

Environmental Impact Assessment

Project Number: 43253-026
June 2019

India: Karnataka Integrated and Sustainable Water Resources Management Investment Program – Project 2

Vijayanagara Channels

(Annexure 6-10)

Prepared by Project Management Unit, Karnataka Integrated and Sustainable Water Resources Management Investment Program Karnataka Neeravari Nigam Ltd. for the Asian Development Bank. This is an updated version of the draft originally posted in June 2018 available on <https://www.adb.org/India: Karnataka Integrated and Sustainable Water>

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**DETAILS OF EMP COST
ESTIMATES**

VNC MODERNIZATION PROJECT - BIFURCATION OF COSTS

No.	Project Activity	Activities	Cost
1	Site Clearance	Permission from Local Authorities i.e., GP and KFD etc.	Costs to be borne by Contractor
	(Assuming 16 construction sites; one for each canal)	Disposal of Construction Waste and Debris	Costs to be borne by Contractor
		Restoration of sites	Costs to be borne by Contractor
		Pre and Post-Construction Survey, Photographs, Videos and monitoring of environmental attributes	Should be budgeted in the EMP
2	Tree Removal and Afforestation	Preliminary Tree Enumeration	Should be budgeted in the EMP
		Tree Removal	Costs to be borne by Contractor
		Afforestation	Should be budgeted in the EMP
3	Weed Removal and Management	Weed Removal Costs	Costs to be borne by Contractor
		Weed Disposal Management	Costs to be borne by Contractor
		Monitoring the environmental impacts of weed disposal	Should be budgeted in the EMP
4	Silt Removal and Silt Disposal	Silt Removal Costs	Costs to be borne by the Contractor
		Silt Disposal Costs	Costs to be borne by the Contractor
		Monitoring the environmental impacts of silt disposal	Should be budgeted in the EMP
5	Transport of Machinery, Equipment and Material	Machinery, Equipment and Material Costs	Costs to be borne by the Contractor
		Transportation Costs	Costs to be borne by the Contractor
		Maintenance Costs	Costs to be borne by the Contractor
		All approvals and permission from relevant authorities	Costs to be borne by the Contractor
6	Material Sourcing	All approvals and permission from relevant authorities	Costs to be borne by the Contractor
		Material Costs	Costs to be borne by the Contractor
		Transportation Costs	Costs to be borne by the Contractor
		Approvals and consents of Material Suppliers including Consents from KSPCB or other authorities	Material Supplier to bear costs
7	Storage and Handling of Materials	All approvals and permission from relevant authorities	Costs to be borne by the Contractor
		Loading and Unloading Costs at the sites	Costs to be borne by the Contractor
		Storage and Handling Costs	Costs to be borne by the Contractor
		Cost of equipment / PPE to safely handle materials	Costs to be borne by the Contractor

No.	Project Activity	Activities	Cost
		Costs for carrying out emergency measures	Costs to be borne by the Contractor
		Insurance for handling hazardous material storage and handling	Costs to be borne by the Contractor
		Safety Signboards on safe storage and handling of materials	Should be budgeted in the EMP
		Monitoring the environmental impacts of storage and handling of materials	Should be budgeted in the EMP
8	Impact due to Construcion within Notified OCR	Survey to Locate Access Roads for accessing secondary ringbunds	Should be budgeted in the EMP
		Survey to Locate Secondary Ringbunds	Should be budgeted in the EMP
		Construction and Dismantling of Secondary Ringbunds	Should be budgeted in the EMP
		Training Program to carryout works in the OCR	Should be budgeted in the EMP
		Restoration or Ecological Enhancement	Should be budgeted in the EMP
		Rescue and Rehabilitation of wildlife in distress	Should be budgeted in the EMP
		Monitoring the environmental impacts from construction within the OCR	Should be budgeted in the EMP
9	Impact due to construction within Hampi WHA	Designs to suit the Heritage Area landscape	KNNL should update estimates
		No Blasting construction methodology	KNNL should update estimates
		Safety Signs within Hampi WHA on environmental management within Hampi WHA	Should be budgeted in the EMP
		Monitoring the environmental impacts from construction within the Heritage Area	Should be budgeted in the EMP
10	Rehabilitation of Anicuts, Canals and Structures	Monioring the environmental impacts from rehabilitation of Anicuts, Canals and Structures	Should be budgeted in the EMP
		Safety Signs at all construction sites and nearby communities	Should be budgeted in the EMP
11	Construction Campsite Facility Management	Construction Campsite Facility Construction including kitchen, living, bathing, latrine and other basic facilities	Costs to be borne by the Contractor
		Operation and Maintenance of Construction Campsite including providing Drinking Water and other basic facilities	Costs to be borne by the Contractor
		Construction and Operation of Mobile Toilet Facilities for construction workers at the site	Costs to be borne by the Contractor
		Source Separation of Solid Wastes and Solid Waste Management	Costs to be borne by the Contractor
		Construction of Septic Tanks at Construction Campsites	Should be budgeted in the EMP
		Construction of Composting Units for Kitchen Wastes	Should be budgeted in the EMP
		Monitoring the environmental impacts from construction campsite facility management	Should be budgeted in the EMP
		Safety Signs at all campsites and nearby communities	Should be budgeted in the EMP

No.	Project Activity	Activities	Cost
12	Worker Health and Safety	Insurance for Workers and their families	Costs to be borne by the Contractor
		First Aid Costs	Costs to be borne by the Contractor
		PPE Costs	Costs to be borne by the Contractor
		Health Monitoring of Workers and their families	Costs to be borne by the Contractor
		Health Insurance for Workers and their families	Costs to be borne by the Contractor
		Emergency Costs for Community related accidents caused by the Contractor	Costs to be borne by the Contractor
		Training for use of PPE	Should be budgeted in the EMP
		Training on Health Issues	Should be budgeted in the EMP
		Safety Information Boards for Workers Health and Safety at all Construction sites and campsites	Should be budgeted in the EMP
13	Borrow Area Rehabilitation	Approvals for Borrow Area and Establishment of Borrow Areas	Costs to be borne by the Contractor
		Borrow Area Operation Costs	Costs to be borne by the Contractor
		Borrow Area Rehabilitation Costs	Costs to be borne by the Contractor
		Monitoring the environmental impacts of borrow area	Should be budgeted in the EMP
		Baseline and Post-Rehabilitation Survey, Photographs, Videos	Should be budgeted in the EMP
14	Closure Activities	Development of Closure Plan for each campsite and construction site	Costs to be borne by the Contractor
		All civil works and infrastructure requirements to ensure thorough closure of all campsites and construction sites	Costs to be borne by the Contractor
		Approvals from concerned authorities / land owners towards completion of closure activities	Costs to be borne by the Contractor
		Monitoring the environmental impacts of all construction campsites and construction sites	Should be budgeted in the EMP
		Baseline and Closure Survey, Photographs, Videos	Should be budgeted in the EMP

VNC MODERNIZATION PROJECT - EMP COSTS FOR CONSTRUCTION PHASE - PACKAGE 1

Rehabilitation involves 15 canals and 3 anicuts

1USD = INR65

S. No.	ENVIRONMENTAL MANAGEMENT PLAN COSTS		Unit	Unit Cost	Unit Nos.	Amount
1	Site Clearance for Construction Sites					
	<i>Pre and Post Construction Survey</i>	<i>To be conducted for all the 15 construction campsites</i>	Campsites	50,000	15	750,000
	<i>Videos and Photographs for both Baseline, Construction and Post-Construction Scenarios</i>	<i>To be conducted for all the 15 construction campsites</i>	Campsites	20,000	15	300,000
	<i>Air Quality Monitoring at Construction Sites</i>	<i>Assuming 15 campsite locations - One Baseline Air Quality sampling and later sampling every month for 2 years</i>	Sample Nos.	2,000	375	750,000
	<i>Noise Monitoring near Construction Sites</i>	<i>Assuming 15 campsite locations - One Baseline Noise Measurements and later measurements every month for 2 years</i>	Sample Nos.	2,000	375	750,000
	<i>Groundwater Quality Monitoring at Construction Sites</i>	<i>Only GW Monitoring considered for EMP costs; For all construction campsites, then one baseline GW sampling to determine GW flow direction and concentrations of parameters and later GW sampling for every month to determine contaminant concentrations</i>	Sample Nos.	2,000	405	810,000
2	Tree Removal and Afforestation					
	<i>Enumeration of Trees</i>	<i>To be conducted along the entire length of 15 canals with assistance of KFD</i>	No. Canals	50,000	15	750,000
	<i>Compensatory Afforestation</i>	<i>For every tree cut, 4 trees to be planted (assuming 1000 trees would need to be cut) - Cost of Land not considered</i>	Tree Nos.	2,000	4000	8,000,000
3	Weed Removal and Management					
	<i>Weed Removal and Disposal including transportation to disposal sites</i>	<i>DPR to consider costs and later Contractor to bid based on volume</i>				
	<i>Weed Disposal</i>	<i>Composting Unit for Weed Management - One for each District - Koppal, Bellary and Raichur</i>	No. Composting Units	100,000	3	300,000
	<i>Groundwater Quality Monitoring at Weed Disposal Sites</i>	<i>Only GW Monitoring considered for EMP costs; For all composting sites, then one baseline GW sampling to determine GW flow direction and concentrations of parameters and later GW sampling for every month to</i>	Sample Nos.	2,000	75	150,000

S. No.	ENVIRONMENTAL MANAGEMENT PLAN COSTS		Unit	Unit Cost	Unit Nos.	Amount
		determine cantaminant concentrations				
4	Silt Removal and Silt Disposal					
	<i>Desilting Cost and Silt Disposal Costs</i>	<i>DPR to consider costs and later Contractor to bid based on volume</i>				
	<i>Silt Sampling and Analysis</i>	<i>One sample for every 4 km length of the canal; two samples for every anicut; one sample for every km in contaminated lengths</i>	Sample Nos.	5,000	150	750,000
	<i>Groundwater Quality Monitoring at Silt Disposal Location</i>	<i>Only GW Monitoring considered for EMP costs; For all silt disposal sites, one baseline GW sampling (Baseline GW monitoring consists of 3 samples to determine GW Flow direction and concentratons) and later GW sampling every month to determine contaminant concentrations - Assuming 15 silt disposal locations (one for each canal)</i>	Sample Nos.	2,000	375	750,000
5	Transportation of Machinery, Equipment and Material					
	<i>Machinery, Equipment and Material costs; Transportation Costs; Maintenance Costs; All approvals from relevant authorities</i>	<i>DPR to consider costs later Contractor to bid based on requirements including Workshops, if any</i>				
	<i>If Vehicle, Machinery and Equipment Maintenance Workshop is established then Groundwater Quality Monitoring at Workshop Location</i>	<i>Only GW Monitoring considered for EMP costs; For all workshop sites, one baseline GW sampling (Each GW monitoring consists of 3 samples to determine GW Flow direction and concentratons) and sampling every month for 2 years to determine concentrations and another sampling at least six months after close of workshop for one quarter. Assuming 3 Workshops, one for each district</i>	Sample Nos.	2,000	78	156,000
6	Material Sourcing					
	<i>Material Costs, Transportation Costs, All approvals from relevant authorities</i>	<i>DPR to consider costs later Contractor to bid based on requirements including RMC Plant establishment and operation, if any</i>				
	<i>Water Sprinkling Costs at RMC Plant Location</i>	<i>Assuming 3 RMC Locations - one for each district and established by the Contractor - Water Sprinkling to be done every day during dry season; assuming dry season of 9 months for 2 years</i>	Sprinkling Month	100,000	18	1,800,000
	<i>Air Quality Monitoring at RMC Plant Location</i>	<i>Assuming 3 RMC Locations - one for each district and established by the Contractor - One Baseline Air Quality sampling and later sampling every month for 2 years</i>	Sample Nos.	2,000	75	150,000

S. No.	ENVIRONMENTAL MANAGEMENT PLAN COSTS		Unit	Unit Cost	Unit Nos.	Amount
7	Storage and Handling of Materials					
	<i>All permissions from relevant authorities; transportation costs, loading and unloading costs; storage and handling costs; insurance costs; emergency costs;</i>	<i>DPR to consider costs later Contractor to bid based on requirements</i>				
	<i>Construction of platform for lubricant and oil storage to prevent direct spills</i>	<i>Lumpsum costs to be considered for 3 sites, one for each district</i>				500,000
	<i>PPE Costs</i>	<i>PPE to be provided to the Workers for safe handling of materials</i>	Lumpsum			1,000,000
	<i>Safety Sign Boards</i>	<i>Safety Sign Boards to be putup at site for storage and handling of materials</i>	Lumpsum			100,000
	<i>Cleanup of Accidental Spills</i>	<i>To be costed by Contractor - Lumpsum considered for now</i>	Lumpsum			2,000,000
	<i>Groundwater Monitoring and Storage Sites especially hazardous materials</i>	<i>Only GW Monitoring considered for EMP costs; Hazardous Materials storage sites, one baseline GW sampling (Each GW monitoring consists of 3 samples to determine GW Flow direction and concentrations) and sampling every month for 2 years to determine contaminant concentrations . Assuming 3 sites, one for each district</i>	Sample Nos.	2,000	75	150,000
8	Impact due to construction within the River for 3 Anicuts					
8.1	Monitoring					
	<i>Noise Monitoring</i>	<i>Noise Monitoring to be done at two locations one at the site of construction and another at the ring bund location as and when required</i>	<i>Measuring Meter</i>	100,000	3	300,000
	<i>River Water Monitoring</i>	<i>River Monitoring to be done at two locations one at the site of construction and another at the ring bund location as and when required</i>		2,000	72	144,000
	<i>Post-Construction monitoring of the aquatic biodiversity (one-time) for the three anicuts</i>			50,000	3	150,000
9	Impact due to construction within the Hampi WHA	Because certain portions of Anegundi, Raya, Basavanna and Kalaghatta are within the Hampi WHA and only THURTHA Canal is considered in PACKAGE 2				
	<i>Designs to suit the Heritage Area landscape</i>	<i>DPR to consider cost</i>				

S. No.	ENVIRONMENTAL MANAGEMENT PLAN COSTS	Unit	Unit Cost	Unit Nos.	Amount	
	<i>including use of no-blast technology</i>					
	<i>Awareness and Training Program on practices to be adopted for working within the Hampi WHA</i>	<i>Lumpsum considered for now</i>	Lumpsum		500,000	
	<i>Safety Sign Boards</i>	<i>Safety Sign Boards to be putup near Hampi WHA sites during construcion period</i>	Lumpsum		100,000	
	<i>Water Sprinkling Costs at Construction Site Location within the Hampi WHA</i>	<i>Assuming Water Sprinkling to be done every day during dry season; assuming dry season of 9 months for 2 years</i>	Sprinkling Month	20,000	18	360,000
	<i>Air Quality Monitoring at Construction Sites within the Hampi WHA</i>	<i>Assuming 2 years of construction within the Hampi WHA - One Baseline Air Quality sampling and later sampling every month for 2 years</i>	Sample Nos.	2,000	25	50,000
	<i>Noise Monitoring at Construction Sites within the Hampi WHA</i>	<i>Assuming 2 years of construction within the Hampi WHA - One Baseline Noise Measurement and later sampling every month for 2 years</i>	Sample Nos.	2,000	25	50,000
	Rehabilitation of Anicuts, Canals and Structures					
	<i>Construction Waste Disposal Costs</i>	<i>To be costed and borne by the Contractor</i>				
	<i>Groundwater Quality Monitoring near Waste Disposal Location</i>	<i>Only GW Monitoring considered for EMP costs; If approved public places are used for waste disposal, then one baseline GW sampling and later sampling for two quarters after waste disposal - Assuming 10 approved waste disposal locations</i>	Sample Nos.	2,000	90	180,000
	<i>Water Sprinkling Costs at Construction Site Location during a month</i>	<i>Assuming Water Sprinkling to be done every day during dry season; assuming dry season of 9 months for 4 year</i>	Sprinkling Month	100,000	36	3,600,000
10	<i>Establishing and Operating Mobile Toilets at construction sites</i>	<i>Assuming 4 construction site locations at any point of time for 4 years</i>	Nos.	5,000	192	960,000
	<i>Air Quality Monitoring at Construction Sites location during a month</i>	<i>Assuming 4 years of construction period - Sampling every month for 4 years for 4 locations every month</i>	Sample Nos.	2,000	192	384,000
	<i>Surface Water Quality Monitoring at Construction Sites location during a month</i>	<i>Assuming 4 years of construction period - Sampling every month for 4 years for 4 locations every month</i>	Sample Nos.	2,000	192	384,000
	<i>Noise Monitoring at Construction Sites location during a month</i>	<i>Assuming 4 years of construction period - Sampling every month for 4 years for 4 locations every month</i>	Sample Nos.	2,000	192	384,000
11	Construction Campsite Facility Management					

S. No.	ENVIRONMENTAL MANAGEMENT PLAN COSTS	Unit	Unit Cost	Unit Nos.	Amount	
	Construction of campsite facilities including living quarters, kitchen, bathing, latrines and other basic facilities; O&M of campsite facilities including provision of drinking water, source separation of solid waste management	<i>To be costed and borne by the Contractor</i>				
	Construction, Operation and Maintenance of septic tanks	<i>Assuming two septic tanks for each of the 3 campsite locations</i>				
	Construction, Operation and Maintenance of Composting Units for Kitchen Wastes	<i>Assuming one composting unit for each of the 3 campsite locations</i>				
	Safety Sign Boards	Lumpsum			100,000	
	Water Sprinkling Costs at Construction Campsite Site Location during a month	<i>Assuming Water Sprinkling to be done every day during dry season; assuming dry season of 9 months for 4 years</i>				
	Air Quality Monitoring at Construction Campsites location during a month	<i>Assuming 4 years of construction period - Sampling every month for 4 years for 3 campsite locations - one in each district</i>				
	Noise Monitoring at Construction Campsites location during a month	<i>Assuming 4 years of construction period - Sampling every month for 4 years for 3 campsite locations - one in each district</i>				
	Groundwater Quality Monitoring at Construction Campsites location during a month	<i>Assuming 4 years of construction period - Sampling every month for 4 years for 3 campsite locations - one in each district</i>				
12	Workers' Health and Safety					
	Insurance, First Aid Costs, Emergency Related Health and Safety Incidents	<i>To be costed by Contractor - Lumpsum considered for now</i>				1,000,000
	PPE Costs	<i>To be costed by Contractor based on Worker Nos. - Lumpsum considered for now</i>				1,500,000
	Health Monitoring and Record Keeping	<i>To be costed by Contractor based on Worker Nos. - Lumpsum considered for now</i>				1,500,000
	Safety Monitoring and Record Keeping	<i>To be costed by Contractor based on Worker Nos. - Lumpsum considered for now</i>				1,000,000
	Health Emergencies for Workers, Labourers and nearby community for issues that can be traced to	<i>To be costed by Contractor - Lumpsum considered for now</i>				2,000,000

S. No.	ENVIRONMENTAL MANAGEMENT PLAN COSTS		Unit	Unit Cost	Unit Nos.	Amount
	<i>the project activity</i>					
13	Borrow Area Rehabilitation					
	<i>Burrow Area Closure</i>	<i>Assuming 10 borrow areas</i>	Burrow Nos.	500,000	10	5,000,000
	<i>Topographic Survey, Photographs and Videos of Burrow Area before and after use</i>	<i>Lumpsum costs to be considered for 10 burrow areas</i>	Burrow Nos.	25,000	10	250,000
	<i>Groundwater Quality Monitoring at Burrow Area</i>	<i>One baseline GW sampling and later sampling for two quarters after Burrow Area Rehabilitation</i>	Sample Nos.	2,000	90	180,000
14	Closure Activities					
	<i>Development of Closure Plan, Implementation of all works as per Plan and approvals from local authorities and any other agencies</i>	<i>To be costed by Contractor - Lumpsum considered for now</i>				2,000,000
	<i>Topographic Survey, Photographs and Videos of all key construction sites before and after use</i>	<i>To be costed by Contractor - Lumpsum considered for now</i>				2,000,000
	<i>Post-closure monitoring of all environmental parameters for one-quarter</i>	<i>To be costed by Contractor - Lumpsum considered for now</i>				500,000
15	Staff Costs and Book Keeping Costs	<i>Four Staff Environmental Engineer to be employed for a 4 year period at Rs. 100,000/= per month</i>	Nos.	100,000	192	19,200,000
16	Purchase of Monitoring and other Equipments	<i>To be costed by Contractor - Lumpsum considered for now</i>	Lumpsum			1,000,000
TOTAL COST INR						67,956,000
Miscellaneous (10% of Total Cost)						6,795,600
Grand Total Cost (INR)						74,751,600
Grand Total Cost (USD)						1,150,025

VNC MODERNIZATION PROJECT - EMP COSTS FOR CONSTRUCTION PHASE - PACKAGE 2

Rehabilitation involves 1 canal (Thurtha) and 8 anicuts (Shivapura Dropped)

1USD = INR65

S.No	ENVIRONMENTAL MANAGEMENT PLAN COSTS		Unit	Unit Cost (INR)	Unit Nos.	Amount
1	Site Clearance for Construction Sites					
	<i>Pre and Post Construction Survey</i>	<i>To be conducted for all the 9 construction campsites (one for canal and one each for 8 anicuts)</i>	Campsites	50,000	9	450,000
	<i>Videos and Photographs for both Baseline, Construction and Post-Construction Scenarios</i>	<i>To be conducted for all the 9 construction campsites</i>	Campsites	20,000	9	180,000
	<i>Air Quality Monitoring at Construction Sites</i>	<i>Assuming 9 campsite locations - One Baseline Air Quality sampling and later sampling every month for 2 years</i>	Sample Nos.	2,000	225	450,000
	<i>Noise Monitoring near Construction Sites</i>	<i>Assuming 9 campsite locations - One Baseline Noise Measurements and later measurements every month for 2 years</i>	Sample Nos.	2,000	225	450,000
	<i>Groundwater Quality Monitoring at Construction Sites</i>	<i>Only GW Monitoring considered for EMP costs; For all construction campsites, then one baseline GW sampling to determine GW flow direction and concentrations of parameters and later GW sampling for every month to determine contaminant concentrations</i>	Sample Nos.	2,000	243	486,000
2	Tree Removal and Afforestation					
	<i>Enumeration of Trees</i>	<i>To be conducted along the entire length of Thurtha Canal with assistance of KFD</i>	No. Canals	100,000	1	100,000
	<i>Compensatory Afforestation</i>	<i>For every tree cut, 4 trees to be planted (assuming 200 trees would need to be cut) - Cost of Land not considered</i>	Tree Nos.	2,000	200	400,000
3	Weed Removal and Management					
	<i>Weed Removal and Disposal including transportation to disposal sites</i>	<i>DPR to consider costs and later Contractor to bid based on volume</i>				
	<i>Weed Disposal</i>	<i>Composting Unit for Weed Management - One for each Bank - Left Bank and Right Bank</i>	No. Composting Units	100,000	2	200,000
	<i>Groundwater Quality Monitoring at Weed Disposal Sites</i>	<i>Only GW Monitoring considered for EMP costs; For all composting sites, then one baseline GW sampling to determine GW flow direction and</i>	Sample Nos.	2,000	50	100,000

S.No	ENVIRONMENTAL MANAGEMENT PLAN COSTS		Unit	Unit Cost (INR)	Unit Nos.	Amount
		<i>concentrations of parameters and later GW sampling for every month to determine cantaminant concentrations</i>				
4	Silt Removal and Silt Disposal					
	<i>Desilting Cost and Silt Disposal Costs</i>	<i>DPR to consider costs and later Contractor to bid based on volume</i>				
	<i>Silt Sampling and Analysis</i>	<i>One sample for every 4 km length of the canal; two samples for every anicut; one sample for every km in contaminated lengths</i>	Sample Nos.	5,000	50	250,000
	<i>Groundwater Quality Monitoring at Silt Disposal Location</i>	<i>Only GW Monitoring considered for EMP costs; For all silt disposal sites, one baseline GW sampling (Baseline GW monitoring consists of 3 samples to determine GW Flow direction and concentratons) and later GW sampling every month to determine contaminant concentrations - Assuming 9 silt disposal locations (one for each canal and 8 Anicuts)</i>	Sample Nos.	2,000	225	450,000
5	Transportation of Machinery, Equipment and Material					
	<i>Machinery, Equipment and Material costs; Transportation Costs; Maintenance Costs; All approvals from relevant authorities</i>	<i>DPR to consider costs later Contractor to bid based on requirements including Workshops, if any</i>				
	<i>If Vehicle, Machinery and Equipment Maintenance Workshop is established then Groundwater Quality Monitoring at Workshop Location</i>	<i>Only GW Monitoring considered for EMP costs; For all workshop sites, one baseline GW sampling (Each GW monitoring consists of 3 samples to determine GW Flow direction and concentratons) and sampling every month for 2 years to determine concentrations and another sampling at least six months after close of workshop for one quarter. Assuming 2 Workshops, one for each bank.</i>	Sample Nos.	2,000	52	104,000
6	Material Sourcing					
	<i>Material Costs, Transportation Costs, All approvals from relevant authorities</i>	<i>DPR to consider costs later Contractor to bid based on requirements including RMC Plant establishment and operation, if any</i>				
	<i>Water Sprinkling Costs at RMC Plant Location</i>	<i>Assuming 2 RMC Locations - one for each Bank and established by the Contractor - Water Sprinkling to be done every day during dry season; assuming dry season of 9 months for 2 years</i>	Sprinkling Month	20,000	18	360,000
	<i>Air Quality Monitoring at RMC Plant Location</i>	<i>Assuming 2 RMC Locations - one for each Bank and established by the Contractor - One Baseline Air Quality sampling and later sampling every month for 2 years</i>	Sample Nos.	2,000	50	100,000

S.No	ENVIRONMENTAL MANAGEMENT PLAN COSTS		Unit	Unit Cost (INR)	Unit Nos.	Amount
7	Storage and Handling of Materials					
	<i>All permissions from relevant authorities; transportation costs, loading and unloading costs; storage and handling costs; insurance costs; emergency costs;</i>	<i>DPR to consider costs later Contractor to bid based on requirements</i>				
	<i>Construction of platform for lubricant and oil storage to prevent direct spills</i>	<i>Lumpsum costs to be considered for 2 sites, one for each Bank</i>				400,000
	<i>PPE Costs</i>	<i>PPE to be provided to the Workers for safe handling of materials</i>	Lumpsum			600,000
	<i>Safety Sign Boards</i>	<i>Safety Sign Boards to be putup at site for storage and handling of materials</i>	Lumpsum			100,000
	<i>Cleanup of Accidental Spills</i>	<i>To be costed by Contractor - Lumpsum considered for now</i>	Lumpsum			1,000,000
	<i>Groundwater Monitoring and Storage Sites especially hazardous materials</i>	<i>Only GW Monitoring considered for EMP costs; Hazardous Materials storage sites, one baseline GW sampling (Each GW monitoring consists of 3 samples to determine GW Flow direction and concentratons) and sampling every month for 2 years to determine contaminant concentrations . Assuming 2 sites, one for each Bank</i>	Sample Nos.	2000	50	100,000
8	Impact due to construction within the OCR					
8.1	Secondary Ring Bunds					
	<i>Equipment Costs (Drones, Camera and Boat Hiring) for Reconnaissance Survey</i>	<i>Assuming two-days per anicut</i>	Days	20000	18	360,000
	<i>Topography and Bathymetric Survey to design secondary ring bund</i>	<i>One of each anicut in the OCR area</i>	Anicut-Nos.	20000	8	160,000
	<i>Construction and Dismantling of Secondary Ring Bund</i>		Anicut-Nos.	1500000	8	12,000,000
	<i>Construction of Approach Roads to move vehnicles, equipment and materials to secondary ring bund</i>		Anicut-Nos.	500000	8	4,000,000
8.2	Awareness and Training Program					
	<i>Awareness for Contractors, Supervisors and</i>	<i>One-day Training Program at two levels</i>	Program	100000	2	200,000

S.No	ENVIRONMENTAL MANAGEMENT PLAN COSTS		Unit	Unit Cost (INR)	Unit Nos.	Amount
	<i>Officials</i>					
	<i>Awareness for Workers</i>	<i>One Program for each anicut</i>	<i>Program</i>	50000	8	400,000
	<i>Safety Sign Boards</i>	<i>Safety Sign Boards to be putup near OCR sites during construcion period</i>	<i>Lumpsum</i>			100,000
8.3	Restoration / Ecological Enhancement					
	<i>Enumeration of Zooplankton and Phytoplankton and any other aquatic flora</i>	<i>To document the existing microphytoplanktons and zooplanktons for making a decision on ecological enhancement.</i>	<i>Anicut-Nos.</i>	100000	8	800,000
	<i>Harvest / Collection of suitable aquatic flora from the river and implanting in the restored anicuts</i>	<i>Collection, Transportation and Implanting Expenses</i>	<i>Anicut-Nos.</i>	50000	8	400,000
	<i>Release of Fingelings such as Ruhu, Catla etc.</i>	<i>The activity to be carried out for 4 years after rehabilitation of anicuts</i>	<i>Anicut-Nos.</i>	200000	8	1,600,000
	<i>Weed Removal and Disposal</i>	<i>This activity to be carried out for 4 years after the rehabilitatio of anicuts</i>	<i>Anicut-Nos.</i>	250000	8	2,000,000
8.4	Rescue and Rehabilitation of Wildlife in Distress					
	<i>Manpower Expenses involving local experts to be hired on a need-basis</i>		<i>Lumpsum</i>	<i>Lumpsum</i>		1,000,000
8.5	Monitoring					
	<i>Noise Monitoring</i>	<i>Noise Monitoring to be done at two locations one at the site of construction and another at the secondary ring bund location as and when required</i>	<i>Measuring Meter</i>	100000	8	800,000
	<i>River Water Monitoring</i>	<i>River Monitoring to be done at two locations one at the site of construction and another at the secondary ring bund location as and when required</i>		2000	192	384,000
	<i>Post-Construction monitoring of the aquatic biodiveristy (one-time) for all OCR anicuts</i>			50000	8	400,000
	<i>Post-Rehabilitation Monitoring quarterly for 4 years to determine the success of mitigation and ecological enhancement measures</i>		<i>Anicut / Year</i>	400000	8	3,200,000
9	Impact due to construction within the Hampi WHA					

S.No	ENVIRONMENTAL MANAGEMENT PLAN COSTS		Unit	Unit Cost (INR)	Unit Nos.	Amount
	<i>Designs to suit the Heritage Area landscape including use of no-blast technology</i>	<i>DPR to consider cost</i>				
	<i>Awareness and Training Program on practices to be adopted for working within the Hampi WHA</i>	<i>Lumpsum considered for now</i>	Lumpsum			500,000
	<i>Safety Sign Boards</i>	<i>Safety Sign Boards to be putup near Hampi WHA sites during construciton period</i>	Lumpsum			100,000
	<i>Water Sprinkling Costs at Construction Site Location within the Hampi WHA</i>	<i>Assuming Water Sprinkling to be done every day during dry season; assuming dry season of 9 months for 2 years</i>	Sprinkling Month	80000	18	1,440,000
	<i>Air Quality Monitoring at Construction Sites within the Hampi WHA</i>	<i>Assuming 2 years of construction within the Hampi WHA - One Baseline Air Quality sampling and later sampling every month for 2 years</i>	Sample Nos.	2000	25	50,000
	<i>Noise Monitoring at Construction Sites within the Hampi WHA</i>	<i>Assuming 2 years of construction within the Hampi WHA - One Baseline Noise Measurement and later sampling every month for 2 years</i>	Sample Nos.	2000	25	50,000
10	Rehabilitation of Anicuts, Canals and Structures					
	<i>Construction Waste Disposal Costs</i>	<i>To be costed and borne by the Contractor</i>				
	<i>Groundwater Quality Monitoring near Waste Disposal Location</i>	<i>Only GW Monitoring considered for EMP costs; If approved public places are used for waste disposal, then one baseline GW sampling and later sampling for two quarters after waste disposal - Assuming 2 approved waste disposal locations (for Package 2)</i>	Sample Nos.	2000	18	36,000
	<i>Water Sprinkling Costs at Construction Site Location during a month</i>	<i>Assuming Water Sprinkling to be done every day during dry season; assuming dry season of 9 months for 4 year</i>	Sprinkling Month	20000	36	720,000
	<i>Establishing and Operating Mobile Toilets at construction sites</i>	<i>Assuming 4 construction site locations at any point of time for 4 years</i>	Nos.	5000	192	960,000
	<i>Air Quality Monitoring at Construction Sites location during a month</i>	<i>Assuming 4 years of construction period - Sampling every month for 4 years for 4 locations every month</i>	Sample Nos.	2000	192	384,000
	<i>Surface Water Quality Monitoring at Construction Sites location during a month</i>	<i>Assuming 4 years of construction period - Sampling every month for 4 years for 4 locations every month</i>	Sample Nos.	2000	192	384,000
	<i>Noise Monitoring at Construction Sites location during a month</i>	<i>Assuming 4 years of construction period - Sampling every month for 4 years for 4 locations every month</i>	Sample Nos.	2000	192	384,000

S.No	ENVIRONMENTAL MANAGEMENT PLAN COSTS	Unit	Unit Cost (INR)	Unit Nos.	Amount	
11	Construction Campsite Facility Management					
	<i>Construction of campsite facilities including living quarters, kitchen, bathing, latrines and other basic facilities; O&M of campsite facilities including provision of drinking water, source separation of solid waste management</i>	<i>To be costed and borne by the Contractor</i>				
	<i>Construction, Operation and Maintenance of septic tanks</i>	<i>Assuming two septic tanks for each of the 2 campsite locations (one for each Bank)</i>	Nos.	200000	4	800,000
	<i>Construction, Operation and Maintenance of Composting Units for Kitchen Wastes</i>	<i>Assuming one composting unit for each of the 2 campsite locations (one for each Bank)</i>	Nos.	100000	2	200,000
	<i>Safety Sign Boards</i>		Lumpsum			100,000
	<i>Water Sprinkling Costs at Construction Campsite Site Location during a month</i>	<i>Assuming Water Sprinkling to be done every day during dry season; assuming dry season of 9 months for 4 years</i>	Sprinkling Month	20000	36	720,000
	<i>Air Quality Monitoring at Construction Campsites location during a month</i>	<i>Assuming 4 years of construction period - Sampling every month for 4 years for 3 campsite locations - one in each Bank</i>	Sample Nos.	2000	96	192,000
	<i>Noise Monitoring at Construction Campsites location during a month</i>	<i>Assuming 4 years of construction period - Sampling every month for 4 years for 3 campsite locations - one in each Bank</i>	Sample Nos.	2000	96	192,000
	<i>Groundwater Quality Monitoring at Construction Campsites location during a month</i>	<i>Assuming 4 years of construction period - Sampling every month for 4 years for 3 campsite locations - one in each Bank</i>	Sample Nos.	2000	96	192,000
12	Workers' Health and Safety					
	<i>Insurance, First Aid Costs, Emergency Related Health and Safety Incidents</i>	<i>To be costed by Contractor - Lumpsum considered for now</i>	Lumpsum			400,000
	<i>PPE Costs</i>	<i>To be costed by Contractor based on Worker Nos. - Lumpsum considered for now</i>	Lumpsum			800,000
	<i>Health Monitoring and Record Keeping</i>	<i>To be costed by Contractor based on Worker Nos. - Lumpsum considered for now</i>	Lumpsum			800,000
	<i>Safety Monitoring and Record Keeping</i>	<i>To be costed by Contractor based on Worker Nos. - Lumpsum considered for now</i>	Lumpsum			800,000
	<i>Health Emergencies for Workers, Labourers and</i>	<i>To be costed by Contractor - Lumpsum considered for now</i>	Lumpsum			1,000,000

S.No	ENVIRONMENTAL MANAGEMENT PLAN COSTS	Unit	Unit Cost (INR)	Unit Nos.	Amount	
	<i>nearby community for issues that can be traced to the project activity</i>					
13	Borrow Area Rehabilitation					
	<i>Borrow Area Closure</i>	<i>Assuming 4 borrow areas</i>	Burrow Nos.	500000	4	2,000,000
	<i>Topographic Survey, Photographs and Videos of Borrow Area before and after use</i>	<i>Lumpsum costs to be considered for 4 burrow areas</i>	Burrow Nos.	25000	4	100,000
	<i>Groundwater Quality Monitoring at Borrow Area</i>	<i>One baseline GW sampling and later sampling for two quarters after Borrow Area Rehabilitation</i>	Sample Nos.	2000	36	72,000
14	Closure Activities					
	<i>Development of Closure Plan, Implementation of all works as per Plan and approvals from local authorities and any other agencies</i>	<i>To be costed by Contractor - Lumpsum considered for now</i>				1,000,000
	<i>Topographic Survey, Photographs and Videos of all key construction sites before and after use</i>	<i>To be costed by Contractor - Lumpsum considered for now</i>				1,000,000
	<i>Post-closure monitoring of all environmental parameters for one-quarter</i>	<i>To be costed by Contractor - Lumpsum considered for now</i>				400,000
15	Staff Costs and Book Keeping Costs	<i>Two Staff Environmental Engineer to be employed for a 4 year period at Rs. 100,000/= per month</i>	Nos.	100000	96	9,600,000
16	Purchase of Monitoring and other Equipments	<i>To be costed by Contractor - Lumpsum considered for now</i>	Lumpsum			1,000,000
TOTAL COST INR					60,460,000	
Miscellaneous (10% of Total Cost)					6,046,000	
Grand Total Cost (INR)					66,506,000	
Grand Total Cost (USD)					1,023,169	

VNC MODERNIZATION PROJECT - TOTAL EMP COSTS FOR THE TWO PACKAGES

1USD = INR65

Project Activity	EMP costs (Package 1)		EMP Costs (Package 2)	
	in INR	in USD	in INR	in USD
Site Clearance Costs	3,360,000		2,016,000	
Tree Removal and Afforestation	8,750,000		500,000	
Weed Removal and Management	450,000		300,000	
Silt Removal and Silt Disposal	1,500,000		700,000	
Transportation of Machinery, Equipment and Material	156,000		104,000	
Material Sourcing	1,950,000		460,000	
Storage and Handling of Materials	3,750,000		2,200,000	
Impact due to construction within the River (for Package 1) and OCR (for Package 2)	594,000		27,804,000	
Impact due to construction within the Hampi WHA	1,060,000		2,140,000	
Rehabilitation of Anicuts, Canals and Canal Structures	5,892,000		2,868,000	
Construction Campsite Facility Management	3,364,000		2,396,000	
Workers' Health and Safety	7,000,000		3,800,000	
Borrow Area Rehabilitation	5,430,000		2,172,000	
Closure Activities	4,500,000		2,400,000	
Staff and Book-keeping Costs	19,200,000		9,600,000	
Purchase of Environmental Monitoring and other Equipment	1,000,000		1,000,000	
Sum-Total	67,956,000		60,460,000	
Miscellaneous (10% of Sum Total)	6,795,600		6,046,000	
Grand Total	74,751,600	1,150,025	66,506,000	1,023,169

Emergency Response Plan Format

EMERGENCY RESPONSE ACTION PLAN

for

Project Name: _____

Project Office Address: _____

Date Prepared: ___/___/___

Guidelines for Emergency Response Plan

Policy Statement

[Contractor Name] is committed to having an emergency response plan in place for each sub-project site to assist workers and the community to respond to any emergency situation.

Emergency Plan

All project sites require:

- a) A method for reporting the emergency;
- b) A list of workers responsible in emergency situations and how to contact them;
- c) A plan for incident investigation and correction of the hazard;
- d) A list of phone numbers for emergency and support services (should be posted by telephones)

Project sites may also require:

- a) A method for sounding the alarm;
- b) A description of potential emergencies;
 - i. Encountering threats to Heritage Area;
 - ii. Encountering threats to Conservation Area;
 - iii. Existing of Contamination at Site;
 - iv. Encountering Wildlife Presence at the Site;
 - v. Medical;
 - vi. Fire;
 - vii. Severe Weather;
 - viii. Chemical / Hazardous Waste Spill;
 - ix. Other....
- c) A map of the workplace that shows evacuation routes and head count location, as well as the location of emergency equipment, first aid station and fire extinguishers
- d) An evacuation, head count and rescue plan.

Plan Testing

At the discretion of the supervisor, emergency response plan fake drills may be held. A fake drill shall require:

- a) Notification of emergency services, all supervision and possibly prior notification of workers;
- b) A pre-determined all clear signal to allow rapid return to work;
- c) An evaluation system to determine the effectiveness of the emergency response plan.

Planning the Emergency Program

If the project site is located within a larger area of the city / town / heritage area/ conservation area which has an existing emergency and evacuation plan, the Contractor shall integrate the project emergency response plan with that of the overall city / town / heritage area / conservation area emergency response plan and ensure a complete Emergency Plan for the project site.

Guidelines for Preparing an Emergency Plan

All projects require an emergency plan. The magnitude and complexity of the plan depends on the size of the project/workplace. Required elements are:

1. Assign a person that is responsible to provide or set up training for the emergency response plan.
2. A method for reporting the emergency. Generally, telephone is the most effective; however, an alternative should exist if the emergency disables the site phones.
3. A list of workers responsible in emergency situations and how to contact them. This should be plainly posted. Eg. First Aid
4. A plan for incident investigation and correction of hazard.
5. A list of phone numbers for emergency and support services. This should be posted by the telephone.
6. A method for sounding an alarm, such as an air horn or warning bell.
7. A description of potential emergencies. This is extremely important from a knowledge view point and should be site-specific. Emergency preparedness is essentially based on anticipating all possible situations.
8. A map of the work place that shows evacuation routes, muster point, head count location, as well as location of emergency equipment, first aid station, fire extinguishers. This should be designed at the start of the job and posted where visible.
9. The manager's routine for shut down of the job. This should be established to ensure that if a shutdown occurs, no potential hazard may be left.
10. A system for communication, both internal and external. Two way radios, telephones or alarms should be available.
11. An evacuation, head count and rescue plan. Rescues should only be attempted by trained persons and only if they do not risk injury to themselves. Each supervisor should have a roll call system in place to ensure that all workers have been evacuated from the hazard area.

Emergency Procedure Checklist

Company		Date	
Completed by		Site	

	In Progress	Completed Date
Program Administration (Who is responsible for implementing the plan?)		
Emergency Response Standard Developed		
Develop Site Emergency Plan		
<ul style="list-style-type: none"> ▪ Identify emergency access routes 		
<ul style="list-style-type: none"> ▪ Indicate location of first aid stations/boxes and fire extinguishers 		
<ul style="list-style-type: none"> ▪ Show job office(s) and storage facilities. (Blankets and special rescue equipment storage) 		
<ul style="list-style-type: none"> ▪ Ensure specialized PPE equipment is on site (indicate location) 		
<ul style="list-style-type: none"> ▪ Ensure sufficient medical aid supplies are available on site (splints, stretchers etc.) & location 		
<ul style="list-style-type: none"> ▪ Locate other firefighting equipment (Standpipes, Siamese connections and hydrants) 		
<ul style="list-style-type: none"> ▪ Locate main power supply to project 		
<ul style="list-style-type: none"> ▪ Identify the location of emergency phones (Post emergency list) 		
<ul style="list-style-type: none"> ▪ Identify nearest hospital or medical center 		
<ul style="list-style-type: none"> ▪ Identify worker evacuation route(s) and assembly area(s) 		
<ul style="list-style-type: none"> ▪ Contact local fire, police and ambulance and provide them with your site plan and list of potential emergencies. 		
<ul style="list-style-type: none"> ▪ Locate services to the project (both above ground and underground) 		
<ul style="list-style-type: none"> ▪ Develop onsite traffic routes 		
<ul style="list-style-type: none"> ▪ Locate outside materials storage and fabricating areas 		
<ul style="list-style-type: none"> ▪ Locate cranes man/material hoists and unloading docks 		
<ul style="list-style-type: none"> ▪ Locate flammable/combustible materials and cylinder storage 		

	In Progress	Completed Date
<ul style="list-style-type: none"> ▪ Locate garbage dumpsters and recycling bins 		
<ul style="list-style-type: none"> ▪ Complete Hazard Identification and Emergency Response checklist. 		
<ul style="list-style-type: none"> ▪ Identify if “high Level” rescue is a possibility. 		
<ul style="list-style-type: none"> ▪ Develop Emergency Response procedures for items identified in your hazard assessment 		
<ul style="list-style-type: none"> ▪ Ensure that all trades on site keep daily personnel lists. (In the event of a major emergency check names against personnel gathered in the assembly area) 		
<ul style="list-style-type: none"> ▪ Include requirements for written notices. (What’s required? When? Completed by whom? Who does it go to?) See legal obligations. 		
<ul style="list-style-type: none"> ▪ Identify the emergency response team & alternates (Post names) 		
<ul style="list-style-type: none"> ▪ Provide specialized training for ER Team members. 		
<ul style="list-style-type: none"> ▪ Designate a contact person to call necessary emergency services and Employer 		
<ul style="list-style-type: none"> ▪ Select member of ER Team to meet and direct emergency services vehicles to accident scene 		
<ul style="list-style-type: none"> ▪ Select team member to deal with the Media, OH&S, etc. or refer them to Employer 		
<ul style="list-style-type: none"> ▪ Ensure all required rescue equipment/materials are readily available on site. 		
<ul style="list-style-type: none"> ▪ Provide for emergency traffic control person (Properly trained) 		
<ul style="list-style-type: none"> ▪ Make provisions for cordoning off the accident scene to protect workers 		
<ul style="list-style-type: none"> ▪ Ensure someone on the ER team documents where the injured worker has been taken. (Hospital, medical center etc.) 		
<ul style="list-style-type: none"> ▪ Set out method of communicating the plan 		

Emergency Numbers - 1

Date:		Location:	
Emergency NO.			
Head Office:			
Site Supervisor:			
Safety Coordinator:			
Emergency Response Team			
Emergency Coordinator:			
Call Person Emergency Services:			
Onsite & Off Site Coordinator:			
Emergency Services Guide:			
First Aiders:			
Site Location:			
Other:			
General Contractor:			
Mobile No.:			
Sub-Contractor:			
Mobile No:			
Sub-Contractor:			
Mobile No:			
Sub-Contractor:			
Mobile No:			

Emergency Numbers – 2

Contractor Name:

Ambulance

EMERGENCY RESPONSE TEAM

Police

Co-ordinator:

Solid Waste Department

Fire Department

Water Utility

Electrical Utility

Gas Utility

Cable Utility

District Disaster Management Unit

Pollution Control Board Unit

Hazardous Waste Unit

Occupational Health & Safety

Gate

OTHER

<i>Name</i>	<i>Position</i>	<i>Office Phone</i>	<i>After Hours</i>

The nearest **hospital** is located at

Phone #

The nearest **clinic** is located at

Phone #

POST NEAR PHONES/KEEP COPY IN VEHICLE

Evacuation Procedure

Define Emergency Response Call Sequence

Call 108

Call Contractor's Project Manager / EHS Manager

Implement Emergency Response Procedure

Definition:

An **evacuation** is a pre-planned process for all personal on the construction site.

Onsite Location: Pre-arrange area where Personnel will report to. Four areas could be planned so that the area can be upwind of emergency location.

Offsite Location: A pre-arrange location should be determined if the construction site area is not safe.

Emergency Response Plan:

The person who has this task will normally be the person in charge of the emergency response operation. It is their task to ensure

- Delegate responsibility according to the training and experience of the workers in the Emergency Response Team. Be sure everyone clearly understands their roles and responsibilities within the emergency response plan (Emergency Response Team - Emergency Numbers sheet) If this activity has been practiced or gone over during a meeting, this will help maintain order during the crisis.
- Ensure that emergency resources, whether people or equipment, are kept at adequate levels in step with the progress of the project. This can be done during work site orientation, toolbox or tailgate meetings, O&HS meetings or morning briefings.

Emergency Response Procedure:

Evacuation:

- Sound the alarm – if there is an immediate threat to the occupants of the construction site (fire, gas leak, chemical spill). Evacuate to onsite location.
- Assume the roles and responsibilities of the Emergency Response Team.
- Eliminate further loses and safeguard the area.
- If the Construction Site is too dangerous, move personnel to Off Site Location

Construction Restarting Procedure:

Restart:

- Sound the alarm for restarting the construction activity;
- Brief the workers and other personnel on what prompted the emergency response;
- Eliminate further loses and safeguard the area.

**ToR of Cultural Heritage
and
Bio-diversity Specialists**

ToR of Cultural Heritage and Bio-diversity Specialist

Cultural Heritage Specialist

The Cultural Heritage Specialist (CHS) shall have at least a Degree in Architecture, Planning, or a related discipline with a minimum of 10 years of experience in working in heritage sites. S/he must have a demonstrated ability to analyze site management problems, develop indicators, devise solutions, and design conservation and heritage components and must have been associated with civil construction works in Heritage areas.

The CHS reports directly to the TL and will play a leading role in the tasks described below:

- (i) In consultation with PMU/PIO, review the design suggested in the DPR and its fit within the overall site;
- (ii) Assess and, where necessary, mitigate possible adverse impacts of the project's physical and non-physical interventions on the affected monuments and their surrounding buffer zones;
- (iii) Oversee implementation of modernization works within the conservation area, restoration, removal, addition, rearrangement and other interventions that may be required so as not to disturb the existing Heritage structures due to the proposed canal rehabilitation works;
- (iv) In close collaboration with the O&M Expert, Environment Specialist and Social and Gender Development Specialists, devise protocols and systems for on-site monitoring and predictive modelling and reporting of the impact of tourism, if any, on the site, their buffer zones, and the surrounding environment;
- (v) Ensure implementation of the Environmental Management Plan for modernization works in heritage areas as provided in the EIA chapter of the VNC Feasibility Study Report;
- (vi) Prepare an Operations Manual for implementation of the aforementioned protocols and systems and conduct workshop to train site managers in the application of the manual;
- (vii) Collection of evidence and preparation of reports towards compliance related to conservation and mitigation efforts implemented as per the guidelines in the EIA chapter in the VNC Feasibility Study Report;
- (viii) Contribute to the preparation of environmental monitoring reports for submission to ADB.

Bio-diversity Specialist

The Bio-diversity Specialist (BS) shall have at least a Masters in Environmental Sciences, Life Sciences, or related discipline with a minimum of 10 years of experience in projects dealing with Biodiversity and Ecological conservation. S/he should have experience in monitoring, evaluation and documentation of bio-diversity conservation measures required in infrastructure development projects in and around ecologically sensitive areas for flora and fauna.

The Specialist will support the smooth running of the Project in accordance with project work plans, and develop strategy for preservation of the ecological balance.

The BS will report directly to TL and shall undertake the following key responsibilities:

- (i) Develop a project implementation strategy and plan for an ecologically safe construction schedule to minimize disturbance to ecologically fragile species of the region;
- (ii) Surveys of flora and fauna before and during construction, and structural inspections regarding potential roosting of the local fauna;
- (iii) Integration of solutions to nature conservation issues into the construction program;
- (iv) Early detection of adverse impacts with respect to flora and fauna and implementing mitigation measures;
- (v) Coordination with relevant authorities as needed;
- (vi) Sensitize the project staff (both Engineers and Contractors) and Water User Cooperative Societies about protecting local bio-diversity as well as conservation aspects;
- (vii) Collection of evidence and preparation of reports towards compliance related to conservation and mitigation efforts implemented as per the guidelines in the Biodiversity and EIA chapters in the VNC Feasibility Study Report.

KARNATAKA NEERAVARI NIGAM LTD



**Karnataka Integrated and Sustainable
Water Resources Management Investment Program**
ADB LOAN No.3172-IND

**VIJAYANAGARA CHANNELS
FEASIBILITY STUDY REPORT**

Volume 2b: Rapid Biodiversity Assessment



Project Management Unit, KISWRMIP
Karnataka Neeravari Nigam Ltd.

Project Support Consultant

SMEC International Pty. Ltd. Australia

in association with

SMEC (India) Pvt. Ltd.



June 2018

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Report for	Karnataka Neeravari Nigam Ltd (KNNL)

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SMEC COMPANY DETAILS

Dr Hasan A. Kazmi

387, Udyog Vihar, Phase-2, Gurgaon – 122002, Haryana

Tel +91 124 4552800

Fax +91 124 4380043

Email Srinivas.Mudrakartha@smec.com, Website: www.smec.com

CONTENTS

EXECUTIVE SUMMARY	1
1. INTRODUCTION	5
1.1 Overview	5
1.2 Objectives of Bio-diversity Assessment	6
1.3 Scope of Bio-diversity Assessment	7
2. STUDY AREA	10
2.1 Overview and geography of study area.....	10
2.2 Tungabhadra Otter Conservation Reserve	11
2.3 Ancient Irrigation Systems in Vijayanagara Empire	12
2.4 Role of Anicuts around Hampi.....	13
2.5 Present status of the Anicuts.....	14
2.6 Need for restoration of ancient Anicuts	15
2.7 Relevance of the present study	16
3. MATERIALS AND METHODS	17
3.1 Trail monitoring and data collection.....	17
3.2 Monitoring of anicuts.....	17
3.3 Documentation.....	17
4. RESULTS AND DISCUSSIONS	18
4.1 Population density of various major fauna	18
4.1.1 Mammals.....	19
4.1.2 Reptiles.....	20
4.1.3 Amphibians.....	21
4.1.4 Ichthyofaunal (Fish fauna).....	22
4.1.5 Avi-Fauna	26
4.1.6 IUCN status of various faunal species in TOCR area	28
4.2 Species Profile	30
4.2.1 Smooth-coated otter–Lutragale perspicillata	30
4.2.2 Population dynamics of Smooth-Coated Otter in anicuts in TOCR.....	32
4.2.3 Mugger crocodile – Crocodylus palustris	34
4.2.4 Population dynamics of Mugger Crocodile in anicuts	36
4.3 Turtles and Tortoises	38
4.3.2 Leith’s Soft-shell Turtle–Nilssonina leithii.....	38
4.3.3 Indian Narrow-headed Soft-shell Turtle–Chitra indica.....	39
4.3.4 Indian flapshell Turtle–Lissemys punctata	40
4.3.5 Indian Black Turtle–Melanochelys trijuga	41
4.3.6 Indian Star Tortoise–Geochelone elegans	41
4.4 Aquatic flora: Macrophytes	42
5. CONCLUSIONS AND RECOMMENDATIONS	44
5.1 Summary of Conclusions.....	44
5.1.1 Major threats to habitat during implementation and mitigation measures	45
5.1.2 General recommendations.....	47
5.1.3 Guidelines for Construction of Secondary Ring Bunds	48
5.1.4 Ecological Conservation, Restoration and Enhancement of Anicuts of OCR	52

5.2	Site Specific recommendations: Hulugi anicut	55
5.3	Site Specific recommendations: Shivapura anicut	55
5.4	Site Specific recommendations: Anegundi anicut	56
5.5	Site specific recommendations: Upper Gangavathi anicut	57
5.6	Site Specific recommendations: Lower Gangavathi anicut	57
5.7	Site Specific recommendations: Bella / Hosur anicut.....	58
5.8	Site Specific recommendations: Turtha anicut.....	58
5.9	Site Specific recommendations: Ramasagara anicut.....	59
5.10	Site Specific recommendations: Kampli anicut	59
6.	APPENDICES	61
7.	ANNEXURES	78
8.	REFERENCES	93

TABLES

Table 1:	Details of the anicuts (weirs) within TOCR area	12
Table 2:	Ichthyofaunal (Fish) Orders and species in TOCR.....	22
Table 3:	IUCN status of Fish Fauna with in TOCR	24
Table 4:	Cosolidated table of IUCN status of major fauna of OCR	10
Table 5:	IUCN Status of various life forms in and around TOCR area.....	11
Table 6:	Smooth coated otter: Population density	32
Table 7:	Population of Muggar crocodile	16

ABBREVIATIONS

BOD	Biological Oxygen Demand
DO	Dissolved Oxygen
DPR	Detailed Project Report
DSLR	Digital Single Lens Reflex
GPS	Global Positioning System
IUCN	International Union for Conservation of Nature
KFD	Karnataka Forest Department
KM	Kilometer
KNNL	Karnataka Neeravari Nigam Limited
MSL	Mean Sea Level
OCR	Otter Conservation Reserve
RET	Rare, Endangered, and Threatened species
SWaN	Society for Wildlife and Nature-an NGO
TCM	Traditional Chinese Medicine
TMC	thousand million cubic feet
TOCR	Tungabhadra Otter Conservation Reserve
VNC	Vijayanagara Channels/ Canals
WPA	Wildlife (Protection) Act, 1972

EXECUTIVE SUMMARY

Rivers are the cradles of human evolution and civilization. Man began exploiting water from river for agriculture and domestic uses. He diverted the river water for farmlands by constructing barrages across the river and dug canals to feed water to far away dry lands. During the Vijayanagara dynasty, many such canal structures were constructed across River Tungabhadra in various locations from Hadagali to Raichur. These barrages that divert the river water to far off farmlands through channels are called as *anicuts* in local Kannada language. Among the 12 *anicuts* and 16 Vijayanagara Channels (VNC), 9 *anicuts* come under the control of the recently formed 'Tungabhadra Otter Conservation Reserve' (TOCR) under the Indian Wildlife (Protection) Act, 1972 to conserve the Rare, Endangered and Threatened (RET) species of flora and fauna found in the river stretch from Holey Mudlapura village to the bridge of Kampli town in Hospet taluk of Bellary district. As these ancient *anicuts* and VNCs are in deteriorated condition due to aging and other factors, the concerned authority has proposed revival and renovation of the ancient *anicuts* to maximize utilization of the river water for irrigation and domestic use. But the formation of the TOCR in the year 2015 has compelled the authorities to recognize the presence of the faunal diversity within the *anicuts* and to explore strategies for execution of the project without causing disturbance to the existing faunal diversity.

Therefore, the Rapid Biodiversity Assessment of the 'Tungabhadra Otter Conservation Reserve' was conducted during May-June 2017 from 'Holey Mudlapura' to 'Kampali' with main focus on the ecology of the major faunal species within the ancient *anicuts* of the Vijayanagara period. The broad objective of the rapid assessment is to estimate the population, abundance and ecology of major faunal species like the Smooth-coated Otter *Lutrogale perspicillata*, Muggar Crocodile-*Crocodylus palustris*, Giant Soft-shelled Turtles like *Chitra Indica* and *Nilssonina Lethii* and fish fauna in the entire stretch of the 'Tungabhadra Otter Conservation Reserve' (TOCR) beginning from Holey Mudlapura village near the reservoir in Koppal taluk of Koppal district to the Bridge at Kampli in Hospet taluk, Bellary district. The study aimed at understanding the ecology of the major faunal species within the vicinity of the 9 ancient *anicuts* located within the TOCR area to assess the likely impact on these species during renovation of the *anicuts* and to explore mitigation solutions. The outcome of the study shall guide planning, execution and monitoring of execution of the project renovation activity.

Under the rapid assessment study, the entire stretch of the river is surveyed for major faunal species; their sign and marks are recorded with intensive focus within the vicinity of the *anicuts*. Trained field staff scouted the selected route in the river with the help of local fishermen and knowledgeable people. Location was recorded using Garmin GPS instrument, images of animals were documented using DSLR cameras, powerful binoculars were used to spot the wildlife in the river, non-invasive methods of observing 'mass latrine' spots and grooming areas of Otters were helpful in determining their population density and behavior.

Major findings

Ecology of major faunal species

The main focus of the study is to explore the habitat use and spatial behavior of the Smooth-coated Otter-*Lutrogale perspicillata*, Muggar Crocodile-*Crocodylus palustris* and other

species. The Smooth-coated Otter is found more in abundance in the vicinity of the *anicuts* than outside of the *anicuts*. Assured availability of water in the *anicuts* helps Otters, crocodiles and other faunal species to hunt for fish and flourish. The Smooth-coated Otters are shy creatures who avoid human beings. After a good hunt, they rest on the elevated rocky banks and bask in the sun. Sometimes, they play/groom on the sandbanks and on rocks. They defecate collectively in a given location as a mark of delineation of their territory. These sprint marks are generally found at the entrance to their nesting areas, near the basking/resting/grooming areas. About 142 positive sites of Smooth-coated Otters were found in and around 9 *anicuts*. Among them, about 74 mass latrine sites (52.11%) and 21 den sites or holts (14.78%) and 47 resting/playing/ grooming sites (33.09%) were identified. It is also found that the Otters prefer rocky area (61.26%), to mud banks (23.23%) and sand banks (15.49%). The reason for this may be that most of the TOCR stretch has rocky surface and banks as against mud and sand.

Muggar Crocodile-*Crocodylus palustris* is also found in abundance in the TOCR area in the ancient *anicuts*. Large water bodies and pools within the river in and around ancient *anicuts* surrounded with thick vegetation provide a safe haven for the *Muggar crocodiles*. Availability of large fish species like Deccan Masheer *Tor khurdee*, introduced species like Ruhu, Catla, Tilapia etc. which provide sufficient food for them. During the rapid assessment, about 30 (40.54%) crocodiles were directly sighted in different locations of the TOCR; further, about 10 (13.51%) nests and nesting sites were found and 34 (45.94%) indirect signs and evidences were recorded. The study was conducted during hot summer, and water in all the *anicuts* had either reduced to the bottom or totally dried up and invaded by water hyacinth. Hence, sighting of a crocodile in such a hostile condition was very difficult. As the crocodiles are nocturnal hunters, it was planned to survey crocodiles during the night. Accordingly, a powerful torch was used to spot the crocodiles in selected locations and found gleaming reflections of crocodile's eyes in the water body. About 12 crocodiles were found near the newly built bridge between Bukkasagara and Kadebagilu, during one of the patrolling nights.

Apart from Otter and *crocodiles*, there are many rare faunal species recorded in the TOCR area. Among the 62 recordings of the other major faunal species were 17 Jackals (27.41%), 6 Jungle cats (9.6%), Small Indian Civet 9 (14.51%), Porcupine 2 (3.22%), Leopard 2 (3.22%), Sloth Bear 13 (20.96%), Monitor Lizard 4 (6.45%) and Black Turtle 9 (14.51%).

Some of the species of the study area fall under different categories of International Union for Conservation of Nature (IUCN) Red data book. Of 20 species of mammals, 14 listed as Least Concerned (LC) (70%), 2 species such as Striped Hyaena and Rusty-spotted Cat are listed under Near Threatened (NT) (10%), and 1 species of mammals is listed under Endangered (EN) category (5%), that is Indian Pangolin. Smooth-coated Otter, Indian Sloth Bear and Indian Leopard are listed under Vulnerable (VU) category (15%). Among the reptiles, Indian Narrow-headed Soft-shell Turtle is listed as Endangered (EN) (3%) and Indian Black Turtle-*Melanochelys trijuga* as Near Threatened (NT) (3%). 3 species are listed as Vulnerable (VU) such as Leith's Soft-shell Turtle-*Nilssonina leithii*, Muggar Crocodile-*Crocodylus palustris*, and Starred Tortoise-*Geochelone elegans* which amounts to 11% of all species of reptiles in the study area. About 8 species of reptiles are listed under Least Concern (LC) (33%) and 13 species as Not Evaluated (NE) (48%). Most of the Not Evaluated (NE) species are Geckos and Lizards. The frogs and toads found in the study area belong to the Least Concerned (LC)

category. Among fishes, one species, i.e., Ray-finned Fish (Harigi menu)-Hypselobarbus pulchellus (1%) is listed as Critically Endangered (CR), 6 fishes species each (7%) listed under Endangered (EN) and Vulnerable (VU) category respectively, and 8 fishes (9%) under Near Threatened (NT) category. About 63 fishes (70%) are listed as Least Concern (LC) and while the rest of 6 fish species (6%) are listed under Not Evaluated (NE) and Data Deficient (DD). About 4 species of birds listed as Near Threatened (NT) 3% of the total number of birds present in the study area. 3 species of birds listed as Vulnerable (VU) category such as Woolly-necked Stork- Ciconia episcopus, Lesser Adjutant- Leptoptilos javanicus, Yellow-throated Bulbul-Pycnonotus xantholaemus, that amounts to 2% of the species of the birds found in the study area.

Recommendations

Otters and *crocodiles* are the major predators of the river apart from the rare Soft-shelled Turtles and fish fauna. The civil works of restoration of the old and dilapidated *anicuts* or barrages can be disastrous to the life of these RET species. But restoration of the *anicuts* would also support these RET species and other forms of life in the long run. Hence, the following recommendations are made to take up restoration activities with zero or minimal disturbance to the wildlife within the TOCR area:

1. Restoration work should be taken up during the period *December to June only* so as to avoid disturbances to the aquatic fauna.
2. Before commencement of the restoration activities, temporary ring bunds should be built using sand bags or any such barrier across the *anicut* about 100 meters away to store water for the wildlife till the completion of the restoration as well as make adequate space for the restoration work.
3. The restoration work should start after 9 am and closed by 5 pm so as to make way for the feeding of crepuscular and nocturnal animals.
4. De-silting and de-weeding activities should be taken up in the front portion of the *anicuts* only; however, the existing native species of bushes and shrubs in the habitat other than restoration area to be retained intact.
5. Retain the rocky islands, sand dunes and mud banks in the middle of the *anicut*, which will help the wildlife like Smooth-coated Otters and crocodiles to bask and rest.
6. De-weeding of the invasive alien weeds such as *Water Hyacinth* and *Ipomoea cornea* is to be taken up in the *anicuts* on regular basis to prevent siltation and to maintain healthy ecosystem.
7. During the restoration of the VN channels, it is advised to build a stone wall along the canal road and leave the other end/ bank of the canal as it is with its mud bank and vegetation wherever possible. This will help endemic life forms like crabs, amphibians, snakes, turtles and birds to feed, nest and live using the available resources.
8. While de-silting and removing the existing structures of the *anicuts*, precaution should be taken to avoid any kind of harm or disturbance to the wild life forms like turtles, snakes, monitor lizards, crocodiles, amphibians and fishes. All these to be rescued and shifted to safer locations. In case a nest of a Crocodile or a Turtle is located, it should be protected or shifted scientifically to a safe location. A Naturalist/Biodiversity expert/Wildlife researcher may be appointed on an ad hoc basis to advise and monitor such instances.

9. An Awareness program on '*the wild life of the river and conservation*' should be conducted for workers, supervisors and managers in the beginning of the restoration work so as to minimize possible harm to the wildlife forms.
10. After completion of the restoration work, all the debris comprising sand bags, plastic, oily soil, metals and any such harmful materials to be removed and cleaned in and around the *anicuts*.
11. Hoardings, signage, bill boards, etc. to be installed depicting the heritage of *anicuts* and the biodiversity within these areas.
12. Water Users Cooperative Society should be formed for each *anicut* comprising the end users, officials of KNNL, KFD and local NGO involved in conservation to monitor and ensure maintenance of the *anicuts* and VNCs in the long run.
13. Take service of suitable biodiversity and ecology experts to advise and oversee the well-being of the major fauna during restoration activities.
14. Take up follow up activities for achieving substantial changes in irrigation, ecology and behavior of wild fauna in the project area as also research, documentation and publication.
15. Make a *special budgetary provision for Environment and Ecology in the DPR* to be revised. This budget shall include provision for ring bunds and other civil works requirements, trainings for contractors and workers, KNNL engineers etc., and cost towards hoardings, signages etc.

1. INTRODUCTION

1.1 Overview

1. Water is the elixir of life. Hence, the human civilization has evolved along the river banks and other water bodies. Therefore, rivers are considered as the cradle of evolution of human civilization. Major human settlements have flourished along the river banks and its watershed areas. Water is synonymous with prosperity. Early human society majorly depended upon rainwater but gradually began diverting the river flow for agriculture and other domestic/civic needs. To address shortages occurring at certain times of low rainfall, river water harvesting technology was adopted, which has also evolved scientifically over thousands of years under various dynasties and kingdoms. Almost all rivers in the world have undergone such transformation leading to betterment of human society. One such effort is exploitation of the river water seen in the form of ancient anicuts (Kannada word for 'barrage' like structures) built during the mighty Vijayanagara dynasty in Tungabhadra River between 13th and 15th century AD.



2. These ancient anicuts are constructed at different locations in Tungabhadra River between Tungabhadra Reservoir in Hospet taluk and Deshnur in Siruguppa Taluk. The anicuts built some 500 to 600 years ago are still functional and providing water for irrigation in Hospet, Koppal, Gangavathi, Kampli, and Sindhanur taluks. Around 20,000 ha of farmland is irrigated utilizing the water from the ancient anicuts without a glitch. Hundreds of small and big villages also use water from these anicuts for domestic purposes.
3. "As a capital of a successful kingdom, the city of Vijayanagara flourished, dominating the political and cultural milieu of south India for 229 years. Vijayanagara could not have operated as a capital in the hostile, semi-arid environment of the Deccan without effective water supply systems to provide for practical and ritual needs of its inhabitants" (Dominic J Davison-Jenkins, 1994).

4. But with lapse of time, these ancient structures that provided water for irrigation for more than six centuries have undergone drastic changes due to natural degradation and anthropogenic activities. Most of the anicuts lost their capacity of meeting the needs of the command area. Physical damage includes damage to the barrages and excessive siltation. Excessive growth of weeds resulted in decreased water storing and carrying capacity of these anicuts.

Figure-1



5. To address these issues related to deferred maintenance, the Karnataka Neeravari Nigam Limited (KNNL) has prepared a Detailed Project Report (DPR) for restoration and renovation of these *anicuts* while the Vijayanagara Channels (VNCs) cater to the irrigation needs of the command area in Hospet, Koppal and Raichur districts.
6. The river stretch from Holey Mudlapura in Koppal taluk near the reservoir to the bridge of Kampli in Hospet taluk has been declared as the '*Tungabhadra Otter Conservation Reserve*' by the Government of Karnataka under the Indian Wildlife (Protection) Act, 1972, to conserve the rare, endangered and threatened (RET) species like Smooth-coated Otter-*Lutrogale perspicillata*, Muggar Crocodile-*Crocodylus palustris* and many other major aquatic flora and fauna. As the restoration and renovation work needs enormous quantity of man power and huge machinery, it is desired to prevent any instances of possible disturbances to the natural behavior of these species and destruction to their natural habitat. Therefore, this 'rapid assessment' of major faunal species within the *anicuts* of TOCR has been taken up to evaluate the habitat use and ecology of these RET species.

1.2 Objectives of Bio-diversity Assessment

- i. Rapid survey and documentation of major fauna of Tungabhadra Otter Conservation Reserve with major thrust on following Rare, Endangered and Threatened (RET) species;
- ii. Smooth Coated Otter;
- iii. Crocodiles;

- iv. Turtles;
- v. Major fish species;
- vi. Study of movement and behavior of the major faunal species with respect to habitat use within the said anicut areas, and
- vii. Exploring strategies for restoration of anicuts by using non-invasive methods to prevent any instances of disturbances to the natural behavior of RET faunal species.

1.3 Scope of Bio-diversity Assessment

7. As the human population increases, pressure on nature and natural resources multiplies resulting in irreparable damage to the fragile ecosystem. There is an urgent need for exploring strategies to exploit natural resources without disturbing the wild flora and fauna and their habitat. The current study is aimed at identifying conflict mitigation strategies and actions to be taken up while renovating the ancient *anicuts* within the TOCR. The present 'rapid assessment' is defined here as a synoptic assessment that has been taken up as a matter of urgency, within the available minimum timeframe to come out with reliable and applicable results for the desired objectives. The unfriendly terrain, hot summer and excessive growth of weeds in the anicuts posed a great challenge to the team during data collection in terms of even mobility. Yet, within the given time, the survey team gathered maximum data in the TOCR area including *anicuts*.
8. The aim of the rapid assessment may be stated as identification of locations of RET faunal species, their behavior pattern, habitat use and strategies for mitigating any instances of disturbances to their natural behavior. The bio-diversity data collected is most useful in planning interventions to avoid threat to existence of wildlife. The scientific process of collection of data included use of binoculars, cameras and GPS equipment.
9. The study also noted the degradation of aquatic habitat due to excessive siltation, *eutrophication* or excessive growth of invasive alien species of weeds such as Water Hyacinth-*Eichhornia crassipes*, and Pink morning glory-*Ipomoea carnea*. The proposed renovation of *anicuts* has the dual objectives of helping improve people's quality of life and supporting the Flora and Fauna of the river. The study of the Environmental Social Impact Assessment (ESIA) demands a forum of multi-stakeholder engagement for long term monitoring and evaluation of these structures and processes.

2. STUDY AREA

2.1 Overview and geography of study area

- Deccan Plateau is the oldest geographical landscape comprising parts of Maharashtra, Eastern Plains of Karnataka, and parts of Telangana and Tamil Nadu. The Deccan Plateau is located in the tropical zone comprising hot climate and dry scrub jungle. Rivers originating in Western Ghats and flowing eastwards through the Deccan Plateau are life lines for man and animals cater to their various needs.



- River Tungabhadra is a major tributary of river Krishna. Two rivers, namely, Tunga and Bhadra, originate from different locations in Western Ghats at an altitude of 1198 MSL and combine at Kudli (name of place, meaning confluence in local Kannada language) near Shimoga to become Tungabhadra. River Tungabhadra flows for about 531 km in the north-east direction through central Karnataka and erstwhile Andhra Pradesh state.
- There is no gainsaying that all civilisations have evolved around perennial rivers owing to abundance of water availability. The human being has learnt techniques of harvesting rain water as well as diverting the flow of rivers for meeting farming needs and for civic use. During the Vijayanagara Dynasty, rulers diverted the river water to towns and for farming by constructing *anicuts* or weirs. Currently, 9 out of the 12 *anicuts* fall of the Vijayanagar Irrigation System fall under the purview of the recently formed ‘Tungabhadra Otter Conservation Reserve’ (TOCR). These 9 *anicuts* are located in the TOCR area that starts from Holey Mudlapura village in Koppal taluk to the bridge at Kampli in Hospet Taluk, Bellary District, northern Karnataka. The geographical location is at latitude 15°16’ N and longitude 76°20’ E near Holey Mudlapura and latitude 15°25’ N and longitude 76°34’ E at the bridge between Kampli and Chikka Jantakal in Gangavati taluk. The glorious capital of the erstwhile Vijayanagara, namely, Hampi, is located at about 15 km from the Tungabhadra reservoir. The nearest city is Hospet located at 5 km from the reservoir.

2.2 Tungabhadra Otter Conservation Reserve

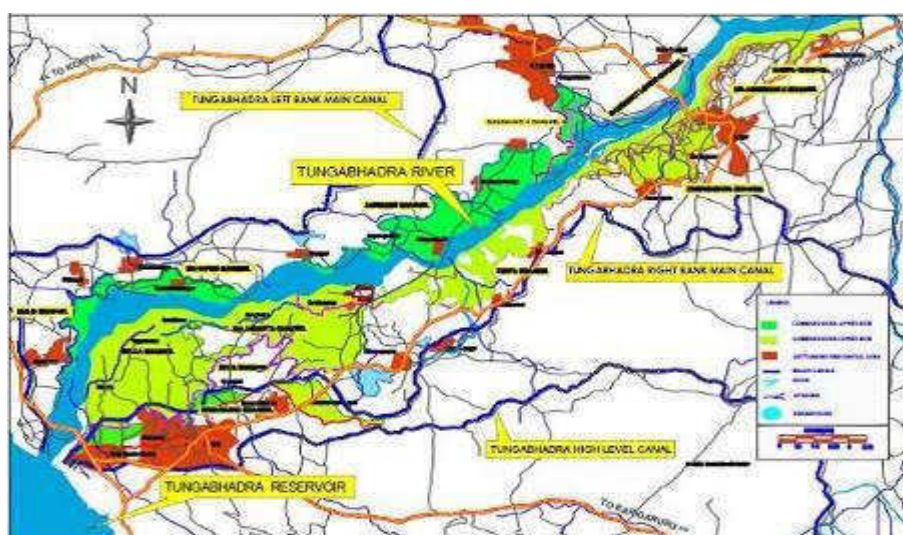
13. River Tungabhadra hosts a repertoire of animals including giant Turtles, Otters, crocodiles and hundreds of species of fishes and so on. Smooth-coated Otter or Indian Smooth-coated Otter *Lutrogale perspicillata* lives along the entire length of the river in considerable numbers. This riparian mammal is listed as Schedule-1 species under the Indian (Wildlife) Protection Act, 1972 and as Vulnerable (VU) by IUCN. These Otters breed during late winter-summer, litter in burrows made under the bushes on the river banks or inside the rocky caves within the river. The Otters also face threat from poachers who trap and club it to remove its skin intact. A decade ago, there were reports of poachers killing hundreds of Otters and transporting tanned skins in bundles for jackets in the far eastern markets. But activists of Wildlife SOS and SWaN¹-a local NGO-patrolled the riparian habitat and alerted the local fishermen on such Otter hunters.
14. Mugger Crocodile or Indian Marsh Crocodile (*Crocodylus palustris*) is a fresh water crocodile commonly seen in Indian rivers. Other species of crocodiles found in India are *Gharials* and *Salt-water Crocodiles*. The Mugger Crocodile is a medium sized one that is seen in fresh water lakes, rivers, ponds, sluggish rivers, swamps, marshes etc. Crocodiles lay eggs on the sand banks and islands in the river during summer. During monsoon, when fresh water flows into these sand dunes, young ones come out and begin their own life journey in the river. The male grows up to 13-16 feet in length. They are generally seen basking on rock outcrops and river banks in the Tungabhadra River near Anegundi, Hampi, Kariyammanagadde and Bukkasagara river. Often villagers kill crocodiles to avenge preying on their goats and sheep in the river. There were also reports that some hunters were killing the crocodiles and taking away their skin for making shoes, bags, etc.
15. Some rare species of Turtles reportedly grew to such a huge size that during the Vijayanagara Empire, soldiers used their carapace-which is light but strong-as a shield in war, and their meat as a speciality food. Accordingly, there are three distinct species of soft shelled turtles found in this river, Leithi's Soft-Shell Turtle (*Nilssonina leithii*) also called as *lagala* by fishermen, Indian Narrow-headed Soft-shell Turtle (*Chitra indica*), Indian soft-shelled turtle (*Lissemys punctata*). Another species of turtle-the Indian Black Turtle or Indian Pond Terrapin (*Melanochelys trijuga*) also found here, which is called as *tismurga* by locals. Among all, *Chitra indica* grows to a great width and length. During 2011, the forest department seized a live specimen of *Chitra indica* from a poacher which weighed around 125 kg and with the width of 1 meter. *Lagala* (*Nilssonina leithii*) is much hunted along with *Chitra indica* by the Bengali poachers.
16. Leith's softshell turtle (*Nilssonina leithii*) is listed as Vulnerable (VU) under Threatened category of IUCN red list. It was one of the most common turtles until a few decades ago, but now facing extinction due to illegal trade, sand mining, excessive siltation, eutrophication and drying up of Rivers during summer. Likewise, another species of turtle Indian soft-shelled turtle (*Lissemys punctata*) also called as *haalaame* listed as Schedule 1 species [part II (8)] in Indian Wildlife Protection Act, 1972.

¹ Society for Wildlife and Nature (SWaN)-Hospet has been working for conservation of wildlife in Bellary district and rest of North Karnataka for one and half decades.

17. There are about hundred species of fishes including endemic *Deccan masher*, *Tunga Garr* found in the Tungabhadra River; some of them are listed under threatened category by IUCN and listed under Schedule-I and II under Wildlife Protection Act, 1972. These are widely hunted leading to some of these rare fishes becoming extinct.
18. Therefore, Society for Wildlife and Nature (SWaN) conducted a research on the river fauna and prepared a proposal to declare the river stretch from Holey Mudlapura to Kampli as a 'Conservation Reserve' and lobbied for the same. Finally, the 34 km stretch of river from Holey Mudlapura near Tungabhadra Dam reservoir to the bridge of Kampli is declared as the "Tungabhadra Otter Conservation Reserve" vide notification No. FEE66: FWL-2015 dated 25.4.2015 by the Government of Karnataka to protect the rare wildlife species from hunting and consequent damage to habitat.

2.3 Ancient Irrigation Systems in Vijayanagara Empire

19. Rivers are considered as the cradle of human civilization. All ancient human settlements flourished along the river banks. Water is necessary for agriculture, animal husbandry and for human use. Hence, techniques of rain water harvest in the form of lakes and tanks is evolved. At the same time, the method of diversion of rivers for irrigation was also developed across the world for agriculture and assured food production.



Map of Anicuts and Vijayanagara Channels

Table 1: Details of Anicuts within TOCR area

S. No.	Name of the <i>anicut</i> (Weir)	Length of the <i>anicut</i> or Weir (km)	Distance from the TB Dam reservoir (km)
Right Bank of TB River			
1	Hulugi <i>anicut</i>	0.518	2.4
2	Shivapura <i>anicut</i>	0.17	8
3	Anegundi <i>anicut</i>	0.518	16
4	Upper Gangavathi	9	27.2
5	Lower Gangavathi <i>anicut</i>	9.54	30.4
Left Bank of TB River			
6	Bella <i>anicut</i>	0.602	2.4
7	Turtha <i>anicut</i>	3.048	16
8	Ramasagara <i>anicut</i>	2.042	28.8
9	Kampli <i>anicut</i>	0.94	30.4

20. During the 13th century, Vijayanagara dynasty was established with the present day Hampi as the capital city on the banks of River Tungabhadra. Hampi city was quite extensive with a large population for which supply of water was very important especially during hot seasons. Therefore, emperors of the dynasty explored ways to ensure adequate water supply to their population. As part of this, they adopted techniques of diversion of Tungabhadra River water by building a weir or barrage at a strategic location across the river. These weirs are called as anicuts in Kannada language. Water from these anicuts flowed through the long stretches of canals popularly called Vijaya Nagara Canals (VNCs). During the Vijayanagara dynasty (1335-1565), about 12 weirs or anicuts and 19 Channels (VNCs) were built in different locations of the river, including near Hampi to cater the needs of agriculture and gardening. The Vijayanagara Channel (VNC) irrigation system is spread over certain locations of Bellary, Raichur and Koppal districts. The geographical area lies between Latitude 14^o30' to 16^o34' N and Longitude 75^o40' to 77^o35' E.
21. A fascinating fact is that all these anicuts and VNCs are still in use (except for a few submerged in the reservoir) and are currently irrigating 16,241 ha in Hospet, Koppal, Gangavathi and Siruguppa taluks. This reflects not only creativity of people during Vijayanagara dynasty, but also the foresight of the kings and individuals in ensuring robust economy, sustainable food production and prosperity of the people.
22. One of the oldest anicuts is Turtha anicut built in 1399 A.D by Bukka Raya on the right bank of Tungabhadra river close to Hampi. The canal from this anicut is called Turtha canal (Turtha means fast, swift) owing to swift current of water that passes through rocky and steep terrain. This canal is functional till date feeding water to hundreds of acres of farmland around Kaddirampura and Hampi. Multiple weirs are constructed between the rocks to divert the water into canal.



2.4 Role of Anicuts around Hampi

23. For more than 600 years, the anicuts and canals have been providing irrigation water for agricultural crops such as paddy, sugarcane, banana, coco-palm, cereals, pulses and vegetables. Farming continues to be the most predominant occupation in the VNC system sustaining thousands of agrarian families over centuries and has been the main cause for economic prosperity of the region.
24. A repertoire of life forms is flourishing in and around the anicuts and VN Channels. Smooth-coated Otters, Muggar crocodiles, Turtles, fishes and hundreds of species of birds, different species of Reptiles inhabit the anicut areas and along the channels. A number of birds including 3 species of Kingfishers, Bee-eaters, Owls make hole nests along the dried banks of VNCs during summer. Other life forms also make use of the canal bank for their food and shelter.

25. The anicuts or weirs are the perennial source of water for livestock, wildlife and for human beings. While water dries up elsewhere during summer, the anicuts hold sufficient water.

2.5 Present status of the Anicuts

26. Over centuries, the Vijayanagara anicuts have been subject to deferred maintenance. Nevertheless, the structures by and large are still in good functional condition save for a breach here and there leading to leakages and decreased storage capacity. Farmers and water user communities sometimes made some efforts to renovate and repair these *anicuts*; however, lack of a holistic approach did not yield much results. Disputes sometimes arise between the farmers of upper and lower *anicuts* over sharing of water; farmers of the upper *area* retort by blocking and diverting the flow.

i) Invasive alien weeds

27. Some anicuts are excessively silted up thus reducing their carrying capacity. In some *anicuts*, there is an alarming growth of invasive alien weeds like *water hyacinth*, *Ipomoea aquatica* and *Ipomoea cornea* leading to choking of the aquatic life forms to eutrophication. Water hyacinth spreads rapidly forming a blanket of vegetation on the surface of the water body thus blocking sun light. Lack of sun light in the water results in highly reduced photosynthesis for phytoplankton, unicellular and multi cellular algae and other aquatic flora. Poor levels of Dissolved Oxygen (DO) in the water leads to decline of zooplanktons, and aquatic fauna including fishes and amphibians. The decreased food base in the form of fishes, frogs and Crustaceans results in decline of major faunal species such as Otters and Crocodiles. Therefore, a separate strategy is to be worked out to contain the invasive alien weeds such as Water Hyacinth and *Ipomoea species* on regular basis in and around the *anicuts*. At the same time, awareness should be created among farmers in the catchment area for controlled use of chemical fertilizers. They should be motivated to use more of organic manure for their agricultural crops. Use of optimal quantities of chemical fertilizers and switching over to organic fertilizers will help in reducing river contamination-reducing the nitrates and phosphates responsible for *Eutrophication* (excessive growth of weeds in water). Sewage from human settlements and effluents from industries also contain an enormous quantity of *nitrates*, *phosphates* and *sulfates*-which are also responsible for excessive weed growth in the *anicuts*. Turtha, Upper Gangavathi, Lower Gangavathi and Kampli *anicuts* are totally covered with water hyacinth and *Ipomoea species*. This also resulted in siltation of the anicuts. The overgrowth of weed combined with lack of water results in adverse effects on population of fishes, Otters, Crocodiles.

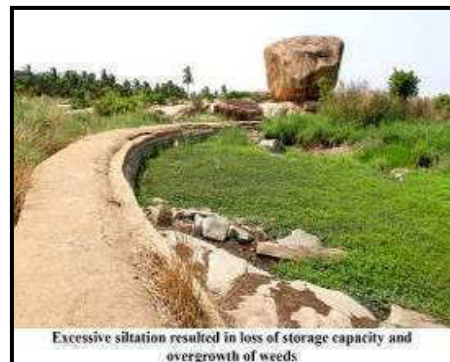


Eutrophication-hazardous growth of Water Hyacinth on surface of water at Kampli anicut



ii) Excessive Siltation

28. Flooding of a river is always good for the health of the river. The flood water currents clean the river by washing away all the excessive weeds, overgrowth, silt etc. But the absence of flood in the last three years resulted in an overgrowth of weeds and bushes, which dry up seasonally, with their biomass converted into soil and settled at the bottom of the *anicut* and natural ponds within the river course. Now, enormous quantity of silt is seen in almost all the *anicuts* including Turtha and Upper Gangavathi. Hence, there are reports of very small number of wildlife owing to non-availability of water and food. Therefore, siltation due to the invasive alien species should be taken seriously and suitable interventions taken up from time to time towards maintenance of the *anicuts*.



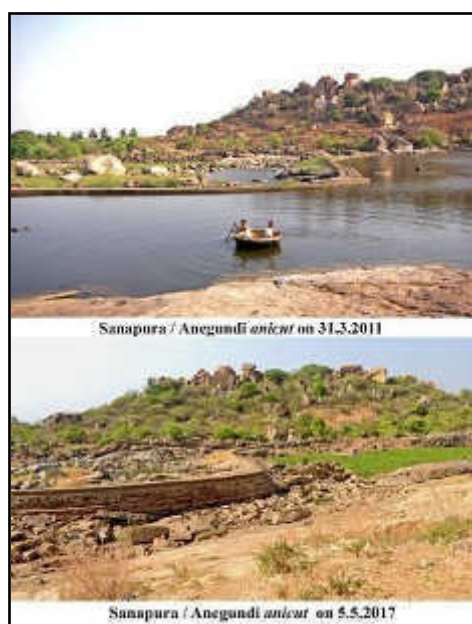
iii) Lack of maintenance

29. After the collapse of the Vijayanagara Empire, not much attention has been paid towards maintenance of the VNC structures; however, farmers continued to repair the weirs and canals themselves to the extent that was possible for them. Overall, the irrigation system of Vijayanagara period has suffered negligence combined with absence of sound management practices. As a result, most of the *anicuts* have lost significantly their carrying capacity due to leakages, breaches, excessive siltation, *eutrophication*, pollution etc.



2.6 Need for restoration of ancient Anicuts

30. The ancient *anicuts* have not only served to divert river water into canals, but also helped store enormous quantities of water throughout the year. Hence, these weirs with abundant water turned ideal habitat for a number of riparian fauna including Smooth-coated Otter, Muggar Crocodile, Turtles and Fishes. The rocky islands, mud-sand banks and islands with thick vegetation became a favorite home for Otters and Crocodiles, where they bask, groom and nest. Over time, weirs have developed a number of leakages and breaches; floods affected the structures and canals. All this resulted in significantly reduced storage in the *anicuts*. To top it, excessive growth of invasive alien species of weeds and resulting siltation further deteriorated *anicuts* function which in turn adversely affected major Fauna.



31. Thus, there is an urgent need for restoration and renovation of the anicuts and the channels to ensure perennial availability of water. Abundance of water will result in availability of sufficient food for apex predators of aquatic ecosystem like Otter and Crocodiles. Restoration of these structures promises protection and growth of the wildlife in the River (see Appendix-Additional Notes).

2.7 Relevance of the present study

32. As the stretch of Tungabhadra River from Holey Mudlapura to Kampli has been declared as the “Tungabhadra Otter Conservation Reserve” (TOCR), under the Indian (Wildlife) Protection, Act, 1972, (section 26 A (b)) for conservation of RET species, it is essential to explore ways and means of taking up restoration of anicuts without disturbing the ecology of RET fauna and ecosystem. Though ownership of anicuts and channels rests with KNNL, in view of the notification of TOCR in 2015, protection of wildlife is governed under the rules of WPA 1972. The Smooth-coated Otters, Muggar Crocodile, Indian Soft-shelled Turtle, Deccan Masheer fish and many more species are listed as Schedule-1 and II species under WPA 1972. Loss of life or destruction of habitat of these species listed under different Schedules of WP Act, 1972 (Section 29) attracts legal actions against individuals and groups.



Researchers documenting the spraint mark of Otters near Hampi

33. Therefore, PSC has taken up a scientific survey of RET species in the form of Rapid Assessment as part of the Feasibility Study of Modernization of Vijayanagara Channels under KISWRMIP Tranche 2.



Mugger Crocodile habitat in T.B. River near Anegundi on 15.1.2011 and 21.7.2017 covered with Water Hyacinth

34. The key focus of rapid biodiversity assessment is to carry out survey of smooth coated otters, Crocodiles, Turtles and fish fauna and their dependence and use of the habitat in and around the ancient anicuts to explore strategies of restoration without damaging their natural behavior and ecology.

3. MATERIALS AND METHODS

35. To begin with, a preliminary visit was made to all the anicuts, and focus areas along the river were identified. Further, with the help of local knowledgeable people, farmers and fishermen, these areas were altered to arrive at a comprehensive list. Data sheets for recording sightings and indirect signs were prepared, and GPS instruments and DSLR/digital cameras organized for documentation. Finally, research and documentation was undertaken in the TOCR area.

3.1 Trail monitoring and data collection

36. After a preliminary visit, regular monitoring of anicuts was initiated with the help of four trained field assistants. To begin with, survey of direct and indirect evidences of wildlife species was taken up along the weir or barrage of each of the 9 *anicuts*. Some of them have a short weir of 50–100 meters and others longer than 2 km. In this trail, direct encounter of Smooth-coated Otters, Muggars, Turtles and other faunal species is recorded. Indirect and positive evidences such as pug mark, scat, and spraint marks, left over kill, nesting –denning or natal sites were recorded. Random survey of the upstream and downstream areas of each *anicut* was also undertaken assuming that Otters move considerable distance from their homes in search of food, as well as grooming sites. Total length of the TOCR is about 35 km; average width is about 1.5 km. Average length of each *anicut* and its upstream and downstream is about 2 km. About 18 km of length and breadth of the river was covered as also each of the *anicuts* and their surroundings. Total area covered in this assessment comprises 25% of the TOCR area.

3.2 Monitoring of anicuts

37. Each *anicut* was monitored the whole day for the purpose of understanding the habitat use by Smooth Coated Otter and Crocodiles. Sightings or indirect evidences were recorded using GPS instrument in a specific format. Spraints, scats, pug marks, etc. were photographed by placing a scale by the side of them to measure their size. The presence of Holts (the shelter homes, breeding dens or burrows), nests, basking and grooming sites were also recorded. Each site was visited and revisited once in three days for four weeks to search for new evidences and sightings. Islands and lakes were also explored using generic coracle (bamboo boat).

Otter-Crocodiles sites were classified as per the following parameters:

- i) *Preferred location*: rock, marsh, sand bank, mud banks;
- ii) *Distance* of the preferred location from edge of water, and
- iii) *Presence or absence* of holts, nests or breeding areas.

3.3 Documentation

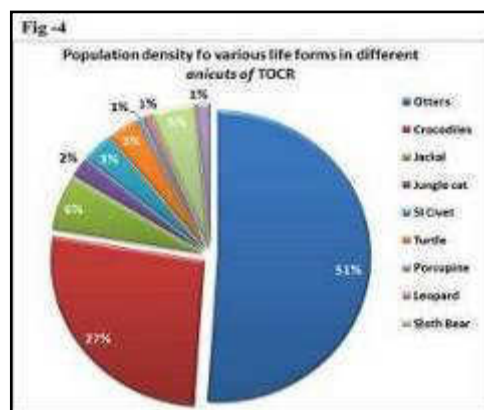
38. Most of the direct sightings were recorded using DSLR cameras which were also used to photograph different species of fishes present in different *anicuts* of TOCR. The scats, spraint marks, pug marks and marks of grooming in the mud banks and sand banks were also recorded using a wooden scale to measure the size of the site of the marking. Spraint marks of otters are conspicuous by their pungent smell and shape. Digital cameras with super zoom lens were used to video graph the natural behavior of otters and other wildlife forms. Under-water cameras were used to document the natural behavior of fishes.

4. RESULTS AND DISCUSSIONS

39. The rapid bio-diversity assessment was carried out for four weeks with another 4 weeks for documentation and extended survey. In the initial four weeks, most of the positive sites of Smooth-coated otters and Mugger Crocodiles were identified in and around the ancient *anicuts*. The smooth coated Otters are crepuscular and nocturnal animals, which avoid encounter with humans. Therefore, direct sighting of otters was relatively less; hence the study depended upon indirect evidences like Scat, Spraint mark, holts, breeding-nesting sites, pug marks and grooming marks.

4.1 Population density of various major fauna

40. The assessment revealed that the entire stretch of TOCR including the *anicuts* have provided an ideal habitat for the Rare, Endangered and Threatened (RET) species like Smooth Coated otter, Mugger Crocodile, Giant Soft-shelled turtles, various fish fauna and other wildlife forms. As the season of this study was hot summer with parched river bed in most of the areas of the TOCR, it was not possible to encounter many wildlife forms in the *anicuts* infested with invasive alien weeds and excessive siltation. Within a



short period of time, maximum man power was deployed for scouting the length and breadth of each *anicut* and identifying the existence of a healthy population of the Smooth-coated otters, Mugger Crocodiles, Soft-shelled Turtles and fish fauna. Due to excessive growth of water hyacinth, the sighting of Crocodiles was not possible during the day. Hence, night patrolling was undertaken to scan the river and the *anicuts* to search for reflection of eyes of crocodiles using powerful torches and accordingly recorded the sightings.

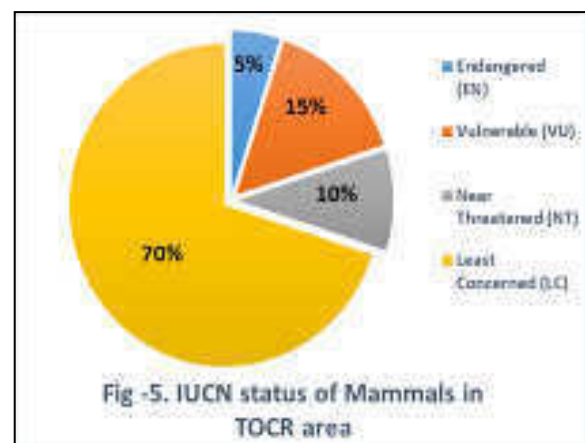
41. Though the positive sites of Otters and crocodiles were found apart from a few direct sightings, both Soft-shelled Turtles and Giant Turtles could not be sighted directly due to the parched river beds, suffocation caused by proliferation of alien invasive weeds and probably summer hibernation. Nevertheless, some shells of the dead Indian Black Turtles were found in the dried river bed.

42. An interesting fact is that the river has a typical dense scrub jungle within its islands. A large island exists between Turtha anicut and Sanapura anicut called as Kariyammanagadde, where considerable number of Sloth Bears, Leopards, Jackals, Porcupines, Small Indian Civet, Jungle Cat etc. live. Therefore, while scouting in and around *anicuts*, the survey team came across the scat, pugmarks, evidences of destruction of termite mound by bears etc.; all these evidences were promptly recorded. Interestingly, 2 positive signs of Leopards (0.71%), 13 positive signs of Indian Sloth Bear (4.67%), 2 positive signs of Porcupine (0.71%), 4 positive signs of Monitor Lizard (1.43%), 9 positive signs of Small Indian Civet (3.23%), 6 positive signs of Jungle Cat (2.1%), 17 positive signs of Jackal (6.11%) were found. About 9 carapaces of dead turtles (3.23%) were found in different parts of the river.

43. Among all the above life forms, the population of Smooth-coated otters is flourishing in and around the *anicuts* in TOCR area. There are about 142 evidences of this mammal which has the highest population density (51.07%). The occurrence of healthy population of this apex predator of aquatic habitat indicates the good health of the habitat and the ecosystem.
44. The population of Muggar Crocodile is also flourishing in the river with 74 evidences (26.61%) indicating good health of the ecosystem.

4.1.1 Mammals

45. In this rapid assessment of faunal diversity, it was found that the entire study area including the surrounding scrub jungle provides an ideal habitat for Rare, Endangered and Threatened (RET) species like, Smooth-coated otter *Lutrogale perspicillata*, Indian Sloth Bear-*Melursus ursinus*, Indian Leopard-*Panthera pardus*, and other wildlife forms. Throughout the study area, the only major mammal species encountered is the Smooth-coated otter *Lutrogale perspicillata*. But there are many more mammals such as Jackals, Small Indian Civet, Palm Civet, Jungle Cat etc. using the aquatic habitat for hunting for crabs and fishes. Though the positive sites of Sloth bear and Leopard were found in the adjoining scrub jungle, direct sightings were not possible due to the limitation of the study area focusing on the aquatic habitat. An interesting fact is that some part of the forest around study area has such a conducive climate with dense vegetation that the visibility of animals behind the bushes was impossible. As some parts of the study area near Bukkasagara are located close to the Daroji Bear Sanctuary, the bears and leopards roam around the villages for feeding. Daroji bear sanctuary harbors considerable number of Sloth Bears, Leopards, Jackals, Porcupines, Small Indian Civet, Palm Civet, Jungle Cat etc life. Therefore, while scouting in and around the study area, the team came across the scat, pugmarks, evidences of destruction of termite mound by bears, scat of leopards, pugmarks of cats etc. and all these evidences were promptly recorded. Interestingly, 2 positive signs of Leopards (0.71%), 13 positive signs of Indian Sloth Bear (4.67%), 2 positive signs of Porcupine (0.71%), 4 positive signs of Monitor Lizard (1.43%), 9 positive signs of Small Indian Civet (3.23%), 6 positive signs of Jungle Cat (2.1%), 17 positive signs of Jackal (6.11%) were found in the vicinity of 1-2 km from the boundary of Tungabhadra Otter Conservation Reserve (TOCR) area (Annexure-5 and Appendix-6).



i) IUCN status of Mammals in the study area:

46. The present study aims at the exploration of faunal diversity in the study area. Though most of the mammals are not visible during broad day light, and which become nocturnal owing to excessive human activities, their movement and existence is recorded only by indirect evidences like, pug marks, scat and other evidences including the secondary data by the villagers/ fishermen. As per direct sightings, interviews with the fishermen and

indirect evidences collected, there are about 20 mammals existing in and around the study area. As for their conservation status is concerned, the International Union for Conservation of Nature (IUCN) has categorized all the living beings on Earth, on the basis of their population and abundance. Among the mammals existing within 1-2-kilometre radius of the study area are categorized based upon their abundance. Out of 20 species of mammals identified to be existing around the study area, 14 are classified as Least Concerned (LC) (70%), 2 species such as Striped Hyaena and Rusty-spotted Cat under Near Threatened (NT) Category (10%) and 2 species of mammals under Endangered (EN) category (10%), that is, Indian Sloth Bear and Indian Pangolin. Smooth-coated Otter and Indian Leopard are listed under Vulnerable (VU) category of IUCN 10% (Fig-5).

4.1.2 Reptiles

47. Reptiles are coldblooded vertebrates that creep and have scaly skin. They propagate by laying eggs. Dinosaurs which ruled the world once upon a time were the largest reptiles. They became extinct more than 65.5 million years ago. Now we can see their miniatures in the form of house geko, calotes, lizard etc. Some of the ancient reptiles still survive in the form of Turtles and Crocodiles. Snakes and Lizards are modern-day reptiles that evolved over a period of time.

Reptiles in and around TOCR area	
Geckos and Lizards	9
Snakes	13
Tortoise and Turtles	5
Crocodiles	1
Total	28

48. In the current study area, about 28 reptiles have been identified. Among them, the largest number of reptiles present was Snakes comprising 13 species (46%), Geckos and Lizards 9 species (32%) and Tortoises and Turtles 3 species (18%). Only one species of crocodile is present (4%).

49. There are 24 species of fresh water turtles and 4 species of Tortoises found in India. Among which 4 species are found in the TOCR area. There are four species of fresh water Turtles found in these waters such as Indian Black Turtle-*Melanochelys trijuga*, Indian Soft-shelled Turtle-*Lissemys punctata* and giant Turtles like Leith's softshell turtle-*Nilssonina leithii* and Indian narrow-headed soft-shell turtle-*Chitra indica*. Only one Tortoise species, Indian star tortoise-*Geochelone elegans* is found in the scrub jungle and grasslands along the periphery of the study area like Kariyammana gadde and Bukkasagara RF along the river. This Tortoise has adapted to live in the dry habitat of scrub jungles. It is unfortunate that almost all of these turtles and tortoises are poached and sold for commercial purposes. Some tribal communities eat the meat of this tortoise as a delicacy thus pushing their population towards depletion. A detailed profile of these species is given in the following.



50. Snakes such as ‘Common Rat Snake’-*Ptyas mucosa*, Russel’s Viper-*Daboia russelii*, Spectacled Cobra- *Naja naja* and Checkered Keelback-*Xenochrophis piscator*, tortoise such as Starred Tortoise-*Geochelone elegans*, Lizards such as Monitor Lizard-*Varanus bengalensis*, Rock Agama-*Psammophilus dorsalis*, and Indian Chameleon-*Chamaeleo zeylanicus* exist in the study area. Mugger Crocodile-*Crocodylus palustris* is the only crocodile species found in TOCR area. There are many more reptiles in the region that need to be explored in a proposed detailed research over a period of 3-4 years. (Appendix-4, Annexure-3)



Indian flapshell turtle - *Lissemys punctata*

ii) IUCN status of Reptiles in the study area

51. During the rapid assessment, reptiles found directly and indirectly are grouped under different categories according to their abundance and status by International Union of Conservation of Nature. Among the reptiles, Indian Narrow-headed Soft-shell Turtle is listed as Endangered (EN) (3%) and Indian Black Turtle-*Melanochelys trijuga* as Near Threatened (NT) (3%). Five species are listed as Vulnerable (VU) such as Leith's Soft-shell Turtle-*Nilssonina Leithii*, Mugger Crocodile-*Crocodylus palustris*, Indian Rock Python-*Python bivittatus*, Saw-scaled Viper-*Echis carinatus*, and Starred Tortoise-*Geochelone elegans*-which comprises 18% of all species of reptiles in the study area. About 8 species of reptiles are listed under Least Concern (LC) (29%), and 13 species as Not Evaluated (NE) (46%). Most of the Not Evaluated (NE) species are Geckos and Lizards (**Fig-6**).



Narrow-mouthed Frog - *Microhyla rubra* (I.2 Anon)

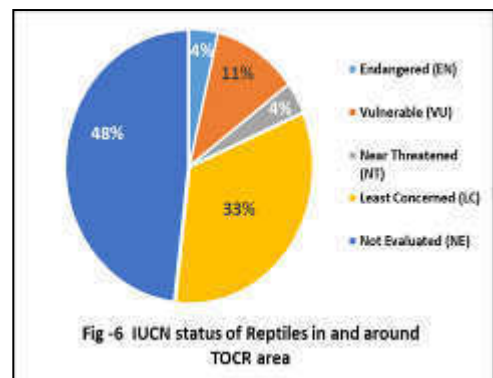


Fig -6 IUCN status of Reptiles in and around TOCR area

4.1.3 Amphibians

52. Amphibians are coldblooded vertebrates. They have two stages of life; in the early stage, they live in water and breathe with the help of skin/ gills and have tail for swimming. When they become adult, they lose the tail and breathe with lungs and live on the surface. Amphibians are indicators of the health of any ecosystem as they are very sensitive to changes in the climatic condition and water pollution. The Class Amphibia is broadly classified into three Orders such as Anura (Frogs and Toads), Urodela (Salamanders) and Apoda (Caecilians).



A tiny bush frog

There are about 7,000 amphibians estimated across the world and of which 90% are Frogs. The frogs play a vital role in any given ecosystem. They are also considered as indicator of water pollution. A female frog lays up to 20,000 eggs in the form of a jelly-like mass called as 'frogs spawn', in water or in wet environs. The eggs hatch in 6 to 21 days and the hatchlings are called 'tadpoles'. These tadpoles look like a tiny fish with tail but without limbs, breath with internal or external gills or lung. They feed upon the larvae of mosquitoes and thus keep their population at check. Water pollution and loss of frog habitat is resulting in their dwindling population and cause of 'mosquito borne' diseases like Malaria, Dengue and Chikungunya. These diseases are spreading rapidly.

53. In the study area Frogs such as the Indian Bullfrog-*Hoplobatrachus tigerinus*, Common Indian Tree Frog- *Rhacophorus maculatus*, Indian Skipper Frog-*Euphlyctis cyanophlyctis*, and different species of Bush frogs and Common Indian Toad-*Duttaphrynus melanostictus* are found during a casual survey. During night, 'croaks' with varying pitches of frogs were heard; some of them resemble with those of Western Ghats. As the study area contains thick bushes, rocky crevices and thorny banks, it was difficult to reach each and every part of the study area to explore the amphibians. Hence, based on the different pitches of the croaks, it is inferred that there must be many more species of amphibians in the study area, which may be explored in a dedicated study. All the frogs and toads found in the study area belong to the Least Concerned (LC) category of IUCN (Appendix-3/ Annexure-2).

4.1.4 Ichthyofaunal (Fish fauna)

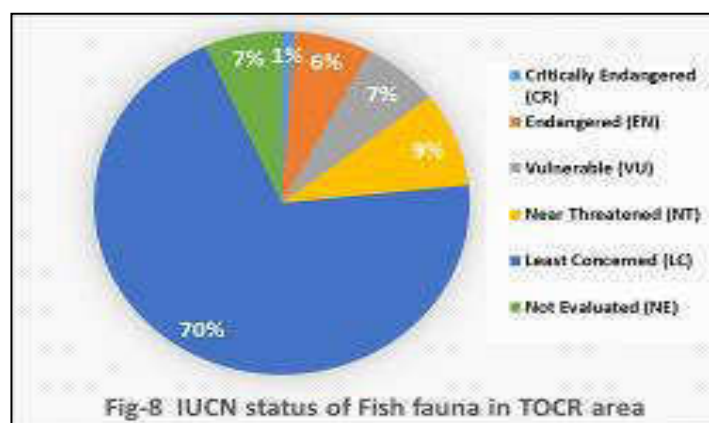
54. A fish is described as a limbless cold-blooded vertebrate animal living wholly in water with gills and fins. Fishes are adapted to aquatic life by having internal and external skeletal frame, gills for breathing and fins for movement. Fishes also get adapted to salt water and fresh water ecosystems with suitable modifications. A coldblooded organism feeds upon algae, aquatic grass and plants, phytoplankton, Zooplanktons, invertebrates, crustaceans, fishes etc. Fishes are considered a rich source of protein and vitamin for upper level consumers in the food chain. About 33,000 species of fishes are listed across the world by 'Fish Base'-a global information system on fishes.

Table 2: Ichthyofaunal (Fish) Orders and species in TOCR

S. No.	Order	No. of Species
1	Perciformes	9
2	Anguilliformes	1
3	Cyprinodontiformes	1
4	Siluriformes	17
5	Cypriniformes	57
6	Beloniformes	2
7	Synbranchiformes	2
8	Osteoglossiformes	1
	Total species	90

Table 3: IUCN status of Fish Fauna with in TOCR

S. No.	IUCN Status	Numbers	Percentage
1	EX (Extinct)	0	0
2	EW (Extinct in Wild)	0	0
3	CR (Critically Endangered)	1	1.11%
4	EN (Endangered)	6	6.66%
5	VU (Vulnerable)	6	6.66%
6	NT (Near Threatened)	8	8.88%
7	LC (Least Concerned)	63	70%
8	NE (Not Evaluated) DD (Data Deficient)	6	6.66%
Total		90	



Fishes listed under Critically Endangered (CR) by Red data book of IUCN

- i. Ray-finned Fish – *Hypselobarbus pulchellus*

Fishes listed under Endangered (EN) by Red data book of IUCN

- i. White catfish- *Silonia children*
- ii. Zebra Loach-*Botia striata*
- iii. Deccan labeo-*Labeo potail*
- iv. Sandkhol carp – *Thynnichthys sandkhol*
- v. Deccan / Black Mahseer-*Tor khudree*
- vi. Hump back mahseer-*Tor mussullah*

**Fishes listed under Vulnerable (VU) by Red data book of IUCN**

- i. Spike-tail paradise fish-*Macropodus cupanus*
- ii. Deccan nangra-*Gagata itchkeea*
- iii. Mrigal carp-*Cirrhinus cirrhosa*
- iv. Wild common carp-*Cyprinus carpio carpio*
- v. Gobi-*Glossogobius giuris*
- vi. Kolus-*Hypselobarbus kolus*

**Fishes listed under Near Threatened (NT) by Red data book of IUCN**

- i. Tilapia-*Oreochromis mossambica*
- ii. Butter cat fish-*Ompok bimaculatus*
- iii. Pabo catfish-*Ompok pabo*
- iv. Great white sheatfish-*Wallago attu*
- v. Gangetic goonch-*Bagarius bagarius*
- vi. Tunga garra-*Garra bicornuta*
- vii. Pangusia labeo-*Labeo pangusia*
- viii. Manipur osteobrama-*Osteobrama belangeri*

58. The Department of Fisheries releases a number of species of fish every year into the dam and rivers to help the fishermen community harvest fish commercially for their livelihood. One such commercial exotic fish species is Tilapia-*Oreochromis mossambica*. This species has its origin in Cichlidae in Africa. It was introduced to Indian rivers and ponds in 1952. Within a few years, the fish adopted and flourished in the entire Indian Fresh water ecosystem. Fast growing Tilapia is popular among the fish eaters as 'aquatic chicken'. Other species of economic value include Rohu, Catla, and Common Carp-the fry of which is being released in the T.B. Dam reservoir and the river to help the fisherman community. A large quantity of fish is harvested and sold in and around Bellary and Koppal districts. Thousands of families belonging to fishing community are dependent upon fishing both in the reservoir and in the river. As of now, the fishing community harvests the fishes without any regulations. It is not advisable to harvest fish during mating and breeding season; also, the RET species should not be allowed to harvest. If eliminated accidentally, harmful fish species like African Catfish, which

devours endemic fish fauna and crustaceans, will flourish. Hence, there is a need to regularise fishing in the Tungabhadra River.

Project Specific Impact Assessment: *Fishes*

59. Fishes are not affected as long as they are in water. There is unorganized fishing going on at present, where all kinds of big fishes including Endangered Mahseers are hunted. Yet the project may put forth following specific impacts on Fish Fauna:

- i. During restoration, as water goes down or drains down, all the fishes big and small get exposed, and people/ villagers, workers and others may capture/ hunt them. A large number of people may gather to harvest these vulnerable fishes.
- ii. Gathering of large number of people and fishermen may wipe out the fish fauna as some fish species lay eggs in summer and early monsoon.
- iii. Free movement of fishes in their nesting places like swamps, submerged flora, crevices etc. may be hampered.

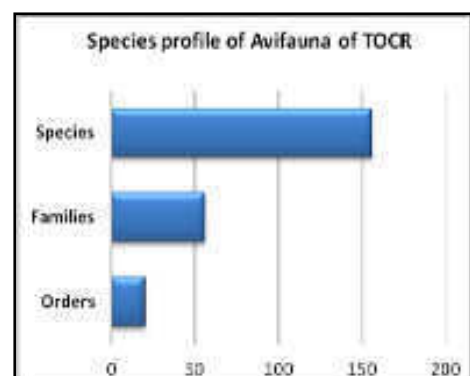
Impact mitigation strategies:

- i. A lot of care has to be taken up during construction of temporary ring bunds by placing sand bags or any such material which should not have chemicals that may destroy the fingerlings.
 - ii. While construction of temporary ring bunds or during restoration of anicuts and de-siltation, if any wild fauna including fish is found under the mud or stones, it should be released into the temporary pool.
60. No oil or chemical should be released in the anicuts area. After completion of the restoration each and every corner should be cleaned, and all the debris and materials should be removed completely.

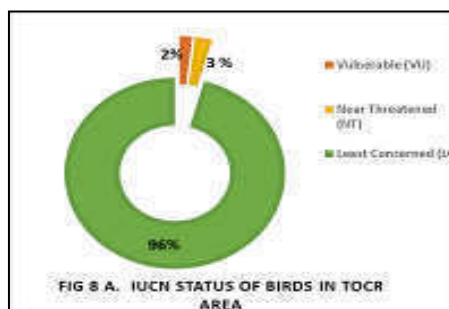


4.1.5 Avi-Fauna

61. Birds are part and parcel of our biodiversity. This is the most common wildlife that everyone comes to see all the time in their life. Birds are adapted to different habitats according to their feeding and nesting habits. During the biodiversity assessment, it is found that about 156 species of birds of different habitats found across the breadth and length of Tungabhadra Otter Conservation Reserve. Water fowls like Purple Swamphen, Bronze-winged Jacana, White-breasted water hen etc. adapted to the habitat of swamps. Their long slender toes help to move on the floating leaves on the surface of water. These birds build floating nests during monsoon and breed. Spot-billed ducks, Lesser Whistling Ducks etc. breed in the islands and on the banks of the river. Different species of Egrets, Ibis, Herons, Storks,



Sandpipers, Lapwings etc., are seen along the river banks. They feed upon the crustaceans, insects, molluscs, fishes etc., from the riparian habitat. In the islands such as Kariyammana Gadde, Virupapura Gadde and rocky scrub jungles along the river lives a rare bird Yellow-throated Bulbul. It is found only in a few pockets of south India. This rare bird is also listed as Vulnerable (VU) by IUCN. Painted Spurfowl, Indian Peafowl, different species of quails, Sandgrouse etc. is found both in the scrub rocky habitat as also in the islands. Large birds like, Woolly necked Storks, Asian Openbill, Cormorants, Herons etc., roost on the rocks in the middle of the river or in the islands in the river. Sometimes, Vulnerable species like Lesser Adjutant found in the islands of the river. Raptors like, Short-toed Snake Eagle, Brahminy Kite, Black Kite, Black-shouldered Kite, Shikra are also found along the river. Rare birds like Oriental Darter are seen in some anicuts like Hosuru and Hulugi (**Appendix-5 / Annexure-4**)



iv) IUCN status of Birds in the study area:

62. About 4 species of birds such as Oriental Darter-*Anhinga melanogaster*, Painted Stork-*Mycteria leucocephala*, Black-headed Ibis- *Threskiornis melanocephalus*, River Tern-*Chlidonias hybrid* are listed as Near Threatened (NT) under IUCN category, which amounts to 3% of the total number of birds present in the study area. 3 species of birds listed as Vulnerable (VU) category such as Woolly-necked Stork- *Ciconia episcopus*, Lesser Adjutant- *Leptoptilos javanicus*, Yellow-throated Bulbul- *Pycnonotus xantholaemus*, that amounts to 2% of the species of the birds are found in the study area (**Fig 8a**).

Project specific Impact assessment: *Birds*

63. Compared to the rest of the aquatic fauna, avifauna is less affected by restoration activities. Birds like Purple Swamphen, Bronze Winged Jacana, Little Grebe, Spot-billed Ducks, Yellow Bittern, etc. make floating nests in the monsoon. Hence, they are not affected as long as there is water in the river even away from the anicuts. During restoration birds move to safe locations. Yet possible impacts of restoration activities are listed as follows:



- i. Regular foraging and roosting behavior may be disturbed.
- ii. Migratory birds may change their regular roosting ground and transit locations.

Impact mitigation strategies:

- i. Swamp and marshy banks in the upstream of the anicuts shall be retained.
- ii. Staff and workers are well informed about protection measures of all wildlife including birds.
- iii. Species Profile.

4.1.6 IUCN status of various faunal species in TOCR area

64. Some of the species of the study area fall under different categories of IUCN Red data book. Of 20 species of mammals, 1 species of mammals, i.e., Indian Pangolin is listed under Endangered (EN) category (5%), Smooth-coated Otter, Indian Sloth Bear and Indian Leopard under Vulnerable (VU) category 15%, 2 species such as Striped Hyaena and Rusty-spotted Cat under Near Threatened (NT) (10%), and, 14 as Least Concerned (LC) (70%).

Table 4: Consolidated Table of IUCN status of Major Fauna of OCR

IUCN status	Mammals	Reptiles	Birds	Amphibians	Fishes	Total	%
Critically Endangered (CR)	0	0	0	0	1	1	0.32
Endangered (EN)	1	1	0	0	6	8	2.60
Vulnerable (VU)	3	3	3	0	6	15	4.87
Near Threatened (NT)	2	1	4	0	8	15	4.87
Least Concerned (LC)	14	9	156	8	63	250	81.17
Not Evaluated (NE)	0	13	0	0	6	19	6.17
	20	27	163	8	90	308	

65. Among the reptiles, Indian Narrow-headed Soft-shell Turtle is listed as Endangered (EN) (3%) and Indian Black Turtle-Melanochelys trijuga as Near Threatened (NT) (3%). 3 species are listed as Vulnerable (VU) such as Starred Tortoise-Geochelone elegans, Leith's Soft-shell Turtle-Nilssonina Leithii, and Mugger Crocodile-Crocodylus palustris-which amounts to 11% of all species of reptiles in the study area. About 9 species of reptiles are listed under Least Concern (LC) (33%) and 13 species as Not Evaluated (NE) (48%). Most of the Not Evaluated (NE) species are Geckos and Lizards.
66. The Amphibians such as frogs and toads found in the study area belong to the Least Concerned (LC) category.
67. Among fishes, one species, i.e., Ray-finned Fish (Harigi menu)-Hypselobarbus pulchellus (1%) is listed as Critically Endangered (CR), 6 fish species each (7%) under Endangered (EN) and Vulnerable (VU) category respectively, and 8 fishes (9%) under Near Threatened (NT) category. About 63 fishes (70%) are listed as Least Concern (LC) while the rest of 6 fish species (6%) are listed under Not Evaluated (NE) and Data Deficient (DD).
68. About 4 species of birds listed as Near Threatened (NT) 3% of the total number of birds present in the study area. 3 species of birds listed as Vulnerable (VU) category such as Woolly-necked Stork- Ciconia episcopus, Lesser Adjutant-Leptoptilos javanicus, and Yellow-throated Bulbul-Pycnonotus xantholaemus-amounts to 2% of the species of the birds found in the study area.

Table 5: IUCN Status of Various Life Forms in and around TOCR area

S. No.	Common name	Scientific name	IUCN Status
Mammals			
1	Smooth-coated Otter	<i>Lutrogale perspicillata</i>	VU
2	Indian Leopard	<i>Panthera pardus</i>	VU
3	Indian Sloth Bear	<i>Melursus ursinus</i>	VU
4	Striped Hyena	<i>Hyaena hyaena</i>	NT
5	Rusty-spotted Cat	<i>Prionailurus rubiginosus</i>	NT
6	Indian Pangolin	<i>Manis crassicaudata</i>	EN
Reptiles			
1	Starred Tortoise	<i>Geochelone elegans</i>	VU
2	Indian Black Turtle	<i>Melanochelys trijuga</i>	NT
3	Leith's Soft-shell Turtle	<i>Nilssonia Leithii</i>	VU
4	Indian Narrow-headed Soft-shell Turtle	<i>Chitra indica</i>	EN
5	Mugger Crocodile	<i>Crocodylus palustris</i>	VU
Birds			
1	Oriental Darter	<i>Anhinga melanogaster</i>	NT
2	Painted Stork	<i>Mycteria leucocephala</i>	NT
3	Woolly-necked Stork	<i>Ciconia episcopus</i>	VU
4	Lesser Adjutant	<i>Leptoptilos javanicus</i>	VU
5	Black-headed Ibis	<i>Threskiornis melanocephalus</i>	NT
6	River Tern	<i>Sterna aurantia</i>	NT
7	Yellow-throated Bulbul	<i>Pycnonotus xantholaemus</i>	VU
Fishes			
1	<i>Oreochromis mossambica</i>	Tilapia	NT
2	<i>Glossogobius giuris</i>	Bar-eyed Gobi	VU
3	<i>Macropodus cupanus</i>	Spike-tail paradise fish	VU
4	<i>Silonia childre</i>	White catfish	EN
5	<i>Ompok bimaculatus</i>	Butter cat fish	NT
6	<i>Ompok pabo</i>	Pabo catfish	NT
7	<i>Wallago attu</i>	Great white sheatfish/boal	NT
8	<i>Bagarius bagarius</i>	Gangetic goonch	NT
9	<i>Gagata itchkeea</i>	Deccan nangra	VU
10	<i>Botia striatus</i>	Zebra / Tiger loach	EN
11	<i>Cirrhinus cirrhosa</i>	Mrigal carp	VU
12	<i>Cyprinus carpio carpio</i>	Wild common carp	VU
13	<i>Garra bicornuta</i>	Tunga garra	NT
14	<i>Labeo pangusia</i>	Pangusia labeo	NT
15	<i>Labeo potail</i>	Deccan labeo	EN
16	<i>Osteobrama belangeri</i>	Manipur osteobrama	NT
17	<i>Hypselobarbus kolus</i>	Kolus	VU
18	<i>Hypselobarbus pulchellus</i>	Ray-finned Fish	CR
19	<i>Thynnichthys sandkhol</i>	Sandkhol carp	EN
20	<i>Tor khudree</i>	Deccan / black Mahseer	EN
21	<i>Tor mussullah</i>	Hump back mahseer	EN

4.2 Species Profile

4.2.1 Smooth-coated otter–*Lutrogale perspicillata*

“Otters are the ambassadors of wetlands”

Classification:

Kingdom	:	<i>Animalia</i>
Phylum	:	<i>Chordata</i>
Class	:	<i>Mammalia</i>
Order	:	<i>Carnivora</i>
Family	:	<i>Mustelidae</i>
Subfamily	:	<i>Lutrinae</i>
Genus	:	<i>Lutrogale</i>
Species	:	<i>L.Perspicillata</i>



Binomial nomenclature: *Lutrogale perspicillata* (Geoffroy Saint Hilaire, 1826)

IUCN status : VU (Vulnerable)

WPA, 1972 status: Schedule-II

Description

69. There are 13 species of otters in the world and five species occur in Asia. Smooth-coated otter *Lutrogale perspicillata* is the largest among Asian otters. This is strong and sturdy, with long, thick body, short legs, and webbed feet with sharp claws, wide neck, round head, small round eyes, short ears, and short hairless muzzle with thick whiskers. It is dark brown to reddish brown in color in the upper part and light brown in the lower parts; fur is thick and velvety and has two layers which helps to keep the body warm. The tail is thick, long and conical-which is more flattened at the end than other otters. Fore limbs are shorter than the hind limbs. Males are larger than females.

Range Description

70. The Smooth-coated otter is distributed throughout south-east Asia, from Indonesia in the East to India and Pakistan. However, recent evidences indicate that their range and population is shrinking due to reasons of poaching and loss of habitat. They attain weight between 7 and 11 kg, and body length between 1 and 1.3 meters.

Habitat and Ecology

71. As aptly said, “**Otters are the ambassadors of wetlands**”, the Smooth-coated otter prefers an aquatic habitat in the plain land and semi-arid region of North-west India and Deccan Plateau (Prater, 1971). It prefers large rivers, lakes, swamps, mangroves and estuaries. It forages in rice fields also (Foster-Turly,1992). It prefers rivers with rocky terrain and sand/ mud banks, or islands that provide a place for resting, grooming and littering. Islands and river banks with thick vegetation provide cover during travelling, foraging, resting and grooming. They avoid open islands and sand/ mud banks due to lack of escape opportunities (Hussain, 1993; Hussain and Choudhury, 1995). During breeding season, they use swamps and rocky crevices as natal den sites and nursery sites. During summer, they move to ponds with slow or stagnant water, and islands with vegetation in the perennial rivers (Hussain and Choudhury, 1997).



72. Smooth-coated otters predominantly feed on large fishes with $\frac{1}{2}$ to 1 foot in length which they hunt and eat while swimming in the river. Sometimes, they hunt large fishes too. They also prey upon shrimps, crabs, frogs and insects, and sometimes upon birds and rats (Prater, 1971, Foster-Turly, 1992). This indicates their opportunistic feeding behavior. The scales and bone remains of the devoured fish and shell of the crabs can be seen in their defecation called as spraints. The major fish species they devour in TOCR consists of *Tilapia*, *Ruhu*, *Catla*, and *Deccan Masheer* etc.-fishes that fishermen harvest for their livelihood. This indicates that the Smooth-coated otters diet depends upon the availability of the food base as listed above. It is observed that Otters in captivity attain sexual maturity at the age of twenty-two months (Desai, 1974). They breed once a year and the breeding season varies from one place to another, majorly depending upon the favorable conditions, natal areas, abundance of prey base etc. The gestation period is 61-65 days.



73. They give birth to the young ones in a burrow or rocky crevices near water. They remain blind and helpless for one month and start swimming after 2 months. The cubs wean for 4-5 months, live with the mother for one year, after which they disperse to live independently and attain sexual maturity at the age of two years. The size of the litter varies from two to five. Home range varies from 5.5 km to 17 km in low density habitats (Hussain, 1993).
74. Smooth-coated otters use scent marks for demarcation of their territory and for communication. They have a pair of scent glands at the base of their tail. Together with this scent and the faeces, they mark on vegetation, rocks, shorelines etc. near their feeding, grooming and natal areas. This behavior is known as sprainting. They are known to live up to 20 years in captivity but less than 10 years in the wild (Ronald Nowak, 1999) which is to be confirmed. This is also governed by the availability of abundance of prey base. They form small family groups consisting of a pair with 2-5 off springs. Male helps to gather food for the young ones. (Annexure-1)

4.2.2 Population dynamics of Smooth-Coated Otter in anicuts in TOCR

75. During the rapid biodiversity assessment, it is found that the population of Smooth-coated otters is high compared to rest of the major fauna. In 142 positive signs of otters, about 74 (52.11%) mass latrine or mass sprainting sites, 21 (14.78%) natal sites or Holts and 47 (33.09%) resting and grooming sites are found in different *anicuts* within the TOCR area. The largest population of otter is found in Ramasagara *anicut* vicinity with 31 (21.83%) positive sites. Next largest population is found in Hulugi *anicut* where 24 (16.90%) positive sites found. Bella and Anegundi *anicuts* have 23 (16.19%) of the Otter population, while Kampli *anicut* has revealed 17 (11.97%) positive sites. Owing to excessive growth of weeds, over siltation and non-availability of fair water body with prey base, very few positive sites of otters are found in Shivapura 8 (5.6%), Upper Gangavathi 7 (4.9%), Lower Gangavathi 2 (1.4%) and Turtha 7 (4.9%). This indicates the decline of Otter population due to unsupportive and unhealthy habitat.

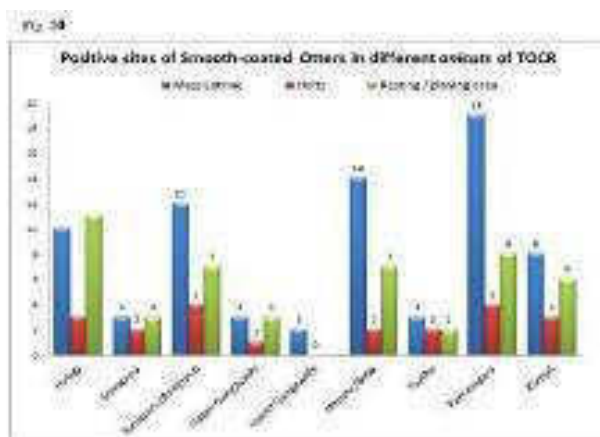
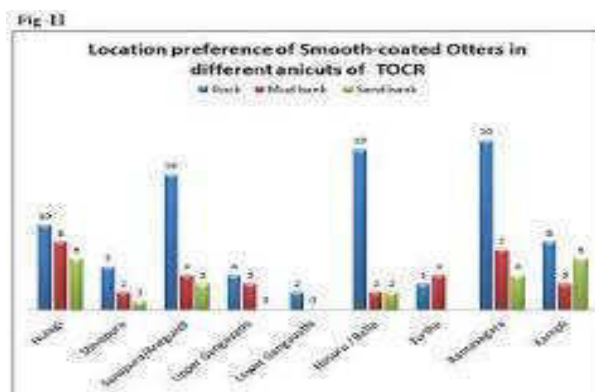


Table 6: Smooth Coated Otter: Population Density

SI No.	Name of the <i>anicut</i>	Mass Latrine	Holts	Resting/ grooming area	Total	%
1	Hulugi	10	3	11	24	16.9
2	Shivapura	3	2	3	8	5.63
3	Anegundi	12	4	7	23	16.19
4	Upper Gangavathi	3	1	3	7	4.929
5	Lower Gangavathi	2	0	0	2	1.4
6	Bella	14	2	7	23	16.19
7	Turtha	3	2	2	7	4.92
8	Ramasagara	19	4	8	31	21.83
9	Kampali	8	3	6	17	11.97
	Total	74	21	47	142	
	%	52.11	14.78	33.09		

Location preference

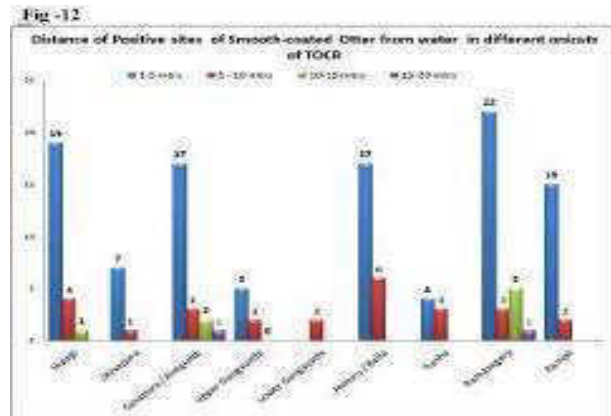
76. Generally, Smooth-coated otters are shy animals and avoid human presence. They need fairly deep and fresh water body with sufficient prey base. Normally they go for foraging early morning and evenings. Sometimes, hunt during the night and in broad day light also. After the hunt, they rest on the rock, mud-sand mounds in



the middle of the water covered with vegetation. Also use sand banks for basking, playing and grooming. It is found that they prefer rocky islands and crevices for mass latrine, resting and grooming and for breeding also. Of 142 signs 87 (61.26%) positive signs found on rocky terrain. 33 (23.23%) positive signs found on mud banks or islands and 22 (15.49%) found on the sand banks. Preference to rocky islands and crevices basically depends upon their availability. They use the rocky, mud and sand dunes and banks covered with thick vegetation.

Distance from water

77. Smooth-coated otters prefer to stay near a water body so as to escape into water in case of any threat. However, they do move away for foraging and for marking their territories.
78. During the study period, 142 positive sites were observed out of which 106 sites are very close to the water body 1-5 meters (74.64%). About 26 sites were found within 5-10 meters from the edge of the water (18.30%).
79. Eight positive sites were found about 10-15 meters away from water (5.63%) and only 2 sites found away about 15-20 from the edge of the nearest water body (1.4%). This indicates their preference to be in proximity to a water body.



Project specific Impact assessment: Smooth-coated Otter

80. It is observed in the field that, the Smooth-coated Otters are highly adaptable to changing geophysical landscapes. This is evident from prolonged field observation of their behavior. As water starts flowing and rivers swell, they move to the extreme end of a bank and dig burrow under the bushes. As water recedes, they gradually move towards the edge of water and when river turns into trickle during late winter and summer, they give birth to young ones in the holts in the middle of water, or under the thick bush on the mud banks of the river. They also adapt to human disturbances like construction works, fishing, harvesting of crops along the banks where they roam, etc.
81. During the construction period, a temporary barrage should be built using sand bags or any such material to retain a pool of water to facilitate restoration of the anicuts and de-siltation.
82. During this period following specific impacts may be exerted on Otters:
- Movement of people and machinery may drive them away from their routine path.



- ii. Otters may temporarily change their grooming and resting areas to the nearest safe location at the edge of the water.
- iii. Change in behavior may occur due to displacement. Otters are territorial social animals. Each group has its own territory which they demarcate using spraint marks. When one group enters into another’s territory, a clash may take place. In the fight, they scratch their noses or bite each other’s body parts. Generally, they avoid confrontation.

Impact mitigation strategies:

- i. Start restoration work in December and complete it by June during which, the Otter would have given birth to young ones and shifted to a safe location.
- ii. The work in the anicut areas should be taken up between 9 am and 5 pm, as Otters are crepuscular animals, i.e., active in the morning and evening, hunting for fish and other food sources.
- iii. A separate watcher should be appointed at each anicut to monitor the movement of Otters and other faunal species.

4.2.3 Mugger crocodile – *Crocodylus palustris*

Classification:

Kingdom	:	<i>Animalia</i>
Class	:	<i>Sauropsida</i>
Order	:	<i>Crocodylia</i>
Family	:	<i>Crocodylidae</i>
Subfamily	:	<i>Crocodylinae</i>
Genus	:	<i>Crocodylus</i>
Species	:	<i>C. palustris</i>
Scientific Name	:	<i>Crocodylus palustris</i> (Lesson, 1831)
IUCN status	:	VU (Vulnerable)
WPA, 1972 status	:	Schedule-I (part II, 1D)



Table 7: Population of Muggar crocodile

S. No.	Name of the <i>anicuts</i>	Direct sightings	Nesting areas	Scat/ sign marks	Total	%
1	Hulugi	1	0	2	3	4.054
2	Shivapura	3	3	2	8	10.81
3	Anegundi	3	2	9	14	18.91
4	Upper Gangavathi	1	1	3	5	6.75
5	Lower Gangavathi	0	0	0	0	0
6	Bella	3	0	1	4	5.4
7	Turtha	0	0	3	3	4.05
8	Ramasagara	11	2	8	21	28.37
9	Kampli	8	2	6	16	21.62
	Total	30	10	34	74	
	%	40.54	13.51	45.94		

General characteristics

83. There are three species of crocodiles in India, viz, Muggar Crocodile, Gharial and Salt water Crocodile. Muggar Crocodile is also known as 'Marsh Crocodile', 'Indian Swamp Crocodile' etc. Adult crocodiles are dark grey to bright olive in color while the young ones are light colored. Their entire body is covered with black spots and large scales. It has a long, flattened body, with thick, long tail comprising sharp scales.



Snout is broad and heavily armed with large scutes around the neck. Fingers and toes are webbed. Male attain 4-5 meters (13-16 ft) length and up to 200-kilogram weight. Females are smaller.

Geographical distribution

84. Muggar crocodile belongs to a fresh water species distributed in India and south-east Asian countries, namely, Pakistan, Bangladesh, Sri Lanka, Nepal, Iran and Indo-China region.

Natural Habitat

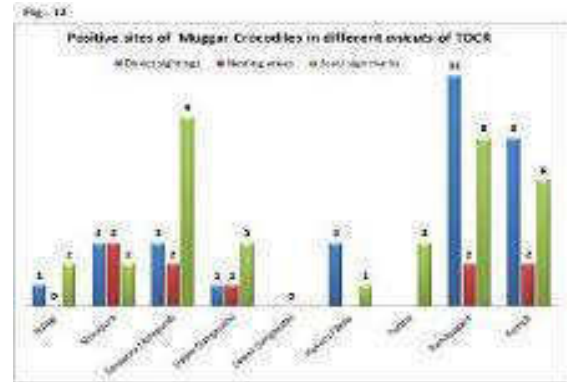
85. Muggar Crocodile is found in fresh water rivers, lakes and marshes. It prefers slow-moving shallow rivers and canals, reservoirs and marshy lakes with rocky boulders or mud banks.

Behavior

86. Muggar crocodiles can swim at a speed of 13 km per hour while hunting the prey. In case of emergency, they can swim at 19 km per hour. Normally, they move gently or leisurely in still water.

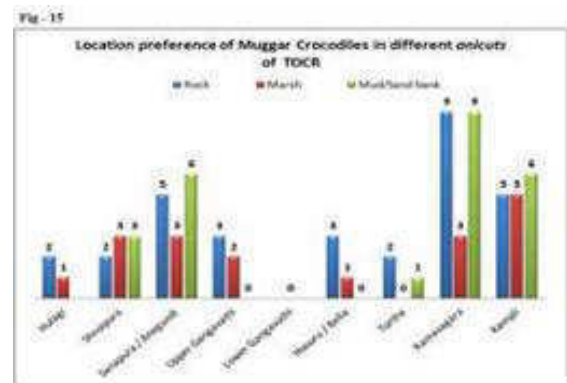
Hunting and diet

87. Mugger Crocodile eats fishes, snakes, turtles, birds, and small mammals like monkeys, squirrels, ungulates, otters and livestock. It is a cunning predator, waits in the water bodies and ambushes gullible animals that come to drink water. It drags the prey into water and devours. During dry season, it digs a burrow of around 6 feet depth and equally wide under the thick vegetation and rests (field observations).



Reproductive behavior

88. Male crocodiles attain sexual maturity at the age of 10 years and female at 6 years. The female digs a deep and wide hole in dried puddles by the side of a pool or perennial water body and lays up to 30 eggs at a time and guards them. The eggs are large with thick shell. Incubation period is 55 to 75 days. The female carries the hatchlings in mouth and releases them in water.



4.2.4 Population dynamics of Mugger Crocodile in anicuts

89. In the course of rapid assessment, it is found that the Mugger Crocodile is the second largest major fauna present in all anicuts of TOCR area. The availability of a favorable habitat, abundance of prey base, ideal nesting and nursing site etc. causes the crocodile population to flourish.

90. During the rapid assessment, 74 positive signs of crocodiles in different anicuts of TOCR were found. About 30 crocodiles were sighted directly (40.54%), 10 nesting sites (13.51%), and 34 scat and signs (45.94%).

91. Largest population of otters is found in the vicinity of Ramasagara anicut with 21 (28.37%) positive sites followed by Kampali anicut where 16 (21.62%) positive sites were found. Anegundi anicut has 14 (18.91%), Shivapura 8 (10.81%), Upper Gangavathi 5 (6.75%), Bella has 4 (5.40%), and Hulugi and Turtha 3 positive sites each (4.05%) of the crocodiles. Lower Gangavathi has no positive sites of crocodiles. The reason for low population density is due to excessive growth of weeds, excessive siltation and non-availability of fair water body with prey base. Hence, there is an urgent need to intervene and explore positive solution to clear the lake off weeds.

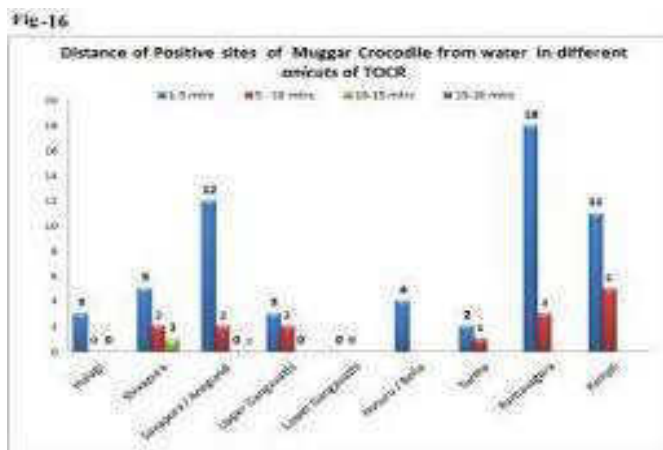


Location preference

92. Generally, Mugger crocodiles avoid human beings. They prefer rocky islands or sand dunes covered with vegetation in the middle of a water body, stagnant pools of river, or fresh water body with prey base. Normally, they go for foraging during early morning and evenings. They hunt during night generally, but also during day time as necessary. After the hunt, they rest on the rock, and mud–sand mounds in the middle of the water covered with vegetation.
93. About 31 positive sights are found on the rocks or rocky terrain (41.89%), which proved as the most preferred location for them. Second choice of preference is Mud/Sand mound in the middle of the still waters. About 25 such observations were made (33.78%). During winter and dry seasons, they prefer to hide under the cover of marshes. About 18 such sights are observed (24.32%).

Distance from water

94. Mugger crocodiles prefer to stay as close to the water body as possible. The reason for this may be access to food base; proximity to water also provides an easy escape from any kind of threats.
95. Of the 74 positive sites and observations, 58 sites are found within 1-5 m distance from the shore (78.37%). In about 15 instances, positive sites were found within 5-10 m (20.27%). Only one site was found at about 10-15 m away from the shore of the water body (1.35%). During breeding season, they make nest little away from large pool in a dried puddle. This helps them to hunt for food and protect the nest as well as carry the hatchlings from nesting site to the nursing site in the water body.



Project specific Impact assessment: Mugger Crocodiles

96. Mugger Crocodiles are sensitive to the human disturbances. Though they tolerate human presence at safe distance, they move away from increased disturbances. It is observed that Crocodiles lay eggs by the side of perennial water pools, on the edge of the partially dried puddles. They make burrows at the side wall of the puddle and lay up to 30 eggs and cover them with soil. Generally, they prefer sandy banks. After laying eggs, they burrow a deep and wide cavity under thick grass and stay there protecting their eggs. As eggs hatch after a month, the mother picks up each hatchling in its mouth and releases them in the nearby perennial pool.
97. It is found that except Hosuru/Bella *anicut* most of the nests of crocodiles are found away from anicuts. Hence, restoration activities may not directly hamper the nesting behavior of Crocodiles. Yet restoration activities may exert the following specific impacts on Crocodiles:

- i. Excessive movement of massive machinery and a large number of workers may drive crocodiles away from pools.
- ii. They may shift their location temporarily to safe marshy areas nearby.
- iii. People/ workers out of curiosity may chase crocodiles or sometimes (if not informed of the importance of wild fauna to the laborers), they may try to kill the animal out of fear and prejudice.

Impact mitigation strategies

- i. Start restoration work in December and complete it by June. During this period, water level will go down and crocodiles also go to deep-water.
- ii. Work in the *anicut* areas to be taken up between 9 am and 5 pm, as the Otters are crepuscular animals, i.e., active in the morning and evening, hunting for fish and other food sources.
- iii. Awareness about the wildlife and their conservation be created among the staff including site managers, contractors, laborers etc., well in advance before commencement of the restoration activities.

4.3 Turtles and Tortoises

98. About 24 species of fresh water turtles and 4 species of Tortoises are found in India. The 'Tungabhadra Otter Conservation Reserve' (TOCR) and its islands with scrub jungle have 4 turtles and one tortoise. Fresh water Turtles like Indian Black Turtle-*Melanochelys trijuga*, Indian Soft-shelled Turtle-*Lissemys punctata*, Leith's softshell turtle-*Nilssonina leithii* and Indian narrow-headed soft-shell turtle-*Chitra indica* are found in the TOCR area. Only one Tortoise species, Indian star tortoise-*Geochelone elegans*, is found on the islands and in surrounding scrub jungles.
99. It is said that during the Vijayanagara Empire, soldiers were killing the giant turtles in the river, eating the meat and using the carapace as a shield in the war. The carapace is light and strong. At present, the population of the giant turtles has declined drastically-becoming endangered in this part due to illegal hunting and poaching.
100. There are two distinct species of 'Giant Soft-shelled turtles' found in the river.

4.3.2 Leith's Soft-shell Turtle-*Nilssonina leithii*

Classification:

Kingdom	:	<i>Animalia</i>
Phylum	:	<i>Chordata</i>
Class	:	<i>Reptilia</i>
Order	:	<i>Testudines</i>
Sub order	:	<i>Cryptodira</i>
Family	:	<i>Trionychidae</i>
Genus	:	<i>Nilssonina</i>
Species	:	<i>N.leithii</i>
Scientific Name:		<i>Nilssonina leithii</i> (Grey, 1872)
IUCN status	:	VU (Vulnerable)
WPA, 1972 status:		Schedule-I



Leith's softshell turtle - *Nilssonina leithii*

- 1) Leith's Soft-shell Turtle is also called as *lagala* in local language which is listed in the Vulnerable under Threatened category of IUCN red list, and also listed as Schedule-I species of Indian Wildlife Protection Act, 1972. This species is endemic in Central and south Indian rivers in Madhya Pradesh, Maharashtra, Odissa, Karnataka, Andhra Pradesh, Tamil Nadu and Kerala. It is commonly found in rivers like Godavari, Bhavani, Ghataprabha, Tungabhadra, Cauvery, Moyar etc. (Das, I., Sirsi, S., Vasudevan, K., and Murthy, B.H.C.K. 2014). It was most commonly found turtle till a few decades ago; now it is facing extinction due to illegal trade, siltation and drying up of Rivers during summer.
- 2) This rare turtle is found in the shallow waters of the Tungabhadra River throughout the TOCR area. Hunters from "Bangladesh" rehabilitation camp near Sindhanur in Raichur district are noted hunters of turtles. They use a rope with hundreds of hooks and drag it across the shallow waters of the river during winter and summer to capture this rare Turtle that dwells in under water sand in the shallow rivers. It is learnt that the carapace of this turtle is being smuggled to China for making TCM. During the study, the team was unable to see or observe these species owing to low water level and over growth of weeds in the *anicuts*. However, local fishermen confirmed that the turtle population is still significant throughout the river.

4.3.3 Indian Narrow-headed Soft-shell Turtle—*Chitra indica*

Classification:

Kingdom	:	Animalia
Phylum	:	Chordata
Class	:	Sauropsida
Order	:	Testudines
Sub order	:	Cryptodira
Family	:	Trionychidae
Genus	:	<i>Chitra</i>
Species	:	<i>C.indica</i>
Scientific Name	:	<i>Chitra indica</i> (Grey, 1831)
IUCN status	:	EN (Endangered)
WPA, 1972 status	:	Schedule-I



101. Indian Narrow-headed Soft-shell Turtle or Small-headed Soft-shell Turtle-*Chitra indica*, is also listed in the Endangered under Threatened category by IUCN red data book. This turtle is listed as Schedule 1 species under Indian Wildlife Protection Act, 1972. A rare turtle, generally found in Indus and Sutlej rivers in Pakistan, Ganges, Godavari, Mahanadi in India and some rivers of Nepal and Bangladesh (Das, I., Singh S., 2009) also found in Tungabhadra Otter Conservation Reserve (TOCR).



102. It is also found in some south Indian Rivers. It prefers clear, large or medium rivers with sandy bottoms where it spends most of its time hidden under the sand exposing its nose

and eyes only. It feeds upon fish, frogs, crustaceans, mollusks etc. and attains very large size-up to 1.1 meters width and weighing up to 120 kilograms. It is widely hunted by the local tribal community (*Budga Jangama, Shikari, Sindhollu, Hakki pikki etc.*) and (so-called) *Bangla* poachers for its meat and carapace which is reportedly used in Traditional Chinese Medicine. It is found that the latter-named poachers are more active than the former. One such large specimen was rescued from the poachers on 15th August 2011. This is probably the largest living specimen found in India, which is reported by Samad Kottur and published in Zoological Survey of India newsletter in 2011 (Samad Kottur-ZSI Newsletter: Volume 03: No. 08 August 2011). The study collected indirect evidences and secondary data further corroborated with the local community and fishermen. They also confirmed that the population is significant which however needs to be confirmed by conducting detailed studies.

4.3.4 Indian flapshell Turtle–*Lissemys punctata*

Classification:

Kingdom	:	Animalia
Phylum	:	Chordata
Class	:	Reptilia
Order	:	Testudines
Sub order	:	Cryptodira
Family	:	Trionychidae
Genus	:	<i>Lissemys</i>
Species	:	<i>L. punctata</i>
Scientific Name:		<i>Lissemys punctata</i> (Lacepede, 1788)
IUCN status	:	LC (Least Concerned)
WPA, 1972 status:		Schedule-I (Part II (8))



Indian flapshell turtle - *Lissemys punctata*

103. The Indian flap-shell Turtle or Indian Soft-shell Turtle is also a fresh water turtle found in south Asian Rivers and water bodies. This is a most common and widespread species of turtles in south Indian rivers as well as in the Tungabhadra river within the TOCR area. It can be easily identified by its soft pale olive green rounded shell or carapace, pale yellow plastron and a pair of flaps and conspicuous short proboscis like nose resembling like that of a pig's snout, large head and black eyes with white eye ball that appears like that of a human eye. It can withdraw its head and limbs into its shell and front plastron. The carapace length of grown up adult is 37 mm. This is omnivorous, feeds upon aquatic plants, invertebrates, small vertebrates, and scavenges the carrion.

104. During the study, some individuals were sighted in the *anicuts*. However, their population is declining due to illegal hunting and trapping by fishermen and tribal hunters.

4.3.5 Indian Black Turtle–*Melanochelys trijuga*

Classification:

Kingdom	:	Animalia
Phylum	:	Chordata
Class	:	Reptilia
Order	:	Testudines
Family	:	Geoemydidae
Genus	:	<i>Melanochelys</i>
Species	:	<i>M. trijuga</i>
Scientific Name	:	<i>Melanochelys trijuga</i> (Schweigger, 1812)
IUCN status	:	NT (Near Threatened)
WPA, 1972 status	:	Schedule-I (Part II (8))



Indian Black Turtle -*Melanochelys trijuga*

105. Indian Black Turtle also called as Indian Pond Terrapin is one of the most common turtles found in rivers, ponds, lakes and other freshwater bodies in India. Its shell is dark, while plastron is brown with yellow streaks. The adult grows up to 45 cm. It is a crepuscular reptile that indulges in active foraging every morning and evening, and is often seen basking on the tip of a rocky outcrop or on dead wood during day time.

106. It is omnivorous feeding upon the aquatic plants, insects etc. and also scavenges the carrion. During the rapid assessment, local fishermen revealed that it comes out of water to the river bank in search of cattle dung and feeds upon it.

4.3.6 Indian Star Tortoise–*Geochelone elegans*

Classification:

Kingdom	:	Animalia
Phylum	:	Chordata
Class	:	Reptilia
Order	:	Testudines
Family	:	Testudinidae
Genus	:	<i>Geochelone</i>
Species	:	<i>G.elegans</i>
Scientific Name:		<i>Geochelone elegans</i> (Schoepff,1795)
IUCN status	:	VU (Vulnerable)
WPA, 1972 status:		Schedule-IV (Part II)



107. Indian Star Tortoise is a terrestrial reptile that lives in the dry scrub jungle of the Deccan Plateau. It has a convex dorsal shield appearing like a hump. Its black carapace with pale yellow streaks resembles a star; hence, it is called as Star Tortoise. The tortoise does not have web feet, and hence it is unable to live in aquatic conditions. The limbs are pointed with bony tubercles (similar to claws). It feeds upon the succulent plants, grass, fallen fruits, flowers etc. Sometimes, it devours upon carrion also; lives in the dry scrub jungle and takes shelter among rocky boulders and tufts of grass.

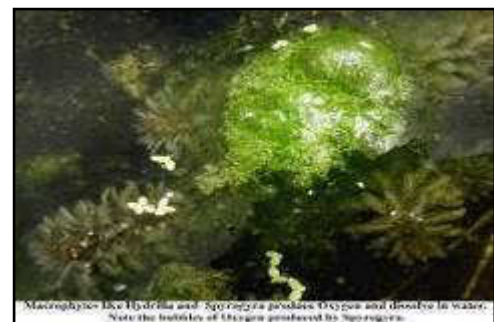
108. In TOCR area, Star Tortoises can be seen in the islands of Kariyamanagaddi and surrounding forests namely Sanapura Reserve Forest and Bukkasagara Reserve Forest of Daroji Bear Sanctuary.

4.4 Aquatic flora: Macrophytes

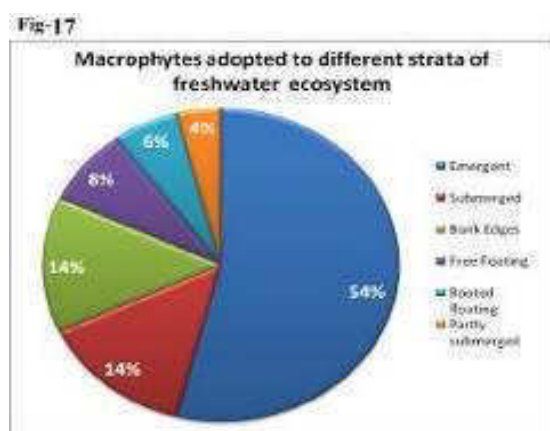
109. Fresh water ecosystem is one of the aquatic ecosystems of the planet Earth. Freshwater ecosystem which includes ponds, lakes, rivers, springs, streams, wetlands, marshes etc. is the life giver for rest of the non-marine living organisms on Earth. About 97% of water on Earth is saline accumulated over times immemorial in Oceans and seas. Of the 3% fresh water, 69% is in the form of glaciers and ice caps. Of the remaining 30% (out of 3% of the world's water) is in the form of ground water. Only 1% of the fresh water is available on the surface of the Earth in the form of lakes, rivers, ponds, streams etc. A typical ecosystem is evolved in and around the fresh water environment, where aquatic plants play a vital role in supporting the biodiversity and health of riparian ecosystem. Fresh water plants also called as macrophytes have evolved by adapting to different strata of the aquatic ecosystem such as submerged, emergent, free floating, and rooted floating. The role of the submerged macrophytes is crucial to the maintenance of aquatic ecosystem. These submerged macrophytes as well as phytoplankton and algae produce oxygen for the aquatic faunal species. The species abundance and faunal diversity is dependent upon the presence of submerged aquatic flora and DO.



110. The study has also identified some key species of aquatic flora in and around the TOCR area. While the submerged flora provides oxygen and food for the faunal species, the emerged flora provides protection from exposure to animals like Smooth-coated Otters, Crocodiles etc. Otters make burrows in the thick bushes on the banks of the river while Crocodiles hide under the marshes in the banks. Some fish species take refuge in the submerged flora to protect themselves from predators.



111. Though the aquatic flora is supporting the ecosystem, the hazardous growth of water hyacinth-*Eichornia crassipes* has covered the surface of water like a carpet in almost all *anicuts* and pools within the TOCR area. The thick carpet of water hyacinth does not allow sunlight to penetrate into the water body. Non-availability of sunlight hampers the process of photosynthesis of submerged flora. As there is no photosynthesis taking place, no oxygen is produced resulting in reduced DO. Lack of dissolved oxygen leads to death of planktons, and small and large aquatic fauna including crustaceans and fishes. The death and decay of underwater flora results in pollution of water, which later begins to stink. The overgrowth of water hyacinth



also helps sudden burst of mosquito population resulting in the cause of deadly diseases like Malaria, Dengue, Chikungunya, and Filariasis among people living around the river. Excessive growth of water hyacinth also results in siltation of *anicuts* and pools, leading to lack of storage of water.

112. In Upper and Lower Gangavathi *anicuts*, water spinach-*Ipomoea aquatica* has grown hazardously covering the surface of these *anicuts*. The hazards are similar to that of water hyacinth.

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary of Conclusions

113. The rapid bio diversity assessment of all the nine *anicuts* present within TOCR area revealed that the entire TOCR area has an ideal habitat for RET species like Smooth-coated otter, Mugger Crocodile, four species of Turtles, hundreds of species of fish fauna and also supporting a repertoire of avifauna. Based on the data collected and analyzed, it is observed that currently all the nine *anicuts* within TOCR area have deteriorated resulting in reduced storage capacity.

Causes/Issues

- i. Natural degradation of the weirs due to aging and damage due to floods and corrosion;
- ii. Leakages of *anicuts*;
- iii. Excessive siltation in *anicuts* and rest of the river and the channels;
- iv. Eutrophication, i.e., excessive growth of invasive alien weeds in *anicuts*, rest of the river and channels;
- v. Lack of systematic monitoring and management protocols, and
- vi. Lack of awareness among local population regarding conservation of *anicuts* and river from pollution.

The degradation of Anicuts resulted in:

- Low water storage capacity in the *anicuts*;
- Poor supply of water for irrigation through channels which are also degraded and destroyed;
- Low production of the cash crop like sugar cane, banana and paddy;
- Depleting prey base for apex predators of the river due to low storage of water;
- Loss of habitat for major fauna and resulting low population density;
- Loss of livelihood for the fishermen community;
- Excessive growth of alien weeds like Water Hyacinth and Ipomoea on the surface of water that spread like a green carpet, resulting in absence of sunlight inside water;
- Lack of sunlight inside the water resulting in loss of endemic submerged aquatic flora and resulting low DO levels;
- Loss of ecosystem and collapse of food chain;
- Loss of aquatic wildlife like Smooth-coated Otter, Crocodiles, Turtles, Fish fauna etc due to degradation of *anicuts* and rest of the river;
- Man-animal conflict, for example, Crocodiles may enter inhabitations and prey upon the livestock due to lack of food base, and
- Loss of bio-diversity.

5.1.1 Major threats to habitat during implementation and mitigation measures

Major threats to the destruction of habitat	Mitigation Measures
<p>1 The movement of people and machinery would drive the Otters and Crocodiles away from their routine path. They may temporarily shift their grooming and resting areas to the nearest safe location at the edge of the water. Turtles and fishes are not much bothered about the human activities, as they are in the water and stay in the temporary pools created during restoration period.</p>	<p>1 The restoration of <i>anicuts</i> in the TOCR area to be taken up and to be finished within six months on priority basis. After completion of restoration of <i>anicuts</i> located within TOCR, restoration of channels and other <i>anicuts</i> should be taken up, so as to cause minimal disturbance to the wildlife within TOCR area.</p>
<p>2 The change in behavior displayed by Otters and Crocodiles is temporary. It is observed in the field that, every year, when river floods during monsoon, Otters and Crocodiles move to the banks to stay there temporarily. As water recedes, they slowly move into the river edges and on sand mounds/rocky islands in the river. Otters and Crocodiles tolerate intrusion of fishermen, cattle and people in and around the river. As soon as men and cattle approach, Otters and Crocodiles slowly move away to safe location in marshy river banks. Hence, during restoration work, the aquatic fauna would tolerate the temporary displacement.</p>	<p>2 Start the restoration work of <i>anicuts</i> of TOCR area in January and complete it by June. During this period, water level will go down and Crocodiles also move away to deep-water pools.</p>
<p>3 Otters are territorial social animals. Each group (also called as bevy/ romp/lodge/ family) has its own territory which they demarcate using spraint marks. Due to restoration work, bebies of Otters may be disoriented and may enter into each other's territory leading to clashes. During fight, they scratch each other's noses or bite body parts. Generally, they avoid confrontation.</p>	<p>3 Work in <i>anicut</i> areas to be taken up between 9 am and 5 pm, as Otters are crepuscular animals, i.e., active and busy during mornings and evenings hunting for fish and other food sources.</p>
<p>4 Workers and people present at the site of restoration work may chase Crocodiles, Otters, or sometimes (if not aware of the importance of wild fauna to the laborers), may kill them out of fear or prejudice when they come across them. They may also capture Turtles and wild fish for consumption.</p>	<p>4 Awareness about the wildlife and their conservation is to be created among the staff including site managers, contractors, laborers etc., well in advance before commencement of the restoration activities.</p>

<p>5 Turtles are shy animals and avoid human presence and interference. They lay eggs in the sand mounds and along banks during late summer. Young ones come out of their nests during first floods of monsoon. Giant turtles and Soft-shelled Turtles rest in the bottom of the shallow river while Flop-shelled Turtle and Indian Black Turtle bask or rest on the sand/mud banks and rocky outcrops. Chances of construction party/ contractor to collect sand from the river that may be the nesting ground for Turtles and Crocodiles is not ruled out.</p>	<p>5 The staff, contractors and workers should be well educated or trained about the behavior, nesting and other aspects of Otters, Crocodiles, Turtles, fish fauna and their conservation before commencement of work. All of them should be impressed upon not to kill any of these wildlife and snakes when they come across, or hunt fish or any wildlife in the restoration area.</p>
<p>6 During restoration, as water goes down or drains out, all the fishes, big and small, get exposed. People/villagers, workers and others may capture/hunt them. A large number of people may gather to capture these vulnerable fishes. Gathering of large number of people and fishermen may wipe out the fish fauna as some fish species lay eggs in summer and early monsoon. Free movement of fishes in their nesting places like swamps, submerged flora, crevices etc. may be hampered.</p>	<p>6 A lot of care is to be taken up during construction of temporary barrages by sand bags or any such materials which should not have chemicals, oil, grease etc., that may destroy the fingerlings and any other wildlife.</p> <p>114. People have to be thoroughly educated about the importance of these valuable species, and the need for their conservation. Volunteers should be prepared.</p>
<p>7 Regular foraging and roosting behavior of animals may be disturbed. Migratory birds may change their regular roosting ground and transit locations. As birds are highly adaptable, and always on the move in search of safer locations, this disturbance is temporary, and the avifauna will retreat to their previous habitat as soon as it is restored.</p>	<p>7 During construction of temporary barrage or during restoration of anicuts and de-siltation, any wild fauna including fish found under the mud or stones, should be rescued and released into the temporary pool. There should be a separate team under the guidance of the biodiversity expert to rescue and release the wildlife from restoration site to the temporary barrages.</p>
	<p>8 No oil or chemicals, plastics, cement, metals etc., shall be released in the anicuts area. After completion of the restoration work, each and every corner should be cleaned of these hazardous materials and chemicals, and all the debris/materials removed completely.</p>

116. It may be noted that restoration activities will temporarily hamper routine movement of Otters. However, once completed, the modernization project would help Otters and other aquatic life forms to flourish on account of abundance of water in the anicuts throughout the year. There is a lot of experience to substantiate this fact (**See Appendix-B for Additional Notes**).

Project Specific Impact Assessment:

117. Turtles lay eggs in the sand mounds and along banks during late summer, and the young ones come out of their nests during the first floods of monsoon. Giant turtles and Soft-shelled Turtles rest in the bottom of the shallow river while Flop-shelled Turtle and Indian Black Turtle bask or rest on the sand/mud banks and rocky outcrops.

118. The restoration activities may exert the following specific impacts on Turtles:

- i. Excessive movement of massive machinery and a large number of workers may drive the Turtles away from their resting places such as mud banks and rocky outcrops in the river.
- ii. They may shift their location temporarily to safe sand/mud banks /marshy areas nearby.
- iii. People/ workers out of curiosity may capture the Turtles and disturb their movement.
- iv. People may kill them whenever they come across the turtles for consumption.

Impact mitigation strategies

- i. Not to disturb the sand/ mud banks and rocky islets.
- ii. Staff and workers of the Contractor should be well educated about the Turtles and their conservation.
- iii. They should also be informed not to kill any snakes, not to hunt fishes, and so on.

5.1.2 General recommendations

119. General Guidelines to be followed while carrying out Rehabilitation Work in Otter Conservation Area to protect the Rare, Endangered and Threatened species and other aquatic life in and around the anicuts:

- i. Restoration work should be taken up during the period December to June only to avoid disturbance to the aquatic fauna. During this period, flow of water in the river is minimal and chances of floods are very less.
- ii. Before commencement of the restoration activities, ring bunds should be built 50-100 meters away from the *anicut* using sand bags or any such material to facilitate storage of water for the wildlife. Water should be ensured till completion of the restoration work to enable major fauna, fishes and amphibians to remain in their habitat; otherwise, they may migrate to other locations leading to local conflicts.
- iii. Restoration work should start after 9 am and closed by 5 pm so as to make way for feeding needs of crepuscular and nocturnal animals.
- iv. De-silting and de-weeding should be taken up only in the frontal portion of the *anicuts*, but the existing native species of bushes and shrubs along the shore line are to be retained. This will help the animals to take shelter and hide under the cover of vegetation.





- v. Retain the rocky islands, sand dunes and mud banks existing normally in the middle of the *anicut* which would help wildlife such as Smooth-coated Otters and Crocodiles to bask and rest.
- vi. De-weeding of invasive alien weeds like *water hyacinth* and *Ipomoea cornea* is to be taken up in the anicuts on regular basis to prevent siltation as well as maintain healthy ecosystem.
- vii. During restoration work, it is advised to build a stone wall or a concrete wall along the road side of the canal and leave the other end/ bank of the canal as it is with its mud bank and vegetation wherever possible. This will help the endemic life forms such as crabs, amphibians, snakes, turtles and birds to feed, nest and live making use of the available resources.
- viii. While de-silting and removing the existing structures of the *anicuts*, precaution should be taken to avoid any kind of harm or disturbance to the wild life forms such as turtles, snakes, monitor lizards, Crocodiles, amphibians and fishes which generally hide under the crevices of walls. Further, they should be rescued and shifted to safer locations. In case any nest of Crocodile or Turtle is spotted, it should be protected or shifted scientifically to a safer location.
- ix. Awareness program on '*the wild life of the river and conservation*' should be conducted for workers, supervisors and managers before the restoration work is begun.
- x. After completion of the restoration work, all debris of sand bags, plastic, oily soil, and metals should be removed and cleaned.
- xi. Hoardings, signages, bill boards etc. should be erected depicting the heritage of *anicuts* and the biodiversity within these areas.
- xii. Water Users Cooperative Societies, where existing, and officials of KNNL, KFD and local conservation NGO within the jurisdiction of each of the *anicuts* may be involved to monitor the rehabilitation activities and take care of maintenance of the *anicuts* and channels.
- xiii. A trained rescue team should be kept on standby for safe rescue operations of any aquatic fauna including for those in distress during restoration activities. One of the rescue team members should be present at the site to rescue and release the wildlife in safe nearby locations.
- xiv. Assistance of a Naturalist/ Wildlife researcher may be taken on ad hoc basis to advise, oversee and monitor rehabilitation activities.
- xv. Study likely changes in irrigation, ecology and behavior of wild fauna in the project area as part of research, documentation and publication (**See Appendix- C for additional Notes**).




5.1.3 Guidelines for Construction of Secondary Ring Bunds





120. 'Coffer dams' or primary ring bunds are planned to be constructed close to each anicut to check water and facilitate restoration work. If water from the anicut is drained completely to make way for construction of the anicuts, routine movement and activity of aquatic fauna such as Otters, Crocodiles, Turtles and fishes will be affected and may lead to their

depletion. Therefore, water in the anicuts should be retained by building another temporary structure or a 'secondary ring bund' to retain water on the upstream side of each anicut. This secondary ring bund shall be built under the guidance of the Biodiversity Adviser/agency at a safe distance of at least 50 meters from the place of work to prevent disturbances such as noise during construction activity. These secondary ring bunds act as temporary anicuts and do not affect the routine activity of aquatic fauna. Before construction both types of ring bunds, a "location specific pre-construction survey" for the nesting birds and other aquatic faunal species shall be conducted. Based on the suggestions by the biodiversity adviser/ agency, ring bunds shall be constructed.

121. In case site conditions permit, both the primary and secondary ring bunds can be merged together to form a single diversion structure.
122. Both primary and secondary ring bunds or coffer dams shall be dismantled and removed completely after completion of restoration of anicuts.
123. The structure, length and width of each secondary ring bund varies depending upon the specific location, season and condition of the anicut. Hence, each aspect shall be meticulously planned before construction of secondary ring bund.
124. Details of secondary ring bunds for restoration of anicuts within the OCR area:

S. No.	Photo of the anicut	Details
1	<p>Fig - 20 Interventions: Hosuru/Bella Anicut</p>  <p>The image shows a satellite view of the Hosuru/Bella Anicut. A yellow arrow points to a line of sand bags across the river. A red arrow points to a structure labeled 'Otters'. The Google Earth logo is visible in the bottom right corner.</p>	<p>Bella anicut:</p> <ol style="list-style-type: none"> 1. Otters and Crocodiles are active in this anicut. 2. A suitable secondary ring bund shall be built across the river in the upstream of the anicut.
2	<p>Fig-21 Interventions- Turtha anicut</p>  <p>The image shows a satellite view of the Turtha anicut. A yellow arrow points to a line of sand bags across the river. The Google Earth logo is visible in the bottom right corner.</p>	<p>Turtha Anicut:</p> <ol style="list-style-type: none"> 1. A complex of 5 and more anicuts. 2. Excessive weed grown and flow choked due to excessive sedimentation. 3. Suitable secondary ring bund to be built based on the physical condition of the anicut.

<p>3</p>	<p>Fig- 22 Interventions - Ramasagara Anicut</p> 	<p>Ramasagara Anicut</p> <ol style="list-style-type: none"> 1. It is a very long anicut. 2. Otters and Crocodiles are present in good numbers in this anicut area. 3. Existing islands shall not be destroyed. 4. Secondary ring bunds shall be planned meticulously based on the existing anicut condition and water level in the anicut area.
<p>4</p>	<p>Fig -23 Interventions - Kampli anicut</p> 	<p>Kampli Anicut</p> <ol style="list-style-type: none"> 1. Otters are present in good number in the anicut area. 2. A suitable secondary ring bund shall be built based on the condition of the site and season.
<p>5</p>	<p>Fig -15 Interventions: Hulagi anicut</p> 	<p>Hulagi Anicut</p> <ol style="list-style-type: none"> 1. It is a very broad anicut. 2. Otters and Crocodiles are present in good number in this anicut. 3. Otters use the long “finger shaped” islands for resting and mass defecation. 4. They also breed inside the rocky island around anicut. 5. Construction of secondary ring bund shall be planned meticulously based on the condition of the anicut and season.

<p>6</p>	<p>Fig-16 Interventions - Shivapura anicut</p> 	<p>Shivapura Anicut</p> <ol style="list-style-type: none"> 1. Otters and Crocodiles are in good number in the upstream of the anicut. 2. Construction of Secondary ring bund shall be planned based on the condition.
<p>7</p>	<p>Fig - 17 Interventions- Sanapura /Anegundi anicut</p> 	<p>Sanapura Anicut</p> <ol style="list-style-type: none"> 1. Otters use the anicut as corridor. 2. The Secondary ring bund shall be built across the narrow part of the river.
<p>8</p>	<p>Fig-18 Interventions - Upper Gangavathi</p> 	<p>Upper Gangavathi Anicut</p> <ol style="list-style-type: none"> 1. It is a very long anicut. 2. Most of the anicut area is excessively silted up. 3. The secondary ring bund shall be built based on the condition of the location.
<p>9</p>	<p>Fig-19 Interventions - Lower Gangavathi anicut</p> 	<p>Lower Gangavathi Anicut</p> <ol style="list-style-type: none"> 1. It is a very long anicut. 2. Secondary ring bunds shall be constructed based on the condition of the anicut.

5.1.4 Ecological Conservation, Restoration and Enhancement of Anicuts of OCR

A. Ecological Conservation

- i. Ecological restoration of VNC *anicuts* and channels shall be undertaken in consultation with the Biodiversity advisor/ agency, who shall be well versed with the native aquatic flora and fauna. He will also supervise ecological restoration/enhancement of the *anicuts* and channels of not only OCR but also rest and *anicuts*.
 - ii. **Secondary Ring Bunds:** Before actual restoration of each *anicut*, a safe and secured secondary ring bund shall be constructed. Each ring bund shall be built in the upstream of each *anicut* in such a way that the routine of the aquatic fauna such as Otters and Crocodiles shall not be altered. Each ring bund shall be built keeping the ecological perspective in mind. The ring bund shall be located least 50 meters from the site of restoration of *anicut*. The advice or suggestions of the biodiversity expert/agency shall be considered during construction of ring bund. This ring bund shall store water and facilitate Otters, Crocodiles, Turtles and indigenous fish species to continue their routine activities.
125. After completion of the restoration of the *anicuts*, the ring bunds shall be removed completely to restore the ecosystem to its previous state.
- iii. **Retention of Islands, Sand and Mud Banks:** The contractor shall retain existing islands, mud and sand banks as they are. These are the natural resting, grooming places of Otters and Crocodiles. Sand banks/ dunes are the places for nesting of Crocodiles and turtles. Stony islands are the breeding areas of Otters. Hence, all such places shall be retained without any disturbance to the OCR area.
 - iv. **Removal of Weeds:** Floating weeds such as *Water hyacinth* and *Ipomoea* shall be removed completely. If any bird's nest or chicks are found, such an area should be left out for 2-3 weeks, as the waterfowls incubate their eggs for 20 to 30 days. Birds like ducks, moorhens, jacanas, grebes etc., make floating nests during monsoon and winter. But Yellow bittern and some other birds breed during summer or early monsoon on floating weeds. So, timely supervision and advise of the "Biodiversity Advisor" should be followed in spirit to take care of such nuances.
 - v. **Awareness Program & Training:** Prior to the beginning of the restoration works, one full day training/ awareness program shall be organized for the project site managers, contractors, sub-contractors, labour contractors, supervising officials etc., in different locations/ regions as per convenience. Another full day training/ awareness program shall be conducted for machinery operators, workers, labourers and all other ground level staff in their respective working areas, well before beginning of the restoration work. Topic for training shall include: brief history of the Vijayanagara *anicuts* and the channels, importance of wildlife, rare aquatic wild flora and fauna of *anicut* area, preventing conflict with wild fauna, how to protect them, how to handle crisis situation, how to rehabilitate the fauna in distress, keeping site area free from disturbance in morning and evenings, no cooking and littering of food and plastic, and use of improvised toilets.

B. Ecological Restoration

- i. **Sediment:** Sedimentation or silt formation over time has decreased the carrying capacity of *anicuts* and the channels. The over growth of invasive alien weeds such as Water Hyacinth and Ipomoea during monsoon and winter covers entire surface of water and during summer the weed dries and decomposes leading to accumulation of silt. As the river has not been flooded for many years, the sedimentation increased to maximum level. Hence, accumulated excessive sedimentation and invasive alien weeds such as Water Hyacinth and Ipomoea shall be removed without destroying the fragile ecosystem of the OCR.
- ii. **Importance of Sediment:** Sediment (or silt) plays a vital role in elemental cycling in the aquatic environment. Sediment is responsible for transporting a significant proportion of many nutrients and contaminants (Bartram. J. *et al* 1996). This is crucial for submerged aquatic flora, and also acts as the place for decomposition of dead matter. The sediment formed over many decades is enabling growth of rich aquatic flora and presence of required dissolved oxygen (DO) for aquatic fauna.

126. Therefore, 1% - 5% or 10% of the rich sediment from the bottom of the *anicuts* shall be removed and retained carefully at the site of restoration and shall be introduced back to the base of *anicut* after completion of the work. The stored sediment shall be spread at the entire bottom of the *anicut* equally. The sediment collected for restoration of ecosystem may have eggs of fishes and other fauna as well as the roots/ rhizomes of the aquatic flora. Therefore, 1 to 5% of the sediment shall help regeneration of native aquatic flora and fauna.
- iii. **Restoration of Aquatic Flora:** Apart from placing back the sediment, biodiversity enhancement measures such as introducing the identified indigenous or native submerged flora such as *Hornwort*, *spirogyra*, *sword plant*, *cryptocoryne species* etc., shall be taken up after completion of the restoration work. More than 10 species of submerged flora are flourishing in different *anicuts* and channels. Need to identify such submerged flora for each site and same species shall be introduced in fraction. Small quantity of the plant matter of submerged aquatic flora will grow slowly and should spread gradually to form a primary succession. This submerged aquatic flora is vital in production of oxygen, in the form of dissolved oxygen (DO) which is a life giver for aquatic fauna. The floating and semi submerged flora occupy their niche area in the secondary succession naturally. Finally, tertiary succession such as bushes and trees along the bank will occupy their niche over a period of time.
- iv. **Rescue & Rehabilitation of Wildlife in Distress:** Many faunal species like Crocodiles, Otters, Snakes, Crabs etc., may have taken refuge inside the cracks and crevices of the walls of the old *anicuts*. Hence, utmost care should be exercised while removing the old *anicuts*. Wherever these faunal species including fishes, crabs, turtles, etc. are present, they shall be allowed to move to the adjacent water body or shall be introduced into the temporary pool made with ring bund around the *anicuts*. Training and awareness programs on aquatic fauna for

- all the ground level staff needs to be conducted well before the start of the restoration work, which will help the staff to act in an eco-friendly manner.
- v. **Restricted Human Activity:** The construction and all related activities in the OCR area shall be restricted between 9 am and 5 pm. No movement of vehicles as well as humans shall be allowed in and around anicuts, before and after this period of time, as Otters are active in morning and evening. The contractor shall provide helmets and jackets of same colour to the workers for easy identification.
 - vi. **Settlement of Workers:** Settlements of workers shall be at least 300 meters away from the site of construction. The contractor shall provide improvised toilets away from the site and should strictly instruct the workers to use them. Open defecation, cooking and littering of food and waste shall be totally prohibited in the site area.
 - vii. **No Pollution:** During construction, hazardous materials such as chemicals, fossil fuel, plastic, tyres, tubes, paint, grease, waste clothes, packing materials etc., shall not be used or littered in and around the *anicuts*. After completion of the work each and every corner of the restoration area and surroundings shall be rid of all such hazardous materials and wastes.
 - viii. **First Aid:** Contractor shall provide a first aid kit and any such safety measures for the safety of the workers. The first aid kit shall be kept at a place of easy access and shall be visible to everyone. Underneath the kit, contact number of the contractor/ ambulance shall be provided for attending to any emergencies.

C. Ecological Enhancement

- i. **Enriching the Ecosystem:** Sedimentation or silt removed and stored separately shall be broadcast over the restored anicut to restore the ecosystem. Along with this, submerged aquatic flora shall also be introduced at different levels of the anicut so as to bring back the aquatic ecosystem.
- ii. **Release of Fingerlings:** After completion of restoration of the anicuts, fingerlings of fishes like *Ruhu* and *Catla* shall be released in the anicut during monsoon so as to provide secured food source for Otters and Crocodiles. The release of fingerlings shall be continued for 3-4 years in each anicut in OCR to safeguard the food source of Otters and Crocodiles.
- iii. **Weed Removal:** Alien invasive weeds such as Water Hyacinth and Ipomoea shall be removed from the anicuts from time to time to maintain the health of each anicut for 3-4 years. Separate budget may be provided for removal of weeds periodically from each anicut for a period of 3-4 years.
- iv. **Advocacy:** After restoration of each anicut, fishing shall be stopped in the anicut area (from the anicut to 200 meters upstream). For achieving this objective, advocacy shall be taken up at different levels to prevent fishing within the purview of each anicut. Threats to wildlife such as fishing, sand mining, release of effluents-



sewage, use of dynamites or explosives for fishing shall be prevented for secured and safe future of aquatic fauna. The Biodiversity Adviser/ Agency shall take up this responsibility to safeguard the anicuts as well as the aquatic RET fauna. There shall be a separate budget for advocacy and lobbying.

- v. **Research and Documentation/ Monitoring:** Restoration and enhancement of ecosystem shall be documented regularly along with evidence of flourishing of aquatic RET species of fauna. Research on restoration of ecosystem shall be taken up and (positive) changes shall be documented systematically. After completion of 4 years of ecological restoration and enhancement, a research report shall be published to establish the validity of scientific approach followed for restoration of the anicuts. There shall be a separate budget for this activity for 4 years of research and documentation.

5.2 Site Specific recommendations: *Hulugi anicut*

127. Located in the Left bank of Tungabhadra river near Holey Mudlapura and Matti Mudlapura, the Hulugi *anicut* shelters significant population of smooth coated Otters, Crocodiles and other major fauna. Sand dunes and mud islands serve as a very good resting and grooming site for Otters. About 3 holts have been observed with 24 positive sites. This indicates that the Otters depend upon the habitat of Hulugi *anicut*. But destruction of bunds and excessive siltation and Eutrophication has deteriorated the *anicut*.

128. Following recommendations are made:

- Strengthen the weir of the *anicuts* in the following manner without disturbing the habitat and natural behavior of the major fauna.
- Otters are found to rest and groom in the middle mud islands and breeds in the rocky holts around this *anicut*. Therefore, it is advised to build ring bunds of sand bags or any such barrage to hold water during the restoration period. As the terrain is rocky, it is advised to use man power and small machines to remove silt and reconstruct the weirs.
- All the general recommendations mentioned in the foregoing are also applicable to this site.

5.3 Site Specific recommendations: *Shivapura anicut*

129. Located on the Left bank of Tungabhadra River, Shivapura *anicut* shelters smooth coated Otters, Crocodiles and other major fauna. Though the weir across the left bank river is small, its upstream side has several mud banks and large pools. Sand dunes and mud islands provide a very good resting and grooming site for Otters. Here, 2 holts have been found with 8 positive sites. This indicates that the Otters depend upon the habitat of Shivapura



anicut. It is found that this anicut is the most favorable site for the Crocodiles to breed. By the side of a large pool on the upstream side, 3 nests of Crocodiles with 30 eggs are found in each nest. This indicates the importance of this *anicut* for Crocodiles.

130. Therefore, following recommendations are made:

- The main *anicut* or the weir of Shivapura is only 0.17 km at the tail end of a narrow stream on the left bank. The river in the upstream takes the shape of a canal due to the presence of a large island in the middle of the river. Another weir is located near the Markandeya Temple. Before taking up of reconstruction of the weirs, it is advised to build a temporary weir across the river about 75-100 meters from the *anicut*. It was observed that there was very less activity of major fauna around these two weirs. Moreover, this part of *anicuts* has a lot of disturbance due activity agricultural and religious activities. Therefore, use of large machinery may not pose any threats to the major fauna.
- All the other general recommendations made in the foregoing apply.

5.4 Site Specific recommendations: *Anegundi anicut*

131. Located on the Left bank of Tungabhadra River, Anegundi anicut shelters smooth coated Otters, Crocodiles and other major fauna. The weir is built across the left bank using a natural structure of rocks. There are large pools of water and a rocky terrain on the upstream side of this *anicut*. Sand dunes and mud islands here provide a very good resting and grooming site for Otters. During the study period, 4 holts were located with 23 positive sites. This location is also favorable site for breeding Crocodiles; 2 nests were found in this area. Apart from these, there are indirect evidences of leopards and sloth bear. This indicates the importance of this *anicut* for the major fauna.



132. The following recommendations are made:

- The main *anicut* or the weir of Anegundi is about half a kilometer. A crescent shaped primary barrage is built using large granite slabs on the naturally existing rocky terrain. Water is diverted to the VNC by a long weir built parallel to the river which towards the end deviates from the river.
- Before taking up of reconstruction of the weirs, it is advised to build a temporary ring bund across the river about 75-100 meters from the front primary *anicut*.
- General recommendations made in the foregoing apply and are to be strictly followed.

5.5 Site specific recommendations: Upper Gangavathi anicut

133. Located on the Left bank of Tungabhadra River, Upper Gangavathi anicut also shelters smooth coated Otters, Crocodiles and other major fauna but comparatively less in number due to the deteriorated condition of the *anicut*. There are large pools and rocky terrain on the upstream side of this *anicut*, but all are excessively silted up and covered completely with invasive alien weeds like *water hyacinth*, and *Ipomoea cornea*. In addition, illegal sand mining is rampant which has also weakened or damaged the weirs. There are a number of weirs in different locations which are severely damaged over time and with leakages. Therefore, this *anicut* has lost its storage capacity. During the study, only one holt of smooth coated otter was found with 7 positive sites. Only one nesting site of Crocodiles was found with two positive sites. Apart from these, indirect evidence of jackals and sloth bears was found. This indicates the importance of this *anicut* for the major fauna.



134. The following recommendations are made:

- The *anicut* of the Upper Gangavathi is about 0.78 km running parallel to the river. Hence, there is a need for careful planning while taking up the implementation work.
- Before taking up reconstruction of the weirs, it is advised to build temporary barrages across the river about 25-50 meters from the primary *anicut*.
- General recommendations made in foregoing is to be strictly followed.

5.6 Site Specific recommendations: Lower Gangavathi anicut

135. Located on the Left bank of the Tungabhadra River, Lower Gangavathi anicut is the last *anicut* on the left bank. Though the location is ideal for major fauna, very less number of positive sites were found in its vicinity. There are large pools and rocky terrain on the upstream side of this *anicut*; but. all are excessively silted up and covered completely with invasive alien weeds like *water hyacinth* and *Ipomoea cornea* at the end of the anicut. Due to this reason, very less positive sites were found during the rapid assessment. Only two positive sites of Smooth coated otter were found here with no indication of Crocodiles. However, local people emphasized the presence of a number of Crocodiles hidden under the carpet of weeds.



136. Therefore, following recommendations are made:

- There is a long *anicut* or weir built parallel to the river with sluice gates. The length of this weir is 0.45 km. Here, it is necessary to build 3 temporary ring bunds of sand bags to store water during restoration works. Another barrage or weir is located at the extreme end of the *anicut* at the eastern end from where water deviates from the river. Here, it is necessary to build a temporary ring bund of sand bags to store water during bund renovation.
- General recommendations stated in the foregoing are applicable to this site also and need to be followed strictly.



5.7 Site Specific recommendations: *Bella / Hosur anicut*

137. Bella or Hosur anicut is located on the right bank of Tungabhadra River near Hosur village in Hospet taluk, Bellary district. The ancient *anicut* is an ideal home for smooth coated Otters, Crocodiles and other major fauna. The weir is built across the right bank river and has a large pool with rocky and mud banks. The rocky boulders present in the right bank provide a favourable site resting, grooming and holt site for Otters. During the study, 2 Holts were located with 23 positive sites. This *anicut* has 3 positive sites of Crocodiles. Located very near to the buzzing highway and human settlements, it is surprising to find both Otters and Crocodiles existing without get disturbed.



138. The following recommendations are made:

- The main *anicut* or the weir of the Hosur is 0.602 kilometer. The long barrage was built along the granite surface of the river, supported with large granite slabs.
- Before taking up reconstruction of the weirs, it is advisable to build a temporary barrage on the front portion of the *anicut* to store water for the existing wildlife.
- General recommendations stated in the foregoing are applicable to this site and should be strictly followed.

5.8 Site Specific recommendations: *Turtha anicut*

139. Turtha anicut is the first barrage built by the 2nd Emperor of the Vijayanagara Empire, Bukka Deva Raya II, during 1399-1406 to provide water to Hampi-the capital city. It is located on the right bank of the Tungabhadra River about 1 km away from Hampi in Hospet taluk. The ancient *anicut* is an ideal home for smooth coated Otters, Crocodiles and other major fauna. The length of the weirs is 3.048 km with a chain of small and large bunds built across the river taking advantage of the rocky terrain and boulders. A number of pools is also present. However, due to excessive siltation and over growth of invasive

weeds, leakages and breakages, the entire *anicut* is in a poor physical state. Nevertheless, the rocky boulders and mud banks provide resting, grooming and holt site for Otters. During the study, 2 holts were found with 7 positive sites of smooth coated Otters. This *anicut* has 3 positive sites of Crocodiles. If renovated scientifically, this *anicut* will become an ideal haven for RET species.



140. The following recommendations are made:

- Before taking up reconstruction of the weirs, it is advised to build a number of temporary barrages in front of the weirs to store water for the existing wildlife.
- All other general recommendations made are applicable and are to be strictly followed.

5.9 Site Specific recommendations: *Ramasagara anicut*

141. Ramasagara anicut is another *anicut* with a long bund that runs about 2.042 km from the center of the river, near Ramasagara in Hospet taluk. It is located on the right bank of Tungabhadra River and serves as an ideal home for Smooth Coated Otters, Crocodiles and other major fauna. Though there are issues like excessive siltation and overgrowth of weeds, wildlife is flourishing here. During the study, 4 holts were found with 31 positive sites of smooth coated Otters. About 2 nesting sites of Crocodile with 21 positive sites were also found.



142. Therefore, following recommendations are made:

- Before taking up reconstruction of the weirs, it is advised to build a number of temporary ring bunds in front of the weirs to ensure storage of water for the existing wildlife.
- All other general recommendations made are applicable and are to be strictly followed.

5.10 Site Specific recommendations: *Kampli anicut*

143. Kampli anicut is the last *anicut* on the right bank of the river within the TOCR area. It has a bund of 0.94 km that runs from the center of the river, near Ramasagara in Hospet taluk. The pools and the bund present in this anicut serve as an ideal home for Smooth Coated Otters, Crocodiles and other major fauna. During the study, 3 holts were found

with 17 positive sites of smooth coated Otters. About 2 nesting sites of Crocodile with 16 positive sites were also located.



144. Therefore, the following recommendations are made:

- Before taking up reconstruction of the weirs, it is advised to build a ring bund in front of the weirs to store water for the existing wildlife.
- All other general recommendations remain the same and are to be strictly followed.

6. APPENDICES

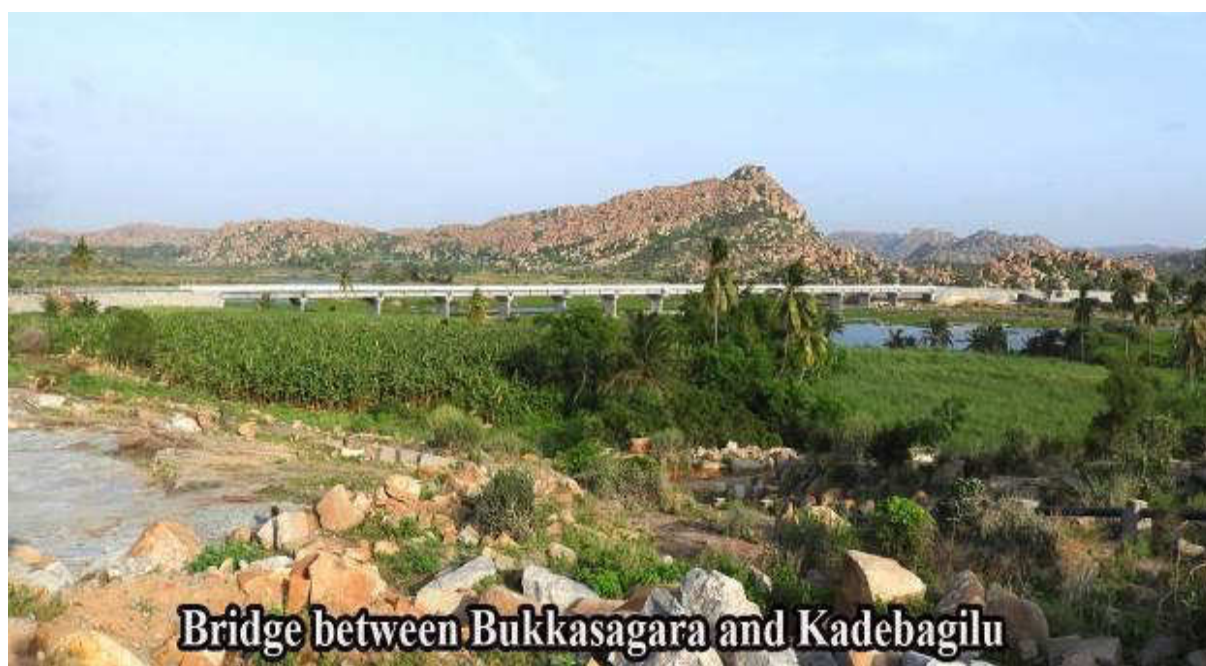
Appendix-A

Additional Notes

Evidences of Otters surviving short period of disturbances:

A bridge connecting Bukkasagara in Hospet taluk and Kadebagilu in Gangavathi taluk was built across river Tungabhadra. The construction work began in June 2014 and completed by February 2017. The Bridge was 0.65 kms long built passing through the habitat of Smooth-coated Otters in the River Tungabhadra. The construction work took place for two and half years, employing heavy machinery and a large work force. The flowing water was mostly blocked by temporary barrages, allowing water to flow in one narrow path. While construction work was under progress, local fishermen continued to fish around the bridge. The fishermen shared that even during the peak of construction period, Otters were riding upon their nets to steal trapped fishes. However, Otters were maintaining a safe distance of 100-200 meters away from the construction site during busy hours of construction activities.

During the RBA, researchers found 3 holts and hectic activity of the Otters under both sides of the bridge. Whenever fishermen went for pulling out their nets, Otters arrived to steal or hunt for fish. Somehow, Otters consider fishermen as their friend and not a potential threat like Crocodile and dogs. In this site, there is a breeding population of Otters; fishermen confirmed that they breed in the holts of these mud islands covered with thick growth of grasses and bushes.



Thus, we can infer that the Smooth-coated Otters are highly adaptable; they can put up with temporary disturbances. Though the disturbance extended to two and a half years, and the present hectic movement of vehicles on the bridge appears to be disturbing them, their population is increasing in this particular part. Moreover, in this part of the river water flows throughout the year, whereas most of the anicuts are excessively silted and infested with weeds like water hyacinth and Ipomoea. This resulted in the degradation of anicuts with reduced Otter movement to the river.

If the anicuts are de-silted and restored, the population of Otters shall flourish once again.

Note: Google images given below, photos and videos which show the change of habitat and subsequent restoration of Otters.

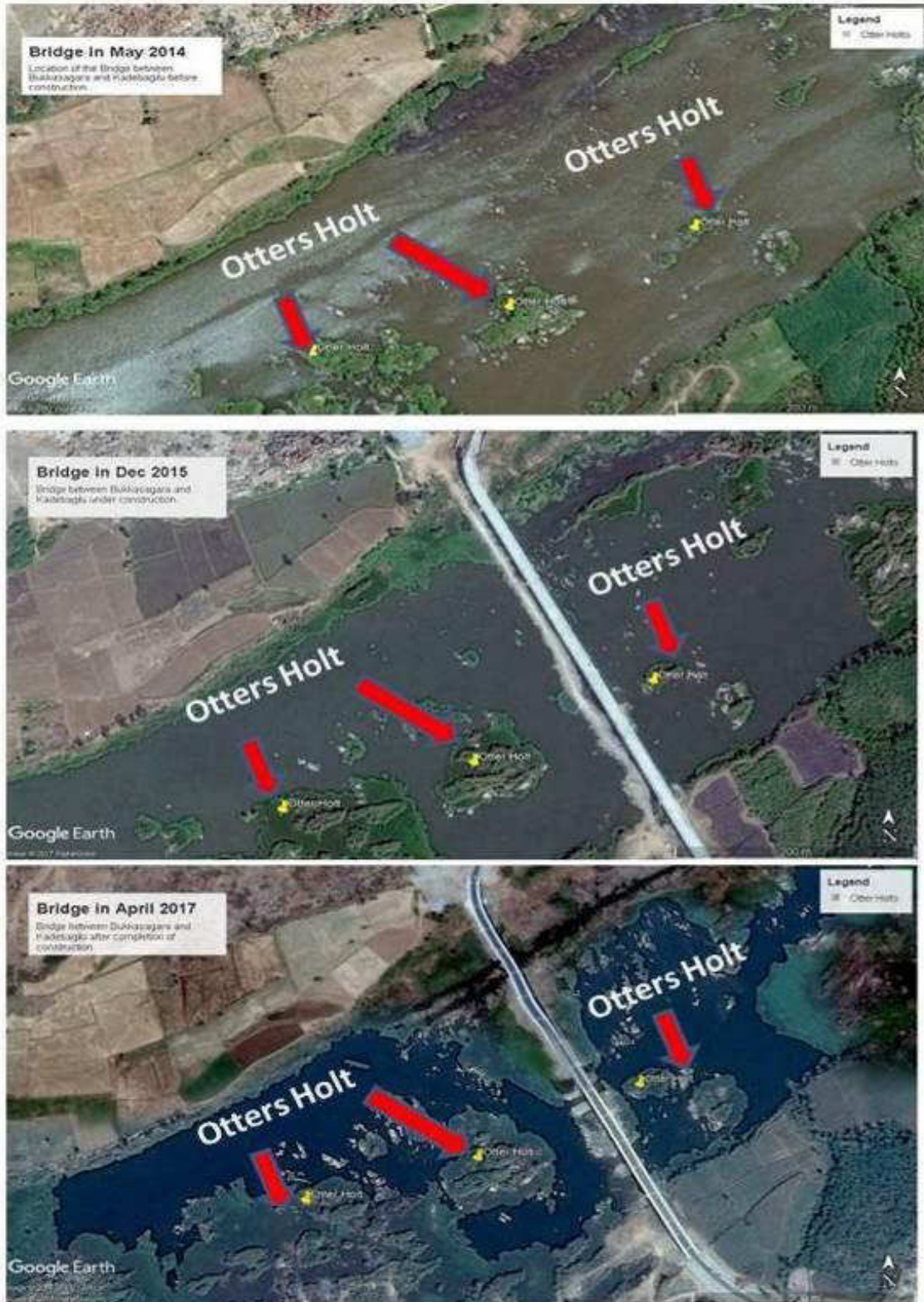


Literature:

A study conducted for finding out the disturbances of developmental activities on Otters in Turkey indicated that higher sprinting activity was found at a site below the dam due to the relatively more stable standing water formed at the foot of the dam, offering sufficient food availability at this site throughout the year (Ulhami and Urfan, 2004)¹.

1. Ülhami T.Z.N, Ürfan ALBAYRAK (2004) **The Effect of Disturbances to Habitat Quality on Otter (*Lutra lutra*) Activity in the River Kyzilirmak (Turkey): A Case Study.**

Different stages of construction of Bridge between Bukkasagara and Kadebagilu across River Tungabhadra



Appendix -1 Some images of Otter habitat and its behaviour



Otters Holt at Hulagi anicut



Otter spraint (defecate) at the entrance of the Holts *en mass*



Otters mass latrine or spraint and grooming site at Hulagi anicut



Otters defecate *en mass* at the grooming and basking sites to demarcate their territory.



Otter's mass latrine or spraint marks in different *anicuts* of TOCR.



Otters Holt near *Hole Mudlapura* village very close to human habitation.



Otters hunt for large fishes like this *Deccan Masheer* and litter tail end at the bank which is scavenged by Kites and Crows.

Appendix- 2 Fish fauna of Tungabhadra River

Note: During the rapid assessment the following fishes are documented.



Oreochromis mossambica IUCN- NT



Pseudotroplus maculatus IUCN- LC



Parambassis ranga IUCN- LC



Tor khudree IUCN- EN



Labeo rohita IUCN- LC



Catla catla IUCN- LC



Wallago attu IUCN- NT



Silonia childreni IUCN- EN



Gagata itchkeea IUCN- VU



Mystus cavasius IUCN- LC



Osteobrama belangeri IUCN- NT



Rita gogra IUCN- LC



Garra fuliginosa IUCN- LC



Garra bicornuta IUCN- NT



Xenentodon cancila IUCN- LC



Hyporhamphus limbatus IUCN- LC



Neotropius khavalchor DD

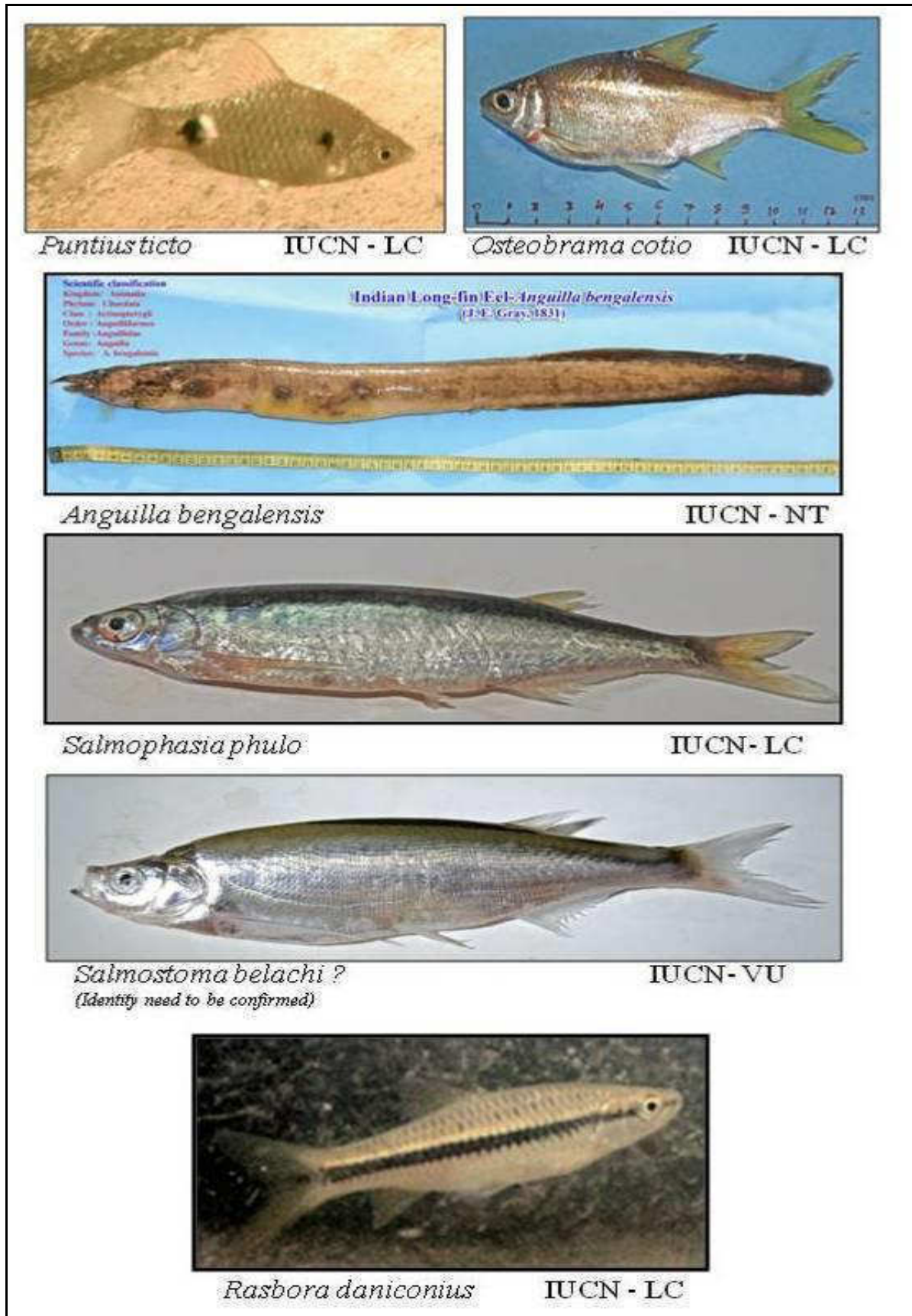


Notopterus notopterus IUCN- LC



Channa marulius

IUCN- LC



Appendix -3

Some Amphibians of TOCR area



Common Indian Tree Frog



Indian Skipper Frog



A tiny Bush Frog



Common Indian Toad



Narrow-mouthed Frog



Termite nest Frog



Indian Bullfrog



Ferguson's toad

Note: All the above frogs and toads area listed under Least Concerned (LC) by IUCN

Appendix -4 Images of some reptiles in and around TOCR area



**Indian Star Tortoise-
Geochelone elegans VU**



Indian Chameleon LC



Rock Agama LC



Spotted supple Skink NE



Oriental Garden Lizard NE



Monitor Lizard



Bronze-backed Tree Snake NE



Cat Snake NE



Green Vine Snake NE



Barred Wolf Snake NE



Rat Snake NE



Russel's Viper VU



Red Sand Boa NE



Spectacled Cobra NE

EN-Endangered, VU-Vulnerable, NT-Near Threatened, LC-Least Concern, NE - Not Evaluated

Appendix-4 Images of some reptiles of TOCR area



Mugger Crocodile-*Crocodylus palustris* IUCN status VU



**Leith's Soft-shell Turtle-*Nilssonina leithii*
IUCN status VU**



**Indian Narrow-headed Soft-shell Turtle.
-*Chitra indica* IUCN status EN**



**Indian Flap Shell-*Lissemys punctata*
IUCN status LC**



**Indian Black Turtle
Melanocheilus trijuga IUCN status NT**

EN-Endangered, VU-Vulnerable, NT-Near Threatened, LC-Least Concern, NE - Not Evaluated

Appendix-5 Some Birds of aquatic habitat of TOCR



Greater Cormorants Roosting in the middle of the river LC



Black-winged Stilt LC



Black-crowned Night Heron LC



Little Egret LC



Black-headed Ibis NT



Blue-tailed Bee Eater LC



Asian Openbill LC



Baya Weaver LC



Streaked Weaver LC



Purple Swanphen LC

Appendix-5 Some Birds of aquatic habitat of TOCR



Purple Heron LC



Oriental Darter NT



Grey Heron LC



Lesser Whistling Duck LC



Common Coot LC



Small Kingfisher LC



Spot-billed Duck LC



River Tern (Juvenile) NT



Little Grebe LC

VU-Vulnerable, NT-Near Threatened, LC-Least Concern,

Appendix -6 Some mammals in and around TOCR



Indian Leopard VU



Smooth-coated Otter VU



Jungle Cat LC



Indian Jackal LC



Indian Sloth Bear EN



Hanuman Langur LC



Bonnet Macaque LC



Indian Porcupine LC



Small Indian Civet LC



Rusty-spotted Cat NT



Indian Palm Squirrel LC



Common Palm Civet LC



Indian Grey Mongoose LC



Indian Pangolin EN

EN-Endangered, VU-Vulnerable, NT-Near Threatened, LC-Least Concern,
 *File photos for reference, only some of them photographed during the research period.

Appendix-7

Some aquatic plants of TOCR



Dwarf copperleaf - *Alternanthera sessilis*



Esthwaite Waterweed - *Hydrilla verticillata*



Water Lettuce - *Pistia stratioides*



Duck weed - *Lemna perpusilla*



Water silk - *Spirogyra indica*



Hornwort - *Ceratophyllum demersum*



Lesser Indian Reed Mace - *Typha angustata*



Spotted Knot weed - *Persicaria lapathifolia*



Common Sopubia - *Sopubia delphinifolia*

Appendix-8: Some aerial images of the *anicuts* in TOCR







7. ANNEXURES

Annexure 1: Checklist of Fish fauna of Tungabhadra River

S. No	Scientific name	Common name	Local name	IUCN Status
ORDER: I PERCIFORMES		FAMILY: 1. AMBASSIDAE		
1	<i>Chanda nama</i> (Hamilton, 1822)	Elongate glass perchlet	Bachanike meenu	LC
2	<i>Parambassis ranga</i> (Hamilton, 1822)	Indian glassy fish	Bachanike meenu	LC
		FAMILY: 2 CHANNIDAE		
3	<i>Channa marulius</i> (Hamilton, 1822)	Giant snake head	Murrel/ Avlu mottu	LC
4	<i>Channa striata</i> (Bloch, 1793)	Striped snake	Kutchchu	LC
5	<i>Channa punctatus</i> (Bloch, 1793)	Bloch / snake head	Murrel	LC
		FAMILY: 3 CICHLIDAE		
6	<i>Pseudotropheus maculatus</i> (Bloch, 1795)	Orange Chromide	Eli meenu/ Harishina meenu	LC
7	<i>Oreochromis mossambica</i>	Tilapia	Jilebi meenu	NT
		FAMILY: 4 GOBIDAE		
8	<i>Glossogobius giurus</i>	Bar-eyed Gobi	Bhangi sidda	VU
		FAMILY: 5 OSPHRONEMIDAE		
9	<i>Macropodus cupanus</i> (Cuvier, 1831)	Spike-tail paradise fish	Champarke	VU
ORDER: II ANGUILLIFORMES		FAMILY: 6 ANGUILLIDAE		
10	<i>Anguilla nebulosa</i> (Mc Clelland, 1894)	Mottled eel	Havu meenu	LC
ORDER: III CYPRINODONTIFORMES		FAMILY: 7 APLOCHELIDAE		
11	<i>Aplocheilus lineatus</i> (Valenciennes, 1840)	Golden wonder killi fish	Moogu malli	LC
ORDER: IV SILURIFORMES		FAMILY: 8 BAGRIDAE		
12	<i>Sperata seenghala</i> (Sykes, 1839)	Giant river catfish	Dodda bale meenu	LC
13	<i>Hemibagrus maydelli</i> (Rossel, 1964)	Krishna mystus	Haddu meenu	LC
14	<i>Mystus aor</i> (Hamilton, 1822)	Long whiskered cat fish	Suragi	LC
15	<i>Mystus cavasius</i> (Hamilton, 1822)	Gangetic mystus	Meese girla	LC
16	<i>Rita hastata</i> (Valenciennes, 1840)	Deccan rita	Gokra	LC
17	<i>Rita gogra</i> (Valenciennes, 1840)	Gogra rita	Arshina Goggarike	LC
		FAMILY: 9 PANGASSIDAE		
18	<i>Pangassius pangassius</i> (Hamilton, 1822)	Pangas cat fish	Polgeker / Pangas	LC
		FAMILY: 10 SCHILBEIDAE		
19	<i>Neotropius khavalchor</i> (Kulkarni, 1952)	Khavalchor cat fish	Ili meenu	DD
20	<i>Pseudeutropius goongwaree</i> (Sykes, 1839)	Indian potasi	Halathi	DD

21	<i>Pseudeutropius takree</i> (Sykes, 1839)	Indian takree	Halathi	LC
22	<i>Silonia childreni</i> (Sykes, 1839)	White catfish	Bili-halathi	EN
23	<i>Silonia silondia</i> (Hamilton, 1822)	Silond catfish	NS	LC
FAMILY: 11 SILURIDAE				
24	<i>Ompok bimaculatus</i> (Bloch, 1794)	Butter cat fish	Godli / Pabda	NT
25	<i>Ompok pabo</i> (Hamilton, 1822)	Pabo catfish	NS	NT
26	<i>Wallago attu</i> (Bloch & Schneider, 1801)	Great white sheatfish/boal	Baale meenu	NT
FAMILY: 12 SISORIDAE				
27	<i>Bagarius bagarius</i> (Hamilton, 1822)	Gangetic goonch	NS	NT
28	<i>Gagata itchkeea</i> (Sykes, 1839)	Deccan nangra	Bande garlu	VU
ORDER: V CYPRINIFORMES		FAMILY: 13 BALITORIDAE		
29	<i>Homaloptera maculata</i> (Gray, 1820)	Rock carp / Loach	Kalla	LC
30	<i>Indoreonectes evezardi</i> (Day, 1872)	Ray finned fish	Murangi	LC
31	<i>Schistura semiarmata</i> (F. Day, 1867)	Dotted loach	Murangi	LC
FAMILY: 14 COBITIDAE				
32	<i>Botia striatus</i> (Narayan Rao, 1920)	Zebra / Tiger loach	Handi meenu	EN
33	<i>Lepidocephalichthys thermalis</i> (Valenciennes, 1840)	Common spiny loach	Hunase	LC
FAMILY: 15 CYPRINIDAE				
34	<i>Amblypharyngodon mola</i> (Hamilton, 1822)	Mola carplet	Enapu pakke	LC
35	<i>Cabdio morar</i> (Hamilton, 1822)	Aspidoparia	Ola halale	LC
36	<i>Barilius barila</i> (Hamilton, 1822)	Barred baril	Chalake	LC
37	<i>Barilius barna</i> (Hamilton, 1822)	Barna baril	Kere kalyani	LC
38	<i>Barilius bendelisis</i> (Hamilton, 1807)	Mirror fish	Belichi	LC
39	<i>Catla catla</i> (Hamilton, 1822)	Catla	Katla	LC
40	<i>Chela cachius</i> (Hamilton, 1822)	Silver hatchlet chela	Barle	LC
41	<i>Cirrhinus cirrhosa</i> (Bloch, 1795)	Mrigal carp	Arja	VU
42	<i>Cirrhinus fulungee</i> (Sykes, 1839)	Deccan white carp	Arja	LC
43	<i>Cirrhinus mrigal</i> (Hamilton, 1822)	Mrigal	Mriga	LC
44	<i>Cirrhinus reba</i> (Hamilton, 1822)	Reba carp	Arja	LC
45	<i>Ctenopharyngodon idella</i> (Valenciennes, 1844)	Grass carp	Hullu gende	NE
46	<i>Cyprinus carpio carpio</i> (Linnaeus, 1758)	Wild common carp	Samanya gende	VU
47	<i>Danio aequipinnatus</i> (Mc Clelland, 1839)	Giant danio	Bidirele	DD
48	<i>Esomus danrica</i> (Hamilton, 1822)	Flying barb	Meese pakke	LC
49	<i>Garra bicornuta</i> (Narayan Rao, 1920)	Tunga garra	Mukudigya	NT

50	<i>Garra fuliginosa</i> (Fowler, 1934)	Single horn Garra	Mukudi	LC
51	<i>Labeo bata</i> (Hamilton, 1822)	Minor carp/ blackline	Kolchu meenu	LC
52	<i>Labeo boga</i> (Hamilton, 1822)	Boga labeo	NS	LC
53	<i>Labeo boggut</i> (Sykes, 1839)	Boggut labeo	Gubbali	LC
54	<i>Labeo calbasu</i> (Hamilton, 1822)	Karnataka labeo	Kage	LC
55	<i>Labeo fimbriatus</i> (Bloch, 1795)	Fringe-lipped peninsula carp	Kemmeenu	LC
56	<i>Labeo kontius</i> (Jordon, 1849)	Pigmouth carp	Moogi halale	LC
57	<i>Labeo pangusia</i> (Hamilton, 1822)	Pangusia labeo	Pangus	NT
58	<i>Labeo porcellus</i> (Haeckel, 1844)	Bombay labeo	Kaki dindu	LC
59	<i>Labeo potail</i> (Sykes, 1839)	Deccan labeo	Argaleo mosu	EN
60	<i>Labeo rohita</i> (Hamilton, 1822)	Rohu	Rohu	LC
61	<i>Osteobrama belangeri</i> (Valenciennes, 1844)	Manipur osteobrama	Kambagi	NT
62	<i>Osteobrama cotio</i> (Hamilton, 1822)	Ray finned fish	NS	LC
63	<i>Osteobrama neilli</i> (Day, 1873)	Nilgiri	Koona	LC
64	<i>Osteobrama vigorsii</i> (Sykes, 1839)	Godawari osteobrama	Koera / Parake	LC
65	<i>Osteochilus nashii</i> (Day, 1869)	Konti barb	Kantaka / Bagasi	LC
66	<i>Oxygaster clupeoides</i> (Bloch, 1795)	Razor belly minnow	NS	LC
67	<i>Puntius amphibius</i> (Valenciennes, 1842)	Scarlet banded barb	Pakke meenu	DD
68	<i>Puntius carnaticus</i> (Jordon, 1849)	Carnatic carp	Machalu	LC
69	<i>Puntius chola</i> (Hamilton, 1822)	Chola barb	Dodda karse	LC
70	<i>Hypselobarbus dobsoni</i> Day, 1876)	Krishna carp	Say meenu	DD
71	<i>Puntius dorsalis</i> (Jordon, 1849)	Long snouted barb	Mooti gende	LC
72	<i>Hypselobarbus kolus</i> (Sykes, 1839)	Kolus	Kolsu	VU
73	<i>Puntius narayani</i> (Hora, 1937)	Narayan barb	Narayani/ pakke	LC
74	<i>Puntius bimaculatus</i> (Bleeker, 1863)	Long snout bard	Pakke	LC
75	<i>Hypselobarbus pulchellus</i> (Day, 1870)	Ray-finned Fish	Harigi/ Saymeen	CR
76	<i>Puntius sarana</i> (Hamilton, 1822)	Olive barb	Did pakke/ gende	LC
77	<i>Puntius sophore</i> (Hamilton, 1822)	Spot fin swamp barb	Gude pakke	LC
78	<i>Puntius ticto</i> (Hamilton, 1822)	Ticto barb	Bud pakke/naya pais	LC
79	<i>Rasbora daniconius</i> (Hamilton, 1822)	Slender / blackline barb	Golai	LC
80	<i>Rohtee ogilbii</i> (Sykes, 1839)	Vatani rohtee	Batte garra / Bipsi	LC
81	<i>Salmophasia phulo</i> (Hamilton, 1822)	Fine scale minnow	Malli meenu	LC
82	<i>Schismatorhynchus nukta</i> (Sykes, 1839)	Moray/double mouth tor	Mukarathi	LC
83	<i>Thynnichthys sandkhol</i> (Sykes, 1839)	Sandkhol carp	Banga	EN

84	<i>Tor khudree</i> (Sykes, 1839)	Deccan / black Mahseer	Kaage meenu	EN
85	<i>Tor mussullah</i> (Sykes, 1839)	Hump back mahseer	NS	EN
ORDER: VI BELONIFORMES		FAMILY: 16 BELONIDAE		
86	<i>Xenentodon cancila</i> (Hamilton, 1822)	Needle nose fish	Sooji meenu	LC
FAMILY: 17 HEMIRAMPHIDAE				
87	<i>Hyporhamphus limbatus</i>	Congaturi halfbeak	Sanna suji meenu	LC
ORDER: VII SYNBRANCHIFORMES		FAMILY: 18 MASTACEMBELLIDAE		
88	<i>Mastacembelus armatus</i> (Lacepede, 1800)	Spiny eel	Haavu meenu	LC
89	<i>Macrogathus pancalus</i> (Hamilton, 1822)	Striped spiny eel	Haavu meenu	LC
ORDER: VIII. OSTEOGLOSSIFORMES		FAMILY: 19 NOTOPTERIDAE		
90*	<i>Notopterus notopterus</i> (Pallas, 1769)	Bronze feather back	Chappali meenu	LC
(CR -Critically Endangered, EN-Endangered, VU- Vulnerable, NT-Near Threatened, LC-Least Concern, DD-Data deficient, NE = Not Evaluated) . NS = No specific name)				

Annexure 2: Checklist of Frogs and Toads in TOCR area

S. No.	Common Name	Scientific Name	Frequency	Residential Status	IUCN Status
Order: 1. Anura					
Family: 1. Rhacophoridae					
1	Indian tree frog	<i>Polypedates maculatus</i>	Common	Resident	LC
Family: 2. Dicroglossidae					
2	Indian bullfrog	<i>Hoplobatrachus tigerinus</i>	Common	Resident	LC
3	Indian skipper frog	<i>Euphlyctis cyanophlyctis</i>	Common	Resident	LC
Family:3. Microhylidae					
4	Red narrow-mouthed Frog,	<i>Microhyla rubra</i>	Common	Resident	LC
5	Termite nest Frog	<i>Ramanella variegata</i>	Common	Resident	LC
Family:4. Nyctibatrachidae					
6	Night Frog	<i>Nyctibatrachus sps</i>	Common	Resident	LC
Family:5. Bufonidae					
7	Asian common toad	<i>Duttaphrynus melanostictus</i>	Common	Resident	LC
8	Ferguson's toad	<i>Duttaphrynus scaber</i>	Common	Resident	LC
(CR -Critically Endangered, EN-Endangered, VU-Vulnerable, NT-Near Threatened, LC-Least Concern, DD-Data deficient, NE = Not Evaluated)					
More amphibians are present, and hence, need to explore in greater detail.					

Annexure 3: Checklist of common reptiles found in and around Tungabhadra Otter Conservation Reserve

S. No.	Common Name	Scientific name	IUCN Status
Geckos and Lizards			
1	Giant Leaf-toed Gecko	<i>Hemidactylus giganteous</i>	LC
2	Rock Gecko	<i>Pristurus rupestris</i>	LC
3	Termite Hill Gecko	<i>Hemidactylus triedrus</i>	NE
4	Rock Agama	<i>Psammophilus dorsalis</i>	LC
5	Common Garden Lizard	<i>Calotes versicolor</i>	NE
6	Forest Calotes	<i>Calotes rouxii</i>	LC
7	Indian Chameleon	<i>Chamaeleo zeylanicus</i>	LC
8	Spotted Supple Skink	<i>Lygosoma punctata</i>	NE
9	Monitor Lizard	<i>Varanus albigularis</i>	NE
Snakes*			
1	Spectacled Cobra	<i>Naja naja</i>	NE
2	Red Sand Boa	<i>Eryx johnii</i>	NE
3	Russel's Boa	<i>Gongylophis conicus</i>	NE
4	Checkered Keelback	<i>Xenochrophis piscator</i>	NE
5	Common Krait	<i>Bungarus caeruleus</i>	NE
6	Common Rat Snake	<i>Ptyas mucosa</i>	NE
7	Russell's Viper	<i>Daboia siamensis</i>	LC
8	Saw-scaled Viper	<i>Echis carinatus</i>	LC
9	Common Indian Cat Snake	<i>Boiga trigonata</i>	LC
10	Common Wolf Snake	<i>Lycodon capicunus</i>	NE
11	Green Vine Snake	<i>Oxybelis fulgidus</i>	NE
12	Bronze-backed Tree Snake	<i>Dendrelaphis tristis</i>	NE
Tortoise and Turtles			
1	Starred Tortoise	<i>Geochelone elegans</i>	VU
2	Indian Flap Shell	<i>Lissemys Punctata</i>	LC
3	Indian Black Turtle	<i>Melanochelys trijuga</i>	NT
4	Leith's Soft-shell Turtle	<i>Nilssonina Leithii</i>	VU
5	Indian Narrow-headed Soft-shell Turtle	<i>Chitra indica</i>	EN
Crocodiles			
1	Mugger Crocodile	<i>Crocodylus palustris</i>	VU
(CR -Critically Endangered, EN-Endangered, VU-Vulnerable, NT-Near Threatened, LC-Least Concern, DD-Data deficient, NE=Not Evaluated)			
* More number of snakes are there, need to identify			

Annexure 4: Checklist of Birds in and around Tungabhadra Otter Conservation Reserve

S. No	Common Name	Scientific Name	Frequency	Residential Status	IUCN Status
	Order: 1. Podicipediformes				
	Family: 1. Podicipedidae				
1	Little Grebe	<i>Tachybaptus ruficollis</i>	Common	Resident	LC
	Order: 2. Pelecaniformes				
	Family:2. Anhingidae				
2	Oriental Darter	<i>Anhinga melanogaster</i>	Uncommon	Seasonal	NT
	Family:3. Phalacrocoracidae				
3	Little Cormorant	<i>Phalacrocorax niger</i>	Common	Resident	LC
4	Great Cormorant	<i>Phalacrocorax carbo</i>	Rare	Seasonal	LC
5	Indian Cormorant	<i>Phalacrocorax fuscicollis</i>	Very Rare	Seasonal	LC
	Family:4. Ardeidae				
6	Grey Heron	<i>Ardea cinerea</i>	Common	Resident	LC
7	Purple Heron	<i>Ardea purpurea</i>	Common	Resident	LC
8	Green-backed Heron	<i>Butorides striata</i>	Rare	Resident	LC
9	Indian Pond Heron	<i>Ardeola grayii</i>	Common	Resident	LC
10	Cattle Egret	<i>Bubulcus ibis</i>	Common	Resident	LC
11	Little Egret	<i>Egretta garzetta</i>	Common	Resident	LC
12	Intermediate Egret	<i>Mesophoyx intermedia</i>	Common	Resident	LC
13	Eastern Great Egret	<i>Ardea alba modesta</i>	Common	Resident	LC
14	Black-crowned Night Heron	<i>Nycticorax nycticorax</i>	Uncommon	Resident	LC
15	Cinnamon Bittern	<i>Ixobrychus cinnamomeus</i>	Rare	Resident	LC
16	Black Bittern	<i>Dupetor flavicollis</i>	Rare	Resident	LC
17	Yellow Bittern	<i>Ixobrychus sinensis</i>	Rare	Summer Migratory	LC
	Order: 3. Ciconiiformes				
	Family: 5. Ciconiidae				
18	Painted Stork	<i>Mycteria leucocephala</i>	Uncommon	Seasonal	NT
19	Asian Openbill	<i>Anastomus oscitans</i>	Uncommon	Seasonal	LC
20	Woolly-necked Stork	<i>Ciconia episcopus</i>	Uncommon	Seasonal	VU
21	Lesser Adjutant	<i>Leptoptilos javanicus</i>	Very Rare	Seasonal	VU
22	Black-headed Ibis	<i>Threskiornis melanocephalus</i>	Common	Resident	NT
23	Red-naped Ibis	<i>Pseudibis papillosa</i>	Common	Resident	LC
24	Glossy Ibis	<i>Plegadis falcinellus</i>	Common	Resident	LC

25	Eurasian Spoonbill	<i>Platalea leucorodia</i>	Uncommon	Seasonal	LC
	Order: 4. Anseriformes				
	Family: 6. Anatidae				
26	Lesser Whistling-duck	<i>Dendrocygna javanica</i>	Uncommon	Resident	LC
27	Knob-billed Duck	<i>Sarkidiornis melanotos</i>	Common	Resident	LC
28	Indian Spot-billed Duck	<i>Anas poecilorhyncha</i>	Common	Resident	LC
	Order: 5. Accipitriformes				
	Family: 7. Accipitridae				
29	Oriental Honey-buzzard	<i>Pernis ptilorhyncus</i>	Uncommon	Seasonal	LC
30	Black-winged Kite	<i>Elanus caeruleus</i>	Common	Resident	LC
31	Black Kite	<i>Milvus migrans</i>	Common	Resident	LC
32	Brahminy Kite	<i>Haliastur indus</i>	Common	Resident	LC
33	Short-toed Snake Eagle	<i>Circaetus gallicus</i>	Common	Resident	LC
34	Western Marsh-harrier	<i>Circus aeruginosus</i>	Common	Winter Migratory	LC
35	Shikra	<i>Accipiter badius</i>	Common	Resident	LC
36	White-eyed Buzzard	<i>Butastur teesa</i>	Uncommon	Resident	LC
	Order: 6. Falconiformes				
	Family: 8. Falconidae				
37	Common Kestrel	<i>Falco tinnunculus</i>	Uncommon	Winter Migratory	LC
	Order: 7. Galliformes				
	Family: 9. Phasianidae				
38	Grey Francolin	<i>Francolinus pondicerianus</i>	Common	Resident	LC
39	Jungle Bush Quail	<i>Perdica asiatica</i>	Common	Resident	LC
40	Indian Peafowl	<i>Pavo cristatus</i>	Common	Resident	LC
41	Painted Spurfowl	<i>Galloperdix lunulata</i>	Rare	Resident	LC
	Order: 8. Turniciformes				
	Family: 10. Turnicidae				
42	Barred Buttonquail	<i>Turnix suscitator</i>	Common	Resident	LC
	Order: 9. Gruiformes				
	Family: 11. Rallidae				
43	Brown Crake	<i>Amaurornis akool</i>	Uncommon	Resident	LC
44	Ruddy-breasted Crake	<i>Porzana fusca</i>	Uncommon	Resident	LC
45	White-breasted Waterhen	<i>Amaurornis phoenicurus</i>	Common	Resident	LC
46	Purple Swamphen	<i>Porphyrio porphyrio</i>	Common	Resident	LC
47	Common Moorhen	<i>Gallinula chloropus</i>	Common	Resident	LC
48	Common Coot	<i>Fulica atra</i>	Common	Resident	LC

	Order: 10. Charadriiformes				
	Family: 12. Charadriidae				
49	Little Ringed Plover	<i>Charadrius dubius</i>	Uncommon	Resident	LC
50	Kentish plover	<i>Charadrius alexandrinus</i>	Uncommon	Resident	LC
51	Yellow-wattled Lapwing	<i>Vanellus malabaricus</i>	Common	Resident	LC
52	Red-wattled Lapwing	<i>Vanellus indicus</i>	Common	Resident	LC
	Family: 13. Scolopacidae				
53	Common Sandpiper	<i>Actitis hypoleucos</i>	Uncommon	Winter Migratory	LC
54	Wood Sandpiper	<i>Tringa glareola</i>	Uncommon	Winter Migratory	LC
55	Common Green shank	<i>Tringa nebularia</i>	Uncommon	Winter Migratory	LC
56	Common Redshank	<i>Tringa totanus</i>	Uncommon	Winter Migratory	LC
57	Pin-tailed Snipe	<i>Gallinago stenura</i>	Uncommon	Winter Migratory	LC
	Family: 14. Recurvirostridae				
58	Black-winged Stilt	<i>Himantopus himantopus</i>	Uncommon	Resident	LC
	Family: 15. Sternidae				
59	River Tern	<i>Sterna aurantia</i>	Common	Resident	NT
60	Whiskered Tern	<i>Chlidonias hybrida</i>	Common	Winter Migratory	LC
	Order: 11. Columbiformes				
	Family: 16. Columbidae				
61	Laughing Dove	<i>Streptopelia senegalensis</i>	Common	Resident	LC
62	Eurasian Collared Dove	<i>Streptopelia decaocto</i>	Common	Resident	LC
63	Red Turtle Dove	<i>Streptopelia tranquebarica</i>	Uncommon	Resident	LC
64	Spotted Dove	<i>Streptopelia chinensis</i>	Uncommon	Resident	LC
	Order: 12. Psittaciformes				
	Family: 17. Psittaculidae				
65	Plum-headed Parakeet	<i>Psittacula cyanocephala</i>	Uncommon	Resident	LC
66	Rose-ringed Parakeet	<i>Psittacula krameri</i>	Common	Resident	LC
	Order: 13. Cuculiformes				
	Family: 18. Cuculidae				
67	Blue-faced Malkoha	<i>Phaenicophaeus viridirostris</i>	Uncommon	Resident	LC
68	Sirkeer Malkoha	<i>Taccocua leschenaultii</i>	Uncommon	Resident	LC
69	Jacobin Cuckoo	<i>Clamator jacobinus</i>	Common	Monsoon Migratory	LC
70	Common Hawk-Cuckoo	<i>Hierococcyx varius</i>	Common	Resident	LC
71	Asian Koel	<i>Eudynamys scolopacea</i>	Common	Resident	LC

72	Greater Coucal	<i>Centropus sinensis</i>	Common	Resident	LC
	Order: 14. Strigiformes				
	Family: 19. Strigidae				
73	Indian Eagle Owl	<i>Bubo bengalensis</i>	Uncommon	Resident	LC
74	Spotted Owlet	<i>Athene brama</i>	Common	Resident	LC
	Order: 15. Caprimulgiformes				
	Family: 20. Caprimulgidae				
75	Jungle Nightjar	<i>Caprimulgus indicus</i>	Common	Resident	LC
	Order: 16. Apodiformes				
	Family: 21. Apodidae				
76	Asian Palm Swift	<i>Cypsiurus balasiensis</i>	Common	Resident	LC
	Order: 17. Coraciiformes				
	Family: 22. Alcedinidae				LC
77	Common Kingfisher	<i>Alcedo atthis</i>	Common	Resident	LC
	Family: 23. Halcyonidae				
78	White-throated Kingfisher	<i>Halcyon smyrnensis</i>	Common	Resident	LC
	Family: 24. Cerylidae				
79	Pied Kingfisher	<i>Ceryle rudis</i>	Common	Resident	LC
	Family: 25. Meropidae				
80	Asian Green Bee-eater	<i>Merops orientalis</i>	Common	Resident	LC
81	Blue-tailed Bee-eater	<i>Merops philippinus</i>	Uncommon	Seasonal	LC
	Family: 26. Coraciidae				
82	Indian Roller	<i>Coracias benghalensis</i>	Common	Resident	LC
	Order: 18. Bucerotiformes				
	Family: 27. Upupidae				
83	Hoopoe	<i>Upupa epops</i>	Common	Resident	LC
	Family: 28. Bucerotidae				
84	Indian Grey Hornbill	<i>Ocyrceros birostris</i>	Common	Resident	LC
	Order: 19. Piciformes				
	Family: 29. Megalaimidae				
85	Coppersmith Barbet	<i>Megalaima haemacephala</i>	Common	Resident	LC
	Family: 30. Picidae				
86	Brown-capped Pygmy Woodpecker	<i>Dendrocopos nanus</i>	Common	Resident	LC
87	Black-rumped Flameback	<i>Dinopium benghalense</i>	Common	Resident	LC
	Order: 20. Passeriformes				

	Family: 31. Alaudidae				
88	Singing bush Lark	<i>Mirafra cantillans</i>	Common	Resident	LC
89	Indian bush Lark	<i>Mirafra erythroptera</i>	Common	Resident	LC
90	Ashy-crowned Sparrow-lark	<i>Eremopterix grisea</i>	Common	Resident	LC
91	Rufous-tailed Lark	<i>Ammomanes phoenicura</i>	Common	Resident	LC
92	Sykes's Lark	<i>Galerida deva</i>	Common	Resident	LC
	Family: 32. Hirundinidae				
93	Barn Swallow	<i>Hirundo rustica</i>	Common	Winter Migratory	LC
94	Wire-tailed Swallow	<i>Hirundo smithii</i>	Common	Resident	LC
95	Red-rumped Swallow	<i>Hirundo daurica</i>	Common	Resident	LC
96	Streak-throated Swallow	<i>Hirundo fluvicola</i>	Common	Resident	LC
	Family: 33. Motacillidae				
97	White Wagtail	<i>Motacilla alba</i>	Common	Winter migratory	LC
98	White-browed Wagtail	<i>Motacilla maderaspatensis</i>	Common	Resident	LC
99	Grey Wagtail	<i>Motacilla cinerea</i>	Common	Winter migratory	LC
100	Yellow Wagtail	<i>Motacilla flava</i>	Common	Winter migratory	LC
101	Paddyfield Pipit	<i>Anthus rufulus</i>	Common	Resident	LC
	Family: 34. Campephagidae				
102	Black-headed Cuckooshrike	<i>Lalage melanoptera</i>	Common	Resident	LC
103	Small Minivet	<i>Pericrocotus cinnamomeus</i>	Common	Resident	LC
	Family: 35. Pycnonotidae				
104	Red-vented Bulbul	<i>Pycnonotus cafer</i>	Common	Resident	LC
105	White-browed Bulbul	<i>Pycnonotus luteolus</i>	Common	Resident	LC
106	Yellow-throated Bulbul	<i>Pycnonotus xantholaemus</i>	Rare	Resident	VU
	Family: 36. Aegithinidae				
107	Common Iora	<i>Aegithina tiphia</i>	Common	Resident	LC
	Family: 37. Laniidae				
108	Brown Shrike	<i>Lanius cristatus</i>	Common	Resident	LC
109	Bay-backed Shrike	<i>Lanius vittatus</i>	Common	Resident	LC
110	Long-tailed Shrike	<i>Lanius schach</i>	Common	Resident	LC
111	Southern grey Shrike	<i>Lanius meridionalis</i>	Common	Resident	LC
	Family: 38. Muscicapidae				
112	Oriental Magpie-robin	<i>Copsychus saularis</i>	Common	Resident	LC
113	Indian Robin	<i>Saxicoloides fulicatus</i>	Common	Resident	LC

114	Black Redstart	<i>Copsychus saularis</i>	Common	Winter Migratory	LC
115	Common Stonechat	<i>Saxicola torquatus</i>	Common	Winter Migratory	LC
116	Blue Rock-thrush	<i>Monticola solitarius</i>	Uncommon	Winter Migratory	LC
117	Pied Bushchat	<i>Saxicola capraa</i>	Common	Resident	LC
	Family: 39. Timaliidae				
118	Tawny-bellied Babbler	<i>Dumetia hyperythra</i>	Uncommon	Resident	LC
	Family: 40. Sylviidae				
119	Yellow-eyed Babbler	<i>Chrysomma sinense</i>	Uncommon	Resident	LC
	Family: 41. Leiothrichidae				
120	Common Babbler	<i>Argya caudata</i>	Uncommon	Resident	LC
121	Large grey Babbler	<i>Argya malcolmi</i>	Common	Resident	LC
122	Jungle Babbler	<i>Turdoides striata</i>	Common	Resident	LC
123	Yellow-billed Babbler	<i>Turdoides affinis</i>	Common	Resident	LC
	Family: 42. Cisticolidae				
124	Zitting cisticola	<i>Cisticola juncidis</i>	Common	Resident	LC
125	Rufous-fronted Prinia	<i>Prinia buchanani</i>	Common	Resident	LC
126	Grey-breasted Prinia	<i>Prinia hodgsonii</i>	Common	Resident	LC
127	Jungle Prinia	<i>Prinia sylvatica</i>	Common	Resident	LC
128	Ashy Prinia	<i>Prinia socialis</i>	Common	Resident	LC
129	Plain Prinia	<i>Prinia inornata</i>	Common	Resident	LC
130	Common Tailorbird	<i>Orthotomus sutorius</i>	Common	Resident	LC
	Family: 43. Acrocephalidae				
131	Clamorous Reed-Warbler	<i>Acrocephalus stentoreus</i>	Common	Winter Migratory	LC
132	Blyth's Reed-warbler	<i>Acrocephalus dumetorum</i>	Common	Winter Migratory	LC
	Family: 44. Phylloscopidae				
133	Greenish Warbler	<i>Phylloscopus trochiloides</i>	Common	Winter Migratory	LC
	Family: 45. Muscicapidae				
134	Asian brown Flycatcher	<i>Muscicapa dauurica</i>	Common	Resident	LC
	Family: 46. Paridae				
135	Great Tit	<i>Parus major</i>	Common	Resident	LC
	Family: 47. Dicaeidae				
136	Thick-billed Flowerpecker	<i>Dicaeum agile</i>	Common	Resident	LC
137	Pale-billed Flowerpecker	<i>Dicaeum concolor</i>	Common	Resident	LC
	Family: 48. Nectariniidae				
138	Purple-rumped Sunbird	<i>Leptocoma zeylonica</i>	Common	Resident	LC

139	Purple sunbird	<i>Cinnyris asiaticus</i>	Common	Resident	LC
	Family: 49. Ploceidae				
140	Red Avadavat	<i>Amandava amandava</i>	Common	Resident	LC
141	Indian Silverbill	<i>Euodice malabarica</i>	Common	Resident	LC
142	Scaly-breasted Munia	<i>Lonchura punctulata</i>	Common	Resident	LC
143	Tricoloured Munia	<i>Lonchura malacca</i>	Common	Resident	LC
	Family: 50. Passeridae				
144	House Sparrow	<i>Passer domesticus</i>	Common	Resident	LC
	Family: 51. Ploceidae				
145	Baya Weaver	<i>Ploceus philippinus</i>	Common	Resident	LC
146	Streaked Weaver	<i>Ploceus manyar</i>	Common	Resident	LC
	Family: 52. Sturnidae				LC
147	Common Myna	<i>Acridotheres tristis</i>	Common	Resident	
148	Brahminy Starling	<i>Sturnia pagodarum</i>	Common	Resident	LC
149	Rosy Starling	<i>Pastor roseus</i>	Common	Winter Migratory	LC
150	Chestnut-tailed Starling	<i>Sturnia malabarica</i>	Common	Winter Migratory	LC
	Family: 53. Oriolidae				
151	Indian golden Oriole	<i>Oriolus kundoo</i>	Common	Resident	LC
	Family: 54. Dicruridae				
152	Black Drongo	<i>Dicrurus macrocercus</i>	Common	Resident	
	Family: 55. Corvidae				
153	House Crow	<i>Corvus splendens</i>	Common	Resident	LC
154	Indian jungle Crow	<i>Corvus macrorhynchos culminatus</i>	Common	Resident	LC
	Family: 56. Emberizidae				
155	Black-headed Bunting	<i>Emberiza melanocephala</i>	Common	Winter Migratory	LC
156	Red-headed Bunting	<i>Emberiza bruniceps</i>	Common	Winter Migratory	LC
* More species require year-long study.					

Annexure 5: Checklist of Mammals in and around Tungabhadra Otter Conservation Reserve

S. No.	Common name	Scientific name	IUCN Status	Location
1	Smooth-coated Otter	<i>Lutrogale perspicillata</i>	VU	Throughout the River
2	Indian Leopard	<i>Panthera pardus</i>	VU	Adjacent forest and islands
3	Indian Sloth Bear	<i>Melursus ursinus</i>	VU	Adjacent forest and islands
4	Striped Hyena	<i>Hyaena hyaena</i>	NT	Sanapura Forest
5	Indian Wolf	<i>Canis lupus</i>	LC	Sanapura Forest
6	Indian Jackal	<i>Canis aureus</i>	LC	Islands
7	Indian Fox	<i>Vulpes bengalensis</i>	LC	Adjacent forests
8	Eurasian Wild Pig	<i>Sus scrofa</i>	LC	Adjacent forests / Islands
9	Indian Crested Porcupine	<i>Hystrix indica</i>	LC	Adjacent forests and Islands
10	Jungle Cat	<i>Felis chaus</i>	LC	Adjacent forests and Islands
11	Rusty-spotted Cat	<i>Prionailurus rubiginosus</i>	NT	Sanapura Island
12	Small- Indian Civet	<i>Viverricula indica</i>	LC	Around River
13	Common Palm Civet	<i>Paradoxurus hermaphroditus</i>	LC	Islands
14	Common Mongoose	<i>Herpestes edwardsii</i>	LC	Around river
15	Ruddy Mongoose	<i>Herpestes smithii</i>	LC	Around river and Forest
16	Indian Pangolin	<i>Manis crassicaudata</i>	EN	Adjacent forest and Islands
17	Bonnet Macaque	<i>Macaca radiata</i>	LC	Around River
18	Hanuman Langur	<i>Semnopithecus dussumieri</i>	LC	Around River
19	Indian Black-naped Hare	<i>Lepus nigricollis</i>	LC	Around River and forests
20	Three-striped Palm Squirrel	<i>Funambulus palmarum</i>	LC	Around River and Forests

(CR -Critically Endangered, EN-Endangered, VU-Vulnerable, NT-Near Threatened, LC-Least Concern, DD-Data deficient)

Annexure 6: Checklist of common aquatic flora / Macrophytes of TOCR

S. No.	Common name	Botanical name	Family	Life Forms	IUCN status
1	Floating lace plant	<i>Aponogeton natans</i>	Aponogetonaceae	Submerged	LC
2	Common stonewort	<i>Chara sps</i>	Characeae	Submerged	NE
3	Hornwort	<i>Ceratophyllum demersum</i>	Ceratophyllaceae	Submerged	LC
4	Esthwaite Waterweed	<i>Hydrilla verticillata</i>	Hydrocharitaceae	Submerged	LC
5	Guppy Grass	<i>Najas indica</i>	Hydrocharitaceae	Submerged	LC
6	Fennel Pondweed	<i>Potamogeton pectinatus</i>	Potamogetonaceae	Submerged	LC
7	Tape grass/ Eel grass	<i>Vallisneria spiralis</i>	Hydrocharitaceae	Submerged	LC
8	Water Shamrock	<i>Marsilea quadrifolia</i>	Marsileaceae	Partly Submerged	LC
9	Duck-lettuce,	<i>Ottelia alismoides,</i>	Hydrocharitaceae	Partly submerged	LC
10	Dwarf copperleaf	<i>Alternanthera sessilis</i>	Amaranthaceae	Emergent	LC
11	Blistering ammania	<i>Ammania baccifera</i>	Lythraceae	Emergent	LC
12	India joint-vetch	<i>Aeschonemene indica</i>	Fabaceae	Emergent	LC
13	Water Hyssop	<i>Bacopa monnieri</i>	Scrophulariaceae	Emergent	LC
14	Aquatic Job's tears	<i>Coix aquatica</i>	Poaceae	Emergent	NE
15	Bengal day flower	<i>Commelina benghalensis</i>	Commelinaceae	Emergent	LC
16	Carolina day flower	<i>Commelina hasskarlii</i>	Commelinaceae	Emergent	LC
17	Nut grass	<i>Cyperus rotundus</i>	Cyperaceae	Emergent	LC
18	Bermuda grass	<i>Cynodon dactylon</i>	Poaceae	Emergent	LC
19	Purple bane	<i>Cyathocline purpurea</i>	Asteraceae	Emergent	LC
20	Suryavarthi	<i>Crozophora rottlerii</i>	Euphorbiaceae	Emergent	LC
21	Rushlike dopatrium	<i>Dopartium junecum</i>	Scrophulariaceae	Emergent	LC
22	Canada spikesedge	<i>Elaeocharis geniculata</i>	Cyperaceae	Emergent	LC
23	Spike-rush	<i>Elaeocharis capitata</i>	Cyperaceae	Emergent	LC
24	Pipewort	<i>Eriocaulan cinereum</i>	Eriocaulaceae	Emergent	NE
25	Wild grass	<i>Echinochloa calorum</i>	Poaceae	Emergent	LC
26	Gomphrena weed	<i>Gomphrena celosioides</i>	Amaranthaceae	Emergent	NE
27	Lotus Sweet juice	<i>Glinus lotoides</i>	Molluginaceae	Emergent	NE
28	Pinyuin	<i>Gnaphalium pulvinatum</i>	Asteraceae	Emergent	NE
29	Dwarf heliotrope	<i>Heliotropinum supinum</i>	Boraginaceae	Emergent	LC
30	Asian Marshweed	<i>Limnophylla sessiflora</i>	Plantaginaceae	Emergent	LC
31	Marsh buckwheat	<i>Polygonum glabrum</i>	Polygonaceae	Emergent	NE
32	Turkey Tangle frogfruit	<i>Phyla nodiflora</i>	Verbinaceae	Emergent	LC
33	Rotala	<i>Rotala serpillifolia</i>	Lythraceae	Emergent	LC

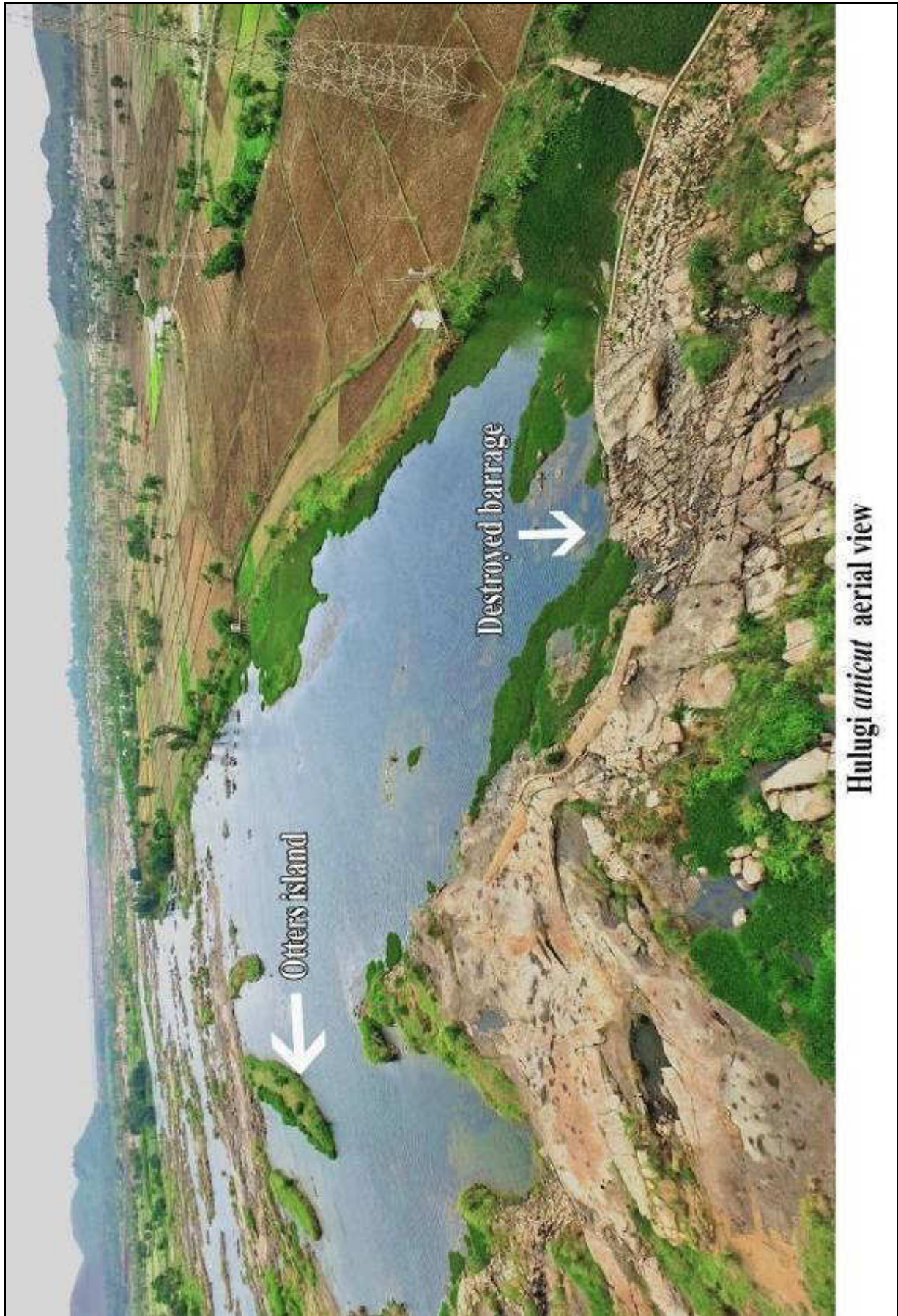
34	Sesbania pea	<i>Sesbania bispinosa</i>	Fabaceae	Emergent	LC
35	East Indian Globe Thistle	<i>Sphaeranthus indicus</i>	Asteraceae	Emergent	LC
36	Reed Mace/Aapu	<i>Typha angustata</i>	Typhaceae	Emergent	NE
37	Water hyacinth	<i>Eichornia crassipes</i>	Pontederiaceae	Free floating	NE
38	Duck weed	<i>Lemna perpusilla</i>	Lemnaceae	Free floating	LC
49	Water Lettuce	<i>Pistia stratioides</i>	Araceae	Free floating	LC
40	Floating Crystalwort	<i>Riccia fluitans</i>	Ricciaceae	Free floating	NE
41	Water Spinach	<i>Ipomoea aquatica</i>	Convolvulaceae	Rooted floating	LC
42	Water silk	<i>Spirogyra indica</i>	<u>Zygnemataceae</u>	Rooted floating	LC
43	Duck Lettuce	<i>Ottellia alismoides</i>	Hydrocharitaceae	Rooted floating	LC
44	False daisy/Bhringraj	<i>Eclipta abla</i>	Asteraceae	Bank edges	LC
45	Lesser Fimbristylis	<i>Fimbristylis milliacea</i>	Cyperaceae	Bank edges	LC
46	Madras carpet	<i>Grangea maderaspatana</i>	Asteraceae	Bank edges	LC
47	Pink morning glory	<i>Ipomoea carnea</i>	Convolvulaceae	Bank edges	NE
48	Swamp shield-fern	<i>Cyclosorus interruptus</i>	<u>Polypodiales</u>	Bank edges	LC
49	Chinese Mullein	<i>Verbascum chinense</i>	Scrophulariaceae	Bank Edge	LC
50	Common Sopubia	<i>Sopubia delphinifolia</i>	Scrophulariaceae	Bank edge	VU

Annexure 7: IUCN status of various faunal species in TOCR area

IUCN status	Mammals	Reptiles	Birds	Amphibians	Fishes	Total	%
Critically Endangered (CR)	0	0	0	0	1	1	0.32
Endangered (EN)	1	1	0	0	6	8	2.60
Vulnerable (VU)	3	3	3	0	6	15	4.87
Near Threatened (NT)	2	1	4	0	8	15	4.87
Least Concerned (LC)	14	9	156	8	63	250	81.17
Not Evaluated (NE)	0	13	0	0	6	19	6.17
	20	27	163	8	90	308	

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Hulugi *anicut* aerial view

ANNEXURE 10. SEDIMENT SAMPLING PLAN FOR VNC IRRIGATION SYSTEM

Introduction

The rehabilitation of VN Channel system will require the removal of silt along canals and anicuts by dredging. The excavation of silt material is necessary to execute the civil works and increase the capacity of the canals to convey water. Through the years, transport of water in the canal results in deposition of sediments and lead to local drainage problems. Hence, silt need to be dredged and transferred to places away from the canals or put to use in some practical applications.

There are different ways to dispose or use the substrate silt from the canals and anicuts. First is the reuse of silt as source of plant nutrients for crop production in farmlands. During the stakeholder consultations (described in detail in the EIA report), farmers in the VNC area expressed interest to welcome the disposal of silt in farms. The farmers believe that silt in the canals is abundant with plant nutrients, hence, valuable for fertilization of land. Second is to use the silt as filling materials. The contractor would know if the silt in the canal has physical properties useful for construction. Lastly, the silt will be disposed in the landfill if the silt has contamination of heavy metals. The dredged material will not be used either for land fertilization or filling material if there is findings of heavy metals in the silt.

Whichever disposal mechanism or reuse is opted during the project execution, analysis of the chemical properties (quality) of silt is mandatory action before discard or re-use. For various locations such as at the anicut sites and canals along habitations or towns will undergo silt analysis. This plan shows the procedure on how to perform the silt test for the project.

Parameters to be analysed

The sampling and analysis of the sediment samples shall be performed using the services of a laboratory that is certified under ISO 9001:2015, 14001:2015 and OHSAS 18001:2007, NABL Accredited and Ministry of Environment, Forests and Climate Change (MoEFCC), Government of India, under Environment (Protection) Act, 1986.

In view of the possible type and source of contamination, the sediments should be analysed for the presence of the following parameters mentioned in Table 1 but not limited to:

Table 1: Parameters for sediment analysis

Sl. No	Particulars	Standards
1	pH	IS 2720 part 26
2	Texture	Department of Agriculture Cooperation and Farmers' Welfare, Ministry of Agriculture, Government of India
3	Colour	
4	Available Phosphorous	
5	Available Nitrogen	
6	Available Potassium	
7	Sulphur	
8	Calcium	
9	Magnesium	
10	Sodium	
11	Boron	
12	Permeability	IS 2720 part 17
13	Organic Carbon	IS 2720 part 22
14	Organic Matter	
15	Electrical Conductivity	IS 14767 2000
16	Cyanide	APHA 23 rd edition 4500 CN

SI. No	Particulars	Standards
17	Moisture Content	IS 2720 part 2 nd
18	Zinc	USEPA 3050B
19	Chromium	
20	Aluminium	
21	Copper	
22	Iron	
23	Manganese	

There are other parameters not included in the table that could be analysed for each of the sediment sample such as arsenic, zinc, cadmium, copper, mercury and nickel. Since heavy metal analysis is costly, parameters will depend on the possible point sources of pollution. The point sources of pollution will be assessed prior to the sampling program at the relevant location.

Sampling Methodology

The sediments can be collected by adopting the Grab Sampling methodology by scoops. The use of scoops and spoons are inexpensive, widely available, non-mechanical, very portable, able to sample nearly every sediment type and easy to use. Scoops are used to collect sediment samples primarily from canals/ shallow waters. Care shall be taken when the scoop is raised through the water column during retrieval to minimize the loss of extremely fine material, in particular. Disadvantages of using a scoop or spoon include limited sample volume and possible loss of very fine material during retrieval. The scooped sediment sample is immediately stored in a cold container at about 4°C. The sample container should be uniquely named along with preparation of a sampling map showing the exact location including coordinates and any nearby landmark to ensure re-location of the sampling point for cross verification or for mitigation measures.

Sampling Location

The sampling locations in the five identified channel locations along with chainage lengths in the VNC command area is given in Table 2. These locations are selected because of the presence of domestic, agricultural and industrial activities. The sediment samples shall be collected prior to the start of the construction within the chainage lengths of Basavanna, Raya, Siruguppa, Bichal and Kallaghatta canals, respectively as indicated in Table 2:

Table 2: Specific Key Locations where sediment samples should be collected

S. No.	Name of the Canal	Location of Increased Habitation Areas	Total Canal Length (km)	Habitations starting From Chainage	Habitations ending at Chainage
1	Basavanna	Hospet Town	16.50	3.26 km	6.0 km
2	Raya	Hospet Town	27.74	6.62 km	9.62 km
3	Siruguppa	Siruguppa Town One branch of canal from 8.25 km chainage goes into Siruguppa town in which the Command Area is completely converted to habitation areas	10.85	8.0 km	10.0 km
4	Bichal	Within Bichal Village	14.50	12.8 Km	14.1 km
5	Kalaghatta	Near Sugar Factory	7.02	5 km	5.5 km

Further, to determine the adverse impact of agricultural activities, at a minimum a sediment sample will be collected at every 4-km length of the canal. Considering that the total length of the canals is 220km,

about 55 sediment samples have to be collected and analysed for the parameters mentioned in the Table 1. In addition, sediment samples from agricultural land along the canal between the chainages indicated in Table 2 should also be collected and analysed, as well. Further, two samples in each of the anicut areas (12 nos.) where rehabilitation work is being taken up shall be collected and analysed. The estimated samples are provided in Table 3 below:

Table 3: Estimated Number of Samples

S. No.	Name of the Canal	GPS Coordinates		Length of the Canal (km)	Number of samplings
		Canal Head-end	Canal Tail-end		
Kamalapura Sub-Division (Right Bank)					
1	Basavanna	15°15'51.89"N 76°20'43.08"E	15°16'38.28"N 76°27'45.91"E	16.5	3
2	Raya	15°15'52.75"N 76°20'42.19"E	15°17'56.59"N 76°26'47.13"E	27.74	3
3	Bella	15°17'17.56"N 76°20'59.82"E	15°19'12.05"N 76°22'38.96"E	5.5	1
4	Kalaghatta	15°18'55.54"N 76°22'49.12"E	15°19'16.91"N 76°25'40.84"E	7.02	3
5	Turtha	15°19'50.04"N 76°26'6.00"E	15°22'7.67"N 76°31'59.23"E	18.69	2
6	Ramasagara	15°22'4.33"N 76°31'48.46"E	15°23'53.66"N 76°36'9.59"E	15.5	2
7	Kampli	15°23'18.67"N 76°33'12.26"E	15°26'12.52"N 76°38'51.33"E	23.55	2
8	Belagodahalla	15°23'31.04"N 76°34'11.71"E	15°26'10.12"N 76°37'17.31"E	11.22	2
Oddarahatti Division (Left Bank)					
9	Anegundi	15°20'47.68"N 76°26'7.23"E	15°23'36.34"N 76°31'43.36"E	19.44	2
10	Shivapura	15°20'8.10"N 76°21'50.45"E	15°20'8.31"N 76°24'26.93"E	6.54	1
11	Hulugi	15°17'34.78"N 76°20'24.86"E	15°20'27.83"N 76°21'42.06"E	10.69	2
12	Upper Gangavathi	15°22'47.66"N 76°32'1.62"E	15°25'25.26"N 76°33'5.47"E	9	1
13	Lower Gangavathi	15°23'33.20"N 76°32'48.90"E	15°25'44.16"N 76°35'36.11"E	9.54	1
Siruguppa Sub-Division (Right Bank)					
14	Siruguppa	15°36'58.36"N 76°50'24.52"E	15°39'2.04"N 76°53'37.06"E	10.85	3
15	Deshnur	15°37'17.06"N 76°50'19.28"E	15°40'43.86"N 76°53'24.35"E	9.03	1
Manvi Sub-Division (Left Bank)					
16	Bichal	15°57'39.67"N 77°13'45.60"E	15°57'29.05"N 77°20'53.44"E	14.5	3

Sampling Quantity, timing and Cost Estimate

It is estimated that 32 sediment samples need to be collected and analysed prior to construction. These samples need to be collected at pre-construction stage to determine the silt condition and decide on the disposal for the dredged sediments. It is estimated that **Rs. 10,00,000/- (Rupees Ten Lakhs Only)** will be required for sediment sampling activity.

Preventive measures for canal water contamination

As described, the industrial effluents, agricultural waste water and sewage are often directly discharged into canals in the five identified channels and the corresponding chainages (Table 1). The KNNL ICZ Munirabad has already written to the concerned municipalities and Karnataka Pollution Control Board (Regional Office) to initiate both regulatory and mitigation measures to prevent disposal into the channels and is following up with the authorities.