Usman Wala and Kothi Fateh Muhammad, Gavial occasionally visited. Across the study area, the total estimated population was 27 individuals, with 6 confirmed juveniles (Table 1; Figure 2).

Although high anthropogenic pressure was observed in all the surveyed sites, including agriculture, fishing, and industrial runoff, which negatively affected habitat quality, substantial habitat degradation was noticed at Ferozpur Bridge and Head Sulemanki (Table 3). Across the surveyed sites, water quality varied. Industrial and agricultural activities were the major source of water pollution, which may threaten long-term population viability in these areas (Table 4).

Figure 2: Gavial distribution in Pakistan

Table 2: Breeding Site Characteristics and Viability

Site Name	Breeding Status	Juveniles No.	Key Habitat Features	Threat Level
Nagar Amin	Active	2	Sandy riverbanks, deep water	Moderate
Ferozpur Bridge	Active	3	Sandy, vegetated river margins	High
Badhian Usman Wala	Inactive	0	Rocky, mixed habitat	Low
Kothi Fateh Muhammad	Inactive	0	Vegetated, shallow riverbank	Low
Head Sulemanki	Inactive	0	Thick reeds, sandy banks	Moderate

Table 3: Anthropogenic Pressures on Gavial Habitats

Site Name	Primary Threats	Impact on Habitat	Conservation Urgency
Nagar Amin	Livestock grazing, fishing	Moderate	High
Ferozpur Bridge	Agriculture, sand mining, fishing	High	High
Badhian Usman W	Occasional fishing	Low	Medium
Kothi Fateh Muhammad	Minimal disturbance	Low	Low
Head Sulemanki	Sand mining, industrial runoff	Moderate	Medium

Table 4: Water Quality and Environmental Factors

Site Name	Water Quality	Pollution Sources	Effect on Gavial Population
Nagar Amin	Good	Low agri runoff	Low impact
Ferozpur Bridge	Poor	Industial and agri runoff	High impact
Badhian Usman W	Good	None	Low impact
Kothi Fateh Muhammad	Moderate	Mini agri runoff	Low impact
Head Sulemanki	Poor	Sand mining, industrial runoff	High impact

DISCUSSION

Gavial (gharial) was a permanent resident of the northern Indian subcontinent river system, including the Sutlej River, throughout history. However, due to overexploitation, pollution, and habitat destruction, species became extinct in the wild habitat in Pakistan. Current study results yielded remarkable findings regarding the reappearance of gharial (Gavialis gangeticus) in Pakistan after three decades of absence in the wild. The reappearance of gharial in five distinct locations along the Sutluj River is a significant ecological event (Khan *et al*., 2012). This event reflects the species' resilience and potential cross-border conservation effects.

In India, substantial ex-situ conservation efforts and breeding programs have been underway, followed by reintroduction into the wild. The possible hypothesis for the gharials' reappearance in Pakistan's Sutlej River is cross-border downstream migration from India, as there is a continuous riverine ecosystem between India and Pakistan. The proximate Gharial sighting locations to the Indian border support our hypothesis that animals might have crossed the border for a suitable habitat.

The transboundary movement of gharials shows that species depend on their ecosystems; they do not adhere to political boundaries. Although the habitat is suitable for Gavial in India, due to high water flow and vegetation density, optimal breeding grounds are missing. In contrast, five potential habitat sites, including two breeding grounds for Gavial, are present in Pakistan. Deep river channels, abundant prey, and minimal human disturbance along breeding grounds can support viable populations in Pakistan. This difference highlights that Pakistan can play a crucial role in the conservation of the gharial. To ensure a sustainable Gavial population, Pakistan can create a safer and more stable environment by addressing the specific threats and implementing strict legislation. Collaborative monitoring can provide valuable data to inform conservation strategies. An integrated management approach and bilateral conservation agreements between both countries are essential to ensure the long-term survival of the species.

Despite the positive presence, there are several challenges to Gavial in the study area. Like many transboundary rivers, the Sutluj River faces significant anthropogenic pressures (industrial pollution, agricultural runoff, and habitat fragmentation) (Saikia, 2013). These factors are also a substantial risk for the Gavial population. In most of the areas, Gavial is killed due to human-wildlife conflict. Critical habitats of the species along the river should be identified, and transboundary protected areas should also be established where feasible. Local communities' education and awareness programs, highlighting the ecological and cultural significance of Gharials, can significantly affect the conservation and protection of the species. For adaptive management strategies, long-term monitoring programs along with technological tools are essential (Gupta *et al*., 2021; Stevenson and Whitaker, 2010). Gavial is an apex predator that ensures the health and balance of riverine ecosystems. The reappearance of Gavial in Pakistan holds immense ecological significance, as their recovery indicates a potential improvement in the ecological status of the river. This significant ecological event offers hope for the revival of other native species and overall biodiversity.

CONCLUSION

Current field survey findings revealed a rare glimpse of hope for the Gavial population in Pakistan. The reappearance of the species after three decades suggests a potential natural recolonization facilitated by conservation efforts in India. For long-term sustainability of the Gavial population after this transboundary conservation success, collaborative efforts, habitat protection, and community engagement are crucial. This discovery also highlights the importance of a holistic and integrated approach to conservation, where political boundaries do not hinder the survival of endangered species and ecological processes. By focusing on species, habitats, and ecosystems, we can create a sustainable future for endangered species even among the cross-border boundaries. The recovery of Gharial's return to Pakistan is a piece of evidence of the flexibility of nature and the potential success of concerted conservation efforts. This gharial event can serve as a model for other ecological regions and species facing similar conservation challenges.

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